

**FEDERAL HIGHWAY  
ADMINISTRATION  
EASTERN FEDERAL  
LANDS HIGHWAY  
DIVISION**

**SOILS AND FOUNDATION  
REPORT**

**FINAL 100% SUBMITTAL**

REHABILITATION OF PARK ROADS  
FOR BLUE RIDGE PARKWAY  
YANCEY AND BUNCOMBE  
COUNTIES, NORTH CAROLINA

PRA-BLRI 2P14  
CONTRACT NO. DTFH71-02-D-00004  
TASK ORDER 0003

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## **Soils and Foundation Report**

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for Blue Ridge Parkway  
Yancey and Buncombe Counties,  
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## Background

Blue Ridge Parkway is a 469-mile scenic corridor that connects Shenandoah Valley in Virginia to the Great Smoky Mountains National Park in North Carolina. Adjacent to the parkway, which ranges in elevation from 649 feet to 6,047 feet, are recreational areas that include picnic facilities, hiking trails, visitor centers, overlooks, and campgrounds.

The Blue Ridge Parkway, conceived as a Depression-relief project in the 1930s, took more than 50 years to construct. The parkway is frequented by visitors who come to enjoy the vistas and the foliage and a number of citizen groups concerned with maintaining the pristine nature of the mountain ranges traversed by the Parkway.

The pavement along Blue Ridge Parkway and adjacent access roads and pull-offs is in various stages of deterioration and in need of rehabilitation. Area features such as asphalt paths, granite curbs, rubble and masonry walls and steps are also in need of repair. The project, referred to as Section 2P, consists of the rehabilitation of the parkway pavement between Milepost 359.8, at the Balsam Gap Overlook, and Milepost 375.3. Also included is the reconstruction, replacement, or rehabilitation of ditches, pipes, walls, sidewalks, and curbs.

The Blue Ridge Parkway project is for the Eastern Federal Lands Highway Division (EFLHD) of the Federal Highway Administration (FHWA) of the U.S. Department of Transportation and the U.S. National Park Service (NPS). The Blue Ridge Parkway is used by thousands of tourists every year and special consideration will be made to ensure that the overlooks, visitors center, and the parkway itself remain accessible at all times.

The purpose of this report is to document the findings of the subsurface investigations and to present geotechnical recommendations.

## Project Area

### Overview

Within Section 2P, there are six parking and pull-off areas, one picnic parking area with a 1.2-mile access road referred to as Craggy Garden, a visitor's center parking area located along Section 2P at approximately Mile 364.6, and three tunnels that have already been reconditioned. Along with the roadway and parking areas, three areas of potential embankment instability were observed during project development. These

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areas are located at mileposts 361.8, 362.8, and 363.4. Within the project limits, the average roadway width is 22 feet and the length is approximately 15.5 miles long. Appendix A contains all the figures for this report. Figure 1 presents a Project Location Map. Figures 2 through 12 present more detailed plans showing the roadway, Visitor's Center, picnic areas, and pull-offs.

### Regional Geology

Section 2P lies within the Blue Ridge physiographic province east of the French Broad River and west of Mount Mitchell. Figure 13 in Appendix A illustrates the geologic map prepared for this section. The Blue Ridge physiographic province resulted from a series of mountain building (orogeny) and metamorphic events beginning with the Grenville Orogeny, 1,000 million years ago (mya), and culminating with the Alleghanian Orogeny (300-245 mya).<sup>1</sup> Cycles of continental collision and rifting resulted in a structurally complex group of ultramafic and mafic rocks, and high-grade metamorphic rocks.

The geology of the area is predominantly the Ashe Metamorphic Suite (AMS) containing a series of layered mica gneiss, quartz-feldspar gneiss, mica schist, pegmatite, amphibolites, and eclogites. The gneiss and schist are interpreted as metamorphosed conglomerates and sandstones. The amphibolites are interpreted as metamorphosed basalt (volcanic rock).<sup>2</sup> The eclogites are interpreted as metamorphosed rocks that were part of an accretionary wedge of a convergent continent.<sup>3</sup> The schist, gneiss, and amphibolites are the result of low-to-moderate pressure and moderate-to-high temperature conditions. The eclogites were exposed to high pressure and moderate-to-high temperature conditions. The above pressure – temperature environments are consistent with continental collision events.

The AMS is in the hanging wall (the thrust sheet above the plane of the fault) of the Holland Mountain Fault (HMF), which trends northeast-southwest in this area and dips to the southeast. Thrusts faults are low angle (less than 30 degrees) reverse faults. These faults are shown as single traces on geologic maps; however, in the field they occur as a series of faults and splays rather than a single expression. Within the hanging wall of the HMF is the Burnsville Fault, which roughly parallels (separation approximately 4 miles) the HMF in this study area. The Burnsville Fault was thought to be a thrust fault as shown on the geologic map. Recently the fault has been reinterpreted as a dextral strike-slip shear zone, which is the boundary between the Pumpkin Patch thrust sheet to the west and Spruce Pine thrust sheet to the east.<sup>4</sup> The studied section lies within the Spruce Pine thrust sheet southeast of the Burnsville Fault approximately 20 miles south of Burnsville, North Carolina.

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## Procedures and Results

### Pavement Condition Survey

The initial task of the geotechnical investigation was to conduct a pavement condition survey of Section 2P, including overlooks, the picnic area parking, and access road. This survey was conducted to help determine initial areas of concern and to help produce the most efficient layout of the borings. Evaluation techniques and severity levels used were the same as those from previous FHWA studies. Photographs of typical distresses are located in Appendix B.

The field survey examined five major categories of distress: transverse cracking, fatigue cracking, rutting, patches, and block cracking. The survey data is listed by milepost and is presented in Table 1.

| Mile Post | Cracking                 |                          |    | Rutting<br>(% Surface Area) |     |   | Number of Patches |    |    | Block Crackin<br>g % |     |
|-----------|--------------------------|--------------------------|----|-----------------------------|-----|---|-------------------|----|----|----------------------|-----|
|           | No. of Transverse Cracks | Fatigue (% Surface Area) |    |                             | L   | M | H                 | S  | M  |                      | L   |
|           |                          | L                        | M  | H                           |     |   |                   |    |    |                      |     |
| 359.8     | 4                        |                          |    |                             |     |   |                   |    |    |                      |     |
| 360       | 5                        |                          |    |                             | 2   |   |                   |    |    |                      |     |
| 361       | 10                       | 2                        |    |                             |     |   |                   | 2  | 2  | 1                    |     |
| 362       | 9                        | 2                        |    |                             |     |   |                   | 3  |    |                      |     |
| 363       | 15                       | 3                        |    |                             |     |   |                   | 4  | 1  | 1                    |     |
| 364       | 54                       | 16                       | 8  | 2                           |     | 1 |                   | 12 | 1  | 1                    |     |
| 365       | 41                       | 14                       | 14 | 1                           | 4   |   |                   | 23 | 5  | 4                    |     |
| 366       | 77                       | 37                       | 36 | 2                           | 5   | 1 |                   | 28 | 5  | 4                    |     |
| 367       | 65                       | 41                       | 26 | 0.8                         |     |   |                   | 26 | 9  | 2                    |     |
| 368       | 6                        | 25                       | 9  | 0.3                         |     |   |                   | 16 | 4  | 3                    |     |
| 369       | 49                       | 19                       | 3  | 0.5                         | 1.3 |   |                   | 16 | 5  | 2                    | 2.3 |
| 370       | 72                       | 18                       | 4  | 0.6                         | 4   |   |                   | 10 | 3  | 1                    |     |
| 371       | 46                       | 36                       | 22 |                             | 10  |   |                   | 38 | 11 | 5                    |     |
| 372       | 64                       | 46                       | 28 | 5                           | 7   |   |                   | 58 | 13 | 13                   | 3   |

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| TABLE 1 (cont.)<br>Summary of Pavement Condition Survey |   |                             |     |     |                             |   |   |                      |    |    |                         |
|---|---|-----------------------------|-----|-----|-----------------------------|---|---|----------------------|----|----|-------------------------|
| Mile Post   | Cracking  |                             |     |     | Rutting<br>(% Surface Area) |   |   | Number of<br>Patches |    |    | Block<br>Crackin<br>g % |
|   | No. of<br>Transverse<br>Cracks                                  | Fatigue<br>(% Surface Area) |     |     |                             |   |   |                      |    |    |                         |
|   |   | L                           | M   | H   | L                           | M | H | S                    | M  | L  |                         |
| 373   | 30  | 34                          | 38  | 11  | 16                          |   |   | 89                   | 19 | 20 | 15                      |
| 374   | 61  | 12                          | 23  | 13  | 15                          | 2 |   | 65                   | 13 | 9  | 24                      |
| 375.3   | 6   | 12                          | 5   |     |                             |   |   | 1                    |    | 1  | 83                      |
| Picnic Road   | 51  | 20                          | 0.3 | 0.3 |                             |   |   |                      | 3  |    |                         |
| Visitor Center  | Approximately 1,700 linear feet of block and thermal cracking.  |                             |     |     |                             |   |   |                      |    |    |                         |
| Craggy Dome   | Approximately 3,000 linear feet of block and thermal cracking.  |                             |     |     |                             |   |   |                      |    |    |                         |
| Picnic Parking  | Approximately 2,800 linear feet of block and thermal cracking.  |                             |     |     |                             |   |   |                      |    |    |                         |
| Graybeard Overlook                                      | Block cracking with 10- to 12-foot centers.                     |                             |     |     |                             |   |   |                      |    |    |                         |
| Balsam Gap  | Block and thermal cracking with 10-foot centers.                |                             |     |     |                             |   |   |                      |    |    |                         |
| Lane Pinnacle   | Approximately 500 linear feet of thermal cracks.                |                             |     |     |                             |   |   |                      |    |    |                         |
| Bull Creek Valley                                       | Approximately 350 linear feet of transverse and block cracking. |                             |     |     |                             |   |   |                      |    |    |                         |
| Glassmine Falls   | Approximately 545 linear feet of block and thermal cracking.    |                             |     |     |                             |   |   |                      |    |    |                         |

Transverse cracking was measured by counting the total number of transverse cracks per mile within each section. In order to speed the rate of information collection, transverse cracks were only counted if the crack was greater than ¼ inch in width.

Fatigue cracking was measured by percent surface area of the mile in which it occurred. Fatigue cracking was categorized into three severity levels: low (L), moderate (M), and high (H). The severity levels were based on example photographs and descriptions in the Strategic Highway Research Program (SHRP) publication, *Distress Identification Manual for the Long-Term Pavement Performance Project*.

Rutting was measured in three severity levels: low, moderate, and high. Each severity level was measured in percent surface area of the mile in which it occurred. The three severity levels are based on rut depth and are defined as follows:

- low = 0 to 0.5 inch deep
- moderate = 0.5 to 1.5 inches deep
- high = 1.5 inches and greater deep

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Patches were counted and totaled for each mile in three categories of severity: small, medium, and large. The patches category includes other forms of distress, such as potholes and depressions. The severity levels were based on the square feet of the affected surface area, as follows:

small (S) = 9 square feet and less

medium (M) = 9 square feet to 50 square feet

large (L) = 50 square feet and greater

Similar to fatigue cracking, block cracking was measured by percent surface area of the mile in which it occurred. No severity levels are associated with block cracking.

Longitudinal cracking was not one of the major categories of distress investigated, but minor quantities of low-severity longitudinal cracking were identified.

The pullouts and overlooks were generally surveyed by their distress category, and the total length of cracking was measured with a survey wheel.

### Soil Borings

The soil boring program consisted of borings with Standard Penetration Test (SPT) and Dynamic Cone Penetrometer (DCP) testing for pavement and subgrade evaluation. The soil borings were drilled by S&ME, Inc., of Knoxville, Tennessee. Burns Cooley Dennis Inc., of Jackson, Mississippi, performed the DCP testing. The shallow borings were generally drilled and sampled to a depth of 4 feet below ground surface (BGS). Early refusal (before the 4-foot depth) was encountered in 14 of the 39 shallow borings.

A total of 45 borings were drilled in the project pavements and provided data for correlation with non-destructive testing (NDT) and investigation of conditions at representative locations. Borings were generally spaced along the roadway at approximately ½-mile intervals. The final locations were determined based on the results of the condition survey and consideration of high-severity distress areas. Pavement, base, and subgrade materials were evaluated.

Each boring included drilling through the asphalt concrete surface. Eight 6-inch asphalt cores were recovered at various locations along the project. Continuous SPT in accordance with American Association of State Highway and Transportation Officials (AASHTO) T-206 were taken in 13 borings for an estimated 3 feet below the aggregate base (i.e., two 1.5-foot SPT samples) to determine the type and thickness of

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subbase and to determine subgrade conditions. If large gravel or rock fragments in the pavement subbase prevented using SPT or DCP, the subbase was augered through and evaluated visually based on auger returns. Auger refusal was encountered in 12 borings within the scope of the investigation. Boring logs are presented in Appendix C.

The DCP testing was performed in 29 borings to evaluate in-situ subgrade strengths. The DCP testing was conducted to a depth of approximately 3 feet below the pavement surface. Based on a correlation developed by the U.S. Army Corps of Engineers Waterways Experiment Station, the DCP penetration and blow count data were converted to California Bearing Ratios (CBR). Results of the DCP testing are located in Appendix D.

At mileposts 361.8, 362.8, and 363.4, two additional borings, each on either side of the pavement, were drilled to an average depth of 28 feet. Due to the boulder fill under the roadway, these borings were advanced by rock coring methods. Once solid rock was encountered, a run of 5 to 10 feet was cored. Due to the boulder fill no undisturbed samples (AASHTO T-207) were taken.

Boring abandonment was based on two categories: more than 5 feet and less than 5 feet in depth. Borings more than 5 feet were backfilled with tamped cuttings to within 2 feet of the existing subgrade. A plastic hole plug was then compacted in the hole. Asphalt cold patch was placed at least as thick as the existing roadway, and in many cases thicker, to replace the hard pavement surface and was crowned to allow for settling and to redirect rainfall away from the borehole. Borings less than 5 feet were closed using the same method except that the plastic hole plug was omitted.

### Sampling

Material sampling was conducted in borings B-1 through B-40 as the borings were advanced. Sampling was typically conducted continuously after the top 1 foot. Soil samples were recovered with a 2¼-inch-outside-diameter split-barrel sampler in accordance with AASHTO T200-87. Representative portions of recovered samples were preserved in glass jars for laboratory testing. The sampling sequence for the borings is summarized on the boring logs in Appendix B.

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## Field Tests and Measurements

During the subsurface investigation, the geotechnical field crews conducted the following field tests and measurements:

- Standard Penetration Testing (SPT)
- Dynamic Cone Penetration (DCP) Testing
- Falling Weight Deflectometer (FWD) Testing

As previously mentioned, SPT was performed in accordance with AASHTO T206-87. The SPT sampler was driven into the subgrade using a 140-pound hammer falling 30 inches. Sample recovery measurements were made and recorded for each sampling attempt. A field description by color and texture was made for each recovered sample.

Dynamic cone penetration was used to conduct in-situ testing of subgrade materials at 29 selected locations. The DCP testing was conducted to depths ranging between 1 foot and 3 feet below the asphalt pavement surface. Due to the significant amount of rock fragments in the subgrade materials, the depth of many DCP tests was limited. Based on a correlation developed by the U.S. Army Corps of Engineers, the DCP penetration data were converted to California Bearing Ratio (CBR). A summary of the DCP test results is presented in Table 2. Plots illustrating the computed variation in CBR with depth below the pavement surface are provided in Appendix D. The DCP testing report is provided in Appendix E. The presence of large gravel and boulders influenced many of the DCP tests. Those CBR values indicated as "100+" are generally the result of boulders in the subgrade.

| <b>Mile, Station<br/>(Boring No.)</b> | <b>Depth Intervals<br/>(inches)</b> | <b>Average CBR<br/>Values</b> |
|---------------------------------------|-------------------------------------|-------------------------------|
| 359 41+50 (B-1)                       | 10-15                               | 40                            |
|                                       | 15-20                               | 6                             |
|                                       | 20-32                               | 3                             |
| 360 50+00 (B-2)                       | 10-16                               | 20                            |
|                                       | >16                                 | 100+                          |
| 362 10+50 (B-4)                       | 9-12                                | 30                            |
|                                       | >12                                 | 100+                          |
|                                       | 24-29                               | 1.5                           |
|                                       | 29-34                               | 8                             |

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| TABLE 2 (cont.)<br>Summary of DCP Tests Results |                             |                       |
|---|-----------------------------|-----------------------|
| Mile, Station<br>(Boring No.)                   | Depth Intervals<br>(inches) | Average CBR<br>Values |
| 362 23+00 (B-5)                                 | 8-10                        | 50                    |
|   | >10                         | 100+                  |
|   | 30-40                       | 2.5                   |
| 362 51+00 (B-6)                                 | 7-18                        | 30                    |
|   | >18                         | 100+                  |
|   | 34-38                       | 40                    |
| 363 10+50 (B-7)                                 | 10-17                       | 35                    |
|   | >17                         | 100+                  |
| 363 34+00 (B-8)                                 | 7-11                        | 35                    |
|   | >11                         | 100+                  |
| 367 21+50 (B-15)                                | >10                         | 80                    |
|   | >12                         | 100+                  |
| 367 39+00 (B-16)                                | 5-10                        | 40                    |
|   | 10-15                       | 25                    |
|   | 15-23                       | 10                    |
|   | 23-29                       | 40                    |
|   | >29                         | 100+                  |
| 368 12+50 (B-17)                                | 10-24                       | 25                    |
|   | 24-40                       | 8                     |
| 368 38+00 (B-18)                                | 14-17                       | 40                    |
|   | >17                         | 100+                  |
| 369 4+50 (B-19)                                 | >11                         | 100+                  |
| 369 14+00 (B-20)                                | 11-14                       | 40                    |
|   | >14                         | 100+                  |
| 369 39+00 (B-21)                                | 8-11                        | 35                    |
|   | >11                         | 100+                  |
| 370 13+00 (B-22)                                | 8-11                        | 70                    |
|   | >11                         | 100+                  |
| 370 38+00 (B-23)                                | 10-16                       | 70                    |
|   | >16                         | 100+                  |
| 371 15+00 (B-24)                                | 10-28                       | 30                    |
|   | >28                         | 100+                  |

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| <b>TABLE 2 (cont.)</b>                |                                     |                               |
|---------------------------------------|-------------------------------------|-------------------------------|
| <b>Summary of DCP Tests Results</b>   |                                     |                               |
| <b>Mile, Station<br/>(Boring No.)</b> | <b>Depth Intervals<br/>(inches)</b> | <b>Average CBR<br/>Values</b> |
| 371 30+00 (B-26)                      | >12                                 | 20                            |
|                                       | >14                                 | 100+                          |
| 372 14+00 (B-27)                      | 6-14                                | 35                            |
|                                       | 14-21                               | 20                            |
|                                       | >21                                 | 100+                          |
| 373 17+00 (B-29)                      | 9-26                                | 20                            |
|                                       | 26-33                               | 50                            |
| 373 37+00 (B-30)                      | 11-15                               | 4                             |
|                                       | 15-28                               | 6                             |
|                                       | >28                                 | 100+                          |
| 374 36+00 (B-32)                      | 11-22                               | 10                            |
|                                       | >24                                 | 100+                          |
| 375 0+00 (B-33)                       | >8                                  | 100+                          |
|                                       | 12-14                               | 40                            |
|                                       | >14                                 | 100+                          |
| PA 20+50 (B-34)                       | 4-10                                | 25                            |
|                                       | >10                                 | 100+                          |
| PA 36+80 (B-35)                       | 6-12                                | 4                             |
|                                       | 12-40                               | 1                             |
| Picnic Parking (B-PA)                 | 8-32                                | 50                            |
| Craggy Dome Lower (B-CDL)             | 16-32                               | 3                             |
| Craggy Dome Upper (B-CDU)             | 14-16                               | 10                            |
|                                       | >17                                 | 100+                          |

Water was not encountered during drilling in any of the borings: however, fluctuations in the groundwater level due to seasonal and climatic effects should be expected.

Non-destructive testing by falling weight deflectometer (FWD) was conducted by ERES Consultants to assess pavement and subgrade structural conditions within the project limits. The FWD tests were performed in accordance with AASHTO T 256-77 (1990) and the *Guide of Design of Pavement Structures*. FWD testing involves subjecting a pavement to an impulse load and measuring the resulting deflection basin.

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The FWD had a seat load of 9 kips and two test loads of 12 and 15 kips. The shape and magnitude of the deflection basin are used to analytically determine the moduli of the pavement and subgrade using software packages such as EverCalc or WESDEF. These properties are in turn used to determine the structural support capability of the pavement using a pavement design method such as the AASHTO method. The properties can then be used to analytically estimate the pavement load capacity and remaining life of the pavement using a limiting stress/strain analysis. There were 138 non-destructive test locations on the parkway. Some data points were not useable due to subgrade conditions or interference from traffic; these data were discarded. The FWD report is provided in Appendix F.

## Laboratory Testing

For classification, index properties, and design parameters, the following laboratory testing was conducted on select representative soil samples:

Atterberg limits (AASHTO T-89 and T-90)

Moisture content (AASHTO, T-265)

Sieve analysis (AASHTO T-88)

The results of the laboratory soil tests are presented in Appendix G and summarized in Table 3.

| Mile, Station<br>(Boring No.) | Sample<br>Number | Water<br>Content<br>(%) | Atterberg Limits |    |    | Percent<br>Passing No.<br>200 Sieve | AASHTO<br>Classifi-<br>cation |
|-------------------------------|------------------|-------------------------|------------------|----|----|-------------------------------------|-------------------------------|
|                               |                  |                         | LL               | PL | PI |                                     |                               |
| 359 41+50 (B-1)               | 1                | 28.8                    | 46               | 31 | 15 | 50.4                                | A-7-6                         |
|                               | 2                | 21.6                    | 33               | 27 | 6  | 34.9                                | A-2-4                         |
| 360 50+00 (B-2)               | 1                | 67.9                    | 65               |    |    | 61.5                                | A-7-6                         |
|                               | 2                | 15.8                    | 32               |    |    | 29.3                                | A-2-4                         |
| 361 51+00 (B-3)               | 1                | 10.7                    |                  |    |    | 26.7                                | A-2-4                         |
| 362 10+50 (B-4)               | 1                | 4.5                     |                  |    |    |                                     | A-2-4                         |
| 362 23+00 (B-5)               | 1                | 26                      |                  |    |    | 37.7                                | A-4                           |
|                               | 2                | 32.9                    |                  |    |    |                                     | A-4                           |
| 362 51+00 (B-6)               | 1                | 7.3                     |                  |    |    |                                     | A-2-4                         |
|                               | 2                | 9.7                     |                  |    |    |                                     | A-2-4                         |

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**TABLE 3 (cont.)**  
**Summary of Laboratory Tests Results**

| Mile, Station<br>(Boring No.) | Sample<br>Number | Water<br>Content<br>(%) | Atterberg Limits |    |    | Percent<br>Passing No.<br>200 Sieve | AASHTO<br>Classifi-<br>cation |
|-------------------------------|------------------|-------------------------|------------------|----|----|-------------------------------------|-------------------------------|
|                               |                  |                         | LL               | PL | PI |                                     |                               |
| 363 10+50 (B-7)               | 1                | 11.1                    | 33               |    |    | 28.1                                | A-2-4                         |
|                               | 2                | 11.8                    |                  |    |    |                                     | A-2-4                         |
| 363 34+00 (B-8)               | 1                | 17.8                    |                  |    |    | 24.4                                | A-2-4                         |
|                               | 2                | 10.4                    |                  |    |    |                                     | A-2-4                         |
| 364 3+50 (B-9)                | 1                | 2.8                     |                  |    |    |                                     | A-2-4                         |
| 364 36+00 (B-10)              | 1                | 11.1                    |                  |    |    |                                     | A-2-4                         |
|                               | 2                | 5                       |                  |    |    |                                     | A-2-4                         |
| 365 11+00 (B-11)              | 1                | 22.2                    |                  |    |    | 32.3                                | A-2-4                         |
|                               | 2                | 10.3                    |                  |    |    |                                     | A-2-4                         |
| 366 11+00 (B-12)              | 1                | 14.6                    |                  |    |    |                                     | A-2-4                         |
|                               | 2                | 12.8                    | 34               |    |    | 24.1                                | A-2-4                         |
| 366 15+00 (B-13)              | 1                | 9.1                     |                  |    |    |                                     | A-2-4                         |
| 366 43+00 (B-14)              | 1                | 5.5                     |                  |    |    |                                     | A-2-4                         |
|                               | 2                | 4.2                     |                  |    |    |                                     | A-2-4                         |
| 367 39+00 (B-16)              | 1                | 11.1                    |                  |    |    |                                     | A-2-4                         |
|                               | 2                | 9.9                     |                  |    |    |                                     | A-2-4                         |
| 368 12+50 (B-17)              | 1                | 19.9                    |                  |    |    | 34.9                                | A-2-4                         |
|                               | 2                | 20.6                    |                  |    |    |                                     | A-2-4                         |
| 368 38+00 (B-18)              | 1                | 15.2                    | 41               |    |    | 31.3                                | A-2-4                         |
| 369 4+50 (B-19)               | 1                | 12.2                    |                  |    |    |                                     | A-2-4                         |
|                               | 2                | 4.7                     |                  |    |    |                                     | A-2-4                         |
| 369 14+00 (B-20)              | 1                | 9.9                     |                  |    |    |                                     | A-2-4                         |
|                               | 2                | 9.6                     |                  |    |    |                                     | A-2-4                         |
| 369 39+00 (B-21)              | 1                | 5.5                     |                  |    |    |                                     | A-2-4                         |
| 370 13+00 (B-22)              | 1                | 10.3                    |                  |    |    |                                     | A-2-4                         |
|                               | 2                | 8.0                     | 32               |    |    | 21.7                                | A-2-4                         |
| 370 38+00 (B-23)              | 1                | 9.7                     |                  |    |    | 31.2                                | A-2-4                         |
|                               | 2                | 7.2                     |                  |    |    |                                     | A-2-4                         |
| 371 15+00 (B-24)              | 1                | 11.3                    |                  |    |    | 23.1                                | A-2-4                         |
|                               | 2                | 14.9                    |                  |    |    |                                     | A-2-4                         |
| 371 25+00 (B-25)              | 1                | 10.9                    |                  |    |    | 27.2                                | A-2-4                         |
|                               | 2                | 28.3                    |                  |    |    | 46.3                                | A-4                           |

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| TABLE 3 (cont.)<br>Summary of Laboratory Tests Results |                  |                         |                  |    |    |                                     |                               |
|--|------------------|-------------------------|------------------|----|----|-------------------------------------|-------------------------------|
| Mile, Station<br>(Boring No.)                          | Sample<br>Number | Water<br>Content<br>(%) | Atterberg Limits |    |    | Percent<br>Passing No.<br>200 Sieve | AASHTO<br>Classifi-<br>cation |
|  |                  |                         | LL               | PL | PI |                                     |                               |
| 371 30+00 (B-26)                                       | 1                | 11.3                    |                  |    |    | 22.7                                | A-2-4                         |
|  | 2                | 6.7                     |                  |    |    |                                     | A-2-4                         |
| 372 14+00 (B-27)                                       | 1                | 17.9                    | 25               | 24 | 1  | 37.8                                | A-4                           |
| 372 39+50 (B-28)                                       | 1                | 12.6                    |                  |    |    | 17.7                                | A-2-4                         |
|  | 2                | 18                      |                  |    |    | 32.6                                | A-2-4                         |
| 373 17+00 (B-29)                                       | 1                | 13.4                    |                  |    |    | 32.1                                | A-2-4                         |
| 373 37+00 (B-30)                                       | 1                | 19.3                    |                  |    |    | 50.4                                | A-4                           |
|  | 2                | 21.2                    |                  |    |    | 40.6                                | A-4                           |
| 373 49+50 (B-31)                                       | 1                | 16.6                    | 33               | 31 | 2  | 39.6                                | A-4                           |
|  | 2                | 7                       |                  |    |    |                                     | A-2-4                         |
| 374 36+00 (B-32)                                       | 1                | 19.7                    | 34               |    |    | 40.3                                | A-4                           |
|  | 2                | 3.1                     |                  |    |    |                                     | A-2-4                         |
| 375 0+00 (B-33)  | 1                | 14.2                    | 29               | 24 | 5  | 48.2                                | A-4                           |
|  | 2                | 0.9                     |                  |    |    |                                     | A-2-4                         |
| PA 20+50 (B-34)  | 1                | 7.9                     |                  |    |    |                                     | A-2-4                         |
|  | 2                | 20                      |                  |    |    |                                     | A-2-4                         |
| PA 36+80 (B-35)  | 1                | 27.4                    |                  |    |    | 33.2                                | A-2-4                         |
|  | 2                | 27.8                    |                  |    |    |                                     | A-2-4                         |
| Picnic Parking (B-PA)                                  | 1                | 8.7                     |                  |    |    | 23.2                                | A-2-4                         |
|  | 2                | 4.9                     |                  |    |    |                                     | A-2-4                         |
| Visitor Center (B-VC)                                  | 1                | 20.5                    |                  |    |    | 28.2                                | A-2-4                         |
|  | 2                | 29.4                    |                  |    |    |                                     | A-2-4                         |
| Craggy Dome Lower (B-CDL)                              | 1                | 33.1                    |                  |    |    | 36.8                                | A-2-4                         |
| Craggy Dome Upper (B-CDU)                              | 1                | 10                      |                  |    |    |                                     | A-2-4                         |
|  | 2                | 0.8                     |                  |    |    |                                     | A-2-4                         |

Tests were conducted on eight asphalt cores that were drilled during the field investigation. The thicknesses of the cores were measured. The in-place density and absorption were then determined, which indicates the asphalts compaction and in-place air voids. The asphalt cores were combined in order to have enough sample to evaluate the in-place hot-mix asphalt characteristics. These tests included determining the

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asphalt content, aggregate gradation, and the absolute viscosity of the recovered asphalt surface course and binder. The cores were grouped into three representative composite (Group 1, 2, and 3) samples. Tests were conducted to determine the asphalt content and aggregate gradation (T-30) of the hot-mix-asphalt mixture and the absolute viscosity of the recovered asphalt binder. The results of the laboratory asphalt tests are presented in Appendix G and summarized in tables 4, 5, and 6.

| <b>TABLE 4</b>                     |                      |              |                       |                              |                       |
|------------------------------------|----------------------|--------------|-----------------------|------------------------------|-----------------------|
| <b>Asphalt Pavement Properties</b> |                      |              |                       |                              |                       |
| <b>Core No.</b>                    | <b>Mile, Station</b> | <b>Layer</b> | <b>Thickness (in)</b> | <b>Bulk Specific Gravity</b> | <b>Absorption (%)</b> |
| 1                                  | 360 24+00            | Surface      | 1                     | Damaged                      | Damaged               |
|                                    |                      | Binder       | 1.5                   | 2.304                        | 0.98                  |
|                                    |                      | Base         | 2                     | 2.397                        | 0.36                  |
| 2                                  | 361 51+00            | Surface      | 1.2                   | 2.299                        | 0.36                  |
|                                    |                      | Binder       | 3                     | 2.313                        | 2.58                  |
|                                    |                      | Base         | 2.7                   | 2.407                        | 0.91                  |
| 3                                  | 365 11+00            | Surface      | 1.5                   | 2.253                        | 1.67                  |
|                                    |                      | Base         | 2.3                   | 2.272                        | 3.09                  |
| 4                                  | 367 39+00            | Surface      | 1.1                   | 2.182                        | 1.87                  |
|                                    |                      | Base         | 2.1                   | 2.291                        | 3.7                   |
| 5                                  | 369 39+00            | Surface      | 1                     | 2.245                        | 1.59                  |
|                                    |                      | Binder       | 1.6                   | 2.32                         | 2.03                  |
|                                    |                      | Base         | 1.4                   | 2.377                        | 0.5                   |
| 6                                  | 372 14+00            | Surface      | 1.1                   | 2.212                        | 1.95                  |
|                                    |                      | Base         | 2.2                   | 2.304                        | 1.36                  |
| 7                                  | 373 37+00            | Surface      | 1.4                   | 2.196                        | 4.22                  |
|                                    |                      | Base         | 2                     | 2.342                        | 1.07                  |
| 8                                  | 374 36+00            | Surface      | 1.3                   | 2.148                        | 4.08                  |
|                                    |                      | Base         | 2.3                   | 2.346                        | 2.93                  |

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| <b>TABLE 5</b>   |                        |                |                |
|--|------------------------|----------------|----------------|
| <b>Hot Mix Asphalt Properties<br/>Surface Course Layer</b> |                        |                |                |
| <b>Sieve Size</b>  | <b>Percent Passing</b> |                |                |
|  | <b>Group 1</b>         | <b>Group 2</b> | <b>Group 3</b> |
| 1/2 in.  | 100.0                  | 100.0          | 100.0          |
| 3/8 in.  | 95.2                   | 91.9           | 95.3           |
| No. 4  | 63.9                   | 50.3           | 53.5           |
| No. 8  | 48.1                   | 23.2           | 23.5           |
| No. 16   | 37.7                   | 14.6           | 13.3           |
| No. 30   | 29.1                   | 11.9           | 10.4           |
| No. 50   | 20.0                   | 9.8            | 8.4            |
| No. 200  | 5.8                    | 4.7            | 3.8            |
| Asphalt Content (%)  | 5.9                    | 5.6            | 5.5            |
| Absolute Viscosity<br>(poise)                              | 37,612                 | 198,644        | 319,342        |
| Note: Composite Samples - Cores trimmed and combined       |                        |                |                |
| Group 1 = Cores 1 and 2                                    |                        |                |                |
| Group 2 = Cores 3, 4, and 5                                |                        |                |                |
| Group 3 = Cores 6, 7, and 8                                |                        |                |                |

| <b>TABLE 6</b>   |                        |                |                |
|--|------------------------|----------------|----------------|
| <b>Hot Mix Asphalt Properties<br/>Binder/Base Course Layer</b> |                        |                |                |
| <b>Sieve Size</b>  | <b>Percent Passing</b> |                |                |
|  | <b>Group 1</b>         | <b>Group 2</b> | <b>Group 3</b> |
| 1 in.  | 100.0                  | 100.0          | 100.0          |
| 3/4 in.  | 97.6                   | 97.8           | 99.5           |
| 1/2 in.  | 78.6                   | 86.1           | 83.6           |
| 3/8 in.  | 66.6                   | 72.4           | 71.9           |
| No. 4  | 45.4                   | 51.7           | 54.5           |
| No. 8  | 36.4                   | 36.7           | 42.8           |
| No. 16   | 30.1                   | 28.0           | 33.4           |
| No. 30   | 23.9                   | 21.5           | 25.3           |

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| TABLE 6 (cont.)  |                 |         |         |
|--|-----------------|---------|---------|
| Hot Mix Asphalt Properties<br>Binder/Base Course Layer |                 |         |         |
| Sieve Size   | Percent Passing |         |         |
|  | Group 1         | Group 2 | Group 3 |
| No. 50   | 16.3            | 14.2    | 16.5    |
| No. 200  | 4.7             | 5.3     | 6.2     |
| Asphalt Content (%)                                    | 5.1             | 4.9     | 5.0     |
| Absolute Viscosity<br>(poise)                          | 32,516          | 283,912 | 215,887 |
| Note: Composite Samples - Cores trimmed and combined   |                 |         |         |
| Group 1 = Cores 1 and 2                                |                 |         |         |
| Group 2 = Cores 3, 4, and 5                            |                 |         |         |
| Group 3 = Cores 6, 7, and 8                            |                 |         |         |

### Data Summary

The boring logs represent a compilation of field and laboratory data and descriptions of the soil samples by a geotechnical engineer. As shown on the geologic map included as Figure 13, Section 2P is located on two different geologic groups within the Ashe Metamorphic Suite. The first geologic group runs from Milepost 359.8 to just west of Milepost 370.0. This group consists of Kyanite schist and gneiss. The second part of the project from just west of Milepost 370.0 to Milepost 375.3 is located in the Muscovite-Biotite gneiss group. From the subsurface investigation and the laboratory results, no noticeable differences in soil classification are detected among the various geologic units.

The soils throughout the project are generally classified as silty sands (SM) with a significant percent of fines (silt size) and rock fragments with an AASHTO classification of A-2-4. Moisture content was taken from each sample recovered and typically ranged from 10 to 20 percent. Atterberg limits were attempted on a few samples with results showing a low plasticity index (PI). Sieve analyses were conducted on 36 samples to determine the percent passing the No. 200 sieve. The results ranged from 17.7 to 61.5 percent, typically between 22 and 45 percent.

### Pavement Design

The project was analyzed by stations and separated into segments. These segments were determined by the pavement condition survey, field data (DCP), laboratory data,

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and the non-destructive testing. All previously mentioned information was collected, summarized, and compiled to determine the final design.

Flexible pavement design and new asphaltic concrete pavement design analyses are performed in accordance with AASHTO *Guide for Design of Pavement Structures*, 1993. The flexible pavement design analyses are for a 20-year performance period. The design analysis to determine the 18-kip equivalent single axle load (ESAL) for the roadway is based upon average daily traffic (ADT) counts for the highway section. The traffic on the non-highway sections (pullouts, visitor center parking, picnic road, etc) should be considerably less than the main highway. For the non-highway pavements, the ADT was reduced by half. The traffic counts are assumed to include 2.5 percent recreational vehicles, 2.5 percent travel trailers, and 0.2 percent construction/maintenance vehicles. A traffic growth rate of 2 percent is also assumed. The effective roadbed soil support number is determined for each section of roadway from empirical correlation to CBR values and soil classifications. Other parameters specified in the analysis include a 50 percent directional factor, a lane distribution factor of 1.0, a regional factor of 1.5, and a terminal serviceability index of 2.0. A design structural number is calculated using the parameters above and compared against the structural number calculated from the thickness and structural coefficient of each layer. In the design for the mill and overlay sections, the underlying base material was given a conservative structural coefficient of 0.11, which correlates to a CBR of 50. The asphalt left after milling was given a reduced structural coefficient of 0.2.

The nominal maximum size aggregate (NMSA) was supplied for each asphalt layer by the FHWA. The NMSA for the AC binder layer is 0.75 inch and 0.5 inch for the AC surface course. The NMSA is important because each asphalt layer must be three to four times the thickness of the aggregate. Therefore, minimum thicknesses of 1.5 inches for surface layer and 2.5 inches for binder layer are recommended.

The reconstruction typical sections were determined to have two different designs. One of the designs is for the mainline parkway and other one is for the Craggy Dome upper parking, Craggy Garden picnic parking, and Visitor Center parking. The following section is for the mainline parkway. The pavement design consists of compacting an existing 6 inches of base overlain by 3 inches of AC binder topped with 2 inches of AC surface course. The other reconstruction design also includes compaction of existing base with 2.5 inches of AC binder and 1.5 inches of surface course. The typical pavement and repair sections are provided in tables 7 and 8.

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| <b>TABLE 7</b>                     |  |
|------------------------------------|--|
| <b>Typical Sections for Repair</b> |  |
| <b>Typical Section No.</b>         | <b>Reconstruction</b>  |
| 1                                  | 2.0" Surface Course, Class C, Grade D, Type III Smoothness   |
|                                    | 3.0" Binder, Grade C   |
|                                    | 6.0" Recompacted Existing Base                               |
| 2                                  | 1.5" Surface Course, Class C, Grade D, Type III Smoothness   |
|                                    | 2.5" Binder, Grade C   |
|                                    | 6.0" Recompacted Existing Base                               |
| <b>Option</b>                      | <b>Milling and Overlay</b>                                   |
| 3                                  | Mill 2.0"  |
|                                    | Replace with 2.5" Binder, Grade C                            |
|                                    | 1.5" Surface Course, Class C, Grading D, Type III Smoothness |
| 4                                  | Mill 1.0"  |
|                                    | Replace with 2.5" Binder, Grade C                            |
|                                    | 1.5" Surface Course, Class C, Grade D, Type III Smoothness   |

| <b>TABLE 8</b>                          |                                |                             |                      |   |
|---|--------------------------------|-----------------------------|----------------------|---|
| <b>Recommended Sections and Repairs</b> |                                |                             |                      |   |
|   | <b>Beginning Mile, Station</b> | <b>Ending Mile, Station</b> | <b>Repair Method</b> | <b>Typical Section No. (from Table 7)</b> |
| Parkway                                 | 359, 39+00                     | 366, 24+10                  | Mill & Overlay       | 3   |
|   | 366, 24+10                     | 368, 20+00                  | Reconstruction       | 1   |
|   | 368, 20+00                     | 370, 2+00                   | Mill & Overlay       | 3   |
|   | 370, 2+00                      | 375, 4+57                   | Reconstruction       | 1   |
| Craggy Garden                           | Access Road                    |                             | Both                 | 1 and 3                                   |
|   | Picnic Parking                 |                             | Reconstruction       | 2   |
| Craggy Dome                             | 2-Tier Parking                 |                             | Reconstruction       | 2   |

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| TABLE 8 (cont.)                  |                         |                      |                |                                    |
|----------------------------------|-------------------------|----------------------|----------------|------------------------------------|
| Recommended Sections and Repairs |                         |                      |                |                                    |
|                                  | Beginning Mile, Station | Ending Mile, Station | Repair Method  | Typical Section No. (from Table 7) |
| Visitor Center                   | Parking                 |                      | Reconstruction | 2                                  |
| Overlooks                        | Balsam Gap              |                      | Mill & Overlay | 4                                  |
|                                  | Bull Creek              |                      | Mill & Overlay | 4                                  |
|                                  | Graybeard               |                      | Mill & Overlay | 4                                  |
|                                  | Glassmine Falls         |                      | Mill & Overlay | 4                                  |
|                                  | Lane Pinnacle           |                      | Mill & Overlay | 4                                  |

Less-distressed segments can be repaired by milling and overlaying. Such areas may be milled 1 to 2 inches and overlaid with 2.5 inches of binder and 1.5 inches of AC surface course. During the milling process, a minimum of 1.5 inches of asphalt should be left on the roadway. The sections from approximately Milepost 367 to 375.3 typically have pavement thickness ranging from 3 to 4 inches. The pavement design calculations are located in Appendix H.

**Supplemental Investigation**

Since the 70 percent submittal, additional investigation has been conducted along the parkway. This investigation was conducted to confirm the existence and define the nature of any base type material immediately underlying the existing pavements. The NPS requires that the mainline pavement remain open to traffic during reconstruction and that reconstructed sections are covered with a binder layer at the end of each day. Therefore, it is significant that any existing base section be utilized versus requiring a new base section and lengthening the construction process. A total of 13 asphalt sections from mile marker 368.0 to 375.0 were cored and measured and samples of the underlying base material were collected. Representative samples of the base material were transported to the laboratory for sieve analyses. The results are summarized below in Table 9. The test results are located in Appendix G. Photographs of the cores are included in Appendix B.

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| <b>TABLE 9</b>  |                   |                  |                 |                   |                  |
|---|-------------------|------------------|-----------------|-------------------|------------------|
| <b>Laboratory Test Results for Existing Base Material</b> |                   |                  |                 |                   |                  |
| <b>Milepost</b>   | <b>Sieve Size</b> | <b>% Passing</b> | <b>Milepost</b> | <b>Sieve Size</b> | <b>% Passing</b> |
| 370.0   | ¾"                | 74.3             | 374.0           | ¾"                | 70.1             |
|   | #4                | 44.8             |                 | #4                | 39.8             |
|   | #10               | 38.0             |                 | #10               | 34.4             |
|   | #40               | 27.1             |                 | #40               | 24.2             |
|   | #200              | 13.0             |                 | #200              | 11.3             |
| 373.0   | ¾"                | 77.1             | 374.3           | ¾"                | 76.9             |
|   | #4                | 52.7             |                 | #4                | 46.5             |
|   | #10               | 46.0             |                 | #10               | 41.1             |
|   | #40               | 32.0             |                 | #40               | 30.7             |
|   | #200              | 11.9             |                 | #200              | 14.3             |
| 373.5   | ¾"                | 74.2             | 375.0           | ¾"                | 90.2             |
|   | #4                | 41.1             |                 | #4                | 55.0             |
|   | #10               | 35.8             |                 | #10               | 46.5             |
|   | #40               | 25.3             |                 | #40               | 32.4             |
|   | #200              | 11.2             |                 | #200              | 14.3             |

Investigation of the three areas of instability at mileposts 361.8, 362.8, and 363.4 were determined not to be deep-rooted stability problems. The pavement depressions at these three areas appear due to the loss of finer subgrade material into the underlying boulder fill. The boulder fill has large open voids into which the subgrade soils have migrated over the years. A deep subgrade patch will be required for this repair. These three areas defined on the plans should be sub-excavated an additional 6 inches beyond the normal repair. Geotextile Type III-B per section 704 of the FP-96 specifications should be placed on the sub-excavated areas and the area backfilled with compacted aggregate base.

## **Recommendations**

Our recommendations, based on the findings of our subsurface investigation of the Blue Ridge Parkway Rehabilitation project area, are as follows:

### **Earthwork**

#### Aggregate Base Course

Design of the pavement sections has considered the existing base material. Once the asphalt pavement has been removed the base material should be compacted to 95 percent of a modified proctor (AASHTO T-180). Areas showing rutting or pumping should be excavated and replaced for a minimum thickness of 6 inches.

#### Pavement Section

Due to the inconsistent distresses, various repairs are required. Areas requiring mill and overlay, exposed potholes, and shrinkage cracks greater than 0.10 inch in width should be repaired before placing overlay. The typical pavement repair sections are provided in Table 7 with the affected stations, parking areas, and overlooks listed in Table 8.

### **Craggy Dome Retaining Wall**

At the Craggy Dome Overlook, located at Milepost 364.1, stone retaining walls are utilized to support both upper and lower parking lots. The retaining walls are constructed of dry stacked Grandfather Mountain Stones with the upper 2 feet of stones mortared together.

The lower retaining wall is approximately 255 feet in length and varies in height from approximately 4 to 13 feet. The upper retaining wall is approximately 116 feet in length and varies in height from 3 to 7 feet.

Both the upper and lower walls were visually examined and representative stones and cracks measured and photographed. Due to deterioration over the years, the upper wall has undergone differential settlement, both vertically and horizontally, causing tilting and separation of the stones.

The lower retaining wall was evaluated and found to be generally stable and will not need to be removed. The existing culvert through the wall in the northwest corner is plugged and a new culvert is to be rerouted from the existing inlet around the end of the wall.

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The upper retaining wall will need to be partially dismantled and carefully rebuilt. Approximately 66 linear feet of wall will be dismantled and rebuilt. The inlet box and culvert appear to have had an effect on the walls stability. Complete replacement of the inlet and culvert along with the placement of a concrete foundation beneath the dismantled section will correct the wall deficiencies.

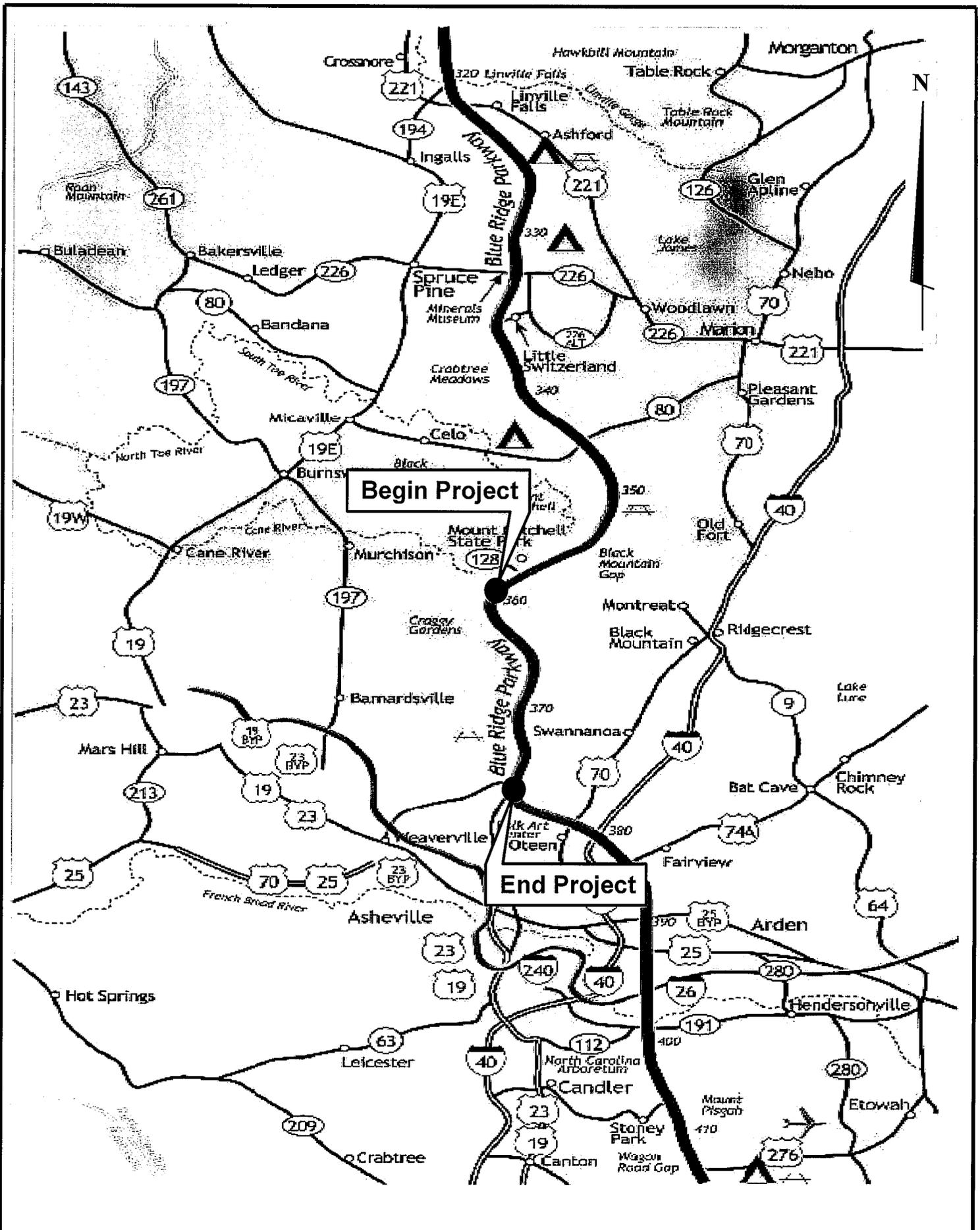
Once the stones are removed, a concrete footing will be built for support of the stones. The stone walls will then be rebuilt, following the stone layout and numbering scheme to replicate the original wall.

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8. Federal Highway Administration, *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-96 English Units*, Washington, D.C., 2001.

## **Appendix A**

Project Maps



**ARCADIS**

1210 PREMIER DRIVE, SUITE 200  
 CHATTANOOGA, TN 37421  
 Tel. 423/55-7193 Fax 423/55-7197

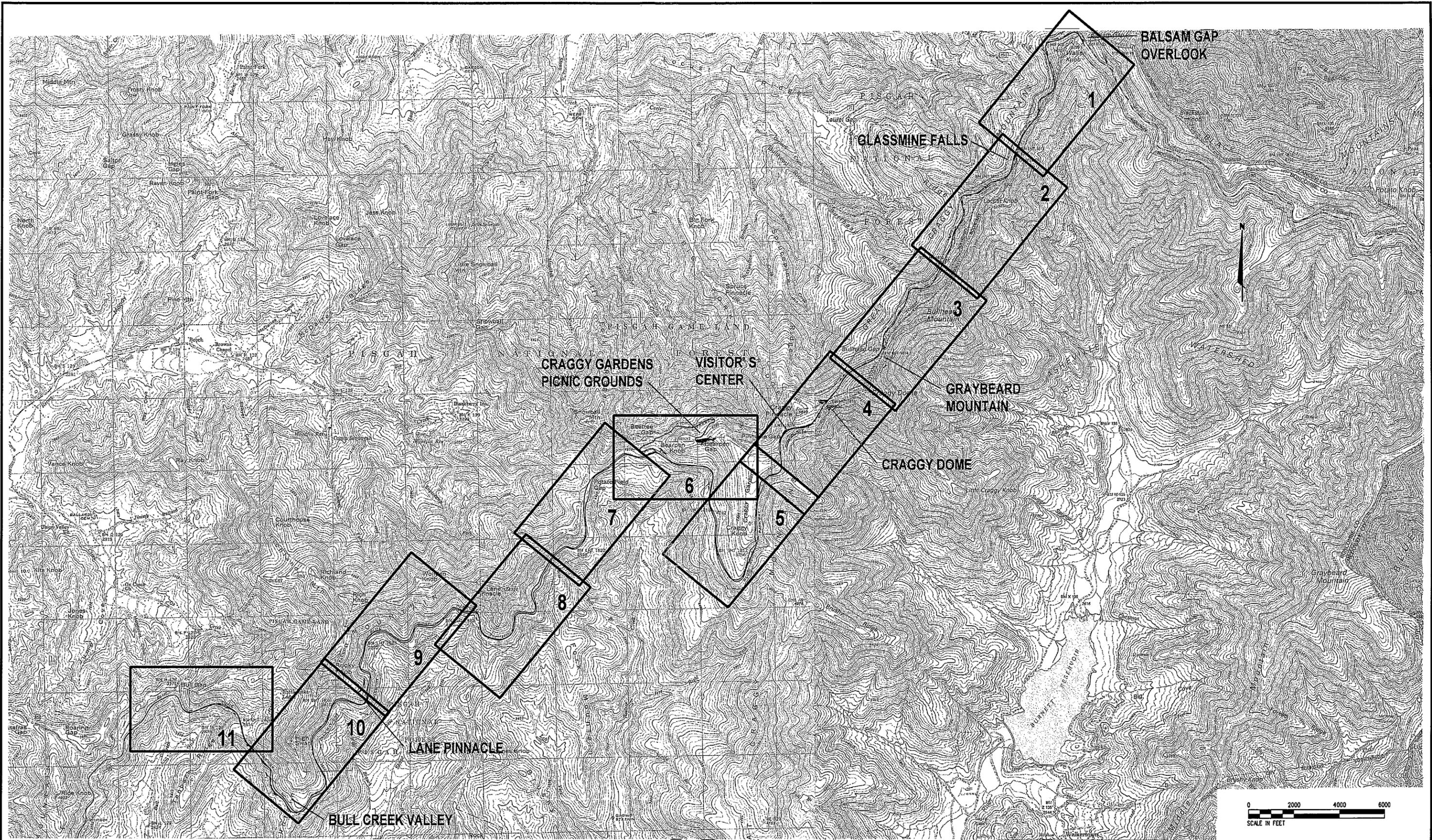
**LOCATION MAP**  
**BLUE RIDGE PARKWAY**  
**YANCEY & BUNCOMBE COUNTIES, NC**

PROJECT NUMBER

CT052885

FIGURE NUMBER

1



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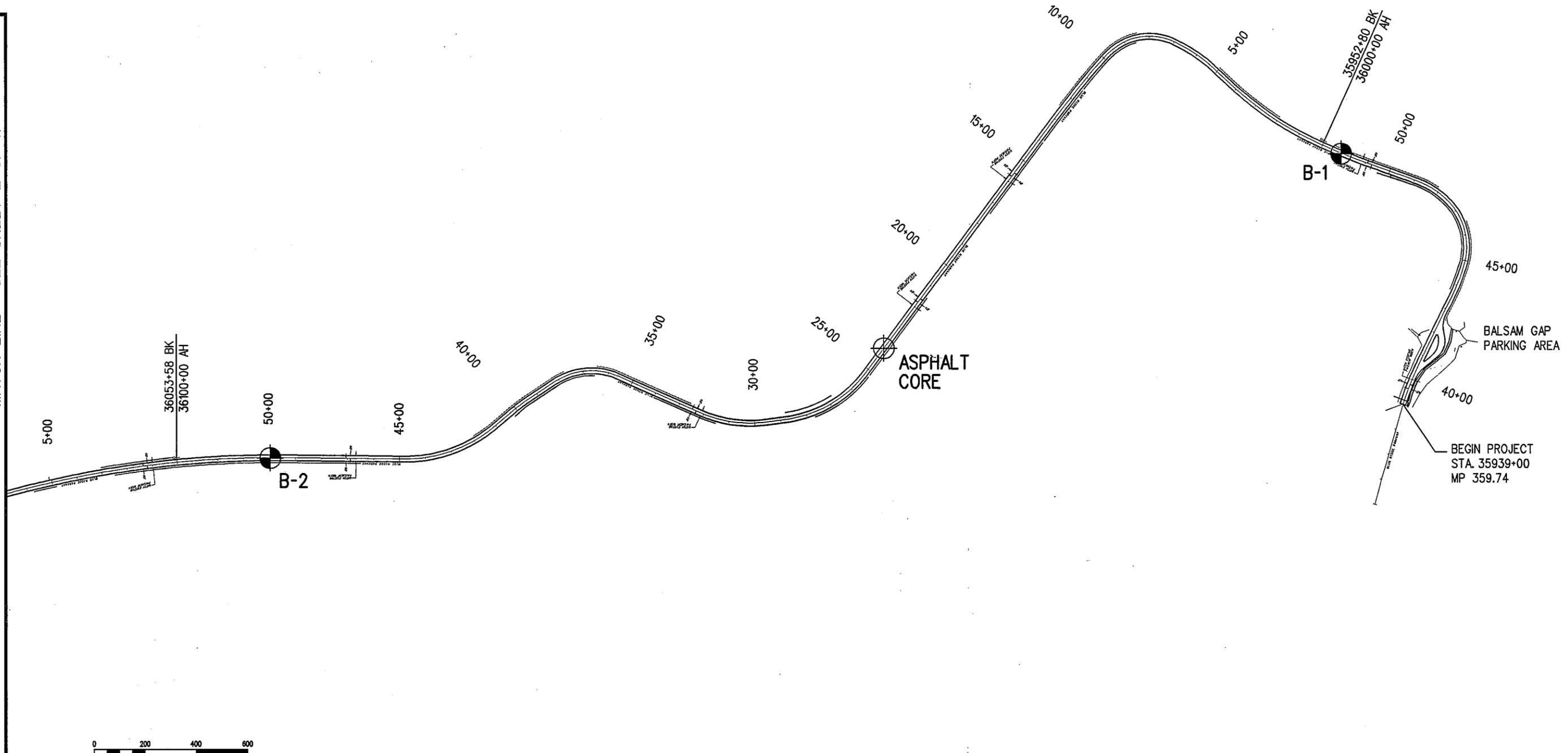
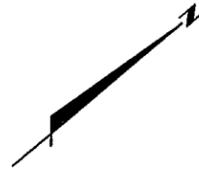
| NO. | DATE | REVISION DESCRIPTION | BY  |
|-----|------|----------------------|-----|
|     |      |                      | CKD |

**ARCADIS**  
 1210 PREMIER DRIVE, SUITE 200  
 CHATTANOOGA, TN 37421  
 Tel: 423/756-7193 Fax: 423/756-7197

BLUE RIDGE PARKWAY  
 YANCEY & BUNCOMBE COUNTIES,  
 NORTH CAROLINA

|                            |              |                               |                                   |
|----------------------------|--------------|-------------------------------|-----------------------------------|
| DRAWN<br>JRC               | DATE<br>EDIT | PROJECT MANAGER<br>B. CHAMLEE | DEPARTMENT MANAGER<br>B. WHITAKER |
| BORING LOCATION<br>KEY MAP |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|                            |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 2        |
|                            |              | SHEET OF                      |                                   |

MATCH LINE - SEE SHEET 2 OF 11



BEGIN PROJECT  
STA. 35939+00  
MP 359.74



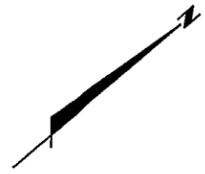
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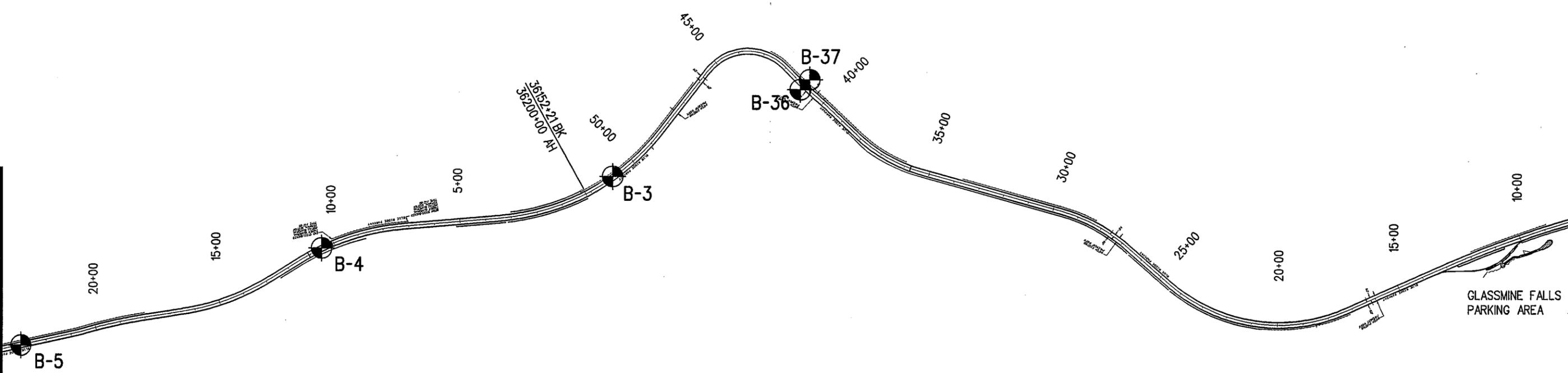
BLUE RIDGE PARKWAY  
 YANCEY & BUNCOMBE COUNTIES,  
 NORTH CAROLINA

|                                       |              |                               |                                   |
|---------------------------------------|--------------|-------------------------------|-----------------------------------|
| DRAWN<br>JRC                          | DATE<br>EDIT | PROJECT MANAGER<br>B. CHAMLEE | DEPARTMENT MANAGER<br>B. WHITAKER |
| BORING LOCATION PLAN<br>SHEET 1 OF 11 |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|                                       |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 3        |
|                                       |              | SHEET OF                      |                                   |



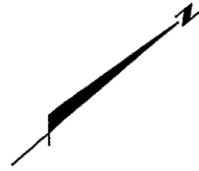
MATCH LINE - SEE SHEET 3 OF 11

MATCH LINE - SEE SHEET 1 OF 11



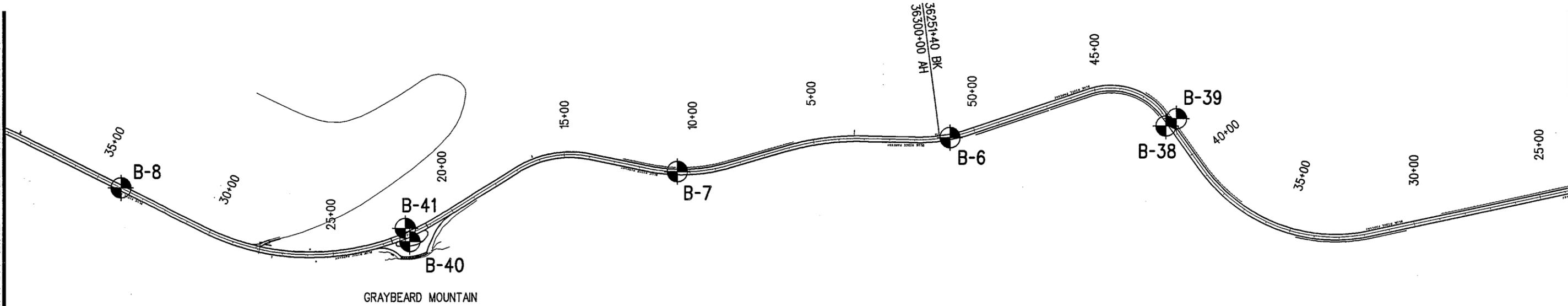
|                  |                             |  |  |  |  |  |   |                             |  |  |  |
|------------------|-----------------------------|--|--|--|--|--|---|-----------------------------|--|--|--|
| copyright © 2003 |                             |  |  | <br><small>1210 PREMIER DRIVE, SUITE 200<br/>         CHATTANOOGA, TN 37421<br/>         Tel: 423/756-7163 Fax: 423/756-7167</small> | <b>BLUE RIDGE PARKWAY<br/>         YANCEY &amp; BUNCOMBE COUNTIES,<br/>         NORTH CAROLINA</b> |  | <small>DRAWN</small><br>JRC               | <small>DATE</small><br>EDIT | <small>PROJECT MANAGER</small><br>B. CHAMLEE     | <small>DEPARTMENT MANAGER</small><br>B. WHITAKER |  |
|                  | <b>BORING LOCATION PLAN</b> |  |  |  |  |  | <small>SCALE</small><br>AS SHOWN          |                             | <small>CHECKED</small><br>S. MANNING             |  |  |
|                  | <b>SHEET 2 OF 11</b>        |  |  |  |  |  | <small>PROJECT NUMBER</small><br>CT052885 |                             | <small>DRAWING NUMBER</small><br><b>FIGURE 4</b> |  |  |
|                  |                             |  |  |  |  |  |   |                             | <small>SHEET</small> OF                          |  |  |

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MATCH LINE - SEE SHEET 4 OF 11

MATCH LINE - SEE SHEET 2 OF 11



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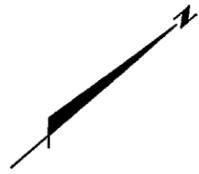
| NO. | DATE | REVISION DESCRIPTION | BY | CKD |
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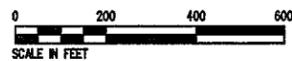
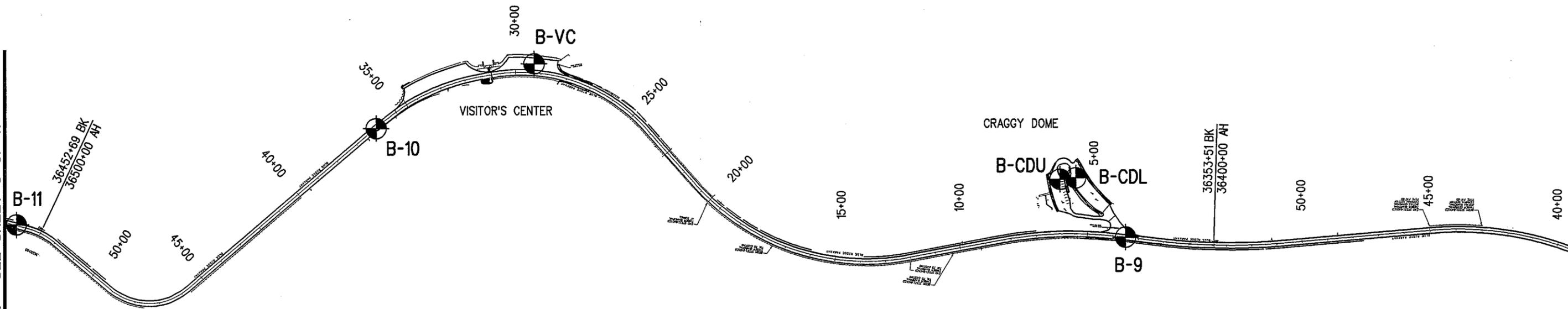
BLUE RIDGE PARKWAY  
 YANCEY & BUNCOMBE COUNTIES,  
 NORTH CAROLINA

|                                       |              |                               |                                   |
|---------------------------------------|--------------|-------------------------------|-----------------------------------|
| DRAWN<br>JRC                          | DATE<br>EDIT | PROJECT MANAGER<br>B. CHAMLEE | DEPARTMENT MANAGER<br>B. WHITAKER |
| BORING LOCATION PLAN<br>SHEET 3 OF 11 |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|                                       |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 5        |
|                                       |              | SHEET OF                      |                                   |



MATCH LINE - SEE SHEET 5 OF 11

MATCH LINE - SEE SHEET 3 OF 11



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| DRAWN<br>JRC                          | DATE<br>EDIT | PROJECT MANAGER<br>B. CHAMLEE | DEPARTMENT MANAGER<br>B. WHITAKER |
| BORING LOCATION PLAN<br>SHEET 4 OF 11 |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|                                       |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 6        |
|                                       |              | SHEET OF                      |                                   |



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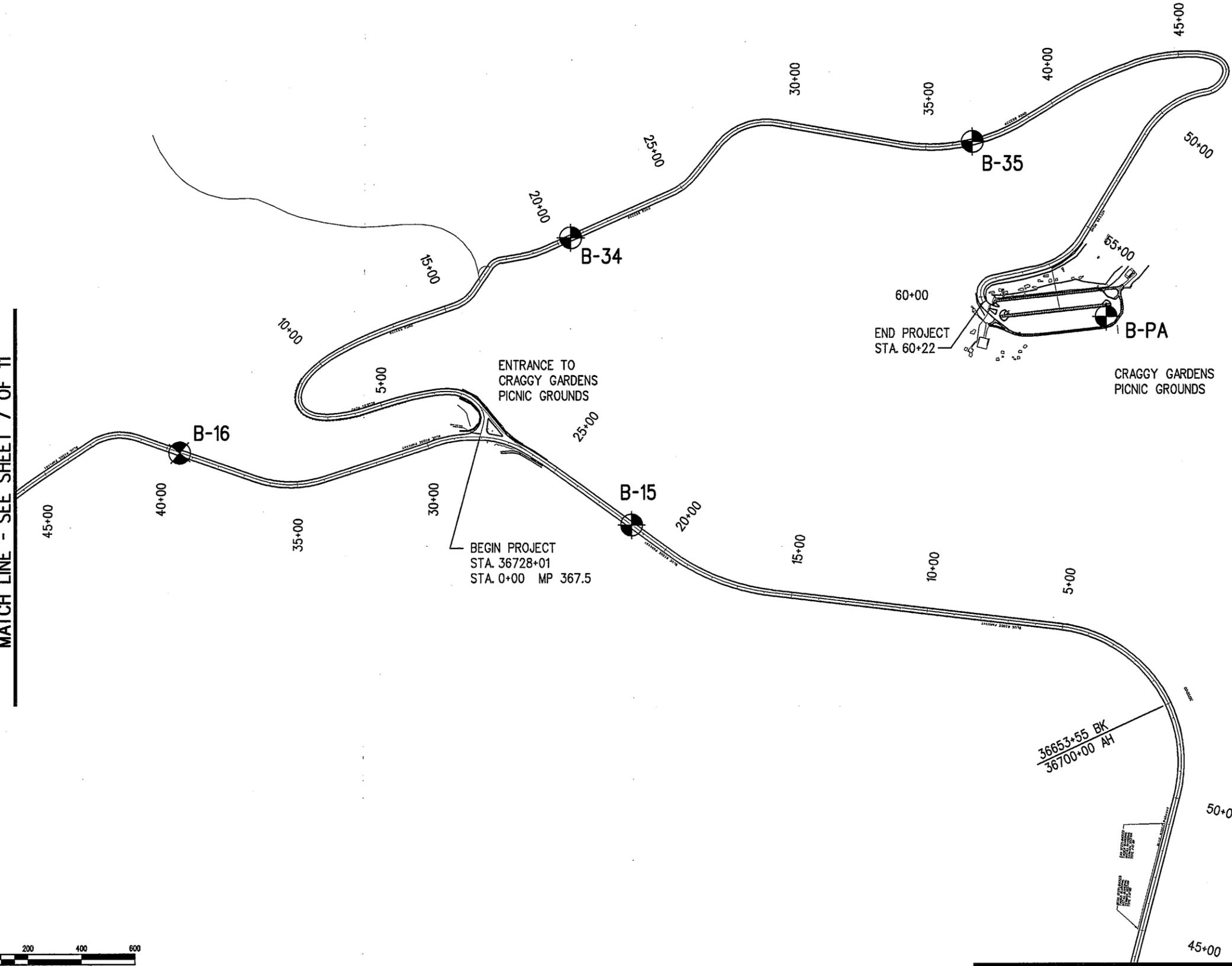
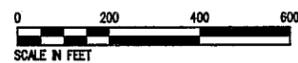
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| BORING LOCATION PLAN<br>SHEET 5 OF 11 |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|                                       |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 7        |
|                                       |              | SHEET OF                      |                                   |

MATCH LINE - SEE SHEET 7 OF 11



MATCH LINE - SEE SHEET 5 OF 11

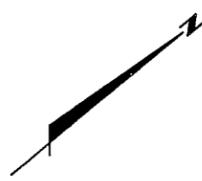
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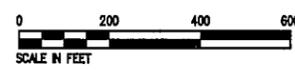
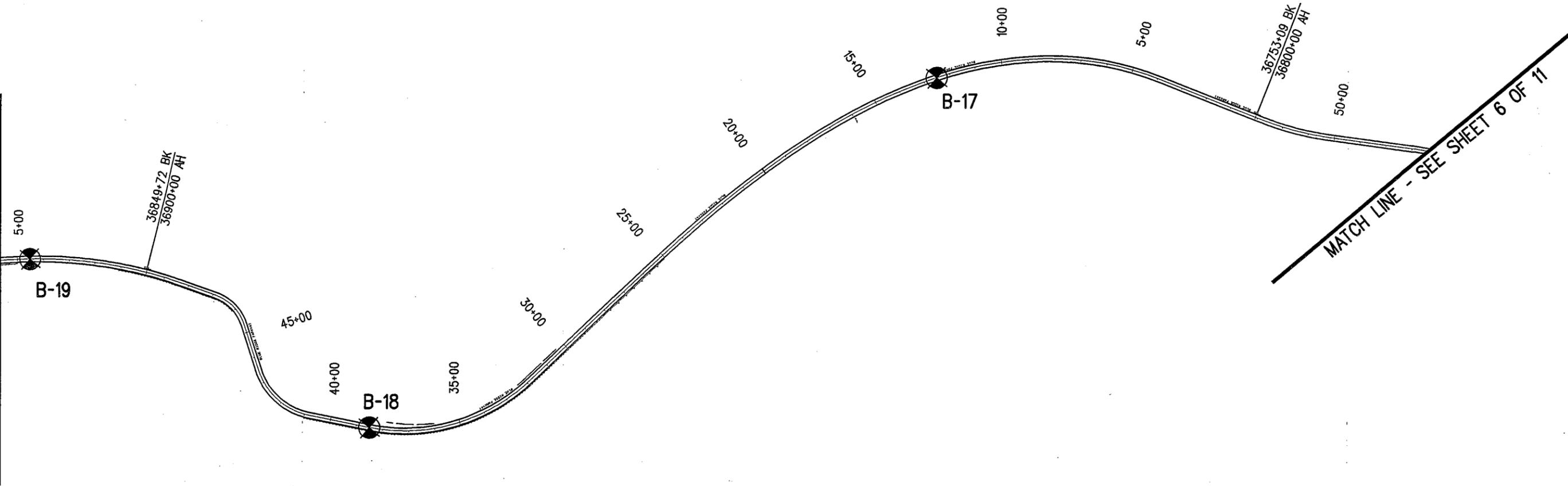
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| BORING LOCATION PLAN<br>SHEET 6 OF 11 |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|                                       |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 8        |
|                                       |              | SHEET                         | OF                                |



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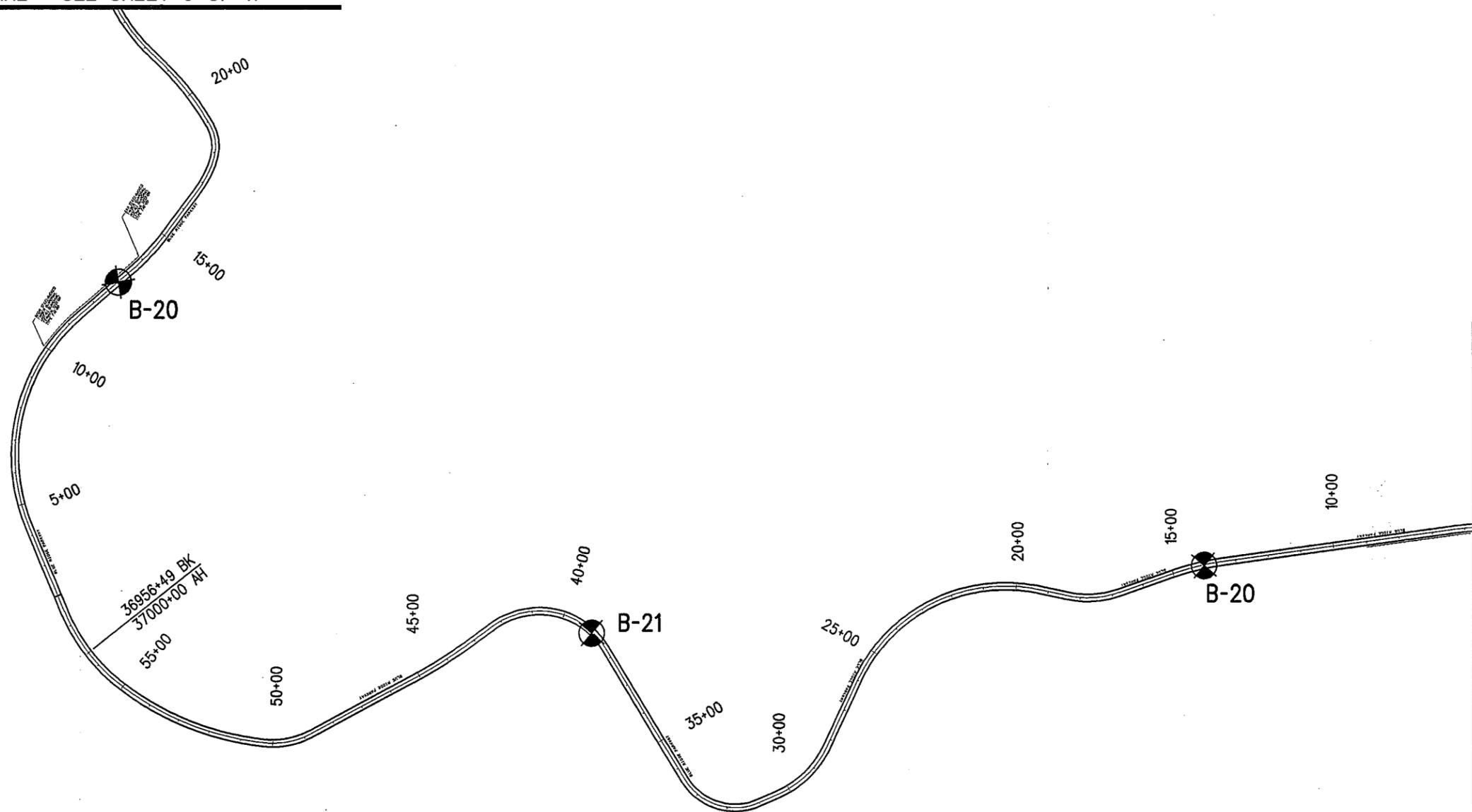
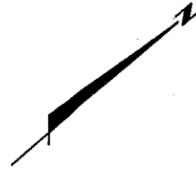


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| BORING LOCATION PLAN<br>SHEET 7 OF 11 |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|                                       |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 9        |
|                                       |              | SHEET OF                      |                                   |

MATCH LINE - SEE SHEET 9 OF 11



MATCH LINE - SEE SHEET 7 OF 11



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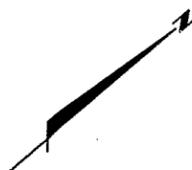
| NO. | DATE | REVISION DESCRIPTION | BY  |
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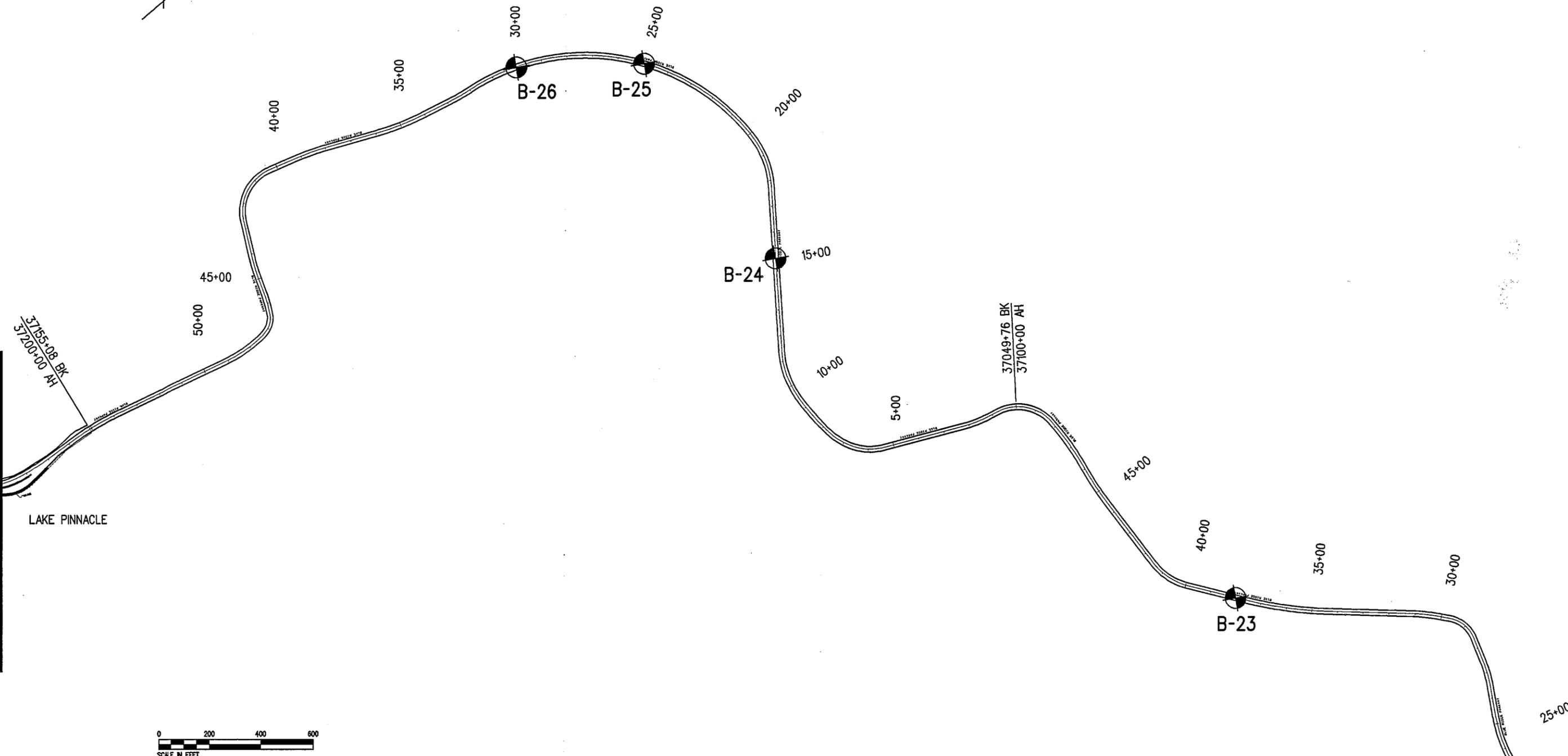
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YANCEY & BUNCOMBE COUNTIES,  
NORTH CAROLINA

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| BORING LOCATION PLAN<br>SHEET 8 OF 11 |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|                                       |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 10       |
|                                       |              | SHEET OF                      |                                   |



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MATCH LINE - SEE SHEET 8 OF 11

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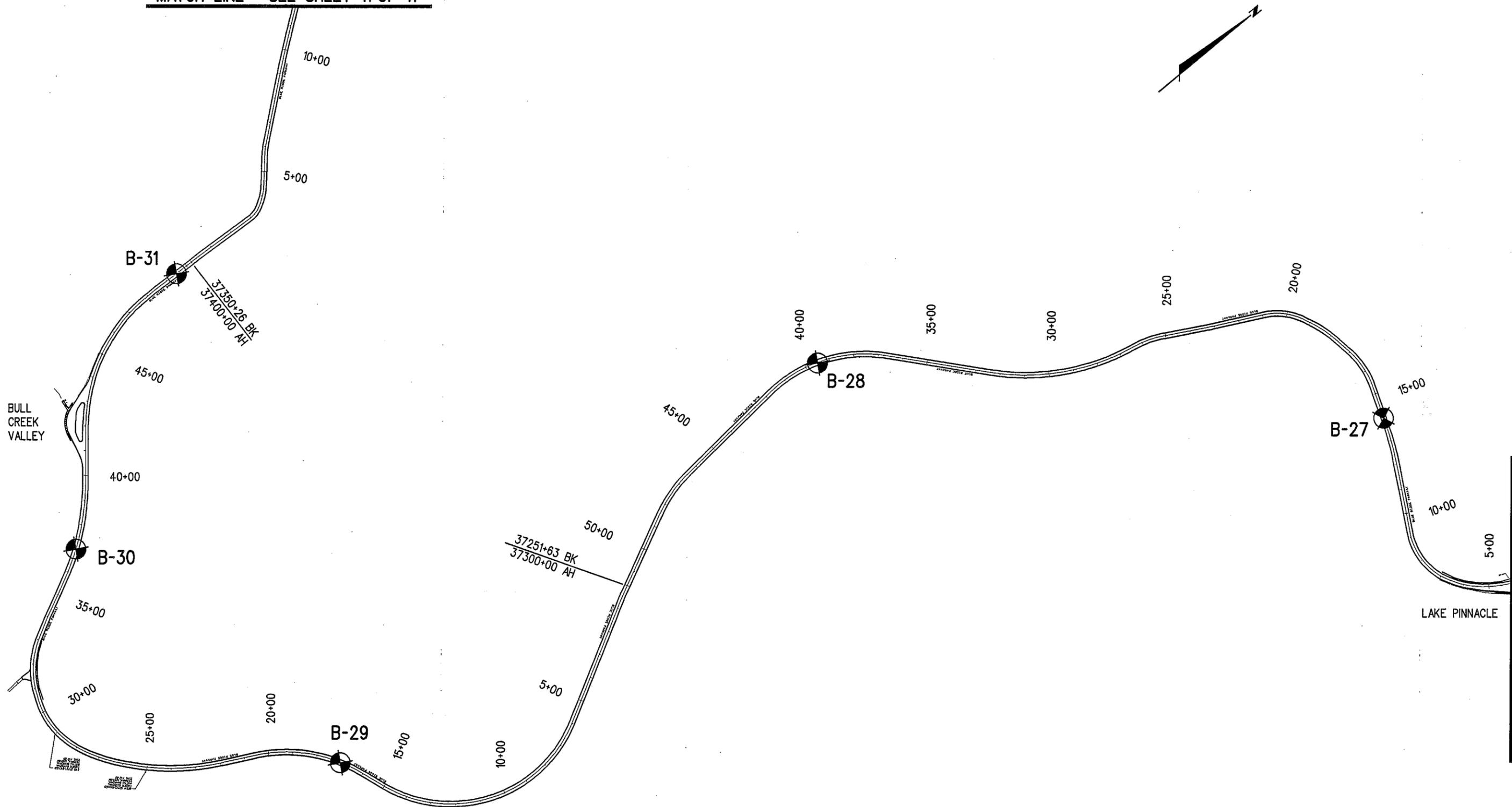
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 NORTH CAROLINA

|                                       |              |                               |                                   |
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| DRAWN<br>JRC                          | DATE<br>EDIT | PROJECT MANAGER<br>B. CHAMLEE | DEPARTMENT MANAGER<br>B. WHITAKER |
| BORING LOCATION PLAN<br>SHEET 9 OF 11 |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|                                       |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 11       |
|                                       |              | SHEET OF                      |                                   |

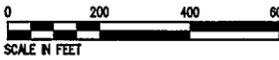
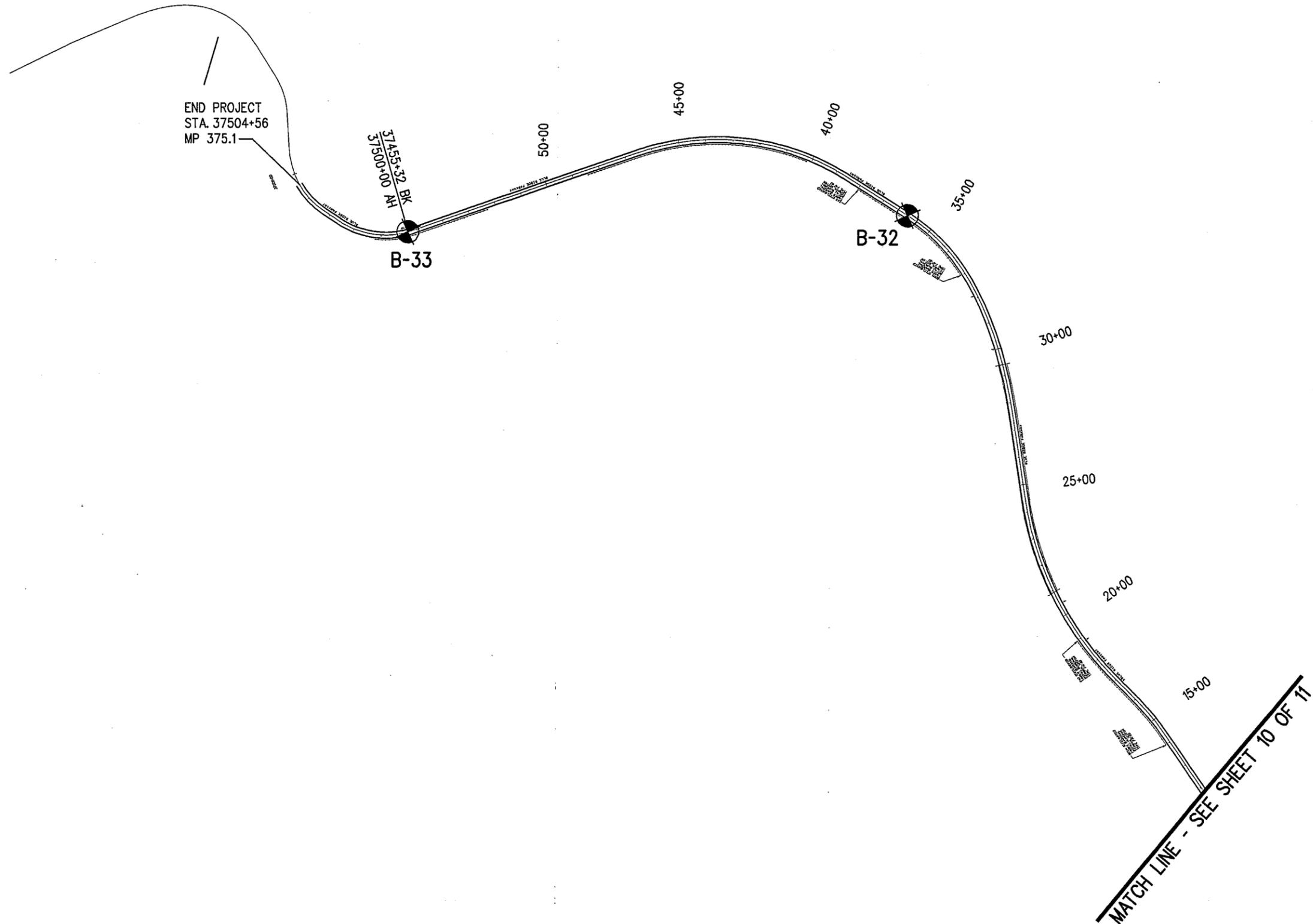
MATCH LINE - SEE SHEET 11 OF 11



MATCH LINE - SEE SHEET 9 OF 11

|                  |                      |  |  |  |   |   |                            |                             |              |                               |                                   |
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|                  | BORING LOCATION PLAN |  |  |  |   |   | SCALE<br>AS SHOWN          | CHECKED<br>S. MANNING       |              |                               |                                   |
|                  | SHEET 10 OF 11       |  |  |  |   |   | PROJECT NUMBER<br>CT052885 | DRAWING NUMBER<br>FIGURE 12 |              |                               |                                   |
|                  |                      |  |  |  |   |   | SHEET OF                   |                             |              |                               |                                   |

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| BORING LOCATION PLAN<br>SHEET 11 OF 11 |              | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|  |              | PROJECT NUMBER<br>CT052885    | DRAWING NUMBER<br>FIGURE 13       |
|  |              | SHEET                         | OF                                |

Description of Map Units

Unconformity

**Ybg** Biotite gneiss - Pinkish gray to light gray, massive to well foliated, granitic to quartz monzonite; includes variably mylonitized orthogneiss and paragneiss interlayered amphibolite, calcsilicate rock, and marble.

Ashe Metamorphic Suite

**Zal** Laminated biotite gneiss - Finely laminated to thin layered; locally contains massive gneiss and micaceous granule conglomerate; includes schist, phyllite, and amphibole.

**Zam** Metagraywacke - Foliated to massive, locally conglomeratic; interlayered and gradational with mica schist, muscovite, muscovite-biotite gneiss, and rare graphite schist.

**Zak** Kyanite schist and gneiss - Massive and interlayered with quartz schist and biotite gneiss. Garnet staurolite, and (or) sillimanite commonly occur; aluminous.

**Zamb** Muscovite-biotite gneiss - Locally sulfidic; interlayered and gradational with mica schist, minor amphibolite and hornblend.

Richard Russell Formation and amphibolitic basement complex

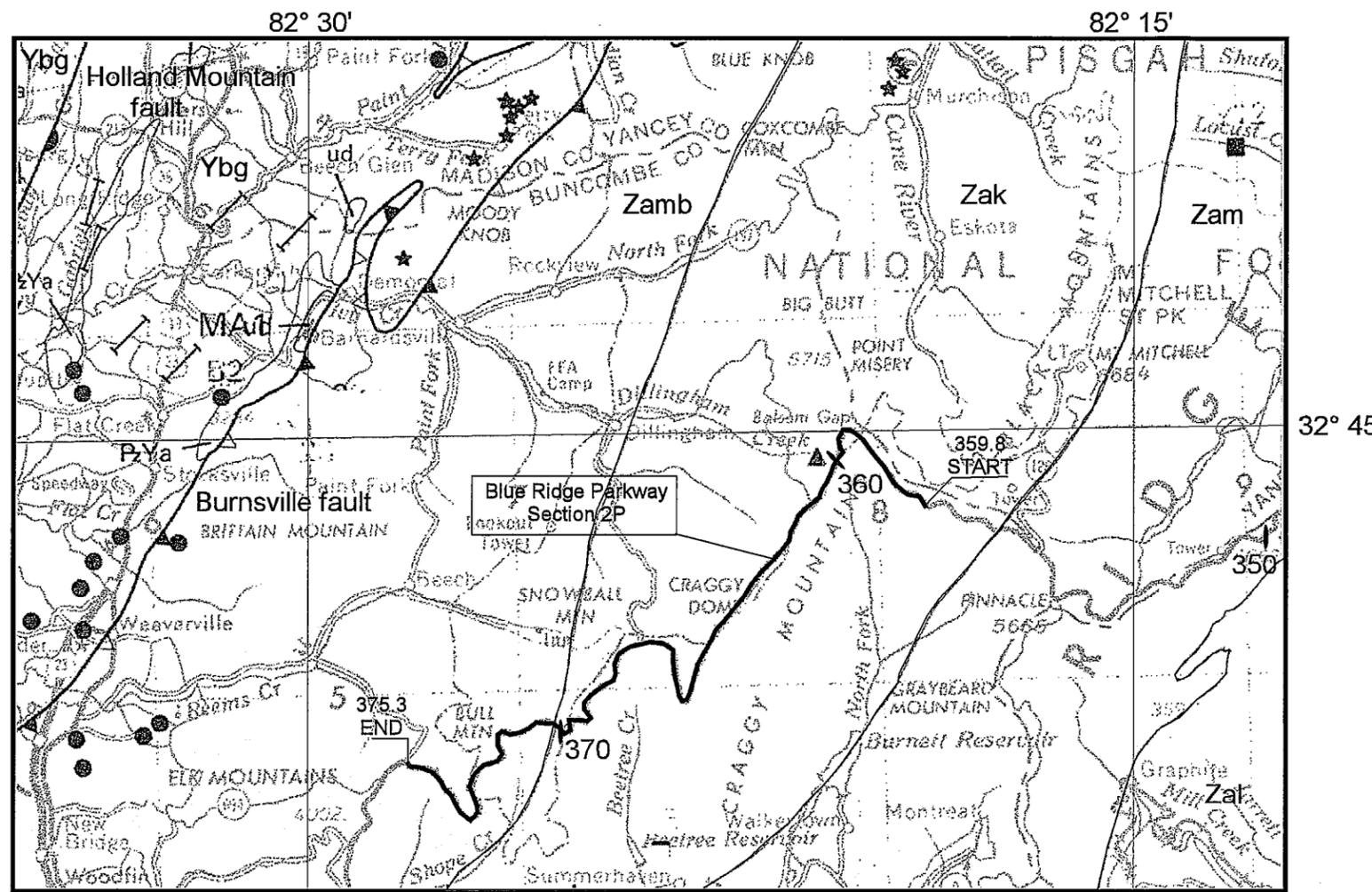
**PzYa** Amphibolite - Equigranular, massive to well foliated, interlayered, rarely discordant, metamorphosed intrusive and extrusive mafic rock; may include ultramafic rock and metasedimentary rock.

Intrusive and other igneous rocks

**u ▲** Metaultramafic rock, undifferentiated - Metamorphosed dunite, serpentinite, soapstone, and other altered ultramafic rock. Smaller bodies shown by symbol.

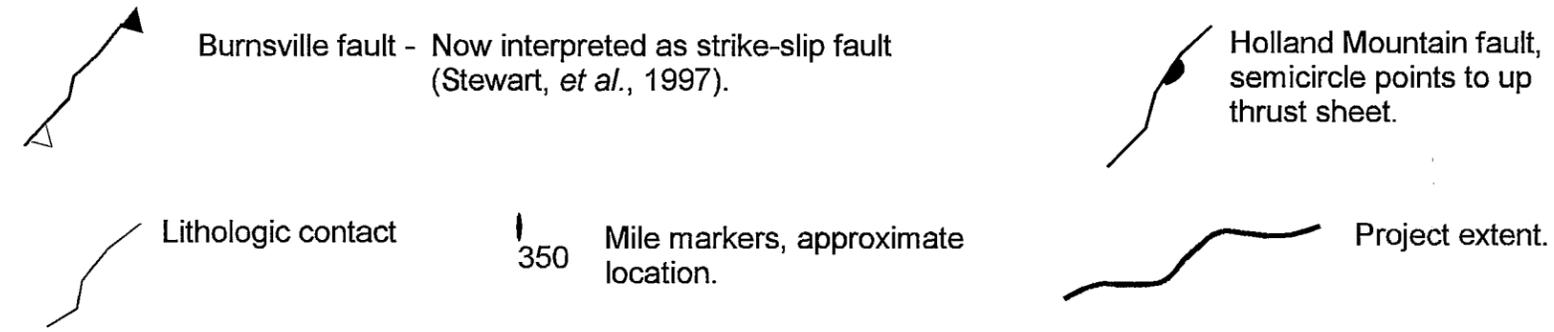
**ud ●** Dunite and peridotite - smaller bodies shown by symbol.

**us ★** Talc schist, soapstone, and serpentinite - smaller bodies shown by symbol.



Modified from "Preliminary Bedrock Geologic Map of the Knoxville 1° x 2° Quadrangle, Tennessee, North Carolina, and South Carolina" by Robinson, G. R., Jr.; Lesure, F. J.; Marlowe, J. I. II; Foley, N. K.; and Clark, S. H., 1979.

MAP SYMBOLS



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NORTH CAROLINA

|              |                  |                               |                                   |
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| DRAWN<br>DAP | DATE<br>10/22/03 | PROJECT MANAGER<br>B. CHAMLEE | DEPARTMENT MANAGER<br>B. WHITAKER |
| GEOLOGIC MAP |                  | SCALE<br>AS SHOWN             | CHECKED<br>S. MANNING             |
|              |                  | PROJECT NUMBER<br>CT052885    | FIGURE NUMBER<br>14               |

| NO. | DATE | REVISION DESCRIPTION | BY  |
|-----|------|----------------------|-----|
|     |      |                      | CKD |

## **Appendix B**

Project Photographs

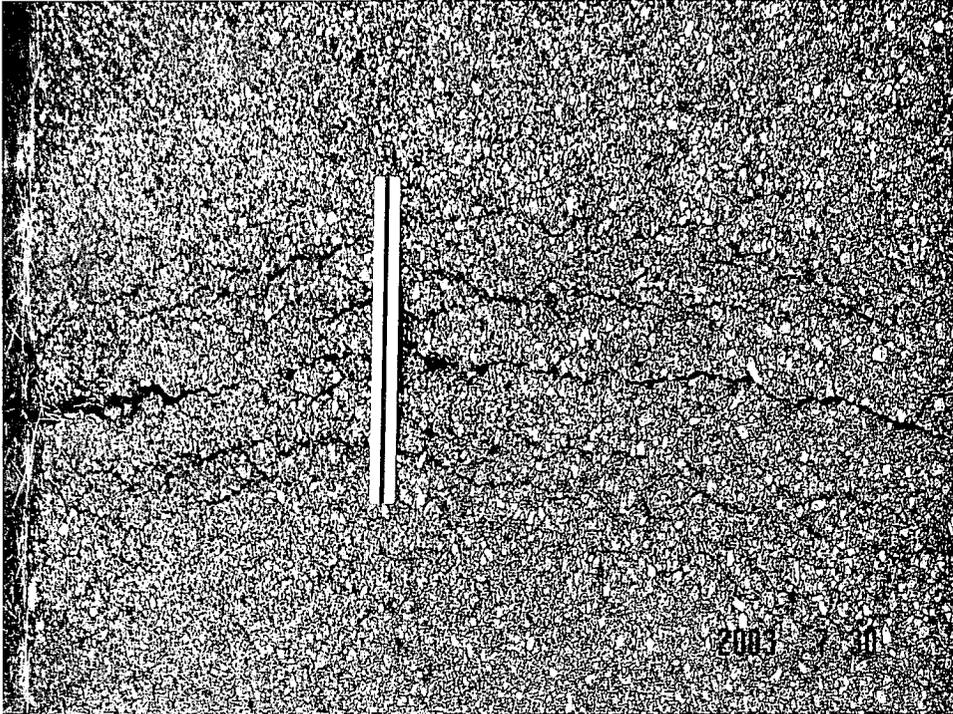


Photo 1  
1/4-Inch Transverse Crack with  
Adjacent Fatigue Cracking



Photo 2  
High Fatigue Cracking with High  
Severity Patching in Wheel Paths



Photo 3  
Moderate Severity Fatigue  
Cracking in Wheel Paths



Photo 4  
Low Severity Fatigue Cracking in  
Wheel Paths

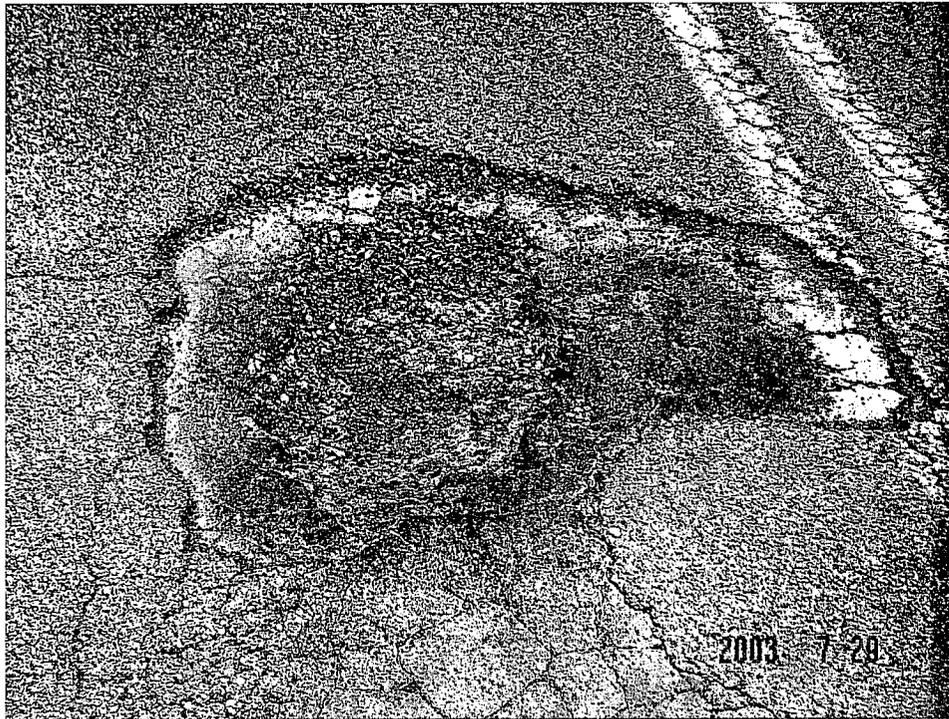


Photo 5  
Medium Pothole

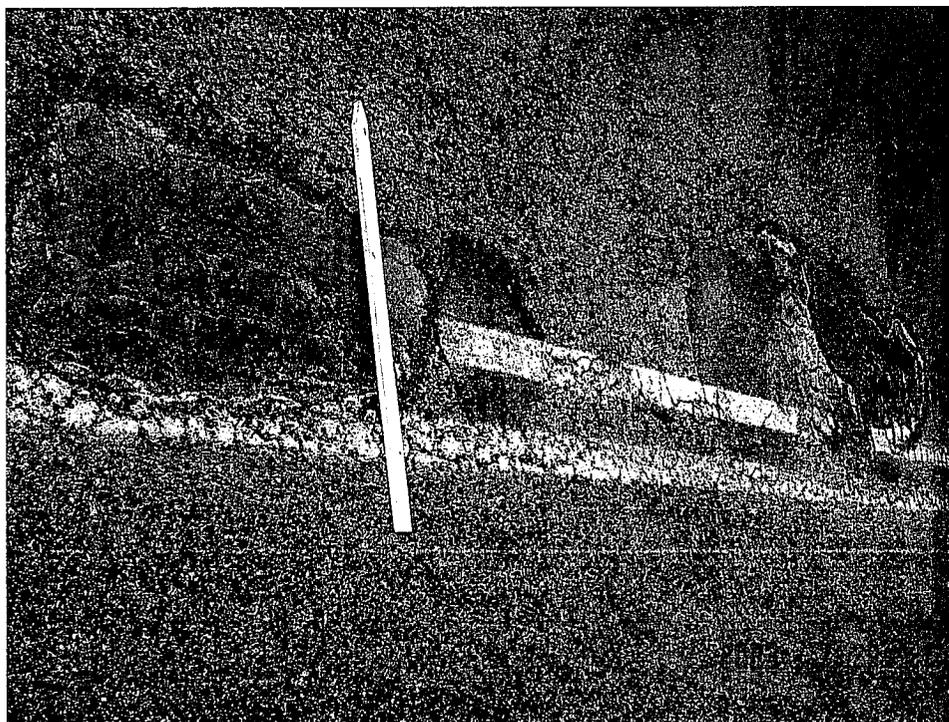


Photo 6  
Series of Small to Medium  
Potholes and Patching

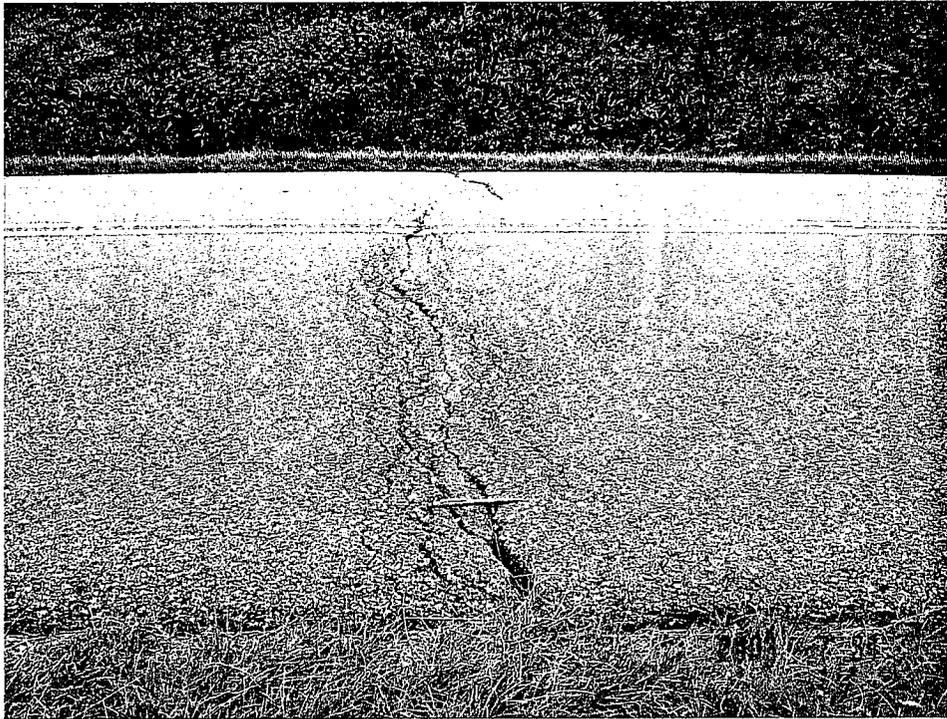


Photo 7  
1/2-Inch Transverse Crack with  
Adjacent Fatigue Cracking



Photo 8  
1/2-Inch Rutting in Wheel Path



Photo 9  
High Severity Fatigue Cracking  
with Small Pothole in Wheel Path

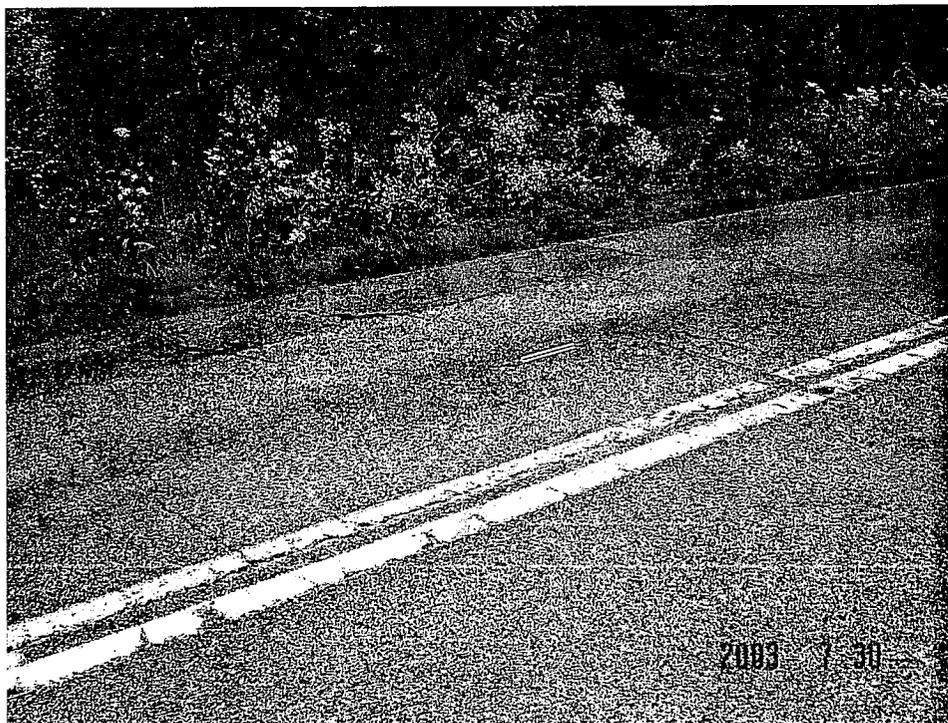


Photo 10  
Block Cracking



Photo 11  
Rock Core Drilling



Photo 12  
Dynamic Cone Penetration



Photo 13  
Non-Destructive Testing (Falling  
Weight Deflectometer)

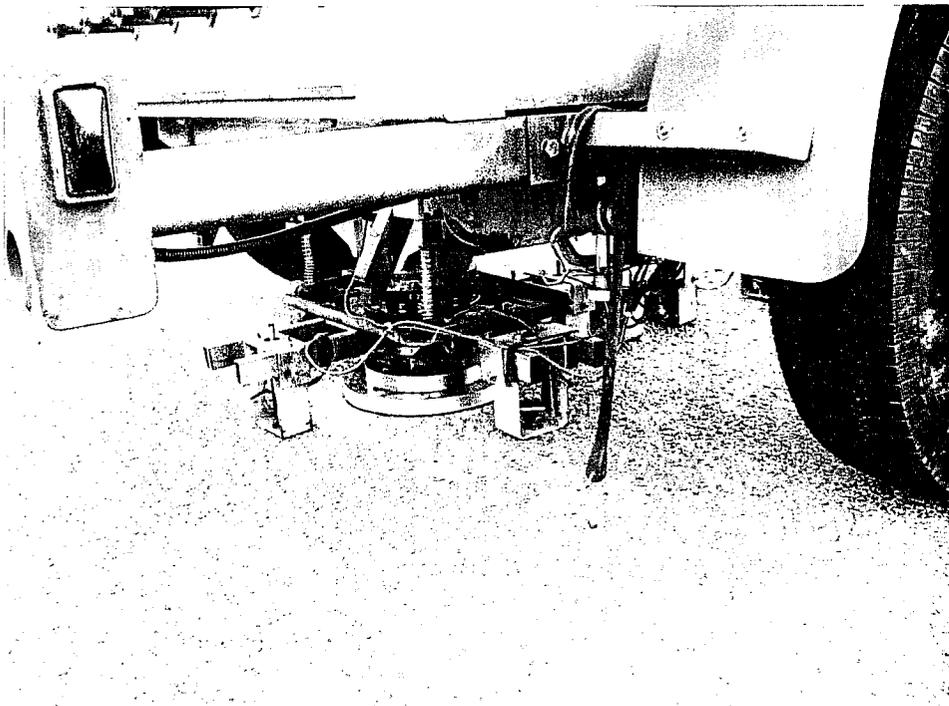


Photo 14  
Falling Weight Deflectometer  
Apparatus

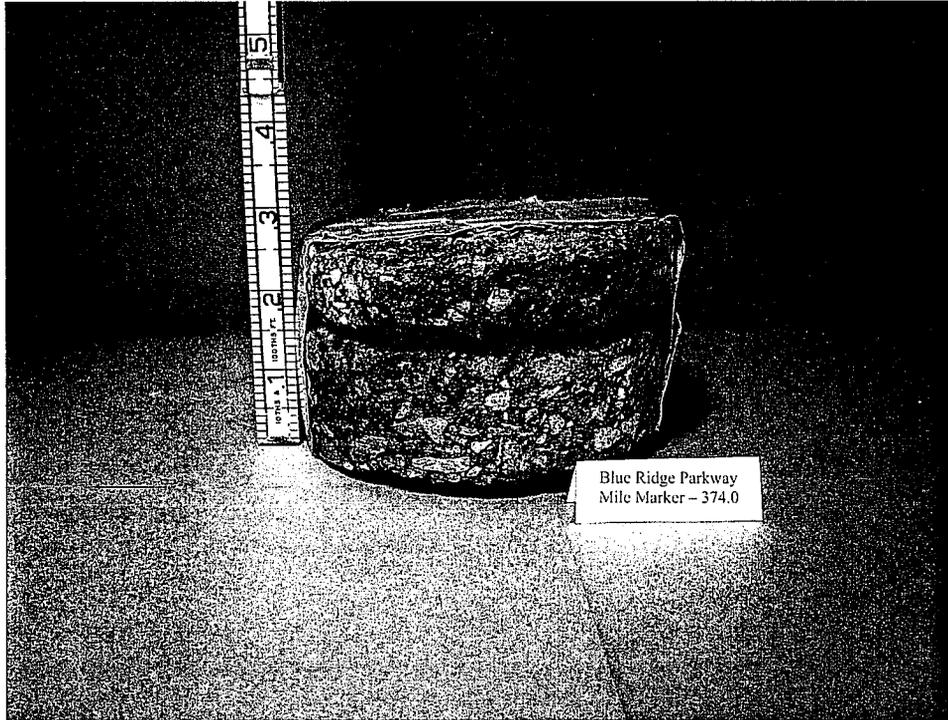


Photo 15  
Additional Asphalt Cores  
Mile Marker 374.0



Photo 16  
Additional Asphalt Cores  
Mile Marker 367.0



Photo 17  
Additional Asphalt Cores  
Mile Marker 368.0

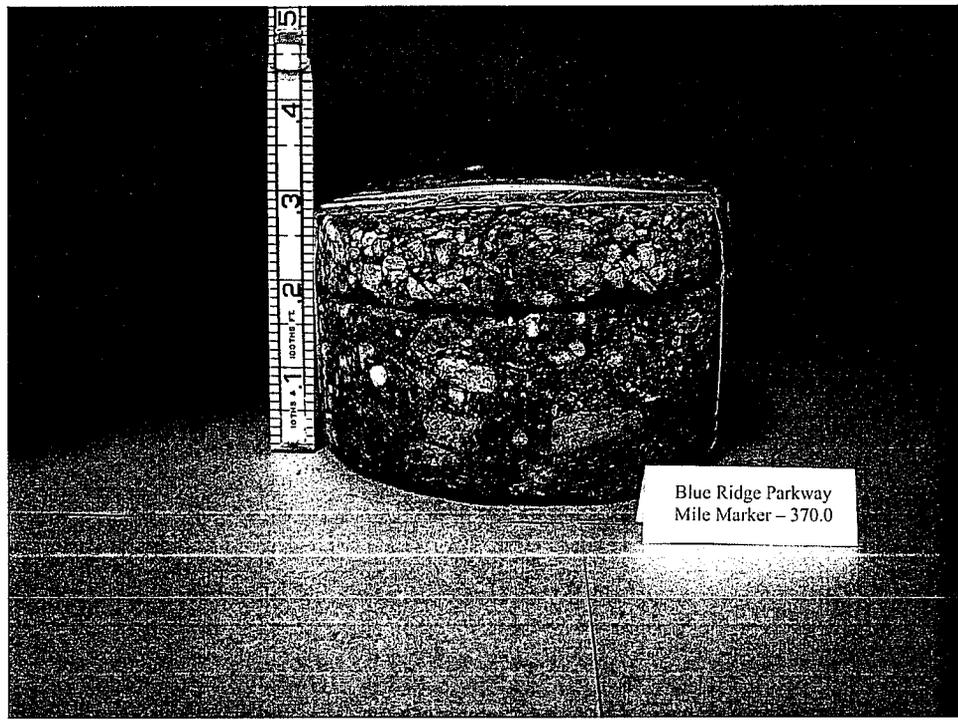


Photo 18  
Additional Asphalt Cores  
Mile Marker 370.0

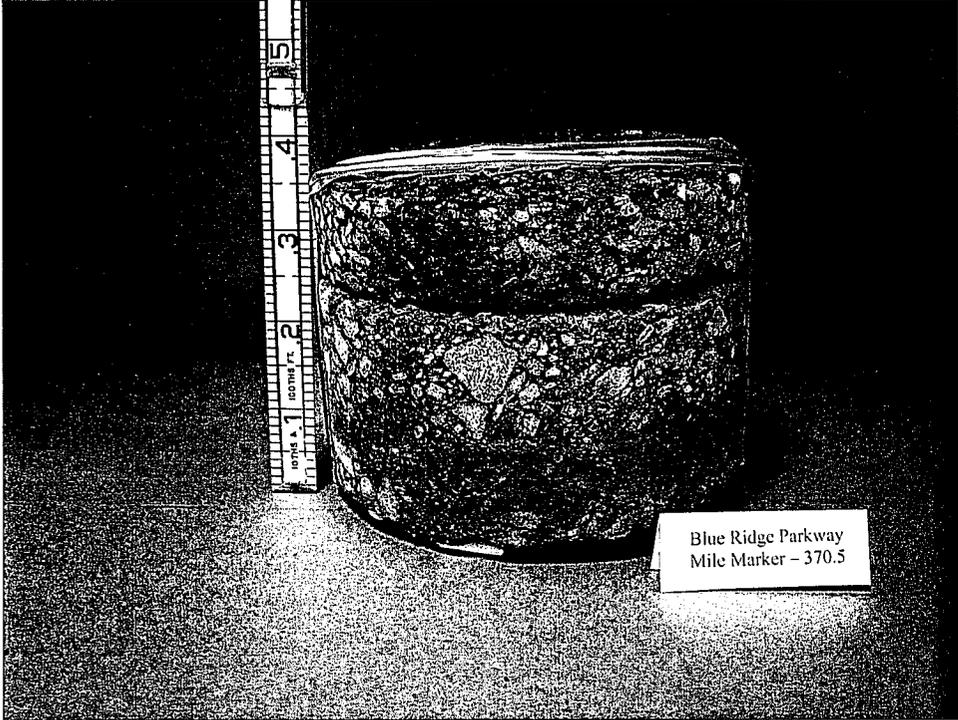


Photo 19  
Additional Asphalt Cores  
Mile Marker 370.5

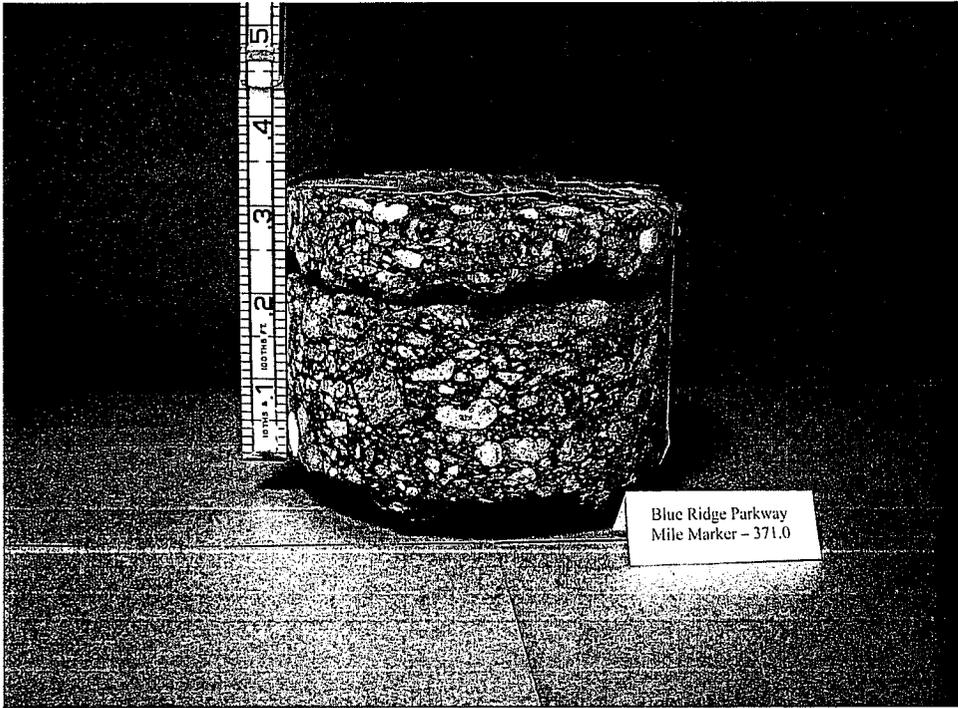


Photo 20  
Additional Asphalt Cores  
Mile Marker 371.0

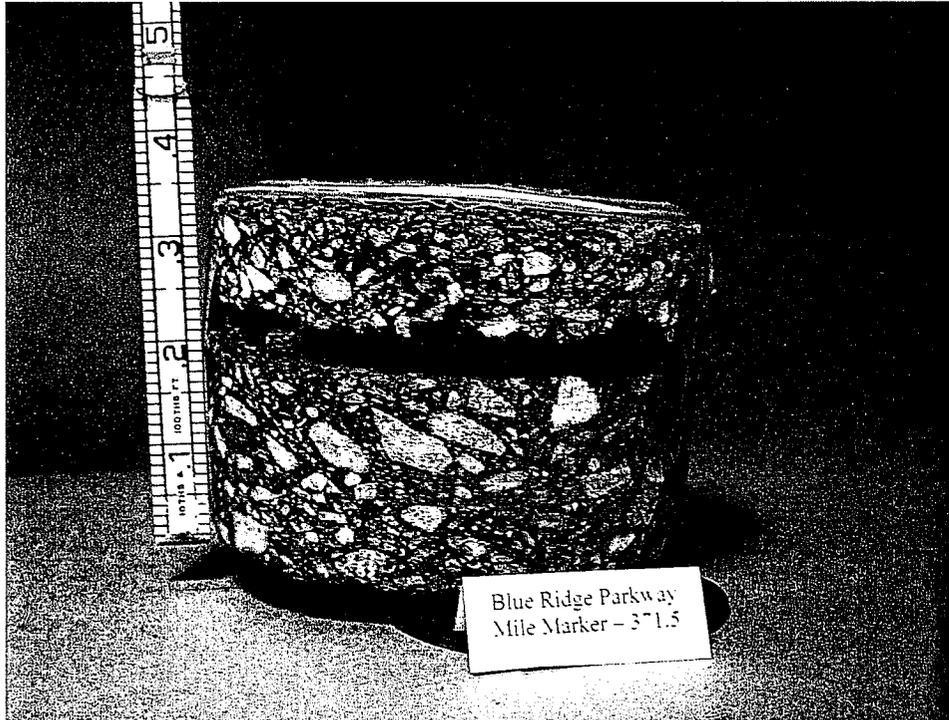


Photo 21  
Additional Asphalt Cores  
Mile Marker 371.5

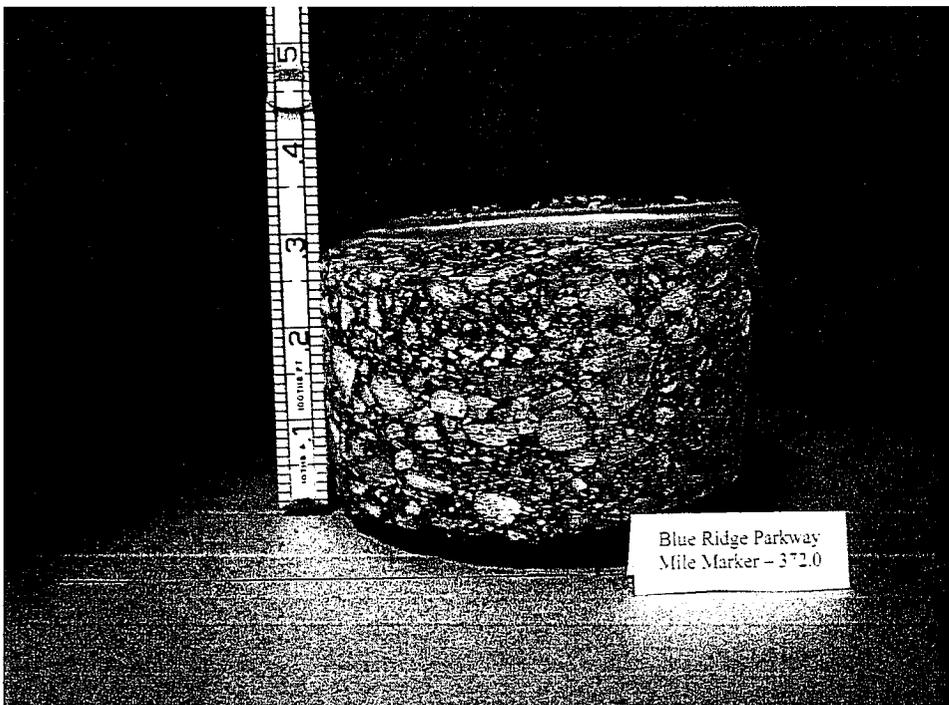


Photo 22  
Additional Asphalt Cores  
Mile Marker 372.0



Photo 23  
Additional Asphalt Cores  
Mile Marker 372.5



Photo 24  
Additional Asphalt Cores  
Mile Marker 373.0

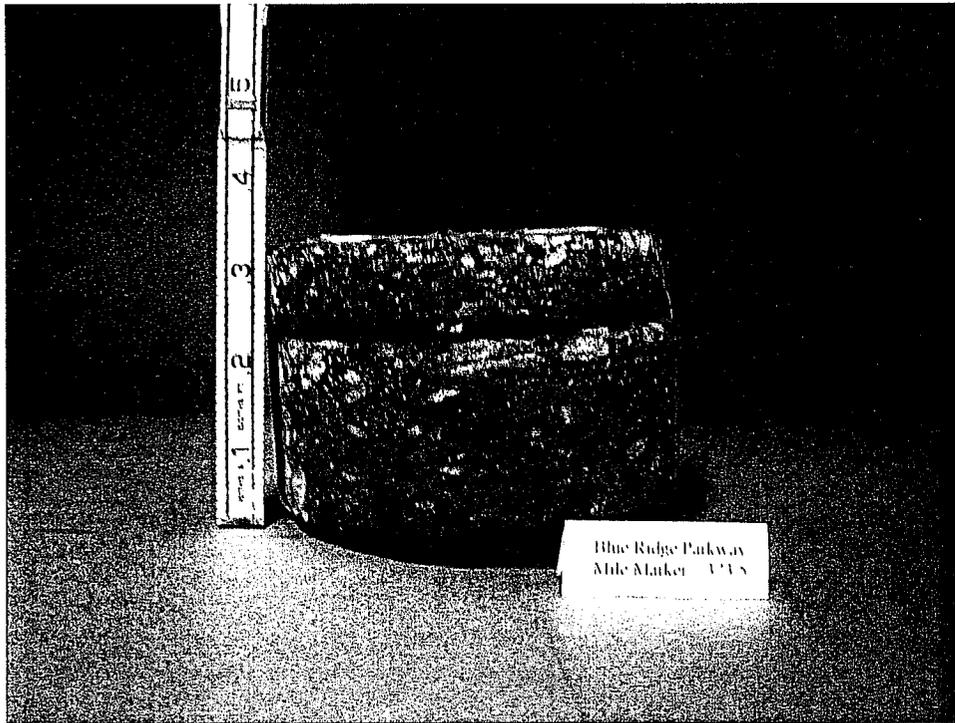


Photo 25  
Additional Asphalt Cores  
Mile Marker 373.5

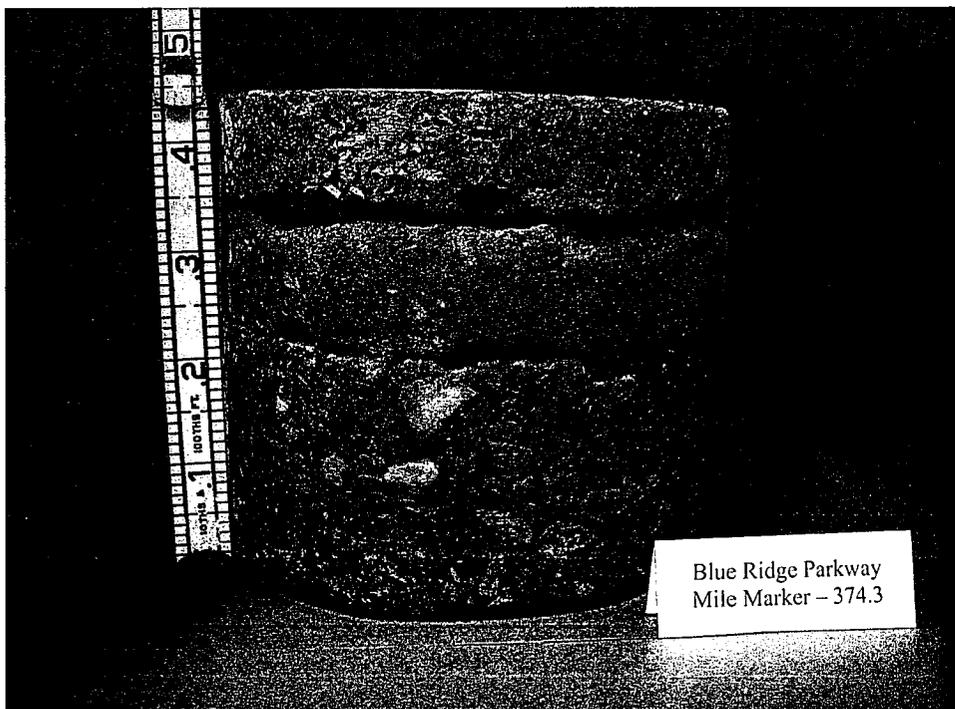


Photo 26  
Additional Asphalt Cores  
Mile Marker 374.3



Photo 27  
Additional Asphalt Cores  
Mile Marker 375.0

## **Appendix C**

Boring Logs

|  |                             |   |
|--|-----------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>           | <b>Notes:</b><br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 4 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc   |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550   |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Tan orange clayey SILT (A-7-6)                    |          |             | 1.0-2.5      |       |  |    |    |    |    |            |
| 2           |             |   | 28.8     |             |              |       |  |    |    |    |    |            |
| 3           |             | Tan orange silty SAND (A-2-4)                     |          |             | 2.5-4.0      |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface. | 21.6     |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

|  |                             |   |
|--|-----------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>           | <b>Notes:</b><br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 4 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc   |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550   |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Dark brown sandy SILT (A-7-6)                     |          |             | 1.0-2.5      |       |  |    |    |    |    |            |
| 2           |             |   | 67.9     |             |              |       |  |    |    |    |    |            |
| 3           |             | Dark brown silty SAND (A-2-4)                     |          |             | 2.5-4.0      |       |  |    | ●  |    |    | 11-15-16   |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

|  |                                |   |
|--|--------------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>              | <b>Notes:</b><br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 1.66 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc      |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550      |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                 | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown micaceous silty SAND (A-2-4)               | 10.7     |             | 1.0-1.7      |       |  |    |    |    |    |            |
| 2           |             | Auger refusal at 1.66 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 3           |             |  |          |             |              |       |  |    |    |    |    |            |
| 4           |             |  |          |             |              |       |  |    |    |    |    |            |
| 5           |             |  |          |             |              |       |  |    |    |    |    |            |
| 6           |             |  |          |             |              |       |  |    |    |    |    |            |
| 7           |             |  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 362/10+50  
(B-4)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 4 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem Augers

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG   | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|---|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |   |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |  | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |  | Brown micaceous silty fine SAND (A-2-4)           | 4.5      |             |              |       |  |    |    |    |    |            |
| 2           |   |   |          |             |              |       |  |    |    |    |    |            |
| 3           |   |   |          |             |              |       |  |    |    |    |    |            |
| 4           |   | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |   |   |          |             |              |       |  |    |    |    |    |            |
| 6           |   |   |          |             |              |       |  |    |    |    |    |            |
| 7           |   |   |          |             |              |       |  |    |    |    |    |            |

 - Initial Depth to Water

 - Final Depth to Water

|  |                             |   |
|--|-----------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>           | <b>Notes:</b><br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 4 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc   |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550   |   |

| DEPTH (ft.) | GRAPHIC LOG                                       | Soil Description | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|---|------------------|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |   |                  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           | Asphalt   |                  |          |             |              |       |  |    |    |    |    |            |
| 1           | Brown micaceous silty fine SAND (A-4)             |                  | 26.0     |             |              |       |  |    |    |    |    |            |
| 2           | Brown micaceous silty fine SAND (A-4)             |                  | 32.9     |             |              |       |  |    |    |    |    |            |
| 3           | Brown micaceous silty fine SAND (A-4)             |                  |          |             |              |       |  |    |    |    |    |            |
| 4           | Boring Terminated at 4 feet below ground surface. |                  |          |             |              |       |  |    |    |    |    |            |
| 5           |   |                  |          |             |              |       |  |    |    |    |    |            |
| 6           |   |                  |          |             |              |       |  |    |    |    |    |            |
| 7           |   |                  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

|  |                             |   |
|--|-----------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>           | <b>Notes:</b><br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 4 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc   |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550   |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Weathered Biotite Gneiss Schist (A-2-4)           | 7.3      |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   | 9.7      |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

|  |                             |  |
|--|-----------------------------|--|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>           | Notes:<br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 4 feet |  |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc   |  |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550   |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown micaceous silty fine SAND (A-2-4)           | 11.1     |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   | 11.8     |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

|  |                             |   |
|--|-----------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>           | <b>Notes:</b><br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 4 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc   |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550   |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown micaceous silty fine SAND with rock fragments (A-2-4) | 17.8     |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   | 10.4     |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface.           |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

|  |                                |  |
|--|--------------------------------|--|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>              | Notes:<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 1.75 feet |  |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc      |  |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550      |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown micaceous silty fine SAND with rock fragments (A-2-4) | 2.8      |             |              |       |  |    | ●  |    |    | 17-50/3"   |
| 2           |             | Auger refusal at 1.75 feet below ground surface.            |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   |          |             |              |       |  |    |    |    |    |            |
| 4           |             |   |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

|  |   |
|--|---|
| <b>PROJECT:</b><br>Blue Ridge Parkway<br>Section 2P<br>Asheville, NC | <b>BORING LOG      364/36+00</b><br><b>(B-10)</b> |
|--|---|

|  |                             |  |
|--|-----------------------------|--|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>           | Notes:<br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 4 feet |  |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc   |  |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550   |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | No Sample   | 11.1     |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   | 5.0      |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

|  |                                |  |
|--|--------------------------------|--|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>              | Notes:<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 3.25 feet |  |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc      |  |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550      |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                 | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown micaceous silty fine SAND (A-2-4)          |          |             |              |       |  |    |    |    |    | 7-7-7      |
| 2           |             |  |          |             |              |       |  |    |    |    |    |            |
| 3           |             | No Recovery                                      |          |             |              |       |  |    |    |    |    | 17-50/3"   |
| 4           |             | Auger refusal at 3.25 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |  |          |             |              |       |  |    |    |    |    |            |
| 6           |             |  |          |             |              |       |  |    |    |    |    |            |
| 7           |             |  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

|   |                      |  |
|---|----------------------|--|
| PROJECT NO.: CT052885.0000.00008          | ELEVATION:           | Notes:<br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Scott Manning                  | BORING DEPTH: 4 feet |  |
| DATE DRILLED: 8/6/2003                    | DRILLER: S&ME, Inc   |  |
| DRILLING METHOD: 4.25" Hollow Stem Augers | DRILL RIG: CME 550   |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown micaceous silty fine SAND (A-2-4)           |          |             |              |       |  |    |    |    |    | 10-9-11    |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   |          |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    | 6-7-8      |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 366/15+00  
(B-13)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 2.5 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem Augers

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown micaceous silty fine SAND with rock fragments (A-2-4)    | 9.1      |             |              |       |  |    |    |    |    | 18-50/3"   |
| 2.5         |             | No Recovery<br>Auger refusal at 2.5 feet below ground surface. |          |             |              |       |  |    |    |    |    | 50/0"      |
| 3           |             |  |          |             |              |       |  |    |    |    |    |            |
| 4           |             |  |          |             |              |       |  |    |    |    |    |            |
| 5           |             |  |          |             |              |       |  |    |    |    |    |            |
| 6           |             |  |          |             |              |       |  |    |    |    |    |            |
| 7           |             |  |          |             |              |       |  |    |    |    |    |            |

▽ - Initial Depth to Water

▽ - Final Depth to Water

|  |                                |  |
|--|--------------------------------|--|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>              | Notes:<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 2.83 feet |  |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc      |  |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550      |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count  |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|-------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |             |
| 0           | ASPHALT     | Asphalt   |          |             |              |       |  |    |    |    |    |             |
| 1           | SAND        | Brown micaceous silty fine SAND with rock fragments (A-2-4) | 5.5      |             |              |       |  |    |    |    |    | 18-16-50/2" |
| 2           | SAND        | Dark gray gravelly silty fine to coarse SAND (A-2-4)        | 4.2      |             |              |       |  |    |    |    |    | 50/4"       |
| 3           |             | Auger refusal at 2.83 feet below ground surface.            |          |             |              |       |  |    |    |    |    |             |
| 4           |             |   |          |             |              |       |  |    |    |    |    |             |
| 5           |             |   |          |             |              |       |  |    |    |    |    |             |
| 6           |             |   |          |             |              |       |  |    |    |    |    |             |
| 7           |             |   |          |             |              |       |  |    |    |    |    |             |

- Initial Depth to Water
- Final Depth to Water

**PROJECT:**  
*Blue Ridge Parkway  
 Section 2P  
 Asheville, NC*

**BORING LOG 367/21+50  
 (B-15)**

**PROJECT NO.:** CT052885.0000.00008

**ELEVATION:**

**Notes:**  
 Auger refusal was not encountered.  
 Groundwater was not encountered in boring at time of drilling.

**LOGGED BY:** Scott Manning

**BORING DEPTH:** 4 feet

**DATE DRILLED:** 8/6/2003

**DRILLER:** S&ME, Inc

**DRILLING METHOD:** 4.25" Hollow Stem Augers

**DRILL RIG:** CME 550

| DEPTH (ft.) | GRAPHIC LOG   | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|---|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |   |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |  | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |   | No Sample   |          |             |              |       |  |    |    |    |    |            |
| 2           |   |   |          |             |              |       |  |    |    |    |    |            |
| 3           |   | No Sample   |          |             |              |       |  |    |    |    |    |            |
| 4           |   | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |   |   |          |             |              |       |  |    |    |    |    |            |
| 6           |   |   |          |             |              |       |  |    |    |    |    |            |
| 7           |   |   |          |             |              |       |  |    |    |    |    |            |

 - Initial Depth to Water  
 - Final Depth to Water

|   |                      |  |
|---|----------------------|--|
| PROJECT NO.: CT052885.0000.00008          | ELEVATION:           | Notes:<br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Scott Manning                  | BORING DEPTH: 4 feet |  |
| DATE DRILLED: 8/6/2003                    | DRILLER: S&ME, Inc   |  |
| DRILLING METHOD: 4.25" Hollow Stem Augers | DRILL RIG: CME 550   |  |

| DEPTH (ft.) | GRAPHIC LOG   | Soil Description | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|---|------------------|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |   |                  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           | Asphalt   |                  |          |             |              |       |  |    |    |    |    |            |
| 1           | Gray brown gravelly silty fine to medium SAND (A-2-4) |                  | 11.1     |             |              |       |  |    |    |    |    | 10-18-21   |
| 2           |   |                  |          |             |              |       |  |    |    |    |    |            |
| 3           |   |                  | 9.9      |             |              |       |  |    |    |    |    | 10-20-42   |
| 4           | Boring Terminated at 4 feet below ground surface.     |                  |          |             |              |       |  |    |    |    |    |            |
| 5           |   |                  |          |             |              |       |  |    |    |    |    |            |
| 6           |   |                  |          |             |              |       |  |    |    |    |    |            |
| 7           |   |                  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

|  |                             |   |
|--|-----------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>           | <b>Notes:</b><br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 4 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc   |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550   |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | White tan silty fine to coarse SAND (A-2-4)       |          |             |              | 19.9  |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   |          |             |              | 20.6  |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 368/38+00  
(B-18)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 2.5 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem Augers

DRILL RIG: CME 550

| DEPTH (ft) | GRAPHIC LOG   | Soil Description                                | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|------------|---|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|            |   |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0          |  | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1          |  | Brown micaceous silty fine SAND (A-2-4)         | 15.2     |             |              |       |  |    |    |    |    |            |
| 2.5        |   | Auger refusal at 2.5 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 3          |   |   |          |             |              |       |  |    |    |    |    |            |
| 4          |   |   |          |             |              |       |  |    |    |    |    |            |
| 5          |   |   |          |             |              |       |  |    |    |    |    |            |
| 6          |   |   |          |             |              |       |  |    |    |    |    |            |
| 7          |   |   |          |             |              |       |  |    |    |    |    |            |

 - Initial Depth to Water

 - Final Depth to Water

|   |                         |  |
|---|-------------------------|--|
| PROJECT NO.: CT052885.0000.00008          | ELEVATION:              | Notes:<br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Scott Manning                  | BORING DEPTH: 3.25 feet |  |
| DATE DRILLED: 8/6/2003                    | DRILLER: S&ME, Inc      |  |
| DRILLING METHOD: 4.25" Hollow Stem Augers | DRILL RIG: CME 550      |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown slightly micaceous silty fine to coarse SAND (A-2-4) | 12.2     |             |              |       |  |    |    |    |    | 3-17-24    |
| 2           |             |  |          |             |              |       |  |    |    |    |    |            |
| 3           |             | Refused on a boulder                                       | 4.7      |             |              |       |  |    |    |    |    | 38-50/4"   |
| 4           |             | Auger refusal at 3.25 feet below ground surface.           |          |             |              |       |  |    |    |    |    |            |
| 5           |             |  |          |             |              |       |  |    |    |    |    |            |
| 6           |             |  |          |             |              |       |  |    |    |    |    |            |
| 7           |             |  |          |             |              |       |  |    |    |    |    |            |

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 369/14+00  
(B-20)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 4 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem Augers

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown micaceous silty fine SAND (A-2-4)                     | 9.9      |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             | Brown micaceous silty fine SAND with rock fragments (A-2-4) | 9.6      |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface.           |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

☒ - Initial Depth to Water

☒ - Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 369/39+00  
(B-21)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 1 foot

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem Augers

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                    | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
|             |             | From auger cuttings - Brown silty fine SAND (A-2-4) | 5.5      |             |              |       |  |    |    |    |    |            |
| 1           |             | Auger refusal at 1 foot below ground surface.       |          |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   |          |             |              |       |  |    |    |    |    |            |
| 4           |             |   |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

▽ - Initial Depth to Water

▽ - Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 370/13+00  
(B-22)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 4 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem  
Augers

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Red brown micaceous silty fine SAND (A-2-4)       | 10.3     |             |              |       |  |    |    |    |    | 11-13-9    |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   | 8.0      |             |              |       |  |    |    |    |    | 8-6-5      |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water

- Final Depth to Water

|  |   |
|--|---|
| <b>PROJECT:</b><br>Blue Ridge Parkway<br>Section 2P<br>Asheville, NC | <b>BORING LOG    370/38+00</b><br><b>(B-23)</b> |
|--|---|

|  |                                |   |
|--|--------------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>              | <b>Notes:</b><br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 2.75 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc      |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550      |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                 | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Gray brown silty fine SAND (A-2-4)               |          |             |              | 9.7   |  |    |    |    |    |            |
| 2           |             |  |          |             |              |       |  |    |    |    |    |            |
| 3           |             | Auger refusal at 2.75 feet below ground surface. |          |             |              | 7.2   |  |    |    |    | ●  | 50/3"      |
| 4           |             |  |          |             |              |       |  |    |    |    |    |            |
| 5           |             |  |          |             |              |       |  |    |    |    |    |            |
| 6           |             |  |          |             |              |       |  |    |    |    |    |            |
| 7           |             |  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water
- Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 371/15+00  
(B-24)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:

Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 4 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem  
Augers

DRILL RIG: CME 550

| DEPTH<br>(ft.) | GRAPHIC<br>LOG | Soil Description   | W<br>OR<br>PPR | WATER<br>LEVEL | SAMPLE<br>DEPTH | ELEV. | Standard Penetration Test Data<br>N- (Blows/ft) |    |    |    |    | Blow<br>Count |
|----------------|----------------|--|----------------|----------------|-----------------|-------|---|----|----|----|----|---------------|
|                |                |  |                |                |                 |       | 10  | 30 | 50 | 70 | 90 |               |
| 0              |                | Asphalt  |                |                |                 |       |   |    |    |    |    |               |
| 11.3           |                | Red brown micaceous gravelly silty fine to medium SAND (A-2-4) |                |                |                 |       |   |    |    |    |    |               |
| 14.9           |                |  |                |                |                 |       |   |    |    |    |    |               |
| 4              |                | Boring Terminated at 4 feet below ground surface.              |                |                |                 |       |   |    |    |    |    |               |

- Initial Depth to Water

- Final Depth to Water

**PROJECT:**

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 371/25+00  
(B-25)**

**PROJECT NO.:** CT052885.0000.00008

**ELEVATION:**

**Notes:**  
Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

**LOGGED BY:** Scott Manning

**BORING DEPTH:** 4 feet

**DATE DRILLED:** 8/6/2003

**DRILLER:** S&ME, Inc

**DRILLING METHOD:** 4.25" Hollow Stem  
Augers

**DRILL RIG:** CME 550

| DEPTH<br>(ft.) | GRAPHIC<br>LOG | Soil Description                                  | W<br>OR<br>PPR | WATER<br>LEVEL | SAMPLE<br>DEPTH | ELEV. | Standard Penetration Test Data<br>N- (Blows/ft) |    |    |    |    | Blow<br>Count |
|----------------|----------------|---|----------------|----------------|-----------------|-------|---|----|----|----|----|---------------|
|                |                |   |                |                |                 |       | 10  | 30 | 50 | 70 | 90 |               |
| 0              |                | Asphalt   |                |                |                 |       |   |    |    |    |    |               |
| 1              |                | Dark brown micaceous silty fine SAND (A-2-4)      |                |                |                 |       |   |    |    |    |    | 4-5-7         |
| 2              |                | Dark brown micaceous silty fine SAND (A-4)        |                |                |                 |       |   |    |    |    |    | 8-4-2         |
| 3              |                | Dark brown micaceous silty fine SAND (A-4)        |                |                |                 |       |   |    |    |    |    |               |
| 4              |                | Boring Terminated at 4 feet below ground surface. |                |                |                 |       |   |    |    |    |    |               |
| 5              |                |   |                |                |                 |       |   |    |    |    |    |               |
| 6              |                |   |                |                |                 |       |   |    |    |    |    |               |
| 7              |                |   |                |                |                 |       |   |    |    |    |    |               |

- Initial Depth to Water

- Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 371/30+00  
(B-26)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 4 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem Augers

DRILL RIG: CME 550

| DEPTH (ft) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|            |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0          |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1          |             | Brown micaceous silty fine SAND (A-2-4)           | 11.3     |             |              |       |  |    |    |    |    |            |
| 2          |             |   |          |             |              |       |  |    |    |    |    |            |
| 3          |             |   | 6.7      |             |              |       |  |    |    |    |    |            |
| 4          |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5          |             |   |          |             |              |       |  |    |    |    |    |            |
| 6          |             |   |          |             |              |       |  |    |    |    |    |            |
| 7          |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water

- Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 372/14+00  
(B-27)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 2 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem Augers

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                              | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt                                       |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Red brown micaceous silty fine SAND (A-4)     | 17.9     |             |              |       |  |    |    |    |    |            |
| 2           |             | Auger refusal at 2 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   |          |             |              |       |  |    |    |    |    |            |
| 4           |             |   |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

▽ - Initial Depth to Water

▽ - Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 372/39+50  
(B-28)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 4 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem  
Augers

DRILL RIG: CME 550

| DEPTH<br>(ft.) | GRAPHIC<br>LOG | Soil Description                                  | W<br>OR<br>PPR | WATER<br>LEVEL | SAMPLE<br>DEPTH | ELEV. | Standard Penetration Test Data<br>N- (Blows/ft) |    |    |    |    | Blow<br>Count |
|----------------|----------------|---|----------------|----------------|-----------------|-------|---|----|----|----|----|---------------|
|                |                |   |                |                |                 |       | 10  | 30 | 50 | 70 | 90 |               |
| 0              |                | Asphalt   |                |                |                 |       |   |    |    |    |    |               |
| 1              |                | Brown micaceous silty fine SAND (A-2-4)           | 12.6           |                |                 |       |   |    |    |    |    | 7-11-5        |
| 2              |                |   |                |                |                 |       |   |    |    |    |    |               |
| 3              |                |   | 18.0           |                |                 |       |   |    |    |    |    | 8-9-11        |
| 4              |                | Boring Terminated at 4 feet below ground surface. |                |                |                 |       |   |    |    |    |    |               |
| 5              |                |   |                |                |                 |       |   |    |    |    |    |               |
| 6              |                |   |                |                |                 |       |   |    |    |    |    |               |
| 7              |                |   |                |                |                 |       |   |    |    |    |    |               |

▽ - Initial Depth to Water

▽ - Final Depth to Water

|  |                               |   |
|--|-------------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>             | <b>Notes:</b><br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 2.5 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc     |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550     |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown micaceous silty fine SAND (A-2-4)         | 13.4     |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             | Auger refusal at 2.5 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 4           |             |   |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

|   |                      |  |
|---|----------------------|--|
| PROJECT NO.: CT052885.0000.00008          | ELEVATION:           | Notes:<br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Scott Manning                  | BORING DEPTH: 4 feet |  |
| DATE DRILLED: 8/6/2003                    | DRILLER: S&ME, Inc   |  |
| DRILLING METHOD: 4.25" Hollow Stem Augers | DRILL RIG: CME 550   |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown silty fine SAND (A-4)                       | 19.3     |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   | 21.2     |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

PROJECT: *Blue Ridge Parkway  
Section 2P  
Asheville, NC*

**BORING LOG 373/49+50  
(B-31)**

PROJECT NO.: CT052885.0000.00008  
 ELEVATION:  
 LOGGED BY: Scott Manning  
 BORING DEPTH: 2.9 feet  
 DATE DRILLED: 8/6/2003  
 DRILLER: S&ME, Inc  
 DRILLING METHOD: 4.25" Hollow Stem Augers  
 DRILL RIG: CME 550

Notes:  
 Groundwater was not encountered in boring at time of drilling.

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                       | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown slightly micaceous silty SAND (A-4)              | 16.6     |             |              |       |  |    |    |    |    | 8-12-21    |
| 2           |             | Weathered Biotite Gneiss Schist Rock Fragments (A-2-4) | 7.0      |             |              |       |  |    |    |    |    | 50/5"      |
| 3           |             | Auger refusal at 2.9 feet below ground surface.        |          |             |              |       |  |    |    |    |    |            |
| 4           |             |  |          |             |              |       |  |    |    |    |    |            |
| 5           |             |  |          |             |              |       |  |    |    |    |    |            |
| 6           |             |  |          |             |              |       |  |    |    |    |    |            |
| 7           |             |  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

|   |                      |   |
|---|----------------------|---|
| PROJECT NO.: CT052885.0000.00008          | ELEVATION:           | <b>Notes:</b><br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Scott Manning                  | BORING DEPTH: 4 feet |   |
| DATE DRILLED: 8/6/2003                    | DRILLER: S&ME, Inc   |   |
| DRILLING METHOD: 4.25" Hollow Stem Augers | DRILL RIG: CME 550   |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                       | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown slightly micaceous silty SAND (A-4)              | 19.7     |             |              |       |  |    |    |    |    |            |
| 3           |             | Weathered Biotite Gneiss Schist rock fragments (A-2-4) | 3.1      |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface.      |          |             |              |       |  |    |    |    |    |            |
| 5           |             |  |          |             |              |       |  |    |    |    |    |            |
| 6           |             |  |          |             |              |       |  |    |    |    |    |            |
| 7           |             |  |          |             |              |       |  |    |    |    |    |            |

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 375/0+00  
(B-33)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 4 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem Augers

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG  | Soil Description                                       | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|--|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |  |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |   | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 1           |   | Red brown micaceous silty Sand (A-4)                   | 14.2     |             |              |       |  |    |    |    |    |            |
| 3           |  | Weathered Biotite Gneiss Schist rock fragments (A-2-4) | 0.9      |             |              |       |  |    |    |    |    |            |
| 4           |  | Boring Terminated at 4 feet below ground surface.      |          |             |              |       |  |    |    |    |    |            |
| 5           |  |  |          |             |              |       |  |    |    |    |    |            |
| 6           |  |  |          |             |              |       |  |    |    |    |    |            |
| 7           |  |  |          |             |              |       |  |    |    |    |    |            |

 - Initial Depth to Water

 - Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG PA/20+50  
(B-34)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:

Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 4 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem  
Augers

DRILL RIG: CME 550

| DEPTH<br>(ft.) | GRAPHIC<br>LOG  | Soil Description  | W<br>OR<br>PPR | WATER<br>LEVEL | SAMPLE<br>DEPTH | ELEV. | Standard Penetration Test Data<br>N- (Blows/ft) |    |    |    |    | Blow<br>Count |
|----------------|---|---|----------------|----------------|-----------------|-------|---|----|----|----|----|---------------|
|                |   |   |                |                |                 |       | 10  | 30 | 50 | 70 | 90 |               |
| 0              |    | Asphalt   |                |                |                 |       |   |    |    |    |    |               |
| 1              |    | Brown silty fine to medium SAND with rock fragments (A-2-4) | 7.9            |                |                 |       |   |    |    |    |    |               |
| 2              |    | Brown silty fine to medium SAND (A-2-4)                     | 20.0           |                |                 |       |   |    |    |    |    |               |
| 3              |   | Brown silty fine to medium SAND (A-2-4)                     |                |                |                 |       |   |    |    |    |    |               |
| 4              |  | Boring Terminated at 4 feet below ground surface.           |                |                |                 |       |   |    |    |    |    |               |
| 5              |   |   |                |                |                 |       |   |    |    |    |    |               |
| 6              |   |   |                |                |                 |       |   |    |    |    |    |               |
| 7              |   |   |                |                |                 |       |   |    |    |    |    |               |

 - Initial Depth to Water

 - Final Depth to Water

|  |                                       |
|--|---------------------------------------|
| <b>PROJECT:</b><br>Blue Ridge Parkway<br>Section 2P<br>Asheville, NC | <b>BORING LOG PA/36+80<br/>(B-35)</b> |
|--|---------------------------------------|

|   |                      |  |
|---|----------------------|--|
| PROJECT NO.: CT052885.0000.00008          | ELEVATION:           | Notes:<br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Scott Manning                  | BORING DEPTH: 4 feet |  |
| DATE DRILLED: 8/6/2003                    | DRILLER: S&ME, Inc   |  |
| DRILLING METHOD: 4.25" Hollow Stem Augers | DRILL RIG: CME 550   |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown silty fine SAND (A-2-4)                     | 27.4     |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             |   | 27.8     |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- ▽ - Initial Depth to Water
- ▽ - Final Depth to Water

**PROJECT:**

*Blue Ridge Parkway  
Section 2P  
Asheville, NC*

**BORING LOG 361.8 L  
(B-36)**

**PROJECT NO.:** CT052885.0000.00008

**ELEVATION:**

**Notes:**  
Groundwater was not encountered in boring at time of drilling.

**LOGGED BY:** Dewayne Ponds

**BORING DEPTH:** 18.3 feet

**DATE DRILLED:** 8/8/2003

**DRILLER:** S&ME, Inc

**DRILLING METHOD:** NQ Rock Core

**DRILL RIG:** CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Topsoil   |          |             |              |       |  |    |    |    |    |            |
|             |             | Shot rock and sand  |          |             |              |       |  |    |    |    |    |            |
| 2.5         |             | Pull 1 - from 2.0 to 8.0 feet.<br>Material consisted of shot rock and sand  |          |             |              |       |  |    |    |    |    |            |
|             |             | Run - 6.0 feet<br>Rec - 50%<br>RQD - 50%  |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7.5         |             | Pull 2 through 4 are short run with difficult drilling -<br>from 8.0 to 13.0 feet.<br>Material consisted of shot rock and sand. |          |             |              |       |  |    |    |    |    |            |
| 10          |             |   |          |             |              |       |  |    |    |    |    |            |
| 12.5        |             | Pull 5 - from 13.0 to 18.0 feet.<br>Material consisted of shot rock and dark soil   |          |             |              |       |  |    |    |    |    |            |
| 15          |             | Run - 5.0 feet<br>Rec - 14%<br>RQD - 14%  |          |             |              |       |  |    |    |    |    |            |
| 17.5        |             | Pull 6 - from 18.0 to 20.0 feet.  |          |             |              |       |  |    |    |    |    |            |

☒ - Initial Depth to Water

☒ - Final Depth to Water

**PROJECT:**

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 361.8 L  
(B-36)**

**PROJECT NO.:** CT052885.0000.00008

**ELEVATION:**

**Notes:**  
Groundwater was not encountered in boring at time of drilling.

**LOGGED BY:** Dewayne Ponds

**BORING DEPTH:** 18.3 feet

**DATE DRILLED:** 8/8/2003

**DRILLER:** S&ME, Inc

**DRILLING METHOD:** NQ Rock Core

**DRILL RIG:** CME 550

| DEPTH<br>(ft.) | GRAPHIC<br>LOG | Soil Description  | W<br>OR<br>PPR | WATER<br>LEVEL | SAMPLE<br>DEPTH | ELEV. | Standard Penetration Test Data<br>N- (Blows/ft) |    |    |    |    | Blow<br>Count |
|----------------|----------------|---|----------------|----------------|-----------------|-------|---|----|----|----|----|---------------|
|                |                |   |                |                |                 |       | 10  | 30 | 50 | 70 | 90 |               |
| 20             |                | Material consisted of shot rock and sand from 20.0 to 23.0 feet.<br>Metagraywake with interbedded mica schist<br><br>Run - 5.0 feet<br>Rec - 68%<br>RQD - 68% |                |                |                 |       |   |    |    |    |    |               |
| 22.5           |                | Pull 7 - from 23.0 to 27.2 feet.<br>Metagraywake with interbedded mica schist<br><br>Run - 4.2 feet<br>Rec - 100%<br>RQD - 100%                               |                |                |                 |       |   |    |    |    |    |               |
| 27.5           |                | Coring terminated at 27.2 feet below ground surface.  |                |                |                 |       |   |    |    |    |    |               |
| 30             |                |   |                |                |                 |       |   |    |    |    |    |               |
| 32.5           |                |   |                |                |                 |       |   |    |    |    |    |               |
| 35             |                |   |                |                |                 |       |   |    |    |    |    |               |

- Initial Depth to Water

- Final Depth to Water

|  |   |
|--|---|
| <b>PROJECT:</b><br>Blue Ridge Parkway<br>Section 2P<br>Asheville, NC | <b>BORING LOG      361.8 R</b><br><b>(B-37)</b> |
|--|---|

|                                  |                         |  |
|----------------------------------|-------------------------|--|
| PROJECT NO.: CT052885.0000.00008 | ELEVATION:              | Notes:<br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Dewayne Ponds         | BORING DEPTH: 18.3 feet |  |
| DATE DRILLED: 8/8/2003           | DRILLER: S&ME, Inc      |  |
| DRILLING METHOD: NQ Rock Core    | DRILL RIG: CME 550      |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           | █           | Asphalt  |          |             |              |       |  |    |    |    |    |            |
|             | █           | Shot rock and sand   |          |             |              |       |  |    |    |    |    |            |
| 2.5         | █           |  |          |             |              |       |  |    |    |    |    |            |
|             | █           | Pull 1 - from 4.0 to 8.0 feet.<br>Material consisted of shot rock and sand   |          |             |              |       |  |    |    |    |    |            |
| 5           | █           | Run - 4.0 feet<br>Rec - 25%<br>RQD - 25%                                     |          |             |              |       |  |    |    |    |    |            |
| 7.5         | █           |  |          |             |              |       |  |    |    |    |    |            |
|             | █           | Pull 2 - from 8.0 to 12.0 feet.<br>Material consisted of shot rock and sand  |          |             |              |       |  |    |    |    |    |            |
| 10          | █           | Run - 4.0 feet<br>Rec - 25%<br>RQD - 25%                                     |          |             |              |       |  |    |    |    |    |            |
| 12.5        | █           |  |          |             |              |       |  |    |    |    |    |            |
|             | █           | Pull 3 - from 12.0 to 17.0 feet.<br>Material consisted of shot rock and sand |          |             |              |       |  |    |    |    |    |            |
| 15          | █           | Run - 5.0 feet<br>Rec - 20%<br>RQD - 20%                                     |          |             |              |       |  |    |    |    |    |            |
| 17.5        | █           |  |          |             |              |       |  |    |    |    |    |            |
|             | █           | Pull 4 - from 17.0 to 22.0 feet.<br>Material consisted of shot rock and sand |          |             |              |       |  |    |    |    |    |            |
|             | █           | Run - 5.0 feet   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 361.8 R  
(B-37)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Dewayne Ponds

BORING DEPTH: 18.3 feet

DATE DRILLED: 8/8/2003

DRILLER: S&ME, Inc

DRILLING METHOD: NQ Rock Core

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 20          |             | Rec - 36%<br>RQD - 36%  |          |             |              |       |  |    |    |    |    |            |
| 22.5        |             | Pull 5 - from 22.0 to 27.0 feet.<br>Material consists of shot rock and sand.                    |          |             |              |       |  |    |    |    |    |            |
| 25          |             | Run - 5.0 feet<br>Rec - 36%<br>RQD - 36%  |          |             |              |       |  |    |    |    |    |            |
| 27.5        |             | Pull 6 - from 27.0 to 32.0 feet.<br>Metagraywacke with interbedded mica schist and mica Gneiss. |          |             |              |       |  |    |    |    |    |            |
| 30          |             | Run - 5.0 feet<br>Rec - 100%<br>RQD - 100%  |          |             |              |       |  |    |    |    |    |            |
| 32.5        |             | Coring terminated at 32.0 feet below ground surface.  |          |             |              |       |  |    |    |    |    |            |
| 35          |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water

- Final Depth to Water

|                                  |                         |  |
|----------------------------------|-------------------------|--|
| PROJECT NO.: CT052885.0000.00008 | ELEVATION:              | Notes:<br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Dewayne Ponds         | BORING DEPTH: 18.3 feet |  |
| DATE DRILLED: 8/7/2003           | DRILLER: S&ME, Inc      |  |
| DRILLING METHOD: NQ Rock Core    | DRILL RIG: CME 550      |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           | ▽           | Topsoil and Sand  |          |             |              |       |  |    |    |    |    |            |
|             | ▽           | Augered to 2 feet through topsoil, sand, and boulders   |          |             |              |       |  |    |    |    |    |            |
| 2.5         | ●           | Pull - 1 from 2.0 to 8.3 feet.<br>Material consisted of cobble and boulder fill.  |          |             |              |       |  |    |    |    |    |            |
|             | ●           | Run - 6.3 feet<br>Rec - 29%   |          |             |              |       |  |    |    |    |    |            |
| 5           | ●           |   |          |             |              |       |  |    |    |    |    |            |
| 7.5         | ●           |   |          |             |              |       |  |    |    |    |    |            |
| 10          | ●           | Pull - 2 from 8.3 to 13.3 feet.<br>Material consisted of boulder fill with voids to approximately 12 feet. the final 1.3 feet is a Mica Schist with Horn Blend Gneiss |          |             |              |       |  |    |    |    |    |            |
|             | ●           | Run - 5.0 feet<br>Rec - 32%   |          |             |              |       |  |    |    |    |    |            |
| 12.5        | ■           |   |          |             |              |       |  |    |    |    |    |            |
| 15          | ■           | Pull - 3 from 13.3 to 18.3 feet.<br>Mica Schist with Horn Blend Gneiss  |          |             |              |       |  |    |    |    |    |            |
|             | ■           | Run - 5.0 feet<br>Rec - 100%<br>RQD - 100%  |          |             |              |       |  |    |    |    |    |            |
| 17.5        | ■           |   |          |             |              |       |  |    |    |    |    |            |

▽ - Initial Depth to Water  
 ▽ - Final Depth to Water



|                                  |                         |   |
|----------------------------------|-------------------------|---|
| PROJECT NO.: CT052885.0000.00008 | ELEVATION:              | <b>Notes:</b><br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Dewayne Ponds         | BORING DEPTH: 23.4 feet |   |
| DATE DRILLED: 8/8/2003           | DRILLER: S&ME, Inc      |   |
| DRILLING METHOD: NQ Rock Core    | DRILL RIG: CME 550      |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           | ●           | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 0 - 4.0     | ●           | Drill through pavement and set NW casing to 4.0 feet.<br>Material consisted of sand and boulders   |          |             |              |       |  |    |    |    |    |            |
| 4.0 - 12.2  | ●           | Pull 1 - from 4.0 to 12.2 feet.<br>Material consisted of boulder fill with soil and clear voids in between.<br><br>Run - 8.2 ft<br>Rec - 18%<br>RQD - 18%    |          |             |              |       |  |    |    |    |    |            |
| 12.2 - 17.2 | ●           | Pull 2 - from 12.2 to 17.2 feet.<br>Material consisted of boulder fill with soil and clear voids in between.<br><br>Run - 5.0 feet<br>Rec - 12%<br>RQD - 12% |          |             |              |       |  |    |    |    |    |            |
| 17.2 - 22.2 | ●           | Pull 3 - from 17.2 to 22.2 feet.<br>Material consisted of bulder fill with soil and clear voids in between.  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

PROJECT:  
*Blue Ridge Parkway  
 Section 2P  
 Asheville, NC*

**BORING LOG 362.8 R  
 (B-39)**

PROJECT NO.: CT052885.0000.00008  
 ELEVATION:  
 LOGGED BY: Dewayne Ponds  
 BORING DEPTH: 23.4 feet  
 DATE DRILLED: 8/8/2003  
 DRILLER: S&ME, Inc  
 DRILLING METHOD: NQ Rock Core  
 DRILL RIG: CME 550

Notes:  
 Groundwater was not encountered in boring at time of drilling.

| DEPTH (ft.) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 20          |             | Run - 5.0 feet<br>Rec - 20%<br>RQD - 20%   |          |             |              |       |  |    |    |    |    |            |
| 22.5        |             | Pull 4 - from 22.2 to 23.4 feet.<br>Metagraywake with seven joints ranging from 15 to 30 degrees.  |          |             |              |       |  |    |    |    |    |            |
| 25          |             | Run - 1.2 feet<br>Rec - 116%<br>RQD - 116%<br>Coring terminated at 23.4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 27.5        |             |  |          |             |              |       |  |    |    |    |    |            |
| 30          |             |  |          |             |              |       |  |    |    |    |    |            |
| 32.5        |             |  |          |             |              |       |  |    |    |    |    |            |
| 35          |             |  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water  
 - Final Depth to Water

**PROJECT:**

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 363.4 L  
(B-40)**

**PROJECT NO.:** CT052885.0000.00008

**ELEVATION:**

**Notes:**  
Groundwater was not encountered in boring at time of drilling.

**LOGGED BY:** Dewayne Ponds

**BORING DEPTH:** 18.3 feet

**DATE DRILLED:** 8/6/2003

**DRILLER:** S&ME, Inc

**DRILLING METHOD:** NQ Rock Core

**DRILL RIG:** CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Topsoil  |          |             |              |       |  |    |    |    |    |            |
|             |             | Shot rock and sand   |          |             |              |       |  |    |    |    |    |            |
| 2.5         |             |  |          |             |              |       |  |    |    |    |    |            |
| 5           |             | Pull 1 - from 5.0 to 8.0 feet.<br>Material consisted of shot rock and sand   |          |             |              |       |  |    |    |    |    |            |
|             |             | Run - 3.0 feet<br>Rec - 16%<br>RQD - 16%                                     |          |             |              |       |  |    |    |    |    |            |
| 7.5         |             |  |          |             |              |       |  |    |    |    |    |            |
|             |             | Pull 2 - from 8.0 to 13.0 feet.<br>Material consisted of shot rock and sand  |          |             |              |       |  |    |    |    |    |            |
|             |             | Run - 5.0 feet<br>Rec - 36%<br>RQD - 36%                                     |          |             |              |       |  |    |    |    |    |            |
| 10          |             |  |          |             |              |       |  |    |    |    |    |            |
|             |             |  |          |             |              |       |  |    |    |    |    |            |
| 12.5        |             |  |          |             |              |       |  |    |    |    |    |            |
|             |             | Pull 3 - from 13.0 to 18.0 feet.<br>Material consisted of shot rock and sand |          |             |              |       |  |    |    |    |    |            |
|             |             | Run - 5.0 feet<br>Rec - 6%<br>RQD - 0%                                       |          |             |              |       |  |    |    |    |    |            |
| 15          |             |  |          |             |              |       |  |    |    |    |    |            |
|             |             |  |          |             |              |       |  |    |    |    |    |            |
| 17.5        |             |  |          |             |              |       |  |    |    |    |    |            |
|             |             | Pull 4 - from 18.0 to 23.0 feet.   |          |             |              |       |  |    |    |    |    |            |

▽ - Initial Depth to Water

▽ - Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 363.4 L  
(B-40)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Dewayne Ponds

BORING DEPTH: 18.3 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: NQ Rock Core

DRILL RIG: CME 550

| DEPTH (ft) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|            |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 20         |             | Material consisted of shot rock and sand to 21.5 feet and metagraywacke bedrock to 23.0 feet<br><br>Run - 5.0 feet<br>Rec - 40%<br>RQD - 18% |          |             |              |       |  |    |    |    |    |            |
| 22.5       |             | Pull 5 - from 23.0 to 28.0 feet. white Pegmatite intrusion<br><br>Run - 5.0 feet<br>Rec - 100%<br>RQD - 86%                                  |          |             |              |       |  |    |    |    |    |            |
| 27.5       |             | Pull 6 - from 28.0 to 33.0 feet. White Pegmatite Intrusion<br><br>Run - 5.0 feet<br>Rec - 100%<br>RQD - 84%                                  |          |             |              |       |  |    |    |    |    |            |
| 32.5       |             | Coring terminated at 33.0 feet below ground surface.   |          |             |              |       |  |    |    |    |    |            |
| 35         |             |  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water

- Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 363.4 R  
(B-41)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Dewayne Ponds

BORING DEPTH: 18.3 feet

DATE DRILLED: 8/7/2003

DRILLER: S&ME, Inc

DRILLING METHOD: NQ Rock Core

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 0           |             | Shot rock and sand   |          |             |              |       |  |    |    |    |    |            |
| 2.5         |             |  |          |             |              |       |  |    |    |    |    |            |
| 5           |             | Pull 1 - from 5.2 to 12.2 feet.<br>Material consisted of shot rock and sand  |          |             |              |       |  |    |    |    |    |            |
| 7.5         |             | Run - 7.0 feet<br>Rec - 32%<br>RQD - 10%                                     |          |             |              |       |  |    |    |    |    |            |
| 10          |             |  |          |             |              |       |  |    |    |    |    |            |
| 12.5        |             | Pull 2 - from 12.2 to 17.2 feet.<br>Material consisted of shot rock and sand |          |             |              |       |  |    |    |    |    |            |
| 15          |             | Run - 5.0 feet<br>Rec - 36%<br>RQD - 7%                                      |          |             |              |       |  |    |    |    |    |            |
| 17.5        |             | Pull 3 - from 17.2 to 22.2 feet.<br>Material consisted of shot rock and sand |          |             |              |       |  |    |    |    |    |            |
|             |             | Run - 5.0 feet   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water

- Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

**BORING LOG 363.4 R  
(B-41)**

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Dewayne Ponds

BORING DEPTH: 18.3 feet

DATE DRILLED: 8/7/2003

DRILLER: S&ME, Inc

DRILLING METHOD: NQ Rock Core

DRILL RIG: CME 550

| DEPTH (ft.) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 20          |             | Rec - 64%<br>RQD - 0%  |          |             |              |       |  |    |    |    |    |            |
| 22.5        |             | Pull 4 - from 22.2 to 27.2 feet.<br>Material consisted of shot rock and sand<br>Run - 5.0 feet<br>Rec - 60%<br>RQD - 10% |          |             |              |       |  |    |    |    |    |            |
| 25          |             |  |          |             |              |       |  |    |    |    |    |            |
| 27.5        |             | Pull 5 - from 27.2 to 32.2 feet.<br>Metagraywacke fine to coarse grained with a pegmatite intrusion.                     |          |             |              |       |  |    |    |    |    |            |
| 30          |             | Run - 5.0 feet<br>Rec - 88%<br>RQD - 64%   |          |             |              |       |  |    |    |    |    |            |
| 32.5        |             | Coring terminated at 33.0 feet below ground surface.   |          |             |              |       |  |    |    |    |    |            |
| 35          |             |  |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water

- Final Depth to Water

|  |  |
|--|--|
| <b>PROJECT:</b><br>Blue Ridge Parkway<br>Section 2P<br>Asheville, NC | <b>BORING LOG</b> <b>Visitor Center</b><br><b>(B-VC)</b> |
|--|--|

|   |                      |  |
|---|----------------------|--|
| PROJECT NO.: CT052885.0000.00008          | ELEVATION:           | Notes:<br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| LOGGED BY: Scott Manning                  | BORING DEPTH: 4 feet |  |
| DATE DRILLED: 8/6/2003                    | DRILLER: S&ME, Inc   |  |
| DRILLING METHOD: 4.25" Hollow Stem Augers | DRILL RIG: CME 550   |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                  | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown silty fine to medium SAND (A-2-4)           |          |             |              |       |  |    |    |    |    | 7-11-9     |
| 2           |             |   | 20.5     |             |              |       |  |    |    |    |    |            |
| 3           |             |   | 29.4     |             |              |       |  |    |    |    |    | 5-5-4      |
| 4           |             | Boring Terminated at 4 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- ▽ - Initial Depth to Water
- ▽ - Final Depth to Water

|  |  |
|--|--|
| <b>PROJECT:</b><br>Blue Ridge Parkway<br>Section 2P<br>Asheville, NC | <b>BORING LOG    Picnic Parking<br/>(B-PA)</b> |
|--|--|

|  |                             |   |
|--|-----------------------------|---|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>           | <b>Notes:</b><br>Auger refusal was not encountered.<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 4 feet |   |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc   |   |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550   |   |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description   | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|--|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |  |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt  |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Brown tan silty fine to medium SAND (A-2-4)                          | 8.7      |             |              |       |  |    |    |    |    |            |
| 2           |             |  |          |             |              |       |  |    |    |    |    |            |
| 3           |             | Gray brown tan silty fine to medium SAND with rock fragments (A-2-4) | 4.9      |             |              |       |  |    |    |    |    |            |
| 4           |             | Boring Terminated at 4 feet below ground surface.                    |          |             |              |       |  |    |    |    |    |            |
| 5           |             |  |          |             |              |       |  |    |    |    |    |            |
| 6           |             |  |          |             |              |       |  |    |    |    |    |            |
| 7           |             |  |          |             |              |       |  |    |    |    |    |            |

- ▽ - Initial Depth to Water
- ▽ - Final Depth to Water

PROJECT:

Blue Ridge Parkway  
Section 2P  
Asheville, NC

# BORING LOG Craggy Dome (B-CDU)

PROJECT NO.: CT052885.0000.00008

ELEVATION:

Notes:

Auger refusal was not encountered.  
Groundwater was not encountered in boring at time of drilling.

LOGGED BY: Scott Manning

BORING DEPTH: 4 feet

DATE DRILLED: 8/6/2003

DRILLER: S&ME, Inc

DRILLING METHOD: 4.25" Hollow Stem  
Augers

DRILL RIG: CME 550

| DEPTH<br>(ft.) | GRAPHIC<br>LOG  | Soil Description  | W<br>OR<br>PPR | WATER<br>LEVEL | SAMPLE<br>DEPTH | ELEV. | Standard Penetration Test Data<br>N- (Blows/ft) |    |    |    |    | Blow<br>Count |
|----------------|---|---|----------------|----------------|-----------------|-------|---|----|----|----|----|---------------|
|                |   |   |                |                |                 |       | 10  | 30 | 50 | 70 | 90 |               |
| 0              |    | Asphalt   |                |                |                 |       |   |    |    |    |    |               |
| 1              |    | Brown red silty fine SAND (A-2-4)                                       | 10.0           |                |                 |       |   |    |    |    |    |               |
| 2              |    |   |                |                |                 |       |   |    |    |    |    |               |
| 3              |   | Soft (no recovery) cuttings recorded as - Brown silty fine SAND (A-2-4) | 0.8            |                |                 |       |   |    |    |    |    |               |
| 4              |  | Boring Terminated at 4 feet below ground surface.                       |                |                |                 |       |   |    |    |    |    |               |
| 5              |   |   |                |                |                 |       |   |    |    |    |    |               |
| 6              |   |   |                |                |                 |       |   |    |    |    |    |               |
| 7              |   |   |                |                |                 |       |   |    |    |    |    |               |

 - Initial Depth to Water

 - Final Depth to Water

|  |  |
|--|--|
| <b>PROJECT:</b><br>Blue Ridge Parkway<br>Section 2P<br>Asheville, NC | <b>BORING LOG      Craggy Dome<br/>(B-CDL)</b> |
|--|--|

|  |                               |  |
|--|-------------------------------|--|
| <b>PROJECT NO.:</b> CT052885.0000.00008          | <b>ELEVATION:</b>             | Notes:<br>Groundwater was not encountered in boring at time of drilling. |
| <b>LOGGED BY:</b> Scott Manning                  | <b>BORING DEPTH:</b> 2.5 feet |  |
| <b>DATE DRILLED:</b> 8/6/2003                    | <b>DRILLER:</b> S&ME, Inc     |  |
| <b>DRILLING METHOD:</b> 4.25" Hollow Stem Augers | <b>DRILL RIG:</b> CME 550     |  |

| DEPTH (ft.) | GRAPHIC LOG | Soil Description                                | W OR PPR | WATER LEVEL | SAMPLE DEPTH | ELEV. | Standard Penetration Test Data N- (Blows/ft) |    |    |    |    | Blow Count |
|-------------|-------------|---|----------|-------------|--------------|-------|--|----|----|----|----|------------|
|             |             |   |          |             |              |       | 10   | 30 | 50 | 70 | 90 |            |
| 0           |             | Asphalt   |          |             |              |       |  |    |    |    |    |            |
| 1           |             | Red brown silty fine to medium SAND (A-2-4)     | 33.1     |             |              |       |  |    |    |    |    |            |
| 2           |             |   |          |             |              |       |  |    |    |    |    |            |
| 3           |             | Auger refusal at 2.5 feet below ground surface. |          |             |              |       |  |    |    |    |    |            |
| 4           |             |   |          |             |              |       |  |    |    |    |    |            |
| 5           |             |   |          |             |              |       |  |    |    |    |    |            |
| 6           |             |   |          |             |              |       |  |    |    |    |    |            |
| 7           |             |   |          |             |              |       |  |    |    |    |    |            |

- Initial Depth to Water
- Final Depth to Water

## **Appendix D**

Field Test Results

# DCP TEST DATA

File Name: M359S41+50

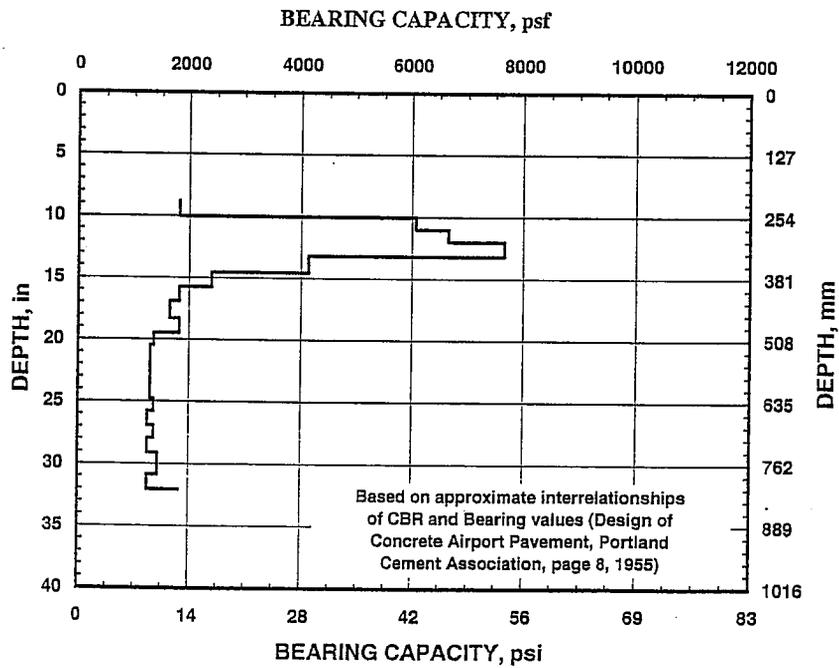
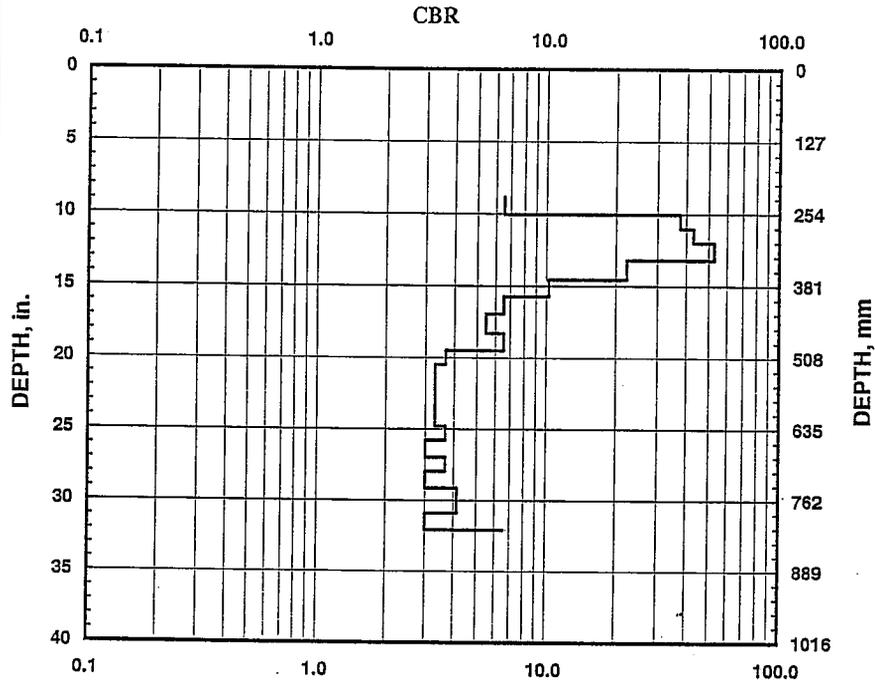
Project: BLUE RIDGE PARKWAY  
 Location: M359 STA 41+50

Date: 6-Aug-03  
 Soil Type(s): ML with rock fragments

- Hammer
- 10.1 lbs.
  - 17.6 lbs.
  - Both hammers used

- Soil Type
- CH
  - CL
  - All other soils

| No. of Blows | Accumulative Penetration (mm) | Type of Hammer |
|--------------|-------------------------------|----------------|
| 0            | 225                           | 2              |
| 2            | 255                           | 2              |
| 8            | 280                           | 2              |
| 9            | 305                           | 2              |
| 13           | 335                           | 2              |
| 7            | 370                           | 2              |
| 3            | 400                           | 2              |
| 2            | 430                           | 2              |
| 2            | 465                           | 2              |
| 2            | 495                           | 2              |
| 1            | 520                           | 2              |
| 2            | 575                           | 2              |
| 2            | 630                           | 2              |
| 1            | 655                           | 2              |
| 1            | 685                           | 2              |
| 1            | 710                           | 2              |
| 1            | 740                           | 2              |
| 2            | 785                           | 2              |
| 1            | 815                           | 2              |





# DCP TEST DATA

File Name: M362S10+50

Project: BLUE RIDGE PARKWAY  
 Location: M362 STA 10+50

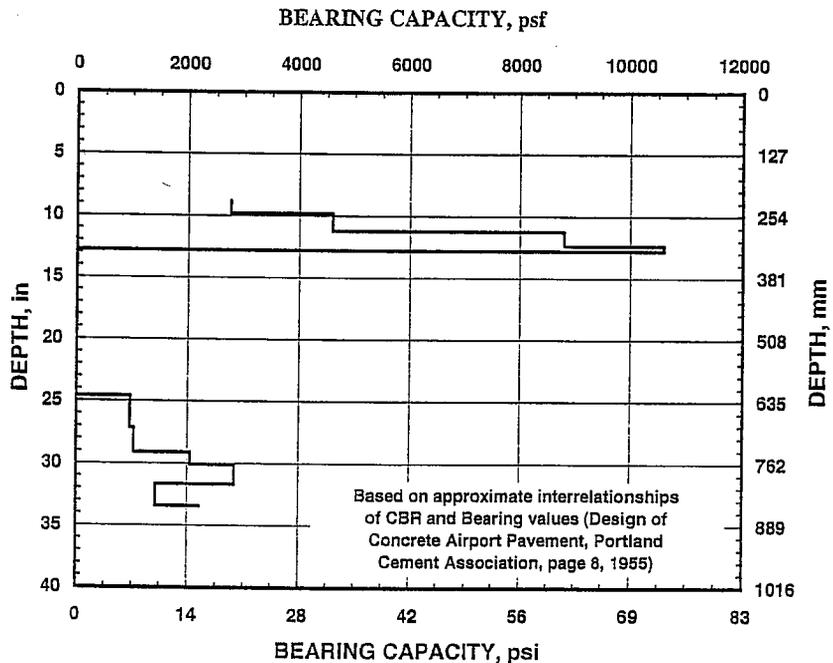
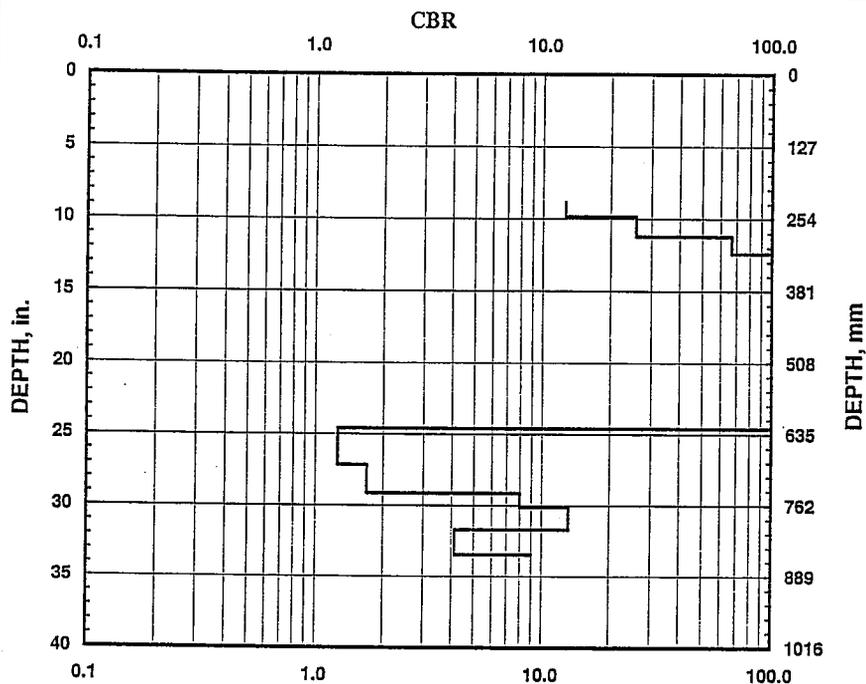
Date: 6-Aug-03  
 Soil Type(s): SM with rock fragments

Hammer  
 10.1 lbs.  
 17.6 lbs.  
 Both hammers used

Soil Type  
 CH  
 CL  
 All other soils

| No. of Blows | Accumulative Penetration (mm) | Type of Hammer |
|--------------|-------------------------------|----------------|
| 0            | 225                           | 2              |
| 3            | 250                           | 2              |
| 8            | 285                           | 2              |
| 16           | 315                           | 2              |
| 10           | 325                           | 2              |

|   |     |   |
|---|-----|---|
| 0 | 625 | 2 |
| 1 | 690 | 2 |
| 1 | 740 | 2 |
| 2 | 765 | 2 |
| 5 | 805 | 2 |
| 2 | 850 | 2 |









































## **Appendix E**

DCP Testing

November 5, 2003

ARCADIS G & M, Inc.  
1210 Premier Drive, Suite 200  
Chattanooga, Tennessee 37421

Project No. 03432

Attention: Mr. Bob Chamlee

**Asphalt Pavement Investigation  
Blue Ridge Parkway – Section 2P  
Milepost 359.8 to 375.3  
Asheville, North Carolina**

Gentlemen:

Submitted here is the report of our asphalt pavement investigation for the above-referenced project. This field and laboratory testing was authorized by a signed agreement dated July 10, 2003.

**General**

Plans are being developed by ARCADIS for the Eastern Federal Lands Highway Division of the Federal Highway Administration to rehabilitate a portion of the Blue Ridge Parkway between mileposts 359.8 and 375.3 near Asheville, North Carolina. Burns Cooley Dennis, Inc., was requested by ARCADIS to conduct dynamic cone penetrometer (DCP) testing, laboratory testing of subgrade soils and hot mix asphalt samples and to provide preliminary recommendations for pavement rehabilitation.

The asphalt pavement conditions along this portion of the Blue Ridge Parkway vary from good to very poor. The asphalt roadway has experienced numerous distresses with varying severity levels. The typical pavement distresses include alligator cracking (fatigue), raveling (weathering and oxidation), linear cracking (thermal), block cracking and potholes. Numerous asphalt patches have been placed along the route. This asphalt pavement needs rehabilitation to prevent further deterioration of the flexible pavement structure. Typical pavement conditions at the time of our field investigation (August 2003) are illustrated in Photos 1 through 14.

The field investigation was coordinated and directed by Mr. Scott Manning of ARCADIS. Pavement coring and subgrade drilling and sampling were conducted by S & ME. Asphalt pavement and subgrade conditions along this portion of the Blue Ridge Parkway were explored and evaluated at forty (40) locations selected by ARCADIS.

The specific purposes of our investigation were:

- 1) to conduct in-situ dynamic cone penetrometer (DCP) testing of subgrade soils at selected boring locations;
- 2) to evaluate pertinent physical properties of the hot-mix-asphalt (HMA) layers and the subgrade soils encountered by means of visual examination and routine laboratory tests performed on selected representative samples obtained from exploratory coreholes and borings; and
- 3) to provide guideline recommendations for pavement repair and rehabilitation.

### **Dynamic Cone Penetrometer (DCP) Testing**

A dynamic cone penetrometer (DCP) was utilized to conduct in-situ testing of subgrade materials at twenty-nine (29) selected locations. The DCP testing was conducted to depths ranging between about 1 ft and 3 ft below the asphalt pavement surface. Due to the significant amount of rock fragments in the subgrade materials, the depth of many DCP tests was limited. Based on a correlation developed by the U. S. Army Corps of Engineers, the DCP penetration and the blow count data were converted to California Bearing Ratios (CBRs). A summary of the DCP test results is presented in Table 1. Plots illustrating the computed variation in CBR with depth below the surface for each DCP test are presented in Table 1.

The DCP testing of the subgrade soils yielded CBR values ranging from about 1 (weak) to 100 (very strong). The typical average CBR values range between 10 and 50. The typical in-situ CBR values are high to very high for subgrade soils. These high subgrade strength values have been influenced by the significant amount of rock fragments in the subgrade soils. Low CBR values were determined at three locations.

### **Subgrade Soil Testing**

All of the subgrade soil samples were visually examined in the laboratory by a geotechnical technician and geotechnical engineer. Routine classification tests were performed on thirty-six (36) subgrade materials selected by ARCADIS to verify field classifications and to assist in evaluating the strengths, expansive properties and classifications of the soils encountered in the borings.

The classifications and the plasticity characteristics of the subgrade soils were evaluated by means of visual examination and twelve (12) sets of Atterberg liquid and plastic limit tests. The numerical difference between the liquid limit and plastic limit and the proximity of the in-situ water content to the plastic limit are indicators of the potential for a fine-grained soil (clay)

to shrink or swell upon changes in the moisture content or to consolidate under loading. The proximity of the water content to the plastic limit is also an indicator of soil strength. Atterberg limit test results are also useful in estimating and verifying subgrade CBR values. The results of the Atterberg limit tests are presented in Table 2.

To aid in classifying the subgrade materials, sieve analysis tests were conducted on thirty-six (36) samples to determine the percent fines passing the No. 200 sieve. The percentage of minus No. 200 sieve is also presented in Table 2.

Sixty-seven (67) water content tests were performed to evaluate the in-situ moisture conditions and to corroborate field estimates of strength. The results of the moisture content tests are presented in Table 2.

In general, subgrade soils encountered below the asphalt pavement include silts (ML) and silty sands (SM) with rock fragments. The predominant subgrade soil type between mileposts 359 and 375 is silty sand (SM) with an AASHTO classification of A-2-4 ( typical design CBR values range between 20 and 30).

### **Hot-Mix-Asphalt Testing**

The thickness of the asphalt layer was determined by measuring the sidewall of the borehole and the extracted field cores. The total thickness of the asphalt layer at each boring location was determined during the drilling operation is presented in Table 2. The thickness of the various asphalt layers at the core locations is presented in Table 3. The asphalt pavement thickness was found to range between 2.5 in. to 7 in. with a typical thickness of 3.5 in. to 4.5 in.

The in-place density and absorption determinations indicate the asphalt pavement compaction levels are marginal with some very low compaction levels. The low compaction levels (high in-place air voids) are generally located between Milepost 365 and 374. The high in-place air void contents have caused the asphalt layers to weather and oxidize at a faster rate than normal. The extreme weathering is one of the primary causes of the significant amount of fatigue cracking. The bulk specific gravity and absorption of each asphalt layer is presented in Table 3.

In order to have sufficient hot-mix-asphalt material to evaluate, the eight (8) cores were grouped to produce three (3) composite samples. Tests were performed on asphalt pavement core samples that had been trimmed and combined to evaluate the in-place HMA mixture characteristics. Tests were conducted to determine the asphalt content and aggregate gradation of the HMA mixture and the absolute viscosity of the recovered asphalt binder. The results of the laboratory tests for the surface course layers are presented in Table 4. The laboratory test results for the binder/base layers are presented in Table 5.

Surface Layer. The test results indicate Group 2 and Group 3 HMA materials are very similar. The asphalt content, extracted aggregate gradation and asphalt binder viscosity for these

groups are significantly different than Group 1. Groups 2 and 3 have a coarser aggregate gradation and a higher asphalt viscosity. HMA materials within the pavement areas represented by Groups 2 and 3 have oxidized and weathered much more than the HMA materials represented by Group 1. The asphalt surface layer within the area represented by Groups 1 and 2 are not suitable for hot-mix-recycling. These surface layers should be removed prior to any pavement rehabilitation.

Binder/Base Layer. The test results indicate the HMA mixture properties are very similar for all three groups. The primary difference between these samples is the asphalt binder's viscosity. Group 1 has a much lower viscosity (softer) than Group 2 and 3.

## **Recommendations**

Based on current pavement conditions, field testing, laboratory evaluations and information provided by ARCADIS, it is our opinion that the following rehabilitation procedures be considered to rehabilitate the Blue Ridge Parkway between Mileposts 359 and 375.

### 1) Mill and Overlay

- Repair structurally distressed areas
- Mill 2 in. of existing asphalt layer
- Place 3 in. of asphalt surface course layer

### 2) Reconstruction

- Option 1
  - Remove existing asphalt layers
  - Scarify and compact subgrade soils (minimum 12 in.)
  - Place 8 in. crushed stone base layer
  - Place 4 in. asphalt surface layer (two layers)
- Option 2
  - Remove existing asphalt layers
  - Cold mix recycle existing asphalt layer and subgrade (minimum 8 in.)
  - Place 3 in. of asphalt binder layer
  - Place 2 in. of asphalt surface layer

These rehabilitation options should be selected based on pavement surface conditions and structural integrity. Areas that exhibit a significant amount of fatigue cracking should be

reconstructed. Sections of the roadway that are generally in fair to good condition should be milled and overlaid with a minimum 3-in. overlay.

The pavement thickness recommendations presented above should be considered guideline recommendations based on experience with previous Eastern Federal Lands Highway Division projects. A detailed pavement design based on anticipated traffic volumes and intensities is beyond the scope of this investigation. We understand that ERES Consultants is preparing a detailed pavement design for the actual traffic loadings and appropriate design parameters for the subgrade soils and asphalt pavement layers.

### **Report Limitations**

The conclusions and recommendations discussed in this report are based on the conditions as they existed at the time of our field investigation and further on the assumption that the borings were representative of the pavement and subsurface conditions throughout the pavement area investigated. It should be noted that actual pavement and subsurface conditions between and beyond the boring locations might differ from those encountered at those locations.

This report has been prepared for ARCADIS for specific application to the geotechnical-related aspects for pavement improvements to the Blue Ridge Parkway north of Ashville, North Carolina. The only warranty made by us in connection with the services provided is we have used the degree of care and skill ordinarily exercised under similar conditions by reportable members of our profession practicing in the same or similar locality. No other warranty, expressed or implied, is made or intended.

We appreciate the opportunity to be of service. If you have any questions concerning this letter or need additional services, please do not hesitate to call.

Very truly yours,

BURNS COOLEY DENNIS, INC.

R. C. Ahlrich, Ph.D., P.E.

S. Caleb Douglas, P.E.

RCA/khb  
Copies Submitted: (3)

**PHOTOS**



Photo 1. Blue Ridge Parkway M362 Station 10+00  
No Distress



Photo 2. Blue Ridge Parkway M366 Station 41+00  
Wheelpath Fatigue Cracking (Low Severity)



Photo 3. Blue Ridge Parkway M366 Station 41+00  
Fatigue Cracking and Potholes (High Severity)



Photo 4. Blue Ridge Parkway M367 Station 47+00  
Wheelpath Fatigue Cracking



Photo 5. Blue Ridge Parkway M372 Station 49+00  
Minimal Cracking



Photo 6. Blue Ridge Parkway M373 Station 45+25  
Fatigue Cracking and Raveling (High Severity)



Photo 7. Blue Ridge Parkway M374 Station 1+00  
Wheelpath Fatigue Cracking

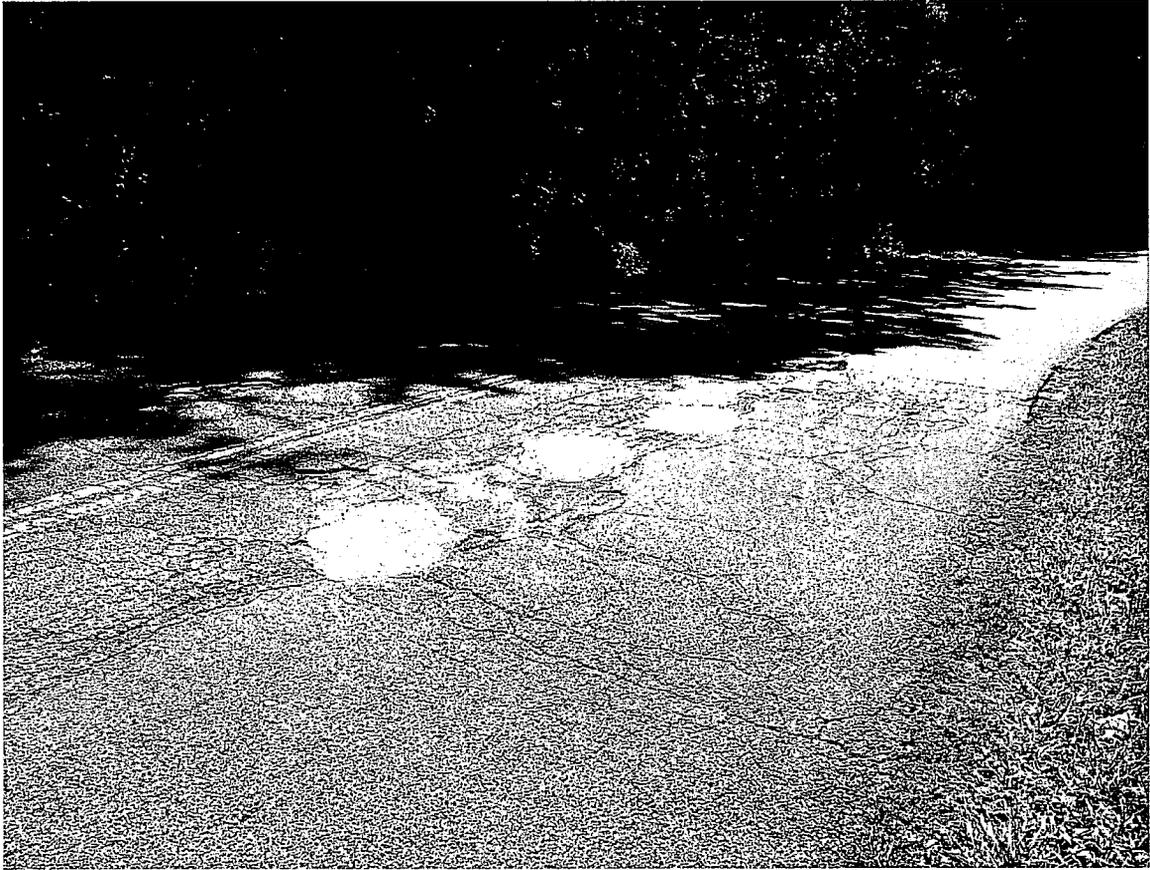


Photo 8. Blue Ridge Parkway M374 Station 2+75  
Fatigue Cracking with Asphalt Patch ( Medium Severity)



Photo 9. Craggy Gardens Visitor Center  
Thermal Cracking



Photo 10. Craggy Dome Lower Tier Parking  
Thermal Cracking



Photo 11. Blue Ridge Parkway Near Craggy Dome  
Thermal Cracking



Photo 12. Blue Ridge Parkway  
Typical High Severity Raveling



Photo 13. Blue Ridge Parkway  
Typical Fatigue Cracking with Asphalt Patch



Photo 14. Blue Ridge Parkway  
Typical Fatigue Cracking and Raveling in Wheelpath

**DYNAMIC CONE PENETROMETER  
TEST RESULTS**

**TABLE 1**  
**SUMMARY OF DCP TEST RESULTS - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Location                  | Depth Interval (in)<br>Below Pavement Surface | Average CBR Values |
|---------------------------|---|--------------------|
| MM 359<br>Station 41 + 50 | 10 - 15                                       | 40                 |
|                           | 15 - 20                                       | 6                  |
|                           | 20 - 32                                       | 3                  |
| MM 360<br>Station 50 + 00 | 10 - 16                                       | 20                 |
|                           | @ 16  | 100+               |
| MM 362<br>Station 10 + 50 | 9 - 12  | 30                 |
|                           | @ 12  | 100+               |
|                           | 24 - 29 (*)                                   | 1.5                |
|                           | 29 - 34 (*)                                   | 8                  |
| MM 362<br>Station 23 + 00 | 8 - 10  | 50                 |
|                           | @ 10  | 100+               |
|                           | 30 - 40 (*)                                   | 2.5                |
| MM 362<br>Station 51 + 00 | 7 - 18  | 30                 |
|                           | @ 18  | 100+               |
|                           | 34 - 38 (*)                                   | 40                 |
| MM 363<br>Station 10+50   | 10 - 17                                       | 35                 |
|                           | @ 17  | 100+               |
| MM 363<br>Station 34+00   | 7 - 11  | 35                 |
|                           | @ 11  | 100+               |
| MM 367<br>Station 21+50   | @ 10  | 80                 |
|                           | @ 12  | 100+               |
| MM 367<br>Station 39+00   | 5 - 10  | 40                 |
|                           | 10 - 15                                       | 25                 |
|                           | 15 - 23                                       | 10                 |
|                           | 23 - 29                                       | 40                 |
|                           | @ 29  | 100+               |
| MM 368<br>Station 12+50   | 10 - 24                                       | 25                 |
|                           | 24 - 40                                       | 8                  |

(\*) Note: Additional DCP testing conducted after split-spoon sampling

**TABLE 1 (continued)**  
**SUMMARY OF DCP TEST RESULTS - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Location                | Depth Interval (in)<br>Below Pavement Surface | Average CBR Values |
|-------------------------|---|--------------------|
| MM 368<br>Station 38+00 | 14 - 17<br>@ 17                               | 40<br>100+         |
| MM 369<br>Station 4+50  | @ 11  | 100+               |
| MM 369<br>Station 14+00 | 11 - 14<br>@ 14                               | 40<br>100+         |
| MM 369<br>Station 39+00 | 8 - 11<br>@ 11                                | 35<br>100+         |
| MM 370<br>Station 13+00 | 8 - 11<br>@ 11                                | 70<br>100+         |
| MM 370<br>Station 38+00 | 10 - 16<br>@ 16                               | 70<br>100+         |
| MM 371<br>Station 15+00 | 10 - 28<br>@ 28                               | 30<br>100+         |
| MM 371<br>Station 30+00 | @ 12<br>@ 14                                  | 20<br>100+         |
| MM 372<br>Station 14+00 | 6 - 14<br>14 - 21<br>@ 21                     | 35<br>20<br>100+   |
| MM 373<br>Station 17+00 | 9 - 26<br>26 - 33                             | 20<br>50           |
| MM 373<br>Station 37+00 | 11 - 15<br>15 - 28<br>@ 28                    | 4<br>6<br>100+     |
| MM 374<br>Station 36+00 | 11 - 22<br>@ 24                               | 10<br>100+         |

**TABLE 1 (continued)**  
**SUMMARY OF DCP TEST RESULTS - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Location                            | Depth Interval (in.)<br>Below Pavement Surface | Average CBR Value |
|-------------------------------------|--|-------------------|
| MM 375<br>Station 0+00              | @ 8  | 100+              |
|                                     | 12 - 14 (*)                                    | 40                |
|                                     | @ 14 (*)                                       | 100+              |
| Picnic Area<br>Parking              | 8 - 32   | 50                |
| Picnic Access Road<br>Station 20+50 | 4 - 10   | 25                |
|                                     | @ 10   | 100+              |
| Picnic Access Road<br>Station 36+80 | 6 - 12   | 4                 |
|                                     | 12 - 40  | 1                 |
| Craggy Dome<br>Lower                | 16 - 32  | 3                 |
| Craggy Dome<br>Upper                | 14 - 16  | 10                |
|                                     | @ 17   | 100+              |

(\*) Note: Additional DCP testing conducted after auger sampling



































# DCP TEST DATA

File Name: M371S15+00

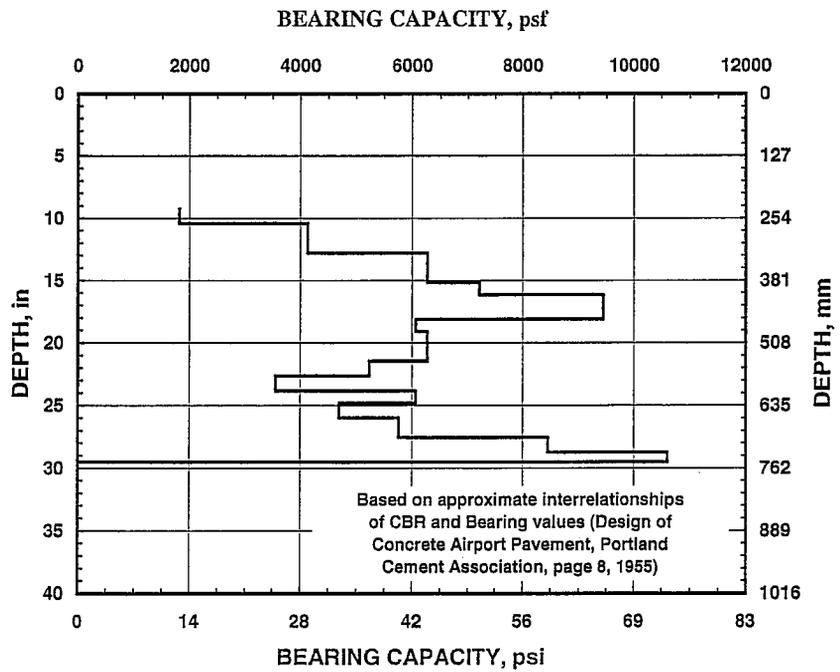
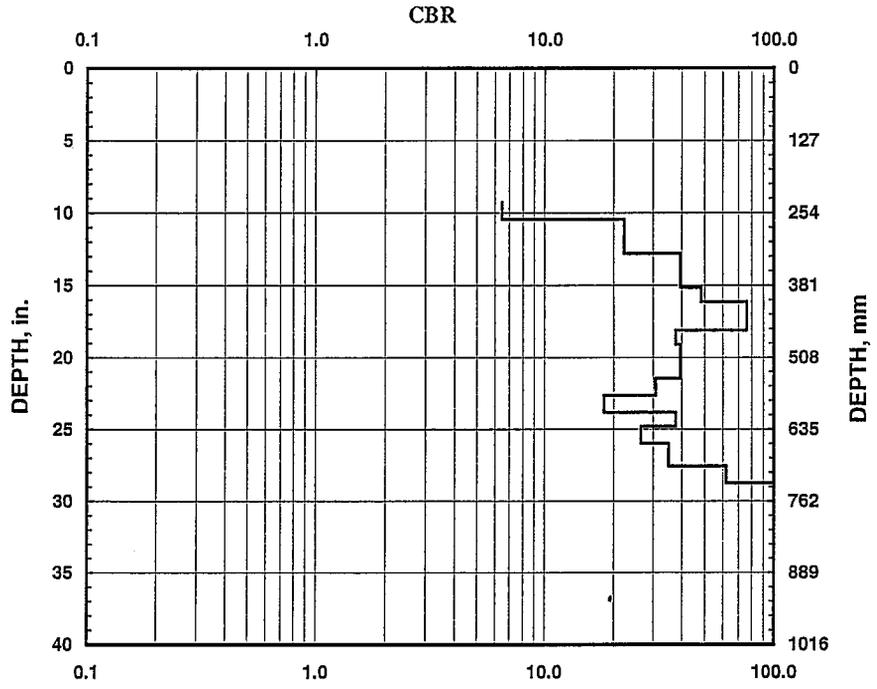
**Project:** BLUE RIDGE PARKWAY  
**Location:** M371 STA 15+00

**Date:** 5-Aug-03  
**Soil Type(s):** SM with rock fragments

**Hammer**  
 10.1 lbs.  
 17.6 lbs.  
 Both hammers used

**Soil Type**  
 CH  
 CL  
 All other soils

| No. of Blows | Accumulative Penetration (mm) | Type of Hammer |
|--------------|-------------------------------|----------------|
| 0            | 235                           | 2              |
| 2            | 265                           | 2              |
| 7            | 300                           | 2              |
| 5            | 325                           | 2              |
| 10           | 355                           | 2              |
| 10           | 385                           | 2              |
| 10           | 410                           | 2              |
| 15           | 435                           | 2              |
| 15           | 460                           | 2              |
| 8            | 485                           | 2              |
| 10           | 515                           | 2              |
| 10           | 545                           | 2              |
| 8            | 575                           | 2              |
| 5            | 605                           | 2              |
| 8            | 630                           | 2              |
| 7            | 660                           | 2              |
| 12           | 700                           | 2              |
| 15           | 730                           | 2              |
| 20           | 750                           | 2              |















# DCP TEST DATA

File Name: PA

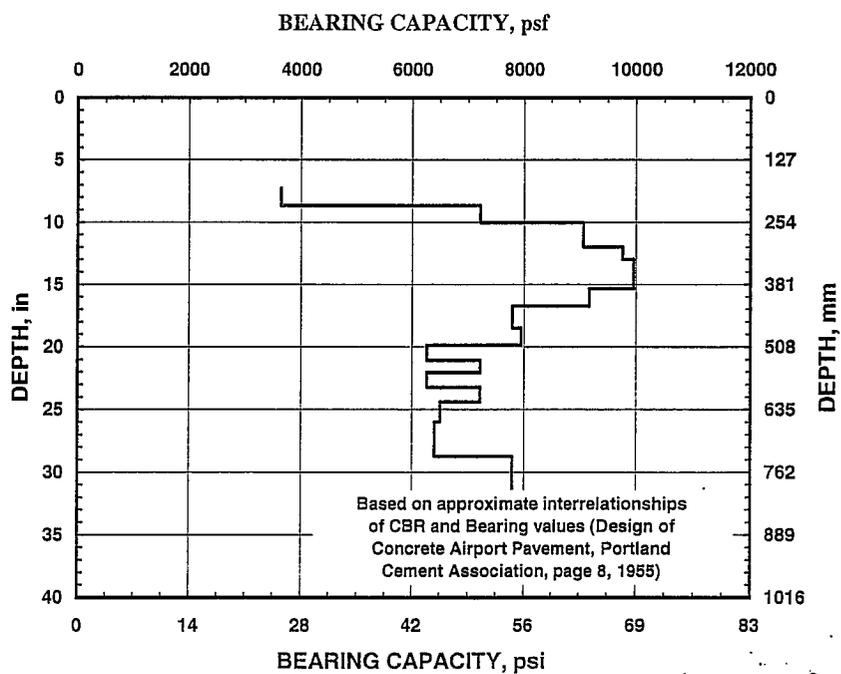
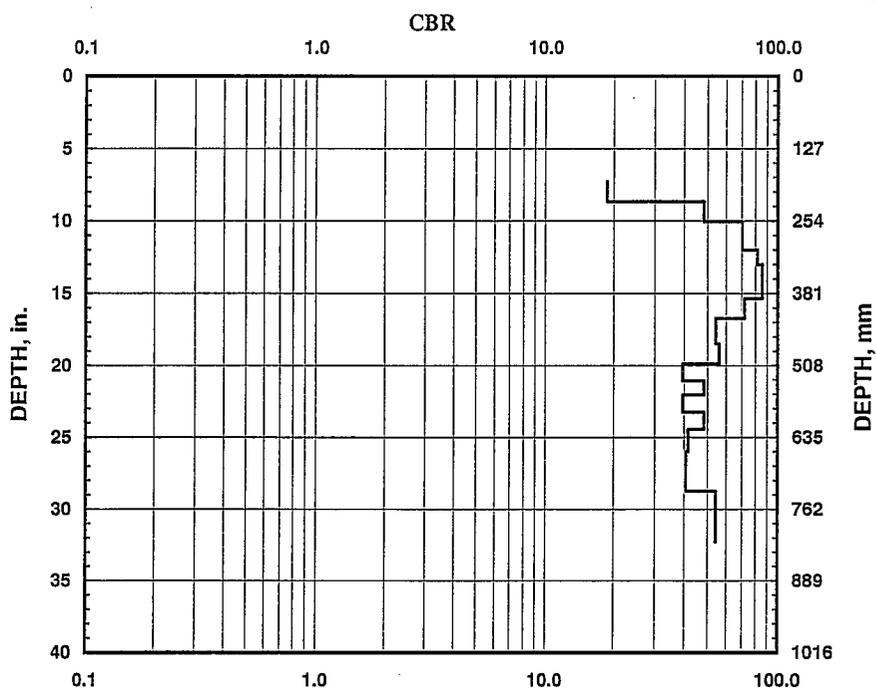
**Project:** BLUE RIDGE PARKWAY  
**Location:** PICNIC AREA PARKING

**Date:** 5-Aug-03  
**Soil Type(s):** SM with rock fragments

**Hammer**  
 10.1 lbs.  
 17.6 lbs.  
 Both hammers used

**Soil Type**  
 CH  
 CL  
 All other soils

| No. of Blows | Accumulative Penetration (mm) | Type of Hammer |
|--------------|-------------------------------|----------------|
| 0            | 185                           | 1              |
| 3            | 220                           | 1              |
| 7            | 255                           | 1              |
| 7            | 280                           | 1              |
| 7            | 305                           | 1              |
| 8            | 330                           | 1              |
| 10           | 360                           | 1              |
| 10           | 390                           | 1              |
| 10           | 425                           | 1              |
| 10           | 470                           | 1              |
| 8            | 505                           | 1              |
| 5            | 535                           | 1              |
| 5            | 560                           | 1              |
| 5            | 590                           | 1              |
| 6            | 620                           | 1              |
| 7            | 660                           | 1              |
| 6            | 695                           | 1              |
| 6            | 730                           | 1              |
| 10           | 775                           | 1              |
| 10           | 820                           | 1              |











**SUBGRADE SOIL TEST RESULTS**

**TABLE 2**  
**LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Mile | Boring Location |       | Asphalt Pavement Thickness (inches) (1) | Sample Number     | Water Content (%) | Atterberg Limits |          |          | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |  |
|------|-----------------|-------|---|-------------------|-------------------|------------------|----------|----------|-------------------------|---------------------------------|--|
|      | Station         | Lane  |   |                   |                   | LL               | PL       | PI       |                         |                                 |  |
| 359  | 52+00           | Right | 5                                       | 1<br>2            | 28.8<br>21.6      | 46<br>33         | 31<br>27 | 15<br>6  | 50.4<br>34.9            | ML/A-7-6<br>SM/A-2-4            |  |
| 360  | 24+00           | Right | 4.25                                    | Asphalt Core Only |                   |                  |          |          |                         |                                 |  |
| 360  | 50+00           | Left  | 5.5                                     | 1 (3)<br>2        | 67.9<br>15.8      | 65<br>32         | NP<br>NP | NP<br>NP | 61.5<br>29.3            | ML/A-7-6<br>SM/A-2-4            |  |
| 361  | 51+00           | Right | 7                                       | 1                 | 10.7              | -----            | -----    | -----    | 26.7                    | SM/A-2-4                        |  |
| 362  | 10+50           | Right | 4.25                                    | 1<br>2            | 4.5               | -----            | -----    | -----    | -----                   | SM/A-2-4                        |  |
|      |                 |       |   | No Sample         |                   |                  |          |          |                         |                                 |  |
| 362  | 23+00           | Right | 5                                       | 1<br>2            | 26.0<br>32.9      | -----            | -----    | -----    | 37.7                    | SM/A-4<br>SM/A-4                |  |
| 362  | 51+00           | Left  | 4                                       | 1<br>2            | 7.3<br>9.7        | -----            | -----    | -----    | -----                   | SM/A-2-4<br>SM/A-2-4            |  |
| 363  | 10+50           | Right | 4                                       | 1<br>2            | 11.1<br>11.8      | 33               | NP       | NP       | 28.1                    | SM/A-2-4<br>SM/A-2-4            |  |

Note: (1) Measurements determined in field by Arcadis.  
(2) Most soil samples contained significant amount of rock fragments.  
(3) Material contains significant amount of mica.

**TABLE 2 - (continued)**  
**LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Boring Location |         | Asphalt Pavement Thickness (inches) (1) | Sample Number | Water Content (%) | Atterberg Limits |       |       | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |
|-----------------|---------|---|---------------|-------------------|------------------|-------|-------|-------------------------|---------------------------------|
| Mile            | Station |   |               |                   | Lane             | LL    | PL    |                         |                                 |
| 363             | 34+00   | 4.5                                     | 1             | 17.8              | -----            | ----- | ----- | 24.4                    | SM/A-2-4                        |
|                 |         |   | 2             | 10.4              | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| 364             | 3+50    | 4.5                                     | 1             | 2.8               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
|                 |         |   | 1             | 11.1              | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| 364             | 36+00   | 4                                       | 2             | 5.0               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
|                 |         |   | 1             | 22.2              | -----            | ----- | ----- | 32.3                    | SM/A-2-4                        |
| 365             | 11+00   | 4.5                                     | 2             | 10.3              | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
|                 |         |   | 1             | 14.6              | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| 366             | 11+00   | 5                                       | 2             | 12.8              | 34               | NP    | NP    | 24.1                    | SM/A-2-4                        |
|                 |         |   | 1             | 9.1               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| 366             | 15+00   | 4.5                                     | 1             | 5.5               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
|                 |         |   | 2             | 4.2               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| 367             | 21+50   | 3                                       | No Samples    |                   |                  |       |       |                         |                                 |
| 367             | 39+00   | 3.25                                    | 1             | 11.1              | -----            | ----- | ----- | 28.0                    | SM/A-2-4                        |
|                 |         |   | 2             | 9.9               | -----            | ----- | ----- | 22.4                    | SM/A-2-4                        |

**TABLE 2 - (continued)**  
**LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Mile | Boring Location |       | Asphalt Pavement Thickness (inches) (1) | Sample Number | Water Content (%) | Atterberg Limits |      |      | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |
|------|-----------------|-------|---|---------------|-------------------|------------------|------|------|-------------------------|---------------------------------|
|      | Station         | Lane  |   |               |                   | LL               | PL   | PI   |                         |                                 |
| 368  | 12+50           | Right | 4                                       | 1             | 19.9              | ----             | ---- | ---- | 34.9                    | SM/A-2-4                        |
|      |                 |       |   | 2             | 20.6              | ----             | ---- | ---- | ----                    | SM/A-2-4                        |
| 368  | 38+00           | Right | 4                                       | 1             | 15.2              | 41               | NP   | NP   | 31.3                    | SM/A-2-4                        |
|      |                 |       |   | 2             | 12.2              | ----             | ---- | ---- | ----                    | SM/A-2-4                        |
| 369  | 4+50            | Left  | 3.5                                     | 1             | 4.7               | ----             | ---- | ---- | ----                    | SM/A-2-4                        |
|      |                 |       |   | 2             | 9.9               | ----             | ---- | ---- | 27.1                    | SM/A-2-4                        |
| 369  | 14+00           | Left  | 4                                       | 1             | 9.6               | ----             | ---- | ---- | ----                    | SM/A-2-4                        |
|      |                 |       |   | 2             | 5.5               | ----             | ---- | ---- | 21.0                    | SM/A-2-4                        |
| 369  | 39+00           | Right | 4                                       | 1             | 10.3              | ----             | ---- | ---- | ----                    | SM/A-2-4                        |
|      |                 |       |   | 2             | 8.0               | 32               | NP   | NP   | 21.7                    | SM/A-2-4                        |
| 370  | 13+00           | Left  | 3.5                                     | 1             | 9.7               | ----             | ---- | ---- | 31.2                    | SM/A-2-4                        |
|      |                 |       |   | 2             | 7.2               | ----             | ---- | ---- | ----                    | SM/A-2-4                        |
| 370  | 38+00           | Right | 4.5                                     | 1             | 9.7               | ----             | ---- | ---- | 31.2                    | SM/A-2-4                        |
|      |                 |       |   | 2             | 7.2               | ----             | ---- | ---- | ----                    | SM/A-2-4                        |

**TABLE 2 - (continued)**  
**LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Boring Location |         | Asphalt Pavement Thickness (inches) (1) | Sample Number | Water Content (%) | Atterberg Limits |       |       | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |
|-----------------|---------|---|---------------|-------------------|------------------|-------|-------|-------------------------|---------------------------------|
| Mile            | Station |   |               |                   | Lane             | LL    | PL    |                         |                                 |
| 371             | 15+00   | 3                                       | 1             | 11.3              | -----            | ----- | ----- | 23.1                    | SM/A-2-4                        |
|                 |         |   | 2             | 14.9              | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| 371             | 25+00   | 3                                       | 1             | 10.9              | -----            | ----- | ----- | 27.2                    | SM/A-2-4                        |
|                 |         |   | 2             | 28.3              | -----            | ----- | ----- | 46.3                    | SM/A-4                          |
| 371             | 30+00   | 3.5                                     | 1             | 11.3              | -----            | ----- | ----- | 22.7                    | SM/A-2-4                        |
|                 |         |   | 2             | 6.7               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| 372             | 14+00   | 3                                       | 1             | 17.9              | 25               | 24    | 1     | 37.8                    | SM/A-4                          |
| 372             | 39+50   | 3.5                                     | 1             | 12.6              | -----            | ----- | ----- | 17.7                    | SM/A-2-4                        |
|                 |         |   | 2             | 18.0              | -----            | ----- | ----- | 32.6                    | SM/A-2-4                        |
| 373             | 17+00   | 3.25                                    | 1             | 13.4              | -----            | ----- | ----- | 32.1                    | SM/A-2-4                        |
| 373             | 37+00   | 3.5                                     | 1             | 19.3              | -----            | ----- | ----- | 50.4                    | ML/A-4                          |
|                 |         |   | 2             | 21.2              | -----            | ----- | ----- | 40.6                    | SM/A-4                          |

**TABLE 2 - (continued)**  
**LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Boring Location |         | Asphalt Pavement Thickness (inches) (1) | Sample Number | Water Content (%) | Atterberg Limits |       |       | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |
|-----------------|---------|---|---------------|-------------------|------------------|-------|-------|-------------------------|---------------------------------|
| Mile            | Station |   |               |                   | Lane             | LL    | PL    |                         |                                 |
| 373             | 49+50   | 3                                       | 1             | 16.6              | 31               | 2     | 39.6  | SM/A-4                  |                                 |
|                 |         |   | 2             | 7.0               | -----            | ----- | ----- | SM/A-2-4                |                                 |
| 374             | 36+00   | 3                                       | 1             | 19.7              | NP               | NP    | 40.3  | SM/A-4                  |                                 |
|                 |         |   | 2             | 3.1               | -----            | ----- | ----- | SM/A-2-4                |                                 |
| 375             | 0+00    | 2.5                                     | 1             | 14.2              | 24               | 5     | 48.2  | SM/A-4                  |                                 |
|                 |         |   | 2             | 0.9               | -----            | ----- | ----- | SM/A-2-4                |                                 |
| PA              | 20+50   | 3.5                                     | 1             | 7.9               | -----            | ----- | ----- | SM/A-2-4                |                                 |
|                 |         |   | 2             | 20.0              | -----            | ----- | ----- | SM/A-2-4                |                                 |
| PA              | 36+80   | 4.5                                     | 1             | 27.4              | -----            | ----- | 33.2  | SM/A-2-4                |                                 |
|                 |         |   | 2             | 27.8              | -----            | ----- | ----- | SM/A-2-4                |                                 |
| Picnic Area     |         | 2                                       | 1             | 8.7               | -----            | ----- | 23.2  | SM/A-2-4                |                                 |
|                 |         |   | 2             | 4.9               | -----            | ----- | ----- | SM/A-2-4                |                                 |

TABLE 2 - (continued)  
 LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS  
 BLUE RIDGE PARKWAY - SECTION 2P  
 ASHEVILLE, NORTH CAROLINA

| Boring Location          |                | Asphalt Pavement Thickness (inches) (1) | Sample Number | Water Content (%) | Atterberg Limits |       |       | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |
|--------------------------|----------------|---|---------------|-------------------|------------------|-------|-------|-------------------------|---------------------------------|
|                          |                |   |               |                   | LL               | PL    | PI    |                         |                                 |
|                          | Visitor Center | 3                                       | 1             | 20.5              | -----            | ----- | ----- | SM/A-2-4                |                                 |
|                          |                |   | 2             | 29.4              | -----            | ----- | ----- | SM/A-2-4                |                                 |
| Craggy Dome - Upper Tier |                | 2.5                                     | 1             | 10.0              | -----            | ----- | ----- | SM/A-2-4                |                                 |
|                          |                |   | 2             | 0.8               | -----            | ----- | ----- | SM/A-2-4                |                                 |
| Craggy Dome - Lower Tier |                | 2.5                                     | 1             | 33.1              | -----            | ----- | ----- | SM/A-2-4                |                                 |

**HOT MIX ASPHALT (HMA)  
TEST RESULTS**

**Table 3**  
**Asphalt Pavement Cores**  
**Blue Ridge Parkway - Section 2P**  
**Asheville, North Carolina**

| Core No. | Core Location              | Layer   | Thickness (in.) | Bulk Specific Gravity | Absorption (%) |
|----------|----------------------------|---------|-----------------|-----------------------|----------------|
| 1        | MM 360<br>Station<br>24+00 | Surface | 1.0             | Damaged               | Damaged        |
|          |                            | Binder  | 1.5             | 2.304                 | 0.98           |
|          |                            | Base    | 2.0             | 2.397                 | 0.36           |
| 2        | MM 361<br>Station<br>51+00 | Surface | 1.2             | 2.299                 | 0.36           |
|          |                            | Binder  | 3.0             | 2.313                 | 2.58           |
|          |                            | Base    | 2.7             | 2.407                 | 0.91           |
| 3        | MM 365<br>Station<br>11+00 | Surface | 1.5             | 2.253                 | 1.67           |
|          |                            | Base    | 2.3             | 2.272                 | 3.09           |
| 4        | MM 367<br>Station<br>39+00 | Surface | 1.1             | 2.182                 | 1.87           |
|          |                            | Base    | 2.1             | 2.291                 | 3.70           |
| 5        | MM 369<br>Station<br>39+00 | Surface | 1.0             | 2.245                 | 1.59           |
|          |                            | Binder  | 1.6             | 2.320                 | 2.03           |
|          |                            | Base    | 1.4             | 2.377                 | 0.50           |
| 6        | MM 372<br>Station<br>14+00 | Surface | 1.1             | 2.212                 | 1.95           |
|          |                            | Base    | 2.2             | 2.304                 | 1.36           |
| 7        | MM 373<br>Station<br>37+00 | Surface | 1.4             | 2.196                 | 4.22           |
|          |                            | Base    | 2.0             | 2.342                 | 1.07           |
| 8        | MM 374<br>Station<br>36+00 | Surface | 1.3             | 2.148                 | 4.08           |
|          |                            | Base    | 2.3             | 2.346                 | 2.93           |

Group 1 - Cores 1 and 2

Group 2 - Cores 3, 4, and 5

Group 3 - Cores 6, 7, and 8

**Table 4**  
**Hot Mix Asphalt Properties**  
**Surface Course Layer**  
**Blue Ridge Parkway - Section 2P**  
**Asheville, North Carolina**

|                                   | <b>Group 1</b>         | <b>Group 2</b> | <b>Group 3</b> |
|-----------------------------------|------------------------|----------------|----------------|
| <b>Sieve Size</b>                 | <b>Percent Passing</b> |                |                |
| ½ in.                             | 100.0                  | 100.0          | 100.0          |
| 3/8 in.                           | 95.2                   | 91.9           | 95.3           |
| No. 4                             | 63.9                   | 50.3           | 53.5           |
| No. 8                             | 48.1                   | 23.2           | 23.5           |
| No. 16                            | 37.7                   | 14.6           | 13.3           |
| No. 30                            | 29.1                   | 11.9           | 10.4           |
| No. 50                            | 20.0                   | 9.8            | 8.4            |
| No. 200                           | 5.8                    | 4.7            | 3.8            |
| <b>Asphalt Content (%)</b>        | 5.9                    | 5.6            | 5.5            |
| <b>Absolute Viscosity (poise)</b> | 37,612                 | 198,644        | 319,342        |

Note: Composite Samples - Cores trimmed and combined

Group 1 = MM 360 Station 24 + 00  
MM 361 Station 51 + 00

Group 2 = MM 365 Station 11 + 00  
MM 367 Station 39 + 00  
MM 369 Station 39 + 00

Group 3 = MM 372 Station 14 + 00  
MM 373 Station 37 + 00  
MM 374 Station 36 + 00

**Table 5**  
**Hot Mix Asphalt Properties**  
**Binder/Base Course Layer**  
**Blue Ridge Parkway - Section 2P**  
**Asheville, North Carolina**

|                                   | Group 1         | Group 2 | Group 3 |
|-----------------------------------|-----------------|---------|---------|
| Sieve Size                        | Percent Passing |         |         |
| 1 in.                             | 100.0           | 100.0   | 100.0   |
| 3/4 in.                           | 97.6            | 97.8    | 99.5    |
| 1/2 in.                           | 78.6            | 86.1    | 83.6    |
| 3/8 in.                           | 66.6            | 72.4    | 71.9    |
| No. 4                             | 45.4            | 51.7    | 54.5    |
| No. 8                             | 36.4            | 36.7    | 42.8    |
| No. 16                            | 30.1            | 28.0    | 33.4    |
| No. 30                            | 23.9            | 21.5    | 25.3    |
| No. 50                            | 16.3            | 14.2    | 16.5    |
| No. 200                           | 4.7             | 5.3     | 6.2     |
| <b>Asphalt Content (%)</b>        | 5.1             | 4.9     | 5.0     |
| <b>Absolute Viscosity (poise)</b> | 32,516          | 283,912 | 215,887 |

Note: Composite Samples - Cores trimmed and combined

Group 1 = MM 360 Station 24 + 00  
MM 361 Station 51 + 00

Group 2 = MM 365 Station 11 + 00  
MM 367 Station 39 + 00  
MM 369 Station 39 + 00

Group 3 = MM 372 Station 14 + 00  
MM 373 Station 37 + 00  
MM 374 Station 36 + 00

## **Appendix F**

FWD Testing



ARA-TR-03-16062

# **BLUE RIDGE PARKWAY**

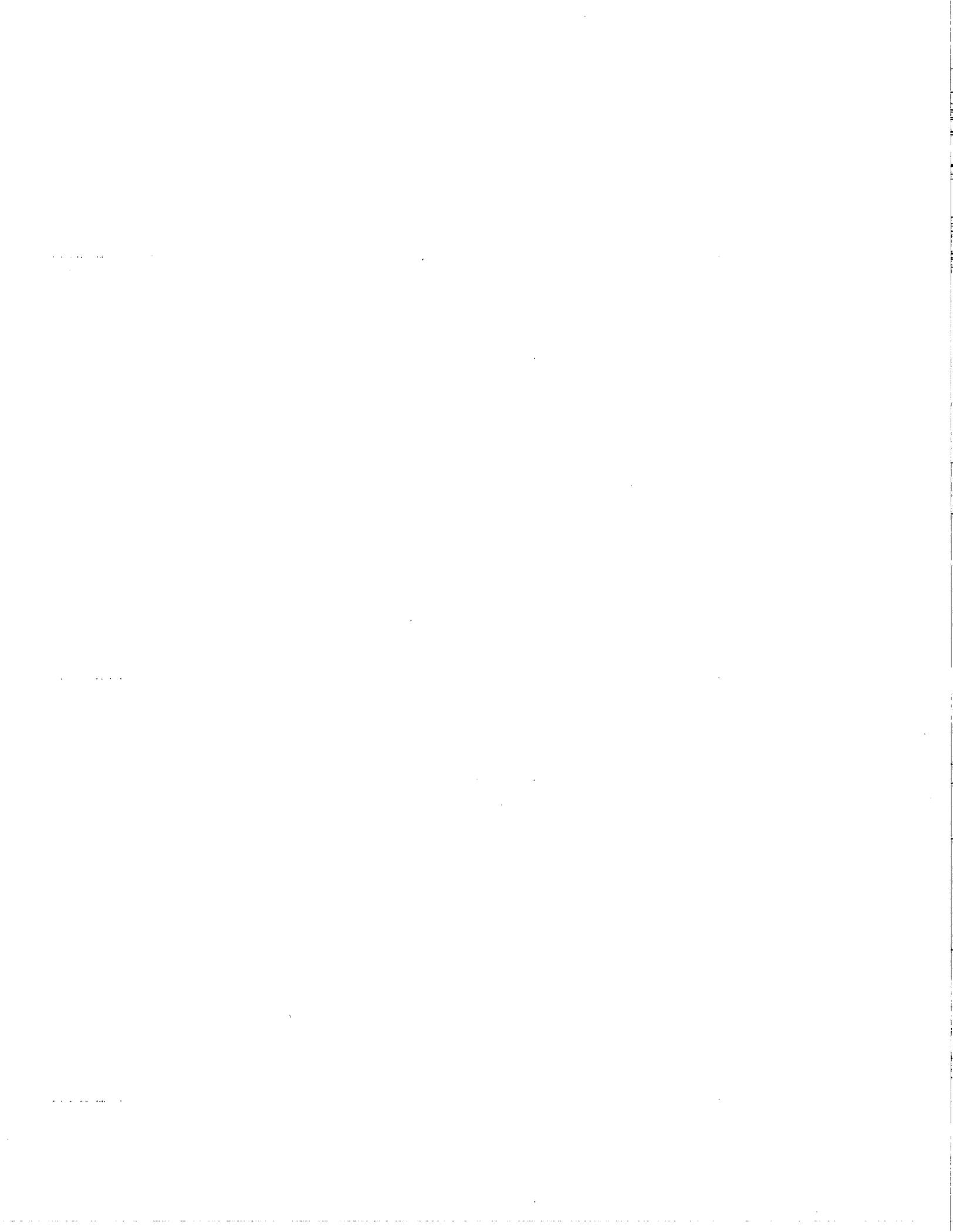
## **STRUCTURAL ANALYSIS AND OVERLAY DESIGN SECTION 2P**

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# 1 BACKGROUND

The Blue Ridge Parkway is a two-lane asphalt concrete (AC) roadway. ARCADIS G&M, Inc., is responsible for preparation of plans, specifications, and estimates for resurfacing and rehabilitation of the parkway, pull offs and parking areas from Milepost 359.8 to Milepost 375.3, known as section 2P. The role of ERES Consultants, a Division of Applied Research Associates, is to provide pavement analysis and rehabilitation recommendations. Specific tasks include:

- Non-destructive testing of the parkway pavement by falling weight deflectometer (FWD)
- Structural analysis by the American Association of State Highway and Transportation Officials (AASHTO) structural number method outlined in the 1993 AASHTO Design Guide
- Recommendations for rehabilitation, including design overlay thickness if required.

## 2 FALLING WEIGHT DEFLECTOMETER

### 2.1 GENERAL

The FWD is a rapid, nondestructive test method, which causes minimal interruption to traffic and causes essentially no damage to the pavements. Figure 1 is a photo of a typical FWD device. A schematic of an FWD system is shown in Figure 2. FWD tests require less than two minutes, and can be performed any time of day or night.



Figure 1. Typical FWD.

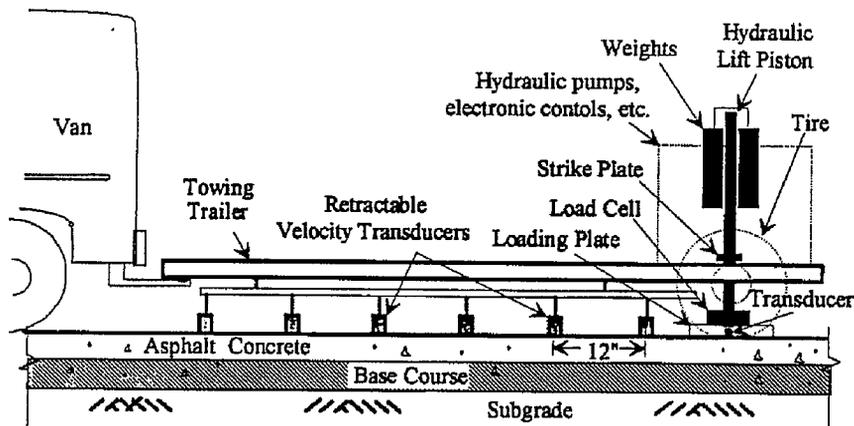


Figure 2. Schematic of FWD.

FWD testing involves subjecting a pavement to an impulse load and measuring the resulting deflection basin. The shape and magnitude of the deflection basin are used to analytically determine the moduli of the pavement and subgrade using software packages such as EverCalc or WESDEF. These properties are in turn used to determine the structural support capability of the pavement using a pavement design method such as the AASHTO method. The properties can then be used to analytically estimate the pavement load capacity and remaining life of the pavement using a limiting stress/strain analysis.

The program EverCalc was used to backcalculate the layer moduli from the deflection data. Backcalculation requires that a pavement model be input into the program. The model defines the number of layers, the thickness of each of the layers, plus the initial moduli for each

layer, the moduli range and Poisson's ratio for each of the layers. Once the pavement model has been defined, EverCalc calculates a set of deflections based on the model and compares the calculated deflections to the measured deflections. EverCalc then adjusts the moduli based on the differences between the calculated and measured deflections and recalculates a new set of deflections. This process is continued until the calculated deflections and measured deflections are within the user input tolerance, the moduli did not change within the user input tolerance, or the number of iterations exceeds the limit input by the user.

## **2.2 RESULTS AND ANALYSIS**

FWD testing was conducted at nominal ¼-mile intervals in both the northbound and southbound lanes. Test points in the northbound lane were offset from test points in the southbound lanes to provide an overall test point spacing of approximately 1/8 of a mile (approximately 700 feet). There were 130 test locations on the parkway. Some data were not useable due to subgrade conditions or interference from traffic; these data were discarded.

Data were collected at ten selected locations in pull-offs and parking areas adjacent to section 2P. The adjacent pavements that were tested are:

- Balsam Gap Overlook
- Bull Creek Overlook
- Craggy Dome Overlook (two test locations)
- Lane Pinnacle Overlook
- Picnic area parking (two tests)
- Picnic area access road (two test locations)
- Visitor Center parking

The second test in the picnic parking area was discarded because the deflection basin was improperly shaped. The shape of the discarded basin and magnitude of the deflections was consistent with extremely weak pavement and subgrade.

### **2.2.1 Pavement Layer Thickness**

No data were available concerning base layers. A base layer thickness of 12 inches was initially assumed for all test points. Results of the backcalculation analysis later showed this assumption to be false; however, the results of the backcalculation analysis are considered correct because the software treated the layer as an additional layer of subgrade.

Cores were taken for AC thickness determination at 34 locations in section 2P. Eighteen cores were from the southbound lane (SB), 15 cores were from the northbound lane (NB), and one core with no lane designation. The AC thicknesses determined from the cores is shown in Figure 3. Six cores were taken in the pull-offs and parking areas adjacent to the parkway: two in the picnic area access road, one in the picnic area, one in the visitor center parking lot, and two at Craggy Dome. Core thicknesses for pull-off and parking area pavements are given in Table 1.

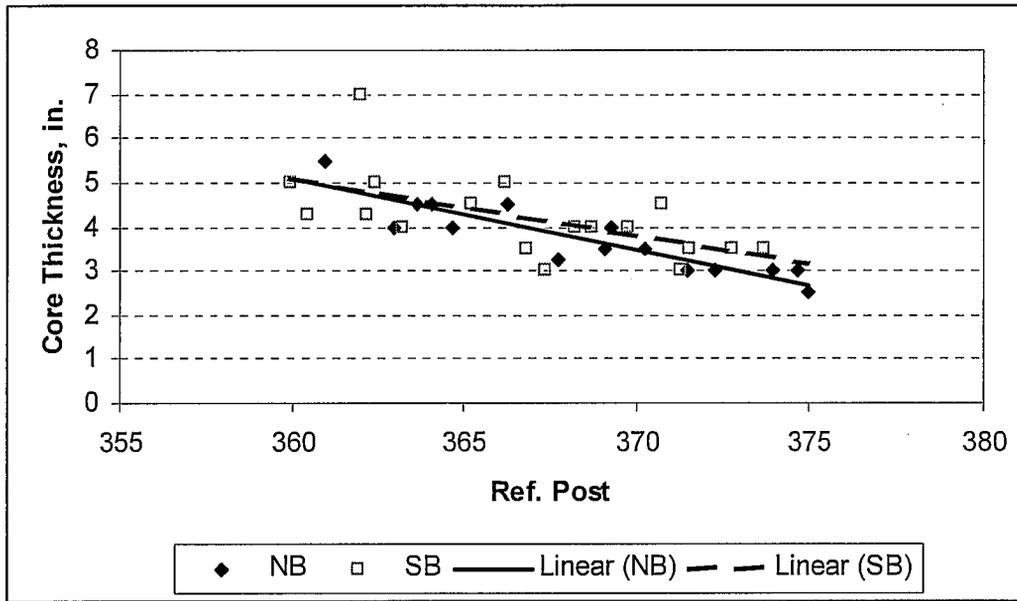


Figure 3. Pavement thickness determined from cores.

Table 1. Thickness of cores from pull-offs and parking areas.

| Core Location                     | Core Thickness (inch) |
|-----------------------------------|-----------------------|
| Picnic Area Access Road sta 20+50 | 3.5                   |
| Picnic Area Access Road sta 36+80 | 4.5                   |
| Picnic Area Parking               | 2.0                   |
| Visitor Center Parking            | 3.0                   |
| Upper Craggy Dome                 | 2.5                   |
| Lower Craggy Dome                 | 2.5                   |

Thickness of the AC layer must be determined at each test point to analyze deflection data by backcalculation. Typically, this is done by selecting a representative thickness for specific sections, or by interpolating the thickness for test points located between cores. Pavement thickness for pull-offs and parking lots was taken as the thickness of the core nearest the test point.

The thickness plot for the parkway shows a general trend of the AC decreasing in thickness from about 5 inches thick at the beginning of the section to about 3 inches thick at the end, with no areas of uniform thickness. For this analysis, a linear regression model was used to determine the thickness of the AC layer at each test point because of the variability between the cores and the long distances between the cores. The model was checked for validity by comparing predicted thicknesses to known thicknesses at locations where cores were taken. The average absolute difference between the predicted thickness and the measured thickness is 0.3 inches for the northbound cores and 0.5 inches for the southbound cores. This is an extremely accurate model, given that actual pavement thicknesses can change over distances as small as two to three feet.

The higher average absolute difference for the southbound cores is likely the seven-inch core at reference post 361 plus 51+00. To determine if that core indicates thicker pavement near where the core was taken, a plot of deflection results near the core (Figure 4) was evaluated. The plot shows one test point at reference post 362 plus 10+50 to have greater pavement stiffness

according to the Area Basin Factor, which is related to the area under a plotted deflection basin curve. There was no trend in increased strength around Reference Post 362, the location of the 7-inch core. The 7-inch core was then considered an isolated condition.

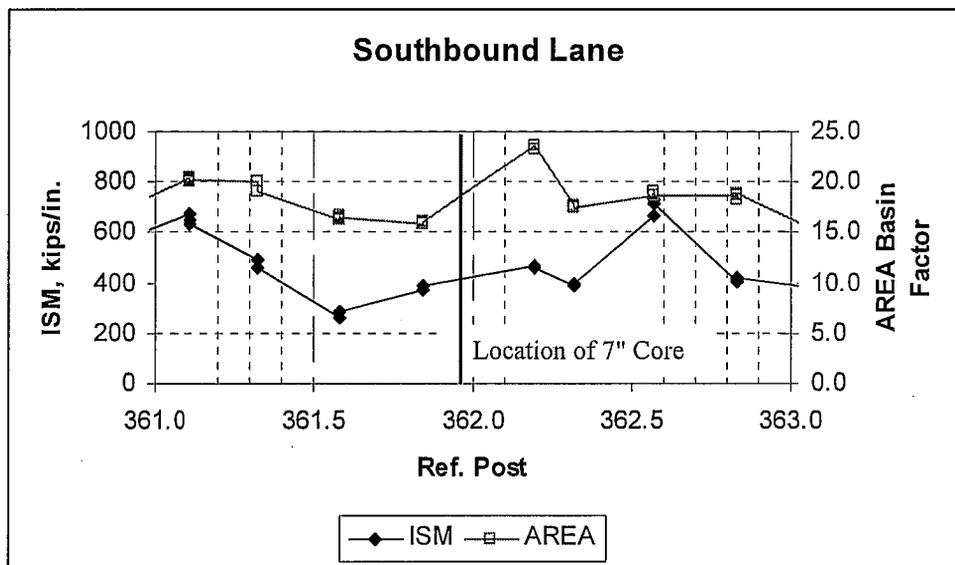


Figure 4. Deflection characteristics in the vicinity of the 7-inch core.

### 2.2.2 Depth to Stiff Layer

The presence of an underlying ‘apparent stiff layer’ such as bedrock will have an influence on the measured deflections. The EverCalc backcalculation software was selected for its ability to estimate the depth of the apparent stiff layer. The estimation process uses the thickness of the bound layer and deflection basin characteristics as input.

In our experience, the algorithms used by EverCalc tend to underestimate the depth to the apparent stiff layer when the pavement is in poor condition. Underestimating the depth to the apparent stiff layer results in lower backcalculated subgrade moduli. The low subgrade moduli, in turn, results in surface or base moduli that are too high. This results in backcalculation models that do not match measured deflection basins, as evidenced by high root mean square (RMS) errors. The RMS is a measure of agreement between the measured and calculated deflection basin. In these cases, much of the RMS error is due to large differences between the measured and calculated deflections for the outer sensors. The RMS error for this dataset is 26% when the EverCalc depth-to-bedrock model is used. Figure 5 shows that the RMS error is closely related to the percent error of the outer sensor deflection for this dataset, meaning it is likely that EverCalc is underestimating the depth of bedrock for much of the data. However, if the model predicts near-surface bedrock, e.g., a stiff layer at depths of less than five feet, it is likely that such a layer exists. The existence of near-surface bedrock predicted by the model can be confirmed by examination of outer sensor data. If outer sensor deflections are less than one mil, it is very likely the pavement is above near-surface bedrock. Several of the test points have deflections close to zero, a definite indicator that a very stiff layer is close to the surface.

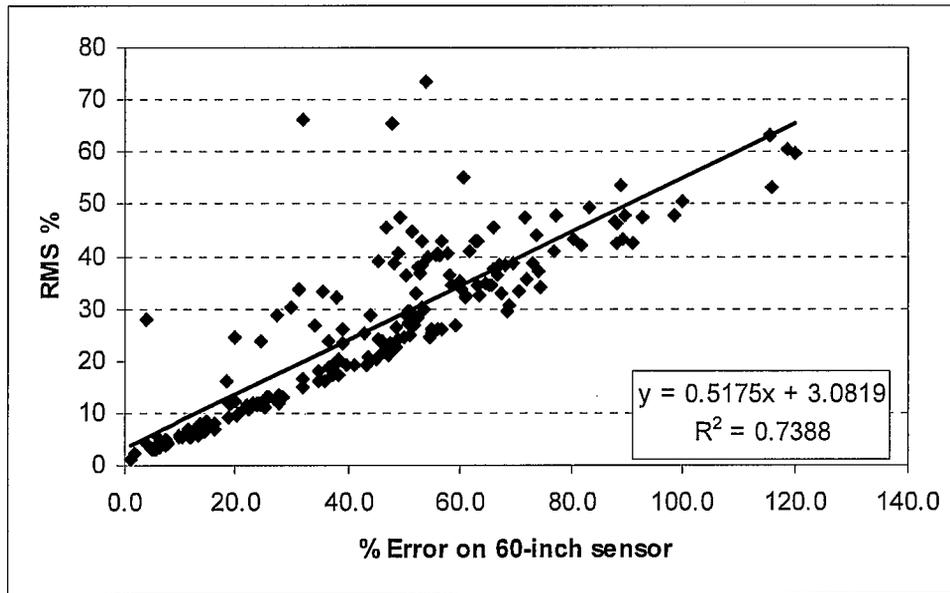


Figure 5. Relationship between overall basin RMS and percent error on 60-inch sensor.

The Hogg model was also used to calculate the subgrade thickness. The Hogg model sets the depth to the apparent stiff layer at 10 times the characteristic length. The characteristic length is calculated from the deflection basin and is related to the depth at which significant deflection no longer occurs. After the subgrade thicknesses were determined by the Hogg model, a backcalculation analysis was performed with subgrade thicknesses based on the results. The backcalculation results are an improvement over the EverCalc calculated depth to stiff layer, with a total RMS error of 18%.

The depth to bedrock estimate on the pull-offs and parking lots was further refined by multiplying the original estimate by the error of the outer deflection sensor and performing the backcalculation again. This method was able to reduce RMS error to less than 10% for six of the nine test locations.

The calculated depth to bedrock on the parkway ranged from 2 to 12 feet, as shown in Figure 6. The depth to bedrock is approximately eight to ten feet at mile 359, and steadily decreases until mile 365. Bedrock is generally found at a depth of four to seven feet between miles 365 and 375. The calculated depth to bedrock on parking lots and pull-offs ranges from 5.5 feet to 8 feet, with the exception of the picnic area access road, which has a calculated depth to bedrock of 16.5 feet at station 19+98 and 13 feet at station 40+00.

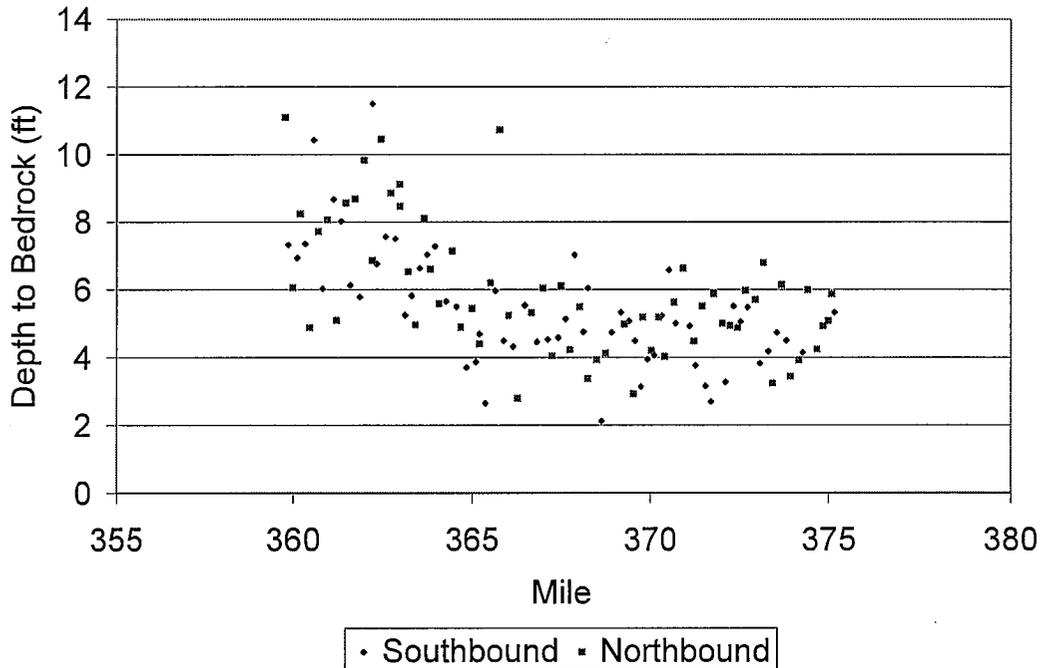


Figure 6. Hogg model calculated depth to bedrock.

### 2.2.3 Layer Moduli of the Parkway

The average calculated layer moduli for the parkway data points are shown in Table 2, along with the maximum, minimum, and standard deviation for each layer. The AC and base layer moduli maximum and minimum values are the limits set during the analysis, indicating that the model used in backcalculation was not the most accurate model. The most likely source of error in the model is the base thickness, which was assumed to be 12 inches thick in lieu of base thickness data.

Table 2. Calculated layer moduli.

|                           | AC Modulus (ksi) | Base Modulus (ksi) | Subgrade Modulus (ksi) |
|---------------------------|------------------|--------------------|------------------------|
| <b>Average</b>            | 392              | 26                 | 14                     |
| <b>Minimum</b>            | 75               | 5                  | 3                      |
| <b>Maximum</b>            | 1500             | 150                | 50                     |
| <b>Standard Deviation</b> | 357              | 22                 | 10                     |

Section 2P was divided into five segments for structural analysis based on the deflection plot, shown in Figure 7. The outer (60-inch) sensor deflection, which is most affected by subgrade conditions, varies considerably, from approximately 0.1 mils to 7 mils. The large variation indicates that bedrock is near the surface in some areas and is covered by a comparatively soft material in other areas. Segment 3 has consistently higher outer sensor deflections than the rest of the area of interest, indicating that larger overall deflections in this area may be caused by the subgrade. The outer sensor deflections in segment 5 are similar to the outer sensor deflections of the other segments, indicating the larger overall deflections in this area are caused by the upper layers. Table 3 shows the average 0-inch offset (inner) and 60-inch offset (outer) sensor deflection and average layer moduli for each analysis segment. Moduli from the backcalculation analysis were not multiplied by the 0.33 factor recommended in the

1993 AASHTO design guide due to the limited depth to bedrock. Shallow bedrock produces lower moduli in backcalculation analyses; therefore, it is more appropriate to use a 15<sup>th</sup> percentile value in this situation. Table 4 shows the 15<sup>th</sup> percentile modulus of each layer. As shown in Tables 3 and 4, the backcalculation results show that the assumed 12-inch base layer has approximately the same modulus as the underlying subgrade, indicating that the assumed base is not present. The modulus of the base of Segment 4 was approximately double the modulus of the subgrade, indicating that some sort of base material is present. The thickness of the base material in Segment 4 is unknown.

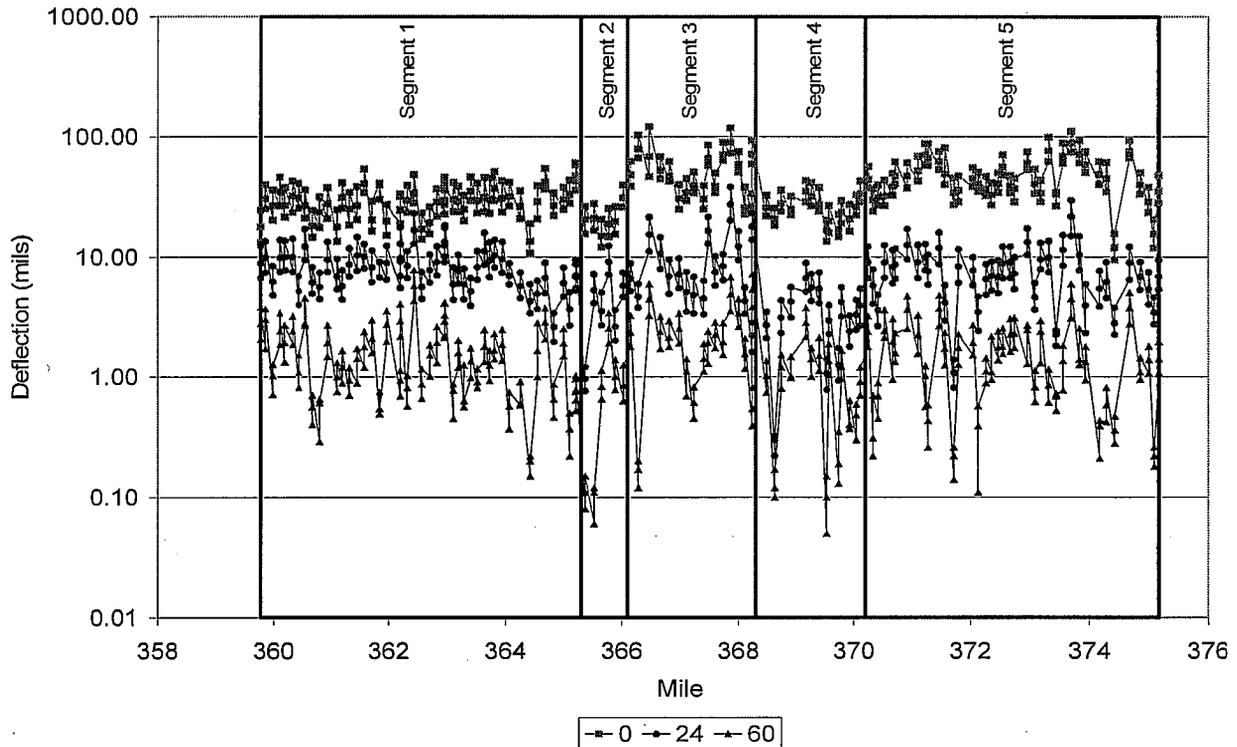


Figure 7. FWD sensor deflection by station.

Table 3. Average layer moduli and deflections by analysis segment.

|                           | Mile                        |         |                             |         |                             |         |                             |         |                              |         |
|---------------------------|-----------------------------|---------|-----------------------------|---------|-----------------------------|---------|-----------------------------|---------|------------------------------|---------|
|                           | Segment 1<br>359.7 to 365.3 |         | Segment 2<br>365.3 to 366.1 |         | Segment 3<br>366.1 to 368.3 |         | Segment 4<br>368.3 to 370.2 |         | Segment 5<br>370.2 to 375.17 |         |
|                           | Average                     | Std Dev | Average                      | Std Dev |
| Inner Sensor Defl. (mils) | 30.37                       | 10.08   | 21.88                       | 6.98    | 54.71                       | 24.23   | 26.21                       | 7.54    | 48.04                        | 19.75   |
| Outer Sensor Defl. (mils) | 1.65                        | 1.18    | 0.94                        | 0.92    | 2.36                        | 1.65    | 1.02                        | 0.79    | 1.62                         | 1.17    |
| AC Modulus (ksi)          | 485.88                      | 371.42  | 643.74                      | 552.39  | 169.11                      | 93.13   | 324.58                      | 267.68  | 360.23                       | 346.24  |
| Base Modulus (ksi)        | 19.02                       | 11.84   | 28.05                       | 15.19   | 30.55                       | 20.60   | 51.14                       | 31.98   | 24.51                        | 21.07   |
| Subgrade Modulus (ksi)    | 13.42                       | 5.92    | 25.14                       | 13.90   | 10.17                       | 6.71    | 23.58                       | 13.95   | 11.89                        | 8.55    |

Table 4. 15<sup>th</sup> percentile layer moduli by analysis segment.

| Segment                | 1              | 2              | 3              | 4              | 5               |
|------------------------|----------------|----------------|----------------|----------------|-----------------|
| Mile                   | 359.7 to 365.3 | 365.3 to 366.1 | 366.1 to 368.3 | 368.3 to 370.2 | 370.2 to 375.17 |
| AC Modulus (ksi)       | 149.36         | 185.46         | 90.04          | 161.86         | 141.82          |
| Base Modulus (ksi)     | 8.58           | 10.18          | 9.39           | 24.98          | 8.23            |
| Subgrade Modulus (ksi) | 8.74           | 12.58          | 4.14           | 13.17          | 6.02            |

#### 2.2.4 Layer Moduli of the Pull-Offs and Parking Areas

Each data point for the pull-offs and parking areas was analyzed separately because five of the seven pavements had a single test point, and the test points in the remaining parking areas were widely spaced. Analysis of an individual deflection test is highly sensitive to model inputs, because the tools to detect and eliminate outliers by comparison to other tests from pavements with similar structure are not available. Analyses of thin pavements are particularly sensitive, requiring large changes in estimated modulus to accommodate small changes in pavement thickness and deflection. Backcalculation results of the pull-offs and parking areas are shown in Table 5.

Table 5. Backcalculation results for pull-offs and parking areas.

|          | Balsam Gap |       | Bull Creek |       | Upper Craggy Dome |       | Lower Craggy Dome |       | Lane Pinnacle |       | Picnic Area Parking |       | Picnic Access Road sta 19+98 |       | Picnic Access Road sta 40+00 |       | Visitor Center Parking |       |
|----------|------------|-------|------------|-------|-------------------|-------|-------------------|-------|---------------|-------|---------------------|-------|------------------------------|-------|------------------------------|-------|------------------------|-------|
|          | E ksi      | T in. | E ksi      | T in. | E ksi             | T in. | E ksi             | T in. | E ksi         | T in. | E ksi               | T in. | E ksi                        | T in. | E ksi                        | T in. | E ksi                  | T in. |
| AC       | 330        | 3*    | 103        | 3*    | 446               | 2.5   | 316               | 2.5   | -             | -     | -                   | 2     | 381                          | 3.5   | 924                          | 4.5   | 270                    | 2     |
| Base     | 13.6       | 12    | 18.6       | 12    | 5.5               | 12    | 5.0               | 12    | -             | -     | -                   | 12    | 5.0                          | 8     | 8.7                          | 8     | 19.6                   | 12    |
| Subgrade | 5.7        | 90    | 12.5       | 72    | 6.4               | 83    | 5.1               | 88    | 20.0          | 67    | 5.0                 | 98    | 2.5                          | 197   | 3.5                          | 156   | 5.8                    | 77    |

\* estimated AC thickness

AC layer moduli appear reasonable, with the exception of the picnic access road, which is extremely stiff. The backcalculated moduli of the pull-offs and parking areas are generally consistent with the backcalculation result for the Parkway. The backcalculation process was unable to determine acceptable AC and base layer moduli for the picnic parking area and Lane Pinnacle pull-off, most likely due to the estimated layer thicknesses. Note that the AC thickness was not available for Balsam Gap, Bull Creek, and Lane Pinnacle; the values given are estimates that yield the best backcalculation results. Given the similarity to the parkway results, the estimated base layer thickness, the sensitivity to layer thickness, and the lack of statistical validation, we recommend using a typical modulus of 150 ksi for the existing AC layers.

### 3 STRUCTURAL ANALYSIS

#### 3.1 DESIGN STRUCTURAL NUMBER

The AASHTO design method was used for structural analysis. The traffic data in Table 6 was provided by ARCADIS. A structural number of 3 and a 4% growth rate for a 20-year design life with a terminal serviceability of 2.5 was assumed for traffic calculations. The design ESAL for this traffic mix is approximately 208,000 ESALs. A design ESAL of 208,000 ESALs is recommended. To estimate traffic levels for pull-offs and parking lots, it was assumed that 50% of traffic on the parkway would stop at any given pull-off. This gives a design ESAL of 104,000 ESALs for parking lots and pull-offs.

Table 6. Traffic data.

| Vehicle               | Axle Weight/Type | Current Daily Volume | Growth Factor | Design Load | ESAL Factor | Design ESAL    |
|-----------------------|------------------|----------------------|---------------|-------------|-------------|----------------|
| Passenger Cars        | 2-kip/single     | 3,700                | 29.78         | 40,217,890  | 0.0003      | 12,066         |
| Travel Trailer        | 14-kip/tandem    | 100                  | 29.78         | 1,086,970   | 0.0420      | 45,653         |
| Recreational Vehicles | 10-kip/single    | 100                  | 29.78         | 1,086,970   | 0.1180      | 128,262        |
| Construction Vehicles | 18-kip/single    | 2                    | 29.78         | 21,740      | 1.0000      | 21,740         |
| <b>Total</b>          |                  |                      |               |             |             | <b>207,721</b> |

Reliability, a statistical degree of certainty, was obtained from Part II Table 2.2 of the AASHTO design guide. The Blue Ridge Parkway falls into the functional class of a rural freeway. A reliability of 95% was selected. The AASHTO recommended standard deviation of 0.35 for flexible pavements was selected. The initial serviceability of the parkway was assumed to be 4.6. The terminal serviceability of 2.0 was selected because the road is a tourist attraction, yielding a drop in serviceability of  $4.6 - 2.5 = 2.1$  points. Parking lots and pull-offs were assumed to have a terminal serviceability of 2.0, yielding a serviceability drop of  $4.6 - 2.0 = 2.6$  points. The 15<sup>th</sup> percentile subgrade moduli shown in Table 3 were used for roadbed modulus values for the parkway. The subgrade moduli listed in Table 4 were used for roadbed moduli for the parking lots and pull-offs. The required structural number for each segment as determined from Part II Figure 3.1 of the AASHTO design guide is shown in Table 7.

Table 7. Required structural numbers.

| Segment        | Roadbed Modulus (ksi) | Required SN |
|----------------|-----------------------|-------------|
| 1              | 9                     | 2.46        |
| 2              | 13                    | 2.14        |
| 3              | 4                     | 3.29        |
| 4              | 13                    | 2.14        |
| 5              | 6                     | 2.85        |
| Balsam Gap     | 5.7                   | 2.56        |
| Bull Creek     | 12.5                  | 1.92        |
| Craggy Dome    | 5.8                   | 2.55        |
| Lane Pinnacle  | 20.0                  | 1.60        |
| Picnic Parking | 5.0                   | 2.67        |
| Picnic Access  | 3.0                   | 3.28        |
| Visitor Center | 5.8                   | 2.54        |

### 3.2 EFFECTIVE STRUCTURAL NUMBER

Effective structure number was determined from the known layer thicknesses and moduli. Structural number is determined by the equation  $SN = a_1D_1 + a_2D_2$  where  $a_1$  and  $a_2$  are structural layer coefficients and  $D_1$  and  $D_2$  are the layer thicknesses of the AC and base, respectively. The structural layer coefficient  $a_1$  was determined from Part II Figure 2.5 of the AASHTO design guide using the 15<sup>th</sup> percentile AC layer modulus from Tables 4 and 5. The structural layer coefficient  $a_2$  was determined from Part II Figure 2.6 of the AASHTO design guide using the 15<sup>th</sup> percentile base layer modulus from Tables 4 and 5. The average AC thickness of each analysis segment was determined from the thickness values used in the backcalculation results. Base thickness was assumed to be 12 inches when present. Table 12 summarizes the effective structural number calculations.

Table 8. Effective structural numbers for Section 2P.

| Segment 1                |         |      |                |             |
|--------------------------|---------|------|----------------|-------------|
| Layer                    | E (ksi) | a    | Thickness (in) | aD          |
| AC                       | 149     | .25  | 4.6            | 1.15        |
| Base                     | -       | -    | -              | -           |
| <b>Structural Number</b> |         |      |                | <b>1.15</b> |
| Segment 2                |         |      |                |             |
| Layer                    | E (ksi) | a    | Thickness (in) | aD          |
| AC                       | 185     | .275 | 4.1            | 1.13        |
| Base                     | -       | -    | -              | -           |
| <b>Structural Number</b> |         |      |                | <b>1.13</b> |
| Segment 3                |         |      |                |             |
| Layer                    | E (ksi) | a    | Thickness (in) | aD          |
| AC                       | 90      | .2   | 3.9            | 0.78        |
| Base                     | 9       | .03  | 12             | 0.36        |
| <b>Structural Number</b> |         |      |                | <b>1.14</b> |
| Segment 4                |         |      |                |             |
| Layer                    | E (ksi) | a    | Thickness (in) | aD          |
| AC                       | 161     | .25  | 3.6            | 0.90        |
| Base                     | 25      | .12  | 12             | 0.36        |
| <b>Structural Number</b> |         |      |                | <b>1.26</b> |
| Segment 5                |         |      |                |             |
| Layer                    | E (ksi) | a    | Thickness (in) | aD          |
| AC                       | 141     | .25  | 3.0            | 0.75        |
| Base                     | -       | -    | -              | -           |
| <b>Structural Number</b> |         |      |                | <b>0.75</b> |

\* estimated AC thickness

Table 9. Effective structural numbers for parking areas and pull-offs.

| <b>Balsam Gap</b>              |         |     |                |             |
|--------------------------------|---------|-----|----------------|-------------|
| Layer                          | E (ksi) | a   | Thickness (in) | aD          |
| AC                             | 150     | .25 | 3.0*           | 0.75        |
| Base                           | 13.6    | .06 | 12             | 0.72        |
| <b>Structural Number</b>       |         |     |                | <b>1.47</b> |
| <b>Bull Creek</b>              |         |     |                |             |
| Layer                          | E (ksi) | a   | Thickness (in) | aD          |
| AC                             | 150     | .25 | 3.0*           | 0.75        |
| Base                           | 18.6    | .09 | 12             | 1.08        |
| <b>Structural Number</b>       |         |     |                | <b>1.83</b> |
| <b>Craggy Dome</b>             |         |     |                |             |
| Layer                          | E (ksi) | a   | Thickness (in) | aD          |
| AC                             | 150     | .25 | 2.5            | 0.63        |
| Base                           | -       | -   | -              | -           |
| <b>Structural Number</b>       |         |     |                | <b>0.63</b> |
| <b>Lane Pinnacle</b>           |         |     |                |             |
| Layer                          | E (ksi) | a   | Thickness (in) | AD          |
| AC                             | 150     | .25 | 2.0*           | 0.50        |
| Base                           | -       | -   | -              | -           |
| <b>Structural Number</b>       |         |     |                | <b>0.50</b> |
| <b>Picnic Area Parking</b>     |         |     |                |             |
| Layer                          | E (ksi) | a   | Thickness (in) | aD          |
| AC                             | 150     | .25 | 2.0            | 0.50        |
| Base                           | -       | -   | -              | -           |
| <b>Structural Number</b>       |         |     |                | <b>0.50</b> |
| <b>Picnic Area Access Road</b> |         |     |                |             |
| Layer                          | E (ksi) | a   | Thickness (in) | aD          |
| AC                             | 150     | .25 | 4.0            | 1.00        |
| Base                           | -       | -   | -              | -           |
| <b>Structural Number</b>       |         |     |                | <b>1.00</b> |
| <b>Visitor Center</b>          |         |     |                |             |
| Layer                          | E (ksi) | a   | Thickness (in) | aD          |
| AC                             | 150     | .25 | 2.0            | 0.50        |
| Base                           | 19.6    | .09 | 12             | 1.08        |
| <b>Structural Number</b>       |         |     |                | <b>1.58</b> |

\* estimated AC thickness

- no base layer

## 4 PAVEMENT REHABILITATION RECOMMENDATIONS

Structural analysis results indicate that the pavement is structurally deficient. These results are supported by the presence of scattered fatigue cracking and rutting. A structural enhancement is required. Two rehabilitation methods were examined:

- Structural overlay
- Complete reconstruction.

New AC material was assumed to be dense-graded material with a layer coefficient of 0.42, which corresponds to a modulus of 400 ksi for new pavement. New base materials are assumed to have a CBR of 80, which corresponds to a layer coefficient of 0.13.

### 4.1 STRUCTURAL OVERLAY

A structural overlay should be preceded by milling a minimum one-inch layer from the existing pavement. Milling operations should completely remove the surface course of the existing pavement, but leave a minimum 1.5" layer of AC above the subgrade. If either criterion cannot be met, the pavement should be completely reconstructed. Areas with moderate to severe fatigue cracking should be repaired with a full depth patch prior to being overlaid. Table 10 summarizes the minimum required overlay thicknesses for each analysis segment, rounded up to the nearest ½-inch.

Table 10. Required overlay thicknesses.

| Segment        | Existing AC (inch) | Effective SN | Required SN | Recommended Overlay (inch) |
|----------------|--------------------|--------------|-------------|----------------------------|
| 1              | 4.6                | 1.51         | 2.46        | 3.5                        |
| 2              | 4.1                | 1.49         | 2.14        | 2.5                        |
| 3              | 3.9                | 1.14         | 3.29        | 5.5                        |
| 4              | 3.6                | 1.26         | 2.14        | 2.5                        |
| 5              | 3.0                | 1.11         | 2.85        | 5.0                        |
| Balsam Gap     | 3.0*               | 1.47         | 2.56        | 3.0                        |
| Bull Creek     | 3.0*               | 1.83         | 1.92        | 0.5                        |
| Craggy Dome    | 2.5                | 0.87         | 2.55        | 5.0                        |
| Lane Pinnacle  | 2.0*               | 0.50         | 1.60        | 3.0                        |
| Picnic Parking | 2.0                | 0.50         | 2.67        | 5.5                        |
| Picnic Access  | 4.0                | 1.16         | 3.28        | 5.5                        |
| Visitor Center | 2.0                | 1.58         | 2.54        | 2.5                        |

\* estimated AC thickness

### 4.2 COMPLETE RECONSTRUCTION

Complete reconstruction is removal of the pavement structure to the subgrade and placing new base and surface courses. The subgrade should be scarified, recompacted, and proof rolled. The base layer should be either crushed stone or processed recycled asphalt pavement. In-place cold recycling is not recommended due the high variability in AC thickness and quality. The base course should have a minimum CBR of 80. A recycled AC/soil mix would be acceptable for the base if the resulting material had a CBR of 80. Table 11 lists the minimum recommended pavement layer thicknesses for an unimproved subgrade. Scarification and recompaction of the subgrade may result in thinner required pavement sections based upon recompacted subgrade strengths. Base thicknesses may be increased to improve constructability if desired. The

AASHTO procedure allows AC layer thicknesses as low as 2.5 inches for the parkway and 2.0 inches for the pull-offs, however, a minimum AC thickness of 4.0 inches for the parkway and 3.5 inches for the pull offs is recommended. A minimum base thickness of six inches, instead of the minimum of four inches allowed by the AASHTO procedure, is also recommended.

Table 11. Minimum reconstructed pavement layer thicknesses.

| Segment        | Required SN | AC (inch) | Base (inch) |
|----------------|-------------|-----------|-------------|
| 1              | 2.46        | 4.0       | 6           |
| 2              | 2.14        | 4.0       | 6           |
| 3              | 3.29        | 4.0       | 13          |
| 4              | 2.14        | 4.0       | 6           |
| 5              | 2.85        | 4.0       | 9           |
| Balsam Gap     | 2.56        | 3.5       | 9           |
| Bull Creek     | 1.92        | 3.5       | 6           |
| Craggy Dome    | 2.55        | 3.5       | 9           |
| Lane Pinnacle  | 1.60        | 3.5       | 6           |
| Picnic Parking | 2.67        | 3.5       | 10          |
| Picnic Access  | 3.28        | 3.5       | 14          |
| Visitor Center | 2.54        | 3.5       | 9           |

**APPENDIX A**  
**FALLING WEIGHT DEFLECTOMETER TEST LOCATIONS**

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| Mile Post | Station | Lane | Mile Post | Station    | Lane |
|-----------|---------|------|-----------|------------|------|
| 359       | 41+00   | NB   | 367       | 32+00      | SB   |
| 359       | 45+50   | SB   | 367       | 33+00      | SB   |
| 359       | 52+00   | NB   | 367       | 39+00      | NB   |
| 360       | 6+00    | SB   | 367       | 45+75      | SB   |
| 360       | 10+50   | NB   | 367       | 48+00      | SB   |
| 360       | 17+50   | SB   | 367       | 53+00      | NB   |
| 360       | 24+00   | NB   | 368       | 12+50      | NB   |
| 360       | 26+50   | NB   | 368       | 25+50      | NB   |
| 360       | 30+00   | SB   | 368       | 39+00      | NB   |
| 360       | 43+00   | SB   | 369       | 4+50       | NB   |
| 360       | 50+00   | NB   | 369       | 9+00       | SB   |
| 361       | 6+00    | SB   | 369       | 14+00      | NB   |
| 361       | 10+50   | NB   | 369       | 21+00      | SB   |
| 361       | 17+00   | SB   | 369       | 28+00      | NB   |
| 361       | 24+00   | NB   | 369       | 30+00      | SB   |
| 361       | 30+50   | SB   | 369       | 39+00      | SB   |
| 361       | 37+50   | NB   | 369       | 41+50      | NB   |
| 361       | 44+50   | SB   | 369       | 49+00      | SB   |
| 361       | 51+00   | NB   | 369       | 55+00      | NB   |
| 362       | 10+50   | NB   | 370       | 6+00       | SB   |
| 362       | 10+50   | SB   | 370       | 13+00      | NB   |
| 362       | 17+00   | SB   | 370       | 17+50      | SB   |
| 362       | 23+00   | NB   | 370       | 22+00      | NB   |
| 362       | 30+00   | SB   | 370       | 28+00      | SB   |
| 362       | 37+50   | NB   | 370       | 35+50      | NB   |
| 362       | 44+00   | SB   | 370       | 38+00      | SB   |
| 362       | 50+95   | NB   | 370       | 49+00      | NB   |
| 362       | 51+00   | NB   | 371       | 6+00       | SB   |
| 363       | 6+00    | SB   | 371       | 12+46      | NB   |
| 363       | 10+50   | NB   | 371       | 15+00      | SB   |
| 363       | 15+50   | SB   | 371       | 25+00      | NB   |
| 363       | 21+50   | NB   | 371       | 30+00      | SB   |
| 363       | 27+50   | SB   | 371       | 38+00      | SB   |
| 363       | 34+02   | NB   | 371       | 42+00      | NB   |
| 363       | 38+50   | SB   | 371/372   | 55+08/0+00 | NB   |
| 363       | 43+00   | NB   | 372       | 7+00       | SB   |
| 363       | 50+00   | SB   | 372       | 14+00      | NB   |
| 364       | 3+50    | NB   | 372       | 19+00      | SB   |
| 364       | 13+51   | SB   | 372       | 24+83      | NB   |
| 364       | 29+00   | SB   | 372       | 29+00      | SB   |
| 364       | 32+50   | NB   | 372       | 35+96      | NB   |
| 364       | 35+96   | NB   | 372       | 39+50      | SB   |
| 364       | 44+00   | SB   | 372       | 51+00      | NB   |
| 365       | 0+00    | NB   | 373       | 5+00       | SB   |
| 365       | 5+50    | SB   | 373       | 10+00      | NB   |
| 365       | 11+00   | NB   | 373       | 17+00      | SB   |
| 365       | 11+00   | SB   | 373       | 23+50      | NB   |
| 365       | 19+50   | SB   | 373       | 29+50      | SB   |
| 365       | 27+50   | NB   | 373       | 36+83      | NB   |

| Mile Post      | Station | Lane | Mile Post     | Station | Lane |
|----------------|---------|------|---------------|---------|------|
| 365            | 34+50   | SB   | 373           | 44+00   | SB   |
| 365            | 41+00   | NB   | 373           | 49+52   | NB   |
| 365            | 47+00   | SB   | 374           | 2+50    | SB   |
| 366            | 1+50    | NB   | 374           | 8+87    | NB   |
| 366            | 8+00    | SB   | 374           | 15+00   | SB   |
| 366            | 15+00   | NB   | 374           | 22+40   | NB   |
| 366            | 25+04   | SB   | 374           | 28+50   | SB   |
| 366            | 35+00   | NB   | 374           | 35+87   | NB   |
| 366            | 43+00   | SB   | 374           | 41+00   | SB   |
| 366            | 52+00   | NB   | 374           | 45+26   | NB   |
| 367            | 6+00    | SB   | 375           | 0+00    | NB   |
| 367            | 12+50   | NB   | 375           | 2+50    | SB   |
| 367            | 12+50   | SB   | 375           | 4+81    | NB   |
| 367            | 21+50   | SB   | 375           | 5+00    | SB   |
| 367            | 25+00   | NB   | 375           | 9+00    | SB   |
| Picnic Road    | 19+98   |      | Craggy Dome   | Upper   |      |
| Picnic Road    | 40+00   |      | Craggy Dome   | Lower   |      |
| Picnic Parking | Test 1  |      | Balsam Gap    |         |      |
| Picnic Parking | Test 2  |      | Lane Pinnacle |         |      |
| Visitor Center | Test 1  |      | Bull Creek    |         |      |

## **Appendix G**

### **Laboratory Test Results**

**LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Boring Location   |       | Asphalt Pavement Thickness (inches) (1) | Sample Number | Water Content (%) | Atterberg Limits |       |       | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |
|-------------------|-------|---|---------------|-------------------|------------------|-------|-------|-------------------------|---------------------------------|
|                   |       |   |               |                   | LL               | PL    | PI    |                         |                                 |
| 359               | 52+00 | 5                                       | 1             | 28.8              | 31               | 15    | 50.4  | ML/A-7-6                |                                 |
| 360               | 24+00 | 4.25                                    | 2             | 21.6              | 27               | 6     | 34.9  | SM/A-2-4                |                                 |
| Asphalt Core Only |       |   |               |                   |                  |       |       |                         |                                 |
| 360               | 50+00 | 5.5                                     | 1 (3)         | 67.9              | NP               | NP    | 61.5  | ML/A-7-6                |                                 |
| 361               | 51+00 | 7                                       | 2             | 15.8              | NP               | NP    | 29.3  | SM/A-2-4                |                                 |
| 362               | 10+50 | 4.25                                    | 1             | 10.7              | -----            | ----- | 26.7  | SM/A-2-4                |                                 |
|                   |       |   | 1             | 4.5               | -----            | ----- | ----- | SM/A-2-4                |                                 |
|                   |       |   | 2             | No Sample         |                  |       |       |                         |                                 |
| 362               | 23+00 | 5                                       | 1             | 26.0              | -----            | ----- | 37.7  | SM/A-4                  |                                 |
|                   |       |   | 2             | 32.9              | -----            | ----- | ----- | SM/A-4                  |                                 |
| 362               | 51+00 | 4                                       | 1             | 7.3               | -----            | ----- | ----- | SM/A-2-4                |                                 |
|                   |       |   | 2             | 9.7               | -----            | ----- | ----- | SM/A-2-4                |                                 |
| 363               | 10+50 | 4                                       | 1             | 11.1;             | NP               | NP    | 28.1  | SM/A-2-4                |                                 |
|                   |       |   | 2             | 11.8              | -----            | ----- | ----- | SM/A-2-4                |                                 |

Note: (1) Measurements determined in field by Arcadis.  
(2) Most soil samples contained significant amount of rock fragments.  
(3) Material contains significant amount of mica.

**LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS**  
**BLUE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Boring Location |       | Mile | Station | Lane | Asphalt Pavement Thickness (inches) (1) | Sample Number | Water Content (%) | Atterberg Limits |       |       | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |
|-----------------|-------|------|---------|------|---|---------------|-------------------|------------------|-------|-------|-------------------------|---------------------------------|
| Station         | Lane  |      |         |      |   |               |                   | LL               | PL    | PI    |                         |                                 |
| 363             | 34+00 |      | Left    | 4.5  | 1                                       | 17.8          | -----             | -----            | ----- | 24.4  | SM/A-2-4                |                                 |
|                 |       |      |         |      | 2                                       | 10.4          | -----             | -----            | ----- | ----- | SM/A-2-4                |                                 |
| 364             | 3+50  |      | Left    | 4.5  | 1                                       | 2.8           | -----             | -----            | ----- | ----- | SM/A-2-4                |                                 |
| 364             | 36+00 |      | Left    | 4    | 1                                       | 11.1          | -----             | -----            | ----- | ----- | SM/A-2-4                |                                 |
|                 |       |      |         |      | 2                                       | 5.0           | -----             | -----            | ----- | ----- | SM/A-2-4                |                                 |
| 365             | 11+00 |      | Right   | 4.5  | 1                                       | 22.2          | -----             | -----            | ----- | 32.3  | SM/A-2-4                |                                 |
|                 |       |      |         |      | 2                                       | 10.3          | -----             | -----            | ----- | ----- | SM/A-2-4                |                                 |
| 366             | 11+00 |      | Right   | 5    | 1                                       | 14.6          | -----             | -----            | ----- | ----- | SM/A-2-4                |                                 |
|                 |       |      |         |      | 2                                       | 12.8          | 34                | NP               | NP    | 24.1  | SM/A-2-4                |                                 |
| 366             | 15+00 |      | Left    | 4.5  | 1                                       | 9.1           | -----             | -----            | ----- | ----- | SM/A-2-4                |                                 |
| 366             | 43+00 |      | Right   | 3.5  | 1                                       | 5.5           | -----             | -----            | ----- | ----- | SM/A-2-4                |                                 |
|                 |       |      |         |      | 2                                       | 4.2           | -----             | -----            | ----- | ----- | SM/A-2-4                |                                 |
| 367             | 21+50 |      | Right   | 3    | No Samples                              |               |                   |                  |       |       |                         |                                 |
| 367             | 39+00 |      | Left    | 3.25 | 1                                       | 11.1          | -----             | -----            | ----- | 28.0  | SM/A-2-4                |                                 |
|                 |       |      |         |      | 2                                       | 9.9           | -----             | -----            | ----- | 22.4  | SM/A-2-4                |                                 |



**LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS**  
**BLJE RIDGE PARKWAY - SECTION 2P**  
**ASHEVILLE, NORTH CAROLINA**

| Boring Location |         |      | Asphalt Pavement Thickness (inches) (1) | Sample Number | Water Content (%) | Atterberg Limits |       |       | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |
|-----------------|---------|------|---|---------------|-------------------|------------------|-------|-------|-------------------------|---------------------------------|
| Mile            | Station | Lane |   |               |                   | LL               | PL    | PI    |                         |                                 |
| 373             | 49+50   | Left | 3                                       | 1             | 16.6              | 33               | 31    | 2     | 39.6                    | SM/A-4                          |
|                 |         |      |   | 2             | 7.0               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| 374             | 36+00   | Left | 3                                       | 1             | 19.7              | 34               | NP    | NP    | 40.3                    | SM/A-4                          |
|                 |         |      |   | 2             | 3.1               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| 375             | 0+00    | Left | 2.5                                     | 1             | 14.2              | 29               | 24    | 5     | 48.2                    | SM/A-4                          |
|                 |         |      |   | 2             | 0.9               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| PA              | 20+50   | Left | 3.5                                     | 1             | 7.9               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
|                 |         |      |   | 2             | 20.0              | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| PA              | 36+80   | Left | 4.5                                     | 1             | 27.4              | -----            | ----- | ----- | 33.2                    | SM/A-2-4                        |
|                 |         |      |   | 2             | 27.8              | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| Picnic Area     |         |      | 2                                       | 1             | 8.7               | -----            | ----- | ----- | 23.2                    | SM/A-2-4                        |
|                 |         |      |   | 2             | 4.9               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |

**LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS  
 BLUE RIDGE PARKWAY - SECTION 2P  
 ASHEVILLE, NORTH CAROLINA**

| Boring Location          |         |      | Asphalt Pavement Thickness (inches) (1) | Sample Number | Water Content (%) | Atterberg Limits |       |       | % Passing No. 200 Sieve | USCS/AASHTO Classifications (2) |
|--------------------------|---------|------|---|---------------|-------------------|------------------|-------|-------|-------------------------|---------------------------------|
| Mile                     | Station | Lane |   |               |                   | LL               | PL    | PI    |                         |                                 |
| Visitor Center           |         |      | 3                                       | 1             | 20.5              | -----            | ----- | ----- | 28.2                    | SM/A-2-4                        |
|                          |         |      |   | 2             | 29.4              | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| Craggy Dome - Upper Tier |         |      | 2.5                                     | 1             | 10.0              | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
|                          |         |      |   | 2             | 0.8               | -----            | ----- | ----- | -----                   | SM/A-2-4                        |
| Craggy Dome - Lower Tier |         |      | 2.5                                     | 1             | 33.1              | -----            | ----- | ----- | 36.8                    | SM/A-2-4                        |

**Asphalt Pavement Cores**  
**Blue Ridge Parkway - Section 2P**  
**Asheville, North Carolina**

| Core No. | Core Location              | Layer   | Thickness (in.) | Bulk Specific Gravity | Absorption (%) |
|----------|----------------------------|---------|-----------------|-----------------------|----------------|
| 1        | MM 360<br>Station<br>24+00 | Surface | 1.0             | Damaged               | Damaged        |
|          |                            | Binder  | 1.5             | 2.304                 | 0.98           |
|          |                            | Base    | 2.0             | 2.397                 | 0.36           |
| 2        | MM 361<br>Station<br>51+00 | Surface | 1.2             | 2.299                 | 0.36           |
|          |                            | Binder  | 3.0             | 2.313                 | 2.58           |
|          |                            | Base    | 2.7             | 2.407                 | 0.91           |
| 3        | MM 365<br>Station<br>11+00 | Surface | 1.5             | 2.253                 | 1.67           |
|          |                            | Base    | 2.3             | 2.272                 | 3.09           |
| 4        | MM 367<br>Station<br>39+00 | Surface | 1.1             | 2.182                 | 1.87           |
|          |                            | Base    | 2.1             | 2.291                 | 3.70           |
| 5        | MM 369<br>Station<br>39+00 | Surface | 1.0             | 2.245                 | 1.59           |
|          |                            | Binder  | 1.6             | 2.320                 | 2.03           |
|          |                            | Base    | 1.4             | 2.377                 | 0.50           |
| 6        | MM 372<br>Station<br>14+00 | Surface | 1.1             | 2.212                 | 1.95           |
|          |                            | Base    | 2.2             | 2.304                 | 1.36           |
| 7        | MM 373<br>Station<br>37+00 | Surface | 1.4             | 2.196                 | 4.22           |
|          |                            | Base    | 2.0             | 2.342                 | 1.07           |
| 8        | MM 374<br>Station<br>36+00 | Surface | 1.3             | 2.148                 | 4.08           |
|          |                            | Base    | 2.3             | 2.346                 | 2.93           |

Group 1 - Cores 1 and 2

Group 2 - Cores 3, 4, and 5

Group 3 - Cores 6, 7, and 8

Hot Mix Asphalt Properties  
 Surface Course Layer  
 Blue Ridge Parkway - Section 2P  
 Asheville, North Carolina

|                            | Group 1         | Group 2 | Group 3 |
|----------------------------|-----------------|---------|---------|
| Sieve Size                 | Percent Passing |         |         |
| ½ in.                      | 100.0           | 100.0   | 100.0   |
| 3/8 in.                    | 95.2            | 91.9    | 95.3    |
| No. 4                      | 63.9            | 50.3    | 53.5    |
| No. 8                      | 48.1            | 23.2    | 23.5    |
| No. 16                     | 37.7            | 14.6    | 13.3    |
| No. 30                     | 29.1            | 11.9    | 10.4    |
| No. 50                     | 20.0            | 9.8     | 8.4     |
| No. 200                    | 5.8             | 4.7     | 3.8     |
| • Asphalt Content (%)      | 5.9             | 5.6     | 5.5     |
| Absolute Viscosity (poise) | 37,612          | 198,644 | 319,342 |

Note: Composite Samples - Cores trimmed and combined

Group 1 = MM 360 Station 24 + 00  
 MM 361 Station 51 + 00

Group 2 = MM 365 Station 11 + 00  
 MM 367 Station 39 + 00  
 MM 369 Station 39 + 00

Group 3 = MM 372 Station 14 + 00  
 MM 373 Station 37 + 00  
 MM 374 Station 36 + 00

**Hot Mix Asphalt Properties  
Binder/Base Course Layer  
Blue Ridge Parkway - Section 2P  
Asheville, North Carolina**

|                                   | Group 1                | Group 2 | Group 3 |
|-----------------------------------|------------------------|---------|---------|
| <b>Sieve Size</b>                 | <b>Percent Passing</b> |         |         |
| 1 in.                             | 100.0                  | 100.0   | 100.0   |
| 3/4 in.                           | 97.6                   | 97.8    | 99.5    |
| 1/2 in.                           | 78.6                   | 86.1    | 83.6    |
| 3/8 in.                           | 66.6                   | 72.4    | 71.9    |
| No. 4                             | 45.4                   | 51.7    | 54.5    |
| No. 8                             | 36.4                   | 36.7    | 42.8    |
| No. 16                            | 30.1                   | 28.0    | 33.4    |
| No. 30                            | 23.9                   | 21.5    | 25.3    |
| No. 50                            | 16.3                   | 14.2    | 16.5    |
| No. 200                           | 4.7                    | 5.3     | 6.2     |
| <b>Asphalt Content (%)</b>        | 5.1                    | 4.9     | 5.0     |
| <b>Absolute Viscosity (poise)</b> | 32,516                 | 283,912 | 215,887 |

Note: Composite Samples - Cores trimmed and combined

Group 1 = MM 360 Station 24 + 00  
MM 361 Station 51 + 00

Group 2 = MM 365 Station 11 + 00  
MM 367 Station 39 + 00  
MM 369 Station 39 + 00

Group 3 = MM 372 Station 14 + 00  
MM 373 Station 37 + 00  
MM 374 Station 36 + 00



# Tri-State Testing & Drilling, LLC

6228 Bonny Oaks Drive  
Chattanooga TN 37416  
(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M  
1210 Premier Drive, Suite 200  
Chattanooga, TN 37421  
Attn: Scott Manning  
Project: Blue Ridge Parkway  
Date: 10/25/04

## REPORT OF GRAIN SIZE

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|               | 370.0              |  |               | 440.09         |
|---------------|--------------------|--|---------------|----------------|
| <u>Sieves</u> | <u>Dry Weight:</u> |  | <u>% Ret.</u> | <u>% Pass.</u> |
| 3/4"          | 113.14             |  | 25.7          | 74.3           |
| 1/2"          | 176.87             |  | 40.2          | 59.8           |
| 3/8"          | 201.78             |  | 45.8          | 54.2           |
| #4            | 243.01             |  | 55.2          | 44.8           |
| #10           | 272.75             |  | 62.0          | 38.0           |
| #16           | 288.23             |  | 65.5          | 34.5           |
| #40           | 320.71             |  | 72.9          | 27.1           |
| #100          | 367.78             |  | 83.6          | 16.4           |
| #200          | 382.82             |  | 87.0          | 13.0           |

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Remarks:

Copies to: Arcadis G & M

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Project No.: TS:L-2042



Tri-State Testing & Drilling, LLC

6228 Bonny Oaks Drive  
Chattanooga TN 37416  
(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M  
1210 Premier Drive, Suite 200  
Chattanooga, TN 37421  
Attn: Scott Manning  
Project: Blue Ridge Parkway  
Date: 10/25/04

**REPORT OF GRAIN SIZE**

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| 373.0         |                    |               |                |
|---------------|--------------------|---------------|----------------|
| <u>Sieves</u> | <u>Dry Weight:</u> |               | 553.83         |
|               |                    | <u>% Ret.</u> | <u>% Pass.</u> |
| 3/4"          | 126.95             | 22.9          | 77.1           |
| 1/2"          | 197.60             | 35.7          | 64.3           |
| 3/8"          | 216.13             | 39.0          | 61.0           |
| #4            | 261.95             | 47.3          | 52.7           |
| #10           | 299.20             | 54.0          | 46.0           |
| #16           | 324.45             | 58.6          | 41.4           |
| #40           | 376.52             | 68.0          | 32.0           |
| #100          | 459.32             | 82.9          | 17.1           |
| #200          | 487.80             | 88.1          | 11.9           |

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Remarks:

Copies to: Arcadis G & M

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Project No.: TS:L-2043



# Tri-State Testing & Drilling, LLC

6228 Bonny Oaks Drive  
Chattanooga TN 37416  
(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M  
1210 Premier Drive, Suite 200  
Chattanooga, TN 37421  
Attn: Scott Manning  
Project: Blue Ridge Parkway  
Date: 10/25/04

## REPORT OF GRAIN SIZE

---

| 373.5         |                    |               |                |
|---------------|--------------------|---------------|----------------|
| <u>Sieves</u> | <u>Dry Weight:</u> |               | 736.20         |
|               |                    | <u>% Ret.</u> | <u>% Pass.</u> |
| 3/4"          | 189.86             | 25.8          | 74.2           |
| 1/2"          | 318.17             | 43.2          | 56.8           |
| 3/8"          | 365.53             | 49.7          | 50.3           |
| #4            | 433.26             | 58.9          | 41.1           |
| #10           | 472.30             | 64.2          | 35.8           |
| #16           | 495.48             | 67.3          | 32.7           |
| #40           | 549.78             | 74.7          | 25.3           |
| #100          | 639.09             | 86.8          | 13.2           |
| #200          | 653.39             | 88.8          | 11.2           |

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Remarks:

Copies to: Arcadis G & M

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Project No.: TS:L-2044



Tri-State Testing & Drilling, LLC

6228 Bonny Oaks Drive  
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(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M  
1210 Premier Drive, Suite 200  
Chattanooga, TN 37421  
Attn: Scott Manning  
Project: Blue Ridge Parkway  
Date: 10/25/04

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**REPORT OF GRAIN SIZE**

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| 374.0         |                    |        |         |
|---------------|--------------------|--------|---------|
| <u>Sieves</u> | <u>Dry Weight:</u> |        |         |
|               |                    | % Ret. | % Pass. |
| 3/4"          | 133.51             | 29.9   | 70.1    |
| 1/2"          | 205.63             | 46.1   | 53.9    |
| 3/8"          | 236.62             | 53.0   | 47.0    |
| #4            | 268.48             | 60.2   | 39.8    |
| #10           | 292.70             | 65.6   | 34.4    |
| #16           | 306.81             | 68.7   | 31.3    |
| #40           | 338.42             | 75.8   | 24.2    |
| #100          | 383.19             | 85.9   | 14.1    |
| #200          | 395.72             | 88.7   | 11.3    |

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Remarks:

Copies to: Arcadis G & M

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Project No.: TS:L-2045



Tri-State Testing & Drilling, LLC

6228 Bonny Oaks Drive  
Chattanooga TN 37416  
(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M  
1210 Premier Drive, Suite 200  
Chattanooga, TN 37421  
Attn: Scott Manning  
Project: Blue Ridge Parkway  
Date: 10/25/04

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**REPORT OF GRAIN SIZE**

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| 374.3         |                    |               |                |
|---------------|--------------------|---------------|----------------|
| <u>Sieves</u> | <u>Dry Weight:</u> |               | 365.37         |
|               |                    | <u>% Ret.</u> | <u>% Pass.</u> |
| 3/4"          | 84.34              | 23.1          | 76.9           |
| 1/2"          | 135.12             | 37.0          | 63.0           |
| 3/8"          | 169.33             | 46.3          | 53.7           |
| #4            | 195.36             | 53.5          | 46.5           |
| #10           | 215.38             | 58.9          | 41.1           |
| #16           | 227.37             | 62.2          | 37.8           |
| #40           | 253.20             | 69.3          | 30.7           |
| #100          | 297.28             | 81.4          | 18.6           |
| #200          | 313.07             | 85.7          | 14.3           |

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Remarks:

Copies to: Arcadis G & M

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Project No.: TS:L-2046



# Tri-State Testing & Drilling, LLC

6228 Bonny Oaks Drive  
Chattanooga TN 37416  
(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M  
1210 Premier Drive, Suite 200  
Chattanooga, TN 37421  
Attn: Scott Manning  
Project: Blue Ridge Parkway  
Date: 10/25/04

## REPORT OF GRAIN SIZE

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| 375.0         |                    |               |                |
|---------------|--------------------|---------------|----------------|
| <u>Sieves</u> | <u>Dry Weight:</u> |               | 738.45         |
|               |                    | <u>% Ret.</u> | <u>% Pass.</u> |
| 3/4"          | 72.52              | 9.8           | 90.2           |
| 1/2"          | 165.85             | 22.5          | 77.5           |
| 3/8"          | 228.17             | 30.9          | 69.1           |
| #4            | 332.34             | 45.0          | 55.0           |
| #10           | 395.05             | 53.5          | 46.5           |
| #16           | 428.70             | 58.1          | 41.9           |
| #40           | 499.18             | 67.6          | 32.4           |
| #100          | 610.16             | 82.6          | 17.4           |
| #200          | 632.49             | 85.7          | 14.3           |

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Remarks:

Copies to: Arcadis G & M

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Project No.: TS:L-2047

## **Appendix H**

Pavement Design Analysis

|                          |                             |              |
|--------------------------|-----------------------------|--------------|
| Subject: Pavement Design | Job No. CT052885.0001.00008 | BY:<br>CHKD: |
|--------------------------|-----------------------------|--------------|

**Location:** Blue Ridge Parkway, Section 2P  
 Reconstruction Sections Sta. 366, 24+10 to 368, 20+00 and  
 370, 2+00 to 375, 4+57 and Graggy Garden Access Road Sta. 24+00 to 28+50  
 Right Lane Going Downhill and 19+85 to 20+50.

Average Daily Traffic: 3702  
 Design Road Life: 20  
 Annual % Growth: 2.0%

Terminal Servicibility: 2.0  
 Directional Factor: 50%  
 Lane Distribution Factor: 1.0

Regional Factor 1.5  
 In-situ CBR 10.0  
 Existing 6" Agg. Base CBR 50.0  
 Design Soil Support Value 6.1  
 Calculated Design Structural Number: 2.4

| Vehicle Class      | Percent of<br>ADT | Growth<br>Factor | Average<br>Initial<br>Truck<br>Factor | Accumulated<br>18-kip ESALs<br>over<br>Performance<br>Period |
|--------------------|-------------------|------------------|---------------------------------------|--|
| Automobiles        | 94.8%             | 24.29737         | 0.0004                                | 6225   |
| RVs / Light Trucks | 2.5%              | 24.29737         | 0.2                                   | 82078  |
| Bus                | 2.5%              | 24.29737         | 0.88                                  | 361145   |
| Heavy Maint. Truck | 0.2%              | 24.29737         | 0.6                                   | 19699  |
| Total              | 100.0%            |                  |                                       | 4.7E+05  |

**Specified Layer Design**

| Layer        | Material<br>Description | Struct.<br>Coef. (Ai) | Thickness<br>(in) | Calculated SN |
|--------------|-------------------------|-----------------------|-------------------|---------------|
| 1            | AC Surface              | 0.42                  | 2.0               | 0.84          |
| 2            | AC Base                 | 0.34                  | 3.0               | 1.02          |
| 3            | Agg. Base <sup>t</sup>  | 0.11                  | 6.0               | 0.66          |
| <b>TOTAL</b> |                         |                       | 11.0              | 2.52          |

<sup>t</sup> From Fig 2.6. Variation in Granular Base Layer Coefficient, AASHTO Design of Pavement Structures 1993

Subject: Pavement Design

Job No. CT052885.0001.00008

BY:

CHKD:

Location: Blue Ridge Parkway, Section 2P  
 In-Situ CBR of 10.0 Based on DCP data  
 Reconstruction of Craggy Dome Upper Parking, Craggy Garden Picnic Parking  
 and Visitor Center

Average Daily Traffic: 1851  
 Design Road Life: 20  
 Annual % Growth: 2.0%

Terminal Servicibility: 2  
 Directional Factor: 50%  
 Lane Distribution Factor: 1.0

Regional Factor 1.5  
 In-situ CBR 10.0  
 Existing 6" Agg. Base CBR 50.0  
 Design Soil Support Value 6.1  
 Calculated Design Structural Number: 2

| Vehicle Class      | Percent of ADT | Growth Factor | Average Initial Truck Factor | Accumulated 18-kip ESALs over Performance Period |
|--------------------|----------------|---------------|------------------------------|--|
| Automobiles        | 95.0%          | 24.29737      | 0.0004                       | 3119   |
| RVs / Light Trucks | 3.0%           | 24.29737      | 0.2                          | 49247  |
| Bus                | 1.0%           | 24.29737      | 0.88                         | 72229  |
| Heavy Maint. Truck | 1.0%           | 24.29737      | 0.6                          | 49247  |
| Total              | 100.0%         |               |                              | 1.7E+05  |

## Specified Layer Design

| Layer | Material Description   | Struct. Coef. (A <sub>i</sub> ) | Thickness (in) | Calculated SN |
|-------|------------------------|---------------------------------|----------------|---------------|
| 1     | AC Surface             | 0.42                            | 1.5            | 0.63          |
| 2     | AC Binder              | 0.34                            | 2.5            | 0.85          |
| 3     | Agg. Base <sup>t</sup> | 0.11                            | 6.0            | 0.66          |
| TOTAL |                        |                                 | 10.0           | 2.14          |

<sup>t</sup> From Fig 2.6. Variation in Granular Base Layer Coefficient, AASHTO Design of Pavement Structures 1993

|                          |                             |              |
|--------------------------|-----------------------------|--------------|
| Subject: Pavement Design | Job No. CT052885.0001.00008 | BY:<br>CHKD: |
|--------------------------|-----------------------------|--------------|

Location: Blue Ridge Parkway, Section 2P  
 Mill and Overlay Sections Sta. 359, 39+00 to 366, 24+10 and 368, 20+00 to 370, 2+00, and The Craggy Garden Access Road not requiring reconstruction.

Average Daily Traffic: 3702  
 Design Road Life: 20  
 Annual % Growth: 2.0%

Terminal Servicibility: 2  
 Directional Factor: 50%  
 Lane Distribution Factor: 1.0

Regional Factor 1.5  
 In-situ CBR 10.0  
 Existing 6" Agg. Base CBR 50.0  
 Design Soil Support Value 6.1  
 Calculated Design Structural Number: 2.4

| Vehicle Class      | Percent of ADT | Growth Factor | Average Initial Truck Factor | Accumulated 18-kip ESALs over Performance Period |
|--------------------|----------------|---------------|------------------------------|--|
| Automobiles        | 94.8%          | 24.29737      | 0.0004                       | 6225   |
| RVs / Light Trucks | 2.5%           | 24.29737      | 0.2                          | 82078  |
| Bus                | 2.5%           | 24.29737      | 0.88                         | 361145   |
| Heavy Maint. Truck | 0.2%           | 24.29737      | 0.6                          | 19699  |
| Total              | 100.0%         |               |                              | 4.7E+05  |

**Specified Layer Design**

| Layer        | Material Description   | Struct. Coef. (Ai) | Thickness (in) | Calculated SN |
|--------------|------------------------|--------------------|----------------|---------------|
| 1            | AC Surface             | 0.42               | 1.5            | 0.63          |
| 2            | AC Base                | 0.34               | 2.5            | 0.85          |
| 3            | AC Base*               | 0.2                | 2.0            | 0.4           |
| 4            | Agg. Base <sup>†</sup> | 0.11               | 6.0            | 0.66          |
| <b>TOTAL</b> |                        |                    | 12.0           | 2.54          |

\* AC Base left after milling 2 inches with reduced structural coefficient

<sup>†</sup> From Fig 2.6. Variation in Granular Base Layer Coefficient, AASHTO Design of Pavement Structures 1993

Subject: Pavement Design

Job No. CT052885.0001.00008

BY:

CHKD:

**Location:** Blue Ridge Parkway, Section 2P  
 Milling and Overlay of Parking Lots and Overlooks  
 (i.e. Visitor Center, Balsam Gap, Bull Creek, Graybeard, Glassimine Falls,  
 Lane Pinnacle, and Craggy Dome Lower Parking Area)

Average Daily Traffic: 1851  
 Design Road Life: 20  
 Annual % Growth: 2.0%

Terminal Servicibility: 2  
 Directional Factor: 50%  
 Lane Distribution Factor: 1.0

Regional Factor 1.5  
 In-situ CBR 10.0  
 Existing 6" Agg. Base CBR 50.0  
 Design Soil Support Value 6.1  
 Calculated Design Structural Number: 2

| Vehicle Class      | Percent of ADT | Growth Factor | Average Initial Truck Factor | Accumulated 18-kip ESALs over Performance Period |
|--------------------|----------------|---------------|------------------------------|--|
| Automobiles        | 95.0%          | 24.29737      | 0.0004                       | 3119   |
| RVs / Light Trucks | 3.0%           | 24.29737      | 0.2                          | 49247  |
| Bus                | 1.0%           | 24.29737      | 0.88                         | 72229  |
| Heavy Maint. Truck | 1.0%           | 24.29737      | 0.6                          | 49247  |
| Total              | 100.0%         |               |                              | 1.7E+05  |

#### Specified Layer Design

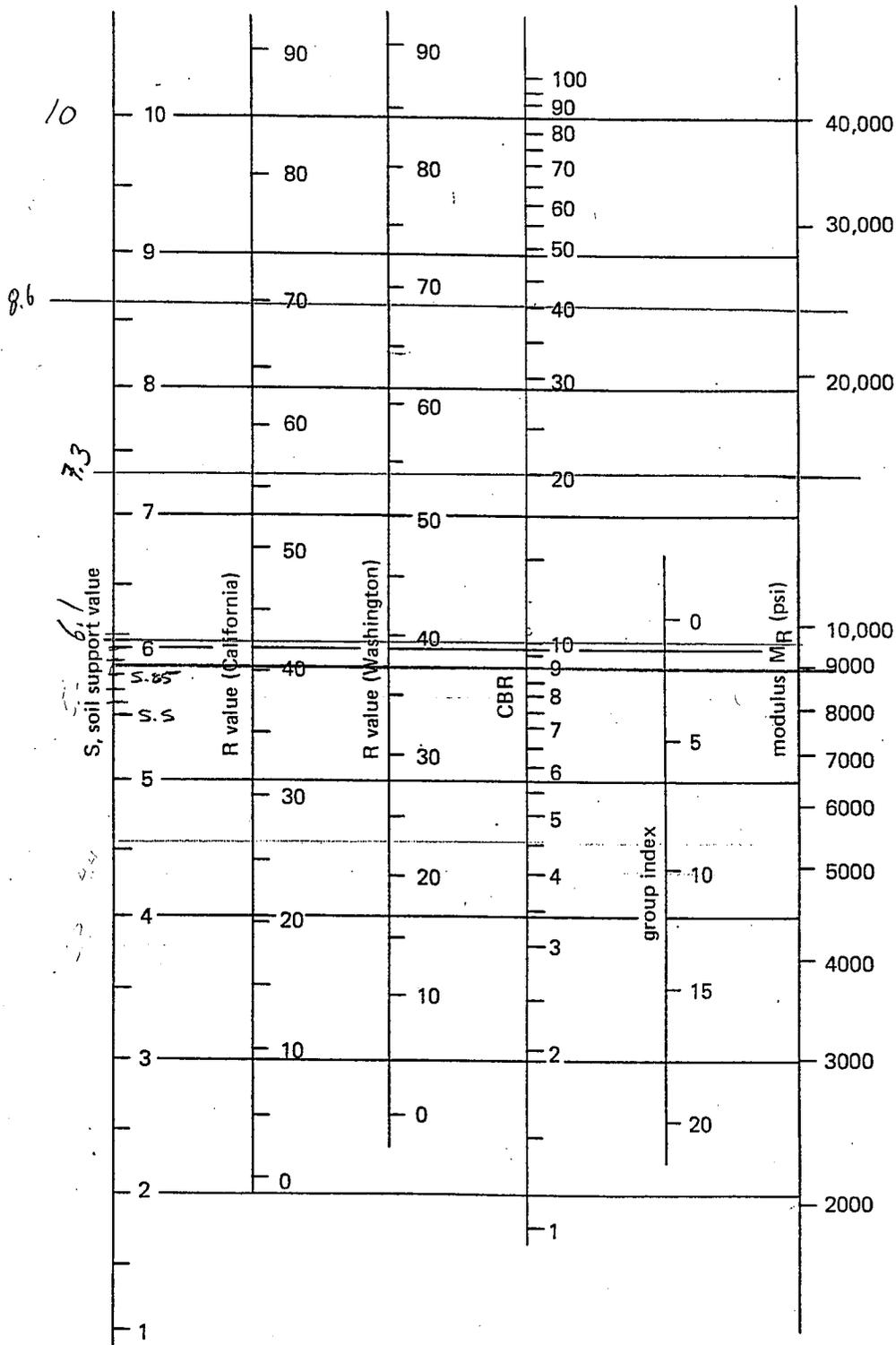
| Layer        | Material Description   | Struct. Coef. (Ai) | Thickness (in) | Calculated SN |
|--------------|------------------------|--------------------|----------------|---------------|
| 1            | AC Surface             | 0.42               | 1.5            | 0.63          |
| 2            | AC Binder <sup>#</sup> | 0.34               | 2.0            | 0.68          |
| 3            | AC Binder <sup>*</sup> | 0.2                | 1.5            | 0.3           |
| 3            | Agg. Base <sup>†</sup> | 0.11               | 6.0            | 0.66          |
| <b>TOTAL</b> |                        |                    | <b>11.0</b>    | <b>2.27</b>   |

\* Mill one inch leaving 1.5 inches

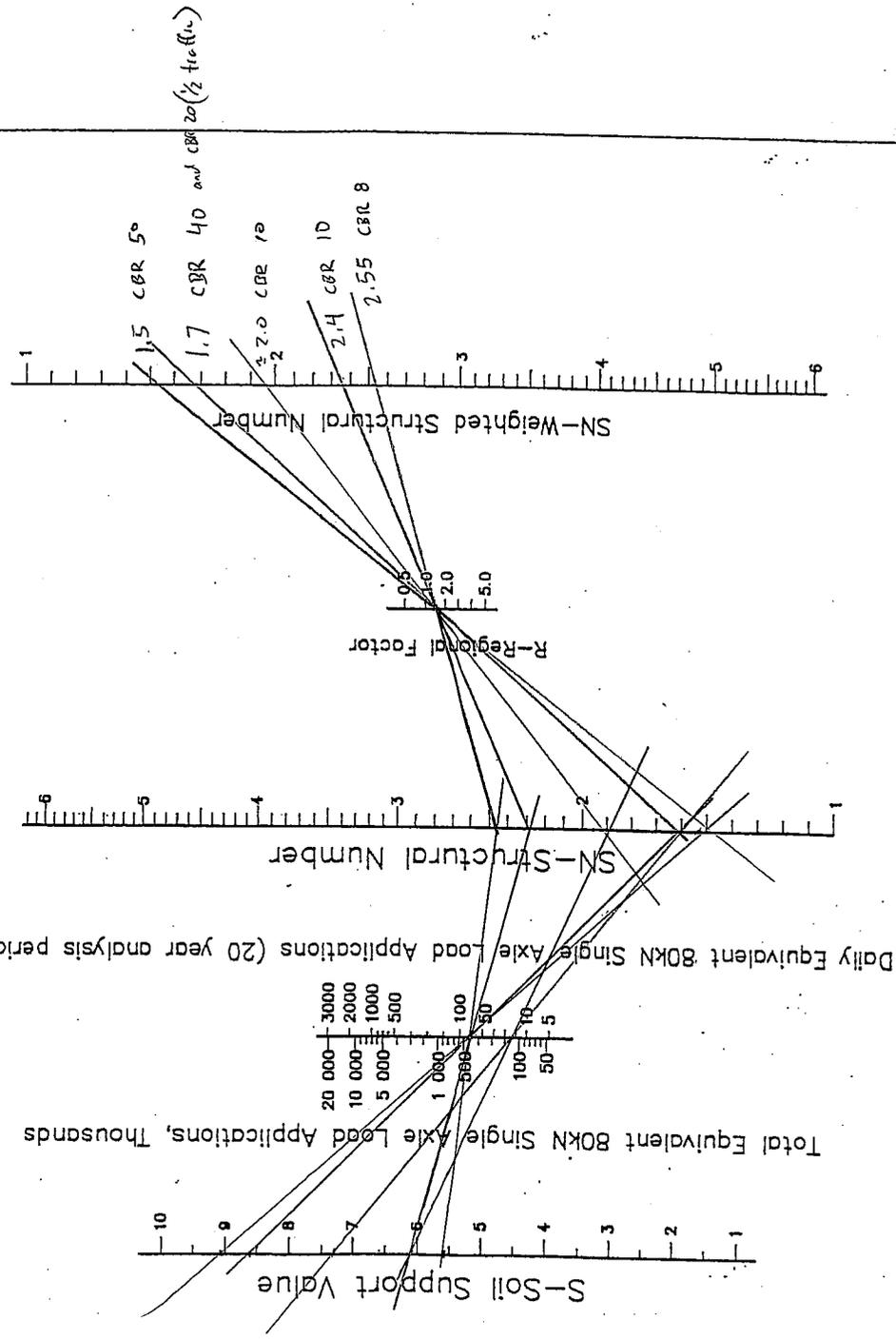
† From Fig 2.6. Variation in Granular Base Layer Coefficient, AASHTO Design of Pavement Structures 1993

**# The layer thickness is to be 3 to 4 times the NMSA of 3/4", therefore the AC Binder is to be 2.5"**

Appendix B: Revised Soil Support Correlations



TRAFFIC



The chart requires two applications of a straightedge for each solution. First, the soil support value of the roadbed soil (on the left scale) and the total or daily equivalent 80kN/single-axle loads for the traffic analysis period (left side of second scale) are used to solve for the unweighted structural number (center scale). This unweighted structural number is used with the selected regional factor (4th scale) to solve for the design SN (right scale) applicable to the total pavement structure. Suitable designs are those whose combinations of materials types and thicknesses satisfy the general equation:

$$SN = a_1 D_1 + a_2 D_2 + a_3 D_3$$

**Exhibit 6.23 Design Chart for Flexible Pavements -  $P_t = 2.0$**

highway facilities a value of 2.5 is recommended while a  $p_t = 2.0$  is suggested for lesser traffic volume roads. Normally, it is recommended that the  $p_t$  value selected should never be less than 2.0. For minor highways, the approach is to keep  $p_t = 2.0$  but reduce the traffic analysis time period.

**Equivalent Wheel Load Repetitions ( $W_{t18}$ ).** For the AASHO design method, mixed traffic within a given period of time (termed the traffic analysis period) is accounted for by equivalent damage factors relative to the standard 18-kip single-axle load (Chapter 4).

Traffic may be equated to daily 18-kip load applications if a common 20-year traffic analysis period is selected, or it may be expressed as the total 18-kip load applications within the traffic analysis period. As can be seen from Table 4.9, the equivalency factors, and hence  $W_{t18}$  applications, are a function of  $p$  and SN. For most design problems, a SN value of 3.0 may be assumed for the equivalency analysis. This value will normally result in an overestimation of the  $W_{t18}$  but in general, the resulting error will be insignificant.

**Regional Factor ( $R$ ).** As noted previously, the regional factor was placed into the AASHO design procedure to allow for its use in climatic environments other than the one that existed during the Road Test. In its present form, the  $R$  value constitutes a fairly significant input value but unfortunately is one that, at present, is not well documented. Based upon an analysis of the Road Test results dealing with the rate of loss of serviceability during various climatic periods during the testing, typical values of  $R$  were developed by the AASHO guide. These values are shown in Table 15.1.

TABLE 15.1. Regional Factors<sup>a</sup>

| Condition  | $R$ value |
|--|-----------|
| Roadbed materials frozen to depth of 5 in. or more | 0.2-1.0   |
| Roadbed materials dry, summer and fall             | 0.3-1.5   |
| Roadbed materials wet, spring thaw                 | 4.0-5.0   |

<sup>a</sup> From AASHO Interim Guide.

Based upon an NCHRP state evaluation study of the AASHO design guide (21), a generalized  $R$  value contour map has been developed for the U.S. and is shown in Figure 15.2. The limitations of such a generalized map should be obvious. In most cases, the selection of the proper  $R$  value must be based upon the local conditions of the highway in combination with the judgement of an experienced engineer. The recommended range in  $R$  by the AASHO design guide for U.S. conditions is from 0.5 to 4.0.

**Structural Number (SN).** The SN is defined as an index number derived from an analysis of traffic, road-bed soil conditions, and regional factor that may be converted to thickness of various flexible-pavement layers through the use of suitable layer coefficients related to the type of material being used in each layer

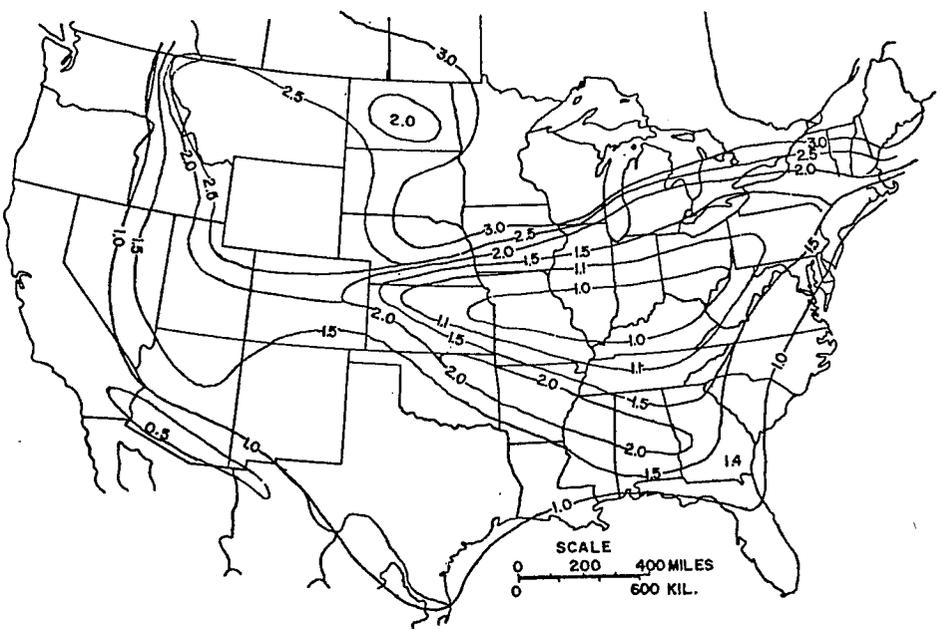


Figure 15.2. Generalized regional map of the United States. (From Van Til et al., NCHRP 128.)

of the pavement structure. The layer coefficient (designated by  $a_1$ ,  $a_2$ , and  $a_3$ , for surface, base and subbase, respectively) is the empirical relationship between SN for a pavement structure and layer thickness, which expresses the relative ability of a material to function as a structural component of the pavement (1).

Analytically, the SN is given by

$$SN = a_1D_1 + a_2D_2 + a_3D_3 \tag{15.9}$$

where the  $D_i$  values are the respective layer thicknesses.

At the AASHO Road Test, four types of basic materials were used in the study: crushed stone, gravel, cement-treated gravel, and bituminous-treated gravel. Based upon the results of the study along with an estimation from results of special base studies at the test, layer coefficients were established by the AASHO Committee on Design and are shown in Table 15.2.

Since the initial publication of the layer coefficients shown in Table 15.2, several state highway departments and trade agencies have developed their own layer coefficients for materials commonly used by their respective agencies. Based upon the NCHRP evaluation study of the AASHO design guide (21), nomographic solutions of the layer coefficients have been proposed from a combined analysis of individual state highway results and a theoretical multilayered elastic analysis. These nomographs are shown in Figure 15.3 and are presented as guides in assessing relative changes in the  $a_i$  values as the measured test response of the material varies.

Since the solution of the AASHO equation results in a design SN, it should be realized that any combination of layer thicknesses and material types satisfying

**FEDERAL HIGHWAY  
ADMINISTRATION  
EASTERN FEDERAL  
LANDS HIGHWAY  
DIVISION**

**SOILS AND FOUNDATION  
REPORT – ADDENDUM**

**FINAL 100% SUBMITTAL**

**CRAGGY GARDENS SLOPE  
INVESTIGATION**

REHABILITATION OF PARK ROADS  
FOR BLUE RIDGE PARKWAY  
YANCEY AND BUNCOMBE  
COUNTIES, NORTH CAROLINA

PRA-BLRI 2P14  
CONTRACT NO. DTFH71-02-D-00004  
TASK ORDER 0003

---

Pete Zimmerman  
Geotechnical Engineer

---

Paul Booth, PE  
Geotechnical Manager

---

Brian Whitaker, PE  
Project Manager

## **Soils and Foundation Report – Addendum**

### **Craggy Gardens Slope Investigation**

### **Rehabilitation of Park Roads for Blue Ridge Parkway Yancey and Buncombe Counties, North Carolina**

PRA-BLRI 2P14  
Contract No. DTFH71-02-D-00004  
Task Order 0003  
Modification No. 003

Prepared for:  
Federal Highway Administration  
Eastern Federal Lands Highway Division

Prepared by:  
ARCADIS G&M, Inc.  
1210 Premier Drive  
Suite 200  
Chattanooga  
Tennessee 37421  
Tel 423 756 7193  
Fax 423 756 7197

Our Ref.:  
CT052885.0002.00015

Date:  
September 2006

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## **Background**

The Blue Ridge Parkway is a 469-mile scenic corridor that connects Shenandoah Valley in Virginia to the Great Smoky Mountains National Park in North Carolina. Adjacent to the parkway, which ranges in elevation from 649 feet to 6,047 feet, are recreational areas that include picnic facilities, hiking trails, visitor centers, overlooks, and campgrounds. The Blue Ridge Parkway, conceived as a Depression-relief project in the 1930s, took more than 50 years to construct.

The pavement along Blue Ridge Parkway and adjacent access roads and pull-offs is in various stages of deterioration and in need of rehabilitation. Area features such as asphalt paths, granite curbs, rubble and masonry walls and steps are also in need of repair. Under initial Task Order No. 0003, ARCADIS was authorized to investigate Section 2P of the Blue Ridge Parkway and develop plans and specifications to rehabilitate this section of the parkway. Section 2P consists of the rehabilitation of the parkway pavement between Milepost 359.8 at the Balsam Gap Overlook and Milepost 375.3. Also included is the reconstruction, replacement, or rehabilitation of ditches, pipes, walls, sidewalks, and curbs. A soils and foundation report has been previously submitted documenting results of subsurface and pavement investigations along Section 2P.

Modification No. 0003 to the Task Order was later issued to cover the investigation and evaluation of an unstable slope located adjacent to the Craggy Gardens Picnic Area access road. The purpose of this addendum to the Soils and Foundation Report is to document the findings of the investigation of the unstable slope and present recommendations for stabilizing the slope.

## **Project Area**

### **Overview**

Within Section 2P, there are six parking and pull-off areas, one picnic parking area with a 1.2-mile access road referred to as Craggy Gardens Access Road, a visitor's center parking area located at approximately Mile 364.6, and three tunnels that have already been reconditioned. Within the project limits, the average roadway width is 22 feet and the length is approximately 15.5 miles. Appendix A contains all the figures for this report. Figure 1 presents a Project Location Map.

## **Regional Geology**

Section 2P lies within the Blue Ridge physiographic province east of the French Broad River and west of Mount Mitchell. The Blue Ridge physiographic province resulted from a series of mountain building (orogeny) and metamorphic events beginning with the Grenville Orogeny, 1,000 million years ago (mya), and culminating with the Alleghanian Orogeny (300-245 mya) (Carter, Merschat et al. 2001). Cycles of continental collision and rifting resulted in a structurally complex group of ultramafic and mafic rocks, and high-grade metamorphic rocks.

The geology of the area is predominantly the Ashe Metamorphic Suite (AMS) containing a series of layered mica gneiss, quartz-feldspar gneiss, mica schist, pegmatite, amphibolites, and eclogites. The gneiss and schist are interpreted as metamorphosed conglomerates and sandstones. The amphibolites are interpreted as metamorphosed basalt (volcanic rock) (Hatcher and Goldberg, 1991). The eclogites are interpreted as metamorphosed rocks that were part of an accretionary wedge of a convergent continent (Willard and Adams 1994). The schist, gneiss, and amphibolites are the result of low-to-moderate pressure and moderate-to-high temperature conditions. The eclogites were exposed to high pressure and moderate-to-high temperature conditions. The above pressure – temperature environments are consistent with continental collision events.

The AMS is in the hanging wall (the thrust sheet above the plane of the fault) of the Holland Mountain Fault (HMF), which trends northeast-southwest in this area and dips to the southeast. Thrust faults are low angle (less than 30 degrees) reverse faults. These faults are shown as single traces on geologic maps; however, in the field they occur as a series of faults and splays rather than a single expression. Within the hanging wall of the HMF is the Burnsville Fault, which roughly parallels (separation approximately 4 miles) the HMF in this study area. The Burnsville Fault was thought to be a thrust fault as shown on the geologic map. Recently the fault has been reinterpreted as a dextral strike-slip shear zone, which is the boundary between the Pumpkin Patch thrust sheet to the west and Spruce Pine thrust sheet to the east (Stewart, Trupe et al. 1997). The studied section lies within the Spruce Pine thrust sheet southeast of the Burnsville Fault approximately 20 miles south of Burnsville, North Carolina.

## **Craggy Gardens Slope Investigation**

### **General**

ARCADIS was tasked with investigating a potentially unstable slope adjacent the access road to the Craggy Gardens Picnic Area, at Milepost 367.6. This investigation was considered necessary after shear cracks were observed in the slope. Photographs 1 and 2 show the slope and general area of concern. Photographs 3 and 4 show examples of the shear cracks at the ground surface. All photographs are provided in Appendix B.

### **Subsurface Investigation**

The first phase of the slide investigation consisted of a subsurface investigation. The subsurface investigation included drilling five borings to depths ranging from 26 to 50 feet. Boring locations are indicated on Figure 2. Borings were advanced by the Standard Penetration Test (ASTM D-1586) method and augering. Representative soil samples were collected for index type testing. Groundwater levels were noted initially after completion of each boring and, when possible, a minimum 24 hours after completion of drilling. A report by S&ME Inc. documenting results of the subsurface investigation is provided in Appendix C.

### **Analyses**

Results of the field investigation were used to develop a typical geologic section through the unstable slope. This is reflected on Figure 3. It is noted that groundwater was encountered within a few feet of the surface within the zone that shear cracking was observed. See borings B-37, 39, and 40. The shear cracking occurred during a period of high rainfall, and high groundwater level is considered the probable cause of the slope instability. Stability analyses were conducted for the typical section using the computer program UTEXAS4. The typical section included an assumed groundwater level at the ground surface. Through an iterative process and based on the location of shear cracks, shear strengths were determined that produced a critical factor of safety of approximately 1.0 for the typical section. This is represented by the Case 1 analysis presented on Figure 3.

Several alternatives were then considered as possible means for stabilizing the slope. The options considered and their approximate estimated costs are summarized in Table 1.

## Soils and Foundation Report - Addendum

Blue Ridge Parkway  
Rehabilitation

**TABLE 1**  
**Stabilization Alternatives**

| <b>Option</b>      | <b>Estimated Cost</b> |
|--------------------|-----------------------|
| Rock Buttress      | \$77,800              |
| Stone Masonry Wall | \$78,900              |
| Collector Trenches | \$38,000              |
| Sheet Piling       | \$69,500              |

Based on the cost estimates, the use of collector trenches to lower the groundwater was considered the preferred option, subject to satisfactory results from slope stability analyses.

Slope stability analyses were again conducted with the same soil shear strengths determined in stability analysis Case 1 and revised groundwater conditions based on installing the collector trenches. This analysis is identified as Case 2 on Figure 3. The Case 2 analysis produced a critical factor of safety of 1.84, which is considered adequate. A seepage analysis was also conducted based on installation of the collector trenches. Calculations are included in Appendix D.

### Recommendations

An investigation and analyses have been conducted for the section of unstable slope near the Craggy Gardens Picnic Area access road. Several alternatives were considered for stabilizing the slope. Based on the results, installation of collector trenches as shown on Figure 4 is recommended. The collector trenches will incorporate the Multi-flow drainage system as requested by the NPS and FHWA.

## References

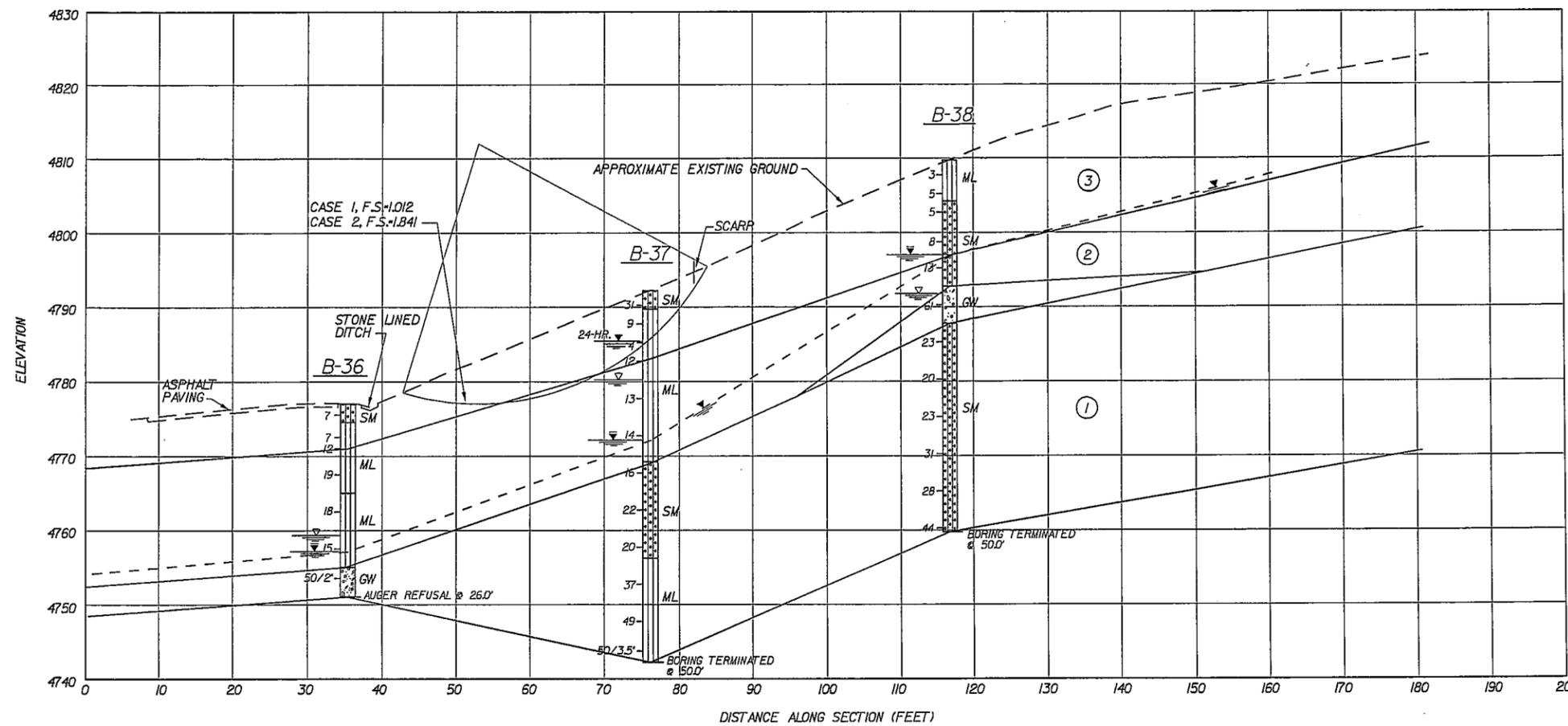
1. Carter, Mark W., Carl E. Mersch, William F. Wilson. "A Geologic Adventure along the Blue Ridge Parkway in North Carolina," Bulletin 98, Raleigh, North Carolina. North Carolina Geological Survey. 3-4 of 60 p. 2001.
2. Hatcher, Robert D. Jr. and Steven A. Goldberg. *The Blue Ridge Geologic Province. Geology of the Carolinas: Carolina Geological Society Fiftieth Anniversary Volume*. The University of Tennessee Press. 22-3 of 406 p. 1991.
3. Willard, R.A., and Mark G. Adams. "Newly Discovered Eclogite in the Southern Appalachian Orogen, Northwestern North Carolina." *Earth and Planetary Science Letters* 123, 61-70. 1994.
4. Stewart, Kevin G., Charles H. Trupe, and Mark G. Adams. *Paleozoic Structure, Metamorphism, and Tectonics of the Blue Ridge of Western North Carolina*, Carolina Geological Society 1997 Field Trip Guidebook. <http://carolinageologicalsociety.org/gb%201997.pdf>. 23 of 107 p. 1997.

## **Appendix A**

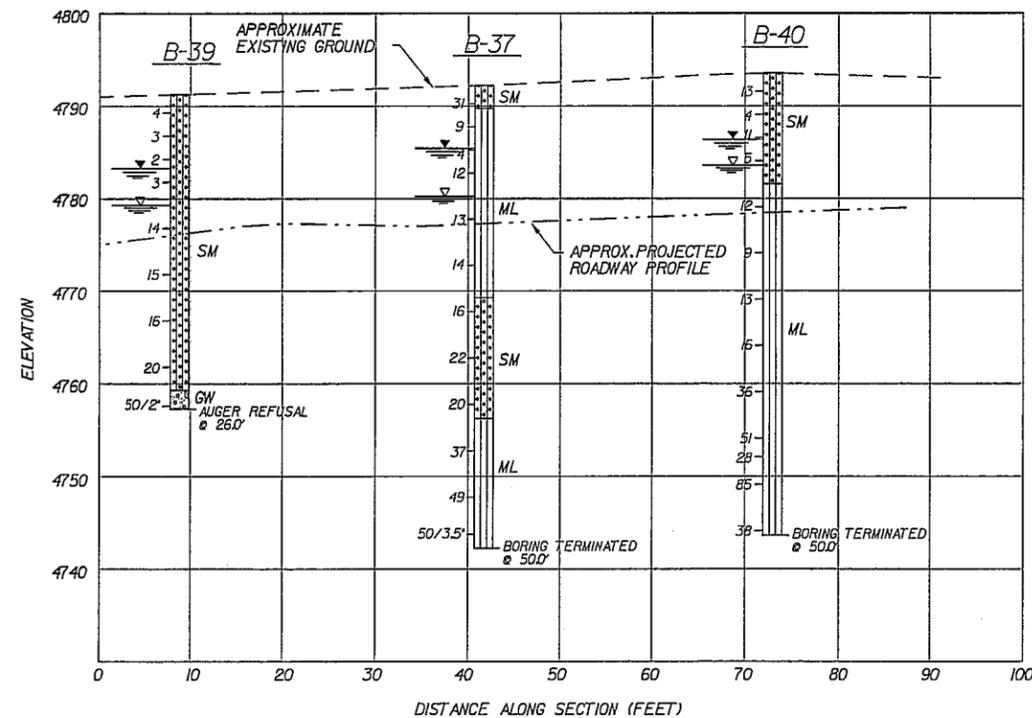
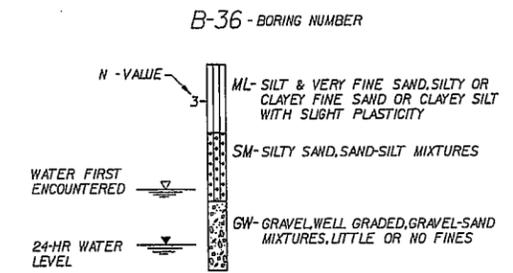
Figures







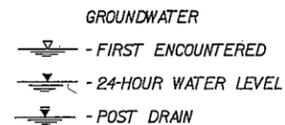
SECTION A



SECTION B

SOIL PARAMETERS

| NO. | DESCRIPTION         | UNIT WEIGHT | SHEAR STRENGTH |                |
|-----|---------------------|-------------|----------------|----------------|
|     |                     |             | COHESION       | FRICTION ANGLE |
| 1   | SILTY SAND          | 120         | 0              | 33             |
| 2   | SILT (ML)           | 110         | 100            | 30             |
| 3   | ML/SM (LOW N-VALUE) | 110         | 100            | 26             |

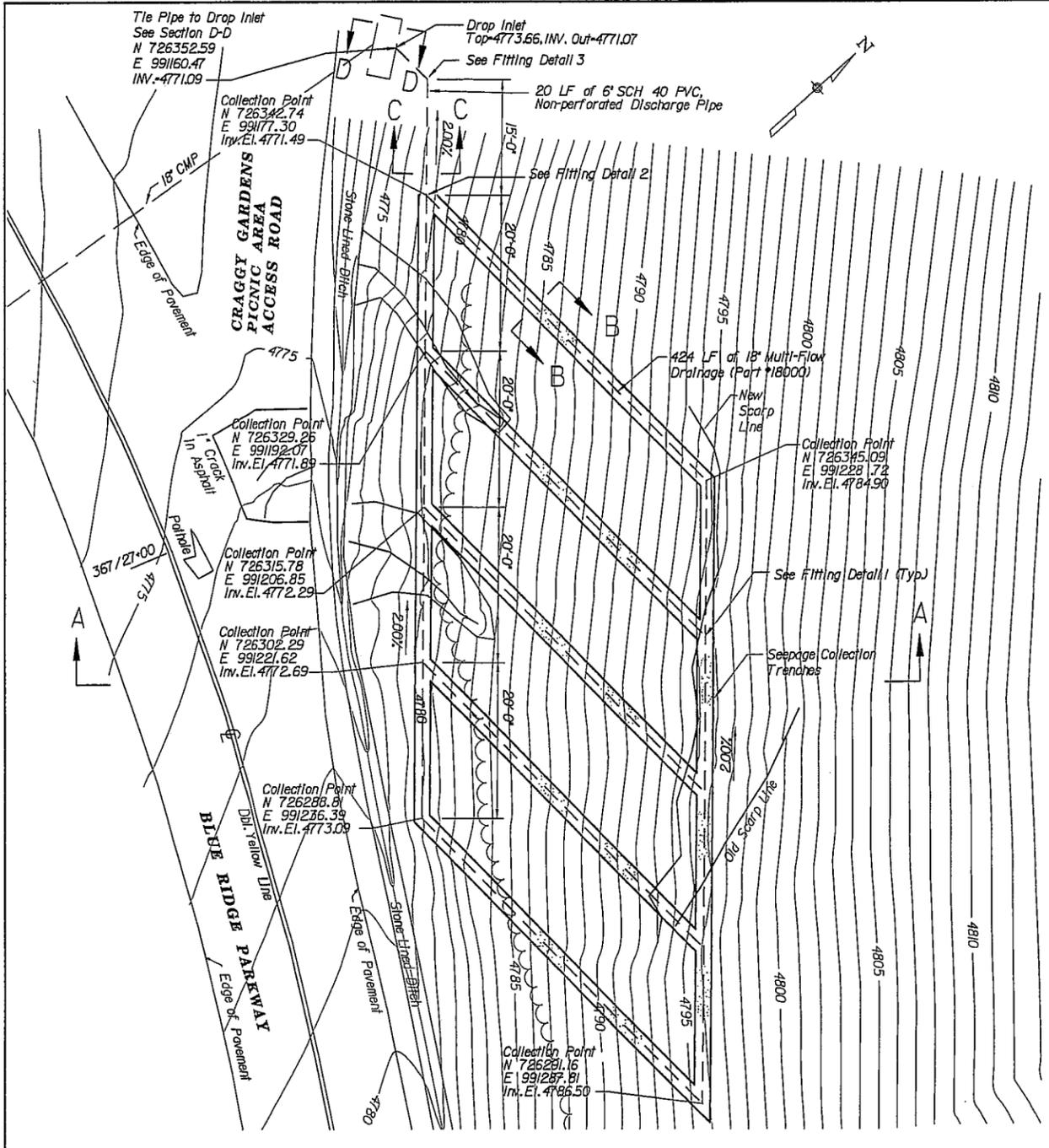


STABILITY ANALYSIS:  
CASE 1 - EXISTING CONDITION  
CASE 2 - POST DRAIN

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

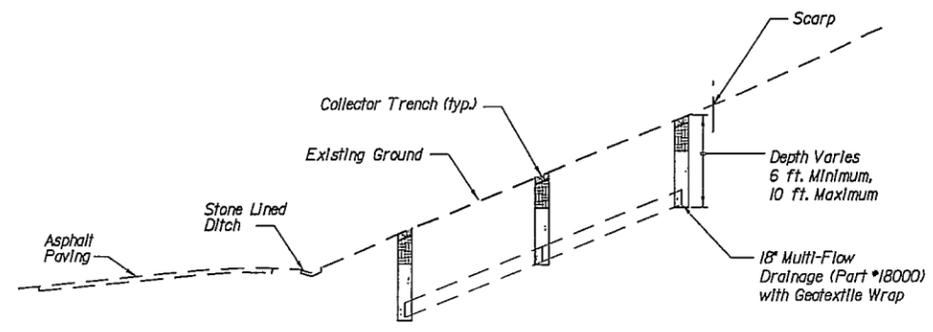
SLOPE INVESTIGATION AT  
CRAGGY GARDENS  
PICNIC ACCESS AREA  
SECTIONS A AND B  
FIG. 3

| NPS NO.      | REG | STATE | PROJECT       | SHEET NO. | TOTAL SHEETS |
|--------------|-----|-------|---------------|-----------|--------------|
| 601<br>43918 | SE  | NC    | PRA-BLRI-2P14 |           |              |

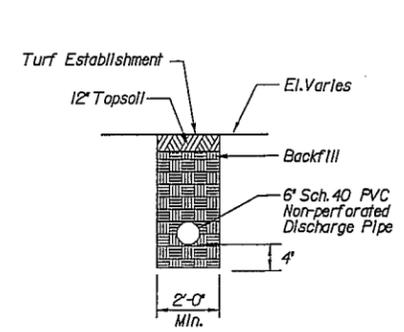


PLAN

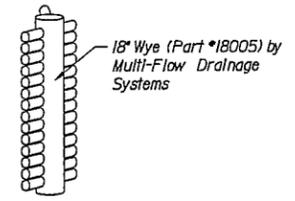
\* See Craggy Gardens Picnic Area Access Road Intersection Plan for control point locations and descriptions.



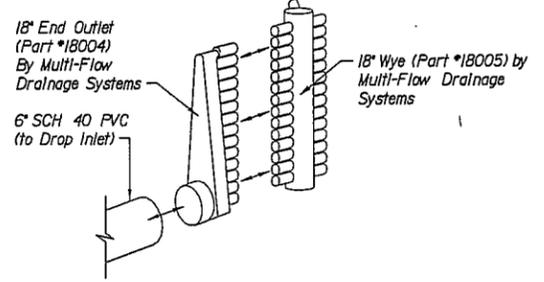
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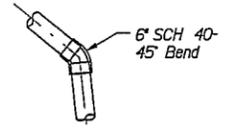
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(SECTION C-C)  
Not to Scale



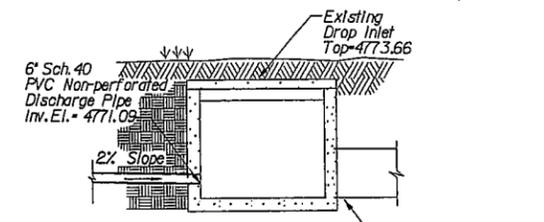
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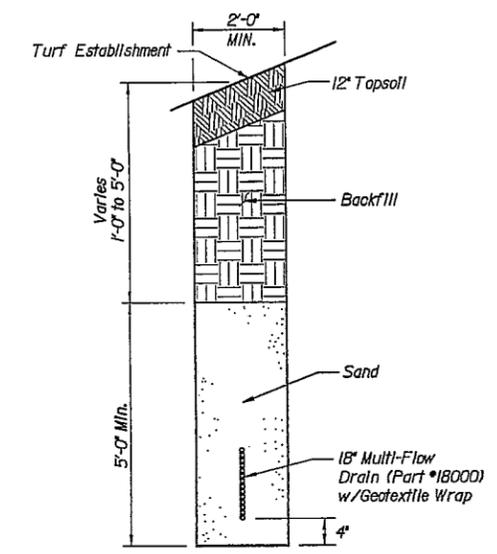
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FITTING DETAIL 3  
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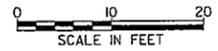
INLET TYPE 4A  
TAPPING DETAIL  
(SECTION D-D)  
Not to Scale



TYPICAL COLLECTOR TRENCH DETAIL  
(SECTION B-B)  
Not to Scale

- Note:
- The contractor shall use the following construction sequence:
1. Place silt fence and Inlet protection at construction area (see Erosion and Sediment Control Narrative sheet).
  2. National Park Service or Blue Ridge Parkway Resource Division personnel may harvest existing vegetation prior to beginning construction.
  3. Clear and grub area that will be disturbed during underdrain construction. The cleared area includes the width of the trench as well as a work area 10 feet in width along the length of the proposed drain. Remove the top 12 inches of soil from the cleared areas. Conserve the top 12 inches of soil and stockpile it separately from the excavated trench soil.
  4. Revegetate the cleared and grubbed area with an appropriate seed mix (annual rye or winter rye depending on the time of year).
  5. Construct the 6" PVC discharge pipe and the 80-foot of collector trench with Multi-Flow Drainage System located on the most downhill portion of the site. A maximum of 25 feet of trench shall be open at any given time. The trench shall be filled with the granular backfill, backfill, and topsoil before excavation is begun on the next 25 feet of trench.
  6. Construct the collector drains that run uphill at a 45-degree angle from the bottom collector. One trench shall be excavated and the drain completed before opening the next collector trench.
  7. Construct the top collector drain. A maximum of 25 feet of trench shall be open at any given time. The trench shall be filled with the granular backfill, backfill, and topsoil before the next 25 feet of trench is excavated.
  8. Place the conserved 12 inches of topsoil on areas that were previously cleared.
  9. Establish turf on the disturbed areas. National Park Service or Blue Ridge Parkway Resource Division personnel may plant appropriate supplemental vegetation.
  10. Remove silt fence and Inlet protection after turf has been established.

Note: It is recommended that construction occur during the driest season possible. It is acceptable to construct this drainage system when the ground surface is frozen.



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

Craggy Gardens  
Picnic Access Area  
Seepage Collector Trenches

## **Appendix B**

Photographs



Photo 1. Mid-slope facing toward Craggy Gardens Access Road.



Photo 2. Facing slope from Blue Ridge Parkway.



Photo 3. Shear cracks on slope.



Photo 4. Shear cracks on slope.

## **Appendix C**

S&ME Inc. Report Documenting  
Results of the Subsurface  
Investigation

**SUBSURFACE EXPLORATION  
REPORT**

**BLUE RIDGE PARKWAY  
CRAGGY GARDENS SLIDE  
ASHEVILLE, NORTH CAROLINA  
S&ME PROJECT NO. 1411-05-098**

Prepared For:

ARCADIS, INC  
1210 PREMIER DRIVE  
SUITE 200  
CHATTANOOGA, TENNESSEE 37421

Prepared By:

S&ME, Inc.  
44 Buck Shoals Road, Suite C-3  
Arden, North Carolina 28704

May 31, 2005



May 31, 2005

Arcadis, Inc.  
1210 Premier Drive  
Suite 200  
Chattanooga, Tennessee 37421

**Attention:** Mr. Bob Chamlee

**Reference:** **SUBSURFACE EXPLORATION REPORT**  
Blue Ridge Parkway at Craggy Gardens Picnic Area  
Asheville, North Carolina  
**S&ME Project No. 1411-05-098**

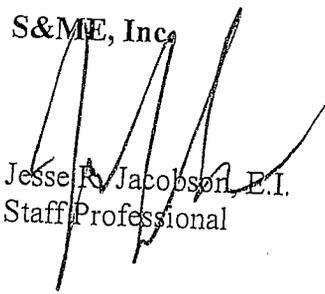
Dear Mr. Chamlee:

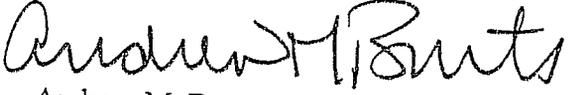
S&ME, Inc. has completed the authorized subsurface exploration program for the cut slope at the Craggy Gardens Picnic Area near Asheville, North Carolina. The exploration was performed in accordance with our Proposal No. ENG-004-05 dated January 5, 2005. This report presents a brief description of the existing slope and data from our subsurface exploration program.

S&ME appreciates the opportunity to provide you with our services. Should you have any questions regarding the information presented in this report, or if we may be of any further assistance, please contact us at your convenience.

Sincerely,

S&ME, Inc.

  
Jesse R. Jacobson, E.I.  
Staff Professional



Andrew M. Burton, P.E.  
Branch Manager

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## APPENDIX

Boring Logs

Laboratory Test Results

## 1.0 PROJECT INFORMATION

A cut slope on the north side of the Blue Ridge Parkway at milepost 367.6 has experienced downward movement. The slide area is above the road and parallels the Parkway at the entrance to the Craggy Garden Picnic Area entrance road. The slide area is roughly 80 feet long and the highest series of tension cracks are roughly 30 feet above the road. The tension cracks had been marked with red ribbon by others and were four to six inches wide and less than a foot deep. The slope inclination appears to range from 2.5:1 to 3:1 (Horizontal:Vertical). There also appears to be a slight bulge in the pavement at the toe of slope.

## **2.0 EXPLORATION AND TESTING PROGRAM**

### **2.1 FIELD TESTING**

Five soil test borings were drilled in the area of the slope. The boring locations were established in the field by Arcadis. Ground surface elevations of the borings were unknown at the time of our exploration.

The soil test borings were extended to depths ranging from 26 to 50 feet. Standard Penetration Tests (ASTM D-1586) were performed, and representative split-spoon soil samples were obtained at each soil test boring location. Standard penetration testing is used to determine soil relative density and consistency information. Split-spoon samples are obtained to visually classify representative soil samples. Standard penetration tests were performed, and split-spoon samples were obtained at 2.5-foot intervals for the first ten feet of depth below the existing grade, and at 5.0-foot depth intervals thereafter. Groundwater levels were recorded at the termination of drilling and at a minimum of 24 hours after the termination of drilling. Bulk samples were collected from each of the borings. No rock coring was performed due to the very deep auger refusals.

### **2.2 LABORATORY TESTING**

The bulk and split-spoon samples were transported to our laboratory where they were visually and manually classified by our Geotechnical Engineering staff. The visual and manual classification of the soils was estimated, based on the Unified Soil Classification System (USCS) and our experience. Representative soil samples were subjected to the following laboratory tests: Natural Moisture Contents, Atterberg Limits and Grain Size Distribution.

Testing was performed in general accordance with ASTM or other applicable testing standards. The results are presented on data sheets in Appendix C.

### 3.0 SUBSURFACE CONDITIONS

The subsurface conditions described herein have been generalized. Detailed data at each soil test boring location can be obtained from the individual Boring Logs provided in the Appendix of this report.

#### 3.1 TOPSOIL

Because the site had been previously stripped in preparation for drilling activities, topsoil was not encountered in the boring locations.

#### 3.2 COLLUVIUM

In Borings B-3 and B-4, a layer of colluvium was encountered to depths of about 22 and 6 feet, respectively. Colluvium is soil transported to its current location by gravity (i.e. landslides in the recent or geologic past). The colluvium consisted of sandy silts, silty sands and weathered rock fragments. The SPT resistance values ranged from 3 to 13 blows per foot (bpf) in the sand and weathered rock fragments, indicating a very loose to medium dense relative density, and from 3 to 5 bpf in the silts, indicating a soft to firm consistency. These values were likely amplified by the presence of rock fragments.

#### 3.3 RESIDUUM

Soil interpreted as residuum was encountered at the ground surface in Borings B-1, B-2 and B-5, and below the colluvium in Borings B-3 and B-4 to depths ranging from 22 to 50 feet. Residuum is soil weathered in place from the underlying parent bedrock. The residuum typically consisted of sandy silt and silty fine sand. The residuum has varying mica and moisture content. SPT resistance values ranged from 2 to 23 blows per foot in the sands, indicating a very loose to medium dense relative density, and from 7 to over 50 bpf in the

silts, indicating a firm to very hard consistency. Borings B-3 and B-5 were terminated in the residual soil at a depth of 50 feet.

### **3.4 PARTIALLY WEATHERED ROCK**

Partially weathered rock (PWR) was encountered directly below the residuum in Borings B-1, B-2 and B-4. Partially weathered rock is a transitional material from very hard residual soil to rock with a standard penetration resistance of at least 50 blows per 6 inches. Boring B-2 was terminated in the PWR at a depth of 50 feet.

### **3.5 REFUSAL MATERIAL**

Refusal to auger advancement was encountered in Borings B-1 and B-4 at a depth of 26 and 34 feet, respectively. The refusal material could consist of a boulder, rock lens, or relatively massive rock within the soil mantle, or potentially the surface of continuous bedrock.

### **3.6 GROUNDWATER**

Groundwater was observed in each boring at depths ranging from 10 to 18 feet just after termination of the boring. However, 24-hour water level readings indicated depths ranging from 7 to 8 feet. Please remember that groundwater elevations will fluctuate due to seasonal and climatic changes, and may fluctuate due to construction activity in the area.

#### 4.0 LABORATORY TEST RESULTS

The following table presents a summary of the results from the laboratory testing program. Testing was performed in general accordance with ASTM or other applicable testing standards. The results are presented on data sheets in Appendix C.

| BORING NO. | DEPTH (feet) |      | NAT. MOIST (%) | GRAIN SIZE DISTRIBUTION |           | ATTERBERG LIMITS |     |
|------------|--------------|------|----------------|-------------------------|-----------|------------------|-----|
|            |              |      |                | Sand & Gravel (%)       | Fines (%) | LL               | PI  |
|            | From         | To   |                |                         |           |                  |     |
| B-1        | 1.0          | 2.5  |                | 71.3                    | 28.6      |                  |     |
| B-1        | 9.0          | 10.5 | 26.8           |                         |           |                  |     |
| B-2        | 2.0          | 3.5  | 17.9           |                         |           |                  |     |
| B-2        | 6.0          | 7.5  | 35.9           | 67.2                    | 32.8      | 32               | NP* |
| B-3        | 4.0          | 5.5  | 49.4           |                         |           | 46               | NP* |
| B-3        | 7.0          | 8.5  | 23.1           |                         |           |                  |     |
| B-3        | 14.0         | 15.5 | 8.3            |                         |           |                  |     |
| B-4        | 3.5          | 5.0  | 32.5           | 80.2                    | 19.7      | 31               | NP* |
| B-4        | 9.0          | 10.5 | 29.            | 92.0                    | 7.0       |                  |     |
| B-4        | 14.0         | 15.5 | 28.1           |                         |           |                  |     |
| B-5        | 6.0          | 7.5  | 21.3           | 84.8                    | 15.2      |                  |     |
| B-5        | 14.0         | 15.5 | 35.1           |                         |           |                  |     |
| B-5        | 19.0         | 20.5 | 33.3           |                         |           |                  |     |

\*NP = Non plastic

## 5.0 LIMITATIONS OF REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practice. The data contained herein are based on the applicable standards of the profession at the time this report was prepared. No other warranty, expressed or implied, is made.

The evaluations submitted in this report are based, in part, upon the data obtained from the subsurface exploration. The nature and extent of variations in subsurface conditions will not become evident until construction. If variations appear evident, it will be necessary to re-evaluate the data contained in this report.

# LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

## SOIL TYPES

(Shown in Graphic Log)



Fill



Asphalt



Concrete



Topsoil



Gravel



Sand



Silt



Clay



Organic



Silty Sand



Clayey Sand



Sandy Silt



Clayey Silt



Sandy Clay



Silty Clay



Partially Weathered Rock



Cored Rock

## WATER LEVELS

(Shown in Water Level Column)

▽ = Water Level At Termination of Boring

▽ = Water Level Taken After 24 Hours

▲ = Loss of Drilling Water

HC = Hole Cave

## CONSISTENCY OF COHESIVE SOILS

### CONSISTENCY

Very Soft

Soft

Firm

Stiff

Very Stiff

Hard

Very Hard

STD. PENETRATION  
RESISTANCE  
BLOWS/FOOT

0 to 2

3 to 4

5 to 8

9 to 15

16 to 30

31 to 50

Over 50

## RELATIVE DENSITY OF COHESIONLESS SOILS

### RELATIVE DENSITY

Very Loose

Loose

Medium Dense

Dense

Very Dense

STD. PENETRATION  
RESISTANCE  
BLOWS/FOOT

0 to 4

5 to 10

11 to 30

31 to 50

Over 50

## SAMPLER TYPES

(Shown in Samples Column)

■ Shelby Tube

⊠ Split Spoon

I Rock Core

□ No Recovery

## TERMS

**Standard Penetration Resistance** - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586.

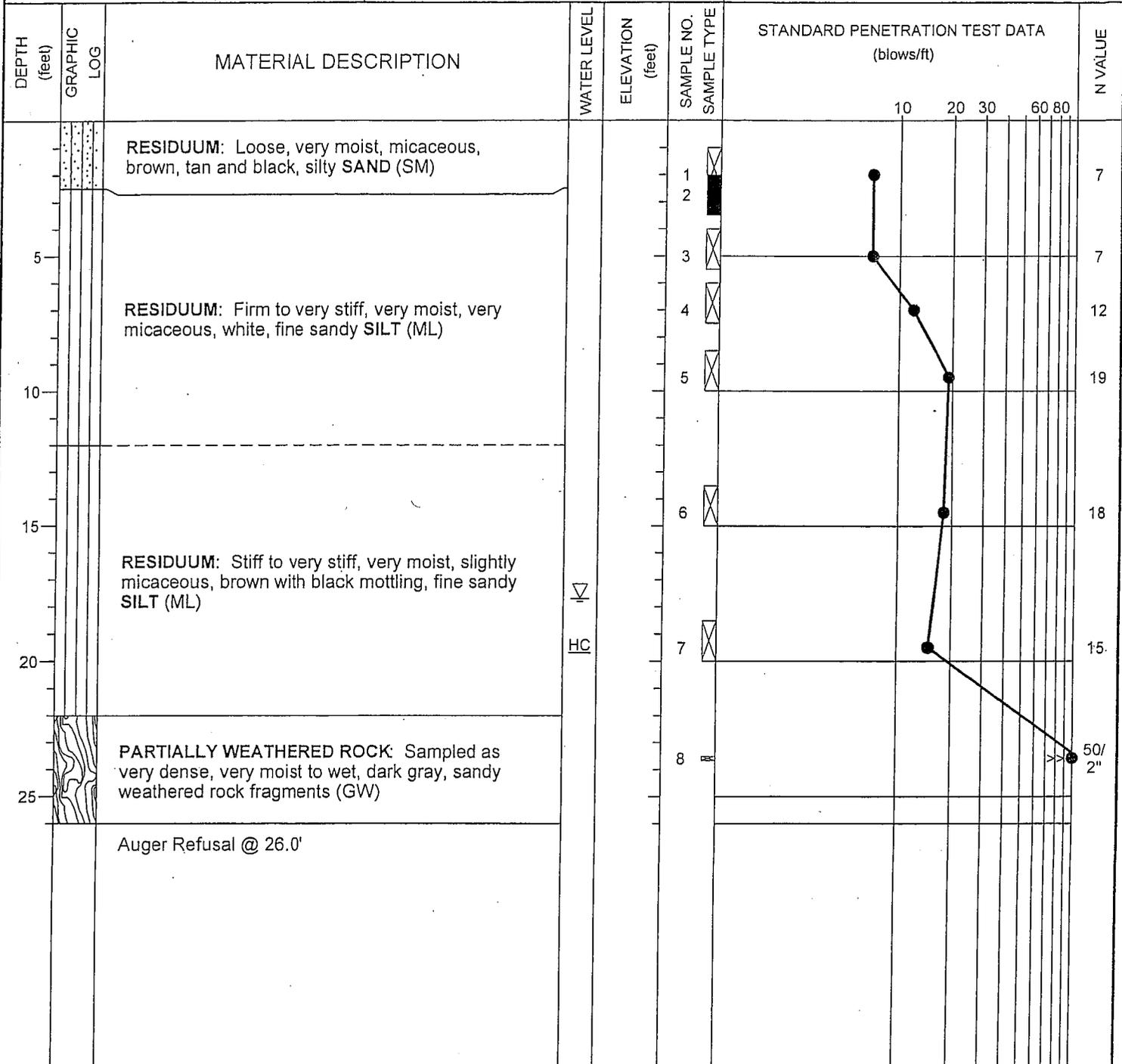
**REC** - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

**RQD** - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.



|                                |                          |
|--------------------------------|--------------------------|
| DATE DRILLED: 4/19/05          | ELEVATION:               |
| DRILLING METHOD: 2 1/4" H.S.A. | BORING DEPTH: 26.0       |
| LOGGED BY: J. JACOBSON         | WATER LEVEL: 17.7' @ TOB |
| DRILLER:                       | DRILL RIG: Mobile B-56   |

NOTES:



BORING LOG 1105098.GPJ S&ME.GDT 6/17/05

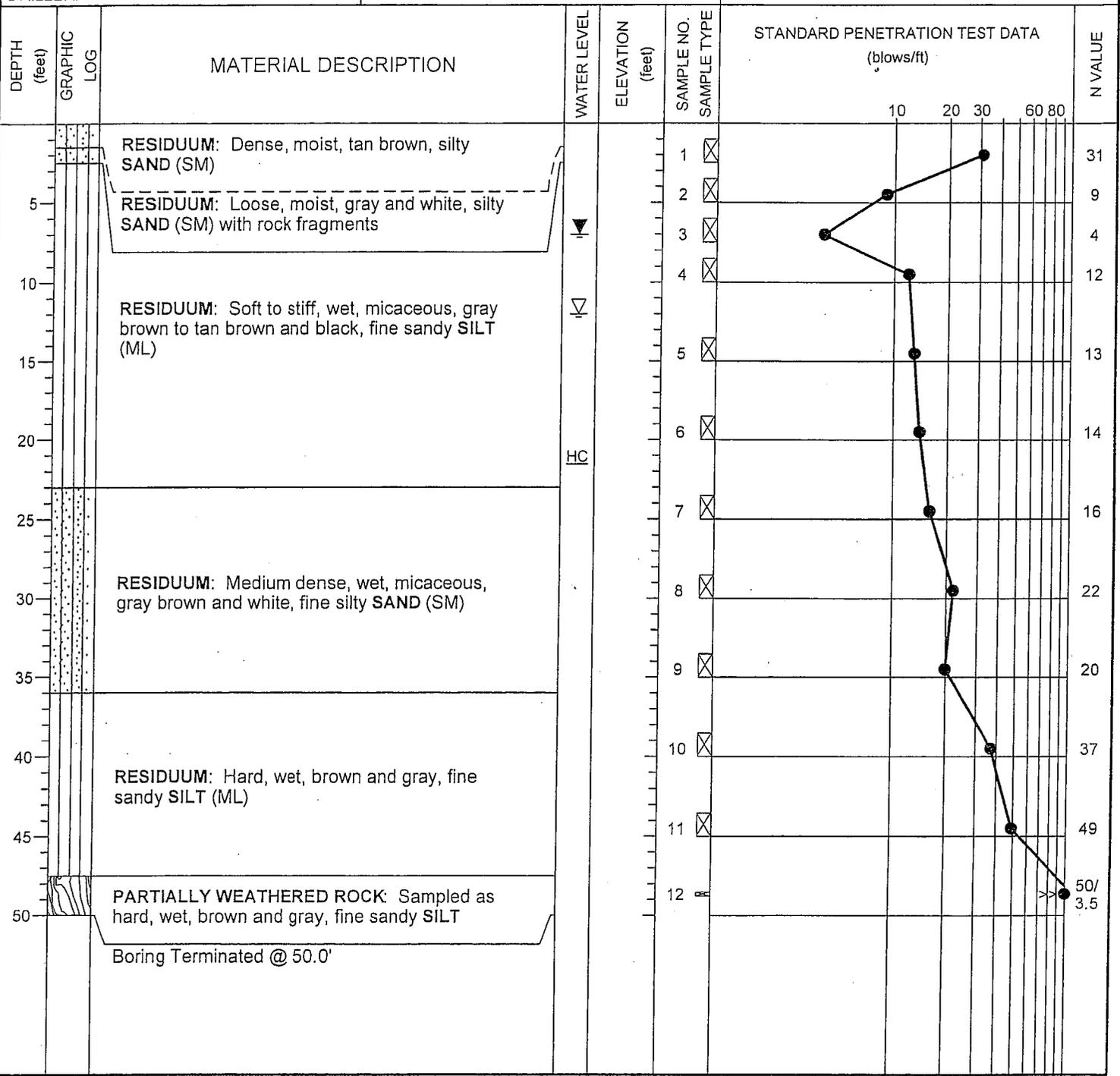
**NOTES:**

1. THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.
2. BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.
3. STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.
4. WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.



|                                |                              |
|--------------------------------|------------------------------|
| DATE DRILLED: 4/18/05          | ELEVATION:                   |
| DRILLING METHOD: 2 1/4" H.S.A. | BORING DEPTH: 50.0           |
| LOGGED BY: J. JACOBSON         | WATER LEVEL: 7.0' @ 24 HOURS |
| DRILLER:                       | DRILL RIG: Mobile B-56       |

NOTES: CUT 5 FEET



BORING LOG 1105098.GPJ S&ME.GDT 6/17/05

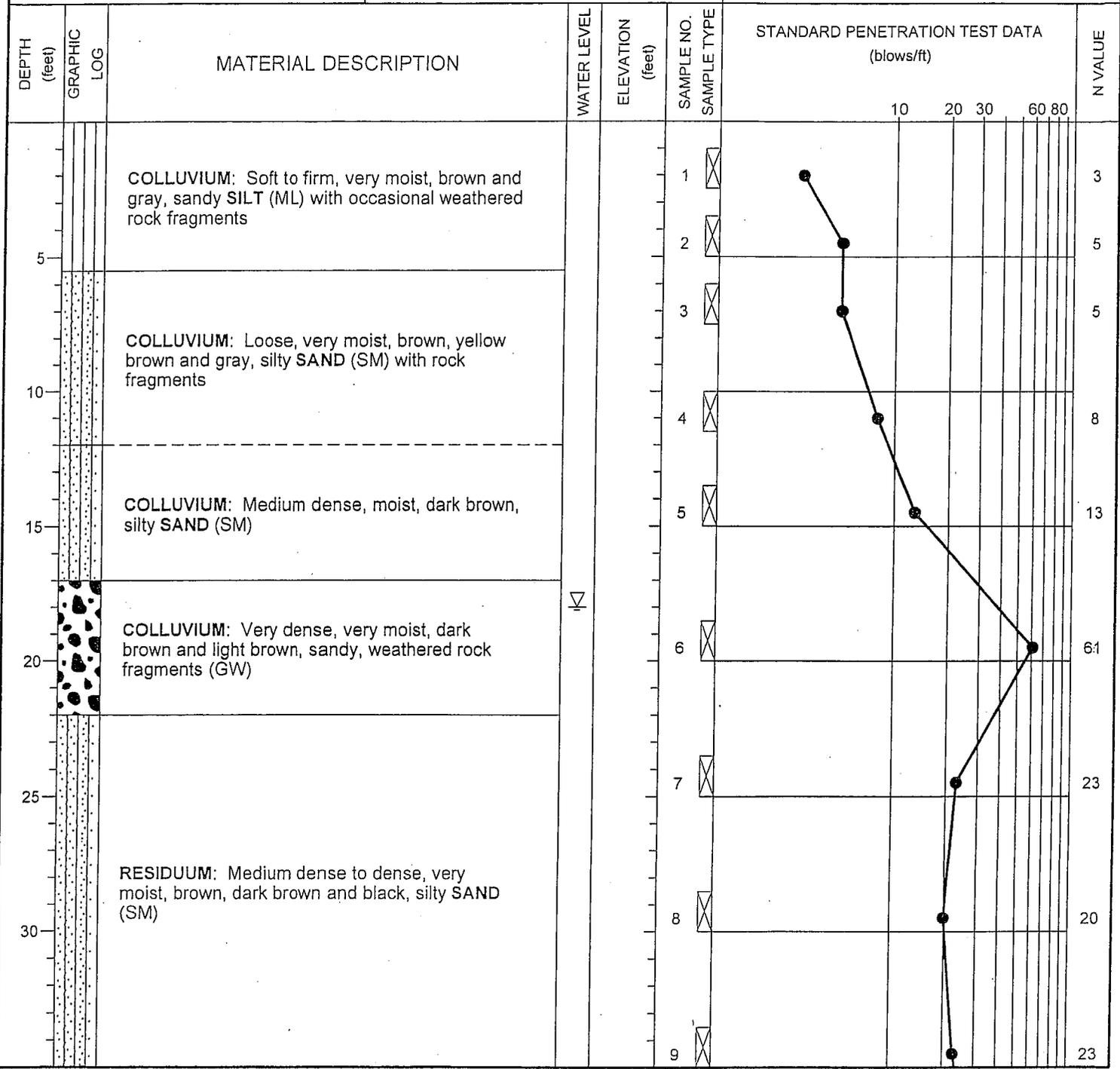
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|                                |                          |
|--------------------------------|--------------------------|
| DATE DRILLED: 4/19/05          | ELEVATION:               |
| DRILLING METHOD: 2 1/2" H.S.A. | BORING DEPTH: 50.0       |
| LOGGED BY: J. JACOBSON         | WATER LEVEL: 18.0' @ TOB |
| DRILLER:                       | DRILL RIG: Mobile B-56   |

NOTES:



BORING LOG 1105098.GPJ S&ME.GDT 6/17/05

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- WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.



|                                |                          |
|--------------------------------|--------------------------|
| DATE DRILLED: 4/19/05          | ELEVATION:               |
| DRILLING METHOD: 2 1/4" H.S.A. | BORING DEPTH: 50.0       |
| LOGGED BY: J. JACOBSON         | WATER LEVEL: 18.0' @ TOB |
| DRILLER:                       | DRILL RIG: Mobile B-56   |

NOTES:

| DEPTH<br>(feet) | GRAPHIC<br>LOG | MATERIAL DESCRIPTION   | WATER LEVEL | ELEVATION<br>(feet) | SAMPLE NO.<br>SAMPLE TYPE | STANDARD PENETRATION TEST DATA<br>(blows/ft) |    |    |       | N VALUE |  |    |
|-----------------|----------------|--|-------------|---------------------|---------------------------|--|----|----|-------|---------|--|----|
|                 |                |  |             |                     |                           | 10   | 20 | 30 | 60 80 |         |  |    |
| 40              |                | RESIDUUM: Medium dense to dense, very moist, brown, dark brown and black, silty SAND (SM)<br>(continued) | HC          | 10                  | X                         |  |    |    |       | 31      |  |    |
| 45              |                |  |             |                     |                           |  |    |    |       |         |  | 28 |
| 50              |                | RESIDUUM: Dense, moist, white and brown, silty fine SAND (SM)  |             |                     |                           |  |    |    |       |         |  |    |
| 50              |                | Boring Terminated @ 50.0'  |             |                     |                           |  |    |    |       |         |  |    |

BORING LOG 1105098.GPJ S&ME.GDT 6/17/05

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4. WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.



**S&ME**

ENGINEERING • TESTING  
 ENVIRONMENTAL SERVICES

DATE DRILLED: 4/18/05 ELEVATION:  
 DRILLING METHOD: 2 1/4" H.S.A. BORING DEPTH: 34.0  
 LOGGED BY: J. JACOBSON WATER LEVEL: 8.0' @ 24 HOURS  
 DRILLER: DRILL RIG: Mobile B-56

NOTES:

| DEPTH<br>(feet) | GRAPHIC<br>LOG | MATERIAL DESCRIPTION   | WATER LEVEL | ELEVATION<br>(feet) | SAMPLE NO. | SAMPLE TYPE | STANDARD PENETRATION TEST DATA<br>(blows/ft) |    |    |    |    | N VALUE |
|-----------------|----------------|--|-------------|---------------------|------------|-------------|--|----|----|----|----|---------|
|                 |                |  |             |                     |            |             | 10   | 20 | 30 | 60 | 80 |         |
| 0-5             |                | COLLUVIUM: Very loose, moist, dark brown and dark brownish gray, silty fine SAND (SM)  |             |                     | 1          | ⊗           |  |    |    |    |    | 4       |
| 5-10            |                | RESIDUUM: Very loose, very moist, dark brown and dark brownish gray, silty fine SAND (SM)  | ▼           |                     | 2          | ⊗           |  |    |    |    |    | 3       |
| 10-15           |                | RESIDUUM: Medium dense, very moist, white, silty SAND (SM)   | ▼           |                     | 3          | ⊗           |  |    |    |    |    | 2       |
| 15-20           |                | RESIDUUM: Medium dense, moist, yellow brown and gray, silty fine SAND (SM)   | HC          |                     | 4          | ⊗           |  |    |    |    |    | 3       |
| 20-25           |                | RESIDUUM: Medium dense, moist, yellow brown and gray, silty fine SAND (SM)   |             |                     | 5          | ⊗           |  |    |    |    |    | 14      |
| 25-30           |                | RESIDUUM: Medium dense, moist, yellow brown and gray, silty fine SAND (SM)   |             |                     | 6          | ⊗           |  |    |    |    |    | 15      |
| 30-34.0         |                | PARTIALLY WEATHERED ROCK: Sampled as very dense, moist, yellow brown and gray, silty fine SAND with some weathered rock fragments<br>Auger Refusal @ 34.0' |             |                     | 7          | ⊗           |  |    |    |    |    | 16      |
|                 |                |  |             |                     | 8          | ⊗           |  |    |    |    |    | 20      |
|                 |                |  |             |                     | 9          | ⊗           |  |    |    |    |    | 50/2"   |

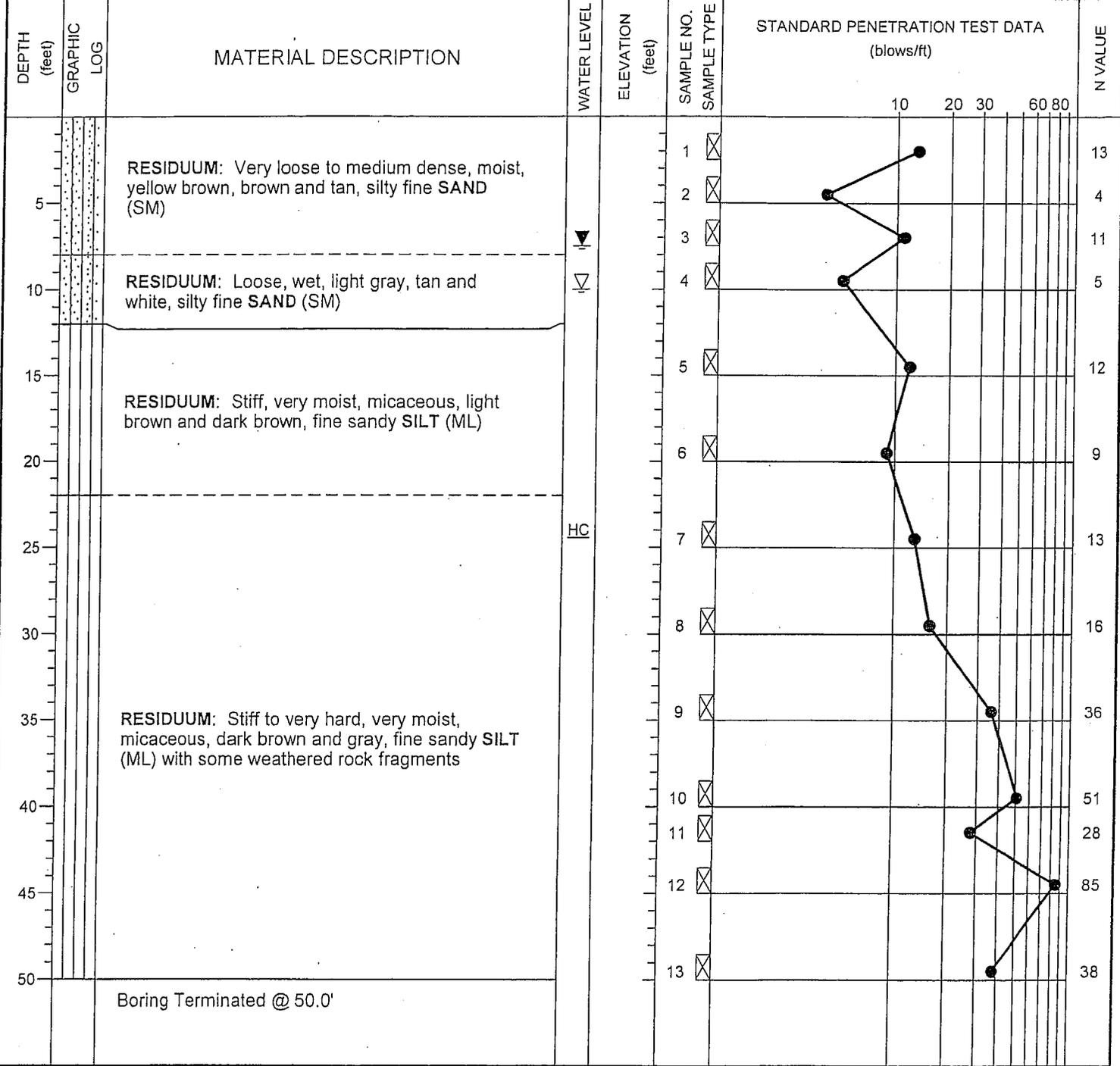
BORING LOG 1105098.GPJ S&ME\_GDT 6/17/05

- NOTES:**
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  - STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.
  - WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.



|                                |                              |
|--------------------------------|------------------------------|
| DATE DRILLED: 4/17/05          | ELEVATION:                   |
| DRILLING METHOD: 2 1/4" H.S.A. | BORING DEPTH: 50.0           |
| LOGGED BY: J. JACOBSON         | WATER LEVEL: 7.5' @ 24 HOURS |
| DRILLER:                       | DRILL RIG: Mobile B-56       |

NOTES:



BORING LOG 1105098.GPJ S&ME.GDT 6/17/05

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## FIELD TESTING PROCEDURES

### SOIL TEST BORINGS

All borings and sampling were conducted in accordance with ASTM D-1586-99 test method. Initially, the borings were advanced by either mechanically augering or wash boring through the overburden soils. When necessary, a heavy drilling fluid is used below the water table to stabilize the sides and bottom of the borehole. At regular intervals, soil samples were obtained with a standard 1.4-inch I.D., 2-inch O.D., split-barrel or split-spoon sampler. The sampler was first seated 6 inches to penetrate any loose cuttings and then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot is designated as the "Standard Penetration Resistance" or N-value. The penetration resistance, when properly evaluated, can be correlated to consistency, relative density, strength and compressibility of the sampled soils.

### WATER LEVEL READINGS

Water level readings are normally taken in conjunction with borings and are recorded on the Boring Logs following termination of drilling (designated by  $\nabla$ ) and at a period of 24 hours following termination of drilling (designated by  $\nabla$ ). These readings indicate the approximate location of the hydrostatic water table at the time of our field exploration. The groundwater table may be dependent upon the amount of precipitation at the site during a particular period of time. Fluctuations in the water table should also be expected with variations in surface run-off, evaporation, construction activity and other factors.

Occasionally the boreholes sides will cave, preventing the water level readings from being obtained or trapping drilling water above the cave-in zone. In these instances, the hole cave-in depth (designated by HC) is measured and recorded on the Boring Logs. Water level readings taken during the field operations do not provide information on the long-term fluctuations of the water table. When this information is required, piezometers are installed to prevent the boreholes from caving.

# Particle Size Analysis of Soils

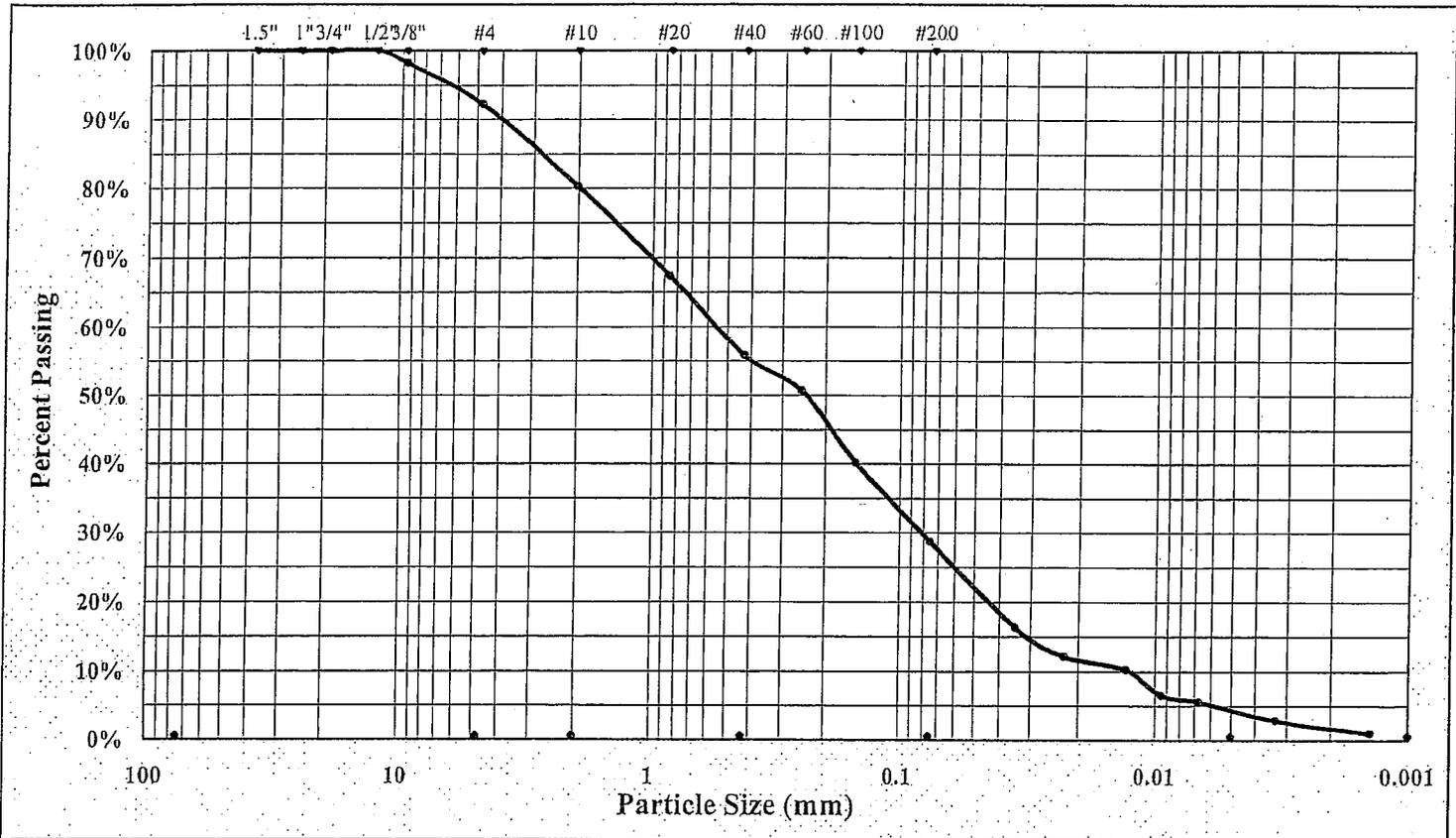


ASTM D 422

S&ME Project #: **1411-05-098**  
 Project Name: **CRAGGY GARDENS**  
 Client Name: **ARCADIS**  
 Client Address:

Report Date: **05-19-05**  
 Test Date(s): **05-17-05**

|   |                 |                              |
|---|-----------------|------------------------------|
| Boring #: <b>B-2</b>                                | Sample #: _____ | Sample Date: <b>04-18-05</b> |
| Location: _____                                     | Offset: _____   | Elevation: <b>Unknown</b>    |
| Sample Description: <b>GRAYISH BROWN SILTY SAND</b> |                 |                              |



|             |                                 |           |                                  |
|-------------|---------------------------------|-----------|----------------------------------|
| Cobbles     | < 300 mm (12") and > 75 mm (3") | Fine Sand | < 0.425 mm and > 0.075 mm (#200) |
| Gravel      | < 75 mm and > 4.75 mm (#4)      | Silt      | < 0.075 and > 0.005 mm           |
| Coarse Sand | < 4.75 mm and > 2.00 mm (#10)   | Clay      | < 0.005 mm                       |
| Medium Sand | < 2.00 mm and > 0.425 mm (#40)  | Colloids  | < 0.001 mm                       |

|                              |       |                  |       |               |
|------------------------------|-------|------------------|-------|---------------|
| Maximum Particle Size        | 1     | Gravel           | 7.8%  | Silt          |
| Silt & Clay (% Passing #200) | 28.6% | Sand             | 63.5% | Clay          |
| Apparent Relative Density    | 2.670 | Moisture Content |       | Colloids      |
| Liquid Limit                 |       | Plastic Limit    |       | Plastic Index |

Description of Sand & Gravel Particles    Rounded     Angular     Hard & Durable     Soft     Weathered & Friable

Mechanical Stirring Apparatus (A)    Length of Dispersion Period:    1 min.    Dispersing Agent:    Sodium Hexametaphosphate:    40 g./ Liter

References:    ASTM D 422: Particle Size Analysis of Soils    ASTM D 421: Dry Preparation of Soil Samples  
 ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils    ASTM D 854: Specific Gravity of Soils  
 ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)  
 Direct entry in this cell is allowed    Direct entry in this cell is allowed

Technical Responsibility: \_\_\_\_\_  
Signature    Position

# Particle Size Analysis of Soils

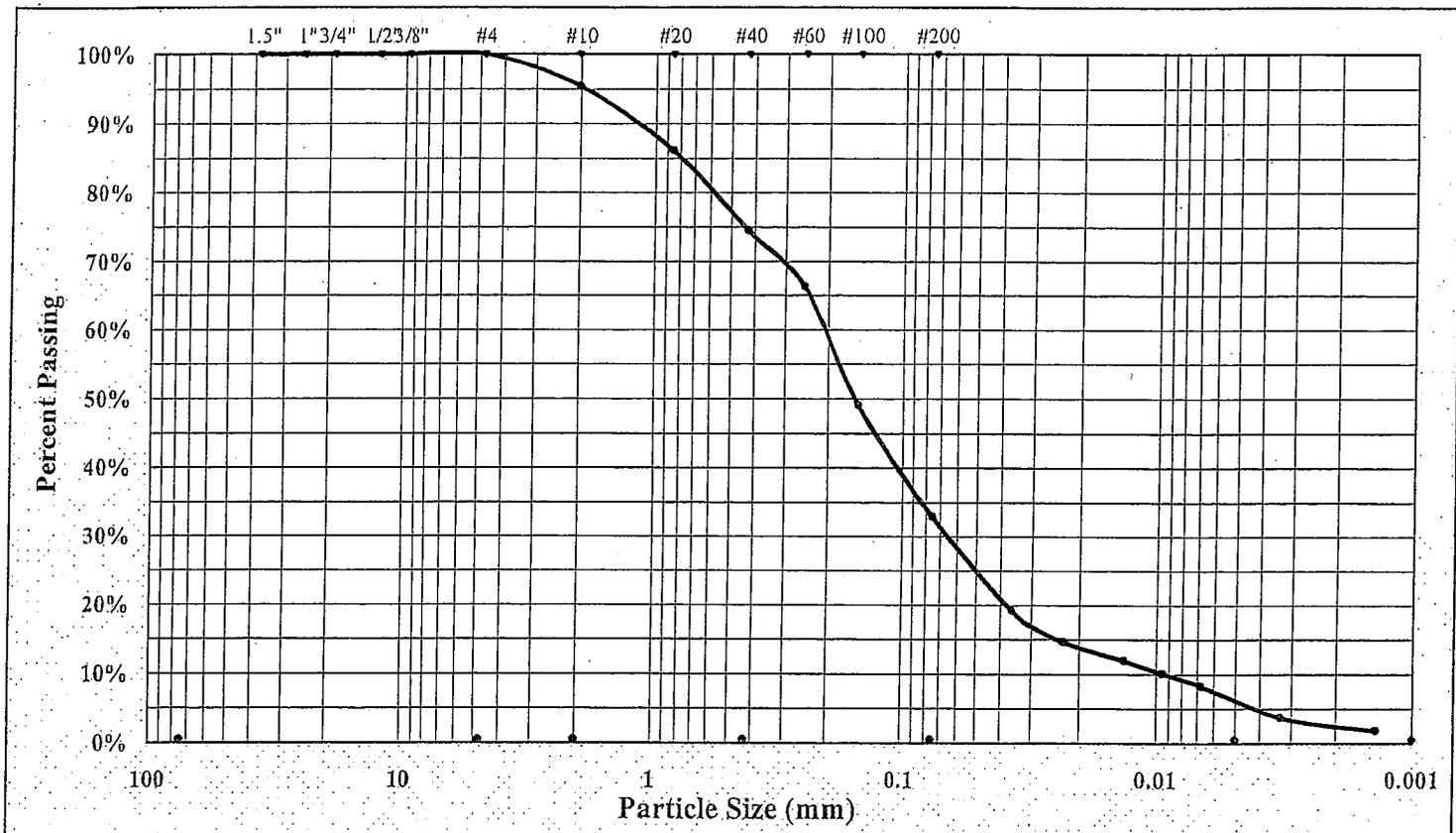


ASTM D 422

S&ME Project #: **1411-05-098**  
 Project Name: **CRAGGY GARDENS**  
 Client Name: **ARCADIS**  
 Client Address:

Report Date: **05-19-05**  
 Test Date(s): **05-17-05**

|  |                 |                              |
|--|-----------------|------------------------------|
| Boring #: <b>B-2</b>                             | Sample #: _____ | Sample Date: <b>04-18-05</b> |
| Location: <b>6' TO 7.5'</b>                      | Offset: _____   | Elevation: <b>Unknown</b>    |
| Sample Description: <b>GRAY BROWN SILTY SAND</b> |                 |                              |



|             |                                 |           |                                  |
|-------------|---------------------------------|-----------|----------------------------------|
| Cobbles     | < 300 mm (12") and > 75 mm (3") | Fine Sand | < 0.425 mm and > 0.075 mm (#200) |
| Gravel      | < 75 mm and > 4.75 mm (#4)      | Silt      | < 0.075 and > 0.005 mm           |
| Coarse Sand | < 4.75 mm and > 2.00 mm (#10)   | Clay      | < 0.005 mm                       |
| Medium Sand | < 2.00 mm and > 0.425 mm (#40)  | Colloids  | < 0.001 mm                       |

|                              |       |                  |       |               |
|------------------------------|-------|------------------|-------|---------------|
| Maximum Particle Size        | 0     | Gravel           | 0.0%  | Silt          |
| Silt & Clay (% Passing #200) | 32.8% | Sand             | 67.2% | Clay          |
| Apparent Relative Density    | 2.670 | Moisture Content |       | Colloids      |
| Liquid Limit                 | 32    | Plastic Limit    | NP    | Plastic Index |
|                              |       |                  |       | NP            |

Description of Sand & Gravel Particles    Rounded     Angular     Hard & Durable     Soft     Weathered & Friable

Mechanical Stirring Apparatus (A)    Length of Dispersion Period:    1 min.    Dispersing Agent:    Sodium Hexametaphosphate:    40 g./ Liter

References:    ASTM D 422: Particle Size Analysis of Soils    ASTM D 421: Dry Preparation of Soil Samples  
 ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils    ASTM D 854: Specific Gravity of Soils  
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 Direct entry in this cell is allowed    Direct entry in this cell is allowed

Technical Responsibility: \_\_\_\_\_  
Signature    Position



# Particle Size Analysis of Soils

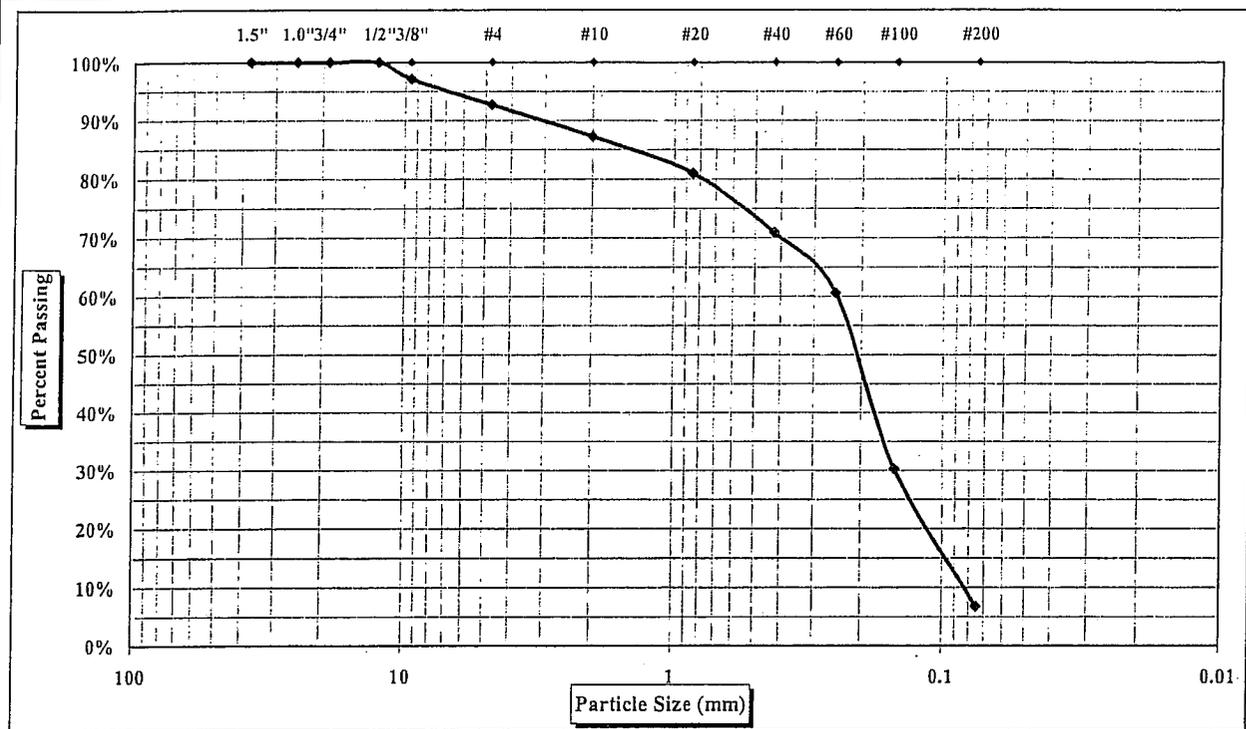


ASTM D 422

S&ME Project #: 1413-05-098  
 Project Name: CRAGGY GARDENS  
 Client Name: ARCADIS  
 Client Address:

Report Date: 05/19/2005  
 Test Date(s): 05/17/2005

|  |           |                             |
|--|-----------|-----------------------------|
| Boring #: B-4                                  | Sample #: | Sample Date: April 18, 2005 |
| Location: 9.0' to 10.5'                        | Offset:   | Elevation: Unknown          |
| Sample Description: DARK BROWN SILTY FINE SAND |           |                             |



|             |                                 |           |                                  |
|-------------|---------------------------------|-----------|----------------------------------|
| Cobbles     | < 300 mm (12") and > 75 mm (3") | Fine Sand | < 0.425 mm and > 0.075 mm (#200) |
| Gravel      | < 75 mm and > 4.75 mm (#4)      | Silt      | < 0.075 and > 0.005 mm           |
| Coarse Sand | < 4.75 mm and > 2.00 mm (#10)   | Clay      | < 0.005 mm                       |
| Medium Sand | < 2.00 mm and > 0.425 mm (#40)  | Colloids  | < 0.001 mm                       |

|                              |      |                 |     |               |     |
|------------------------------|------|-----------------|-----|---------------|-----|
| Maximum Particle Size        | 3/8  | Gravel          | 7%  | Medium Sand   | 16% |
| Silt & Clay (% Passing #200) | 6.7% | Coarse Sand     | 5%  | Fine Sand     | 64% |
| Apparent Relative Density    |      | Organic Content |     |               |     |
| Liquid Limit                 | TNP  | Plastic Limit   | TNP | Plastic Index | TNP |

**Description of Sand & Gravel**

Rounded       Angular       Hard & Durable       Soft       Weathered & Friable

References:      ASTM D 422: Particle Size Analysis of Soils      *Hydrometer portion of test method not utilized.*  
 ASTM D 421: Dry Preparation of Soil Samples      ASTM D 854: Specific Gravity of Soils  
 ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils  
 ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: \_\_\_\_\_

Signature

Position

# Particle Size Analysis of Soils

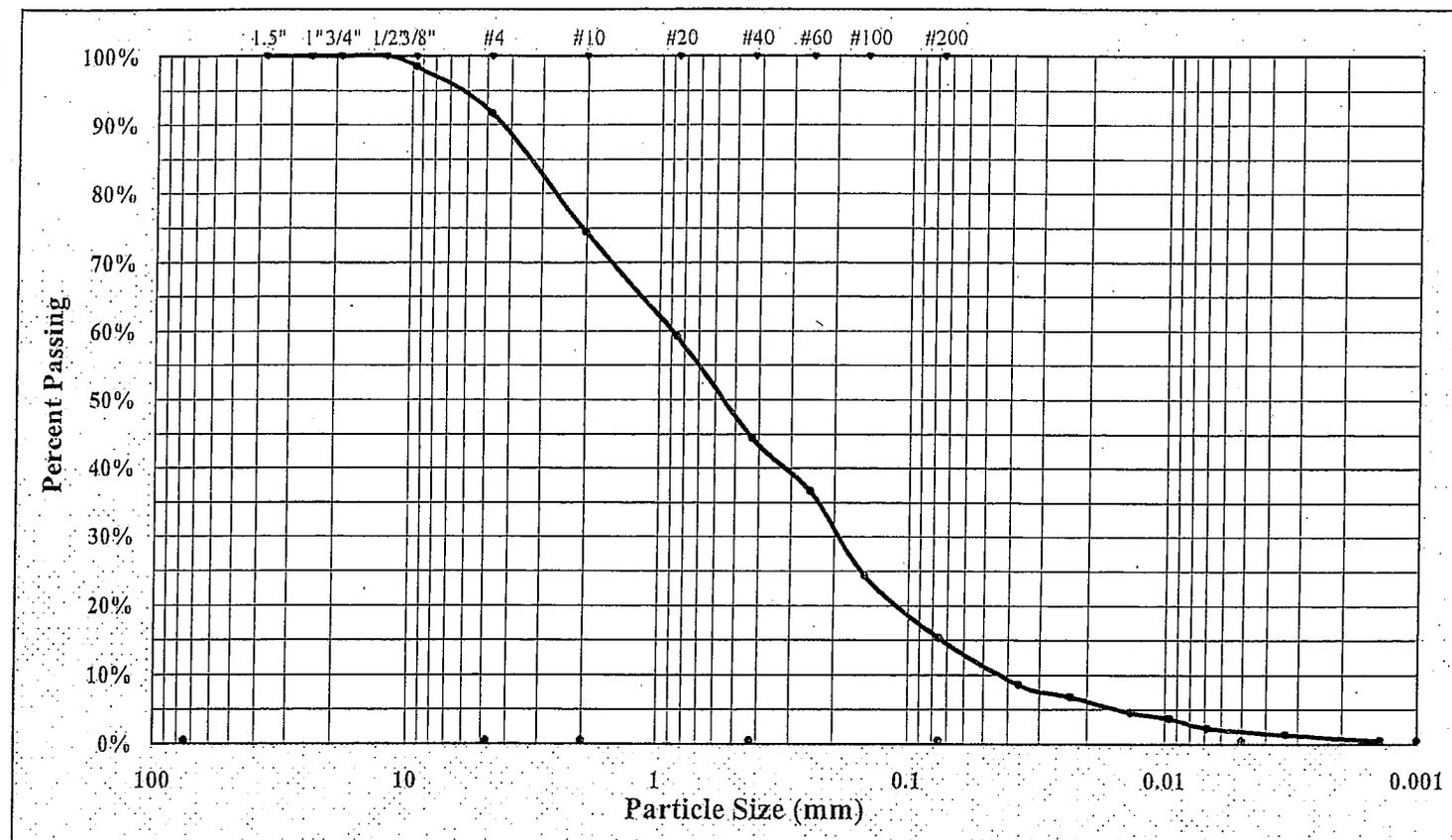


ASTM D 422

S&ME Project #: **1411-05-098**  
 Project Name: **CRAGGY GARDENS**  
 Client Name: **ARCADIS**  
 Client Address:

Report Date: **05-19-05**  
 Test Date(s): **05-17-05**

|                     |                         |           |              |
|---------------------|-------------------------|-----------|--------------|
| Boring #:           | B-5                     | Sample #: | Sample Date: |
| Location:           | 6.0' to 7.5'            | Offset:   | Elevation:   |
| Sample Description: | YELLOW BROWN SILTY SAND |           |              |



|             |                                 |           |                                  |
|-------------|---------------------------------|-----------|----------------------------------|
| Cobbles     | < 300 mm (12") and > 75 mm (3") | Fine Sand | < 0.425 mm and > 0.075 mm (#200) |
| Gravel      | < 75 mm and > 4.75 mm (#4)      | Silt      | < 0.075 and > 0.005 mm           |
| Coarse Sand | < 4.75 mm and > 2.00 mm (#10)   | Clay      | < 0.005 mm                       |
| Medium Sand | < 2.00 mm and > 0.425 mm (#40)  | Colloids  | < 0.001 mm                       |

|                              |       |                  |       |               |  |
|------------------------------|-------|------------------|-------|---------------|--|
| Maximum Particle Size        | 0     | Gravel           | 8.4%  | Silt          |  |
| Silt & Clay (% Passing #200) | 15.2% | Sand             | 76.4% | Clay          |  |
| Apparent Relative Density    | 2.670 | Moisture Content |       | Colloids      |  |
| Liquid Limit                 |       | Plastic Limit    |       | Plastic Index |  |

Description of Sand & Gravel Particles    Rounded     Angular     Hard & Durable     Soft     Weathered & Friable

Mechanical Stirring Apparatus (A)    Length of Dispersion Period:    1 min.    Dispersing Agent:    Sodium Hexametaphosphate:    40 g./ Liter

References:    ASTM D 422: Particle Size Analysis of Soils    ASTM D 421: Dry Preparation of Soil Samples  
 ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils    ASTM D 854: Specific Gravity of Soils  
 ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Direct entry in this cell is allowed

Direct entry in this cell is allowed

Technical Responsibility: \_\_\_\_\_

S&ME, INC.

44 Buck Shoals Rd., Unit C-3, Arden, NC 28704

ASTM D422 B5 6.0 to 7.5'









# MOISTURE - DENSITY RELATIONSHIP

ASTM D 698-A



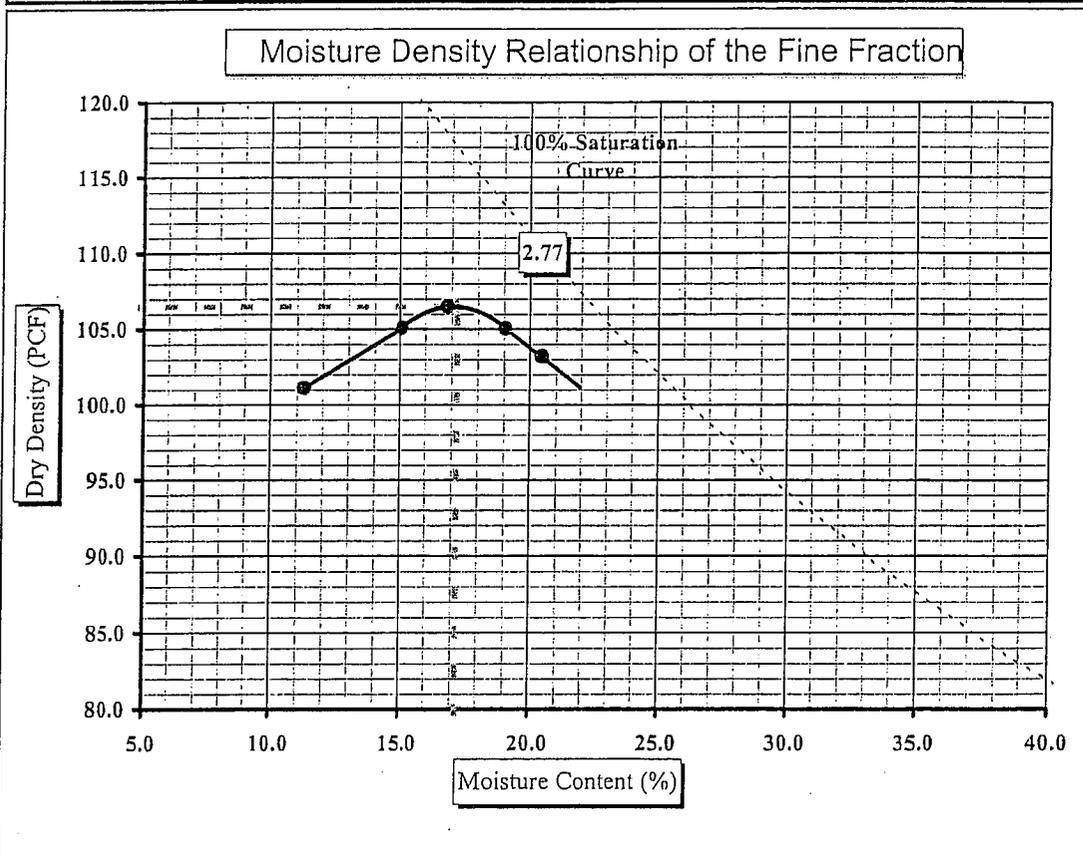
S&ME Project # : 1411-05-098  
 Project Name : Craggy Gardens  
 Client : \_\_\_\_\_

Report Date : May 19, 2005  
 Date Received : January 0, 1900

Log # : 733  
 Sample Location : B-4  
 Sample Description : Brown Silty Sand

Date Tested : May 16, 2005  
 Depth : 1 TO 10

|                          |           |   |    |                              |     |
|--------------------------|-----------|---|----|------------------------------|-----|
| Maximum Dry Density      | 106.5 pcf | Oversize Corrected Maximum Dry Density (pcf)    | NA | Soil Properties              |     |
| Optimum Moisture Content | 17.2 %    | Oversize Corrected Optimum Moisture Content (%) | NA | Moisture Content As Received | TNP |



|                  |     |
|------------------|-----|
| Liquid Limit     | TNP |
| Plasticity Index | TNP |
| Group Symbol     | TNP |

| Oversize Correction<br>ASTM D 4718 |    |
|------------------------------------|----|
| % Oversize On The 3/8"             | NA |
| Bulk Specific Gravity              | NA |

|                   |                                     |
|-------------------|-------------------------------------|
| Mechanical Hammer | <input type="checkbox"/>            |
| Manual Hammer     | <input checked="" type="checkbox"/> |
| Moist Preparation | <input type="checkbox"/>            |
| Dry Preparation   | <input checked="" type="checkbox"/> |

Tested By: TP  
 Reviewed By: 0

**References:**  
 ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort  
 ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

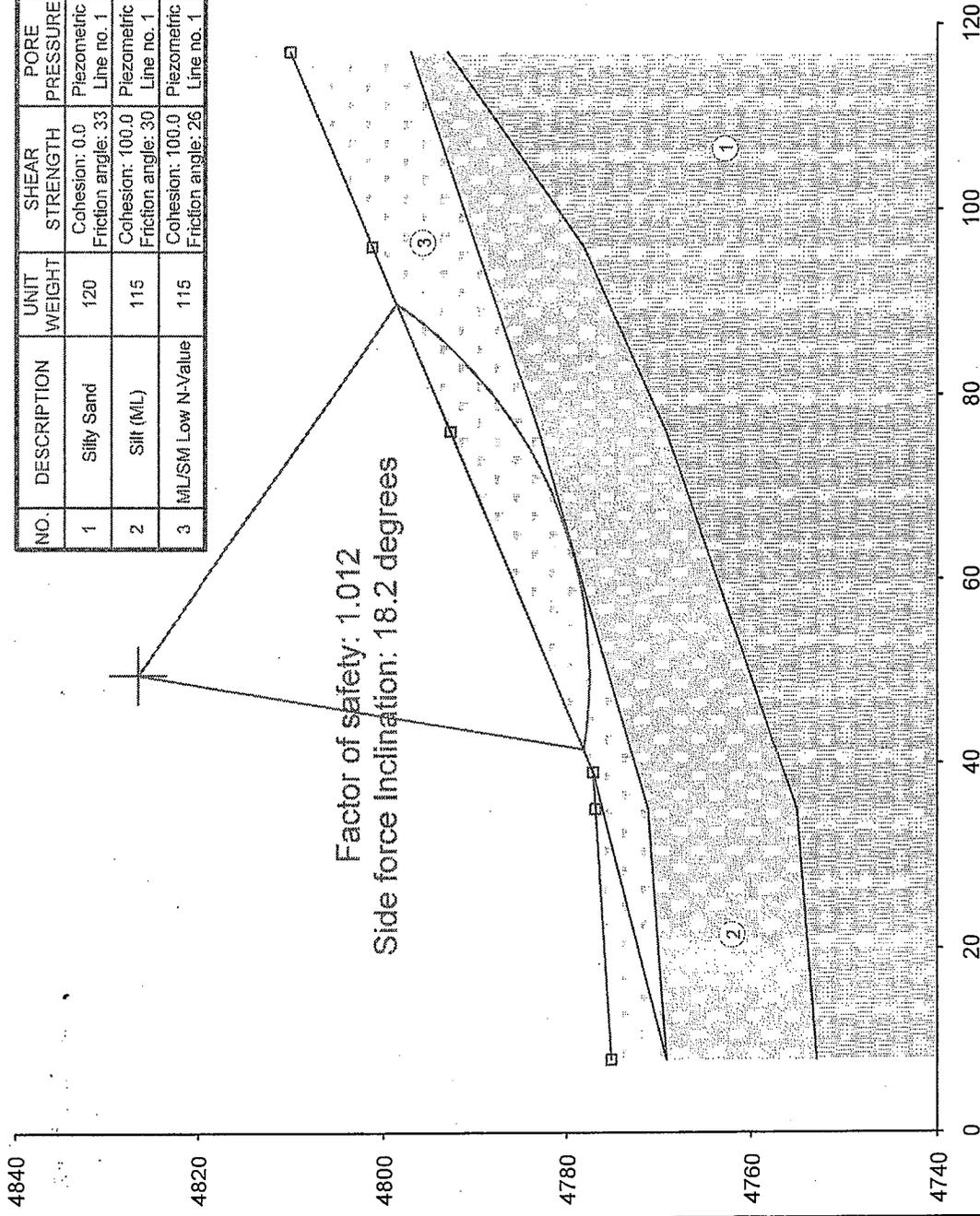
**Notes:**  
 NA= Non-Applicable  
 TBD = To Be Determined  
 TNP = Test Not Performed

## **Appendix D**

Stability and Seepage Analysis  
Calculations

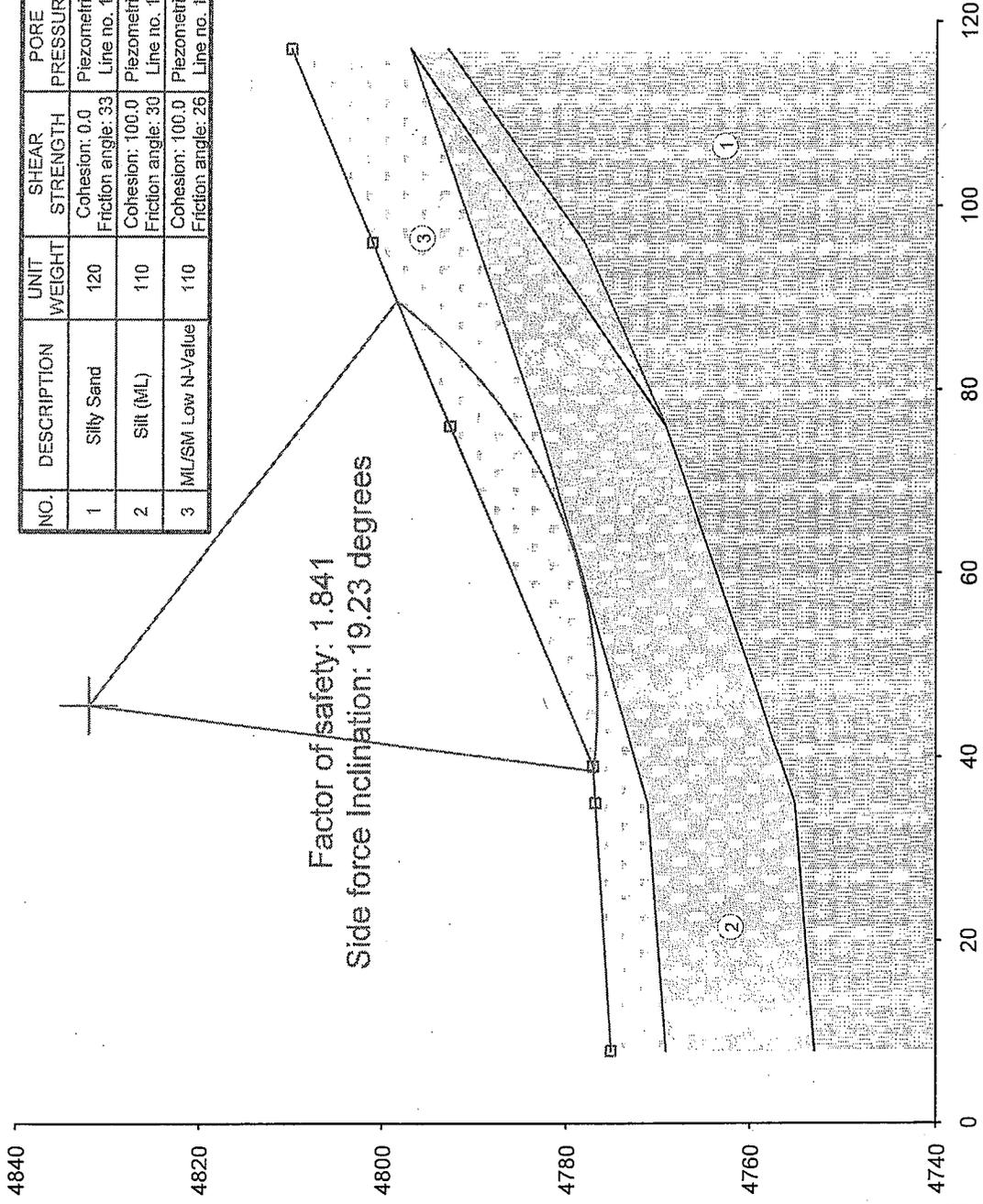
"Slide Investigation - Craggy Garden Picnic Access Area, Blue Ridge Parkway".

| NO. | DESCRIPTION       | UNIT WEIGHT | SHEAR STRENGTH                        | PORE PRESSURE             |
|-----|-------------------|-------------|---------------------------------------|---------------------------|
| 1   | Silty Sand        | 120         | Cohesion: 0.0<br>Friction angle: 33   | Piezometric<br>Line no. 1 |
| 2   | Silt (ML)         | 115         | Cohesion: 100.0<br>Friction angle: 30 | Piezometric<br>Line no. 1 |
| 3   | ML/SM Low N-value | 115         | Cohesion: 100.0<br>Friction angle: 26 | Piezometric<br>Line no. 1 |

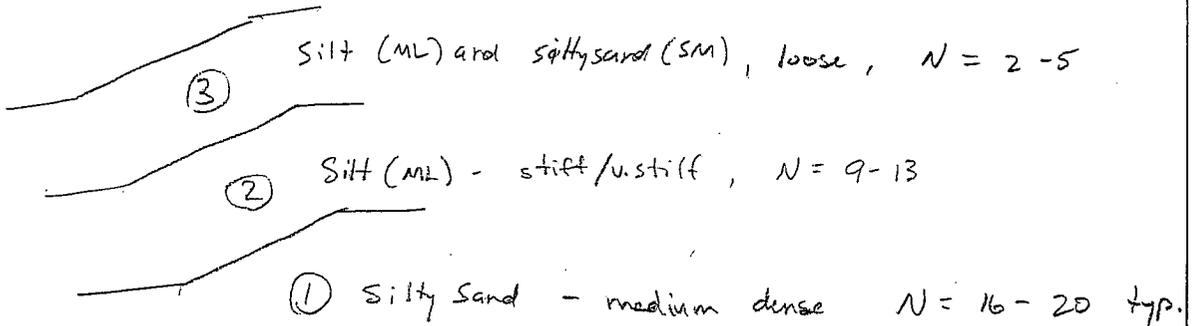


"Slide Investigation - Craggy Garden Picnic Access Area, Blue Ridge Parkway".

| NO. | DESCRIPTION       | UNIT WEIGHT | SHEAR STRENGTH                        | PORE PRESSURE          |
|-----|-------------------|-------------|---------------------------------------|------------------------|
| 1   | Silty Sand        | 120         | Cohesion: 0.0<br>Friction angle: 33   | Piezometric Line no. 1 |
| 2   | Silt (ML)         | 110         | Cohesion: 100.0<br>Friction angle: 30 | Piezometric Line no. 1 |
| 3   | ML/SM Low N-Value | 110         | Cohesion: 100.0<br>Friction angle: 26 | Piezometric Line no. 1 |



Cross Section



Case 1 - Initial slope Failure

Assume that the slope fails when the groundwater surface is high  $\rightarrow$  Factor of safety (F.S.) is approximately 1.0 when slope fails. Limit top of failure circle to approx. location of known scarps.

$\rightarrow$  Groundwater surface defined as piezometric line at the ground surface. Slope is fully saturated.

$\rightarrow$  Strengths are assigned so that  $F.S. \approx 1.0$  - Model is used as calibration for strength assignments

Case 2 - Underdrain installed

$\rightarrow$  groundwater is lowered to the bottom elevation of the drain

$\rightarrow$  strength remains unchanged from Case 1

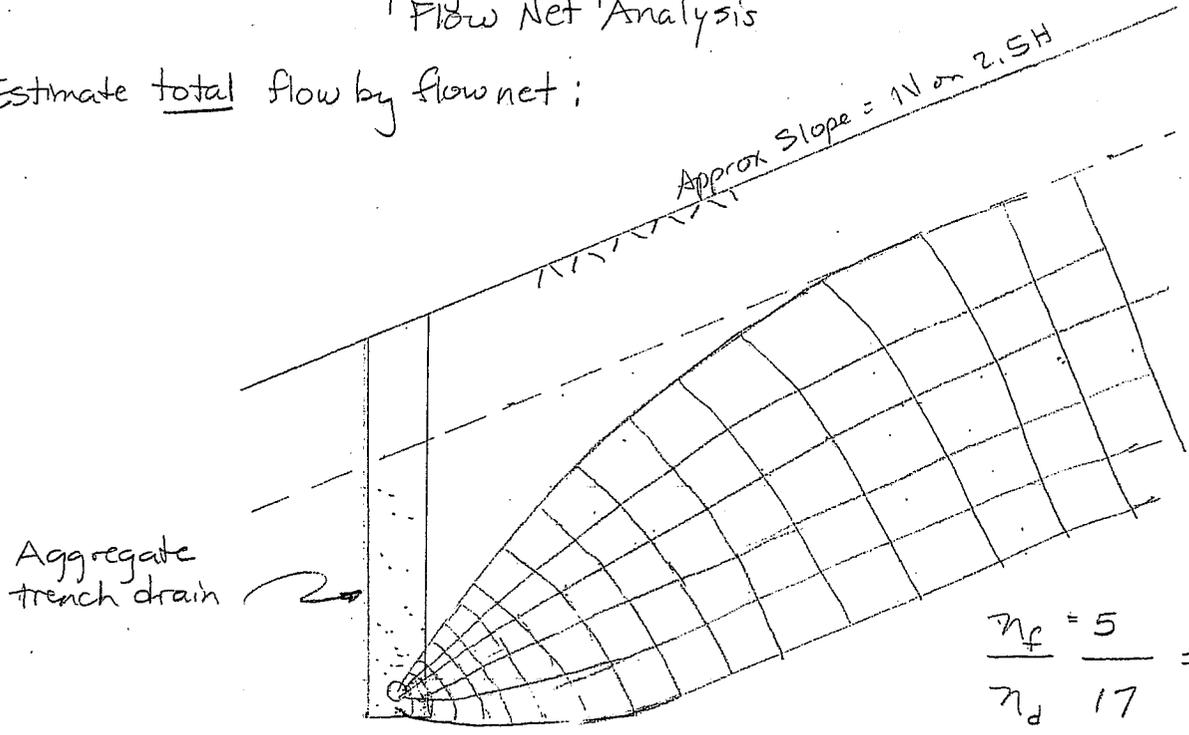
Results (UTEXAS4 Slope stability Software)

Case 1:  $FS = 1.012$

Case 2:  $FS = 1.841$

Seepage Rough Estimate  
 Flow Net Analysis

Estimate total flow by flow net:



$$q = kh \left( \frac{n_f}{n_d} \right) \quad \text{where } h = \text{head}, = 7'$$

$k = \text{permeability}$   
 $= 10^{-3} \text{ cm/sec (conservative value)}$   
 $= 2.835 \text{ ft/day}$

$$q = 2.835 \text{ ft/day} (7') (.3125)$$

$$= 6.2 \text{ ft}^2/\text{day} \text{ or } \text{ft}^3/\text{day}/\text{ft length}$$

$$= 0.03 \text{ gpm}/\text{ft trench}$$

Assume total trench length = ± 400 l.f.,  
 $Q = 0.03 (400) = \underline{12} \text{ gpm}$  (this represents a maximum expected flow)

**Federal Highway Administration  
Eastern Federal Lands Highway  
Division**

**Soils and Foundation Report –  
Addendum 2**

**Pavement Analysis  
Investigation**

Rehabilitation of Park Roads for  
Blue Ridge Parkway  
Yancey and Buncombe Counties, NC

PRA-BLR1 2P14  
Contract No. DTFH71-02-D-00004  
Task Order 0003

**Soils and Foundation Report –  
Addendum 2**

Pavement Analysis Investigation

Rehabilitation of Park Roads for  
Blue Ridge Parkway  
Yancy and Buncombe Counties,  
North Carolina

Prepared for:  
Federal Highway Administration  
Eastern Federal Lands Highway Division

Prepared by:  
ARCADIS  
1210 Premier Drive  
Suite 200  
Chattanooga  
Tennessee 37421  
Tel 423.756.7193  
Fax 423.756.7197

Our Ref.:  
CT052885.0014

Date:  
June 2008

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|                       |          |
|-----------------------|----------|
| <b>Background</b>     | <b>1</b> |
| FDR Pavement Sections | 2        |
| Mainline Parkway      | 3        |
| Parking Areas         | 3        |

## Background

The Blue Ridge Parkway is a 469-mile scenic corridor that connects Shenandoah Valley in Virginia to the Great Smoky Mountains National Park in North Carolina. Adjacent to the parkway, which ranges in elevation from 649 feet to 6,047 feet, are recreational areas that include picnic facilities, hiking trails, visitor centers, overlooks, and campgrounds. The Blue Ridge Parkway, conceived as a Depression-relief project in the 1930s, took more than 50 years to construct.

The pavement along Blue Ridge Parkway and adjacent access roads and pull-offs is in various stages of deterioration and in need of rehabilitation. Area features such as asphalt paths, granite curbs, rubble and masonry walls and steps are also in need of repair. Under initial Task Order No. 0003, ARCADIS was authorized to investigate Section 2P14 of the Blue Ridge Parkway and develop plans and specifications to rehabilitate this section of the parkway. Section 2P14 consists of the rehabilitation of the parkway pavement between Milepost 359.8 at the Balsam Gap Overlook and Milepost 375.3. Also included is the reconstruction, replacement, or rehabilitation of ditches, pipes, walls, sidewalks, and curbs. A soils and foundation report has been previously submitted documenting results of subsurface and pavement investigations along Section 2P14.

Modification Nos. 0006 and 0007 to the Task Order were later issued to cover the investigation and evaluation of alternative pavement rehabilitation techniques. Full Depth Reclamation (FDR) was determined to be the best alternative to rehabilitate the above referenced roadway. This rehabilitation process would reduce and/or eliminate the amount of excess asphalt material that would be required to be “hailed off site” and disposed. The FDR process would also minimize the net change in pavement surface elevations that are very critical along this roadway.

## Full Depth Reclamation

Full Depth Reclamation (FDR) is a rehabilitation technique that uniformly pulverizes and blends the existing asphalt pavement layer, base, subbase and/or subgrade soils to produce a homogeneous base material. The FDR process generally treats and improves 6 in. to 12 in. of the existing pavement structure. The FDR process is performed without heat (similar to cold mix recycling).

The FDR process generally consists of pulverizing the existing pavement materials, adding additional aggregates (if necessary), adding stabilizing additive, mixing,

shaping, compaction, final shaping and placing an asphalt wearing surface. The stabilizing agents generally consist of either Portland cement, lime, fly ash or asphalt emulsion which are used to enhance the mechanical properties and structural strength of the reclaimed base materials. The FDR construction process generally utilizes common roadway construction equipment (i.e., reclaimer or pulverizer, stabilizing additive unit, motor grader and rollers).

Full depth reclamation is an innovative and cost-effective method of rehabilitating and/or reconstructing highly distressed or failed asphalt pavements. This rehabilitation process is best suited for pavements that have reached conditions that are no longer economical to maintain with common maintenance procedures.

Some of the advantages of the FDR process are listed below:

- Reuses existing pavement materials
- Eliminates asphalt layer distresses (i.e., cracking, rutting, potholes)
- Corrects base failures
- Reshapes surface profile
- Improves surface drainage
- Increases structural capacity
- Reduces traffic disruptions during construction

### **FDR Pavement Sections**

The FDR rehabilitation process is recommended as an alternative to reconstructing the highly distressed or failed areas along the referenced section of the Blue Ridge Parkway near Asheville, North Carolina.

Based on the pavement design analysis presented in the Soils and Foundation Report prepared by ARCADIS dated September 2006, the following alternative structural pavement sections developed by Burns Cooley Dennis, Inc., for the Mainline Parkway and the parking areas are provided:

**Mainline Parkway**

The station ranges for the Mainline Parkway are as follows:

366/24+10 to 368/20+00

370/2+00 to 374/20+37

374/30+01 to 375 04+56

These areas will receive the following applications:

- 3 inches of asphalt surface course (two 1.5-inch layers)
- 10 inches of FDR Portland cement-treated base<sup>1</sup> (minimum 300 psi, 7-day compressive strength, minimum of 4% Portland cement by total dry mix)
- Design Structural Number (SN): 2.8

**Parking Areas**

The parking areas include the following:

Craggy Dome

Craggy Garden Visitor Center

Craggy Garden Picnic Area

These areas will receive the following applications:

- 3 inches of asphalt surface course (two 1.5-inch layers)
- 6 inches of FDR Portland cement-treated base (minimum 300 psi, 7-day unconfined compressive strength, minimum of 4% Portland cement by total dry mix)
- Design Structural Number (SN): 2.2

---

<sup>1</sup> Determine 7-day unconfined compressive strength per ASTM D 1633, Method A.

The above pavement structures meet or exceed the structural capacity of the reconstructed asphalt pavement sections presented in the original Soils and Foundation Report for this project.