PROJECT SPECIAL PROVISIONS

Roadway 7-1-95

SP1R01

CLEARING AND GRUBBING: **9-17-02**

Perform clearing on this project to the limits established by Method "II" shown on Standard No. 200.02 of the Roadway Standards.

The 2002 Standard Specifications shall be revised as follows:

Page 2-3, Article 200-5

Delete the first sentence of this article and insert the following:

The property owner will have no right to use or reserve for his use any timber on the project. All timber cut during the clearing operations is to become the property of the Contractor, and shall be either removed from the project by him, or else shall be satisfactorily disposed of as hereinafter provided.

SP2R01

ROADWAY EXCAVATION **03-15-05$_R$**

Revise the *2002 Standard Specifications* as follows:

Page 2-8, delete Article 225-2 and replace with the following:

Erosion Control Requirements

Install erosion control measures as required by the plans prior to any kind of land-disturbing activity.

1. Unless otherwise required by the plans, conduct operations in such a manner that cut and fill slopes are completely graded to final slopes in a continuous operation, and permanently seeded and mulched in accordance with the requirements of the Specifications.

2. Should the Contractor fail to comply with the requirements specified in No. 1 above within the time frames established by the *Sedimentation and Pollution Control Act*, the Contractor shall perform temporary seeding and mulching on any exposed areas at his own expense.

3. When the Contractor fails or neglects to coordinate grading with the permanent seeding and mulching operation, the Engineer may suspend the Contractor's grading operation in accordance with the provisions of Article 108-7 of the *Standard Specifications* until the work is coordinated in a manner acceptable to the Engineer. Failure to perform the directed work may result in the Engineer having the work performed in accordance with Article 105-16 of the *Standard Specifications*.

SP2R25

BORROW EXCAVATION: **2-19-02**

Revise the 2002 Standard Specifications as follows:

Page 2-20, Article 230-6

After the first paragraph, insert the following paragraph:

"No direct payment will be made for the work of Evaluation of Potential Wetlands and Endangered Species as outlined above. Payment at the contract unit price for the pay item 'Borrow Excavation' or 'Grading - Lump Sum' will be considered full compensation for this work.'

SP2R37

SHOULDER AND FILL SLOPE MATERIAL: **5-21-02**

General:

Perform the required shoulder and slope construction for this project in accordance with the applicable requirements of Section 560 and Section 235 of the Standard Specifications except as follows:

Construct the top 6 inches (150-mm) of shoulder and fill slopes with soils capable of supporting vegetation.

Provide soil with a P.I. greater than 6 and less than 25 and with a pH ranging from 5.5 to 6.8. Remove stones and other foreign material 2 inches (50 mm) or larger in diameter. All soil is subject to test and acceptance or rejection by the Engineer.

Obtain material from within the project limits or approved borrow source.

Compensation:

When the Contractor elects to obtain material from an area located beneath a proposed fill sections which does not require excavation for any reason other than to generate acceptable shoulder and fill slope material, the work of performing the excavation will be considered incidental to the item of "Borrow Excavation" or "Shoulder Borrow". If there is no pay item for "Borrow" or "Shoulder Excavation" in the contract, this work will be considered incidental to "Unclassified Excavation". Stockpile the excavated material in a manner to facilitate measurement by the Engineer. Fill the void created by the excavation of the shoulder and fill

slope material with suitable material. Payment for material used from the stockpile will be made at the contract unit price for "Borrow Excavation" or "Shoulder Borrow". If there is no pay item for "Borrow Excavation" or "Shoulder Borrow", then the material will be paid for at the contract unit price for "Unclassified Excavation". The material used to fill the void created by the excavation of the shoulder and fill slope material will be made at the contract unit price for "Unclassified Excavation", "Borrow Excavation", or "Shoulder Borrow", depending on the source of the material.

Material generated from undercut excavation, unclassified excavation or clearing and grubbing operations that is placed directly on shoulders or slope areas, will not be measured separately for payment, as payment for the work requiring the excavation will be considered adequate compensation for depositing and grading the material on the shoulders or slopes.

When undercut excavation is performed at the direction of the Engineer and the material excavated is found to be suitable for use as shoulder and fill slope material, and there is no area on the project currently prepared to receive the material generated by the undercut operation, the Contractor may construct a stockpile for use as borrow at a later date. Payment for the material used from the stockpile will be made at the contract unit price for "Borrow Excavation" or "Shoulder Borrow".

When shoulder material is obtained from borrow sources or from stockpiled material, payment for the work of shoulder construction will be made at the contract unit price per cubic yard (cubic meter) for "Borrow Excavation" or "Shoulder Borrow" in accordance with the applicable provisions of Section 230 or Section 560 of the Standard Specifications.

SP2R50

FLOWABLE FILL: **9-17-02**

Provide and install flowable fill material in accordance with Articles 340-2 of the Standard Specifications.

Discharge flowable fill material directly from the truck into the space to be filled, or by other approved methods. The mix may be placed full depth or in lifts as site conditions dictate. The Contractor shall provide a method to plug the ends of the existing pipe in order to contain the flowable fill.

At locations where flowable fill is called for on the plans and a pay item for flowable fill is included in the contract, the quantity of flowable fill to be paid for will be the actual number of cubic yards (cubic meters) of flowable fill that have been satisfactorily placed and accepted.

The quantity of flowable fill, measured as provided above, will be paid for at the contract unit price per cubic yard (cubic meter) for "Flowable Fill". Such price and payment will be full compensation for all work covered by this provision including but not limited to the mix design, furnishing, hauling, placing and containing the flowable fill.

SP3R30

Payment will be made under:

Flowable Fill ..... Cubic Yard (Cubic Meter)

PRICE ADJUSTMENT - ASPHALT BINDER FOR PLANT MIX: **11-21-00**

Price adjustments for asphalt binder for plant mix will be made in accordance with Section 620 of the Standard Specifications as modified herein.

The base price index for asphalt binder for plant mix is $236.47 per ton (metric ton).

This base price index represents an average of F.O.B. selling prices of asphalt binder at supplier's terminals on September 1, 2005.

SP6R25

DISPOSAL OF WASTE AND DEBRIS: **2-19-02**

Revise the 2002 Standard Specifications as follows:

Page 8-9, Subarticle 802-2(7. Buffer Zones:)

At the end of the last sentence in this subarticle, add the words "unless superseded by an environmental permit."

SP8R03

GUARDRAIL POSTS AND OFFSET BLOCKS: **06-22-04**

Revise the *2002 Standard Specifications* as follows:

Page 10-69, Subarticle 1046-3

Delete this sub-article in its entirety and replace with the following:

1046-3 POSTS AND OFFSET BLOCKS.

(A) General:

The Contractor may at his option furnish either of the following types of steel guardrail posts. Only one type of post will be permitted at any one continuous installation. Use structural steel posts throughout the project, unless otherwise directed or detailed in the plans.

1. Steel W6 x 8.5 or W6 x 9.0 posts
2. Steel 4.5" x 6.0" "C" shape posts (C150 x 12.2 kg/m)

The Contractor may at his option furnish either of the following types of treated timber posts if specifically directed or detailed in the plans. Only one type of post will be permitted at any one continuous installation.

1. Timber 6" x 8" (152 mm x 203 mm) posts.
2. Timber 8" x 8" (203 mm x 203 mm) posts.

(B) Structural Steel Posts:

Fabricate steel posts for guardrail of the size and weight shown on the plans from structural steel complying with the requirements of Section 1072. Metal from which C shape posts are fabricated shall meet the requirements of ASTM A570 for any grade of steel, except that mechanical requirements shall meet the requirements of ASTM A36. Punch or drill the holes for connecting bolts. Burning will not be permitted. After fabrication, the posts shall be galvanized in accordance with Section 1076.

(C) Treated Timber Posts:

Timber guardrail posts shall be of treated southern pine meeting the requirements of Article 1082-2 and 1082-3.

Bore bolt holes to a driving fit for the bolts. A minus tolerance of 1 percent will be allowed in the length of the post. Perform all framing and boring before the posts receive preservative treatment.

(D) Offset Blocks:

Provide 8-inch deep recycled plastic or composite offset blocks that have been approved for use with the guardrail shown in the standard drawings and/or plans. Only one type of offset block will be permitted at any one continuous installation. Prior to beginning the installation of recycled offset block, submit the FHWA acceptance letter for each type of block to the Engineer for approval.

Treated timber offset blocks with steel beam guardrail will not be allowed unless required by Specifications, directed by the Engineer or detailed in the plans. Steel offset blocks with steel beam guardrail will not be allowed.

Recycled plastic or composite offset blocks shall be made from no less than 50% recycled plastic or composite, and shall meet the following minimum requirements:

- Specific Gravity: 0.950
- Compressive Strength in Lateral Direction:..... 1600 psi (11 MPa)
- Maximum Water Absorption: ..... 10% by weight
- Maximum Termite and Ant Infestation:..... 10%
- Testing..... Shall pass NCHRP Report 350, Test Level 3 by CRASH TESTING

Revise the *2002 Standard Roadway Drawings* as follows:

Sheet 4 of 6, Standard 862.03, delete the note and substitute the following:

Note: The midpost and offset block of the WTR section will require special bolt hole drilling in the thrie beam offset block and line post.

SP8R57

GUARDRAIL ANCHOR UNITS, TYPE 350: **04-20-04**

DESCRIPTION

Furnish and install guardrail anchor units in accordance with the details in the plans, the applicable requirements of Section 862 of the Standard Specifications, and at locations shown in the plans.

MATERIALS

The Contractor may at his option, furnish any one of the guardrail anchor units.

Guardrail anchor unit (ET-2000) as manufactured by:

TRINITY INDUSTRIES, INC.
2525 N. STEMMONS FREEWAY
DALLAS, TEXAS 75207
TELEPHONE: 1-800-644-7976

The guardrail anchor unit (SKT 350) as manufactured by:

ROAD SYSTEMS, INC.
3616 OLD HOWARD COUNTY AIRPORT
BIG SPRING, TEXAS 79720
TELEPHONE: (915) 263-2435

Prior to installation the Contractor shall submit to the Engineer:

1. FHWA acceptance letter for each guardrail anchor unit certifying it meets the requirements of NCHRP Report 350, Test Level 3, in accordance with Section 106-2 of the Standard Specifications.

2. Certified working drawings and assembling instructions from the manufacturer for each guardrail anchor unit in accordance with Section 105-2 of the Specifications.

No modifications shall be made to the guardrail anchor unit without the express written permission from the manufacturer. Perform installation in accordance with the details in the plans, and details and assembling instructions furnished by the manufacturer.

CONSTRUCTION

Guardrail end delineation is required on all approach and trailing end sections for both temporary and permanent installations. Guardrail end delineation consists of yellow reflective sheeting applied to the entire end section of the guardrail in accordance with Section 1088-3 of the Standard Specifications and is incidental to the cost of the guardrail anchor unit.

MEASUREMENT AND PAYMENT

Measurement and payment will be made in accordance with Articles 862.5 and 862-6 of the Standard Specifications.

Payment will be made under:

Guardrail Anchor Units, Type 350..... Each

SP8R65

BORROW MATERIAL **02-17-04**

Revise the 2002 Standard Specifications as follows:

Page 10-44

Section 1018-2 II (b) Delete the last sentence in its entirety.

SP10R17

COATED, PAVED AND LINED CORRUGATED STEEL CULVERT PIPE: **10-21-03**

Revise the 2002 Standard Specifications as follows:

Section 1032-4(E) Optional Coatings for Bituminous Coated Pipe and Pipe Arch:

Page 10-58. Delete Numbers 2. and 3., and substitute the following;

2. Type B: In lieu of Type B, Half Bituminous Coated and Partially Paved galvanized pipe, aluminized pipe or polymeric coated pipe without bituminous coating and paving may be used.

3. Type C: In lieu of Type C, Fully Bituminous Coated and Partially Paved galvanized pipe, aluminized pipe or polymeric coated pipe without a bituminous coating and paving may be used.

SP10R25

TRAFFIC CONTROL **01-18-05**
Rev. 06/21/05

Revise the *2002 Standard Specifications* as follows:

WORK ZONE SIGNS

Article 1089-1(A) General is deleted. Substitute the following:

(A) General:

Rigid sign retroreflective sheeting requirements for Types VII, VIII and IX (prismatic) fluorescent are described in Tables 1089-A, 1089-B and 1089-C. Cover the entire sign face of the sign substrate with NCDOT approved Type VII, VIII or IX (prismatic) fluorescent orange reflective sheeting. Apply the reflective sheeting in a workmanlike manner so that there are no bubbles or wrinkles in the material.

Roll-up sign retroreflective requirements are described in Table 1089-D.

1. Work Zones Signs (Stationary)

Use Type VII, VIII or IX (prismatic) fluorescent orange retroreflective sheeting that meets the following reflective requirements in Tables 1089-A, 1089-B or 1089-C respectively. Use approved composite or aluminum for sign backing. Signs and sign supports must meet or exceed NCHRP 350 requirements for Breakaway Devices.

Table 1089-A
Minimum Coefficient of Retroreflection R_A for
TYPE VII Fluorescent Orange Sheeting
(Candelas per lux per square meter)

Observation Angle	Entrance Angle	
	-4°	30°
0.1°	300	170
0.2°	230	130
0.5°	72	41

Table 1089-B
Minimum Coefficient of Retroreflection R_A for
TYPE VIII Fluorescent Orange Sheeting
(Candelas per lux per square meter)

Observation Angle	Entrance Angle	
	-4°	30°
0.1°	300	135
0.2°	210	95
0.5°	75	35

Table 1089-C
Minimum Coefficient of Retroreflection R_A for
TYPE IX Fluorescent Orange Sheeting
(Candelas per lux per square meter)

Observation Angle	Entrance Angle	
	-4°	30°
0.1°	200	110
0.2°	115	65
0.5°	72	41
1.0°	24	14

2. Work Zones Signs (Barricade Mounted)

   Use approved composite or roll-up signs for barricade mounted sign substrates. Approved composite barricade mounted warning signs (black on orange) must be Type VII, VIII or IX sheeting which meet the retroreflective requirements of Table 1089-A, 1089-B or 1089-C. Roll-up mounted barricade warning signs (black on orange) must meet the retroreflective requirements in Table 1089-D. Sign and barricade assembly must meet or exceed the requirements of NCHRP 350 for Work Zone Category II Devices.

3. Work Zones Signs (Portable)

   Use approved composite or roll-up sign substrates on portable sign stands.

   Composite - Use Type VII, VIII or IX (prismatic) fluorescent orange retroreflective sheeting that meets the following reflective requirements in Tables 1089-A, 1089-B or 1089-C. Signs and sign supports must meet or exceed NCHRP 350 requirements for Breakaway Devices.

Roll-up Signs - Use fluorescent orange retroreflective roll-up signs that meet the following reflective requirements:

Table 1089-D
Minimum Coefficient of Retroreflection R_A for Fluorescent Orange Roll-Up Signs
(Candelas per lux per square meter)

Observation Angle	Entrance Angle	
	-4°	30°
0.1°	300	120
0.2°	200	80
0.5°	90	34

Use roll up signs that have a minimum 3/16" x 1 1/4" horizontal rib and 38" x 1 1/4" vertical rib and has been crash test to meet NCHRP 350 requirements and Traffic Control qualified by the Work Zone Traffic Control Unit.

Add the following after 1089-1(C):

(D) Warranty

Warranty requirements for rigid sign retroreflective sheeting Types VII, VIII and IX are described in Subarticle 1093-2(F). Such sheeting shall maintain 80% (Table 1093-10) of its retroreflectivity as shown in Tables 1089 A, B. and C.

Roll-up fluorescent orange retroreflective signs shall maintain 80% of its retroflectivity (Table 1089-D) for years 1 – 2 and 50% for year 3.

Rigid and Rollup Fluorescent orange signs shall maintain a Fluorescence Luminance Factor (Y_F)* of 13% for three (3) years.

*Fluorescence Testing Method is described in ASTM E2301 Test Methods for Fluorescent Retro reflective Sheeting.

Rigid and Roll up fluorescent orange signs shall maintain a total Luminance Factor (Y) of 25 for three (3) years and conform to the requirements of Table 1089-E when measured in accordance with ASTM D4956.

Table 1089-E
Fluorescent Orange colorimetric requirements

Color	1		2		3		4	
	x	y	x	y	x	y	x	Y
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

BARRICADES

Article 1089-3(A) General, delete both paragraphs and substitute the following:

Type III Barricades shall be constructed of perforated square steel tubing and/or angle iron. Provide Type III barricades that use a cross member or stabilization bar and meet the requirements of NCHRP 350 for Work Zone Category II Devices with composite and roll-up signs attached.

Use approved composite or plastic barricade rails that have a smooth face and have alternating orange and white retroreflective stripes that slope at an angle of 45 degrees.

Article 1089-3(C) Reflective Sheeting, delete the first paragraph only and substitute the following:

Use Type VII, VIII or IX (prismatic) retroreflective fluorescent orange sheeting on both sides of the barricade rails. The rail sheeting retroreflectivity values shall meet the retroreflectivity requirements in Table 1089-A, 1089-B or 1089-C and shall be listed on the Department's approved product list or accepted as traffic qualified by the Traffic Control Unit.

SP10R30

DRUMS: **07-16-02**

Revise the 2002 Standard Specifications as follows:

Page 10-195, Subarticle 1089-5(C)

Delete the first (1st) sentence of the first (1st) paragraph and insert the following:

"Provide a minimum of three orange and two white alternating horizontal circumferential stripes covering the entire outside with each drum."

SP11R05

WORK ZONE SIGNS **01-18-05**

Revise the *Standard Specifications* as follows:

DESCRIPTION

Page 11-5, **Article 1110-1 Description**

Replace the second paragraph with the following:

Furnish, install, maintain and relocate portable work zone signs and portable work zone sign stands in accordance with the plans and specifications. When portable work zone signs and portable work zone sign stands are not in use for periods longer than 30 minutes, collapse sign stand and reinstall once work begins.

Replace the last sentence in the third paragraph with the following:

Use work zone signs (portable) only with portable work zone sign stands specifically designed for one another. Work Zone Signs (portable) may be roll up or approved composite.

MATERIALS

Page 11-5, **Article 1110-2 Part (A) General**:

Add the following:

Barricade Mounted Signs.....Article 1089-3

MATERIAL QUALIFICATIONS

Page 11-5, **Article 1110-2 Part (B) Material Qualifications**.

Delete the first sentence in the first paragraph and replace with the following:

Provide portable work zone sign stands, portable signs and sign sheeting which are listed on the North Carolina Department of Transportation's approved product list or accepted as traffic qualified by the Traffic Control Unit.

Delete "Traffic Control Section" in the second sentence of the first paragraph and insert "Traffic Control Unit".

CONSTRUCTION METHODS

Page 11-6, Article 1110-3 CONSTRUCTION METHODS.

Replace **Article 1110-3 (B) Work Zone Signs (Barricade Mounted)** with the following:

Mount approved composite or roll-up signs to barricade rails so that the signs do not cover more than 50 percent of the top two rails or 33 percent of the total area of the three rails. Signs are to be mounted a minimum of 1' from the ground to the bottom of the sign.

Replace **Article 1110-3 (C, 2) Work Zone Signs (Portable)** with the following:

Install portable work zone signs to carry roll-up or approved composite at a minimum height of 1' from the bottom of the sign to the ground on two lane-two way roadways.

Install portable work zone signs to carry roll-up or approved composite at a minimum height of 5' from the bottom of the sign to the ground on multi-lane roadways.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Method of Measurement and Basis of Payment will be in accordance with Section 1110-5 and 1110-6 of the *Standard Specifications*.

SP11R15

PERMANENT SEEDING AND MULCHING: **07-01-95**

The Department desires that permanent seeding and mulching be established on this project as soon as practical after slopes or portions of slopes have been graded. As an incentive to obtain an early stand of vegetation on this project, the Contractor's attention is called to the following:

For all permanent seeding and mulching that is satisfactorily completed in accordance with the requirements of Section 1660, "Seeding and Mulching", and within the following percentages of elapsed contract times, an additional payment will be made to the Contractor as an incentive additive. The incentive additive will be determined by multiplying the number of acres of seeding and mulching satisfactorily completed times the contract unit bid price per acre for "Seeding and Mulching" times the appropriate percentage additive.

Percentage of Elapsed Contract Time	Percentage Additive
0% - 30%	30%
30.01% - 50%	15%

Percentage of elapsed contract time is defined as the number of calendar days from the date of availability of the contract to the date the permanent seeding and mulching is acceptably completed divided by the total original contract time.

SP16R01

TEMPORARY SOIL NAIL WALLS

1.0 GENERAL

The work under this section consists of design, plan preparation and construction of temporary soil nail walls at the locations shown in the plans and in accordance with these specifications.

Temporary soil nailing consists of excavating in lifts, drilling holes into the ground, placing and grouting the nail tendons in the holes, placing geocomposite drain strips and installing weep holes, applying shotcrete facing and installing the nail head anchorage assembly.

The term "Soil Nail" as used in this special provision is intended as a generic term and refers to a reinforcing bar grouted into a drilled hole installed in any type of ground including soil, weathered rock and hard rock.

The Contractor must be experienced in the construction of soil nail walls and have successfully constructed at least 3 projects in the last 3 years involving construction of soil nail walls totaling at least 10,000 square feet (1000 square meters) of wall face area and at least 500 soil nails.

A professional engineer registered in the state of North Carolina employed by the soil nailing Contractor and having experience in the construction of at least 3 completed soil nail retaining wall projects over the past 3 years, must supervise the work. The manufacturers' representatives cannot be used to satisfy the supervising Engineer requirements of this section.

Submit the experience qualifications and details for the referenced design and construction projects, including a brief project description with the owner's name and current phone number. The Engineer will have 15 calendar days to approve or reject the proposed soil nailing Contractor and Designer.

The Contractor is advised to review all available subsurface information and conduct additional investigations, as needed, to determine subsurface conditions such as high groundwater, unstable soil, hard rock, etc. that would adversely affect the cost of construction.

Submit 5 copies of plans and calculations to the Engineer for review and approval and allow 40 calendar days from the date they are received until the Engineer returns them.

A pre-construction meeting is required prior to the start of the work and will be attended by representatives of the Contractor, Wall Subcontractor, Resident Engineer and the Geotechnical Engineering Unit. Soil nailing requires organized coordination of each of these parties. Conduct the pre-construction meeting to clarify the construction requirements, provide appropriate scheduling of the construction activities and identify

contractual relationships and responsibilities. Review of all submittals should be complete prior to scheduling the pre-construction meeting.

2.0 DESIGN CRITERIA AND PLAN REQUIREMENTS

Use the following soil parameters to design the temporary soil nail wall in the absence of any soil parameter information on the plans or laboratory testing on samples collected from the shoring location.

$\phi = 30°$
c= 0 psf (0 Pa)
γ= 120 pcf (18.86 kN/m^3)

The Contractor may elect to perform soil testing to determine soil parameters at the shoring location. Submit the proposed soil parameters to the Engineer for approval prior to using the soil parameters for design.

Design and construct temporary soil nail walls in accordance with the Service Load Design (SLD) procedures contained in the FHWA "Manual for Design and Construction Monitoring of Soil Nail Walls", Report No. FHWA-SA-96-069 and the Soil Nailing Field Inspectors Manual, Publication No. FHWA-SA-93-068. The required partial safety factors, allowable strength factors and minimum global stability soil factors of safety must be in accordance with the FHWA manual, unless specified otherwise. Estimated soil/rock design shear strength parameters, slope and external surcharge loads, type of wall facing and facing architectural requirements, known utility locations, easements and right-of-ways will be as shown on the "Layout Drawings" or specified herein. Structural design of any individual wall elements not covered in the FHWA manual will be by the service load design methods in conformance with Article 3.22 and other appropriate articles of the latest Edition of the AASHTO Standard Specifications for Highway Bridges including current interim specifications.

Shotcrete facing is required and must be a minimum of 4 inches (100 mm) in thickness and reinforced with welded wire and #4 (#13) bars running horizontally above and below the nails and behind the bearing plates.

Geocomposite drainage mats at minimum 10 foot (3 m) centers are required.

A minimum nail inclination of 12 degrees is required. The nail holes must be a minimum of 6 inches (150 mm) and a maximum of 10 inches (250 mm) in diameter with a minimum center to center spacing of 3 feet (1 meter). A minimum clearance from end of soil nail to bottom of nail hole of 6 inches (150 mm) is required.

Do not extend nails beyond the Right of Way or easement line.

The submitted plans should include but will not be limited to the following:

- Elevation views showing all nail locations, proposed ground line elevations and stations and construction joint locations.
- Plan views.
- Section views showing shotcrete reinforcement, vertical nail locations, nail inclinations, drainage details, etc.
- Details of nail head anchorage assemblies, nail holes, drainage mats, etc.
- Verification test nail locations and required design adhesion values.
- Construction sequence.

A professional engineer registered in the state of North Carolina must seal all plans and calculations.

3.0 QUALITY ASSURANCE

The Contractor's superintendent must have a minimum of three years experience and the drill operators and on-site supervisors must have a minimum of one year experience installing soil nails or ground anchors. Prior to starting the work, submit a list identifying the superintendent, drill rig operators and on-site supervisors assigned to the project. The list must contain a summary of each individual's experience and must be sufficiently complete for the Engineer to evaluate the individual qualifications. Consultants or manufacturer's representatives cannot be used to satisfy the requirements of this section.

All nozzlemen are required to have at least one year of continuous experience in similar shotcrete application work and must demonstrate ability to satisfactorily place the material in accordance with the recommendations of ACI 506.3R Guide to Certification of Shotcrete Nozzlemen. Evidence that the proposed nozzelman have been certified to the requirements of ACI 506.3R within the last five years is required.

Work cannot be started nor materials ordered until the Contractor's personnel qualifications have been approved by the Engineer. The Engineer may suspend the work if the Contractor substitutes non-approved personnel for approved personnel. The Contractor will be fully liable for costs resulting from the suspension of work and no adjustments in the contract time resulting from the work suspension will be allowed.

4.0 CONSTRUCTION SUBMITTALS

Provide the following submittals for the Engineer's review and approval. Changes or deviations from the approved submittals must be re-submitted for approval by the Engineer. The Contractor will not be allowed to begin wall construction until all submittal requirements are satisfied and found acceptable to the Engineer. No adjustments in contract time will be allowed due to incomplete submittals. Items listed below that have been included on the contractor prepared plans need not be resubmitted.

At least 30 days prior to initiating the work, submit to the Engineer:

1. Proposed schedule and detailed construction sequences.

2. Methods of excavation to the staged lifts indicated in the plans and excavation equipment types.

3. Drilling methods and equipment.

4. Nail grout mix design including:
   - Brand and type of Portland cement.
   - Source, gradation and quality of all aggregates.
   - Proportions of mix by weight.
   - Compressive strength test results (per AASHTO T106) verifying the required minimum seven day grout compressive strengths or previous test results completed within one year of the start of the work may be submitted for verification of the required compressive strength.

5. Nail grout placement procedures and equipment.

6. Soil nail testing methods and equipment including:
   - Details of the jacking frame and appurtenant bracing.
   - Details showing methods of isolating test nails during shotcrete application (i.e., methods to prevent bonding of the soil nail bar and the shotcrete).
   - Details showing methods of grouting the unbounded length of test nails after completion of testing.
   - Equipment list.

7. Identification number and certified calibration records for each load cell, test jack pressure gauge and jack master pressure gauge to be used. Calibration records must include the date tested, device identification number and the calibration test results and be certified for an accuracy of at least two percent of the applied certification loads by a qualified independent testing laboratory within 30 days prior to submittal.

8. Certified mill test results for nail bars together with properly marked samples from each heat specifying the ultimate strength, yield strength, elongation and composition.

9. Certifications of compliance for bearing plates and nuts.

10. A detailed construction dewatering plan addressing all elements necessary to divert, control and dispose of surface water.

11. Certified shotcrete mix designs including:
    - Brand and type of Portland cement used.
    - Source, gradation and quality of aggregates as specified herein.
    - Proportions of mix by weight.
    - Proposed admixture, manufacturer, dosage, technical literature if allowed.
    - Compressive strength test results verifying the 3-day and 28-day compressive strengths.

12. Certified mill tests for all reinforcing steel together with properly marked samples from each heat specifying the minimum ultimate strength, yield strength, elongation and composition.

13. Complete engineering data for the drainage geotextile and geocomposite drain strip including a 1 ft (300 mm) square sample, manufacturers' certificate of compliance and installation instructions.

14. Certifications of Compliance for weep hole drainage pipes and curing compounds (if used).

15. Specification and data for review on equipment proposed for the project including shotcreting and compressed air equipment, proposed access arrangements and capacities.

5.0 MATERIALS

All materials must conform to the requirements of the applicable sections of the Standard Specifications for Roads and Bridges of the North Carolina Department of Transportation and the following provisions:

Centralizers	PVC pipe or tube, steel or other material not detrimental to the nail steel (wood cannot be used); securely attached to the nail bar; sized to position the nail bar within 1 inch (25 mm) of the center of the drill hole; sized to allow tremie pipe insertion to the bottom of the drill hole; and sized to allow grout to freely flow up the drill hole.
Nail Grout	Neat grout is to be used with a minimum seven day compressive strength of 3000 psi (21 MPa) per AASHTO T106 and a minimum cement of nine sacks per cubic yard.
Cement	Portland Cement conforming to AASHTO M85 Type I, II or III.
Fine Aggregate	Clean, natural sand, AASHTO M6. Artificial or manufactured sand will not be accepted.
Coarse Aggregate	AASHTO M-80, Class B for quality.

Water	Potable, clean and free from substances deleterious to concrete and steel or elements that would cause staining.
Chemical Admixtures	ASTM C1141 and the following:
Accelerator	Fluid type, applied at nozzle, meeting requirements of ASTM D98, C494 Types C or E and C266.
Water-reducer and Superplastisizer	AASHTO M-194, Type A, D, F or G.
Air-Entraining Agent	AASHTO M-194.
Plasticizers	AASHTO M-194, Type A, D, F or G.
Mineral Admixtures:	
Fly Ash	AASHTO M-295, Type F or C.
Silica Fume	ASTM C1240, 90 percent minimum silicon dioxide solids content, not to exceed 12 percent by weight of cement.
Reinforcing Bars	AASHTO M-31, Grade 60 or 75 (420 or 520), deformed. See Section 1070 of the Standard Specifications .
Welded Wire	AASHTO M55/ASTM A185 or A497.
Curing Compounds	AASHTO M-148, Type ID of Type 2.
Excavation Protection	AASHTO M-171 or Polyethylene film.
Solid Bar Nails	AASHTO M31, Grade 60 or 75 (420 or 520) (or Grade 150, 1035 for testing only), threaded steel bars without splices or welds. All bars must be new, straight and undamaged.
Bearing Plates	AASHTO M183 steel plates bearing plates must be furnished by the nail bar manufacturer.
Nuts	AASHTO M291, Grade B, hexagonal fitted with beveled washer or spherical seat to provide uniform bearing. Nuts must be furnished by the nail bar manufacture.
Washer	AASHTO M291 steel.

Joint Filler & Sealant	Section 1028 of the Standard Specifications.
Geocomposite Drain	Miradrain 6200 or Equal.
Weep Hole	ASTM 1785 Schedule 40 PVC, solid and perforated wall.
Drainage Pipe	Cell classification 12454-B or 12354-C, wall thickness SDR 35, with solvent weld or elastomeric gasket joints.
Fittings	ASTM D3034, cell classification 12454-B or 12454-C, wall thickness SDR 35, with solvent weld or elastomeric gasket joints.

6.0 HANDLING AND STORAGE

Carefully handle and store all steel reinforcement items and nail steel on supports to prevent contact with the ground. Damage to the nail steel as a result of abrasion, cuts or nicks, welds and weld spatter will be cause for rejection. Grounding of welding leads to the nail steel will not be allowed. Protect nail steel from dirt, rust and other deleterious substances at all times. Corrosion or pitting of the nails will be cause for rejection.

Provide drainage geotextile and geocomposite drains in rolls wrapped with a protective covering and store in a manner that protects the fabric from mud, dust, dirt, debris and shotcrete rebound. Do not remove protective wrapping until the geotextile or drain strip is installed. Avoid extended exposure to ultra-violet light. Label each roll of geotextile or drain strip in the shipment to identify that production run.

Adequately store cement to prevent moisture degradation and partial hydration. Do not use cement that is caked or lumpy.

7.0 DEWATERING AND DAMAGE CONTROL

Localized areas of perched water may be encountered at the interface of geologic units. Contact the Engineer if groundwater problems persist at the excavation face.

Provide all labor, equipment and materials required to maintain the work area in a sufficiently dry condition such that adverse water related effects do not occur during the construction period. Provide positive control and discharge of all surface water and perched ground water, if encountered, to the extent necessary to prevent adverse conditions as determined by the Engineer.

Damage caused by failure of the construction dewatering and drainage control plan to existing structures, soils or structures included in the work will be repaired by the Contractor to the Engineer's satisfaction at no additional cost to the Department.

The Contractor will be responsible for the condition of any pipe or conduit which may be used for temporary construction dewatering and all such pipes or conduits must be maintained clean and free of sediment during construction. Upon substantial completion of

the work, remove construction dewatering conduits from the site. Alternatively, construction dewatering conduits can be fully grouted (abandoned) or left in a manner that protects the structure and all adjacent facilities from migration of fines through the conduit and potential ground loss.

All dewatering and drainage control costs will be considered incidental to the cost of the temporary soil nail wall.

8.0 EXCAVATION

A. Mass Grading

Overexcavating the original ground beyond the final wall face will not be allowed. In the event that overexcavation beyond the final wall face occurs as a result of the Contractor's operations, restore such overexcavation using a method approved by the Engineer and at no additional cost to the Department.

B. Wall Face Excavation

Excavate from the top down in a staged horizontal lift sequence as shown in the plans. The excavated surface ("neat line") must be within 6 inches (150 mm) of the location shown on the approved submittals. Do not excavate the ground level in front of the wall face more than 3 feet (1 m) below the level of the row of nails to be installed in that lift. Do not excavate a lift until nail installation, reinforced shotcrete placement and nail testing for the preceding lift are complete and acceptable to the Engineer. Prior to advancing the excavation, allow shotcrete and nail grout on the preceding lift to cure for a minimum one day and three days, respectively. After a lift is excavated, clean the cut surface of all loose materials, mud, rebound and other foreign material that could prevent or reduce shotcrete bond.

Take all necessary measures to ensure that installed nails are not damaged during excavation. Repair or replace to the satisfaction of the Engineer and at no cost to the Department nails that are damaged or disturbed during excavation. Remove hardened nail grout protruding from the final wall excavation more than 2 inches (50 mm) in a manner that prevents fracturing the grout at the nail head. Sledge hammer removal of the grout is not allowed. The use of hand held rock chippers is acceptable provided their use does not damage or disturb the remaining grout at the nail head, the nail bar or the surrounding exposed ground.

Complete the excavation to the final wall face ("neat line") and application of the shotcrete in the same work shift unless otherwise approved by the Engineer. Extensions of the excavation face exposure period must be approved by the engineer. The Contractor must demonstrate for each material type at his own expense that the unsupported final excavation face will be stable over the proposed extension of the exposure period. Extensions to the face exposure period will be periodically reviewed and may be revoked by the Engineer at his discretion. Risk of damage to existing structures or structures included in this work will be borne by the Contractor where

approval for extended face exposure period is granted by the Engineer. Where extension of the face exposure period is allowed, provide and install polyethylene sheets (properly anchored to the top and bottom of the excavation) to reduce degradation of the cut face caused by changes in soil moisture, unless otherwise approved by the Engineer.

C. Wall Discontinuities

Where the Contractor's excavation and installation methods result in a discontinuous wall along any continuous nail row, the ends of the wall at the points of discontinuity must be constructed to prevent sloughing or failure of the temporary slopes. Submit a plan for wall discontinuity construction sequencing and shoring to the Engineer for review and approval at least 30 days prior to starting work on the affected wall sections.

D. Protrusions and Voids

Remove all cobbles, boulders, rubble or debris which are encountered at the soil face during excavation and which protrude from the soil face more than 2 inches (50 mm) into the design shotcrete thickness shown on the plans. Backfill any overexcavations with shotcrete. Any shotcrete used to fill voids created by the removal of cobbles and boulders or other obstructions will be considered incidental to the shotcrete wall facing and no additional payment will be made. Generally, rocky ground such as colluvium, hard rock, fill with boulders and weathered rock will be difficult to excavate on a neat line without leaving pockets and voids. The Contractor is recommended to evaluate the subsurface conditions in order to anticipate the total volume of shotcrete needed.

E. Excavation Face Instability

Raveling or local instability of the final wall face excavation due to the presence of groundwater, problematic soil conditions, equipment vibrations or other causes must be brought to the immediate attention of the Engineer.

Temporarily stabilize unstable areas by means of buttressing the exposed face with an earth berm or other methods acceptable to the Engineer. Suspend work in unstable areas until remedial measures submitted by the Contractor and approved by the Engineer have successfully stopped facial instability.

Timber backing or lagging behind soil nail walls that is to remain in place and if greater than 1 inch (25 mm) total thickness must be pressure treated with wood preservative for soil and fresh water use in accordance with AWPB LP-22 to a minimum retention 4 pounds per cubic foot (0.06 kilonewtons per cubic meter). Use one of the following wood preservatives: Creosote, Creosote-Coal tar solution, Penta Chlorophenol, Copper Naphthenate, ammonia copper arsenate, ammoniacal, copper zinc arsenate, acid copper chromate or chromated copper arsenate

F. Access

If temporary work benches are required to install the nails, locate these benches behind any traffic barriers placed for protection of existing traffic. Payment for temporary work benches including the placement and removal of fill and any temporary shoring required will be considered incidental to the cost of the temporary soil nail wall. Equipment and nails may hang over the existing lanes; however, implement lane closures in accordance with the Traffic Control Plans such that equipment and nails do not hang over or into traffic.

9.0 INSTALLATION

A. Classification of Materials

No classification of drilled materials will be made except for identification purposes. Nail installation will include the removal and subsequent handling of all materials encountered in drilling the holes to the required lengths.

B. Equipment

Use drilling equipment that can drill straight and clean holes and has the size and capability to install nails as specified herein. This will include drill rigs with the capability of nail installation and grout placement through the drill casing or hollow-stem auger where drill hole stability cannot be maintained in open holes. Provide sufficient casing/auger lengths on site to maintain uninterrupted installation of soil nails. Where hard drilling conditions such as rock, cobbles, boulders or obstructions are encountered, a down-hole, pneumatic hammer drill bit may be required to advance the nail holes.

C. Drilling

Drill each nail hole at the locations and to the lengths and minimum diameters indicated in the approved submittals unless otherwise approved by the Engineer. Remove cuttings from the holes using compressed air or by mechanical auger flights. Compressed air may not be used where raveling or erodible conditions cause significant disturbance or voids to develop or where facial instability is induced. Water, drilling muds or other fluids used to assist in cutting removal will not be allowed. At final penetration depth, thoroughly clean and make ready the nail hole for examination by the Engineer before nail bar installation or placement of grout. No portion of the nail hole may be left open for more than 60 minutes prior to grouting unless otherwise approved by the Engineer.

D. Nail Hole Support

Provide positive support of the hole during drilling as required to prevent excessive groundwater infiltration or sloughing and caving of the hole prior to nail insertion and/or grouting. Where caving and sloughing occurs, no further drilling will be

allowed until the Contractor selects a method which prevents ground movement. Holes must be continuously supported by casing or alternate methods approved by the Engineer. Drilling fluids such as bentonite or water will not be allowed as a means of hole support. All installation material and other costs due to casing holes will be at no additional expense to the Department.

Provide casing made of steel construction and of ample strength to withstand handling and installation stresses, grout pressure, surrounding earth and groundwater pressures. Remove casings as the grout is placed. The casing extraction may be facilitated by the use of a vibratory extractor, if required. During removal, continually align the casing with the hole.

E. Optional Nail Installation Methods

Optional nail installation methods will require the approval of the Engineer. At the Contractor's option, a thin shotcrete layer may be installed prior to drilling nail holes provided that this construction sequence has been documented and approved by the Engineer. Include in the Contractor's documentation calculations demonstrating the bearing plates are adequate to service the design loads and transfer the stress to the wall by neglecting the bearing area beneath the plate encompassed by the drill hole or block out.

F. Production Nails

No drilling or bar placement for production nails will be allowed without prior written approval by the Engineer of the proposed drilling, installation and grouting methods. Only installation methods that have been successfully verification tested will be approved for production nail installation. Methods which fail to meet the verification and proof test acceptance criteria will be rejected. Methods that differ from those used during installation of verification nails will require additional verification nails prior to approval at no additional cost to the Department.

Provide bar sizes and grades for each nail hole as indicated in the approved submittals. Fit the bar with centralizers as shown in the plans and insert into the drill hole to the required depth without difficulty and in such a manner as to prevent damage to the drill hole. Where the bar cannot be completely inserted, remove the bar and clean or redrill the hole to permit unobstructed installation. Partially installed bars may not be driven or forced into the drill hole and will be rejected. When using open-hole drilling methods are being used, hole cleaning tools suitable for cleaning drill holes along their full length just prior to bar insertion and/or grouting are required.

G. Grouting

Grout the drill hole after installation of the nail bar. Grouting prior to insertion of the nail bar may be allowed provided neat grout without sand is used and the nail bar is immediately inserted through the grout to the specified design length without difficulty. Nails inserted in the grout that has taken set will be rejected and must be replaced at no

additional cost to the Department. No portion of the nail hole may be left open for more than 60 minutes prior to grouting unless otherwise approved by the Engineer. Inject grout at the lowest point of each drill hole through a grouting conduit and fill the hole in one continuous operation. Gravity flow of grout into the nail hole from the excavation face will not be allowed. Cold joints in the grout placement will not be allowed, except for proof test nails. Pump the grout through a grout tremie pipe, casing, hollow-stem auger or drill rods. Maintain the conduit delivering the grout at least 5 feet (1.5 m) below the surface of the grout as the conduit is withdrawn. Withdraw the grouting conduit at a slow and even rate as the nail hole is filled in a manner that prevents the creation of voids. A sufficient quantity of grout to fill the entire nail hole must be available in delivery trucks or grout mixing/pumping plants when the first grout is placed in each nail hole. Record the quantity of grout and the grouting pressures.

If the grouting of any nail is suspended for more than 30 minutes before grouting is complete or if the quality of the grout placement results in a nail that does not satisfy any of the requirements specified herein, then remove and dispose of the steel and grout and install fresh grout and undamaged steel at no additional cost to the Department.

1. Grout Testing

   Provide nail grout that has a minimum compressive strength of 3000 psi (21 Mpa) in seven days. Test the nail grout in accordance with AASHTO T106 at a frequency no less than every 50 cubic yards (38 cubic meters) of grout placed or once per week, which ever comes first.

2. Grouting Equipment

   Provide grouting equipment that produces a uniformly mixed grout free of lumpy and undispersed cement. A positive displacement grout pump is required. Use a pump with a pressure gauge which can measure at least twice but no more than three times the intended grout pressure and a stroke counter (for piston-type grout pumps). Grout pumps without the specified pressure gauge and piston-type grout pumps without a stroke counter may not be used. Size the grouting equipment to be able to grout the entire nail in one continuous operation. A mixer that is capable of continuously agitating the grout during usage is required.

H. Attachment of Bearing Plate and Nut

Attach the bearing plate and nut as shown in the approved submittals. Seat the plate by hand wrench tightening the nut such that uniform contact with the shotcrete is achieved while the shotcrete is still plastic and prior to its initial set. Where uniform contact between the plate and the shotcrete cannot be provided, seat the plate on a mortar pad to provide uniform support. Once the mortar pad has attained strength (minimum one day), hand tighten the nut with a wrench.

Replace bearing plates that are damaged or defective as determined by the Engineer at no additional cost to the Department.

I. Test Nail Unbonded Length

Isolation of the nail bar tendon for production proof test nails is required to prevent bonding of the shotcrete to the nail bar. Isolation through the shotcrete facing must be made in a manner which maintains the tolerances of reinforcing steel behind the bearing plate. Blockouts in the shotcrete that result in no reinforcing below the nail head will not be allowed. Submit details of the method of test nail isolation through the shotcrete facing and the method by which the unbonded length of production proof test nails will be maintained during testing and grouted back after testing to the Engineer for approval.

10.0 SHOTCRETING

Furnish all materials, equipment, tools and labor required for placing and securing geocomposite drainage material, weep holes and reinforced shotcrete. If necessary, trim and clean the soil/rock surfaces and shotcrete cold joints prior to shotcreting.

Shotcrete must comply with the requirements of ACI 506R, "Specification for Shotcrete", except as otherwise specified. Shotcrete consists of an application of one or more layers of mortar or concrete conveyed through a hose and pneumatically projected at a high velocity against a prepared surface.

Shotcrete may be produced by either a dry-mix or a wet-mix process. The wet-mix process consists of thoroughly mixing all the ingredients except accelerating admixtures but including the mixing water, introducing the mixture into the delivery equipment and delivering it, by positive displacement, to the nozzle. The wet-mix shotcrete may then be air jetted from the nozzle at high velocity onto the surface. Dry-mix process is shotcrete without mixing water which is conveyed through the hose pneumatically and the mixing water is introduced at the nozzle.

A. Mix Design

No shotcrete admixture may be used without the Engineer's approval. Thoroughly mix at the rate specified by the manufacturer any admixtures used to entrain air, reduce water-cement ratio, retard or accelerate setting time or accelerate the development of strength. Accelerating additives must be compatible with the cement used, be non-corrosive to steel and not promote other detrimental effects such as cracking and excessive shrinkage. The maximum allowable chloride ion content of all ingredients may not exceed 0.10% when tested to AASHTO T260.

1. Aggregate

Provide aggregate for shotcrete that meets the strength and durability requirement of AASHTO M-80 and M-43 and the following gradation requirements:

Sieve Size	% Passing by Weight
1/2 inch (13 mm)	100
3/8 inch (10 mm)	90-100
No. 4	70-85
No. 8	50-70
No. 16	35-55
No. 30	20-35
No. 50	8-20
No. 100	2-10

2. Proportioning

Proportion and deliver shotcrete with a minimum cement content of 658 pounds per cubic yard (390 kilograms per cubic meter). Aggregate cement ratio may not be more than 4.5 by weight and water/cement ratio may not be more than 0.45. For wet-mix shotcrete the air content at delivery to the pump should be in the range of 7 to 10 percent when tested in accordance with ASTM C231.

3. Strength Requirements

Produce a shotcrete mix capable of attaining 2000 psi (14 MPa) compressive strength in three days and 4000 psi (28 MPa) in 28 days. The average compressive strength of each set of three cores should be equal to or exceed 85 percent with no individual core less than 75 percent of the specified compressive strength.

4. Mixing and Batching

Aggregate and cement may be batched by weight or by volume in accordance with the requirements of ASTM C91 and ASTM C685, respectively. Provide mixing equipment that is capable of thoroughly mixing the materials in sufficient quantity to maintain continuity during placement. Ready mix shotcrete must comply with AASHTO M-157. Batch, deliver and place ready mix shotcrete within 90 minutes of mixing.

B. Field Quality Control

Both preconstruction and production shotcrete test panels are required. Do not disturb test panels within the first 24 hours. Field cure the test panels under conditions similar to those anticipated for the work.

Perform field control tests in the presence of the Engineer. Provide equipment, materials and the services of one or more employees as necessary to obtain shotcrete cores for testing including construction of test panel boxes, field curing requirements and coring. The Department will perform compressive strength testing in accordance with ACI 506R. The frequency specified for test panels is approximate. The Engineer may require a greater or lesser number of panels.

Preconstruction and production test panels must be 18 x 18 inches (450 x 450 mm) and a minimum of 4 inches (100 mm) thick.

Test reports that indicate unsatisfactory compressive shotcrete properties will result in suspension of the crew responsible for the unsatisfactory specimens until they have demonstrated that they are capable of producing acceptable work or until additional specimens have been submitted, tested and proven satisfactory. Cost associated with field quality control testing including additional testing and lost production due to tests failing to meet the specifications will be borne by the Contractor.

1. Preconstruction Test Panels

   Furnish at least two preconstruction test panels for each proposed mixture being considered and for each shooting position to be encountered on the job, made by each application crew. Preconstruction test panels must be made by each application crew using the equipment, materials, mixture proportions and procedures proposed for the job prior to the commencement of work.

   Preconstruction test panels for plain shotcrete must be in accordance with ACI 506.2 and the following:

   a. Provide one preconstruction test panel with the maximum shotcrete thickness and the maximum anticipated reinforcing congestion. Cores extracted from the test panel must demonstrate adequate cover of the reinforcement and must be equal to core grade two or better in accordance with ACI 506.2.

   b. Provide one preconstruction test panel at least 4 inches (100 mm) thick without reinforcement for compressive strength testing.

   c. Slope the sides of the test panels at 45 degrees.

2. Production Test Panels

   Furnish at least one production test panel or, in lieu of production test panels, six 3 inch (75 mm) diameter cores from the shotcrete face for every 5000 square feet (460 square meters) or 50 cubic yards (38 cubic meters) of shotcrete placed, whichever is less. Construct the production test panels simultaneously with the shotcrete facing installation at times designated by the Engineer.

3. Core Testing

   Cut at least six core samples from each pre-construction test panel and production test panel at the frequency specified herein. Soak cores in water for at least 40 hours in accordance with AASHTO T24. Cores should be at least 3 inches (75 mm) in diameter and have a minimum length to diameter ratio of one. When the length of a core is less than twice the diameter, apply correction factors given in ASTM

C42 to obtain the compressive strength of individual cores. Test three cores at 3-days and three more cores at 28-days for compressive strength testing.

Fill core holes in the wall with patching mortar or shotcrete after cleaning and thoroughly dampening.

4. Visual Observation

A clearly defined pattern of continuous horizontal or vertical ridges or depressions at the reinforcing elements after they are covered will be considered an indication of insufficient cover of reinforcement or poor application and probable voids. In this case the application of shotcrete will be immediately suspended and the work carefully inspected by the Engineer. Implement and complete corrective measures prior to resuming the shotcrete operations.

The shotcrete procedure may be corrected by adjusting the nozzle distance and orientation perpendicular to the surface, adjusting the water content of the shotcrete mix or other means acceptable to the Engineer. If necessary, broom and roughen the shotcreted surface to ensure proper bond of subsequent layers.

C. Shotcrete Alignment Control

Provide alignment wires and/or thickness control pins to establish shotcrete thickness and maintain a plain surface. The maximum distance between the wires on any surface should be equal to the vertical nail spacing. Ensure that the alignment wires are tight, true to line and placed to allow further tightening.

D. Surface Preparation

Prior to shotcreting the "birds beak" (ungrouted zone of the nail drill hole near the face), remove all loose materials from the surface of the grout and prepare the joint in accordance with all requirements for joint construction specified herein.

Remove all loose materials and loose dried shotcrete from all receiving surfaces by methods acceptable to the Engineer. Accomplish the removal in such a manner as not to loosen, crack or shatter the surfaces to receive the shotcrete. Any surface material which, in the opinion of the Engineer, is so loosened or damaged must be removed to a sufficient depth to provide a base that is suitable to receive shotcrete. Remove material that loosens as the shotcrete is applied. Do not place shotcrete on frozen surfaces.

E. Delivery and Application

Maintain a clean, dry, oil-free supply of compressed air sufficient for providing adequate nozzle velocity for all parts of the work at all times. Use equipment that is capable of delivering the premixed material accurately, uniformly and continuously

through the delivery hose. Control thicknesses, methods of support, air pressure and rate of placement of shotcrete to prevent sagging or sloughing of freshly-applied shotcrete.

Apply the shotcrete from the lower part of the area upwards to prevent accumulation of rebound on uncovered surfaces. Where shotcrete is used to complete the "birds beak" (ungrouted zone of the nail drill hole near the face), the nozzle must be positioned into the mouth of the drill hole to completely fill the void. Do not use or salvage rebound shotcrete. Remove rebound which does not fall clear of the working area. Hold the nozzle at a distance and an angle approximately perpendicular to the working face so that rebound will be minimal and compaction will be maximized. Rotate the nozzle steadily in a small circular pattern.

F. Defective Shotcrete

Repair surface defects as soon as possible after initial placement of the shotcrete. Remove all shotcrete which lacks uniformity, exhibits segregation, honeycombing or lamination or contains any voids or sand pockets and replace with fresh shotcrete to the satisfaction of the Engineer.

G. Construction Joints

Uniformly taper construction joints toward the excavation face over a minimum distance equal to the thickness of the shotcrete layer. Clean and prepare the surface of the nail grout at the face of the wall to receive shotcrete in a manner equal to all other construction joints.

H. Finish

Shotcrete finish should be either an undisturbed gun finish as applied from the nozzle or a screened finish.

I. Climate

Do not place shotcrete in cold weather when the ambient temperature is below 40°F (4.5°C) and the shotcrete is likely to be subjected to freezing temperatures before gaining sufficient strength to avoid damage. Maintain cold weather protection until the strength of the in-place shotcrete is greater then 750 psi (5.2 MPa). Cold weather protection may include heating under tents, blankets or other means acceptable to the Engineer. Materials may be heated in order that the temperature of the shotcrete, when deposited, is not less than 50°F (10°C) or more than 90°F (32°C).

Suspend shotcrete application during high winds and heavy rains when in the opinion of the Engineer the quality of the application is not acceptable. Remove and replace shotcrete that is exposed to rain and washes out cement or otherwise makes the shotcrete unacceptable to the Engineer. Provide polyethylene sheeting or equivalent

when adverse exposure to weathering is anticipated. Secure polyethylene film to the top and bottom of the excavation.

11.0 WALL DRAINAGE NETWORK

The drainage network consists of installing prefabricated geocomposite drainage strips and weep hole drain pipes as shown in the approved submittals or as directed by the Engineer. Install all elements of the drainage network prior to shotcreting.

A. Geocomposite Drainage Strips

Install geocomposite drain strips as shown in the approved submittals. Place drain strips at construction joints such that the joint is aligned as close as practical along the middle of the longitudinal axis of the drain strip.

Use geocomposite drain strips at least 12 inches (300 mm) wide and secure to the cut face with the geotextile side against the ground before shotcreting. Use securing pins at least 8 inches (200 mm) long with a 1.5 inch (38 mm) diameter head on a minimum grid pattern of 24 inches (600 mm) on center. Discontinuous drain strips are not allowed. If splices are needed, overlap a minimum of 12 inches (300 mm).

When the drain strips cannot be secured tight against the excavation face, place polyethylene film over the drain edges to prevent excess shotcrete from entering the sides of the drain. Alternatively, the drains may be installed in 16 inch (400 mm) wide strips and the film omitted.

B. Weep Hole Drainage Pipes

Install weep hole drainage pipes at locations shown in the approved submittals or as directed by the Engineer. The distance between each weep hole may not be more than 10 feet (3 m). Install pipes of solid PVC pipe to direct water from the geocomposite drain strips to the outside of the facing. Connect the pipes to the drain strips by installing prefabricated drain grates in accordance with the drain strip manufacturer's recommendations. Seal the joint between the drain grate and the drain strip and the drainage pipe to prevent shotcrete intrusion. Damage of the geocomposite drainage board which, in the opinion of the Engineer, may cause interruption in flow will require installation of additional weep holes, at the Contractor's expense.

12.0 NAIL TESTING

Both verification and proof testing of the nails are required. Supply all material, equipment and labor to perform the tests. The Engineer will collect all required data with the assistance of the Contractor. Testing of nails may not be performed within three days of nail grout placement or shotcrete application, whichever occurs last.

Where temporary casing of the unbonded test length of test nails is provided, place the casing in a manner which precludes causing any reaction between the casing and the grouted zone of the nail and/or the stressing apparatus during nail testing.

A. Testing Equipment

Two dial or vernier gauges, a dial gauge support, jack and pressure gauge, master pressure gauge and a reaction frame are required for testing.

Use a minimum of two dial or vernier gauges capable of measuring to 0.001 inch (.025 mm) to measure the nail movement. The dial gauges should have a minimum stroke of 3 inches (75 mm). Align the dial gauges within five degrees from the axis of the nail and support the dial gauges independently of the jacking set-up and the wall. Apply the test load with a hydraulic jack and a pump.

The jack and pressure gauge must be calibrated by an independent testing laboratory as a unit. Provide a pressure gauge that is graduated in 1000 psi (700 KPa) increments or less and has a range not exceeding twice the anticipated maximum pressure during testing unless otherwise approved by the Engineer. Use the pressure gauge to measure the applied load. The minimum ram travel of the jack may not be less than 4 inches (100 mm). The jack should be capable of applying each load in less than one minute.

Independently support and center the jack over the nail so that the nail does not carry the weight of the jack. Calibrate the master pressure gauge with the test jack and pressure gauge as a unit. Monitor the loads on the nails during the verification tests with both the master pressure gauge and electric load cell. The load cell will be used to maintain constant load hold throughout the creep test. Provide recent calibration curves. Place the stressing equipment over the nail in such a manner that the jack, bearing plates, load cell and stressing anchorage are in alignment. Position the jack at the beginning of the test such that unloading and repositioning of the jack during the test is not required.

Provide a reaction frame that is sufficiently rigid and of adequate dimension such that excessive deformation of the test apparatus requiring repositioning of any components does not occur. Where the reaction frame bears directly on the shotcrete, the reaction frame must be designed to prevent fracture of the shotcrete. No part of the reaction frame may bear within 6 inches (150 mm) of the edge of the test nail blockout unless otherwise approved by the Engineer.

B. Verification Testing

Perform verification testing horizontally prior to procuring materials for or installation of production nails to verify the Contractor's installation methods, soil conditions, nail capacity and design assumptions. Verification tests must be performed within the limits of the work area. A minimum of two verification tests or one verification test for each set of assumed soil parameters, which ever is greater, are required at locations

approved by the Engineer. Additional verification tests are required where ground conditions differ from those anticipated or as shown in the approved submittals.

Submit details of the verification testing arrangement including the method of distributing test load pressures to the excavation surface (reaction frame), test nail bar size and grade, grouted hole diameter and reaction plate dimensioning to the Engineer for approval. All verification nail testing must be performed using the same equipment, methods and hole diameter as planned for the production nails. Changes in the drilling or installation method may require additional verification testing as determined by the Engineer at no additional cost to the Department. The nails used for the verification tests are sacrificial and may not be incorporated into the production nail schedule.

Test nails will have both bonded and unbonded lengths. Prior to testing only the bonded length of the test nail may be grouted. The unbonded length of the test nail must be at least 5 feet (1.5 m) unless otherwise approved by the Engineer. The bonded length of the test nail will be based on the bar grade and size such that the allowable bar load is not exceeded, but may not be less than 10 feet (3 m) unless otherwise approved by the Engineer. The allowable bar load during testing may not exceed 80 percent of the ultimate strength of the steel for Grade 150 (1035) bars or 90 percent of the yield strength for Grade 60 and 75 (420 and 520) bars. The minimum bond length of 10 feet (3 m) may require larger or higher grade bars than the production nails in order to achieve 200% of the design load without overstressing the bar. Provide higher capacity bars instead of shortening the bond length too less than the minimum.

The verification test bonded length L_{BV} may not exceed the test allowable bar load divided by two times the design adhesion value. Use the following equation for sizing the test nail bond length to avoid overstressing the verification nail bar:

$$L_{BV} \leq \frac{C f_y A_s}{2 A_D}$$

Where:
- L_{BV} = Maximum Verification Test Nail Bond Length (ft or m)
- f_y = Bar Yield Stress (ksi or kPa)
- A_s = Bar Area (in^2 or m^2)
- A_D = Design Adhesion (kips/ft or kN/m)
- C = 0.8 for Grade 150 (1035) Bar and 0.9 for Grade 60 and 75 (420 and 520) Bars

Determine the design load during testing by the following equation:

$$DTL = L_B \times A_D$$

Where:
- DTL = Design Test Load
- L_B = As-Built Bonded Test Length (ft or m)
- A_D = Design Adhesion (kips/ft or kN/m)

Load and unload verification test nails to twice the design test load (DTL) in accordance with the following schedule.

LOADING		UNLOADING	
LOAD	HOLD TIME	LOAD	HOLD TIME
AL	1 minute	1.75DTL	Until Stable
0.25DTL	10 minutes	1.50DTL	Until Stable
0.50DTL	10 minutes	1.25DTL	Until Stable
0.75DTL	10 minutes	1.00DTL	Until Stable
1.00DTL	10 minutes	0.75DTL	Until Stable
1.25DTL	10 minutes	0.50DTL	Until Stable
1.50DTL	60 minutes	.25DTL	Until Stable
1.75DTL	10 minutes	AL	Until Stable
2.00DTL	10 minutes		

Hold each load increment for at least ten minutes. Monitor the verification test nail for creep at the 1.50 DTL load increment. Measure and record nail movements during the creep portion of the test at 1, 2, 3, 5, 6, 10, 20, 30, 50 and 60 minutes. Extended creep measurements may be required as determined by the Engineer. Maintain all load increments within five percent of the intended load during the creep test using the load cell. Unload the nail in increments of 25 percent with deflection measurements recorded at each unload increment. Each unload increment may be held only for a sufficient time to allow stabilization of the movement reading.

The alignment load (AL) is the minimum load required to align the testing apparatus and may not exceed five percent of the design test load. "Zero" dial gauges after the alignment load has been applied.

C. Proof Testing

Proof testing is required on at least five percent of the production nails in each shotcrete lift to verify the Contractor's methods and the design nail capacity. The Engineer will determine the specific locations and number of these tests.

Proof test nails will have both bonded and unbonded lengths. Prior to testing only the bonded length of the test nail may be grouted. The unbonded length of the test nail must be at least 5 ft (1.5 m) unless approved otherwise by the Engineer. The bonded length of the test nail will be such that the allowable bar load is not exceeded but may not be less than 10 feet (3 m) unless otherwise approved by the Engineer. The allowable bar load may not exceed 80 percent of the ultimate steel strength for Grade 150 (1035) bars and 90 percent of the yield strength for Grade 60 and 75 (420 and 520) bars.

The proof test bonded length L_{BP} may not exceed the test allowable bar load divided by 1.5 times the design adhesion value. Use the following equation for sizing the test nail bond length to avoid overstressing the production bar:

$$L_{BP} \leq \frac{C f_y A_s}{1.5 A_D}$$

Where:
- L_{BP} = Maximum Proof Test Nail Bond Length (ft or m)
- f_y = Bar Yield Stress (ksi or kPa)
- A_s = Bar Stress Area (in^2 or m^2)
- A_D = Design Adhesion (kips/ft or kN/m)
- C = 0.8 for Grade 150 (1035) Bar and 0.9 for Grade 60 and 75 (420 and 520) Bars

Perform proof tests by incrementally loading the nail to 1.5 times the design test load. Determine the design test load by the equation shown for the verification test nails. Measure and record nail movements at each load in the same manner as for verification test nails. Monitor the load with a pressure gauge with a sensitivity and range meeting the requirements of pressure gauges used for verification test nails. Load proof test nails in accordance with the following schedule.

LOADING	
LOAD	HOLD TIME
AL	Until Stable
0.25DTL	Until Stable
0.50DTL	Until Stable
0.75DTL	Until Stable
1.00DTL	Until Stable
1.25DTL	Until Stable
1.50DTL	10 or 60 minutes

The alignment load (AL) should be the minimum load required to align the testing apparatus and may not exceed five percent of the design load (DTL). "Zero" dial gauges after the alignment load has been applied.

Maintain all load increments within five percent of the intended load. Depending on performance, either 10 minute or 60 minute creep tests are required at the maximum test load (1.50 DTL). The creep period will start as soon as the maximum test load is applied. Measure and record nail movements at 1, 2, 3, 5, 6 and 10 minutes. Where nail movement between one minute and 10 minutes exceeds 0.04 inch (1 mm), maintain the maximum test load an additional 50 minutes and record movements at 20, 30, 50 and 60 minutes.

D. Test Nail Acceptance

A test nail will be considered acceptable when:

1. For verification tests, a creep rate less than 0.08 inches (2 mm) per log cycle of time between the six and 60 minute readings is observed during creep testing and the rate is linear or decreasing throughout the creep test load hold period.

2. For proof tests: (a) a total creep less than 0.04 inches (1 mm) is observed between the one and 10 minute readings creep test or a creep rate less than 0.08 inches (2 mm) per log cycle of time is observed during the 60 minute creep test between six and 60 minute readings and; (b) the creep rate is linear or decreasing throughout the creep test load hold period.

3. The total movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the test nail unbonded length.

4. A pullout failure does not occur at the maximum test load. Pullout failure load is defined as the load at which attempts to increase the test load simply result in continued excessive pullout movement of the test nail. Record the pullout failure load as part of the test data.

Proof test nails may be incorporated into the production nail schedule provided that (1) the unbonded test length of the nail hole has not collapsed during testing, (2) the minimum required hole diameter has been maintained and (3) the test nail length is equal to or greater than the scheduled production nail length. Complete test nails meeting these requirements by satisfactorily grouting the unbonded test length. If the unbonded test length of production proof test nails cannot be grouted subsequent to testing due to caving conditions or other reasons, replace the test nail with a similar production nail to the satisfaction of the Engineer at no additional cost to the Department.

E. Test Nail Results

1. Verification Test Nails

The Engineer will evaluate the results of each verification test. Installation methods that do not satisfy the nail testing requirements will be rejected. Where the design adhesion is not attainable by reasonable means, revise the production nail schedule. Incorporate any increases in the quantity, the lengths or the diameters of nails as required by the designer. Reasonable means will be considered to include gravity grouted nails installed as specified herein to the minimum diameter required or to a maximum diameter of 10 inches (250 mm).

2. Proof Test Nails

The Engineer may require that the Contractor replace some or all of the installed production nails between the failed proof test nail and the adjacent passing proof test nail. Abandon nails which fail in proof test and replace them with new proof test nails. Also, the Engineer may require that additional proof testing be conducted to verify that adjacent nails have sufficient load carrying capacity. Modifications may be required which include installing additional test or production nails, installing longer production nails, increasing the drill hole diameter or modifying the installation methods.

13.0 TOLERANCES

A. Soil Nails

Center the bars within 1 inch (25 mm) of the center of the hole. Individual nails must be positioned plus or minus 6 inches (150 mm) from the design locations shown in the approved submitals unless otherwise directed by the Engineer. Location tolerances will be considered applicable to only one nail and not accumulative over large wall areas. The nail inclination should be plus or minus two degrees of that shown in the plans. Use a magnetic angle-indicator tool to align the drill inclination prior to drilling each nail installation hole. Relocate nails which encounter unanticipated obstructions during drilling as directed by the Engineer. Replace soil nails which do not satisfy the specified tolerances due to the Contractor's installation to the Engineer's satisfaction at no additional cost to the Department.

14.0 RECORDS

Record the following information:

1. Contractor's and drill rig operator's names
2. Design and as-built, nail locations and elevations
3. Deviations from specified tolerances
4. Design and as-built, hole lengths and diameters
5. Design and as-built, bar lengths and sizes
6. Groundwater conditions
7. Caving or sloughing of excavation
8. Casing requirements
9. Drilling difficulties

10. Date and time of start and finish of drilling

11. Date, time and method grout was placed including grout pressure

12. Total daily quantity of grout placed and quantity per hole

13. Design changes

Upon completion of the work, submit a complete record of the construction activities including the information listed above to the Engineer.

15.0 MEASUREMENT AND BASIS OF PAYMENT

Temporary soil nail walls will be paid for at the unit bid price for "Temporary Soil Nail Walls" per square foot (square meter) of exposed wall area. The unit bid price will constitute full compensation for all the materials, labor, tools, equipment, testing and incidentals required to design and construct the temporary soil nail walls.

Temporary Soil Nail Walls.....per square foot (square meter)

MSE RETAINING WALLS **3-04-05**

1.0 DESCRIPTION

Design, prepare plans, and construct MSE retaining walls to the lines, grades and locations shown in the plans and in accordance with this specification and the details shown in the plans. Work includes all excavation, leveling pad, concrete face panel, concrete coping, retaining wall backfill, the fabric above the crushed aggregate backfill, and all other materials, labor, tools, equipment and incidentals necessary to complete the work.

Furnish any one of following retaining wall systems or approved equal in accordance with this Special Provision. Declare the choice of retaining wall system at the first Project Preconstruction Conference for the project. The wall system chosen at this Preconstruction Conference becomes the required wall system for the contract.

The Reinforced Earth Wall as manufactured by:

The Reinforced Earth Company
8614 Westwood Center Drive, Suite 1100
Vienna, VA 22182
Telephone (703) 821-1175

The Retained Earth Wall as manufactured by:

Foster Geotechnical
1372 Old Bridge Road, Suite 101
Woodbridge, VA 22192
Telephone (703) 499-9818

The Reinforced Soil Embankment Wall as manufactured by:

T and B Structural Systems
637 W. Hurst Boulevard, Suite 2A
Hurst, TX 76053
Telephone (817) 280-9858

The MSE Plus Wall as manufactured by:

SSL, Inc.
4740 Scotts Valley Drive, Suite E
Scotts Valley, CA 95066
Telephone (831) 430-9300

The Tricon Retained Soil Wall as manufactured by:

Tricon Precast Ltd.
15055 Henry Road
Houston, TX 77060
Telephone (281) 931-9832

The approved equal must meet the following criteria:

1. The MSE Retaining Wall System must utilize precast concrete face panels, and utilize steel soil reinforcements with a positive connection to the panels. Full-height panels are not allowed.

2. The company marketing the system must have successfully completed at least three projects in the last three years involving construction of permanent MSE walls totaling at least 100,000 square feet (10,000 square meters) of wall face area. Submit experience qualifications and details for these projects including owner contact information.

3. All other aspects of this special provision apply to the design, manufacture and construction of this MSE wall system.

Allow 15 calendar days review for approved equal.

Value engineering proposals for other wall systems are not considered.

Design the retaining walls to meet the criteria of the current AASHTO Standard Specifications for Highway Bridges and the requirements specified in the plans.

Submit eight sets of complete working drawings/shop plans, erection plans and design calculations, sealed by a North Carolina Registered Professional Engineer, for review and approval prior to beginning wall work. Allow 40 days for review and approval from the date they are received by the Engineer until they are returned to the Contractor.

Provide the option chosen to meet the requirements of the plans, this Special Provision and the Standard Specifications.

2.0 GENERAL

The Resident Engineer schedules a Preconstruction Conference with representatives from the Contractor, the retaining wall system Supplier, the Geotechnical Engineering Unit, and the Chemical Testing Section of the Materials and Tests Unit to discuss construction details and inspection of the retaining wall.

Provide all necessary material from the Supplier chosen.

Obtain from the Supplier technical instruction and guidance in preconstruction activities, including the Preconstruction Conference, and on-site technical assistance during construction. Follow any instructions from the Supplier closely unless otherwise directed.

3.0 MATERIALS

A. Concrete Panels

Provide the concrete mix designed by the Supplier to the State Materials Engineer prior to use. Design the mix to meet the strength requirements included in this Special Provision under the heading "Casting of Precast Concrete Face Panels".

B. Concrete Leveling Pad

Provide Class A concrete conforming to the applicable requirements in Sections 420 and 1000 of the Standard Specifications for the leveling pad.

C. Concrete Coping

Use Class A Concrete for coping and apply the requirements in Sections 420, 1000, and 1077 of the Standard Specifications. The requirements in Sections 425 and 1070 of the Standard Specifications apply to the reinforcing steel in coping. If preferred, precast coping is permitted unless otherwise stated in the plans.

D. Wall Facing Panel Reinforcing Steel, Soil Reinforcing Mesh, Mats, or Strips

Use reinforcing steel conforming to the applicable requirements in Sections 425 and 1070 of the Standard Specifications.

Shop fabricate the soil reinforcing mesh or mats of cold drawn steel wire conforming to the minimum requirements of AASHTO M32 (M32M) and weld into the finished mesh fabric in accordance with AASHTO M55 (M55M). Hot roll reinforcing strips from bars to the required shape and dimensions with their physical and mechanical properties conforming to AASHTO M223 (M223M), Grade 65 (Grade 450). Cut to lengths and tolerances shown on the plans and punch holes for bolts in the locations shown on plan details. Inspect all reinforcing and tie strips carefully to ensure they are true to size and free from defects that may impair their strength or durability. Galvanize in accordance with the minimum requirements of AASHTO M111.

E. Miscellaneous Panel Components and Attachment Devices

Provide miscellaneous concrete face panel components, including dowels, polyvinylchloride pipe, stirrups, etc., in accordance with the Supplier's recommendations.

Shop-fabricate tie strips of hot rolled steel conforming to the minimum requirements of ASTM A1011, Grade 50 (Grade 345) or equivalent. The minimum bending radius of tie strips is 1 inch (25 mm).

Use 1/2" (12.70 mm) diameter bolts, nuts and washers conforming to AASHTO M164 (M164M). Provide Bolt and thread lengths in accordance with the Supplier's recommendations. Hot-dip galvanize bolts and nuts in accordance with the requirements of AASHTO M232 (M232M).

Fabricate clevis connector and connector bar from cold drawn steel wire conforming to the requirements of AASHTO M32 (M32M) and weld in accordance with AASHTO M55 (M55M). Galvanize loops in accordance with AASHTO M111.

F. Joints and Joint Materials

Provide the type and grade bearing pads approved by the chosen Supplier.

Where shown on the plans, provide a polyester filter fabric cover, approved by the Supplier, for horizontal and vertical joints between panels. Use adhesive approved by the manufacturer to attach the fabric material to the rear of the facing panels.

G. Alignment Pins

Use 5/8" (16 mm) diameter, smooth mild steel bars galvanized in accordance with AASHTO M111 for pins to align the face panels during construction.

H. Coarse Aggregate Backfill (Retaining Wall)

Use only washed, crushed stone backfill material conforming to the applicable requirements for #57, #67, or #78M Stone of Section 1005 and Section 1014-2 of the Standard Specifications and meeting the following criteria:

- Free of organic or otherwise deleterious substances.
- Contains a maximum organic content of 0.1%.
- Electrochemical: Resistivity > 5000 ohm-cm ASTM D1125
  4.5 < pH < 9.5 ASTM D1293

Before placing any backfill, furnish a Type IV certification in accordance with Article 106-3 of the Standard Specifications. Include a copy of all test results conducted in accordance with the above requirements in the certification. The Engineer determines how often NCDOT samples backfill material to assure compliance with gradation and electrochemical requirements.

1. Sample Preparation

Obtain approximately 2,000 grams of representative material and transfer it into a 1 gallon (3.8 liters) wide mouth plastic jug. Then add an equal weight of deionized or distilled water to the sample, and let this mixture set for approximately 30 minutes. At the end of this period, place a lid on the container and vigorously agitate the mixture for 3 minutes. Repeat this agitation at the 2 hour and 4 hour intervals. Allow the sample to set for approximately 20 hours after the 4 hour

agitation so the solids will settle out. At this time remove a sufficient amount of the solution and filter through a coarse paper (Fisher Q8) to obtain the supernate to be analyzed in accordance with the above procedures.

2. Backfill Separation Fabric

Place a layer of fabric on top of the completed coarse aggregate wall backfill to prevent migration of fines from common backfill placed above from contaminating the wall backfill.

Use fabric meeting the applicable requirements for Type 2 fabric as described in Section 1056 of the Standard Specifications.

Overlap the fabric a minimum of 18 inches (460 mm).

4.0 CASTING OF PRECAST CONCRETE FACE PANELS

A. General

Cast concrete face panels and apply the requirements of Sections 1000 and 1077 of the Standard Specifications.

B. Acceptance

Supply concrete for precast panels that attains a 28 day compressive strength of 4000 psi (27.6 MPa) unless otherwise shown on plans.

Acceptance of the concrete face panels with respect to compressive strength is determined on the basis of production lots. A production lot is a group of panels that is represented by a single compressive strength sample and consists of either 40 panels or a single day's production, whichever is less. Make compression tests on standard 6" x 12" (152 mm by 305 mm) or 4" x 8" (102 mm by 203 mm) test specimens prepared in accordance with AASHTO T23. Conduct compressive strength testing in accordance with AASHTO T22.

Cast a minimum of four cylinders for each production lot sampled. Cure all specimens in the same manner as the panels. An acceptance test result is the average compressive strength of two cylinders.

The lot is acceptable if the test results are equal to or greater than 4000 psi (27.6 MPa).

If a production lot fails to meet the specified compressive strength requirements, the production lot is rejected unless the Supplier, at his own expense, obtains and submits evidence of a type acceptable to the Engineer that the strength and quality of the concrete placed within the panels of the production lot is acceptable. If such evidence consists of tests made on cores taken from the panels within the production lot, obtain and test the cores in accordance with the requirements of AASHTO T24.

C. Miscellaneous

1. Casting

Set all panel components in place in the forms to conform to the details on the plans and accepted shop plans prior to casting. Cast the panels on a flat area with the front face of the form at the bottom and the rear face at the top. Set tie strip guides or clevis connectors on the rear face.

Give special care to the clevis connectors: Place all clevis connectors normal to the panel and attach them to the alignment templates using the bars provided with the forms. Tolerance for the vertical and horizontal alignment of the clevis connectors is ±1/8" (3 mm). Clean the holes inside the loops so that they are free of all concrete and debris.

Place the concrete in each unit without interruption and consolidate using an approved vibrator, supplemented by hand tamping to force the concrete into corners of the forms and prevent the formation of stone pockets or cleavage planes. Use clear form oil of the same manufacture throughout the casting operation.

2. Concrete Finish

Provide an ordinary surface finish as defined by Subarticle 420-18(B) of the Standard Specifications for the front face (exposed face of wall) unless otherwise shown on the plans. Screed the rear face of the panel to a uniform surface finish to eliminate open pockets of aggregate and surface distortions in excess of 1/4 inch (6 mm).

3. Tolerances

Manufacture all units within the following tolerances:

- All dimensions within 3/16 inch (5 mm), except the lateral position of the tie strips to within 1 inch (25 mm).
- Surface defects on formed surfaces are not to exceed 1/8 inch in 5 feet (3mm in 1.5 m).

4. Marking

Clearly scribe the date of manufacture, the production lot number, and the piece-mark on the rear face of each panel.

5. Handling, Storage and Shipping

Handle, store and ship all units in such manner as to eliminate the danger of discoloration, chipping, cracks, fractures and excessive bending stresses. Support panels in storage on firm blocking located immediately adjacent to tie strips to

avoid bending the tie strips. Store panels in a horizontal position and stack no more than six high. Do not ship panels prior to 5 days after production.

5.0 CONSTRUCTION METHODS

A. Site Preparation

Perform surface excavation operations and random fill construction in the vicinity of the structure in accordance with the applicable portions of this Special Provision, and in reasonably close conformity to the lines, grades, dimensions, and cross-sections shown on the plans.

B. Retaining Wall Excavation

Excavate all material necessary for the construction of the retaining walls in accordance with the plans and this provision. Excavation includes the construction and subsequent removal of all necessary bracing, shoring, sheeting and cribbing and all pumping, bailing, and draining. Perform random backfilling in accordance with the details in the plans and dispose of or stockpile surplus or unsuitable excavated material as directed by the Engineer.

Perform all necessary clearing and grubbing at the site in accordance with Section 200 of the Standard Specifications.

Notify the Engineer a sufficient time before beginning the excavation so that measurements may be taken of the undisturbed ground.

Shore or brace the excavation in accordance with local and state safety standards. Perform excavation and related work in such sequence that no portion of the retaining wall will be endangered by subsequent operations.

When the retaining wall is adjacent to a traveled way, obtain approval before beginning the excavation. Submit drawings and design calculations for shoring in accordance with the provisions of Subarticle 410-5(D) of the Standard Specifications.

Notify the Engineer after excavating each location of the wall. Do not place the concrete leveling pad until the depth of the excavation and the character of the foundation material have been approved.

Remove all sheeting and bracing as the random backfilling progresses.

Obtain approval for all random backfill material. Large or frozen lumps, wood or other undesirable material is not allowed in the backfill. Compact all backfill in accordance with Subarticle 235-4(C) of the Standard Specifications.

C. Wall Erection

1. Foundation Preparation

Prior to wall construction, grade the foundation for the structure level for a width equal to or exceeding the length of soil reinforcing or as shown on the plans. Compact the foundation to a minimum of 95% of the maximum dry density as determined by AASHTO T99.

2. Leveling Pad Construction

Construct an unreinforced concrete leveling pad of Class A concrete having the dimensions and at the locations and elevations shown on the plans. Cure the leveling pad a minimum of 24 hours before placement of wall panels.

3. Placing Concrete Face Panels

Place precast concrete panels vertically with equipment that does not damage the panels. For erection, handle panels by means of eyes set into the upper edge of the panels. Use other placement methods when approved by the Supplier and Engineer. Place panels in successive horizontal lifts in accordance with the details and at the locations shown on the plans. Externally brace the first lift of panels. Proceed with backfill placement as hereinafter specified. As panel and backfill lifts progress, maintain the panels in vertical position by means of temporary wooden wedges placed in the joint at the junction of the two adjacent panels on the external side of the wall. The maximum tolerance for vertical (plumbness) and horizontal alignment is 3/4 inch (19 mm) when measured along a 10 foot (3 m) straightedge. The maximum allowable offset in any panel joint is 3/4 inch (19 mm). The overall vertical tolerance of the wall (plumbness from top to bottom) is 1/2 inch (13 mm) per 10 feet (3 m) of wall height. As wall erection progresses, install horizontal and vertical joint filler in accordance with the Supplier's instructions.

4. Placing Retaining Wall Backfill and Soil Reinforcing

Place backfill within the structure closely following the erection of each lift of panels. Place the backfill material in layers for the full width shown on the plans. Place layers not more than 7½ inches (190 mm) in depth loose thickness and compact. Compact coarse aggregate backfill with at least four passes of an 8 – 10 ton (7.3 - 9.1 metric ton) vibratory roller in the vibratory mode, or as directed by the Engineer. At each soil reinforcement location, level and compact the backfill material before placing and attaching tie strip, mat or mesh. Place the soil reinforcement normal to the face of the wall or as shown on the plans. Compact backfill layers in a direction parallel to the wall and without disturbance or distortion of soil reinforcement or wall panels. Use only a hand-operated mechanical compactor within 3 feet (1 m) of the face of the wall as a precaution against pushing panels outward and distorting the vertical face of the wall. Exercise extreme care to prevent bending soil reinforcement or panel attachments during

compaction. Compact as required with a minimum of three passes of the hand-operated compactor.

At the end of each day's operation, slope the areas adjacent to the stone backfill such that in the event of rain, surface runoff will be diverted away from the backfill area. Contamination of the stone backfill by soil fines from runoff is grounds for rejection of the backfill.

5. Placing Concrete Coping

When cast-in-place coping is used, place a 1/2 inch deep vertical contraction joint in all exposed faces at a spacing equal to two panel widths and in accordance with Article 825-10(B) of the Standard Specifications. Place the contraction joints in the coping so that it aligns with the vertical joints between the panels.

6.0 BASIS OF PAYMENT

Payment will be made under:

MSE Retaining Walls, Sta. _____ ..... Lump Sum