3. Management Measures to Achieve Watershed Goals

This section describes the management measures developed that will help Codorus Creek stakeholders achieve our watershed goals. Milestones were developed by subwatershed and aggregate for the watershed as a whole. Funding, construction and maintenance activities were also considered.

3.1. Levels of Stream Restoration Efforts

Three levels of restoration efforts are discussed which cover a wide range of required effort, from volunteer assistance using manual labor and hand tools to larger construction efforts using heavy equipment. Best Management Practices (BMPs) were developed for future stream restoration and enhancement efforts in the watershed. These BMPs primarily involve streambank stabilization and consider natural stream channel design elements. Coordination with all adjacent landowners must take place prior to implementing any of the recommended BMPs, including minor volunteer efforts. Ideally, any BMP efforts should be completed during the normal low flow conditions in streams, including any efforts which may not require environmental permitting. With all of the BMPs presented, it is important to complete the restoration efforts as quickly as possible and promptly stabilize all disturbed areas.

3.1.1. Level I: Severe Stream Restoration

Projects which fall into this category are severely impaired reaches along larger streams (e.g., stream orders 3rd and greater) where extensive stabilization is required over considerable distances (over 500 feet length). Although many of the stream reaches in the watershed which are severely impaired can be restored through bank stabilization, some may require a complete change in the dimension, pattern and profile of the stream or a total channel realignment. At a minimum, these types of projects will require a joint permit application to DEP. The need to relocate a stream channel is usually due to safety reasons (extensive storm damage), where land use conflicts occur, or where the impairment is too great to provide the required stabilization using the existing stream pattern. These types of projects require detailed designs and permitting coordination with local, state and federal agencies. It is strongly recommended that a natural stream channel design approach be used for major stream restoration projects. This approach considers aquatic habitat features and is carefully designed so that the channel can maintain the proper geometry.

Although the need for total reconstruction of any stream channels with the watershed is not known at this time, there may eventually be a need to provide this level of restoration or to relocate certain reaches of a stream. It is highly recommended that a natural design approach be used, where possible and feasible. Using information from the watershed assessment, stable reaches of streams can be used as reference reaches based on the size of stream and stream type classification. The channel geometry for these different stream types can be used for reference in the design of new stream channels or major channel reconstruction. This level of design will also require the collection of detailed information from the project reach including stream cross-sections and profiles, meander geometry, and pebble counts. Information included in this plan such as the hydraulic geometry curves can be used for design efforts (bankfull width and cross-sectional area).

3.1.2. Level II: Moderate Stream Restoration

The restoration efforts included under this level are generally for projects with smaller drainage areas (e.g., stream orders 1 and 2, generally less than 5 square miles) and would include many of the moderately impaired stream reaches in these smaller watersheds. Under this category, restoration would include some form of stabilization and would require the use of smaller excavating equipment to install in-stream structures, slope-toe protection and bank reshaping and stabilization. Projects under this level of restoration would typically not involve working in the stream and would not require stream crossings. At a minimum, these projects would require the preparation of a General Permit (GP-3) and coordination with the permitting agencies.

3.1.3. Level III: Slight to None Stream Restoration

These types of restoration projects were developed for manual implementation primarily using hand tools such as shovel, rakes, digging bars, lopping shears, and hand saws. Projects under this category would be minor enhancement and protection efforts and are ideal for implementation by private landowners, watershed groups, nonprofits organizations, and other groups engaging in environmental stewardship and watershed protection. These types of BMPs would generally be implemented on small streams (e.g., stream orders 1 and 2) with channel widths ranging in size between one to six feet. These types of projects would also include restoration of overly wide and shallow channels (entrenched F type) where streambanks are stable. At a minimum, coordination should take place with the permitting agencies. These agencies could then make the decision on the type of permit (if any) that would be required. Included under this level of effort is the construction of in-stream structures such as log and rock vanes which can be constructed manually with volunteer labor using the guidelines presented in the BMPs section.

3.2. Best Management Practices

Best Management Practices (BMPs) and restoration guidelines were developed for stream restoration work in the watershed. All of the BMPs consider the natural stream channel design approach. A matrix which shows BMPs and a rating of their applicability to the various stream types found in the watershed are shown in table 3-1.

The construction of these in-stream structures can be done in wet or dry channel conditions. Working under wet conditions should be avoided when possible; however, many times restoration efforts are more effective, timely and have less overall impact with this approach. Construction with water in the channel allows the contractor to observe the change in flow vectors in response to in-stream structure placement and alignment. Under these conditions, the equipment operator may have to pause momentarily until the water clears before continuing. Based on the watershed assessment, the watershed is sediment-ladened and becomes turbid even during minor rainfall events. Short-term sedimentation in the stream will result from this approach. The long-term benefits of the restoration effort far outweigh the temporary, minor sedimentation impacts especially where severe bank erosion is occurring. The crossing of streams and working within or adjacent to the channel are issues which need to be discussed with the permitting agencies during project planning.

The diversion of stream flow around the work area has the advantage of allowing the equipment operator to continually see the reconstruction of the channel and installation of the structures. The diversion of stream flows around a work area however will add to the construction costs and may also have an adverse impact on aquatic resources within the bypassed channel. Working in a dry channel does not allow the observation of how stream flows will be affected by the structure and may result in the need to make future adjustments.

Table 3-1. Recommended Stream Restoration and Protection BMPs for Various Stream Types

		Stream Types						
	BMP	A4	G4	F4	B4	C4	E4	Comments
#1*	Rock Vanes, Log Vanes	Fair	Fair	Good	Exc.	Good	Fair	Steep vertical banks makes installation difficult, improves w/d ratio
#2	Cross Rock Vanes	Fair	Fair	Fair	Exc.	Good	Fair	Steep vertical banks makes installation difficult.
#3	Root Wads	Good	Good	Good	Exc.	Exc.	Good	Requires extensive re-vegetation above bankfull
#4*	Bank Grading/	Poor	Exc.	Good	Exc.	Exc.	Good	Vegetative stabilization required.
	Rock Protection	Good	Good	Exc.	Exc.	Exc.	Exc.	No limitations.
#5	Stream Crossings, Ramps	Poor	Fair	Fair	Good	Exc.	Exc.	Avoid crossings in entrenched stream reaches.
#6*	Low Flow Channel	N/A	N/A	Exc.	Good	N/A	N/A	Only applies to entrenched streams with high to very high Width/Depth ratio.
#7*	Debris Jam Removal	Exc.	Exc.	Exc.	Exc.	Exc.	Exc.	No limitations.
#8	Culvert Crossing (flood pipes)	Good	Good	Good	Exc.	Exc.	Exc.	Best applied in slightly entrenched stream reaches
#9	Streambank Fencing	Exc.	Exc.	Exc.	Exc.	Exc.	Exc.	No limitations
#10	Streambank Planting							
	Soil Bioengineering	Good	Good	Exc.	Exc.	Exc.	Exc.	Entrenched stream may require grading.
	Riparian Corridor Planting	Exc.	Exc.	Exc.	Exc.	Exc.	Exc.	No limitations.

* *Can be done manually or with heavy equipment depending on stream size.*

3.2.1. BMP #1 – Rock and Log Vanes

Rock and log vanes are in-stream structures used to direct stream flows away from an unstable streambank and into the center of the channel. These structures can be constructed with either rocks or logs and are placed along the outside of a meander bend of the channel. These structures are often installed in series depending on the degree of curvature of the meander bend. The installation of rock vanes requires the excavation of the substrate and the placement of large “footer rocks” on which the rock structures are built. These footer rocks are placed below the desired channel grade to prevent the scour of the structure. The vanes are installed at slopes between 3% and 7% from the streambank to the channel. The vanes are also placed at angles ranging between 20 and 30 degrees from the bank facing upstream (See Appendix A – Typical Drawing 1). The upper portion of the vane is keyed into the bank at the predetermined bankfull height so that higher flows cannot wash out around the structure.

“J” hook rock vanes are similar to rock vanes; however, additional rocks are placed at the end of the structure and slightly downstream. This modification of the rock vane will provide fish habitat in the form of a scour pool at the downstream end of the vane. The proper installation of vanes will prevent the lateral migration of stream channels by directing near-bank stress away from the streambanks and into the center of the channel. These structures also create aquatic habitat by providing designed scour pools downstream of the structure and create velocity vectors that segregate gravels. Typical Drawing 1 shows the configuration and installation procedures.

Larger excavating equipment will be required when large rock is used however smaller rock can be used by manually “shingling” or layering to get the appropriate design features (See Appendix A – Typical Drawing 1A). The top of steeply sloped banks should be graded or collapsed behind the vane to provide backfill material.

Logs can also be used to build vanes but must be anchored into the channel and/or bank. Cables can be attached to both ends of the log using cable clamps and anchored into the bank by attaching to a piece of re-bar driven into the bank or channel. Log vanes have been used effectively by attaching wire mesh on the upstream side with fence staples and filling with a brush layer and coarse gravel and cobbles.

3.2.2. BMP #2 – Cross Rock Vanes

Cross rock vanes are generally used on straight channel reaches in order to provide stability along both streambanks (See Appendix A – Typical Drawing 2). These structures essentially consist of two rock vanes (one on each bank) and are connected with rock between the limbs of the both vanes. The structure is “horseshoe” shaped with the bend in the structure being located upstream. This bend in the structure is also the lowest in elevation and is set at a pre-determined grade elevation. “Footer” rocks are also installed to provide a foundation for the rock structure. Cross rock vanes divert the erosive forces along the streambanks into the center of the channel and create designed, self-maintaining scour holes. In addition to bank protection and aquatic habitat, these structures also provide a set grade control to prevent channel downcutting or headcutting and enhance sediment bedload transport.

3.2.3. BMP #3 – Root Wad Installation

Root wads consist of a tree trunk, uprooted root bole, and a connected length of the tree itself. Root wads will provide bank protection; however, these structures are used primarily to provide habitat (scour pools and overhead cover). Root wads are installed in the thalweg so that the bole or root mass is facing upstream at a slight angle to the flow vectors. A "footer rock" or log is installed on the channel bottom to support the root wad (See Appendix A – Typical Drawing 3). The tree trunk should be keyed into the streambank by excavating a trench and should be at least 12 feet in length. Large rocks are then placed on top of the tree and the trench is backfilled. It may be possible to push smaller root wads into the streambank with heavy equipment. This can be done by using a chain saw to form a point on the end of the stem and pushing the boll into the bank. The size of the root wad and soil conditions will dictate suitable installation conditions. If the conditions are suitable for this method of installation, a shorter trunk stem can be used (at least six to eight feet in length).

3.2.4. BMP #4 – Bank Grading and Rock Toe Protection

The basic concept of this BMP is to provide a more stable bank slope along eroding sections of the channel to reduce the potential of future erosion (See Appendix A – Typical Drawing 4). Along sections of channel where streambanks are steeply sloping to vertical or undercut, the lower bank should be protected with rock which is keyed into the bank and edge of channel. Rock toe protection should be installed up to the bankfull elevation. The upper bank (above the bankfull elevation) should be re-graded to at least 2V:1H; however, if conditions permit, a slope less than 3V:1H is preferred. An effort should be made to avoid disrupting any dense root material. At a minimum, any overhanging bank material which has no root mass protection should be removed to prevent sloughing or encroachment into the stream channel and should be placed outside any areas prone to flooding. Coordination with adjacent landowners may result in the identification of suitable disposal areas. Where stream banks are undercutting trees, rock should be placed underneath the root mass and keyed into the channel. An attempt should be made to upright any trees which may be leaning into the channel and protect the root mass from further bank erosion. All disturbed areas should be stabilized with seed, mulch, and/or riparian plantings.

Meander bends may require additional stabilization due to the higher shear stress along the outside of the meander or the concave portion of the bend. Erosion along the toe of the concave bank can be reduced by armoring the bank with large rock. Rock toe protection is often used in conjunction with the installation of rock or log vanes to protect the lower bank between the structures. Rock used for bank protection should not be taken from the stream channel but instead should be either purchased or obtained outside the immediate stream channel where the work is being performed. The rock used for bank protection should be hard (erosion-resistant) and large enough to resist erosive forces. Larger streams or streams with gradients greater than 2% will generally require larger rock. The top of the "footer rocks" or those rocks keyed into the channel bottom should be flush with the existing substrate. These rocks will serve as a foundation or footer for the subsequent placement of rocks along the bottom of the bank. These "footer rocks" should be placed along the entire eroded reach of the bank being stabilized. Keying these "footer rocks" in the substrate will prevent the undermining or scour along the toe of bank.

Other large rocks are then placed on top of the footer rocks. These rocks should in turn be keyed into the bank especially at the upstream end of the meander bend. This is done by either excavating into the streambank or can be forced into the bank with heavy equipment. Upon completing the placement of rocks, any voids between the rocks should be filled with clean gravel. Willow cuttings can be staked between the rocks to help stabilize the bank.

3.2.5. BMP #5 – Stream Crossings

Ramps For stream restoration projects, temporary crossings may be required to gain equipment access and deliver stone along the opposing bank. Generally, stream crossings require the preparation of General Permit BDWM 6, 7 or 8. The optimum location to cross streams is along slightly entrenched reaches with high width to depth ratios and suitable gravel substrates (C Type). With these conditions, temporary crossings may be approved by the permitting agencies without the required crossing permit. If these stream and bank conditions are not present, an improved crossing will need to be constructed and permitted. If the stream crossing is planned to be a permanent crossing such as a livestock crossing and watering access or for crossing with farm equipment, a general permit will also be required. This BMP is used for restoration projects where a constructed crossing is required and also for permanent agricultural crossings. The crossings are installed by keying in larger stone (No. 4 or No. 5) into the stream bottom and banks along the crossing and placing smaller (No. 2) stone on top of the course stone (See Appendix A – Typical Drawing 5). The depth of the stone base should be at least 12 inches. The crossing approaches are graded to a minimum slope of 4H:1V

3.2.6. BMP #6 – Low Flow Channel

This BMP consists of removing gravel or substrate material from the deeper section of the channel and placing this material between the edge of the new channel and the streambank (See Appendix A – Typical Drawing 6). The concept of this BMP is to create a new low flow channel within the banks of the entrenched channel to provide a narrower and deeper primary channel. The new channel width should be at least one-third to one-half the original F-type channel width. The gravel, stone or rock removed from the primary channel is placed between the edge of the primary channel and the toe of the existing bank and will essentially form a type of floodplain area within the oversized F-type channel. The material placed on this new floodplain area should be raked and graded so that the slope increases between the edge of the new primary channel and the exiting streambank. This new low flow channel will also tend to be self-maintaining as flow velocities will be high in the primary channel allowing for the transport of bedload through the stream reach where this practice is applied. Additional stabilization can be achieved by establishing vegetation along the new builtup floodplain area. Native riparian and aquatic plant species with prolific and dense root mats are ideal for planting. Recommended plant species include water willow (*Justicaamericana)* and lizards tail *(Saurus cernus)*. Once established, these plant species will continue to spread and help settle small bedload and finer particulates during high flow conditions. This BMP works exceptionally well in F4-type streams where the channel has already downcut and adjusted (widened through bank erosion).

Another practice can be used with this approach to help maintain and build the new floodplain area. This practice involves the placement of rocks along the floodplain area to promote additional deposition. The rocks can vary in size but should be flat. Larger rocks should be placed perpendicular to the stream flow and should be placed at an angle (25-40 degrees) so that the downstream edge of the deposition rock should be keyed at least two inches into the substrate to prevent scouring. Small rocks and gravel can be placed under the deposition rocks to provide support so that an upward angle can be maintained during higher flows.

The placement of deposition rocks along the shallow floodplain will create eddies or dead space during higher stream flows and allow small gravel, sand and silt to settle out. Upon placing the deposition rocks, the substrate immediately downstream of the rocks should be planted with aquatic or wetland obligate species in order to help stabilize the substrate along the shallow floodplain gravel bars. The plant species recommended are those which provide prolific rhizome growth as mentioned above. Willow livestake cuttings or other riparian shrub species should be planted along the toe of the original channel banks as discussed under BMP#10.

3.2.7. BMP #7 – Removal of Debris Jams

Debris jams are a natural stream feature and can provide aquatic habitat. Some debris jams can become extensive and lead to accelerated bank erosion. Many jams consist of woody debris which become lodged along a channel reach. These jams can build during high flow events and accumulate finer debris such as leaves and twigs. Many times, these jams will constrict the capacity of the channel and direct flows into a streambank causing erosion. Some jams consist of residual trash (tires, plywood, or appliances) which can also lead to bank erosion.

In areas where debris jams are causing bank erosion or channel scouring, the debris should be removed above the normal water level of the stream (See Appendix A – Typical Drawing 7). By removing the debris above the normal water level, higher flows can pass without restriction. Large woody material can be removed with chain saws while small woody debris can be trimmed with lopping shears and then be removed. All trees along the streambanks which are leaning due to bank erosion should be cut at the base of the tree. The tree and limbs should then be removed out of the flood-prone area. The remaining trunk and roots should be left in place to provide bank stability. All woody debris imbedded in the substrate should remain in place as this material often times provides grade control and aquatic habitat.

Any woody debris material removed from the channel should be discarded outside of the work area which is prone to seasonal flooding. All residual trash should be properly disposed of and will require additional coordination. One approach to the removal of residual trash is to plan stream clean-up activities during the Spring when municipalities often sponsor special trash removal activities.

Included in this BMP is the removal of multiflora rose along the immediate stream bank. This thorny shrub species is invasive and was found growing along many stream reaches in the study area. Multiflora rose may provide some bank protection but is shallow rooted and can be easily removed. Large shrubs tend to grow out into open channels and can cause extensive channel blockages. Once removed, the stream bank should be replanted with more suitable riparian species as discussed under BMP #9.

3.2.8. BMP#8 – Culvert Crossings

The installation of culverts in a stream will require a General Permit BDWM-7. The size of the pipe or culvert for the desired design storm event will need to be determined. Under-sized culvert pipes can result in a “fire hose” effect where backwater along the upstream side of the pipe causes a dramatic increase in velocities. These increased flow velocities can result in channel downcutting and bank erosion.

Under this BMP, it is recommended that the cross-sectional area of the pipe be achieved through the use of a single larger pipe to carry the main flow and at least two smaller diameter pipes to carry additional flood flow (See Appendix A – Typical Drawing 8). The cumulative cross-sectional area will need to be sufficient to carry the design flows. The smaller pipes should be placed higher in elevation and close to the floodplain area as shown in Typical Drawing #5. The primary pipe or culvert should be depressed in the stream substrate in order to provide fish passage. While one larger pipe may be sufficient to carry the design flood flows, the flow velocities from smaller storm events may not be sufficient to transport sediment through the pipe which results in sediment deposition and restriction of flow capacity. The installation of a smaller primary culvert will also provide increased opportunities for fish passage especially during low flow periods. The length of the culvert crossings should allow for stable bank slopes where the pipes are filled above the crossing. Secondary pipes should be installed within the active floodplain.

3.2.9. BMP #9 – Streambank Fencing

The installation of electric fence along a stream corridor in agricultural use is a very effective method of preventing unlimited livestock access to streams. Multi-wire hightensile fence is used along a stream corridor to prevent direct access to the stream banks and to promote a riparian buffer which helps to re-establish vegetation and prevent excess nutrients from entering the stream (See Appendix A – Typical Drawing 9). At a minimum, fencing should be placed along the stream corridor at least 15' from the top of the stream bank. The use of fencing along a stream corridor does not require a permit. In many agricultural settings however livestock access to the stream is desired and will require the installation of designed stone ramps or crossings. All agricultural stream crossings will require a General Permit prior to implementation and is discussed under BMP# 5. With some fencing projects maintenance (mowing) can be an issue with the landowner. One option to address this issue is to provide a wider fenced buffer whereby the inside of the fence can be mowed (single pass) to prevent vegetative grounding of the electric fence.

There are numerous programs available which provide financial assistance to landowners that wish to install streambank fencing. Information on these programs and proper fence installation procedures can be obtained by contacting the York County Conservation District and the Pennsylvania Department of Environmental Protection, Water Management Program.

3.2.10. BMP #10 – Riparian Plantings

Riparian plantings should be included in all stream restoration projects. Plantings used to stabilize streambanks are species which prefer continuous moist to periodically flooded soil conditions. Native plant species recommended for riparian areas include willow, alder, silky dogwood, red osier dogwood, and buttonbush. These species can be purchased from various nurseries. A more cost-effective approach (but more labor intensive) is to acquire cuttings from the project area for planting.

Live Cuttings or Stakes

A cutting is a branch detached from a parent plant, capable of regeneration. Woody cuttings have long been used as a method of providing effective bank stabilization. When planted in soil under proper conditions of sun and moisture, they will grow into mature plants. Various species of willows are the most common shrub species used for erosion control. Cuttings can range from ½ inch to 2 inches in diameter and from 2 feet to 10 feet in length. In all cases, the cuttings must be long enough to reach undisturbed soils and have buds for rooting and leaf development. The branches should be cut at a slant on the base and be blunt on top to facilitate the placement of the cutting into the streambank (See Appendix A – Typical Drawing 10).

Cuttings must be installed during the dormant season which occurs between November and March. Cuttings must be kept moist in a shaded area and placed in the soil within 24 hours of being cut. They will do best when planted in a sunny location with moist soil. The installation of cuttings should begin at the toe of the eroded bank. The cuttings should be inserted into the bank at right angles to the slope at least 4/5 the length of the cutting. The soil surrounding the cutting should be tamped to eliminate all air pockets. For hard compacted soils, an iron bar can be used to make the hole. The density of the installation depends on site conditions ranging from two to six cuttings per square yard. A spacing of two feet per square yard or less is recommended. Each horizontal row of plantings should be offset as shown on Typical Drawing 10.

Seedlings

Rooted woody seedlings can also be used to stabilize streambanks. Seedlings from the project area can be used but are not recommended. Transplants will result in inconsistent survival and require more time and effort to properly collect. Woody riparian species are readily available and low in cost. Seedlings must be kept moist and should be planted within ten days of arrival. The best time to plant seedlings is in early Spring at the end of the dormant season.

An efficient method for planting small seedlings involves the use of a planting bar. A hole is made with the bar, the plant is inserted, and the soil is tamped firmly around the plant. Larger container grown plants require a larger hole sufficient to cover the roots. The spacing of the installed plants is the same as that discussed above. The plants should be watered after installation.

Fascines

Fascines or wattles are sausage-shaped bundles of live woody cuttings used to stabilize streambanks. The cuttings used to make fascines must be from woody species that root easily and have long straight branches such as willows, silky dogwood, or red osier dogwood. Shrub willows are desirable because they branch outward. The cuttings are placed in bundles and vary in length between 10 and 15 feet long and should be around 6 inches in diameter. The branches contained in the bundles should be at least three feet long with a maximum diameter of one inch. The cuttings are placed so that the butt ends and whip ends alternate giving a more uniform shape to the bundle. The cuttings are then secured with twine every 12 to 18 inches. The bundles are then secured to the bank with stakes (live stakes are preferred if available).

Fascines are installed by digging shallow trenches along the streambank contour beginning at the base of the bank. The trench should be at least eight inches deep and dug no more than one hour before planting. Water the trench just before and after planting to help prevent drying. The fascines are then placed in the trench with each bundle overlapping the next by a few inches. Stakes spaced at one-foot intervals are driven through the bundles to secure them with extra stakes at the joints. The fascines are then covered with soil excavated from the trench. The soil should be worked into the voids in the bundle to provide a growing medium for root development. The stakes should protrude at least six inches above the bundle. Trenches should be spaced at least three feet apart proceeding up the bank.

3.3. East Branch Management Measure Milestones by Subwatershed and Aggregate for Watershed as a Whole

Stream restoration in the East Branch Codorus Creek watershed should be undertaken using a watershed approach and natural channel design principles. The logical sequence of restoration efforts would be to begin with the severely impaired reaches in the upper watershed and proceed downstream as funding becomes available. As other contributing drainages enter the main stem, consideration should be given to using the same approach in each subwatershed. Information from the prioritized assessment should be used to identify stream reaches for restoration. Important to any restoration effort is the participation of the private landowners. Without the necessary approvals, the desired restoration cannot proceed.

There are some reaches of streams in the watershed which are very unstable and have been documented to be migrating at an accelerated rate. It may be necessary to consider these reaches for restoration early, regardless of the location in the watershed, especially where there may be an imminent threat to safety or property. Another critical aspect of restoration is the funding. The longer, impaired stream reaches (especially on the larger streams) will require detailed designs, permitting approvals from the regulatory agencies, and, most likely, the use of heavy excavating equipment. The initial restoration phases for the East Branch Codorus Creek watershed has targeted the identified, severely impaired reaches.

There are also many moderately impaired reaches of stream which could be stabilized through manual corrective measures, especially along the smaller drainage courses using the BMPs developed for the project. The removal of debris jams that are causing stream instabilities is an example of restoration or enhancement that can be done by volunteers from various sportsmen or watershed-based groups that collectively can contribute to the overall watershed restoration efforts.

The York Chapter of the Izaak Walton League of America has developed various partnerships for the restoration of the East Branch Codorus Creek. These partnerships can be formed with various government agencies, corporate sponsors, and non-profit groups and include the donation of materials, equipment, supplies, and volunteer labor. The donation of various resources can also be used as matching funds and/or services for various restoration funding programs to maximize funding opportunities. To date through Phase IV restoration, the York Chapter of the Izaak Walton League has secured in-kind restoration funding from project partners valued at over $144,000. These partners include the Pennsylvania Department of Transportation ($92,640), the York Water Company $50,000 and the Pennsylvania Fish and Boat Commission ($2,000). York County Parks has also completed two habitat improvement project within Spring Valley Park with the Pennsylvania Fish and Boat Commission. Nixon County Park has also completed small bank stabilization and habitat improvement projects on the Nixon Park Tributary. These projects incorporated many of the Best Management Practices recommended in this report.

In addition to IWLA volunteers who have expressed an interest in assisting with restoration planting and post-construction monitoring, the Yorktown Senior Environmental Corps has expressed an interest in assisting with post-construction monitoring of future restoration sites.

The IWLA is planning to provide the necessary training to this group for long-term monitoring and in the future may include biological assessments at restoration sites both pre- and post-construction.

There are many funding programs available for stream restoration projects. Information on these programs can be obtained by contacting the PA DEP's Regional Watershed Coordinator or by contacting the Watershed Specialist through the York County Conservation District. These agencies can direct potential project sponsors to various funding sources which can provide plant materials, streambank fencing, and other restoration resources.

3.3.1. Watershed Restoration Efforts: Existing and Planned

Demonstration Project EBCC-024 (Phase I)

Based on the watershed assessment, a stream reach in the watershed was selected for restoration and will serve as a demonstration for the Best Management Practices discussed above. The restoration/demonstration project was selected based on the degree of impairment, landowner participation and budgeted construction funding. The demonstration project selected for restoration is Reach EBCC-024, on the Henry and Janice Brown property. Reach EBCC-024 is approximately 1,400 feet in length and has a drainage area of approximately 22 square miles. The reach has severe bank erosion and channel migration in the upper portion of the reach which was previously a sheep and horse pasture. The lower reach becomes more stable with a good riparian buffer but lacks aquatic habitat. Restoration of this reach included several of the BMPs previously discussed.

East Branch Codorus Creek Watershed Restoration, Phase II

Under the Pennsylvania Environmental Stewardship and Watershed Protection Program (Growing Greener), the IWLA York Chapter #67 received funding to complete the design, permitting and construction of 650 feet of stream restoration on reach EBCC-26. On August 26, 2002 the restoration was completed. The project is located in a cattle pasture with severe bank erosion and channel migration and no riparian vegetation. The right bank was migrating towards S.R. 216 and the channel was eroding around the Ridgeview Road bridge abutment. The Pennsylvania Department of Transportation (PennDOT) partnered with the York Chapter of the Izaak Walton League to complete the restoration work. Through this partnership, PennDOT built the construction entrance and provided other in-kind contributions valued at over $12,000. The project was used as a demonstration for a construction workshop related to stream restoration and involved bank grading and the installation of several in-stream rock structures to protect the roadway and bridge abutment and to provide habitat. The entire reach was fenced from livestock and planted with riparian vegetation.

East Branch Codorus Creek Watershed Restoration, Phase III

Phase III restoration funding has been provided by the Pennsylvania Department of Environmental Protection through the Environmental Protection Agency's Section 319 Non-Point Source Management Program. The funding will be used to survey, design, permit, construct and revegetate approximately 12,000 continuous feet of severely impaired stream reaches. The project includes approximately 7,400 feet of Seaks Run and 4,300 feet of the East Branch Codorus Creek and includes the stabilization of roadways along stream banks. In-kind funding matches for Phase III include the Pennsylvania Department of Transportation ($65,640), York Water Company ($25,000) and the Pennsylvania Fish and Boat Commission ($2,000). Survey, design and permitting were begun in Spring 2005, and construction is scheduled to be complete by Summer 2007.

East Branch Codorus Creek Watershed Restoration, Phase IV

York Chapter 67 of the Izaak Walton League received funding from the Pennsylvania Department of Environmental Protection through the Environmental Protection Agency's Section 319 Non-Point Source Management Program to complete restoration of Phase IV. This restoration phase includes two assessed stream reaches (EBCC-18 & 19) which are located within Spring Valley Park. The length of impaired reach included in Phase 4 is approximately 4,400 feet. The York Water Company has committed and in-kind funding match of $25,000. Restoration work for Phase IV is scheduled to begin in Summer 2007 and be completed later that year.

Future Restoration Efforts and Permit Amendments

The first watershed based permit for the restoration/demonstration project for EBCC-024 will serve as a template for all future minor permit amendments for restoration work in the EBCC watershed. The regional hydraulic curve developed for the watershed will be used in all future project designs. The Izaak Walton League, through its consultant, has and will continue to use the information from the watershed assessment to pursue funding for the restoration of high priority sites. Additional detailed information to be included in future permit amendments will include the following.

- Detailed project description
- Detailed site survey and design (cross sections, profiles, pebble counts, reference reach data)
- Landowner permission form
- PNDI clearance
- PHMC clearance
- York County Conservation District approval (E&S)
- Construction details and sequences
- Design report
- As-built mark ups of cross sections and profiles

East Branch restoration and protection milestones are given by subwatershed and aggregate for the watershed as a whole below (table 3-2).

Table 3-2. East Branch Watershed Goals and Management Measure Milestones by Subwatershed and Aggregate for Watershed as a Whole

Location No.	Stream Name	Reach_ID	Linear Feet (LF)	Riparian Forest Buffers (RFB)	Livestock Crossing (LSC)	Stream Bank Fencing (SBF)	Nutrient Management Plan (NMP)	Stormwater Management (SWM)	Fluvial Geomorphic Restoration (FGM	Wetlands Restoration (WLP)	Total
62	Barshinger Creek	BC06/BC05/BC04	1575	1	0	0	0	1	0	0	2
63	Barshinger Creek	BC08	1260	1	0	1	0	0	0	0	2
64	Barshinger Creek	BC11	2450	1	0	1	0	0	0	0	2
65	Barshinger Creek	BC12/BC13/BC14	3300	1	1	1	1	0	0	0	4
66	Barshinger Creek	BC15/BC16/BC17	3400	1	0	0	0	0	0	0	1
67	Barshinger Creek	BC18/BC19/BC20/BC21	2820	1	1	1	1	0	0	0	4
68	Blymire Hollow Trib	BHT07	1400	1	0	0	0	0	0	0	1
69	Blymire Hollow Trib	BHT503-FILL	200	1	0	0	0	0	0	0	1
70	Blymire Hollow Trib	BHT504	820	1	0	0	0	0	0	0	1
71	Barshinger Creek	DBT09/10/11/12/13	3000	1	0	1	1	0	0	0	3
72	East Branch Codorus Creek	EB25	2075	1	1	1	1	0	0	0	4
73	Hametown Trib	HT05/HT04	1900	1	0	0	0	0	0	0	1
74	Inners Creek	IC10	1100	1	0	0	0	0	0	0	1
75	Inners Creek	IC1101	1185	1	0	0	1	0	0	0	2
76	Inners Creek	IC13/IC12	1180	1	0	0	0	0	0	0	1
77	Inners Creek	IC17	3650	1	0	1	0	0	0	0	2
78	Inners Creek	IC203/IC05/IC06	1025	1	0	0	0	0	0	0	1
79	Inners Creek	IC601	450	1	0	0	1	0	0	0	2
80	Nixon Park Trib	NPT1103/1102	1090	1	0	0	0	0	0	0	1
81	Nixon Park Trib	NPT15/NPT14	1900	1	1	1	1	0	0	0	4
82	Nixon Park Trib	NPT18/NPT17/EB	3670	1	0	0	0	0	0	0	1
83	Ridgeview Road Trib	RRT03/RRT04/RRT05	3350	1	1	1	1	0	0	0	4
		TOTALS	42800	22	5	9	8	1	0	0	45

3.3.2. Monitoring

Upon completion of the restoration projects, as-built markups of cross sections and profiles will be provided. At a minimum, post-construction monitoring will be completed at least once each year. Each restoration project will have monumented cross sections that will be installed during project design. These cross-section locations will be used to monitor stream improvements by comparing pre-construction conditions with the post-construction as-built cross sections. Future restoration projects may also include pre- and post-construction biologic monitoring to measure improvements to the aquatic community.

3.3.3. Stream Restoration Costs

As mentioned throughout the report, the IWLA intends to use a natural channel design approach for all stream restoration. Information collected during the watershed assessment will be used in all restoration design. A regional hydraulic geometry curve has been established for the East Branch Codorus Creek watershed. This information will be important in the design process to determine the appropriate channel geometry. Where required, reference reaches will be used to determine appropriate stream patterns. A general watershed permit was also issued (E67-704) which will provide for more timely permit application reviews for all future restoration projects. All of this information and completed work efforts will result in some long term cost savings as it relates to stream restoration.

Due to the extent of stream impairment in the East Branch watershed, it is difficult to develop a detailed cost estimate for restoration. Each restoration project will need to be approached individually and restoration costs will vary depending on numerous factors including the following:

- Stream size;
- Extent of restoration required (bank stabilization vs. total reconstruction);
- Accessibility;
- Presence of utilities;
- Adjacent land use constraints (structures, roads, etc.); and
- In-kind donation of funding or services.

An approximate restoration cost for all severely impaired stream reaches (Priority 1) in the East Branch watershed was developed using the information from the watershed assessment and is shown on Table 3-3. The costs presented are approximate and are based on 2002 costs with no escalation. The unit costs per foot provided are based on both actual EBCC restoration costs to date and estimates based on stream size. The unit costs for the larger streams are naturally higher due to additional earthwork, increased volume of materials (primarily rock), larger in-stream structures, and larger riparian zone establishment. As illustrated, the estimated cost for construction is approximately $2,000,000. Additional costs include development of site plans, designs, preparation of permit applications, and construction management. Construction management by a trained restoration specialist is important to the success of any project. For cost estimating purposes, these costs were assumed to be 60% of the construction cost. The total cost to restore the severely impaired stream reaches (survey, design, permit, and construct) is estimated to be $3,560,000 or approximately $52.42/ft.

Table 3-3 also shows the restoration funding implemented to date and also funding secured and/or applied for under the Growing Greener program for restoration work in the East Branch watershed. To date, approximately $67,000 has been spent on restoration and $700,000 in grant funding has been awarded for future restoration phases which encompass over 16,500 feet or over three miles of severely impaired stream reaches.

By using the watershed approach and targeting the severely impaired stream reaches, other moderately impaired stream reaches may become stable on their own. By stabilizing these stream reaches first, accelerated bank erosion will be substantially reduced and may allow for proper stream adjustments downstream through a reduction in sediment load (bank erosion) and improved sediment transport.

Table 3-3. East Branch Priority Stream Restoration Costs (2002).

Reach	Ranking	Length	Construction Unit $/ft.	Construction Cost	Design/Permit Cost	Total Project Cost	Funding Secured	In-Kind Match	Project Completed
EBCC-24*	1	1385	$40.00	$55,400.00	$33,240.00	$88,640.00			$42,000
EBCC-26 (1)	2	650	$40.00	$26,000.00	$13,000.00	$39,000.00		$12,700.00	$24,888
SR-10&SR-12	3	7400	$25.00	$185,000.00	$92,500.00	$277,500.00	$226,903	$70,688.00	
EBCC-21 & 23	4	4827	$40.00	$193,080.00	$115,848.00	$308,928.00	$266,907	$21,952.00	
EBCC-18&19	6	3092	$40.00	$123,680.00	$74,208.00	$197,888.00	$204,820	$25,000.00	
EBCC-26 (2)	7	728	$40.00	$29,120.00	$17,472.00	$46,592.00			
DVT-801&702	8	2541	$35.00	$88,935.00	$53,361.00	$142,296.00			
DVT-06, 09&10	9	4175	$35.00	$146,125.00	$87,675.00	$233,800.00			
DVT-401&DVT402	10	2682	$30.00	$80,460.00	$48,276.00	$128,736.00			
IC-17	11	3188	$40.00	$127,520.00	$76,512.00	$204,032.00			
SR-06	12	1104	$25.00	$27,600.00	$16,560.00	$44,160.00			
SR-401&SR-402	13	1172	$30.00	$35,160.00	$21,096.00	$56,256.00			
SR-202	14	2646	$25.00	$66,150.00	$39,690.00	$105,840.00			
SR-401&SR-402	15	1267	$25.00	$31,675.00	$19,005.00	$50,680.00			
EBCC-1001	16	1702	$30.00	$51,060.00	$30,636.00	$81,696.00			
EBCC-1003 & 1004	17	1830	$30.00	$54,900.00	$32,940.00	$87,840.00			
EBCC-1101,1102,110	18	2771	$30.00	$83,130.00	$49,878.00	$133,008.00			
EBCC-1109 &1110	19	1087	$30.00	$32,610.00	$19,566.00	$52,176.00			
WBST-03	20	1974	$32.00	$63,168.00	$37,900.80	$101,068.80			
WBNT-08	21	1301	$45.00	$58,545.00	$35,127.00	$93,672.00			
GRT-04 & 05	22	1975	$45.00	$88,875.00	$53,325.00	$142,200.00			
GRT-11	23	1316	$25.00	$32,900.00	$19,740.00	$52,640.00			
BC-501 & 504	24	1032	$25.00	$25,800.00	$15,480.00	$41,280.00			
BC-101, 102 & 04	25	1711	$28.00	$47,908.00	$28,744.80	$76,652.80			
BC-08	26	811	$35.00	$28,385.00	$17,031.00	$45,416.00			
BC-12 & 13	27	1506	$30.00	$45,180.00	$27,108.00	$72,288.00			
BC-17	28	1747	$30.00	$52,410.00	$31,446.00	$83,856.00			
IC-07	29	1306	$35.00	$45,710.00	$27,426.00	$73,136.00			
EBCC-30	30	2934	$45.00	$132,030.00	$79,218.00	$211,248.00			
Remaining reaches		6052	$30.00	$181,560.00	$108,936.00	$290,496.00			
Total		67912		$2,240,076.00	$1,322,945.60	$3,563,021.60	$ 698,630	$130,340.00	

** Project served as a demonstration and budget was included in with the watershed assessment*

3.4. South Branch Management Measure Milestones by Subwatershed and Aggregate for Watershed as a Whole

Stream restoration in the South Branch Codorus Creek watershed should be undertaken using a watershed approach and natural stream channel design principles. The logical sequence of restoration efforts would be to begin with severely impaired reaches in the upper watershed and proceed downstream as funding becomes available. As other contributing drainages enter the stream corridor, consideration should be given to using the same approach in each subwatershed. Information from prioritized assessments should be used to identify stream reaches for restoration. Important to any restoration effort is the participation of private landowners. Without the necessary approvals, the desired restoration cannot proceed.

There are some reaches of streams in the watershed that are very unstable and have been documented to be migrating at accelerated rates. It may be necessary to consider these reaches for restoration early, regardless of the location in the watershed, especially where there may be an imminent threat to safety or property. Another critical aspect of restoration is the funding. The longer, impaired stream reaches (especially on the larger streams) will require detailed designs and permitting approvals from the regulatory agencies and most likely the use of heavy excavating equipment. Additionally, beginning in 2005 the cost of petroleum products increased dramatically driving up associated costs of equipment operation, materials, transportation, etc. These increased costs are forecast to continue al least through 2008 and possibly beyond.

There are also many moderately impaired reaches of stream that could be stabilized through manual corrective measures, especially along the smaller drainage courses using the Best Management Practices (BMPs) described in this plan. For example, the removal of large woody debris jams on streams is an example of passive restoration that can be done by private landowners, volunteers and municipalities.

The Izaak Walton League of America's York Chapter has developed various partnerships for the restoration of the South Branch Codorus Creek. These partnerships can be formed with various government agencies, corporate sponsors, and nonprofit groups. The partnership with these resources can result in the donation of materials, equipment, supplies, and volunteer labor. These partnerships and donations of various resources can also be used as matching funds and services for various restoration funding programs to maximize funding opportunities.

In addition to IWLA volunteers who have expressed an interest in assisting with restoration planting and post-construction monitoring, the York County Senior Environment Corps has expressed an interest in assisting with post-construction monitoring of future restoration sites. The IWLA is planning to provide the necessary training to this group for long-term monitoring and in the future may include biological assessments at restoration sites, both pre- and post-construction.

There are many funding programs available for stream restoration projects. Information on these programs can be obtained by contacting the PADEP's Regional Watershed Coordinator (717-705-4906) or the York County Conservation District's Watershed Specialist (717-840-7430). These agencies can direct potential sponsors to various funding sources which can provide plant materials, streambank fencing, and other restoration resources.

3.4.1. Watershed Restoration Efforts: Existing and Planned

<u>Demonstration Projects SBCC-10-1 and SBCC-09</u>

Based on the watershed assessment, a stream reach in the watershed was selected for restoration will serve as a demonstration for the Best Management Practices discussed above. The restoration demonstration project was selected based on the degree of impairment, landowner participation and budgeted construction funding. The demonstration projects selected for restoration are reaches SBCC-10-1 and SBCC-09.

SBCC 10-1

Reach SBCC 10-1 is approximately 720 feet in length and begins at S.R. 616 bridge near the intersection of Glen Valley Road. The project reach has a drainage area of approximately 3.2 square miles. The downstream limit of the restoration project is at a large debris jam that will be removed as part of the restoration effort. The project reach has a very limited riparian corridor but becomes stable downstream where a forested buffer is well established.

The stream reach is a C4-type, which was assessed as being severely impaired. The reach has severe bank erosion and channel migration. The property owner of this site stated that the stream has migrated approximately 40 feet over the last 15 years. Three meander bends have short radii of curvature, which contributes to channel instability. The steep or vertical banks (up to three feet in height) are unstable and will continue to erode until stabilized. Muskrats have also burrowed into these banks, which is contributing to further bank erosion.

Restoration of this reach will include several of the BMPs previously discussed. The existing channel alignment will be maintained except in the vicinity of the meanders. Approximately 80 feet of the new natural channel will be constructed between the second and third meander due to the short radius of curvature and improper stream alignment. At the three meanders, the radius of curvature will be lengthened which will allow for a more gradual sweep around the meanders. Information used in the design for the new channel was collected from a stable reference reach located immediately downstream of the demonstration project. In-stream rock structures (i.e., rock vanes, cross-rock vanes, and J-hook vanes) and root wads will be used to help stabilize the streambanks and provide aquatic habitat. These structures will also provide better sediment transport through the restoration site. The restoration plan will establish a riparian buffer along the stream corridor.

SBCC-09

This site is located upstream of SBCC 10-1 and is approximately 100 feet in length. The site is located immediately downstream of the railroad bridge underpass near Railroad Borough. The project consists of an eroded right bank that is migrating. Restoration of this reach will consist of constructing several in-stream rock structures along the right bank. The existing channel alignment will be maintained. Riparian plantings will also be installed to provide a buffer and help stabilize the banks.

Stream Restoration Workshop

Through a partnership developed with the U.S. Fish and Wildlife Service, the Izaak Walton League of America's York Chapter #67 received a grant to sponsor a stream restoration workshop June 22-24, 2000, at the club's compound, near Dallastown. Seventeen people attended the workshop which provided an introduction to watershed assessment, planning and restoration principles. The first day of the workshop involved an introduction to watershed assessments, characteristics and functions of stream corridors, an overview of the South Branch Codorus Creek project, and project planning (i.e., scheduling, permitting, budgeting, and monitoring). At the end of the day, a tour of the watershed took place. The tour included a visit to the planned watershed demonstration project (SBCC 10-1 and SBCC-09), future planned restoration projects, a dam removal project, and a small stream restoration project in Nixon County Park, where natural channel design principles were implemented.

The second day of the workshop focused on restoration project design. An introduction into soil bioengineering techniques was provided. The workshop participants then divided into four groups to complete a restoration project design. Each group was assigned a section of stream through the League's property. The teams then collected information from their assigned reaches and used this information to develop a restoration plan. Each team then had to develop site plans and make presentations to the rest of the audience on their respective designs. The designs included plans, cross-sections, sketches, and planting plans. Each presentation was then critiqued by the other teams and workshop instructors.

Concurrent with the workshop was the installation of two rock vanes in the East Branch Codorus Creek on the League's property. The Pennsylvania Fish and Boat Commission's Adopt-a-Stream Program funded this bank stabilization project. These in-stream structures are BMPs that will be used for future restoration projects. The workshop participants had the opportunity to observe the installation and learn how these structures provide bank stabilization.

The last day of the workshop involved instruction on revegetating restoration sites. The instruction included the harvesting of native plant materials, tools, and planting procedures. Containerized plants were also installed as part of the planting effort.

South Branch Codorus Creek Restoration Phase I

Under the Pennsylvania Environmental Stewardship and Watershed Protection Program (Growing Greener), the IWLA-York applied for restoration funding based on the completed watershed assessment. On April 18, 2000, the League received funding under the program to collect additional information and begin stream restoration efforts in the watershed. Based on the preliminary results of the watershed assessment, three priority 1 (i.e., severely impaired) stream reaches were selected for design, permitting and restoration: SBCC-07, SBCC-015, and SBCC-026. Collectively, these three sites represent approximately 4,000 feet of restoration. Sites SBCC-015 and SBCC-026 are the reaches where severe bank erosion and channel migration were documented. The restoration design and permitting of these sites were completed successfully. The post-construction monitoring of these sites will document the measurable environmental benefits of the restoration.

On August 11, 2000, the IWLA-York submitted a funding request for the design, permitting and restoration of an additional 4,300 feet of severely impaired stream. Under this funding request, the League formed a partnership with the Pennsylvania Department of Transportation (PennDOT) District 8 Maintenance Group to restore streams along state roads in the watershed. The District 8 Maintenance Unit committed to providing materials, equipment and traffic control for restoration projects adjacent to state roads.

Seitzville Dam Removal

Acting on behalf of a watershed landowner, the IWAL-York Chapter sponsored the removal of the Seitzville Dam, with funding provided by the PFBC. As the sponsor, the Chapter was involved in commenting on the demolition plans, contractor selection, and construction oversight. This involvement resulted in the League being able to suggest slight modifications to the demolition plans. The suggested modifications allowed for a more natural channel design consistent with restoration BMPs which also provided the desired goal of fish passage. The League's members monitored bank erosion rates upstream of the dam.

Future Restoration Efforts

The first watershed-based permit for the demonstration of restoration projects for SBCC 10-1 will serve as a template for all future minor permit amendments for the restoration work in the SBCC watershed. The regional hydraulic curve developed for the watershed will be used in all future project designs. The IWLA-York, CCWA, and other stakeholder groups will be using the information from the watershed assessment to purse funding for the restoration of high priority sites. Additional detailed information to be included in future permit amendments will include the following:

- Detailed project description
- Detailed site survey (cross-sections, profiles, pebble counts, reference reach data, etc.)
- Landowner permission form
- PNDI clearance
- PHMC clearance
- Erosion & Sediment Control Plan approval
- Construction details and sequences
- Design report
- As-built plans

South Branch restoration and protection milestones are given by subwatershed and aggregate for the watershed as a whole below (table 3-4).

Table 3-4. South Branch Watershed Goals and Management Measure Milestones by Subwatershed and Aggregate for Watershed as a Whole

Location No.	Stream Name	Reach_ID	Linear Feet (LF)	Riparian Forest Buffers (RFB)	Livestock Crossing (LSC)	Stream Bank Fencing (SBF)	Nutrient Management Plan (NMP)	Stormwater Management (SWM)	Fluvial Geomorphic Restoration (FGM	Wetlands Restoration (WLP)	Total
84	Brush Valley Trib	BRVT09	2560	1	0	0	0	0	0	0	1
85	Buffalo Valley Trib	BUVT02	380	1	1	1	1	0	0	0	4
86	Buffalo Valley Trib	BUVT03/04	1850	1	1	1	1	0	0	0	4
87	Buffalo Valley Trib	BUVT04	1070	1	1	1	1	0	0	0	4
88	Buffalo Valley Trib	BUVT04	955	1	1	1	1	0	0	0	4
89	Buffalo Valley Trib	BUVT04	445	1	1	1	1	0	0	0	4
90	Centerville Creek	CC12	760	1	0	0	0	0	0	0	1
91	Centerville Creek	CC12/CC11	1078	1	0	0	0	0	0	0	1
92	Centerville Creek	CC16/CC17	5250	1	0	0	0	0	0	1	2
93	Centerville Creek	CC18/CC17/CC16	680	1	0	0	0	1	0	0	2
94	Centerville Creek	CC605/CC606/CC607	2000	1	0	0	0	0	0	0	1
95	Centerville Creek	CC701	1000	1	0	1	1	0	0	0	3
97	Fischel Creek	FIC05	1565	1	0	1	0	0	0	0	2
98	Fischel Creek	FIC01	2090	1	0	1	1	0	0	0	3
99	Fischel Creek	FIC02	1360	1	0	0	0	0	0	0	1
100	Fischel Creek	FIC08	1260	1	0	0	0	0	0	0	1
101	Fischel Creek	FIC1003	400	1	0	0	0	0	0	0	1
102	Fischel Creek	FIC1101	1930	1	0	1	0	0	1	0	3
103	Fischel Creek	FIC1201/FIC13	1150	1	0	1	0	0	0	0	2
104	Foust Creek	FOC02/FOC01	1010	1	1	1	1	0	1	0	5
105	Foust Creek	FOC04	780	1	0	1	1	0	0	0	3
106	Foust Creek	FOC07/FOC06	1732	1	0	0	0	0	0	0	1
107	Foust Creek	FOC09/FOC08	2415	1	0	0	0	0	0	0	1
108	Foust Creek	FOC10	1440	1	0	0	0	1	0	0	2
109	Glen Rock Valley Tribs	GRVT03	1660	1	1	1	1	0	0	0	4
110	Glen Rock Valley Tribs	GRVT03	1720	1	1	1	1	0	0	0	4
111	Glen Rock Valley Tribs	GRVT06	1050	1	1	1	1	0	0	0	4
112	Glen Rock Valley Tribs	GRVT206	1300	1	0	0	0	0	0	0	1
113	Glen Rock Valley Tribs	GRVT209/208/GRVT03	1070	1	1	1	1	0	0	0	4
114	Glen Rock Valley Tribs	GRVT501	1270	1	1	1	1	0	1	0	5
115	Hanover Junction Trib	HJT03/HJT04	990	1	0	0	0	0	0	0	1
116	Hanover Junction Trib	HJT05	1575	1	0	0	0	0	0	0	1
117	Hunderford Trib	HuT05	1500	1	0	0	0	0	0	0	1
118	Krebs Valley Trib	KVT0[7]	1850	1	0	0	0	0	0	0	1
119	Krebs Valley Trib	KVT0[9]	2160	1	0	0	0	0	0	0	1

120	Krebs Valley Trib	KVT01	3150	1	0	0	0	0	0	0	1
121	Krebs Valley Trib	KVT04	1480	1	0	0	0	0	0	0	1
122	Krebs Valley Trib	KVT04	2730	1	0	0	0	0	0	0	1
123	Krebs Valley Trib	KVT401	0	0	0	0	0	0	1	0	1
124	Krebs Valley Trib	KVT601/KVT602	3870	1	0	1	1	0	0	0	3
125	New Freedom Church Trib	NFCT04	1000	1	0	0	1	0	0	0	2
126	New Freedom Church Trib	NFCT05	1040	1	1	1	1	0	0	0	4
127	New Salem Trib	NST101/NST02	1885	1	0	0	0	1	0	0	2
128	New Salem Trib	NST301	1000	1	0	1	1	0	0	0	3
129	New Salem Trib	NST502/NST601	780	1	0	0	0	0	0	0	1
130	New Salem Trib	NST703	1070	1	0	0	0	0	0	0	1
131	Pierceville Run	PR02	500	1	0	0	0	0	0	0	1
132	Pierceville Run	PR05/PR06	2000	1	0	0	0	0	0	0	1
133	Pierceville Run	PR12	3280	1	0	0	0	0	0	0	1
134	Pierceville Run	PR3E	850	1	0	0	0	0	0	0	1
135	Pierceville Run	PR502	1000	1	1	1	1	0	0	0	4
136	Pierceville Run	PR601	515	1	0	0	0	0	0	0	1
137	South Branch Codorus Creek	SB1601	1100	1	0	1	1	0	1	0	4
138	South Branch Codorus Creek	SB17	400	1	0	0	0	0	0	0	1
139	South Branch Codorus Creek	SB27	2650	1	0	0	0	0	0	0	1
140	South Branch Codorus Creek	SB28/SB29	8625	1	0	0	0	0	0	0	1
141	South Branch Codorus Creek	SB31	1150	1	0	0	0	0	0	0	1
142	South Branch Codorus Creek	SB36/SB34	1745	1	0	0	0	0	0	1	2
143	South Branch Codorus Creek	SBCC41	1460	1	1	1	1	0	0	0	4
144	South Branch Codorus Creek	SBCC42	3440	1	0	0	0	0	0	0	1
145	Seven Valleys North Trib	SVNT06/SVNT05	1478	1	0	0	0	0	0	0	1
146	Seven Valleys North Trib	SVNT102/SVNT101	500	1	0	1	0	0	0	0	2
147	Seven Valleys South Trib	SVST08/SVST07	1650	1	0	0	0	0	0	0	1
148	Seven Valleys South Trib	SVST11/SVST12	950	1	0	0	0	0	0	0	1
149	Trout Run (South)	TR05	1350	1	0	0	0	0	0	0	1
150	Trout Run (South)	TR06	1640	1	1	1	1	0	0	0	4
151	Trout Run (South)	TR07	1700	1	0	0	0	0	0	0	1
152	Trout Run (South)	TR08	910	1	0	1	0	0	0	0	2
153	Trout Run (South)	TR201/TR202	1500	1	1	1	1	0	0	0	4
154	Trout Run (South)	TR301	775	1	0	0	1	0	0	0	2
155	Travis Trib	TT103	3200	1	0	0	0	0	0	0	1
156	Travis Trib	TT106/TT105/TT104	2320	1	0	1	1	0	0	0	3
157	Wangs Trib	WT01	2560	1	0	1	0	0	0	0	2
158	Wangs Trib	WT02	2110	1	0	0	0	0	0	0	1
		TOTALS	120668	73	16	29	25	3	5	2	153

3.4.2. Monitoring

Upon completion of the restoration projects, as-built markups of cross sections and profiles will be provided. At a minimum, post-construction monitoring will be completed at least once each year. Each restoration project will have monumented cross sections which will be installed during project design. These cross-section locations will be used to monitor stream improvements by comparing pre-construction conditions with the post-construction as-built cross sections. Future restoration projects may also include pre- and post-construction biologic monitoring to measure improvements to the aquatic community.

3.4.3. Stream Restoration Costs

As mentioned throughout the report, the IWLA intends to use a natural channel design approach for all stream restoration. Information collected during the watershed assessment will be used in all restoration design. A regional hydraulic geometry curve has been established for the South Branch Codorus Creek watershed. This information will be important in the design process to determine the appropriate channel geometry. Where required, reference reaches will be used to determine appropriate stream patterns. A general watershed permit was also issued which will provide for more timely permit application reviews for all future restoration projects. All of this information and completed work efforts will result in some long term cost savings as it relates to stream restoration.

Due to the magnitude and extent of stream impairment in the South Branch watershed, it is difficult to develop a detailed cost estimate for restoration. Each restoration project will need to be approached individually and restoration costs will vary depending on numerous factors including the following:

- Stream size;
- Extent of restoration required (bank stabilization vs. total reconstruction);
- Accessibility;
- Presence of utilities;
- Adjacent land use constraints (structures, roads, etc.); and
- In-kind donation of funding or services.

An approximate restoration cost for all severely impaired stream reaches (Priority 1) in the South Branch watershed was developed using the information from the watershed assessment and is given in table 3-9 to 3-16 of section 3.6 of funding, construction and maintenance activities. The costs presented are approximate and are based on 2006 costs with no escalation. The unit costs per foot provided are based on both actual restoration costs to date and estimates based on stream size. The unit costs for the larger streams are naturally higher due to additional earthwork, increased volume of materials (primarily rock), larger in-stream structures, and larger riparian zone establishment. Additional costs include development of site plans, designs, preparation of permit applications, and construction management. Construction management by a trained restoration specialist is important to the success of any project. For cost estimating purposes, these costs were assumed to be 60% of the construction cost. The total cost to restore the identified severely impaired stream reaches (restore the identified severely impaired stream reaches) including survey, design, permit, and construct is estimated to be approximately $150 per linear foot of rural streambank restored and $250 per linear foot of urban streambank restored, or higher.

By using the watershed approach and targeting the severely impaired stream reaches, other moderately impaired stream reaches may become stable on their own. By stabilizing these stream reaches first, accelerated bank erosion will be substantially reduced and may allow for proper stream adjustments downstream through a reduction in sediment load (bank erosion) and improved sediment transport.

3.4.4. Conclusions and Recommendations

Over 66 miles or 45% of streams in the SBCC watershed are impaired, with over 10 miles being severely impaired. The primary source of impairment appears to be bank erosion. Many of the streams assessed have tremendous sediment loading in the form of gravel and silt. During the watershed assessment, there were no real overland flow nonpoint sources of sediment pollution documented. Although many of the streams in the watershed flow through cropland and pasture, it does not appear that these land uses caused the impairment. Many stream reaches were identified as being impaired where agricultural land use was not present, especially where there is no woody riparian vegetation. The majority of the impacts to the SBCC may have started over 100 years ago with land clearing activities especially along the riparian zone. With increasing development over the last 50 to 60 years, the streams never had a chance to stabilize. With ever-increasing development, especially in the upper watershed, stormwater was immediately discharged to the watershed’s streams causing bank erosion, channel downcutting, and lateral migration.

The gradual migration of a stream across a valley floor is a natural process and on stable streams can move several feet over long periods of time (200 years or more). With increased sediment loadings, the accretion of material on the point bar gradually pushes the convex bank into the channel causing the concave bank to erode. According to Leopold (1979), the rate of channel shifting is related to the rate which bedload is being transported in the reach.

The SBCC and its tributaries have high levels of gravel bedload and existing bank erosion is a considerable source of the bedload. Due to the high bedload of the streams, lateral stream migration has been greatly accelerated. During the watershed assessment, landowners have reported channel migration of up to 40 feet over a 15-year period. A review of historical aerial photographs between 1947 and 1971 (prior to Hurricane Agnes flooding, 1972) indicates channel migration up to 80 feet in some locations. During the SBCC watershed assessment, bank erosion over three feet has been documented in ten months along severely impaired reaches.

The amount of documented soil loss at the two bank erosion monitoring locations varied between 0.45 and 0.50 tons of soil per square-foot of streambank in less than a year. Using a conservative average soil loss value of 0.40 tons per foot of streambank per year for the identified severely impaired stream reaches (i.e., 54,366 feet), the annual soil loss due to bank erosion would be approximately 22,000 tons per year or an average of 60 tons per day. There are another 295,395 feet of streams in the watershed which have been identified as being moderately impaired. Using an average soil loss value of 0.20 tons per foot of streambank per year, the total annual soil loss due to bank erosion would be around 59,000 tons per year. Without considering any soil erosion associated with the stream reaches assessed as being slightly impaired to stable reaches (i.e., 426,907 feet), the cumulative annual soil loss along the severely to moderately impaired stream reaches is estimated at 81,000 tons per year or an average of 222 tons per day. This erosion and sedimentation further accelerates bank erosion downstream as the channels attempt to adjust.

Stormwater management regulations promulgated in the mid-1970's contributed to the reduction of flood flow and subsequent impacts to the watershed's streams. A change in agricultural practices also improved soil loss from cropland areas with the implementation of contour planting and no-till practices. During the field assessment, there was no evidence of overland erosion noted in the watershed. Many agricultural livestock operations in the watershed however continue to allow grazing along streambanks, which continues to hinder the ability of the stream to adjust to a stable condition. As mentioned previously, the existing eroded banks are a significant source of sediment in the watershed. With the streambanks eroded near vertical and with high sediment supply in the watershed, the streams will continue to erode and migrate. These bank conditions are also prone to erosion over the winter months as the exposed soil freezes and thaws. This condition is noticeable shortly after snowfall where eroded soils cover any snowfall at the base of the streambanks. Likewise, these soils are prone to wind erosion due to the exposed steeply sloping conditions.

The key to restoring the streams in the watershed is to stabilize streambanks, restore the proper channel dimension, pattern and profile, and establish woody riparian zones along the streams. Streambank stabilization and the establishment of riparian buffers will help reduce the amount of sediment in the South Branch Codorus Creek. This in turn will reduce the channel's need to compensate or adjust further downstream.

3.5. West Branch Management Measure Milestones by Subwatershed and Aggregate for Watershed as a Whole

Over the last several years, tremendous interest has been generated in restoring Codorus Creek. The updated water treatment technology being implemented by Glatfelter is an important first step in the overall stream restoration plan for Codorus Creek. Glatfelter (P.H. Glatfelter Company) was established in 1864 and is a major employer in York County producing wood pulp for paper production. The process of making pulp requires the use of large volumes of water from the Codorus which is returned with a brown tannin color. In

1994 Glatfelter began improving their discharge by substantially reducing chlorine used to bleach the pulp. In 2003, Glatfelter invested in additional pollution prevention technologies in the manufacturing process which removed the tannin coloration. As of October 2003, the majority of the treatment systems were on-line with the remainder expected to be completed by the January 2004.

Due to the size of the Codorus Creek watershed and the degree of impairment it would be advantageous to plan and manage watershed restoration efforts concurrently throughout the subwatersheds with various partners and stakeholders. The Watershed Alliance of York (WAY) was established in 2001 to encourage watershed planning, restoration, and protection through locally led conservation, education and stewardship initiatives in York County. WAY is ideally suited to take a lead role in assisting with the organization of restoration in the Codorus watershed including funding procurement, education, and monitoring. Additionally, the Codorus Implementation Committee (CIC), formed in the 1970's to address creek issues, was revitalized in 2006 to assist with coordinating Codorus Creek Watershed Restoration planning, restoration and protection between and among local governing entities, nonprofit organizations, watershed groups, and other stakeholders.

3.5.1. Watershed Restoration Efforts: Existing and Planned

Stream restoration work is underway in the South and East Branch Codorus Creek watersheds. Several aquatic habitat projects have also been completed in the HQ-CWF section of the upper watershed by the Codorus Chapter of Trout Unlimited. The Chapter also sponsored the preparation of a Rivers Conservation Plan. With this plan being finalized, other restoration funding is available through the Pennsylvania Department of Conservation and Natural Resources (DCNR).

Numerous public and academic interest groups have become established to continue restoration. In addition to actual stream cleanup and other implementation projects, volunteers are playing a major role in watershed education and monitoring.

Phase I Restoration

The CCWA received a Growing Greener grant to survey, design, permit, and construct the first restoration project in the watershed. This Phase I project is reach OC-11 & 12 in Oil Creek watershed and includes restoration of approximately 4,000 feet of severely impaired stream through a cattle pasture. This project will include total channel reconstruction using natural channel design principles. This project will be used as a demonstration for other property owners in the watershed.

Water Resources Development Feasibility Studies Sections #206 and #1135

The U.S. Army Corp of Engineers (ACOE) has invested in the Codorus Creek watershed by providing funding for two restoration-related projects. The first project is the Codorus Ecosystem Restoration Project (Section 206), which involves the feasibility, biological assessment, and preliminary design for identified habitat restoration projects. Using the results of the South and East Branch Codorus watershed assessments, and the preliminary assessment results of this project, the ACOE and their consultants are completing biologic assessment of identified impaired stream reaches, and will be preparing feasibility studies and conceptual designs. This project is being sponsored by York County, which provided 30% matching funds and/or services towards the project.

The second project funded by the ACOE is the York Restoration Project (Section 1135) that focuses on the ecological restoration of the existing 4.9-mile flood control channel through York. A feasibility study is being completed that will consider improvement through channel modifications to improve habitat, aesthetics, and recreation. Although it will be important to maintain flood control capacity, the project will examine the feasibility of environmental modifications. The project sought public input in mid November 2003 and got underway, but is currently on hold due to a freeze on ACOE funding. The Corps (through their consultant) also provided funding to complete Phase III of the watershed assessment (Indian Rock Dam to the Susquehanna River). The Army Corps of Engineers will continue to be an important partner over the next several years.

Future Restoration Planning

Due to the degree of impairment with over 42 miles of severely impaired streams it is difficult to develop a detailed plan. Many restoration projects can be completed concurrently and throughout different areas in the watershed. For example, stabilization or habitat improvement projects with riparian plantings could be considered concurrently. By having multiple restoration partnerships and project sponsors overall watershed restoration can be maximized. It is recommended that following watershed partners continue or begin various restoration plans concurrently in the watershed:

- Izaak Walton League of America - York Chapter 67
- Codorus Chapter Trout Unlimited
- Codorus Creek Watershed Association

Stream restoration along severely impaired reaches will require heavy equipment and detailed surveying, planning and permitting. The restoration planning should be undertaken using a watershed approach. This approach generally requires beginning in the upper watershed, subwatersheds and/or tributaries and working downstream. Although a watershed approach is recommended (upstream to downstream), it may be necessary to consider some reaches earlier in the restoration plan regardless of the location in the watershed, especially where there may be an imminent threat to safety or property. Another critical aspect of restoration is available funding. Information from the prioritized assessment should be used to identify stream reaches for restoration. Early restoration efforts should concentrate on the Priority 1 (severely impaired) reaches in each project subwatershed. A list of severely impaired stream reaches is provided on Table 3-5. By addressing the severely impaired reaches first, there is a high probability that some of the moderately impaired reaches can recover on their own, especially with riparian planting efforts.

Table 3-5. West Branch Watershed Goals and Management Measure Milestones by Subwatershed and Aggregate for Watershed as a Whole

Location No.	Stream Name	Reach_ID	Linear Feet (LF)	Riparian Forest Buffers (RFB)	Livestock Crossing (LSC)	Stream Bank Fencing (SBF)	Nutrient Management Plan (NMP)	Stormwater Management (SWM)	Fluvial Geomorphic Restoration (FGM	Wetlands Restoration (WLP)	Total
1	Codorus Creek	CC22	500	1	0	0	0	0	0	0	1
2	Codorus Creek	CC24	850	1	0	0	0	0	0	0	1
3	Codorus Creek	CC2504	620	1	0	0	0	0	0	0	1
4	Codorus Creek	CC26/CC25	2500	1	0	1	1	0	0	0	3
5	UNT Codorus Creek	CC2602	850	1	0	0	0	0	0	0	1
6	UNT Codorus Creek	CC2701	1500	1	0	0	0	0	0	0	1
7	UNT Codorus Creek	CC2705	1090	1	0	0	0	0	0	0	1
8	Codorus Creek	CC2805	1280	1	0	0	0	0	0	0	1
9	Dee Run	DRT101	460	1	0	0	0	0	0	0	1
10	Dee Run	DRT201	640	1	0	0	0	0	0	0	1
11	Dee Run	DRT301	1175	1	0	0	0	0	0	0	1
12	Emigsville Tributary	ET101	500	1	0	0	0	0	0	0	1
13	Emigsville Tributary	ET502/503/501	1240	1	0	0	0	0	0	0	1
14	Emigsville Tributary	ET607	780	1	0	0	0	0	0	0	1
15	Emigsville Tributary	ET608	735	1	0	0	0	0	0	0	1
16	Emigsville Tributary	ET701	1030	1	0	0	0	0	0	0	1
17	Leaders Heights Trib	LH01	900	1	0	0	0	0	0	0	1
18	Leaders Heights Trib	LH03/LH101	2650	1	0	0	0	0	0	0	1
19	Leaders Heights Trib	LH07/LH401	4480	1	0	0	0	0	0	0	1
20	Lightners School Trib	LST03	1900	1	0	0	0	0	0	0	1
21	Lightners School Trib	LST04	1225	1	0	0	0	0	0	0	1
22	Lightners School Trib	LST05/LST04	4250	1	0	0	0	0	0	0	1
23	Lightners School Trib	LST105	800	1	0	0	0	1	0	0	2
24	Lightners School Trib	LST201	1267	1	0	0	0	1	0	0	2
25	Lincolnway Trib	LWT301/LWT04/LWT05	2280	1	0	0	0	0	0	0	1
26	Mill Creek	MC02/MC03/MC04	1960	1	0	0	0	1	0	0	2
27	Mill Creek	MC09	2600	1	0	0	0	0	0	0	1
28	Mill Creek	MC10	1165	1	0	0	0	0	0	0	1
29	Mill Creek	MC1002	1100	1	0	0	0	0	0	0	1
30	Mill Creek	MC1003	1500	1	0	0	0	0	0	0	1
31	Mill Creek	MC1006	3700	1	0	0	1	1	1	0	4
32	Mill Creek	MC1101	1180	1	0	0	0	0	0	0	1
33	Mill Creek	MC1201	1500	1	0	0	0	0	0	0	1
34	Mill Creek	MC13/MC12	1470	1	0	0	0	0	0	0	1
35	Mill Creek	MC1512	500	1	0	0	0	0	0	0	1
36	Mill Creek	MC1601	420	1	0	0	0	0	1	0	2
37	Mill Creek	MC19	1660	1	0	0	0	0	0	0	1
38	Mill Creek	MC1901	1733	1	0	0	0	0	1	0	2
39	Mill Creek	MC21	0	0	0	0	0	1	0	0	1
40	Mill Creek	MC22	2600	1	0	0	0	0	0	0	1
41	Mill Creek	MC23	1000	1	0	0	0	1	0	0	2
42	Mill Creek	MC2606	1255	1	0	0	0	1	0	0	2
43	Mill Creek	MC2611	1260	1	0	0	0	1	0	0	2
44	Mill Creek	MC2805	1445	1	0	0	0	0	0	0	1

45	Mill Creek	MC2805	0	0	0	0	0	1	0	0	1
46	Mill Creek	MC304	1030	1	0	0	0	0	0	0	1
47	Mill Creek	MC3601	460	1	0	0	0	0	0	0	1
48	Mill Creek	MC3901	0	0	0	0	0	1	0	0	1
49	Mill Creek	MC402	1000	1	0	0	0	0	0	0	1
50	Mill Creek	MC502/MC501	2025	1	0	0	0	0	0	0	1
51	Starview Trib	SVT01	700	1	0	0	0	0	0	0	1
52	Tyler Run	VH04/VH03	675	1	0	0	0	0	0	0	1
53	Tyler Run	VH08	1400	1	0	0	0	0	0	0	1
54	Tyler Run	VH14	1730	1	0	0	0	0	0	0	1
55	Tyler Run	VH401	500	1	0	0	0	0	0	0	1
56	Tyler Run	VH501	2210	1	0	0	0	0	0	0	1
57	Tyler Run	VH802	780	1	0	0	0	0	0	0	1
58	Willis Run	WR01	1500	1	0	0	1	1	0	0	3
59	Willis Run	WR05	1500	1	0	0	0	0	0	0	1
60	Willis Run	WR07	2420	1	0	0	0	0	0	0	1
61	Willis Run	WR301	2020	1	0	0	0	0	0	0	1
159	Bunch Creek	BC05	1250	1	0	1	0	0	0	0	2
160	Bunch Creek	BC301	750	1	0	1	1	0	1	0	4
161	Codorus Creek	CC05	540	1	0	0	0	0	0	0	1
162	Codorus Creek	CC101	1620	1	1	1	1	0	1	0	5
163	UNT Codorus Creek	CC1302	800	1	0	0	0	0	0	0	1
164	Hawksbill Pond Trib	CC1502	4000	1	1	1	1	0	0	0	4
165	Hawksbill Pond Trib	CC1503	0	0	0	0	0	0	0	1	1
166	Hawksbill Pond Trib	CC1503/1504	3135	1	0	0	0	0	0	0	1
167	Hawksbill Pond Trib	CC1601	1875	1	1	1	1	0	1	0	5
168	Hawksbill Pond Trib	CC1604/1603/1602	2565	1	1	1	1	0	1	0	5
169	Hawksbill Pond Trib	CC1606/1605	4270	1	0	0	0	0	0	0	1
170	Codorus Creek	CC201	1000	1	0	0	0	0	0	0	1
171	Codorus Creek	CC401	800	1	0	0	0	0	0	0	1
172	Furnace Creek	FC02	550	1	0	0	0	0	0	0	1
173	Furnace Creek	FC03	314	1	0	0	0	0	0	0	1
174	Furnace Creek	FC04	735	1	0	0	0	0	0	0	1
175	Furnace Creek	FC07/FC06(D/S)	2700	1	0	0	0	0	0	0	1
176	Furnace Creek	FC08/FC801	2525	1	0	1	1	0	0	0	3
177	Furnace Creek	FC10	888	1	0	0	0	0	0	0	1
178	Furnace Creek	FC1002/FC09	590	1	0	0	0	0	0	0	1
179	Furnace Creek	FC1101(D/S)	380	1	0	0	0	0	0	0	1
180	Furnace Creek	FC1202	530	1	0	0	0	0	0	0	1
181	Furnace Creek	FC701	1690	1	1	1	1	0	0	0	4
182	Furnace Creek	FC703	540	1	0	0	0	0	0	0	1
183	Lischy Church Trib	LCT02	2460	1	0	0	0	0	0	0	1
184	Lischy Church Trib	LCT04/LCT03	950	1	0	1	1	0	0	0	3
185	Lischy Church Trib	LCT05	500	1	0	1	1	0	0	0	3
186	Lischy Church Trib	LCT201	625	1	0	0	0	0	0	0	1
187	Long Run	LR01	0	0	0	0	1	0	1	0	2
188	Long Run	LR03	280	1	0	0	0	0	0	0	1
189	Long Run	LR04/LR102	2080	1	1	1	1	0	0	0	4
190	Long Run	LR06	500	1	0	0	0	0	0	0	1
191	Long Run	LR07	500	1	0	0	0	0	0	0	1
192	Long Run	LR09	700	1	0	0	0	0	0	0	1
193	Long Run	LR10	1550	1	0	0	0	0	0	0	1
194	Long Run	LR11	805	1	0	0	0	0	0	0	1
195	Long Run	LR2301 (D/S)	600	1	0	0	0	0	0	0	1
196	Long Run	LR2303	800	1	0	0	0	0	0	0	1

197	Long Run	LR2501 (D/S)	1400	1	0	0	0	0	0	0	1
198	Long Run	LR2701	1260	1	0	0	0	0	0	0	1
199	Long Run	LR2801	630	1	0	0	0	0	0	0	1
200	Long Run	LR2901/LR2902	1360	1	0	0	0	0	0	0	1
201	Long Run	LR3201 (U/S)	750	1	0	0	0	0	0	0	1
202	Long Run	LR3202	1350	1	0	1	1	0	0	0	3
203	Long Run	LR3302	560	1	0	0	0	0	0	0	1
204	Long Run	LR3601	270	1	0	0	0	0	0	0	1
205	Long Run	LR401	1500	1	0	0	0	1	1	0	3
206	Long Run	LR502	900	1	0	0	0	0	0	0	1
207	Long Run	LR503	2050	1	0	0	1	0	0	0	2
208	Long Run	LR902/LR1001	1670	1	0	0	0	0	0	0	1
209	Lehman Trib	LT01	1570	1	0	1	0	0	1	0	3
210	Lehman Trib	LT06/LT05/LT04	1700	1	1	1	1	0	0	0	4
211	Lehman Trib	LT201	500	1	0	1	1	0	1	0	4
212	Nashville Trib	NA02	500	1	0	0	0	0	0	0	1
213	Nashville Trib	NA03	3025	1	0	0	1	1	0	0	3
214	Nashville Trib	NA04	1280	1	0	1	0	0	0	0	2
215	Nashville Trib	NA05	3180	1	0	1	1	0	0	0	3
216	Oil Creek	OC19	2650	1	0	0	0	0	0	0	1
217	Old Paths Trib	OPT04	600	1	0	0	0	0	0	0	1
218	Old Paths Trib	OPT1001	2000	1	1	1	1	1	0	0	5
219	Porters Sidling Trib	PC01	975	1	0	0	0	0	1	0	2
220	Porters Sidling Trib	PC03/PC101	2180	1	0	0	0	0	0	0	1
221	Porters Sidling Trib	PC04/PC201	1650	1	0	0	0	0	0	0	1
222	Porters Sidling Trib	PC05	750	1	0	0	0	0	0	0	1
223	Porters Sidling Trib	PC06	2000	1	0	0	0	0	0	0	1
224	Porters Sidling Trib	PC08	780	1	1	1	1	0	0	0	4
225	Porters Sidling Trib	PC09	500	1	1	1	1	0	0	0	4
226	Porters Sidling Trib	PC10	650	1	0	0	0	0	0	0	1
227	Porters Sidling Trib	PC401	1700	1	1	1	1	0	1	0	5
228	Prospect Hill Trib	PHT01	1480	1	0	1	1	0	0	0	3
229	Prospect Hill Trib	PHT03	500	1	0	0	0	0	0	0	1
230	Prospect Hill Trib	PHT05	750	1	0	0	1	0	0	0	2
231	Spring Grove Trib	SG03	2280	1	0	0	1	1	0	0	3
232	Spring Grove Trib	SGR01	380	1	0	0	0	0	0	0	1
233	Spring Grove Trib	SGR03	1155	1	0	0	0	0	0	0	1
234	Swimming Pool Trib	SPT07/SPT08	1725	1	1	1	1	0	0	0	4
235	Swimming Pool Trib	SPT201	790	1	0	1	1	0	1	0	4
236	Swimming Pool Trib	SPT501	1200	1	0	1	0	0	0	0	2
237	Sunnyside Trib	SS02	350	1	0	0	1	0	0	0	2
238	Sunnyside Trib	SS02	1200	1	0	0	1	0	0	0	2
239	Stoverstown Branch	ST01	1840	1	0	0	0	0	0	0	1
240	Stoverstown Branch	ST02/ST03/ST04	2685	1	0	0	1	1	0	0	3
241	Stoverstown Branch	ST03ST103	2280	1	0	0	0	0	0	0	1
242	Stoverstown Branch	ST04	1390	1	0	0	0	0	0	1	2
243	Stoverstown Branch	ST05(GOLF)	1950	1	0	0	1	1	0	0	3
244	Stoverstown Branch	ST09	640	1	0	0	0	0	0	0	1
245	Stoverstown Branch	ST10	875	1	1	1	0	0	0	0	3
246	Stoverstown Branch	ST11	1650	1	0	0	1	0	0	0	2
247	Stoverstown Branch	ST204/ST205/ST203	1350	1	0	0	1	1	0	0	3
248	Stoverstown Branch	ST501	0	0	0	0	0	0	1	0	1
249	Stoverstown Branch	ST702/ST703	1160	1	0	0	0	0	0	0	1
250	Upper Codorus Creek	UCC03	500	1	1	1	1	0	0	0	4
251	Upper Codorus Creek	UCC04	390	1	1	1	1	0	0	0	4

252	Upper Codorus Creek	UCC06	500	1	1	1	1	0	0	0	4
253	Upper Codorus Creek	UCC08	1150	1	0	0	0	0	0	0	1
254	Upper Codorus Creek	UCC10	750	1	0	0	0	0	0	0	1
255	Upper Codorus Creek	UCC1003/UCC1002	800	1	0	0	0	0	0	0	1
256	Upper Codorus Creek	UCC1004	1785	1	0	0	0	0	0	0	1
257	Upper Codorus Creek	UCC11	3600	1	0	0	0	0	0	0	1
258	Upper Codorus Creek	UCC1201	780	1	0	0	0	0	0	0	1
259	Upper Codorus Creek	UCC14/UCC13/UCC12	1900	1	0	0	0	0	0	0	1
260	Upper Codorus Creek	UCC1402	1600	1	0	0	1	0	0	0	2
261	Upper Codorus Creek	UCC1403	1470	1	0	1	0	0	0	0	2
262	Upper Codorus Creek	UCC15	1550	1	0	0	0	0	0	0	1
263	Upper Codorus Creek	UCC1602	990	1	1	1	1	0	0	0	4
264	Upper Codorus Creek	UCC17/UCC16/UCC18	2850	1	0	0	0	0	0	0	1
265	Upper Codorus Creek	UCC1701/1702	950	1	1	1	1	0	0	0	4
266	Upper Codorus Creek	UCC1801	225	1	0	1	1	0	0	0	3
267	Upper Codorus Creek	UCC1801	735	1	0	1	1	0	0	0	3
268	Upper Codorus Creek	UCC1801(U/S)	950	1	0	1	1	0	0	0	3
269	Upper Codorus Creek	UCC1802	650	1	0	0	0	0	0	0	1
270	Upper Codorus Creek	UCC1803	1105	1	0	0	0	0	0	0	1
271	Upper Codorus Creek	UCC1804	1130	1	1	1	1	0	0	0	4
272	Upper Codorus Creek	UCC1805	1700	1	0	0	0	0	0	0	1
273	Upper Codorus Creek	UCC19/UCC18	1750	1	0	0	0	0	0	0	1
274	Upper Codorus Creek	UCC20	575	1	1	0	0	0	0	0	2
275	Upper Codorus Creek	UCC201	600	1	1	1	1	0	0	0	4
276	Upper Codorus Creek	UCC21	0	0	1	1	0	0	0	0	2
277	Upper Codorus Creek	UCC21/UCC3402	1450	1	0	0	0	0	0	0	1
278	Upper Codorus Creek	UCC22//UCC23	1320	1	0	0	0	0	0	0	1
279	Upper Codorus Creek	UCC2301	1350	1	0	0	0	0	0	0	1
280	Upper Codorus Creek	UCC2901	350	1	1	1	1	0	0	0	4
281	Upper Codorus Creek	UCC3002	750	1	0	0	1	0	0	0	2
282	Upper Codorus Creek	UCC3003	1350	1	0	0	0	0	0	0	1
283	Upper Codorus Creek	UCC302/UCC301	1540	1	1	1	1	0	0	0	4
284	Upper Codorus Creek	UCC3301	600	1	0	0	1	0	0	0	2
285	Upper Codorus Creek	UCC3301	775	1	0	0	1	0	0	0	2
286	Upper Codorus Creek	UCC3301	475	1	0	0	1	0	1	0	3
287	Upper Codorus Creek	UCC3401	600	1	0	1	1	0	1	0	4
288	Upper Codorus Creek	UCC3703	700	1	0	1	0	0	0	0	2
289	Upper Codorus Creek	UCC3704	1300	1	1	1	1	0	0	0	4
290	Upper Codorus Creek	UCC3705	1700	1	1	1	1	0	0	0	4
291	Upper Codorus Creek	UCC3706	720	1	1	1	1	0	0	0	4
292	Upper Codorus Creek	UCC3902	1100	1	1	1	1	0	0	0	4
293	Upper Codorus Creek	UCC401	825	1	0	1	1	0	0	0	3
294	Upper Codorus Creek	UCC601	800	1	0	0	0	0	0	0	1
295	Upper Codorus Creek	UCC701	1120	1	0	0	0	0	0	0	1
296	Upper Codorus Creek	UCC801	2400	1	0	1	1	0	0	0	3
297	Upper Codorus Creek	UCC902	500	1	0	0	0	1	0	0	2
298	West Branch Codorus Creek	WBCC02	700	1	0	0	0	0	0	0	1
299	West Branch Codorus Creek	WBCC03	2140	1	0	1	0	0	0	0	2
300	West Branch Codorus Creek	WBCC04	1380	1	0	0	0	0	0	0	1
301	West Branch Codorus Creek	WBCC07	1250	1	0	1	1	0	0	0	3
302	West Branch Codorus Creek	WBCC08	860	1	0	0	0	0	0	1	2
303	West Branch Codorus Creek	WBCC09	2500	1	0	0	0	0	0	0	1
304	West Branch Codorus Creek	WBCC1001	400	1	0	0	0	0	0	0	1
305	West Branch Codorus Creek	WBCC1201	677	1	0	0	0	0	0	0	1

306	West Branch Codorus Creek	WBCC1302	790	1	0	0	0	0	0	0	1
307	West Branch Codorus Creek	WBCC1501	830	1	0	0	0	0	0	0	1
308	West Branch Codorus Creek	WBCC1902	0	0	0	0	0	0	0	1	1
309	West Branch Codorus Creek	WBCC201	1700	1	0	1	0	0	0	0	2
310	West Branch Codorus Creek	WBCC202	1670	1	1	1	1	0	0	0	4
311	West Branch Codorus Creek	WBCC203	500	1	0	1	1	0	0	0	3
312	West Branch Codorus Creek	WBCC2501	500	1	0	0	0	1	0	0	2
313	West Branch Codorus Creek	WBCC2701	500	1	0	0	1	0	0	0	2
314	West Branch Codorus Creek	WBCC2901	950	1	0	1	1	0	0	0	3
315	West Branch Codorus Creek	WBCC301	2775	1	1	1	1	0	0	0	4
316	West Branch Codorus Creek	WBCC801	560	1	0	0	0	0	0	1	2
		TOTAL	272809	211	30	56	65	20	17	5	404

Where stream restoration partnering opportunities exist (matching funds or services), consideration should be given to pursuing these projects early in long term planning to maximize restoration funding. Important to any restoration effort is the participation of the private landowners. Without the necessary approvals, the desired restoration cannot proceed.

A natural channel design approach based on fluvial geomorphic principles is highly recommended for all major stream restoration projects where conditions permit. A natural channel design provides stream bank/channel stability, improves sediment transport, and enhances aquatic habitat. These design principles often require the installation of in-stream rock and log structures that dramatically increase stream recovery.

As part of the Codorus Creek field assessments, four reference surveys were completed to verify the regional hydraulic curve developed. The regional hydraulic curve is important in restoration design, and should be utilized as a tool in preparing restoration design.

Where possible, any stream restoration work should connect the watershed streams to the floodplain to provide both floodplain attenuation and energy dissipation. This could be achieved either by raising the stream channel elevation or lowering the floodplain elevation. Additional study and coordination with landowners and regulatory agencies would need to occur to determine the feasibility of modifying floodplains. This of course can only be considered where there is no threat of structural damage from flooding.

Major stream restoration projects will require the preparation of a Joint Permit Application requiring PA Department of Environmental Protection and U.S. Army Corp of Engineer authorizations. This first permit application to be submitted for the Phase I restoration project (OC-11&12) on Oil Creek will be a multi-phase restoration application and include the information presented in this report. The PA DEP Southcentral Regional Office promotes this approach, which simplifies and expedites the Joint Permit Application review and processing. The application will include much of the information included in this Watershed Assessment Report. In addition to detailed site-specific environmental information and design plans, this first permit application will include:

- Summary of the reaches of stream requiring restoration

- Map showing the location of the reaches
- Types of restoration techniques being proposed

Information on various Best Management Practices (BMPs) recommended for restoration work in the watershed is included previously. Although each restoration project will require detailed site-specific information, the multi-phase permitting approach will expedite future permit application reviews, and only requires a one-time permit application fee.

The CCWA and other watershed partners should use the information from the Watershed Assessment to pursue funding for the restoration of high priority sites. Additional detailed information to be included in future project permitting will include the following:

- Environmental Assessment Form
- General information Form
- Detailed project description
- Detailed site survey and design (cross sections, profiles, pebble counts, reference reach data)
- Landowner permission form
- Pennsylvania Natural Diversity Index (PNDI) clearance (endangered species)
- Pennsylvania Historical and Museum Commission (PHMC) clearance (historic and/or archaeological resources)
- York County Conservation District approval (E&S)
- Construction details and sequences
- Design report
- As-built mark ups of cross sections and profiles

Realizing that this construction approach to stream restoration (natural channel design) may involve field adjustments, especially with the construction of in-stream bank stabilization/habitat structures, the PA DEP has requested as-built cross sections for all phases of restoration work completed under the Permit. This additional information has been requested as a special condition to the permit.

3.5.2. Monitoring

Upon completion of the restoration projects, as-built markups of cross sections and profiles will be provided. At a minimum, post-construction monitoring will be completed at least once each year. Each restoration project will have monumented cross sections which will be installed during project design. These cross-section locations will be used to monitor stream improvements by comparing pre-construction conditions with the post-construction as-built cross sections. Future restoration projects may also include pre- and post-construction biologic monitoring to measure improvements to the aquatic community.

3.5.3. Stream Restoration Costs

As mentioned throughout the West Branch Assessment report, the IWLA, CCWA and others intend to use a natural channel design approach for all stream restoration. Information collected during the watershed assessment will be used in all restoration design. A regional hydraulic geometry curve has been established for the West Branch Codorus Creek watershed. This information will be important in the design process to determine the appropriate channel geometry. Where required, reference reaches will be used to determine appropriate stream patterns. A general watershed permit needs to be issued, which will provide for more timely permit application reviews for all future restoration projects. All of this information and completed work efforts will result in some long term cost savings as it relates to stream restoration.

Due to the magnitude and extent of stream impairment in the West Branch watershed, it is difficult to develop a detailed cost estimate for restoration. Each restoration project will need to be approached individually and restoration costs will vary depending on numerous factors including the following:

- Stream size;
- Extent of restoration required (bank stabilization vs. total reconstruction);
- Accessibility;
- Presence of utilities;
- Adjacent land use constraints (structures, roads, etc.); and
- In-kind donation of funding or services.

An approximate restoration cost for all severely impaired stream reaches (Priority 1) in the West Branch watershed was developed using the information from the watershed assessment and is given in table 3-9 to 3-16 of section 3.6 of funding, construction and maintenance activities. The costs presented are approximate and are based on 2006 costs with no escalation. The unit costs per foot provided are based on both actual restoration costs to date and estimates based on stream size. The unit costs for the larger streams are naturally higher due to additional earthwork, increased volume of materials (primarily rock), larger in-stream structures, and larger riparian zone establishment. Additional costs include development of site plans, designs, preparation of permit applications, and construction management. Construction management by a trained restoration specialist is important to the success of any project. For cost estimating purposes, these costs were assumed to be 60% of the construction cost. The total cost to restore the identified severely impaired stream reaches (restore the identified severely impaired stream reaches) including survey, design, permit, and construct is estimated to be approximately $150 per linear foot of rural streambank restored and $250 per linear foot of urban streambank restored, or higher.

By using the watershed approach and targeting the severely impaired stream reaches, other moderately impaired stream reaches may become stable on their own. By stabilizing these stream reaches first, accelerated bank erosion will be substantially reduced and may allow for proper stream adjustments downstream through a reduction in sediment load (bank erosion) and improved sediment transport.

3.5.4. Conclusions and Recommendations

Following are 16 general recommendations to guide future planning, restoration and protection efforts in the West Branch Codorus Creek Watershed. These recommendations involve everything from public education and outreach to institutional controls, and implementation of nonstructural and structural Best Management Practices. Additionally, partnerships will be necessary to fully implement all of these measures.

1. The CCWA should continue playing an active role in WAY, and volunteer efforts. It is suggested that all identified watershed partners maximize coordination of planning and restoration activities throughout the watershed.

2. Innovative stormwater management is as important to the health of streams as it is to the surrounding watershed (table 3-8). Among the most beneficial structural and non-structural BMPs are: porous pavement, wet detention/retention, wetland creation, preservation of vegetated areas, and site development that minimizes impervious areas. Since pollutant concentrations in developed watersheds run off during the earliest period of a rainfall event, any detention should be designed to catch and filter smaller storms. Since bankfull (channel-forming) flow varies from between 1.2-1.8 year return interval, release rates should be less than the 1-year flow of the receiving stream to minimize channel erosion. During the assessment, potential areas were noted that could be preserved and used to implement the aforementioned BMPs.

3. A native plant materials center should be considered in the watershed where native plants can be propagated or cuttings (willows and dogwoods) can be harvested by watershed partners and used on various restoration projects. The center could be established on public or private land easily accessible to restoration partners. Potential sites could include Glatfelter or York Water Company. These companies have large land holdings and are active project partners.

4. CCWA as well as other volunteer groups should complete restoration projects, including riparian plantings (table 3-6). Stream reaches in the watershed where streams are stable but have little or no riparian buffers should be a priority. The CCWA has planted five buffer projects and should pursue landowner contacts to begin potential riparian planting projects annually.

5. The reach of Codorus Creek between Spring Grove and Indian Rock dam is preserved for flood storage by the U.S. Army Corps of Engineers. In addition to flood storage, the active floodplain removes fine sediment from the stream. The area behind the dam is managed by the Pennsylvania Game Commission and is open to the public for recreation. The reach was assessed by canoe and provides a scenic canoe resource. The continued preservation of this area is important.

6. The long-term goal of restoring the Codorus will rely on continued planning and implementation within the subwatersheds. The York Chapter 67 of the Izaak Walton

should continue with their phased restoration approach on the South and East Branches by applying to various funding programs for restoration assistance.

7. It is recommended that CCWA continue pursuing restoration partnerships. The Codorus Chapter of Trout Unlimited (CCTU) has been very active in the upper Codorus Creek watershed and sponsored the development of a Rivers Conservation Plan. With an approved plan, additional funding may be available for implementing restoration. The Codorus Chapter was instrumental with landowner contact for the recently approved Phase I funding through the Growing Greener Program to restore 4,000 feet of Oil Creek. Projects in the Oil Creek watershed and will have a higher likelihood of restoration funding due to the recently approved Total Maximum Daily Load established for the watershed. The CCTU should continue with these efforts and take the lead in sponsoring restoration projects in the Upper Codorus Creek and Oil Creek watersheds.

8. The U.S. Army Corp of Engineers has completed biological assessments throughout Codorus Creek watershed and prioritized habitat restoration projects. CCWA and other watershed partners should continue coordination with the Army Corps to encourage good landowner relationships for potential habitat restoration projects. The Army Corps is also studying the feasibility of improving the flood control channel through York with respect to aesthetics and recreational use. Pending detailed hydraulic analysis, it is recommended that a low flow channel be considered to improve habitat and aesthetics as well as various recreational opportunities.

9. Natural channel design using fluvial geomorphic principles should be promoted for all stream stabilization and restoration activities. When properly applied, this design approach provides stream stability and improved habitat and sediment transport. Restoring proper channel geometry will reduce and possibly eliminate channel maintenance. The Pennsylvania Department of Transportation (PennDOT) has shown an early interest in implementing natural channel design considerations for bridge and stream bank stabilization projects along state roads in the East and South Branch Codorus watersheds. Partnerships should be developed with watershed municipalities to address stream stability issues. These partnerships and donation of various resources can also be used as matching funds and/or services for various restoration projects to maximize funding opportunities.

10. Many streams in the watershed have been bermed or have downcut and are no longer connected to their floodplain at bankfull flow. Where possible, restoration should include connecting the stream to the floodplain.

11. Nine bank erosion-monitoring locations have been established to monitor erosion rates in the watershed. At a minimum, it is recommended that these locations be surveyed once a year. An attempt should be made to monitor bank erosion rates on sites targeted for restoration. The existing and/or pre-construction erosion rates should be determined to demonstrate measurable environmental results. As stream restoration is completed it will be important to continue and expand monitoring

efforts to document success. Additional monitoring should include biologic and physical monitoring (pebble counts).

12. Due to the extent of livestock grazing in the watershed, many stream reaches could benefit from stream bank fencing (table 3-7) and riparian buffer planting. There are 25 miles of stream that flow through pastures and have unrestricted access to the stream. The Conservation Reserve Enhancement Program (CREP) administered by the United States Department of Agriculture, provides incentives for landowners to protect streams by taking these areas out of production. Coordination with these landowners and the USDA is suggested to identify potential projects.

13. There are six golf courses in the watershed. Most of the golf courses in the watershed have impaired streams. Many of theses streams could benefit from riparian planting while not restricting recreational use. The golf courses would also benefit through improved aesthetics and reduced maintenance costs associated with bank and channel maintenance. It is recommended that the CCWA coordinate with the different golf courses to consider changes in maintenance practices and installing riparian buffer plantings.

14. There are numerous large woody debris jams on Codorus Creek between Spring Grove and Indian Rock Dam. In order to improve canoe accessibility and safety, it is recommended that at least partial removal of these debris jams be considered with volunteer efforts.

15. York County Parks has pursued and continues to pursue aquatic habitat improvement projects throughout the watershed parks. They are currently working on an educational and stream signage program. It is suggested that County Parks continue with these efforts and coordinate future watershed restoration efforts through WAY.

16. There are over 3 miles of concrete channel in the Willis Run watershed. These channels provide little habitat value; however the water in these channels is prone to accelerated thermal warming during the summer months. It is recommended that riparian buffers be planted along these channels (where feasible) to reduce thermal impacts. A portion of one channel (WR-102) has formed a low flow channel and has a dense growth of watercress. The presence of the watercress provides macroinvertebrate habitat. The potential to modify these concrete channels with vegetation should be investigated.

Table 3-6. Stream Reaches Recommended for Riparian Planting

REACH ID	LENGTH (ft)	PRIORITY	SCORE
WR401	1869	1	8
CC16	3569	1	8
UCC05	1140	2	12
UCC302	1542	2	10
UCC401	1061	2	12
UCC902	1151	2	11
UCC1701	1177	2	10
UCC2501	771	2	10
UCC2406	1283	2	11
UCC3002	1378	2	12
PHT101	1125	2	12
LR202	1389	2	11
LR501	2265	2	10
LR601	1621	2	11
LR503	2508	2	10
LR902	3168	2	11
LR1003	924	2	11
WBCC1902	1162	2	10
WBCC2501	987	2	9
WBCC1701	1331	2	10
LR2701	1885	2	11
LR2501	3543	2	10
LR3801	766	2	10
LR3701	1368	2	12
LR3601	808	2	9
WR05	1500	2	9
VH301	824	2	11
VH04	961	2	10
VH601	1193	2	12
VH702	2096	2	10
VH901	607	2	10
VH1005	1146	2	12
VH1102	396	2	11
VH11	1294	2	11
VH13	1610	2	10
FC101	1362	2	11
FC01	1130	2	10
FC02	1679	2	11
FC04	1225	2	11
FC07	2930	2	11
FC602	1531	2	11
FC603	797	2	11
FC09	1404	2	10
FC903	544	2	10
FC1202	1420	2	10
OC09	1098	2	11
UCC12	1742	2	11
UCC3601	2028	2	12
UCC3703	1975	2	12
LR09	623	2	12
WBCC04	3411	2	12
LR1901	1626	2	12
OC502	882	2	10
CC1604	465	2	10
PC401	766	2	12
MC2901	623	2	9
VH14	1980	2	12
VH16	1183	2	10
FC03	1035	2	12
FC902	480	2	12
OC10	781	2	12
VH02	1331	3	13
VH902	824	3	13
ET604	1214	3	13
ET607	913	3	13
LT202	2471	3	13
CC901	1584	3	13
ST305	1906	3	13
OPT02	2920	3	14
OPT301	1404	3	14
OPT901	3342	3	13
NST09	1468	3	13
NST704	644	3	13
CC1203	2133	3	13
CC1504	1030	3	13
MC1301	2017	3	13
MC1601	1214	3	13
MC2603	1109	3	14
MC3301	1373	3	13
MC3304	1088	3	14
CC2503	1684	3	13
VH501	3115	3	13
VH701	1341	3	13
GR08	2872	3	14
MC1001	422	3	13
SVT101	887	3	13
LST01	1948	3	13
UCC06	3516	3	13
UCC2301	2793	3	13
UCC20	692	3	13
WBCC503	1183	3	13
VH101	1721	3	13

Table 3-6. Stream Reaches Recommended for Riparian Planting (continued)

OC703	1077	2	11
OC704	1251	2	11
OC1306	1030	2	12
OC1401	1874	2	9
ET11	2149	2	12
ET502	972	2	12
ET606	565	2	12
LT201	649	2	10
CC201	1098	2	9
SPT101	1246	2	11
ST03	2492	2	11
ST04	1779	2	9
ST07	422	2	11
ST102	1346	2	11
ST205	612	2	10
ST304	850	2	11
ST702	1299	2	11
LCT03	649	2	11
OPT201	1024	2	11
OPT902	618	2	12
NST303	708	2	12
NST04	1478	2	11
NST402	322	2	12
NST501	1299	2	12
NST502	1040	2	11
CC1202	570	2	11
MC2402	2244	2	10
MC1003	1716	2	11
MC1504	2080	2	12
DRT301	1283	2	12
MC16	1304	2	11
MC2805	2086	2	10
MC3203	359	2	9
MC3308	269	2	11
CC2501	3142	2	12
CC2602	1114	2	12
CC2803	1357	2	12
MC3801	222	2	10
MC3202	248	2	9
UCC1804	850	2	12
LR2801	1996	2	10
VH10	1980	2	12
CC1603	449	2	12
CC1606	2592	2	12
LST05	2038	2	11
LST201	3216	2	12
VH08	1394	3	13
BC04	6267	3	14
BC102	4910	3	13
ET303	1125	3	14
ST08	2202	3	15
ST601	2656	3	13
MC02	1816	3	14
LCT02	2556	3	13
OPT03	840	3	14
OPT101	528	3	15
MC10	1610	3	13
MC1516	333	3	14
MC2501	1674	3	14
MC18	1204	3	13
MC3306	913	3	13
CC2701	1478	3	13
SBCC40	5180	3	13
MC2606	1336	3	15
UCC04	391	3	14
LR1401	729	3	13
WBCC2601	618	3	14
VH201	1991	3	13
VH07	2006	3	13
GR07	3780	3	15
ET04	929	3	16
ET601	903	3	14
LT401	1088	3	15
CC04	834	3	15
ST02	834	3	15
ST11	2629	3	14
ST201	1030	3	13
ST401	982	3	16
OPT401	3606	3	16
NST701	1505	3	13
CC1503	3495	3	13
CC1601	1309	3	15
MC1002	1331	3	15
MC1101	1183	3	13
MC1201	1610	3	14
MC1503	1473	3	13
MC19	1257	3	15
MC4001	539	3	13
CC3201	634	3	13
MC3401	792	3	13
MC3501	723	3	15
LST03	1959	3	14
TOTAL	**52 miles**		

Table 3-7. Stream Reaches Recommended for Streambank Fencing

REACH ID	LENGTH(ft)	PRIORITY	SCORE
CC1502	3717	1	8
CC16	3569	1	8
CC1602	2144	1	6
CC701	2128	1	6
FC801	634	1	6
LH07	3168	1	8
LR04	1531	1	8
LR07	1151	1	8
LR102	512	1	8
LR3202	1737	1	8
LR801	1552	1	8
NA04	1431	1	8
NST05	401	1	8
NST301	1473	1	7
OC12	3411	1	6
OC15	2709	1	6
OC803	1943	1	7
OPT1001	2439	1	8
OPT903	945	1	8
PC01	702	1	6
PC201	1420	1	7
PHT05	1151	1	7
SBCC41	4990	1	8
SPT01	903	1	7
ST10	1225	1	8
ST703	1098	1	7
UCC08	840	1	6
UCC10	739	1	8
UCC1004	2239	1	7
UCC1803	1653	1	7
UCC201	1209	1	8
UCC22	1246	1	7
UCC2401	1531	1	6
UCC2403	1315	1	7
UCC3704	3348	1	5
WBCC07	1484	1	7
CC201	1098	2	9
LCT03	649	2	11
LR05	2012	2	10
LR1901	1626	2	12
LR202	1389	2	11
LR3302	1922	2	10
LT06	444	2	10
LT201	649	2	10
MC01	1800	2	10
MC1003	1716	2	11
NA05	4176	2	10
OC1401	1874	2	9
OC1502	1045	2	10
OC1901	238	2	10
OC805	1288	2	10
OPT201	1024	2	11
OPT904	1964	2	11
PC401	766	2	12
PHT01	697	2	10
PHT101	1125	2	12
SPT07	1320	2	11
SPT201	1030	2	11
SPT501	2529	2	10
ST03	2492	2	11
ST07	422	2	11
ST09	1410	2	12
ST203	576	2	9
ST702	1299	2	11
UCC1403	1478	2	10
UCC1602	1214	2	9
UCC1701	1177	2	10
UCC2501	771	2	10
UCC302	1542	2	10
UCC401	1061	2	12
UCC601	1088	2	10
WBCC03	2149	2	12
WBCC3201	1257	2	10
LR1401	729	3	13
MC1101	1183	3	13
SBCC42	10560	3	13
ST02	834	3	15
ST11	2629	3	14
TOTAL	**24.61 miles**		

Table 3-8. Stream Reaches Recommended for Stormwater Management

POTENTIAL REACHES FOR REGIONAL STORMWATER MANAGEMENT	
REACH	**MUNICIPALITY**
WBCC02	WEST MANHEIM
WR02	WEST MANCHESTER
WR301	MANCHESTER
SG02	SPRING GARDEN
SG03	SPRING GARDEN
SG04	YORK
VH902	YORK
VH802	YORK
VH801	YORK
VH1003	YORK
FC701	WEST MANHEIM
FC09	WEST MANHEIM
FC1002	WEST MANHEIM
FC1201	PENN
FC1202	PENN
FC1203	PENN
FC1301	PENN
CC1302	NEW SALEM
CC1307	NORTH CODORUS
MC701	YORK
MC2301	SPRING GARDEN
MC2101	YORK
MC2501	SPRING GARDEN
MC3602	SPRINGETTSBURY
CC2202	SPRINGETTSBURY
MC2606	SPRINGETTSBURY
LH04	YORK
MC2607	SPRINGETTSBURY
MC101	RED LION
MC101A	RED LION
MC101B	YORK
MC304	YORK
MC501	YORK
MC502	YORK
MC701	YORK

3.6. Funding, Construction and Maintenance Activities

Estimated costs of construction and maintenance activities for management measure developed to achieve goals are summarized by subwatershed and aggregated for watershed as a whole in tables 3-9 through 3-16. Construction costs are based on actual BMP unit costs obtained from the York County Conservation District in 2006. For planning purposes, maintenance costs are assumed to be 15% of the total project cost, for three years following construction.

Table 3-9. Estimated Costs of BMP Construction and Maintenance Activities by Subwatershed and Aggregated for Watershed as a Whole.

Selected Appropriate BMPs	BMP Sites	BMP Length (feet)	BMP Width (feet)	Total Area (SF)	Area Restored/ Protected (acres)	BMP Unit Cost (Dollars)	Total BMP Cost (Dollars)
Riparian Forest Buffer	306	436,277	70	30,539,390	701.09	$2,000	$1,402,176
Livestock Stream Crossing (LF)	51	5,100	16	81,600	1.87	$2.50	$204,000
Stream Bank Fencing (LF)	94	137,295	-	0	110.32	$2.00	$274,590
Nutrient Management Plan (ac)	98	139,735	100	13,973,500	320.79	$0.01	$9,620
Stormwater Management (LF)	24	1,200	70	84,000	1.93	$25	$2,100,000
FGM Stream Restoration (mi)	22	54,259	-	0	10.28	$150	$8,138,850
Wetlands Restoration (ac)	7	10,805	3,500	5,402,500	124.03	$1,225	$151,930
Totals	602	784,671	-	50,080,990	1270.31	-	$12,281,166

Table 3-10. Estimate Costs of Riparian Forest Buffer (RFB) Construction and Maintenance Activities by Subwatershed and Aggregated for Watershed as a Whole.

WS	Stream Name	Reach_ID	Length (LF)	Width (LF)	Total Area (SF)	Total Area (ac)	Unit Cost AC	Total Cost
CC	Codorus Creek	CC22	500	70	35000	0.80	$2,000	$1,607
CC	Codorus Creek	CC24	850	70	59500	1.37	$2,000	$2,732
CC	Codorus Creek	CC2504	620	70	43400	1.00	$2,000	$1,993
CC	Codorus Creek	CC26/CC25	2500	70	175000	4.02	$2,000	$8,035
CC	UNT Codorus Creek	CC2602	850	70	59500	1.37	$2,000	$2,732
CC	UNT Codorus Creek	CC2701	1500	70	105000	2.41	$2,000	$4,821
CC	UNT Codorus Creek	CC2705	1090	70	76300	1.75	$2,000	$3,503
CC	Codorus Creek	CC2805	1280	70	89600	2.06	$2,000	$4,114
CC	Dee Run	DRT101	460	70	32200	0.74	$2,000	$1,478
CC	Dee Run	DRT201	640	70	44800	1.03	$2,000	$2,057
CC	Dee Run	DRT301	1175	70	82250	1.89	$2,000	$3,776
CC	Emigsville Tributary	ET101	500	70	35000	0.80	$2,000	$1,607
CC	Emigsville Tributary	ET502/503/501	1240	70	86800	1.99	$2,000	$3,985
CC	Emigsville Tributary	ET607	780	70	54600	1.25	$2,000	$2,507
CC	Emigsville Tributary	ET608	735	70	51450	1.18	$2,000	$2,362
CC	Emigsville Tributary	ET701	1030	70	72100	1.66	$2,000	$3,310
CC	Leaders Heights Trib	LH01	900	70	63000	1.45	$2,000	$2,893
CC	Leaders Heights Trib	LH03/LH101	2650	70	185500	4.26	$2,000	$8,517
CC	Leaders Heights Trib	LH07/LH401	4480	70	313600	7.20	$2,000	$14,399

CC	Lightners School Trib	LST03	1900	70	133000	3.05	$2,000	$6,107
CC	Lightners School Trib	LST04	1225	70	85750	1.97	$2,000	$3,937
CC	Lightners School Trib	LST05/LST04	4250	70	297500	6.83	$2,000	$13,659
CC	Lightners School Trib	LST105	800	70	56000	1.29	$2,000	$2,571
CC	Lightners School Trib	LST201	1267	70	88690	2.04	$2,000	$4,072
CC	Lincolnway Trib	LWT301/LWT04/LWT05	2280	70	159600	3.66	$2,000	$7,328
CC	Mill Creek	MC02/MC03/MC04	1960	70	137200	3.15	$2,000	$6,299
CC	Mill Creek	MC09	2600	70	182000	4.18	$2,000	$8,356
CC	Mill Creek	MC10	1165	70	81550	1.87	$2,000	$3,744
CC	Mill Creek	MC1002	1100	70	77000	1.77	$2,000	$3,535
CC	Mill Creek	MC1003	1500	70	105000	2.41	$2,000	$4,821
CC	Mill Creek	MC1006	3700	70	259000	5.95	$2,000	$11,892
CC	Mill Creek	MC1101	1180	70	82600	1.90	$2,000	$3,792
CC	Mill Creek	MC1201	1500	70	105000	2.41	$2,000	$4,821
CC	Mill Creek	MC13/MC12	1470	70	102900	2.36	$2,000	$4,725
CC	Mill Creek	MC1512	500	70	35000	0.80	$2,000	$1,607
CC	Mill Creek	MC1601	420	70	29400	0.67	$2,000	$1,350
CC	Mill Creek	MC19	1660	70	116200	2.67	$2,000	$5,335
CC	Mill Creek	MC1901	1733	70	121310	2.78	$2,000	$5,570
CC	Mill Creek	MC22	2600	70	182000	4.18	$2,000	$8,356
CC	Mill Creek	MC23	1000	70	70000	1.61	$2,000	$3,214
CC	Mill Creek	MC2606	1255	70	87850	2.02	$2,000	$4,034
CC	Mill Creek	MC2611	1260	70	88200	2.02	$2,000	$4,050
CC	Mill Creek	MC2805	1445	70	101150	2.32	$2,000	$4,644
CC	Mill Creek	MC304	1030	70	72100	1.66	$2,000	$3,310
CC	Mill Creek	MC3601	460	70	32200	0.74	$2,000	$1,478
CC	Mill Creek	MC402	1000	70	70000	1.61	$2,000	$3,214
CC	Mill Creek	MC502/MC501	2025	70	141750	3.25	$2,000	$6,508
CC	Starview Trib	SVT01	700	70	49000	1.12	$2,000	$2,250
CC	Tyler Run	VH04/VH03	675	70	47250	1.08	$2,000	$2,169
CC	Tyler Run	VH08	1400	70	98000	2.25	$2,000	$4,500
CC	Tyler Run	VH14	1730	70	121100	2.78	$2,000	$5,560
CC	Tyler Run	VH401	500	70	35000	0.80	$2,000	$1,607
CC	Tyler Run	VH501	2210	70	154700	3.55	$2,000	$7,103
CC	Tyler Run	VH802	780	70	54600	1.25	$2,000	$2,507
CC	Willis Run	WR01	1500	70	105000	2.41	$2,000	$4,821
CC	Willis Run	WR05	1500	70	105000	2.41	$2,000	$4,821
CC	Willis Run	WR07	2420	70	169400	3.89	$2,000	$7,778
CC	Willis Run	WR301	2020	70	141400	3.25	$2,000	$6,492
EB	Barshinger Creek	BC06/BC05/BC04	1575	70	110250	2.53	$2,000	$5,062
EB	Barshinger Creek	BC08	1260	70	88200	2.02	$2,000	$4,050
EB	Barshinger Creek	BC11	2450	70	171500	3.94	$2,000	$7,874
EB	Barshinger Creek	BC12/BC13/BC14	3300	70	231000	5.30	$2,000	$10,606
EB	Barshinger Creek	BC15/BC16/BC17	3400	70	238000	5.46	$2,000	$10,927
EB	Barshinger Creek	BC18/BC19/BC20/BC21	2820	70	197400	4.53	$2,000	$9,063
EB	Blymire Hollow Trib	BHT07	1400	70	98000	2.25	$2,000	$4,500
EB	Blymire Hollow Trib	BHT503-FILL	200	70	14000	0.32	$2,000	$643
EB	Blymire Hollow Trib	BHT504	820	70	57400	1.32	$2,000	$2,635

EB	Barshinger Creek	DBT09/10/11/12/13	3000	70	210000	4.82	$2,000	$9,642
EB	East Branch Codorus	EB25	2075	70	145250	3.33	$2,000	$6,669
EB	Hametown Trib	HT05/HT04	1900	70	133000	3.05	$2,000	$6,107
EB	Inners Creek	IC10	1100	70	77000	1.77	$2,000	$3,535
EB	Inners Creek	IC1101	1185	70	82950	1.90	$2,000	$3,809
EB	Inners Creek	IC13/IC12	1180	70	82600	1.90	$2,000	$3,792
EB	Inners Creek	IC17	3650	70	255500	5.87	$2,000	$11,731
EB	Inners Creek	IC203/IC05/IC06	1025	70	71750	1.65	$2,000	$3,294
EB	Inners Creek	IC601	450	70	31500	0.72	$2,000	$1,446
EB	Nixon Park Trib	NPT1103/1102	1090	70	76300	1.75	$2,000	$3,503
EB	Nixon Park Trib	NPT15/NPT14	1900	70	133000	3.05	$2,000	$6,107
EB	Nixon Park Trib	NPT18/NPT17/EB	3670	70	256900	5.90	$2,000	$11,795
EB	Ridgeview Road Trib	RRT03/RRT04/RRT05	3350	70	234500	5.38	$2,000	$10,767
SB	Brush Valley Trib	BRVT09	2560	70	179200	4.11	$2,000	$8,228
SB	Buffalo Valley Trib	BUVT02	380	70	26600	0.61	$2,000	$1,221
SB	Buffalo Valley Trib	BUVT03/04	1850	70	129500	2.97	$2,000	$5,946
SB	Buffalo Valley Trib	BUVT04	1070	70	74900	1.72	$2,000	$3,439
SB	Buffalo Valley Trib	BUVT04	955	70	66850	1.53	$2,000	$3,069
SB	Buffalo Valley Trib	BUVT04	445	70	31150	0.72	$2,000	$1,430
SB	Centerville Creek	CC12	760	70	53200	1.22	$2,000	$2,443
SB	Centerville Creek	CC12/CC11	1078	70	75460	1.73	$2,000	$3,465
SB	Centerville Creek	CC16/CC17	5250	70	367500	8.44	$2,000	$16,873
SB	Centerville Creek	CC18/CC17/CC16	680	70	47600	1.09	$2,000	$2,185
SB	Centerville Creek	CC605/CC606/CC607	2000	70	140000	3.21	$2,000	$6,428
SB	Centerville Creek	CC701	1000	70	70000	1.61	$2,000	$3,214
SB	Fischel Creek	FIC05	1565	70	109550	2.51	$2,000	$5,030
SB	Fischel Creek	FIC01	2090	70	146300	3.36	$2,000	$6,717
SB	Fischel Creek	FIC02	1360	70	95200	2.19	$2,000	$4,371
SB	Fischel Creek	FIC08	1260	70	88200	2.02	$2,000	$4,050
SB	Fischel Creek	FIC1003	400	70	28000	0.64	$2,000	$1,286
SB	Fischel Creek	FIC1101	1930	70	135100	3.10	$2,000	$6,203
SB	Fischel Creek	FIC1201/FIC13	1150	70	80500	1.85	$2,000	$3,696
SB	Foust Creek	FOC02/FOC01	1010	70	70700	1.62	$2,000	$3,246
SB	Foust Creek	FOC04	780	70	54600	1.25	$2,000	$2,507
SB	Foust Creek	FOC07/FOC06	1732	70	121240	2.78	$2,000	$5,567
SB	Foust Creek	FOC09/FOC08	2415	70	169050	3.88	$2,000	$7,762
SB	Foust Creek	FOC10	1440	70	100800	2.31	$2,000	$4,628
SB	Glen Rock Valley Tribs	GRVT03	1660	70	116200	2.67	$2,000	$5,335
SB	Glen Rock Valley Tribs	GRVT03	1720	70	120400	2.76	$2,000	$5,528
SB	Glen Rock Valley Tribs	GRVT06	1050	70	73500	1.69	$2,000	$3,375
SB	Glen Rock Valley Tribs	GRVT206	1300	70	91000	2.09	$2,000	$4,178
SB	Glen Rock Valley Tribs	GRVT209/208/GRVT03	1070	70	74900	1.72	$2,000	$3,439
SB	Glen Rock Valley Tribs	GRVT501	1270	70	88900	2.04	$2,000	$4,082
SB	Hanover Junction Trib	HJT03/HJT04	990	70	69300	1.59	$2,000	$3,182
SB	Hanover Junction Trib	HJT05	1575	70	110250	2.53	$2,000	$5,062
SB	Hungerford Trib	HuT05	1500	70	105000	2.41	$2,000	$4,821
SB	Krebs Valley Trib	KVT0[7]	1850	70	129500	2.97	$2,000	$5,946
SB	Krebs Valley Trib	KVT0[9]	2160	70	151200	3.47	$2,000	$6,942

SB	Krebs Valley Trib	KVT01	3150	70	220500	5.06	$2,000	$10,124
SB	Krebs Valley Trib	KVT04	1480	70	103600	2.38	$2,000	$4,757
SB	Krebs Valley Trib	KVT04	2730	70	191100	4.39	$2,000	$8,774
SB	Krebs Valley Trib	KVT601/KVT602	3870	70	270900	6.22	$2,000	$12,438
SB	New Freedom Trib	NFCT04	1000	70	70000	1.61	$2,000	$3,214
SB	New Freedom Trib	NFCT05	1040	70	72800	1.67	$2,000	$3,343
SB	New Salem Trib	NST101/NST02	1885	70	131950	3.03	$2,000	$6,058
SB	New Salem Trib	NST301	1000	70	70000	1.61	$2,000	$3,214
SB	New Salem Trib	NST502/NST601	780	70	54600	1.25	$2,000	$2,507
SB	New Salem Trib	NST703	1070	70	74900	1.72	$2,000	$3,439
SB	Pierceville Run	PR02	500	70	35000	0.80	$2,000	$1,607
SB	Pierceville Run	PR05/PR06	2000	70	140000	3.21	$2,000	$6,428
SB	Pierceville Run	PR12	3280	70	229600	5.27	$2,000	$10,542
SB	Pierceville Run	PR3E	850	70	59500	1.37	$2,000	$2,732
SB	Pierceville Run	PR502	1000	70	70000	1.61	$2,000	$3,214
SB	Pierceville Run	PR601	515	70	36050	0.83	$2,000	$1,655
SB	South Branch Codorus Creek	SB1601	1100	70	77000	1.77	$2,000	$3,535
SB	South Branch Codorus Creek	SB17	400	70	28000	0.64	$2,000	$1,286
SB	South Branch Codorus Creek	SB27	2650	70	185500	4.26	$2,000	$8,517
SB	South Branch Codorus Creek	SB28/SB29	8625	70	603750	13.86	$2,000	$27,720
SB	South Branch Codorus Creek	SB31	1150	70	80500	1.85	$2,000	$3,696
SB	South Branch Codorus Creek	SB36/SB34	1745	70	122150	2.80	$2,000	$5,608
SB	South Branch Codorus Creek	SBCC41	1460	70	102200	2.35	$2,000	$4,692
SB	South Branch Codorus Creek	SBCC42	3440	70	240800	5.53	$2,000	$11,056
SB	Seven Valleys North Trib	SVNT06/SVNT05	1478	70	103460	2.38	$2,000	$4,750
SB	Seven Valleys North Trib	SVNT102/SVNT101	500	70	35000	0.80	$2,000	$1,607
SB	Seven Valleys South Trib	SVST08/SVST07	1650	70	115500	2.65	$2,000	$5,303
SB	Seven Valleys South Trib	SVST11/SVST12	950	70	66500	1.53	$2,000	$3,053
SB	Trout Run (South)	TR05	1350	70	94500	2.17	$2,000	$4,339
SB	Trout Run (South)	TR06	1640	70	114800	2.64	$2,000	$5,271
SB	Trout Run (South)	TR07	1700	70	119000	2.73	$2,000	$5,464
SB	Trout Run (South)	TR08	910	70	63700	1.46	$2,000	$2,925
SB	Trout Run (South)	TR201/TR202	1500	70	105000	2.41	$2,000	$4,821
SB	Trout Run (South)	TR301	775	70	54250	1.25	$2,000	$2,491
SB	Travis Trib	TT103	3200	70	224000	5.14	$2,000	$10,285
SB	Travis Trib	TT106/TT105/TT104	2320	70	162400	3.73	$2,000	$7,456
SB	Wangs Trib	WT01	2560	70	179200	4.11	$2,000	$8,228
SB	Wangs Trib	WT02	2110	70	147700	3.39	$2,000	$6,781
WB	Bunch Creek	BC05	1250	70	87500	2.01	$2,000	$4,017
WB	Bunch Creek	BC301	750	70	52500	1.21	$2,000	$2,410
WB	Codorus Creek	CC05	540	70	37800	0.87	$2,000	$1,736
WB	Codorus Creek	CC101	1620	70	113400	2.60	$2,000	$5,207
WB	UNT Codorus Creek	CC1302	800	70	56000	1.29	$2,000	$2,571
WB	Hawksbill Pond Trib	CC1502	4000	70	280000	6.43	$2,000	$12,856
WB	Hawksbill Pond Trib	CC1503/1504	3135	70	219450	5.04	$2,000	$10,076
WB	Hawksbill Pond Trib	CC1601	1875	70	131250	3.01	$2,000	$6,026
WB	Hawksbill Pond Trib	CC1604/1603/1602	2565	70	179550	4.12	$2,000	$8,244
WB	Hawksbill Pond Trib	CC1606/1605	4270	70	298900	6.86	$2,000	$13,724

WB	Codorus Creek	CC201	1000	70	70000	1.61	$2,000	$3,214
WB	Codorus Creek	CC401	800	70	56000	1.29	$2,000	$2,571
WB	Furnace Creek	FC02	550	70	38500	0.88	$2,000	$1,768
WB	Furnace Creek	FC03	314	70	21980	0.50	$2,000	$1,009
WB	Furnace Creek	FC04	735	70	51450	1.18	$2,000	$2,362
WB	Furnace Creek	FC07/FC06(D/S)	2700	70	189000	4.34	$2,000	$8,678
WB	Furnace Creek	FC08/FC801	2525	70	176750	4.06	$2,000	$8,115
WB	Furnace Creek	FC10	888	70	62160	1.43	$2,000	$2,854
WB	Furnace Creek	FC1002/FC09	590	70	41300	0.95	$2,000	$1,896
WB	Furnace Creek	FC1101(D/S)	380	70	26600	0.61	$2,000	$1,221
WB	Furnace Creek	FC1202	530	70	37100	0.85	$2,000	$1,703
WB	Furnace Creek	FC701	1690	70	118300	2.72	$2,000	$5,432
WB	Furnace Creek	FC703	540	70	37800	0.87	$2,000	$1,736
WB	Lischy Church Trib	LCT02	2460	70	172200	3.95	$2,000	$7,906
WB	Lischy Church Trib	LCT04/LCT03	950	70	66500	1.53	$2,000	$3,053
WB	Lischy Church Trib	LCT05	500	70	35000	0.80	$2,000	$1,607
WB	Lischy Church Trib	LCT201	625	70	43750	1.00	$2,000	$2,009
WB	Long Run	LR03	280	70	19600	0.45	$2,000	$900
WB	Long Run	LR04/LR102	2080	70	145600	3.34	$2,000	$6,685
WB	Long Run	LR06	500	70	35000	0.80	$2,000	$1,607
WB	Long Run	LR07	500	70	35000	0.80	$2,000	$1,607
WB	Long Run	LR09	700	70	49000	1.12	$2,000	$2,250
WB	Long Run	LR10	1550	70	108500	2.49	$2,000	$4,982
WB	Long Run	LR11	805	70	56350	1.29	$2,000	$2,587
WB	Long Run	LR2301 (D/S)	600	70	42000	0.96	$2,000	$1,928
WB	Long Run	LR2303	800	70	56000	1.29	$2,000	$2,571
WB	Long Run	LR2501 (D/S)	1400	70	98000	2.25	$2,000	$4,500
WB	Long Run	LR2701	1260	70	88200	2.02	$2,000	$4,050
WB	Long Run	LR2801	630	70	44100	1.01	$2,000	$2,025
WB	Long Run	LR2901/LR2902	1360	70	95200	2.19	$2,000	$4,371
WB	Long Run	LR3201 (U/S)	750	70	52500	1.21	$2,000	$2,410
WB	Long Run	LR3202	1350	70	94500	2.17	$2,000	$4,339
WB	Long Run	LR3302	560	70	39200	0.90	$2,000	$1,800
WB	Long Run	LR3601	270	70	18900	0.43	$2,000	$868
WB	Long Run	LR401	1500	70	105000	2.41	$2,000	$4,821
WB	Long Run	LR502	900	70	63000	1.45	$2,000	$2,893
WB	Long Run	LR503	2050	70	143500	3.29	$2,000	$6,589
WB	Long Run	LR902/LR1001	1670	70	116900	2.68	$2,000	$5,367
WB	Lehman Trib	LT01	1570	70	109900	2.52	$2,000	$5,046
WB	Lehman Trib	LT06/LT05/LT04	1700	70	119000	2.73	$2,000	$5,464
WB	Lehman Trib	LT201	500	70	35000	0.80	$2,000	$1,607
WB	Nashville Trib	NA02	500	70	35000	0.80	$2,000	$1,607
WB	Nashville Trib	NA03	3025	70	211750	4.86	$2,000	$9,722
WB	Nashville Trib	NA04	1280	70	89600	2.06	$2,000	$4,114
WB	Nashville Trib	NA05	3180	70	222600	5.11	$2,000	$10,220
WB	Oil Creek	OC19	2650	70	185500	4.26	$2,000	$8,517
WB	Old Paths Trib	OPT04	600	70	42000	0.96	$2,000	$1,928
WB	Old Paths Trib	OPT1001	2000	70	140000	3.21	$2,000	$6,428

WB	Porters Sidling Trib	PC01	975	70	68250	1.57	$2,000	$3,134
WB	Porters Sidling Trib	PC03/PC101	2180	70	152600	3.50	$2,000	$7,006
WB	Porters Sidling Trib	PC04/PC201	1650	70	115500	2.65	$2,000	$5,303
WB	Porters Sidling Trib	PC05	750	70	52500	1.21	$2,000	$2,410
WB	Porters Sidling Trib	PC06	2000	70	140000	3.21	$2,000	$6,428
WB	Porters Sidling Trib	PC08	780	70	54600	1.25	$2,000	$2,507
WB	Porters Sidling Trib	PC09	500	70	35000	0.80	$2,000	$1,607
WB	Porters Sidling Trib	PC10	650	70	45500	1.04	$2,000	$2,089
WB	Porters Sidling Trib	PC401	1700	70	119000	2.73	$2,000	$5,464
WB	Prospect Hill Trib	PHT01	1480	70	103600	2.38	$2,000	$4,757
WB	Prospect Hill Trib	PHT03	500	70	35000	0.80	$2,000	$1,607
WB	Prospect Hill Trib	PHT05	750	70	52500	1.21	$2,000	$2,410
WB	Spring Grove Trib	SG03	2280	70	159600	3.66	$2,000	$7,328
WB	Spring Grove Trib	SGR01	380	70	26600	0.61	$2,000	$1,221
WB	Spring Grove Trib	SGR03	1155	70	80850	1.86	$2,000	$3,712
WB	Swimming Pool Trib	SPT07/SPT08	1725	70	120750	2.77	$2,000	$5,544
WB	Swimming Pool Trib	SPT201	790	70	55300	1.27	$2,000	$2,539
WB	Swimming Pool Trib	SPT501	1200	70	84000	1.93	$2,000	$3,857
WB	Sunnyside Trib	SS02	350	70	24500	0.56	$2,000	$1,125
WB	Sunnyside Trib	SS02	1200	70	84000	1.93	$2,000	$3,857
WB	Stoverstown Branch	ST01	1840	70	128800	2.96	$2,000	$5,914
WB	Stoverstown Branch	ST02/ST03/ST04	2685	70	187950	4.31	$2,000	$8,629
WB	Stoverstown Branch	ST03ST103	2280	70	159600	3.66	$2,000	$7,328
WB	Stoverstown Branch	ST04	1390	70	97300	2.23	$2,000	$4,467
WB	Stoverstown Branch	ST05(GOLF)	1950	70	136500	3.13	$2,000	$6,267
WB	Stoverstown Branch	ST09	640	70	44800	1.03	$2,000	$2,057
WB	Stoverstown Branch	ST10	875	70	61250	1.41	$2,000	$2,812
WB	Stoverstown Branch	ST11	1650	70	115500	2.65	$2,000	$5,303
WB	Stoverstown Branch	ST204/ST205/ST203	1350	70	94500	2.17	$2,000	$4,339
WB	Stoverstown Branch	ST702/ST703	1160	70	81200	1.86	$2,000	$3,728
WB	Upper Codorus Creek	UCC03	500	70	35000	0.80	$2,000	$1,607
WB	Upper Codorus Creek	UCC04	390	70	27300	0.63	$2,000	$1,253
WB	Upper Codorus Creek	UCC06	500	70	35000	0.80	$2,000	$1,607
WB	Upper Codorus Creek	UCC08	1150	70	80500	1.85	$2,000	$3,696
WB	Upper Codorus Creek	UCC10	750	70	52500	1.21	$2,000	$2,410
WB	Upper Codorus Creek	UCC1003/UCC1002	800	70	56000	1.29	$2,000	$2,571
WB	Upper Codorus Creek	UCC1004	1785	70	124950	2.87	$2,000	$5,737
WB	Upper Codorus Creek	UCC11	3600	70	252000	5.79	$2,000	$11,570
WB	Upper Codorus Creek	UCC1201	780	70	54600	1.25	$2,000	$2,507
WB	Upper Codorus Creek	UCC14/UCC13/UCC12	1900	70	133000	3.05	$2,000	$6,107
WB	Upper Codorus Creek	UCC1402	1600	70	112000	2.57	$2,000	$5,142
WB	Upper Codorus Creek	UCC1403	1470	70	102900	2.36	$2,000	$4,725
WB	Upper Codorus Creek	UCC15	1550	70	108500	2.49	$2,000	$4,982
WB	Upper Codorus Creek	UCC1602	990	70	69300	1.59	$2,000	$3,182
WB	Upper Codorus Creek	UCC17/UCC16/UCC18	2850	70	199500	4.58	$2,000	$9,160
WB	Upper Codorus Creek	UCC1701/1702	950	70	66500	1.53	$2,000	$3,053
WB	Upper Codorus Creek	UCC1801	225	70	15750	0.36	$2,000	$723
WB	Upper Codorus Creek	UCC1801	735	70	51450	1.18	$2,000	$2,362

WB	Upper Codorus Creek	UCC1801(U/S)	950	70	66500	1.53	$2,000	$3,053
WB	Upper Codorus Creek	UCC1802	650	70	45500	1.04	$2,000	$2,089
WB	Upper Codorus Creek	UCC1803	1105	70	77350	1.78	$2,000	$3,551
WB	Upper Codorus Creek	UCC1804	1130	70	79100	1.82	$2,000	$3,632
WB	Upper Codorus Creek	UCC1805	1700	70	119000	2.73	$2,000	$5,464
WB	Upper Codorus Creek	UCC19/UCC18	1750	70	122500	2.81	$2,000	$5,624
WB	Upper Codorus Creek	UCC20	575	70	40250	0.92	$2,000	$1,848
WB	Upper Codorus Creek	UCC201	600	70	42000	0.96	$2,000	$1,928
WB	Upper Codorus Creek	UCC21/UCC3402	1450	70	101500	2.33	$2,000	$4,660
WB	Upper Codorus Creek	UCC22//UCC23	1320	70	92400	2.12	$2,000	$4,242
WB	Upper Codorus Creek	UCC2301	1350	70	94500	2.17	$2,000	$4,339
WB	Upper Codorus Creek	UCC2901	350	70	24500	0.56	$2,000	$1,125
WB	Upper Codorus Creek	UCC3002	750	70	52500	1.21	$2,000	$2,410
WB	Upper Codorus Creek	UCC3003	1350	70	94500	2.17	$2,000	$4,339
WB	Upper Codorus Creek	UCC302/UCC301	1540	70	107800	2.47	$2,000	$4,949
WB	Upper Codorus Creek	UCC3301	600	70	42000	0.96	$2,000	$1,928
WB	Upper Codorus Creek	UCC3301	775	70	54250	1.25	$2,000	$2,491
WB	Upper Codorus Creek	UCC3301	475	70	33250	0.76	$2,000	$1,527
WB	Upper Codorus Creek	UCC3401	600	70	42000	0.96	$2,000	$1,928
WB	Upper Codorus Creek	UCC3703	700	70	49000	1.12	$2,000	$2,250
WB	Upper Codorus Creek	UCC3704	1300	70	91000	2.09	$2,000	$4,178
WB	Upper Codorus Creek	UCC3705	1700	70	119000	2.73	$2,000	$5,464
WB	Upper Codorus Creek	UCC3706	720	70	50400	1.16	$2,000	$2,314
WB	Upper Codorus Creek	UCC3902	1100	70	77000	1.77	$2,000	$3,535
WB	Upper Codorus Creek	UCC401	825	70	57750	1.33	$2,000	$2,652
WB	Upper Codorus Creek	UCC601	800	70	56000	1.29	$2,000	$2,571
WB	Upper Codorus Creek	UCC701	1120	70	78400	1.80	$2,000	$3,600
WB	Upper Codorus Creek	UCC801	2400	70	168000	3.86	$2,000	$7,713
WB	Upper Codorus Creek	UCC902	500	70	35000	0.80	$2,000	$1,607
WB	West Branch Codorus Creek	WBCC02	700	70	49000	1.12	$2,000	$2,250
WB	West Branch Codorus Creek	WBCC03	2140	70	149800	3.44	$2,000	$6,878
WB	West Branch Codorus Creek	WBCC04	1380	70	96600	2.22	$2,000	$4,435
WB	West Branch Codorus Creek	WBCC07	1250	70	87500	2.01	$2,000	$4,017
WB	West Branch Codorus Creek	WBCC08	860	70	60200	1.38	$2,000	$2,764
WB	West Branch Codorus Creek	WBCC09	2500	70	175000	4.02	$2,000	$8,035
WB	West Branch Codorus Creek	WBCC1001	400	70	28000	0.64	$2,000	$1,286
WB	West Branch Codorus Creek	WBCC1201	677	70	47390	1.09	$2,000	$2,176
WB	West Branch Codorus Creek	WBCC1302	790	70	55300	1.27	$2,000	$2,539
WB	West Branch Codorus Creek	WBCC1501	830	70	58100	1.33	$2,000	$2,668
WB	West Branch Codorus Creek	WBCC201	1700	70	119000	2.73	$2,000	$5,464
WB	West Branch Codorus Creek	WBCC202	1670	70	116900	2.68	$2,000	$5,367
WB	West Branch Codorus Creek	WBCC203	500	70	35000	0.80	$2,000	$1,607
WB	West Branch Codorus Creek	WBCC2501	500	70	35000	0.80	$2,000	$1,607
WB	West Branch Codorus Creek	WBCC2701	500	70	35000	0.80	$2,000	$1,607
WB	West Branch Codorus Creek	WBCC2901	950	70	66500	1.53	$2,000	$3,053
WB	West Branch Codorus Creek	WBCC301	2775	70	194250	4.46	$2,000	$8,919
WB	West Branch Codorus Creek	WBCC801	560	70	39200	0.90	$2,000	$1,800
	TOTALS		436277		30539390	701.09		$1,402,176

Table 3-11. Estimated Costs of Livestock Stream Crossings (LSC) Construction and Maintenance Activities by Subwatershed and Aggregated for Watershed as a Whole.

WS	Stream Name	Reach_ID	Width (LF)	Length (LF)	Area (SF)	Cost (SF)	Unit Cost	Restored (ac)
EB	Barshinger Creek	BC12/BC13/BC14	16	100	1600	$2.50	$4,000	0.04
EB	Barshinger Creek	BC18/BC19/BC20/BC21	16	100	1600	$2.50	$4,000	0.04
EB	East Branch Codorus Creek	EB25	16	100	1600	$2.50	$4,000	0.04
EB	Nixon Park Trib	NPT15/NPT14	16	100	1600	$2.50	$4,000	0.04
EB	Ridgeview Road Trib	RRT03/RRT04/RRT05	16	100	1600	$2.50	$4,000	0.04
SB	Buffalo Valley Trib	BUVT02	16	100	1600	$2.50	$4,000	0.04
SB	Buffalo Valley Trib	BUVT03/04	16	100	1600	$2.50	$4,000	0.04
SB	Buffalo Valley Trib	BUVT04	16	100	1600	$2.50	$4,000	0.04
SB	Buffalo Valley Trib	BUVT04	16	100	1600	$2.50	$4,000	0.04
SB	Buffalo Valley Trib	BUVT04	16	100	1600	$2.50	$4,000	0.04
SB	Foust Creek	FOC02/FOC01	16	100	1600	$2.50	$4,000	0.04
SB	Glen Rock Valley Tribs	GRVT03	16	100	1600	$2.50	$4,000	0.04
SB	Glen Rock Valley Tribs	GRVT03	16	100	1600	$2.50	$4,000	0.04
SB	Glen Rock Valley Tribs	GRVT06	16	100	1600	$2.50	$4,000	0.04
SB	Glen Rock Valley Tribs	GRVT209/208/GRVT03	16	100	1600	$2.50	$4,000	0.04
SB	Glen Rock Valley Tribs	GRVT501	16	100	1600	$2.50	$4,000	0.04
SB	New Freedom Church Trib	NFCT05	16	100	1600	$2.50	$4,000	0.04
SB	Pierceville Run	PR502	16	100	1600	$2.50	$4,000	0.04
SB	South Branch Codorus	SBCC41	16	100	1600	$2.50	$4,000	0.04
SB	Trout Run (South)	TR06	16	100	1600	$2.50	$4,000	0.04
SB	Trout Run (South)	TR201/TR202	16	100	1600	$2.50	$4,000	0.04
WB	Codorus Creek	CC101	16	100	1600	$2.50	$4,000	0.04
WB	Hawksbill Pond Trib	CC1502	16	100	1600	$2.50	$4,000	0.04
WB	Hawksbill Pond Trib	CC1601	16	100	1600	$2.50	$4,000	0.04
WB	Hawksbill Pond Trib	CC1604/1603/1602	16	100	1600	$2.50	$4,000	0.04
WB	Furnace Creek	FC701	16	100	1600	$2.50	$4,000	0.04
WB	Long Run	LR04/LR102	16	100	1600	$2.50	$4,000	0.04
WB	Lehman Trib	LT06/LT05/LT04	16	100	1600	$2.50	$4,000	0.04
WB	Old Paths Trib	OPT1001	16	100	1600	$2.50	$4,000	0.04
WB	Porters Sidling Trib	PC08	16	100	1600	$2.50	$4,000	0.04
WB	Porters Sidling Trib	PC09	16	100	1600	$2.50	$4,000	0.04
WB	Porters Sidling Trib	PC401	16	100	1600	$2.50	$4,000	0.04
WB	Swimming Pool Trib	SPT07/SPT08	16	100	1600	$2.50	$4,000	0.04
WB	Stoverstown Branch	ST10	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC03	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC04	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC06	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC1602	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC1701/1702	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC1804	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC20	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC201	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC21	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC2901	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC302/UCC301	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC3704	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC3705	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC3706	16	100	1600	$2.50	$4,000	0.04
WB	Upper Codorus Creek	UCC3902	16	100	1600	$2.50	$4,000	0.04

WB	West Branch Codorus Creek	WBCC202	16	100	1600	$2.50	$4,000	0.04
WB	West Branch Codorus Creek	WBCC301	16	100	1600	$2.50	$4,000	0.04
	Total		816	5100	81600		$204,000	1.87

Table 3-12. Estimated Costs of Streambank Fencing (SBF) Construction and Maintenance Activities by Subwatershed and Aggregated for Watershed as a Whole.

WS	Stream Name	Reach_ID	Length (LF)	Unit Cost	Total Cost	Area Restored (ac)
CC	Codorus Creek	CC26/CC25	2500	$2.00	$5,000	2.01
EB	Barshinger Creek	BC08	1260	$2.00	$2,520	1.01
EB	Barshinger Creek	BC11	2450	$2.00	$4,900	1.97
EB	Barshinger Creek	BC12/BC13/BC14	3300	$2.00	$6,600	2.65
EB	Barshinger Creek	BC18/BC19/BC20/BC21	2820	$2.00	$5,640	2.27
EB	Barshinger Creek	DBT09/10/11/12/13	3000	$2.00	$6,000	2.41
EB	East Branch Codorus Creek	EB25	2075	$2.00	$4,150	1.67
EB	Inners Creek	IC17	3650	$2.00	$7,300	2.93
EB	Nixon Park Trib	NPT15/NPT14	1900	$2.00	$3,800	1.53
EB	Ridgeview Road Trib	RRT03/RRT04/RRT05	3350	$2.00	$6,700	2.69
SB	Buffalo Valley Trib	BUVT02	380	$2.00	$760	0.31
SB	Buffalo Valley Trib	BUVT03/04	1850	$2.00	$3,700	1.49
SB	Buffalo Valley Trib	BUVT04	1070	$2.00	$2,140	0.86
SB	Buffalo Valley Trib	BUVT04	955	$2.00	$1,910	0.77
SB	Buffalo Valley Trib	BUVT04	445	$2.00	$890	0.36
SB	Centerville Creek	CC701	1000	$2.00	$2,000	0.80
SB	Fischel Creek	FIC05	1565	$2.00	$3,130	1.26
SB	Fischel Creek	FIC01	2090	$2.00	$4,180	1.68
SB	Fischel Creek	FIC1101	1930	$2.00	$3,860	1.55
SB	Fischel Creek	FIC1201/FIC13	1150	$2.00	$2,300	0.92
SB	Foust Creek	FOC02/FOC01	1010	$2.00	$2,020	0.81
SB	Foust Creek	FOC04	780	$2.00	$1,560	0.63
SB	Glen Rock Valley Tribs	GRVT03	1660	$2.00	$3,320	1.33
SB	Glen Rock Valley Tribs	GRVT03	1720	$2.00	$3,440	1.38
SB	Glen Rock Valley Tribs	GRVT06	1050	$2.00	$2,100	0.84
SB	Glen Rock Valley Tribs	GRVT209/208/GRVT03	1070	$2.00	$2,140	0.86
SB	Glen Rock Valley Tribs	GRVT501	1270	$2.00	$2,540	1.02
SB	Krebs Valley Trib	KVT601/KVT602	3870	$2.00	$7,740	3.11
SB	New Freedom Church Trib	NFCT05	1040	$2.00	$2,080	0.84
SB	New Salem Trib	NST301	1000	$2.00	$2,000	0.80
SB	Pierceville Run	PR502	1000	$2.00	$2,000	0.80
SB	South Branch Codorus	SB1601	1100	$2.00	$2,200	0.88
SB	South Branch Codorus	SBCC41	1460	$2.00	$2,920	1.17
SB	Seven Valleys North Trib	SVNT102/SVNT101	500	$2.00	$1,000	0.40
SB	Trout Run (South)	TR06	1640	$2.00	$3,280	1.32
SB	Trout Run (South)	TR08	910	$2.00	$1,820	0.73
SB	Trout Run (South)	TR201/TR202	1500	$2.00	$3,000	1.21
SB	Travis Trib	TT106/TT105/TT104	2320	$2.00	$4,640	1.86
SB	Wangs Trib	WT01	2560	$2.00	$5,120	2.06
WB	Bunch Creek	BC05	1250	$2.00	$2,500	1.00
WB	Bunch Creek	BC301	750	$2.00	$1,500	0.60
WB	Codorus Creek	CC101	1620	$2.00	$3,240	1.30
WB	Hawksbill Pond Trib	CC1502	4000	$2.00	$8,000	3.21

WB	Hawksbill Pond Trib	CC1601	1875	$2.00	$3,750	1.51
WB	Hawksbill Pond Trib	CC1604/1603/1602	2565	$2.00	$5,130	2.06
WB	Furnace Creek	FC08/FC801	2525	$2.00	$5,050	2.03
WB	Furnace Creek	FC701	1690	$2.00	$3,380	1.36
WB	Lischy Church Trib	LCT04/LCT03	950	$2.00	$1,900	0.76
WB	Lischy Church Trib	LCT05	500	$2.00	$1,000	0.40
WB	Long Run	LR04/LR102	2080	$2.00	$4,160	1.67
WB	Long Run	LR3202	1350	$2.00	$2,700	1.08
WB	Lehman Trib	LT01	1570	$2.00	$3,140	1.26
WB	Lehman Trib	LT06/LT05/LT04	1700	$2.00	$3,400	1.37
WB	Lehman Trib	LT201	500	$2.00	$1,000	0.40
WB	Nashville Trib	NA04	1280	$2.00	$2,560	1.03
WB	Nashville Trib	NA05	3180	$2.00	$6,360	2.56
WB	Old Paths Trib	OPT1001	2000	$2.00	$4,000	1.61
WB	Porters Sidling Trib	PC08	780	$2.00	$1,560	0.63
WB	Porters Sidling Trib	PC09	500	$2.00	$1,000	0.40
WB	Porters Sidling Trib	PC401	1700	$2.00	$3,400	1.37
WB	Prospect Hill Trib	PHT01	1480	$2.00	$2,960	1.19
WB	Swimming Pool Trib	SPT07/SPT08	1725	$2.00	$3,450	1.39
WB	Swimming Pool Trib	SPT201	790	$2.00	$1,580	0.63
WB	Swimming Pool Trib	SPT501	1200	$2.00	$2,400	0.96
WB	Stoverstown Branch	ST10	875	$2.00	$1,750	0.70
WB	Upper Codorus Creek	UCC03	500	$2.00	$1,000	0.40
WB	Upper Codorus Creek	UCC04	390	$2.00	$780	0.31
WB	Upper Codorus Creek	UCC06	500	$2.00	$1,000	0.40
WB	Upper Codorus Creek	UCC1403	1470	$2.00	$2,940	1.18
WB	Upper Codorus Creek	UCC1602	990	$2.00	$1,980	0.80
WB	Upper Codorus Creek	UCC1701/1702	950	$2.00	$1,900	0.76
WB	Upper Codorus Creek	UCC1801	225	$2.00	$450	0.18
WB	Upper Codorus Creek	UCC1801	735	$2.00	$1,470	0.59
WB	Upper Codorus Creek	UCC1801(U/S)	950	$2.00	$1,900	0.76
WB	Upper Codorus Creek	UCC1804	1130	$2.00	$2,260	0.91
WB	Upper Codorus Creek	UCC201	600	$2.00	$1,200	0.48
WB	Upper Codorus Creek	UCC2901	350	$2.00	$700	0.28
WB	Upper Codorus Creek	UCC302/UCC301	1540	$2.00	$3,080	1.24
WB	Upper Codorus Creek	UCC3401	600	$2.00	$1,200	0.48
WB	Upper Codorus Creek	UCC3703	700	$2.00	$1,400	0.56
WB	Upper Codorus Creek	UCC3704	1300	$2.00	$2,600	1.04
WB	Upper Codorus Creek	UCC3705	1700	$2.00	$3,400	1.37
WB	Upper Codorus Creek	UCC3706	720	$2.00	$1,440	0.58
WB	Upper Codorus Creek	UCC3902	1100	$2.00	$2,200	0.88
WB	Upper Codorus Creek	UCC401	825	$2.00	$1,650	0.66
WB	Upper Codorus Creek	UCC801	2400	$2.00	$4,800	1.93
WB	West Branch Codorus Creek	WBCC03	2140	$2.00	$4,280	1.72
WB	West Branch Codorus Creek	WBCC07	1250	$2.00	$2,500	1.00
WB	West Branch Codorus Creek	WBCC201	1700	$2.00	$3,400	1.37
WB	West Branch Codorus Creek	WBCC202	1670	$2.00	$3,340	1.34
WB	West Branch Codorus Creek	WBCC203	500	$2.00	$1,000	0.40
WB	West Branch Codorus Creek	WBCC2901	950	$2.00	$1,900	0.76
WB	West Branch Codorus Creek	WBCC301	2775	$2.00	$5,550	2.23
	TOTALS		137295		$274,590	110.28

Table 3-13. Estimated Costs of Nutrient Management Plan (NMP) Implementation and Maintenance Activities by Subwatershed and Aggregated for Watershed as a Whole.

WS	Stream Name	Reach_ID	Length (LF)	Width (LF)	Area (SF)	Cost (ac)	Total Cost	Area (ac)
CC	Codorus Creek	CC26/CC25	2500	100	250000	$30	$172	5.74
CC	Mill Creek	MC1006	3700	100	370000	$30	$255	8.49
CC	Willis Run	WR01	1500	100	150000	$30	$103	3.44
EB	Barshinger Creek	BC12/BC13/BC14	3300	100	330000	$30	$227	7.58
EB	Barshinger Creek	BC18/BC19/BC20/BC21	2820	100	282000	$30	$194	6.47
EB	Barshinger Creek	DBT09/10/11/12/13	3000	100	300000	$30	$207	6.89
EB	East Branch Codorus Creek	EB25	2075	100	207500	$30	$143	4.76
EB	Inners Creek	IC1101	1185	100	118500	$30	$82	2.72
EB	Inners Creek	IC601	450	100	45000	$30	$31	1.03
EB	Nixon Park Trib	NPT15/NPT14	1900	100	190000	$30	$131	4.36
EB	Ridgeview Road Trib	RRT03/RRT04/RRT05	3350	100	335000	$30	$231	7.69
SB	Buffalo Valley Trib	BUVT02	380	100	38000	$30	$26	0.87
SB	Buffalo Valley Trib	BUVT03/04	1850	100	185000	$30	$127	4.25
SB	Buffalo Valley Trib	BUVT04	1070	100	107000	$30	$74	2.46
SB	Buffalo Valley Trib	BUVT04	955	100	95500	$30	$66	2.19
SB	Buffalo Valley Trib	BUVT04	445	100	44500	$30	$31	1.02
SB	Centerville Creek	CC701	1000	100	100000	$30	$69	2.30
SB	Fischel Creek	FIC01	2090	100	209000	$30	$144	4.80
SB	Foust Creek	FOC02/FOC01	1010	100	101000	$30	$70	2.32
SB	Foust Creek	FOC04	780	100	78000	$30	$54	1.79
SB	Glen Rock Valley Tribs	GRVT03	1660	100	166000	$30	$114	3.81
SB	Glen Rock Valley Tribs	GRVT03	1720	100	172000	$30	$118	3.95
SB	Glen Rock Valley Tribs	GRVT06	1050	100	105000	$30	$72	2.41
SB	Glen Rock Valley Tribs	GRVT209/208/GRVT03	1070	100	107000	$30	$74	2.46
SB	Glen Rock Valley Tribs	GRVT501	1270	100	127000	$30	$87	2.92
SB	Krebs Valley Trib	KVT601/KVT602	3870	100	387000	$30	$267	8.88
SB	New Freedom Church Trib	NFCT04	1000	100	100000	$30	$69	2.30
SB	New Freedom Church Trib	NFCT05	1040	100	104000	$30	$72	2.39
SB	New Salem Trib	NST301	1000	100	100000	$30	$69	2.30
SB	Pierceville Run	PR502	1000	100	100000	$30	$69	2.30
SB	South Branch Codorus	SB1601	1100	100	110000	$30	$76	2.53
SB	South Branch Codorus	SBCC41	1460	100	146000	$30	$101	3.35
SB	Trout Run (South)	TR06	1640	100	164000	$30	$113	3.76
SB	Trout Run (South)	TR201/TR202	1500	100	150000	$30	$103	3.44
SB	Trout Run (South)	TR301	775	100	77500	$30	$53	1.78
SB	Travis Trib	TT106/TT105/TT104	2320	100	232000	$30	$160	5.33
WB	Bunch Creek	BC301	750	100	75000	$30	$52	1.72
WB	Codorus Creek	CC101	1620	100	162000	$30	$112	3.72
WB	Hawksbill Pond Trib	CC1502	4000	100	400000	$30	$275	9.18
WB	Hawksbill Pond Trib	CC1601	1875	100	187500	$30	$129	4.30
WB	Hawksbill Pond Trib	CC1604/1603/1602	2565	100	256500	$30	$177	5.89
WB	Furnace Creek	FC08/FC801	2525	100	252500	$30	$174	5.80
WB	Furnace Creek	FC701	1690	100	169000	$30	$116	3.88
WB	Lischy Church Trib	LCT04/LCT03	950	100	95000	$30	$65	2.18
WB	Lischy Church Trib	LCT05	500	100	50000	$30	$34	1.15
WB	Long Run	LR04/LR102	2080	100	208000	$30	$143	4.78
WB	Long Run	LR3202	1350	100	135000	$30	$93	3.10
WB	Long Run	LR503	2050	100	205000	$30	$141	4.71
WB	Lehman Trib	LT06/LT05/LT04	1700	100	170000	$30	$117	3.90

WB	Lehman Trib	LT201	500	100	50000	$30	$34	1.15
WB	Nashville Trib	NA03	3025	100	302500	$30	$208	6.94
WB	Nashville Trib	NA05	3180	100	318000	$30	$219	7.30
WB	Old Paths Trib	OPT1001	2000	100	200000	$30	$138	4.59
WB	Porters Sidling Trib	PC08	780	100	78000	$30	$54	1.79
WB	Porters Sidling Trib	PC09	500	100	50000	$30	$34	1.15
WB	Porters Sidling Trib	PC401	1700	100	170000	$30	$117	3.90
WB	Prospect Hill Trib	PHT01	1480	100	148000	$30	$102	3.40
WB	Prospect Hill Trib	PHT05	750	100	75000	$30	$52	1.72
WB	Spring Grove Trib	SG03	2280	100	228000	$30	$157	5.23
WB	Swimming Pool Trib	SPT07/SPT08	1725	100	172500	$30	$119	3.96
WB	Swimming Pool Trib	SPT201	790	100	79000	$30	$54	1.81
WB	Sunnyside Trib	SS02	350	100	35000	$30	$24	0.80
WB	Sunnyside Trib	SS02	1200	100	120000	$30	$83	2.75
WB	Stoverstown Branch	ST02/ST03/ST04	2685	100	268500	$30	$185	6.16
WB	Stoverstown Branch	ST05(GOLF)	1950	100	195000	$30	$134	4.48
WB	Stoverstown Branch	ST11	1650	100	165000	$30	$114	3.79
WB	Stoverstown Branch	ST204/ST205/ST203	1350	100	135000	$30	$93	3.10
WB	Upper Codorus Creek	UCC03	500	100	50000	$30	$34	1.15
WB	Upper Codorus Creek	UCC04	390	100	39000	$30	$27	0.90
WB	Upper Codorus Creek	UCC06	500	100	50000	$30	$34	1.15
WB	Upper Codorus Creek	UCC1402	1600	100	160000	$30	$110	3.67
WB	Upper Codorus Creek	UCC1602	990	100	99000	$30	$68	2.27
WB	Upper Codorus Creek	UCC1701/1702	950	100	95000	$30	$65	2.18
WB	Upper Codorus Creek	UCC1801	225	100	22500	$30	$15	0.52
WB	Upper Codorus Creek	UCC1801	735	100	73500	$30	$51	1.69
WB	Upper Codorus Creek	UCC1801(U/S)	950	100	95000	$30	$65	2.18
WB	Upper Codorus Creek	UCC1804	1130	100	113000	$30	$78	2.59
WB	Upper Codorus Creek	UCC201	600	100	60000	$30	$41	1.38
WB	Upper Codorus Creek	UCC2901	350	100	35000	$30	$24	0.80
WB	Upper Codorus Creek	UCC3002	750	100	75000	$30	$52	1.72
WB	Upper Codorus Creek	UCC302/UCC301	1540	100	154000	$30	$106	3.54
WB	Upper Codorus Creek	UCC3301	600	100	60000	$30	$41	1.38
WB	Upper Codorus Creek	UCC3301	775	100	77500	$30	$53	1.78
WB	Upper Codorus Creek	UCC3301	475	100	47500	$30	$33	1.09
WB	Upper Codorus Creek	UCC3401	600	100	60000	$30	$41	1.38
WB	Upper Codorus Creek	UCC3704	1300	100	130000	$30	$90	2.98
WB	Upper Codorus Creek	UCC3705	1700	100	170000	$30	$117	3.90
WB	Upper Codorus Creek	UCC3706	720	100	72000	$30	$50	1.65
WB	Upper Codorus Creek	UCC3902	1100	100	110000	$30	$76	2.53
WB	Upper Codorus Creek	UCC401	825	100	82500	$30	$57	1.89
WB	Upper Codorus Creek	UCC801	2400	100	240000	$30	$165	5.51
WB	West Branch Codorus Creek	WBCC07	1250	100	125000	$30	$86	2.87
WB	West Branch Codorus Creek	WBCC202	1670	100	167000	$30	$115	3.83
WB	West Branch Codorus Creek	WBCC203	500	100	50000	$30	$34	1.15
WB	West Branch Codorus Creek	WBCC2701	500	100	50000	$30	$34	1.15
WB	West Branch Codorus Creek	WBCC2901	950	100	95000	$30	$65	2.18
WB	West Branch Codorus Creek	WBCC301	2775	100	277500	$30	$191	6.37
	TOTALS		139735		13973500		$9,624	320.79

Table 3-14. Estimated Costs of Stormwater Management (SWM) Construction and Maintenance Activities by Subwatershed and Aggregated for Watershed as a Whole.

WS	Stream Name	Reach_ID	Length (LF)	Width (LF)	Area (SF)	Unit Cost (LF)	Total Cost	Area Protected (ac)
CC	Lightners School Trib	LST105	50	70	3500	$25	$87,500	0.08
CC	Lightners School Trib	LST201	50	70	3500	$25	$87,500	0.08
CC	Mill Creek	MC02/MC03/MC04	50	70	3500	$25	$87,500	0.08
CC	Mill Creek	MC1006	50	70	3500	$25	$87,500	0.08
CC	Mill Creek	MC21	50	70	3500	$25	$87,500	0.08
CC	Mill Creek	MC23	50	70	3500	$25	$87,500	0.08
CC	Mill Creek	MC2606	50	70	3500	$25	$87,500	0.08
CC	Mill Creek	MC2611	50	70	3500	$25	$87,500	0.08
CC	Mill Creek	MC2805	50	70	3500	$25	$87,500	0.08
CC	Mill Creek	MC3901	50	70	3500	$25	$87,500	0.08
CC	Willis Run	WR01	50	70	3500	$25	$87,500	0.08
EB	Barshinger Creek	BC06/BC05/BC04	50	70	3500	$25	$87,500	0.08
SB	Centerville Creek	CC18/CC17/CC16	50	70	3500	$25	$87,500	0.08
SB	Foust Creek	FOC10	50	70	3500	$25	$87,500	0.08
SB	New Salem Trib	NST101/NST02	50	70	3500	$25	$87,500	0.08
WB	Long Run	LR401	50	70	3500	$25	$87,500	0.08
WB	Nashville Trib	NA03	50	70	3500	$25	$87,500	0.08
WB	Old Paths Trib	OPT1001	50	70	3500	$25	$87,500	0.08
WB	Spring Grove Trib	SG03	50	70	3500	$25	$87,500	0.08
WB	Stoverstown Branch	ST02/ST03/ST04	50	70	3500	$25	$87,500	0.08
WB	Stoverstown Branch	ST05(GOLF)	50	70	3500	$25	$87,500	0.08
WB	Stoverstown Branch	ST204/ST205/ST203	50	70	3500	$25	$87,500	0.08
WB	Upper Codorus Creek	UCC902	50	70	3500	$25	$87,500	0.08
WB	West Branch Codorus Creek	WBCC2501	50	70	3500	$25	$87,500	0.08
	TOTALS		1200	1680	84000		$2,100,000	1.93

Table 3-15. Estimated Costs of Stream Restoration (FGM) Construction and Maintenance Activities by Subwatershed and Aggregated for Watershed as a Whole.

WS	Stream Name	Reach_ID	Length (LF)	Unit Cost (LF)	Total Cost	Stream R&P (mi)
CC	Mill Creek	MC1006	3700	$150	$555,000	0.70
CC	Mill Creek	MC1601	420	$150	$63,000	0.08
CC	Mill Creek	MC1901	1733	$150	$259,950	0.33
SB	Fischel Creek	FIC1101	1930	$150	$289,500	0.37
SB	Foust Creek	FOC02/FOC01	1010	$150	$151,500	0.19
SB	Glen Rock Valley Tribs	GRVT501	1270	$150	$190,500	0.24
SB	Krebs Valley Trib	KVT401	22176	$150	$3,326,400	4.20
SB	South Branch Codorus Creek	SB1601	1100	$150	$165,000	0.21
WB	Bunch Creek	BC301	750	$150	$112,500	0.14
WB	Codorus Creek	CC101	1620	$150	$243,000	0.31
WB	Hawksbill Pond Trib	CC1601	1875	$150	$281,250	0.36
WB	Hawksbill Pond Trib	CC1604/1603/1602	2565	$150	$384,750	0.49
WB	Long Run	LR01	3000	$150	$450,000	0.57
WB	Long Run	LR401	1500	$150	$225,000	0.28
WB	Lehman Trib	LT01	1570	$150	$235,500	0.30

WB	Lehman Trib	LT201	500	$150	$75,000	0.09
WB	Porters Sidling Trib	PC01	975	$150	$146,250	0.18
WB	Porters Sidling Trib	PC401	1700	$150	$255,000	0.32
WB	Swimming Pool Trib	SPT201	790	$150	$118,500	0.15
WB	Stoverstown Branch	ST501	3000	$150	$450,000	0.57
WB	Upper Codorus Creek	UCC3301	475	$150	$71,250	0.09
WB	Upper Codorus Creek	UCC3401	600	$150	$90,000	0.11
	TOTALS		54259		$8,138,850	10.28

Table 3-16. Estimated Costs of Wetlands Restoration (WRP) Construction and Maintenance Activities by Subwatershed and Aggregated for Watershed as a Whole.

WS	Stream Name	Reach_ID	Length (LF)	Width (LF)	Area (SF)	Area (ac)	Cost (ac)	Total Cost	Total WRP (ac)
SB	Centerville Creek	CC16/CC17	5250	500	2625000	60.26	$1,225	$73,821	60.26
SB	South Branch Codorus Creek	SB36/SB34	1745	500	872500	20.03	$1,225	$24,537	20.03
WB	Hawksbill Pond Trib	CC1503	500	500	250000	5.74	$1,225	$7,031	5.74
WB	Stoverstown Branch	ST04	1390	500	695000	15.96	$1,225	$19,545	15.96
WB	West Branch Codorus Creek	WBCC08	860	500	430000	9.87	$1,225	$12,093	9.87
WB	West Branch Codorus Creek	WBCC1902	500	500	250000	5.74	$1,225	$7,031	5.74
WB	West Branch Codorus Creek	WBCC801	560	500	280000	6.43	$1,225	$7,874	6.43
	TOTALS		10805	3500	5402500	124.02		$151,930	124.03