PRESTRESSED CORED SLAB BRIDGES

Material shall meet the requriements of the North Carolina Department of Transportation Standard Specifications.

A. GROUT FOR TRANSVERSE STRANDS

All recesses at the ends of transverse strands shall be filled completely with a non-shrink, non-metallic grout. All recesses shall be filled in a neat and workmanlike manner and the grout shall match the neat lines of the cored slabs.

B. EPOXY PROTECTIVE COATING (10-12-01)

1. Description

This work consists of preparing the concrete surface and furnishing and applying an epoxy protective coating to the surfaces described in this Special Provision. When epoxy protective coating is required, cure the top surfaces of the bent or end bent caps in accordance with the Standard Specifications, but do not use the Membrane Curing Compound method.

2. Materials

Use an epoxy coating that meets the most recently published NCDOT Specification on the date of advertisement. Use the epoxy coating that meets NCDOT-Type 4A Flexible, epoxy coating, moisture insensitive.

Provide a certification for the proposed epoxy showing that it meets NCDOT- Type 4A.

The following companies have epoxies that meet Type 4A Specifications:

- E-Bond Epoxy, Inc.
  Fort Lauderdale, Florida 33307
- Permagile Industries
  Plainview, NY 11803
- Poly-Carb
  Cleveland, OH 44139
- Tamms, Inc.
  Mentor, OH 44060
- Adhesive Engineering
  Cleveland, OH 44122-5554
- Kaufman Products
  Baltimore, MD 21226-1131
- Prime Resins
  Lithonia, GA 30058
- Sika Corporation
  Lyndhurst, N. J. 07071

A copy of the specifications for Epoxy Resin Systems is available from the Materials and Tests Unit.

3. Surfaces

With the exception of cored slab bridges, apply the epoxy protective coating to the top surface area, including chamfer area, of bent caps under expansion joints and of end bent caps, excluding areas under elastomeric bearings. For cored slab bridges, do not apply the epoxy protective coating to the bent or end bent caps. Also, apply epoxy protective coating to the ends of prestressed concrete members as noted on the plans.

Use extreme care to keep the area under the elastomeric bearings free of the epoxy protective coating. Do not apply the epoxy protective coating in the notch at the ends of the prestressed concrete girders. Thoroughly clean all dust, dirt, grease, oil, laitance, and other objectionable material from the concrete surfaces to be coated. Air-blast all surfaces immediately prior to applying the protective coating. Use only use cleaning agents pre-approved by the Engineer.

4. Application

Apply epoxy protective coating only when the air temperature is at least 40°F (4°C) and rising, but less than 95°F (35°C) and the surface temperature of the area to be coated is at least 40°F (4°C). Remove any excess or free standing water from the surfaces before applying the

coating. Apply one coat of epoxy protective coating at a rate such that it covers between 100 and 200 ft^2/gal (2.5 and 5 m^2/liter).

Note: Under certain combinations of circumstances, the cured epoxy protective coating may develop "oily" condition on the surface due to amine blush. This condition is not detrimental to the applied system.

Apply the coating so that the entire designated surface of the concrete is covered and all pores filled. To provide a uniform appearance, use the exact same material on all visible surfaces.

5. Basis of Payment

No separate measurement or payment will be made for preparing, furnishing and applying the epoxy protective coating to the concrete surfaces.

Payment at the contract unit prices for the various pay items will be full compensation for the above work including all materials, equipment, tools, labor, and incidentals necessary to complete the work.

C. TOLERANCES FOR PLACING RAIL ANCHORAGE BARS

The exterior cored slab sections shall be manufactured with the parapet anchorage bars (#5s3 or #5 s6) placed to meet the following tolerances:

Deviation from plan position of an individual bar	± 1/4"
Horizontal alignment (deviation from a straight line which coincides with the plan center line of bars)	± 1/4 "
Projection of bars above top of cored slab (deviation from plan dimension)	± 1/4 "

D. MATCHMARKING

In order to be assured of a good, neat field fit, spans shall be assembled by manufacturer in his yard and pieces match-marked. Pieces must fit together neatly and in a workmanlike manner.

E. ERECTION OF PRESTRESSED CONCRETE CORED SLABS

The transverse strands shall be greased and then placed in a non-corrosive 1/2" diameter, 1/16" wall thickness black polyethylene pipe meeting the requirements of ASTM D2239. The grease and pipe shall not be applied in the areas of the recesses at the ends of the tensioning strands where grout is to be applied.

In erecting the prestressed cored slabs, the 1/2" transverse post tensioning strands shall be placed and tensioned to 30,980 pounds in each span. After the 1/2" transverse strand has been tensioned in a span and before any equipment, material or barrier rail is placed on the span, the shear keys and dowel holes shall be filled with the mix or grout as specified else where in these special provisions, except as noted in the next four paragraphs:

(1) The Contractor will be allowed with the approval of the Engineer, to place material and equipment on the cored slab spans on mats after the transverse strands have been tensioned to 30,980 pounds.

(2) The Contractor must submit a detailed drawing for approval to the Engineer for the mats he intends to place on the cored slabs for his material and equipment. This drawing should give a complete description of the material and equipment that the Contractor intends to place on the mats.

(3) In the event the Contractor uses mats and places material and equipment on the cored slabs, the transverse strands shall be retensioned to 30,980 pounds after the material and equipment is removed from the spans. The shear keys shall be grouted after the transverse strands have been retensioned.

F. GROUTING OF PRESTRESSED CORED SLABS

After all erection work has been completed the shear keys shall be grouted by the Contractor with a non-shrink, non-metallic grout.

The non-shrink, non-metallic grout shall be on the Department's approval list and shall meet the approval of the Engineer. The minimum strength for this grout shall be 3000 pounds per square inch after curing for 3 days minimum.

G. SURFACE FINISH

Top surface of slab sections shall be given a broom finish. No surface finish will be required for sides and bottom of slab sections.

H. CHAMFERS

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Bottom corners on ends and sides of all slab sections and top outside corner of exterior slab sections shall be chamfered 3/4". Vertical corners at ends of slab sections shall not be chamfered except acute corners of skew slabs shall be chamfered 3/4". Pre-stressed caps shall be chamfered 3/4" on all corners.

I. SIDEWALK

Sidewalk shall be cast-in-place after parapet has been cast and has obtained a minimum concrete compressive strength of 3,000 p.s.i. Due to camber of the prestressed concrete cored slabs, the thickness of the sidewalk will actually be variable in order to obtain a uniform grade line along the top surface of sidewalk throughout the entire bridge. The 2'-6" vertical distance (as shown on construction plans for distance between the top surface of parapet to top of back surface line of sidewalk) shall control in construction of sidewalk. Sidewalk surface shall have a broomed texture transverse to the line of traffic.

Concrete shall be class "AA".

Payment for sidewalk will be included in the contract lump sum price for "Placement of Superstructure".

III. CAST-IN-PLACE CONCRETE PARAPET AND END POSTS

The cast-in-place concrete parapet and end posts shall be in accordance with the applicable parts of the Standard Specifications with the following exceptions and additions.

Concrete shall be CLASS "AA"

A. CONSTRUCTION REQUIREMENTS

Formwork utilized for casting of parapet and end posts shall be of sufficient condition to assure smooth surfaces and true alignment throughout the entire bridge. Due to camber of the prestressed concrete cored slabs, the height of parapet will actually be variable in order to obtain a uniform grade line along the top surface of parapet throughout the entire bridge. After formwork removal, apply a Class I surface finish to top and sides of concrete parapet and end posts.

B. MEASUREMENT AND BASIS OF PAYMENT

The complete and accepted cast-in-place concrete parapet and end posts will be measured on a per linear foot basis from end to end of posts, including any joint openings along stated distance. Payment will be on a per linear foot basis as per measured length of parapet and end posts.

IV. ELASTOMERIC BEARINGS 70 (10-03-02)

Use elastomeric bearings in accordance with Article 1079-2 of the Standard Specifications except as follows:

TABLE 1079-2
NATURAL RUBBER ELASTOMER REQUIREMENTS

Grade (durometer)	50	60
PHYSICAL PROPERTIES Hardness ASTM D2240	50 +5 -5	60 +5 -5

A. BASIS OF PAYMENT

The above work covered by this provision will be included in the contract lump sum price for "Placement of Superstructure". The above prices and payments will be full compensation for all work covered by this provision including but not limited to furnishing all materials, labor, tools, equipment and all incidentals necessary to complete the work.

V. PAINTING STEEL PILES

A. DESCRIPTION

This work shall consist of surface preparation, shop painting with a primer, and applying two shop coats of coal tar epoxy paint. The surface preparation, materials and painting of the steel piles, steel angles and plates, if used, shall be in accordance with the applicable parts of the Standard Specifications and with this Special Provision.

B. SURFACE PREPARATION

Surfaces to be painted shall be prepared by near white blast cleaning in accordance with Subarticle 442-8A of the Standard Specifications. All burrs and shear lips shall be removed from the ends of piles prior to painting.

C. MATERIALS

The shop paint primer shall be a prequalified self-curing inorganic zinc paint that is on North Carolina's approved list. The minimum dry thickness of the prime coat shall be 3 mils.

The coal tar epoxy paint shall meet the requirements of the Structural Steel Paint Council Specifications Paint #16.

The first coat shall be red coal tar epoxy. The second coat shall be black coal tar epoxy. The wet paint thickness of each coat shall be 10 - 12 mils. The total dry paint thickness of all coats shall be not less than 19 mils and all paint shall be applied by spraying.

D. PAINTING

The entire length of the pile shall have the primer coat and the two coats of epoxy paint. Damaged or rejected areas of paint shall be thoroughly cleaned of all foreign or loose material and promptly painted at the approval of the Engineer. In areas where the primer coat of paint is damaged, the metal surface shall be prepared by near white blasting, or other approved methods in accordance with the Standard Specifications before re-painting the damaged areas. In areas where the epoxy coat of paint is damaged, these areas shall be cleaned of all foreign or loose material and the surface roughened by blasting or other approved means to provide a good bonding surface for the new coat.

No epoxy paint shall be applied until the zinc primer coat has thoroughly cured throughout the full thickness of the paint film. (NCDOT Chemical Procedure PF-2).

The first coat of red coal tar epoxy must be tacky (not dry to touch) when the black coal tar epoxy is applied. Should the first coat dry to a tack free surface, it shall be sand blasted to roughen the surface before the second coat is applied.

E. BASIS OF PAYMENT

The work covered by this provision will be included in the contract bid price per linear foot for "HP 12x53 Steel Piles". This compensation includes the painting of pile bracing when required. The above prices and payments will be full compensation for all work covered by this provision including but not limited to furnishing all materials, labor, tools, equipment and all incidentals necessary to complete the work.

VI. GALVANIZING STEEL PILES

(In lieu of painting, steel piles may be galvanized.)

A. DESCRIPTION

This work consists of surface preparation and galvanizing of steel piles in accordance with Section 1076 of the Standard Specifications. For steel piles, angles and plates, prepare the surface and provide materials in accordance with the applicable parts of the Standard Specifications.

B. BASIS OF PAYMENT

The work covered by this provision will be included in the contract bid price per linear foot for "HP 12x53 Steel Piles" or "HP 14x73 Steel Piles". This compensation includes the galvanizing of pile bracing when required. The above prices and payments will be full compensation for all work covered by this provision including but not limited to furnishing all materials, labor, tools, equipment and all incidentals necessary to complete the work.

VII. THERMAL SPRAYED COATING (METALLIZATION)

(In lieu of painting, steel piles may be metallized)

If this method of treating steel piles is chosen, a detailed procedure must be submitted to the Engineer for approval. The submittal must be in accordance with guidelines stipulated in the Standard Specifications.

A. BASIS OF PAYMENT

The work covered by this provision will be included in the contract bid price per linear foot for "HP 12x53 Steel Piles" Steel Piles". This compensation includes the metallization of pile bracing when required. The above prices and payments will be full compensation for all work covered by this provision including but not limited to furnishing a detailed submittal, materials, labor, tools, equipment and all incidentals necessary to complete the work.

X. DRILLED PIERS 73 (10-03-02)

A. GENERAL

1. Description

The work in this special provision governs the construction of Drilled Piers, also known as "Drilled Shafts" and "Caissons". Drilled piers are a reinforced concrete section, cast-in-place against in situ, undisturbed material. Drilled piers are a straight shaft type and vertical. Construct drilled piers in accordance with the details and dimensions shown on the plans and the requirements of this special provision.

2. Work Experience

The Contractor/Subcontractor and the Contractor's/Subcontractor's superintendent performing the work described in this special provision is required to have installed drilled piers of both diameter and length similar to those shown on the plans and have a minimum of five years experience with underwater concrete placement prior to the bid date for this project.

This work is performed under the supervision of the Contractor's/Subcontractor's superintendent, who is knowledgeable and experienced in the construction of drilled piers using casing and/or slurry. Use equipment that has the capacity to undertake the work and is sufficient to complete the work within the specified contract time. Furnish evidence of experience and expertise that the Contractor/Subcontractor meets the following requirements.

To verify the ability to construct drilled piers for this project, submit a list containing a description of at least two projects completed in the last five years on which those responsible for the drilled pier construction have installed drilled piers of similar size as shown in the plans and with similar excavation techniques anticipated for this project. Include on the list of projects the names and phone numbers of the project Owner's representatives who can verify the Contractor/Subcontractor's participation on the project.

3. Construction Sequence Plan

Develop and submit a drilled pier construction sequence plan for all the drilled piers for review and acceptance 30 days prior to beginning construction of the drilled piers. Provide detailed project specific information in the drilled pier construction sequence plan including:

(1) Work experience in accordance with Section 1.0, Item B.

(2) List and size of proposed equipment including: cranes, kelly bars, drill rigs, vibratory hammers, augers, core barrels, cleanout

buckets, airlifts and/or submersible pumps, tremies and/or concrete pumps, casing (diameters, thicknesses and lengths), desanding equipment (for slurry construction), etc.

(3) Details of the sequence of drilled pier construction, including the order of drilled pier construction.

(4) Details of pier excavation methods.

(5) Details of proposed methods to clean the pier excavation bottom.

(6) Details of reinforcement placement including support and method to center in the excavation.

(7) Details of concrete placement including proposed operational procedures for the concrete tremie or pump; including initial placement, how the tremie or pump is raised during concrete placement and what type of discharge control is proposed to prevent concrete contamination when the tremie or pump is initially placed in the excavation.

(8) Details of casing installation and temporary casing removal including order of telescoped casing removal.

(9) Required submittals for concrete mix designs.

(10) Details of the slurry to be used (if applicable), including: product information, manufacturers mixing instructions, slurry equipment information and how the Contractor proposes to use the slurry. Also, submit a written approval from the bentonite supplier that the water to be used is acceptable.

(11) Details on the handling of drilling spoils and slurry overflow including environmental control procedures used to prevent the loss of concrete, slurry and spoils.

(12) Details of how the level of slurry is maintained above the highest piezometric pressure head (if applicable).

(13) Other information shown in the plans or requested by the Engineer.

The Engineer reviews the drilled pier construction sequence plan for conformance with the plans, specifications and special provisions. Within 15 days of receiving the plan, the Engineer notifies the Contractor of any additional information required and/or changes that are necessary to satisfy the plans, specifications and special provisions. Submit changes for re-evaluation of any unsatisfactory part of the construction sequence plan that is rejected. The Engineer responds to the Contractor within 7 days after receiving the proposed changes. If any changes in procedure are made during the construction of the drilled piers, inform the Engineer in writing and await

approval of the proposed modifications prior to the construction of the remaining drilled piers.

4. Preconstruction Conference

After the drilled pier construction sequence plan is accepted but prior to beginning any drilled pier work, schedule a drilled pier preconstruction conference with the drilling superintendent, the Concrete Supplier, the Resident Engineer including the inspector, the Area Bridge Construction Engineer and the Soils and Foundation Design Engineer to discuss construction and inspection of the drilled piers.

5. Definition of Rock

For the purposes of this special provision, "Rock" is defined as a continuous intact natural material in which the penetration rate with a rock auger is less than 2 inches (50 mm) per 5 minutes of drilling at full crowd force. This definition excludes discontinuous loose natural materials such as boulders and man-made materials such as concrete, steel, timber, etc.

6. Rock Socket

When required by a plan note, provide a minimum penetration into rock as directed by the Engineer.

B. EXCAVATION

Perform the excavations required for the drilled piers to the dimensions and elevations shown on the plans or otherwise required by the Engineer, including any miscellaneous grading or excavation to install the drilled pier.

Excavate the drilled pier with a drill rig of adequate capacity. Use a rig that is capable of drilling through soil and non-soil including rock, boulders, timbers, man-made objects and any other materials encountered. Blasting is not permitted to advance the excavation. Blasting for core removal is only permitted when approved by the Engineer. Use a drill rig capable of drilling a minimum of 25% deeper than the deepest drilled pier shown in the plans. Use drilling tools equipped with vents designed to stabilize the hydrostatic pressure above and below the tool during extraction from the excavation. For drilled piers constructed with slurry, monitor the rate at which the drilling tools are inserted and extracted so as to minimize sidewall suction action in the excavation. Drilling below the tip elevations shown on the plans is required if necessary to achieve adequate bearing.

Maintain a drilling log during the drilled pier excavation and provide it to the Engineer. Include in the log information such as top and bottom elevation of each stratum encountered, drilling tools used and drilling time in each stratum and material descriptions of each soil and rock layer.

Drilling spoils consist of all material excavated including water removed from the excavation either by pumping or with augers. Dispose of spoils, with the exception of those containing slurry, as directed by the Engineer and in accordance with Section 802 of the Standard Specifications.

Construct drilled piers at the locations shown on the plans and within the tolerances specified herein. If tolerances are exceeded, provide additional construction as approved by the Engineer to bring the piers within the tolerances specified. Construct the drilled piers such that the axis at the top of the piers is no more than 3 inches (75 mm) in any direction from the position indicated in the plans. Build drilled piers within 1% of the plumb deviation for the total length of the piers. Measure the plumbness of the drilled piers by an accurate procedure, such as an inclinometer on the kelly bar or other approved techniques. Unless a plan note requires the construction joint to be moved below the ground line, construct the finished top of pier elevation between 1 inch (25 mm) above and 3 inches (75 mm) below the top of pier elevation shown on the plans.

When drilling from a barge, use a fixed template that maintains shaft position and alignment during all excavation and concrete placement operations. Floating templates (attached to a barge) are not allowed unless approved by the Engineer.

Stabilize all drilled pier excavations with steel casing and/or bentonite slurry except, as approved by the Engineer, the portions of the excavations in rock as defined by Section 1.0, Item E. Stabilize excavations at all times from the beginning of drilling through concrete placement. Provide casing or slurry in rock if unstable material is anticipated or encountered during drilling. When slurry is used, a partially excavated pier is subject to the time requirements in Section 2.0, Item C, Number 1. When slurry is not used, do not leave a partially excavated pier open overnight unless the excavation is cased to rock.

If the tip of the drilled pier excavation is in rock as defined by Section 1.0, Item E, dewater the excavation to the satisfaction of the Engineer. The minimum diameter of the drilled pier excavation in rock is 2 inches (50 mm) less than the design drilled pier diameter shown on the plans.

If electing to remove a casing and substitute a larger diameter or longer casing through unstable or caving material, either backfill the excavation or stabilize it with a bentonite slurry prior to removing the casing to be replaced. Use other methods, as approved by the Engineer, to control the stability of the excavation during casing replacement.

1. Permanent Steel Casing

   Use permanent steel casings as directed by the Engineer and/or a note on the plans. Use permanent casings that are clean smooth non-corrugated watertight steel of ample strength to withstand handling and driving stresses and the pressures imposed by concrete, earth or backfill. Provide permanent casing steel conforming to ASTM A252, Grade 2. The

minimum wall thickness of the permanent steel casing depends on the casing diameter and the following requirements.

CASING WALL THICKNESS

Casing Diameter	Minimum Wall Thickness
Less than 42 inches (1066 mm)	3/8 inch (9 mm)
42 inches (1066 mm) to 78 inches (1982 mm)	1/2 inch (12 mm)
Greater than 78 inches (1982 mm)	5/8 inch (16 mm)

Provide permanent casings with an outside diameter not less than specified size of the drilled pier. If approved by the Engineer, a permanent casing larger in diameter than the drilled pier design diameter is permitted. No payment will be made for additional construction materials or other costs associated with a request for a larger casing diameter.

Extend the permanent casings from the top of pier elevation or top of permanent casing elevation if shown on the plans to a depth not greater than the permanent casing tip elevation shown on the plans. If electing to extend the permanent steel casing below the permanent casing tip elevation, get prior approval from the Engineer and provide additional drilled pier length if required. No payment will be made for the additional drilled pier length and casing unless the previously approved extension is necessary for dewatering purposes. Place all permanent casings in contact with undisturbed material. Install permanent casing in one continuous unit. If splices are necessary for the casing, use an approved method of splicing. Splices are considered incidental and no additional compensation will be allowed if approved.

Remove any portion of the permanent steel casing that extends above the top of the drilled pier after the drilled pier concrete has achieved a compressive strength of 4500 psi (31.0 MPa). The cost of casing removal will be considered incidental to the cost of the permanent steel casing.

2. Temporary Steel Casing

Provide temporary casing to stabilize drilled pier excavations, protect personnel and prevent caving or sloughing, that is clean smooth non-corrugated watertight steel of ample strength to withstand handling and driving stresses and the pressures imposed by concrete, earth or backfill.

Use temporary steel casings with an outside diameter not less than the specified size of the piers, except for casing to protect inspection personnel. Temporary steel casings are subjected to the same minimum wall thickness requirement as permanent steel casings as shown in Section 2.0, Item A.

Temporary steel casings that become bound or fouled during pier construction and cannot be practically removed constitute a defect in the drilled pier. Improve such defective shafts to the satisfaction of the Engineer by removing the shaft concrete and extending the shaft deeper, providing a replacement shaft, or other acceptable means. Complete all corrective measures including redesign as a result of defective shafts to the satisfaction of the Engineer without additional compensation or an extension of the completion date of the project.

3. Slurry (NOT REQUIRED IN THIS CONTRACT)

When slurry use is not noted on the plans, slurry construction is an option.

Use slurry composed of bentonite having a mineral grain size that remains in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system to minimize or eliminate bottom sedimentation. Provide material used to make the suspension with a percentage and specific gravity sufficient to maintain the stability of the excavation and allow for proper concrete placement.

When slurry is used and permanent steel casing is not required, use temporary casing a minimum of 10 feet (3 m) long at the top of the excavation. Maintain the top of the temporary casing a minimum of 1 foot (300 mm) above the ground surface surrounding the casing. This temporary casing is also subject to the minimum wall thickness as required for permanent steel casing as shown in Section 2.0, Item A.

Maintain the slurry in the pier excavation at a level not less than 5 feet (1.5 m) or the drilled pier diameter (whichever is greater) above the highest piezometric pressure head along the depth of the pier. It is anticipated that the highest piezometric pressure head is the static water elevation or the groundwater elevation. However, the Contractor is responsible for determining the highest piezometric pressure head. The use of steel casing to maintain the required slurry level is permitted; however, in accordance with the basis of payment for permanent steel casing, no payment will be made for casing that is cut off. If the slurry level in the excavation suddenly changes or cannot be practically maintained, or the slurry construction method does not produce the desired result, stop the pier construction until an alternate construction procedure is approved by the Engineer.

Thoroughly premix the bentonite slurry with clean, fresh water. Have a sample of the water used on the project tested by an independent laboratory, at no additional cost to the Department, to verify that it is suitable for use with the bentonite slurry. Submit written approval from the bentonite supplier that the water to be used is acceptable. Allow 24 hours for hydration of the slurry, prior to introduction into the pier excavation.

Slurry tanks of adequate capacity are required for slurry circulation, storage and treatment. Excavated slurry pits are not allowed in lieu of slurry tanks without prior approval from the Engineer. Take all steps necessary to prevent the slurry from "setting up" in the drilled pier. Such methods include, but are not limited to: agitation, circulation and/or adjusting the properties of the slurry. Provide desanding equipment as necessary to achieve a slurry sand content of 2% or less by volume prior to placement of the reinforcement steel.

(a) Time

Adjust the excavation operations so that the maximum time the slurry is in contact with the sidewalls of the uncased portions of the drilled pier excavation (from time of drilling to completing concrete placement) does not exceed 24 hours. Also, agitate the slurry in the drilled pier excavations a minimum of every 4 hours. Do not allow an excavated slurry shaft below the steel casing to go unagitated overnight. Do not work on more than two drilled piers per drill rig below the steel casing at any time.

If the 24 hour time limit is exceeded, overream the drilled pier excavation beneath the steel casing a minimum of 1 inch (25 mm) and a maximum of 3 inches (75 mm), or as required by the Engineer, prior to performing other operations in the excavation. Overream with a grooving tool, overreaming bucket or other approved equipment at a minimum spacing of 12 inches (300 mm). The Contractor bears all costs associated with both overreaming and additional shaft concrete placement at no additional cost to the Department.

If concrete placement is not completed within three days of beginning drilling, enlarge the design drilled pier diameter by a minimum of inches (150 mm), or as required by the Engineer, the entire length of the pier at no additional cost to the Department. Enlarging the drilled pier includes replacing the steel casing with steel casing the same size to which the drilled pier is enlarged at no additional cost to the Department.

(b) Sampling

Take all slurry samples using an approved sampling tool. Test slurry samples to determine density, viscosity and pH to establish an acceptable working pattern during slurry use. Test a minimum of four samples during each 8 hours of slurry use for each drilled pier. Take the first sample for the first 8 hours from the slurry tank prior to introduction into the pier excavation. Take the remaining samples from the bottom of the drilled pier excavation. When the test results are acceptable and consistent, a decrease in the testing frequency to one sample per 4 hours of slurry use is permitted.

Prior to placing the reinforcing steel in any drilled pier excavation, extract slurry samples from the bottom of each pier excavation and at intervals not exceeding 10 feet (3 m) up the pier, until two consecutive samples produce acceptable values for density, viscosity, pH and sand content.

(c) Testing

Have a qualified Engineer or technician, approved by the Engineer, conduct control tests to determine density, viscosity and pH. Use suitable apparatus for the control tests. The following table shows the acceptable range of values for those physical properties:

BENTONITE SLURRY
Sodium Montmorillonite (Commercial Bentonite)
Acceptable Range of Values

Property (units)	At Time of Slurry Introduction	In Hole at Time of Drilling	Test Method
Density, pcf (kg/m^3)	64.3 – 69.1* (1030-1107*)	64.3 – 75.0* (1030-1201*)	Density Balance
Viscosity, sec./quart (sec./0.95 liters)	28 – 45	28 – 45	Marsh Cone
PH	8 – 11	8 – 11	pH paper pH meter

* Increase the density by 2 pcf (32 kg/m^3) in saltwater.

Notes:

1. Perform tests when the slurry temperature is above 40°F (4.4°C).
2. The maximum sand content is 2% by volume at any point in the borehole prior to placement of the reinforcement steel as determined by the American Petroleum Institute sand content base.
3. When field conditions warrant, an adjustment to the limits and test methods in the above table is permitted only after a successful test hole demonstration. Obtain the Engineer's written approval before use.

When any slurry samples are found to be unacceptable, take whatever action is necessary to bring the bentonite slurry within specification requirements. Do not place reinforcement steel until resampling and testing produce acceptable results.

Generate reports of all tests required above, have them signed by an authorized representative, and submit them to the Engineer upon completion of each drilled pier. Representatives of the Department reserve the right to perform comparison tests as determined necessary during bentonite slurry operations.

(d) Slurry Disposal

Comply with all applicable local, state and federal regulations, as well as with the environmental permits of the project when disposing of excavated materials contaminated with slurry. Keep all excavated materials, spoils from the desanding unit and slurry out of the water and contain them at all times. The cost of the containment, removal and disposal of excavated materials contaminated with slurry, as well as the slurry itself, is incidental to the cost of constructing the drilled piers.

C. CLEANING

Excavate the bottom of the drilled pier to a level plane or stepped with a maximum step height of 12 inches (300 mm). Regardless of construction methods used, clean the bottom of the excavation of loose material using a technique approved by the Engineer. When the drilled pier excavation can not be dewatered and is not hand cleaned, clean the bottom of the excavation with a cleanout bucket and an airlift or submersible pump.

D. INSPECTION METHODS AND REQUIREMENTS

After the drilled pier excavation is complete and immediately prior to placement of the reinforcing steel and concrete, demonstrate the proper condition of the drilled pier excavation to the Engineer for verification. Provide bosun chairs, gas meters, safety equipment, lights, mirrors, weighted tape measures, steel probes, personnel and all assistance required for the Engineer to inspect the drilled pier excavations.

1. Bearing Capacity

One or more of the following tests are used to verify the conditions and continuity of the bearing material prior to placement of the reinforcing steel. If the required tip bearing capacity is not satisfied, then increase the drilled pier length as determined by the Engineer. Payment for the additional length of the drilled pier to achieve adequate bearing will be made per the drilled pier pay items.

(a) Visual Inspection

The tip bearing of the drilled pier excavation is inspected either by entering the excavation or visually from the top of the excavation as directed by the Engineer.

(b) Test Hole

If the tip of the drilled pier excavation is in rock as defined by Section 1.0, Item E, drill one or more 1½ inch (38 mm) diameter

test holes in each drilled pier to a depth at least 6 feet (1.83 m) below the tip elevation.

(c) Standard Penetration Test (SPT)

When noted on the plans that a SPT is required, drive a split barrel sampler a minimum of 18 inches (450 mm) below the drilled pier tip elevation or to refusal in accordance with ASTM D1586.

Complete the SPT using NW rods through casing or another stabilizing method as approved by the Engineer. Extend the SPT rods from the top of the drilled pier excavation to the drilled pier tip elevation. Firmly support the SPT casing at the top of the drilled pier excavation and rest it on the bottom of the excavation. Conduct the SPT a minimum of 12 inches (300 mm) away from the sidewalls of the excavation and be sure not to scrape the sidewalls of the excavation while inserting or withdrawing the SPT equipment. Have the SPT device on-site prior to reaching the drilled pier tip elevation. Report the number of blows needed to drive the split barrel sampler and a description of the recovered soil sample to the Engineer. The Engineer determines the number of blows required for bearing.

2. Bottom Cleanliness

One or more of the following inspection procedures are used to check the cleanliness of the pier excavation bottom prior to placement of the reinforcement steel and concrete.

The pier excavation bottom is considered clean if a minimum of 50% of the bottom area has less than ½ inch (13 mm) of sediment and no portion of the bottom area has more than 1½ inches (38 mm) of sediment as determined by the Engineer.

(a) Visual Inspection

The cleanliness of the drilled pier excavation bottom is observed either by entering the excavation or from the top of the excavation as directed by the Engineer.

(b) Steel Probe

If the excavation is not dewatered or if the Engineer requires it, lower a steel probe to the bottom of the drilled pier excavation to ensure that cleaning has been satisfactorily completed. Supply a steel probe that is 2 feet (0.6 m) long with a flat tip on the sounding end, weighs approximately 9 pounds (#10 rebar) (4 kg, #32 rebar) and is suspended from the opposite end with a non-stretch cable.

(c) Shaft Inspection Device (SID) 83
(NOT REQUIRED IN THIS CONTRACT)

E. REINFORCING STEEL

Completely assemble a cage of reinforcing steel, consisting of longitudinal and spiral bars and place it in the drilled pier excavation as a unit immediately after the proper condition of the excavation is demonstrated to the Engineer. When concrete placement does not follow immediately after cage placement, remove the steel from the pier excavation unless the Engineer directs otherwise. If the cage is removed, recheck pier excavation cleanliness in accordance with this special provision prior to reinstallation of the cage.

If the drilled pier excavation is cased down to rock, immediate placement of the reinforcing steel and the concrete is not required. If electing to delay placement of the reinforcing steel and concrete due to the presence of rock, recheck the excavation for proper cleanliness immediately prior to placement of the reinforcing steel.

1. Construction, Placement, Support and Alignment

If it is determined in the field that the drilled pier must be longer, adequate reinforcement is required in the extended length as directed by the Engineer.

Lift the cage so racking and cage distortion does not occur. Keep the cage plumb during concrete operations and casing extraction. Check the position of the cage before and after placing the concrete. Position the splice length of the drilled pier cage so that the column or footing has the minimum concrete cover shown on the plans.

Securely cross-tie the vertical and spiral reinforcement at each intersection with double wire. Support or hold down the cage so that the vertical displacement during concrete placement and casing extraction does not exceed 6 inches (150 mm).

2. Bolsters, Blocks and Spacers

Do not set the cage on the bottom of the drilled pier excavation. Place plastic bolsters under each vertical reinforcing bar. If required by the Engineer, provide concrete blocks instead of plastic bolsters to limit rebar cage settlement. Place blocks under each vertical rebar that have a 4 inch (100 mm) minimum diameter and that have a depression to receive the vertical reinforcing bar. Ensure that the blocks are tall enough to raise the rebar cage off the bottom of the drilled pier excavation a minimum of 3 inches (75 mm).

In order to ensure a minimum of 4 inches (100 mm) of concrete cover and achieve concentric spacing of the cage within the pier, tie plastic spacer

wheels, subject to the Engineer's approval, at five points around the cage perimeter. Use spacer wheels that provide a minimum of 4 inches (100 mm) "blocking" from the outside face of the spiral bars to the outermost surface of the drilled pier except in rock as defined by Section 1.0, Item E. Use spacer wheels in the rock zone that provide a minimum of 2 inches (50 mm) "blocking". Tie spacer wheels that snap together with wire and allow them to rotate. Use spacer wheels that span at least two adjacent vertical bars. Start placing spacer wheels at the bottom of the cage and continue up along its length at maximum 10 foot (3 m) intervals. At the Engineer's direction, supply additional peripheral spacer wheels and closer intervals if necessary.

F. CONCRETE

Begin concrete placement immediately after inserting reinforcing steel into the drilled pier excavation. Prior to placing concrete, assure the Engineer that sufficient quantities of concrete are available and that sufficient transportation is committed to the project to deliver the concrete within the time frame set forth within this special provision.

(1) Concrete Mix

Provide the mix design for Drilled Pier Concrete for approval and, except as modified herein, meeting the requirements of Section 1000 of the Standard Specifications.

Designate the concrete as Drilled Pier Concrete with a minimum compressive strength of 4500 psi (31.0 MPa) at 28 days. Make certain the cementitious material content complies with one of the following options:

- Provide a minimum cement content of 640 lbs/yd^3 (380 kg/m^3) and a maximum cement content of 800 lbs/yd^3 (475 kg/m^3); however, if the alkali content of the cement exceeds 0.4%, reduce the cement content by 20% and replace it with fly ash at the rate of 1.2 lb (1.2 kg) of fly ash per lb (kg) of cement removed.
- If Type IP blended cement is used, use a minimum of 665 lbs/yd^3 (395 kg/m^3) Type IP blended cement and a maximum of 833 lbs/yd^3 (494 kg/m^3) Type IP blended cement in the mix.

Limit the water-cementitious material ratio to a maximum of 0.45. Do not air-entrain Drilled Pier Concrete.

Produce a workable mix so that vibrating or prodding is not required to consolidate the concrete. When placing the concrete, make certain the slump is between 5 and 7 inches (125 and 175 mm) for dry placement of concrete or 7 and 9 inches (175 and 225 mm) for wet placement of concrete.

Use Type I or Type II cement or Type IP blended cement and either No. 67 or No. 78M coarse aggregate in the mix. Use an approved water-reducer, water-reducing retarder, high-range water-reducer, or high-range water-reducing retarder to facilitate placement of the concrete if necessary. Do not use a stabilizing admixture as a retarder in Drilled Pier Concrete without approval of the Engineer. Use admixtures that satisfy AASHTO M194 and add them at the concrete plant when the mixing water is introduced into the concrete. Redosing of admixtures is not permitted.

Place the concrete within 2 hours after introducing the mixing water. Ensure that the concrete temperature at the time of placement is 90°F (32°C) or less.

(a) Slump Loss Test

If any drilled pier concrete pour is greater than 40 yd^3 (31 m^3) per pier, provide a slump loss test before beginning the drilled pier operation. The slump loss test verifies that the drilled pier concrete maintains a slump of at least 4 inches (100 mm) a minimum of 4 hours after batching. Perform the test with a Division of Highways representative present. Have the concrete producer notify the Department at least 72 hours prior to the test.

Conduct the slump loss test as follows:

(1) Batch the actual mix design at 9 inches (225 mm) initial slump and at the highest concrete temperature expected on the job, but no less than 60°F (15.5°C).

(2) Batch at least 4 yd^3 (3 m^3) in a mixer truck. Begin timing the test when the mixing water is introduced into the mix.

(3) After initial mixing, measure and record the slump, ambient temperature, concrete temperature and percent air. Ensure all concrete properties are within specifications.

(4) Mix the concrete intermittently at agitation speed for 30 seconds every 15 minutes.

(5) Measure and record the slump, ambient and concrete temperatures, and percent air after every second 15 minute interval until the slump is 3½ inches (90 mm).

Make certain the concrete maintains a minimum slump of 4 inches (100 mm) 4 hours after batching.

Once a mix design is accepted and the slump loss test is on file with the Materials and Tests Unit, resubmit the design for subsequent projects without the slump loss test.

2. Concrete Placement

Place concrete such that the drilled pier is a monolithic structure. Vibration is only permitted, if needed, in the top 10 feet (3 m) of the drilled pier or as directed by the Engineer. Remove any contaminated concrete from the top of the drilled pier and the wasted concrete from the area surrounding the drilled pier. Contain all concrete that spills over the permanent casing of the drilled pier.

Do not remove temporary casing until the level of concrete within the casing is in excess of 10 feet (3 m) above the bottom of the casing being removed. Maintain the concrete level at least 10 feet (3 m) above the bottom of innermost casing throughout the entire casing extraction operation, except when concrete is at or above the top of drilled pier elevation. Sustain a sufficient head of concrete above the bottom of casing to overcome outside soil and water pressure. As the casing is withdrawn, exercise care in maintaining an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the drilled pier concrete. Exerting downward pressure, hammering and/or vibrating the temporary casing is permitted to facilitate extraction.

After all the pumps have been removed from the excavation, the water inflow rate determines the concrete placement procedure. If the inflow rate is less than 6 inches (150 mm) per half hour, the concrete placement is considered dry. If the water inflow rate is greater than 6 inches (150 mm) per half hour, the concrete placement is considered wet.

Keep a record of the volume of concrete placed in each drilled pier excavation and make it available to the Engineer. For drilled piers constructed with slurry or as directed by the Engineer, record a graphical plot of the depth versus theoretical concrete volume and actual measured concrete volume for each drilled pier and provide it to the Engineer when finished placing concrete.

(a) Dry Placement

Prior to placing concrete, make certain the drilled pier excavation is dry so the flow of concrete completely around the reinforcing steel can be certified by visual inspection. If the concrete free fall does not exceed 60 feet (18.3 m), placing the concrete by a central drop method where the concrete is chuted directly down the center of the excavation is permitted.

For drilled piers exceeding 60 feet (18.3 m) in length, use a tremie or a pump to place concrete as described in Section 6.0, Item B, Number 3. Support the tremie or pump so that the concrete free fall is less than 60 feet (18.3 m) at all times.

(b) Wet Placement

Maintain a static water or slurry level in the excavation prior to placing concrete underwater. When temporary casing is used as the method to stabilize the excavation, place concrete only with a pump (no tremie).

Once the concrete in the excavation reaches the same elevation as the static water level, placing concrete with the dry method is permitted. Before changing to the dry method of concrete placement, remove the water above the concrete and clean the concrete surface of all scum and sediment to expose clean, uncontaminated concrete.

(c) Tremie and Pump

Place concrete with a tremie or a pump in accordance with the applicable parts of Sections 420-6 and 420-8 of the Standard Specifications that concern tremie and/or concrete pumping operations. Use a tremie consisting of a sectional tube a minimum of 10 inches (254 mm) in diameter unless otherwise approved or directed by the Engineer. Use a tremie tube or pump pipe made of steel with watertight joints. Passing concrete through a hopper at the tube end or through side openings as the tremie is retrieved during concrete placement is permitted. Use a discharge control to prevent concrete contamination when the tremie tube or pump pipe is initially placed in the excavation. Extend the tremie tube or pump pipe into the concrete a minimum of 5 feet (1.5 m) at all times except when the concrete is initially introduced into the pier excavation. If the tremie tube or pump pipe pulls out of the concrete for any reason after the initial concrete is placed, restart concrete placement with a steel capped tremie tube or pump pipe.

(d) Placement Time

Place concrete within the time frames specified in Table 1000-2 of the Standard Specifications for Class AA concrete and this special provision. Never place concrete so fast as to trap air, slurry, water, fluids, soil or any other deleterious materials in the vicinity of the reinforcing steel and the annular zone between the rebar cage and the excavation walls. Should a delay occur because of concrete delivery or other factors, reduce the placement rate to maintain some movement of the concrete. No more than 45 minutes is allowed between placements.

After the first drilled pier is successfully completed, do not make any significant changes in construction methods, equipment or materials, unless approved by the Engineer.

If caving or sloughing occurs, compensation is not provided for additional concrete to fill the resulting voids.

Within the first 16 hours after a drilled pier has achieved its initial concrete set (as determined by the Engineer), do not drill adjacent piers, do not install adjacent piles, and do not allow any equipment wheel loads or "excessive" vibrations to occur at any point within a 20 foot (6 m) radius of the drilled pier.

In the event that the procedures described herein are performed unsatisfactorily, the Engineer reserves the right to shut down the construction operations and/or reject the drilled piers. If the integrity of a drilled pier is in question, use core drilling, sonic or other approved methods at no additional cost to the Department and under the direction of the Engineer. Dewater and backfill core drill holes with an approved high strength grout with a minimum compressive strength of 4500 psi (31.0 MPa) as directed by the Engineer. Remedial measures are directed by and require approval from the Engineer. No compensation will be paid for losses or damage due to remedial work or any investigation of drilled piers found defective or not in accordance with this special provision or the construction plans.

H. NON-DESTRUCTIVE TESTING

The Engineer furnishes the non-destructive testing (NDT) equipment. NDT requires the attachment of an accelerometer to the top of the drilled pier. Measurements are made while tapping the top of the drilled pier with a hammer. The Engineer furnishes the materials, labor and equipment necessary for the installation of the accelerometer.

If the NDT instruments and supporting equipment are damaged due to the fault or negligence of the Contractor, replace the damaged equipment at no additional cost to the Department.

After installation, notify the Engineer that the drilled piers are ready to be tested. A drilled pier is tested only after the concrete has been in place for 5 days and the concrete has achieved a minimum compressive strength of 3000 psi (20.7 MPa). Grind four flat dry areas on top of the drilled pier down to exposed aggregate with a grinder or some other acceptable device. The Engineer selects the location of the four ground surfaces. Several velocity records as a function of time are averaged at each test location. The NDT field data is recorded with digital data acquisition equipment. Field testing is estimated to take 1 hour per drilled pier. Evaluation and interpretation of the field data requires 3 working days after testing. Further construction above the drilled piers that were tested is not allowed until the analysis of the NDT field data is complete.

The Engineer determines the number of drilled piers to be tested with NDT. It is anticipated that all drilled piers require testing. The cost of this work is included in the contract unit price bid for the drilled pier pay items. No separate payment will be made. Claims are not permitted for any delay incurred, including but not limited to the installation of the instrumentation or the collection and analysis of the NDT data.

I. COMPENSATION

A. Method of Measurement

1. Drilled Piers in Soil

The quantity of "Drilled Piers in Soil" to be paid for will be the linear feet (meters) of the drilled piers exclusive of the linear feet (meters) of "Drilled Piers Not in Soil" computed from elevations and dimensions as shown on the plans or from revised dimensions authorized by the Engineer. Drilled piers through air or water will be paid for as "Drilled Piers in Soil".

2. Drilled Piers Not in Soil

The quantity of "Drilled Piers Not in Soil" to be paid for will be the linear feet (meters) of drilled piers excavated in non-soil as determined by the Engineer. Non-soil is defined as material that can not be cut with a rock auger and requires excavation by coring, air tools, hand removal or other acceptable methods. Top of non-soil elevation is that elevation where the rock auger penetration rate is less than 2 inches (50 mm) per 5 minutes of drilling at full crowd force and coring, air tools, etc. are used to advance the excavation. For pay purposes, after non-soil is encountered, earth seams, rock fragments and voids in the excavation less than 3 feet (0.9 m) in total length will be considered "Drilled Piers Not in Soil". If the non-soil is discontinuous, payment will revert to "Drilled Piers in Soil" at the elevation where non-soil is no longer encountered.

3. Permanent Steel Casing

The quantity of "Permanent Steel Casing" to be paid for will be the linear feet (meters) of permanent steel casing as directed and authorized to be used. The length to be paid for will be measured along the permanent casing from the top of the casing elevation or top of the pier elevation, whichever is lower, to the casing tip elevation. Casing will be paid for only when permanent casing is authorized or when the Engineer directs the Contractor to leave a casing in place that then becomes a permanent part of the pier. No payment will be made for temporary steel casings that become

bound or fouled during pier construction and cannot be practically removed.

4. Shaft Inspection Device (SID) (NOT REQUIRED IN THIS CONTRACT)

The quantity of "SID Inspection" to be paid for will be per drilled pier as noted on the plans and/or directed by the Engineer. SID inspections are performed until the bottom cleanliness of the drilled pier excavation is acceptable by this special provision; however, payment will only be made for the initial SID inspection of each drilled pier excavation.

5. Standard Penetration Test (SPT)

The quantity of "SPT Testing" to be paid for will be the actual number of SPT tests performed as noted on the plans and/or directed by the Engineer.

B. Basis of Payment

1. Drilled Piers in Soil

Payment will be made at the contract unit price per linear foot (meter) for 42" Dia. Drilled Piers in Soil". Such payment will include, but is not limited to, furnishing all labor, tools, equipment, materials including concrete complete and in place and all incidentals necessary to excavate the drilled piers and complete the work as described in this special provision. No additional payment will be made for slurry use. No additional payment will be made for any miscellaneous grading or excavation to install the drilled pier. "Reinforcing Steel" and "Spiral Column Reinforcing Steel" will be paid for separately and will not be part of this pay item.

2. Drilled Piers Not in Soil

Payment will be made at the contract unit price per linear foot (meter) for 42" Dia. Drilled Piers Not in Soil". Such payment will include, but is not limited to, furnishing all labor, tools, equipment, materials including concrete complete and in place and all incidentals necessary to excavate the drilled piers and complete the work as described in this special provision. No additional payment will be made for slurry use. No additional payment will be made for any miscellaneous grading or excavation to install the drilled pier. "Reinforcing Steel" and "Spiral Column Reinforcing Steel" will be paid for separately and will not be part of this pay item.

3. Permanent Steel Casing

Payment will be made at the contract unit price per linear foot (meter) for "Permanent Steel Casing for 42" Dia. Drilled Pier". Such payment will include, but is not limited to, furnishing all material, labor, tools, equipment and all incidentals necessary to install the casing in the pier excavation.

4. Shaft Inspection Device (SID)
(NOT REQUIRED IN THIS CONTRACT)

The quantity of "SID Inspection" to be paid for will be per drilled pier as noted on the plans and/or directed by the Engineer. SID inspections are performed until the bottom cleanliness of the drilled pier excavation is acceptable by this special provision; however, payment will only be made for the initial SID inspection of each drilled pier excavation.

5. Standard Penetration Test (SPT)

The quantity of "SPT Testing" to be paid for will be the actual number of SPT tests performed as noted on the plans and/or directed by the Engineer.

XI. CROSSHOLE SONIC LOGGING (07-09-02)

A. GENERAL

Use the non-destructive testing method called Crosshole Sonic Logging (CSL) to verify the integrity of the drilled pier and the quality of the concrete. The Engineer will determine the number of CSL tests and which drilled piers will be CSL tested on this project. Drilled piers are referred to as piers in this special provision.

The CSL test measures the time for an ultrasonic pulse to travel from a signal source in one access tube to a receiver in another access tube. In uniform, good quality concrete, the travel time between equidistant tubes should yield relatively consistent arrival times and corresponds to a reasonable pulse velocity, signal amplitude and energy from the bottom to the top of the pier. Longer travel times, decrease in pulse velocity, and lower amplitude/energy signals indicate the presence of irregularities such as poor quality concrete, voids, honeycombing, cracking and soil intrusions. The signal may be completely lost by the receiver and CSL recording system for severe defects such as voids and soil intrusions.

The CSL Consultant must have a minimum 3 years experience of CSL testing and have a Registered North Carolina Professional Engineer supervising the testing and interpretation of results. **Submit** the proposed CSL Consultant to the

Engineer for approval 30 days before beginning drilled pier construction. The following evidence of qualification needs to be included, unless previously approved by the Department and no changes have occurred since previous submittal:

- Written evidence of successful completion of CSL tests, brief descriptions and reference's phone numbers for three recent CSL projects.
- Personnel qualifications
- Equipment description
- Example report

Make all necessary arrangements with the CSL Consultant to have the CSL tests satisfactorily performed on the selected drilled piers and in accordance with this special provision. The CSL Consultant must supply to the Contractor technical instruction and guidance in preconstruction activities, and on-site technical assistance and guidance during set up and performance of the CSL tests. Provide suitable access to the site and to the top of piers to be tested. Follow instructions from the CSL Consultant unless the Engineer directs otherwise.

Place CSL tubes in all drilled piers. Perform CSL testing only on drilled piers selected by the Engineer a minimum 7 days after concrete placement and after concrete achieves a minimum compressive strength of 3000 psi (20.7 MPa), but within 30 days after concrete placement. After CSL test results have been reviewed and the Engineer has accepted the drilled pier or approves grouting of the tubes, dewater the tubes and core holes, if any, and backfill with the approved grout. When the Engineer elects not to CSL test a pier, dewater the tubes and backfill them with an approved 4500 psi (31.0 MPa) compressive strength grout.

B. PREPARATION FOR CSL

Install four tubes in each drilled pier with a diameter of 5 feet (1524 mm) or less, and install six tubes in each pier with a diameter of greater than 5 feet (1524 mm). Provide 2 inch (50 mm) inside diameter Schedule 40 steel pipe conforming to ASTM A53, Grade A or B, Type E, F, or S. The tubes must have a round, regular internal diameter free of defects or obstructions, including any at tube joints, in order to permit the free, unobstructed passage of source and receiver probes. The tubes must provide a good bond with the concrete, and be watertight.

Fit the tubes with a watertight threaded cap on the bottom and a removable threaded cap on the top. Securely attach the tubes to the interior of the reinforcement cage. Install the tubes in each drilled pier in a regular, symmetric pattern such that each tube is equally spaced from the others around the perimeter of the cage. Tube placement must be such that large vertical reinforcing bars do not block the direct line between adjacent tubes.

The tubes are typically wire-tied to the reinforcing cage every 3 feet (1 m) or otherwise secured such that the tubes remain in position during placement of the rebar cage and the concrete. The tubes must be as near to vertical and as parallel as possible, as non-vertical tubes can adversely affect data analysis. Extend the tubes from 6 inches (150 mm) above the pier tip to at least 3 feet (1 m) above the top of the pier. If the pier top elevation is below ground elevation, extend tubes at least 2 feet (610 mm) above ground surface. If the drilled pier tip elevation is excavated more than 1 foot (305 mm) below the tip elevation in the original plans, extend the tubes using proper threaded mechanical couplings to within 6 inches (150 mm) of the revised pier tip elevation.

Before placement of the reinforcement cage into the drilled pier, record the tube lengths and tube positions along the length of the cage. After placement of concrete, measure the stickup of the tubes above the top of the drilled piers and verify tube spacing.

Verify that unobstructed passage of the probes is achievable before the CSL Consultant arrives on site. If testing equipment will not pass through the entire length of the CSL tube, core a 2 inch (50 mm) diameter hole through the concrete the full length of the drilled pier at no cost to the Department. Locate the core hole approximately 9 inches (230 mm) inside the pier reinforcement from obstructed tube or as determined by the Engineer. Fill core hole with clean, potable water and cover to keep out debris.

Immediately after placement of the reinforcement cage and within 2 hours after concrete placement, fill the CSL tubes with clean, potable water, and cap them to keep out debris. The Engineer will reject CSL tubes that are not filled with water or capped. When removing the caps, exercise care not to apply excess torque, force or stress, which could break the bond between the tubes and the concrete.

Submit to the Engineer the CSL tube size, the manufacturer's certificate of compliance, cap details, couplings, any joints details, and the proposed method of attaching the tubes, 30 days before beginning drilled pier construction.

C. CSL EQUIPMENT

The minimum requirements of the CSL equipment are as follows:

- A microprocessor based CSL system for display of individual CSL records, analog-digital conversion and recording of CSL data, analysis of receiver responses and printing of report quality CSL logs
- Ultrasonic source and receiver probes which can travel through 2 inch (50 mm) I.D. steel pipe
- An ultrasonic voltage pulser to excite the source with a synchronized triggering system to start the recording system
- A depth measurement device to electronically measure and record the source and receiver depths associated with each CSL signal
- Appropriate filter/amplification and cable systems for CSL testing

- An acquisition system that stores each log in digital format, with drilled pier identification, date, time and test details, including the source and receiver gain. Arrival time data must be displayed graphically during data acquisition.
- 3D tomographic imaging software, or source for completing the work.

D. CSL TEST PROCEDURE

Provide the Engineer and CSL Consultant with the following:

- Tube lengths and positions
- Record of the drilled pier construction information including the pier bottom and top elevations
- Construction dates before CSL testing

Conduct CSL tests between each perimeter pair and major principal diameter and log, unless otherwise directed by the Engineer.

Perform the CSL testing with the source and receiver probes in the same horizontal plane unless test results indicate defects or poor concrete zones, in which case the defect zones must be further evaluated with angle tests (source and receiver vertically offset at greater than 1.5 feet (460 mm) in the tubes). Report any defects indicated by decreased signal velocity and lower amplitude/energy signals to the Engineer at the time of testing, and conduct angle tests in the zones of the defects as defined by the Concrete Condition Rating Criteria (CCRC) in Section 5.0 of this special provision.

Make CSL measurements at depth intervals of 2 ½ inches (65 mm) or less from the bottom of the tubes to the top of each pier. Pull the probes simultaneously, starting from the bottom of the tubes, using a depth-measuring device to electronically measure and record the depths associated with each CSL signal. Remove any slack from the cables before pulling to provide for accurate depth measurements of the CSL records. In the event defects are detected, conduct additional logs, as needed, at no additional cost to the Department. The Department will not accept any claims for either lost time or the actual expense of further investigation of defects.

If steel tube debonding occurs, then core drill a 2 inch (50 mm) diameter hole to the depth of debonding for each debonded tube in order to perform the CSL logs at no additional cost to the Department.

E. CSL RESULTS AND REPORTING

Submit the test results in the form of a report including four original copies of CSL results to the Engineer within 5 working days of completion of CSL testing. The CSL report should include but not limited to the following:

- Project identification
- Dates of testing
- Table and a plan view of each pier tested with accurate identification of tube coordinates and tubes referenced to the site
- Tube collar elevation
- Names of personnel that performed the tests/interpretation and their affiliation
- Equipment used
- Interpretation, analysis, and results.

Include CSL logs for each tube pair tested with analysis of the initial pulse arrival time, velocity, relative pulse energy/amplitude, and stacked waveform plotted versus depth. List all zones defined by the Concrete Condition Rating Criteria (CCRC) in a tabular format including the percent velocity reduction and the velocity values used from the nearby zone of good quality concrete. Discuss each zone defined by the CCRC in the CSL report as appropriate.

Base the results on the percent reduction in velocity value from a nearby zone of good quality concrete with good signal amplitude and energy as correlated to the following:**Concrete Condition Rating Criteria (CCRC)**

CCRC	Rating Symbol	Velocity Reduction	Indicative Results
Good	G	≤ 10 %	Good quality concrete
Questionable Defect	Q	>10 % & < 20 %	Minor concrete contamination or intrusion. Questionable quality concrete.
Poor	P/D	≥ 20 %	Defects exist, possible water/slurry contamination, soil intrusion, and/or poor quality concrete.
No Signal	NS	No Signal received	Soil intrusion or other severe defect absorbed the signal (assumes good bond of the tube-concrete interface).
Water	W	V = 4750 fps (1450 mps) to 5000 fps (1525 mps)	Water intrusion, or water filled gravel intrusion with few or no fines present.

The following are a few examples of types and causes of defects:

- Necking or arching of the concrete on withdrawal of the temporary casing.
- Necking or contamination of the concrete due to collapse of the side walls.
- Soft toe due to incomplete cleaning or collapse of the side walls.
- Horizontal lenses of silt\mud\bentonite due to the tremie pipe rising above the concrete
- Voids due to the use of low-slump concrete.
- Honeycombing due to washout of fines.
- Trapping of contaminants due to pumping concrete to fast.
-

Provide the original pulse signal data files and ASCI format of the picks with a header (identifying the pier tested, tube coordinates and each data column) in an electronic file to the Engineer. The Engineer will require 7 working days to evaluate the CSL test results and determine whether or not the drilled pier is acceptable. Evaluation of CSL test results, with ratings other than good (G) per the Concrete Condition Rating Criteria (CCRC) may require further investigation and additional time for review and analysis of the data. Do not grout the CSL tubes or perform any further work on the CSL tested drilled pier until the Engineer determines whether the drilled pier is acceptable. Perform tomography in order to further investigate and delineate the boundaries of any defective/unconsolidated zones with 20% or more reduction in velocity value as correlated to the CCRC. Process CSL data to construct easy to understand 2D/3D (2D cross-sections between tubes and 3D volumetric images for the entire pier) *color-coded* tomographic images indicating velocity variations along the pier. Location and geometry of defective/unconsolidated zones must be identified in 3D color images with detailed discussion in the CSL report. Any further tests deemed necessary by the Engineer in order to determine the acceptability of the drilled pier will be determined after reviewing the CSL report. Additional test or analysis options include 3D tomographic imaging, single-hole sonic testing, gamma-gamma nuclear density logging, sonic echo or impact response tests, and concrete coring, in addition to load testing of the piers.

The Engineer will determine the depth, location, and the number of core holes when concrete coring is required. Drill a minimum of two PQ size core holes to intercept the suspected defect zones. Use a coring method that provides maximum core recovery and minimizes abrasion and erosion. Provide concrete cores properly marked in a wooden crate and labeling the drilled pier depth at each interval of core recovery to the NCDOT Materials and Test Unit for evaluation and testing. Submit to the Engineer a drilling report that includes the NCDOT project number, name of the Drilling Contractor, date drilled, percent core recovery and signed by the Contractor. Allow 7 working days after submitting the core records for the Department's review.

F. CORRECTION OF UNACCEPTABLE DRILLED PIER

When the Engineer determines a drilled pier is unacceptable, the Engineer will direct the Contractor to submit remedial measures to the Department for approval. No compensation will be made for remedial work or losses or damage due to remedial work of drilled piers found defective or not in accordance with the drilled pier special provision or the construction plans. Modifications to the drilled pier design or any load transfer mechanisms required by the remedial action must be designed and calculations sealed by a Registered North Carolina Professional Engineer. Include drawings sealed by a Registered North Carolina Professional Engineer for all foundation elements affected. Do not begin remedial action work until the Department has reviewed and accepted the remedial action plan. Allow 10 working days after submitting the remedial work plan for the Department's review and acceptance. Furnish all materials and work necessary to correct defective drilled piers.

G. MEASUREMENT AND BASIS OF PAYMENT

The complete and accepted crosshole sonic logging tubes will be included in the contract unit price bid per foot of drilled piers. No separate payment will be made. Such payment will be full compensation for furnishing, installing, dewatering and grouting all CSL tubes and 2 inch (50 mm) diameter core holes, if applicable, and for all materials, labor, tools, equipment and incidentals necessary to complete the work.

The complete and accepted CSL testing will be paid for in accordance with Article 104-8(A) of the Standard Specification. Such payment will be full compensation for all procurements, conducting the CSL testing, reporting of results and incidentals necessary to complete the work.

PLACEMENT OF SUBSTRUCTURE

Placement of Substructure shall be in accordance with the Standard Specifications.

Payment of construction of substructure end bent caps and inter bent caps, columns and temporary rip rap for causeways as indicated in the Permit and Plans,will be included at the Lump Sum bid price for "Placement of Substructure".This price shall be full compensation for all material, tools, equipment, labor and for all incidentals Necessary to complete the work.

CLEARING AND GRUBBING

Clearing and grubbing at the site shall have been performed in accordance with Article 200-3, 200-4 and 200-5 of the Standard Specifications.

Payment for "Clearing and Grubbing" will be included at the lump sum bid price for "Excavation and Embankment". This price shall be full compensation for all materials, tools, equipment, labor, and for all incidentals necessary to complete the work.

ATTACHMENT B: GEOTECHNICAL

The following Geotechnical Boring Logs "attachment B" are for information only and are not a part of this contract. These boring logs are for investigation only and no accuracy is implied or guaranteed. No claim will be allowed as a result of the use of this information.

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N.C.D.O.T. GEOTECHNICAL UNIT
BORING LOG

SHEET 1 OF 1

PROJECT NO. MA05001B	ID. N/A	COUNTY Wake	GEOLOGIST C. Baldwin
SITE DESCRIPTION Bridge #133 on SR 1930 over Richland Creek			GROUND WATER (ft)
BORING NO. B1-A	BORING LOCATION 13+71	OFFSET 5ft LT	ALIGNMENT -L-
COLLAR ELEV. 104.5 ft	NORTHING	EASTING	0 HR. N/A*
TOTAL DEPTH 60.5 ft	DRILL MACHINE CME 550	DRILL METHOD 3.25" ID HSA/NQ-3	HAMMER TYPE Automatic
DATE STARTED 1/25/05	COMPLETED 1/25/05	SURFACE WATER DEPTH N/A	24 HR. N/A*

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP NO	MOI	LOG	SOIL AND ROCK DESCRIPTION
104.5					Ground Surface				104.5 0.0
104.1	0.4	6	3	2	5		M		-ASPHALT & ABC STONE- 104.1 0.4
101.0	3.5								-ROADWAY EMBANKMENT- 101.5 3.0
		1	2	1	3		M		Brown, fine to coarse SAND (A-2-4)
98.0	6.5								Reddish-brown, clayey SILT (A-4), with mica. 98.5 6.0
		1	2	1	3		M		Reddish-brown, silty CLAY (A-6), with some fine to coarse sand & mica. 94.5 10.0
91.0	13.5								-ALLUVIAL-
		1	1	1	2		W		Gray, fine to coarse sandy CLAY (A-6), with some silt & mica.
86.0	18.5								86.9 18.6
		1	5	4	9	SS-26	16.6%		Gray, fine to coarse SAND (A-1-b(0)), with trace silt & clay.
81.0	23.5								81.0 23.6
		18	36	36	72	SS-27	11.8%		-RESIDUAL-
76.0	28.5								Gray & white, fine to coarse SAND (A-2-4(0)), with trace silt & clay. 76.6 29.0
		18	60/0.3'		60/0.3'				-WEATHERED ROCK-
71.0	33.5								Brown, BIOTITE GNEISS. 69.6 36.0
		100/0.5'			100/0.5'	RS-1			-CRYSTALLINE ROCK-
									Gray & white to brown, mod. sev. weath., mod. hard to hard BIOTITE GNEISS. 67.5 37.0
									-WEATHERED ROCK-
									Brown, severely weathered, soft to medium hard BIOTITE GNEISS. 64.0 46.6
									-CRYSTALLINE ROCK- 61.8 42.7
									Black & white, moderately severely weathered, moderately hard to hard BIOTITE GNEISS. 61.8 42.8 59.7 44.8
						RS-2			-WEATHERED ROCK-
									Brown, sev. weath., v. soft BIOTITE GNEISS.
									-CRYSTALLINE ROCK-
									Black & white, moderately weathered, hard BIOTITE GNEISS. 54.0 50.6
									White, pink & gray, moderately weathered, very hard GRANITE.
									Boring Terminated at Elevation 54.0 ft in CRYSTALLINE ROCK (GRANITE)

NOTES:

1) Geologist indicates strata break in split spoon at a depth of 29.0'.
2) Auger refusal at a depth of 35.0'.
3) Coring began at a depth of 35.0'.

* Groundwater not measured due to water introduced for coring.

NCDOT BORE SINGLE FR6-338 GPJ NC_DOT.GDT 2/9/06

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BORING LOG

SHEET 1 OF 1

PROJECT NO. MA05001B	ID. N/A	COUNTY Wake	GEOLOGIST C. Baldwin
SITE DESCRIPTION Bridge #133 on SR 1930 over Richland Creek			GROUND WATER (ft)
BORING NO. B2-B	BORING LOCATION 14+30	OFFSET 12ft RT	ALIGNMENT -L-
COLLAR ELEV. 89.6 ft	NORTHING	EASTING	0 HR. N/A*
TOTAL DEPTH 30.6 ft	DRILL MACHINE CME 550	DRILL METHOD 3.25" ID HSA/NQ-3	HAMMER TYPE Automatic
DATE STARTED 1/26/05	COMPLETED 1/26/05	SURFACE WATER DEPTH N/A	24 HR. N/A*

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
89.6					Ground Surface				89.6 0.0
89.6	0.0	1	2	2	4		W		-ALLUVIAL- Brown, fine to coarse SAND (A-2-4), with some silt & gravel.
86.1	3.5	2	4	4	8	SS-32	18.2%		86.1 3.5 Gray, fine to coarse SAND (A-1-b(0)), with trace silt & clay.
82.1	7.5	37	60/0.3'		60/0.3'				82.1 7.5 -RESIDUAL- Brown, silty fine to coarse SAND (A-2-4) 80.6 9.0
76.1	13.5	60/0.1'			60/0.1'				-WEATHERED ROCK- Brown, severely weathered, soft to medium hard BIOTITE GNEISS. 70.5 19.1
						RS-3			-CRYSTALLINE ROCK- Gray & white, moderately severe to moderately weathered, moderately hard to hard BIOTITE GNEISS.
						RS-4			59.0 30.6

Boring Terminated at Elevation 59.0 ft in CRYSTALLINE ROCK (BIOTITE GNEISS)

NOTES:

1) Driller indicates harder drilling at a depth of 7.5'.
2) Geologist indicates strata break in split spoon at a depth of 9.0'.
3) Auger refusal at a depth of 17.5'.
4) Coring began at a depth of 17.5'.

* Groundwater not measured due to water introduced for coring.

NCDOT BORE SINGLE P66-338.GPJ NC_DOT.GDT 2/2/05

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BORING LOG

SHEET 1 OF 1

PROJECT NO. MA05001B	ID. N/A	COUNTY Wake	GEOLOGIST C. Baldwin
SITE DESCRIPTION Bridge #133 on SR 1930 over Richland Creek			GROUND WATER (ft)
BORING NO. EB1-A	BORING LOCATION 13+28	OFFSET 5ft LT	ALIGNMENT -L-	0 HR. 19.3
COLLAR ELEV. 104.7 ft	NORTHING	EASTING	24 HR. N/A*
TOTAL DEPTH 33.8 ft	DRILL MACHINE CME 550	DRILL METHOD 2.25" ID HSA	HAMMER TYPE Automatic
DATE STARTED 1/24/05	COMPLETED 1/24/05	SURFACE WATER DEPTH N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
104.7					Ground Surface				104.7 0.0
104.4	0.3	2	2	2	4	SS-1	35.9%		-ASPHALT & ABC STONE- 104.4 0.3
101.2	3.5	2	2	3	5		M		-ROADWAY EMBANKMENT- Reddish-brown, fine to coarse sandy CLAY (A-7-6(12)), with little silt. 101.2 3.5
96.2	8.5	2	1	2	3	SS-3	19.2%		-ALLUVIAL- Gray, fine to coarse sandy CLAY (A-6(2)), with trace silt.
91.2	13.5	2	1	2	3		W		91.2 13.5
86.2	18.5	1	2	5	7		M		Gray, fine to coarse SAND (A-2-4). 86.2 18.5
81.2	23.5	60/0.3"			60/0.3"				Gray, silty CLAY (A-6), with some fine sand & mica. 82.2 22.5
76.2	28.5	60/0.3"			60/0.3"				-WEATHERED ROCK- Brown, BIOTITE GNEISS.
71.2	33.5	60/0.3"			60/0.3"				70.9 33.8

Boring Terminated at Elevation 70.9 ft in WEATHERED ROCK (BIOTITE GNEISS)

NOTES

1) Driller indicates harder drilling at a depth of 22.5'.

* Boring backfilled upon completion due to its location in the roadway.

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SHEET 1 OF 1

PROJECT NO. MA05001B	ID. N/A	COUNTY Wake	GEOLOGIST C. Baldwin
SITE DESCRIPTION Bridge #133 on SR 1930 over Richland Creek			GROUND WATER (ft)
BORING NO. EB1-B	BORING LOCATION 13+34	OFFSET 15ft RT	ALIGNMENT -L-	0 HR. 19.0
COLLAR ELEV. 104.5 ft	NORTHING	EASTING	24 HR. N/A*
TOTAL DEPTH 33.8 ft	DRILL MACHINE CME 550	DRILL METHOD 2.25" ID HSA	HAMMER TYPE Automatic
DATE STARTED 1/24/05	COMPLETED 1/24/05	SURFACE WATER DEPTH N/A	

ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
104.5					Ground Surface				104.5 0.0
104.2	0.3	2	2	2	4		M		104.2 -ASPHALT & ABC STONE- 0.3
101.0	3.5	5	8	5	13	SS-15	9.0%		-ROADWAY EMBANKMENT- Reddish-brown & brown, fine to coarse SAND (A-2-4(0)), with little silt & clay
96.5	8.0	2	2	2	4		M		96.5 8.0 Reddish-brown, silty CLAY (A-6), with some fine to coarse sand. 94.5 10.0
91.0	13.5	WOH	2	2	4		W		-ALLUVIAL- Gray, fine to coarse SAND (A-2-4(0)), with little clay & silt.
86.0	18.5	1	1	2	3	SS-16	26.0%		
81.5	23.0	38	60/0.3"		60/0.3"				81.5 23.0 80.5 24.0 -RESIDUAL- Brown, silty fine to coarse SAND (A-2-4)
76.0	28.5	60/0.2"			60/0.2"				-WEATHERED ROCK- Brown, BIOTITE GNEISS.
70.7	33.8	60/0.3"			60/0.3"				70.7 33.8 Boring Terminated at Elevation 70.7 ft in WEATHERED ROCK (BIOTITE GNEISS)

NOTES:

1) Driller indicates harder drilling at a depth of 23.0'.
2) Geologist indicates strata break in split spoon at a depth of 24.0'.

* Boring backfilled upon completion due to its location in the roadway.

NCDOT BORE SINGLE F66338.GPJ NC_DOT.GDT 3/28/05

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BORING LOG

SHEET 1 OF 1

PROJECT NO. MA05001B	ID. N/A	COUNTY Wake	GEOLOGIST C. Baldwin
SITE DESCRIPTION Bridge #133 on SR 1930 over Richland Creek			GROUND WATER (ft)
BORING NO. EB2-A	BORING LOCATION 14+67	OFFSET 4ft LT	ALIGNMENT -L-	0 HR. Dry
COLLAR ELEV. 104.9 ft	NORTHING	EASTING	24 HR. N/A*
TOTAL DEPTH 22.8 ft	DRILL MACHINE CME 550	DRILL METHOD 2.25" ID HSA	HAMMER TYPE Automatic
DATE STARTED 1/24/05	COMPLETED 1/24/05	SURFACE WATER DEPTH N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
104.9					Ground Surface				
104.6	0.3	1	3	2	5		M		-ASPHALT & ABC STONE-
101.4	3.5								-ROADWAY EMBANKMENT- Brown, silty CLAY (A-6), with some fine to coarse sand & mica.
		2	3	3	6		M		
96.4	8.5								Brown, silty fine to coarse SAND (A-2-4), with trace gravel & mica.
		2	2	2	4	SS-11	28.3%		-ALLUVIAL- Gray, clayey SILT (A-4), with some fine to coarse sand.
91.4	13.5								
		4	2	9	11	SS-12	15.3%		-RESIDUAL- Gray, white & brown, fine to coarse SAND (A-2-4(0)), with little clay, trace silt.
86.4	18.5								
		4	7	11	18		M		
83.9	21.0								
82.1	22.8	60/0.0'			60/0.0'				-CRYSTALLINE ROCK- Brown, BIOTITE GNEISS

Boring Terminated with Standard Penetration Test Refusal at Elevation 82.1 ft in CRYSTALLINE ROCK (BIOTITE GNEISS)

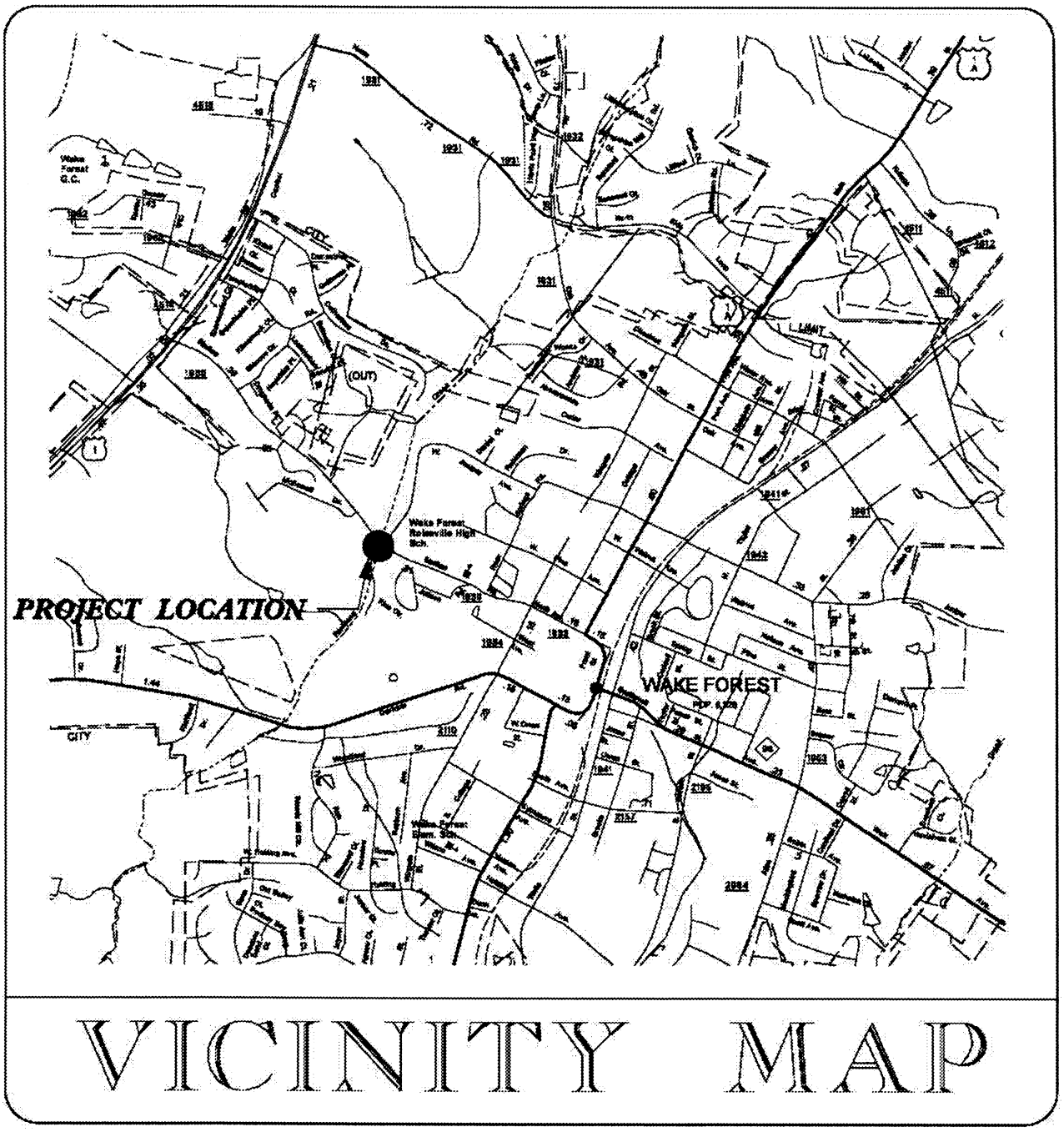
NOTES:

1) Driller indicates harder drilling at a depth of 21.0'.
2) Auger refusal at a depth of 22.8'.

* Boring backfilled upon completion due to its location in the roadway.

NCDOT BORE SINGLE P66-338.GPJ NC_DOT.GDT 2/2/06

BRIDGE LOCATION MAP



LOCATION: BRIDGE NO. 133 ON SR 1930 STADIUM DRIVE OVER RICHLAND CREEK