

SECTION 321 – STREAM BIOENGINEERING REVETMENTS

321.01 DESCRIPTION

This section covers general in-stream bioengineering revetments to create stable environmentally acceptable stream bank protection and habitat enhancement. These specifications further describe work indicated on plans and details. Other restrictions and requirements indicated in project permits shall also apply.

321.02 MATERIALS AND CONSTRUCTION

A. Disposal of Flush Cut or other Woody Vegetation

1. Unless specifically shown on plans, all trees and woody growth slated for removal shall either be removed offsite or chipped and spread onsite as directed by the M-NCPPC construction manager.

B. Erosion Control Matting [ECM]

1. Unless specified otherwise, all erosion control matting (ECM) shall be Bio-D 70, or approved equal, as described in Specification Section 323. Matting shall be "keyed" into ground 12 inches on the top and bottom of slopes. Contact Design Engineer where "key trench" will impact primary tree root systems. Secure with 24 -inch wood stakes, 2 per square yard.
2. Base soil shall be tilled to a three-inch depth; rake in three inches organic matter [top soil] prior to ECM placement.
3. Seeding for ECM areas shall be seeded with mix as described in these specifications. See Section II.

C. Weirs and Cross Vanes

1. Cross vanes are constructed such that the apex of the structure points upstream. The angle the wings make the upstream bank should be approximately 20 to 30 degrees so that flows are directed away from the banks and deeper pool areas are created directly downstream of the vane or weir. The center portion of the cross vane(s) is to be 1/3 the width of the top of the channel bank.
2. The top layer of rock shall rest upon at least one tier of footer rocks and shall be partially buried in the streambed a minimum of 12" (30 cm). On unstable bed substrates, two tiers of footer rocks may be required to prevent the downstream face of the vortex weir or cross vane from being undermined.
3. The top elevation of the center vortex rock at the apex of the vane should be at or near bed level to permit fish passage at low flows and the end vortex rocks on either bank

should be at bankfull level. The end vortex rocks should be partially buried in the streambank and should touch the adjoining vortex rocks.

4. Once the excavated portion of the bank has been backfilled, it should be armored with appropriately sized riprap, sod mats, or willow transplants.
5. Rocks shall meet the tenets of the 'Stone Sizing Chart' (sheet 5). Rocks must have a density of greater than 160 lbs / cu. ft. Concrete will not be accepted in lieu of rocks for cross vanes.

D. Stone Toe Protection

1. Rock toe protection shall be composed of angular stones sized per the tenets of the "Stone Sizing Chart" (sheet 5). Concrete or white rock will not be accepted.
2. The placement of rock toe protection shall begin below the invert of the stream as shown on the Construction Drawings. The larger stones shall be placed along the outside edge or face of the limit of the toe protection. The riprap shall be placed with suitable equipment to produce a uniformly graded mass of stones that is secure enough to remain in place during normal streamflow. Placing stones by methods that cause segregation is prohibited.
3. The surface elevation of completed rock toe installations shall be flush with adjacent channel bed or bank slope elevations, and shall not create an obstacle to flow. The plus or minus tolerance of the surface of the finished riprap installation shall be 6" from the lines and grades shown on the Contract Drawings when measured perpendicular to the exterior surface of the stonework.
4. Placed material not conforming to the specified limits shall be removed and replaced at no additional cost.
5. The stone shall be placed and distributed so the resulting layer will contain a minimum of voids and there will be no pockets of same size material. The stone shall be placed to its full course thickness in one operation in a manner that the underlying material will not be displaced or worked into the course of rock toe being placed.

E. Live Stake

1. Live branch cutting shall be approximately one quarter to one half inch (0.5" to 2") in diameter.
2. Cutting shall be long enough to reach the back of the bench and extend a minimum of one-foot (1') from the rebuilt slope face. Side branches and bark shall remain intact prior to installation.
3. Live branch cutting shall consist of a mix of three or more of the following species with at least one willow (*Salix*) and one dogwood (*cornus*) species included. Each species shall comprise no more than 50% and no less than 20% of the mix.

Cornus amomum	Silky Dogwood
Cornus stolonifera	Red Osier Dogwood
Salix nigra	Black Willow
Salix purpurea	Streamco Willow
Salix sericea	Silky Willow
Sambucus canadensis	American elderberry
Viburnum dentatum	Arrowwood

4. Live Material Preparation:

- a. All cuts shall be smooth and the cut surface kept small. The use of large pruning shear or power saws may be required.
- b. Live materials not installed within eight (8) hours of harvesting, shall be protected against drying out and overheating. Protection against drying out shall be accomplished by keeping the material: covered, transported in refrigerated vehicles, moistened and/or kept in soak pits. Storage of live materials shall include continuous shade by covering with evergreen branches or plastic sheeting. Proper storage shall also include sheltering live plant material from the wind and protection from drying by being heeled into moist soils and/or sprayed with anti-transpirant chemicals. Where water is available, live branch cutting shall be sprayed or immersed. Warm water (over 15°C) Stimulates growth and should be used only upon the approval of the engineer. Any cost associated with such storage is incidental to the overall costs

5. Construction:

- a. Branches shall be constructed two to three foot (2'-3') deep and buds upward.
- b. Branches shall be excavated horizontally on the contour. The surface of the branch shall be sloped so that the outside edge is higher than the back edge.
- c. Branch layer rows shall begin two feet (2') above the top of the bioengineered revetment or the top of rock bank stabilization.
- d. Branch tips shall extend a minimum of one foot (1') beyond the edge of the bench.

F. J-Hooks

1. Rocks for J-Hook construction shall have an intermediate diameter as specified in the design details.
2. Shape and orientation: J-Hooks shall be angled 20 to 30 degrees from the upstream bank.
3. Height: The bank-end of the J-Hook shall be at the bankfull elevation and the tip of j-

hook shall be partially embedded in the streambed such that it is submerged even during low flows. This tip shall be placed to form a semi-circular structure at the streambed. The vane arm shall be placed at a vertical angle of 3% to 7%.

4. Length: J-hooks shall span a maximum of 1/3 of the channel width, depending on the channel size. J-hooks may span up to 60% of the channel width. The larger the channel, the shorter the vane should be relative to the channel width.
5. When installing j-hooks, the bank end of the structure shall be firmly anchored a minimum of 1-2 rocks into the bank. J-hook rocks shall be placed on top of footer rocks such that each vane rock touches adjacent rocks and rests upon two halves of each footer rock below it, and so that the vane rock is offset in the upstream direction. J-hook rocks shall be shingled upstream.

G. Invasives Species Control

- 1 Invasive species control program shall utilize appropriate Integrated Pest Management practices and the use of a professional certified pesticide applicator. The applicator shall be certified in the following categories depending upon the nature of the application area: Forest, Right of Way, or Aquatic Pest Control (for work directly adjacent to or over water).
- 2 Growth habits of invasives are rapid and site conditions may change dramatically, therefore the program may be altered at the time of implementation.
- 3 Cutting of the large plant masses followed by chemical controls is suggested at this time. Mowing of the target species may occur any time of the year. Herbicide application will follow cutting. During the growing season, the identified plants may be treated with a non-selective herbicide (glyphosphate), applied according to label directions. However, care should be taken to ensure that the timing of the application is conducive to uptake and translocation of the herbicide. The applicator should ensure that the herbicide is listed for use against the selected species, and is labeled for aquatic use if the application will be made over water. During periods outside of the growing season, the woody weeds identified may be treated with systemic herbicides labeled for dormant season applications (triclopyr).
- 4 A follow up treatment of control is to be performed 1 month after the beginning of the following growing season (approximately May 1st).
- 5 It is the responsibility of the applicator to select the proper herbicide for the targeted species based on the time of year, and to use the herbicide in a manner that is consistent with the label. Additionally, it is the responsibility of the applicator to obtain Toxic Materials Permits for the use of herbicides

H. Filter Cloth

1. Filter cloth shall meet ASTM D751 (puncture strength - 125 lb)

ASTM D-1117 (Mullen burst strength - 400 PSI)

ASTM D-1682 (Tensile strength - 300 lb)

2. Fabric shall have 0.08" thick E.O.S. of #80 sieve, and maintain 125 GPM per sq. ft. flow rate.

321.03 MEASUREMENT AND PAYMENT

- A. Payment will be full compensation for all material, labor, equipment, tools and incidental items necessary to complete the work. Payment shall be made on a unit rate or lump sum basis as shown in the bid proposal. ECM shall be paid for based on the finished surface area of matting installed. Live Stakes shall be paid for by actual number of stakes installed. Weirs, Cross Vanes, Rock Vanes, J-Hooks, and Stone Toe Protection shall be paid for based on the actual linear footage of the structure measured along the centerline of top stones placed to form footers, tie-ins, arms, apex, etc. of revetment structures. Excavation, backfill, drainage/scour stone, filter cloth, and other ancillary items required for complete installation shall be considered incidental to the costs of the revetments.