

Riparian Buffer Installation for the Houston Property on the West River, Newfane, VT

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I. Introduction

In the fall of 2006 I approached the West River Watershed Alliance (WRWA) in search of project opportunities that I could use for my Antioch New England University Masters project. After an initial meeting, it was agreed that I could design and coordinate a riparian buffer restoration project using Supplemental Environmental Project (SEP) funding that the watershed alliance had acquired. SEPs are an innovative management tool that proactively help to mitigate environmental violations through the implementation of “on the ground” projects vs. traditional monetary fines. SEPs can work in several ways. One method of SEPs is to have the violator undertake a voluntary, environmentally beneficial project in exchange for mitigation of the penalty to be paid. A second methodology is for a natural resource agency (such as a Natural Resource Conservation District) to use the monetary enforcement penalty for a project which directly benefits the environment or public health, and which generally has some relationship to the original location and nature of violation.

Through their water quality monitoring program, WRWA identified several reaches of the West River where levels of E. coli, and/or total phosphorous exceeded water quality guidance standards. These areas were also identified as potential project sites where a SEP would be beneficial. After negotiations with several landowners in the identified areas, a project site was selected and a native-plant riparian buffer was installed using the SEP funding. The following report serves as the final documentation for my Masters project as well as a project report for WRWA, the Windham County NRCD, and the property owners where the project took place.

Purpose and Objective

The purpose of this report is to provide the West River Watershed Alliance (WRWA), the Windham County NRCD, and the Houston property owners a reference that summarizes how Supplemental Environmental Project (SEP) funds were used, what the goals and objectives of the project were, and what was accomplished.

The objective is to provide all stakeholders with a snapshot of the baseline conditions (what existed prior to the buffer installation), and an outline of the methodology (what was done on the ground) to help guide future monitoring and management of the buffer.

Scope of Study

The scope of work for this project included the following:

- WRWA application for funding for riparian buffers in Newfane area.
 - Grant application for \$3,000.00 to be applied towards volunteer training and recruitment, educational public outreach efforts, and equipment purchases.
- Landowner Partnership
 - Identified high priority areas within the Newfane area for buffer installation, contacted potential landowners and educated them about the SEPs and the proposed riparian buffer project, site visit with the Houston property manager to discuss project potential, formalized project agreement with the Houston property manager, coordinated with property manager to implement site preparation, and project installation.
- Houston Property Site Assessment
 - GIS Spatial Analysis to identify ecologically significant features to be incorporated into the design of the riparian buffer. Analysis included National Wetlands Inventory (NWI), surface water, soil survey, land use cover type, conservation lands, aquifers, USGS topography, pervious and semi pervious road surfaces, natural heritage rare, threatened and endangered species.
 - Site reconnaissance and ground-truthing of existing vegetation cover type (both native and non-native/invasive), erosion hotspots, wildlife habitat, agricultural and forestry practices, historical river flow, potential buffer length, width, and slope.
- Houston Property Riparian Buffer Design and Installation
 - A buffer plant species list was developed using GIS to identify existing soil types on site, the referenced soil series of Vermont was then used to link the soil type with the natural plant communities commonly associated with existing soil conditions¹, this was cross-referenced with

¹ Based on “Wetland, Woodland, Wildland – A guide to the Natural Communities of Vermont” by Elizabeth Thompson and Eric Sorenson, TNC and VT DFW, 2000

the plant communities found via site reconnaissance to develop a list of missing plant components, tree canopy health, cover and structure was assessed to help refine appropriate planting list, landowner was consulted for approval of all plant species.

- Generated a database of native plant nurseries in the New England region (Appendix A.) and researched available plant material and cost, developed a plant order to maximize species abundance and diversity, erosion control, and use available funds.
- Prepared site for volunteers and plant installation through manual removal (weed whip, shovel, etc) of non-native invasive/noxious plant species, and containerized plants were laid out in specific planting locations.
- Volunteers were recruited through personal contact, Internet postings and Email list-serves, volunteers were educated on West River watershed issues, project funding, WRWA, and proper plant installation, plants were installed with weed mats and watered.

II. Project Site Description

A. West River Watershed Assessment Summary

In order to place the buffer project within the context of the West River watershed (Figure 1.), the watershed summary produced in conjunction with the Basin 11 management plan is given below:

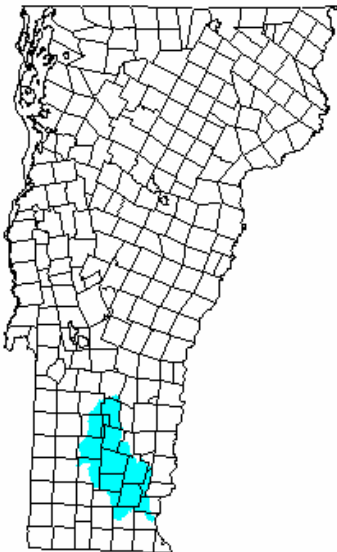


Figure 1. Locus map of West River Watershed, VT.

Source: <http://www.rpc.windham.vt.us/gis/data/westriv/index.htm>

“The West River Watershed has been designated as a “special focus area - high priority” by the United States Fish and Wildlife Service (USFWS) because of its rare species, potential for Atlantic salmon restoration, and contiguous habitat type. Specific threats to the West River watershed identified by USFWS and The Nature Conservancy of Vermont (TNC) are sedimentation and thermal modification due to riparian vegetation removal, flood control dams, erosion and flow alteration. Observed changes, especially in the condition of the West River, over the last several years have increased public awareness and concern for its ecological health and the health of those using the Watershed for recreational purposes.²”

“The length of the main-stem is 46 miles and the river drains a watershed that is 423 square miles. The dominant land cover type in the West River watershed, covering 86% of the area is forest. The remaining land cover is comprised of: agricultural use (3%), surface water (5%), transportation uses (4%), and wetlands (1%). The assessment lists and maps 25 river or stream swimming sites on the reservoirs and 17 pond sites in the upper West River watershed. Water quality monitoring is conducted at many of the swimming areas that are considered high use. The West River is well-known for canoeing and kayaking and especially for the spring and fall Ball Mountain Dam whitewater releases. There are currently three Class A designations and one Outstanding Resource Water designation in the West River watershed. Three rare invertebrate species (cobblestone tiger beetle, brook floater mussel, and the eastern pearlshell mussel) were found either in the West River or on its shores. Nineteen species of reptile and amphibian were located along the West River watershed (study area): six salamander species, seven frog or toad species, three turtle species, and three snake species. Thirty-three locations of vernal pools or areas that serve as amphibian breeding sites have been identified and mapped; seven of those sites are considered “classic” vernal pools being natural, temporary pools in forested areas with no inlet or outlet. The uppermost portion of and smaller tributaries of the West River watershed support healthy populations of wild native brook trout, and in some cases naturalized brown trout. Atlantic salmon populations are healthy throughout the entire watershed with the exception of Townshend Dam where high summer water temperatures impact trout and salmon³.”

Through their water quality monitoring program, the West River Watershed Alliance (WRWA) identified several reaches of the West River where levels of E. coli, and/or total phosphorous exceeded water quality guidance standards. E. coli is monitored because it is recommended by the U.S. EPA as the best indicator of health risk from water contact in recreational waters, and “if fecal coliform counts are high (over 200 colonies/100 ml of a water sample) in a river or lake, there is a

² <http://www.vacd.org/wncrd/BasinPlanning/Assessments.html#West>

³ <http://www.vacd.org/wncrd/BasinPlanning/Assessments.html#West>

greater chance that pathogenic organisms are also present.”⁴ Total phosphorous is monitored because excess phosphates in water stimulate plant growth, such as algal blooms. When the plants/algae decompose, oxygen is consumed and oxygen levels can significantly drop, impacting water quality and possibly even causing fish kills.

B. Riparian Buffer Location, Size, and Topography

The installed riparian buffer is located on the Houston property along the West bank of the West River, in Newfane, Vermont (Figure 2). This location was one of several proposed project sites due to its location between monitoring sites that showed high E.coli levels. Currently the buffer sits adjacent to an active hay field (historically sheep pasture) that lies within the floodplain terrace of the river. The hay field lays at the toe of a steeply sloped Southeast facing ridge upon which several houses and barns sit alongside River Road.

The sub watershed is approximately 421.85 acres in size (Figure 3.) The average slope across the area is an 13% grade with a steep ridge that drains into a several 1st order, ephemeral streams. This type of topography leads to what is termed as a “Flashy” sub-watershed due to the short response time of precipitation runoff draining to the bottom of the watershed. The steepness of the slope also contributes to high energy flows that may carry a significant amount of sediment (particularly from the dirt road) and that seem to be creating sources of channel erosion along the riverbank. In addition, the toe of the slope is a continuous source of groundwater outbreak, though the energy of the flow is somewhat attenuated by the hay field. The buffer itself runs North – South and is approximately 600 ft in length with an average width of 15 feet for a total area of 9,000 square feet or 0.20 acres.

C. Soils

Understanding the soils underlying and surrounding the buffer is a critical component of the project. Soil characteristics such as structure, texture, and strength drive the soils’ ability to resist erosion, infiltrate water, break down and filter nutrients and other runoff pollution, support embankments (such as the river bank) and sustain native plant communities that require specific growing conditions.

⁴ West River Watershed Alliance Water Quality Monitoring Program Report 2004

Soil erosion is important for several reasons. One reason is that nutrients such as phosphorous adhere to small soil particles. When these particles of soil are washed into our waterways they can carry with them large quantities of nutrients that can then overload the aquatic system causing nuisance and sometimes harmful algal blooms. In freshwater systems phosphorous (found in manure and most fertilizers) is the nutrient that causes such blooms, while in salt water environments it is nitrogen.

Not only do eroded soil particles foul our rivers and streams with excess nutrients, but they also increase the downstream erosive power of water. As more sediment is washed into rivers and streams, it increases the concentration of grains that can then actively erode stream banks - much as increasing grades of sand paper become more gritty and powerful. The greater the erosive power, the more sediment and nutrients are being added to our waterways. A third reason soil erosion is important, is that often the soil being eroded is the edge of a landowners field! Soil erosion is therefore important to control in order to maintain your property acreage! Finally, as water slows down, it loses its ability to carry the eroded soil and the grains

settle out, potentially burying fish spawning sites and the macroinvertebrates that the fish feed upon.

Many of the same characteristics that drive soil erosion are also important factors in soil's ability to infiltrate water. Water infiltration is important in that it determines the volume of water which can seep down into the soil and then filter out excess nutrients and pollutants which would otherwise reach rivers, lakes and streams through storm-water runoff. Water that does not infiltrate into the ground runs across the surface of the land carrying nutrients and sediment into lakes, rivers and streams.

In addition to soil erosion and water infiltration, soil characteristics also play a role in bank support. Attributes such as soil aggregation, moisture and strength will help determine the need for bank stabilization measures such as rip rap, erosion control fabric, bio-logs, and other bank-armoring techniques.

The soil types found in the buffer area are comprised of Ondawa fine sandy loam (Appendix B.) characterized as frequently flooded (though short duration and usually during spring), well drained with a root restrictive layer greater than 60 inches and no zone of water saturation within a depth of 72 inches. The K factor, which represents the susceptibility of soil to erosion and the rate of runoff, is relatively low (susceptibility is low) at 0.24 (Table 1.)

D. Plant Community Cover Type

Cover type of the site is important to know for several reasons. First, if this was a large scale bank stabilization/restoration project, soil loss and runoff modeling may be necessary to calculate the volume of erosion/overland flow. This information would be needed to help determine which bank stabilization techniques (such as erosion control fencing, bio-engineering, armoring, etc.) would adequately withstand the volume of water-runoff and erosion coming down through the watershed.

Differences in cover type are also important because they impact the energy, timing, and volume of storm-water runoff. For example, rain that is intercepted by tree leaves or that is taken up by plants roots reduces the total volume of water that could potentially runoff the landscape. In addition, runoff that is slowed down by woody and herbaceous material such as tree trunks and hay stems, and water that is allowed to infiltrate into a permeable surface (such as a forest floor or agricultural field) loses most of it's velocity, and therefore energy. This reduction in energy reduces the water's ability to erode soils, and also increases the time it takes for the water to reach rivers and streams. The slowing down of the water spreads out the volume of water reaching the river at any one time, and therefore reduces the total volume of the river's peak flow, hence reducing flooding and erosion potential. In contrast, raindrops falling over an industrial landscape, for example, would have no impediments and would quickly reach the ground. Without opportunity to infiltrate into the ground, a raindrop would flow quickly over impervious surfaces such as pavement and make its way to the river, causing flashy water levels that rise very quickly and to a higher volume than in the previous scenario. This type of flash flooding not only increases flooding and erosion potential, but also scours away in stream habitat, makes it difficult for native vegetation to grow and produces disturbed areas ripe for invasion by exotic plant species.

Finally, because a major objective of this project is to restore native vegetation, knowing the existing plant community cover type will help evaluate types of vegetation that will grow well at the site (existing vegetation), what types of vegetation are needed to stabilize the stream bank and filter nutrients, the biodiversity of the site (what species of native plants

are missing and should be included in the planting plan), and the habitat quality of the site (what plants are needed to provide high quality food and cover for native fauna).

The majority of the project site and surrounding sub-watershed is forested, while hay fields makes up roughly 14% percent of the land area⁵. The natural plant communities found on the buffer site (Sugar maple – ostrich fern riverine floodplain forest) correspond with the natural plant communities listed to be commonly associated with Ondawa soils in “Wetland, Woodland, Wildland – A guide to the Natural Communities of Vermont” by Elizabeth Thompson and Eric Sorenson. Large sugar maples (*Acer saccharum*) dominate the canopy of the buffer site and is actively sugared twice a year. Also found scattered throughout the overstory and understory were Alternate-leaved dogwood (*Cornus alternifolia*), White Ash (*Fraxinus Americana*), Musclewood (*Carpinus caroliniana*), American Elm (*Ulmus Americana*), Red Oak (*Quercus rubra*) Black cherry (*Prunus serotina*), Sycamore (*Platanus occidentalis*). Herbacious species found on site included Zigzag goldenrod (*Solidago flexicaulis*), Sensitive fern (*Onoclea sensibilis*), Bottlebrush grass (*Elymus hystrix*), Lady Fern (*Athyrium filix-femina*), Graceful sedge (*Carex gracillima*), and White snakeroot (*Eupatorium rugosum*)⁶.

Non-native species found on the site included Japanese barberry (*Berberis thunbergii*) and dwarf honeysuckle (*Lonicera xylosteum* L.), while Japanese knotweed (*Fallopia japonica*.), purple loosestrife (*Lythrum salicaria*), and reed canary grass (*Phalaris arundinacea*) were notice along roadsides and disturbed areas within the surrounding watershed. Of these species, purple loosestrife and Japanese knotweed are considered invasive and/or noxious weeds, while reed canary grass and Japanese barberry are considered to have potential to become invasive (Appendices C-E).

E. Surface Water

Existing surface water on the site plays an important role in the design of the riparian buffer. Surface water location and type can influence decisions surrounding habitat protection, enhancement and connectivity, erosion

⁵ These are rough estimates based off of aerial photography vs. orthophotography. (Aerial photography is not corrected for measurement as orthophotography is)

⁶ Initial site reconnaissance was performed in early summer, a more thorough inventory should be taken in late summer as to ensure no species were missed.

control installation, and the location of specific plant species in planting plan.

Streams and wetlands located within or adjacent to riparian buffers can act as habitat corridors and critical breeding grounds for multiple fish and amphibian species. Designing the buffer to connect to or at least come within species migration range of the existing streams/wetlands enhances the habitat value of the riparian buffer.

Another way surface water can add value to a riparian buffer is through storm-water mitigation. Local topography can be altered to direct storm-water flow to drain into engineered swales, or existing depressions, or wetlands. This will slow down run-off, giving it a chance to infiltrate, drop sediments, and filter nutrients before eventually draining into the river. In contrast, existing surface water and surface water paths such as stream beds or ephemeral drainages can be a source of erosion. For example on this project site, there are several back-cutting channel erosion sites stemming from drainage pathways. If left untreated, such erosion hotspots can eventually turn into large problems.

Surface water within the riparian buffer will also determine the layout of the planting plan. Mean annual surface water elevation, and local site conditions should be used to determine the planting location of obligate wet species (requires saturated conditions), transition zones for facultative wet (tolerates both wet and dry) and obligate upland species. High water marks should also be used to determine where not to plant. For example, placing plant material in areas of the river that receive high energy flows throughout the year will most likely result in a waste of time and resources. Carefully tailoring the planting plan to compliment existing surface water conditions will help ensure a successful buffer.

First order ephemeral streams drain the sub-watershed surrounding the project site drains in a general East, Southeast direction, spanning a length of approximately 1.9 miles before entering the hayfield abutting the project site (Figure 3.). A first order stream borders the northern edge of the buffer and a shallow ephemeral drainage ditch off of an access road runs through the southern end of the buffer. Riverine wetlands border the littoral zone of the river including a sandbar towards the southern bound of the buffer.

F. Groundwater

Due to high costs of mapping and the complexity of groundwater flow, groundwater is often given little consideration in low budget projects. Such an oversight is to the detriment of the project for groundwater can play an important role in plant survival, overland flow, and is a potential nutrient/pollutant source. A few simple on the ground observations can provide information that is important to the success many buffer projects.

Groundwater often provides a critical source of water throughout the growing season for wetlands, streams, and the plants and animals that depend on them. By slowly recharging wetlands and streams, groundwater is extremely important during times of low flow or drought.

Not only does groundwater play an important role where it emerges in breakouts, but it also can have an impact while still underground. Water table height and the rate at which it drains can determine the volume of water that can infiltrate into the soil over a given rain event. If the water table reaches the surface, all incoming rainwater then becomes storm-water runoff. The groundwater table is also of concern when taking into consideration the rooting depth of woody and herbaceous plants. If the groundwater table is high, shallow rooting may occur, minimizing the soil stabilization benefits of trees and shrubs. In fact, shallow rooting of trees may eventually result in tipped trees and sources of erosion.

Lastly, because groundwater can travel great distances, there is always the potential for contaminants. Even though a project site may be miles from any hazardous waste sites or other pollutant sources, this does not mean it is completely safe from their impacts. A groundwater outbreak may reveal pollutants whose source is many miles away. Also, depending on the bedrock through which it travels, groundwater may pick up a significant

amount of nutrients. A phase 1 site assessment was not performed to determine if there was any potential for groundwater pollution.

A ground water outbreak at the toe of the slope drains into the hay field abutting the buffer. While site reconnaissance did not reveal any overland flow resulting from the outbreak, the site conditions were fairly moist, especially after a recent rainfall. Although the groundwater outbreak may not directly contribute to overland flow into the buffer, it may contribute significantly to it indirectly. Through saturating the soil, the groundwater may take up any potential pore space available to storm-water to infiltrate into, thereby impeding water infiltration and exacerbating storm-water runoff. Personal communication with the property manager reveals that a “tremendous” amount of water comes off the hill throughout the year.

G. Threatened and Endangered Species

Species diversity helps to provide economic and ecological services that all humans benefit from. Complex environmental interactions and processes driven by species diverse ecosystems provide us with clean air, clean water, healthy soils, important medicines, crop pollination, and natural beauty for us to enjoy. A general rule of thumb is that the more diverse the ecosystem, the healthier it is – unfortunately, the current rate of species extinction is estimated to be 100 to 1,000 greater than it naturally has been over past rates in the history of the planet. Including biodiversity in natural resource management – especially when it involves rare and/or threatened species – is therefore paramount.

While there were no known threatened or endangered species found on the immediate project site, NRCD GIS data layer shows that a population of the state threatened brook floater mussel (*Alasmidonta varicose*) (Figure 4.) has been found in the West River or on its shores on in close proximity to the buffer site. Because the population is located upstream of the buffer project, there is no danger to the mussel from project installation and maintenance.

III. Buffer Description

A. Project Rationale

As outlined in the project description, the West River Watershed has been designated as a high priority focus area by USFWS due to its rare species, potential for Atlantic salmon restoration, and contiguous habitat type. In addition to threats of thermal pollution, sedimentation, erosion and flow alteration, WRWA has identified several reaches of the West River where levels of *E. coli*, and/or total phosphorous (TP) exceeded water quality guidance standards. In addition to being located in one of the identified reaches with high *E. coli*/TP levels, several site characteristics signified that the Houston property would be a good location for a riparian buffer. Although the project site is located on a straightaway section of the West River, (just downstream of a meander), there is still visible active scouring and slumping of the river bank (Figure 5). In addition, many of the large sugar maple trees that comprise the majority of woody vegetation found along the bank are also reaching the limits of their lifespan as is evident through visible decay, tree size, and decline of canopy health. Several areas of channel erosion are also cutting into the bank and removing rooting anchor sites for the sugar maples. Compounded with presence of the state threatened brook floater mussel (*Alasmidonta varicose*) and the rarity of the existing plant community in the state of Vermont⁷, this particular reach of the river is a prime location for a riparian buffer.

Riparian buffers are simply a protective area between a waterbody and human activity, such as development or agriculture (MA Buffer Manual). Buffers can act as conduits, filters or barriers controlling flows of energy, matter and species in landscapes (Editorial Ecological Engineering 24, 2005). Various ecological and economical functions of buffers include:

- to filter polluted overland and subsurface flows from adjacent agricultural fields (such as sediment, pesticides, and nutrients)
- to protect banks of water bodies against erosion
- to filter polluted air from the local sources (e.g., big farm complexes agrochemically treated fields)

⁷ “Intact examples of this community are in Vermont...most examples were cleared for agricultural use...”
Thompson and Sorrenson

- provide thermal shading for a waterbody through canopies
- to improve the microclimate in adjacent fields
- to create more connectivity in landscapes and providing habitat
- serve recreational and aesthetical purposes

(Editorial Ecological Engineering 24, 2005) (see also Lowrance et al., 1997 and Gregory et al. 1991).

B. Buffer Methodology

Erosion Control

In order to help reduce erosion at the site, several rows of woody trees and shrubs were installed the length of the buffer. Root systems of vegetation help bind the soil together, reducing erosion. Dawson and Kern-Hansen (1979) refer to several studies that showed stream bank stability increased of 85 and 95% after trees and bushes were installed.

Rows were alternated to provide optimal canopy and root coverage and spreading of overland flow (Figure 6). In areas of channel erosion several plant species were concentrated on all sides of the channel (and sometimes



within) in order to minimize future erosion. Emphasis of plant selection was on fast growing species with extensive, fibrous root systems that also provided quality habitat (Appendix J.) Sugar maples were also emphasized for their aesthetic fall foliage and to allow future sugaring on the site.

Figure 6. Alternating rows of plants used to maximize canopy/root coverage and to spread overland flow.

Habitat Restoration

In designing and installing the buffer, several considerations were given to habitat restoration, including invasive plant management, plant community restoration, and canopy restoration.

It has been shown that maintaining a high diversity of plant functional groups within the plant community can enhance resistance to invasion from exotic species (Pokorny et al). While the existing site was already relatively diverse, plant species selection sought to optimize plant species diversity on the site by enhancing the abundance of species that were growing on site in low numbers, or not present at the time of site reconnaissance. The relatively low abundance and aggressiveness⁸ of the present invasive species were judged to be at a level that would not threaten to overcrowd the buffer planting. Furthermore, minimal monitoring and manual removal of exotic species should keep the issue of exotic invasion at a minimum.

While the sugar maples on site provide a dense upper canopy, the project site currently has minimal middle canopy coverage. For this reason, selection of shrubs including alternate leaved dogwood and red osier dogwood were included in the planting plan. In addition, use of larger sized potted trees and shrubs added an immediate impact on the middle canopy establishment and rainfall interception. In addition to improving the canopy, the selected tree species of White Ash, Red Oak, and Alternate leaved dogwood provide food and cover for many types of wildlife including ruffed grouse and other birds, squirrels, small rodents, deer, turkey, cotton tail rabbits, beaver, and bear⁹.

⁸ Aggressiveness was judged here by general growing habits of species and the invasive status determined by state of Vermont.

⁹ <http://plants.usda.gov/>

In addition to adding habitat value, specific plant species were included in the planting plan to enhance the plant species diversity on the site by enlarging the abundance of species that were growing on site in low numbers, or not present at the time of site reconnaissance. Plants included in the planting plan that enhanced species already present included: Sugar Maple, White Ash, Red Oak, and Alternate leaved dogwood. Plants included in the planting plan that were not present at the time of the site reconnaissance include: Box elder, Red osier dogwood¹⁰, and Ostrich fern. Unfortunately, due to the timing of the project, species availability was limited due to low nursery stock.

Nutrient Attenuation

Riparian buffers are often used in agricultural settings to reduce nutrient pollution. While phosphorus removal rates of buffers have been shown to be as high as 93% (Limet al. 1998), most studies reported removal rates of 60%–90% (Line et al. 2000; Young et al. 1980). Since use of the hay field as a grazing pasture has stopped, and the hay field is not actively fertilized, nutrient removal concerns for the site are limited to those of overland flow and erosion. This is fortunate because the width of the buffer strip is roughly half of the traditional minimum of 30 feet. This is due to the landowners request to keep as much of the hayfield as possible active. The narrowness of the buffer along with the slope will greatly reduce its effectiveness as a nutrient buffer. This is especially true for soluble P, as riparian buffers may become saturated (as discussed in the groundwater section) and allow large concentrations of soluble P to bypass them. Figure 7. shows the recommended buffer strip widths based on the slope of the land.

Recommended Buffer Strip Widths

Based on Slope

Slope of Land (%)	Minimum width of Buffer Strip (feet)
0	50
5	70
10	90
15	110
20	130
25	150

¹⁰ Although red osier floodplain forest, the leaved dogwood.

ar maple – Ostrich fern
c of stock of Alternate

Figure 7.

Source: Finley 1987 in *Establishing Vegetative Buffer Strips Along Streams to Improve Water Quality*. Pennsylvania State University. 1996.

Though the buffer strips width limits its effectiveness, the addition of trees and shrubs should increase infiltration, which should aid in sediment and nutrient removal.

Plant Installation and Location

The project site covers an area of approximately 9,000 square feet or 0.2 acres, running a length of 600 linear feet with a variable width from 10 to 20 feet, averaging around 15 feet wide. The site was prepared for plant installation through manual removal (weed whip) of herbaceous ground cover, exotic invasive species, and noxious plants such as poison ivy. No erosion control measures (such as hay bales, or fabric) were used during site preparation because no soil was being disturbed and the project budget limited available resources to just plant material.

A general planting plan was designed to allocate at least 2 staggered rows (more where space allowed) of alternating species along the length of the buffer (Figure 8.). Specific locations of plant species were flagged with surveyor pin flags prior to planting and criteria for location took into account site conditions such as sun/shade, erosion hotspots, and shading of the river and hay field. Plants were placed to maximize river shading and minimize hay field shading (tall trees were planted as close to the river as possible and never closer to the hay field than the existing maple trees while shrubs were located further inland and ferns abutted the fence of the hay field). Spacing for plants were 5 foot centers with rows being placed 3 feet apart at a density of roughly 537 stems per acre. This density of plant material (which is twice the density of average NRCD buffers) is to ensure a decent survival rate due to the expected mortality from desiccation, weed competition, animal browse, disease, etc. which can be estimated to be 30% or more of newly installed trees. Also, 20% of the plant

material comprised of ferns, and should not be considered as heavily in the density calculation.

The ferns were placed closest to the hay field and fence as to provide the maximum aesthetic benefit for the landowner and to avoid consuming planting space closer to the bank where trees and shrubs would be more beneficial towards stabilization. Colorful flowering species such as dogwoods were distributed evenly throughout the site to maximize aesthetic benefits. The idea behind this was that a strong aesthetic buffer would serve as a good model buffer for adjacent landowners. Species in each row were also alternated as to ensure an even distribution of habitat cover type.

Weed mats were stapled around each plant to suppress weed competition and help maintain soil moisture. Each plant was also watered with several gallons of water after being planted, and flagged with surveyors tape so that the land manager could later identify the plants for maintenance. Due to the size of the plants, tree tubes were not installed¹¹. Personal communication with the land owner revealed that beavers had historically traveled through the site, though site reconnaissance did not show any fresh beaver signs or other herbivory.

Plants were intentionally kept back from the immediate edge of the bank in order to avoid loss through flooding and bank erosion. Studies have shown that the amount of riparian vegetation destroyed by can range from nearly zero to almost 40% of pre-flood coverage (Hawkins, Bartz, Neale 1997). This was a concern because the project site is subject to flooding throughout the year and the West River has damn releases that may destroy newly planted vegetation. A good option for stabilizing the bank would be live stake cuttings of dogwoods or similar species. Live stakes are a virtually free source of plant material and therefore mortality is less of a concern than with expensive containerized plants. Due to the timing of the project however, live stakes were not used. Below is a list of the species and quantity list of the plants installed (Table 2.). A copy of the plant order can be found in the Appendix F.

Volunteers were recruited to help install the plant material. The reasoning was to maximize budget efficiency while also educating local landowners about the benefits of riparian buffers and instilling them with a

¹¹ Tree tubes were planned to be used on 15-20 red osier bare root seedlings, but the plants were destroyed while in storage.

sense of stewardship over their local watershed. A total of 10 volunteers installed and watered all of the plants during a 4 hour volunteer work day. Most participants then stayed afterwards for a BBQ lunch provided by the land manager Fred Houston and WRWA. Pictures of the planting event can be found in the Appendix H.

Trees		
Sugar Maple	17	25
White Ash	17	25
Boxelder	7	10
Red Oak		0
Total	41	60
Shrubs		
Alternate leaved dogwood	7	10
Red Osier Dogwood	17	25
Red Osier Dogwood	13	20
Total	37	55
Ferns		
Ostrich Fern	14	21
Project Total	92	136

Table 2. Plant species list.

IV. Conclusions and Recommendations

The goals of the buffer, to provide bank stabilization, reduce erosion, increase shading of river, enhancement of the canopy structure and habitat/plant community, enhancement of visual aesthetics for the purpose of use as a demonstration project were successfully met.

Bank stabilization was provided by installing trees and shrubs along the bank. The roots of these trees will aid in stabilizing the river bank and will eventually take the place of the aging sugar maples that currently dominate the site. The addition of trees and shrubs in areas of channel erosion also helped reduce overall erosion from the site. The mixture of shrub species with tree species will enhance the canopy structure by providing a middle canopy layer. The trees shrubs will also aid in increasing the aesthetic nature of the buffer due to their colorful flower blossoms and fall foliage.

In addition to aiding in erosion control and enhancing the aesthetic of the project, the trees and shrubs will also provide high quality food and cover for a variety of native wildlife, increase the size of river corridor available for wildlife habitat, and also helping to restore a plant community that is rare in Vermont. Eventually these trees and shrubs will also provide shading for the edges of the river.

In addition to the ecological benefits of the project, a simple cost analysis can show the value of this project economically. By quantifying the project in dollars, one can use this project as a baseline placeholder for later comparison. The cost of this project compared to the replacement cost of a project needed to remediate the impacts of an extreme storm event (that could cause erosion along roadsides or private property) would show that pro-active measures such as volunteer riparian buffer project can save a significant amount of money when compared to expensive, reactive mitigation projects. A cost summary for the project can be found in Appendix G.

While initial monitoring of the buffer shows a promising future, continuous monitoring and maintenance will help ensure that the project is a success for years to come. It is recommended that WRWA work with the landowner and volunteers to continue to monitor plant survival, erosion issues, and the presence of invasive species. Also, the value of the buffer project can further be enhanced through increasing the buffer width, further stabilization and shading of the stream bank through the use of live stakes,

and by working with abutting landowners to implement buffer projects on their land in order to extend buffer and provide a contiguous corridor for wildlife and watershed protection. Other ways to add value to the project could be to consider implementing a habitat restoration area for the brook floater mussel and through inviting the horse farm managers to take a tour of the project in order to see if they would consider implementing a similar project on the Eastern side of the river.