DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Watershed Management

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TITLE: Riparian Forest Buffer Guidance

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AUTHORITY: The Pennsylvania Clean Streams Law P.L 1987, Act 394 of 1937, as amended (35 P.S. 691.1 *et seq.*)

POLICY: The Riparian Forest Buffer Guidance outlines recommendations for installation and protection of riparian forest buffers that are useful in mitigating or controlling point and nonpoint source pollution to waters of this Commonwealth and to facilitate compliance of regulatory requirements. Riparian forest buffers are a type of riparian buffer that serve as a barrier to prevent most pollutants from getting into aquatic environments. They also provide enhanced instream sequestration and degradation of contaminants.

PURPOSE: The purpose of this guidance is to assist the Pennsylvania Department of Environmental (DEP) staff in providing and further developing riparian forest buffer recommendations for regulatory, voluntary, and grant programs. It will also serve to assist any interested entities (municipal, regional, state, federal, and others) in understanding the functions and values of riparian forest buffers, the importance of sustaining and enhancing riparian forest buffers, and in developing appropriate science-based guidelines or policies. Finally, this guidance is a tool for regulated entities for meeting regulatory requirements.

APPLICABILITY: The recommendations for installation and protection of riparian forest buffers found in this guidance can be applied in regulatory, voluntary, and grant programs throughout this Commonwealth that involve activities adjacent to water bodies.

DISCLAIMER: The policies and procedures outlined in this guidance are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of DEP to give the rules in these policies that weight or deference. This document establishes the framework within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

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I. INTRODUCTION

A riparian buffer is a best management practice (BMP) that is an area of permanent vegetation along perennial or intermittent streams, rivers, lakes, ponds and reservoirs that is left undisturbed to allow for natural succession of native vegetation. A riparian buffer may consist of grasses and forbs, or a combination of vegetation types to include grasses, forbs, shrubs and trees.

A riparian forest buffer is a specialized type of riparian buffer consisting of permanent vegetation that is predominantly native trees and shrubs that provide at least 60% uniform canopy cover. It is located along perennial or intermittent streams, rivers, lakes, ponds and reservoirs and is maintained in a natural state or sustainably managed to protect and enhance water quality, stabilize stream channels and banks, and separate land use activities from surface waters. Riparian forest buffers can be in place as newly established or existing, where protection is critical.

Riparian forest buffers are crucial to the protection and enhancement of the water resources in Pennsylvania. They are extremely complex ecosystems that help provide optimum food and habitat for stream communities as well as being useful in mitigating or controlling point and nonpoint source pollution by both keeping the pollutants out and increasing the level of instream pollution processing. Riparian forest buffers serve as a barrier to prevent most pollutants from entering aquatic environments. They also provide enhanced instream sequestration and degradation of contaminants primarily due to increased biological activity (Sweeney et. al, *Riparian*). Used as a component of an integrated management system including nutrient management along with erosion and sediment control practices, riparian forest buffers can produce a number of beneficial effects on the quality of water resources (Welsch, *Riparian*). Riparian forest buffers can be effective in removing excess nutrients and sediment from surface runoff and shallow groundwater, stabilizing streambanks, and shading streams and rivers to optimize light and temperature conditions for aquatic plants and animals. Riparian forest buffers also ameliorate the affects of some pesticides and directly provide dissolved and particulate organic food needed to maintain high biological productivity and diversity in the adjoining stream (Sweeny et. al, *Resurrecting*). Riparian forest buffers provide significant flood attenuation and storage functions within the watershed. Finally, the protection of existing riparian forest buffers coupled with the establishment of new riparian forest buffers can have a significant impact on moderating the affects of climate change on aquatic ecosystems, particularly in our headwater streams (Beschta et. al, *Stream* and Seavey et. al, *Why*).

Scientific literature supports the riparian forest buffer (with stormwater entering the buffer as sheet flow or shallow concentrated flow) as the only best management practice that can do all of the following: Capture and hold stormwater runoff from the majority of Pennsylvania storms in a given year; infiltrate most of that water and/or transport it as shallow flow through the forest buffer soils where contaminate uptake and processing occurs; release excess storm flow evenly, further processing dissolved and particulate substances associated with it; sequester carbon at significant levels; improve the health of the stream and increase its capacity to process organic matter and nutrients generated on the site or upstream of the site.

Numerous studies demonstrate that riparian forest buffers are particularly effective in mitigating adverse impacts, due to their proximity immediately adjacent to the surface water and their function as a physical buffer to that surface water. Specifically, riparian forest buffers protect surface waters from the effects of runoff by providing filtration of pollutants,

bank stability, groundwater recharge, rate attenuation and volume reduction. Riparian forest buffers reduce soil loss and sedimentation/nutrient and other pollution from adjacent upslope flow (Dosskey et al *Assessment*). Riparian forest buffers also remove, transform, and store nutrients, sediments, and other pollutants from sheet flow and shallow sub-surface flow and have the potential to remove substantial quantities of excess nutrients through root-zone uptake (Desbonnet et al, *Vegetated*, Lowrance et al *Water*, Mayer et al, *Riparian*, and Newbold et al, *Water*). Further, the riparian forest buffer's tree canopy shades and cools water temperature, which is especially critical to support high quality species/cold water species - a function not as effectively provided by any other BMP (Jones, *Quantifying*).

The purpose of this guidance is to assist DEP staff in providing and further developing riparian forest buffer recommendations for regulatory, voluntary, and grant programs. It can be utilized by the regulated community to facility compliance with regulatory requirements, such as those in 25 Pa. Code Chapter 102 relating to erosion and sediment control and stormwater management. It will also serve to assist any interested entities (municipal, regional, state, federal, and others) in understanding the functions and values of riparian forest buffers, the importance of sustaining and enhancing riparian forest buffers, and in developing appropriate science-based guidelines or policies.

Additional recommendations for the establishment of riparian forest buffers and the protection, maintenance, and enhancement of both newly established and existing riparian forest buffers can be found in Appendix C, Riparian Forest Buffer Management Plan Toolkit: Restoring and Protecting Pennsylvania's Riparian Forest Buffers.

II. GUIDANCE

A. Definitions

1. Canopy Cover - Area of ground covered by the crowns of trees or woody vegetation as delineated by the vertical projection of crown perimeters. It is commonly expressed as a percent of total ground area.

2. Floodplain - The 100-year floodway and that maximum area of land that is likely to be flooded by a 100-year flood as shown on the floodplain maps approved or promulgated by the Federal Emergency Management Agency.

3. Forbs - A herbaceous plant other than a grass.

4. Forest Management Plan - A plan written by a forestry professional with a four-year degree in forestry from an institution accredited by the Society of American Foresters (SAF) or a two-year degree in forestry from an institution recognized by the SAF.

5. Intermittent Stream - A body of water flowing in a channel or bed composed primarily of substrates associated with flowing water, which, during periods of the year, is below the local water table and obtains its flow from both surface runoff and groundwater discharges.

6. Invasive Plant Species - Nonnative species that can thrive in areas beyond their natural range of dispersal. They are characteristically adaptable and aggressive and have a high reproductive capacity. See Table 1 for a list of invasive shrubs and trees that are commonly found in riparian forest buffers in Pennsylvania.

7. Lake, Pond or Impoundment - Surface water with a hydraulic residence time of 14 days or more based on average annual daily stream flow. Residence time is determined at average annual daily stream flow and normal pool volume. In the absence of actual records, an average annual daily discharge rate of 1.5 CFS per square mile is used.

8. Normal Pool Elevation -

   (i) For bodies of water which have no structural measures to regulate height of water, the height of water at ordinary stages of low water unaffected by drought.

   (ii) For structurally regulated bodies of water, the elevation of the spillway, outlet control, or dam crest which maintains the body of water at a specified height.

   (iii) The term does not apply to wetlands.

9. Noxious Weeds - A plant determined by Pennsylvania law to be injurious to public health, crops, livestock, agricultural land, or other property. Refer to 7 Pa. Code 110 §110.1 for a current list of noxious weeds, available at: http://www.pacode.com/secure/data/007/chapter110/chap110toc.html.

10. Perennial stream - A body of water flowing in a channel or bed composed primarily of substrates associated with flowing waters and capable, in the absence of pollution or other manmade stream disturbances, of supporting a benthic macroinvertebrate community which is composed of two or more recognizable taxonomic groups of organisms which are large enough to be seen by the unaided eye and can be retained by a United States Standard No. 30 sieve (28 meshes per inch, 0.595 mm openings) and live at least part of their life cycles within or upon available substrates in a body of water or water transport system.

11. Riparian buffer - A best management practice that is an area of permanent vegetation along surface waters. A riparian buffer may consist of grasses and forbs only, or a combination of vegetation types to include grasses, forbs, shrubs and trees.

12. Riparian Forest Buffer - A type of riparian buffer that consists of permanent vegetation that is predominantly native trees and shrubs along surface waters that is maintained in a natural state or sustainably managed to protect and enhance water quality, stabilize stream channels and banks, and separate land use activities from surface waters.

13. Riparian Forest Buffer Management Plan - should consist of the following at a minimum:

    (i) A planting plan for converted or newly established riparian forest buffers that identifies the number, density, and species of native trees and shrubs appropriate to a geographic location that will achieve 60% uniform canopy cover.

    (ii) A maintenance schedule and measures for converted or newly established riparian forest buffers to ensure survival and growth of plantings and protection from competing plants and animals including noxious weeds and invasive species over a five (5) year establishment period including activities or practices used to maintain the riparian forest buffer including the disturbance of existing vegetation, tree removal, shrub removal, clearing, mowing, burning or spraying in accordance with long term operation and maintenance.

    (iii) An inspection schedule and measures to ensure long term maintenance and proper functioning of riparian forest buffers including measures to repair damage to the buffer from storm events greater than the 2 year/24 hour storm.

14. Sheet Flow - Also known as overland flow, a technical term as described in more detail for engineering purposes in the Erosion and Sediment Pollution Control Program Manual, 363-2134-008 (as amended and updated).

15. Succession - The temporal changes of plant and animal populations and species in an area that has been disturbed.

16. Surface Waters - Perennial and intermittent streams, rivers, lakes, reservoirs, ponds, wetlands, springs, natural seeps, and estuaries, excluding water at facilities approved for wastewater treatment such as wastewater treatment impoundments, cooling water ponds, and constructed wetlands used as part of a wastewater treatment process.

17. Sustainable Forestry - Methods of forest management that do not interfere with natural cycles or damage the ecological balance of the riparian buffer.

18. Top of Streambank - First substantial break in slope between the edge of the bed of the stream and the surrounding terrain. The top of streambank can either be a natural or constructed (that is, road or railroad grade) feature, lying generally parallel to the watercourse.

19. Top of Slope - A break in slopes adjacent to steep banked streams that have little or no floodplain; or a break in slope where the side slopes adjacent to an incised or deeply cut channel meet the floodplains that have been abandoned or are undergoing abandonment.

20. Wetlands - Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs and similar areas.

B. Conditions Where Practice Applies

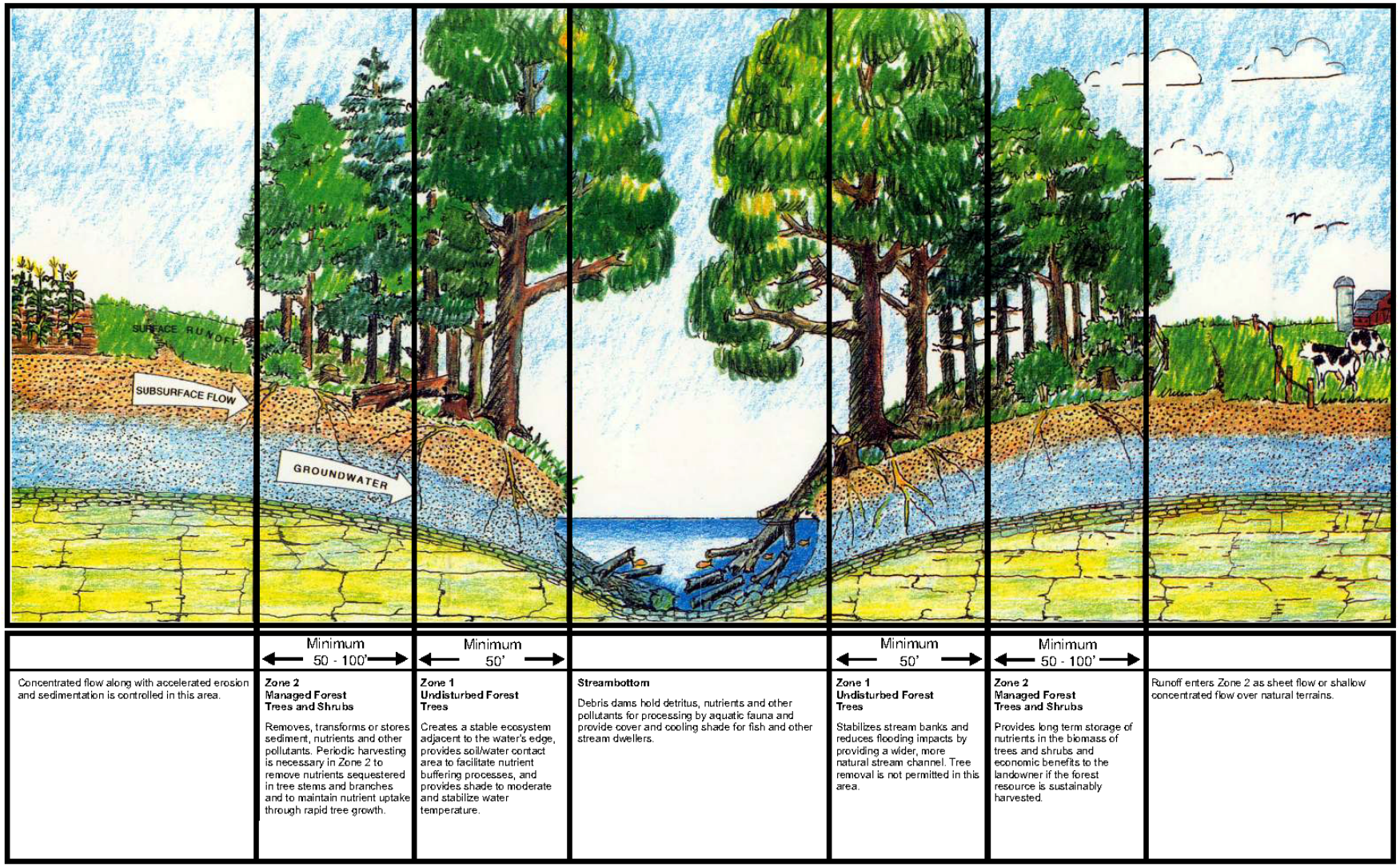
Riparian forest buffers should be located along surface waters. If there are trees and shrubs in the area along the perennial or intermittent stream, river, lake, pond, or reservoir, the project sponsor should determine whether or not there is an existing riparian forest buffer by using Appendix B, Evaluation and Classification of Existing Riparian Forest Buffers, and Section II.C.

If the area in question has no trees or shrubs, a riparian forest buffer should be established according to the recommendations in Section II.B.

C. Composition of Newly Established Riparian Forest Buffers

DEP recommends that newly established riparian forest buffers be composed of two distinct zones (Zones 1 and 2) and be designed to filter surface runoff as sheet flow and down slope subsurface flow which occurs as shallow groundwater.

Concentrated flow and accelerated erosion and sedimentation should be controlled in the area up grade and immediately adjacent to the area where a riparian forest buffer will be established. Since concentrated flow may erode the forest floor and impede the ability of the riparian forest buffer to intercept pollutants, an herbaceous strip or appropriate Best Management Practice (Rocco, *Level*) may be needed to protect the newly established riparian forest buffer (Welsch, *Riparian*).



Adapted from Welsch (*Riparian*)

Figure 1. Two-Zoned Riparian Forest Buffer

1. **Zone 1–Undisturbed Native Trees** (See Appendix C.1 "Native Riparian Tree/Shrub Plant Selection" on page 76 of this document).

a. Location

Zone 1 should begin at the top of the streambank or normal pool elevation of a lake, pond, or reservoir and occupy a strip of land with a **minimum** width, consistent with Section II.D, which is measured horizontally on a line perpendicular from the top of streambank or normal pool elevation of a lake, pond or reservoir. Predominant vegetation should be composed of a variety of native tree species.

b. Purpose

The purpose of Zone 1 is to: create a stable ecosystem adjacent to the water's edge; provide soil/water contact area to facilitate nutrient buffering processes; provide shade to moderate and stabilize water temperature encouraging the production of beneficial algal forms; and contribute necessary detritus and large woody debris as food to the ecosystem. Zone 1 stabilizes streambanks and shorelines and reduces flooding impacts by providing a wider, more natural stream channel and flood prone area.

c. Recommendations

(1) Runoff to be filtered by Zone 1 should be limited to sheet flow or natural subsurface flow only. Concentrated flow and accelerated erosion and sedimentation should be controlled in the area up grade and immediately adjacent to the riparian forest buffer. Outflow from subsurface drains should not be allowed to pass through the riparian forest buffer in pipes or tile drains.

(2) Dominant vegetation should be composed of a variety of native riparian tree species. (See Appendix C.1 "Native Riparian Tree/Shrub Plant Selection" on page 76 of this document.)

(3) Management of Zone 1 should be limited to bank stabilization and activities or practices used to maintain the riparian forest buffer including the disturbance of existing vegetation, and tree and shrub removal, as needed to allow for natural succession of native vegetation and the protection of public health and safety.

(4) Livestock should be excluded from Zone 1 except for designated stream crossings.

2. Zone 2–Managed Native Trees and Shrubs)

a. Location

Zone 2 should begin at the landward edge of Zone 1 and occupy an additional strip of land with a **minimum** width, consistent with Section II.D, which is measured horizontally on a line perpendicular from the top of streambank or normal pool elevation of a lake, pond or reservoir. Predominant vegetation must be composed of a variety of native riparian tree and shrub species.

b. Purpose

The purpose of Zone 2 is to remove, transform, or store sediment, nutrients, and other pollutants and provide long-term storage of nutrients in the biomass of trees and shrubs. It also provides habitat and corridor for wildlife habitat and economic benefits to the landowner if the forest resource is sustainably harvested.

c. Recommendations

(1) Concentrated flow and accelerated erosion and sedimentation should be controlled in the area up grade and immediately adjacent to the riparian forest buffer. Since concentrated flow may erode the forest floor and impede the ability of the riparian forest buffer to intercept pollutants, an herbaceous strip or appropriate Best Management Practice (Rocco, *Level*) may be needed to protect the riparian forest buffer in the area up grade and immediately adjacent to Zone 2 (Welsch, *Riparian*).

(2) Dominant vegetation should be composed of a variety of native riparian tree and shrub species. (See Appendix C.1 “Native Riparian Tree/Shrub Plant Selection” on page 76 of this document.)

(3) Management activities such as sustainable harvesting, conducted in accordance with a Forest Management Plan are allowed in Zone 2 as long as 60% of the canopy cover is maintained. Noxious weeds and invasive plant species should be removed or controlled to the extent possible.

(4) Livestock should be excluded from Zone 2 except for designated stream crossings.

(5) See Appendix C, Riparian Forest Buffer Management Plan Toolkit: Restoring and Protecting Pennsylvania’s Riparian Forest Buffers, for additional information on planting and maintaining Zone 2 of a riparian forest buffer.

D. Composition of Existing Riparian Forest Buffers

If there is woody vegetation in the area along the surface waters, see Appendix B, Evaluation and Classification of Existing Riparian Forest Buffers.

Existing riparian forest buffers can be classified as follows:

1. Class 1

- Width of area with woody vegetation is 100 feet or greater which is measured horizontally on a line perpendicular from the top of streambank or normal pool elevation of a lake, pond or reservoir
- Minimum 60% uniform canopy cover (area of ground covered by a vertical projection of the canopy of predominantly native shrubs and trees)
- Pennsylvania Noxious Weeds and invasive species are removed and controlled to the extent possible

2. Class 2

- Width of area with woody vegetation is 100 feet or greater which is measured horizontally on a line perpendicular from the top of streambank or normal pool elevation of a lake, pond or reservoir
- **Less** than 60% uniform canopy cover (area of ground covered by a vertical projection of the canopy of predominantly native shrubs and trees)
- Pennsylvania Noxious Weeds and invasive species are removed and controlled to the extent possible

3. Class 3

- Width of area with woody vegetation is **less** than 100 feet which is measured horizontally on a line perpendicular from the top of streambank or normal pool elevation of a lake, pond or reservoir
- **Less** than 60% uniform canopy cover (area of ground covered by a vertical projection of the canopy of predominantly native shrubs and trees)
- Pennsylvania Noxious Weeds and invasive species present

Existing riparian forest buffers in Class 2 should be enhanced by additional plantings in open spaces around existing native trees and shrubs. In Zone 1, immediately adjacent to the top of streambank or lake shoreline, native trees should be planted on 10-foot centers (approximately 435 stems per acre). In Zone 2, a mix of native trees and shrubs should be planted on 10-foot centers (approximately 435 stems per acre).

Existing riparian forest buffers in Class 3 should be enhanced **and widened** by additional plantings in open spaces around existing native trees and shrubs. In Zone 1, immediately adjacent to the top of streambank or normal pool elevation of a lake, pond or reservoir, native trees should be planted on 10-foot centers (approximately 435 stems per acre). In Zone 2, a mix of native trees and shrubs should be planted on 10-foot centers (approximately 435 stems per acre).

Noxious weeds and invasive species should be removed and controlled to the extent possible in all existing riparian forest buffers.

Concentrated flow and accelerated erosion and sedimentation should be controlled in the area up grade and immediately adjacent to the existing riparian forest buffer. Since concentrated flow may erode the forest floor and impede the ability of the riparian forest buffer to intercept pollutants, an herbaceous strip or appropriate Best Management Practices such as a level lip spreader (Rocco, *Level*) or grassed swale may be needed to protect the existing riparian forest buffer (Welsch, *Riparian*).

E. Average Riparian Forest Buffer Minimum Widths

Regardless of other factors, 100 feet (50 feet Zone 1 and 50 feet Zone 2) is the average **minimum** riparian forest buffer width that DEP recommends for regulatory, voluntary, and grant activities. This width applies to perennial or intermittent streams, rivers (**minimum** 100 feet on both sides of the stream or river), lakes, ponds, and reservoirs (Wenger, *Review* and Mayer, *Riparian*).

The average width should be extended to a **minimum** of 150 feet (50 feet Zone 1 and 100 feet Zone 2) along perennial or intermittent streams, rivers (minimum 150 feet on both sides of the stream or river), lakes, ponds, and reservoirs designated as Exceptional Value or High Quality waters (Sweeney, *Streamside*; Meyer et. al, *Rivers*, and Mayer, *Riparian*).

The width should be extended on a case-by-case basis in areas known to be sources of sediment and in areas of known high nutrient content or where fertilizer, manure, or animal waste or sludge application occurs. The width should be extended in areas where there are steep slopes or soils of very low permeability or high erosion potential, steep stream gradients, or anywhere that specific goals, conditions, and evidence are interpreted to indicate that additional width is needed to achieve the desired environmental functions and benefits.

F. Management of Established and Existing Riparian Forest Buffers

DEP recommends that both existing and newly established riparian forest buffers be managed to enhance and maximize the unique value of these resources. At a minimum a riparian forest management plan should consist of:

1. A planting plan for converted or newly established riparian forest buffers that identifies the number, density, and species of native trees and shrubs appropriate to geographic location that will achieve 60% uniform canopy cover.

2. A maintenance schedule and measures for converted or newly established riparian forest buffers to ensure survival and growth of plantings and protection from competing plants and animals including noxious weeds and invasive species over a five (5) year establishment period including activities or practices used to maintain the riparian forest buffer including the disturbance of existing vegetation, tree removal, shrub removal, clearing, mowing, burning or spraying in accordance with long term operation and maintenance.

3. An inspection schedule and measures to ensure long term maintenance and proper functioning of riparian forest buffers including measures to repair damage to the buffer from storm events greater than the 2 year/24 hour storm.

For detailed information on management of riparian forest buffers, see Appendix C, Riparian Forest Buffer Management Plan Toolkit: Restoring and Protecting Pennsylvania's Riparian Forest Buffers. General recommendations on practices and activities within riparian buffers and Zones 1 and 2 of the riparian forest buffer include:

1. The native trees and shrubs within the riparian forest buffer should not be disturbed. Sustainable forestry in accordance with a Forest Management Plan for that activity that maintains 60% uniform canopy cover is allowed in Zone 2.

2. Soil disturbance should not take place within the riparian buffer including riparian forest buffers by grading, stripping of topsoil, plowing, cultivating, or other practices.

3. Activities used to maintain the riparian buffer such as the disturbance of existing vegetation, and tree and shrub removal, as needed for natural succession of native vegetation and the protection of public health and safety are allowed.

4. Filling or dumping should not occur within the riparian buffer.

5. Except as permitted by DEP riparian buffers should not be drained by ditching, under drains, or other drainage systems.

6. Animals should not be housed, grazed, or otherwise maintained within the riparian buffer.

7. Motorized vehicles should not be stored or operated within the riparian buffer.

8. Materials should not be stored within the riparian buffer.

9. Facilities, activities, and stream restoration projects approved by DEP are permitted within the riparian buffer.

10. Scientific studies approved by DEP, including water quality monitoring, biological stream surveys, and stream gauging are permitted within the riparian buffer.

11. Individual trees in the riparian buffer may be removed which are in danger of falling, causing damage to dwellings or other structures, or causing the blockage of streams that results in significant streambank erosion or navigational hazard.

12. Selective herbicide application by a qualified professional is permitted as one of the tools to control noxious weeds and invasive species of plants in riparian buffers.

13. Passive or low impact recreational activities are encouraged so long as the functioning of the riparian buffer is maintained.

G. Protection of Riparian Forest Buffers

The best way to ensure a riparian buffer's longevity is to protect it with a permanent easement, such as the model Riparian Forest Buffer Protection Agreement (Agreement) developed by DEP and the Pennsylvania Land Trust Association. The Agreement is a tool to help private landowners and conservation organizations work in partnership to establish permanent riparian forest buffers along Pennsylvania's surface waters.

The Agreement helps to achieve these conservation objectives while keeping the property in the landowner's ownership and control. The Agreement is between the landowner (the "Owner") and the conservation organization (the "Holder"). In the Agreement, the Owner places permanent restrictions on activities that would harm the water, forest, or soil, and the Holder commits to watch over the land and enforce the restrictions.

The Agreement can be found in Appendix C.6. Further guidance can be obtained by contacting the Bureau of Watershed Management at 717-772-5807 or at: http://conserveland.org/model_documents/#riparian.

H. Reporting

It is recommended that you submit a completed "Pennsylvania Stream ReLeaf - Project Data Sheet" as found in Appendix C.5 to the Department within one year of establishing or protecting riparian buffers to include riparian forest buffers.

III. HOW TO APPLY THE GUIDANCE

Riparian buffers should be measured horizontally with no more than a 10% variation below the minimum width from the normal pool elevation for lakes, ponds, and reservoirs and from the top of streambank or top of slope for intermittent and perennial streams and rivers, depending on site characteristics as described below, to the edge of project activity.

A. Lakes, Ponds, and Reservoirs

Riparian buffers on lakes, ponds, and reservoirs are measured inland perpendicular to the shoreline beginning at the normal pool elevation.

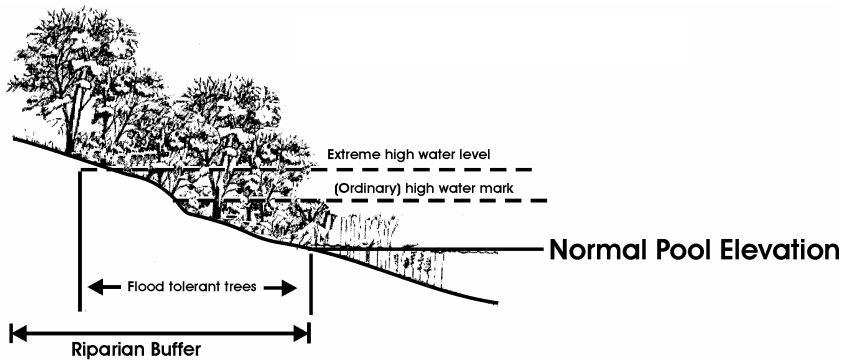


Figure 2. Lake Normal Pool Elevation

B. Intermittent and Perennial Streams and Rivers

Riparian buffers on intermittent and perennial streams and rivers should be measured inland from either the top of streambank or top of slope, depending on the physical stream channel characteristics. The most common scenarios are:

1. Channels where the break in bank slope represents the stage at which bankfull flow accesses a relatively flat and wide floodplain; riparian buffers should be measured from the top of bank.

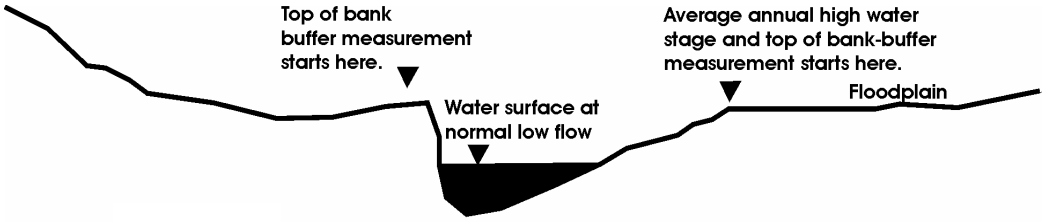


Figure 3. Measuring Riparian Buffer

2. Channels contained in a narrow V-shaped valley that has steep side slopes and little or no floodplain; riparian buffers should be measured from the top of slope.

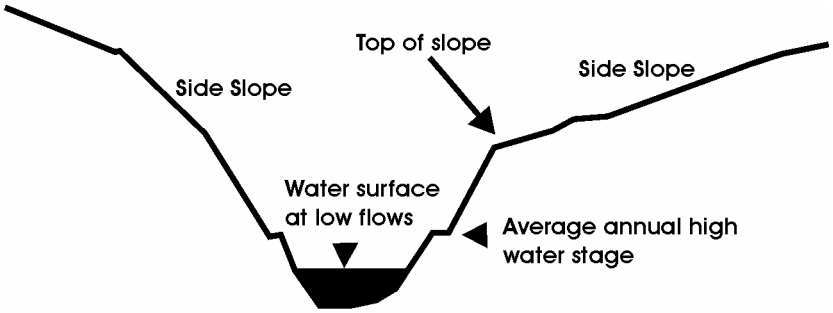


Figure 4. Measuring Riparian Buffer

3. Channels that have an accessible floodplain on one side of the channel but run adjacent to the steep, side slope of a valley or high terrace on the other; riparian buffers should be measured from the **top of slope** where the channel runs adjacent to the valley wall or high terrace and the **top of bank** where the channel has access to the floodplain.

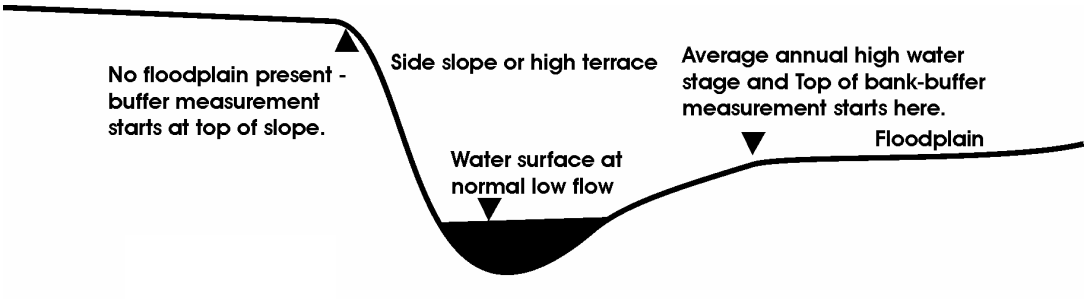


Figure 5. Measuring Riparian Buffer

4. Channels that have recently abandoned their floodplain as a result of a lowering of the streambed and are creating a new floodplain at a lower elevation; riparian buffers should be measured from the **top of slope**, defined as the edge of the most recently abandoned floodplain.

APPENDIX A
Functions and Benefits of Riparian Forest Buffers

Riparian forest buffers serve many functions and provide many benefits including:

1. Protection and Enhancement of Water Quality

a. Filtration of pollutants in runoff: Mature riparian forest buffers can slow overland runoff from any source by increasing the water's contact time with the spongy forest floor. Runoff containing pollutants such as sediments, nutrients, pathogens, and toxics from rooftops, streets, lawns, farm fields, and parking lots can flow into a riparian forest buffer from the area up grade and be considerably cleaner when it enters the perennial or intermittent stream, lake, pond, or reservoir. The forest floor of the riparian forest buffer soaks up the water and makes pollutants contained in it available for processing into less harmful forms. The tree roots can also remove pollutants from shallow groundwater flowing beneath the forest floor to the waterbody.

b. Light control and water temperature moderation: A mature riparian forest buffer that is at least 100 feet in width lowers light levels in the streambank or shoreline area of a waterbody that inhibits the growth and production of harmful algae and helps maximize stream width by shading out grasses. The shading that a riparian forest buffer provides helps to lower water temperatures in summer and moderates harsh winter temperatures by trapping back-radiation (Beschta et al., *Stream*). Both light control and water temperature moderation maximize dissolved oxygen content in lake and stream waters and increase the amount of instream pollutant processing.

c. Pollutant processing: Trees in a mature riparian forest buffer, their fallen leaves and the plants and animals that live on, in, and under the trees form an ecosystem that is capable of processing pollutants such as sediments, nutrients, and toxics in the water that passes through the riparian forest buffer as sheet flow. The leaves of native trees in the riparian forest buffer that wash into the stream serve as a rich food source for benthic macroinvertebrates which are capable of instream pollutant processing.

d. Infiltration and maintenance of streamflow: Riparian forest buffers slow overland runoff allowing for infiltration of surface water that helps to maintain base flow in streams and rivers.

e. Channel and shoreline stability/decrease in erosion: The canopy of a mature riparian forest buffer collects water and protects the ground below in storm events. The rain water also tracks along the trunk of the large trees before reaching the ground. The root network of the riparian forest buffer is tightly intertwined and holds soil particles together keeping them securely in place against the forces of both direct precipitation and stormwater runoff from areas surrounding the riparian forest buffer. This reduces the force of the water as it reaches the waterbody. In this way, riparian forest buffers minimize shoreline and streambank erosion, instream scour, and sedimentation associated with channel instability.

2. Protection and Enhancement of Aquatic Habitat

a. Water quality: The water quality functions described in Section 1 of this appendix are crucial to the protection of aquatic habitat. Moderating water temperatures and light levels in both summer and winter and maintaining sufficient dissolved oxygen levels and stream width are essential to a healthy ecosystem. Removing pollutants from runoff helps to ensure clean water and oxygen for aquatic organisms. Maintaining stream volume ensures flowing water even during the driest months to provide habitat for aquatic biota. Reducing the amount of sediment entering a perennial or intermittent stream, river, or lake protects the eggs and young fish, amphibians, and benthic macroinvertebrates from suffocation. This also helps increase the epifaunal substrate and cover, which provide important habitat for benthic macroinvertebrates and other aquatic organisms.

b. Shoreline and streambank stability: Tree roots in the mature riparian forest buffer stabilize shorelines and streambanks. They also allow for undercut banks that provide cover and cool water refuge for fish, reptiles, and amphibians.

c. Stream width: The shading associated with mature riparian forest buffers along the banks of rivers and streams prevents channel narrowing due to riparian grasses.

d. Food supply: Organic detritus (leaves, twigs, and other materials) derived from riparian forest buffers is a critical source of the energy for supporting aquatic food chains in most aquatic ecosystems.

e. Woody debris: Large woody debris (LWD) from the riparian forest buffer enters the aquatic ecosystem as trees fall into the perennial or intermittent stream, river, lake, pond, or reservoir or are delivered to the waterbody through floodwaters. LWD provides: refuge from high flows for aquatic biota; overhead cover for fish; substrate and food for benthic macroinvertebrates; and substrate for plants. LWD influences the formation of pools, backwaters, and shallow slack water, increasing the complexity of aquatic habitat and influencing the storage and transport of aquatic food sources. During high flows, LWD traps sediments and retards scouring of the channel bed and banks. This reduces the affects of wave action on lake shorelines, maintaining habitat for aquatic biota.

f. Lakeshore, channel, and floodplain stability: Attenuating floodwater is as important for aquatic biota as it is for the channel or lake shoreline itself. Floodwaters that are not allowed to dissipate horizontally over a floodplain build up energy within the channel, often causing excessive scour of the channel bed that can cause fish kills and amphibian mortality due to mobilization of large substrates in the channel bed. The mature trees of the riparian forest buffer stabilize both streambanks and lake shorelines preventing the collapse of undercut banks that provide cover and cool water refuge for fish, reptiles, and amphibians.

3. Moderation of the Effects of Climate Change

a. Aquatic ecosystem adaptation: Riparian forest buffers maintain or enhance instream ecological health. Keeping the aquatic system as healthy as possible will help to keep the ecosystem stable and better able to adapt to a changing climate. Mature riparian forest

buffers contribute significantly to the energy source for the ecosystem and provide habitat and ecological niches leading to a diverse and stable aquatic community (Seavy, N.E. et al., *Why).*

b. **Temperature moderation:** Mature riparian forest buffers, properly sized, provide a significant temperature moderating effect, keeping water and riparian temperatures cooler and diurnal temperature fluctuations less extreme (Jones et al, *Quantifying*).

c. **Reduction in suspended sediment:** Riparian forest buffers stabilize streambanks leading to less suspended sediment entering the water column. Suspended sediment will lead to increased stream temperatures and a depressed aquatic community.

d. **Reduction of carbon source (footprint):** Riparian forest buffers reduce the carbon source of the ecosystem due to their fallow nature. Also carbon sequestration values could be attributed to the mature trees within a riparian forest buffer.

4. Protection and Enhancement of Terrestrial Habitat

a. **Habitat for wildlife and vegetation:** The vertical and horizontal dimensions of riparian forest buffers provide multiple habitat benefits. The trees provide cavities for birds and small mammals to rest, nest, and breed. The native trees and shrubs of the riparian forest buffer also provide fruits, nuts, and seed for a diverse population of native wildlife. A large part of the life cycles of amphibians and reptiles occur in mature riparian forest buffers. The same is true for many aquatic insects, which use riparian vegetation as reproductive swarming sites, nymph emergence sites, and food. In addition, many species of native forbs can survive only in areas near water.

b. **Support of aquatic food chains and webs as they relate to terrestrial food webs:** The vertical and horizontal dimensions of riparian forest buffers provide multiple habitat benefits. Vegetation, such as fallen leaves and branches, are important in providing food and cover for benthic macroinvertebrates and fish. These macroinvertebrates and small fish, in turn, provide food for many larger fish, reptiles, amphibians, mammals, and birds.

c. **Habitat for rare, threatened, and endangered species:** Many of Pennsylvania's rare species of plants and animals are dependent on riparian forest buffers for at least a part of their life cycle.

d. **Preventing the spread of exotic or invasive species:** Nonnative invasive or exotic species and noxious weeds can easily establish in disturbed areas that were historically riparian forest buffers. These plants can significantly disrupt natural communities. Maintaining and restoring riparian forest buffers that are composed of predominantly native species is a key component in controlling the spread of these species.

e. **Travel corridors for migration and dispersal:** Many wildlife species in Pennsylvania are dependent on riparian forest buffers that act as corridors for safe travel for a wide array of wildlife. They also provide for wildlife passage through otherwise uninhabitable regions during periods of food shortage, for seasonal or diurnal movements within home ranges, and dispersal routes for juveniles of many species.

f. **Breeding habitat:** Many wildlife species, especially waterfowl, shore birds, many songbirds, and most amphibians and reptiles require the habitat provided by mature riparian forest buffers as conditions for breeding and for raising their young. Vernal pools found in many riparian forest buffers in Pennsylvania are critical habitat for breeding reptiles and amphibians.

g. **Genetic interchange:** Riparian forest buffers around Pennsylvania's streams, rivers, lakes, ponds, and reservoirs provide important dispersal routes for juveniles and breeding adults of some wildlife species. In this way the riparian forest buffers assist in genetic interchange with other local populations.

5. Protection of Channel and Lake Shoreline Stability

a. **Flood attenuation:** Riparian forest buffers that are a minimum of 100 feet wide provide space for channel meanders, stream movement, and floodwaters to spread out horizontally. This dissipates stream energy and protects channel stability and shoreline integrity in receiving waterbodies. The spongy floor of a riparian forest buffer along a pond, lake, or reservoir slows the affect of direct precipitation and runoff from areas adjacent to the riparian forest buffers and protects shorelines during floods.

b. **Reduced effects of storm events:** Mature riparian forest buffers that are sufficiently wide can slow the speed and reduce the volume of surface runoff from upland areas. The spongy floor of a riparian forest buffer along a pond, lake, or reservoir slows the affect of direct precipitation and runoff from areas adjacent to the riparian forest buffers. This protects stream channel beds and banks from powerful flash flooding that can scour and erode the channel. It also protects lake shorelines from erosive forces during large storms events and flooding.

c. **Streambank and shoreline stabilization:** The trees and shrubs in riparian forest buffers bind soil and increase the strength of the soil matrix. This enhances streambank and lake shoreline stability, which are important for reducing soil and property loss from the bank or shore, reducing sediment input to the waterbody, and maintaining overall channel stability. Mature trees also protect lakeshores from wave action.

d. **Ice damage control:** Riparian forest buffers along streams and rivers trap ice slabs during spring breakup, reducing the potential of jamming at downstream constrictions. Jamming can result in backwater and flooding upstream, which can lead to channel instability. Mature riparian forest lakeshore buffer zones are able to absorb the pressures of mid-winter ice push, protecting upland development from ice damage (Northwest Regional Planning Commission, *The Shoreline*).

6. Social and Economic Benefits

a. **Flood control:** Riparian forest buffers moderate floodwaters and protect human land use and investments from hazards associated with stream dynamics and shore erosion.

b. **Ice damage control:** The trees in Zone 1 of a mature riparian forest buffer insulate and warm the waters on the near shoreline/streambank area. This protects human land use

and investments from ice damage on the near shoreline/streambank and from affects of ice jamming and subsequent upstream flooding.

c. **Maintenance of optimal water quality for drinking water and recreation:** This would include protection of water quality for activities such as boating, swimming, fishing, and wildlife viewing.

d. **Maintenance of wastewater assimilation capacity of streams for reducing wastewater treatment costs:** Mature riparian forest buffers that are properly sized lower water temperature thereby increasing dissolved oxygen. This increases the waterbody's capacity to assimilate organic wastes, such as from wastewater treatment plants, and can greatly lower the cost of wastewater treatment (Ernst, *Protecting*).

e. **Passive recreational activities:** Riparian forest buffers provide natural surroundings for relaxation, observation of wildlife, photography, hunting, fishing, and other activities important to the people of Pennsylvania. Frequently pervious paths are cut through riparian areas and are used for hiking, bicycling, jogging, bird watching, and leisurely walks.

f. **Intrinsic values:** Mature riparian forest buffers composed of predominantly native vegetation enhances the preservation of natural functioning ecosystems and biological diversity.

APPENDIX B
Evaluation and Classification of Existing Riparian Forest Buffers

This evaluation should be performed by a forestry professional with a two or four year degree in forestry from an institution accredited by the Society of American Foresters **or professional trained in the use of this form and procedure.**

Introduction

The objective of this procedure is to determine the classification of existing riparian forest buffers through sampling known as a cruise. The sample consists of milliacre plots (3' 9" radius) taken at a frequency of at least 10 plots per acre (Figure 1). Each plot will cover approximately 43.47 square feet. The riparian forest buffer will be classified by the following characteristics: canopy cover, noxious weeds, and invasive plant species. Upon completion, a cruise will have sampled approximately 1% of the riparian forest buffer and, along with other observations, will provide an estimate of the classification of the riparian forest buffer.

Definitions

Canopy Cover - area of ground covered by the crowns of trees or woody vegetation as delineated by the vertical projection of crown perimeters. It is commonly expressed as a percent of total ground area.

Invasive Plant Species - nonnative species that can thrive in areas beyond their natural range of dispersal. They are characteristically adaptable and aggressive and have a high reproductive capacity. See Table 1 for a list of invasive shrubs and trees that are commonly found in riparian forest buffers in Pennsylvania. For a *Pennsylvania Field Guide to Common Invasive Plants in Riparian Areas,* go to: http://www.acb-online.org/pubs/projects/deliverables-145-1-2004.pdf.

Milliacre Plot - sample plot with a radius of 3' 9" covering 43.47 square feet or approximately 1/1,000 of an acre. A cruise consisting of 10 milliacre sample plots per acre samples 1% of the population which can be used to estimate the entire population.

Noxious Weeds - a plant determined by Pennsylvania law to be injurious to public health, crops, livestock, agricultural land, or other property. Refer to 7 Pa. Code 110 §110.1 for a current list of noxious weeds, available at: http://www.pacode.com/secure/data/007/chapter110/chap110toc.html.

Equipment

- 100-foot measuring tape
- Yardstick
- 66-foot line–chain (optional)
- Compass (optional)
- Handheld Global Positioning System (GPS) unit
- Topographic map or aerial photo of area
- Clipboard
- Site monitoring summary sheet
- Plot sample sheets
- Calculator

- Pencils
- Flagging
- Densiometer (optional)

Procedure

1. Use a topographic map or aerial photograph showing site and handheld GPS unit to record location of riparian forest buffer sampling plots.

2. Determine the boundary of your riparian forest buffer area using features such as fences, field edges, woodland edges, streams, marked changes in land use, or the landowner's property line, if applicable.

3. Map the perimeter of the riparian forest buffer either by recording a minimum of 4 latitude/longitude points with the handheld GPS unit, pacing off the area, or using a measuring tape. Record on the site map the location of the riparian forest buffer relative to the stream and other key landscape features.

4. Calculate the area and acreage of the riparian forest buffer and record the acreage.

   To determine the area in square feet, multiply the average length of the riparian forest buffer by the average width: Area (ft^2) = Average Length (ft) x Average Width (ft)

   To determine the acreage, divide the area by 43,560.

   Acreage (ac) = Area (ft^2) / (43,560 ft^2/ac)

5. Using a compass or handheld GPS unit, determine the azimuth or direction of a baseline that is approximately in line with the long axis of the riparian forest buffer.

6. The milliacre sample plots should be taken at a minimum frequency of 10 plots per acre or every 66 feet (1 chain). Determine the location of the sample plots for the given area by walking the baseline and marking 66-foot intervals. At the end of the baseline, turn 90 degrees and walk in a line perpendicular to the baseline for 66 feet. Turn 90 degrees again and walk parallel to the baseline marking 66-foot intervals.

7. At each plot, estimate percent canopy cover for trees and shrubs by randomly placing the five-by-five-inch grid (found on page 22) on the ground—face up—within the sample plot. Count the number of squares shaded and multiply that number by 4 to estimate percent canopy cover. Alternatively, you can use a Densiometer to estimate percent canopy cover.

8. At each plot estimate the percent cover of noxious weeds and/or invasive species (Table 1).

9. At each plot, record the following: percent cover of noxious weeds and/or invasive species (Table 1), and percent canopy cover of trees and shrubs. ******In order for noxious weeds and/or invasive species to be recognized, the survey should be done during the growing season. For percent canopy cover to be estimated properly, the survey should be done near mid-day, when the shade is direct.******

10. See attached Summary Sheet and Plot Sample Sheet to complete a cruise and summarize the data for the riparian forest buffer. Next, see information below to classify the riparian forest buffer according to the data on the Summary Sheet.

Existing Riparian Forest Buffer Classification

Class 1

- Width of area with trees and shrubs is 100 feet or greater as measured from top of streambank or lake shoreline
- Minimum 60% uniform canopy cover (area of ground covered by a vertical projection of the canopy of predominantly native shrubs and trees).
- Pennsylvania Noxious Weeds and invasive species are removed and controlled to the extent possible

Class 2

- Width of area with trees and shrubs is 100 feet or greater as measured from top of streambank or lake shoreline
- Less than 60% uniform canopy cover (area of ground covered by a vertical projection of the canopy of predominantly native shrubs and trees)
- Pennsylvania Noxious Weeds and invasive species are removed and controlled to the extent possible

Class 3

- Width of area with trees and shrubs is less than 100 feet as measured from top of streambank or lake shoreline
- Less than 60% uniform canopy cover (area of ground covered by a vertical projection of the canopy of predominantly native shrubs and trees)
- Pennsylvania Noxious Weeds and invasive species present

Existing riparian forest buffers in Class 2 should be enhanced by additional plantings in open spaces around existing native trees and shrubs. In Zone 1 immediately adjacent to the top of streambank or normal pool elevation, native trees should be planted on 10-foot centers (approximately 435 stems per acre). In Zone 2, a mix of native trees and shrubs should be planted on 10-foot centers (approximately 435 stems per acre).

Existing riparian forest buffers in Class 3 should be enhanced **and widened** by additional plantings in open spaces around existing native trees and shrubs. In Zone 1 immediately adjacent to the top of streambank or lake shoreline, native trees should be planted on 10-foot centers (approximately 435 stems per acre). In Zone 2, a mix of native trees and shrubs should be planted on 10-foot centers (approximately 435 stems per acre).

Noxious weeds and invasive species should be removed and controlled to the extent possible. See Appendix C, Riparian Forest Buffer Toolkit: Restoring and Protecting Pennsylvania's Riparian Forest Buffers, for additional information.

Concentrated flow and accelerated erosion and sedimentation should be controlled in the area up grade and immediately adjacent to the existing riparian forest buffer. Since concentrated flow may erode the forest floor and impede the ability of the riparian forest buffer to intercept pollutants, an herbaceous strip or appropriate Best Management Practice (Rocco, *Level*) may be needed to protect the existing riparian forest buffer (Welsch, *Riparian*).

Figure 6
Milliacre Plots Per Acre to Meet 1% a Cruise

2	acres	=	20 plots
1¾	acres	=	18 plots
1½	acres	=	15 plots
1¼	acres	=	13 plots
1	acre	=	10 plots
¾	acre	=	8 plots
½	acre	=	5 plots
¼	acre	=	3 plots

Table 1
Invasive Shrubs and Trees Commonly Found in Pennsylvania's Riparian Areas

Shrubs	
Berberis thunbergii	Japanese barberry
Berberis vulgaris	European barberry
Elaegnus angustifolia	Russian olive
Elaeagnus umbellata	Autumn olive
Euonymus alatus	Winged Euonymus
Ligustrum obtusifolium	Border privet
Ligustrum vulgare	Common privet
Lonicera maackii	Amur honeysuckle
Lonicera morrowii	Morrow's honeysuckle
Lonicera morrowii x tatarica	Bell's honeysuckle
Lonicera standishii	Standish honeysuckle
Lonicera tartarica	Tartarian honeysuckle
Polygonum cuspidatum	Japanese knotweed
Rhamnus catharticus	Common buckthorn
Rhamnus frangula	Glossy buckthorn
Rubus phoenicolasius	Wineberry
Spiraea japonica	Japanese spiraea
Viburnum opulus var. opulus	Guelder rose
Trees	
Acer platanoides	Norway maple
Acer pseudoplatanus	Sycamore maple
Ailanthus altissima	Tree-of-heaven
Paulownia tomentosa	Princess tree
Pyrus calleryana	Callery pear
Ulmus pumila	Siberian elm

SUMMARY SHEET

Riparian Forest Buffer Coordinates _____
Stream Name _____
Date _____
Area _____
Evaluator's Name _____

A. Total Number of Plots _____

B1. Percent Canopy Cover of Predominantly Native Trees and Shrubs per plot, Total _____
B2. Percent Canopy Cover of Predominantly Native Trees and Shrubs per plot, Average (B1 ÷ A) ____
B3. Percent Canopy Cover of Predominantly Native Trees and Shrubs per plot (B2 x 100) _____

C1. Estimated Percent Cover Invasive Species per Plot, Total _____
C2. Estimated Percent Cover Invasive Species per Plot, Average (C1 ÷ A) _____
C3. Estimated Percent Cover Invasive Species (C2 ÷ B2) x 100) _____%

D1. Estimated Percent Cover Noxious Species Cover per Plot, Total _____
D2. Estimated Percent Cover Noxious Species Cover per Plot, Average (D1 ÷ A) _____
D3. Estimated Percent Cover Noxious Stems per Acre (D2 x 100) _____

E1. Percent Canopy Cover of Predominantly Native Trees and Shrubs, Total _____%
E2. Percent Canopy Cover of Predominantly Native Trees and Shrubs, Average (E1 ÷ A) _____%

Are there any other invasive shrubs, invasive trees, or noxious weeds in proximity to the riparian forest buffer that may be of concern to land management? If yes, please explain. _____
_____

Are there signs of wildlife damage to plants within, or in proximity to, the riparian forest buffer that may delay the establishment of the riparian forest buffer? If yes, please explain. _____
_____

Are there any tree or shrub diseases or insect pests present within, or in proximity to, the riparian forest buffer that may delay or cause failure of riparian forest buffer establishment? _____
_____

If there is less than 60% canopy cover of predominantly native trees and shrubs on average throughout the site, are there enough native trees and shrubs to provide seed source to achieve 60% canopy cover of trees and shrubs in 5 years? _____

***Please provide a sketch of the riparian forest buffer on the back of this paper.**

Sketch of Riparian Forest Buffer

PLOT SAMPLE SHEET

Riparian Forest Buffer Name _____
Owner _____
Date _____
Plot # _____
Plot Coordinates _____

Name _____

Total Cover _____

Estimated Invasive Species Cover _____

Estimated Noxious Weeds Cover_____

Percent Canopy Cover of Native Trees and Shrubs_____

- Estimate percent canopy cover for native trees and shrubs by randomly placing the five-by-five-inch grid, on the back of this paper, on the ground—face up—within the sample plot. Count the number of squares shaded and multiply that number by 4 to estimate percent canopy cover. Alternatively, use a Densitometer to estimate percent canopy cover for native trees and shrubs.

Species Present, Observations, and Other Notes:

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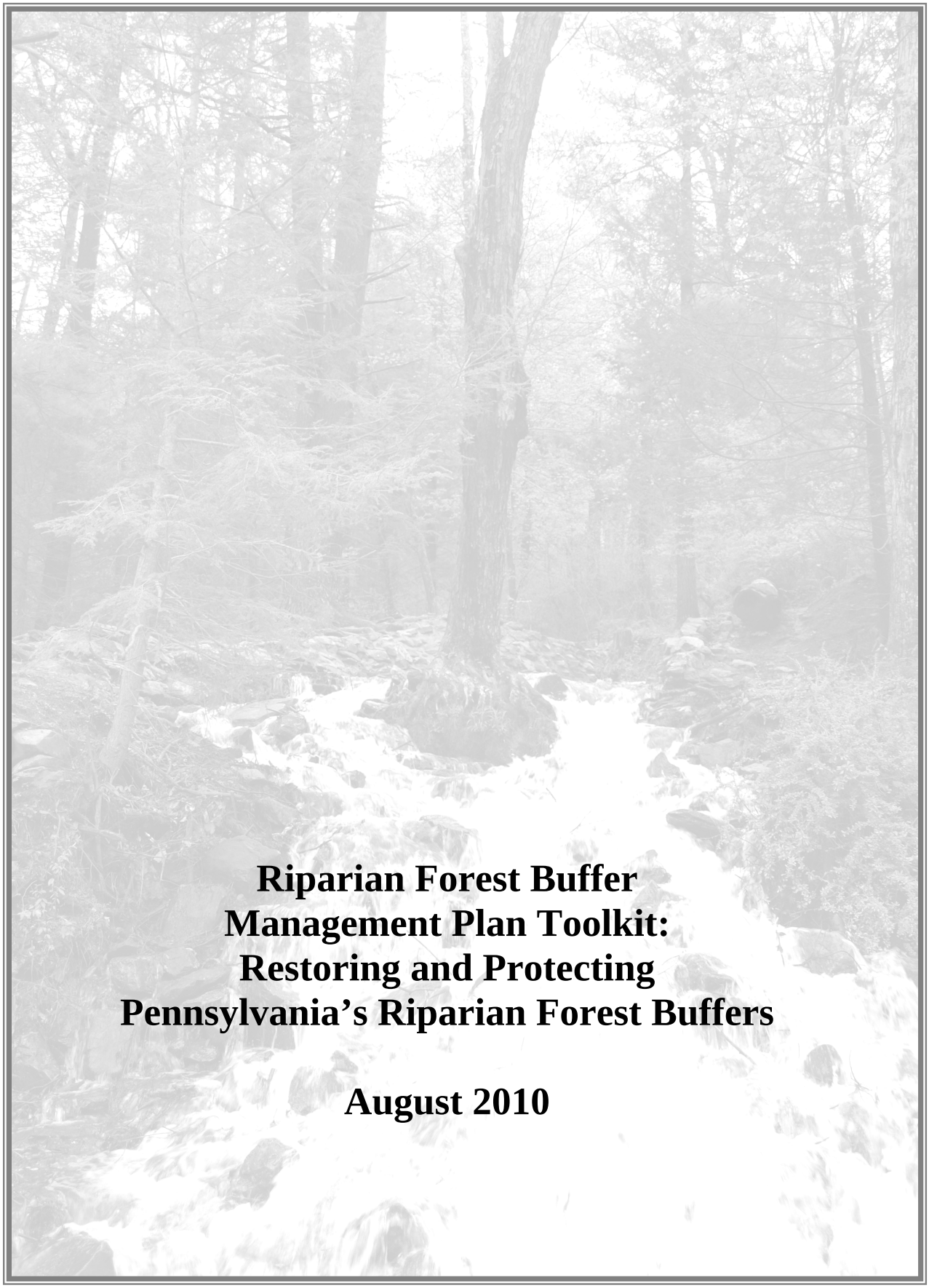
APPENDIX C



Riparian Forest Buffer Management Plan Toolkit: Restoring and Protecting Pennsylvania's Riparian Forest Buffers

August 2010

Riparian Forest Buffer Management Plan Toolkit:
Restoring and Protecting Pennsylvania's Riparian Forest Buffers

Special credit to the *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers* (Chesapeake Bay Program) upon which the planting guide drew heavily and to the *Riparian Forest Buffer* series written by Robert Tjaden, Maryland Cooperative Extension Service.

Acknowledgement is also given to *Native Trees, Shrubs & Vines for Urban & Rural America: A Planting Design Manual for Environmental Designers* by Gary L. Hightshoe, 1998, for the illustrations and facts on selected native trees contained in the text of the toolkit. Reprinted with permission of John Wiley & Sons, Inc.

We also credit the publication *Vascular Flora of Pennsylvania* for the use of the physiographic province map of Pennsylvania.

The information given in the Riparian Forest Buffer Toolkit is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Alliance for the Chesapeake Bay, Inc., PA Department of Conservation and Natural Resources and PA Department of Environmental Protection is implied.

3rd Edition
August 2010

For additional copies of this toolkit or if you find this publication helpful please tell us how used it by contacting the Pennsylvania Department of Environmental Protection, Bureau of Watershed Management at 717-772-5807, or visit DEP through its homepage at www.depweb.state.pa.us, keyword: Stream ReLeaf.

Front photo cover – Credit: Rebecca J. Wertime, Alliance for the Chesapeake Bay
Falls at Caledonia State Park, Chambersburg, PA

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PURPOSE OF TOOLKIT

A riparian buffer is a best management practice (BMP) that is an area of permanent vegetation along surface waters. A riparian buffer may consist of grasses and forbs, or a combination of vegetation types to include grasses, forbs, shrubs and trees.

A riparian forest buffer is a specialized type of riparian buffer consisting of permanent vegetation that is predominantly native trees and shrubs. It is located along surface waters and is maintained in a natural state or sustainably managed to protect and enhance water quality, stabilize stream channels and banks, and separate land use activities from surface waters.

The purpose of this toolkit is to provide users with the latest information on how to write and implement a riparian forest buffer management plan. It includes information on planning for, designing, establishing and maintaining riparian forest buffers. In addition it includes information on the protection of existing and recently established riparian buffers. It is may be used by any individuals or groups who have an interest in restoring and protecting riparian buffers.

RIPARIAN FOREST BUFFER MANAGEMENT PLAN OVERVIEW

At a minimum a riparian forest management plan should consist of:

1. A planting plan for converted or newly established riparian forest buffers that identifies the number, density, and species of native trees and shrubs appropriate to geographic location that will achieve 60% uniform canopy cover.

2. A maintenance schedule and measures for converted or newly established riparian forest buffers to ensure survival and growth of plantings and protection from competing plants and animals including noxious weeds and invasive species over a five (5) year establishment period including activities or practices used to maintain the riparian forest buffer including the disturbance of existing vegetation, tree removal, shrub removal, clearing, mowing, burning or spraying in accordance with long term operation and maintenance.

3. An inspection schedule and measures to ensure long term maintenance and proper functioning of riparian forest buffers including measures to repair damage to the buffer from storm events greater than the 2 year/24 hour storm.

POSSIBLE ELEMENTS OF A RIPARIAN FOREST BUFFER PLANTING PLAN

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Creating a Design That Meets Multiple Objectives 37
Drawing a Planting Plan 45
Site Preparation 48
Determining Maintenance Needs 50

Planning will go a long way to making your riparian forest buffer project a success. It's critical to understand your objectives, and match your project goals and site conditions with the right plants.

When completed, a planting plan should include:

- ✓ *a map of the site with appropriately marked planting zones,*
- ✓ *a plant species list,*
- ✓ *planting directions,*
- ✓ *equipment/tool list,*
- ✓ *site preparation directions, and*
- ✓ *a maintenance schedule*

A sample planting plan is provided in Figure 7.

Ticks…

When going out in the field take the following precautions to prevent contracting Lyme's Disease and/or Rocky Mountain spotted fever:

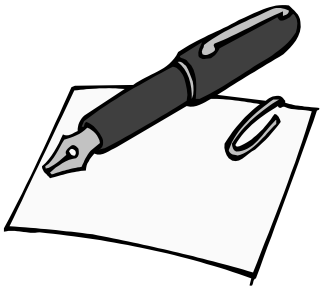
1. Wear protective light-colored clothing while outdoors, including a broad-brimmed hat, a long-sleeved shirt, and long pants tucked into the socks;
2. Check the body daily for the presence of ticks;
3. Use tick repellents, DEET, or permethrins;
4. Use forceps or tweezers to carefully remove ticks attached to the skin. Apply gentle, constant retraction of the tick where it attaches to the skin (not the body of the tick);
5. Seek immediate medical attention if signs or symptoms of early Lyme's disease or R.M. spotted fever appear.

Source: Four Common Ticks of Pennsylvania. The Penn State University Cooperative Extension. 2007.

Obtaining Landowner Permission and Support
If your site is privately owned, contact the landowner and enlist his/her approval and support of the project. Walk along the stream with the landowner and discuss his/her goals and wishes. The landowner's commitment is essential for the project's success. On publicly owned land, it is also necessary to obtain permission and the cooperation of the public agency that has land ownership responsibilities.

Making Sure Your Project Site Is Suitable for Restoration
A simple walk along the stream targeted for riparian forest buffer restoration is an excellent diagnostic technique. A field visit will aid you in analyzing the physical and vegetative features of your site as described below.

When you walk your stream segment, the following tools will help with your investigation:



- Field guide to identify native trees and shrubs
- Clipboard with pad of paper and pencil to sketch a map of the site
- USGS topographic map of your streamwalk area (or a handheld GPS unit can be used with the coordinates entered in ahead of time)
- Tape measure
- Camera
- Waterproof boots
- Thorn-proof clothing
- Work gloves

No matter what the scale of your project, a map of some type is necessary for proper planning and sharing information about your project with others. A map showing how your project fits into the larger geographic area may be required in order to obtain funding from existing grant programs. A good map to start with are the 7.5 minute USGS topo maps, which are available from county planning offices, sporting goods stores, engineering/survey supply stores or download one from the internet.

Consider areas where streamsides lack shrubs or trees, or where bare soil is exposed to erosion along the shore. If streambanks are extensively eroded, you should obtain professional help in evaluating the need for streambank restoration before riparian forest buffers are planted. Look for evidence of instability, such as vertical, eroded banks, excessive sediment deposition, and signs of frequent flooding. Rapidly eroding streambanks can undermine seedlings before they become established. Extensive streambank restoration will require additional time, professional advice, assistance and funding.

Analyzing Your Site's Physical Conditions
a) **Soil evaluation** -- Soil moisture, seasonal high water table, flooding potential, topography, soil pH, and soil texture (proportion of clay, silt and sand) are all important physical characteristics of a site's soil that affect plant viability. For instance, most streamside plants tolerate a wide variety of soil textures, although certain species do not tolerate excessively sandy or clayey soils.

A soil survey will give you basic, background information about these characteristics, which you can then match with specific species of trees and shrubs. Soil surveys are available at your county conservation district; regional Natural Resources Conservation Service offices; or on the internet (see Appendix D, References and Resources). Professionals at these offices can help you understand the soil survey symbols and how they apply to your specific site.

To obtain accurate information on the soil's organic content, pH levels, and nutrient composition, test the soil at various locations within the streamside area. Soil test kits are available from your local Cooperative Extension Service office (or on-line), private nurseries, and private laboratories. An extension agent can tell you how many samples are needed for your project's area.

b) Shovel test -- With shovel in tow, dig up a small area to determine the degree of soil compaction. If possible, take a soils specialist with you to help identify any special soil characteristics, such as the presence of a hardpan, shallow soil, or high water table that can interfere with the function of tree roots.

c) Identification of the hardiness zone -- Tree species are designated to particular hardiness zones based on their tolerance to winter cold. In Pennsylvania, the hardiness zones range from 5 to 7. Nearly all the plant species listed in Appendix C.1 are classified as being hardy in the zone range. However, caution must be exercised when specifying plants near the northern limit of their hardiness zone. Streamside areas typically lie in frost pockets that effectively reduce the regional zone by at least one increment. Microclimate is also affected by solar exposure.

Analyzing Your Site's Vegetative Features

While physical features control plant selection, *existing* vegetation in a streamside area will dictate the choice of strategy for riparian forest buffer establishment. Depending on whether the site is presently a pasture, an overgrown abandoned field, or a mid-succession forest (halfway between field and forest), different approaches are needed to properly establish the desired vegetation. An area's present condition affects conditions such as competition for light, water, and nutrients. Different plant species will respond differently to these conditions.

To evaluate your existing vegetation on-site, refer to Appendix B, Evaluation and Classification of Existing Riparian Forest Buffers.

TREE TIP

Sugar maple, red oak, and hickory trees indicate well-drained soils. Sycamore and yellow poplar grow well in moist soils; Pin oak, willow and swamp white oak grow in wet, poorly-drained soils.

In addition, the upper soil layers will also determine the plant community likely to emerge during riparian forest buffer establishment. This area includes not only the seeds of the plants in the immediate vicinity, but also the substantial extent of the root biomass from which new vegetation can sprout.

The first step is to look around at what is already growing in the vicinity. You might find that soils derived from limestone best support hardwoods like walnut, beech, ash, elm, red cedar, red oak and shagbark hickory; pines, on the other hand, do well in sandstone-based soils.

Identify Desirable Species

Retaining native tree and shrub species that thrive in riparian areas will provide substantial benefits for the stream ecosystem. Appendix C.1 lists native species along with their riparian forest buffer functions and values. Carefully examine the site to locate the seedlings of these species. While certain species may be inappropriate as part of the final stand (for example, black locust where nitrate reduction is a goal -- this species takes nitrogen from the air and fixes it in the soil), they should be retained during riparian forest buffer establishment to provide shade for tolerant species and to protect the stream environment.

The term "native" refers to a plant species that has originated in a particular region where it will perform better, have fewer insect and disease problems and is adapted to surrounding growing conditions.

In addition to those listed, there are also several pioneer tree species that can be found colonizing a streamside area. Although they are short-lived, shade intolerant, upland species, these plants provide shade and structural diversity in a young riparian forest and their presence will benefit the establishment of a riparian forest buffer. Pioneer riparian species include gray birch, big tooth-aspen, black cherry and sweet cherry (high wildlife value), staghorn sumac, black locust (a nitrogen fixer, useful for canopy establishment), box-elder maple and sassafras.

Several native shrub and vine species also thrive in the transitional disturbed conditions found in streamside areas. Common species include blackberry, greenbrier, poison ivy, wild grape, Virginia creeper, and spicebush. While less desirable as components of a riparian forest, these native species can provide an effective ground cover during establishment of the riparian forest buffer and also provide many wildlife benefits. It is important to note that some of these species can and will grow up and over newly planted trees. Therefore, they should be selectively controlled if this occurs. Eventually, forest canopy species will shade out the intolerant species.

Identify Undesirable Species

Since the introduction of exotic plants for landscape and reclamation purposes over the last century, many exotic species have aggressively invaded streamside areas in Pennsylvania. In many areas, these plants have completely taken over the riparian areas to the exclusion of desired native species, effectively stalling the natural progression of native plant communities. Most invasive species reproduce heavily from ground root systems, as well as by seeds.

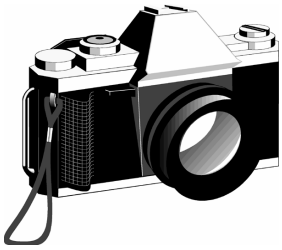
These plants are so aggressive when established that it is preferable to control them as much as possible before the riparian forest buffer planting. If present in adjacent upland areas, these plants should be controlled to reduce the seed source in the streamside zone. In pasture conditions, sod-forming cold season grasses are also undesirable in the streamside area since they compete with tree seedlings and confine streams, causing narrow incised channels.

For information on the identification and control of noxious weeds and invasive plants see Appendix D, References and Resources.

Identify Sensitive Species or Habitats to Protect

The Pennsylvania Natural Heritage Program (PNHP) (formerly known as Pennsylvania Natural Diversity Inventory, PNDI) is a collection of data that describes the state's rarest and most significant ecological features, including plant and animal species of special concern, rare and exemplary natural communities and outstanding geologic features. Since riparian zones in particular are rich in wildlife habitat and wetland plant species, it's important to consult the PNHP database to be aware of any rare, threatened or endangered species of plants or animals in the vicinity of your project. Information about how to access the PNHP database can be found in Appendix D, References and Resources. You can also request that a local agency representative check the PNHP for your site, perhaps from the DCNR - Bureau of Forestry or County Planning Commission.

Don't be afraid to take too many photos or draw too many pictures. These will help you remember what you saw and aid in your next step – designing the riparian forest buffer.



Drawing A Map of the Site

As you collect the information noted above, sketch a map of the site that shows the stream width and length, streambank condition, existing streamside vegetation, width of desired riparian forest buffer, and adjacent land uses. (You may want to download a satellite imagery of your site if it is available to use along side of the site map.) Other conditions may also be worthwhile to note, such as stream activities (livestock or recreational access sites), discharge pipes or other obstructions to digging, or conditions of the stream such as evidence of algae or scum floating or covering rocks.

Also, note any access areas near the site where plants and materials can be delivered.

Creating A Design That Meets Multiple Objectives

The two-zone system explained in Section II.B was developed to help plan riparian forest buffers. This two-zone concept is intended to be flexible in order to achieve both water quality and landowner objectives.

Consider Landowner Objectives

Designing a streamside riparian forest buffer may involve more than applying scientific criteria. If your project does not involve regulatory activities, determining the landowner's goals and wishes is critical to the success of your project. Constraints imposed by land use do not always allow for an "ideal" 2-zone riparian forest buffer design; in these cases, modifications must be made to meet as many objectives as possible. Answers to questions like those listed below will guide your determination of the total size of a riparian forest buffer to plant and what species to include.

Questions to ask if project is established through voluntary measures...

- What is the landowner's current use of the riparian zone?
- What is the landowner's need for an economic return from the riparian area?
- What is the owner's interest in conserving the site in perpetuity?
- What is the owner's interest in harvesting timber or other forest products from the riparian area?
- What is the owner's ability to carry out management responsibilities?
- What is the owner's interest in recreational pursuits or wildlife enhancements?
- What is the owner's interest in maintaining a view of the stream from his/her private residence?
- Is the landowner interested in linking his/her riparian site to a planned greenway or recreational trail?
- Would the landowner be interested in participating in any government or privately funded conservation programs to help restore or conserve his/her existing streamside property? Is the land currently enrolled in any existing conservation program?
- Are there any legal limitations currently placed on the riparian site by existing federal or state regulations, deed restrictions, and or municipal zoning?
- Does the landowner have any objections to volunteers maintaining the site once it is planted?
- Is the landowner able and willing to maintain the plantings to ensure that they become established?

As you discuss options with the landowner, specific objectives will evolve and need to be considered in choosing the appropriate width and native plant species for the riparian forest buffer.

In agricultural settings, many farmers have conservation plans developed in cooperation with the USDA Natural Resources Conservation Service and county conservation districts. A conservation plan usually addresses the total resource concerns of the landowner, so it is important to integrate plans for a riparian forest buffer into the overall farm conservation plan.

Ideal Riparian Forest Buffer Width

The ideal riparian forest buffer width for use in water quality and aquatic habitat maintenance is a **minimum** of 100 feet. Riparian forest buffers that are 100 feet or more in width sustain long-term protection of aquatic resources because they contain a "critical mass" or sustainable width that is essential for long term sediment and nutrient reductions. The width should be extended to a **minimum** of 150 feet (50 feet for Zone 1 and 100 feet for Zone 2) adjacent to streams designated as Exceptional Value Waters and as High Quality Waters (refer to Section II.D).

From a scientific standpoint, you should consider the facts about your stream with regard to 1) its resource value, 2) the substrate of the stream, 3) the soils and slope in adjacent land, 4) the intensity of adjacent land use, and 5) the desired riparian forest buffer functions. The function of the riparian forest buffer, that is, the reason for installing a riparian forest buffer, should be the overriding criterion in determining riparian forest buffer width with other factors influencing the final decision to a greater or lesser degree.

Situations may warrant the decision to go with a **wider** width, such as those outlined in Section II.D and:

- A stream within a watershed providing municipal water supply,
- An area where steep slopes add a greater risk of runoff pollution, and/or
- A site where riparian forest buffer width is expanded to incorporate sensitive landscape features such as floodplains and wetlands.

Of all the scientific criteria that can be applied to making riparian forest buffer width determinations, the most important are the specific functions that a riparian forest buffer needs to provide under site-specific conditions. Some judgment and setting of priorities is nearly always necessary to attain the 100 foot minimum riparian forest buffer width for a desired set of functions.

To provide an array of functions, riparian forest buffers should be a minimum of 100 feet in width under most circumstances. Riparian forest buffer widths toward the lower end of the range (100 to 150 feet) provide physical and biological benefits to the waterbody, while riparian forest buffer widths greater than 100-150 feet are likely to provide more protection of physical, chemical and biological characteristics of the aquatic resource. Streamside riparian forest buffers narrower than 100 feet are generally less effective and require greater long-term maintenance.

TREE TIP

Forests provide as much as 40 times the water storage of a cropped field and 15 times that of turf grass.

Consider the Costs
Establishment and maintenance costs should be considered up front in the plan design. Although every project is site-specific, the following estimates provide realistic per acre costs on which to base your own budget figures.

All costs shown in Tables 2 and 3 are the estimated price of practices installed by a contractor - including labor. If planting is conducted by volunteers the price of planting may be lower depending on the size and cost of seedling planted.

Table 2. Establishing New Riparian Forest Buffer
Per Acre Estimated Costs
$385 – 4,723/acre*
All costs shown are the price of practices installed - including labor.

	***Estimated Per Item Cost**	**Estimated Total Cost**	**Estimated Total Cost**
	Establishment	110 trees per acre – (20' by 20' spacing)	435 trees per acre – (10' by 10' spacing)
Planting	Hardwood tree seedlings $3.50/seedling (12–18 inch) (no shelter)	$385	$1,523
Subtotal (Establishment)		**$385**	**$1,523**
	Optional/ Maintenance Costs		
Reinforcement Planting	**50 seedlings/acre (30' x 30' spacing) @$3.50/seedling (12-18 inch)**	$175	$175
Invasives Removal	$200 per acre	$200	$200
Seedling Protection	Shelter/stake **$5 / tree installed**	$550	$2,175
Competition Control	Herbicide treatment/Mowing $130.00/per acre annually for 5 years	$650	$650
Subtotal (Optional Costs)		**$1,575**	**$3,200**
Total Costs (Establishment + Optional Costs)		**$1,960**	**$4,723**
	*Estimated Per Item Cost	**Estimated Total Cost**	**Estimated Total Cost**

***Cost Estimates based on 2009 dollars**

Table 3. Enhancing Existing Riparian Forest Buffer
Per Acre Estimated Costs
$0 - $2,725/acre*
All costs shown are the price of practices installed – including labor.

	Estimated Per Item Cost	Estimated Total Cost
	Enhancement	
Enhancement Planting	Hardwood tree seedlings (200 trees per acre) $3.50/seedling (12 – 18 inch) (no shelter)	$700
	Maintenance	
Reinforcement Planting	Year two after enhancement 50 seedlings/acre (30' x 30' spacing)	$175
Subtotal (Enhancement)		**$875**
	Optional Costs	
Seedling Protection	Shelter/stake $5 / tree installed	$1,000
Invasives Removal	$200 per acre	$200
Competition Control	Herbicide treatment/Mowing 130.00/per acre annually for 5 years	$650
Subtotal (Optional Costs)		**$1,850**
Total Costs (Enhancement + Optional Costs)		**$2,725**

***Cost Estimates based on 2009 dollars**

Pick the Right Plants
An important step in planning and establishment is the Plant Schedule, which lists the plant species, quantity, size and type (See Figure 7, Sample Riparian Forest Buffer Planting Plan). Planting specifications should detail the installation procedures, protection measures, and maintenance practices to be followed.

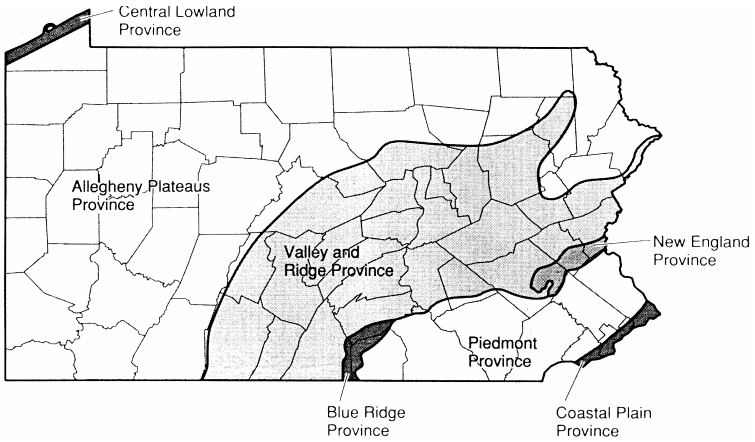
Keep in mind the two-zone riparian forest buffer system when selecting the right plants for the right riparian forest buffer zone.

Zone 1 is nearest the streambank, has recommended 50-75 feet width, and is a no harvest tree zone to achieve streambank stabilization.
Zone 2 is recommended to be at the minimum of 50-75 feet wide; harvested trees and shrubs promote nutrient removal as newly planted trees take up more nitrogen for early growth.

Which Species?
Designing the planting plan starts with selecting the best plants for each particular combination of sun/shade, moisture, flooding and soil pH. Your streamwalk and up front research will give you this basic information.

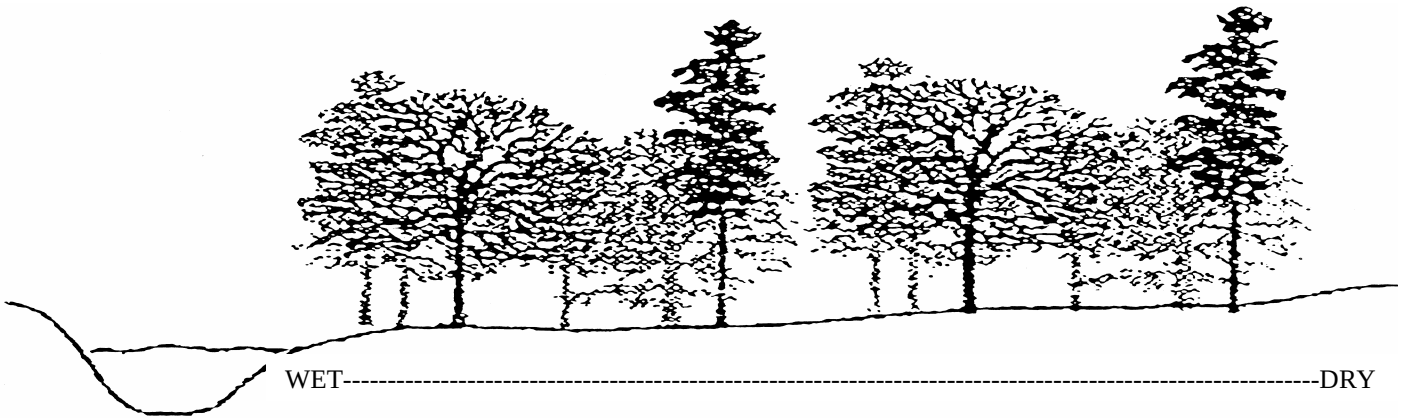
Species Range
If species native to the area in which you are working are planted, they are more likely to establish and grow with less need for maintenance and water. The physiographic regions in which each species is most likely to occur (Piedmont, Valley and Ridge, and/or Appalachian Mountains) are listed in Appendix C.1. This information will help to determine regional limitations.

Physiographic Regions of Pennsylvania



Flood Tolerance
Although all of the shrubs and trees in Appendix C.1 are commonly found in Pennsylvania's riparian areas, some species are not able to survive frequent or prolonged flooding. Trees that are planted closest to the waterway are more likely to be flooded and should be able to withstand a high water table. More flood-tolerant trees should be planted in any site that tends to be very wet as well. Figure 7 provides some examples of tree and shrub species that fit into the typical moisture conditions of a streamside area. Species not suited for reasons of pH, moisture, or flooding will be excluded from certain areas of the riparian zone.

The remaining species are selected according to wildlife value, price, economic value, availability and other landowner objectives. Appendix C.1 lists native riparian plants and their tolerance and preference levels for growth and wildlife characteristics. For assistance in locating a native plant nursery contact your local cooperative extension or the Pennsylvania Landscape and Nursery Association can also direct you to local nurseries that stock native trees and shrubs.



TREES

Silver maple
Box elder→
Persimmon→
River birch→
Red (Green) ash
Pawpaw→
Sycamore→
Cottonwood
Swamp white oak
Black willow

SMALL TREES/SHRUBS

Smooth alder
Chokeberry, red
Chokeberry, black→
Dogwood, red-osier/silky
Summersweet→
Winterberry→
Swamp rose
Swamp azalea
Meadowsweet→
Highbush blueberry→
Witherod→
N. arrowwood
Willow, sandbar

TREES

←Maple, red→
Bitternut hickory→
←Birch, black/sweet→
←Black, yellow→
←Redbud→
←Hackberry→
American beech→
←Ash, White→
←Honey Locust→
Kentucky coffee tree→
Tuliptree→
Black gum→
←Large-toothed aspen→
←Oak, pin→
←Oak, shingle
←Red (slippery) elm

SMALL TREES/SHRUBS

Mountain Laurel→
American hornbeam→
Shadbush (A.arborea & canadensis) →
Dogwood, gray & flowering→
American hazelnut→
←Common spicebush
←Rosebay Rhododendron
←Southern Arrowwood
←Ninebark
American Elder→
←Bayberry→

TREES

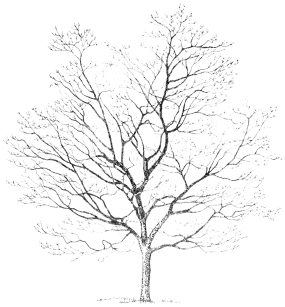
←White pine
Black cherry
Sassafras
Canada hemlock
Oak, white
←Oak, red
Oak, chestnut
←Hickory, shagbark
←Maple, sugar
←Black walnut

SMALL TREES/SHRUBS

Witchhazel
Staghorn sumac
Nannyberry
Blackhaw

Arrows denote that certain species can tolerate either a wetter or drier environment.

Figure 7. Sample Planting Recommendations According to Moisture Conditions



Flowering dogwood,
Cornus florida

What Size Plants?

Your choice of planting stock, which ranges from seeds to large caliber nursery stock, depends to a large extent on available funding resources. Larger plant material, such as balled and burlapped (B&B) trees or large container stock (>2 gallons), will cost more, although they will attain the desired goals more rapidly. Alternatives include bare root stock, seedlings, plugs, seeds and live stakes (cuttings).

Where funding is limited, least expensive material can be widely used, while the most expensive material can be used sparingly in high visibility locations or in other high priority areas where, for instance, you may want faster results or ease of maintenance over the first few years. Where cost differential is not a factor, plants remaining on the list should be used in roughly equal proportions within each combination of physical conditions to provide the greatest diversity and resistance to plant diseases.

TREE TIP

When establishing a new riparian forest buffer, it is usually both economical and practical to select a group of no more than 6 to 12 species.

Zone 1 provides detritus and shade to the stream and should consist solely of hardwood tree species. As it is located along the streambank, Zone 1 is likely to be flooded and should therefore be dominated by flood tolerant tree species, such as sycamore, river birch and maple.

Zone 2 contains a managed forest and may include hardwoods and conifers that have more intermediate flood tolerances.

The area upgrade and immediately adjacent to *Zone 2* may include a strip of herbaceous vegetation or Best Management Practice (such as a level spreader) to intercept concentrated flow and sediment from runoff. Shrubs and small trees may also be desirable in this area to provide a diversity of habitats for birds and native wildlife.

For more information on level spreaders see Appendix D, References and Resources.

Balled & Burlapped
The most expensive approach is to plant the canopy, midstory and understory in the final locations, using balled and burlapped (B&B) and large container stock. B&B material will attain a higher canopy height in the shortest time. Large material is most appropriate in riparian forests where intensive multiple uses are anticipated, as in urban development or part of an urban park system.

This approach is inappropriate on most riparian sites since B&B material is relatively expensive and the root ball is heavy. Also, the potential damage and stress to the root ball when dug from the nursery and in transportation is to be considered when purchasing B&B plants. Some species such as persimmon, oaks and black gum have very sensitive root systems and may not have as high survival rate as B&B material.

Container Stock
Plants purchased in containers are not as expensive as B&B stock and can reach canopy closure quicker than using smaller bare root stock. Also, containerize plants with well established root systems will have a higher survival rate during times of drought. Container size can range from a SP4 (3" sq. x 9" deep) to a #7 (approximately 6 gallons). Sizes available may vary from nursery to nursery.

Depending on the size and location of the area to be planted will determine the container size selected due to weight and size of hole to be dug for planting purposes. It is important to inspect the root ball prior to planting for girdling (or encircling) roots that can limit the growth of the plant.

Bare Root Stock
A more cost-effective approach is to use bare root material. Planting density should be higher than the final stem density desired, to allow for losses due to competition, stress and deer. Bare root material can grow relatively rapidly after the root system is established, reaching canopy closure soon after similar size B&B material. Bare root plantings are best in situations where visible plantings are desired after riparian forest buffer planting.

Recently, larger caliper bare root stock has become available and shows good survivability. This maybe a good alternative to B&B material for it is less expensive and can be intermixed with smaller planting stock.

Seedlings and Plugs
Seedlings can be purchased as container grown seedlings or bare root seedlings. Container grown seedlings are often grown in paper pots that disintegrate and allow for both seedling and pot to be planted. This increases survival rate because the plant never loses contact with the soil and suffers less stress. Plastic containers work well for producing plugs that are pulled out of the container before planting.

In situations where a longer time to attain canopy closure is acceptable, smaller bare root seedlings are used. They are the least expensive type of plants. Seedling stock is either lifted directly from the nursery bed and shipped or is shipped as transplants (two years in the nursery and one year in a transplant bed).

Seedlings and plugs should be grown from nursery propagated stock and the original source should be from your local area or physiographic region.

Depending upon plant condition, species, and site stresses, the survival rates for seedlings and plugs range from less than 30 percent to over 90 percent.

Seedlings and two-year transplants are considerably less expensive than larger stock depending on source and type of plant. Herbaceous control is more extensive, though, requiring at least several years of control in order to increase the survivability of the seedlings.

Tree shelters accelerate growth and increase the survivability of seedlings but add to the installation costs. Where shelters are used, the density can be decreased and the results improved (see Planting Methods section, Tree Shelters subsection).

Seeds and Live Stakes

For certain riparian species with large seeds, such as walnut and oak, planting of the seed is a viable alternative. While the planting material may be the least expensive, tree shelters are required to obtain acceptable survivability. Given the absence of transplant shock and the favorable conditions inside a shelter, growth rates from seed can be surprisingly fast. Walnut seedlings in shelters have grown up to 4 feet within the first growing season. For forbs, seed is the material of choice. When purchasing seeds make sure it is collected from the local area to increase rates of survivorship.

Live stakes are a very inexpensive way to create new plants right from your own planting stock. Species such as red-osier and silky dogwoods and willows will readily root from a cutting taken from the parent plant. These stakes can be directly planted in the streambank itself without having to dig a planting hole.

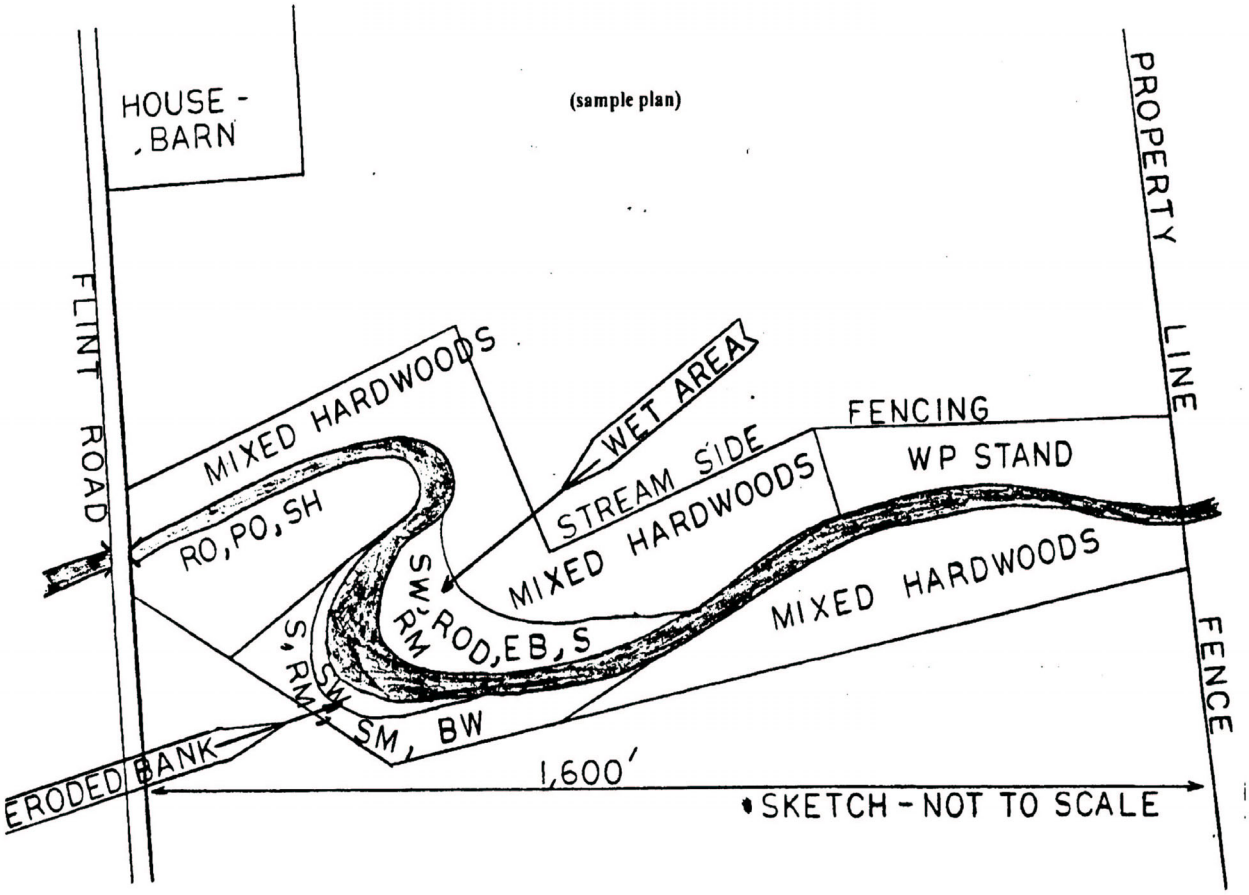
If you do not have species that will easily root or you are limited on time, you can purchase live stakes from nurseries that sell them.

Drawing a Planting Plan

Given the planting density and a conceptual plant mix, drawing up the planting plan is straightforward. The plan can be a simple line drawing of the site with areas denoted for tree and shrub species with appropriate notes on spacing and riparian forest buffer width.

Figure 8 provides an example of this type of planting plan of a riparian forest buffer in an agricultural setting. On this site, a minimum width of 100 feet is planned for a mixed hardwood riparian forest buffer within a streamside fence.

Figure 8. Sample Planting Plan



Tree/Shrub	Number	Symbol	Tree/Shrub	Number	Symbol
White Pine	*60*	*WP*	*Red Oak*	*150*	*RO*
Pin Oak	*170*	*PO*	*White Ash*	*180*	*WA*
Red Maple	*140*	*RM*	*Silver Maple*	*70*	*SM*
Sycamore	*100*	*S*	*Black Willow*	*100*	*BW*
Shagbark Hickory	*60*	*SH*	*Sandbar Willow*	*150*	*SW*
Red-osier Dogwood	*170*	*ROD*	*Elderberry*	*150*	*EB*

Spacing: *All hardwood and shrub species will be planted at a more or less random 8'-10' spacing. Sandbar Willow and Red-osier Dogwood will be planted immediately along the stream in flagged out areas. White Pine will be planted in groupings at a spacing of 8' and a minimum of 15' from any hardwood.*

Tree protectors: *Use for Red Oak, Pin Oak, White Ash, Red Maple, Silver Maple, Shagbark Hickory*

Total number of trees and shrubs to plant: 1500

Number of tree protectors (and wood stakes): 970

Number of people needed to plant: *30* *(5 hours of work with each person planting 8-10 trees per hour)*

Many riparian plant species have a wide degree of tolerance in soil moisture, pH, and shade. Therefore, these species can be used effectively in many locations through the streamside area.

Where site conditions permit a wide choice of material, the individual species selection is not as important as the overall mix in a particular area. Overall, the planting plan should appear random; the crucial issue being that all plants are native and are located where they will thrive.

Another way to draw a planting plan is to delineate the canopy plants with graphic symbols of a diameter representing the spacing and random arrangement throughout the streamside area. (If mowing is not used for herbaceous control, an artificial grid pattern is not necessary.) Understory plants are similarly arranged, using symbols of smaller diameter. Typically, there should be at least three or four understory trees for every canopy tree. This will provide structural diversity similar to mature forests. Shrub species are most intensively arranged at the margins of streamside riparian forest buffers, where edge effects are the greatest. To avoid clutter and provide more graphic clarity in the dense plantings of the riparian forest buffer, complete names can be omitted from the plan. Instead, species can be listed by initials generally representing the genus and species, with the key listed on the planting plan. Figure 9 provides an example of such a planting plan with the plant key.

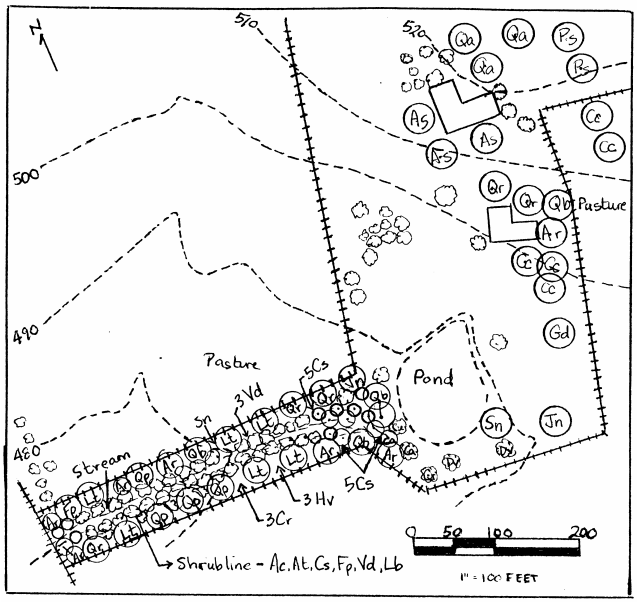


Figure 9. **Sample Conceptual Planting Plan**

KEY

Serviceberry, *Amelanchier canadensis*	Ac	Black walnut, *Juglans nigra*	Jn
Red maple, *Acer rubrum*	Ar	Common spicebush, *Lindera benzoin*	Lb
Sugar maple, *Acer saccharum*	As	Tuliptree, *Liriodendron tulipfera*	Lt
Paw paw, *Asimina triloba*	At	Eastern white pine, *Pinus strobus*	Ps
Summersweet, *Clethra alnifolia*	Ca	White oak, *Quercus alba*	Qa
Redbud, *Cercis canadensis*	Cc	Swamp white oak, *Quercus bicolor*	Qb
Grey dogwood, *Cornus racemosa*	Cr	Pin oak, *Quercus palustris*	Qp
Red-osier dogwood, *Cornus sericea*	Cs	Northern red oak, *Quercus rubra*	Qr
Persimmon, *Diospyros virginiana*	Dv	Black willow, *Salix nigra*	Sn
Red/Green ash, *Fraxinum pennsylvanica*	Fp	S. Arrowwood, *Viburnum dentatum*	Vd
Kentucky coffee-tree, *Gymnocladus dioica*	Gd		

Site Preparation

Tool & Equipment List for Site Preparation:

- brush ax
- bush hog
- weed whacker
- herbicide
- backpack sprayer
- lopping shears
- pick axe or mattock
- mower
- tractor with disk & seeder

Herbicides Suitable for Riparian Areas

"Most Preferred"
- Glyphosate (Rodeo, Aquamaster, Glyphomate 41 or Touchdown Pro)

"Preferred"
- Metsulfuron (Escort)
- Sulfometuron (Oust XP)
- Triclopyr (Garlon 3A, Pathfinder II)
- Pendimethalin (Pedulum Aquacap)

"Acceptable"
- Imazapry (Arsenal)
- 2, 4 D (Generic)

Highly mobile or toxic herbicides to avoid within riparian areas:
- Hexazinone
- Picloram
- Atrazine

Sources:
Chesapeake Riparian Handbook – A Guide for Establishing and Maintaining Riparian Forest Buffers, U.S. Forest Service and Personnel, Penn State University, Department of Horticulture, College of Agricultural Sciences.

Before beginning site preparation review Section II.A-D again. If necessary complete Appendix B, Evaluation and Classification of Existing Riparian Forest Buffers.

Often, a streamside riparian forest buffer area to be reforested will have a mixture of undesirable species, pasture, overgrown fields and a line of pioneer species of trees along the stream requiring a combination of site preparation techniques. Wetlands and streams should not be exposed to herbicides if it can be avoided. In stubborn situations, a variety of physical and herbicidal methods will be effective in manipulating the plant composition to control undesired species.

It's best to acquire the help of a professional in determining whether chemical controls are absolutely necessary to prepare a site for planting. Site-specific hydrology and soil conditions will dictate what types of herbicidal applications can be done without detriment to surface water quality. Even though aquatic insects and fishes seem to be unaffected by the "Most Preferred" herbicides, diatoms (a type of single-celled algae) are likely to be affected. Not withstanding the apparently low toxicity of such herbicides to aquatic organisms, timing application after peak diatom activity in early spring should result in lesser effects upon stream ecosystems. Where invasive species are a problem, consult a professional. *Important reminder: Before using an herbicide, read the label and follow instructions carefully. Do not use a "restricted use" pesticide unless you are a formally trained, certified pesticide applicator.*

In some situations, site preparation can require up to a year of vegetative control prior to planting. Any necessary streambank stabilization needs to be included in the planting plan so work can proceed in a logical order.

Pasture Conditions

The recommended method of preparing a former pasture site for a riparian forest buffer planting is through the use of herbicides.

Sites that were pastures have been highly impacted by disturbance of animal traffic compacting and exposing the soil, well-developed root systems of weeds and weed seeds from animal feed and the growth of cool-season perennial grasses. In order to prepare the site for planting of trees and shrubs, keep soil disturbance to a minimum to reduce erosion and germination of dormant weed seeds. It is important to note that soil runoff from tilled fields into local waterways is a major source of pollution whereas the proper application of herbicides by trained, certified pesticide applicators is less of a pollution risk.

Before applying herbicides, lay out the site for the final planting configuration (see Riparian Forest Buffer Establishment section, Planting Layout: Marking the Site subsection). This will help decide whether the herbicides should be applied in a "strip" pattern or a 4' square spot around each planting location. Keep in mind cool season perennial grasses need to be reduced or eliminated in order for the newly planted trees and shrubs to not only survive but to grow. These grasses will compete for the same vital nutrients and moisture and potentially shade out the small seedling if not contained in a tree shelter after planting. Also, tall grasses provide wonderful habitat for rodents such as voles that will kill the young plant by girdling it (see Animal Damage section, Voles subsection).

(Field photograph – Phil Pannill, MD DNR.)

For site preparation in the fall, prior to spring planting and maintenance around tree shelters after planting, it is recommended by Penn State University to use sulfometuron (XP) with glyphosate (Rodeo). If the site contains both herbaceous and woody undesirable species a mixture of glyphosate and triclopyr can be used to control these species as well as for post-planting weed control. For specific application rates please read the herbicide label or contact a trained, certified pesticide applicator.

Another approach in restoring a riparian forest buffer on a pasture land is to apply no herbicide -- simply plant young trees and seedlings at a higher density directly into the grass cover and mulch around the plant stems to control weed and grass growth. With this approach, mowing and weeding will be necessary until the trees mature and provide their own natural weed control by shading out underneath growth. Some thinning may be required as the trees compete for space. Please note, high mortality may occur due to vole damage utilizing this method (see Animal Damage section, Voles subsection).

Abandoned Fields

Reforesting an abandoned field in a riparian area will take some expertise for this landscape type will contain varying ages of natural regenerating species of native tree, shrubs and herbaceous plants including the undesirable species of invasive and noxious weeds. In this situation, site preparation focuses on releasing the desired saplings and other plants from competition by undesired species. Release methods vary according to the target species and extent of infestation by the undesirable species.

Before the application of herbicides first decide how the site will be maintained – mowing, herbicide or both. Mark the plants to be eradicated based on the maintenance requirement, keeping as many native species as possible. Apply the herbicides in a two-fold manner:

First, reduce the presence of undesirable species with a variety of control techniques such as spraying basal bark herbicides (spraying the base of plant) during the dormant season, cutting large shrubs and vines then treating the stumps to prevent resprouting and mowing everything around the "keepers" after they have leafed out in late spring (see Riparian Forest Buffer Management Plan section, Invasive Plant Control Methods subsection).

Secondly, prepare the site for additional planting by applying the specifications listed in the pasture conditions above.

If planting a riparian forest buffer in a park or public setting take great care in applying herbicides of any kind and be prepared to educate the public on why they are necessary for site preparation and long-term survivability of the newly planted trees and shrubs. Mowing may need to occur more often in this type of landscape but it would be best to leave a rough cut lawn between the rows or the plants (8" to 10"). In the fall the lawn should be mowed one last time for the season to prevent vole damage (yes – they are even

present in the well-managed turf landscapes). In addition, the installation of signage would provide a good educational opportunity not only to explain the importance of riparian forest buffers but also why the site may look "messy" to the visiting public.

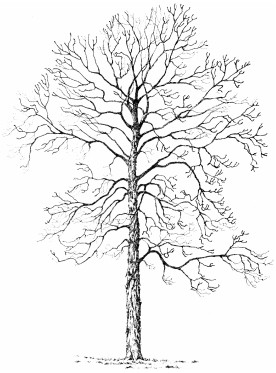
Undesirable Species

Other problem species such as multi-flora rose and honeysuckle will still need to be controlled by cutting, pulling and/or using herbicides. Remember the control of these species is a process not a short-term project for seeds of some can stay dormant in the soil for 20 years or longer.

> ***Important Note…***
> Try to limit disturbance when eradicating noxious weeds and invasive plants from the site. If large areas of soil are exposed then plant a cover group of annual rye, clover, etc. before planting the trees to reduce soil erosion and reinvasion of undesirable species of plants.

Determining Maintenance Needs

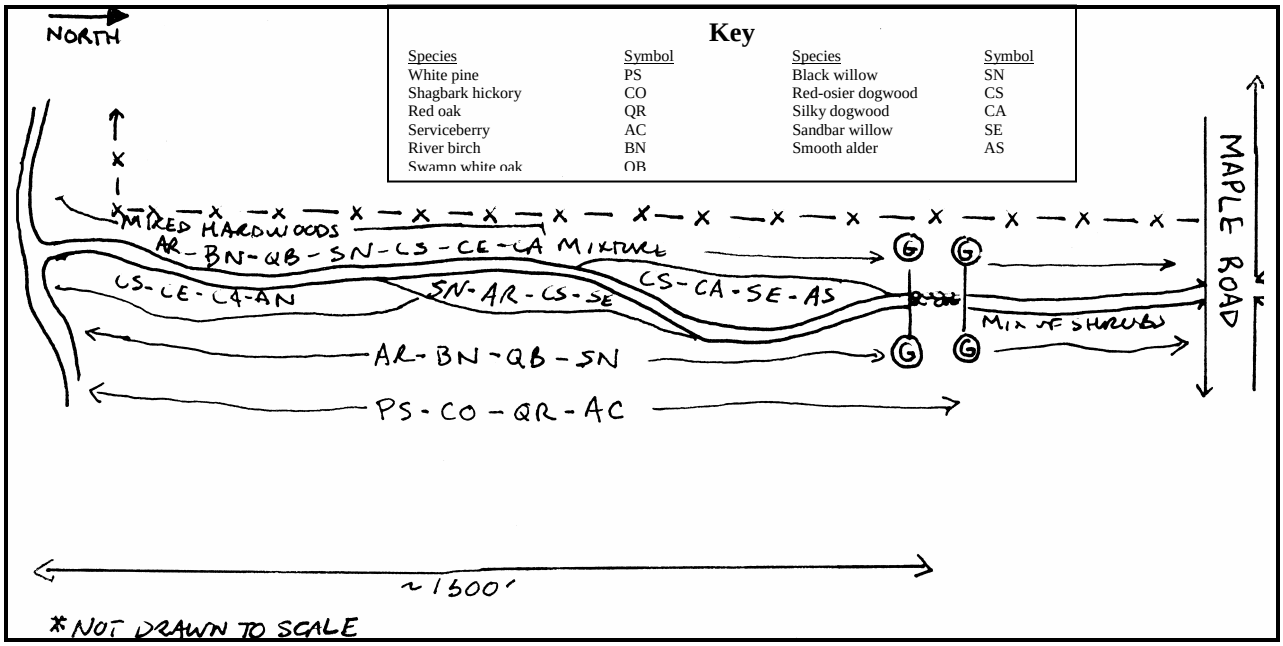
Before the actual establishment of the streamside riparian forest buffer, serious consideration must be given to maintenance needs and long-term monitoring or inspection of the site. Often times this issue is overlooked in the planning process but is an important key in the longevity and sustainability of the forest. It's advisable to develop a schedule that identifies the commitments of each party in maintaining the site. Make this schedule a part of the site plan so that everyone is familiar with the assigned responsibilities. Groups that may be able to assist with maintenance include service corps, high school and college students, and scout clubs. A detailed overview of maintenance and monitoring considerations is covered in the Riparian Forest Buffer Management Plan section.



Shagbark Hickory

Turn the page for a sample planting plan (Figure 10). This shows compilation of the information that is collected from the nine elements.. Go to Appendix C.2 for a blank planting plan template to be used for your riparian forest buffer planning and planting project.

Figure 10. Sample Riparian Forest Buffer Planting Plan



Location: 999 Maple Road, Quercusville, PA

Species	Latin Name	Size	Quantity	Pattern/Spacing
White pine	*Pinus strobus*	bareroot	95	6-8 feet random spacing for all trees and shrubs
Shagbark hickory	*Carya ovata*	container	45	
Red oak	*Quercus rubra*	container	50	
Serviceberry	*Amelanchier canadensis*	bareroot	50	
Red maple	*Acer rubrum*	container	70	
River birch	*Betula nigra*	bareroot	70	
Swamp white oak	*Quercus bicolor*	container	40	
Black willow	*Salix nigra*	bareroot	70	
Red-osier dogwood	*Cornus sericea*	bareroot	170	
Silky dogwood	*Cornus amomum*	bareroot	200	
Sandbar willow	*Salix exigua (interior)*	bareroot	220	
Smooth alder	*Alnus serrulata*	bareroot	120	

Equipment/Tools:

shovels
auger
buckets
trees
mulch
gloves
flagging
tree shelters (if applicable)

Site Preparation:

Remove invasive plants and noxious weeds, mow site, mark planting areas and pre-dig holes (if needed).

Maintenance Responsibilities:

Regular mowing; mulch if needed; replace dead trees if mortality is over 40 percent in one area.

Number of volunteers: 35

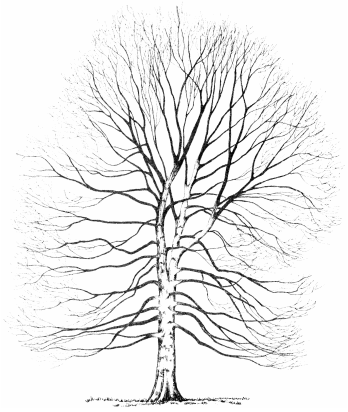
Directions to site: Route 700 South; right on Bobcat Road; 7 miles to Maple Road; left and go approx. 2 miles; planting area on right; look for big cow in pasture.

RIPARIAN FOREST BUFFER PLANTING AND ESTABLISHMENT

Purchasing Plants

It is important to purchase plants native to the area. This is due to the fact that locally evolved species have better vigor and hardiness and are better able to compete. These "natives" also provide food to aquatic insects, some of which have mouths adapted to feed only on these local species of plant materials.

In recognition of the merits of native material, many nurseries now stock native plants. Where available, this stock should be used, although much of the plant material may have to come from more distant genetic sources. Nursery stock from large or distant suppliers often comes from a biotype far removed from the site of installation. Where stock from remote sources differs substantially in hardiness, it is a less desirable option, even though its cost may be slightly more competitive. Local sources (such as propagated from seed) may be a little more expensive, but the better quality control and reduced shipping and handling costs can offset initial price disadvantages. When purchasing plants from a nursery, ask what is the source of the plant material and/or if it is being propagated onsite.



American Beech

It is important to note that plant species should not be dug and transplanted from the wild. In many cases the species are site specific to the growing conditions and some have a deep taproot (persimmon and black gum as examples) which if severed will kill the plant. Seeds may be collected; however, seed planting has its drawbacks and requires knowledge of specialized techniques. Also, it's important to leave enough seeds for wildlife and survivability of wild plant populations.

During formulation of the plan, likely sources of plant materials will have to be identified, contacted and visited to check on the condition of the stock. The size, condition, and health of the plants should be examined before ordering if possible. Specimen material can be tagged at this time, and arrangements for delivery, payment, and guarantee conditions are drawn up. When ordering plants, it is important to provide as much lead time as possible to ensure the best selection. Prior to early spring is the best time to place orders, as the best trees are shipped first. Consider ordering 10 to 15 percent more trees and shrubs than what you think you will need. The additional plants can be planted in a nearby "holding" area and used for replacement plantings.

In most cases, plants should not be paid for until delivery and unloading. This ensures that delivered material meets the specifications stipulated, and that the plants arrive in good condition. Plants that do not meet specifications should not be accepted and sent back to the supplier with arrangements for replacement or refund. The material should be examined for the following criteria at time of delivery.

Vigor **-** The plants should have well developed branches and adequate buds. Gently bend tree seedlings to check for pliability; if the seedling snaps, then it is too dry and should not be planted. Bark should be pliable and green when scratched, without shriveling or discoloring. Leaves should not be discolored or desiccated, or show spotting indicative

Roots - B&B plants should have the specified root ball size (minimum 1' of rootball per inch of caliper). The root ball should be securely wrapped without any signs of looseness, or the roots are likely to be damaged and/or desiccated. The ball should be moist. Container plants should be upright and firmly rooted. Inspect for circling, kinked, or "J" roots that may girdle the tree. Rootbound plants often have roots protruding above the surface or through the drain holes, a leggy appearance, and/or they are unusually large for the container. Bare root material should be wrapped in burlap and packing. The roots should be damp, fresh, and flexible.

Wounds and Diseases - The trunk should be free of abrasions, cuts, scars, knots, and/or sunscald injury. There should be no insect egg masses or fungi on the branches or trunk.

Be sure to store delivered plants in a cool spot, out of direct sunlight, and water them adequately.

Planting Layout: Marking the Site

Prior to planting, the site may be marked so plants are planted in the right place. A specific marker is used to delineate each plant at each location. This approach may be helpful for the inexperienced.

A variety of markers can be used. On mowed sites, lime can be rapidly applied to the ground and vegetation, but this method has minimal ability to convey species selection. Various colors of spray paint can be used to differentiate species, as well as color-coded flagged wires. Survey flagging can be used in a similar manner if enough vegetation is present onto which the flagging can be tied.

To mark the site, it is not necessary to conform rigidly to geometry set forth in the planting plan. If mowing is essential to control weeds, trees should be spaced evenly in rows across the planting area to prevent tree loss from lawnmower damage. Trees can be planted randomly or in clusters in mowed areas, but trees may be lost due to lawnmower damage. In random, mow-free plantings, trees are placed irregularly throughout the planting area, which is converted to a "natural forest" by not mowing. Weeds should be periodically removed around individual seedlings until trees become established (generally three years after planting). See Riparian Forest Buffer Management Plan section for more detail.

Plants should not be placed where roots, stumps, hummocks, depressions, and gullies will interfere or create less than optimal conditions. Plants should not be placed next to existing trees or shrubs. Knowing the average plant spacing, relative plant location is easily paced off, starting from the streambank and proceeding upslope. Landmarks from the mapping are used to ensure that spacing errors are not compounded as the planter proceeds along the stream.

In smaller sites where the riparian forest buffer is not too wide, an experienced professional should be able to mark the plantings without even drawing up a detailed planting plan. Each plant or mix of species is placed as he/she proceeds through the streamside area, based upon judgment of site conditions and knowledge of plant availability. The plantings are then counted, and the plant list is drawn up according to the actual layout. This is a more accurate method as to total number, and the total effort involved is reduced. A conceptual plan is still necessary to assist the inexperienced in staging.

For large sites or sites that have hard or heavy clay soil, you may want to predrill the planting holes prior to planting day. You can rent soil augers or ask for an in-kind contribution from a landscaping company to do the job. Predrilled holes speed planting tremendously and help the workers focus their energies on planting the trees and shrubs correctly. See Riparian Forest Buffer Establishment section, Planting Methods subsection, for more information.

Planting Practices

Planting Seasons

Trees and shrubs can be planted during the spring or fall, with the preference in early spring between mid-March and May 1st. Deciduous species are best planted in the early spring before bud break in April. This ensures the longest season for root growth and gives the plant a chance to establish feeder roots prior to the moisture demands of the growing season. While less than optimal, planting can extend into late May in the moist conditions found in streamside areas. Evergreens can be planted with good results before the new growth is fully extended in May. Planting later in the growing season will subject plants to moisture stress, unless proper care is taken to ensure adequate moisture in the root zone.

In the fall, evergreens can be planted after the heat of summer has passed. Most deciduous trees and shrubs can be planted later in the fall after leaf drop, since their roots will continue to grow until the soil temperature falls below 45 degrees. However, the ground must have adequate moisture, or a severe winter will kill the trees. Many oaks are listed as fall hazard plants, so they should be planted only in the spring.

PLANTING TIP

When planting seedlings, it's helpful to mark the plants with colored ribbons or flagging to make them easier to locate during maintenance tasks. Young plants can easily become "lost" in areas where weeds and other pioneer species are left to grow. You can also color-code the ribbons to mark plants that have died within the first year for replacement at a later date.

PLANTING TIP

Keep seedling roots moist and do not allow them to be exposed for extended periods of time. When planting, you can either dip the roots into water and cover them with a bag, or you can stand the seedlings in a bucket of water filled to the root collar.

Winter transplanting is possible if the soil around the tree to be transplanted is not frozen, and if the planting area is mulched enough to prevent freezing throughout the winter. Bare root material, seedlings and live stakes should be planted in the winter to early spring while they are still dormant. Planting bare root material after leaf emergence is not recommended even if adequate shade and moisture are present.

Storage Before and During Planting

After delivery, plant material should be stored on site in a moist, shaded location prior to and during planting. The root balls of B&B stock and the packing of bare root stock should be thoroughly watered and kept moist with a covering of peat moss, straw, or sawdust. Bare root stock can be stored for several weeks if "heeled in" by laying the plants in a trench of loose soil or mulch (Figure 11). The tops should face toward the south at an angle of 30 to 45 degrees.

Seedlings should be moist and cool upon receipt and can be stored by stacking them in a circle with the roots facing inward in layers separated by packing material and kept moist at all times. Alternatively, they can be heeled in (Figure 8) or refrigerated if facilities are available. Container material is least susceptible to moisture stress and will store well if properly watered.

If you transport seedlings in an open truck or trailer, cover the seedlings with a tarp to prevent excessive drying from high winds. So that air can circulate, do not lay the tarp directly on the seedlings.

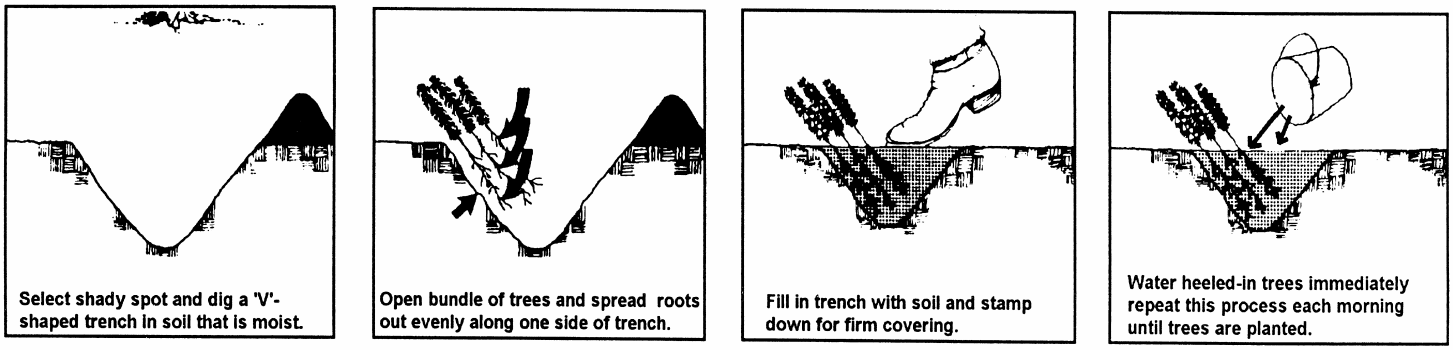


Figure 11. Heeling in Seedlings to Protect Roots
(Source: Tree Planting Notes, Minnesota Department of Natural Resources, Division of Forestry)

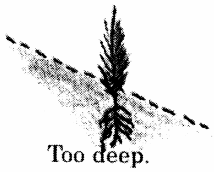
Planting Methods

B&B Trees

B&B stock should never be picked up by the trunk or dropped, as this will damage the root ball. To move B&B stock during planting, the root ball should be firmly cradled. The planting hole should be twice the width of the root ball, but no deeper. Soil amendments, such as the addition of organic matter, are not recommended since few roots will grow beyond the amended soils. All sod should be discarded. The root collar (the base of the plant stem) should be placed at the same level as the original soil grade; if the hole is overdug and backfill is necessary, the tree should be placed an inch or two higher to allow for settlement. After placement of the tree, completely remove any wire baskets and twine. Remove as much burlap as possible without damaging the root ball by cutting it down to where the root ball rests on the native soil. Work the backfill around the root ball, firmly compacting in place to avoid any air pockets. Fill up to original grade with the balance of the soil, compact, and water. If necessary, fill in any spots that settle, and place excess soil in a ring around the tree to retain water. A mulch of wood chips and/or geotextile fabric should be placed in a three-to-four-foot-diameter circle around the tree to inhibit grass and herbaceous competition (final mulch layer will look a "bagel" or "doughnut"). Avoid placing organic mulch directly against the trunk, as this will harbor insects and rodents that may damage the tree. (For more information on mulching, see Riparian Forest Buffer Management Plan section, Mulching subsection).

TREE TIP

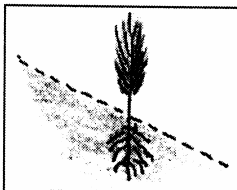
Avoid these errors in planting:



Too deep.
Needles buried.

Too shallow.
Roots exposed.

"L," "J" or "U" roots. Hole too narrow and/or shallow.



THE IDEALLY PLANTED TREE

Container Stock

For container material, the planting hole should be twice as wide and as deep as the soil in the container. Carefully remove or cut the container away from the plant to expose the roots. After exposing the roots, look for circling roots. The small ones can be teased apart and spread out in the planting hole. Plants with large and extensive circling roots should be rejected. Place in planting hole with the root collar slightly above the final plant soil grade. Backfill, water, and mulch as in B&B plants (see the Riparian Forest Buffer Management Plan section for more information).

Bare Root Seedlings and Year Transplants

Trees can be planted by hand or by machine. A correctly planted tree should have the following general characteristics:

1) Planted at about the same depth, or not to exceed one-half inch deeper than it was in the nursery. Use the root collar for depth judgment.
2) Have the main roots nearly straight and spread out, not doubled, or sharply bent.
3) Have the soil firm around the roots. Leave no air pockets.
4) Have the tree in an upright position, and have it nearly even with the general ground level, not sunk in a hole or raised on a mound.

There are two methods of hand planting – slit method (using planting bar or dibble) (Figure 13) and side-hole method (using mattock) (Figure 14). Hand planting tools such as planting bars, dibble bars, mattocks, and hoe-dads are used for rapid planting of bare root stock and seedlings.

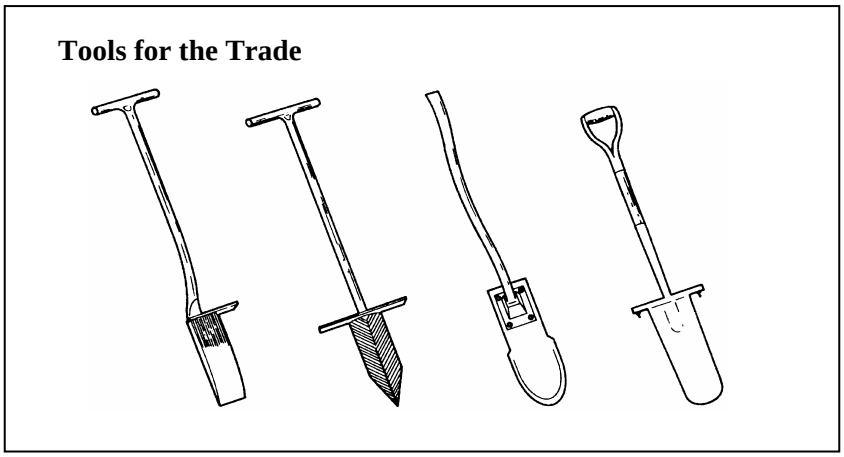
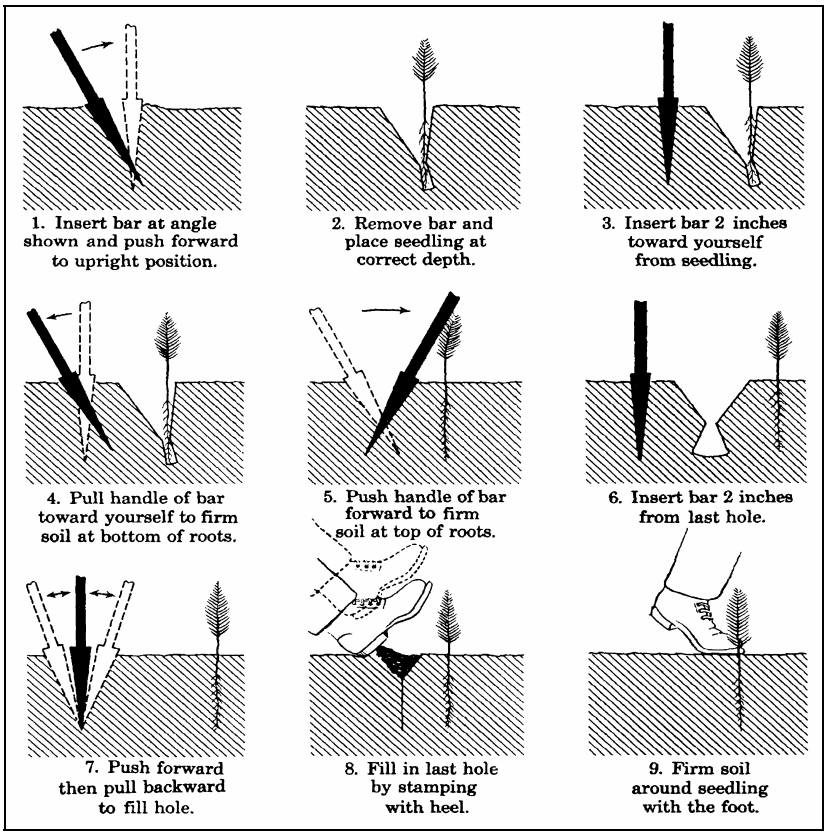
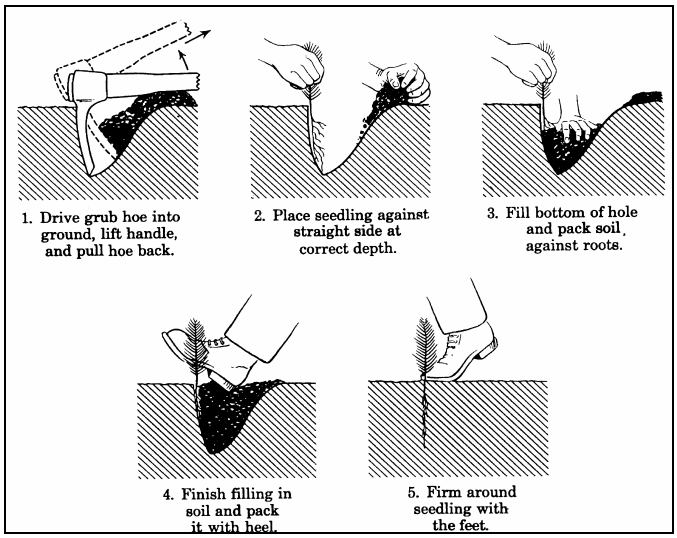


Figure 12. Tree-Planting Tools (left to right): planting bar, a pointed planting bar for stony soils, the Rindi grub-hoe (L-shaped) for making straight-sided holes, and a tile spade planting shovel for digging deep holes for large planting stock. (Source: The Practice of Silviculture, Smith, 1986).

Figure 13. Slit Method of Planting (Source: U.S. Forest Service)

The **slit method** consists of making a slit with a planting bar or dibble bar for smaller seedlings. It is much more rapid than the side-hole method. After placement, the bar is reinserted several inches away, rocked away from the seedling to kick in the soil at the bottom of the roots, and then rocked toward the plant to compress the soil around the base of the plant. Where water is not available to settle the soil, it is important to firmly compress the soil around the plants.





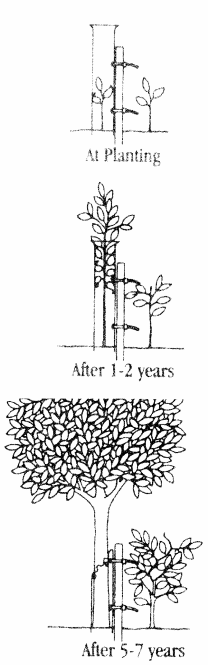
The side-hole method consists of digging a hole deep enough with a mattock or grub hoe to hold the roots of the tree. Mattocks and hoe-dads are suitable for larger seedlings and most bare root stock.

Figure 14. **Side-Hole Method of Planting**
(Source: U.S. Forest Service and The Practice of Silviculture, Smith, 1986)

Tree Shelters

In areas where deer browsing is a substantial problem or where you want rapid growth, tree shelters, plastic tubes that fit over the trees, have been used with considerable success. With shelters 4 feet high, seedlings are protected until the root system is well established. Five-foot shelters should be used where browsing is very heavy. Shelters also prevent rabbits and rodents from girdling the base of the tender trunks. Where deer browsing is light, shorter tree shelters (2 or 3 foot lengths) will provide protection at a lower cost. Over-planting other vigorous species is another method to sustain deer browsing without excessive pressure on the desired species.

Tree shelters enhance growth in early stage development.



Source: 1997 Native Plants for the Environment, Octoraro Wholesale Nursery Catalog.

Other benefits of tree shelters are:
1) Provide a favorable microclimate for seedlings. When shelters are properly installed, moisture transpired from the leaves condenses inside the tube, resulting in more humidity and moister root zone.
2) Increased carbon dioxide levels, resulting in favorable growth. Tree shelters generally increase initial growth rates by a factor of two to four times that of unsheltered seedlings.
3) Protect against wind and drought, shelters increase seedling survivability in adverse circumstances. Red oak is particularly responsive to the benefits of tree shelters.
4) Management of competing vegetation after planting is much easier; mowing and weed whacker strikes are prevented, and herbicides are isolated from trunk contact.

There is some concern that shelters reduce rooting and trunk strength due to wind isolation during initial growth. However, once the sapling has emerged so the crown spreads, there is enough trunk movement to build stem and root strength. The tree then allocates resources toward stem growth. For this reason, tree shelters should be left on for two to three years after emergence. After this time, the tree shelter may be physically removed.

The cost of installing tree shelters varies according to the product type and size used. Because of the cost involved, shelters would not be recommended for every seedling. They are most appropriate for the more expensive seedlings of species difficult to establish, such as red oak. However, reductions in maintenance costs and increased seedling vigor associated with tree shelters suggest that shelter plantings may be a more cost-effective approach than planting unprotected larger material.

There are many different types and styles of tree shelters that can be used, therefore, research and select the shelter that is based on the site conditions – density of deer population, light conditions (sun vs. shade), landscape type (pasture vs. park setting), etc.

If the decision is made to install tree shelters for the site make sure the base of the shelter is driven at least three inches into the ground to avoid a chimney effect, which increases moisture loss and reduces the girdling of the tree by rodents. The tree shelter is then fasten to a rot-resistant wooden stake such as white oak by plastic ties (usually come with the shelter). The stake should be placed on the upwind and upstream side and protective mesh placed over the top to prevent entry of birds. Netting will be removed as soon as the tree begins to grow out of the top of the shelter.

Is It Necessary to Fertilize?

Generally, adding fertilizer at the time of planting is not necessary, especially if your plant species match your site's soil conditions. A soil test will, however, help you determine the need for any soil amendments.

When taking a soil test, it's important to dig deep to cover the depth of your average seedling root length (20 to 30 inches). Your local Cooperative Extension Service agent can give you the proper guidance in testing your site before planting begins.

If the soil has been seriously disturbed, such as on abandoned mine sites, then fertilizer and other soil amendments may be needed to recondition the soil for planting.

RIPARIAN FOREST BUFFER MAINTENANCE, INSPECTION AND MONITORING

(Please note, if the riparian forest buffer is located on land that is enrolled in a federal agricultural program such as the Conservation Reserve Enhancement Program (CREP), maintenance and monitoring of the riparian forest buffer should follow the conservation plan written for that site.)

The most critical period after establishing a streamside riparian forest buffer is the time spent maintaining the trees until their growth gives adequate shade to control weed competition.

Until canopy closure, a newly planted buffer should be maintained to control competition from weeds.

Weed competition has been found to be a significant factor in limiting buffer growth and survival.

Ongoing maintenance, inspection and monitoring practices are necessary for at least 5 years to ensure establishment of a thriving riparian forest buffer, especially if smaller seedling plant material has been used. Even where large plants are involved, deer browse, invasion by exotic plant species and competition by herbaceous forbs and grasses will be a continuing problem. Maintenance, inspection and monitoring plans should be written for the specific site. Caretakers need to be advised of the duties involved in performing regularly scheduled riparian forest buffer maintenance. These preventative measures are necessary to ensure the long-term effectiveness of the riparian forest buffer and can include:

- watering
- mulching
- weed control
- monitoring for problems
- proper planting methods and placement of plants
- replacement of dead plant materials

A sample Riparian Forest Buffer Management Schedule and Agreement can be found in Appendix C.3.

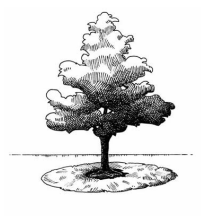
Watering

Deep regular watering throughout the first growing season is optimal for riparian forest buffer establishment. If watering is difficult due to accessibility or lack of labor, plants will need to rely on rain events. Planting in the fall may produce the best results as the likelihood of sufficient rain during the initial phase of establishment is increased. When possible, plant the riparian forest buffer following a period of rain when the soil is already moist. Local fire companies may be willing to help with the initial watering of the riparian forest buffer using a pumper truck. Planting day is a good time to recruit volunteers for a regular, seasonal watering schedule.

After one full growing season, the newly planted riparian forest buffer should be established and not require supplemental watering, however, if it is extremely dry in the growing season, watering may increase the survivability of the established riparian forest buffer.

Mulching
(Please note, if the riparian forest buffer floods frequently or high vole population is present do not apply mulch.)

The proper type of mulch can have many benefits even though it is considered by some to be a cosmetic top dressing. The benefits of organic mulch helps to retain soil moisture, retard evaporation, moderate soil temperature and provide some weed suppression around the plants. Research suggests that the height, growth and trunk diameter increase significantly if the ground near the tree base is kept free of grass. Besides the clear advantage or preventing competition between turf and young trees, expect fewer tree injuries caused by mowing equipment.



The proper method of applying mulch is to place two to four inch layer of coarse, slow to decompose materials, such as shredded bark, compost, leaf mulch or wood chips around the plants. Uncomposted mulches, such as grass clippings and sawdust, decompose rapidly and require more frequent applications. Leave air space between the tree trunk and any mulch so that it looks like a "doughnut or bagel" in shape. For added protection against the invasion of weeds, lay heavy cardboard beneath the mulch. The cardboard will eventually decompose.

Tree and mulch graphic source: 'Mulch: Your Tree's Best Friend.' Courtesy of the Missouri Department of Conservation.

Do not heap up or place mulch directly against the tree trunk. This will create a moist area that can provide a favorable environment for boring insects or fungal growth as well as root problems and voles girdling the base of the tree and associated roots.

Once the tree canopy begins to close and shade the growth of weeds and grasses mulching can either decrease or be eliminated.

Mulch Selection – Shredded hardwood mulch has good moisture retention, provides weed control benefits and is relatively unaffected by wind and rain. Shredded mulch is marketed in coarse, medium and fine grinds. The more coarse the grind, the greater the moisture retention and weed control benefits. Coarse ground mulch is less susceptible to dispersion by wind and rain. Make sure that it has been properly composted before use. Composted mulch is typically darker and does not exhibit the heating and strong odor of newly mulched wood.

Improperly composted wood chips can be harmful to plants because the decomposing micro-organisms are not yet neutralized. When the chips are stored in large piles, sufficient amounts of alcohol and/or acetic acid can accumulate and kill plants when the chips are later used as mulch. Another concern of using freshly chipped waste is that the composition is unknown. If the material being chipped was dead, diseased, insect infested or not properly sterilized, these problems can be spread by using it as mulch. Uncomposted yard waste, such as grass clippings, twigs, branches, and leaves can be harmful to plants when used as mulch due to competition with the plant for soil nitrogen to continue decomposition.

The mulches used most frequently on reforestation sites are a combination of wood-chips, leaves and twigs because they are readily available and require a nominal delivery fee. If possible, stockpile this type of mulch for six months to a year before use or reserve monies in the riparian forest buffer budget for obtaining composted mulch.

Mulch Checklist:

- If using organic mulch, check its source, to make sure the mulch is not contaminated with weed seeds or invasive tubers.
- A 2-4 inch layer of mulch is needed to prevent weed growth, to conserve moisture and to moderate soil temperature.
- All trees and shrubs should be mulched at planting time to help them become established.
- Coarse mulching material is best; finer materials compact too easily.
- Mature weeds draw much needed moisture away from newly planted trees and shrubs; remove weeds sprouting through the mulch promptly.

Controlling Weed Competition
Until canopy closure, a newly planted riparian forest buffer should be maintained to control competition from weeds. Weed competition has been found to be a significant factor in limiting riparian forest buffer growth and survival. A riparian forest buffer maintenance plan should include weed control as well as monitoring for invasive plants, which thrive in newly disturbed soils. Remember weed control is a process not a short-term project. Many of the weed species seeds can lie dormant in the soil for many years.

Mowing or String Trimming – Mowing or trimming is a suggested method in controlling weed competition in a newly established riparian forest buffer. This activity should occur twice during the growing season: once before weeds grow higher than 18 inches and again just before seed production, typically in late summer. Mower height should be between 8-12 inches to minimize cutting of slow-growing native plants. Mowing or trimming will also help in the control of vole populations by decreasing the cover. It is suggested that no mowing occur from April 1 to August 1 to allow birds to nest and raise their young.

Weed Mats – Weed mats are black geo-textile fabric, typically sold in 3 feet by 3 feet sheets with a split in the middle to allow each mat to be placed over a seedling. Weed mat fabric is available in rolls to cover entire rows. Mats are used to suppress weed growth around newly planted vegetation by providing shade and preventing seed disposition.

A properly installed weed mat can be effective for several years. It is installed after the tree is planted and should be installed over mowed or otherwise cut or removed vegetation. The mat is secured with one stake at each corner, tamped into the soil at an angle to prevent heaving. The mats should be removed once the trees have developed a canopy that will naturally shade out competitive weed growth.

Herbicide – An appropriate herbicide may be sprayed between rows of plants in a riparian forest buffer in order to control weed competition in a large area and to encourage the growth of the trees and shrubs in the newly planted riparian forest buffer. Always consider the proximity to water and choose an herbicide appropriate to a natural area. Herbicide use is regulated in Pennsylvania by the Department of Agriculture. Pennsylvania's regulations require that volunteers work under the supervision of a certified applicator. See the second sidebar under Step 8: Prepare Your Site Ahead of Time section for a list of selected herbicides that can be used in riparian areas.

Animal Damage
Deer
Overabundance of deer has become a problem in much of Pennsylvania due to the elimination of large predators and the availability of abundant habitat and food sources in agricultural fields and suburban landscapes, particularly where sprawling development creates more forest edge habit. The normal diet of white tailed deer consists of leaves, twigs, forbs, acorns, lichens and fruit consumed at an average of 5-15 pounds per day per deer. In areas in which deer densities are high, deer will browse all vegetation within reach, severely damaging or killing many plants in a newly planted riparian forest buffer.

Mortality Factors for Riparian Forest Buffers:

- A survival rate of 70% for planted trees on a typical site is considered a fairly good indicator of success.
- Tree shelters improve survival.
- Weeds and vines are the most significant problems affecting the survival and growth of planted trees.
- Deer, damage from mowing, insects, poor planting and shading from adjacent trees are lesser factors.
- Weed control in riparian planting sites must be weighed with the potential for increasing deer browse.
- Effects of drought are difficult to determine. Decisions on site selection, time of planting, species and type of stock should be made to ensure that planted trees will succeed despite dry weather.

Riparian Forest Buffer Survival and Success in Maryland, April 2001.

There are several ways to evaluate the potential threat of deer damage during the planning stage of the riparian forest buffer project. One sign of a high deer density is an overgrazed understory. In areas of high deer population densities, a browse line 5-6 feet above the ground will be apparent. Look for rubbing and scraping marks on trees in the area. If the riparian forest buffer area is currently in agricultural use, the farmer should be able to indicate the intensity of the deer problem locally.

Take steps to protect newly planted riparian forest buffer plants in areas of higher deer populations and monitor for deer damage. The following approaches can be used to minimize damage to young plants.

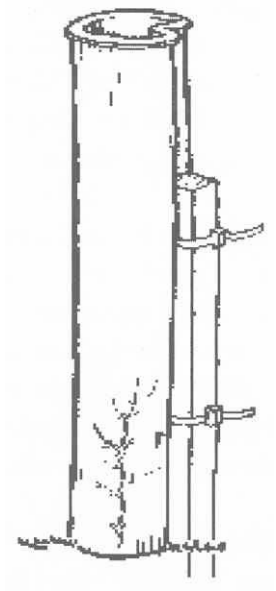
Plant Selection – Some tree varieties are *rarely* damaged by deer except in areas of high deer densities. They include: serviceberry, black gum, persimmon, sycamore, beech, and ash. Less frequently damaged small trees and shrubs include: pawpaw, red-osier dogwood and common elderberry.

Deer Repellants – Deer repellants work on the principle of repelling deer with a bad smell, a frightening scent or a bad taste. Results vary widely. Homemade remedies including soap, human hair cuttings, mothballs, ammonia and dried blood meal operate on the same principle as commercial repellents. Most repellants must be reapplied after rain or periodically, in order to guarantee continued coverage. Repellants are most effective when the deer herd is not very large and work better during summer when a wider variety of alternative food is available. When population pressures are high, deer will overcome smell or taste obstacles and browse treated plants.

Tree Shelters – In areas where deer browse is a substantial problem, shelters have been used with considerable success. Tree shelters are plastic tubes that fit over newly planted trees. They are available in heights from 2-6 feet and are secured with a wooden, rot-resistant stake (select the proper height by taking into account the snow accumulation in the winter months). A shelter can protect a tree from gnawing by voles or rabbits if it is installed with the base buried at least three inches in the ground. Improperly installed shelters that are vulnerable to vole intrusion can actually create an inviting place for voles by protecting the rodents from predators. In locations with high vole populations, rodenticide may be placed in the tree tube to prevent vole damage. Netting should be placed over the top of the tree tube, to prevent woodland debris from smothering the plant as well as birds nesting in it.

Tree shelters also have been shown to create a favorable microclimate for seedlings. Inside a properly installed tree shelter, moisture is conserved from transpiring leaves and carbon dioxide levels are increased providing favorable growth conditions. Tree shelters make mowing and trimming easier by protecting trees from accidental strikes. Most tree shelters do not decompose over time and should be removed when the trunk diameter grows beyond 2 inches. When the bark begins to grow against the shelter, the tree can develop cankers that threaten the health of the tree.

Tree Shelters are not a substitute for weeding. Check regularly to make sure shelters do not become choked with weeds. Use of a weed mat, herbicides, mulch and mowing to keep vegetation 4 feet away from newly planted trees is suggested.



Check tree shelters at regular maintenance intervals to:

- Repair broken stakes
- Tighten stake lines
- Straighten a leaning tube
- Clean debris from the tube
- Remove netting as tree grows

CAUTION!

Stinging insects (wasps, yellow jackets, bees) are often found in the shelters. Remove old nests during the winter months.

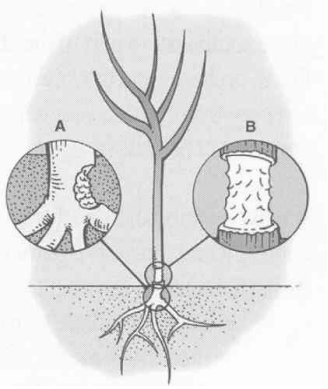
Please note, if the site has a high deer population it is suggested that the shelters be slit rather than completely removed so they will continue to protect the trunk from deer rubbing. Deer will rub a tree up to 4 to 5" in diameter. This will also protect the tree if ongoing herbicide usage is expected and leaving split tubes in place will prevent potential herbicide damage.

Fencing – Deer can jump a fence up to 10 feet high. They prefer to go under barriers, so the bottom wire of a fence should be placed no more than 10-12 inches off the ground. Fences should be monitored regularly and repairs should be done immediately, before deer discover the new food source within the riparian forest buffer.

One of the least expensive types of fencing is 8 foot plastic fencing. It is both effective and easily repaired. Electric fences can have as few as two wires, placed at 10-12 inches and 30-36 inches high. To be effective the electric fence should be baited initially and baited again every month or so. The bait consists of metal tabs smeared with a food such as peanut butter. Deer will learn to fear the fence by contact with it through their sensitive mouth area and will habitually stay away from the area it encloses.

Farm animals such as mature cattle, horses, and swine cause the greatest damage to stream banks. Fencing prevents livestock from entering and polluting the stream with waste products, trampling banks causing erosion and grazing streamside riparian forest buffer zones. Livestock fencing systems commonly used along waterways for permanent installations are page wire fencing and 4 strand barbed wire fencing for large livestock. Barbed wire fence is less expensive to install than page fencing systems but requires far more maintenance.

High-tensile smooth wire fencing when electrified for livestock is usually installed as permanent fencing. When not electrified, this system uses 6-8 strands; electrified systems use 2 strands. High-tensile wire fencing offers increased strength, reduced maintenance cost and is easier to handle than barbed wire fencing.



Vole damage on young tree

Meadow voles *(Microtus pennsylvanicus)* and pine voles *(Microtus pinetorum)*, formerly more common in commercial orchards, have become a significant problem in newly planted riparian areas.

Damage from voles includes girdling, destruction of the root system by chewing, and disappearance of herbaceous plants.

Deep layers of mulch, mulch placed directly next to tree trunks and mulch with a fine particle size attracts voles and should not be used.

Voles

Pennsylvania has two species of vole that are known to damage trees: the meadow vole and the pine vole. Voles are small, mouse-like rodents which feed on herbaceous plants in spring, fall and summer. During winter months, when their preferred food is unavailable, voles feed on the roots and bark of tree or shrub seedlings, leading to the eventual death of the plants. The meadow vole is the most common vole in Pennsylvania and is found throughout the state. It favors meadow areas that have a dense ground cover of grasses that will protect it from being seen by predators as it makes its way along above-ground runs. The pine vole is found primarily in the southeastern part of the state. It creates underground runs in old farm fields, orchards and thickets that have sandy, loose soil. Vole populations can vary from year to year depending on food, climate, disease and the presence of predators.

A newly established riparian forest buffer site should be monitored for voles before winter, when extensive plant damage can occur. To monitor for voles during the summer months:

- Look for telltale sign of voles such as surface runways of meadow voles. These will have fresh grass clippings and piles of green or tan rice shaped droppings. Also evident are the barrow entrances of pine voles, which tend to have a conical pile of dirt beside them composed of soil discarded by the vole while digging.

th marks, partly eaten slices or missing slices.

- Trapping of voles during the fall can help bring down population numbers before winter when they can threaten small trees. It is recommended that traps be placed beside active vole trails.

Protecting Trees from Voles – Voles have many natural predators including hawks, owls, foxes, cats and snakes, so they seek out areas that provide ample cover from these dangers. Mowing grass and other cover allowing plenty of open space between trees can reduce vole populations by exposing them to predators especially in the fall.

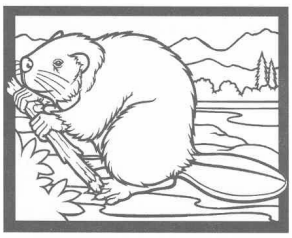
If installed to a soil depth of 3 inches (and at least 8 inches above the average snow depth), tree shelters or quarter-inch mesh tree guards can protect trunks from meadow vole gnawing, however, studies have shown that voles will tunnel down to eat the tree roots. Keep in mind that a vole can kill a 5" diameter tree either by girdling the trunk at ground level or tunneling into the root system. One study of tree shelters showed that shelters which allow more light to penetrate the interior seemed to deter vole damage.

Beaver

Beavers are found throughout Pennsylvania. Though typically preferring remote areas, they are not found in more developed areas. In many cases, the presence of beavers can be spotted by the existence of a dam and lodge. Along streams or rivers too wide or fast to dam, beavers will burrow deep into the bank or build a lodge on the bank. Adult beavers have been found to cut down up to 300 trees per year, most having diameters of less than 3 inches. This can pose a serious threat to newly planted trees.

Protection of Trees from Beaver – Monitor for signs of beaver activity before installation of a riparian forest buffer. Signs include gnawed trees and lodge sites. If beaver appear to be active near the project site, tree seedlings can be protected with wire fencing with a nine-inch or smaller mesh, installed around the tree to a height of 3 feet. This fencing should be anchored at the bottom to keep the beaver from working its way under the fence.

Another method to prevent beaver gnawing is to paint the lower bark of the tree seedlings with a mixture of latex paint and mason sand. The ratio is approximately 5 ounces of sand to one quart of paint. The mixture results in an unappetizing cover for the beaver to gnaw through.



Beavers are strict vegetarians who prefer the bark, cambium, twigs, leaves and roots of deciduous trees that grow along streams. They favor aspen, alders, boxelder, fir, pine, cedar, willows, maple, poplar and beech. Beavers will also eat soft aquatic vegetation including duckweed, pond lily, bulrushes, bracken fern and green grasses.

While the positive impacts of beaver are more numerous than their negative ones, the impact of local beaver on new riparian forest buffers can turn a planted area into a lake or a field of gnawed sticks.

Trees can be protected from girdling or cutting by wire mesh extending 2-3 feet above ground or by painting sanded paint or aluminum roof coating on lower trunks.

Invasive Plants – The Super Weeds

Invasive plants are weeds with characteristics that make them extremely threatening to the survival of a new riparian forest buffer. They pose a threat because of their ability to spread aggressively, reproduce prolifically and are very difficult to control once established.

Invasive plants can overrun native vegetation and prevent the long term sustainability of native riparian vegetation. Non-native species can degrade the habitat for wildlife and diminish the pollution prevention capacity of a vegetated riparian forest buffer significantly.

Restoration sites that did not contain invasive plants at the time of restoration may develop an unanticipated infestation, due to the soil disturbance associated with planting. Monitor restoration sites regularly for signs of invasive plants. The most common invasive plant found in an informal survey of 99 riparian forest buffer restoration sites in Pennsylvania was multiflora rose (*Rosa multiflora*) followed by Canada thistle (*Cirsium arvense*), purple loosestrife (*Lythrum salicaria*), Japanese honeysuckle (*Lonicera japonica*), and tree-of-heaven (*Ailanthus altissima*).

Invasive Plant Identification

Become familiar with the appearance of invasive plants common to your region. When a plant seems to be spreading aggressively by growing back quickly and tenaciously after weeding, it should be identified and appropriate control methods researched. Many invasive plants look similar to one or more native plants. Research should include an understanding of how the invasive plant differs from similar native. Check at least two sources to confirm identification before taking action. If those sources cannot help make a positive identification, call the county Conservation District office or Cooperative Extension office to arrange for identification of the sample.

PA Noxious Weed: Canada Thistle

Invasive Plant Control Methods

Once the plant has been identified as a noxious weed or invasive plant several methods of control can be selected. Invasive plant control in a riparian or a wetland setting should be approached with caution for several reasons:

- Proximity to water makes herbicide contamination of surface and ground water much harder to avoid or impossible to control.
- Riparian and wetland areas are critical wildlife habitat areas. Invasive plant control can disturb or destroy habitat for a large number of valuable species. Mechanical removal of invasive plants can lead to erosion, resulting in siltation of the waterway.

PA Noxious Weed: Bull Thistle

Choice of control method is based on a number of considerations including the size of the infestation, the amount of vegetation that should be retained and resources available to the group. Control methods fall into three broad categories:

- Mechanical
- Mechanical with Chemical
- Chemical (Herbicide)

Plan to monitor and retreat for regrowth of the invasive plant, in spring and fall, for several years after initial control efforts.

Mechanical Methods of Invasive Plant Control
This method stops the invasive plant from growing and spreading without the use of chemical herbicides. Methods used depend on the plant, the location and the resources available. Among them are:

- Hand pulling
- Cutting of seed heads/repeated cutting to diminish vigor
- Pulling with tools, such as weed wrench
- Mowing to diminish plant vigor and prevent seed formation
- Covering with plastic
- Brush hogging or bulldozing (least desirable for small infestations)

Invasive plants are extremely persistent, requiring regular monitoring and continued removal efforts. Many cannot be eradicated by manual means alone.

Chemical
(Disclaimer…The following is an overview summary of the more common chemical control methods and is neither intended nor adequate to provide instruction for their use.)

Herbicide is one type of pesticide. In some instances herbicides are appropriate to use to control invasive plants – with caution. The following are the most common methods of chemical application to control invasive plants:

Foliar is applied directly to the leaves. To carefully control the application of the herbicide so that it does not fall on desirable plants or water and for small infestations, it can be wiped on using gloves or sponges dampened by the herbicide. A spray bottle or backpack sprayer can be used with a lesser degree of accuracy for small scale foliar applications in less sensitive areas. To cover a large or difficult to reach area, a large boom sprayer can be used.

Basal bark application of herbicide is applied with a brush or sprayed directly onto the lower bark of the tree by a sprayer.

Pre-emergent herbicides are used to prevent seeds from sprouting. This type of herbicide is used primarily around newly planted sites to prevent germination of the seed of undesirable plants. Many invasive plant species produce copious numbers of seeds that will germinate over the course of several years if not controlled.

Hack and Squirt refers to making 2-4 inch wide hacks into the tree's bark with an ax or a machete at intervals of 2 inches around the trunk. Herbicide is squirted into the hacked area. This method helps prevent the tree from re-sprouting, as happens when a tree is girdled, by removing a ring of bark around the trunk.

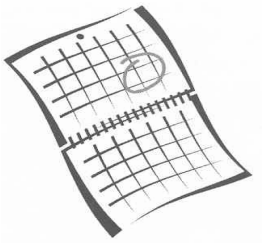
Caution:
In Pennsylvania pesticides (herbicides, insecticides, etc.) are regulated in several ways:

- Use of any pesticide on property not owned by the applicator can only be done by a Certified Pesticide Applicator or someone working under the direction of a Certified Pesticide Applicator,
- Purchase of or use of restricted use pesticides can only be done by a Certified Pesticide Applicator,
- Pesticide recommendations can only be made by a Certified Pesticide Applicator.

Conservation groups have addressed some of the risk factors associated with using herbicides within natural areas in innovative ways. Techniques of direct placement of herbicide, mentioned above, minimize drift to water or desired plants and have been found to be highly effective, though labor intensive. Wiper applicators in various forms are used for direct placement, such as herbicide dampened gloves (worn over a nitrile glove) used to wipe herbicide over the leaves of the target plant, tongs with herbicide-dampened sponges or sponge applicator bottles.

Glyphosate (as in Rodeo), and to a lesser extent triclopyr (sold as Garlon), are selected for direct applications in natural areas. Both are systemic herbicides; they travel throughout the plant and kill the roots. Glyphosate has formulations for use in or near water, has limited persistence in the environment and does not harm animals.

An excellent source of objective, science-based information about pesticides and pesticide-related topic is the National Pesticide Information Center (see Appendix D for contact information).



Inspect and Monitor the Riparian Forest Buffer
Riparian forest buffers should be inspected, monitored and managed to maintain their maximum water quality and wildlife habitat benefits. Monitoring should be done to discover emerging threats to the planting and to determine the effectiveness of the restoration project. During the first few years after installation, the new riparian forest buffer should be inspected and monitored four times annually. The riparian forest buffer should also always be inspected within a few days after severe storms for evidence of sediment deposit, erosion or gully formation. Repairs should be made as soon as possible.

Monitoring for Survival
The two monitoring methods outlined here are for monitoring vegetation. These procedures will help you to determine how many of the plants installed are still living, to identify possible threats to plant health, and to evaluate whether or not remedial action should occur. These procedures will not provide information on how the riparian forest buffer is functioning as a protective strip between land and water.

New buffers should be monitored four times annually for the first three years after installation.

Recommended months for monitoring are:

- *February*
- *May*
- *August*
- *November*

Method I – Total Count
If the riparian forest buffer area is an acre or less (435 stems) count the survival over the entire project site. This approach will provide the richest data and is easier when the trees are planted in rows or in a grid pattern. But if manpower is limited and if the site is greater than an acre, a total count may not be feasible, development of a systematic sampling system may be the most practical method of monitoring the site (see Method II below).

If at all possible, review the planting plan to become familiar with the site layout. The planting plan usually provides you with all the information needed to determine the best strategy for walking through the site. Pick a route that allows you to move efficiently throughout the site while eliminating the possibility for double counts.

Begin your walk through the site. It is highly recommended to carry a counter with you to prevent counting error. Observe the health of each plant and *count only live plants*. Continue walking on your route through the site until all plants have been examined.

Survival rates can be calculated as the number of live plants divided by number of installed plants multiplied by 100:

# of live plants/# of plants installed x 100 = percent survival

This is the survival rate for the riparian forest buffer. Compare this survival rate to the project goal or acceptable performance standard. For some government programs a 70% survival rate is deemed to be a successful establishment.

Method II – Systematic Line Plot Cruise

A representative sample can be determined by delineating sample plots and making counts within the sample sites. A description of how to designate sample plots is located in Appendix C.4, Monitoring Survival Using Systematic Line Plot Cruise. The data derived from this type of monitoring should look at both survival of the planted material and natural regeneration to determine if project goals have been met and if in-fill plantings should be done to maintain plant density. Information on species survival or on environmental factors impacting the planting can be of use in planning new management strategies and future projects. This method of monitoring can inform riparian forest buffer owners about which species to replant and whether tree shelters or new weed control practices are necessary.

Overall this method was designed to monitor riparian forest buffers from one to five years old, although it is also applicable for older riparian forest buffers. It can be used for plantings with a variety of riparian forest buffer management practices including mown sites, overgrown sites, and sites with or without tree shelters.

From the data collected, you will be able to estimate the survival for all of the trees planted in the riparian forest buffer area, as well as the stocking (number of trees per acre, including natural regeneration.)

If the riparian forest buffer is established or existing for greater than 5 years, use Appendix B, Evaluation and Classification of Existing Riparian Forest Buffers.

Monitoring for Problems or Changes

When out in the field incorporating a visual assessment into the monitoring method is good practice. A number of problems can occur after planting and can be corrected if discovered early thus avoiding further loss of planting stock. The project site should be monitored to determine if any of the following problems have occurred:

- Wildlife damage
- Livestock damage
- Damage from insects
- Disease
- Invasion by invasive plants
- Erosion
- Vandalism

?

Why monitor?

- Assess ecosystem health
- Detect early signs of change
- Identify problems
- Document successes
- Determine achievement of planting goals

- Damage to fencing or tree shelters
- Flooding
- Drought mortality

An online resource for the diagnosis of insect or disease problems is available from the Maryland Cooperative Extension Home and Garden Information Center. This resource offers photographic keys to diagnose and solve plant, insect and wildlife problems and the website link can be found in Appendix D, References and Resources.)

Monitoring Tools

No matter what technique is used you will need several items to help systematically monitor the riparian forest buffer site. These include:

- Field notebook for recording observations such as damage, wildlife sightings or soil conditions
- Final planting plan for the site, to locate trees and determine a walking route or sampling plan for the site
- Handheld counter to aid counting of living plants
- Field guide to track survival by species or identify invasives
- Camera for photographing the riparian forest buffer from permanent photo stations; i.e., fixed points within the riparian forest buffer site such as a marked post or a designated spot near a mature tree
- Site Monitoring Summary Form to organize collected data (Appendix C.4)

You may use DEP's Pennsylvania Stream ReLeaf – Project Data Sheet (see Appendix C.5) to voluntarily assist the state in keeping track of riparian forest buffers being restored, established and/or conserved in the Commonwealth.

Monitoring for Water Quality

Numerous methods exist for measuring changes to stream and watershed health. Bank stabilization can be tracked by monitoring cross-sectional area or movement of banks relative to stationary pins. The quality of stream habitat can be measured by monitoring changes in temperature, populations of fish and aquatic macroinvertebrates (see the brief overview of Monitoring for Water Quality at the end of this section), cobble embeddedness, or pebble counts. Such monitoring can help determine over the long term whether a riparian forest buffer planting is working the way it was intended, but these methodologies are beyond the scope of this publication.

Water quality monitoring data can be of value if a project goal is to ultimately protect or improve water quality. Continued testing of chemical parameters and macroinvertebrates will provide an understanding of the impact of the project. To learn more about water quality monitoring, visit the PA DEP Citizen's Volunteer Monitoring Program website found in Appendix D, References and Resources.

What is a macroinvertebrate?

Macroinvertebrates are small bottom-dwelling aquatic animals without backbones, which can be seen with the naked eye. The abundance and type of macroinvertebrates in a stream provide indicators of water quality. Headwater areas especially will have mayflies, stoneflies and caddisflies as indicators of clean and healthy water.
(Graphic source: Field Guide to Freshwater Invertebrates, Annabel Wildrick (Illustrations), http://www.seanet.com/~leska/Online/Guide.html)

RIPARIAN FOREST BUFFER PROTECTION

Retaining existing riparian forest buffers is the most cost effective method of protecting surface water from runoff, sediment pollution, stream bank erosion and destructive flooding.

The following lists a variety of protection tools that are available to interested communities and landowners to protect land along stream corridors. These tools can be designed to fit local conditions.

- Fee simple acquisition
- Conservation easements
- Municipal planning tools
- Riparian forest buffer ordinances
- Development tools

An overview of these methods will be discussed in this chapter in order to provide a basis for selecting riparian forest buffer protection options appropriate to a specific locality.

Fee Simple Acquisition of Riparian Land

Fee simple acquisition of the land is a transfer of ownership through purchase, donation or a trade for less environmentally sensitive land. This type of ownership is most desirable if the resources contained on the land are highly sensitive.

Whether by purchase, donation or trading of land, the municipality or conservation group will hold the deed and have control over its use as well as be responsible for monitoring, maintenance, insurance, taxes and long-term property management.

The Pennsylvania Department of Conservation and Natural Resources (DCNR) offers funds for land acquisition projects for the purpose of preserving natural and critical habitat areas and open space through the Community Conservation Partnership Program.

These funds are available to conservation groups, municipalities, nonprofit land trusts and conservancies to encourage the preservation of open space and natural areas either through fee simple acquisition or acquisition of conservation easements. Lands acquired with these funds must be open to the public.

Conservation Easements

An alternative to buying riparian land is the purchase of the property owner's right to use that riparian land for specific purposes through the purchase of a conservation easement. The Protection Agreement, also known as a ***conservation easement*** or ***conservation servitude***, is an agreement between a landowner and a private land trust or government and limits certain uses on all or a portion of a property for conservation purposes while keeping the property in the landowner's ownership and control. The easement remains with the property in perpetuity and is transferred with ownership of the land.

The conservation easement can be an appropriate tool to protect natural resources when it is necessary or desirable to keep the land in a private landowner's ownership and control. If a conservation organization wants to manage the land in a significant way or to have substantial access to and use of the property, then acquisition of the land itself should be considered.

The agreement is tailored to the particular property and to the goals of the landowner and conservation organization. For example, an agreement might allow sustainable forestry but restrict most other uses. Another agreement might prohibit construction and logging within 100 feet of a stream but allow it elsewhere. Another might support farming but forbid development.

A conservation easement intends to protect the conservation value of a particular piece of property such as a riparian forest buffer. This value can be written into the easement to protect only the riparian forest buffer or the entire parcel, with specific requirements to riparian forest buffer protection. For tax purposes, it may be more advantageous to a land owner to protect the entire parcel adding special protection for the riparian forest area.

Most conservation easements are donated by landowners who wish to protect a beloved place. Under certain circumstances, easements are sold at a bargain price or fair market value. Donations and bargain sales that meet IRS requirements can result in federal tax benefits (see Appendix C.7 for more information on federal tax benefits).

Local governments can partner with land trusts in the acquisition of conservation easements. This type of relationship is beneficial in that land trusts often have less regulatory constraints than a municipal entity. In many instances they can act more quickly, raise tax-deductible funds for purchase and purchase at above appraisal prices. Land trusts also have more experience coordinating the acquisition process.

A sample Riparian Forest Buffer Protection Agreement can be found in Appendix C.6.

Legal Aspects of Conservation Easements

Although conservation easements have been recognized under-common law in Pennsylvania for many years, the state legislature enacted the Conservation and Preservation Easements (32 P.S. §§5051 *et seq.* (2009)) to give state authority to perpetual conservation and historic preservation easements. The Act shifted the rules of legal interpretation in favor of the grant of easement. In other words, the burden of proof is now on the person who challenges the validity of an easement, rather than on the easement holder.

Pennsylvania has further supplemented PA Act 29 with Act 153 (32 P.S. §§5001 *et seq.* (2009)), which gives authority to townships, cities, and boroughs to establish a dedicated revenue source for land conservation and to charge a fee to create that revenue. The Act allows these local government entities to open up for referenda the question of imposing an additional tax on residents to finance open space initiatives.

Once the ordinance is passed, open space fund would be used by the local government to either acquire land and/or purchase development rights to protect water resources, watersheds, and natural resources such as floodplains and steep slopes.

Landowner Liability - Liability for injuries arises if the eased or purchased land is open for public access. If that is the case, Pennsylvania has several recreational use statutes to limit the potential liability of the landowner. The Recreation Use of Land and Water Act (Act of February 2, 1966, P.L. (1965) 1860, No. 586, as amended, 68 P.S. §477-1 *et seq.*) limits landowner liability to willful or malicious failure to warn or guard against a dangerous condition, use, structure or activity. This statute was specifically drafted to encourage landowners to make their land and water areas available for traditional recreational uses, such as hunting and fishing. The Pennsylvania Rails-to-Trails Act, Act 188 (32 P.S. §§5611 *et seq.* (2009)), also limits liability for property owners with property surrounding or adjoining a rail trail.

Planning Tools for Municipalities

The legal basis for local governments to protect Pennsylvania's streams and regulate the use of the adjoining riparian land resides in the Pennsylvania Municipalities Planning Code, Act 247 (53 P.S. §§10101 *et seq.* (2009)). This legislation sets a framework for municipality planning and specifies the types of controls that maybe used to regulate land use and the acceptable purposes for which municipalities may enact land use regulation.

In the Planning Code, authority is given to municipalities to protect water supply and enact riparian corridor protection ordinances. Additionally, many riparian features such as woodlands, historic resources, wildlife habitat, wetlands, wooded areas, and scenic vistas can be protected under the Planning Code.

Municipalities have several avenues in which to plan for and determine land use. A **County Comprehensive Plan** determines future location, character and timing of land development in the county and is updated every ten years. According to the Municipalities Planning Code, zoning ordinances enacted in the county are required to have general consistency with the comprehensive plan, which should contain planning for natural and historic resource protection.

> Comprehensive Plans
> If you are planning to work with riparian forest buffers, research to see if your municipality's has riparian forest buffer protection ordinance. Why?
>
> Not all counties in Pennsylvania have comprehensive plans or riparian forest buffer zoning ordinances.

An Official Municipality Map designates existing and proposed open space reservations. The map designates areas within a municipality that will eventually be used for public purposes and declares the intent of the municipality governing body to purchase that land. It is a tool that can be used to protect existing vegetated riparian forest buffers. However, municipalities are legally obligated to purchase such lands within twelve months of a landowner's expressed intent to develop the land; therefore, if a municipality fails to act the designation is null and void.

Zoning

Land use ordinances define land use restrictions and plans. Zoning is one of the most common types of land use ordinances. In Pennsylvania, municipalities including county level entities can adopt zoning regulations. It is a tool commonly used to control the location and intensity of development. Zoning is useful in protecting public health, safety and welfare as well as guiding growth.

Zoning that protects riparian wetland buffers may be part of an existing natural resource protection ordinance, storm water ordinance or floodplain ordinance. These regulations should be reviewed for their adequacy in protecting riparian areas. An overlay zoning ordinance pertaining to riparian forest buffer protection is appropriate in a municipality that already has a zoning ordinance in place. For a municipality that does not have zoning ordinances in place, a separate, freestanding ordinance may be necessary to protect riparian forest buffers.

> Weed Ordinances…
> Many PA communities have weed ordinances that may interfere with preserving or restoring riparian forest buffers. Check for local regulations and possible restrictions before starting riparian forest buffer work.

Municipal Riparian Forest Buffer Ordinances

Components of a Riparian Forest Buffer Ordinance - Typically zoning ordinances consist of two parts: a text defining the elements listed below, and a map of the districts zoned. A chart following this section provides information for acquiring copies of several riparian forest buffer ordinances enacted in Pennsylvania. Generally speaking this type of ordinance is constructed in the following manner:

- *Definition of a riparian forest buffer* - This section describes the location as "perennial or intermittent streams, rivers, lakes, ponds or reservoirs." The definition should further refer to specific features of the community to be protected such as the names of streams and ponds. It also describes the functions of the riparian forest buffer; e.g., the removal of nutrients, sediment, organic matter, pesticides and other pollutants prior to entry into surface water.
- *Legislative intent/purpose of the ordinance* - This section provides a rationale for the regulation using scientifically proven benefits of riparian forest buffers for community benefit. Ordinances should clearly tie health, safety and welfare issues to any ordinance so that the requirement cannot be seen as an arbitrarily applied "taking".

- *Definition of riparian forest buffer boundary* - Depending on the goals of the riparian forest buffer, there are many different approaches to defining riparian forest buffer width, boundaries and allowable activities. Examples include:
  - Zoned riparian forest buffers - designates minimum width of Zone 1 as 50 feet and Zone 2 as 50 to 100 feet;
  - Riparian forest buffer averaging - allows for variable riparian forest buffer widths within a development site; allows developers to narrow the riparian forest buffer width at some points if the average width of the riparian forest buffer meets the minimum criteria; streamside zones should not be encroached upon.
- *Specified quality of vegetation in riparian forest buffer* - A list of appropriate native tree and shrub species may be created by the municipality, as well as rules concerning minimum plant density.
- *Permitted uses within the riparian forest buffer* - Permitted uses may include passive use areas, livestock crossings, and streambank stabilization. Ordinance language typically allows tree removal by the property owner as part of normal maintenance so long as the disturbance is under a determined square footage. Land uses would again be primarily passive.
- *Uses specifically prohibited in riparian forest buffer* - These restrictions could be specified by riparian forest buffer zones. In the zone closest to the stream, the ordinance might prohibit all removal of plants except invasive plants and those presenting a hazard to safety or property Restrictions applied to all zones may include clear-cutting of vegetation and storage of hazardous or noxious materials.
- *Regulation of nonconforming structures and uses* - Nonconforming structures and uses are those that legally exist prior to adoption of the ordinance. Their regulation under the ordinance should be defined.
- *Procedures to file for appeals or exemption* - Include procedures to follow for those property owners wishing to file appeals or to seek exception from, or modification to, particular sections of the riparian forest buffer ordinance.
- *Delineation requirements* - Ordinances can require that riparian forest buffers appear on clearing and grading plans and that they be physically delineated on site to protect the integrity of the riparian forest buffer during construction; a pre-construction meeting to review any site constraints that may impact a riparian forest buffer can also be required.
- *Riparian forest buffer management and maintenance* - Ordinances can clearly outline post-construction maintenance responsibilities. In riparian forest buffer management and maintenance agreements, allowable activities can be listed, authority to inspect a riparian forest buffer can be listed, authority to inspect a riparian forest buffer can be defined and conditions under which a landowner is responsible for repairs can be described.

Riparian Forest Buffer Ordinance Terms:

Zoning District:
A designated area within a municipality that contains a unique characteristic. The overlay is an amendment that adds a riparian forest buffer overlay zone in addition to or superseding the underlying zoning district(s). The overlay zone can span more than one zoning district and can impose more restrictive regulations than those in the underlying zoning district.

Takings:
Takings are an exercise of governmental authority in restricting a property owner's use of his property. To minimize a charge of takings, a riparian forest buffer ordinance should include wording in the legislative intent to justify the riparian forest buffer on the basis of sound science and concern for public safety and health.

***Net** Regulations:*
The technique of deducting environmentally constrained lands, such as wetlands, steep slopes, floodplains and woodlands, from the total developable area used for development density calculations. It is intended to protect and preserve environmentally sensitive land particularly in areas that are nearly fully developed and where there is greater development pressure on environmentally sensitive land.

Case Studies in Riparian Forest Buffer Ordinances

Website references for model riparian forest buffer ordinances can be found in Appendix D, References and Resources. A number of municipalities in Pennsylvania either have adopted a riparian forest buffer ordinance or are in the process.

Development Tools That Promote Conservation of Riparian Forest Buffers

Article V of the Planning Code (53 P.S. §§10101 *et seq.* (2009)) grants municipalities the power to control the development of subdivisions. Municipalities can take a regulatory or incentive-based approach to protect riparian areas in new developments. The degree of riparian area protection is likely to vary with the approach. Best results occur when a municipality identifies riparian areas to protect early in the planning stage of a new development. Intervention during early planning stages often promotes good will efforts from the developer. Amenities such as greenways or trails along stream corridors that result from municipal intervention can benefit the developer as well as protect the water resource as these green spaces can enhance the desirability of property within a new development.

Conservation by Design

Growing Greener: Conservation by Design incorporates conservation considerations into the development process and municipal ordinances, patterning development around networks of open space. Conservation by Design arranges new development on sites to be developed so that half or more of the buildable land in subdivisions is permanently set aside as open space. The same number of housing units can be built—just on smaller lots—so landowners and developers are not financially penalized. Conservation by Design differs from traditional cluster developments in that it places conservation planning at the beginning of the development process rather than at the end and establishes higher standards for both the quantity and quality of open space.

Municipalities can incorporate Conservation by Design land use regulations into their zoning, subdivision and land development ordinances. Developers can incorporate Conservation by Design concepts into their development process. Residents of the municipality can advocate for their elected officials to implement Conservation by Design. Certain land trusts and consultants can provide land conservation and land use planning expertise to the municipalities.

Transferable Development Rights

Transfer of development rights (TDR) program allows landowners to transfer the right to develop one parcel of land to a different parcel of land. This program is established by local zoning ordinances.

Land ownership provides landowners with a bundle of rights, such as mineral rights, water rights, air rights or development rights. Each right may be separated from the rest and transferred to someone else while the original owner still retains ownership of the land.

In some cases, these rights may be sold or transferred to public agencies or qualified nonprofit organizations. Example of this is the Farmland Preservation program in Pennsylvania.

The transfer or sale of development rights allows the owner to retain their land but not the right to develop or alter the property. Some examples of the purchase or donation of development rights result in protecting the lands such as a riparian forest buffer zone or an agricultural conservation areas that been utilized by several municipalities.

APPENDIX C.1
Native Riparian Tree/Shrub Plant Selection

TREES								
Common/ *Scientific Name*	**Region**	**[1]Wet Code**	**Soil pH**	**Flood Tolerance**	**Height(ft)**	**Shade Tolerance**	**Wildlife Value**	**Comments**
Red maple *Acer rubrum*	P, R, A	FAC	5.5-7.0	tolerant	75-100	tolerant	food source-fruits and young shoots	used in furniture, flooring and grown as an ornamental; fall color
*Silver maple *A. saccharinum*	P, R, A	FACW	4.0-6.5	tolerant	75-100	intermediate	food source-seeds and young twigs	fast growth
Sugar maple *A. saccharum*	R, A	FACU-	4.0-7.0	intolerant	75-100	very tolerant	food source-seeds and twigs	important lumber and maple sugar source; fall color
Serviceberry *Amelanchier arborea/laevis/ canadensis*	P, R, A	FAC-	4.5-7.0	tolerant	20-40	intermediate	food source-fruit, twigs and leaves	edible berry; ornamental; flowers in early spring; single trunk or shrub-like
Pawpaw *Asimina triloba*	P, R, A	FACU+	5.0-7.0	intolerant	20-35	tolerant	food source-fruit and leaves; host plant for zebra swallowtail butterfly larvae	found mainly in southern tier counties; largest native edible fruit in North America
**Yellow birch *Betula alleghaniensis*	P, R, A	FAC	4.5-7.0	intolerant	60-100	intermediate	food source-seeds, young twigs and shoots and catkins	important source of hardwood lumber; twigs taste of wintergreen
Black (Sweet) birch *B. lenta*	R, A	FACU	5.0-7.0	intolerant	50-75	intermediate	food source-catkins, buds, seeds, leaves and twigs	lumber and fuel source; former commercial source of wintergreen
River birch *B. nigra*	P, R	FACW	4.5-7.5	tolerant	40-70	intolerant	food source-seeds, buds, young twigs and foliage	local timber value; ornamental – exfoliating bark
*American hornbeam *Carpinus caroliniana*	P, R, A	FAC	4.0-7.5	intolerant	35-50	very tolerant	food source-catkins, buds, seeds, leaves and twigs	slow growth rate; not drought tolerant; also called ironwood or musclewood
**Bitternut hickory *Carya cordiformis*	P, R, A	FACU+	6.5-7.5	intermediate	75-100	intolerant	bitter nuts not favored as much as other hickories	high value for fuel

TREES								
Common/ *Scientific Name*	**Region**	**[1]Wet Code**	**Soil pH**	**Flood Tolerance**	**Height (ft)**	**Shade Tolerance**	**Wildlife Value**	**Comments**
**Shagbark hickory *C. ovata*	P, R, A	FACU-	4.0-8.0	intolerant	75-100	intermediate	food source-twigs and nuts	one of the best commercial hickories-lumber source
*Redbud *Cercis canadensis*	P, R	FACU-	4.5-7.0	intolerant	20-35	tolerant	food source-seeds, foliage and flower pollen for honeybees	grown as an ornamental; blooms in early spring
Hackberry *Celtis occidentalis*	P, R	FACU	6.0-8.0	intermediate	75-100	intermediate	food source-fruits and twigs; shelter and nesting sites	little importance as timber producer; fuel wood; fast growth
Flowering dogwood *Cornus florida*	R, A	FACU-	5.0-7.0	very intolerant	35-50	intermediate	food source-fruit	specialty wood products; edible fruits; **susceptible to anthracnose**
**Persimmon *Diospyros virginiana*	P	FAC-	5.0-7.0	intermediate	50-75	tolerant	food source-fruits, twigs and nectar	slow growing; optimum edible fruit bearing begins at age 25; specialty wood products
American beech, *Fagus grandifolia*	P, R, A	FACU	4.0-6.5	very intolerant	75-100	very tolerant	food source-nuts	wood is used for flooring, furniture and fuel wood
White ash *Fraxinus americana*	P, R, A	FACU	5.0-7.5	intermediate	75-100	tolerant	food source-fruit	wood used for many purposes; **susceptible to Emerald Ash Borer (EAB)**
Red (Green) ash *F. pennsylvanica*	P, R	FACW	5.0-8.0	tolerant	50-75	intolerant	minimal food source-twigs and fruits	important lumber tree; **susceptible to EAB**
Honey-locust *Gleditsia triacanthos*	R, A	FAC-	6.0-8.0	intermediate	50-75	intolerant	food source-seeds and pods	not widely used in riparian projects; a thornless variety is used for street and shade tree
**Kentucky coffee-tree *Gymnocladus dioica*	A	FACU-	6.0-8.0	intermediate	75-100	intolerant	low appeal to wildlife	wood used for various purposes, though not abundant; limited natural range in PA

TREES								
Common/ *Scientific Name*	**Region**	**[1]Wet Code**	**Soil pH**	**Flood Tolerance**	**Height(ft)**	**Shade Tolerance**	**Wildlife Value**	**Comments**
Black walnut *Juglans nigra*	P, R	FACU	5.5-8.0	intermediate	75-100	intolerant	food source-twigs and nuts	very important lumber tree
Tuliptree/poplar *Liriodendron tulipifera*	P, R, A	FACU	4.5-6.5	intermediate	75-100	intermediate	food source-nectar and seeds	valuable hardwood species
Black-gum *Nyssa sylvatica*	P, R, A	FAC	4.5-6.0	intermediate	50-75	intolerant	food source-fruits, twigs and nectar	lumber source; grown as an ornamental; fall color
* **Hop-hornbeam *Ostrya virginiana*	P, R	FACU-	4.0-7.5	very intolerant	35-50	very tolerant	food source-buds, catkins and seeds	understory tree; ornamental
Eastern white pine *Pinus strobus*	P, R, A	FACU	4.0-6.5	intolerant	75-100	intermediate	high value food source-needles and seeds; used for cover	lumber source; grown as an ornamental
Sycamore *Platanus occidentalis*	P, R, A	FACW-	5.0-6.5	intermediate	75-100	intermediate	moderate value for cover and nesting; food source-fruits	limited commercial value; ornamental (bark)
Eastern cottonwood *Populus deltoides*	P, A	FAC	6.5-7.5	tolerant	75-100	intolerant	food source-bark, twigs, leaves and buds	softwood used mostly for paper pulp
Large-toothed aspen *P. grandidentata*	P, R, A	FAC-	5.0-6.5	intolerant	50-75	very intolerant	food source- bark, twigs, leaves, catkins and buds	softwood used mostly for paper pulp
Wild black cherry *Prunus serotina*	P, R, A	FACU	5.0-7.5	very intolerant	50-75	intolerant	high value food source-fruits, twigs and nectar	highly valued lumber tree
White oak *Quercus alba*	P, R, A	FACU-	4.5-7.0	intolerant	75-100	intermediate	high value food source-acorns and twigs	important lumber tree
Swamp white oak *Q. bicolor*	P, R	FACW+	4.5-6.5	tolerant	75-100	intermediate	food source-acorns and twigs	lumber occasionally used in general construction

TREES								
Common/ *Scientific Name*	**Region**	**[1]Wet Code**	**Soil pH**	**Flood Tolerance**	**Height(ft)**	**Shade Tolerance**	**Wildlife Value**	**Comments**
**Chestnut oak *Q. montana*	P, R	UPL	4.5-7.0	intolerant	50-75	intermediate	food source-acorns and twigs	lumber used for various uses
Pin oak *Q. palustris*	P, R, A	FACW	4.5-6.5	tolerant	50-75	intolerant	food source-acorns and twigs	lumber often sold as white oak
Northern red oak *Q. rubra*	P, R, A	FACU-	4.5-6.5	intermediate	75-100	intermediate	medium value for nesting and food source-acorns	lumber used for various uses
*Black willow *Salix nigra*	P, R, A	FACW+	5.0-8.0	very tolerant	35-50	very intolerant	food source-buds, fruit, and twigs	excellent for wicker baskets and furniture
Sassafras *Sassafras albidum*	P, R, A	FACU-	4.5-7.0	very intolerant	35-50	intolerant	food source-twigs and fruits	poor quality wood used occasionally
American basswood *Tilia americana*	P, R, A	FACU	4.5-7.5	intolerant	75-100	tolerant	food source-twigs, seeds and nectar	important lumber tree and for paper pulp
Canada hemlock *Tsuga canadensis*	P, R, A	FACU	4.0-6.0	intolerant	75-100	very tolerant	food source-seeds, twigs, needles and bark; used for cover	lumber source for pulp and siding; **susceptible to Hemlock Wooly Adelgid**
**Red (Slippery) elm *Ulmus rubra*	P, R, A	FAC	5.5-7.0	tolerant	50-80	intermediate	food source-seeds and twigs	wood inferior to American Elm but used for furniture and paneling

SMALL TREES/SHRUBS								
Common/ *Scientific Name*	**Region**	**[1]Wet Code**	**Soil pH**	**Flood Tolerance**	**Height(ft)**	**Shade Tolerance**	**Wildlife Value**	**Comments**
**Smooth alder *Alnus serrulata*	P, R, A	OBL	5.0-7.0	very tolerant	12-20	very intolerant	food source-fruit	*A. incana* and *A.rugosa* (northern species). Note: *A. rugosa* can be confused with *A. glutinosa* (non-native, invasive) in the nursery trade.
Red chokeberry *Photinia (Aronia) arbutifolia*	P, R, A	FACW	5.5-7.5	very tolerant	6-12	intermediate	very low wildlife value	ornamental (red leaves in autumn)
Black chokeberry *P. melanocarpa*	P, R, A	FAC	6.5-8.0	very tolerant	3-6	intermediate	food source-seeds and twigs	
Buttonbush *Cephalanthus occidentalis*	P, R, A	OBL	5.5-8.5	very tolerant	6-12	very intolerant	food source-fruit	unique flower and fruit arrangement – round ball
Summersweet *Clethra alnifolia*	P	FAC+	4.5-6.5	very tolerant	6-12	tolerant	food source-fruits and twigs	ornamental; found mainly in coastal plain (southeast PA)
Silky dogwood *Cornus amomum*	P, R, A	FACW	5.0-7.0	very tolerant	6-12	intolerant	food source-fruits	bluish colored fruit
Gray dogwood *C. racemosa*	P, R, A	FAC-	5.0-7.0	intermediate	6-12	tolerant	food source-fruits; cover	white fruit setoff by bright red fruit stalks; spreads by suckering
Red-osier dogwood *C. sericea*	P, R, A	FACW+	6.0-8.5	very tolerant	6-12	intermediate	food source-fruits, buds, and twigs	ornamental (red-stems); whitish colored fruit
**Amer. hazelnut *Corylus americana*	P, R, A	FACU-	5.0-7.0	intolerant	6-12	tolerant	food source-nuts (higher nutritional value than acorns and beechnuts)	use as a border plant, colonizer
Witchhazel *Hamamelis virginiana*	P, R, A	FAC-	4.5-6.0	intolerant	20-35	very tolerant	leaves toxic to some animals	blooms in the autumn; can tolerate limited flooding
Winterberry *Ilex verticillata*	P, R, A	FACW+	4.5-7.5	very tolerant	6-15	intermediate	intermediate wildlife value	fruits poisonous to humans; dioecious (male and female separate)

SMALL TREES/SHRUBS								
Common/ *Scientific Name*	**Region**	**[1]Wet Code**	**Soil pH**	**Flood Tolerance**	**Height(ft)**	**Shade Tolerance**	**Wildlife Value**	**Comments**
**Mountain laurel *Kalmia latifolia*	P, R, A	FACU	4.5-5.5	intolerant	12-20	very tolerant	high value as food esp. for winter browse for deer	understory plant for established riparian forest buffers with acidic soils
Common spicebush *Lindera benzoin*	P, R, A	FACW-	4.5-6.0	intermediate	6-12	very tolerant	high value as food source-fruits and leaves; host plant for spicebush swallowtail butterfly	early settlers used spicebush as an indicator of good agricultural land
Northern bayberry *Morella (Myrica) pensylvanica*	P, R	FAC	5.5-8.0	very tolerant	6-12	intolerant	food source-fruits	limited range – SE PA
**Ninebark *Physocarpus opulifolius*	P, R, A	FACW-	4.5-6.5	very tolerant	6-12	intolerant	food source-fruit	
**Rosebay rhododendron *Rhododendron maximum*	P, R, A	FAC	4.0-5.5	tolerant	20-35	intolerant	food source-buds and twigs (winter browse)	understory plant for established riparian forest buffers with acidic soils
**Swamp azalea *R. viscosum*	P	OBL	4.0-7.0	very tolerant	6-12	intermediate	food source-nectar for hummingbirds and butterflies	limited range – SE PA; understory plant for established riparian forest buffers with acidic soils
Staghorn sumac *Rhus typhina*	P, R, A	None	4.5-7.0	intolerant	35-50	intermediate	food source-fruit	clump forming – spreads by rhizomes
**Swamp rose *Rosa palustris*	P, R, A	OBL	4.0-7.0	very tolerant	4-10	intolerant	food source-fruit	fragrant, solitary pink flowers
*Pussy willow *Salix discolor*	P, R, A	FACW	4.0-7.0	very tolerant	20-35	very intolerant	high value as food source	catkin furry and is a harbinger of spring
Sandbar willow *Salix exigua (interior)*	P, R, A	OBL	6.0-8.5	very tolerant	15-20	very intolerant	food source-fruits and twigs	limited natural range in PA

SMALL TREES/SHRUBS								
Common/ *Scientific Name*	**Region**	**[1]Wet Code**	**Soil pH**	**Flood Tolerance**	**Height(ft)**	**Shade Tolerance**	**Wildlife Value**	**Comments**
**Silky willow *Salix sericea*	P, R, A	OBL	5.0-7.0	very tolerant	up to 12'	intermediate	food source – foliage and nectar	rapid grower; native alternative to Russian olive (invasive)
American elder *Sambucus canadensis*	P, R, A	FACW-	5.0-7.0	very tolerant	6-12	intermediate	high value food source-fruit, twigs and leaves	new growth contains a glucoside than can be fatal to livestock
Meadowsweet *Spiraea latifolia*	P, A	FACW+	6.5-7.5	very tolerant	3-6	intermediate	food source-fruit and twigs	
Highbush blueberry *Vaccinium corymbosum*	P, R, A	FACW-	4.5-7.5	very tolerant	6-12	tolerant	food source-fruit	commercial food crop
**Witherod *Viburnum cassinoides*	P, R, A	FACW	5.0-7.0	very tolerant	6-12	tolerant	food source-fruit	dense, multi-stemmed
Southern arrowwood *V. dentatum*	P	FAC	5.0-6.5	tolerant	6-12	tolerant	food source-fruit	leaves and twigs hairy; limited natural range in PA
Nannyberry *V. lentago*	P, A	FAC	5.0-7.0	intolerant	20-35	intermediate	food source – fruit and twigs	
Blackhaw *V. prunifolium*	P, R, A	FACU	5.0-7.5	very intolerant	20-35	intolerant	food source – fruit	
Northern arrowwood *V. recognitum*	P, R, A	FACW-	5.0-7.0	tolerant	6-12	tolerant	food source-fruit and nectar and pollen of the flowers	leaves and twigs nearly hairless (glabrous); found throughout PA

Key for Appendix C.1:

* Short lived: Trees < 100 years Shrubs < 20 years

** May be hard to find in a nursery

P = Piedmont Province

R = Ridge and Valley Province

A = Allegheny Plateau Province

[1]The wetland indicator code used in this document is for Region 1 (based on the National Wetland Indicator Status)

Indicator Code	Wetland Type	Comment
OBL	Obligate Wetland	Occurs almost always (estimated probability 99%) under natural conditions in wetlands.
FACW	Facultative Wetland	Usually occurs in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
FAC	Facultative	Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
FACU	Facultative Upland	Usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found on wetlands (estimated probability 1%-33%).
UPL	Obligate Upland	Occurs in wetlands in another region, but occurs almost always (estimated probability 99%) under natural conditions in non-wetlands in the regions specified. If a species does not occur in wetlands in any region, it is not on the National List.

The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands), and a negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).

Source: U.S. Fish and Wildlife Service. 1988. *National list of vascular plant species that occur in wetlands.* U.S. Fish & Wildlife Service Biological Report 88 (26.9).

APPENDIX C.2
Riparian Forest Buffer Site Plan Template

Contact: _____ **Phone Number:** _____

Location: _____

Species	Latin Name	Size	Quantity	Pattern/Spacing

Equipment/Tools:	**Site Preparation:**
Maintenance Responsibilities:	**Number of volunteers:** **Directions to site:**

APPENDIX C.3
Sample Riparian Forest Buffer Inspection and Maintenance Schedule

The following is a sample maintenance schedule to optimize survival of a newly planted riparian forest buffer. Keep in mind tasks are the same for each riparian forest buffer but there may be site variations, therefore, add to the schedule additional tasks that are site specific. Refer back to the Toolkit Maintenance and Monitoring section for additional details.

Maintenance Tasks for Riparian Forest Buffers **Year**	**1**	**2**	**3**	**4**	**5**
Check tree shelters (March-April) Suggested activities: straighten and re-drive any loose stakes, replace damaged/rotten stakes; check ties and tighten or replace if needed; remove large wasp nest (before they come active); remove bird nets if tree has reached the top of the shelter.	x	x	x	x	x
Remove shelters (Spring) It is recommended to remove when trees that are at least 2 inches in diameter at top of tube; leave stake in place to deter buck rub; if tree is droopy, secure to stake with biodegradable material.			x	x	x
Herbicide application (April-May) Apply broad-spectrum herbicide to protect trees from rodents and reduce competition by other plants (add a pre-emergent herbicide advisable); ideally spray 3' strips along shelters or 4' circle spots (if not mowing the site).	x	x	x	x	
Mowing (Summer and Fall) Mow between rows at least twice between June and late September to prevent weeds going to seed, and reduce existing vegetation competition. If rodent population is high , reduce habitat by mowing additional three years in the fall only (see herbicide application above). If not mowing, spot spraying for invasive plants if needed.	x	x			
Herbicide application (mid-August-early October) Apply broad-spectrum herbicide only to control perennial noxious or invasive weeds, reduce existing vegetation competition, and protect trees from rodents (ideally spray 3' strips along shelters, but could be 4' circles)	x	x	x	x	
Survival (Late Fall) Check and note any survival problems – disease, insects and invasive weed issues. Check for natural regeneration and where abundant limit further mowing unless site is prone to rodents and invasive plants.	x	x	x	x	
Replacement plantings (Fall to Spring) First identify and address the cause of losses (most commonly voles and other rodents), replant any areas with significant losses to reinforce tree stocking to desired levels; check natural regeneration for potential free recruitment of trees.		x	x		
Flooding If riparian forest buffer site floods check within one week of any flood, straighten and reposition or replace shelters and stakes if need be - downed tubes will pin and kill trees and invite rodent damage.	x	x	x	x	
Other Task(s):					

(Sources: *Landowners Guide to Buffer Success*, Chesapeake Bay Foundation and *Riparian Forest Buffer Design and Maintenance*, MD Department of Natural Resources Forest Service)

APPENDIX C.4
Monitoring Survival Using Systematic Line Plot Cruise

The Maryland Department of Natural Resources Forest Service developed the sampling method described below to monitor a broad range of riparian forest buffers. This method is designed to collect information about natural regeneration as well as survival of planted trees. The sampling method can be used for plantings with a variety of riparian forest buffer management practices including mowed sites, overgrown sites and sites with or without tree shelters.

This monitoring procedure has been designed to have a sampling intensity ranging from approximately 2.5% to 10% of the riparian forest buffer area, depending on the size of the riparian forest buffer. Testing has shown that this level of sampling will provide an accurate picture of overall plant survival for the whole site.

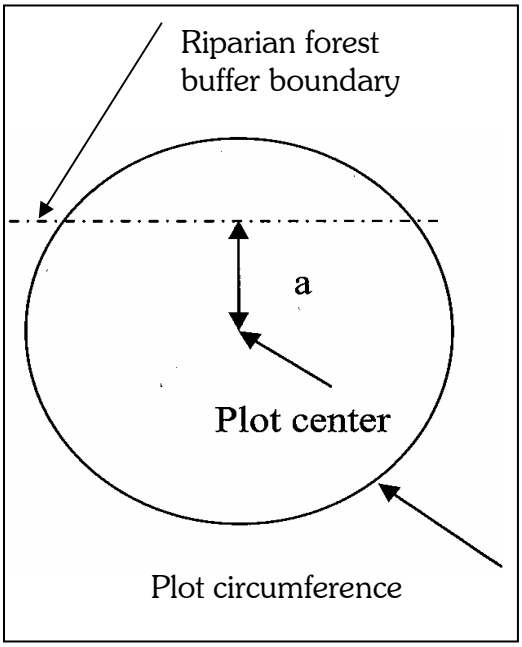
Calculation of Monitoring Results From Partial Plots - It is quite possible that one or more plots will straddle the boundary of the riparian forest buffer. When this occurs, data from the "partial" plot is collected and added to the data from the other plots. Refer to the figure and table below to determine the area of a partial plot. Once you have determined the area of the partial plot, this number must be added to the area of the other plots when calculating the total area sampled. **Only the area of the partial plot located within the riparian forest buffer boundary should be added to the total area sampled.**

This partial plot area is obtained by measuring the distance from plot center to the riparian forest buffer boundary (distance "a") and finding the corresponding plot area in the following table. Round "a" to the nearest foot.

Plot table

Value of "a" (feet)	Area of Plot (acres)
1	0.0055
2	0.0061
3	0.0066
4	0.0071
5	0.0076
6	0.0081
7	0.0085
8	0.0089
9	0.0093
10	0.0096
11	0.0099
11.78	0.01

Descriptive drawing of a partial plot



Equipment List

- Tape
- Compass
- Surveyor's Stakes
- Clip Board
- Site Monitoring summary form
- Calculator

On Site Data Collection

1. Use riparian forest buffer map used for planting plan and/or aerial photograph showing site to record position of sampling sites.

2. Determine the boundary of your riparian forest buffer area using features such as fences, field edges, woodland edges or streams within 12 feet of the planted trees. If there is no defining boundary within 12 feet, mark the riparian forest buffer boundary as a line outside the line of planted trees by a distance of ½ the average distance between trees in the riparian forest buffer area. If trees are planted approximately 10 feet apart, the boundary will be five feet beyond the outside row.

3. Unless the current acreage and location of the riparian forest buffer are known with certainty, map the perimeter of the riparian forest buffer either by pacing off the area or using a measuring tape. Record on the site map the location of the riparian forest buffer relative to the stream and other key landscape features.

4. Calculate the area of the riparian forest buffer and record the acreage.

   To determine the area in square feet, multiply the average length of the riparian forest buffer by the average width: Area (ft^2) = Average Length (ft) x Average Width (ft)

   To determine the acreage, divide the area by 43,560:
   Acreage (ac) = Area (ft^2)/(43,560 ft^2/ac)

5. Using a compass, determine the azimuth or direction, of a baseline that is approximately in line with the long axis of the riparian forest buffer. If the upland side of the riparian forest buffer is relatively straight, this is usually a good baseline. Plot lines will fall perpendicular to the baseline, from waters edge along a 90 degree line the width of the riparian forest buffer.

6. Determine the appropriate sampling intensity based on the area of the riparian forest buffer to be measured as described in the below table.

Riparian Forest Buffer Area	Distance between Plotlines	Distance between Plots	Approximate Area Samples
1-10 acres	264 feet	33 feet	*5%*
>10 acres[1]	264 feet	66 feet	*2.5%*

7. Choose one end of your baseline as a starting point, if possible at boundary. From that point, measure or pace off a distance of 132 feet (66 feet for riparian forest buffer areas <1 acre) along the baseline.

8. Turn 90 degrees toward the stream; this will point you in the direction of your plot line. From this point, measure a distance of *16.5* feet (33 feet for riparian forest buffer areas >10 acres) in along the plotline toward the stream. Establish this point as the plot center of the first plot using a wire flag, stake or pole.

[1] For areas greater than ten acres but less than 66 feet wide, use plotlines 528 feet apart and plots 33 feet apart along each line.

9. Define a plot with a radius of 11.78 feet from the center point. The plot area is equal to 1/100th of an acre.

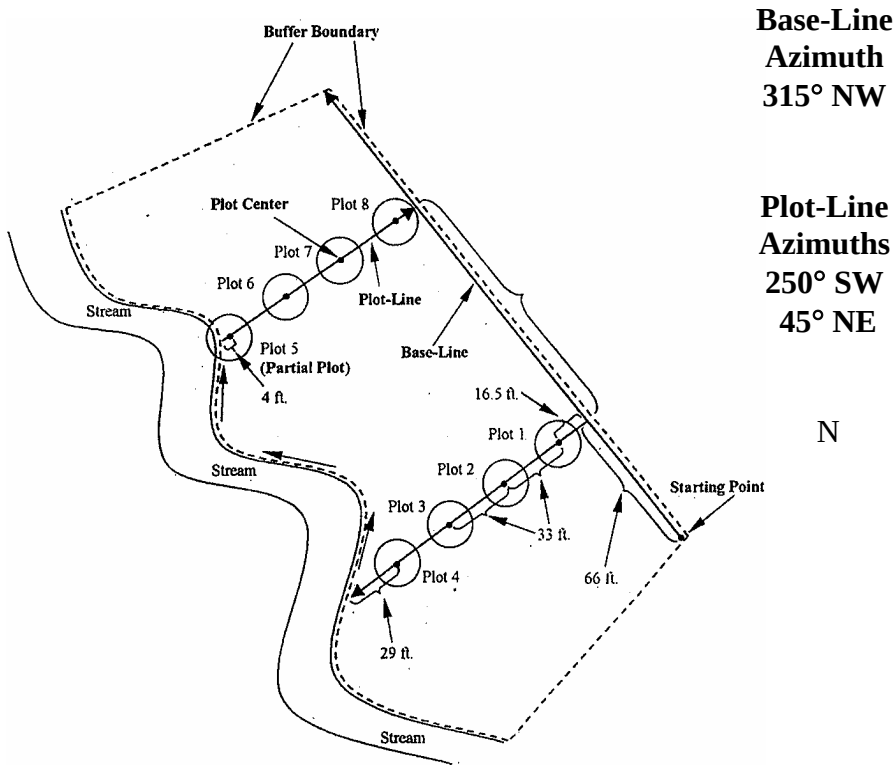
10. Record all data using the Site Monitoring Summary Form at the end of the chapter.

11. Continue on in this manner until you reach the boundary of the riparian forest buffer area. If your plot center falls within the riparian forest buffer area but at a distance less than 11.78 feet from the boundary, your plot will straddle the riparian forest buffer boundary, forming a partial plot. Refer to the section "Calculation of Monitoring Results from Partial Plots" (page 81).

12. To begin a new plotline, pace off 264 feet (132 feet for riparian forest buffers <1 acre) parallel to the base line at waters edge and away from your original starting point.

13. Repeat Steps 8-10 along the new plotline.

Riparian forest buffer site with example of monitoring layout. Note that the area of this site is less than 1 acre so the distance between the starting point and the first plot-line is 66 feet and the distance between plot-lines is 132 feet.



Avg. Length— 265 feet	**Acreage — 0.76 acres**
Avg. Width —125 feet	**Total Area Sampled — 0.077 acres**
Area —33,125 feet^2	**Percent Sampled — 10.1%**

Streamside Riparian Forest Buffer Monitoring
SITE MONITORING SUMMARY FORM

Site Name_____Date Collected_____Collected by_____

Total Area (acres)_____Area Sampled_____Number of Plots_____

Original Planting Density (Trees or Shrubs per Acre)

Original Planting Density _____

B&B/Containerized Saplings _____ Sheltered Seedlings _____

Seedlings w/o Shelters _____ Other_____

Trees and Shrubs Counted During Monitoring

		Number of Each Plant Type					Condition*	
Tree or Shrub Species	Number Counted	Planted Seedling	Sheltered Seedling	B&B/ Container	Natural Regen.	Other	1	2
TOTALS:								

***1=Healthy and free to grow, not significantly impaired or damaged. Likely to survive and grow.**
***2=Damaged or impaired by some problem.**

Number of Species Counted: _____

Plant Condition Summary: Percent Healthy _____% Percent Damaged _____%

Vegetative Competition:

None		Light	Medium	Heavy
Over Entire Site				
Tally for each plot				

Comments:_____

_____

_____

3940-FM-WM0100 Rev. 2/2008

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

APPENDIX C.5

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

PENNSYLVANIA STREAM RELEAF – PROJECT DATA SHEET

I. CONTACT INFORMATION:

Your Name: _____ Today's Date: _____

Organization (if applicable): _____ E-mail Address: _____

Street Address or Box #: _____

City: _____ State: _____ Zip: _____ Telephone: _____
(Area code)

II. PROJECT LOCATION/IDENTIFICATION: (PLEASE INCLUDE PROJECT SITE MAP)

Landowner/Project Name: _____ Project Dates: _____/_____
(Optional) Start End

City: _____ State: _____ Zip: _____ County: _____

Municipality: _____ Land Ownership Type: ☐ Federal ☐ State ☐ Public ☐ Private
Is buffer permanently protected? ☐ Yes or ☐ No

Stream Name: _____ State Water Plan Watershed: _____ (e.g. 4A, 5B, 10C)
(or name of nearest downstream) (See map on back)

Latitude: _____ Longitude: _____
(Please take reading from upstream end of project or center if project is a pond, lake or wetland)

Note: A USGS 7.5 Topographic Quadrangle map, <u>including Map Name</u> and indicating project site, will provide latitude and longitude.

Waterbody associated with Project: ☐ Unnamed Tributary ☐ Stream ☐ Lake or Pond ☐ Wetland ☐ River

Adjacent Land Use: ☐ Forest ☐ Herbaceous/shrub ☐ Crops ☐ Grass (warm season) ☐ Pasture ☐ Paved Other: _____

III. BUFFER CHARACTERISTICS:

Buffer Type: ☐ Forest ☐ Trees/Shrubs ☐ Grasses ☐ Fencing only Other: _____

First Side: Length of stream buffer in feet: _____ Average width of stream buffer in feet: _____

Second Side: Length of stream buffer in feet: _____ Average width of stream buffer in feet: _____

Sources of Technical Assistance: (e.g. NRCS, DCNR, conservation district, consultant) _____

Sources of Funding: (e.g. Growing Greener, DCNR, CREP, CBF/DU, 319) _____

ADDITIONAL COMMENTS:

_____

_____

Web site: www.depweb.state.pa.us
Keyword: Watersheds New topics:
Stream ReLeaf Project Data Web Form
& Information Center

Please return to: **Pa. DEP, Bureau of Watershed Management**
PO Box 8555
Harrisburg, PA 17105-8555
Attn: Stream ReLeaf Program
Phone: (717) 772-5637
Fax: (717) 787-9549

APPENDIX C.6
Sample Riparian Forest Buffer Protection Agreement

A. RIPARIAN FOREST BUFFER PROTECTION AGREEMENT

THIS RIPARIAN FOREST BUFFER PROTECTION AGREEMENT (this "Protection Agreement") dated as of _____ (the "Agreement Date") is by and between _____ (the "undersigned Owner or Owners") and _____ (the "Holder").

Article 1. Background

1.01 Property

The undersigned Owner or Owners are the sole owners in fee simple of the Property described in Exhibit "A" (the "Property"). The Property is also described as:

Street Address:
Municipality:
County:
Parcel Identifier:

1.02 Purpose

Conservation Objectives

The undersigned Owner or Owners and Holder are entering into this Protection Agreement to establish a riparian forest buffer (the "Riparian Buffer") along _____ Creek (the "Creek") for the following purposes (collectively, the "Conservation Objectives"): to maintain and improve the quality of water resources associated with the Creek; to perpetuate and foster the growth of healthy forest; to preserve habitat for Native Species dependent on water resources or forest; and to ensure that activities and uses in the Riparian Buffer are sustainable, i.e., they neither diminish the biological integrity of the Riparian Buffer nor deplete the soil, forest and other natural resources within the Riparian Buffer over time.

Riparian Buffer Area

The Riparian Buffer consists of the strips of land stretching _____ (__) feet landward from the Top of the Banks of the Creek, together with the banks and bed of the Creek, to the extent that the strips, banks and bed are contained within the Property.

Baseline Documentation

The report (the "Baseline Documentation"), to be kept on file at the principal office of Holder, describes the conservation values of the Riparian Buffer identified in the Conservation Objectives, describes existing conditions of the Riparian Buffer including Existing Improvements as of the Agreement Date, and includes, among other information, photographs depicting the Riparian Buffer.

1.03 Owners' Control

Owners reserve all rights and responsibilities pertaining to their ownership of the Property but for the rights *specifically* granted to Holder in this Protection Agreement. No public access is granted by virtue of this Protection Agreement.

1.04 Defined Terms

Initially capitalized terms used and not otherwise defined in this Article I are defined in the last Article of this Protection Agreement (the "Glossary").

Article II. Restrictive Covenants: Improvements

No Improvements are permitted within the Riparian Buffer except as set forth in this Article II.

2.01 Existing Improvements

Any Existing Improvement may be maintained, repaired and replaced in its existing location. An Existing Improvement may be expanded or relocated if the expanded or relocated Improvement complies with requirements applicable to an Additional Improvement of the same type set forth in this Article.

2.02 Additional Improvements

Only the following Additional Improvements are permitted within the Riparian Buffer:

Existing Agreements

Improvements that Owners are required to allow under Existing Agreements.

Other Additional Improvements

Fences, walls and gates along the perimeter of the Riparian Buffer; signs not exceeding one square foot each; and habitat improvement devices such as birdhouses and bat houses.

Trails of highly porous surface and footbridges for non-motorized use.

Subject to Review, fish passage, fish habitat improvement and stream bank stabilization structures.

Subject to Review, irrigation facilities accessory to agricultural use of the Property.

Subject to Review, stream crossing and access structures and associated access corridor for the purpose of allowing passage across the Riparian Buffer by livestock, horses and agricultural equipment to cross the Creek or access water in the Creek in a specified location. It is Owners' responsibility to install fencing whenever necessary to prevent grazing within or other unrestricted access to the Riparian Buffer by horses or livestock.

Subject to Review, access drives and utility lines but only if there is no other reasonably feasible means to provide access and utility services to the Property except via the Riparian Buffer.

Article III. Restrictive Covenants: Activities; Uses; Disturbance of Resources

No activities, uses or disturbances of resources are permitted within the Riparian Buffer except as set forth in this Article III.

3.01 Existing Agreements

Activities, uses and Construction that Owners are required to allow under Existing Agreements are permitted.

3.02 Other Activities and Uses

Except as provided in the preceding section, activities and uses within the Riparian Buffer are limited to those permitted below and provided in any case that the intensity or frequency of the activity or use does not have the potential to materially and adversely impair maintenance or attainment of Conservation Objectives.

Disturbance of Resources

Cutting trees, Construction or other disturbance of resources, including removal of Invasive Species, to the extent reasonably prudent to remove, mitigate or warn against an unreasonable risk of harm to Persons, property or health of Native Species on or about the Riparian Buffer. Owners must take such steps as are reasonable under the circumstances to consult with Holder prior to taking actions that, but for this provision, would not be permitted or would be permitted only after Review.

Planting Native Species but no monoculture.

Removal of Invasive Species to accommodate replanting with Native Species.

Sustainable forestry in accordance with a Resource Management Plan approved for that activity after Review but not within fifty (50) feet of the top of the bank of the Creek.

Agricultural use is limited to passage of horses, livestock and equipment via a corridor (if any) permitted under Article II to access water at a specified location or stream crossing structures (if any) permitted under Article II.

Subject to Review, stream bank stabilization, dam removal and other habitat improvement activities.

Other resource management activities consistent with Conservation Objectives and conducted in accordance with the Resource Management Plan approved for that activity after Review.

Subject to Review, removal and disturbance of soil, rock and vegetative resources to the extent reasonably necessary to accommodate Construction of and maintain access to Improvements within the Riparian Buffer with restoration as soon as reasonably feasible by replanting with Native Species.

Vehicular use (including motorized vehicular use) in connection with an activity permitted within the Riparian Buffer or otherwise in the case of emergency.

Recreational and Educational Uses

Activities that do not require Improvements other than those permitted within the Riparian Buffer and do not have the potential to materially and adversely affect Conservation Objectives such as (i) walking, nature study, bird watching, fishing and hunting; and (ii) other educational or scientific activities consistent with maintenance or attainment of the Conservation Objectives.

Article IV. Rights and Duties of Holder and Beneficiaries

4.01 Grant to Holder

By signing this Protection Agreement and unconditionally delivering it to Holder, the undersigned Owner or Owners, intending to be legally bound, grant and convey to Holder a conservation servitude over the Riparian Buffer in perpetuity for the purpose of administering and enforcing the restrictions and limitations set forth in this Protection Agreement. The undersigned Owner or Owners warrant to Holder that the Riparian Buffer is, as of the Agreement Date, free and clear of all Liens or, if it is not, that Owners have obtained and attached to this Protection Agreement as an exhibit the legally binding subordination of any Liens affecting the Riparian Buffer as of the Agreement Date.

4.02 Rights and Duties of Holder

The grant to Holder under the preceding section gives Holder the right and duty to perform the following tasks:

Enforcement

To enforce the terms of this Protection Agreement in accordance with applicable provisions of this Protection Agreement including, in addition to other remedies, the right to enter the Property to investigate a suspected, alleged or threatened violation.

Inspection

To enter the Property and inspect the Riparian Buffer for compliance with the requirements of this Protection Agreement upon reasonable notice, in a reasonable manner and at reasonable times.

Review

To exercise rights of Review in accordance with the requirements of this Article as and when required under applicable provisions of this Protection Agreement.

Interpretation

To interpret the terms of this Protection Agreement, apply the terms of this Protection Agreement to factual conditions on or about the Riparian Buffer, respond to requests for information from Persons having an interest in this Protection Agreement or the Riparian Buffer (such as requests for a certification of compliance), and apply the terms of this Protection Agreement to changes occurring or proposed within the Riparian Buffer.

4.03 Other Rights of Holder

The grant to Holder under this Article also permits Holder, without any obligation to do so, to exercise the following rights:

Amendment

To enter into an amendment of this Protection Agreement with Owners if Holder determines that the amendment is consistent with and in furtherance of the Conservation Objectives; will not result in any private benefit prohibited under the Internal Revenue Code; and otherwise conforms to Holder's policy with respect to amendments of conservation servitudes.

Signs

To install one or more signs identifying the protected status of the Riparian Buffer which may be located (i) within the Riparian Buffer or (ii) in another location within the Property readable from the public right of way and otherwise reasonably acceptable to Owners.

4.04 Review

The following provisions are incorporated into any provision of this Protection Agreement that is subject to Review:

Notice to Holder

At least thirty (30) days before Owners begin or allow any Construction, activity or use that is subject to Review, Owners must notify Holder of the change including with the notice such information as is reasonably sufficient to comply with Review Requirements and otherwise describe the change and its potential impact on natural resources within the Riparian Buffer.

Notice to Owners

Within thirty (30) days after receipt of Owners' notice, Holder must notify Owners of Holder's determination to (i) accept Owners' proposal in whole or in part; (ii) reject Owners' proposal in whole or in part; (iii) accept Owners' proposal conditioned upon compliance with conditions imposed by Holder; or (iv) reject Owners' notice for insufficiency of information on which to base a determination. If Holder gives conditional acceptance under clause (iii), commencement of the proposed Improvement, activity, use or Construction constitutes acceptance by Owners of all conditions set forth in Holder's notice.

Failure to Notify

If Holder fails to notify Owners as required in the preceding subsection, the proposal set forth in Owners' notice is deemed approved.

Standard of Reasonableness

Holder's approval will not be unreasonably withheld; however, it is not unreasonable for Holder to disapprove a proposal that may adversely affect Conservation Objectives.

4.05 Beneficiaries

Owners and Holder grant and convey to any of the Persons identified below (collectively, the "Beneficiaries") the right to exercise Holder's rights and duties under this Protection Agreement should Holder fail to uphold and enforce in perpetuity the restrictions under this Protection Agreement.

- The conservation district of the county in which the Property is located.
- The Commonwealth of Pennsylvania acting through the Department of Environmental Protection.

Article V. Violation; Remedies

5.01 Breach of Duty

If Holder fails to enforce this Protection Agreement, or ceases to qualify as a Qualified Organization, then the rights and duties of Holder under this Protection Agreement may be (i) exercised by a Beneficiary or a Qualified Organization designated by a Beneficiary; and/or (ii) transferred to another Qualified Organization by a court of competent jurisdiction.

5.02 Violation of Protection Agreement

If Holder determines that this Protection Agreement is being or has been violated or that a violation is threatened or imminent then the provisions of this Section will apply:

Notice

Holder must notify Owners of the violation. Holder's notice may include its recommendations of measures to be taken by Owners to cure the violation and restore features of the Riparian Buffer damaged or altered as a result of the violation.

Opportunity to Cure

Owners' cure period expires thirty (30) days after the date of Holder's notice to Owners subject to extension for the time reasonably necessary to cure but only if all of the following conditions are satisfied: (i) Owners cease the activity constituting the violation promptly upon receipt of Holder's notice; (ii) Owners and Holder agree, within the initial thirty (30) day period, upon the measures Owners will take to cure the violation; (iii) Owners commence to cure within the initial thirty (30) day period; and (iv) Owners continue thereafter to use best efforts and due diligence to complete the agreed upon cure.

Imminent Harm

No notice or cure period is required if circumstances require prompt action to prevent or mitigate irreparable harm to natural resource within the Riparian Buffer described in the Conservation Objectives in clear violation of the terms of this Protection Agreement.

5.03 Remedies

Upon expiration of the cure period (if any) described in the preceding Section, Holder may do any one or more of the following:

Coercive Relief

Seek coercive relief to specifically enforce the terms of this Protection Agreement; to restrain present or future violations of this Protection Agreement; and/or to compel restoration of natural resources destroyed or altered as a result of the violation.

Civil Action

Recover from Owners or other Persons responsible for the violation all sums owing to Holder under applicable provisions of this Protection Agreement together with interest thereon from the date due at an annual rate of interest equal at all times to two percent above the "prime rate" announced from time to time in *The Wall Street Journal*. These monetary obligations include, among others, Losses and Litigation Expenses.

Self-Help

Enter the Property to prevent or mitigate irreparable harm to natural resources within the Riparian Buffer identified in the Conservation Objectives in clear violation of the terms of this Protection Agreement.

Restitution

Seek restitution of any amounts paid for this Protection Agreement if the Riparian Buffer is the subject of a taking in eminent domain or other civil action seeking modification or termination of this Protection Agreement or release of the Riparian Buffer from this Protection Agreement.

5.04 Remedies Cumulative

The description of Holder's remedies in this Article does not preclude Holder from exercising any other right or remedy that may at any time be available to Holder under this Article or otherwise under Applicable Law. If Holder chooses to exercise one remedy, Holder may nevertheless choose to exercise any one or more of the other remedies available to Holder at the same time or at any other time.

5.05 No Waiver

If Holder does not exercise any right or remedy when it is available to Holder, that is not to be interpreted as a waiver of any non-compliance with this Protection Agreement or a waiver of Holder's rights to exercise its rights or remedies at another time.

5.06 No Fault of Owners

Holder will waive its right to reimbursement under this Article as to Owners (but not other Persons who may be responsible for the violation) if Holder is reasonably satisfied that the violation was not the fault of Owners and could not have been anticipated or prevented by Owners by reasonable means.

5.07 Continuing Liability

If the Riparian Buffer is transferred while a violation remains uncured, the transferor Owners remain liable for the violation jointly and severally with the transferee Owners. This provision does not apply if Owners (a) notify Holder of the names and address for notices of the transferees and, if less than the entirety of the Property is transferred, furnish Holder with a survey and legal description of the portion of the Property transferred; and (b) Holder has issued a certificate of compliance evidencing no violations within thirty (30) days prior to the transfer. It is the responsibility of the Owners to notify Holder of the transfer and request a certificate of compliance to verify whether violations exist as of the date of transfer.

Article VI. Miscellaneous

6.01 Notices

Requirements

Each Person giving any notice pursuant to this Protection Agreement must give the notice in writing and must use one of the following methods of delivery: (i) personal delivery; (ii) certified mail, return receipt requested and postage prepaid; or (iii) nationally recognized overnight courier, with all fees prepaid.

Address for Notices

Each Person giving a notice must address the notice to the appropriate Person at the receiving party at the address listed below or to another address designated by that Person by notice to the other Person:

If to Owners: _____

_____

_____

If to Holder: _____

_____

_____

6.02 Governing Law

The internal laws of the Commonwealth of Pennsylvania govern this Protection Agreement.

6.03 Binding Agreement

This Protection Agreement binds and benefits Owners and Holder and their respective personal representatives, successors and assigns.

6.04 Amendments, Waivers

No amendment or waiver of any provision of this Protection Agreement or consent to any departure by Owners from the terms of this Protection Agreement is effective unless the amendment, waiver or consent is in writing and signed by an authorized signatory for Holder. A waiver or consent is effective only in the specific instance and for the specific purpose given.

6.05 Severability

If any provision of this Protection Agreement is determined to be invalid, illegal or unenforceable, the remaining provisions of this Protection Agreement remain valid, binding and enforceable. To the extent permitted by Applicable Law, the parties waive any provision of Applicable Law that renders any provision of this Protection Agreement invalid, illegal or unenforceable in any respect.

6.06 Counterparts

This Protection Agreement may be signed in multiple counterparts, each of which constitutes an original, and all of which, collectively, constitute only one agreement.

6.07 Indemnity

Owners must indemnify and defend the Indemnified Parties against all Losses and Litigation Expenses arising out of or relating to: (a) any breach or violation of this Protection Agreement or Applicable Law; (b) damage to property or personal injury (including death) occurring on or about the Riparian Buffer if and to the extent not caused by the negligent or wrongful acts or omissions of an Indemnified Party.

6.08 Guides to Interpretation

Captions

Except for the identification of defined terms in the Glossary, the descriptive headings of the articles, sections and subsections of this Protection Agreement are for convenience only and do not constitute a part of this Protection Agreement.

Terms

The word "including" means "including but not limited to". The word "must" is obligatory; the word "may" is permissive and does not imply any obligation.

Conservation and Preservation Easements Act

This Protection Agreement is intended to be interpreted so as to convey to Holder all of the rights and privileges of a holder of a conservation easement under the Pennsylvania Conservation and Preservation Easements Act, Act 29 of 2001, Pub. L. 390.

Restatement of Servitudes

This Protection Agreement is intended to be interpreted so as to convey to Holder all of the rights and privileges of a holder of a conservation servitude under the Restatement (Third) of Servitudes.

6.09 Entire Agreement

This is the entire agreement of Owners, Holder and Beneficiaries (if any) pertaining to the subject matter of this Protection Agreement. The terms of this Protection Agreement supersede in full all statements and writings between Owners, Holder and others pertaining to the transaction set forth in this Protection Agreement.

6.10 Incorporation by Reference

The following items are incorporated into this Protection Agreement by means of this reference:

- The Baseline Documentation
- The legal description of the Property attached as Exhibit "A"

6.11 Coal Rights Notice

The following notice is given to Owners solely for the purpose of compliance with the requirements of the Pennsylvania Conservation and Preservation Easements Act, Act 29 of 2001, Pub. L. 390:

NOTICE: This Protection Agreement may impair the development of coal interests including workable coal seams or coal interests which have been severed from the Riparian Buffer.

Article VII. Glossary

7.01 Additional Improvements

All buildings, structures, facilities and other improvements within the Riparian Buffer other than Existing Improvements.

7.02 Applicable Law

Any federal, state or local laws, statutes, codes, ordinances, standards and regulations applicable to the Riparian Buffer or this Protection Agreement as amended through the applicable date of reference.

7.03 Beneficiary or Beneficiaries
The Persons (if any) designated as a Beneficiary under Article IV.

7.04 Construction
Any demolition, construction, reconstruction, expansion, exterior alteration, installation or erection of temporary or permanent Improvements; and, whether or not in connection with any of the foregoing, any excavation, dredging, mining, filling or removal of gravel, soil, rock, sand, coal, petroleum or other minerals.

7.05 Existing Agreements
Easements and other servitudes affecting the Riparian Buffer prior to the Agreement Date and running to the benefit of utility service providers and other Persons that constitute legally binding servitudes prior in right to this Protection Agreement.

7.06 Existing Improvements
Improvements located on, above or under the Riparian Buffer as of the Agreement Date as identified in the Baseline Documentation.

7.07 Improvement
Any Existing Improvement or Additional Improvement.

7.08 Indemnified Parties
Holder, each Beneficiary (if any) and their respective members, directors, officers, employees and agents and the heirs, personal representatives, successors and assigns of each of them.

7.09 Invasive Species
A plant species that is (a) non-native (or alien) to the ecosystem under consideration; and (b) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. In cases of uncertainty, publications such as "Plant Invaders of the Mid-Atlantic Natural Areas", by the National Park Service National Capital Region, Center for Urban Ecology and the U.S. Fish and Wildlife Service, Chesapeake Bay Field Office are to be used to identify Invasive Species.

7.10 Lien
Any mortgage, lien or other encumbrance securing the payment of money.

7.11 Litigation Expense
Any court filing fee, court cost, arbitration fee or cost, witness fee and each other fee and cost of investigating and defending or asserting any claim of violation or for indemnification under this Protection Agreement including in each case, attorneys' fees, other professionals' fees and disbursements.

7.12 Losses
Any liability, loss, claim, settlement payment, cost and expense, interest, award, judgment, damages (including punitive damages), diminution in value, fines, fees and penalties or other charge other than a Litigation Expense.

7.13 Native Species
A plant indigenous to the locality under consideration. In cases of uncertainty, published atlases, particularly *The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas* by Rhoads and Klein and *Atlas of United States Trees, vols. 1 & 4* by Little are to be used to establish whether or not a species is Native.

7.14 Owners
The undersigned Owner or Owners and all Persons after them who hold any interest in all or any part of the Riparian Buffer.

7.15 Person
An individual, organization, trust or other entity.

7.16 Resource Management Plan
A record of the decisions and intentions of Owners prepared by a qualified resource management professional for the purpose of protecting natural resources described in the Conservation Objectives during certain operations potentially affecting natural resources protected under this Protection Agreement. The Resource Management Plan includes a resource assessment, identifies appropriate performance standards and projects a multi-year description of planned activities for identified operations to be conducted in accordance with the plan.

7.17 Review
Review and approval of Holder under the procedure described in Article IV.

7.18 Review Requirements

Collectively, any plans, specifications or information required for approval of an activity, use or Construction under Applicable Law (if any) plus (a) the information required under the Review Requirements incorporated into this Protection Agreement either as an exhibit or as part of the Baseline Documentation or (b) if the information described in clause (a) is inapplicable, unavailable or insufficient under the circumstances, the guidelines for Review of submissions established by Holder as of the applicable date of reference.

7.19 Top of the Bank

The elevation at which rising waters begin to inundate the floodplain. In case of ambiguous, indefinite or nonexistent floodplain or question regarding location, the Top of the Bank shall be the bankfull water elevation as delineated by a person trained in fluvial geomorphology and utilizing the most recent edition of *Applied River Morphology* by Dave Rosgen or reference book of greater stature.

[REMAINDER OF PAGE INTENTIONALLY BLANK]

INTENDING TO BE LEGALLY BOUND, the undersigned Owner or Owners and Holder, by their respective duly authorized representatives, have signed and delivered this Protection Agreement as of the Agreement Date.

Witness/Attest:

_____ _____
Name

_____ By: _____
Name

_____
Title

COMMONWEALTH OF PENNSYLVANIA:

COUNTY OF :

ON THIS DAY _____, before me, the undersigned officer, personally appeared _____, known to me (or satisfactorily proven) to be the person(s) whose name(s) is/are subscribed to the within instrument, and acknowledged that he/she/they executed the same for the purposes therein contained.

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

_____, Notary Public

Print Name:

COMMONWEALTH OF PENNSYLVANIA :

SS

COUNTY OF :

ON THIS DAY _____ before me, the undersigned officer, personally appeared _____, who acknowledged him/herself to be the _____ of _____, a Pennsylvania non-profit corporation, and that he/she as such officer, being authorized to do so, executed the foregoing instrument for the purposes therein contained by signing the name of the corporation by her/himself as such officer.

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

_____, Notary Public

Print Name:

APPENDIX C.7
Federal Tax Benefits

There are two main kinds of federal tax benefits available to conservation donors: federal income tax benefits and federal estate tax benefits.

Expanded Federal Tax Incentives - Extended Federal Tax Benefits were passed with the 2008 Farm Bill. These new incentives apply to all easements donated between January 1, 2006 and December 31, 2009. While the incentive expired for several months in early 2008, it was renewed retroactively such that there will be no gap in eligibility.

Specifically, the new incentives:

- Raises the deduction a donor can take for donating a conservation easement from 30% of their adjusted gross income in any year to 50%;
- Allows qualifying farmers and ranchers to deduct up to 100% of their income; and
- Extends the carry-forward period for a donor to take tax deductions for voluntary conservation agreements from 5 to 15 years.

Conservation easement donations are subject to the same restrictions as they were before. For example, easements must meet the "conservation purposes" test defined in the existing law; they cannot be donated as part of a "quid pro quo" agreement; and they must be donated to a qualified organization – a governmental unit or a publicly-supported charity that has "a commitment to protect the conservation purposes of the donation, and …the resources to enforce the restrictions."

One can never deduct more than the fair market value of the gift. This change simply allows landowners who previously could not deduct the full value of their gift to deduct more of that value.

Source: Land Trust Alliance

Donors of land and conservation easements may claim an income tax deduction under §170 of the Internal Revenue Code. The IRS specifies that to qualify for the deduction, the perpetual easement must be conveyed to a governmental unit or a "qualified organization" that is a §501(c)(3) charitable organization with the commitment and resources to enforce the easement's restrictions.

Additional IRS requirements state the conveyance be "exclusively for conservation purposes," which are defined as:

1) Preservation of land for outdoor recreation by the general public or for education of the general public;
2) Protection of relatively natural fish, wildlife, or plant habitats;
3) Preservation of open space (including farmland and forest land) which yields a significant public benefit AND is either 1) for the general public's scenic enjoyment, or 2) pursuant to a clearly delineated federal, state, or local conservation policy (e.g., an open space plan); or
4) Preservation of historically important land areas or certified historic structures.

The exact amount of tax savings depends on several factors:

- How long the donor has owned the property (benefits are generally greater if owned for more than one year);
- How the donor has used the property (residence, investment, agricultural);

- The income of the donor (the higher one's income, the more one will save on taxes); and
- The value of the donated property (the more valuable the property, the bigger the deduction).

Federal Estate Tax Benefits - A donor may also save substantially on estate taxes if he donates a conservation easement. Under §2031(c) of the Code, up to $500,000 may be excluded from one's taxable estate if he or she had donated a qualifying easement. As with the income tax benefits, the larger the value of the donated easement, the bigger the deduction.

Under the American Farm and Ranch Protection Act of 1997, a landowner's estate also now may totally exclude from federal estate taxation up to 40% of the value of the eased land, with a cap of $500,000. A landowner can donate an easement prior to death or the heirs may choose to donate the easement within a limited time after the landowner's death.

(from PA Land Trust Association, http://conserveland.org/information/con101/cetaxbenefits#fn1)

Additional Links:

Learn more at http://conserveland.org/pp/fedtax/fedtaxbenefits08_QA.

U.S. Treasury Regulations on Donations of Conservation Easements

The Federal Law on Donations Of Conservation Easements (and other partial interests)

LandSavers: Conservation Easements
http://www.greentreks.org/landsavers/webcast-conservationeasements.htm

Private Landowner Network: Conservation Easements – The Latest Tool in the Protection of Lands and Landscapes in the Mississippi Delta. by Laurel A. Florio, J.D.
http://www.privatelandownernetwork.org/plnlo/easementquestionsanswers.asp

Private Landowner Network: What is a "Conservation Easement"?
http://www.privatelandownernetwork.org/plnlo/conease.asp

Brandywine Conservancy - Conservation Easements
http://www.brandywineconservancy.org/conservation_easments/page2.html

Using Conservation Easements to Preserve Open Space: A Guide for Pennsylvania Municipalities
http://conserveland.org/lpr/download/6735/using_conservation_easements.pdf

Land Trust Alliance: Tax Benefits for Conservation
http://www.landtrustalliance.org/policy/taxincentives

APPENDIX D
References and Resources

References:

Beschta, R.L. et. al. 1987. *Stream Temperature and Aquatic Habitat: Fisheries and Forestry Interactions.* In: Salo, E.O. and T.W. Cundy eds. Streamside Management: Forestry and Fisheries Interactions. University of Washington, Institute of Forest Resources, Contribution No. 57.

Burby, R. 1988. *Cities Under Water: A Comparative Evaluation of Ten Cities' Efforts to Manage Floodplain Land Use.* Institute of Behavioral Science #6. Boulder, CO. 250 pp.

Chesapeake Bay Foundation. 1996. *A Dollars and Sense Partnership: Economic Development and Environmental Protection.* Chesapeake Bay Foundation. Annapolis, MD.

Desbonnet, A., P. Pogue, V. Lee, and N. Wolff. 1994. *Vegetated Buffers in the Coastal Zone: A Summary Review and Bibliography*. Coastal Resources Center, University of Rhode Island.

Dosskey, M. G., M. J. Helmers, D. E. Eisenhauer, T. G. Franti, and K. D. Hoagland. 2002. *Assessment of concentrated flow through riparian buffers.* Journal of Soil and Water Conservation 57:336-343.

Ernst, C. 2004. *Protecting the Source: Land Conservation and the Future of America's Drinking Water*. Trust for Public Land and the American Water Works Association, Water Protection Series. 56pp.

Jones, K. L., G. C. Poole, J. L. Meyer, W. Bumback, and E. A. Kramer. 2006. *Quantifying expected ecological response to natural resource legislation: a case study of riparian buffers, aquatic habitat, and trout populations*. Ecology and Society 11:15.

Jordan, T. E., D. L. Correll, and D. E. Weller. 1993. *Nutrient interception by a riparian forest receiving inputs from adjacent cropland.* Journal of Environmental Quality 22:467-473.

Lowrance, R., R. Todd, J. Fail, O. Hendrickson, Jr., R. Leonard, and L. Asmussen. 1984. *Riparian forests as nutrient filters in agricultural watersheds.* BioScience 34:374-377.

Lowrance, R., L. et. al., 1997. *Water quality functions of riparian forest buffer systems in the Chesapeake Bay Watershed*. Environmental Management 21:687-712.

Mayer, P.M. et al., *Riparian Buffer Width, Vegetative Cover, and Nitrogen Removal Effectiveness: A Review of Current Science and Regulations*, Cincinnati, OH, 2005, EPA/600/R-05/118.

Meyer, J.L. et al., *Where Rivers Are Born: The Scientific Imperative for Defending Small Streams and Wetlands,* Washington, DC, American Rivers, Sierra Club, 2003.

Newbold, D.J. et al., *Water Quality Functions of a 15-Year Old Riparian Forest Buffer System,* American Water Resources Association 2008 Summer Specialty Conference, Riparian

Ecosystems and Buffers: Working at the Water's Edge, June 30–July 2, 2008, Virginia Beach, VA, 2008.

Northwest Regional Planning Commission. 2004. *The Shoreline Stabilization Handbook* http://nsgd.gso.uri.edu/lcsg/lcsgh04001.pdf.

Peterjohn, W. T. and D. L. Correll. 1984. *Nutrient dynamics in an agricultural watershed: observations on the role of a riparian forest*. Ecology 65:1466-1475.

Rocco, D., *Level Spreaders and Off-Site Discharges of Stormwater to Non-Surface Waters,* Pennsylvania Department of Environmental Protection, 9-15-2007, Proceedings from 2007 Pennsylvania Stormwater Management Symposium, Villanova University, 10/17/2007, http://www.depweb.state.pa.us/southeastro/lib/southeastro/level_spreaders_and_off_site_discharge.pdf.

Seavy, N.E. et al., *Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research,* Journal of Ecological Restoration, September, 2009.

Sweeney, B.W., *Streamside Forests and the Physical, Chemical, and Trophic Characteristics of Piedmont Streams in Eastern North America*, Water Science Technology Journal, 1993.

Sweeney, B.W. et al., *Riparian Deforestation, Stream Narrowing and Loss of Stream Ecosystem Services,* Pennsylvania Natural Academy of Sciences (PNAS), Volume 101, No. 39, 2004, pp. 14132-14137.

Sweeney, B.W. and Blaine, J.G., *Resurrecting the In-Stream Side of Riparian Forests.* Journal of Contemporary Water Research & Education, Issue 136, 2007, pp. 17-27.

Vidon, P. G. F. and A. R. Hill. 2004. Landscape controls on nitrate removal in stream riparian zones. Water Resources Research 40.

Welsch, D.J., *Riparian Forest Buffers, Function and Design for Protection and Enhancement of Water Resources,* U.S.D.A. Forest Service, Northeastern Area, Radnor, PA, NA-PR-07-91, 1991, http://www.na.fs.fed.us/spfo/pubs/n_resource/buffer/cover.htm.

Wenger, S., *A Review of the Scientific Literature on Riparian Buffer Width, Extent, and Vegetation,* Publication of the Office of Public Service and Outreach, Institute of Ecology, University of Georgia, 1999.

Other Informational Resources:

Alliance for the Chesapeake Bay, *Pennsylvania Field Guide to Common Invasive Plants in Riparian Areas,* 2004, http://www.acb-online.org/pubs/projects/deliverables-145-1-2004.pdf.

Center for Watershed Protection, *Better Site Design: A Handbook for Changing Development Rules in Your Community*. Ellicott City, MD. 1998.

Chesapeake Bay Foundation, *Landowner Guide to Buffer Success*. April 2007. http://www.cbf.org/site/DocServer/buffer_guide.10.30.07.pdf?docID=11663.

Delaware Riverkeeper Network. *Adopt-A-Buffer Toolkit: Monitoring and Maintaining Restoration Projects*. September 2003. http://www.delawareriverkeeper.org/pdf/Toolkit-Final.pdf.

Elias, T.S., *Field Guide to North American Trees.* 1989, Soderstrom Publishing Group, Inc.

Federal Interagency Stream Restoration Working Group (FISRWG) (15 Federal agencies of the United States Government), *Stream Corridor Restoration: Principles, Processes, and Practices*. FISRWG (10/1998). GPO Item No. 0120-A; SuDocs No. A 57.6/2: EN 3/PT.653. http://www.nrcs.usda.gov/technical/stream_restoration/.

Fergus, C., *Trees of Pennsylvania and the Northeast*, 2002, Stackpole Books, Mechanicsburg, PA.

Foote, L.E. and S. B. Jones, *Native Shrubs and Woody Vines of the Southeast: Landscaping Uses and Identification.* 1989, Timber Press, Portland OR.

Harlow, W.M., *Trees of the Eastern and Central United States and Canada* 1957, Dover Publications, Inc., New York.

Hightshoe, G.L., *Native Trees, Shrubs and Vines for Urban and Rural America -- A Planting Design Manual for Environmental Designers*, 1988, John Wiley and Sons, Inc., New York.

King County, Washington, *Live Stake Planting and Planting Tips.* http://www.kingcounty.gov/environment/stewardship/nw-yard-and-garden/live-stake-plantings.aspx.

Maryland Department of Natural Resources Forest Service, *Riparian Forest Buffer Design and Maintenance*. June 2005. http://www.dnr.state.md.us/forests/download/rfb_design&maintenance.pdf.

Oregon State University and U.S. Environmental Protection Agency, *National Pesticide Information Center*. http://www.npic.orst.edu/.

Palone, R.S. and A.H. Todd (editors), *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers*. USDA Forest Service. NA-TP-02-97. Radnor, PA. 1997 http://www.na.fs.fed.us/pubs/misc/riparian_handbook/chesapeake_bay_riparian_handbook.pdf.

Pennsylvania Department of Agriculture, *Noxious Weeds Control List* http://www.pacode.com/secure/data/007/chapter110/chap110toc.html.

Pennsylvania Department of Conservation and Natural Resources, *Invasive and Exotic Plant Tutorial for Natural Lands Managers* http://www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm.

Pennsylvania Department of Environmental Protection Citizens' Volunteer Monitoring Program, *Designing Your Monitoring Program: A Technical Handbook for Community-Based Monitoring in Pennsylvania.* 2001. http://www.depweb.state.pa.us/watershedmgmt/cwp/view.asp?a=1431&q=493545.

Pennsylvania Land Use Law Library. http://www.landuselawinpa.com/.

Pennsylvania Natural Heritage Program (formerly Pennsylvania Natural Diversity Inventory (PNDI)) http://www.naturalheritage.state.pa.us/HomePage.aspx.

Petrides, G.A., *Peterson Field Guides to Trees and Shrubs.* 1986, Houghton Mifflin Co., Boston.

Rhoads, A.F., and Klein, W.M., Jr., *Vascular Flora of Pennsylvania -- Annotated Checklist and Atlas.* 1993, American Philosophical Society, Philadelphia.

Stroud Water Resource Center. Riparian Forest Buffer Program. http://www.stroudcenter.org/research/riparianbuffer.htm.

University of Maryland Cooperative Extension, *Reducing Vole Damage to Ornamental Plants in Landscape, Orchards and Nurseries***.** University of Maryland Cooperative Extension. 2004. http://extension.umd.edu/publications/PDFs/FS654.pdf.

University of Minnesota-Duluth, *Site Design Stormwater Toolkit: Parking Lot Filter Strips*. LakeSuperiorStreams. Duluth, MN 55812. 2009. http://www.duluthstreams.org/stormwater/toolkit/filterstrips.html.

U.S. Department of Agriculture National Resources Conservation Service. *Web Soil Survey*. http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.

U.S. Department of Agriculture National Resources Conservation Service. *Invasive and Noxious Weeds.* http://plants.usda.gov/java/noxious?rptType=State&statefips=42.

U.S. Department of Agriculture. *PLANTS Database.* http://plants.usda.gov/.

Wenger, S. J. and L. Fowler, *Protecting Stream and River Corridors*. Publication of the Carl Vinson Institute of Government, University of Georgia, 2000. http://www.rivercenter.uga.edu/publications/pdf/riparian_buffer_guidebook.pdf.