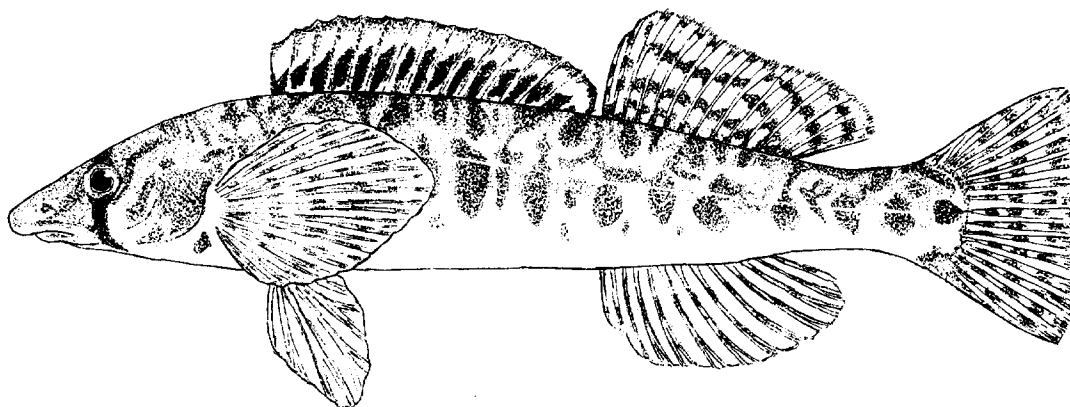


**River Restoration Plan  
For The  
North Fork Roanoke River Fish kill**



**Prepared by:**

**Blacksburg Country Club**

**For:**

**The Commonwealth of Virginia**

**And**

**The U.S. Fish and Wildlife Service**

**December 2011**

Drawing Credit: Mike Pinder, DGIF

## I. OVERVIEW

### Spill Background

The Blacksburg Country Club (BCC) property is located in the headwaters of the Roanoke River watershed on the North Fork Roanoke River (NFRR). On July 9, 2007, a BCC employee filled a 150 gallon sprayer with three chemicals: Chipco Signature (dry fungicide), Syngenta Daconil ZN (liquid fungicide) and Syngenta Primo Maxx (liquid plant growth inhibitor). During the tank filling process, the dry chemical congealed and blocked the tank intake. The tank overflowed and the chemicals spilled into the adjacent NFRR. The BCC employee filling the tank walked away and was not present when the spill occurred. When the employee returned, he saw the spill and washed the spilled chemicals into a collection pipe which drained into the NFRR. On July 10, 2007, farmers, whose properties are situated downstream from the BCC property, observed numerous dead and dying fish in the NFRR and called the Virginia Department of Environmental Quality (DEQ).

### Trustee Assessments

The DEQ and Department of Game and Inland Fisheries (DGIF) initiated an investigation that included the collection of water samples for analytical chemistry analysis and the completion of fish-kill count. The results of the water sample analyses collected by Virginia revealed the presence of chlorothalonil; a primary constituent of fungicides which is toxic to aquatic organisms at extremely low doses. The fish-kill count estimated that 10,335 fish were killed by the spill. Included in this estimate were 169 Roanoke logperch (*Percina rex*); which are endangered species under the Endangered Species Act. It was estimated that about 1.4 miles of the NFRR was adversely impacted by the spill. The DEQ subsequently issued a Notice of Violation to the BCC on August 8, 2007. On April 28, 2009, a Special Order by Consent was issued by the Virginia State Water Control Board.

### Authority

The Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. §§9601-9675 (CERCLA), allows the United States, the individual states and Federally recognized Indian tribes to assert natural resource damages (42 U.S.C. §9607). In this case, the natural resource trustees (collectively the "Trustees") are the Department of Interior (DOI), acting through the U.S. Fish and Wildlife Service (Service), and the Commonwealth of Virginia. In the fall of 2007, the Trustees signed a Memorandum of Agreement that provides a framework for Trustee coordination in assessing natural resource damages, restoration planning, and restoration implementation.

Natural resources are defined in CERCLA as including; "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled" by the natural resource trustees [42 U.S.C. §9601(16)]. The President has designated the Secretary of DOI as a Federal trustee for natural resources. Executive Order 12777, 56 Fed. Reg. 54757 (Oct. 22, 1991). The Secretary of DOI acts as a trustee for natural resources belonging to, managed by, controlled by or appertaining to the United States including their supporting ecosystems. 42 U.S.C. §9607(f) and 40 C.F.R. §300.600(b)(2). At this site, DOI is the Federal trustee for the Roanoke logperch, which is an endangered species under the Endangered Species Act, 16 U.S.C. §1531 *et seq.*, as well as their habitats and the surface water as part of the supporting ecosystem. The Roanoke logperch was listed endangered on August 18, 1989.

### Purpose

At this time, the Trustees are not pursuing an injury assessment in accordance with the DOI Natural Resource Damage Assessment and Restoration (NRDAR) regulations at 40 C.F.R. Part 11 because it is

anticipated that the Trustees and BCC will settle the NRDA claims pursuant to a court approved consent decree. The NRDAR regulations are not mandatory [40 C.F.R. §300.615 (c)(1) (iv)]. The Trustees and BCC have worked cooperatively to develop a suite of mutually-acceptable river restoration projects (restoration projects) that will be implemented by BCC and are designed to protect and restore Roanoke logperch habitat over time on BCC property. These habitat protection and enhancement measures have been selected and designed with the primary purpose of improving water quality within the NFRR. These water quality improvements will, in turn, facilitate the improvement of natural reproduction of this vital sub-population of the Roanoke logperch. Aerial photographs of the restoration projects can be found in Appendix B attached and incorporated by reference herein and a cost estimate summary can be found in Table 12. Importantly, this work will complement several other river restoration/water quality improvement projects that have already been implemented within the NFRR watershed, upstream from the BCC property.

## II. RESTORATION PROJECTS DESCRIPTIONS

### Reference Cross Sections

Definition/measurement of the reference cross sections is the first step in designing Rosgen natural river channel design project. The NFRR runs through the center of the golf course and has 46-square mile drainage area. Total amount of river reach surveyed was 3,458 linear (ln) feet (ft) with 6 cross-sections included within the reach. The channel fits a Rosgen channel type B4/1c (Rosgen 1994); however, considering that the channel morphology is largely controlled by geologic structure (i.e. it is not exclusively an alluvial channel), natural channel design and the available Ridge and Valley regional curves (Keaton et al. 2005) should be used with caution.

A reference cross-section (Appendix A attached and incorporated by reference herein) was compared to U.S. Geologic Survey (USGS) regional curves for the Ridge and Valley Physiographic province (Keaton et al. 2005). Measurements were within an acceptable margin of error and used for comparison with other impacted sections of the surveyed reach (see Table 1). Other surveyed cross sections fit well within the regional curve cross-sectional area, but the cross-section selected as the reference appeared the most stable.

**Table 1**

<b>Regional Curves for Maryland, Virginia, &amp; West Virginia Valley and Ridge Physiographic Province (Keaton 2005)</b>			
	<b>Cross-sectional Area (ft<sup>2</sup>)</b>	<b>Depth (ft)</b>	<b>Width (ft)</b>
<b>Regional Curve</b>	200	3.0	66.1
<b>Section 0+70</b>	210.4	3.0	70.2

Assessment of the surveyed reach indicated that overall channel dimensions are within range and moderate modifications will improve stability. In-stream modifications suggested include creating/re-grading bank-full benches, point-bar grading and natural protection of the river bank toe. These are discussed in detail below. Primary actions needed include the restoration of the river riparian buffer, which is continuously mowed at this time.

### General Riparian Restoration Requirements

The following shall be implemented by BCC:

Discontinuation of mowing within a minimum of 35 ft of the NFRR and restoration of at least a 35-ft wide riparian buffer throughout the river reach will be conducted to improve river bank

stability and river ecological integrity. A mixture of trees, shrubs, and herbaceous plants will be established to augment the existing riparian buffer. In places where it is not possible to develop a forested riparian buffer because tall vegetation would interfere with golf course play, a mix of deep-rooted native forbs and grasses will be established. In these areas, a minimum buffer of five to 10 ft will be established. All buffers must have clearly visible physical markers placed on the property to prevent mowing of the buffer zones. This will stabilize the river bank and would intercept potential pollutants that might run off from local portions of the golf course from fertilization and/or pesticide application. Unless otherwise agreed to by BCC and the Trustees, BCC shall plant species listed in Tables 2 to 4 which are native to Virginia. These plant species provide aesthetic value and would be ecologically beneficial to the river. Unless otherwise agreed to by BCC and the Trustees, BCC shall plant live stakes of the species listed in Table 5 for areas recently graded or difficult to plant. Additionally, exotic natives will be removed from the riparian buffers to minimize their spread including garlic mustard (*Alliaria petiolata*) and multiflora rose (*Rosa multiflora*).

Whenever river banks are regraded, they will be seeded with a native herbaceous mix, covered with straw at a rate of three square bales per 1000 ft<sup>2</sup>, coir fiber matting, and planted with perennials through the matting. Where the toe of the slope is disturbed, it will be stabilized with either appropriately-sized boulders or coir fiber logs staked into the river bed and the banks and planted with native wetland plants. As bridges are replaced on the golf course, the replacement bridge will be sufficiently long to provide area for flood flows under the bridge and to prevent the hardening of the river banks by bridge abutments on the bank face.

All restoration project areas must have clearly visible physical markers placed on the property to prevent impacts from the golf course maintenance activities. BCC will perform golf course maintenance in a manner which will not reduce or disrupt the continued functioning of the restoration projects. If adverse impacts to the restoration projects are unavoidable, BCC will consult with the Trustees on activities that will minimize those impacts and the appropriate restoration for lost natural resources and services.

**Table 2 – List of Riparian Trees**

<u>Genus</u>	<u>Species</u>	<u>Common Name</u>
<i>Acer</i>	<i>negundo</i>	boxelder
<i>Amelanchier</i>	<i>arborea</i>	serviceberry
<i>Asimina</i>	<i>triloba</i>	paw paw
<i>Carya</i>	<i>cordiformis</i>	bitternut hickory
<i>Cornus</i>	<i>alternifolia</i>	alternate-leaf dogwood
<i>Diospyros</i>	<i>virginiana</i>	persimmon
<i>Fagus</i>	<i>grandifolia</i>	American beech
<i>Juglans</i>	<i>nigra</i>	black walnut
<i>Liriodendron</i>	<i>tulipifera</i>	tulip poplar
<i>Nyssa</i>	<i>sylvatica</i>	black gum
<i>Platanus</i>	<i>occidentalis</i>	sycamore
<i>Quercus</i>	<i>palustris</i>	pin oak
<i>Salix</i>	<i>nigra</i>	black willow

**Table 3 - List of Small Trees and Shrubs**

<u>Genus</u>	<u>Species</u>	<u>Common Name</u>
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<i>Alnus</i>	<i>serrulata</i>	hazel alder
<i>Aronia</i>	<i>arbutifolia</i>	red chokeberry
<i>Aronia</i>	<i>melanocarpa</i>	black chokeberry
<i>Carpinus</i>	<i>caroliniana</i>	musclewood
<i>Cephalanthus</i>	<i>occidentalis</i>	buttonbush
<i>Cercis</i>	<i>canadensis</i>	redbud
<i>Cornus</i>	<i>amomum</i>	silky dogwood
<i>Cornus</i>	<i>florida</i>	flowering dogwood
<i>Hamamelis</i>	<i>virginiana</i>	witch-hazel
<i>Ilex</i>	<i>verticillata</i>	winterberry
<i>Lindera</i>	<i>benzoin</i>	spicebush
<i>Ostrya</i>	<i>virginiana</i>	hornbeam
<i>Rhus</i>	<i>glabra</i>	smooth sumac
<i>Sambucus</i>	<i>canadensis</i>	elderberry
<i>Viburnum</i>	<i>dentatum</i>	arrowwood

Table 4 - List of Forbs, Grasses and Ferns

<u>Genus</u>	<u>Species</u>	<u>Common Name</u>
<i>Acorus</i>	<i>americanus</i>	sweet flag
<i>Andropogon</i>	<i>gerardii</i>	big bluestem
<i>Arundinaria</i>	<i>gigantea</i>	river cane
<i>Asclepias</i>	<i>incarnata</i>	swamp milkweed
<i>Aster</i>	<i>novae-angliae</i>	New England aster
<i>Caltha</i>	<i>palustris</i>	marsh marigold
<i>Chasmanthium</i>	<i>latifolium</i>	river oats
<i>Chelone</i>	<i>glabra</i>	white turtlehead
<i>Dichanthelium</i>	<i>clandestinum</i>	deer-tongue
<i>Elymus</i>	<i>hystris</i>	bottlebrush grass
<i>Elymus</i>	<i>virginicus</i>	Virginia wild rye
<i>Equisetum</i>	<i>hyemale</i>	horsetail, scouring rush
<i>Eupatorium</i>	<i>fistulosum</i>	Joe-pye weed
<i>Eupatorium</i>	<i>perfoliatum</i>	boneset
<i>Festuca</i>	<i>rubra</i> L. ssp. <i>arenaria</i>	creeping red fescue
<i>Hibiscus</i>	<i>mocheutos</i>	Eastern rosemallow
<i>Helenium</i>	<i>autumnale</i>	sneezeweed
<i>Juncus</i>	<i>effusus</i>	soft rush
<i>Lobelia</i>	<i>cardinalis</i>	cardinal flower
<i>Lobelia</i>	<i>siphilitica</i>	great blue lobelia
<i>Mertensia</i>	<i>virginica</i>	Virginia bluebells
<i>Monarda</i>	<i>didyma</i>	bee balm
<i>Osmunda</i>	<i>cinnamomea</i>	cinnamon fern
<i>Osmunda</i>	<i>regalis</i>	royal fern
<i>Panicum</i>	<i>virgatum</i>	switchgrass
<i>Phlox</i>	<i>divaricata</i>	woodland phlox
<i>Phlox</i>	<i>paniculata</i>	summer phlox
<i>Podophyllum</i>	<i>peltatum</i>	mayapple
<i>Polystichium</i>	<i>acrostichoides</i>	Christmas fern
<i>Rudbeckia</i>	<i>laciniata</i>	cut-leaved coneflower
<i>Scirpus</i>	<i>cyperinus</i>	wooly bulrush

<i>Solidago</i>	<i>rugosa</i>	rough-stemmed goldenrod
<i>Sorghastrum</i>	<i>nutans</i>	Indiangrass
<i>Sparganium</i>	<i>americanum</i>	American bur-reed
<i>Verbena</i>	<i>hastata</i>	blue vervain
<i>Vernonia</i>	<i>noveboracensis</i>	New York ironweed

**Table 5 - List of Live Stake Material**

<b>Genus</b>	<b>Species</b>	<b>Common Name</b>
<i>Cornus</i>	<i>amomum</i>	silky dogwood
<i>Cornus</i>	<i>stolonifera</i>	red-osier dogwood
<i>Salix</i>	<i>nigra</i>	black willow
<i>Sambucus</i>	<i>canadensis</i>	elderberry
<i>Viburnum</i>	<i>dentatum</i>	arrowwood

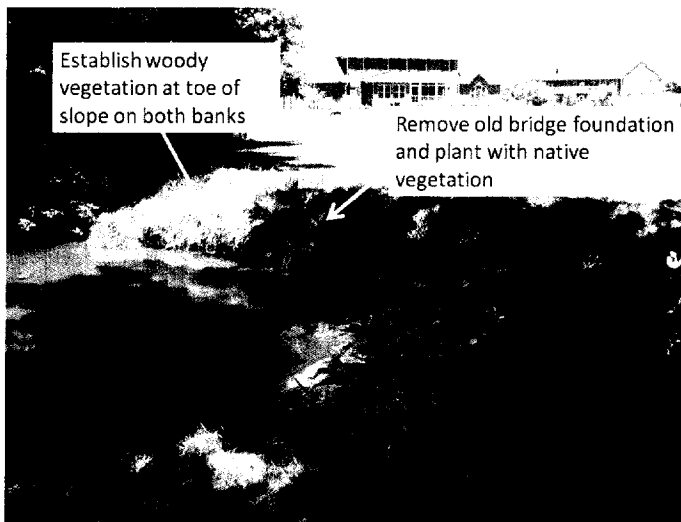
**Restoration Project 1: Hole #3 Tee Riverbank Stabilization**

Figure 1. Proposed bank stabilization upstream of Tee #3 bridge.



Figure 2. Unstable river bank and tile drainage downstream of Tee #3 bridge.

Approximately 100 ft upstream of the bridge at Tee #3, on the north side of the river, erosion is occurring around an old concrete bridge foundation. The concrete bridge foundation will be removed from the river and the river bank planted with deep-rooted, native herbaceous vegetation. Additionally, small shrubs will be established at the river bank toe between the bridge and the upstream edge of the golf course property boundary (Figure 1). Just downstream of the #3 Tee bridge, extensive bank retreat is occurring along the southern bank due to flow expansion and turbulence around several large trees just downstream of the bridge, as well as tile drainage from the golf course (Figure 2). The section is predominantly a long pool before entering a compound bend where bedrock control occurs. A single arm rock vane will be constructed just downstream of the bridge to redirect flow away from the south bank toward the center of the channel. The design and construction of the rock vane will follow specifications found in "The Virginia Stream Restoration and Stabilization Best Management Practices Guide" 2004 (BMP Guide),



Practice 4.1. at [http://www.dcr.virginia.gov/soil\\_and\\_water/documents/streamguide.pdf](http://www.dcr.virginia.gov/soil_and_water/documents/streamguide.pdf). For example, selection of appropriate rock material must be based upon such variables as velocity, flatness (stackable), ability to tie into bank-full elevation with cut off, and the ability of footer rocks to be placed below the depth of scour. Downstream of the rock vane, the river bank will be graded and planted with native woody vegetation to reestablish bank stability. The required bank slope and measures to control the tile drainage will be determined by BCC employees and Dr. Tess Wynn, with the approval of the Trustees.

A corrugated plastic pipe discharges storm water runoff into the river on the north bank approximately 250 ft downstream of the #3 Tee bridge (Figure 3). Discharge from this culvert has created a scour pool with a gravel outlet. To minimize future erosion, the scour pool and outlet channel will be lined with riprap, underlain by filter fabric. Pool depth and the outlet channel invert will be maintained at the existing elevations to maintain the energy dissipation provided by the existing pool.



Figure 3. Corrugated plastic pipe storm drain outlet.

**Table 6: Restoration Project 1 Cost Estimate**

Restoration Project 1	
ITEM	Estimated Cost
Grade a bankfull bench along 164 ln ft of river	\$4,480
-Excavator at \$135/hr at 16 hours	
-Bulldozer/Front-end Loader at \$75/hr at 16 hours	
-Dump truck hauling at \$70/hr at 16 hours	
(Assumes that spoil will stay on BCC property otherwise add \$2,000)	
Live Stakes	\$305
-100 live stakes at \$1.25/stake	
-Labor estimated at 10 hours at \$18.00/hr	

Forbs and Grasses	\$964
-reseeded with native mix at \$40/lb at 15lb an acre	
-40 bales of straw at \$5.50/bale	
-Labor estimated at 8 hours at \$18.00/hr	
Rip rap and Filter Fabric	\$545
-18 tons of rip rap and placement by excavator	
Tree and Shrub Planting	\$570
-4 BB trees at \$80/tree	
-50 3-gallon shrubs at \$5/shrub	
-Labor estimated at \$18.00/hr for 32 hours	
Rock Vane	\$2,790
-Excavator installation at \$135/hr at 5 hours	
-Rock delivery of 45-tons at \$50/ton (See Practice 4.1 of the BMP Guide)	
Miscellaneous Cost at 10%	\$965
<b>Total Estimated Cost</b>	<b>\$10,619</b>

### **Restoration Project 2: Hole #2 (Cross-Over) Riverbank Stabilization**



Figure 4. Proposed bank stabilization downstream of #2 bridge.

Restoration Project 2 runs along the surveyed reach from 1,040 ft to 1,893 ft; at the start of the reach a compound bend exists that is bedrock controlled. The first bend is stable due to sycamores along the bank and the bedrock control. The second meander downstream of the bridge at Fairway #2 is actively eroding and will be re-graded and planted with deep-rooted herbaceous perennials and low woody plants that can be sheared several times per year. The meander bend will be graded to a 3:1 slope on the outside and a 7:1 slope on the inside of the meander bend. Areas not in play will be planted with native trees.



Figure 5. Gravel bar behind #11 green.

Downstream of the meander bend in the middle of Fairway #2, a gravel bar along the #11 green is increasing the channel curvature. Due to recent droughts, grass has established on the bar and is collecting sediment. Trees on the outside of the meander are holding the river in place with a few minor erosion spots. This bar will be observed to remove any woody vegetation that may promote flow deflection against the opposite river bank. The opposite bank near the #13 green is out of play and will be densely vegetated to minimize river bank migration in this area.



**Table 7: Restoration Project 2 Cost Estimate**

<b>Restoration Project 2</b>	
<b>ITEM</b>	<b>Estimated Cost</b>
Grade a bankfull bench along 189 ln ft of river	\$4,480
-Excavator at \$135/hr at 16 hours	
-Bulldoze/Front-end Loader at \$75/hr at 16 hours	
-Dump truck hauling at \$70/hr at 16 hours	
(Assumes that spoil will stay on BCC property otherwise add \$4,000)	
Forbs and Grasses	\$964
-reseeded with native mix at \$40/lb at 15lb an acre	
-40 bales of straw at \$5.50/bale	
-Labor estimated at 8 hours at \$18.00/hr	
Tree Planting	
-5 BB trees at \$80/tree	\$750
-70 3-gallon shrubs staggered in 5 shrub clusters at \$5/shrub	
-Labor estimated at \$18.00/hr for 12 hours	
Live Stakes	\$305
-100 live stakes at \$1.25/stake	
-Labor estimated at 10 hours at \$18.00/hr	
Miscellaneous Cost at 10%	\$650
<b>Total Estimated Cost</b>	<b>\$7,149</b>

**Restoration Project 3: Riverbank Stabilization Along #12 Tee Box**

Figure 6. Riverbank by #13 green and #12 Tees

Below cross-section 21+51 (see Appendix A, Run Cross-Section 21+51), a 176-ft long stretch of river bank on the eastern bank (#13 green) will be re-graded to a 7:1 slope, where not currently vegetated with woody species, and planted with woody riparian vegetation. The costs for this portion of Restoration Project 3 are given in Table 8.

**Table 8: Restoration Project 3 Riverbank Stabilization Cost Estimate**

<b>Restoration Project 3 – South-western Bank</b>	
<b>ITEM</b>	<b>Estimated Cost</b>
Grade a bankfull bench along 176 ln ft of river	\$4,480
-Excavator at \$135/hr at 16 hours	
-Bulldoze/Front-end Loader at \$75/hr at 16 hours	
-Dump truck hauling at \$70/hr at 16 hours	
(Assumes that spoil will stay on BCC property otherwise add \$4,000)	
Forbes and Grasses	\$964
-reseeded with native mix at \$40/lb at 15lb an acre	
-40 bales of straw at \$5.50/bale	
-Labor estimated at 8 hours at \$18.00/hr	
Tree Planting	\$750
-5 BB trees at \$80/tree	
-70 3-gallon shrubs staggered in 5 shrub clusters at \$5/shrub	
-Labor estimated at \$18.00/hr for 12 hours	
Miscellaneous Cost at 10%	\$619
<b>Estimated Cost</b>	<b>\$6,813</b>

**Restoration Project 4: Bank Stabilization Before Hole #12 Bridge (Tee)**

Figure 7. Riverbank curvature in front of #12 Tee

on the outside of the meander bend will be cut back to a 3:1 slope and planted with native woody vegetation. Where woody vegetation will interfere with the play of golf, deep-rooted herbaceous material will be used.

Restoration Project 4 corresponds to 1,989 ft to 2,210 ft on the survey reach profile and runs between the tee boxes for Hole #12. Due to the tight radius of curvature through this section, it is necessary to utilize harder armoring methods to stabilize the banks without modifying the curvature. Large stone (boulders) will be used to reinforce the toe of the slope on the outside of the meander bend at Section 21+57. The rock size class selection will be made in accordance with Practice 4.1 of the BMP Guide. Live stakes (e.g. alder, willow) will be placed between the rocks. In addition to the toe protection, the banks

**Table 9: Restoration Project 4 Cost Estimate**

<b>Restoration Project 4</b>	
<b>ITEM</b>	<b>Estimated Cost</b>
Grading and rip rap placement on 95 ln ft -Excavator at \$135/hr at 8 hours -Bulldoze/Front-end Loader at \$75/hr at 8 hours -Dump truck hauling at \$70/hr at 8 hours (Assumes that spoil will stay on BCC property otherwise add \$2,000)	\$2,240
Forbs and Grasses -reseeded with native mix at \$40/lb at 15lb an acre -40 bales of straw at \$5.50/bale -Labor estimated at 8 hours at \$18.00/hr	\$964
Tree Planting -10 BB trees at \$80/tree -25 3-gallon shrubs staggered in 5 shrub clusters at \$5/shrub -Labor estimated at \$18.00/hr for 10 hours	\$1,105
Live Stakes -100 live stakes at \$1.25/stake -Labor estimated at 10 hours at \$18.00/hr	\$305
Large Boulders (See Practice 4.1 of the BMP Guide)	\$1,200
Miscellaneous Cost at 10%	\$581
<b>Total Estimated Cost</b>	<b>\$6,395</b>

**Restoration Project 5: Bank Stabilization Just Past Hole #12 Bridge (Tee)**

Restoration Project 5 enters the last section of river surveyed between 2,157 ft and 2,661 ft on the profile survey. Erosion is evident around the bridge the concrete bridge support is being undermined. Downstream of the bridge, the lack of riparian vegetation is allowing erosion to occur. Toe protection in the form of coir fiber logs will be installed and steep banks will be re-graded to a 3:1 slope and replanted with woody vegetation.

Figure 8. Erosion downstream of #12 Tee Bridge.



Figure 9. Sycamore to be removed near #12 tee box.

Additional erosion is occurring near the #12 tee due to a large sycamore tree protruding into the river (Figure 4). This tree will be removed and used to reinforce the river bank. As many roots as possible will be cut and the tree pulled down at a 30 degree angle to the river bank. The root wad will face upstream and will be pulled toward the scoured zone behind the tree which now contains a pool. The tree will be topped and a minimum of 15 ft of tree bole will be buried in the river bank. The area between the root wad and the bank will be filled in and planted with woody vegetation. The toe of the slope that is filled will be reinforced with coir fiber logs.

**Table 10: Restoration Project 5 Cost Estimate**

<b>Restoration Project 5</b>	
<b>ITEM</b>	<b>Estimated Cost</b>
Grade a bankfull bench along 90 ln ft of river	\$4,480
-Excavator at \$135/hr at 16 hours	
-Bulldoze/Front-end Loader at \$75/hr at 16 hours	
-Dump truck hauling at \$70/hr at 16 hours	
(Assumes that spoil will stay on BCC property otherwise add \$2,500)	
Coir Matting with Stakes	\$1,197
-2 rolls of 120 sq. yds of coir @ \$315.00/roll	
-300 wooden stakes at \$0.45/stake)	
-Labor estimated at 24 hours at \$18.00/hr	
Tree Planting	\$1,230
-10 BB trees at \$80/tree	
-50 3-gallon shrubs staggered in 5 shrub clusters at \$5/shrub	
-Labor estimated at \$18.00/hr for 10 hours	
Forbs and Grasses	\$964
-reseeded with native mix at \$40/lb at 15lb an acre	
-40 bales of straw at \$5.50/bale	
-Labor estimated at 8 hours at \$18.00/hr	
Live Stakes	\$305
-100 live stakes at \$1.25/stake	
-Labor estimated at 10 hours at \$18.00/hr	
Tree Work to cut roots and rotate into place	\$1,500
Miscellaneous Cost at 10%	\$967
<b>Total Estimated Cost</b>	<b>\$10,643</b>

**Restoration Project 6: Bank Stabilization at Fairway Cross-Over Hole #12**

Downstream of the second bridge at #12 hole, additional bank erosion is occurring due to flow expansion following the bridge. At this site, the river banks on both sides of the river will be graded to a 3:1 slope and planted with woody vegetation where practical. During grading, the channel will be narrowed from the bridge opening to the downstream riffle, providing a smooth bank transition from the bridge to the riffle to minimize the occurrence of eddies during high flows. In this transition area the bank toes will be protected using large boulders.

Figure 10. Downstream of #12 Second Bridge

**Table 11: Restoration Project 6 Cost Estimate**

**Restoration Project 6**

<b>ITEM</b>	<b>Estimated Cost</b>
Grade a bankfull bench along 250 ln ft of river	\$4,480
-Excavator at \$135/hr at 16 hours	
-Bulldoze/Front-end Loader at \$75/hr at 16 hours	
-Dump truck hauling at \$70/hr at 16 hours	
(Assumes that spoil will stay on BCC property otherwise add \$2,500)	
Tree Planting	\$1,590
-10 BB trees at \$80/tree	
-25 3-gallon shrubs staggered in 5 shrub clusters at \$5/shrub	
-Labor estimated at \$18.00/hr for 30 hours	
Forbs and Grasses	\$964
-reseeded with native mix at \$40/lb at 15lb an acre	
-40 bales of straw at \$5.50/bale	
-Labor estimated at 8 hours at \$18.00/hr	
Live Stakes	\$305
-100 live stakes at \$1.25/stake	
-Labor estimated at 10 hours at \$18.00/hr	
Large Boulders (See Practice 4.1 of the BMP Guide)	\$1,200
Miscellaneous Cost at 10%	\$853
<b>Total Estimated Cost</b>	<b>\$9,392</b>

### **III. MONITORING, RESTORATION PROJECTS TIME-LINE, AND BUDGET SUMMARY**

The objective of any monitoring plan is to ensure that the project goals are met; therefore, monitoring requirements are established to quantitatively link project goals and outcomes. The main goals of the BCC restoration plan are to improve the riparian buffer and minimize streambank erosion along the reach of the NFRR that runs through the BCC. It is anticipated that these local improvements will improve water quality and habitat for the Roanoke log perch in the NFRR. However, water quality, as well as benthic macroinvertebrate and fish communities, reflect the conditions of the entire watershed and are not necessarily indicative of the success of local resource management actions (Ranganath et al., 2009). Therefore, monitoring by the BCC will consist of measures that directly reflect the success of the management actions. For riparian restoration projects this will consist of monitoring vegetation survival in restored/enhanced buffer areas. For streambank stabilization projects, monitoring will consist of surveying of monumented cross sections. Both cross section and longitudinal surveys will be conducted for the stream reach with the cross vane.

#### **Monitoring and Corrective Action Measures**

A monitoring plan and corrective action measures will be an integral part of specific restoration project actions contained within this restoration plan. The specific restoration actions presented in this restoration plan will be monitored by BCC and included in the monitoring report. Evaluation and corrective action techniques, time tables, and allocation of funding for the monitoring and corrective action portion of any restoration project are considered to be restoration project-specific. The restoration projects will include specific monitoring and corrective action components as follows.

#### **Monitoring**

Monitoring by BCC will be conducted after the completion of each restoration project over a period of 10 years. BCC will submit a monitoring report to DEQ and the Service by December 1 of years 1, 2, 3, 4, 6, 8, 10 after the completion of each restoration project. For example, if restoration project 2 is completed in November 2013, the first (Spring and Fall) monitoring report for restoration project 2 will be due December 15, 2014. Each monitoring report will cover those restoration projects which are due to be reported upon and will be inclusive of all 6 projects as each is completed. BCC grants to the Trustees, and their representatives, access to the restoration projects for purposes of planning and monitoring the restoration projects.

BCC will incorporate the six restoration projects into its written maintenance practices and nutrient management plan. The maintenance practices and nutrient management plan will include the buffer zones as they relate to mowing, fertilizer application, and herbicide spraying. These practices will be accomplished in accordance with the Nutrient Management Plan that was agreed to by BCC in the April 28, 2009, Special Order by Consent issued by the DEQ/State Water Control Board in lieu of certain civil charges in connection with the August 8, 2007, Notice of Violation W2007-08-001. In general, as per the BCC's nutrient management plan, a 35 ft buffer of at least 6-12 inch tall grass will be maintained around all river banks. Nutrient application setbacks are approximately 50 ft from surface water, but may be applied closer to surface waters when appropriate erosion and sediment control devices are in place for non-vegetated areas and when fully vegetated buffer zones are maintained. In the latter instance (fully vegetated buffer in place), Nitrogen (N) and Phosphorous (P) fertilizers will be applied no closer than 35 ft to surface waters. The use of fertilizers with slow release nitrogen will be used.

#### **Monitoring Requirements**



Monitoring will generally follow that outlined in the *Stream Channel Reference Sites: An Illustrated Guide to Reference Sites* (Harrelson, Cheryl C; Rawlins, C. L.; Potyondy, John P. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.).

Timing. Monitoring activities shall occur during the growing season, and at least once during the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup> and 10<sup>th</sup> growing seasons following the completion of each project. After Year 3, physical monitoring of river condition (e.g. longitudinal profiles, cross-sections, channel width and depth) may be conducted outside of the growing season.

In addition, monitoring shall adhere to the following general schedules:

- a) For any year in which planting was conducted, monitoring of woody vegetation shall take place no earlier than October and at least 6 months following planting;
- b) Monitoring of vegetation (herbaceous and woody species) shall be conducted during the growing season.
- c) If all performance criteria have not been met in the 10<sup>th</sup> year, then a monitoring report shall be required for each consecutive year until two sequential annual reports indicate that all criteria have been successfully satisfied.
- d) Submittal of a final monitoring report (typically prepared the 10<sup>th</sup> growing season following completion of construction activities, including planting) shall be required.

The river monitoring program shall follow the guidelines established below:

Within one week after any storm event that meets or exceeds a one-year, 24-hour duration, as determined by the onsite rain gauge or the nearest National Weather Service station the river(s) shall be visually inspected for damages. Any damage noted shall be reported to the U.S. Army Corps of Engineers, the Service and DEQ in writing within one week of inspection, with supporting photographs, and accompanied by a remediation plan. Photographs and narrative shall be utilized to summarize performance and necessity of remediation efforts in the next monitoring report.

1. River Channel Preservation- For the linear footage where no instream work was accomplished (regardless of riparian buffer activities), the following monitoring shall occur:

Permanent cross-sections shall be established to ensure that the same locations are used each monitoring year. A minimum of one cross-section per 1000 linear feet will be required. Total number required will vary depending on project length and complexity and shall be determined by the BCC, the Service and DEQ. Additional cross-sections may be required to show areas where aggradation, degradation, erosion, and mid-channel bars have developed.

The following will be documented at each cross-section:

- Ground level photographs shall be provided with each monitoring report for the purpose of documenting vegetation and river stability. The photographs will be taken annually during November or December of that monitoring year at representative cross-sections and will clearly show the channel upstream and downstream, the riparian buffer area, and each river bank.
- Cross-sectional measurements shall include riverbanks, riverbed, water surface, bankfull, and adjacent floodplain elevations.

- The same cross section for all previous monitoring years will be overlain on this cross section.

2. River Enhancement - For the linear footage of river with river enhancement activities (as defined in Section II), the following monitoring will occur in addition to those outlined for river restoration project areas:

Permanent cross-sections shall be established to ensure that the same locations are used each monitoring year. Representative cross-sections (with permanent markers established during the first monitoring interval) will be surveyed at intervals on a representative sample of riffles and pools. The total number required will vary depending on project length and complexity and shall be determined by the BCC, the Service and DEQ. Additional cross-sections may be required to show areas where aggradation, degradation, erosion, and mid-channel bars have developed.

- a) Sample plots for river bank vegetation (10 square feet in size) shall be located on each bank 100 feet upstream or downstream of each cross-section where riverbank plantings were completed. Sampling shall be conducted in accordance with Appendix E attached and incorporated by reference herein;
- b) Beginning with Year 2, The U.S. Forest Service Stream Reach Inventory and Channel Stability Evaluation (Pfankuch, 1975) will be performed at each permanent cross-section and additional locations to provide a representative assessment.

3. River Enhancement with Structures: Photo documentation will be provided for each structure depicting the full width, length, and landscape position so that all portions of the structure are visible. For the linear footage of river with river enhancement with structures activities (as defined in Appendix C attached and incorporated by reference herein), the following monitoring will occur in addition to those outlined for river restoration project areas:

- a) Each instream structure shall have the following data collected:
  - i. Photographs documenting structural integrity and function
  - ii. Surveyed profile documenting invert elevation

#### **Monitoring Report Requirements**

Monitoring reports shall include at a minimum the following information:

1. A Title page indicating the site name, phase (if applicable), monitoring year, any requested action and Preparer identification (name, address, phone number and email address).
2. Ground level photographs as described in Appendix D, attached and incorporated by reference;
3. A detailed narrative summarizing the condition of the restoration and all regular maintenance and monitoring activities;
4. A drawing based upon the grading plans of the BCC property that depicts topography, and the location of sampling plots, cross-section, and permanent photo stations;
5. For preservation activities including buffer preservation, photographic documentation and discussion of visual observations;
6. For buffer restoration/enhancement/reestablishment: Results of vegetation survey including per plot reporting of all herbaceous species present (with corresponding estimate of percent cover, indicator status, native status, planted/volunteer category for each species), all woody species

present (with corresponding indicator status, native status, planted/volunteer category, percent cover of bare ground and/or open water, dominant species identification, percent cover and/or stem count of non-native or invasive species in each vegetation layer, species richness, percent non-native/invasive vegetation in each vegetation layer, survival rate of planted vegetation, woody stem density by species in sample plot and by acre, an estimate of natural revegetation, average height of woody species in each sample and percent change in height since previous monitoring event in accordance with the appropriate success standards; and  
If the oak (*Quercus*) is one of the species planted by BCC then the monitoring report shall also include the number and species of *Quercus* (sp) rated FAC (facultative) or wetter (excluding FAC) in each sample plot (counts and numbers per acre);

7. For river preservation, enhancement, and restoration activities, monitoring reports shall present yearly data in tabular and graphical format comparing as-built, current, and previous years monitoring data. Monitoring reports shall include a discussion of any deviation from as-built or previous year's data.

8. A corrective action plan, if necessary, which shall include any proposed actions or maintenance activities, a schedule, and a monitoring plan (e.g., the control of undesirable species, the repair of a damaged water control device, the replacement of damaged, planted vegetation, etc.).

9. All reports shall contain the following signed certification statement:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

10. As-Built Report: An as-built report shall be submitted within 60 days of completion of each project. The report shall include:

- a) plan view of the constructed/restored rivers, and adjacent buffers with location of all permanent sampling stations, photo stations, monitoring wells, instream and river bank structures, and all permanent cross-sections and profiles;
- b) photographs of the completed project taken from permanent photo stations. Photos from each station must be grouped with corresponding photos from previous monitoring reports;
- c) profiles of instream structures, cross-sections, and longitudinal river profiles taken from permanent locations and compared to design plans;
- d) pebble counts and summary geomorphologic data;
- e) Planting zones, phases, and densities;
- f) As-built elevations.

11. Each monitoring report will include detailed resource documentation, tables summarizing attainment of success criteria.

12. Any additional information required to adequately characterize site conditions (as needed).

#### **Success Criteria**

The overall goal for the river restoration is to ensure that the dimension, pattern, and profile of the river enhancement and restoration areas: 1) remain within the natural range of variability present in the reference data

obtained for the design; 2) remain stable; 3) exhibit appropriate habitat diversity; and 4) have healthy viable riparian buffers that reduce or eliminate sedimentation and non-point source nutrient run-off. In addition, restoring appropriate biological diversity and integrity should be the aim of any project.

(a) RIVER PRESERVATION AREAS

For the linear footage of river in which no instream or bank work is accomplished, but river preservation is done (regardless of riparian area activities) (as defined in Appendix C attached and incorporated by reference herein ), the following success criteria will apply:

Dimension

The analysis of representative riffle cross-sections shall indicate that they have not aggraded, degraded, widened, or narrowed to the point where they have become unstable or will cause instability. The following measurements will be used to aid in making this determination each monitoring year:

1. The Width / Depth Ratio Stability Rating (measured Width / Depth Ratio divided by the approved as-built Width / Depth Ratio) shall not be greater than 1.3. If the channel is incising, then the Width / Depth Ratio Stability Rating shall not be less than 0.7.
2. The Bank Height Ratio shall not increase or decrease by an amount greater than 0.2 of the approved as-built Bank Height Ratio.

*Other measurements to consider include cross-sectional (bankfull) area of the channel, floodprone elevation, bankfull elevation, floodprone width, entrenchment ratio, mean depth, bankfull width, and hydraulic radius. It may be useful to consider paired cross-sections of riffles and pools, with at least one pair per reach and river channel type. Useful depictions include pool width ratio and pool depth ratios.*

(b) RIVER ENHANCEMENT

For the linear footage of river with river enhancement activities (as defined in Appendix C attached and incorporated by reference herein), the following success criteria will apply in addition to those outlined in Appendix E attached and incorporated by reference herein:

**River Reach Stability**

The analysis of the riverbank from the top of the bank to the ordinary high water mark shall indicate a significant amount of natural protection to prevent riverbank erosion that could jeopardize the stability of the riverbank or the river reach.

The following measurements will be used to aid in making this determination each monitoring year:

1. Where riverbank plantings are undertaken: The numbers of live stakes, planted, or volunteer woody species providing bank stabilization from the top of bank to ordinary high water mark shall be at least one (1) living stem per 50 square feet per river edge along the bank by the end of the first growing season following planting and maintained each monitoring year until canopy coverage is 50% for any identified reach. Canopy coverage shall be at least 50% each monitoring year thereafter.

2. Native non-invasive herbaceous plant coverage shall be at least 80% by the end of the first growing season, and at least 80% each monitoring year thereafter, until canopy cover exceeds 30%. Any seeds used for plant establishment should conform to Virginia Seed Law (Sections 3.1-262 Code of Virginia) and Virginia Seed Regulations (2 VAC 5-290-10 et. seq) and shall be free of tall fescue, Bermuda grass, and other allelopathic turf grass species, as well as plant species on the Virginia Department of Conservation and Recreation's Invasive Alien Plant List.
3. The individual Index Values of the Bank Erodibility Hazard Index (BEHI) rating for any identified reach shall be equal to or less than the previous year's Index Value. In addition, the Total Score shall be equal to or less than the previous year's Total Score, and shall have a Total Score of "Moderate" by Monitoring Year 3, and a Total Score of "Low" by Monitoring Year 5, and maintained at "Low" throughout the remainder of the monitoring period.
4. The U.S. Forest Service Stream Reach Inventory and Channel Stability Evaluation (Pfankuch, 1975) rating shall be "Good" each monitoring year, beginning with Year 2.

#### **Pattern**

The analysis of the plan-view survey or field measurements shall indicate that the river is not migrating significantly to the point where it will cause significant bank erosion and cause instability.

The following criteria will be used to aid in making this determination each monitoring year:

1. The sinuosity of the river does not increase or decrease by an amount greater than 0.1 of the approved as-built pattern.
2. The thalweg of each channel cross-section does not move by more than 10% of the width of the approved as-built channel width in any given year.
3. The Radius of Curvature / Bankfull Width Ratio does not increase or decrease by an amount greater than 0.2 of the as-built condition. For instance, if the as-built ratio is 3.0, the acceptable ratio shall be 2.8 to 3.2 remain within the range of variability present in the reference data

#### **(c) RIVER ENHANCEMENT WITH STRUCTURES**

For the linear footage of river with river enhancement with structures activities (as defined in Appendix C attached and incorporated by reference herein), the following success criteria will apply:

##### Structures

The analysis of each instream structure shall indicate that it is performing its intended function, and not adversely affecting the river. The following measurements will be used to aid in making this determination each monitoring year:

1. Absence of under cutting, washing around, or erosion of the bank or riverbed associated with any instream structure, excluding any minor channel scour within the thalweg immediately downstream of a structure caused by its intended redirection of flow.
2. The invert elevation (controlling elevation) of the header rocks or logs of any vane, j-hook, cross-vane, W-weir, or other structure shall not vary more than 0.2 feet from the approved as-built.

Materials (if applicable)

The analysis of the pebble count data shall not show a significant change in streambed materials to the point that indicates a shift in bedload material due to stream instability. The following measurement will be used to aid in making this determination each monitoring year:

The D50 size particle remains within its approved as-built size class (silt, sand, gravel, cobble, or boulder)

**(d) RIVER RESTORATION**

For the linear footage of river with river restoration activities, the following success criteria will apply:

**Profile**

The analysis of the longitudinal profile shall indicate that the bed elevation has neither aggraded nor degraded to the point where it will cause instability.

The following criteria will be used to aid in making this determination each monitoring year:

The analysis of the longitudinal profile does not indicate significant alterations in the locations, depths, and slopes of river features (riffle, run, pool, and glide)

The analysis of the pebble count data shall not show a significant change in riverbed materials to the point that indicates a shift in bedload material due to river instability.

The D50 size particle shall remain within its approved as-built size class (silt, sand, gravel, cobble, or boulder).



**Restoration Project Schedule**

The Roanoke Logperch spawning period occurs in April and May each year. As such, no work can occur in the NFRR between March 15 and June 30 of each year. With this in mind, the following schedule provides implementation time frames relative to each restoration project. BCC will be responsible for obtaining the necessary permits and compliance with all other regulatory requirements and issues related to work within the river and along the river banks. If approval of any required permit is delayed notwithstanding BCC's timely submission of all application materials, or for any reason beyond the control of BCC, the Service agrees to renegotiate in good faith any implementation time frames affected by the delay. There are no objections to BCC working with DGIF or other agencies as any landowner would do for assistance with permitting, compliance and regulatory requirements.

The six restoration projects being undertaken are designed to occur in stages from where the NFRR enters the BCC's property. Project three will commence first. Project one will be done last as it is deemed the most complicated project. Should there be an opportunity, it is permissible to accelerate the timeline and complete restoration projects sooner than the projected completion dates. Notwithstanding, all restoration projects should be complete by the end of 2016. Monitoring will continue for no less than ten years after project completion.

**Restoration project 1 - Dates:**

- Planning for this restoration project will take place by December 1, 2015. Actual river bank and vegetation work will be complete by November 15, 2016.

**Restoration Project 2 – Dates:**

- Planning for this restoration project will take place by December 1, 2012. Actual river bank and vegetation work be complete by November 15, 2013.

**Restoration Project 3 – Dates:**

- Planning for this restoration project will take place by March 1, 2012. Actual river bank and vegetation work be complete by November 15, 2012.

**Restoration Projects 4 and 5 – Dates:**

- Planning for these two restoration projects will take place by December 1, 2013. Actual river bank and vegetation work be complete by November 15, 2014.

**Restoration Project 6 – Dates:**

- Planning for this restoration project will take place by December 1, 2014. Actual river bank and vegetation work will be complete by November 15, 2015.

**Budget Considerations**

Heavy machinery work will take slightly longer than normal due to the sensitive nature of the golf course greens and ability to move spoil off site. Disposal of cut soils and sediments must be placed away from all of the grading sites.

Costs reflected in this restoration plan are estimates. Table 12 summarizes estimated costs for each restoration project and provides a grand total to restore the targeted reach of the NFRR through BCC property. BCC shall perform the work described in the restoration plan even if the estimated costs are different from those listed in this restoration plan.

**Table 12: Total Estimated Restoration Projects Costs**

Project 1 – Hole #3 Tee River bank Stabilization	\$10,619
Project 2 – Hole #2 Cross-over River bank Stabilization	\$7,149
Project 3 – River bank Stabilization by #13 Green	\$6,813
Project 4 – Bank Stabilization Before Hole #12 Bridge	\$6,395
Project 5 – Bank Stabilization Just Past Hole #12 Bridge (Tee)	\$10,643
Project 6 – Bank Stabilization at Fairway Cross-over Hole #12	\$9,392
<b>Total Estimated Cost</b>	<b>\$51,011</b>

## IV. REGULATORY COMPLIANCE

### **National Environmental Policy Act (NEPA), 42 USC §§ 4321, et seq. 40 CFR Parts 1500-1508, 43 CFR Part 46**

Congress enacted NEPA in 1969 to establish a national policy for the protection of the environment. NEPA applies to Federal agency actions that affect the human environment. NEPA established the Council on Environmental Quality (CEQ) to advise the President and to carry out certain other responsibilities relating to implementation of NEPA by Federal agencies. Restoration of natural resources under CERCLA must comply with NEPA and the CEQ regulations implementing NEPA. In addition, DOI must follow its NEPA procedures at 43 CFR Part 46, its Bureau-specific NEPA procedures at Part 516 of the Departmental Manual (DM) Chapters 8-15 and bureau guidance. (73 FR 61292 (10/15/2008)).

The BCC has integrated this Plan with the NEPA process to comply with those requirements. This integrated process allows the BCC to meet requirements of CERCLA and NEPA concurrently. The Plan was intended to accomplish NEPA compliance by summarizing the current environmental setting and describing the purpose and need for restoration action. Categorical exclusions are classes of actions which do not individually or cumulatively have a significant effect on the human environment. Categorical exclusions are not the equivalent of statutory exemptions. If exceptions to categorical exclusions apply under 43 CFR 46.210, the Departmental categorical exclusions cannot be used. In addition to the actions listed in the departmental categorical exclusions outlined at 43 CFR 46.210, the following actions are designated categorical exclusions under 516 DM 8.5, unless the action is an exception to the categorical exclusion:

(3) The construction of new, or the addition of, small structures or improvements, including structures and improvements for the restoration of wetland, riparian, inriver, or native habitats, which result in no or only minor changes in the use of the affected local area. The following are examples of activities that may be included.

- i. The installation of fences.
- ii. The construction of small water control structures.
- iii. The planting of seeds or seedlings and other minor revegetation actions.
- iv. The construction of small berms or dikes.

(6) The reintroduction or supplementation (e.g., stocking) of native, formerly native, or established species into suitable habitat within their historic or established range, where no or negligible environmental disturbances are anticipated.

(8) Consultation and technical assistance activities directly related to the conservation of fish and wildlife resources.

(11) Natural resource damage assessment restoration plans, prepared under sections 107, 111, and 122(j) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA); section 311(f)(4) of the Clean Water Act; and the Oil Pollution Act; when only minor or

negligible change in the use of the affected areas is planned.

**Endangered Species Act (ESA), 16 USC §§ 1531, et seq., 50 CFR Parts 17, 222, 224**

Under the ESA, the Service publishes a list of endangered and threatened species. Section 7(a) (1) of the ESA directs all Federal agencies to conserve endangered and threatened species and their habitats and encourages such agencies to utilize their authorities to further these purposes. Section 7(a) (2) of the ESA requires that Federal agencies shall, in consultation with the Service/NFMS, insure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of any endangered and threatened species or result in the destruction or adverse modification of designated critical habitat.

**National and State Historic Preservation Acts**

The restoration area under consideration by this plan is a golf course and is devoid of cultural resources. The restoration actions outlined in this Plan will not affect any known National Historic Site or any known nationally significant cultural, scientific or historic resources.

**Virginia Erosion and Sedimentation Law**

In Virginia, there are approximately 170 local erosion and sediment control programs. They work to prevent soil erosion, sedimentation, and runoff from land-disturbing activities. These problems can damage public and private properties, waters, river channels, and other natural resources. One way Virginia Department of Conservation and Recreation and local government employees fight erosion and sedimentation is by implementing the Virginia Erosion and Sediment Control (ESC) Law. Virginia was one of the first states to tackle this problem. The ESC law encourages land developers to consider soil erosion and sediment control a routine part of development. Local authorities must approve a riparian project's erosion and sediment control plan before land can be cleared or excavated. Clearly, erosion and sediment control practices and principles help owners protect their land and water resources. Some agricultural practices and engineering operations, along with other activities such as mining and silviculture, are exempt. Projects disturbing less than 10,000 square feet are usually exempt unless a local ordinance has lowered that limit. This information will be forwarded to restoration project proponents for consideration.

**Virginia Solid and Hazardous Waste Management**

Any soil or sediment that is suspected of contamination, or wastes that are generated, must be tested and disposed of in accordance with applicable Federal, state, and local laws and regulations. This applies to soils that are disturbed by restoration endeavors contemplated in this Plan. The DEQ does not suggest that additional soils be removed. The laws which might apply to contaminated soils encountered in Plan implementation include, but are not limited to, the Virginia Hazardous Waste Act (*Virginia Code* sections 10.1-1400 *et. sec.*, the Virginia Hazardous Waste Management Regulations (9 VAC 20-60), and the Virginia Regulations for the Transport of Hazardous Materials (9 VAC 20-110).

**Clean Water Act**

BCC will be responsible for obtaining all necessary 404 permits from DEQ and/or the US Army Corp of Engineers and/or any other governmental agency, for any proposed in-stream restoration work.

## **V. PREPARERS AND PERSONS CONSULTED**

### **Blacksburg Country Club**

Tom Duetsch, General Manager  
Lee Daniels, Board Member  
Dr. Tess Wynn, Virginia Tech

### **Department of Interior**

#### **Fish and Wildlife Service**

John Schmerfeld, NRDAR Biologist, Virginia Field Office  
David Byrd, Fish and Wildlife Biologist, Virginia Field Office  
Cindy Schulz, Project Leader, Virginia Field Office  
Dr. Susan Lingenfelser, Contaminants Program Leader, Virginia Field Office  
Anne Condon, NRDAR Biologist, Virginia Field Office

### **Commonwealth of Virginia**

#### **Department of Environmental Quality**

Melanie Davenport, Director of Enforcement  
Jerry Ford, Enforcement

### **Department of Game and Inland Fisheries**

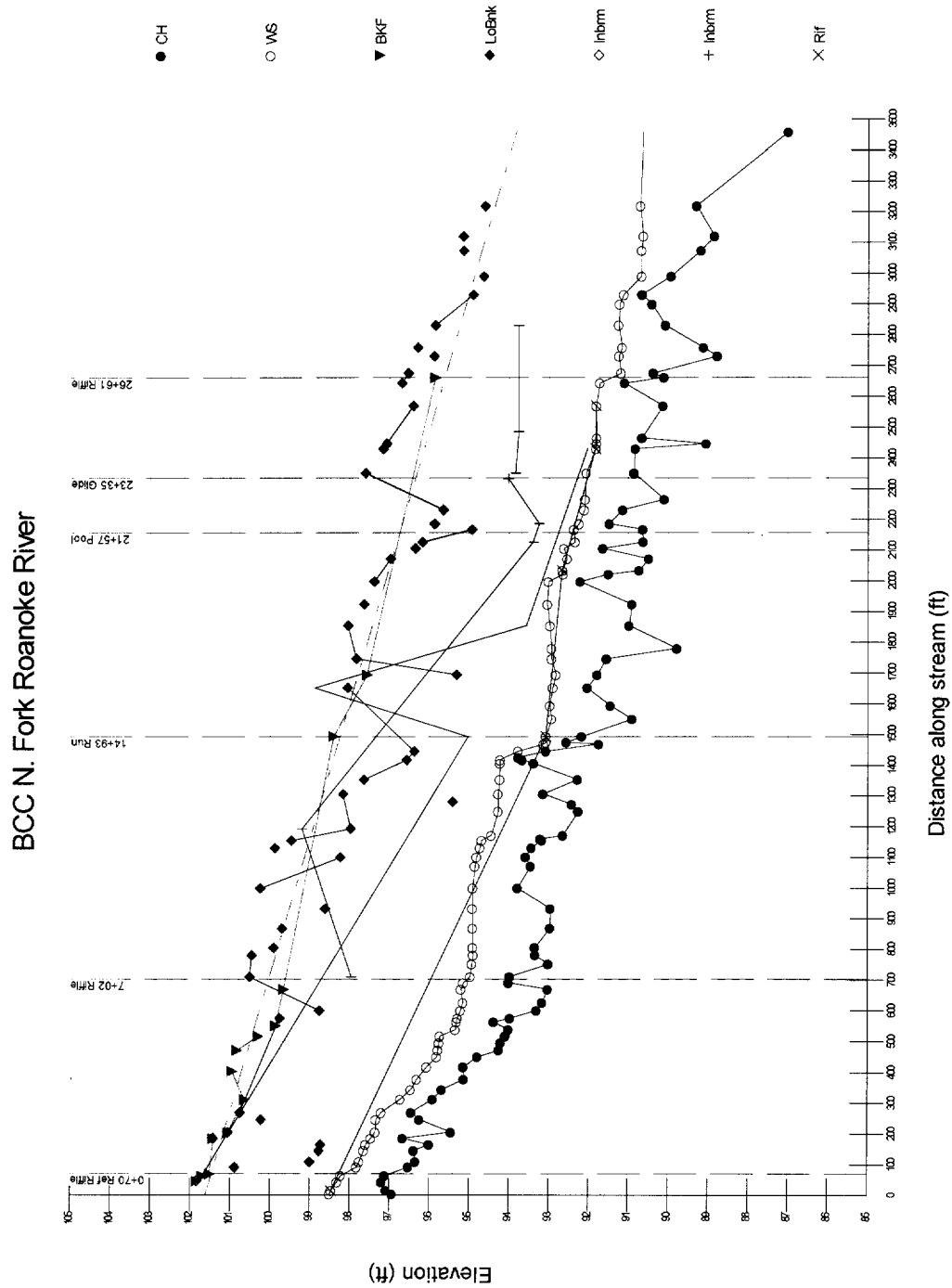
Mike Pinder, Regional Biologist  
Brian Watson, State Malocologist  
Bill Bennett, Landowner Incentive Program Biologist

## VI. REFERENCES

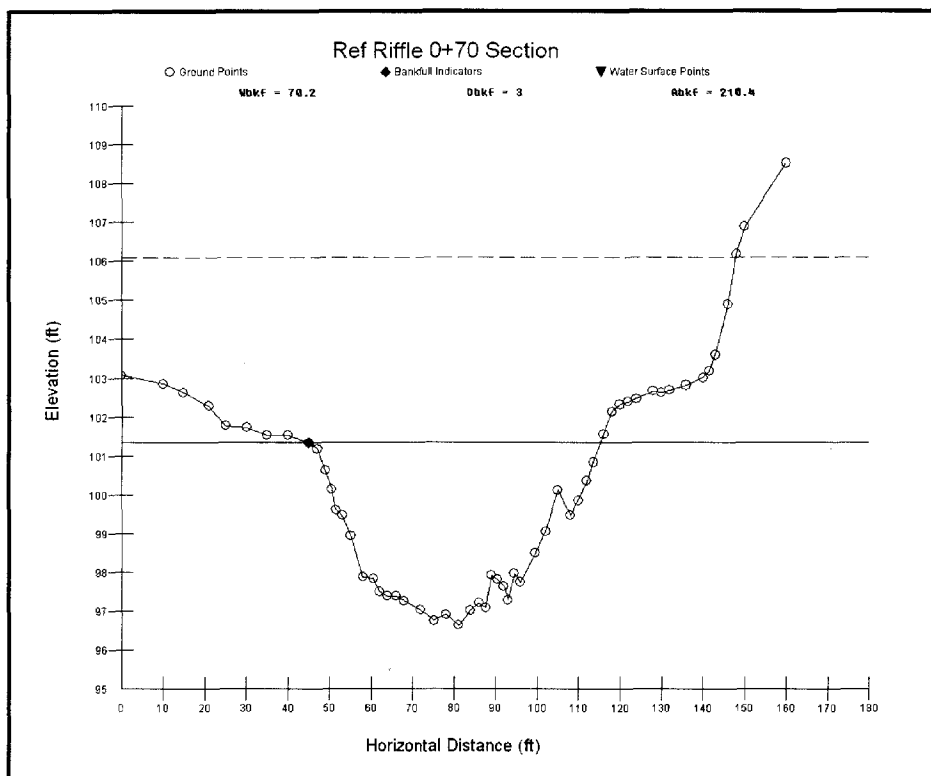
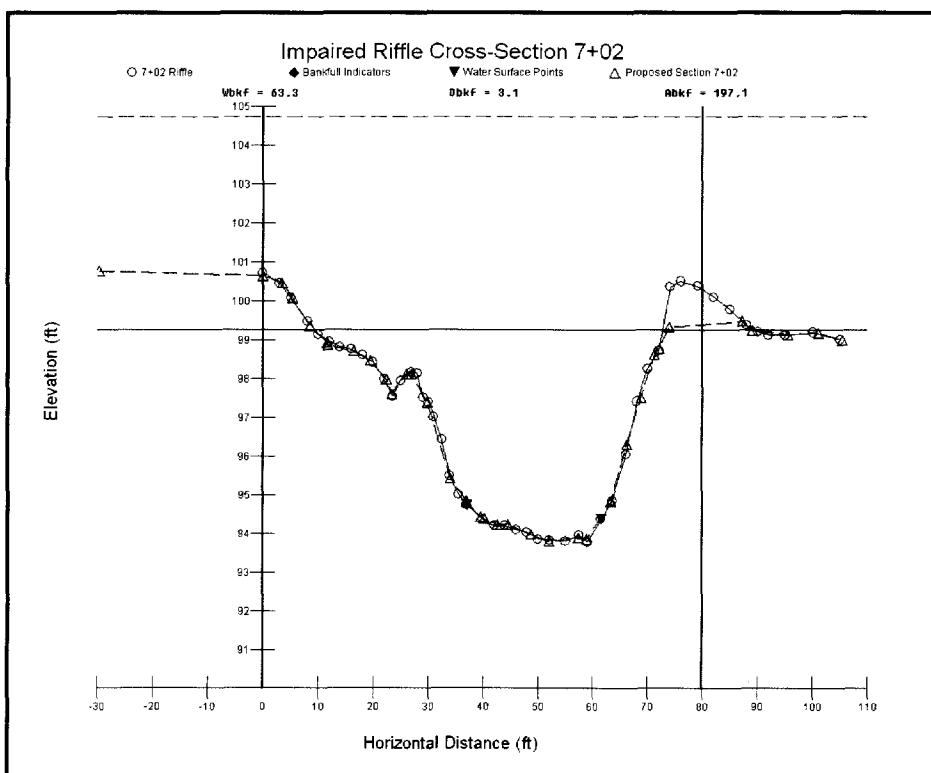
- Fischer, R. A., and Fischenich, J.C. 2000. "Design recommendations for riparian corridors and vegetated buffer strips," *EMRRP Technical Notes Collection*. (ERDC TN-EMRRP-SR-24). U.S. Army Engineer Research and Development Center: Vicksburg, MS.  
[www.wes.army.mil/el/emrrp](http://www.wes.army.mil/el/emrrp)
- Keaton, J.N., Messinger, Terence, and Doheny, E.J. 2005. Development and analysis of regional curves for rivers in the non-urban Valley and Ridge Physiographic Province, Maryland, Virginia, and West Virginia: U.S. Geological Survey Scientific Investigations Report 2005-5076
- Lee, K. H., T. M. Isenhardt, and R. C. Shultz. 2003. Sediment and nutrient removal in an established multi-species riparian buffer. *Journal of Soil and Water Conservation* 58(1): 1-8.
- Mueller-Dombois, D., and H. Ellenberg 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York.
- Pfankuch, D. J. 1975. Stream reach inventory and channel stability evaluation-A watershed management procedure. US Department of Ag. Forest Service, Intermountain Forest and Range Experiment Station. Ogden.
- Reed, P.B., Jr. 1988. National List of plant species that occur in wetlands: National summary. U.S. Fish and Wildl. Serv. Biol. Rep. 88(24). 244 pp.
- Rosgen, D. L. 1994. A classification of natural rivers. *Catena* 22: 169-199

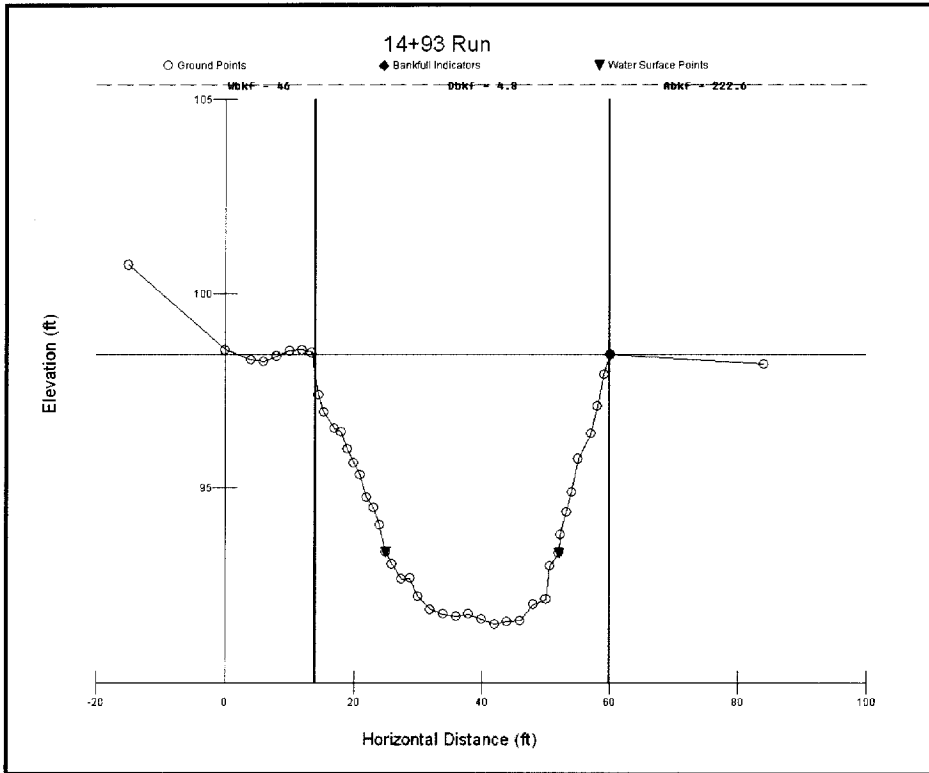


## Appendix A

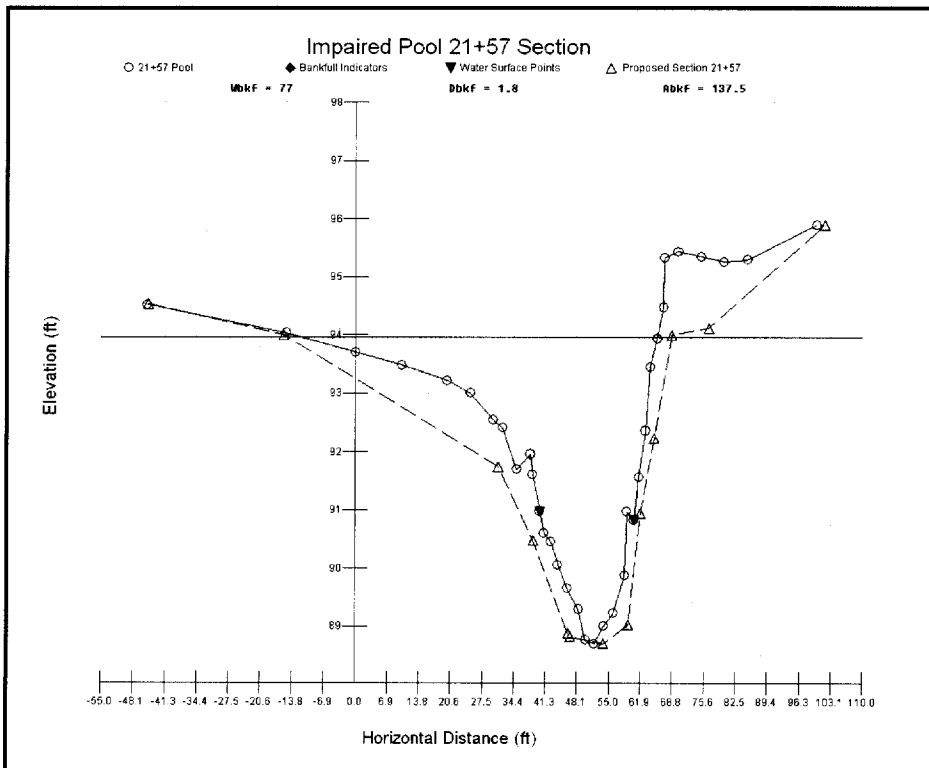


**BCC North Fork Roanoke River Longitudinal Profile**

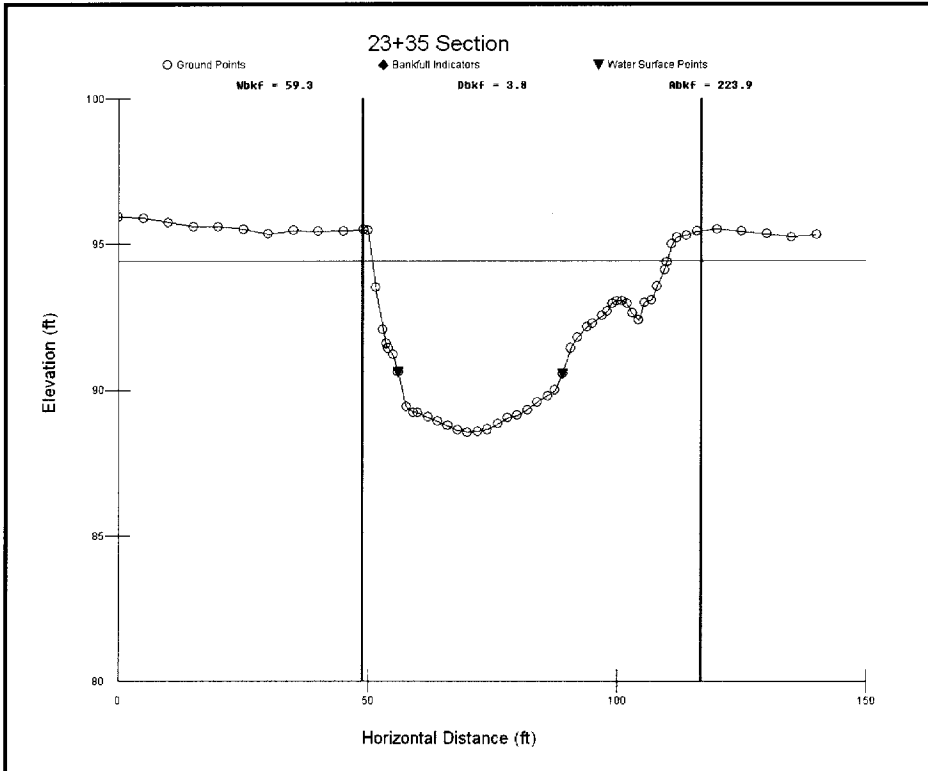
**Reference Riffle Cross-Section****Riffle Cross-Section 7+02**



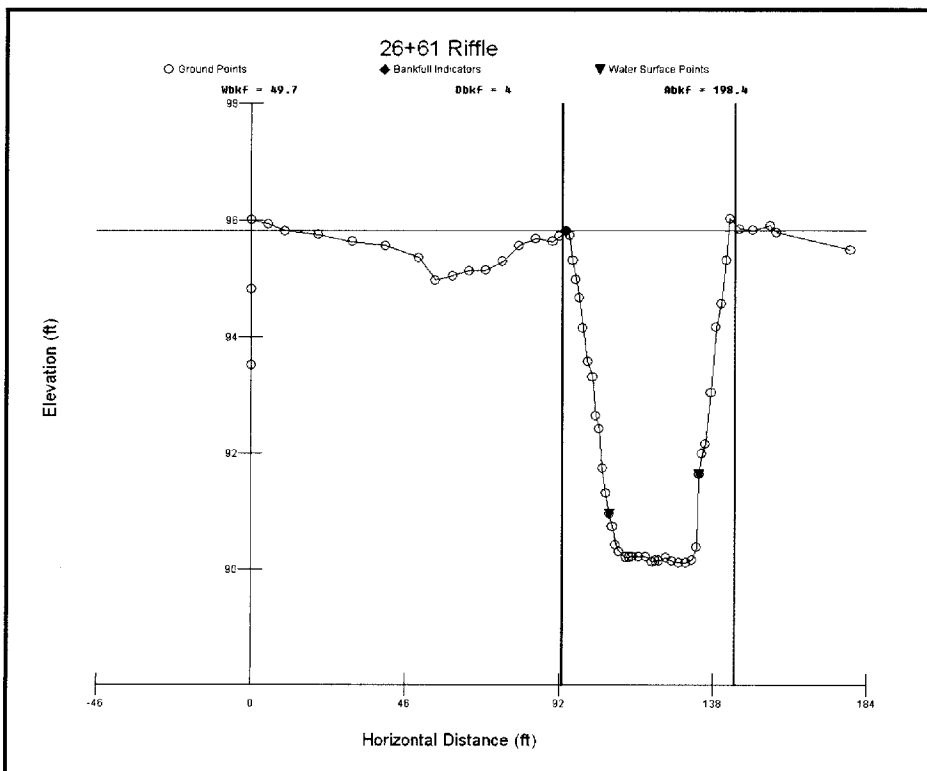
**Run Cross-Section 14+93**



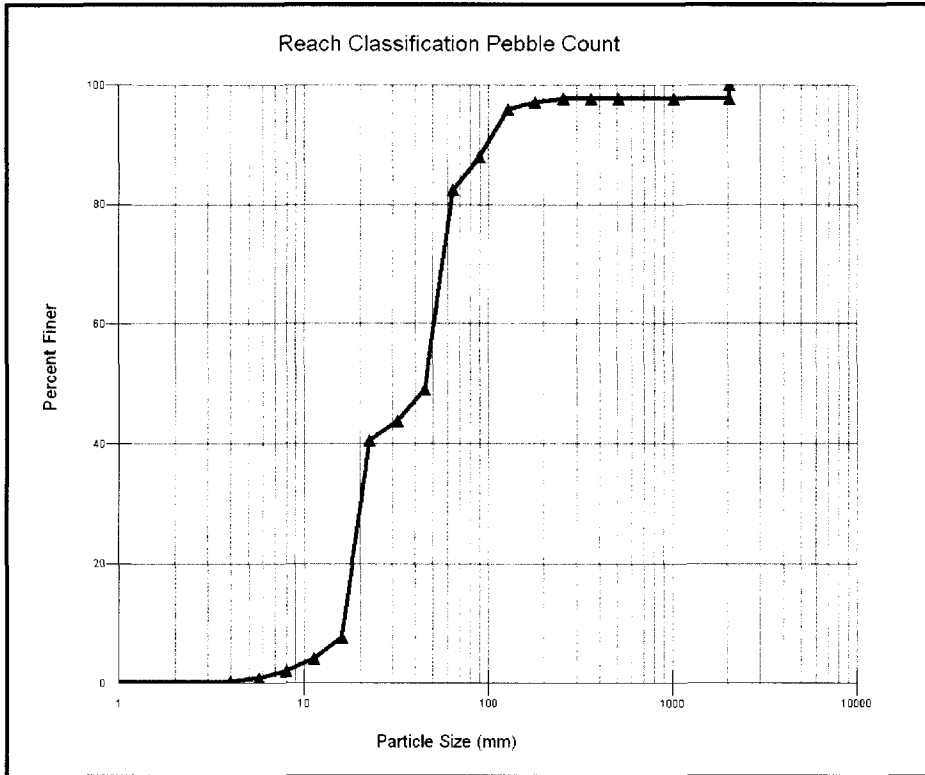
**Pool Cross-Section 21+57**



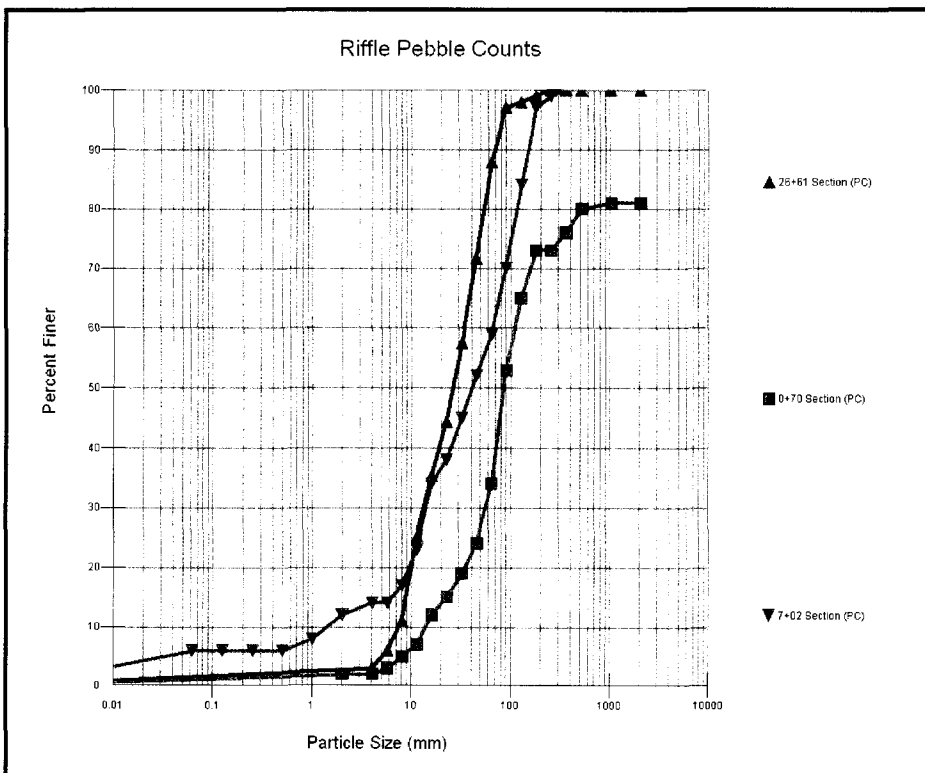
**Glide Cross-Section 23+35**



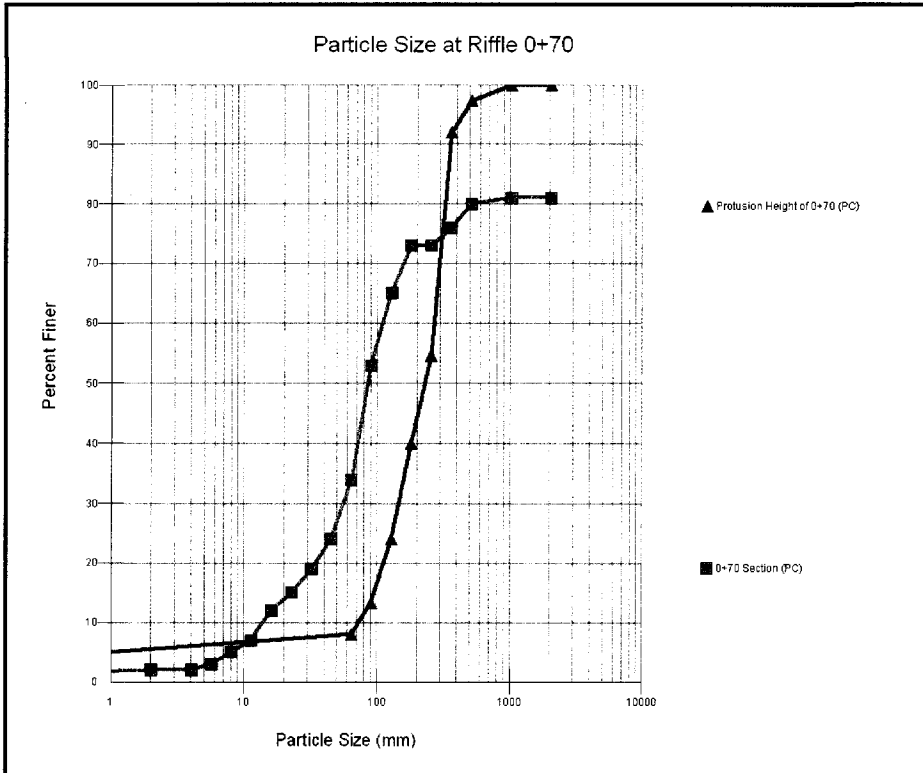
**Riffle Cross-Section 26+61**



**Reach Pebble Count**



**Riffles Pebble Count Overlain**



**Reference Riffle Pebble Count and Protrusion Height Measurements**

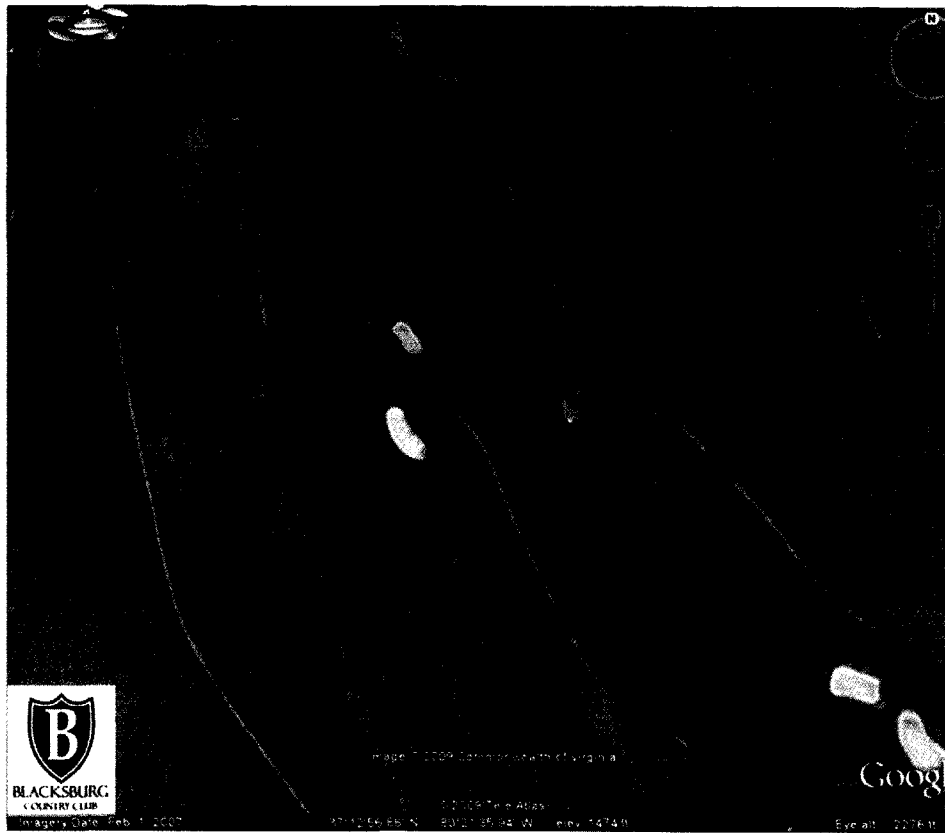


**APPENDIX B**



Project #1 - Hole  
#3 Tee  
Streambank  
Stabilization

Project #2 - Hole  
#2 Cross-over  
Streambank  
Stabilization



Project #5 - Bank  
Stabilization Just  
Past Hole #12  
Tee Bridge

Project #6 -  
Streambank  
Stabilization  
At Fairway  
Cross-over  
Hole #12

## APPENDIX C Definitions

**RIVER PRESERVATION** –Protection of ecologically important rivers through the implementation of appropriate physical mechanisms. Preservation includes the protection of riparian areas adjacent to rivers as necessary to ensure protection or enhancement of the overall river. The river system must be a high quality, relatively undisturbed system that requires little or no enhancement activities.

### RIVER ENHANCEMENT

**River Enhancement, Habitat, and Bank Stabilization** – Enhancement activities include physical alterations to the channel that do not constitute Restoration but directly augment channel stability, water quality, and stream ecology in accordance with a reference condition, where appropriate. These activities may include in-stream and/or riverbank activities, but fall short of restoring one or more of the geomorphic variables: dimension, pattern and profile. Included in Stream Enhancement are habitat structures, bio-remediation activities, riverbank plantings (below top of bank), and creation of bankfull benches.

**River Enhancement with Structures** - This activity includes structures that are specifically designed and result in grade control and/or bank stabilization. Accepted structures include, but are not limited to cross-vanes, j-hook vanes, native material revetments, W rock weirs, rock vortex weirs, log-vanes, constructed riffles, and step-pools. These structures may be created out of appropriate sized rock or logs, boulders or cobbles based on the size of the river and the flow regime.

**RIVER RESTORATION** - Converting an unstable, altered, or degraded river corridor, including adjacent riparian zone (buffers) and flood-prone areas, to its natural stable condition considering recent and future watershed conditions. This process should be based on a reference condition/reach for the river valley type and includes restoring the appropriate geomorphic dimension (cross-section), pattern (sinuosity), and profile (channel slopes), as well as reestablishing the biological and chemical integrity, including transport of the water and sediment produced by the river's watershed in order to achieve dynamic equilibrium.

## APPENDIX D

### Monitoring Requirements

Timing. Monitoring activities shall occur during the growing season, and at least once during the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup> and 10<sup>th</sup> growing seasons following completion of grading. After Year 3, physical monitoring of river condition (e.g. longitudinal profiles, cross-sections, channel width and depth) may be conducted outside of the growing season

In addition, monitoring shall adhere to the following schedules:

- (a) For any year in which planting was conducted, monitoring of woody vegetation shall take place no earlier than October and at least 6 months following planting;
- (b) Monitoring of vegetation (herbaceous and woody species) shall be conducted during the growing season.
- (c) If all performance criteria have not been met in the 10<sup>th</sup> year, then a monitoring report shall be required for each consecutive year until two sequential annual reports indicate that all criteria have been successfully satisfied.
- (d) Submittal of a final monitoring report (typically prepared the 10<sup>th</sup> growing season following completion of construction activities, including planting) shall be required.

The monitoring program *for upland buffer preservation areas* shall consist of:

Visual Observations: Visual observations shall be provided with each monitoring report through a written discussion of the buffer condition, any significant changes to the buffer, and photographic documentation, as necessary to further describe the buffer condition. Visual observations including name of the observer and date of the observation shall also be noted on the As-Built drawings

The monitoring program *for upland buffer restoration/establishment/reestablishment areas* shall consist of:

1. Visual Description. Visual descriptions shall be provided with each monitoring report by one of the following means: (i) ground level photographs, taken facing north, south, east and west, from stations located adjacent to each vegetation plot [permanent markers shall be established to ensure that the same locations (and view directions) are monitored in each monitoring period], or (ii) one color aerial photograph (8" x 10" or larger) depicting the entire site. An aerial photograph should be taken after site construction (including planting) and again in the 3<sup>rd</sup> and 7<sup>th</sup> year following final grading

2. Vegetation. Sample plots shall be located on a stratified random basis over the site in order to sample all habitat areas of buffer at locations adjacent to each photo location marker. The following *minimum* numbers of samples will be required:

If the buffer area is < 5 acres, then a minimum of 3 plots/acre is necessary

If the buffer area is > 5 acres but less than 20 acres, then a minimum of 2 plots/acre is necessary.

If the buffer area is > 20 acres, then a minimum of 1 plot/acre is necessary

However, all cells, fields, or blocks shall be sampled.

Each plot shall be of a size no less than 400 square feet for woody plants and 3'x3' for herbaceous plants (or circular with approximately the same surface area). Alternative sampling methods (*for instance use of point-line, point frame, or line-intercept sampling techniques; use of species-area curves or sample size analyses to establish numbers of samples, etc.*) may be submitted for Trustees' review and approval. The vegetation data shall be collected in each sample plot during the growing season and shall include:

- (a) For herbaceous plots, identification of all herbaceous species found in the sampling plot (with corresponding estimate of percent cover, indicator status, native status, planted/volunteer category for each species), and the percent of bare ground and open water.
- (b) For woody plots, identification of all live woody species found in the sampling plot (with corresponding indicator status, native status, planted/volunteer category, stem count, extrapolated stems/acre), number of dead stems.
- (c) Vegetation species identification by common and scientific name;
- (d) Estimates of percentage cover overall, and for each species utilizing the following cover classes:

**Cover class, range and midpoint used in data analysis.**

<b>Description</b>	<b>Range</b>	<b>Midpoint</b>
Cover class 1	1 – 5	2.5
Cover class 2	6 – 25	15
Cover class 3	26 – 50	37.5
Cover class 4	51 – 75	62.5
Cover class 5	76 – 95	85
Cover class 6	95 – 100	97.5

\*Mueller-Dombois and Ellenberg (1974).

Cover class data shall be relativized within each plot to 100% cover to allow for comparison between plots of varying sizes

;

- (c) Identification of dominant species in each vegetation stratum
- (d) Species Richness – the number of species found at the site at time of data collection (include all species found in a plot with individual % cover estimates)
- (f) Survival of planted species (per plot and per acre); and
- (g) Percent cover and/or stem count of non-native or invasive species in each vegetation layer,
- (h) Average height of planted woody species in each sample plot and percent change in height by species since previous monitoring event

The monitoring program for rivers shall follow the guidelines established below:

Within one week after any storm event that meets or exceeds a 1-year, 24-hour duration, as determined by the onsite rain gauge or the nearest National Weather Service station the river(s) shall be visually inspected for damages. Any damage noted shall be reported to the Army Corps of Engineers, the Service and DEQ in writing within 1 week of inspection, with

supporting photographs, and accompanied by a remediation plan. Photographs and narrative shall be utilized to summarize performance and necessity of remediation efforts in the next monitoring report.

1. River Channel Preservation - For the linear footage where no instream work was accomplished (regardless of riparian buffer activities), the following monitoring shall occur:

Permanent cross-sections shall be established to ensure that the same locations are used each monitoring year. A minimum of one cross-section per 1000 linear feet will be required. Total number required will vary depending on project length and complexity. Additional cross-sections may be required to show areas where aggradation, degradation, erosion, and mid-channel bars have developed.

The following will be documented at each cross-section:

- Ground level photographs shall be provided with each monitoring report for the purpose of documenting vegetation and river stability. The photographs will be taken annually during November or December of that monitoring year at representative cross-sections and will clearly show the channel upstream and downstream, the riparian buffer area, and each river bank.
- Cross-sectional measurements shall include riverbanks, riverbed, water surface, bankfull, and adjacent floodplain elevations.
- The same cross section for all previous monitoring years will be overlain on this cross section.

2. River Enhancement - For the linear footage of river with river enhancement activities (as defined in Appendix C), the following monitoring will occur in addition to those outlined for River Preservation areas:

Permanent cross-sections shall be established to ensure that the same locations are used each monitoring year. Representative cross-sections (with permanent markers established during the first monitoring interval) will be surveyed at intervals on a representative sample of riffles and pools. The total number required will vary depending on project length and complexity. Additional cross-sections may be required to show areas where aggradation, degradation, erosion, and mid-channel bars have developed.

- a. Sample plots for river bank vegetation (10 square feet in size) shall be located on each bank 100 feet upstream or downstream of each cross-section where riverbank plantings were completed. Sampling shall be conducted in accordance with Appendix D.
- b. Beginning with Year 2, The U.S. Forest Service Stream Reach Inventory and Channel Stability Evaluation (Pfankuch, 1975) will be performed at each permanent cross-section and additional locations to provide a representative assessment.

3. River Enhancement with Structures: Photo documentation will be provided for each structure, regardless of type, depicting the full width, length, and landscape position so that all portions of the structure are visible. For the linear footage of river with river enhancement with structures activities (as defined in Appendix C), the following monitoring will occur in addition to those outlined for river Preservation and river Enhancement areas:

- a. Each instream structure shall have the following data collected:
  - i. Photographs documenting structural integrity and function
  - ii. Surveyed profile documenting invert elevation

## APPENDIX E

### Success Criteria

The Trustees and the BCC will use best professional judgment, visual observations and monitoring reports to evaluate attainment of success criteria and in determining whether part or the entire project is successful or whether corrective actions are warranted. Success will be determined on a plot, well, field, or cell basis. Presenting averages or means of plot data across a project is not satisfactory to demonstrate success. Any means or averages of plot data must apply to distinctly homogenous areas, with sampling conducted on a stratified random basis and sampling intensity shall be sufficient to calculate means and the coefficient of variation. The following criteria will be used to assess project success:

1. Submittal of required documentation, including monitoring reports and as-built drawings.
2. In Restoration Project, including Buffer areas,
  - a. The final monitoring report (Year 10) shall document that all preserved areas, including Buffers are intact in their approved condition
  - b. No more than 5% aerial cover over the entire preservation area and/or individual areas no larger than ¼ acre in size beyond that identified in the baseline evaluation of the preservation areas may be made up by invasive species such as *Typha latifolia*, *Phragmites australis*, *Lonicera japonica*, *Pueraria lobata*, or *Ailanthus altissima*. Any deviation from this standard must be agreed upon by the Trustees and the BCC. *Invasive species are identified on the Virginia Department of Conservation and Recreation's Invasive Alien Plant list. This list of invasive plants may be found at [http://www.dcr.virginia.gov/natural\\_heritage/documents/invlist.pdf](http://www.dcr.virginia.gov/natural_heritage/documents/invlist.pdf)*

*River buffer preservation areas are those portions of the river buffer in which no work, including but not limited to disturbance, grading, clearing, or planting is conducted.*

3. In Buffer areas,
  - a. A minimum of 400 woody stems of native trees and shrubs per acre (including volunteers) from the top of the river bank landward and/or within the wetland shall be achieved by the end of the first growing season following planting and maintained each monitoring year until canopy coverage is 30%. Canopy coverage shall be at least 30% each monitoring year thereafter. *(The number of woody stems per acre may vary under certain circumstances. For example, if invasive species need to be controlled upon implementation of the project, then a lower density may be appropriate in order to mow and/or spray).*
  - b. Native non-invasive herbaceous plant coverage shall be at least 60% by the end of the first growing season, and at least 80% each monitoring year thereafter. Any seeds used for plant establishment should conform to the Virginia Seed Law (Sections 3.1-262 Code of Virginia) and Virginia Seed Regulations (2 VAC 5-290-10 et seq.) and shall be free of tall fescue, Bermuda grass, and other allelopathic turf grass species, as well as plant species on the Virginia Department of Conservation and Recreation's Invasive Alien Plant List.
  - c. No more than 5% aerial cover per 500 linear foot river segment, and/or buffer cell, field, or block may be made up by invasive species such as *Typha latifolia*, *Phragmites australis*,



*Lonicera japonica, Pueraria lobata, or Ailanthus altissima.* Any deviation from this standard must be agreed upon by the Trustees and the BCC. *Invasive species are identified on the Virginia Department of Conservation and Recreation's Invasive Alien Plant list. This list of invasive plants may be found at [http://www.dcr.virginia.gov/natural\\_heritage/documents/invlist.pdf](http://www.dcr.virginia.gov/natural_heritage/documents/invlist.pdf)*

- d. The Year 5 and the final monitoring report (typically Year 10) shall contain documentation by cell, field, or block that demonstrates that all vegetation within the buffer area is healthy and thriving and the average tree height of all surviving trees within sample plots are at least 5 feet in height.

#### 5. River Success Criteria

*It is important to note that this is not a standard set of criteria to be placed on all projects.*

The overall goal for the river compensation is to ensure that the dimension, pattern, and profile of the river enhancement and restoration areas: 1) remain within the natural range of variability present in the reference data obtained for the design; 2) remain stable; 3) exhibit appropriate habitat diversity; and 4) have healthy viable riparian buffers.

The Trustees and the BCC will use best professional judgment, visual observations and monitoring reports to evaluate attainment of success criteria and in determining whether part or the entire project is successful or whether corrective actions are warranted.

#### RIVER ENHANCEMENT

For the linear footage of river with river enhancement activities, the following success criteria will apply:

##### River Reach Stability

The analysis of the riverbank from the top of the bank to the ordinary high water mark shall indicate a significant amount of natural protection to prevent riverbank erosion that could jeopardize the stability of the riverbank or the river reach.

The following measurements will be used to aid in making this determination each monitoring year:

1. Where riverbank plantings were undertaken: The numbers of live stakes, planted, or volunteer woody species providing bank stabilization from the top of bank to ordinary high water mark shall be at least 1 living stem per 50 square feet per river edge along the bank by the end of the first growing season following planting and maintained each monitoring year until canopy coverage is 50% for any identified reach. Canopy coverage shall be at least 50% each monitoring year thereafter.

- 2 Native non-invasive herbaceous plant coverage shall be at least 80% by the end of the first growing season, and at least 80% each monitoring year thereafter, until canopy cover exceeds 30%. Any seeds used for plant establishment should conform to Virginia Seed Law (Sections 3.1-262 Code of Virginia) and Virginia Seed Regulations (2 VAC 5-290-10 et. seq) and shall be free of tall fescue, Bermuda grass, and other allelopathic turf grass species, as well as plant species on the Virginia Department of Conservation and Recreation's Invasive Alien Plant List.

3 The U.S. Forest Service Stream Reach Inventory and Channel Stability Evaluation (Pfankuch, 1975) rating shall be "Good" each monitoring year, beginning with Year 2.

(c) RIVER ENHANCEMENT WITH STRUCTURES

For the linear footage of river with river enhancement with structures activities the following success criteria will apply:

Structures

The analysis of each instream structure shall indicate that it is performing its intended function, and not adversely affecting the river. The following measurements will be used to aid in making this determination each monitoring year:

1. Absence of under cutting, washing around, or erosion of the bank or riverbed associated with any instream structure, excluding any minor channel scour within the thalweg immediately downstream of a structure caused by its intended redirection of flow.
2. The invert elevation (controlling elevation) of the header rocks or logs of any vane, j-hook, cross-vane, W-weir, or other structure shall not vary more than 0.2 feet from the approved as-built.