

SECTION 02271

SLOPE PROTECTION AND EROSION CONTROL

1. PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Plan Riprap.
- B. Plain Riprap Spillway.
- C. Plain Riprap Bank Protection.
- D. Reinforced Grass Spillway.
- E. Equalizing Weir.
- F. Cobblestone Streambed Protection.
- G. Heavy Riprap.
- H. Gabion Mattress Slope Protection.
- I. Gabion Basket Cascade.
- J. Gabion Basket Channel.
- K. Gabion Basket Toe Wall.
- L. Rock Lined Channel With Gabion Basket Sidewalls.
- M. Stilling Basin.
- N. Rock Channel 6 Foot Width.
- O. Grass Lined Channel 10 Foot Bottom Width.
- P. Temporary Debris Fence.
- Q. Cross Vane.
- R. Riprap Toe Drainage System.
- S. Boulders.
- T. Stream Restoration Details, 6 Narrow Channel with Rock Riprap, 12 New Channel.
- U. Stream Restoration Details, 15 Riffle Zone, 17 Crossvane, 19 J-Hook.

1.2 RELATED SECTIONS

- A. Section 01560 – Temporary Controls.
- B. Section 02211 – Rough Grading.

- C. Section 02218 – Landscape Grading.
- D. Section 02222 – Excavation.
- E. Section 02223 – Backfilling.
- F. Section 02279 – Filter Fabric.
- G. Section 02715 – Lateral Tile Drains, Surface Outlet Tubes.
- H. Section 02751 – Drain Crossings.
- I. Section 02110 – Site Clearing.
- J. Section 02274 – Soil Erosion Control.

### 1.3 REFERENCES

- A. Part 91 of Act 451 of 1994, (as amended), Soil Erosion and Sedimentation Control Act.
- B. Natural Crushed Stone Association (N.C.S.A.).
- C. Michigan Department of Transportation: Current edition of the Standard Specifications for Construction.
- D. ASTM D-4595 – Test method for geo-grid tensile strength.
- E. ASTM A-641 Standard Specification for Galvanized Carbon Steel Wire.

### 1.4 SUBMITTALS

- A. Submit under provisions of Section 01300 - Submittals.
- B. Submit shop drawings and product data for all items to be installed and/or constructed within this Section.

### 1.5 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. Plain Riprap:
  - 1. Basis of Measurement: At the unit price bid per square yard as stated in the proposal.
  - 2. Basis of Payment: Includes material, labor, and equipment for installation of filter fabric, placement of riprap to a depth of 1 foot, excavation, and grading to provide required contours as shown on the plans and as indicated in the specifications.
- B. Plain Riprap Spillway:
  - 1. Basis of Measurement: At the unit price bid per lineal foot as stated in the proposal.
  - 2. Basis of Payment: Includes materials, labor, and equipment for installation of filter fabric, placement of riprap to a depth of 1 foot, excavation, and grading to required contours as shown on the plans and as indicated in the specifications.

- C. Plain Riprap Bank Protection:
  - 1. Basis of Measurement: At the unit price bid per lineal foot as stated in the proposal.
  - 2. Basis of Payment: Includes materials, labor, and equipment for installation of filter fabric, placement of riprap to a depth of 1 foot, excavation, and grading to required contours as shown on the plans and as indicated in the specifications.
  
- D. Reinforced Grass Spillway:
  - 1. Basis of Measurement: At the unit price bid per square yard as stated in the proposal
  - 2. Basis of Payment: Includes materials, labor, and equipment for installation of reinforced grass spillway including: turf reinforcement mat, header and toe protection, placement of soils, seeding, fertilizing, mulching, excavation, and grading to required contours as shown on the plans and directed by the Engineer.
  
- E. Equalizing Weir:
  - 1. Basis of Measurement: At the unit price bid per each as stated in the proposal.
  - 2. Basis of Payment: Includes all the labor, material, and equipment necessary to install the equalizing weir as shown on the plans and as directed by the Engineer.
  
- F. Cobblestone Streambed Protection:
  - 1. Basis of Measurement: At the unit price bid per linear foot of cobblestone spread in the streambed as protection as stated in the proposal.
  - 2. Basis of Payment: Includes equipment, materials, and labor, for installation of filter fabric, placement of cobblestone to a depth of 8 inches, placement of boulders, excavation, and grading to required contours as shown on the plans and directed by the Engineer.
  
- G. Heavy Riprap:
  - 1. Basis of Measurement: At the unit price bid per square yard as stated in the proposal.
  - 2. Basis of Payment: Includes all labor, materials, and equipment necessary to install heavy riprap to a minimum depth of 16 inches and filter fabric for this project as specified, determined in field by Engineer, and/or shown on plans.
  
- H. Gabion Mattress Slope Protection:
  - 1. Basis of Measurement: At the unit price bid per square yard as stated in the proposal.
  - 2. Basis of Payment: Includes material, equipment, and labor to install the mattress. Clearing and grubbing, excavation and removal of excess soils to the grades or sub-grades shown on the plans and or details. Placement of geo-textile fabric and or bedding stone on prepared sub-grade where called for on the drawings or details. Placement of gabion baskets and mattresses and filling of baskets of mattresses with stone. The size, number, and arrangement of the gabion baskets or mattresses to be according to the schedules, details, and plans shown in the plans and the specifications for gabion baskets.
  
- I. Gabion Basket Cascade (No. 1 and No. 2):
  - 1. Basis of Measurement: At the unit price bid per each as stated in the proposal.

2. Basis of Payment: Includes material, equipment, and labor to install basket cascades as shown on the plans. Clearing and grubbing, excavation and removal of excess soils to the grades or sub-grades as shown on the drawings and or details. Placement of geo-textile fabric and or bedding stone on prepared sub-grade where called for on the drawings or details. Placement of gabion baskets and mattresses and filling of baskets of mattresses with stone. The size, number, and arrangement of the gabion baskets or mattresses to be according to the schedules, details, and drawings shown in the plans and the specifications for gabion baskets.
- J. Gabion Basket Channel:
1. Basis of Measurement: At the unit price bid per linear foot as stated in the proposal.
  2. Basis of Payment: Includes material, equipment, and labor to install the basket channel as shown on the plans. Clearing and grubbing, excavation and removal of excess soils to the grades or sub-grades as shown on the drawings and or details. Placement of geo-textile fabric and or bedding stone on prepared sub-grade where called for on the drawings or details. Placement of gabion baskets and mattresses and filling of baskets of mattresses with stone. The size, number, and arrangement of the gabion baskets or mattresses to be according to the schedules, details, and drawings shown in the plans and the specifications for gabion baskets.
- K. Gabion Basket Toe Wall:
1. Basis of Measurement: At the unit price bid per linear foot as stated in the proposal.
  2. Basis of Payment: Includes material, equipment, and labor to install the basket toe wall as shown on the plans. Clearing and grubbing, excavation and removal of excess soils to the grades or sub-grades as shown on the drawings and or details. Placement of geo-textile fabric and or bedding stone on prepared sub-grade where called for on the drawings or details. Placement of gabion baskets and mattresses and filling of baskets of mattresses with stone. The size, number, and arrangement of the gabion baskets or mattresses to be according to the schedules, details, and drawings shown in the plans and the specifications for gabion baskets.
- L. Rock Lined Channel With Gabion Basket Sidewalls:
1. Basis of Measurement: At the unit price bid per linear foot as stated in the proposal.
  2. Basis of Payment: Includes material, equipment, and labor to install the basket toe wall as shown on the plans. Clearing and grubbing, excavation and removal of excess soils to the grades or sub-grades as shown on the drawings and or details. Placement of geo-textile fabric and or bedding stone on prepared sub-grade where called for on the drawings or details. Placement of gabion baskets and mattresses and filling of baskets of mattresses with stone. The size, number, and arrangement of the gabion baskets or mattresses to be according to the schedules, details, and drawings shown in the plans and the specifications for gabion baskets. Channel between the gabion sidewalls. Work includes items listed above plus the placement of stone, size and type as indicated on the plans, schedules and details, within the proposed new channel.

- M. Stilling Basin:
1. Basis of Measurement: At the unit price bid per lump sum as stated in the proposal.
  2. Basis of Payment: Includes material, equipment, and labor to install the stilling basin as shown on the plans. Clearing and grubbing, excavation and removal of excess soils to the grades or sub-grades shown on the drawings and or details. Placement of geo-textile fabric and or bedding stone on prepared sub-grade where called for on the drawings or details. Placement of stone is to be according to the schedules, details, and drawings shown in the plans and the specifications. Work includes items listed above plus the placement of stone, size and type as indicated on the plans, schedules and details, within the proposed new channel. Also included is the finish grading, seeding and placement of soil erosion control blankets within the graded areas beyond the stonework as shown on the detail.
- N. Rock Channel 6 Foot Width:
1. Basis of Measurement: At the unit price bid per lineal foot as stated in the proposal.
  2. Basis of Payment: Includes material, equipment, and labor to install the rock channel as shown on the plans. Clearing and grubbing, excavation and removal of excess soils to the grades or sub-grades as shown on the drawings and or details. Placement of geo-textile fabric and or bedding stone on prepared sub-grade where called for on the drawings or details. Placement of stone is to be according to the schedules, details, and drawings shown in the plans and the specifications. Work includes items listed above plus the placement of stone, size and type as indicated on the plans, schedules and details, within the proposed new channel. Also included is the finish grading, seeding and placement of soil erosion control blankets within the graded areas beyond the stonework as shown on the detail.
- O. Grass Lined Channel 10 Foot Bottom Width:
1. Basis of Measurement: At the unit price bid per lineal foot as stated in the proposal.
  2. Basis of Payment: Includes material, equipment, and labor to install the rock channel as shown on the plans. Clearing and grubbing, excavate and shape the channel cross-section per the detail and grades as shown on the drawings and details. Spread the spoils within the drain easement as shown on drawings and detail. Excess spoil to be removed off site. Seeding and mulch and blankets within the entire drain easement width. Removal of trees less than 8 inches incidental.
- P. Temporary Debris Fence:
1. Basis of Measurement: At the unit price bid per each as stated in the proposal.
  2. Basis of Payment: Basis of Measurement: Includes all labor, material, and equipment necessary to install debris fence, maintain and clean during construction, and remove upon completion of the project according to the Engineer and/or as shown on the plans.
- Q. Cross Vane:
1. Basis of Measurement: At the unit price bid per each as stated in the proposal.
  2. Basis of Payment: Includes materials, labor, and equipment for placement of riprap, dewatering, excavation, and grading to required contours as shown on plans and indicated in the specifications.

- R. Riprap Toe Drainage System:
1. Basis of Measurement: At the unit price bid per square yard as stated in the proposal.
  2. Basis of Payment: Includes material, labor, and equipment for installation of filter fabric, placement of plain riprap to a depth of 18 inches, placement of 4 inches of Type B fill, placement of 6 inches of topsoil, seeding of all disturbed areas, excavation, grading to provide required contours as shown on the plans and indicated in the specifications.
- S. Boulders:
1. Basis of Measurement: At the unit price bid per each as stated in the proposal.
  2. Basis of Payment: Includes material, labor and equipment for installation of several boulders ranging in size from 4 feet to 6 feet. Locate the boulder as shown on the plans.
- T. Stream Restoration Details, 6 Narrow Channel with Rock Riprap, 12 New Channel:
1. Basis of Measurement: At the unit price bid per linear foot as stated in the proposal.
  2. Basis of Payment: Includes all labor, material and equipment to excavate, spoil removal and disposal, clearing, geotextile, riprap, cobblestone, gravel and the installation per appropriate detail as shown on the drawings.
- U. Stream Restoration Details, 15 Riffle Zone, 17 Crossvane, 19 J-hook:
1. Basis of Measurement: At the unit price bid per each as stated in the proposal.
  2. Basis of Payment: Includes all labor, material and equipment to excavate, spoil removal and disposal, clearing, geotextile, riprap, cobblestone, gravel and the installation per appropriate detail as shown on the drawings.

## 2. PART 2 PRODUCTS

### 2.1 MATERIALS

- A. **Crushed concrete is not acceptable.** Note that all rock materials shall be uniformly white crushed limestone. Samples of the limestone shall be submitted for approval prior to construction. The Owner reserves the right to reject any and all of the limestone that is too dark or not consistent in color.
- B. Cobblestone – Sound, tough, durable rock or uniformly white crushed limestone free from structural defects. Use natural stone for streambed protection. Material to be uniform in size and range in dimension from 3 inches to 12 inches. MDOT 916.01.
- C. Plain Riprap – Sound, tough, durable uniform white crushed limestone free from structural defects. Material to be uniform in size and range in dimension from 8 to 16 inches. MDOT 916.01.
- D. Heavy Riprap – Sound, tough, angular durable uniformly white crushed limestone free from structural defects. Material to be uniform in size and not less than 16 inches in the least dimension, with an average of 18 inches to 24 inches diameter. MDOT 916.01.
- E. All materials must be approved by Engineer before used on project.
- F. Filter Fabric - As specified in Section 02279 - Filter Fabric.
- G. Geo-Grid Netting – For retaining wall tiebacks shall be as specified on the drawings.

- H. Gabions – Mesh opening, hexagon nominal 3 ¼ inches x 4 ½ inches; Netting wire 0.1181 inch nominal diameter; Selvedge wire 0.1535 inch nominal diameter; Binding wire 0.0866 inch nominal diameter; Galvanizing 0.80 ounces per square foot; as manufactured by Maccaferri or equal.
- I. Basket Size – as shown on the plans and schedules.
- J. Gabion Stone – crushed limestone having a minimum size of 4 inches and a maximum size of 8 inches. Stone dry density shall be a minimum of 165 pounds per cubic foot.
- K. Gabion Bedding Stone – National Crushed Stone Association (N.C.S.A) #FS-2 having a minimum size of No. 100, average size of No. 4, and a maximum size of 2 inches. Stone dry density shall be a minimum of 165 pounds per cubic foot.
- L. Equalizing Weir - crushed limestone having a minimum size of 2 inches and a maximum size of 4 inches. Stone dry density shall be a minimum of 165 pounds per cubic foot.
- M. Reinforced Grass Spillway turf reinforcement mat: North American Green SC150.
- N. Reinforced Grass Spillway securing pins: 6 inch North American Green Eco Stakes or Engineer approved equivalent.

### 3. PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Exact location of plain riprap, plain riprap spillways, and cobblestone streambed protection to be determined by Engineer during construction.
- B. Implement temporary controls under provisions of Section 01560 – Temporary Controls.

#### 3.2 RIPRAP PROTECTION

- A. Clear topsoil and rough grade to required contours. Over excavate protection area equal to the thickness of the protection.
- B. Place filter fabric with all edges "toed in" a minimum of 12 inches. Riprap will not pass inspection if filter fabric is not "toed in."
- C. Place protection on filter fabric; tamp protection until individual pieces are firmly bedded.
- D. Hand place stone, if necessary, to assure that there are no void spaces in protection. Upon completion the filter fabric should not be visible.
- E. Bank and grade protection shall be installed as needed per location as directed by the Engineer.
- F. Toe of slope protection shall be installed along the bank to a height of 3 foot vertically above the flow line of the drain.

#### 3.3 RIPRAP SPILLWAYS

- A. Clear topsoil and rough grade to required dimensions. Over excavate spillway so that upon completion the flow line of the spillway is recessed 18 inches below the proposed side slope of the open drain.

- B. Spillway shall be constructed with a 4 foot bottom and 2 horizontal to 1 vertical side slope unless directed otherwise by the Engineer. Riprap should be placed to a width of 8 foot across the spillway.
- C. Filter fabric shall be placed under riprap and toed-in as shown on construction plans.
- D. Spillway will not pass inspection if filter fabric is not "toed in."
- E. Riprap should be placed starting at the toe of slope and extend to 3 foot beyond same side top of bank.
- F. Tamp riprap until individual pieces are firmly bedded.
- G. Hand place stone, if necessary, to assure that there are no void spaces in protection. Upon completion the filter fabric should not be visible.

#### 3.4 REINFORCED GRASS SPILLWAY

- A. Repair washouts in spillway area.
- B. Prepare side slopes as shown on plans in undisturbed area.
- C. Over excavate area equal to the thickness of required topsoil and protection.
- D. Place topsoil as shown on plans.
- E. Rake in fertilizer; apply at the rate of 15 pounds per 1000 square feet.
- F. Seed topsoil with ditch bank seeding mix at a rate of 6 pounds per 1,000 square feet.
- G. Place North American Green SC-150, or Engineer approved equal, turf reinforcement mat with all edges extending completely under entire header and toe protection.
- H. Place straw mulch over seeded areas.
- I. Place turf reinforcement mat with all edges extending completely under entire header and toe protection.
- J. Place header and toe protection. Tamp until individual pieces are firmly bedded.
- K. Place metal pins over entire spillway to anchor fabric at 2 feet on center.

#### 3.5 COBBLESTONE SPLASH PADS FOR FIELD TILE OUTLETS

- A. A splash pad shall be placed at the outlet of each C.M.P. tile outlet and surface outlet tube.
- B. Splash pads must be a minimum of 2 feet wide and must be a minimum of 1.5 feet wider than the diameter of the tile outlet.
- C. Splash pads range from 1 to 5 square yards of riprap depending on field conditions.
- D. Splash pad must be constructed in a "V" shape with center of splash pad excavate 1 feet deeper than edges of splash pad.

3.6 RIPRAP CHECK DAMS

- A. Construct check dams to required contours and elevations as shown on plans. Check dams should be bowl shaped to direct flow of water through center.
- B. Filter Fabric must be toed in and overlapped at seam.
- C. Check dam shall have a filter fabric core to hold back water.
- D. Riprap should extend at an adequate distance beyond crest (min. 10 feet) to protect from scour downstream.

3.7 EQUALIZING WEIR

- A. Construct weir to required elevation as shown on plans. Top of weir shall be flat to distribute water flow equally across the top of the weir.
- B. Place filter fabric on subgrade prior to placing stone for weirs.
- C. Top of weir shall remain flat and extend to a point where the finished grade and top of weir elevation are equal.

3.8 COBBLESTONE STREAMBED PROTECTION

- A. Rough grade to required dimensions.
- B. Construct as indicated on the plans.
- C. Over excavate so that upon completion, top of cobblestone is at flow line elevation.
- D. Cobblestone shall extend to top of bank or a maximum of 8 foot both right and left banks from center.
- E. Cobblestone shall be installed a minimum of 8 inches deep.
- F. Hand place boulders, along bottom of flow line as indicated on the plans or as directed by the Engineer.

3.9 GABIONS AND STONE BEDDING

- A. Assemble Gabions prior to placement.
- B. Excavate subgrade place filter fabric on subgrade where shown on drawings or details to design elevation and prepare for placement.
- C. Place 4 inch bedding stone over subgrade of filter fabric when shown on plans or details to provide level and uniform surface for placement of first row of Gabions.
- D. Place Gabions and attached adjacent units along top and vertical edges before filling with Gabion Stone. Keep Gabions stretched to assure proper filling.
- E. When the Gabion is 1/3 and 2/3 full, place-connecting wires, one in each direction, with the ends looped around two meshes at each end.
- F. Close top and wire to all vertical surfaces of the Gabion.

- G. Backfill behind the filled Gabion with backfill as specified on the plans to the height of each completed Gabion compacted in place before the next Gabion is installed and filled. This is to support the overhanging portion of the above baskets. The Gabions shall be hand filled on those surfaces visible to produce an esthetically pleasing appearance.
- H. Wire empty Gabions placed on top of a completed row, to the front and back of a filled row.
- I. Install the number of rows shown on the plans or to the required finish elevation, staggering vertical joints 2-3 inches.

### 3.10 CROSS VANE

- A. Engineer/Wetland Consultant shall stake cross vanes locations.
- B. Construct to required contours and elevations as shown on plans. Cross Vanes shall be bowl shaped to direct flow of water through center.
- C. Cross vane will not pass inspection if filter fabric is not "toed in."
- D. Tamp riprap until individual pieces are firmly bedded.
- E. Hand place stone, if necessary, to assure that there are no void spaces in protection.

### 3.11 RIPRAP TOE DRAINAGE SYSTEM

- A. Install as indicated on the plans and directed by the Engineer.
- B. Clear topsoil and rough grade to required contours.
- C. Grade area surrounding riprap toe drainage blanket to provide positive drainage
- D. Place filter fabric with all edges "toed in" a minimum of 12 inches. Riprap will not pass inspection if filter fabric is not "toed in."
- E. Hand place stone, if necessary, to assure that there are no void spaces in riprap.
- F. Upon completion the filter fabric should not be visible.

### 3.12 BOULDERS

- A. Install as indicated on the plans and directed by the Engineer.

### 3.13 STREAM RESTORATION DETAILS, 6 NARROW CHANNEL WITH ROCK RIPRAP, 12 NEW CHANNEL

- A. Clear topsoil and rough grade to required contours. Over excavate protection area equal to the thickness of the protection.
- B. Place filter fabric with all edges "toed in" a minimum of 12 inches. Riprap will not pass inspection if filter fabric is not "toed in."
- C. Place protection on filter fabric; tamp protection until individual pieces are firmly bedded.

- D. Hand place stone, if necessary, to assure that there are no void spaces in protection. Upon completion the filter fabric should not be visible.
- E. Over excavate area equal to the thickness of required topsoil and protection.
- F. Construct as indicated on the plans.
- G. Construct to required contours and elevations as shown on plans. Cross vanes shall be bowl shaped to direct flow of water through center.
- H. Cross vane will not pass inspection if filter fabric is not "toed in."
- I. Tamp riprap until individual pieces are firmly bedded.

3.14 STREAM RESTORATION DETAILS, 15 RIFFLE ZONE, 17 CROSSVANE, 19 J-HOOK

- A. Clear topsoil and rough grade to required contours. Over excavate protection area equal to the thickness of the protection.
- B. Place filter fabric with all edges "toed in" a minimum of 12 inches. Riprap will not pass inspection if filter fabric is not "toed in."
- C. Place protection on filter fabric; tamp protection until individual pieces are firmly bedded.
- D. Hand place stone, if necessary, to assure that there are no void spaces in protection. Upon completion the filter fabric should not be visible.
- E. Over excavate area equal to the thickness of required topsoil and protection.
- F. Construct as indicated on the plans.
- G. Construct to required contours and elevations as shown on plans. Cross vanes shall be bowl shaped to direct flow of water through center.
- H. Cross vane will not pass inspection if filter fabric is not "toed in."
- I. Tamp riprap until individual pieces are firmly bedded.

END OF SECTION