Vermont Trees for Streams Resource Guide

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I. Introduction

The Vermont Trees for Streams Resource Guide is intended for conservation managers whose goal is to properly identify, plan for, and install vegetated buffer projects. Whether a landowner wanting to learn more, or an interested concerned citizen who is new to the process, or an experienced land steward whose practices match those within, the step by step methods is meant to inform and outline a consistent and up to date process for installing buffers.

Riparian Areas and Buffers as a Practice

There are a number of terms used to describe a buffer, and in some cases it depends on the use. There are buffers for backyards, farmland, and urban areas. There are also buffers for lakes and ponds and different requirements for each. Outlined in the VT Agency of Agriculture Accepted Agricultural Practices (VT AAPs), Vegetative Buffer Strips (or Buffer Zone) are required to be "maintained between cropland and adjoining surface waters." They are defined as an area of perennial vegetation between the edge of annual cropland and the top of the bank of the adjoining surface water. Here are three terms and definitions that describe their function:

> **Filter Strip** is an area of grass or other permanent vegetation used to reduce sediment, organics, nutrients, pesticides, and other contaminants from runoff. (USDA)
>
> **Buffer Strip** refers to a barrier of permanent vegetation between waterways and land uses such as agriculture or urban development. (VT DEC)
>
> **Riparian Forest Buffer** can be defined as a protected forested zone along streams and rivers having a floral and faunal community distinct from upland areas and functions to buffer the impact of human land use activities.

These terms are used interchangeably or distinctly within different fields and by different practitioners. For the purposes of this Vermont Trees for Streams Guide, the term buffer is used to describe the Riparian Forest Buffer.

Riparian Forest Buffers should be clearly distinguished from vegetative or grassed filter strips commonly recommended as a best management practice (BMP) because of their ability to accomplish both water quality and ecological roles. Riparian buffers are designed and managed to provide shade, restore stream habitat, and to trap and remove nutrients, sediments, pesticides, and other chemicals from surface runoff and subsurface/groundwater flows.

II. Land Use History and Hydrology

Land use has dramatically changed the landscape over the past two hundred years. In the late 1800's settlement, industry, and transportation not only changed the landscape of the forests and fields but also changed the hydrology of the waterways. Deforestation, mills, dams, railroads and subsequent sedimentation, invariably affected the ebb and flow of the rivers hydrogeology and ecology.

In the past a popular practice was to cut trees along the river for a variety of reasons from opening a view, providing access to fields or the stream, or to remove problematic trees that had the potential to fall in the river. Scientists have found that in the absence of vegetation along river corridors, banks and stream beds become eroded, polluted with sediments and chemicals, are void of animal and aquatic life, degrade the water quality downstream and negatively affect the cycle of life in the river. Nationwide 70%-90% of natural riparian areas have been lost or degraded. Maintaining, installing, or protecting riparian areas helps stabilize stream banks by preventing excessive erosion and in doing so protects the channels stability.

Stream Stressors

The historical use of rivers and waterways brought about a dramatic imbalance of the sediments and water within the channel and the effects are still present today. The Vermont Department of Environmental Conservation developed a list of ten major stressors to surface water. The Vermont Surface Water Management Strategy Agency outlines the stressors, source, and strategies to address them. Channel Erosion, Encroachments, Land Erosion, and Thermal Stress, are the main stressors and threats that are applicable to unvegetated banks. For example, installing stone to armor a bank increases the velocity of the water, which in turn may cause erosion down river from the site of armoring.

River bank erosion either in the channel or on the adjacent land can be caused by a change in the stream flow, water flowing through or over the bank, or from a concentrated runoff point. The extensive root systems and assemblage of vegetation in a riparian buffer will help maintain the stability of the streambank and channel capacity over time much more than unvegetated banks. The stability of the streambank and the effectiveness for the riparian buffer correlates to the soil type, buffer width, and type of vegetation. A network of mature trees, surrounded by an assemblage of shrubs, and carpeted with herbaceous plants creates a fibrous net that retains soil and protects banks from erosion. In addition, this fibrous network absorbs and dissipates the water velocity and scouring potential from overland flow and channel flow.

Thermal Stress may be caused by the lack of shade, or chemical changes as a result from erosion and deposition of sediments or by pollutants that enter the water. When sediments are added and suspended in the water, the water becomes murky or turbid. Turbidity, along with the effects of a slow and broad river, increases the temperature and decreases the oxygen levels. On a biological level, the aquatic organisms that are adapted to live within a cold, well oxygenated, and deep, fast running river will not survive. This is true for the macroinvertebrates as well as certain types of fish, such as Brook trout.

The canopy of vegetation within a riparian buffer maintains shade and protection within the waterway especially on smaller streams, and within the width of the buffer. Many riverine species benefit from these shaded corridors throughout all seasons during migration, while raising young, or while foraging. The debris from fallen limbs, leaves, and trees also create habitat for a diversity of species.

Non-Point Source Pollution

Waste products from sources that can be traced back to a specific point and the origin identified, are called ***point source pollution***. The contributors of point source pollution such as waste water treatments plants and industrial facilities were required to comply with local, state, and federal regulation to control or stop altogether wastes from entering waterways. While the results are promising, regulation and policies are still in place to strengthen the initial efforts to further reduce point source pollution.

Presently, the most concerning contributor to poor water quality is non-point source pollution. Non-point source (NPS) pollution is waste that reaches surface water or groundwater indirectly or in a diffuse manner. NPS pollution occurs when rainfall, snowmelt, or irrigation runs over land or through the ground, picks up pollutants, and deposits them into rivers, lakes, and coastal waters or introduces them into ground water.

The most common NPS pollutants are nutrients and sediments. These pollutants wash into water bodies from developed areas, agricultural land, animal feeding operations, construction sites, and other types of land use. Other common NPS pollutants include pesticides, pathogens, salts, oil and grease, toxic chemicals, and heavy metals. Many environmental and human health problems result from NPS pollutants. In Vermont, phosphorus is a significant non-point pollutant.

Originally in Vermont, point sources such as factories and waste water treatment plants were credited to be the leading contributor of phosphorus. After strict management actions were taken, phosphorus loads were decreased considerably from these point sources. Studies from the Lake Champlain Basin Program's State of the Lake Report 2008 estimated that phosphorus load is derived from less than 10% by point sources and 90% by non-point sources; developed land appears to be the leading cause of non-point pollution.

Non point sources of phosphorus can be attributed to three different land use types: Developed, Agriculture, and Forested. Developed land contributions of phosphorus can be from septic systems, runoff from driveways, rooftops, parking lots, and construction sites. Uninformed everyday citizens also contribute phosphorus from lawn fertilizers, detergents, and pet waste. Agricultural sources from crop and livestock production can also create runoff that leads directly to waterways. While agricultural sources are mostly secondary to developed areas, it is important to address each contributor and provide long term solutions for the health of Vermont's waters.

One of the most important and effective functions of a riparian buffer is to capture, filter, and recycle sediments, nutrients, and chemicals from upland sources. The fibrous network of roots, especially those created by herbaceous plants, deceases sediments and non-point pollution from entering waterways. The thick thatch of ground cover acts as a sponge by absorbing pollutants that are broken down by organic methods.

Unsustainable Impacts

The river management techniques in the 19th and 20th century have led to a recurring cycle of flood damage and manipulation of the rivers at an enormous cost. Millions have been spent annually to control rivers within a defined and set corridor while development is built within floodplains. The pattern of ever-increasing erosion hazards and flood losses from inundation has become a vicious cycle causing damage to infrastructure, farms, homes and businesses. Despite efforts to barricade or control rivers, the power of water is a force that is undeniably resilient. With flooding occurring at increasing rates, the unsustainable practices of the past will continue to impact land based enterprises.

In the past a popular practice was to cut trees along the river for a variety of reasons from opening a view, providing access to fields or the stream, or to remove problematic trees that had the potential to fall in the river. Scientists have found that in the absence of vegetation along river corridors, banks and stream beds become eroded, polluted with sediments and chemicals, are void of animal and aquatic life, degrade the water quality downstream and negatively affect the cycle of life in the river. Nationwide 70%-90% of natural riparian areas have been lost or degraded. Many of Vermont's rivers share the same percentage of loss. Maintaining, installing, or protecting riparian areas helps stabilize stream banks by preventing excessive erosion and in doing so protects the channels stability.

<u>Goals of Riparian Habitat Restoration in Vermont</u>

Protection of River Corridors

The VT Agency of Natural Resources River Management Programs approach to manage streams uses science-based natural channel techniques to restore the balance and stability of a stream's equilibrium, called Fluvial Geomorphology (see the next section). By assessing and identifying stressors and disturbances within the length of an entire stream or within smaller unique sections, restoration and protection projects are prioritized. Conservation managers, in collaboration with affected and interested landowners, invest in those practices that will have a long-term benefit to restore stream equilibrium conditions and those that protect land based enterprises. For example, if a section of a river has been historically channelized through a town, identifying and protecting a floodplain upstream or downstream can release the water pressure on the channelized section, and in doing so protects the towns infrastructure from future flood events.

Another natural channel technique is the protection of river corridors from development or encroachments. The Vermont River Management Program has developed a mapping methodology to describe local flood hazards which is useful and important to any type of community planning process. Fluvial Erosion Hazard zones are being considered in an increasing number of Vermont communities as a way to provide long term and financially feasible water quality protection.

Restoring natural areas adjacent to rivers, or riparian buffers, can tremendously reduce the amount of non-point source pollution, erosion, and flooding that occurs in Vermont. The use of riparian buffers near streams has long been recognized as an important strategy for protecting and improving water quality while simultaneously protecting or restoring the stream ecosystem. Acre for acre, forests contribute less sediment and nutrient runoff pollution than any other land use. In recent years, studies have suggested that streamside forests can serve as highly effective filters that control both surface runoff and, in many landscapes, groundwater flow in streams. In addition, they provide shade, temperature control, and food required by many aquatic species.

Stream Restoration Projects

The goal of stream restoration should be to design and manage channels in a natural form. Until recently, scientific principles of hydrology and geomorphology had not been widely applied to stream restoration techniques. The "Natural Channel Systems Approach" recognizes the role of hydrologic function of streams and rivers as part in the overall health of the natural ecosystem.
A healthy natural stream system should exhibit two key characteristics:

- Physically, the stream system will be dynamically stable. It will exhibit self-regulatory mechanisms that are stable over time and adjust to accommodate changes in water yields and sediment loads.
- Biologically, the stream and valley system will be self-sustaining and self-regulating. It will exhibit healthy ecological functions manifested by productive vegetative communities in the valley. The stream and valley system will have healthy aquatic and terrestrial communities

supported by diverse habitat.

Restoration Project Planning Goals

It is important to use many different types of resources when determining if a restoration project is beneficial and appropriate. The installation of riparian buffers areas alone should not be viewed as a stream restoration technique for unstable eroding banks. Trees and other vegetation cannot quickly cure the erosion problems of an unstable stream system. It is best to combine tree planting with other stabilization and erosion control practices to resolve active areas of erosion. Many landowners, however, may be unable to undertake the time or cost involved in a major stream restoration project.

Buffer Establishment

Natural vegetated buffer zones can be found in areas that have not been developed. In Vermont, some are more common in higher headwaters away from areas of encroachment. Initiated in the 1990's, buffer restoration projects are becoming more common to see throughout Vermont. In some cases, large scale restoration projects that include a buffer require the technical expertise of river scientists and environmental engineers and may include grading an area to remove berms, or shaping of stream banks where scouring and undercutting are serious challenges. These restoration projects allow flood water during high water events access to floodplains. Ideally a buffer would incorporate all the different parameters found in a natural buffer zone and have three distinct zones of vegetation. Beginning with the zone closest to the stream, these zones are:

> **Zone 1:** Contains mature trees and shrubs that provide shade and have robust root systems to maintain bank stability and support a healthy wildlife ecosystem. Slow growing trees, with their deep root systems, can help stabilize stream banks against the erosive energy of fast flowing water during rain events or spring runoff while providing critical shade to keep water cooler and provide fallen branches that create favorable aquatic habitat conditions.
>
> **Zone 2:** Consist of trees and shrubs that pull nutrients up through their root systems sequestering P and N. Some management of vegetation could occur in this zone so long as the functions of the zone are not compromised. Shrubs may not develop as sturdy or extensive a root system but they often grow fast and tend to form clumps which amplify their effectiveness.
>
> **Zone 3:** Strips of tall grass that traps sediments and dissipates the energy of the flow of runoff slowing it down enough to allow for some infiltration. Grass has a dense sod which is effective at holding soil in place and trapping sediment as it moves from the land towards the water.

III. Planning Riparian Buffer Restoration Projects

Before visiting the site, it is helpful to have an understanding of the locale. Some sites are identified through the River Corridor Planning process where a multitude of information is available, while other sites may be identified spontaneously without prior knowledge of the geomorphic condition. Either way it is suggested to preview as much data on the site as is feasible, and to create a parcel map of the property boundaries to have on hand.

The first and foremost tool to use if available is a River Corridor Plan and GIS Maps based on the completion of a Geomorphic Assessment. This will identify many of the attributes of the river and site, such as stream type, bankfull width and depth, and evolution stage that are helpful in identifying the objectives for the restoration project. The attributes of the Reach (Scale) and the Channel Evolution stage are imperative to know when initiating a restoration project.

Site Selection

Evaluation of a site for establishment of a riparian buffer often highlights the need for additional actions to stabilize the stream or protect the channel itself through stabilization or control of bank erosion. Before restorative measures are applied to actively eroding streambanks, it is essential to understand what is causing the erosion problem. Otherwise, time and money expended for restoration are wasted. It is necessary to look at the streambank as part of the channel, the channel as part of the stream, and the stream in relation to its watershed.

Unfortunately, many of the techniques used to control erosion at a single point on a stream have actually accelerated erosion or degraded downstream conditions. Focusing on the restoration of natural vegetation and the form and function of channels may be the best approaches to maintaining the rivers health over the long term.

When identifying a site for a buffer installation and insure its success, there are a number of attributes to consider including its intended function. Many different guidelines recommend or in some cases require different buffer widths for specific purposes. For example, the VT AAPs require all farms to have a vegetative buffer of 10 feet or 25 feet at runoff point. Recognize that a set buffer width may not always meet the intended function or protect the water source so it's best to have flexibility when determining the minimum and maximum width. Evaluating the local conditions can help increase the success for the project and its long term benefit. Determining the type of land use adjacent to the buffer and the characteristics of the topography, hydrology, and soils can decide the width and the vegetation best suited for the buffer. Depending on the function of the buffer it is best to consider these attributes and how each interrelates with the other.

Fluvial Geomorphology

To understand how best to protect and restore and river channel, scientists evaluate the physical condition of streams using fluvial geomorphology most beginning with a stream geomorphic assessment. Fluvial geomorphology allows scientists to study the interactions between water and the land. As this science continues to advance, it helps explain why we have conflicts with rivers, particularly during flood events. This science can then be used to predict and manage for a river's behavior. Findings are used to reduce loss of land from erosion, protect infrastructure such as roads and bridges, and identify best practices for river management. Stream Geomorphic Assessments or River Corridor Plans can help conservation managers and landowners better understand the interactions between the water and the land and how best to prioritize river restoration and protection projects.

Current Geomorphology Stage

Identified in River Corridor Plans, streams are subdivided into separate reaches. A reach is the fundamental unit where restoration and protection projects are identified and prioritized in the stream corridor. To establish goals and objectives, each reach is evaluated with regard to its landscape and individual characteristics, as well as their influence on stream corridor function and integrity.

When investigating the reach, it is important to identify the bank stability for the particular site as it relates to the entire reach. Instability downstream and/or upstream may continue to occur until the root cause is determined and stabilized. A most common form of local instability is bank erosion along the concave bank in a meander bend. This signature attribute may be occurring as part of the natural meander process, and most likely will require additional time to stabilize.

The stage of channel evolution is a primary diagnostic tool for differentiating between local and system wide channel stability problems in a disturbed stream or constructed channel. If the channel is in the mid stages of evolution and exhibiting steep banks, it may be best to explore other options before installing a vegetative buffer. When identifying a site for a buffer, it is best to install in reaches that are stable (Stage 1 or 5) or in some cases, stabilizing (Stage 4).

Channel Stages

When the dynamic equilibrium of a river is altered, fairly predictable processes are exhibited. Fluvial geomorphologists use a “Channel Evolution Model” to interpret these processes. The model helps predict and plan for the results of the changes.

The model starts with a river that is balanced or stable (Step 1: Stable). The bankfull channel develops in response to the bankfull flows. A river forms its bankfull channel in response to a storm event that occurs on a fairly regular basis, every 12 to 18 months. These are the housekeeping flows that maintain the channel shape. The bankfull stage is defined by the elevation point where regular flooding occurs and is indicated by a scour mark with deposits of sand or silt, perennial vegetation edge, and where roots are exposed.

Changes in the watershed such as deforestation and urbanization increase the amount of water entering the channel. This exerts more energy within the banks. The channel responds by lowering the elevation of the bed. This is called degradation or incision (Step 2: Incision).

The banks become unstable and fail, creating a wider channel (Step 3: Widening), and the resulting sediments are deposited farther downstream, in turn causing more erosion.

As the channel tries to regain its equilibrium, the river channel is no longer degrading or widening, but remains unstable (Step 4: Stabilizing). Finally, if given enough time and room, it will adjust to the changes and form a stable channel at a lower elevation (Step 5: Stable).

The end result of channel evolution is a series of noticeable terraces along the river. This process may take 60 years or more. Incision and widening can happen during a single storm event over minutes to hours, but it will take years for the river to achieve dynamic equilibrium once again.

Stream Types

While not all rivers are alike, they do share fundamental physical features – channel, banks, floodplain, and sinuosity. These physical features are shaped by the regions climate, geology, topography (valley type and slope) and vegetation. Within one watershed one would expect to find these aspects all together quite similar. However, different elevations shape the physical features as well as the environmental aspects. Streams are classified into reference stream types to characterize a streams attributes and geomorphic setting within the watershed. Referencing a stream type, whether headwaters, tributaries, or main stem can be helpful to understand the dynamic balance of the stream and in some cases the vegetation type.

For the majority of buffer projects many are within the main stem of a river. Vegetation along banks provides a buffer to the scouring action of water. When a river floods beyond its banks, floodplains are storehouses that allows infiltration to occur. The ground-water is then released slowly back into the river. Sinuosity is the amount the river channel meanders, or bends and relates to the stream length versus the valley length. Generally, meanders are created as the water flows through the channel and scours sediment on the outside of the meander forming pools. The sediment is then deposited opposite onto point bars, towards the inside of a meander forming riffles.

Bankfull Width and Depth

The bankfull width and bankfull depth measurements are used to help determine the stability of the river, and its ability to effectively transport both water and sediment. Bankfull width is measured as the width from edge to edge of the river at bankfull. Bankfull depth is measured as the mean depth from edge to edge of the river at bankfull. The mean depth and width are important to measure because a river that is too shallow will not have the energy to effectively transport both water and sediment. A river that is too shallow will have a high width/depth ratio, indicating that it is unstable and likely is aggrading or filling up with sediment, which often leads to bank erosion as the stream tries to flow around the accumulating sediment.

Sometimes it can be difficult to determine the correct elevation for bankfull, especially when rivers are unstable. This is because it takes years for the river to respond to high flows with subtle changes in slope of the banks or vegetation lines.

Width/Depth Ratio

The width/depth (w/d) ratio describes a relationship between the bankfull width and depth that is independent of the actual sizes of the rivers**.** For example, wide and shallow unstable rivers have a high width/depth ratio, while the same river in a stable form will have a lower width/depth ratio. Every stream type will have a different range of width-depth ratios.

Studies on many rivers have found that in general, steeper rivers have lower w/d ratios, and shallower rivers have higher w/d ratios. When streams are unstable this ratio is used to describe the amount of disturbance. For example, a stable riffle-pool system may have a width/depth ratio of around 25. But a disturbed over-widened reach may have a w/d ratio of 80. This number helps to indicate “departure” from the undisturbed condition.

IV. Developing Riparian Buffer Projects

Programs and Partners

There are a variety of programs and partners who provide technical and financial assistance to landowners for the installation of buffers.

Trees for Streams is a Vermont Natural Resources Conservation District program that was established in 1990. This program best suits landowners who have smaller properties who own land along a river, stream, lake or pond. However, this program is also beneficial for landowners with larger properties who are not interested in the state or federal programs as listed below. Districts plant native trees and shrubs and may use bioengineering techniques, such as tree revetments and willow plantings, to stabilize banks. Landowners pay 20% of materials fees and agree to maintain the site for twenty years by signing a Stewardship Agreement. The Conservation District will provide consultation and labor and the remaining 80% materials fees with support from grants and partners when applicable. Partners have included Lake Champlain Basin Program, Department of Vermont Fish and Wildlife, Department of

Environmental Conservation, Watershed Groups or Associations, Rotary Clubs, Educational Institutions, Scout and Volunteer Clubs, to name a few.

Additional Vermont Buffer Programs
There are many opportunities for landowners to reduce or prevent erosion on their property and to restore riparian areas. The USDA Natural Resources Conservation Service (NRCS), the USDA Farm Service Agency, the Vermont Agency of Agriculture, Food, and Markets, the US Fish and Wildlife Service Partners for Fish and Wildlife Program, the Vermont Department of Environmental Conservation (VT DEC), and local watershed groups may offer financial incentives for landowners to apply these management practices in an effort to improve water quality. There are a variety of local, state and federal partnerships that offer incentive programs which provide technical and financial assistance for landowners of all types who are willing to create streamside forests adjacent to the surface water resource.

Conservation Reserve Enhancement Program (CREP) USDA Farm Service Agency
Voluntary land retirement program that helps eligible owners of agricultural land to address soil, water, and related natural resource concerns on their lands. Enrolled land is taken out of production for the 15 or 30-year contract period and typically planted to a filter strip and/or a riparian buffer. Cost-share/ contract payments.

Eligibility/Availability
Landowners must have owned or operated their land for 12 months prior to enrollment and must have a water quality concern that can be ameliorated through changes in agricultural activities. The main resource concern is a prominent stream or river adjoining fields with issues such as concentrated nutrient and pollutant runoff, and significant sediment losses due to overland flow.

Conservation Reserve Program (CRP) USDA Farm Service Agency
Provides assistance to reduce soil erosion and sedimentation of streams and lakes, improve water quality, establish wildlife habitat, and enhance forests and wetlands resources. Encourages conversion of highly erodible cropland or other environmentally sensitive acreage to vegetative cover. Provides annual rental payments for the term of the multi-year contract and cost sharing to establish vegetative cover and other practices.

Eligibility/Availability
Similar to CREP program. Contact program official for extensive requirements.

Vermont Agricultural Buffer Program (VABP) VT Agency of Agriculture, Food and Markets
The program promotes water quality by providing incentive payments to plant a 25 foot wide harvestable (unlike CREP) perennial filter strip on annual cropland adjacent to a stream. Pays $90-150/acre per year plus $123/acre establishment costs. Five-year minimum contract required. No manure allowed on buffer, but fertilizer can be used with soil test and nutrient recommendation. Harvest between June 1st and September first only. Most buffers are 25 feet wide unless a water quality concern deems the need for a larger buffer. The participant can leave this program at any time to enroll the same land in another certified buffer program that the land is deemed eligible for, such as CREP.

Eligibility/Availability

Willingness to commit to five-year minimum contract and meet contract terms for planting a harvestable perennial filter strip adjacent to a stream. Some fertilizer restrictions apply.

Environmental Quality Incentive Program (EQIP) **Natural Resource Conservation Service**
Provides financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural or forest land. Incentive payments provided for eligible conservation practices. Increased incentive payments available for eligible limited resource producers, beginning farmers, and socially disadvantaged farmers. The focus of this program is to address existing resource concerns.

Eligibility/Availability
People who are engaged in livestock or agricultural production including forestry on eligible land, or owners of such land.

Partners for Fish and Wildlife **US Fish and Wildlife Service**
Program seeks to achieve voluntary habitat restoration on private lands, through financial and technical assistance, for the benefit of Federal Trust species, including migratory birds; threatened and endangered species; inter-jurisdictional fish; certain marine mammals; and species of international concern. Program provides assistance to landowners to restore wildlife habitat and fish passage, often in drained wetlands and degraded stream banks. Also assists with invasive species control.

Eligibility/Availability
Any privately-owned land is potentially eligible; most applicants are agricultural producers.

River Corridor Easements **VT Department of Environmental Conservation**
Promotes river corridor and floodplain protection as a principal method for reducing flood hazards, improving water quality, and restoring riparian habitats to minimize conflicts between human investments and the dynamics of rivers. The DEC has provided grants to qualified conservation organizations to purchase or receive donated river corridor easements.

Eligibility/Availability
Check with the local DEC Watershed Basin planner for more details on the program specifics.

Site Visit: Documenting Site Conditions
Once the site is identified, a site visit is necessary to measure the planting area, assess planting conditions, soils, current vegetative cover, and other factors. After contacting the landowner, and sending informational materials that explains the benefits of establishing a riparian buffer and a program overview, schedule a site visit to discuss the options. It’s best to complete a site visit during the growing season to observe what growing conditions will be like for the plants and to develop an idea of site preparations and future maintenance needs.

1. Meet with property owners on-site to establish a clear understanding of the program(s), size of the buffer, and responsibilities for all the parties involved. Inquire about adjacent landowner’s potential interest. If the land is leased or managed by another, it is imperative to decide who will involve and communicate the program to this contact. In some cases, the initial site visit may take two visits, initially to discuss the program options with the property owner and another once the property owner has confirmed their involvement.

2. Flag the locations for the planting boundaries in the presence of the landowner. Complete an initial site report to note the site conditions that will be included in the Site Report. Check for the presence of obstacles such as berms, highly eroded areas, invasives, overhead utility lines, etc. Establish acceptable access point(s) to the site for plant delivery, volunteer parking, and other neighborhood concerns.
3. Sample digging conditions at several locations. Note any potential difficulties, such as hard, compacted, or rocky soil; insufficient or excess soil moisture; landfill materials; or roots. If the soil is particularly hard, for example, bring additional tools for the task. Also, consider reducing the project scope to match the trees planted with the number of volunteers anticipated for the planting.

Adjacent Land Use

To receive the best benefits from a buffer, consider the type of adjacent land use. Whether the land is forested, a farm field, road, or residential will influence the permeability of the surface, or how well the water soaks into and over the ground. More permeable surfaces such as forests and grasslands intercept and slow the velocity of water, hence preventing the sediments and nutrients from entering rivers. If the adjacent land contains a high percentage of impermeable surfaces (pavements and roof tops) then the amount of water carried towards the stream and the velocity at which it travels will be higher. Impervious surfaces, especially those in found in business and residential areas, often carry non-point pollutants.

Width and Effectiveness

One of the important factors which determine the effectiveness of a buffer is its size or effective width. Buffers that are too narrow may still place water quality or aquatic resources at risk. Although wider is nearly always better, buffers that are wider than needed may unnecessarily restrict use of a portion of the land. Therefore, the need to determine "minimum" widths has been a primary focus of resource agencies and local governments for many years

> Four criteria are generally discussed for determining the adequate width of riparian buffers for protection of streams. They are the:

1. Existing or potential value of the resource to be protected,
2. Site, watershed, and buffer characteristics,
3. Intensity of adjacent land use, and
4. Specific water quality and/or habitat functions desired.

The concept that "anything is better than nothing" will be raised. This is probably an accurate assessment when it comes making some improvements in stream or shoreline habitat but a minimum width is necessary to maintain the function of a stable streambank. It is important to recognize that for a riparian buffer to serve the water quality functions of buffering impacts from adjacent land use, a "critical mass" or sustainable width is often essential. For the purposes of the Vermont Trees for Streams program, the minimum width to achieve this water quality goal is 35 feet.

Buffers more than 50 feet have proven to maximize the effectiveness of filtering nutrients from a field. The most commonly prescribed minimum buffer widths for use in water quality and habitat maintenance are approximately 75 to 100 feet. The scientific literature appears to support that buffers of less than 35 feet cannot sustain long term protection of aquatic resources. However, it may be difficult to suggest a buffer width more than 35 feet especially in small confined valleys. To provide an array of functions, buffers should be a minimum of 35 to 100 feet in width (if appropriate) under most circumstances.

The Acceptable Agricultural Practices (AAPs) require a 10 foot wide vegetated buffer between the top of the bank and annual crop land (e.g. corn fields or vegetable and fruit plots). If there is a point within the field and buffer where the runoff flow is concentrated and the point of runoff is obvious, then an additional 15 feet of vegetated buffer is required. Medium Farm Operations and Large Farm Operations must maintain a wider buffer than what is required under the AAPs. For these a standard of 25 feet and 50 feet at point of runoff is required.

Although there are generally no requirements for buffers on residential land unless dictated by local zoning or ordinance, buffer widths and their associated benefits are similar to field situations. The wider the buffer, the greater the benefits for preventing erosion, creating aquatic and wildlife habitat, and for absorbing soluble nutrients. For buffers on residential or commercial parcels, landowners may also want to consider aesthetics and access.

Landowner concerns most often serve to constrain the width of a buffer. These decisions may be due to aesthetics, economic considerations, livestock watering and pasture management, operation of adjacent farm fields, competing uses, or existing developments. It is imperative that landowners be part of the process in identifying the width and length of the buffer before proceeding with the planting plan.

Buffer Connectivity
A contiguous buffer that increases the overall connectivity of the riparian habitat along a river is more effective than a disconnected buffer and a highly regarded objective. A prominent gap within a mostly vegetated bank is a weak point in the buffer that disrupts the ecological connectivity within the riparian corridor. Within this gap, the existing buffer can be undermined leading to concentrated amounts of runoff that has a potential to create rill or gully erosion. Gaps also disrupt the dispersal and colonization of native plants and animals. If left unchecked these areas are prone to the establishment of invasive plants. Eliminating the gaps within the buffer accelerates the potential for native plants to establish within this protective habitat, and in turn, create a more manageable and beneficial river corridor.

Site Slope/Topography
Knowing the topography, the surface features and their relative positions and elevations, gives a frame of reference for the river and thus the objective properties of a buffer. Features such as slope and the size of the watershed area contributing runoff to the buffer are aspects to consider when maintaining or creating a buffer. For instance, slow shallow streams may be acceptable with grass buffers, while steep flashy streams with high energy flows during rain events would benefit from the strong root systems of mature trees in a buffer. Observing the regional aspects such as valley slopes is important also; a steep walled valley, for example, will transmit water to a stream faster than a wide flat valley. Smaller aspects such as small hummocks and undulations in the land near the stream are also significant. If the land adjacent to the stream is flat and dips towards the stream, there will be more stress on the buffers effectiveness than a rough hummocky landscape which slows and dissipates high energy water flows.

Hydrology and Soils
The hydrology or the movement of water throughout the watershed will determine how effective a buffer will be in protecting for water quality. Climate, geology and soils, and vegetation interact with, intercept, and transpire the water within the buffer locale. Investigate the moisture holding capacity of the soil, if the soils in a buffer are fairly wet with a high percentage of clay then their ability to absorb

moisture is diminished and therefore a wider width or higher density of plants for the buffer can be a solution. Well drained sandy soils will have faster infiltration rates than heavy clay soils so a narrower, grass and shrub buffer might suffice. Climate is another important aspect. The rate at which rainfall occurs is highly correlated with the amount of runoff. Therefore, a high intensity rainfall will produce more runoff and reduce the effectiveness of the buffer than a low intensity rainfall because the rain is falling faster than can be absorbed by the soils.

Soil Types

NRCS Web Soil Survey or the VT ANR Natural Resources Atlas provides maps to determine the soil type. Parent material has a direct effect on soil texture, which is one of the most important characteristics affecting site quality and species composition. It influences the chemical properties of the soil, soil moisture, and root development. The soil type is also used to identify the natural community type and the assemblage of shrubs and trees to plant.

Texture also is related to the amount of soil moisture retained. Most riparian plants tolerate a wide variety of soil textures, although certain species do not tolerate excessively sandy or clayey soils. Sandy soils are droughty, so drought-tolerant species should be planted in them. Clay loams have good soil moisture characteristics, and heavy clay soils lack proper aeration.

Soil color is quick way to indicate the soil properties that affect plant development. The overall color of the soil is an indicator of organic matter content. Some soil colors and the characteristics associated with them are:

> **Black** - High in organic matter and may be poorly drained. Soil becomes darker as organic matter increases from 0 to 8 percent. At 8 percent or above, soil is essentially black.
> **Brown -** Good organic matter content and well drained.
> **Red -** Low in organic matter and well drained. Redness is due to oxidized iron or red parent material.
> **Gray** - Low in organic matter and poorly drained. Gray color is due to excess water and poor aeration.
> **Yellow** - Low in organic matter and well drained.

Natural Community Types

While physical features control plant selection, soil types and existing vegetation in a riparian area can help dictate the choice of strategy for buffer establishment. Depending on whether the site is presently a pasture, an overgrown abandoned crop field, or a mid-successional forest, different approaches are needed to properly establish the desired vegetation.

In Vermont, one way to determine vegetation within a buffer is through its soil type. One method to determine the soil type is to refer to the online mapping system and appropriate soil layer on the VT Natural Resource Atlas. By identifying the point for a soil type on site, a USDA NRCS Soil Fact Sheet can be opened which then refers to the Natural Community Type. In addition the resource guide, *Wetland, Woodland, Wildland – A Guide to Natural Communities*, identifies soil series and their associated natural communities. The resource guide outline specific species to use for restoration purposes and takes the guesswork out of identifying species to use for installation.

Plant selection can also be chosen based on the geographic region, plant height and form, and the native vegetation present at the site. Trees growing nearby will reveal the parent material of the area and indicate what trees grow naturally on that site. Survey adjacent sites along the stream if the site is not vegetated. The list created from this survey will be the basis for researching the other species for the final plant list. Do not assume that if a particular species exists at a site, it is native.

Planting Plan
After determining physical site conditions, the detailed planting plan starts by determining the appropriate species, size, density, and layout depending on the budget of the project. When mapping the physical constraints of a riparian site, designing the planting plan becomes a process of selecting the best plants for the site conditions. Referring to the NRCS Riparian Forest Buffer Job Sheet outlines an established method for determining how to create a planting plan. As the planting plan is developed, it is best to consider how to maximize the survivability, the long term benefit, and sustainability for the buffer planting.

At present in Vermont, it is recommended that the majority of the Trees for Streams planting plans consider these factors:

1. Species are chosen based on the Natural Community Type. If the species cannot be found, it is recommended to delay the project until suitable species can be found.
2. Using Bare-root stock 3-5' in height in most cases, especially where Canary-reed grass is common. Larger Balled and Burlap stock can be used to demarcate the buffer boundary especially on large farm fields.
3. Planting density of 250 stems/acre for locations where some vegetation exists, and 400 stems/acre for locations where little to no vegetation exists.
4. Tree shelters/tubes/mats are used sparingly if at all.
5. It is critical to create a plan for storage, handling, and implementation to reduce mortality.
6. The survival rate should range from 70 to over 90 percent. If mortality rates are higher, it is recommended to review the planting plan procedures and/or request assistance from a partner before re-planting a site.

Plant Material Types

Vegetation Type/Considerations
Identifying the species native to the local riparian site is done by identifying the Natural Community Type as discussed previously. Some suggest using local biotypes since they have better vigor and hardiness and are better able to compete. While local biotypes may be more appropriate for a riparian site, it is likely that most planting material will have to be obtained from available nursery stock which may not be from a local source. Least expensive material can be widely used, while the most expensive material will be used sparingly in high visibility locations where it will be most appreciated. Planting stock ranges from seedlings to large caliper nursery stock. Planting strategies are largely determined by the extent of available funding resources and the site characteristics. Seedling and transplants are inexpensive and easier to install but if planted in tall herbaceous perennials, the survivability rate would decrease remarkable due to competition especially without mulch mats.

Larger plant material, such as taller bare root stock and balled and burlapped (B&B) trees will cost much more, although they will attain the desired goals more rapidly. The following sections are estimates as of 2013, and may vary widely due to a variety of reasons including but not limited to: 1. Number of stems per species (purchasing more may decrease the per stem cost), 2. Shipping rates relative to plant size and/or nursery location, and 3. Expertise of installation crew.

Bare Root Stock
The most 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 herbivory. Bare root stock are often seedling starts that are transplanted to fields and grow for more than two years.

Monitoring efforts have found that stems between three to five-foot in height and around ¾ inches in diameter and spacing of 14 to 16 feet have a higher survival rate. Roughly 250-400 plants are needed per acre. 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 material ranges in price from $2.00 to $6.00+ (when purchased in bulk) per plant for three to five-foot plants, less than half the price of Balled & Burlap trees for the same height. Hand planting with mattocks is the least expensive method, especially in rocky sites but root spread may be compromised though using shovels to dig the planting holes is best. Installation costs should run from $2.00 to $5.00 per plant, indicating an installed cost from $4.00 to $11.00 per plant.

Bare Root Seedlings and Year Transplants
In situations where a longer time to attain canopy closure is acceptable and there is little to no competition from tall grasses, smaller 1-0 and 2-0 seedlings or 2-1 transplants can be used. 1-0 and 2-0 seedlings are lifted directly from the nursery bed and shipped. They are the least expensive type of plants. 2-1 seedlings spend two years in the nursery and one year in a transplant bed. Often, this may be the only alternative to obtaining enough stock for large projects.

Seedlings and two-year transplants are considerably less expensive *but are often shorter* than what is recommended. Prices vary from $0.30 to $1.50 per plant according to source and type of plant. With experienced personnel, at least 60 to 80 plants can be planted per hour. At $10.00 per hour, this results in installation costs from $0.10 to $0.15 per plant, indicating an installed cost of $0.40 to $1.65 per plant. Herbaceous control measures may be necessary over time, requiring at least several years of control.

Container Grown Seedlings
Container grown seedlings may have similar growing challenges in highly competitive herbaceous sites as bare root seedlings and transplants. In sites that are conducive to small plants, container grown seedlings can be planted more quickly and efficiently than bare root seedlings since they are commonly grown in paper pots that disintegrate after planting. This increases survival rate because the plant never loses contact with its soil, and suffers less stress. Containerized seedlings can be grown 1) as tubelings in plantable pots or tubes 2) as plugs that are pulled out of the containers before planting, and 3) in blocks of pressed peat or pulp that serves as both a container and a rooting medium. Plastic containers work well for producing plugs. They are reusable and may be returned to the wholesaler.

Container grown seedlings range in price from $2.50 to $12.00 each, depending on the size of the plant. Plugs are sold in quantities of 50 plants, ranging in price from 50¢ to 85¢ per plug. There are advantages to container seedlings over bare root seedlings. Survival risks are lower for container seedlings than for bare root seedlings.

Live Stakes, Wattles, and Fascines
Living woody plant cuttings are capable of quickly rooting in moist soils that are denuded of vegetation or in sites where bioenginnering techniques are necessary. Stakes are generally ½-2 inches in diameter

and 1-3 long. Wattles are comprised of live whips or stems ¼ -1 inch in diameter bundled in 3-5 feet lengths. Fascines are made in the same manner as wattles but are a continuous bundle created for a specific length to the site's needs.

Stakes are available between $1.75-$2.25 depending on the source and species. Wattles and fascines are sold per length, but generally wattles can cost from $7.50-$10.00 depending on the overall length. Installation costs for wattles and fascines vary based on the site conditions and length. At $10.00 per hour, installation costs for stakes are $0.40 to $1.65 per plant.

Balled & Burlap

The most expensive approach is to plant the canopy, midstory, and understory species is to use Balled & Burlap (B&B) stock. 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. Because of the increased costs for this stock, a common use of B&B material is to plant it as a boundary to demarcate the buffer from an agricultural field, or a developed area.

The most common sizes of planting stock are 1½ to 2½ in caliper. Most B&B trees are too heavy to easily handle and transport. In mature riparian forests, canopy tree stem density is roughly 150 stems per acre, indicating a tree spacing of 16 to 18 feet. B&B material will attain a higher canopy height in the shortest time.

The typical plant cost for B&B material 1½ inch caliper is about $35.00 and up. Five-foot tall B&B material costs from $8.00 to $20.00, depending upon source and species. Installation costs are about $10.00 to $30.00 per plant, depending upon method, size of plant, and source.

V. <u>Implementation</u>

Storage and Handling of Materials

The storage and handling of materials from the time they are delivered to when they are planted in the field is often overlooked but may be the most important aspect for increasing the survivability of the material. Coordinating and minimizing the time between the delivery and planting time is most advantageous. Storing materials in a cooler is the best option or if unavailable, on site in a shaded area.

All materials, especially the roots, should be kept moist 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. Seedlings 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, or refrigerated if facilities are available. Container material is least susceptible to moisture stress and will store well if properly watered. Stakes, wattles, and fascines can be sprayed with water and wrapped to retain moisture.

When transporting the materials cover the plants with a tarp or packaging to keep them out of the direct sunlight and wind. Once at the site, keep the materials in a shaded area in buckets with moistened roots, and in water up until the time of planting.

Buffer Installation Logistics
Once planting plans are confirmed and trees are ordered, it's a good time to plan for the installation. Many programs request volunteer support within the community or watershed where the proposed project will occur which can help in the continued success for the program. Contact existing or established community-based organizations that may lend their support for the project.

Prior to planting, it's important to finalize the planting plan with the landowner by flagging the site to delineate the area and/or if time is available to mark each plant location. When at the location, it's helpful to work out the logistics for the volunteers, such as busing drop off sites, facilities, washroom, etc. if necessary.

If funds are available, some essential tools such as shovels and gloves could be purchased and used for subsequent projects provided that adequate transportation and storage are available. Obtaining tools to equip large numbers of workers for a one-day event can be a challenge. Listed below are some suggestions for locating and obtaining tools:

- Contact local partners, agencies, organizations, etc. for help. They may be willing to lend equipment for a one-day weekend event if the tools are retrieved and returned in a timely manner.
- Sponsor an event with an established restoration group that has access to the necessary equipment.
- Request volunteers to bring their own tools for the event.

Trees can be planted during the spring or fall. Spring planting is best in Vermont due to the availability of stock, volunteers, and weather conditions. Materials planted in the fall will need an adequate time for the roots to grow in before becoming dormant. Deciduous trees are best planted in the early spring before bud break in April. Spring planting 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 but no later than late May in the moist conditions found in riparian areas. 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. Most deciduous and conifer trees 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.

Planting Procedures
Before the day of the planting, notify the property owner of the time and number of volunteers or work crew that will be installing the materials. If working with a volunteer group, provide a list of items to bring to the site and outline the objectives for the day.

The day of the planting or other restoration activity, plan for a short demonstration of how to proceed safely and properly to achieve project goals. Explain the goals of the project and how their efforts will be valuable toward achieving those goals. Volunteers bring a variety of experiences to the project that may be useful in performing the task at hand.

Provide an explanation for each tool and instruction in its use. Some volunteers may be inexperienced in tree planting. Take time to demonstrate the proper techniques to plant to all participants and provide guidance as needed, explaining the importance to planting the materials correctly as you proceed.

Plant material should be stored on site in a moist shaded location prior to and during planting. Soil amendments are not recommended, since few roots will grow beyond the amended soils. All sod should be discarded, or turned upside down as mulch around the hole. Combine Soil Moist Root Dip in several buckets of water on-site during the planting in which to store the plant materials and/or dip the plants prior to planting.

Planting Directions
A correctly planted tree should have the following general characteristics:

1. Planted at about twice the size of the length and depth of the root mass.
2. Use the root collar to determine the depth for the root mass. The root collar should be nearly even with the general ground level, not sunk in a hole or raised on a mound.
3. Have the main roots nearly straight and spread out, not doubled, or sharply bent.
4. Fill in the hole with lose crumbling soil, not patches of sod.
5. Have the tree in an upright position, holding it level if necessary.
6. Have the soil firm around the roots tamping (not stamping) the soil. Leave no air pockets.
7. Lightly pull on the main stem to ensure the tree is securely planted.
8. Water until soil is saturated.

Tree Shelters/Tubes/Mats
Tree shelters accelerate growth and increase the survivability of seedlings. Where shelters are used, the density can be decreased and the results improved. However, monitoring efforts have found that herbivory may also be increased. It is best to consider the surrounding landscape before using seedlings.

Depending on the site condition, different tree protections can be utilized if necessary. Where deer or beaver browsing is apparent, tree shelters can provide herbivory protection. Shelters that are 2 or 3 foot lengths may deter rodent damage in overgrown fields. Larger shelters that 4 or 5 foot lengths may deter deer herbivory. Overplanting other vigorous species is another method to sustain browsing without excessive pressure on the desired species. In areas with tall grass, such as Canary reed grass, geotextile fabric can act as a mulch to increase the survivability of the plant.

On Going Maintenance & Monitoring
The most critical period during riparian forest buffer establishment is maintenance of the newly planted trees if applicable. Ongoing maintenance practices are important if not necessary to ensure establishment of a thriving buffer, particularly where smaller seedling plant material has been used. If funding allows, it's important to check the status of the buffer soon after planting, to continue watering if necessary, and to monitor the site.

Completed Site Report
Once the planting is completed, record the specifics on the projects implementation for your records.

Site Report specifics can include:
1. Property Owner and Contact information
2. Location of Project

3. Contact Person and Date of Site Visit
4. Site Location including the Watershed, Waterway Name, Reach Number
5. Site Description including RCP Data, Project Objectives, Present state of site
6. Tasks completed to date
7. What actions were taken
8. Soil Type
9. Natural Community Type
10. Acreage, linear feet, and width
11. Plant Invoice
12. Signed Contracts
13. Map of the site outlining the project
14. Volunteer group and time
15. Photographs of before and after project

VI. Resources

Technical Resources

Thompson, E.H. and Sorenson, E.R. 2005. *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont*. The Nature Conservancy and the Vermont Department of Fish and Wildlife. University Press of New England.

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Vermont Agency of Natural Resources. 2015. *Vermont Natural Resources Atlas.* Montpelier, VT. http://anrmaps.vermont.gov/websites/anra5/

Nurseries

During formulation of the plan, likely sources of stock should be identified and contacted for catalogs and checked for availability about four to six months before the planting date. When able, local sources should be used and may be a little more expensive, but the better quality control and reduced shipping and handling costs can offset initial price disadvantages. Sources can be evaluated as to size, price, and availability, though often certain species are unavailable or expensive, while others may be abundant in the trade, and relatively inexpensive. It is also recommended to check with partnering organizations on the nurseries capabilities to provide native, accurate, and healthy species.

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. The material should be examined for size, form, vigor, roots, wounds, and diseases at delivery if possible or at the storage area before planting.

List of Nurseries

Alpha Nurseries. Holland, MI 49423. (269) 857-7804
Cold Stream Farm LLC, 2030 Freesoil Road, Free Soil, MI 49411. (231) 464-5809
Drinkwater's Nursery. 564 Lawrence Road, Waterford, VT 05819. (802) 583-9748
Engels Nursery. Fennville, MI 49408. (269) 543-4123
Intervale Nursery. 180 Intervale Road, Burlington, VT 05401. (802) 660-0440
Lawyer Nursery, Inc. 6625 MT Highway 200, Plaine, MT 59859. (800) 551-8875
Meadowview Nursery. Naples, NY 14512. (866) 547-3954.
Musser Forests, Inc. 1880 Route 119 HWY N Indiana, PA 15701. (800) 643-8319

VII. References

This guide is intended for educational purposes only. Excerpts were used with permission. Palone, R.S. and Todd, A.H. 1997. *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers.* USDA Forest Service. NA-TP-02-97. Radnor, PA.

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Kline, Mike. 2010. *Vermont ANR River Corridor Planning Guide to Identify and Develop River Corridor Protection and Restoration Projects, 2nd edition*. Vermont Agency of Natural Resources. Waterbury, VT.

Lake Champlain Basin Program. 2008. *2008 State of the Lake and Ecosystem Indicators Report.* Grand Ilse, VT.

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