Complete all work according to Intermediate Contract Time #1. See Intermediate Contract Time #1 for times and liquidated damages.

Step 1:
-Install temporary work zone signing.

Step 2:
-Place Portable Concrete Barrier (PCB) 2' from outside edgeline from Sta. 17+00+/- to Sta. 23+00+/- using Roadway Standard Drawing 1101.02 Sheet 3 of 7. Set temporary crash cushion at the approaching end of PCB before removal of the lane closure. If applicable, flare PCB using Roadway Standard Drawing 1101.11 Sheet 3 of 4.

Step 3:
-Remove portion of existing shoulder and construct proposed shoulder up to but not including the final layer of surface course as shown in the construction plans.

Step 4:
-Place PCB in final location using Roadway Standard Drawing 1101.02 Sheet 3 of 7. See Construction Plans.

Step 5:
-Mill the remainder of the existing shoulder 2" and place final layer of surface course along entire proposed shoulder using Roadway Standard Drawing 1101.02 Sheet 3 of 7. See Construction Plans.

Step 6:
Remove all traffic control signs and devices and open I-40 eastbound to existing traffic pattern.

TOE SCOUR PROTECTION

1.0 GENERAL

Construct the Toe Scour Protection in accordance with Section 235 of the 2002 Standard Specifications, the details shown on the plans, this provision, and as directed by the Engineer. Schedule a preconstruction meeting with representatives of the Contractor, Geotechnical Engineering Unit, and the Engineer.

The Toe Scour Protection will be required as shown on the plans, and other locations as directed by the Engineer.

Density requirements will not apply to the Toe Scour Protection construction, but compact to the satisfaction of the Engineer.

2.0 CONSTRUCTION

Lay the Ring Nets smooth and free from folds, wrinkles, or creases. Where a layer of Ring Nets becomes discontinuous, such as at the end of a roll, a minimum overlap of 12 inches is required with the upper Ring Net placed over the lower Ring Net. Stake as needed to hold the ring nets in place until it is covered with fill material. Do not operate equipment directly on the Ring Nets. In the event the Ring Nets are displaced or damaged, reposition or replace the Ring Net at no additional cost to the Department.

Place the Class VII Material in maximum 4-foot lifts. End Dumping on the Ring Nets will not be allowed.

3.0 MATERIALS

A. Class VII Material

The Toe Scour Protection shall consist of Select Material, Class VII, meeting the requirements of Section 1016 of the 2002 Standard Specifications.

B. Class A Rip Rap

The rip rap shall consist of Rip Rap Materials, Class A, meeting the requirements of Section 1042 of the 2002 Standard Specifications.

C. Ring Net

The nets shall be made from interlocking steel rings, each ring with a nominal diameter of 12 inches. Rings shall be composed of steel wire coiled into a loop with 7 loops per ring. Three steel clips shall be fastened

around each ring to hold the ring together. Each ring shall connect to the four adjoining rings by passing through them.

The Nets shall be manufactured and assembled in accordance with the contract documents and plans and the manufacturer's standards and requirements.

The wire shall be high tensile strength alloy steel wire with a nominal diameter of 0.118 inches and the minimum tensile strength of the wire shall be 256,000 pounds per square inch.

The wire shall be galvanized with a 95% zinc / 5% aluminum coating, and the minimum weight of the coating shall be 0.655 ounces per square foot.

D. Galvanized Chainlink Mesh

The mesh shall be woven construction and shall be diamond shaped. The mesh shall be made with either 0.118 inches (3-millimeter) or 0.157 inches (4-millimeter) diameter wire and the ends of each wire formed into a loop and twisted. The loops of the wire mesh shall be fastened together to prevent unraveling of the mesh. The wire shall be galvanized high strength alloy steel wire with a minimum tensile strength of 256,000 pounds per square inch (of 1,770 kilonewtons per square meter). The mesh shall have a minimal longitudinal tensile strength of 10,200 pounds per foot (150 kilonewtons per meter) for the 0.118 inch (3-millimeter mesh) and 17,130 pounds per foot (250 kilonewtons per meter) for the 0.157 inch (4-millemeter) mesh.

The wire shall be hot dipped galvanized with Zinc/Aluminum and the minimum of the coating shall be 0.49 ounces per square foot (150 grams per square meter). The coating shall be 95% Zinc and 5% Aluminum.

The mesh shall be 3 dimensional. The size of the mesh shall be 83 millimeters (3.27 inches) by 143 millimeters (5.63 inches) ($\pm$ 2%) and the depth shall be 15 millimeters (0.59 inches) ($\pm$ 1 mm). The mesh shall have 12 meshes per meter in the transverse direction and 7 meshes per meter in the longitudinal direction. The mesh shall be supplied in 3.5 meter (11.5 feet) wide by 30-meter (98.4 feet) long rolls.

4.0 METHOD OF MEASUREMENT

A. Toe Scour Protection

The quantity of Class VII material to be paid for will be the actual number of tons, which has been incorporated into the completed and accepted

work. The material will be measured by weighing in trucks on certified platform scales or other certified weighing devices or by methods approved by the Engineer.

B. Class A Rip Rap

The quantity of Class A Rip Rap to be paid for will be the actual number of tons, which has been incorporated into the completed and accepted work. The material will be measured by weighing in trucks on certified platform scales or other certified weighing devices or by methods approved by the Engineer.

C. Ring Net

The quantity of Ring Net to be paid for will be the area in square yards, measured along the face of the Ring Net, over which the net has been acceptably placed. All hardware required shall be incidental to the cost of the Ring Nets.

D. Galvanized Chainlink Mesh

The quantity of Galvanized Chainlink Mesh to be paid for will be the area in square yards, measured along the face of the slope, over which the Galvanized Chainlink Mesh has been acceptably placed. All hardware required shall be incidental to the cost of the Galvanized Chainlink Mesh.

5.0 BASIS OF PAYMENT

A. Toe Scour Protection

The quantity of select material will be paid for at the contract unit price per ton for "Select Material, Class VII." Payment will be full compensation for all work and materials covered by this provision, including but not limited to furnishing, hauling, handling, placing, compacting, and maintaining the select material.

B. Class A Rip Rap

The quantity of rip rap materials will be paid for at the contract unit price per ton for "Rip Rap Materials, Class A." Payment will be full compensation for all work and materials covered by this provision, including but not limited to furnishing, hauling, handling, placing, compacting, and maintaining the select material.

C. Ring Net

The quantity of Ring Net will be paid for at the contract unit price per square yard of "Ring Net." Payment will be full compensation for all work covered by this provision, including but not limited to testing, furnishing, hauling, placing, and connecting the ring nets. All hardware required shall be incidental to the cost of the Ring Nets.

D. Galvanized Chainlink Mesh

The quantity of Galvanized Chainlink Mesh will be paid for at the contract unit price per square yard of "Galvanized Chainlink Mesh." Payment will be full compensation for all work covered by this provision, including but not limited to testing, furnishing, hauling, placing, and connecting the ring nets. All hardware required shall be incidental to the cost of the Galvanized Chainlink Mesh.

Payment will be made under

Select Material, Class VII..... Ton
Rip Rap Materials, Class A.....Ton
Ring Net..... Square Yards
Galvanized Chainlink Mesh.....Square Yards

GROUTED ROCK DOWELS

1.0 DESCRIPTION

Furnish and install 1 inch diameter (Grade 150) or 1-1/4 inch diameter (Grade 75), 10 ft. minimum (front row) and 20 ft minimum (back row) long steel bar threaded rock dowels at locations as determined by the Engineer. The installation frequency, location and length of Rock Dowels are to be determined by the Engineer during construction of the Toe Scour Protection. Conditions encountered may require the Engineer to change the frequency and length of Rock Dowels from those indicated by these Special Provisions.

2.0 SUBMITTALS

Supply the following information:

A. Product Data and Manufacturers Instructions: Not less than 5 days prior to commencing drilling and include:

1. Pre-mixed, non-shrink anchoring grout type.

2. Anti-corrosion compound for inside of anchor head.

3. Mill test reported for each heat or lot of prestressing components used to fabricate the anchors showing ultimate load, yield, percent elongation at yield and modulus of elasticity.

B. Daily Records: Within 5 days after completion of each anchor installation in each area. Submit records of each rock anchor on the Contractors anchor report form and test log. Include drilling conditions, bolt location, length, and grout volume.

3.0 MATERIALS

A. 1 Inch or 1-1/4 Inch Diameter Rock Dowels

1. General: Use anchor assembly 1 inch (Grade 150) or 1-1/4 inch diameter (Grade 75), 20 ft. long deformed or continuously threaded steel bar conforming to ASTM 615 complete with epoxy coating for permanent installations, centralizers on 4 ft. centers, couplings where required, grout tubes, and anchor head assembly consisting of a galvanized anchor plate, galvanized lock washer, and hex nut.

2. Manufacturer: Use all prestressing components from the product of a manufacturer regularly engaged in the fabrication of permanent rock anchor systems. The fabrication procedure must be in strict accordance with the manufacturer details.

3. Corrosion Protection: Include a corrosion protection system for the permanent rock dowels to protect the full length of the bar. The corrosion protection system should comprise a continuous epoxy coating bonded to the bar, or and approved equivalent system. Apply corrosion protection system to the bars prior to their installation in the drill holes.

   Paint the exposed anchor plate and bar with two coats of zinc-rich paint; the zinc-rich paint must meet the requirements of Article 1080-9 of the Standard Specifications.

B. Anchoring Grout

1. The grout must be a pre-mixed, unsanded, non-metallic, non-shrink grout, which can be mixed to a flowable consistency with a minimum 7-day compressive strength of 3000 psi. and a minimum 28 day compressive strength of 5500 psi. Cylinders will be made at such frequencies as determined by the Engineer and conduct testing in accordance to Section 1054-6 of the Standard Specifications.

2. Use pre-mixed grout from the product of a manufacturer regularly engaged in the manufacture of cementitious grouts for rock anchoring.

   a. Water

      Use water in Portland cement grouts that is clear, fresh water, free from injurious amounts of oil, acid, alkali, organic matter, sediment or any other deleterious substance.

3.0 CONSTRUCTION METHODS

A. General

Prior to installation, all anchor corrosion protection components and the anchor assembly must be handled and stored to avoid corrosion and damage such as abrasion, cuts, cracks, nicks, pits, welds or weld splatters. Any such damage of the anchor components of the anchor assembly may be rejected as determined by the Engineer.

B. Installation Sequence

Sequence rock dowel installation such that the grout anchorage has set for a time not less than six days prior to applying any vertical or horizontal loading.

C. Site Preparation

Before drilling anchor holes, level all soil and loose and broken rock in the bearing area.

D. Drilling

1. General:

a. Equipment: Drill holes with a rotary-percussion drill.

b. Drill Logs: Driller must keep an accurate log noting depth from surface of any changes in rock hardness, rate of drilling, presence of water, fracture zones and voids.

c. Cleaning: Clean holes thoroughly of all cuttings and rock fragments by flushing with high pressure air.

2. Anchor Holes:

a. Dimensions: Drill anchor holes a minimum diameter of 6 inch or as specified by the anchor manufacturer and 2 feet deeper than the anchor length.

b. Orientation: Drill anchor holes no more than 30 degrees from vertical.

c. Deviation: The anchor holes must not deviate by more than one foot from the specified location determined by the collar location and the required alignment of the anchor. The Engineer may require that drill hole orientation surveys be carried out, at the Contractors expense, where there is evidence of excessive deviation.

E. Anchor Insertion:

1. Following acceptance of a drill hole, install the rock anchor assembly comprising steel bar, corrosion protection, centralizers and grout tubes in the hole. Do not bend anchors during handling and anchor must slide freely into the hole without hammering or pushing.

2. The anchor head assembly must be firmly supported at its final location during grouting and for the curing period.

F. Grouting

1. General: Place grout only at the temperature range recommended by the grout manufacturer.

   Do not use grout with an expired date in the work and dispose of at an authorized location.

   Do not use grout that has any hardened lumps in the work and dispose of at an authorized location.

2. Mixing: Mix grout in a colloidal or high shear grout mixer in accordance with the grout manufacturers published instructions. Use only enough mixing water to produce a grout with the required consistency for the placing method proposed. Place grout immediately after mixing.

3. Placing Grout:

   a. General: Place grout quickly and continuously to avoid overworking, segregation, bleeding and disturbance of initial set.

      Do not use grout which has stiffened due to delay in the work and dispose of at an authorized location.

      Do not re-temper grout after initial mixing.

   b. Pump grout into the annular space between the rock and the anchor using a grout tube extending to the lower end of the drill hole to fill the hole to the collar.

5.0 METHOD OF MEASUREMENT

The quantity of 1¼ inch diameter rock bolts to be paid for will be measured by the linear feet from the lower end of the bar to the upper surface of the anchor plate to the nearest foot.

6.0 BASIS OF PAYMENT

The quantity of Grouted Rock Dowels, measured as provided above will be paid for at the contract unit price per linear foot for Grouted Rock Dowels.

Such price and payment will be considered full compensation for all work covered by this provision including but not limited to furnishing all materials, drilling, tensioning, testing, alignment measurements, grouting/redrilling as required, anchor grouting, and meeting all

acceptance criteria of the anchors, as well as construction of the reaction blocks and removal of all formwork.

Payment will be made under:

Grouted Rock Dowel.....Linear Feet

PERMANENT ANCHOR TIEBACK RETAINING WALL:

1.0 General:

The work under this section consists of design, plan preparation, furnishing materials, and construction of proposed Permanent Tieback Retaining Wall At Slide #4 from Station 20+89.59 to Station 22+64.01 –L- in accordance with the plans, these specifications and in reasonably close conformity with the lines, grades, and dimensions shown on the plans.

A permanent anchor tieback anchor retaining wall consists of soldier piles and timber lagging supported by post-tensioned ground anchors with permanent concrete facing system consisting of precast concrete panels, cast-in-place, or shotcrete facing.

Submit 8 copies of plans and calculations to the Engineer for review and approval and allow 5 calendar days from the date they are received until they are returned by the Engineer.

A pre-construction meeting must be held prior to the start of the work and must be attended by representatives from the Prime Contractor, Wall Subcontractor, Resident Engineer, Materials and Test Unit, and Geotechnical Engineering Unit to discuss construction details and inspection of the wall construction. Review of all submittals must be completed prior to scheduling the pre-construction meeting.

No value engineering construction proposal will be allowed.

2.0 Design Criteria:

Wall design must be in accordance with the criteria set forth in the AASHTO Specifications for Highway Bridges and the FHWA Manual "Ground Anchors and Anchored Systems Manual", Publication No FHWA-IF-99-015.

Use the soil parameters shown on the plans to design the tieback wall.

Design all wall components for a 100-year design life.

Include calculations and details of the permanent concrete facing in the design package. Design a minimum 6 inch (150 mm) thick concrete facing to be constructed on a minimum 6 inch (150 mm) thick by 12 inch (300 mm) wide unreinforced concrete leveling pad. Construct the concrete facing of the tieback retaining wall in accordance with Section 825 of the Standard Specifications with an ordinary surface finish.

Extend the wall to the rockline elevation between Station 21+50.00 –L- to Station 22+00.00 –L- and backfill against the wall face to the elevation shown on plans. The remaining wall will have a minimum embedment of 2'-0".

Install soldier piles a minimum of 5 feet (1.5 meters) into competent bedrock.

Install permanent tieback anchors through boulder fill into competent bedrock.

Provide plans containing sufficient information to lay out and construct the wall including but not limited to the following:

1. Elevation views showing all proposed and existing ground lines and stations, soldier piles, precast concrete facing panels, leveling pad elevations, construction joint locations.

2. Plan views showing all horizontal layout information.

3. Section views showing in detail all wall components, the proximity of other structures, proposed and existing ground lines, etc.

4. Specific details of wall components.

5. Construction sequence.

3.0 Materials:

All materials are to be as specified or better, and as approved by the Engineer. Submit requests for substitutions to the Engineer five days before intended installation.

A. Fabricate tieback tendons from single or multiple elements of the following:

1. Steel bars conforming to ASTM Designation A722, "Uncoated High-Strength Steel Bars for Prestressed Concrete."

2. Seven-wire strand conforming to ASTM Designation A416/416M, "Uncoated Seven-Wire Stress-Relieved Strand for Prestressed Concrete."

3. Compact seven-wire strands conforming to ASTM Designation A779, "Uncoated Seven-Wire Compacted, Stress-Relieved Steel Strand for Prestressed Concrete."

Submit to the Engineer mill test reports for each heat or lot of prestressing material used to fabricate tendons.

B. Submit cement anchor grout mix design to the State Materials Engineer for approval. Supply Portland Cement conforming to ASTM Specification C-150, Type I, II, or III, and potable water. Supply cement that is fresh, free from lumps or any indication of hydration. Use admixtures that will impart low water content, flowability and minimum bleeding in the cement grout only with the consent of the Engineer. Do not use admixtures that contain chemicals that may have a harmful effect on the prestressing steel or cement. If admixtures are to be used, submit to the Engineer prior to using the admixture, the manufacturer's literature indicating the type of admixture and the manufacturer's recommendations for mixing the admixtures with grout. Expansive additives which cause air bubbles in the grout will not be allowed. Use grouting equipment that includes a mixer capable of producing a grout free of lumps and undispersed cement. Use a positive displacement grout pump. Equip the pump with a pressure gauge to monitor grout pressures at the nozzle, using a gauge capable of measuring pressures of at least 150 psi (1035 kPa), or twice the actual grout pressures used.

Size the grouting equipment to enable the tieback to be grouted in one continuous operation. Use mixing and storage times that do not cause excessive temperature build-up in the grout. Use a mixer capable of continuously agitating the grout.

C. Use anchorage and hardware suitable for the type of anchor tendon used and capable of developing 95% of the guaranteed specified minimum ultimate tensile strength of the tendon when tested in the unbonded state without failure of the tendon. Supply anchorage devices capable of holding the prestressing steel at a load producing a stress of not less than 95% of the guaranteed specified minimum ultimate tensile strength of the prestressing steel without exceeding anticipated set and without failure of either the anchorage or the prestressing steel. Anchorages shall be capable of lift-off, detensioning or retensioning a tendon at any time prior to grouting.

Fabricate the bearing plate from steel plate conforming to AASHTO M270 Grade 250 Specifications. Size the bearing plate so that the bending stress in the plate does not exceed 0.75 times the yield strength of the steel at the tieback design load or 1.00 times the yield strength of the steel at the maximum tieback test load.

Provide polyvinyl chloride (PVC) trumpets made from Type I, Schedule 40, Grade PVC 1120 pipe conforming to the requirements of ASTM D-1785. The plastic material shall be resistant to aging by ultra-violet light.

Provide steel trumpets made from pipe or tube conforming to the requirements of ASTM A-53 for pipe and ASTM A-500 for tubing.

Provide trumpets with an inside diameter equal to or larger than the hole in the bearing plate furnished by the tendon supplier, and long enough to accommodate movements of the structure during testing and stressing. For strand tendons, consult

the tendon supplier to determine the minimum length trumpet required to make a transition from the diameter of the tendon in the unbonded length to the diameter of the tendon at the anchorhead. Provided a watertight seal between the trumpet and the unbonded length corrosion protection.

If grout is used to fill the trumpet, then the seal is temporary and it acts as a grout form. If corrosion inhibitor is used to fill the trumpet, then the seal is permanent and it shall be fabricated from Buna-N-synthetic rubber or equal.

Furnish anchor nuts and plates for bars having complementary spherical shapes at the contact areas.

Furnish anchorheads of either steel meeting the requirements of AASHTO M270 Grade 250, or cast ductile iron meeting the requirements of ASTM A-536 Grade 80-55-06.

D. Use corrosion inhibitor (grease) conforming to the following test requirements:

Chlorides	10 ppm max.	by ASTM B-512
Nitrates	10 ppm max.	by ASTM D-992
Sulfides	10 ppm max.	by APHA 427D(15th ED)

The corrosion inhibitor (grease) must remain ductile and free from cracks and must not become fluid over the anticipated range of temperatures encountered during fabrication, transport, storage and while in service. The inhibitor must be impervious to moisture and air, be a self-healing film and displace water. The corrosion inhibitor must have a reserve alkalinity for long-term acid neutralization.

E. Epoxy Coating: Epoxy coating must be an electrostatically applied coating meeting M-284 (ASTM A-775). Any required field patching must meet ASTM A-775 or ASTM D-3196.

F. Corrugated Tubes: The following corrugated tubes will be acceptable:

1. High density corrugated polyethylene (PE) tubing conforming to the requirements of AASHTO M252-851.

2. High density corrugated polypropylene (PP) tubing manufactured from plastic classified as Type II-26500-D by ASTM D-2146. The minimum wall thickness of the tubing shall be 0.04 inches (1.0 mm).

3. Corrugated polyvinyl chloride (PVC) tubes with a minimum wall thickness of 0.04 inches (1.0 mm).

G. Heat Shrinkable Tube: Heat shrinkable tubing must have an outer heat shrinkable polyethylene plastic internally coated with a thixotropic sealant. Recovered wall thickness must be at least 0.04 inches (1.0 mm). Coating thickness must be at least 0.02 inches (0.50 mm).

H. Bondbreaker: Use any of the following bondbreakers:

1. Bar Tieback Tendon: Low density polyethylene tubing, polypropylene tubing or polyvinyl chloride tubing with a minimum wall thickness of 0.06 inches (1.50 mm).
2. Strand Tieback Tendon: A polyethylene tube or a hot melt extruded polypropylene tube with a minimum wall thickness of 0.06 inches (1.50 mm).

I. Electrical Insulation: The electrical insulation must be a multipolymer plastic sheet manufactured expressly for bearing purposes. Fabricate the electrical insulation from a material that is: an electrical insulator; resistant to attack from cement; the corrosion inhibitor, or the environment; nondetrimental to the prestressing steel; prevents oxygen and moisture from coming in contact with the anchorage or bearing plate; and is capable of withstanding atmospheric exposure and ultra-violet light degradation if the anchorhead is to remain exposed to the atmosphere.

J. Steel members used as soldier piles must conform to the applicable sections of the Standard Specifications. Steel piles must contain 0.2% minimum copper, and must be ASTM Grade A36 or better. Stiffeners at the anchor location must be 0.75 inch (19 mm) thick steel plates and must be ASTM Grade A36 or better and 0.2% copper, or must be painted (including welds) with two coats of zinc-rich paint.

K. Concrete and reinforcing steel must conform to the applicable sections of the Standard Specifications.

L. Concrete for coping must be Class A and conform to the applicable requirements in sections 420 and 1000 of the Standard Specifications. Reinforcing Steel in coping must conform to the applicable requirements in sections 425 and 1070 of the Standard Specifications.

M. Filter fabric on the backside of the wall, used in conjunction with a granular material or with a molded, polymeric core must conform to Section 1056-1 of the Standard Specifications.

N. Drain pipes installed along the lower portions of the wall near the leveling pad or footing must conform to Section 815 of the Standard Specifications.

O. Timber lagging must conform to the requirements of Section 1082-1 of the Standard Specifications and be a minimum of 4" in thickness

P. Class VI Select Material (#57 Stone) must conform to the requirements of Section 1005 and Section 1016 of the Standard Specifications.

4.0 Permanent Concrete Facing System

Precast Concrete Panels

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

A. Materials and Fabrication

Supply concrete for precast panels that attains the 28 day compressive strength as required by the submitted tie back wall design and plans.

Provide materials and fabricate members in accordance with the requirements of Division 10 of the Standard Specifications for Roads and Structures.

B. 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.

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). 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:

a. All dimensions within 3/16 inch (5 mm).

b. Surface defects on formed surfaces are not to exceed 1/8 inch in 5 feet (3mm in 1.5 m).

3. Marking

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

4. 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. Store panels in a horizontal position and stack no more than six high.

Cast-In-Place (CIP) Concrete Facing

Construction of the concrete facing must conform to the requirements of Section 420 of the Standard Specifications, unless otherwise specified herein. Form the exposed face of the concrete facing with an acceptable forming system. A properly designed form bracing system to resist the lateral concrete pressure is required to keep the finished wall in good alignment. Submit formwork and falsework system to be approved by the Engineer before the beginning of any formwork.

The vertical face of the wall must be plumb or have a back-batter no greater than two percent (2%) for the total height of the wall. No forward leaning of the wall in any magnitude is allowed.

Deliver the concrete to the formed area by means of tremie or drop chute to prevent the formation of honeycomb. Concrete must be placed in maximum three foot (1 m) lifts and vibration may not be used to move the concrete horizontally.

Use internal vibrations only. No external vibrations are allowed. Vibrate one lift at a time and extend the vibrator to 6 to 12 inches (150 to 300 mm) into the preceding lift. After a momentary pause, withdraw the vibrator slowly, at a rate of one to two inches (25 to 50 mm) per second. Insert the vibrator at an interval of 12 to 18 inches (300 to 450 mm) and adjust the interval as necessary to insure the affected area of vibrator overlap by a sufficient amount. Maintain a constant time lag from the time of concrete placement to the time of vibration application through the entire wall.

Accomplish patching as needed with epoxy mortars or specially mixed grouts for patching. Do not use concrete from subsequent placements for patching. Patch may be recessed slightly and smearing fill material on the surrounding finished surface is not allowed. Use light sand blasting to improve the appearance of the finished surface of the wall as directed by the Engineer.

After stripping and patching, apply the finished wall surface as soon as possible with one coat of cure and seal compound. The cure and seal compound should be compatible with the form release compound.

Permanent Shotcrete Facing

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 must have a screed 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 unless cold weather protection is in place. Maintain cold weather protection until the strength of the in-place shotcrete is greater then 750 psi (5.2 MPa). **Cold weather protection must be heated enclosures, or other means acceptable to the Engineer.** Heated enclosures must comply with the requirements of ACI 306R, "Cold Weather Concreting". 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). Placement of shotcrete and concrete during cold weather must be in accordance with ACI 306R, "Cold Weather Concreting".

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.

5.0 Corrosion Protection:

A. General:

Prestressed anchors and the anchor head assembly must be doubly protected against corrosion. The cement grout in the bond zone constitutes one protection system; cement grout in the unbonded zone does not constitute a protection system. Corrosion protection begins with the storage, fabrication, and handling of the tendon components prior to insertion in the borehole. Proper care is required to avoid prolonged exposure to the elements, and to avoid mechanical or physical damage which would reduce or impair the future ability of the components to resist any adverse conditions encountered during their service life.

B. Tendon Fabrication:

Fabricate tendons in accordance with approved details and free of dirt, detrimental rust, or other deleterious substances. Install the plastic sheath at the fabrication shop as a single piece without splices. Field installation of the plastic sheath shall not be allowed. Prior to installation, handle and store tendons in such a manner as to avoid corrosion and physical damage. Field repair damaged coatings with ultra-high molecular weight polyethylene tape or heat shrinkable tubing. Damage such as abrasions, cuts, nicks, welds, weld splatters, or heavy corrosion and pitting, will be cause for rejection of the tendon. Replace rejected tendons at no cost to the Department in terms of either material replacements and/or resulting time delays.

1. Strand Tendon:

Apply a polyethylene tube or a hot-melt extruded polypropylene tube over a corrosion inhibiting grease coated strand for the entire unbonded length of each individual strand of the tieback tendon. Coat the individual wires of each tendon with grease to completely fill the space between the tube and the strand, making provisions to prevent the grease from escaping at the ends of

the tubes. Place the bond length and lower two feet of the unbonded length in a corrugated tube. Centralize the tendon within the corrugated tube with a minimum of 0.02 inches (0.50 mm) of grout cover. Use spacers along the bond length to separate the strands so the tendon will bond to the encapsulation grout. Mix with the encapsulation grout, if desired, admixtures which control bleed water, improve flowability, reduce water content and are expansive. Three options for grouting inside the encapsulation are available:

a. Grout the tendons inside the encapsulation after the tendon has been placed in the drill hole, or

b. Grout the tendons inside the encapsulation prior to inserting the tendon in the drill hole and then place in the drill hole provided the grout has not achieved initial set or a maximum of 45 minutes, or

c. Grout the tendons and allow to set inside the encapsulation for a period of 24 hours prior to inserting the tendon in the drill hole. In this case, support the entire length of tendon at sufficient intervals during installation such that excessive bending does not occur.

2. Bar Tendon:

Epoxy coat the bar tendon with a minimum thickness of 0.008 inches (0.20 mm). Install a tight fitting bondbreaker around the encapsulated bar over the unbonded length.

6.0 Construction:

A. Excavation and Backfill:

Coordinate scheduling with the Wall Subcontractor such that earthwork and wall construction can be accomplished at a minimum of delay to each.

Excavation must be in reasonably close conformity to the limits and construction stages shown on the plans or specified in the contract and limited to that necessary to install the lagging.

B. Temporary Earth Support:

Construct temporary earth support between soldier piles such as to be safe and provide adequate resistance to earth loads. Use sound materials, free of defects, and placed in a workmanlike manner.

Fill small voids behind the lagging with hand tamped on site soils.

C. Soldier Piles:

Set all soldier piles in pre-augered or drilled holes. Keep holes open, if required, by casing or other means approved by the Engineer. Place concrete such that free fall greater 5 feet (1.5 meters) does not occur. Use a lean sand grout mixture to fill the remainder of the hole to the ground surface. Remove this mixture as required to install the timber lagging. Set piles and concrete holes as soon as practical after drilling. At no time shall more than 5 holes be left open before setting piles and concreting. The vertical alignment of the piles shall not exceed 1/8"/1'.

Shaft excavation must conform to the applicable provisions of Section 410 of the Standard Specifications. Haul off and waste material resulting from shaft excavation. Do not place shaft excavation on the slope. Provide Class A concrete meeting the requirements of Section 1000 of the Standard Specifications or as approved by the Engineer. Design the Class "A" concrete with a 6-inch to 8-inch slump.

Cast shaft concrete against undisturbed ground unless otherwise permitted by the Engineer, and construct in accordance with Section 825 of the Standard Specifications. If over-excavation occurs vertically, backfill with #57 Stone Backfill before setting the pile. Remove all loose and soft material and dewater the excavation immediately before and during the concrete casting operation. Make the top of the concrete shafts generally level.

D. Anchor Installation:

The holes for the anchors must be drilled. Core drilling, rotary drilling, auger drilling or percussion drilling may be used. If water is used in the drilling operation, dispose of the water in such a manner that erosion of the wall site is minimized. *Any damage to the site by water erosion shall be repaired by the Contractor at no cost to the Department.* If the hole will not stand open, install casing as required to maintain a clean and open hole. Provide a hole diameter not less than 3 inches (75 mm) if no pressure grouting is used. Pressure grouting is defined as grouting with a pressure greater than 60 psi (415 kPa). Use a drill bit with a diameter not less than 0.12 inches (3 mm) smaller than the specified hole diameter. The hole shall be within 3 inches (75 mm) of plan location and drilled to the inclination specified on the approved design plans within a three degree tolerance. Do not extend holes outside the right-of-way limits. Thoroughly clean holes in rock of all dust, rock chips, grease or other deleterious material prior to inserting the tendon.

Install the tendon in the casing or hole drilled for the anchor, taking care to insure that the tendon's corrosion protection is not damaged during handling or installation. If the sheathing has been damaged, repair it with ultra high molecular weight PE tape. Wind the tape spirally around the tendon so as to completely seal the damaged area. Use a pitch of the spiral to ensure a double thickness at all points. Install the tendon in the

bond length in such a way as to insure that it has a minimum of 0.5 inch (13 mm) grout cover. Degrease the bond length of strands or wires prior to installation by using Acetone, MEK, or MIBK leaving no residue on the tendon. Other substances may be used subject to approval by the Engineer. Include all costs of cleaning tendons in the price bid for Contract items.

Drill holes 1 foot (0.3 meter) minimum longer than tendons. Insert the tendon after the hole is drilled to the final depth. Do not subject anchor tendons to sharp bends. Provide centralizers at maximum 10 foot (3.0 meters) center-to-center spacing throughout the bond length to insure that the tendons do not contact the wall of the drill hole, with the lowest centralizer no more than 5 feet (1.5 meters) from the bottom of the bond length. Do not use centralizers made of wood or any other material detrimental to the tendon steel or sheathing. If multi-element tendons are used without a fixed anchorage at the lower end, provide adequate spacing of the tendon elements to achieve proper grout coverage. Do not use anchors for grounding electric equipment.

Perform the grouting operation after the tendon is inserted. Inject grout at the lowest point of the anchor. Place grout over the entire anchor length. Do not allow the top of the grout column to contact the wall or the trumpet. After grouting, the tendon shall remain undisturbed until the grout has cured for at least 72 hours. Record the following data during the grouting operation:

a. Type of mixer
b. Water/cement ratio
c. Type of additives
d. Grout pressure
e. Type cement
f. Test sample strengths (prior to stressing)
g. Volume of grout placed in bond and free lengths

After lockoff of the post-tension force, fill the trumpet with non-bleed, expansive grout, or grease. Coat the exposed surface of the anchorage with mastic, and cover with a metal cap or Portland Cement concrete.

E. Anchor Testing and Stressing:

Each anchor must be tested. The maximum test load must not exceed 80% of the guaranteed ultimate tensile strength of the tendon. Conduct performance tests for the first two anchors installed for each specified design load capacity and 5% of the remaining anchors at locations to be chosen by the Engineer. Proof test all remaining anchors. Install no additional anchors until the first two anchors have been successfully performance tested.

1. Performance Tests:

Do performance tests by incrementally loading and unloading the anchor in accordance with the following schedule. Record the movement of the tendon to the nearest 0.001 inch (0.025 mm) with respect to an independent fixed reference point. The jack and pressure gauge shall have been calibrated as a unit. Use a pressure gauge graduated in 100 psi (700 kPa) increments or less. Use a master gauge to verify the accuracy of the production gauge at the beginning of each shift.

Cycle	Load	Cycle	Load
1	0	5	0.50P
	0.25P		0.75P
	AL		1.00P
2	0.25P		1.20P
	0.50P		1.33P
	0.25P		1.20P
	AL		1.33P*
3	0.50P	Adjust to lockoff load.	
	0.75P	Actual lock-off loads may be	
	0.50P	somewhat higher to account	
	AL	for seating losses.	
		* Hold 50 minutes for creep test.	
4	0.50P		
	0.75P		
	1.00P	AL (Alignment Load)	
	0.75P	P (Design Load)	
	0.50P		
	AL		

To prevent misalignment of testing equipment, maintain a minimum Alignment Load (AL) of 0.05P.

Hold each load increment until movement ceases, or a minimum of 1 minute. Submit loading and unloading rates (tons per minute) for approval. Apply each load in less than 30 seconds after the jack pump is started.

Perform a Creep Test by holding the 1.33P load for 50 minutes. While maintaining a constant load, record anchor movement (total movement) at 0, 1/2,

1, 3, 5, 10, 20, 30, 40 and 50 minutes. Begin the observation time when load is applied to the pump.
The Engineer will review all performance tests to determine if the anchor is acceptable. An anchor shall be acceptable if:

1) The total elastic movement obtained exceeds 80% of the theoretical elastic elongation of the free length.

2) The creep movement does not exceed 0.08 inches (2 mm) during the 5 minutes to 50 minutes time increments regardless of tendon length and load.

2. Proof Tests:

Perform proof tests by incrementally loading and unloading the anchor in accordance with the following schedule. Record the movement of the tendon to the nearest 0.001 inch (0.025 mm) with respect to an independent fixed reference point. Monitor the jack load with a pressure gauge or load cell.

0
0.25P
0.50P
0.75P
1.00P
1.20P
1.33P (Hold for creep test)
Adjust to lockoff load.

Actual lockoff load may be somewhat higher to account for seating losses.

Perform a Creep Test by holding the 1.33P load for 5 minutes. Holding the load constant, record anchor movement (total movement) at 0 second, 30 second, 1 minute, 3 minute, and 5 minute intervals. Begin observation times the moment the jack begins to apply the 1.33P load. If the movement between the 30 second and the 5 minute reading is 0.08 inches (2 mm) or more, maintain the load for an additional 45 minutes and record the movement at 10, 20, 30, 40, and 50 minutes. Record all movements in relation to a fixed reference point. The acceptance criteria shall be as in A and B above.

3. Lift-Off Tests:

Make a lift-off reading of all anchors after transferring the load to the end anchorage and prior to removing the jack. The load determined shall be within 5% of lockoff load. If the lift-off load is not within this tolerance, reset the end anchorage and make another lift-off reading. Perform lift-off tests within 7 days of when the load was locked-off in the anchor.

After five lift-off tests are performed, the Engineer will *specify* lift-off tests be performed on a random basis such that the total number of tests will be on no more than 10% of the remaining anchors.

4. Cutting of Tendon Protrusions:

After an anchor has been accepted by the Engineer, the portion of the anchored tendon protruding over the anchor may be cut, if not otherwise required for use in retesting. Cutting must be done according to the tendon manufacturer's recommendations as approved by the Engineer. Care must be taken not to damage the tendon anchor.

5. Redesign:

If anchors fail during performance tests or proof tests, modify the design or construction procedures, subject to review by the Engineer. These modifications may include reducing the anchor design load by increasing the number of anchors, increasing the grout pressure, requiring post-grouting or increasing the bond length. Any modification of design or construction procedure will be at no cost to the Department. Install the redesigned anchors in the wall and test as previously defined at no cost to the Department.

Those anchors that fail the performance or proof tests may be incorporated in the wall. Propose a reduced Design Load and retest as noted above. Acceptance of such anchors will be at the discretion of the Department.

7.0 Records

Provide the Engineer with the following records:

1. As-built drawings showing the location of the tiebacks, total tieback length, anchor length, and unbonded length one month after completion of the tieback installation.

2. Steel and grout certifications and mill reports prior to incorporating these materials in the work.

3. Grouting records indicating the cement type, quantity injected, and the grout pressures twice a week.

4. Tieback test results twice a week.

8.0 Method of Measurement

A. Permanent Anchor Tieback Retaining Wall - The quantity of Permanent Anchor Tieback Retaining Wall to be paid for will be the actual final square feet (square meters) of installed retaining wall face. Measurement will be made vertically from the final grade at the bottom of the wall to the bottom of the concrete coping.

B. Grout for Tieback Anchors - The quantity of Grout for Tieback Anchors to be paid for will be the actual number of cubic yards (cubic meters) of this material which has been placed as shown on the plans and as directed by the Engineer.

9.0 Basis of Payment

A. Permanent Anchor Tieback Retaining Wall

Payment will include all costs for concrete, reinforcing steel, shaft excavation, lagging, piles, anchors, furnishing and placing precast concrete panels, labor, design and all other materials and equipment including but not limited to drilling holes, post-tensioning, performing and evaluating all tests, submitting records of tests, all tools and all other miscellaneous items necessary to complete the work, including concrete coping and drainage above and below wall, with the exception of the items noted below.

Excavation of the material in front of the retaining wall will be paid for as "Unclassified Excavation" in accordance with Section 225 of the Standard Specifications.

Payment will be made under:

"Permanent Anchor Tieback Wall At Slide #4,
(Sta 20+89.59 to Sta 22+64.01).....Square Feet (Square Meter)

B. Grout for Tieback Anchors

The quantity of Grout for Tieback Anchors, measured as provided above will be paid for at the contract unit price per cubic yard (cubic meter) for "Tieback Anchor Grout". Such price and payment will be considered full compensation for furnishing, mixing, placing submitting records of tests, all tools and all other miscellaneous items necessary to complete the work

Payment will be made under:

"Grout for Tieback Anchors at Wall At Slide #4,
(Sta 20+89.59 to Sta 22+64.01).....Cubic Yard (Cubic Meter)