

Item No.	Pay Item	Pay Unit
8031XX0	( <u>size</u> )" Corrugated Metal Pipe Slope Drain	Linear Foot
8032XX0	( <u>size</u> )" Bituminized-Fiber Pipe Slope Drain	Linear Foot
8033XX0	( <u>size</u> ) " Polyvinyl Chloride (PVC) Pipe Slope Drain	Linear Foot
8034XX0	( <u>size</u> ) " Pipe Slope Drain	Linear Foot
8035000	Metal Intake Spillway Assembly	Each

## SECTION 804

### RIP-RAP AND SLOPE PROTECTION

**804.01 Description.** This work shall consist of placing protective coatings of broken stone or concrete (which may or may not be grouted), bagged sand and cement, polyvinyl chloride coated wire enclosed rock gabions, precast concrete slabs or slope protection in accordance with these specifications and in conformity with the lines, grade and thickness shown on the plans or established by the Engineer. This work shall also consist of placing an approved fabric on a prepared slope beneath the rip-rap.

#### MATERIALS

**804.02 Stone for Rip-Rap.** Stones shall be hard quarry or field stone and shall be of such quality that they will not disintegrate on exposure to water or weathering. The stone shall be suitable in all respects for the purpose intended. Only stone obtained from an approved source shall be used.

Rip-rap shall be well graded stone with test samples falling between the following gradation limits:

Stone Size Range (Feet)	Stone Weight Range (Pounds)	Percent of Gradation
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1.5 D <sub>50</sub> to 1.7 D <sub>50</sub>	3.0 W <sub>50</sub> to 5.0 W <sub>50</sub>	Smaller Than 100
1.2 D <sub>50</sub> to 1.4 D <sub>50</sub>	2.0 W <sub>50</sub> to 2.75 W <sub>50</sub>	85
1.0 D <sub>50</sub> to 1.15 D <sub>50</sub>	1.0 W <sub>50</sub> to 1.5 W <sub>50</sub>	50
0.4 D <sub>50</sub> to 0.6 D <sub>50</sub>	0.1 W <sub>50</sub> to 0.2 W <sub>50</sub>	15

Rip-rap gradation classes shall conform to the following table:

Rip-Rap Class	Rock Size (Feet)	Rock Size <sup>2</sup> (Lbs.)	Percent of Rip-Rap Smaller Than
A	0.75	37	100
	0.50	11	50
	0.20	0.7	15
B <sup>1</sup>	1.30	200	100
	0.95	75	50
	0.40	5	10
C <sup>1</sup>	1.80	500	100
	1.30	200	50
	0.40	5	10
D <sup>1</sup>	2.25	1000	100
	1.80	500	50
	0.95	75	10
E <sup>1</sup>	2.85	2000	100
	2.25	1000	50
	1.80	500	5
F <sup>1</sup>	3.60	4000	100
	2.85	2000	50
	2.25	1000	5

<sup>1</sup> Based on AASHTO Gradations.

<sup>2</sup> Assuming specific gravity of 2.65.

**804.03 Stone for Foundation Rip-Rap.** Stone pieces used for the protection of foundations, piers, abutments, and walls

shall range in weight from a minimum of 25 pounds to a maximum of 250 pounds. At least 60% of the stone pieces shall weigh more than 150 pounds.

**804.04 Concrete for Rip-Rap.** Acceptable concrete, broken into proper size pieces, with no exposed reinforcing steel, and meeting the requirements as specified in these specifications may be used in lieu of stone for hand placed rip-rap, with written permission of the Engineer.

**804.05 Bagged Sand-Cement Rip-Rap.**

**A. Bags.** Bags shall be made of burlap or other approved material and shall have a capacity of one to two cubic feet. Bag sizes shall be approved by the Engineer before use.

**B. Sand.** Sand shall conform to the requirements of Subsection **701.10**.

**C. Portland Cement.** Portland cement shall conform to the requirements set forth in Subsection **701.02**.

**804.06 Grouted Rip-Rap.** The rip-rap stone shall conform to the requirements of Class B rip-rap as shown in Subsection **804.02**.

The grout shall be composed of one part portland cement conforming to the requirements of Subsection **804.05C** and three parts sand conforming to the requirements set forth in Subsection **804.05B**. The water content of the grout shall be such as to permit gravity flow into the interstices or voids with limited spading and brooming.

**804.07 Precast Concrete Rip-Rap.** Precast concrete rip-rap shall consist of unreinforced portland cement concrete units of the thickness specified and shall conform to the details shown on the plans. The concrete for precast rip-rap shall conform to the requirement for Class 2500 concrete as set forth in Section **701**.

#### **804.08 Polyvinyl Chloride Coated Wire Enclosed**

**Gabions.** PVC Coated Wire Enclosed Gabions consist of mats of baskets with uniformly sized partitions fabricated from galvanized and PVC coated wire mesh which is then filled with stone, connected together, and anchored to the slope or channel bottom to be protected. The finished gabions shall meet the following requirements:

1. Polyvinyl Chloride (PVC) Coated Wire. The wire mesh manufactured for use in gabions shall have the following properties:

Physical Property	Gabions
Wire Diameter (gage)	0.105 inch (12 gage)
Tensile Strength of Wire	60,000 psi
Mesh openings	3 inches X 3 inches
Galvanizing	In accordance with ASTMA 641, Class 3
PVC Coating, gray in color	0.015 inch thick min.
Lacing Wire diameter (gage)	0.087 inch (13.5 gage)
Spiral Binder diameter (gage)	0.105 inch (12 gage)

The longitudinal and transverse members of the wire mesh shall be securely connected at each intersection. The openings formed shall be substantially square or rectangular. PVC coating of the wire mesh shall be accomplished after fabrication of the fabric.

The PVC coating must be resistant to the destructive effects of immersion in acidic, salt, or polluted water, exposure to ultraviolet light and abrasion, and shall retain these characteristics after a period of not less than 3000 hours under tests in accordance with ASTM G 23.

2. Rock. Rock used to fill the PVC Coated Wire units shall meet the requirements of Subsection **804.02** of the standard specifications. The rock used shall be well-graded and 70%, by weight, shall exceed in least dimension the wire mesh opening. The maximum size of stone, measured normal to the slope, shall not exceed the thickness of the gabion.

3. Lacing Wire, Spiral Binder Wire, and Stiffeners. Lacing wire and spiral binder wire, which are used to assemble, interconnect, and close gabion units, and stiffeners, which support units by forming diagonal braces, shall have the same PVC coating as the wire mesh.

4. Geotextile Fabric. Geotextile Fabric used shall be in accordance with Subsection **804.11**.

**804.09 Concrete for Slope Protection.** Concrete for slope protection shall conform to the requirements for Class 2500 concrete as set forth in Section **701**.

**804.10 Fiber Reinforced Concrete Slope Protection.** Fiber reinforced concrete for slope protection shall conform to ASTM C 94, ASTM C 1116, ASTM C 1018, ASTM E 119, and the following characteristics:

1. Chemical. The fiber reinforcement shall be virgin polypropylene which is inert to alkali and chemical attack; fiberglass or polyester-based fibers are unacceptable.

2. Physical. The reinforcement shall be fibrillated, twisted-bundle form; monofilament or untwisted fibers are unacceptable.

3. Length. The minimum fibrous length shall be based on the top-size coarse aggregate – Multi Design Gradation

**804.11 Geotextile Fabric for Slope Protection.** This fabric shall be an engineering fabric type capable of reducing soil erosion. Only fabrics appearing on the Department's approval listing will be allowed to be used. The manufacturer's literature concerning the proposed product and proof of satisfactory performance shall also be submitted to the Engineer.

Geotextiles used for erosion control under rip-rap applications shall conform to the physical requirements given below:

1. Strength Property Requirements (all fabrics)

	Class 1 Fabric Protected <sup>1</sup>	Class 2 Fabric Unprotected
Grab Strength ASTM D 4632	90 lbs.	200 lbs.
Seam Strength <sup>2</sup> ASTM D 4632	80 lbs.	180 lbs.
Puncture Strength ASTM D 4833	40 lbs.	80 lbs.
Burst Strength ASTM D 3786	140 psi	250 psi
Trapezoid Tear Strength ASTM D 4533	40 lbs.	80 lbs.
Elongation at Failure ASTM D 4632	15% minimum	15% minimum
Ultraviolet Degradation at 500 Hours ASTM D 4355	50% Strength Retained	50% Strength Retained

1 Fabric is said to be protected when cushioned from rock placement by a sufficient layer of sand or gravel at least 6 inches thick or by zero height placement. All other conditions are said to be unprotected.

2 Values apply to both field and manufactured seams. Seams should be sewn upwards for inspection.

## 2. Piping Resistance (Soil Retention) & Permittivity Requirements:

	AOS (ASTM D 4751)	Permittivity (ASTM D 4491)
Type A	=No. 30 Std Sieve	=0.7 sec <sup>-1</sup>
Type B	=No. 40 Std Sieve	=0.2 sec <sup>-1</sup>
Type C	=No. 60 Std Sieve	=0.1 sec <sup>-1</sup>
Type D	AOS and fabric permittivity requirements will be based on site specific design and will be indicated in the special provisions of the proposal	

Type A fabric will generally be specified for soils with less than 15% particles by weight passing the No. 200 sieve.

Type B fabric will generally be specified for soils with 15% to 50% particles by weight passing the No. 200 sieve.

Type C fabric will generally be specified for soils with more than 50% particles by weight passing the No. 200 sieve.

Type D fabric will generally be specified for Critical/Severe Applications

**804.12 Granular Filter.** When so specified on the plans, granular filter will be used instead of geotextile filter fabric under rip-rap. It shall consist of a layer or layers of well-graded crushed stone or gravel meeting the gradations specified on the plans. The gradation of each layer shall conform to the following relationship with the gradation of the underlying material, either soil or filter material.

$$\frac{D_{15} \text{ (coarser layer)}}{D_{85} \text{ (finer layer)}} \leq 5 \leq \frac{D_{15} \text{ (coarser layer)}}{D_{15} \text{ (finer layer)}} \leq 40$$

Where:

$D_{15}$  is the diameter of the particle size that 15% of the material is smaller than.

$D_{85}$  is the diameter of the particle size that 85% of the material is smaller than.

No more than 5% of the filter material should pass the No. 200 sieve.

## CONSTRUCTION REQUIREMENTS

**804.13 Placing Rip-Rap.** Rip-rap shall be placed on a prepared slope or area that shall conform to the lines, grades, and thickness shown on the plans. It shall be placed on either a fabric or a granular filter as specified on the plans. For larger rip-rap sizes, the plans or the Engineer may call for a layer of sand to be placed over the fabric to prevent puncture. The thickness of the rip-rap shall be equal to the maximum stone diameter or the thickness specified in the plans, whichever is greater.

The rip-rap shall be placed either mechanically or by hand in such a manner that the larger stones are well distributed and the entire mass of stone conforms to the specified gradation. It shall be placed so that there are the minimum practical percentage of voids. The rip-rap shall be placed to its full thickness in one operation and in such a manner as to avoid displacing the underlying material. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.

When called for on the plans at bridge end fills, a trench shall be dug along the toe of the fill 2 feet deep and the rip-rap will be placed from the bottom of the ditch to the specified height, unless the plans specify a different toe treatment.

**804.14 Placing Foundation Rip-Rap.** The stone, graded so that the smaller stone is uniformly distributed throughout the mass, may be placed by dumping, and shall be placed to the required thickness on approved slopes at locations designated on the plans or at other locations designated by the Engineer.

**804.15 Placing Sand-Cement Rip-Rap.** The preparation of the slope and trench shall be as specified in Subsection **804.13**. The bags shall be filled with sand and cement with sufficient water to moisten the mix in the ratio of 5 parts sand to one part cement. Upon filling, the bags shall be securely tied closed. Placing shall commence at the bottom and progress upward with the tied ends of the bags turned inward. The joints shall be broken and the bags shall be manipulated so that the bag surfaces shall be in full contact to the extent feasible.

Terminal cutoff walls will be placed at each end of the bagged sand-cement rip-rap treatment. Cutoff walls, 3feet wide by 3 feet deep shall be placed approximately every 30 feet along the length of the treatment or as directed by the Engineer.

Whenever placement of sand cement bags is delayed sufficiently to affect the bond between succeeding courses, a small trench, one half sack depth, shall be excavated back of the last row in place and the trench filled with concrete before the next layer laid. At the start of each day's work, or when a delay of over 2 hours occurs during the placing of successive layers of sacks, the previously placed sacks shall be moistened and dusted with cement to develop bond.

**804.16 Grouted Rip-Rap.** The aggregate, preparation of the slope and method of placing the rip-rap for grouted rip-rap shall be as specified in Subsection **804.13**. After the rip-rap has been placed and approved, all interstices or voids between the stones shall be filled with mortar to a depth of not less than 4 inches below the surface of the stone. The face or surface of the stones shall be left reasonably free of grout.

Plastering of the rip-rap will not be permitted. The spaces between the stones shall be reasonably free of sand or other material and shall be wet during the placing of the grout.

The edges on the ends of the grouted rip-rap shall be tied to solid rock, formed into smooth transitions, or trenched well back into the bank to prevent undermining. The bottom of the grouted rip-rap shall be founded on solid rock or extended below the depth of possible scour. Weep holes shall be provided through the grout blanket to relieve any hydrostatic pressure behind the blanket.

**804.17 Placing Precast Concrete Rip-Rap.** The slope on which the rip-rap is to be placed shall conform to the typical cross-section shown on the plans or as directed by the Engineer and shall be prepared as specified in Subsection **804.13**. Placing shall begin in a trench below the toe of the slope and progress upward. Each piece shall be placed by hand perpendicular to the slope. It shall be firmly embedded against the slope in such manner that the vertical and horizontal joint space between individual units does not exceed 3/8 inch, unless otherwise permitted. Half blocks, odd shaped blocks, or Class 2500 concrete shall be used to fill the voids at the end of the sections to be placed or on curved shaped sections. The top course shall conform as nearly as practicable to the prescribed berm or shoulder elevation.

Any adjustment necessary to achieve this shall be obtained by constructing a wedge course as directed. This wedge course, when required, shall consist of Class 2500 concrete. Toe walls, when required, shall consist of Class 2500 concrete. All concrete shall be jointed and textured as directed to blend with the precast blocks.

**804.18 Placing Geotextile Fabric for Slope Protection.**

Geotextile fabric for slope protection shall be placed in accordance with plan details at locations shown on the plans or as directed by the Engineer. The slope on which the fabric is to be placed shall be within reasonable conformity with the plans and shall be in a relatively smooth condition free from

obstructions, debris or sharp objects that may puncture the fabrics. Construction equipment should not operate directly on the fabric.

The fabric shall be placed with the long dimension parallel to the toe of the slope and shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. If more than one strip is necessary, the strips shall overlap a minimum of 18 inches. Transverse laps shall be placed so the upstream strip laps over the downstream strip. Horizontal laps shall be placed so the lower strip laps over the upper strip. Laps may be eliminated provided the joint is sewn using an approved method.

Approved fastener pins shall be installed through both strips of overlapped fabric at no less than 5 foot intervals along a line through the midpoint of the overlap, and at any other locations as necessary to prevent any slippage of the fabric.

When placing material on the fabric, the height of the drop shall be limited in order to prevent damage to the fabric. The Contractor shall demonstrate that the placement technique will prevent damage to the fabric. Placement of the material shall begin at the toe of the slope and proceed upward.

Any fabric damaged during installation or during placement of filter materials, slope protection, or other materials shall be repaired or replaced by the Contractor with no additional compensation. Extensively damaged fabric shall be removed and replaced as directed by the Engineer. When the majority of the fabric is undamaged, individual isolated cuts, tears, or punctures may be repaired by placing a patch of geotextile fabric over the damaged areas. The patch shall extend at least 18 inches beyond the damage in all directions, or the entire perimeter of the patch shall be fastened by an approved sewing method.

The Contractor shall cover the fabric with the specified material before damage or deterioration from ultraviolet light

occurs. Fabric not covered within thirty (30) calendar days after placement shall be removed and replaced without any additional compensation. If damage or deterioration is evident before thirty (30) days after placement as determined by the Engineer, the fabric shall also be removed and replaced without any additional compensation.

**804.19 PVC Coated Wire-Enclosed Gabions.** Before the installation of gabions the channel shall be excavated as shown in the plans or as directed by the Engineer. The resulting subgrade shall be smooth, firm, and free from protruding objects or voids that would affect the proper placement of the PVC coated wire mesh units or damage the geotextile fabric.

Geotextile Fabric meeting the requirements of Subsection **804.11**(Class 2) shall be required for all gabions and shall be placed on the prepared subgrade. Adjacent strips shall be overlapped a minimum of 2 feet. Care shall be exercised in placing and anchoring the empty PVC coated wire mesh units to ensure proper alignment and to avoid damage to the geotextile fabric. Should the geotextile be damaged, it shall be replaced or repaired at the Contractor's expense as directed by the Engineer.

Placement of the units shall begin at the vertical abutment wall and proceed upstream or downstream. The empty units shall be placed on the geotextile fabric and the vertical ends bound together with lacing or spiral binder wires sufficiently to allow stretching of the units to remove any kinks. Stretching methods will be at the option of the Contractor. Once the units are placed in proper alignment, stakes, pins, or other approved methods shall be used to secure the units. Adjacent units shall be interconnected at intervals not to exceed six inches with lacing or spiral binder wire.

The empty units shall be filled carefully with rock placed by hand or machine to maintain alignment of the units with the rock placed uniformly in the units, with a minimum of voids between the rock, and avoiding bulging of the side or

top mesh. Dropping of the rock shall be limited to a height that prevents damage to the PVC coating or 36 inches, whichever is less. Once filled, the lid of the units shall be closed and secured with lacing or spiral binder wire. When space limitations along the channel bottom or slope prevents the use of a complete unit, the unit shall be cut to fit as directed by the Engineer.

Any excavation voids existing along the edges of the completed gabions shall be backfilled in a manner acceptable to the Engineer.

**804.20 Slope Protection.** Slope protection shall be cast in place concrete slope protection consisting of either Class 2500 concrete meeting the requirements of Subsection **804.09**, or fiber-reinforced concrete meeting the requirements of Subsection **804.10**. It shall be constructed in accordance with the plans at the locations indicated or where directed by the Engineer. The slope on which slope protection is to be placed shall conform to that shown on the plans unless otherwise directed.

Reinforcement when specified shall conform to the requirements of Section **703** and shall be placed in accordance with plan details. The surface of the slope shall be finished uniformly with floats and textured by dragging with wet burlap. After finishing, the slope protection shall be cured in accordance with the requirements in Subsection **501.24**.

**804.21 Method of Measurement.** Hand placed rip-rap, foundation rip-rap and dumped rip-rap will be measured in tons or cubic yards. Sand-cement rip-rap will be measured in cubic yards. Grouted rip-rap and precast concrete rip-rap (including the area occupied by the wedge course) will be measured in square yards parallel to the slope. Gabions shall be measured by the cubic yard of PVC Coated Wire-Enclosed Rock Gabion of specified thickness. Slope protection and geotextile fabric for slope protection will be measured in square yards.

**804.22 Basis of Payment.** The accepted quantities will be paid for at the contract unit price for the type of Rip-Rap placed, which price and payment shall be full compensation for all excavation, backfilling, preparation of slopes and footing trench, disposal of surplus materials, and for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Payment at the contract unit price for Grouted Rip-rap shall include furnishing and placing the grout only. The aggregate (stone) will be paid for as a separate item. When reinforcement is required in slope protection, payment at the contract unit price shall be full compensation for furnishing all materials, including reinforcement.

Payment at the contract unit price for PVC Coated Wire-Enclosed Rock Gabions shall be full compensation for all rock, excavation, geotextile fabric, stakes, fasteners, backfill, disposal of excess material, including all material, labor, equipment, tools, and incidentals necessary to complete the work.

Payment for each item includes all direct and indirect costs and expenses required to complete the work.

Payment will be made under:

<b>Item No.</b>	<b>Pay Item</b>	<b>Pay Unit</b>
8041100	Hand Placed Rip-Rap	Ton
8041200	Hand Placed Rip-Rap	Cubic Yard
8042100	Foundation Rip-Rap	Ton
8042200	Foundation Rip-Rap	Cubic Yard
8043100	Dumped Rip-Rap	Ton
8043200	Dumped Rip-Rap	Cubic Yard
8043350	Sand Cement Rip-Rap	Cubic Yard
8043370	Grouted Rip-Rap	Square Yard

**Pay Items (Continued)**

Item No.	Pay Item	Pay Unit
8043390	Precast Concrete Rip-Rap	Square Yard
8044100	PVC Coated-Wire Enclosed Rock Gabion	Cubic Yard
8047040	Slope Protection 4" Concrete	Square Yard
8047041	Slope Protection 4" Concrete (Fiber Reinforced)	Square Yard
80482XX	Geotextile For Erosion Control Under Rip-Rap (Class <i>(class)</i> ) Type <i>(type)</i> )	Square Yard

## SECTION 805

### GUARDRAIL

**805.01 Description.** This work shall consist of constructing guardrail, of the type specified, in accordance with these specifications and in conformity with the lines and grades shown on the plans or established by the Engineer. The types of guardrail shall be in accordance with the plans and proposal and are designated as follows:

1. Steel Beam Guardrail (W-Beam)
2. Adjustable Guardrail
3. Steel Beam Guardrail (Double Layer)
4. Steel Beam Guardrail (Thrie)
5. Steel Beam Guardrail (Thrie-Double Layer)
6. Box Beam Median Barrier
7. Tubular Beam Guardrail (Bridge Railing)
8. Temporary Guardrail
9. Concrete Median Barrier
10. Temporary Concrete Median Barrier

The construction of the various types of guardrail shall