Wetlands
Best Management Practice Techniques
For Avoidance and Minimization

Cover image: Bog Mountain beaver pond in Wilmot, NH – credit: Kathryn Michener

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Concord, NH – credit: Jay Aube

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List of Common Acronyms

ADA........ Americans with Disabilities Act

ASSF........ area subject to storm flowage

CWS........ certified wetland scientist

ISDS........ individual sewage disposal system

LOD........ limits of clearing and disturbance

NEIWPCC........ New England Interstate Water Pollution Control Commission

NHDES........ New Hampshire Department of Environmental Services

NHDOT........ New Hampshire Department of Transportation

NHFG........ New Hampshire Fish and Game Department

NHGS........ New Hampshire Geological Survey

RIDEM........ Rhode Island Department of Environmental Management

SWQPA........ Shoreland Water Quality Protection Act

WAP........ Wildlife Action Plan

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Introduction

Background and Purpose

Purgatory Brook, Bow, NH – credit: Sandy Crystall

Under the Wetlands Program Rulemaking and Process Improvement Effort, the New Hampshire Department of Environmental Services (NHDES) is examining all aspects of the program and undertaking a comprehensive rewrite of the rules governing the program. The overarching goals of the Wetlands Program Rulemaking and Process Improvement Effort are to:

- Enhance transparency and predictability.
- Increase consistency and standardization.
- Ensure that decisions made are scientifically-based and protective of New Hampshire's sensitive and important natural resources.

Phase 1 is the Research and Listening Phase, where NHDES staff researched a wide variety of topics and solicited input from a broad array of stakeholders. In 2014, NHDES held over 30 public listening sessions throughout the state. Participants included: the general public, town and regional planning commissions, developers, contractors, consultants, and lakes and rivers management advisory committee members. All participants agreed that NHDES needed to provide more guidance on the wetland permitting review process. There was also broad agreement among stakeholders on the need to clarify the threshold terms of "avoidance" and "minimization."

In 2015-2016, NHDES established a Wetland Rules Workgroup (Workgroup). The Workgroup was comprised of a diverse group of stakeholders to assist in the review of NHDES draft rule concepts. The Workgroup reviewed a summary of the Listening Session public comments. The Workgroup also reviewed an overview of the Rhode Island Department of Environmental Management (RIDEM) *Wetland BMP Manual – Avoidance and Minimization Techniques* (Manual), authored by the RIDEM Office of Water Resources Freshwater Wetlands Program, and published April 2010 by the New England Interstate Water Pollution Control Commission (NEIWPCC). The Workgroup reached a consensus that this Manual should be adapted for New Hampshire and NHDES obtained permission from RIDEM and NEWIPCC to do so. In January, 2018, in conjunction with NHDES' release of draft wetlands rules, NEWIPCC published this draft BMP to receive public comments. NHDES has revised the BMPs based on these comments. This Manual is intended to be used in conjunction with other available materials. The target audience for this Manual is those who prepare applications for submittal to the NHDES Wetlands Bureau, as well as town officials, landowners, builders and contractors.

The Manual is intended to help answer questions and public comments from stakeholders, Wetland Rules Stakeholder groups and applicants, namely "How does an applicant know what NHDES wants?" and "How does an applicant know whether he or she is going to get a permit?" To help answer these questions and to help applicants "get it right the first time," it provides examples of acceptable and permitted wetland-friendly designs and practices that could be used by applicants when designing projects.

This Manual is another tool to help applicants and consultants to prepare more complete applications in order to adequately avoid and minimize impacts to wetlands, reduce costs to the applicants, and to facilitate applicants receiving streamlined decisions from NHDES. It includes project-specific examples and details that are applicable to many project types that have been successfully permitted in New Hampshire.

Guide to Using This Manual

This Manual can be approached in various ways. The authors recommend that the introductory pages and Chapter 1 be read first, before delving into the project-specific chapters.

A review of the Table of Contents reveals that, after the introductory pages, the Manual is largely organized around project types that are the subject of wetlands applications commonly submitted to the NHDES Wetlands Bureau. Each chapter begins with an introduction to the project type, followed by numerous bulleted tips on avoidance and minimization techniques and practices; and in many chapters, the tips are followed by before and after example illustrations. The examples are not intended to be complete site plans, but rather are simplified illustrations the readers should find helpful. The "before" examples depict proposed projects without consideration of wetland avoidance and minimization practices and the "after" examples depict projects that were modified to include the consideration of avoidance and minimization. Bulleted lists accompany the "after" illustrations and describe how the initial proposal was improved with respect to wetland protection. Throughout the Manual, the reader will also find helpful details that would be applicable to various project types.

Lonesome Lake, Franconia Notch – credit: Paige Relf

Some of the "after" examples illustrate some remaining encroachment into regulated wetland areas. Such encroachments have been permitted by NHDES in the past, but only after the applicants have demonstrated that the alterations were truly unavoidable and that remaining impacts were not detrimental. These examples are included because they are based on real-world projects; however, applicants should keep in mind that decisions to permit encroachments are very site-specific.

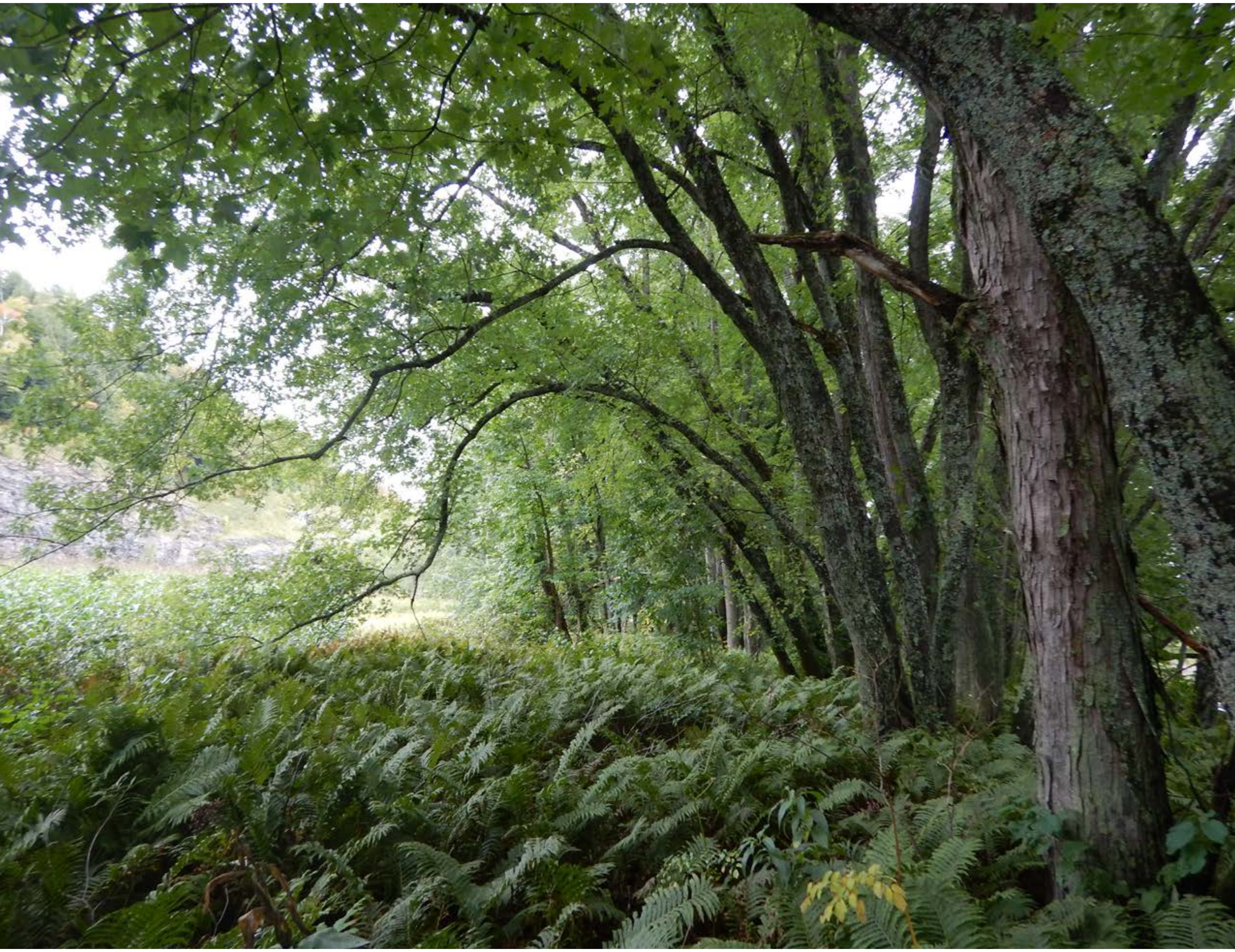
Chapter Guide

Chapter 1 is a primer on the importance of protecting New Hampshire's wetlands, whose functions and values NHDES is charged with protecting, according to New Hampshire Law. This chapter lists various activities or alterations that may be posed in or near wetlands, and that may adversely impact these functions and values both hydrologically and ecologically, especially over time. This builds the case for the critical need for 1) the avoidance of wetlands altogether and 2) the minimization of truly unavoidable impacts.

Chapters 2 through 13 focus on specific project types, beginning with Single-Family Lots and progressing to Utilities. Each chapter can stand alone and as such, the reader will note some repetition in the text and bullets from chapter to chapter, since some common techniques and practices are pertinent to more than one project type. The reader may also find relevant examples and tips within specific chapters that apply to another project type (i.e., water quality treatment). A review of the list of examples will help the reader identify which examples may be of use to them and where to find them.

The authors recommend that all Manual users read the following chapters entirely since these Chapters address activities that are common to many project types: Chapter 7 – Stream and Wetland Crossings, Chapter 9 – Plantings and Chapter 10 – Construction and Maintenance.

Chapter 7 describes stream and wetland crossings. A crossing is rarely a stand-alone project type, but rather a common component of other projects and one of the more frequent alteration types resulting in direct wetland alteration and loss. Applicants often propose crossing wetlands, including rivers and streams, to gain access to upland portions of properties on which to build their projects. Chapter 10, largely through illustrations of culverts and bridges, emphasizes the importance of maximizing span width and maintaining the existing hydrology and substrates of the wetland proposed to be crossed.



Silver Maple floodplain forest, Upper Connecticut River watershed – credit: Melinda Bubier

Chapter 1 – The Importance of Protecting Wetlands

New Hampshire's natural wetland ecosystems, streams, lakes and coastal resources provide the foundation for many activities that drive the state's economy. The New Hampshire wetlands law, RSA 482-A, provides that:

> *"It is found to be for the public good and welfare of this state to protect and preserve its submerged lands under tidal and fresh waters and its wetlands, (both salt water and fresh-water), as herein defined, from despoliation and unregulated alteration, because such despoliation or unregulated alteration will adversely affect the value of such areas..."*

Residents and tourists are attracted to aquatic resources because of their beauty and the recreational opportunities they provide. New Hampshire's wetlands are of great importance for flood control, water purification, water storage and recharge for both groundwater and surface waters. These functions become more valuable with the expected increase in occurrence and severity of storm events associated with climate change. Wetlands also support the food chain, providing habitat for a variety of aquatic and upland plants and animals. Those important functions are why avoidance and minimization of impacts to wetlands is an integral part of designing and building any project that is located in or near a wetland.

Before designing an approvable wetland project plan, it is important for an applicant to understand the functions and values of wetlands that need to be protected. These functions and values are described in State statute and rules. New Hampshire wetlands law, RSA 482-A:2, XI provides "wetland functions" is defined as "the practical measurable values of wetlands. The 12 primary wetland functions are ecological integrity, wetland-dependent wildlife habitat, fish and aquatic life habitat, scenic quality, educational potential, wetland-based recreation, flood storage, groundwater recharge, sediment trapping, nutrient trapping/retention/transformation, shoreline anchoring, and noteworthiness."

"Functions of wetlands often have effects beyond the wetland boundary." (NAP 1995) For example, wetlands store surface water and the effect of this function downstream is a reduction in flood peak. Each wetland function can be measured by evaluating a specific wetland's interaction with the adjacent portion of the landscape and with other wetlands. Understanding the hydrologic and biological connections between individual wetlands, aquatic systems and terrestrial systems is critical to measuring the function of a wetland system or wetland complex. Once each wetland function has been evaluated, the next step is to understand the potential impact a project has to each wetland functional value. The development of a plan should be guided by avoidance and minimization techniques that can be implemented in and around the most sensitive and valuable wetlands.

Protection from Flooding

One of the most important functions of wetlands is their capacity to control flooding, thereby protecting people and property. Wetlands help control floodwaters by storing excess water during heavy periods of rain and snowmelt. During storm events and spring thaws, vegetated wetlands receive runoff from upland areas and water that overflows from rivers and streams, and lakes and ponds. Wetland trees, shrubs, roots, soil and other vegetation reduce flood flow velocities and temporarily hold and store excess water, sometimes for long periods, until it can be slowly released into nearby rivers and streams. While this water is being stored in wetlands, it reduces the risk of flooding to nearby houses, roads, parking lots, etc., and it also lessens the threat of downstream flooding. The ability to reduce the peak level of floods and delay the

Road washout in Jackson, NH

flood crest is one of the most widely-recognized functions of inland wetlands (Carter et al., 1979; Novitzki, 1979; Tiner, 1984).

When heavy rain occurs in a watershed where vegetated wetlands have been altered or destroyed, the rainwater flows more quickly over the land and causes rapid rises and falls in river and stream levels, which in turn can cause flash flooding in the vicinity or downstream. In a watershed with healthy, functioning wetlands, rainwater is temporarily stored there, thus moderating the river and stream levels and both delaying and reducing the flood peak of the storm.

Without question, it is less expensive and easier to protect existing wetlands and their natural flood control function than to pay for flood damages or to build stormwater and flood control structures to manage the water. If wetlands are filled, their ability to store floodwater is diminished, thus putting lives and properties at risk.

A wetland located in a floodplain provides important flood storage functions. A “floodplain” is a flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding. Floodplains perform important natural functions, including temporary storage of floodwaters, prevention of erosion, and moderation of peak flows, water quality and groundwater recharge. Seasonal flooding also maintains biological and physical diversity.

The HB 648 Comprehensive Flood Management Study Commission Final Report (September 2008) noted that “New Hampshire has averaged about one major and destructive flood per decade since the early 20th century, and three major flood events in 2005, 2006, and 2007.” “Land use and development regulations must be implemented in order to minimize damage to existing structures and to protect undeveloped floodplains to maintain their flood storage capacity.” “Land cover conversion toward greater degree of impermeability (e.g., roads, buildings, parking lots, etc.) and toward reduced stormwater retention will substantially affect the watershed runoff characteristics during rainfall events. When a watershed approaches ten percent impervious surface coverage, watershed characteristics begin to decline, including stream channel morphology, flood storage capacity, and water quality.”

A key finding of this report was the need to ensure that bridges and culverts are adequately sized. Additionally, the report provided that the New Hampshire Department of Transportation (NHDOT), NHDES and the New Hampshire Fish and Game Department (NHFG), “with input by the Nature Conservancy, should be tasked to develop the procedure and database for a standard culvert assessment data collection.” As a Stream Crossing Initiative, the New Hampshire Geological Survey (NHGS), NHDES, NHDOT, NHFG and New Hampshire Depratment of Safety – Division of Homeland Security and Emergency Management have partnered to inventory and assess stream crossings.

Additionally, in July 2013, the Legislature enacted Senate Bill 163, to establish the New Hampshire Coastal Risk and Hazards Commission to recommend legislation, rules and other actions to prepare for projected sea-level rise and other coastal and coastal watershed hazards such as storms, increased river flooding, and stormwater runoff, and the risks such hazards pose to municipalities and the state assets in New Hampshire. The Commission published its Final Report and Recommendations to better prepare for and minimize coastal risks and hazards in November 2016.

Groundwater Protection

An aquifer is a layer of porous soil (sand or gravel) or fractured bedrock that can be used as a groundwater supply source. The connection between wetlands and the groundwater system is of particular importance in New Hampshire, where many people rely on groundwater as a source for drinking water, agriculture and other uses. Depending upon their position in the watershed and the underlying geology, some wetlands may feed or recharge the groundwater system, while other wetlands may be areas where groundwater discharges to the surface. Both wetland-groundwater relationships are important. As pointed out in the NH Method, "wetlands that are groundwater recharge areas may play an important role in recharging groundwater supplies by delivering water back into the ground through permeable coarse-textured soils that allow for rapid infiltration of rainwater, snowmelt and run-off. These soils include sands, gravels, and cobbles associated with glacial outwash deposits."

The second, more common situation is where groundwater discharges to the surface of wetlands, which may help to cool surface waters, and maintain habitat and river and stream levels. As groundwater aquifers are developed for water supplies, their impacts to wetlands must be carefully considered. If an aquifer is located beneath a wetland, then pumping it may result in induced groundwater recharge from the wetland, thus resulting in potential long-term changes to the wetland's natural hydrology. If the wetland becomes polluted, then the groundwater that is pumped from the aquifer for drinking water may also become polluted. Therefore, protecting wetlands will, in turn, help protect our groundwater and our drinking water.

Eastern Brook Trout

Fish and Wildlife Habitat

In its "Finding of Public Purpose" for RSA 482-A:1, the New Hampshire Legislature provides that "it is found to be for the public good and welfare of this state to protect and preserve its submerged lands under tidal and fresh waters and its wetlands,…" because of the functions and values these aquatic resources provide. The Legislature specifically recognizes "…the value of such areas as sources of nutrients for finfish, crustacea, shellfish and wildlife of significant value,..." and "…habitats and reproduction areas for plants, fish and wildlife of importance,…"

One of the best-known functions of wetlands is the habitat they provide for a wide variety of wildlife. Many mammals, birds, reptiles and amphibians depend on wetlands for feeding, nesting, escape cover, migration stopovers and wintering habitat. While other wildlife may not require wetlands to meet their life needs, they still utilize them. Certain specially-adapted plants also grow and flourish in wetlands. Even small wetlands that appear dry much of the year are crucial to the survival of certain species and in urban areas, they may be the only remaining habitat for wildlife.

"Identifying high quality wildlife habitat is key to protecting both rare and common wildlife." –WAP

More than one-third of all threatened and endangered wildlife species in the United States live only in wetlands, and nearly 50% of all threatened or endangered species use wetlands at some point in their lives. Many rare plants and animals of New Hampshire also depend on wetlands for survival.

The NHFG Wildlife Action Plan (WAP) provides an excellent resource: wildlife habitat profiles, plant community habitat descriptions and species of greatest conservation need. The WAP identifies habitats and provides maps displaying the most valuable habitats in New Hampshire – Highest Ranked in the Biological Region, Highest Ranked in the State and respective supporting landscapes.

The WAP also includes maps that depict 27 different types of habitats. Many of these habitats correspond to wetland types: from marsh and shrub wetlands, peatlands, temperate swamps, and floodplain forests to coldwater streams and lakes. Each of these wetland habitats are clearly described through the UNH Cooperative Extension, NHFG and Sustainable Forestry Initiative "Habitat Stewardship Series." These brochures include tips on identification of species of conservation focus, and recognizing habitats and why these habitats are important. The New Hampshire Natural Heritage Bureau (NHB) has also identified exemplary natural communities that represent the best remaining examples of New Hampshire's biological diversity, such as alpine/subalpine bog system on Shelburne-Moriah Mountain in Shelburne, a kettle hole bog system at Heath Pond Natural Area in Ossipee and Effingham, or at Red Hill Pond in Sandwich.

Through a joint partnership between NHDES, NHB and NHFG, a webtool was developed to maintain data on known locations of rare species and exemplary natural communities. Anyone planning a project in New Hampshire that requires a permit can access the NHB DataCheck Tool to find out if there are NHB records in the vicinity of the project. NHFG biologists have maintained a database of fish survey records collected throughout the state - see the NH Fish Survey Map tool to see if there are any records of fish surveys.

Black-winged damselfly – credit: Victor Young

No activity may impact a threatened or endangered species, or an area designated or proposed as critical habitat under the federal Endangered Species Act and New Hampshire RSA 212-A, Endangered Species Conservation Act.

Vernal pools provide essential breeding habitat for protected amphibians and reptiles. They are important as wildlife habitat because of the wide range of species that use them, including turtles, frogs, salamanders, fairy shrimp, clam shrimp, fingernail (or "pill" or "pea") clams, caddis flies and other aquatic insects. Some of these species (certain invertebrates, salamanders and frogs) are rarely found outside of areas containing vernal pools. NHFG's guide on Identifying and Documenting Vernal Pools in New Hampshire is a helpful tool.

Minimization and avoidance techniques are critical to protecting sensitive and valuable wildlife habitat, fishery and exemplary natural communities. Plans need to ensure that work activities causing discharge of sediment-producing activities in fish and shellfish or nursery areas, amphibian, and migratory bird breeding areas during spawning or breeding seasons are avoided. Designs must consider impacts to habitat, migratory pathways, potential impacts to nesting, spawning, discharge that would impact water temperature, and other time-of-year restrictions. NHFG recommends that project applicants use "wildlife friendly" erosion control mesh such as woven organic material (e.g., coco or jute matting) or other materials that don't include a welded plastic component. This recommendation is particularly important within "priority resource areas."

Recreational Value

Wetlands support a wide range of active and passive recreational activities, including hunting, hiking, photography, bird watching, research and nature study. Other open-water activities include swimming, fishing and boating. Some of these activities may not be entirely dependent on the presence of water, but they are often enhanced by and focused around wetlands.

The quality of a recreational activity depends, to a great extent, on the health of the wetland system. For example, the fish in a pond will only be healthy if the streams and groundwater that feed the pond are healthy. Fish from ponds and streams that are contaminated with urban or industrial runoff may no longer be safe to eat. Therefore, protecting wetlands helps to provide the consumer with safe and healthy fish.

Wetlands are also important because they provide attractive open space in increasingly urbanized areas. In addition, many wetlands contain unusual physical features or have a particular historical significance.

Water Quality Maintenance

Wetland soils and plants have the capacity to naturally treat surface water and groundwater by filtering nutrients, absorbing pollutants and removing sediment through natural, chemical and physical processes. This natural treatment capacity is limited because if wetlands are used solely for this treatment purpose (and therefore become overburdened), they can become degraded, thus eliminating or affecting their other benefits to people and wildlife. Despite limits, it does help to protect and improve groundwater quality and the water quality of our rivers and streams.

In addition to the functions and values described above, wetlands provide other important contributions, such as the production of commercially-viable products. They serve as sites for scientific research and education, and scenic areas and provide open space; all important reasons to protect wetlands. Understanding the significance of wetland function will help readers understand why impacts to these resources need to be avoided and minimized and the costs associated with not doing so.

This photo shows NHDES staff gathering a water sample at a water lily (aquatic bed) wetland to investigate development of water quality standards for wetlands. NHDES is studying impacts to water quality in different landscape settings by looking at different tolerance levels of invertebrates.

Dolloff Pond, Conway, NH – credit: Sandy Crystall

The potential for a wetland to remove sediment as a hydrologic function is dependent on the sediment load being delivered by runoff and input from upslope in the watershed. Wetlands with higher potential to remove sediment have dense herbaceous vegetation and slow-moving water to filter out the sediments. Wetlands also can remove nutrients (fertilizers) and toxicants (pesticides and heavy metals) from incoming waters to prevent them from travelling to downstream waters in the watershed.

Typically, these sediments and nutrients are trapped and adsorbed to soils high in clay or organic matter and through nitrification and denitrification in alternating oxic and anoxic conditions.

Wetlands also reduce erosion of stream channels downgradient of a wetland, along shorelines (if associated with a lake or a tidally-influenced waterbody) and within the wetland itself.

For smaller or residential projects, NHDES recommends using the New Hampshire Homeowner's Guide to Stormwater Management (March, 2016). This guide provides techniques to minimize impacts from stormwater runoff – including infiltration steps, vegetated swales, water bars and vegetated setbacks.

Understanding Impacts to Wetlands

Many applicants find it helpful to understand some of the direct results of altering wetlands. The following are a few examples.

- If wetlands are filled in order to build a new development, the entire area may be at risk for increased flooding.
- If wetlands are excavated or drained, there is a loss of wildlife habitat for food, nesting and shelter. An area may be much less scenic or have degraded aesthetic value and the opportunity for outdoor recreation, such as canoeing, birdwatching or fishing, may disappear.
- If upland vegetation adjacent to a river or stream is removed, erosion and sedimentation of the riverbank may occur. Polluted stormwater will then have no barrier to flowing directly into the river or stream, thus causing a decline in water quality.

Great Egret – Winnicut River, Greenland, NH – credit: Kevin Lucey

All of these types of alterations can, over time, result in cumulative impacts to the degree that entire watersheds are affected and the benefits that natural wetlands can provide are greatly diminished. Thus, it is important to remember that even on small projects, you must avoid and minimize impacts. A handful of small alterations or changes to a wetland can add up to a significant change in a wetland's functions and values.

When considering a parcel of land for development that contains wetlands, it is advisable to begin by planning ways to avoid the wetland areas entirely. This may be simple if the wetland is only on one side of the property or if an upland portion of the property can be easily accessed. It may be necessary to consider designs for a house, building or trail so as to avoid the wetland, even if they are different from the original project design. After avoiding the existing wetlands, the next step is to minimize any remaining impacts from project development. These steps will help to preserve important wetland functions and values. The same is true for a redevelopment or a land reuse project. Such projects will present various challenges, but also many opportunities to avoid and minimize, as well as to restore.

Project Development: Avoidance and Minimization

Every project submitted by a property owner is evaluated by NHDES to see whether all steps have been taken to avoid alterations in or near wetlands. The following questions may help determine whether or not wetland impacts have been sufficiently avoided and minimized.

- Are there other properties available on which to build that do not contain wetlands? (This is a good first question to ask before buying property with wetlands.)
- Does the project have to be located where it is, or could it be located elsewhere on the property, farther away from the wetlands?

- Are there alternative layouts, designs or technologies that would avoid detrimental wetland impacts and still meet the project purpose by building up instead of out?
- Are there any other project alternatives that would not adversely impact health, safety or the environment?
- Could an easement be obtained from a neighbor for a driveway or to access upland that would allow the project to be built farther away from the wetlands?

The following are key avoidance and minimization techniques common to many project types. These techniques are elaborated on and expanded in each of the subsequent sections.

- Avoid filling wetlands or removing trees and other vegetation from within wetlands.
- Keep disturbed areas to a minimum, and preserve natural areas around wetlands as much as possible.
- Design with the grade of the land to avoid earthwork as much as possible and to maintain existing drainage characteristics.
- For large projects, consider a design that limits road and utility crossings.
- Locate unavoidable crossings at the narrowest section of the wetland or utilize existing crossings, such as from a farm road or cart path, for access to upland areas.
- Schedule in-stream work to occur during low-flow conditions and so that it does not coincide with fish migrations, spawning and egg incubations periods.
- Schedule work so that excavations, deposition or sediment-producing activities in streams or wetlands, or other jurisdictional areas, avoid and minimize impacts during spawning and breeding seasons by using appropriate water quality protection techniques.
- Consider designing a shared driveway to limit the number of wetland crossings in a subdivision or neighborhood.
- Minimize surface area of roads, parking, paving or other artificial and impervious surfaces.
- Utilize boulders, gabions, or retaining walls where appropriate to reduce the amount of filling needed for slopes.
- Use pervious materials, such as crushed stone or gravel, for driveways and roadways.
- Avoid water withdrawal from wetlands.

Juvenile Eastern Newt – credit: Kathryn Michener

Chapter 2 – Single-Family Lots

Single-family house lots are by far the most common project type that NHDES reviews. One of the first things for an applicant to consider is whether or not the size of home desired will fit on the lot chosen, particularly if there are wetlands that need to be avoided. Prior to purchasing the property, it is advisable to have the current owner retain a Certified Wetland Scientist (CWS) to identify the presence of wetlands, delineate the extent or edge of wetlands on the property or verify the delineated edge of a wetland when one is already known to exist. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Single-family home in Wilmot, NH

Site Design

- Avoid building in or near wetlands, if at all possible.
- Locate the house or building closer to the road.
- If a wetland cannot be avoided, consider obtaining an easement from a neighbor to share a driveway and reduce wetland encroachment.
- Remember to provide realistic LOD that will encompass all proposed work and land uses on the site. Consider room for construction vehicles and space for future maintenance (e.g., a backhoe for grading around the house) and use.
- Consider installing a retaining wall, gabions or terracing at the LOD to reduce filling.
- The site design should allow for adequate yard space for future uses, such as decks, sheds, gardens or swing sets outside wetland areas.
- To avoid flooding, determine the boundaries of the 100-year floodplain, as well as lesser-intensity flood event levels and place the house, driveway and parking areas outside the flood zone.

Limits of Clearing and Disturbance

Realistic limits of clearing and disturbance (LOD) will vary from project to project. For some, it may be 10-15 feet from a structure, for others it may be 20-25 feet. NHDES encourages the applicant to thoroughly consider the location of the LOD before submitting the application to avoid future enforcement problems if the LOD is not adhered to.

House Design

- Reduce the size of the house to be built, or consider building “up” instead of “out.”
- Design the garage to be incorporated as part of the first story of the house instead of as a separate structure.
- Decks and other property accessories may need to be reduced in size or eliminated to minimize impact.

Driveways

- Use retaining walls, terracing or gabions to reduce the area of fill needed.
- Maintain existing grading as much as possible.
- Preserve as many large trees and as much of the tree canopy as possible.

- Avoid crossings by locating the driveway outside of wetland areas.
- Minimize the driveway width as much as possible.

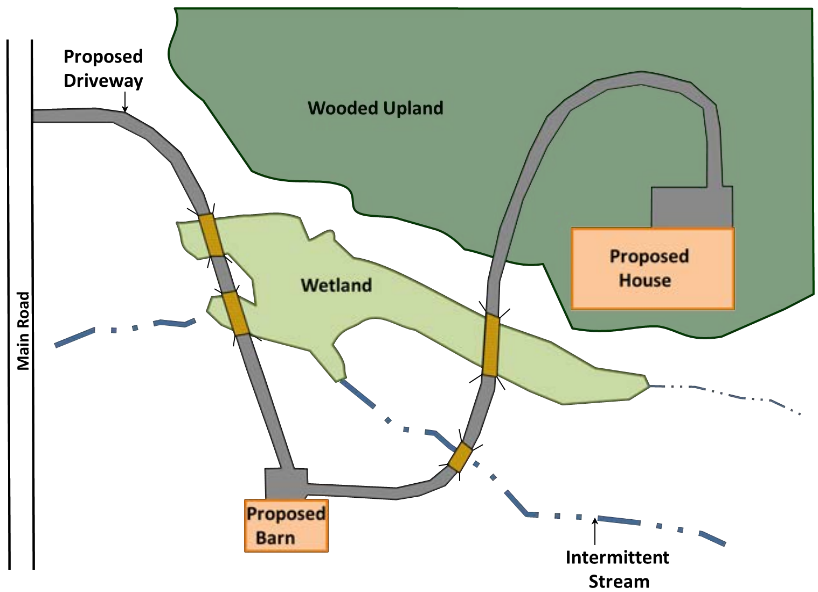
Screens and Plantings

- Create a thick protective transition zone by increasing plantings at the LOD adjacent to wetlands to reduce noise and disturbance to wildlife. Use two to three rows of plantings, instead of just one. If additional rows involve an increase in clearing or soil disturbance in wetland areas, a single row is preferable. Typically, evergreens are preferred because they retain their leaves or needles all year.
- Avoid the use of fertilizers, pesticides, herbicides or pollutants – chemical or organic – within wetlands.

Example 2.1a: Single-Family Home and Driveway – Original Plan

The applicant is proposing a long driveway with multiple wetland crossings to a residence located in the wooded upland area of the lot.

- Driveway meanders through wetlands and crosses in four locations.
- Proposed house is on the edge of the wooded upland, creating a barrier for facultative wetland species – those typically found in wetlands but that can also use non-wetland habitats.



Example 2.1b: Single-Family Home and Driveway – Revised Plan

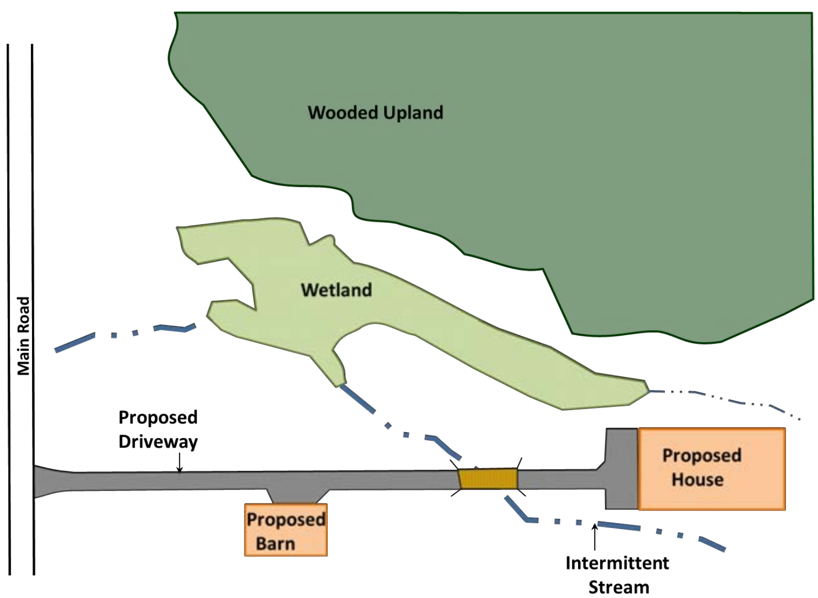
The revised plan allows the house to stay tucked back in the property while greatly reducing the wetland impacts of the driveway.

How wetland impacts were minimized:

√ Wetland crossings were reduced from four to one.

√ The length of the driveway was greatly reduced.

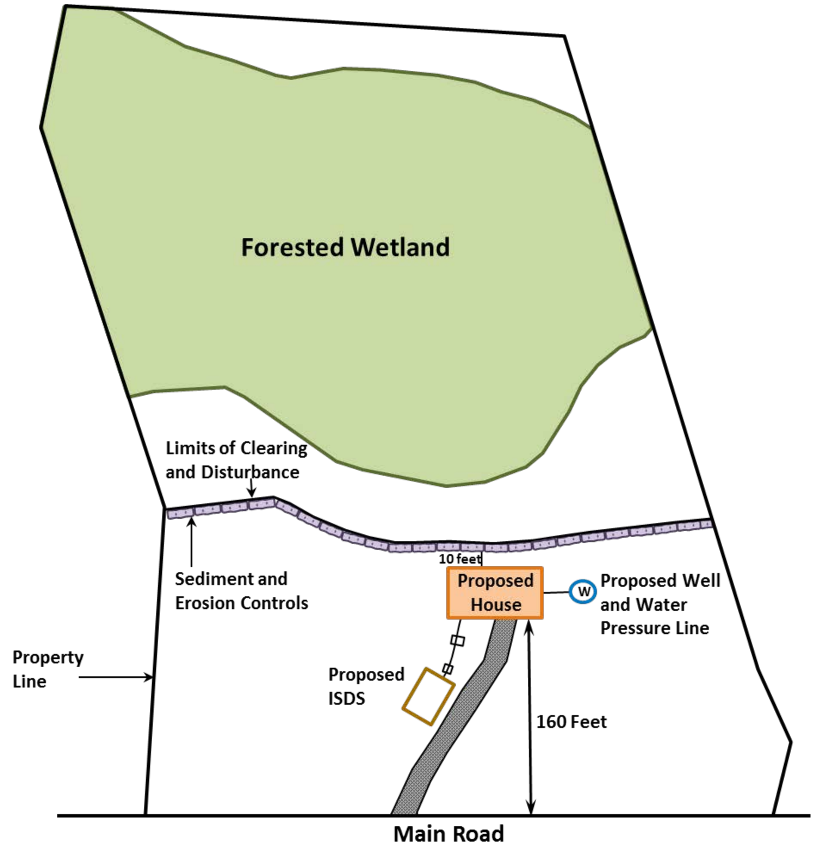
√ The house was relocated out of wooded upland, allowing for free movement of facultative wetland species.



√ The barn remains in the location originally proposed, allowing for straight and convenient access via the same driveway.

Example 2.2a: House Placement – Original Plan

In this example, the house is located more than 160 feet back from the road and only 10 feet from the LOD. The proposed Individual Sewage Disposal System (ISDS) is shown below.

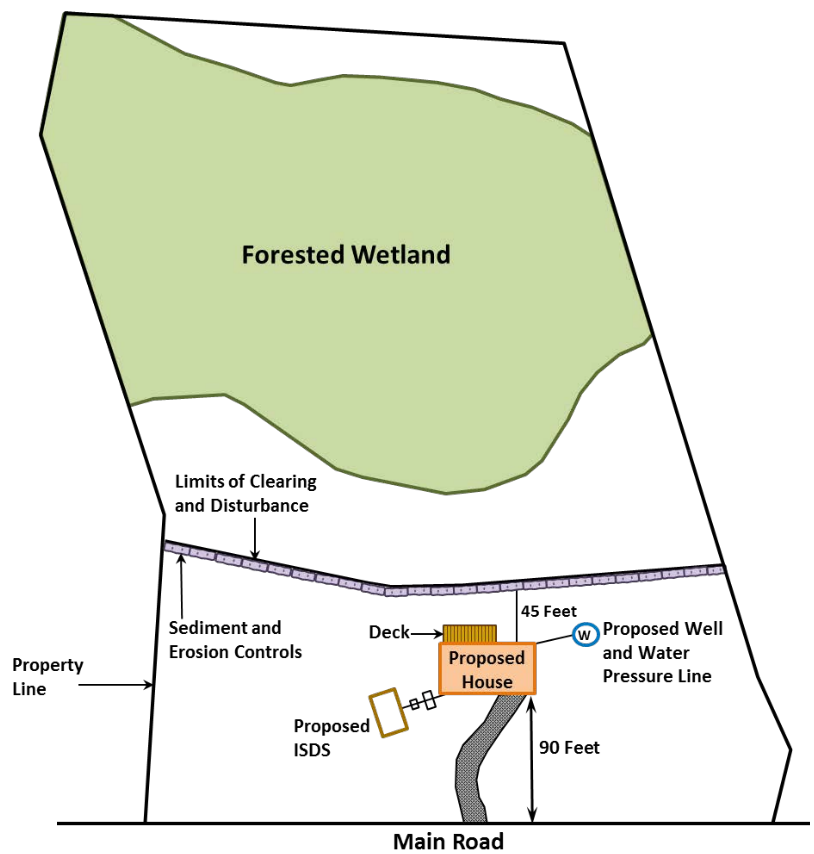


Example 2.2b: House Placement – Revised Plan

On a large lot with plenty of room to build, it is possible to avoid wetlands altogether. Project plans that demonstrate provisions to avoid and minimize impacts to wetlands may eliminate the need for a permit.

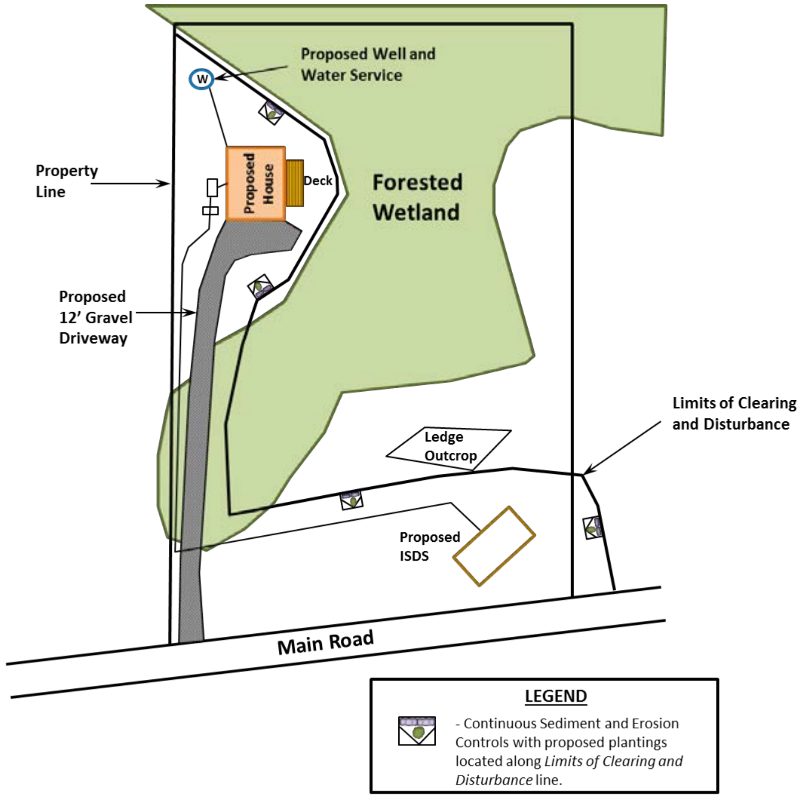
How wetland impacts were minimized:

- √ By moving the house closer to the road, the dwelling remained the same size and a deck was added, given the extra space.
- √ Adequate backyard space does not encroach into the wetland.
- √ In this case, the dwelling and LOD were far enough away from the wetland that the owner did not even need to apply to NHDES for a wetland determination or permit.



Example 2.3a: Lot Layout – Original Plan

This lot is primarily wetland, making it difficult to locate a house and septic system. In the original design, the proposed dwelling, driveway and deck are within the Forested Wetland area. The proposed ISDS is located far away from the house, thus causing a larger area to be disturbed.

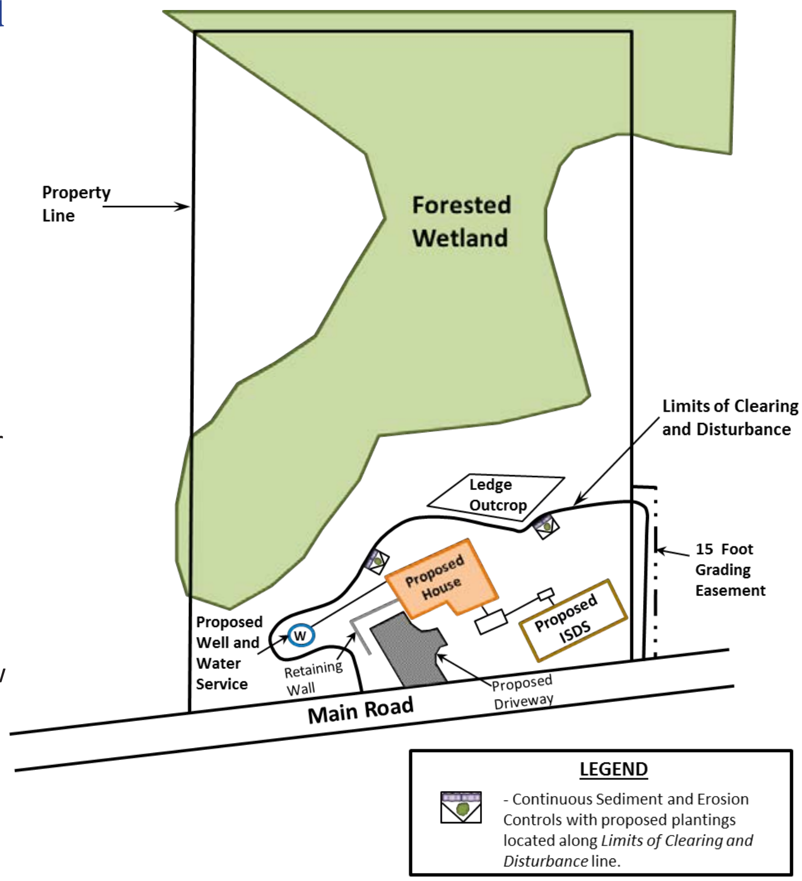


Example 2.3b: Lot Layout – Revised Plan

The revised design, while not ideal, proposes significantly less encroachment into wetland areas by relocating the house.

How wetland impacts were minimized:

- √ The house and driveway were relocated to the front of the lot, resulting in far less wetland encroachment.
- √ The deck was omitted to allow for a larger backyard.
- √ The driveway retaining wall reduced the need for grading near the forested wetland.
- √ A grading easement was obtained from the owners of the neighboring lot to allow for more practical LOD.



Chapter 3 – Subdivisions

Subdivisions cover large parcels of land that often contain wetlands. There may be a need to include a crossing or some other type of encroachment into these areas. Very seldom is a subdivision planned, designed and constructed without affecting nearby wetlands in some way. Large projects often include a number of small encroachments, which may accumulate to create larger overall impacts to wetlands that could otherwise be avoided. NHDES requires that all subdivision applications adhere to the items in New Hampshire Administrative Rules Env-Wt 524 and recommends that the following items are considered when determining how to best avoid and minimize wetlands impacts through alternative designs. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Lot Design

- Configure the lots to completely avoid wetland encroachment.
- Reduce the number of lots to avoid wetland disturbance.
- Provide adequate yard space for future homeowners to add a deck, shed or pool to their property without impacts to adjacent wetlands.

Driveways and Roads

- Design roads and driveways to be as narrow as possible.
- Avoid or limit the number of wetland crossings. If a crossing is unavoidable, design it so that the narrowest section of wetland is traversed or so that it crosses in a previously destroyed or degraded area. (See Chapter 7 – Stream and Wetland Crossings)
- Consider shared driveways for entrance and exit to small subdivisions.

Screens and Plantings

- Increase plantings along roadsides within the LOD to reduce noise and disturbance along wetland crossings and to provide replacement habitat for wildlife. (See Chapter 9 – Plantings for examples)

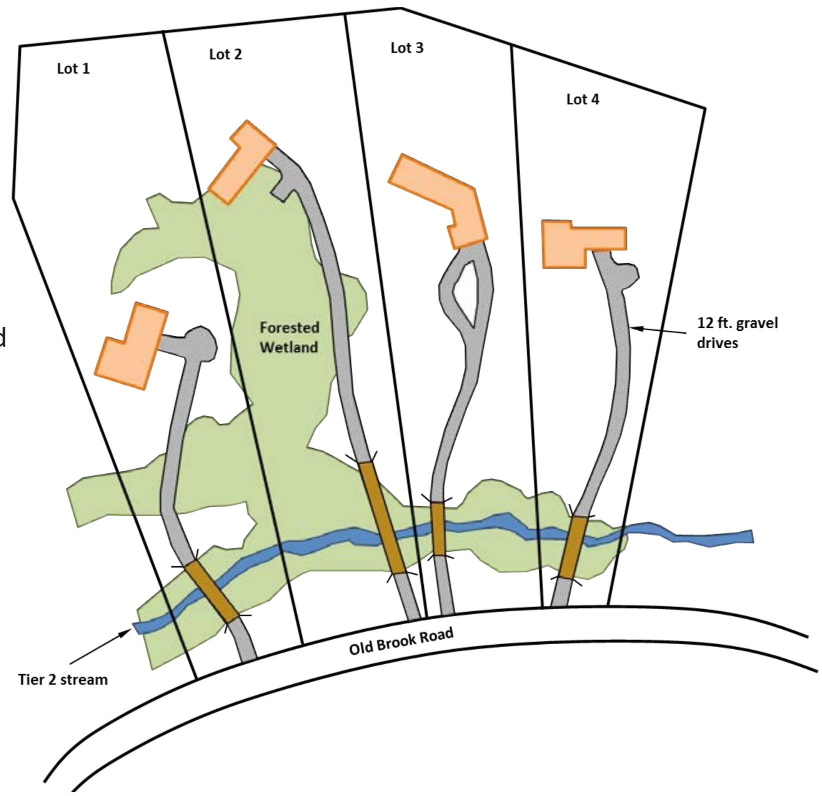
Engineering Considerations

- Work with the grade of the land to avoid or minimize earthwork and to maintain the natural topography and hydrology.
- Decrease impervious surfaces and maintain existing drainage patterns.
- Reduce stormwater runoff from impervious surfaces, and infiltrate to compensate for loss of groundwater recharge.
- Place detention basins and other stormwater controls completely outside of all regulated wetland areas.
- Avoid filling in the 100-year floodplain of any nearby streams or rivers.

- Avoid concentrating flow where possible.
- Consider the use of stone riprap channels to guide stormwater flow over steep or erosive slopes.
- Mitigate peak runoff rates and volumes of stormwater that will reach wetlands. This will help prevent erosion and negative water quality impacts to wetlands.
- Consider flood elevations from the 100-year and lesser flood events when deciding on road location and placement of other structures. (See the overtopping paragraph in Chapter 7).

Example 3.1a: Subdivision – Original Plan

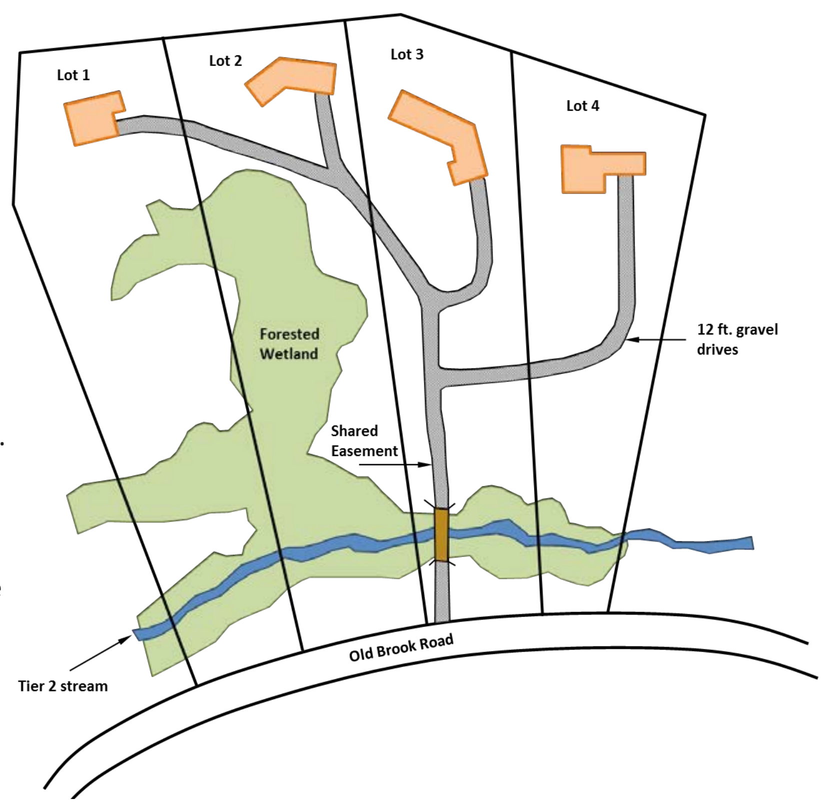
This subdivision was purchased as one large lot and subdivided as illustrated. The original plan was designed with four separate wetland and stream crossings. The proposed driveways in all four lots disturb the stream, stream banks and forested wetland. In addition, the proposed house on Lot 2 is encroaching into the forested wetland area.



Example 3.1b: Subdivision – Revised Plan (Option 1)

How wetland impacts were minimized:

- √ The developer designed a shared easement, reducing the number of crossings over the tier 2 stream from four to one, and moved the driveways so they completely avoided the forested wetlands.
- √ The house on lot 1 is no longer sandwiched between areas of wetland, thus eliminating all encroachment into forested wetlands and allowing for a more realistic and useful yard.
- √ The house on lot 2 was moved out of the forested wetland to available upland at the back of the lot.

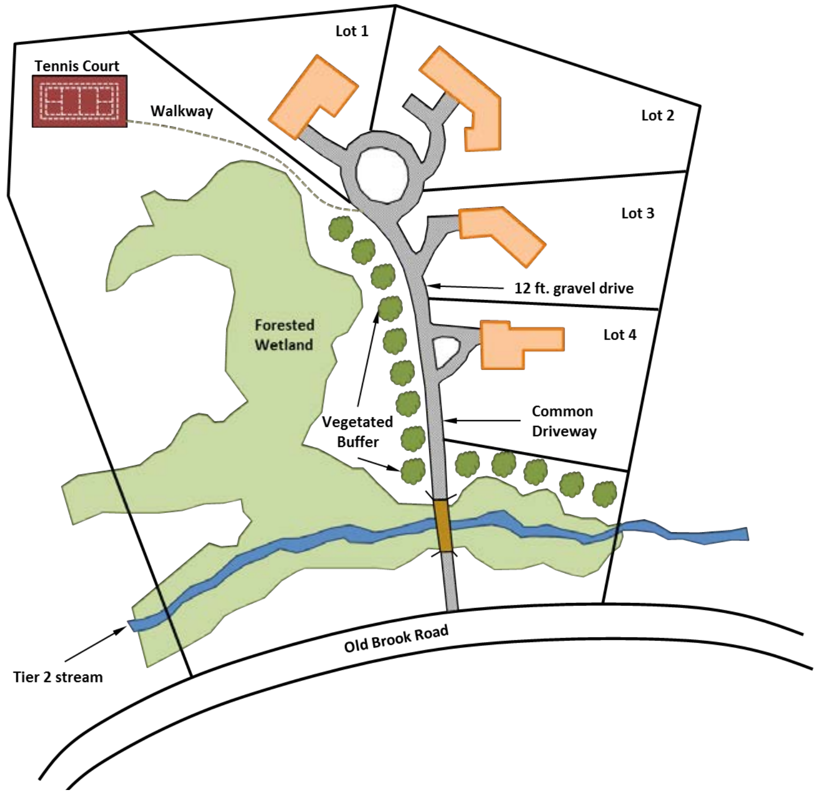


Example 3.1c: Subdivision – Revised Plan (Option 2)

This is a better and more realistic example of impact avoidance and minimization because it incorporates techniques of cluster development and open space preservation, thereby disturbing less land.

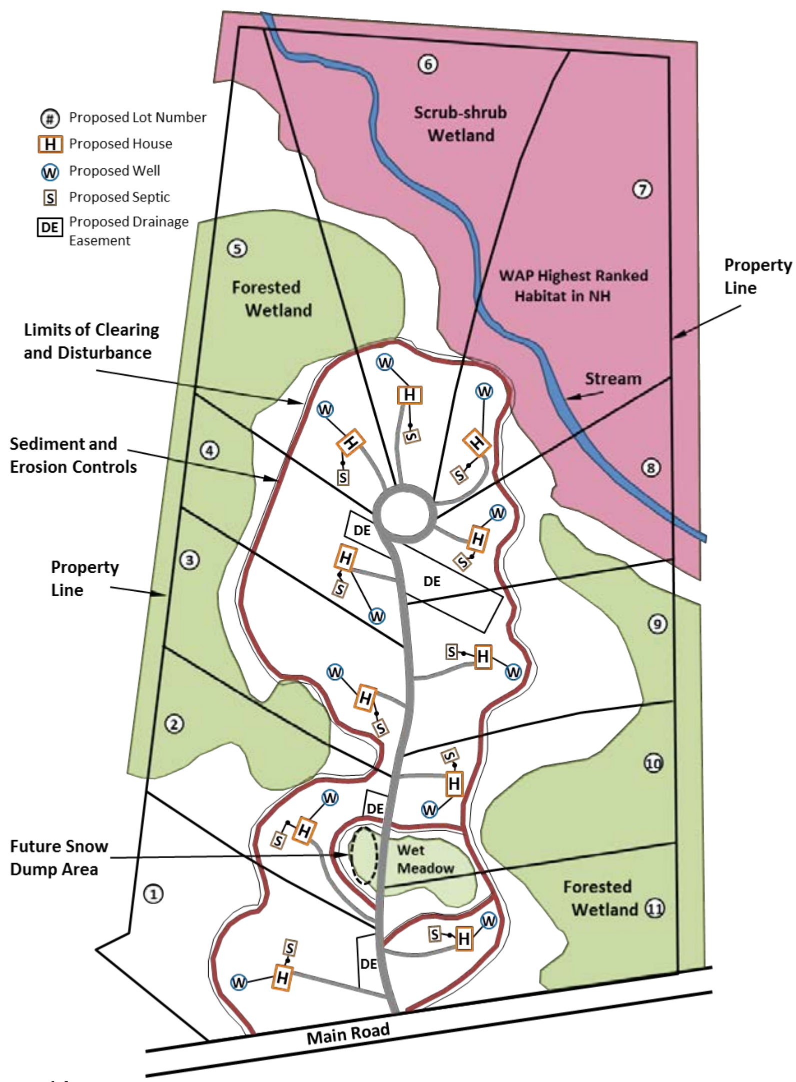
How wetland impacts were minimized:

- √ The lots are now rearranged to limit encroachment into vegetated wetlands with one narrow crossing instead of several crossings.
- √ The amount of land disturbed was also partly reduced by using shorter driveways.
- √ The addition of a vegetated transition zone between the developed areas and the wetlands helps reduce any potential impacts caused by road runoff before water enters the wetland.



Example 3.2a: Subdivision Layout – Original Plan

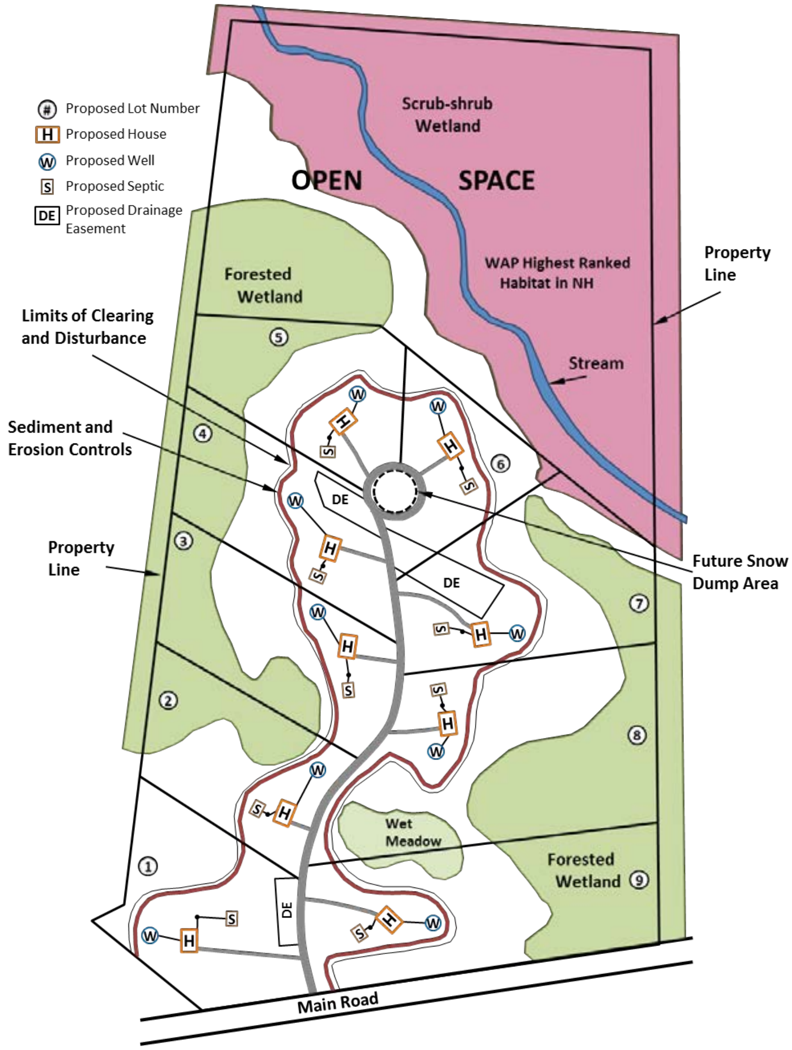
A comparison of examples 3.2a and 3.2b illustrates simple ways to avoid and minimize direct impacts to wetlands. In the original example, the main road to the subdivision fragments a wet meadow. It is also designed for 11 separate dwellings, many of which have very limited yard space, particularly the lots located near the stream. Lots 5, 6, 7 and 8 divide the high-value habitat at the back of the lot, while the LOD often encroach directly into the forested wetlands or scrub-shrub wetland at the back of the property. The erosion controls by lots 10 and 11 cut off connectivity between the forested wetland and the wet meadow and could impede wildlife passage between the two. In addition, one of the drainage easements is adjacent to the wet meadow and the snow dump area is in it.



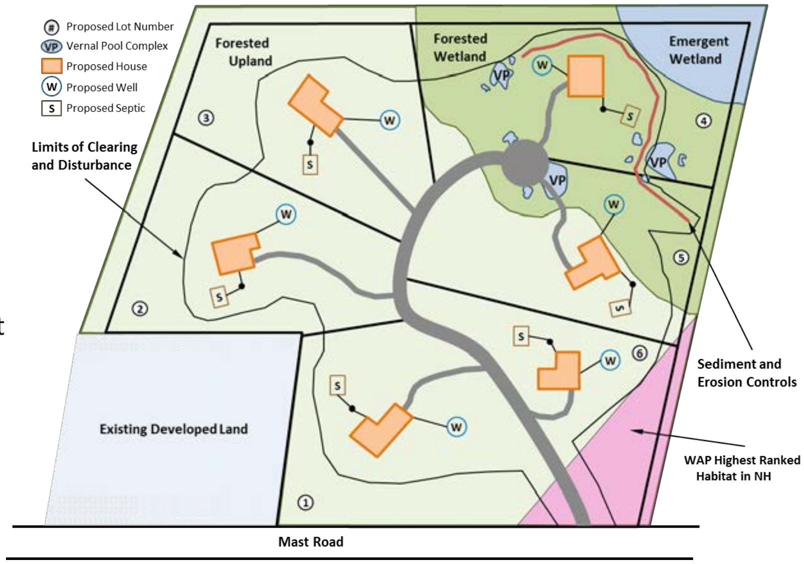
Example 3.2b: Subdivision Layout – Revised Plan

How wetland impacts were minimized:

- √ The developer initially received a variance from the town to allow for only one entrance and exit to the subdivision, which avoided wetland impacts.
- √ Fragmentation of the wet meadow was completely avoided by curving the main entrance road.
- √ The drainage easement closest to the wet meadow was eliminated by making the other easements slightly larger.
- √ The snow dump area was moved from the wet meadow into the upland area within the cul-de-sac.
- √ The developer opted to reduce the LOD on lots 3, 4 and 5 in order to avoid encroaching into the adjacent wetlands.
- √ The lot shapes were reconfigured to propose only nine dwellings, thereby maintaining a vegetated transition zone to the left of the stream and helping to protect wetland functions and values.
- √ Open space was dedicated via a municipal land trust that contains the Highest Ranked Habitat in New Hampshire, according to the WAP developed by NHFG, thus preserving the usefulness of this valuable habitat by preventing further development and preserving it for wildlife use. "Open space" is an area of undeveloped land that may be shared by a development or community.

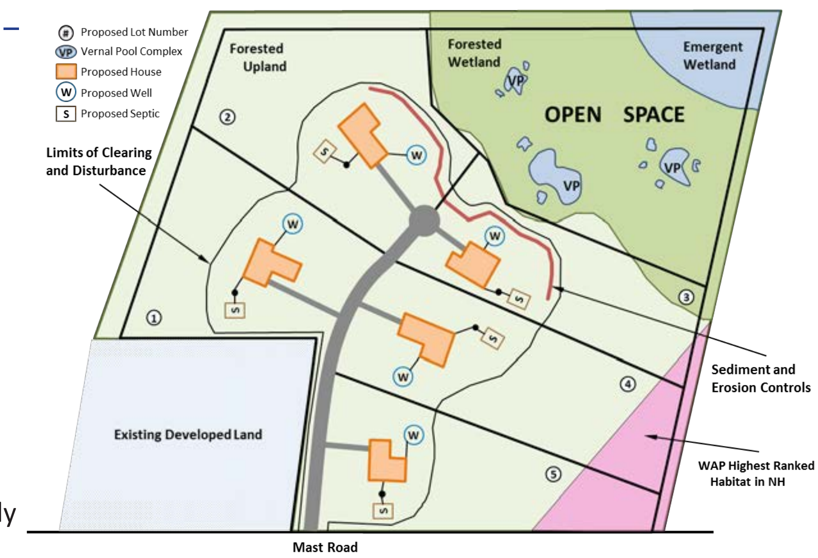


Example 3.3a: Subdivision Layout – Original Plan



This subdivision was purchased as one large, completely forested property and subdivided into six lots as illustrated. A survey by a CWS revealed the presence of a forested wetland with a number of productive vernal pool complexes at the back of the lot. The main road to the subdivision divides the high-value habitat at the front of the lot and the cul-de-sac fills in a vernal pool complex between lots 4 and 5. The LOD encroach directly into the forested wetlands and remove the canopy cover for many of the vernal pool complexes. In addition, the erosion controls on lots 4 and 5 cut off connectivity between the forested wetland, emergent wetland and some of the vernal pools, which could impede wildlife passage between the wetlands.

Example 3.3b: Subdivision Layout – Revised Plan



How wetland impacts were minimized:

- √ The lot shapes were reconfigured to propose only five dwellings, thereby maintaining a vegetated transition zone around the wetlands and helping to protect their functions and values, while also providing enough upland in each lot to allow for future development.
- √ Fragmentation of the Highest Ranked Habitat in New Hampshire was completely avoided and the overall required ground disturbance was reduced by moving the main entrance road towards the previously developed, adjacent property.
- √ The size of the cul-de-sac was reduced and moved closer to the front of the property, further reducing the total amount of ground disturbance required at the site and preventing fill of the vernal pool complex.
- √ The developer opted to move the houses closer to the road and concentrate them towards the previously developed, adjacent lot, thus reducing the LOD on all lots and preserving the canopy cover between the vernal pool complexes. This will allow for unimpeded migration of amphibians and other wildlife between the vernal pools and adjacent wetlands during breeding seasons and consequently help to preserve the genetic diversity of existing amphibian populations.

Chapter 4 – Commercial and Industrial Projects

Applicants proposing commercial and industrial projects, like all others, must first address the wetland avoidance and minimization requirements. Choosing a parcel that has plenty of upland area is important. If upland area is not readily available, developers should explore local zoning variances in order to avoid impacting wetlands.

By the nature of their size, some commercial projects may require wetland mitigation once all other wetland avoidance and minimization efforts have been exhausted. In addition, due to the amount of impervious surface that is often required, including driveways, large parking areas and buildings, it is particularly important to utilize effective stormwater management practices. The following practices can help reduce the impacts that these impervious surfaces may have on adjacent wetlands and surface waters. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Site Layout and Design

- Minimize wetland encroachment as much as possible by reducing the size or scope of the project.
- Avoid fragmenting wetland habitat and corridors.
- Locate projects in previously disturbed areas, if possible.
- Be aware of how the project's stormwater may affect adjacent wetlands and surface waters as a result of increased impervious surfaces.
- Incorporate appropriate soil erosion and sediment controls into the design following guidelines in the New Hampshire Stormwater Manual, Volume 3 Erosion and Sediment Controls During Construction (2008).

Paved Surfaces: Parking, Roads and Driveways

- Reduce the amount of impervious surface as much as possible.
- Design roads and entrances to be as narrow as possible through or adjacent to wetlands.
- Avoid or limit the number of wetland crossings. If a crossing is unavoidable, designing it so that the narrowest section of wetland is traversed usually results in reduced impacts. (See Chapter 7 – Stream and Wetland Crossings)
- Consider a multi-level parking garage to minimize impervious surfaces (and runoff) and protect naturally-vegetated zones.
- When designing a commercial or industrial subdivision, include details on the amount of impervious surface on each lot.
- Provide sufficient stormwater control and treatment. Follow the design criteria in the New Hampshire Stormwater Manual, Volume 2 Post-Construction Best Management Practices Selection & Design (2008).

Snow Removal

- Identify snow storage areas in uplands or parking lot areas that avoid wetland impacts, and minimize salt use.
- If space is limited on the lot, snow may need to be removed from the property to avoid pushing it into wetlands and surface waters.

Screens and Plantings

- Increase plantings along roadsides within the LOD, especially along wetland crossings, to reduce noise and disturbance to adjacent wetlands and wildlife that use them.
- Utilize retaining walls, berms or barriers to avoid filling into wetlands. Be sure to incorporate plantings into the design.
- Consider using permeable surfaces, especially in redeveloped or urbanized areas, to help manage stormwater.

Pervious Surfaces

Using pervious surfaces is a good way to reduce the amount of runoff and impacts from the development. This alternative enables groundwater recharge and facilitates treatment of pollutants via the underlying soil. Common pervious surfaces include porous asphalt, porous concrete, pavers and geotextile grids.

Construction and Maintenance

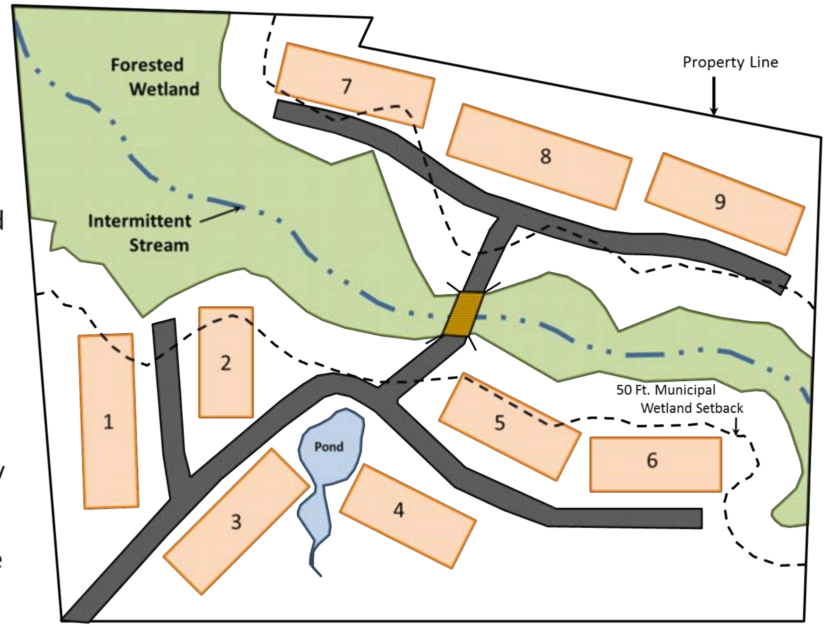
Development of commercial projects often involves the disturbance (clearing, grading, filling) of large tracts of land. As a result, it is vital that sediment and erosion controls are properly installed and maintained throughout the life of the project to prevent construction-related wetland impacts.

Pervious paving and bioretention in a parking lot – credit: Mass.gov

- To properly install controls on site, make sure silt fences are toed into the soil, and bales of hay are securely staked into the ground and trenched into the soil.
- Install sediment and erosion controls as illustrated on design plans. Supplement these controls, within the approved LOD, as the need arises (e.g., around soil, stockpile areas, matting/jute mesh on steep slopes, etc.).
- Schedule regular inspection of sediment and erosion controls (daily to weekly after storm events), and replace or repair them as conditions dictate.
- Specify inspection and maintenance requirements on all stormwater control elements, both during and post construction.
- Catch basin cleanup, regular parking lot sweeping and litter cleanup should be specified where needed.
- Consider snow removal procedures and designate a location for snow to ensure proper protection of wetlands.
- Place construction access roads and locate soil stockpiles as far away from wetlands as possible.
- Perform work near wetlands outside the breeding and migratory season of sensitive wetland species as much as possible.

Example 4.1a: Storage Facility – Original Plan

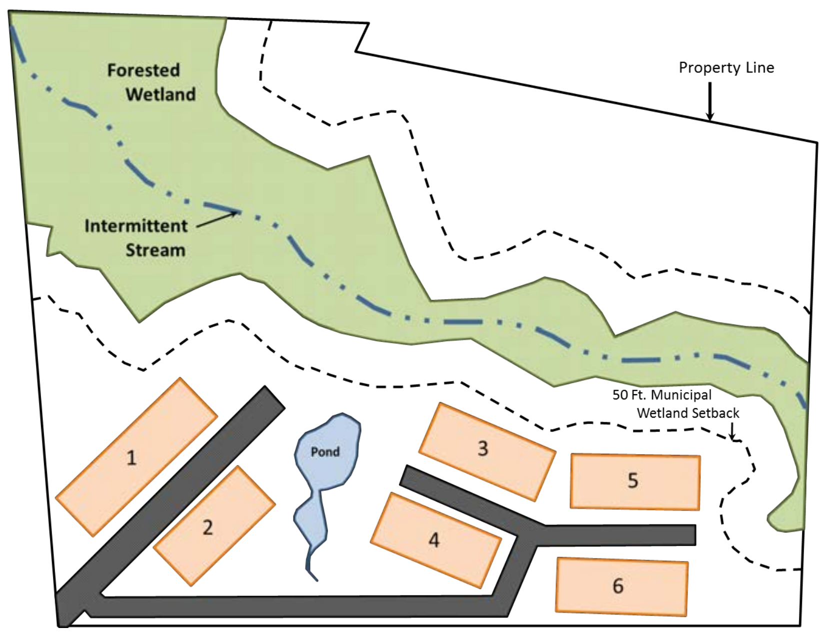
This example illustrates a proposed storage facility near a large forested wetland with an Intermittent Stream and a Pond. Both the original and revised designs included proposed plantings around the Forested Wetland, although they are not shown in this illustration. However, the original design does not avoid and minimize in the following ways:



- A crossing disturbs the forested wetland and intermittent stream, and bisects a wildlife travel corridor along the wetland/ stream drainage.
- The proposed buildings encroach into the local wetland setback.
- There is little room to install sediment and erosion controls without disturbing and further encroaching into the forested wetland and pond, as well as the local wetland setback.

Example 4.1b: Storage Facility – Revised Plan

Sometimes, it is necessary to scale back on a design in order to minimize impacts to wetlands and to have a permittable project. This design improved upon the original design and still met the project purpose.



How wetland impacts were minimized:

√ The buildings were moved farther away from all the wetland areas and local setbacks.

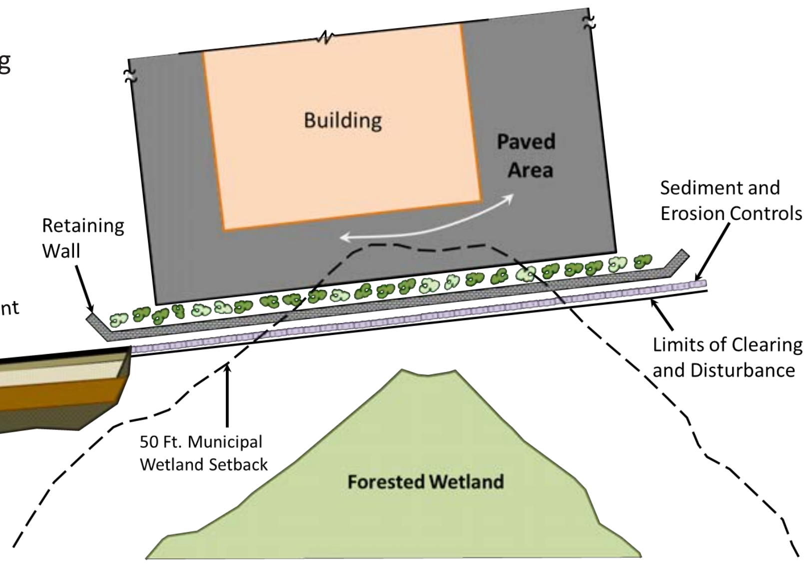
√ The crossing and buildings above the forested wetland (units 7, 8, and 9) were eliminated to minimize impacts and to avoid bisecting the wetland and wildlife corridor.

√ The footprint of storage unit 2 was reduced, thereby increasing its distance from the pond.

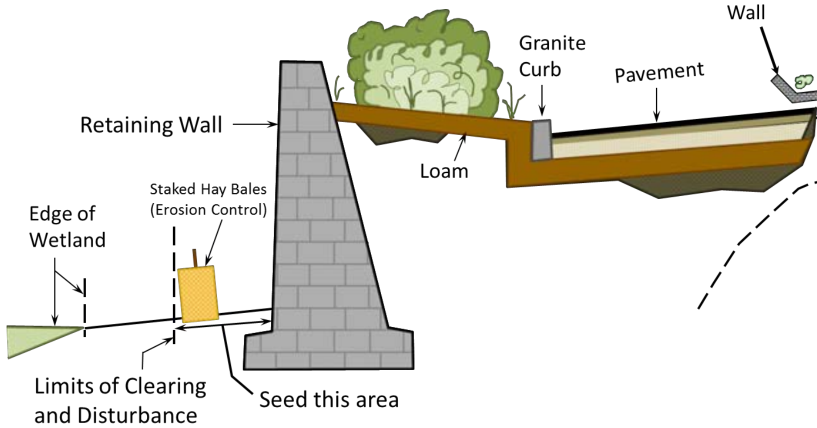
√ A wetland permit is no longer necessary and the project can proceed as shown on the revised plan.

Example 4.2: Retaining Wall

These drawings illustrate a commercial building project located very close to a forested wetland and within the local wetland setback. In this case, there were no alternatives available.



Overhead view



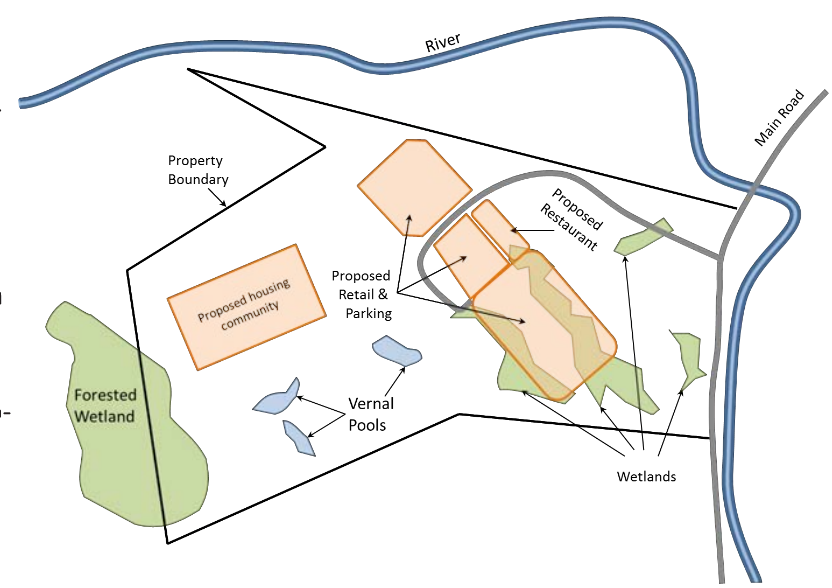
Cross section

How wetland impacts were minimized:

- √ The retaining wall reduced the amount of fill needed to construct the parking/driving area around the building, thereby reducing encroachment into the wetlands.
- √ Plantings were installed on the upland side of the retaining wall to help provide additional screening against noise, light and other disturbances.
- √ Erosion controls and plantings were installed to capture sediment-laden runoff and directly reduce the sheet flow.

Example 4.3a: Commercial Lot Development – Original Plan

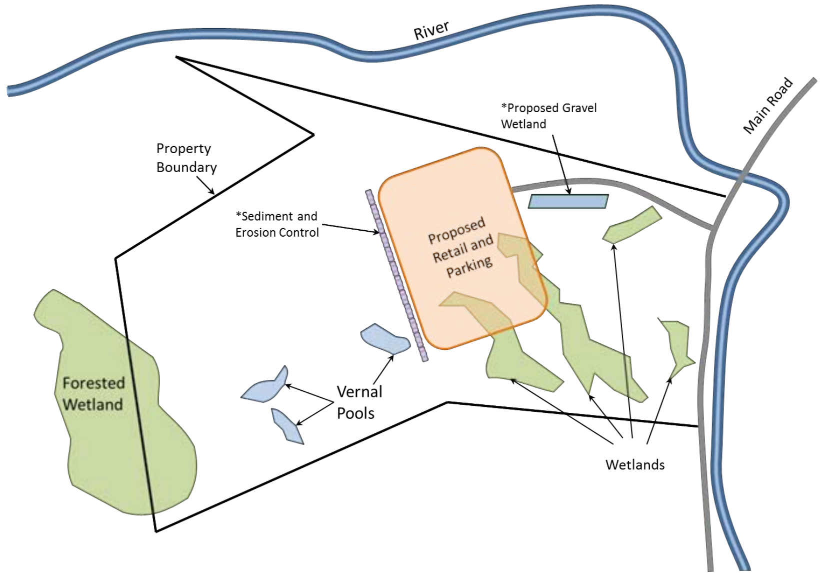
The original plan for development of this project proposed 116,137 square feet of wetland impacts in order to accommodate five commercial buildings with associated parking and utilities.



- The bulk of development would occur on wetlands, leaving them fragmented and damaged.
- The road providing access to the development goes through a small wetland.
- Lack of long-term sediment and erosion controls leaves the vernal pools more vulnerable to pollution and turbidity due to run off from impervious surfaces.
- There are no efforts to mitigate major impacts.

Example 4.3b: Commercial Lot Development – Revised Plan

The final plan reduces impacts to 98,767 square feet in order to accommodate one commercial building with associated parking and utilities.



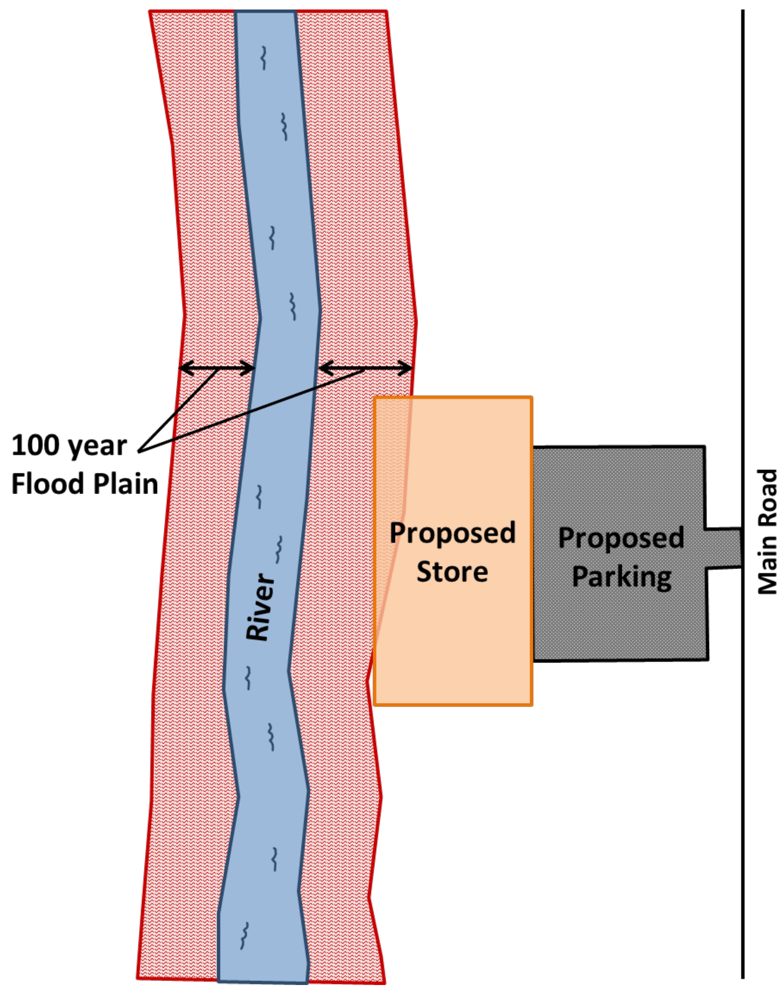
How wetland impacts were minimized:

- √ Sediment and erosion controls were installed reducing pollution and sedimentation in the vernal pools.
- √ A gravel wetland was proposed as a mitigation effort.
- √ Location of building and parking reduces impacts to the wetlands.
- √ The road was moved so that it avoided wetlands completely.
- √ Traffic and pollution was greatly reduced by doing away with the housing community and four of the five commercial buildings.

Example 4.4a: Store and Parking Lot – Original Plan

The original proposal for this project locates the store in the 100-year floodplain.

- The placement of the store in the flood-plain increases impervious surfaces in the flood plain.
- The construction in floodplains will cause displacement of floodwaters offsite.
- The floodplain impacts will reduce flood storage.
- The proposed construction will decrease the amount of water-absorbing/retaining vegetation.
- This impact will cause stormwater runoff to go directly into the river from the park-ing lot and building, carrying pollutants and sediment.
- The proposal will cause an increased risk of property and store damage caused by flooding.

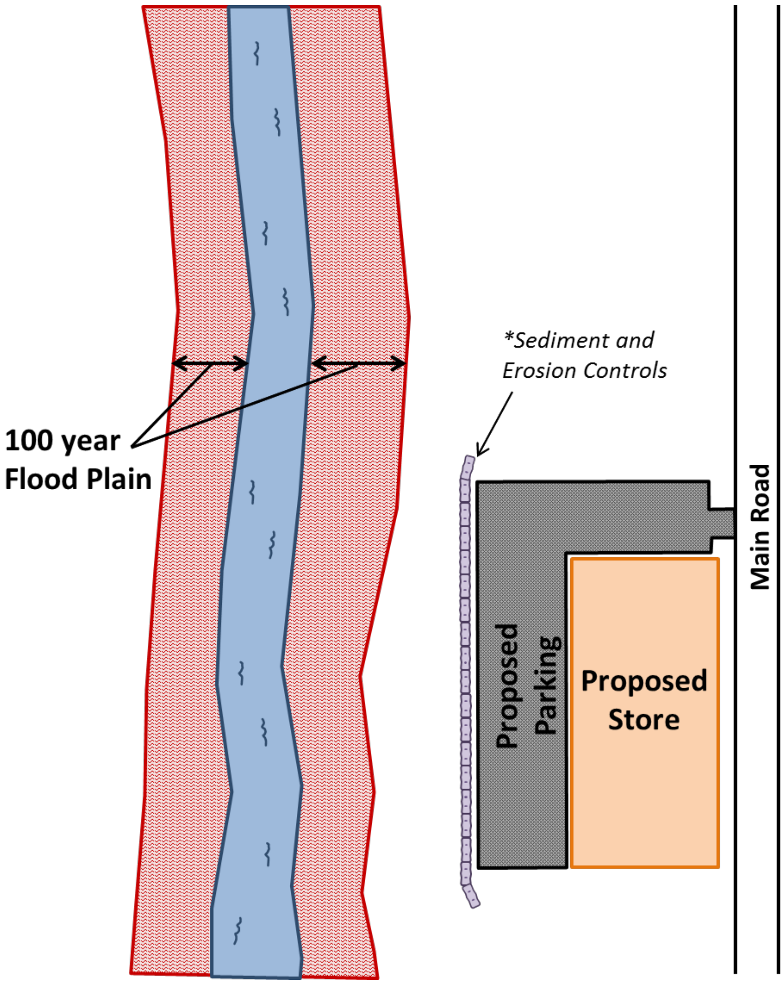


Example 4.4b: Store and Parking Lot – Revised Plan

The revised plan moves the store and parking lot completely out of the flood plain. This redesign will minimize impacts to flood storage wetlands, reducing potential for flood damage, flood displacement, and minimizing risk and damage to offsite properties.

How wetland impacts were minimized:

- √ The parking lot is now located behind the store, maximizing the distance from the river and flood plain, and reducing the risk of water damage.
- √ Sediment and erosion controls are installed on the side of the parking lot facing the river.
- √ The floodplain remains uninhibited and retains functionality.



Merrimack River and the City of Manchester, NH – credit: Jen Drociak

Chapter 5 – Bike Paths, Footpaths, Trails and Boardwalks

Bike paths, footpaths, trails and boardwalks are excellent means of showcasing wetlands and the natural environment, particularly for people who may not otherwise enjoy natural areas. It is NHDES' responsibility to protect wetland areas from unnecessary and undesirable impacts and intrusions into wildlife habitat. Good planning and design simultaneously protect wetlands and provide opportunities for recreational use of the environment. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Planning and Site Selection

Bike paths are unique in that they require long, undivided stretches of land. These are most commonly in the form of former railroad beds or utility easements. It is not a surprise that these stretches of land may include many wetlands and may even follow a larger river or stream. Other smaller trails and paths may specifically be proposed to enhance an area that is set aside for conservation or recreation, which is also likely to have wetland habitat. For all projects, in order to protect wetlands, and their functions and values, it's important for the planner to do the following:

- Research and evaluate the area to decide if the trail will be able to accommodate all projected users without degrading the natural resources. Not all wetland areas can support all types of paths while maintaining wildlife values. If this can't be accomplished, it may be necessary to downsize the project or look for an alternative route for the path or trail. Be sure to take safety standards into consideration when choosing a site.
- Create a design that works with the natural environment. Look for existing disturbed corridors and popular routes, and research the area to find out what types of wildlife are the most sensitive and will need the most protection.
- Avoid areas with steep slopes and rough terrain, as they will be more expensive to convert to a suitable surface and to maintain. If these areas cannot be avoided, it may be necessary to limit the scope of the project or the possible uses of the path. Fewer grade changes will help limit wetland impacts.
- Evaluate the site for engineering constraints such as poor drainage and the presence of floodplains. If floodplains cannot be avoided, strive to balance cuts and fills within the project limits.

Design

Good trail design is critical to help prevent unnecessary and detrimental impacts to wetlands, whether the trail is constructed on a previously disturbed railroad bed or on an undisturbed natural area. The following are general tips to avoid wetlands and minimize impacts:

Grading

- Utilize natural land contours to avoid excessive fill.
- Design retaining walls in areas of steep or irregular topography to minimize the amount of cut and fill needed alongside a path.
- Utilize best management practices for handling stormwater runoff on steeper grades and trail sides to minimize erosion, sedimentation and potential damage to the trail.

Maintaining Habitat Values

- Preserve the natural character of the area, while making it available for recreational use.
- Skirt sensitive wetland areas and provide for views from the periphery instead of bisecting wetlands.
- Preserve natural vegetative transition zones within and around wetlands.
- Use lookouts and overlooks to enjoy wetlands instead of crossing sensitive areas.
- Be sensitive to the wildlife that uses the area.
- Propose limited access to sensitive areas for bird-watching, nature study and non-motorized boating.
- Build outside of areas used by sensitive species and critical wetland areas, such as special aquatic sites.
- Avoid disturbing all rare plants and wildlife.

Human recreational activity in an area may directly impact wildlife and reduce the quality of the habitat provided. Human activities can disturb sensitive habitats, like wetlands, and disturb or displace wildlife. Flushing wildlife raises animals' stress level and increases energy consumption. If repeated frequently, such disturbance can impact reproduction and survivorship. Please see the following fact sheet for more information on Habitat-Sensitive Site Design and Development Practices to Minimize the Impact of Development on Wildlife.

Wetland Crossings (see Chapter 7 for more detail)

- Utilize existing structures and pathways, wherever possible.
- If crossing a sensitive habitat or creating a new trail, keep the crossing as narrow as possible.
- Timber bridges and elevated boardwalks are good options.
- Utilize wildlife passage structures.
- Elevate boardwalks, observation decks and bridges to minimize disturbance to wetland vegetation, as well as to protect wetlands underneath.
- Boardwalks must meet the design criteria in Env-Wt 517.

- Allow spacing between slats in boardwalks to allow light penetration underneath.
- Designs shall incorporate Americans with Disabilities Act (ADA) requirements whenever feasible.

View Platforms, Corridors and Recreational Access Areas

- Utilize existing disturbed or thinned areas for rest areas, or for canoeing or fishing access.
- Design viewing platforms and recreational access areas to prevent future destabilization, erosion and sedimentation to the adjacent wetland.
- If necessary, thin trees and shrubs sparingly for a view of the wetland area.
- Keep recreational corridors narrow.
- Create a minimum number of well-chosen vistas and access points.

Path Dimensions

- Paved multi-use paths in the vicinity of wetlands should not be any wider than 10 feet with two to four feet of clearance on either side for safety and work zone, unless specific circumstances dictate otherwise.
- Footpaths in the vicinity of a wetland should not be wider than 3-5 feet.
- Height clearance is recommended at seven feet for pedestrian/bicycling and 10 feet for horseback riding.
- Selective thinning of trees and shrubs may be necessary adjacent to the primary path in order to provide the necessary height clearance for multiple path users.
- Consider installing retaining walls to reduce disturbance and side slope fill.
- Utilize slope alternatives that avoid filling, yet prevent erosion and sedimentation into wetlands.

Signage

- Place informational signs at the entrance to sensitive habitat areas.

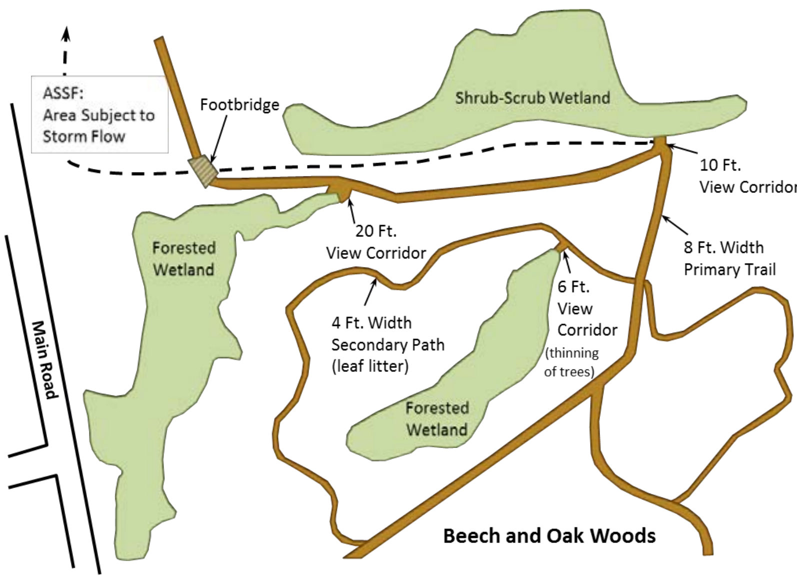
Pervious Surfaces

- Examples include: crushed shells, bark mulch, wood chips or geotextile grates backfilled with stone. These alternative surfaces are more natural and encourage stormwater infiltration.
- Many alternative surfaces are safe and sturdy enough for bikes and wheelchairs.

Plantings

- Plantings should screen sensitive wetland areas from human disturbance: one to three rows of evergreen shrubs and/or trees (six-foot minimum height) work well.
- Use vegetation, such as native, non-invasive thorny plants or a dense evergreen screen to discourage entry to sensitive areas.
- Propose vegetation on both sides of the path to provide a transition zone between the wetland and developed areas.
- Propose planting schemes that are both aesthetic and attractive to wildlife, such as berry-producing trees and shrubs.
- Preserve and enhance existing tree cover and shrubs. Where possible, consider weaving paths around existing trees to help maintain canopy cover and to preserve large-diameter trees.
- Avoid using invasive species, such as Honeysuckle, and try to control existing non-native and invasive species, such as Oriental Bittersweet and Japanese Knotweed.

Example 5.1: Path Layout and Design



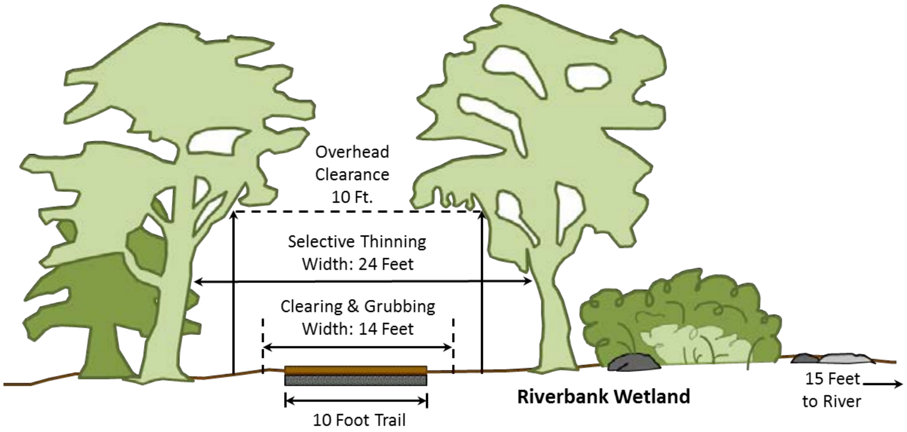
The following example is a portion of the forested conservation area with a proposed trail system. The trails will be used for walking and nature study. The design incorporates many avoidance and minimization measures, which are described below.

How wetland impacts were minimized:

- √ The trails avoid almost all of the wetland areas and are narrow so that less vegetation was cut.
- √ The primary trails were centered on old farm roads and previously-disturbed areas.
- √ The secondary trails were built by trimming woody vegetation, but no trees were removed.
- √ Trails are composed of soil, leaf litter or wood chips, depending on the existing ground conditions. All materials are permeable and allow natural stormwater infiltration.
- √ Materials used to construct the trail were sourced responsibly and do not contain fragments of non-native or invasive plant species.
- √ No grade changes were needed for path construction.
- √ Trails are maintained by mowing or hand removal of larger vegetation.
- √ The path crossed a wetland area subject to stormwater flowage but avoided more sensitive forested wetland areas.
- √ Instead of installing a simple culvert, the footbridge was built with timber decking, which required less fill material and caused less disturbance during construction.
- √ View corridors are not numerous and were kept narrow with proposed signage to explain the sensitive habitat.

Facing page image credit: NHDES staff

Example 5.2: Path Width and Vegetation



This cross-section illustrates the ideal placement of a multi-use path in a forested or floodplain wetland in a suburban or rural area.

In order for path users to fully appreciate the wetland area that is being protected, view corridors might be added at a few select points along the trail that would bring users closer to the edge of the wetland, with signage provided about the wetland and its importance.

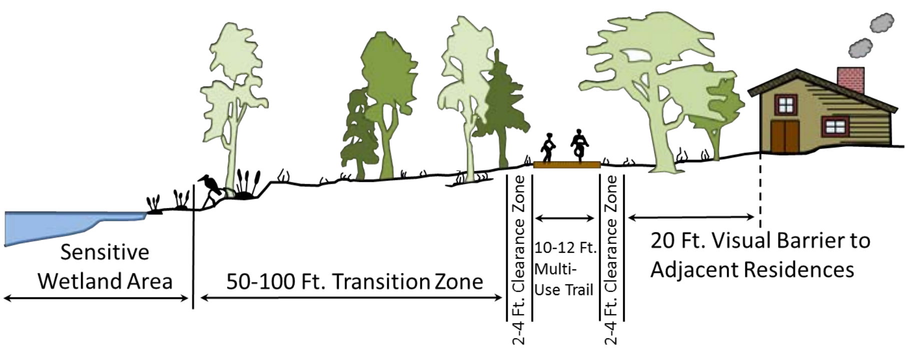
For an urban path, the cross-section would likely look very different with less vegetation and existing development on either side. It is still important to establish a vegetative transition zone on both sides of the trail to protect the wetland as much as possible and to help screen out the encroaching development.

How wetland impacts were minimized:

- √ The path is wide enough to support multiple uses, such as bikes and pedestrians.
- √ The river has a large vegetative transition zone to protect wildlife habitat and water quality values.
- √ The path and cleared areas are narrow to keep wildlife impacts to a minimum.
- √ Only minimal clearing was done to provide the necessary height for the multiple-use trail.

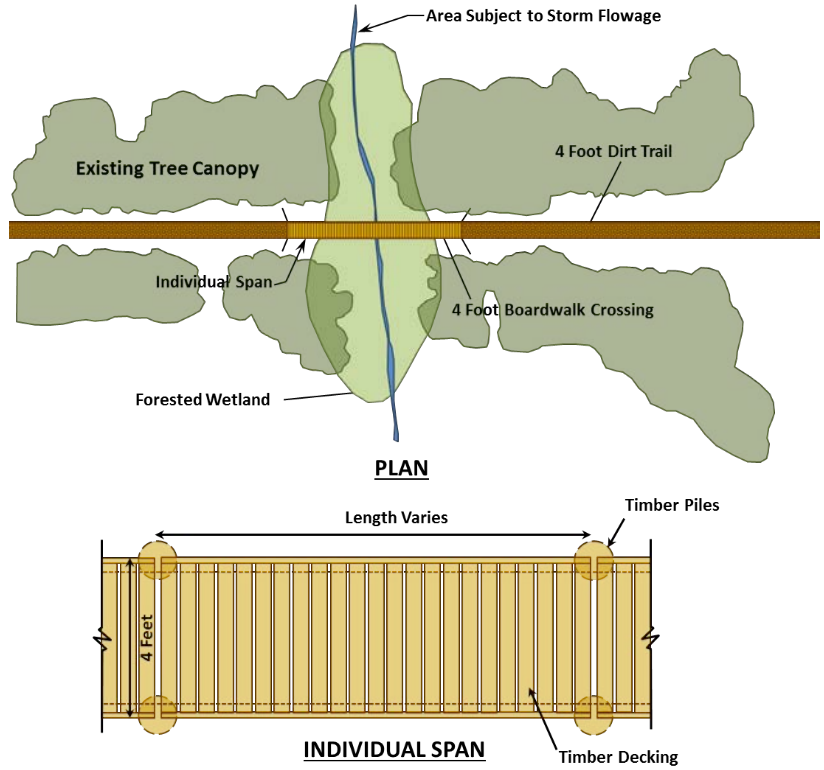
Example 5.3: Vegetative Clearing

This drawing illustrates the width of clearing for a trail. The dimensions listed here are sufficient for a multiple-use trail for bikers and pedestrians.



Example 5.4: Wetland Crossings

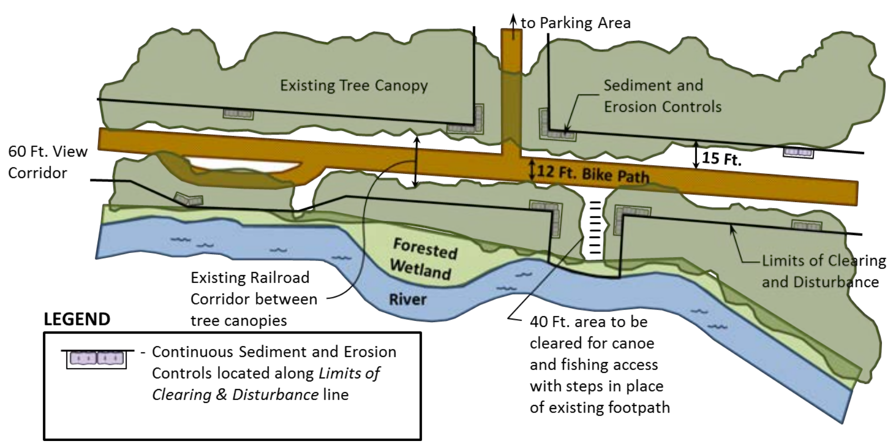
Wetland crossings are sometimes unavoidable in path and trail applications (please see Chapter 7 – Stream and Wetland Crossings for more details on crossings). Wooden bridges, platforms, boardwalks and small footbridges are often the best ways to cross wetland areas, if they must be crossed, or to provide viewing platforms at the edge of wetlands. The following example is a conservation area with existing dirt trails. The wetland needs to be spanned to allow passage through these seasonally-flooded areas. The trail is primarily used for wildlife viewing and environmental education.



How wetland impacts were minimized:

- √ The path and boardwalk crossing are very narrow, only four feet across.
- √ The existing tree canopy was maintained, and only a small amount of ground cover was cleared for the path.
- √ The boardwalk was placed on raised timber piles to maintain ground cover and to allow the passage of small mammals underneath.
- √ The slats are placed ½-inch apart to allow light to penetrate underneath, a requirement for tidal waters, bogs and other sensitive natural wetland systems.
- √ The boardwalk was built in sections, starting from one end, while working from above.

Example 5.5a: View Corridors and Access Areas – Original Plan

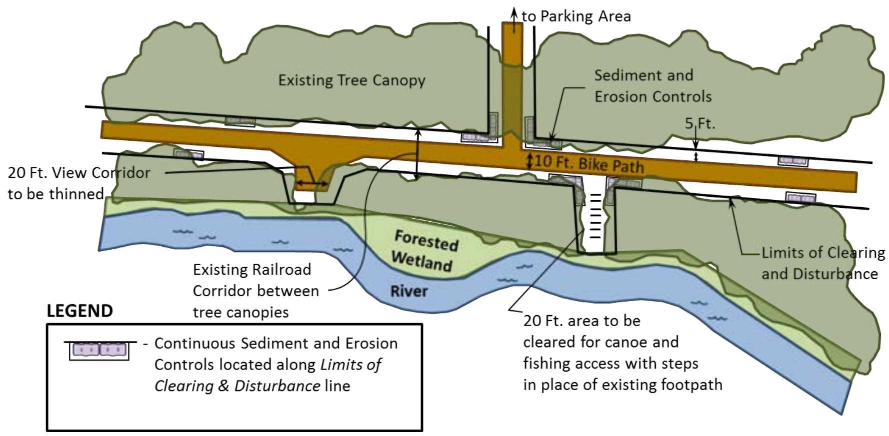


Viewing and recreational access areas are very popular features to incorporate along bike trails and foot paths. It's important to keep in mind that, while these features are acceptable, their placement, width and number should be carefully considered and designed. These corridors often encroach directly into regulated wetlands and may add to the disturbance and degradation of wildlife and wetland quality.

This example illustrates a section of bike path along an abandoned railroad bed. There is existing vegetation on either side of the railroad corridor, although some sections are sparse. A small footpath exists in the location where the canoe and fishing access is proposed to be widened to 40 feet. There is an additional 60-foot wide view corridor 140 feet away that overlooks the river. The 12-foot bike path was designed to cut though portions of the existing vegetation.

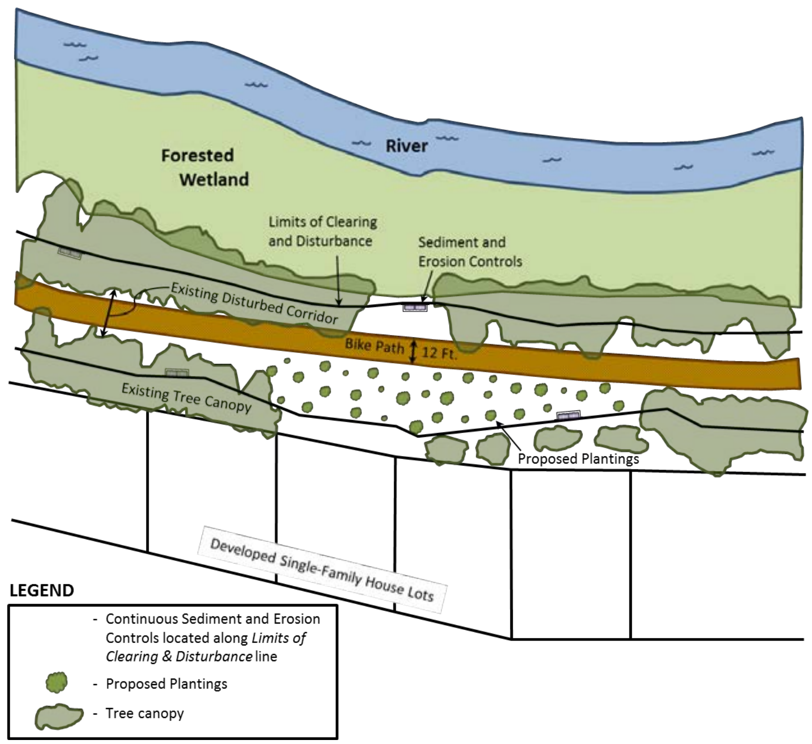
Example 5.5b: View Corridors and Access Areas – Revised Plan

How wetland impacts were minimized:



- √ The canoe and fishing access area was narrowed, as these activities do not require more than 20 feet.
- √ The view corridor was narrowed to 20 feet.
- √ The bike path was relocated and narrowed to 10 feet to maintain the vegetative buffer on either side.
- √ The LOD were narrowed on both sides of the parth to five feet.

Example 5.6a: Plantings – Original Plan



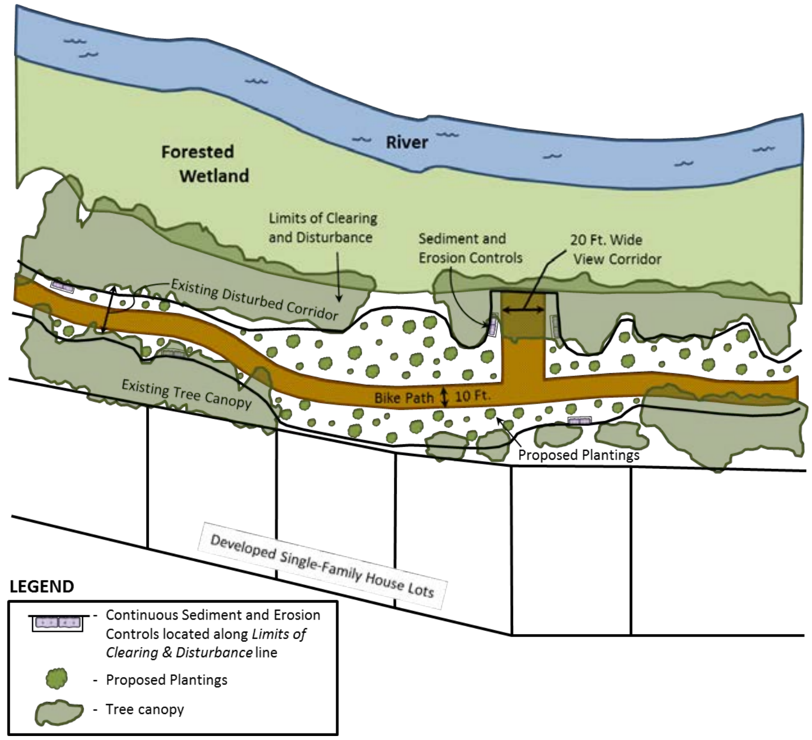
Plantings are an integral part of path and trail design, especially in urban and suburban areas, which may have less vegetation than in rural areas. It's important to remember that not only will trail users and nearby residents and businesses enjoy a path more if development is screened, but the wetland itself will attract more wildlife and may improve water quality if the vegetative planting is enhanced. This may mean it will be necessary to increase native plantings on both sides of the trail. The users' clear view to the wetland may be best achieved through properly located and designed view corridors.

This proposed design illustrates a 12-foot bike bath through an urban area on a previously-disturbed railroad bed and utility easement area. Due to development, much of the original vegetation had been removed from the edge of the wetland. Plantings were to be installed only on one side of the path where the tree canopy was thin.

Example 5.6b: Plantings – Revised Plan

How wetland impacts were minimized:

- √ Plantings were installed on both sides of the path, which was reduced to 10 feet wide.
- √ The plantings are especially thick where there was no tree canopy to provide wildlife habitat.
- √ The existing tree canopy was preserved by moving the path farther away from the river and wetland.
- √ A view corridor was added to allow users to see the wetlands without encroaching upon it. The corridor has sparse vegetation, which allows a clear view without severely diminishing habitat values.



- √ Provides sediment and erosion controls designed to keep eroded soil from entering into nearby wetland and river.

Construction

Due to the proximity of many paths and trails to wetlands, it is extremely important to use environmentally sound construction practices in order to protect the natural resources. The following are some tips of particular importance for trail construction (also see Chapter 10 – Construction and Maintenance).

- Properly install and maintain sediment and erosion controls.
- Limit construction activities within watercourses, vegetated wetlands, and flowing and standing water wetlands to within the low flow period of July – October.
- Restrict construction activities to outside the breeding season/migratory seasons of wildlife that will utilize the area.
- Preserve the existing tree canopy and use selective clearing to keep vegetation removal to a minimum.
- Replant disturbed soils and restore the area to its original topography and hydrology, utilizing wetland soils that were removed and stockpiled from the pre-existing condition.

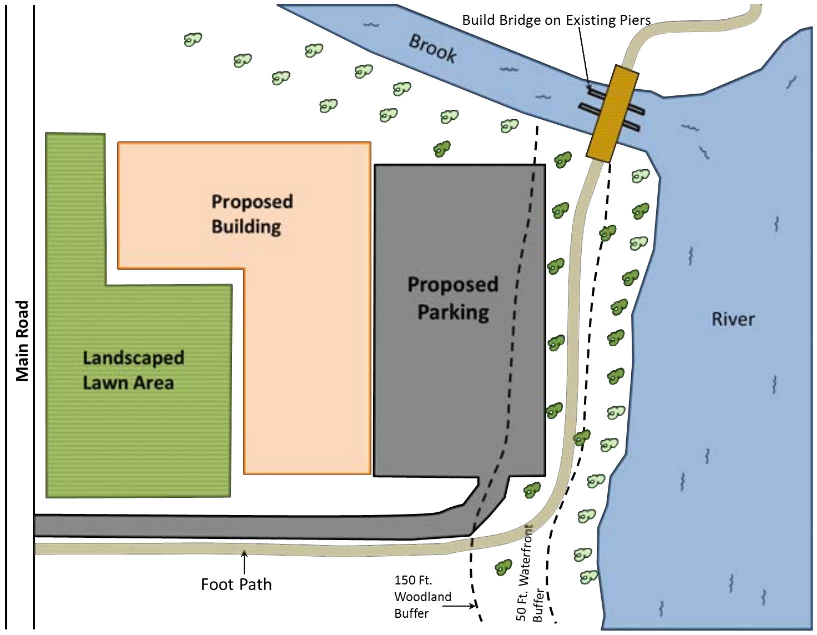
Maintenance

- Minimize or eliminate the use of pesticides, fertilizers and other chemical applications near wetlands.
- Recognize and respond to indicators of destabilization in areas that may receive heavier traffic. Early action can prevent exacerbated destabilization, erosion and sedimentation to adjacent wetlands or surface waters.
- Propose limited mowing, especially near wetland areas.
- Utilize native grass species, which will require little or no watering yet will provide adequate soil stabilization.
- Recognize and eradicate non-native and invasive species early and with best management practices to minimize their spread and colonization of the area.

Example 5.7a: Trail, Parking and Building Along a River – Original Plan

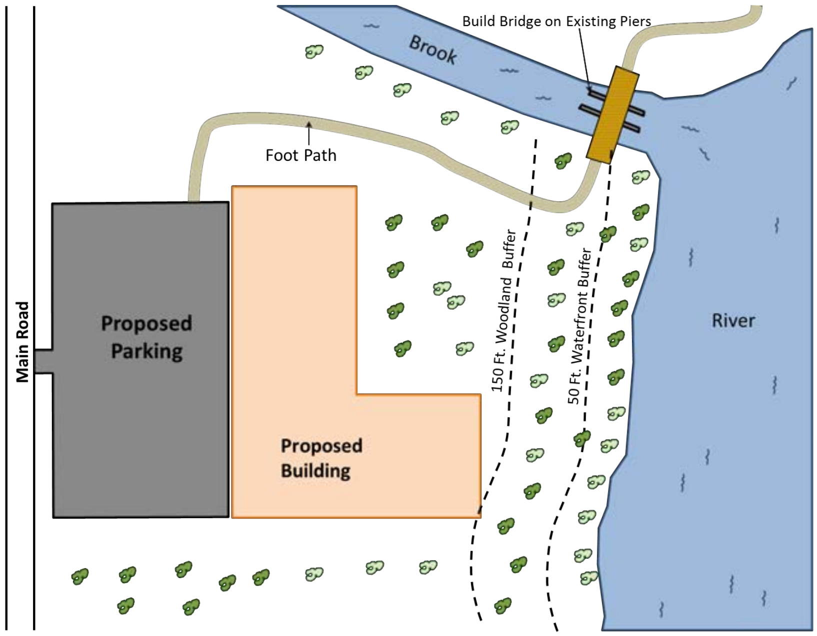
This proposal shows a building with associated parking and trail access along the river.

- The paved area and trail maximize allowable impacts in the woodland buffer, leaving 25% of vegetation. The woodland buffer shall be maintained in accordance with the Shoreland Water Quality Protection Act.
- The parking lot behind the building accumulates runoff from the building while reducing the amount of vegetation.



Example 5.7b: Trail, Parking and Building Along a River – Revised Plan

The revised plan relocates the building, paved area and trails in a way that leaves a much stronger woodland buffer and reduces runoff. For more information, see fact sheet on *Vegetation Management for Water Quality*.



How wetland impacts were minimized:

√ Proposed bridge remains on existing piers.

√ The building and paved area are located closer to the road, leaving the woodland buffer more intact.

√ The paved area in front of the building eliminates the need for a long driveway, reducing the amount of impermeable surfaces.

√ The new location of the foot path reduces impacts to the woodland buffer.

√ Vegetation left behind the building helps absorb run off and reduce sediment deposited into the river.

Chapter 6 – Golf Courses


Golf course on the Pemigewasset River, Ashland, NH – credit: Paige Relf

It is very difficult to plan, design and construct a golf course without affecting wetlands in some way. Courses encompass such large areas of land that they often include numerous wetland crossings and encroachments. It is NHDES' responsibility to ensure that applicants avoid wetland alterations and minimize impacts for every golf course design.

For information specific to environmentally responsible golf course planning and management, please review NHDES' *Making Your Golf Course Greener: A Handbook for Golf Course Managers* publication. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Site Selection and Planning

When choosing a site, it is important for the planner to consider whether there is sufficient buildable area for a course, whether there is access to adequate amounts of water, and whether the topography is appropriate. A site that includes large areas of wetland may not be a good choice if construction will result in many impacts to wetlands. Sometimes, a beautiful site may not be feasible due to wetland constraints or the finances needed to develop the golf course in an environmentally-sound way.

- Evaluate alternative sites before making a final selection.
- Attempt to locate the course on previously used or abandoned properties, such as landfills, sand and gravel operations, or farms.
- Evaluate if the proposed site will be able to supply the amount of water necessary for the course through the development of a water budget and a drought contingency plan that establishes alternate water sources.

Course Design

Once a site is chosen, the course designer must give careful consideration to all wetland areas. Protecting these areas can and should be considered together with course playability and aesthetics.

- Design fairways, tees, greens and golf cart paths to avoid wetlands and filling of floodplains.
- Be sure to consider alternative sizes if upland space is limited. Consider a 9-hole course instead of an 18-hole course.
- Protect existing wetlands, and improve or restore previously degraded areas if possible.
- Create and maintain vegetation transition zones around wetlands to protect their functions and values.

- Maintain interconnected, naturally-vegetated wildlife corridors and passages in the golf course design.
- Design signs and barriers to keep golfers out of sensitive areas. Designate sensitive wetland areas as "no play" zones.
- For unavoidable wetland crossings, design bridges that can be installed as a complete unit from overhead or can be built one section at a time to limit work in wetlands.
- Incorporate pervious surfaces for roads and paths, which will help infiltrate surface water.
- Utilize geographically-native and drought-resistant grasses for the turf. These types of grasses benefit wetland wildlife habitat by requiring less water and less pesticide and fertilizer application, which maintain good wetland water quality. See the *Draft NHDES Manual for Turfgrass Maintenance*.
- Design a course that will naturally "hold" water, maintain wetland hydrology and require minimal topographic changes.
- Ensure that irrigation, drainage and retention systems encourage efficient use of water and protect wetland water quality.
- Develop a stormwater management and pollution prevention plan that takes into consideration runoff, infiltration rates, topography, pollutants and long-term maintenance. Follow design and maintenance criteria in the *New Hampshire Stormwater Manual, Volume 1: Stormwater and Antidegredation*, and *New Hampshire Stormwater Manual, Volume 2: Post-Construction Best Management Practices Selection & Design (2008)*.

Wetland Flyovers

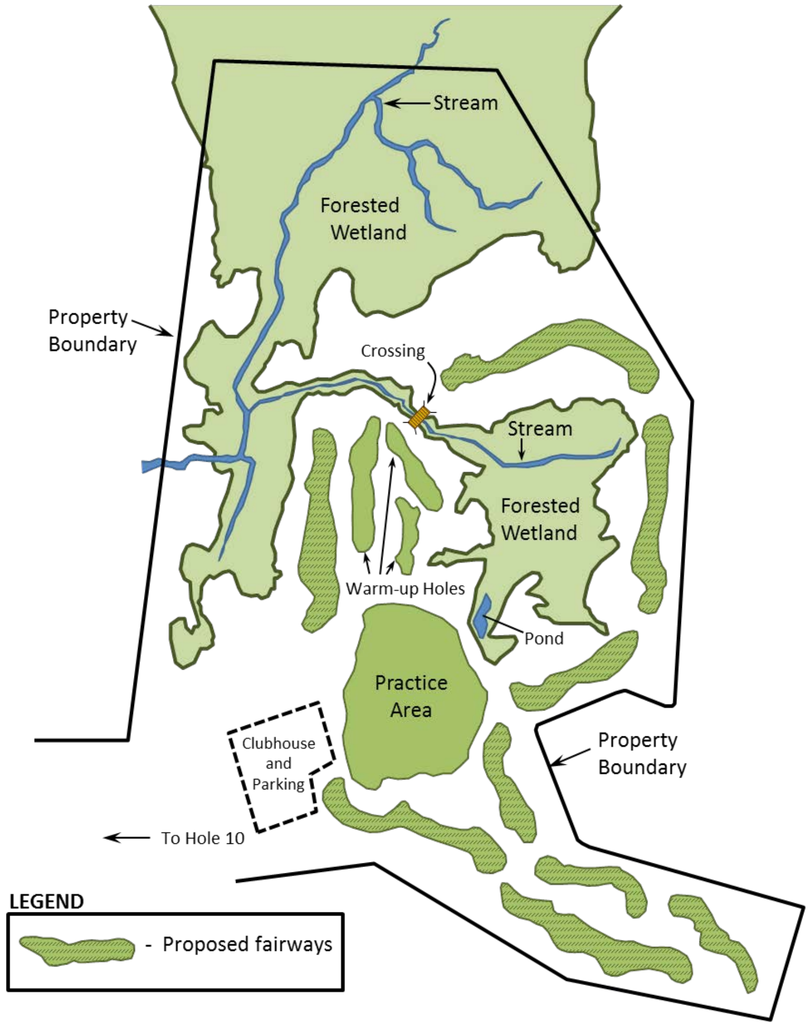
"Flyovers" of wetlands within fairways, especially wetlands dominated by woody vegetation, should be avoided. Wetland flyovers commonly require that wetland trees and shrubs be cut to approximately four to eight feet in height. The tree topping and cutting severely alters the wetland wildlife habitat and may also change the wetland's hydrology. In addition, flyovers necessitate ongoing maintenance and repetitive encroachment into the altered wetland in order to maintain the desired tree height. It is easier, less environmentally damaging, and may be less costly to simply avoid fairway alignments that require flyovers of wetlands.

Example 6.1: Avoiding a Large Wetland Complex

This example is an aerial view of one-half of an existing golf course. The challenge with upgrading this site was to avoid the large forested wetland.

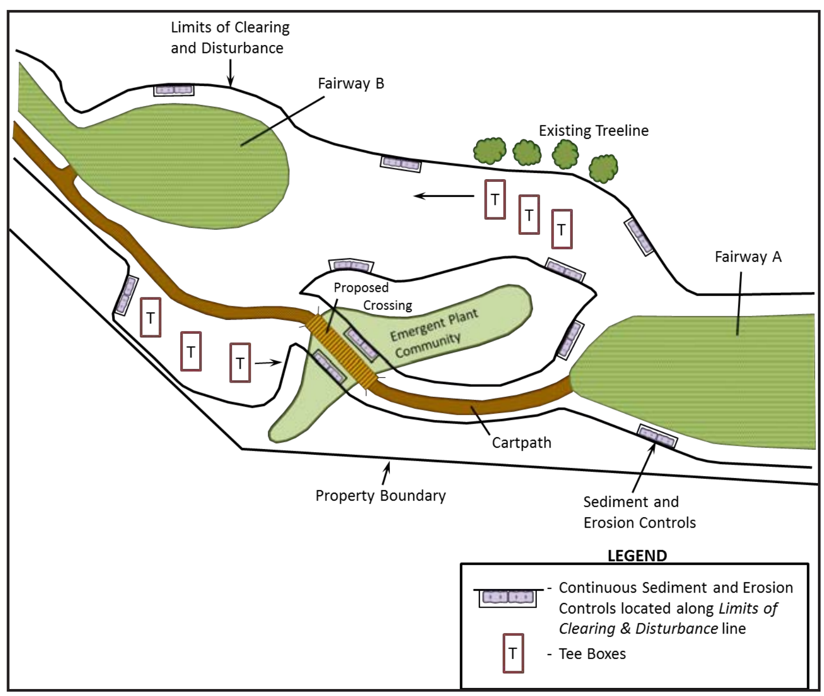
How wetland impacts were minimized:

- √ The fairways were located outside the wetlands near the edges of the property.
- √ A wetland corridor was maintained within the interior of the property, thus preserving wildlife habitat.
- √ A crossing was located at a narrow spot while spanning the entire stream and forested wetland to minimize disturbance of another wetland corridor.
- √ Whenever possible, additional vegetated corridors beyond the riverine wetlands were maintained around the wetland areas.



Example 6.2a: Emergent Plant Community Crossing – Original Plan

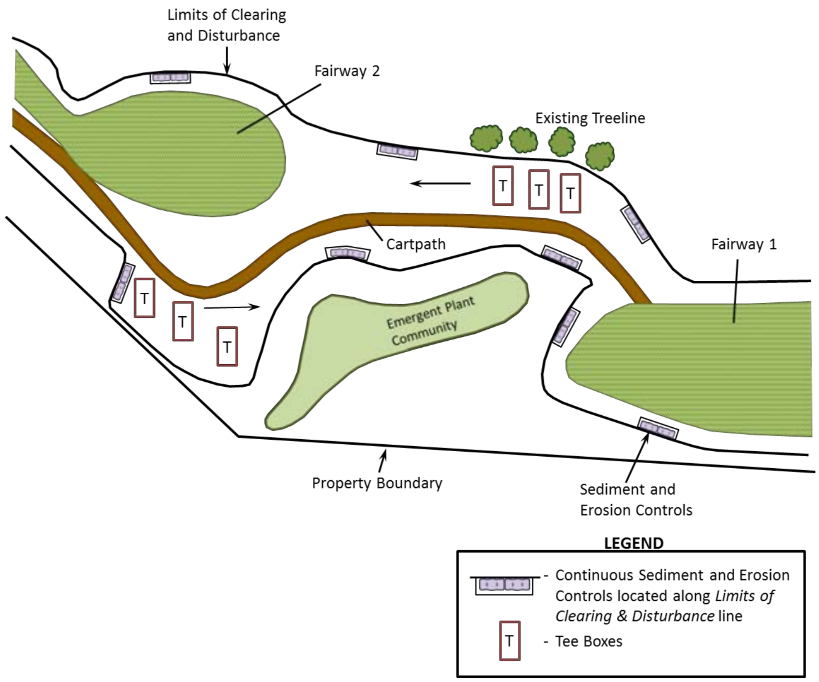
This example illustrates a golf course section that encroaches on an emergent plant community. This particular course is proposed to be built on old farmland. The plant community illustrated only has low ground vegetation, without any large trees that would need to be trimmed for flyovers. This original design bisects the emergent plant community with a crossing for a cart path from Fairway A to Fairway B.



Example 6.2b: Emergent Plant Community Crossing – Revised Plan

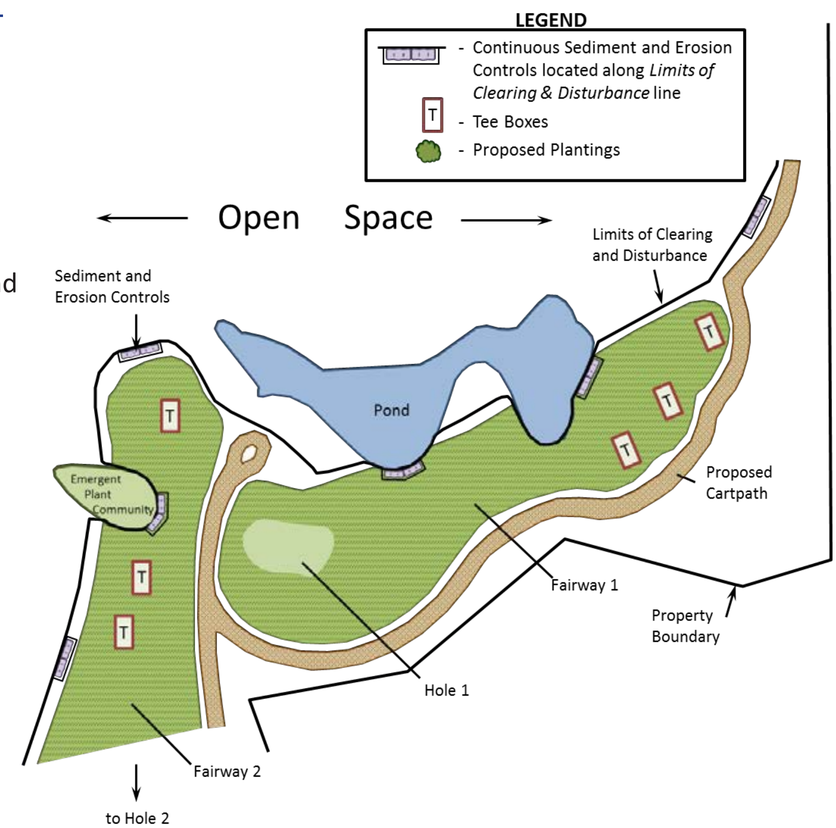
How wetland impacts were minimized:

- √ The cart path was moved around the wetland thus avoiding the emergent plant community and eliminating the crossing.
- √ Narrow but reasonable LOD were maintained.
- √ The existing tree line was maintained where possible.



Example 6.3a: Multiple Wetlands – Original Plan

In this example, it was much more difficult to design a course that avoided impacting wetlands. In the middle of this property lies a series of wetlands – a pond and an emergent plant community. This original design for Fairways 1 and 2 greatly impacts these wetland areas.

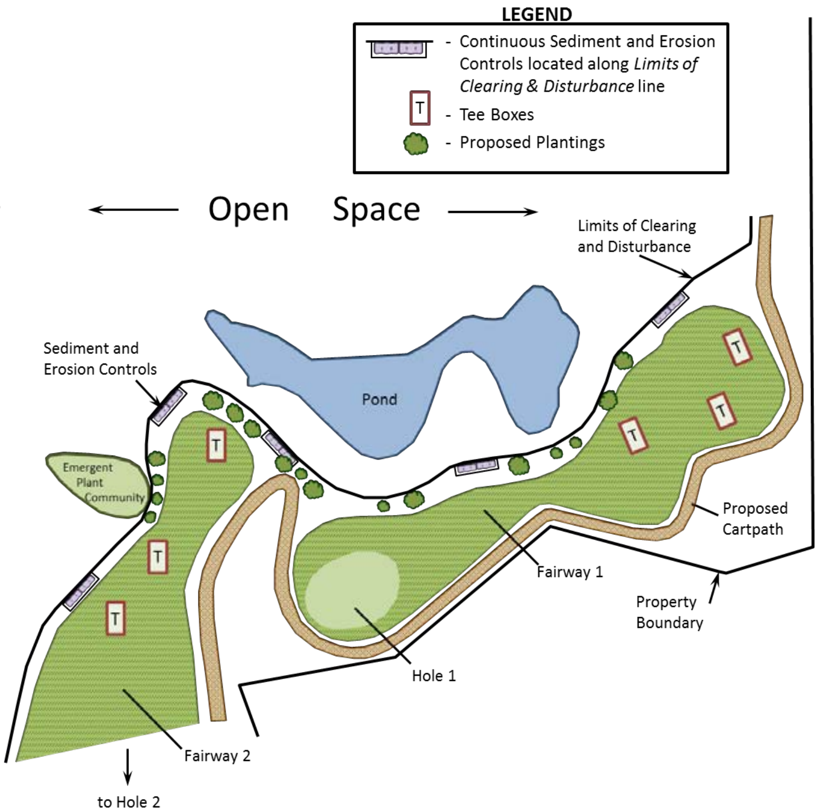


Cattails are an example of emergent plants.

Example 6.3b: Multiple Wetlands – Revised Plan

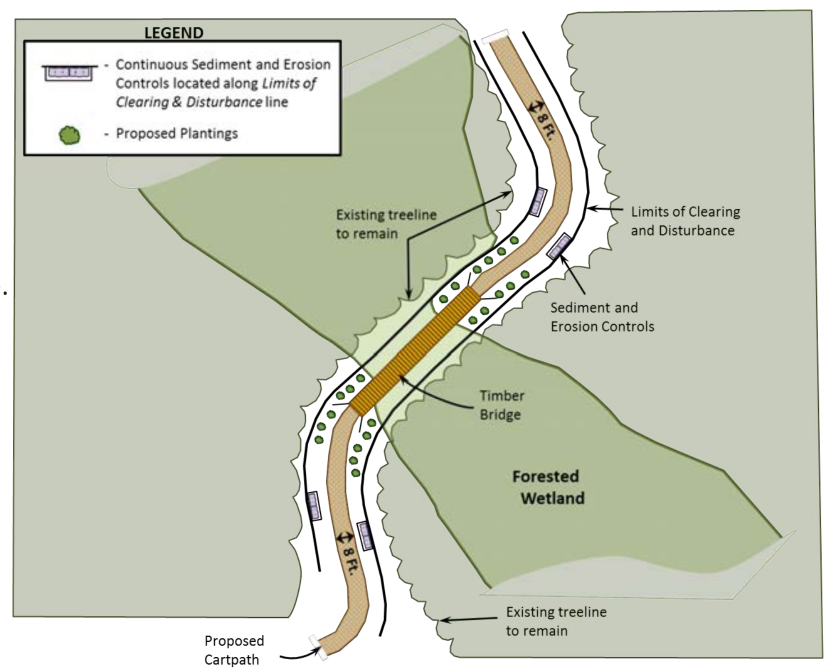
How wetland impacts were minimized:

- √ Fairway 2 and its tee boxes were moved to avoid the emergent plant community.
- √ Fairway 1 and its tee boxes were adjusted to avoid bisecting corners of the pond and to preserve the wetland.
- √ Narrow but reasonable LOD were maintained.
- √ Open space for wildlife habitat corridors was maintained adjacent to the pond.
- √ The existing vegetation was maintained, and plantings were installed, as appropriate, along the LOD line within and adjacent to wetland areas to minimize impacts from loss of wildlife habitat and to reduce the effects of disturbance to wildlife.



Example 6.4: Crossings

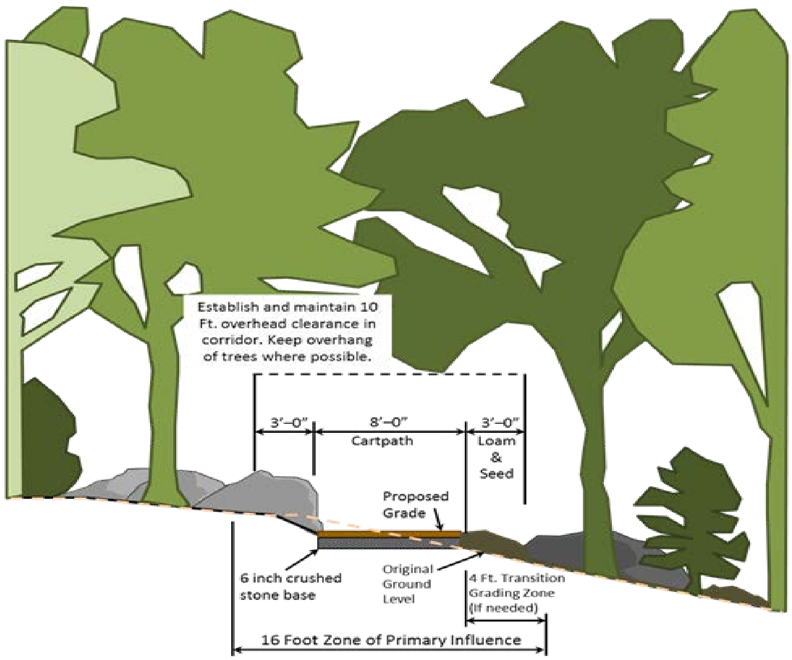
Roads and cart path crossings are common elements proposed in golf course applications. The designer should first try to avoid any crossings. If crossings are unavoidable, their impacts should be minimized. In this particular golf course, a cart path crossing was proposed to access upland for another part of the course. The path and crossing were laid out within a previously-cleared area, which minimized further wetland encroachment and preserved the wetland corridor.



How wetland impacts were minimized:

- √ The cart path and LOD are narrow and utilize an previously-disturbed area to maintain habitat.
- √ The bridge crosses the forested wetland at its narrowest point and spans a small portion of the surrounding upland on either side to allow a clear passage for water and wildlife.
- √ The timber bridge structure was installed in sections which limited impacts to the forested wetland.
- √ Proposed plantings were installed along the LOD line, within and adjacent to wetland areas to minimize impacts from loss of wildlife habitat and reduce the effects of disturbance to wildlife.

Example 6.5: Cart Paths

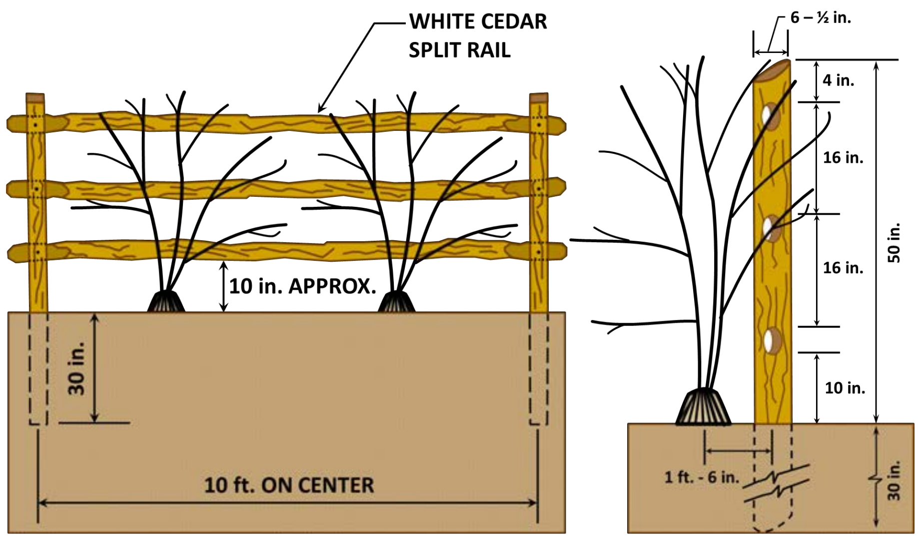


Quite often cart paths are proposed in or near wetlands, including floodplain and riverine wetlands. It is always best to try to avoid these areas; however, if it is not possible, then impacts should be minimized. Cart paths should be installed as close to existing grades as possible. This will prevent future erosion and sedimentation impacts to nearby wetlands. The following example illustrates a conscientious design.

How wetland impacts were minimized:

- √ Only a minimum width of forest was disturbed, including a narrow path and area of influence.
- √ The overhead tree canopy was preserved.
- √ The surface of the proposed path was covered with crushed stone, shells, or other porous material such as wood chips and leaf litter that helps recharge groundwater and prevent the incorporation of pollutants into surface runoff.
- √ Minimum grading was required.

Example 6.6: Preserved Areas



Commonly, golf course designs include fairways and flyovers around sensitive wetland and wildlife areas. Golf balls are often shot over and around these areas, thus creating a need to keep people from trampling through preserved areas for lost golf balls. A rail fence, with native non-invasive rose plantings, is one way to keep people out of sensitive areas. In addition, signs are often posted that read: Conservation Area: Do Not Enter.

How wetland impacts were minimized:

- √ The fence is nearly four feet tall, thus making it very difficult for anyone to climb over to retrieve a ball and thus preventing regular foot or cart traffic through the wetland.
- √ Native rose bushes or other thorny shrubs are planted to further discourage entrance to the protected areas.

Construction

It is important on large projects, such as golf courses, for plans and conditions to be strictly followed. It is helpful to utilize design consultants who are experienced with golf course construction, as well.

- Install proper soil erosion and sediment controls prior to the initial phase of construction (phased or overall project).
- At a pre-construction meeting with all contractors and subcontractors, take note of sensitive wetland/habitat areas that must be avoided per NHDES-approved permit plans and conditions.
- Establish and stabilize material storage and staging areas prior to construction. Install and maintain proper soil erosion and sediment controls around such areas during the life of the project. Stockpile erosion controls for ready replacement of those that deteriorate.
- Phase any clearing that is necessary, instead of cutting and clearing all vegetation at the same time. This will help to control erosion and protect the wetland and wildlife.
- Keep heavy equipment use to a minimum, especially near wetlands or other sensitive areas to reduce soil compaction.
- Recycle any trees and stumps that are removed into mulch or woodchips to be used on site. Woodchips and mulch are not to be placed in a wetland.

Course Use and Maintenance

Water

A water budget, a drought and dry weather contingency plan that establishes alternate water sources, and a method for scaling back irrigation should be developed. A complete application package should include information on irrigation rates or other ways the water withdrawal may affect wetlands.

Depending on the rate and amount of water used for irrigation, it may be necessary to file a Water Use Registration Form through NHDES' Water Use Registration and Reporting Program. Please review NHDES' fact sheet regarding "Water Use Registration and Reporting in New Hampshire."

Pesticides and Fertilizers

NHDES is responsible for protecting wetland areas that could become degraded from runoff carrying pesticides or fertilizers. All pesticides used in New Hampshire must be registered with EPA and the New Hampshire Department of Agriculture's Division of Pesticide Control. Pesticides must be applied in accordance with label instructions and any state Pesticide Management Plan for that pesticide. All commercial and private pesticide applicators, as well as pesticide dealers, are required to be licensed or permitted through the New Hampshire Department of Agriculture's Division of Pesticide Control.

Chapter 7 – Stream and Wetland Crossings

Well-designed roadway crossings allow wildlife unrestricted access to the surrounding landscape, maintain natural conditions without becoming barriers to fish and other aquatic animals, and help protect roads and property from the damaging effects of floods. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1. If it is determined that a wetland cannot be avoided and must be crossed to access an upland area, it is essential to design an appropriate crossing that minimizes adverse effects.

If not properly designed and constructed, wetland crossings can fragment linear habitat corridors, disturb or block fish and wildlife passage, alter ecosystem processes and aquatic communities, flood roads and property, and compromise water quality. Problems are often encountered when crossings (or culverts) are undersized, perched or result in water depths that are too shallow. The following negative consequences commonly result from poor design, improper structure selection or careless construction:

- Water velocities increase in undersized crossings, thus degrading fish and wildlife habitat while also possibly weakening the integrity of a structure.
- High water velocities scour and erode natural substrates above and below the crossing, thus degrading habitat.
- Water can pond upstream of undersized culverts, which can cause changes to the existing habitat while also leading to property flooding, roadway damage and stream erosion.
- Undersized crossings may also become blocked with debris and be time consuming and costly to regularly maintain.
- Perching of a crossing (or culvert) outlet leaves the structure above the natural bottom and thereby acts as a barrier to aquatic organisms. See Stream Crossing Initiative guidance on Aquatic Orgamism Passage.
- Water depths that are too shallow for fish and wildlife movement may occur, especially during seasonal low flows.

Benson Park, Hudson, NH – credit: Fallon Reed

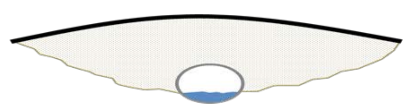
Best Practices for all Types of Crossings

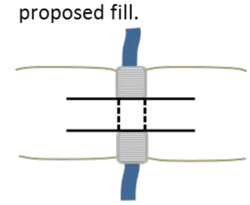
- Avoid crossing open bodies of water, rivers, streams or other wetlands, if possible.
- Where crossings are unavoidable, design them to traverse a narrow section of the wetland.
- Use or upgrade existing paths, cart paths, roads or already disturbed areas so as to avoid previously undisturbed locations.
- Design a crossing that keeps disturbance to a minimum and spans as much of the wetland and stream, or aquatic resource areas, as possible.
- Avoid disturbance to streambeds, wetland soils and other vegetation.
- Avoid fragmenting wetland wildlife habitat by building away from wildlife travel corridors.
- Avoid crossing through, or bisecting, a wetland wildlife breeding area.
- Consider using pre-cast bridges, especially for long spans, that allow installation to be completed with minimal contact with the wetland.
- Design and construct wildlife crossings that attempt to preserve existing light conditions and soil moisture levels.
- Maintain existing elevations, or consider installing retaining walls to reduce disturbance and side slope fill.
- Restore stream channels to natural conditions if disturbance of the channel is unavoidable.
- Avoid impounding water up-gradient of the crossing.
- Maintain existing side slope grades, as much as possible, to minimize fill and any wetland loss.
- Minimize the extent of fill needed on top of a crossing structure by limiting the increase of the road grade as it approaches the crossing point.

Crossing Structure Selection

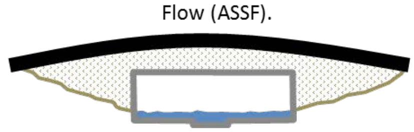
A number of different structures can be used to cross wetlands, including rivers and streams. Each project and wetland to be crossed is different, and a structure that may be appropriate in one situation may not be sufficient for another.

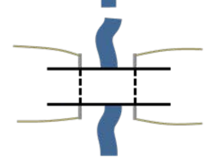
Plan view showing areas of proposed fill.



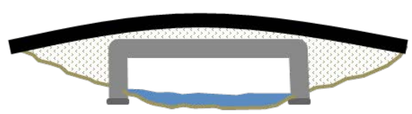


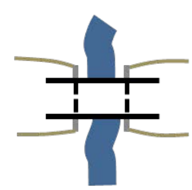
Piped Crossing with Fill
May be appropriate for an Area Subject to Storm Flow (ASSF).



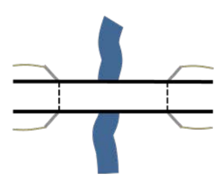


Boxed Culvert with Low Flow Channel
May be acceptable for fish passage.

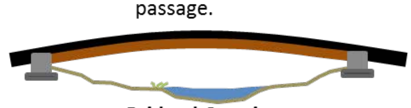


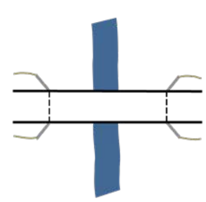


Open-bottom Box Culvert
May be appropriate to maintain a natural stream bed



Pre-cast Arch with Abutments
May be appropriate for a wildlife passage.



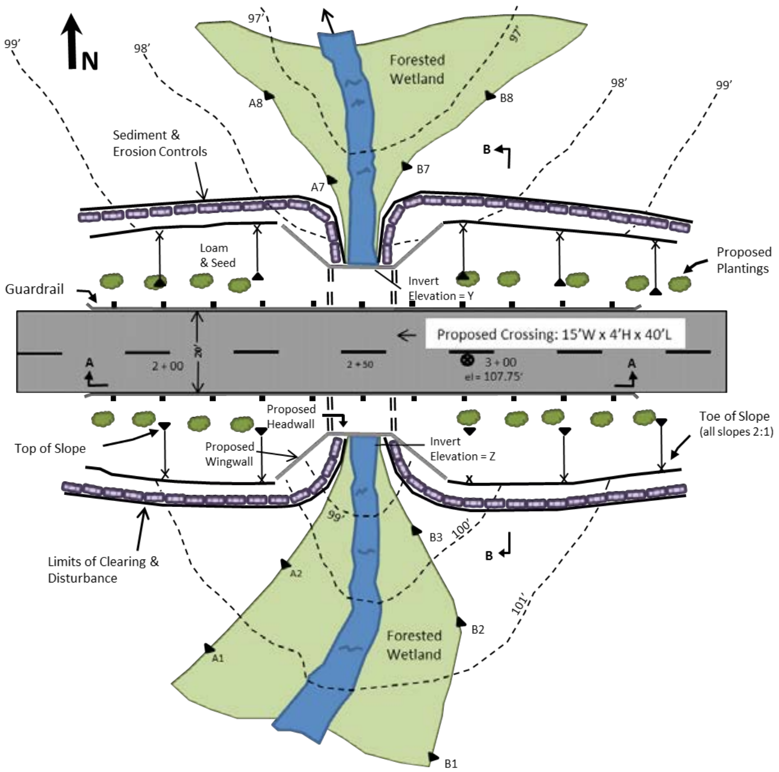


Bridged Crossing
May be appropriate to protect a riverbank wetland

Metal arch crossing – credit: NHDES Staff

Example 7.1: Detailed Labeling Required for Crossings

In addition to the labels required on a full site plan, all plan details included in a wetland application submittal must be completely labeled, as in the example below. Other views, such as a cross section or profile view, may need additional labels for elevations and dimensions.



Crossing Plan View
Scale 1" = X'

Crossing Labels

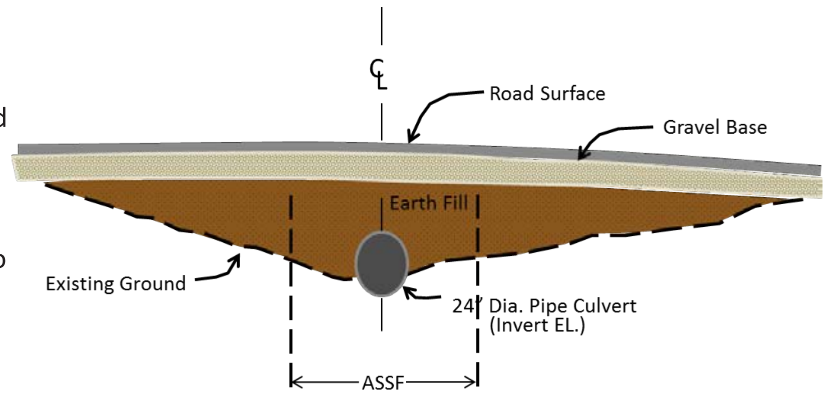
- Existing and proposed contours.
- Spot elevations.
- Floodplain information.
- Cross section locations.
- Surface course.
- Invert elevations.
- Structure dimensions.
- Toe of slope.
- Check dams.
- Riprap/scour protection.
- Loam, seed and plantings.
- Limits of clearing and disturbance (LOD).

Overtopping

Each of the following three examples, as well as the wildlife crossings, carries the potential for "overtopping" during severe rain periods. Consider the quantity of flow involved, such as in a 100-year storm event. If the profile of the road is gentle, creating a broad-crested weir will allow water to overtop the road in a defined area. This will minimize potential for washout of the road surface and may be less dangerous in a major flood event.

Example 7.2: Piped Culvert Crossing

Driveway construction that traverses a wetland is one of the most common types of proposed crossings. The proposed driveway in this example skirts the edge of a piece of property to cross a wetland in a narrow section, in order to reach a large upland area on the southern end of the property. A proposed pipe culvert channels the water from an Area Subject to Storm Flowage (ASSF) underneath the new driveway crossing. A culvert of this type is sufficient for this crossing because the area is not consistently wet.



SECTION THRU PIPE - AA

How wetland impacts were minimized:

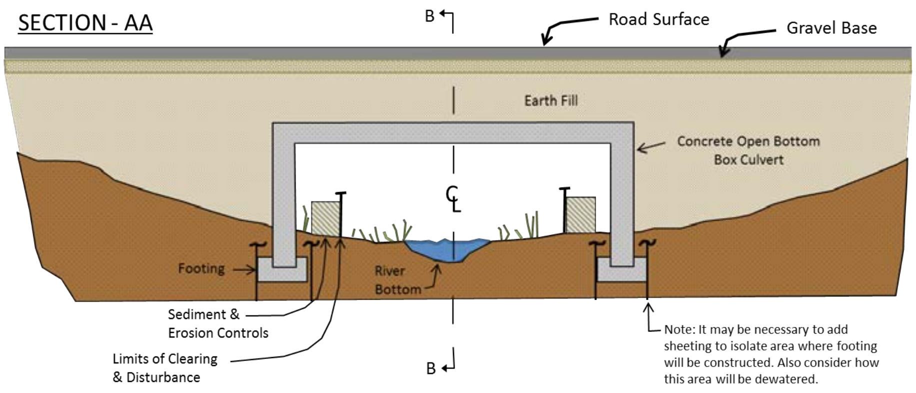
- √ The crossing traverses a narrow part of the ASSF.
- √ The driveway is fairly narrow, so that no more wetland is disturbed than necessary.
- √ The earth fill over the culvert is kept to a minimum and is sufficient to satisfy the structural capacity of the pipe.
- √ Transition plantings (not shown) on either side of the driveway help prevent sedimentation of the wetland and erosion of the slope.
- √ Narrow LOD are maintained.

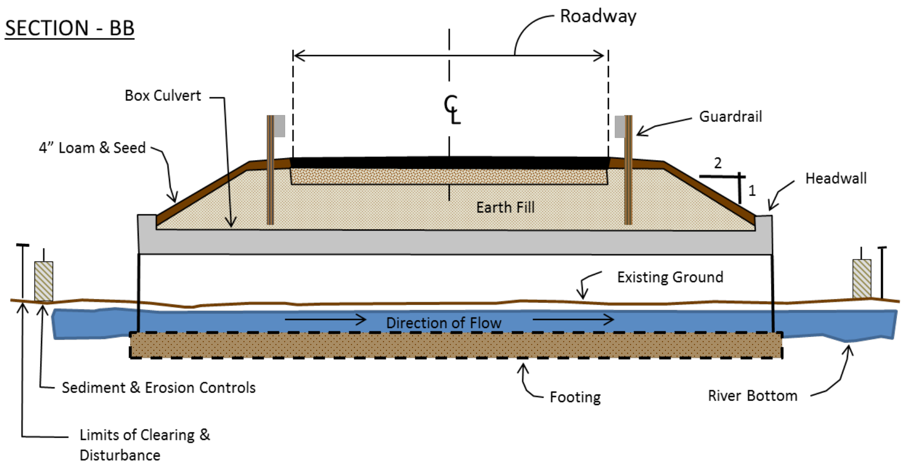
Perched culvert crossing under Ten Rd., Rochester, NH – credit: NHGS

Perched culvert crossing under Sampson Rd., Rochester, NH – credit: NHGS

Example 7.3: Open-Bottom Box Culvert Crossing

A subdivision roadway is a common type of wetland crossing project. The roadway in this example skirts several properties to reach the upland north of the river and forested wetland, thus placing the new subdivision more than 200 feet from the wetland area to be crossed. This example illustrates an open-bottom box culvert used to cross the river and forested wetland. While acceptable, the best type of crossing design would span a greater portion of upland on either side of the river and forested wetland and require less fill. A different type of structure might be necessary to accomplish such a design.





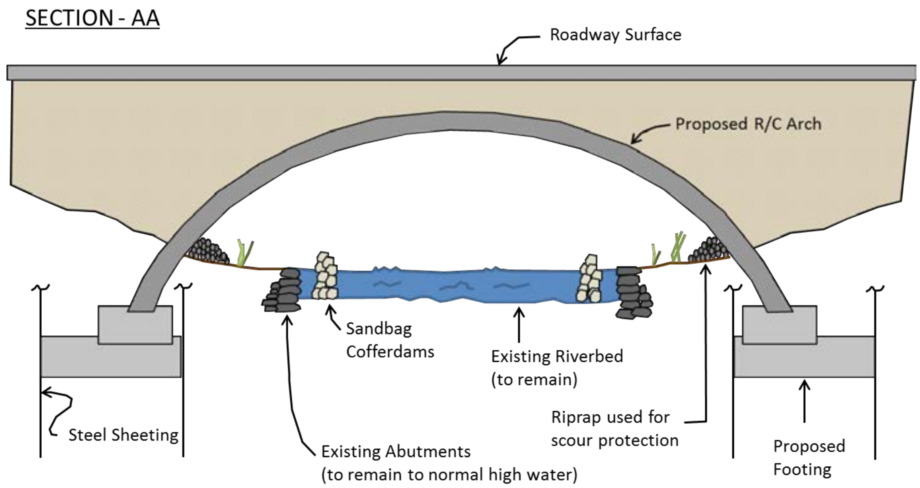
How wetland impacts were minimized:

- √ The open-bottom culvert allows the stream to flow freely in the natural streambed.
- √ Natural vegetation is retained along the river bank. Narrow LOD were maintained.
- √ Sediment and erosion controls were used to enclose and isolate the construction zone to prevent sediment from flowing downstream.
- √ Upon completion of the project, the river bank was restored to its previous condition.

Open-bottom box culvert at McQuesten Brook and Eastman Ave., Bedford, NH – credit: Melinda Bubier

Example 7.4: Concrete Arch Crossing

This example depicts a road upgrade that accommodates increased travel and increased wetland protection through a wider span of the wetland. The existing bridge was removed and replaced with a reinforced concrete arch.

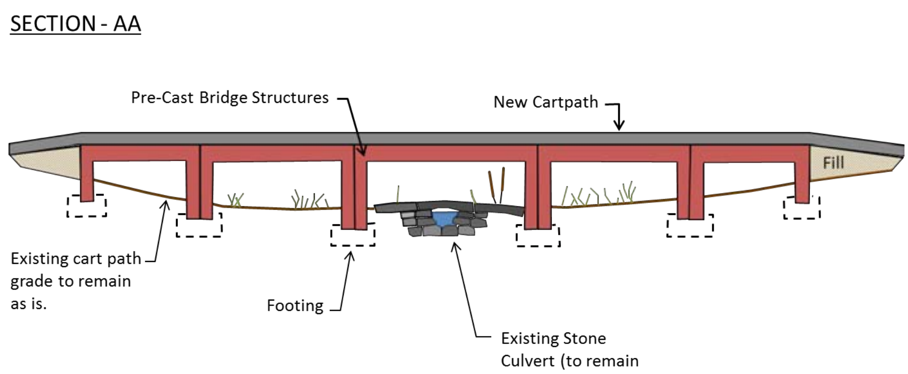


How wetland impacts were minimized:

- √ The new bridge spans the entire river and a portion of the riverbank will be restored, allowing for the free flow of water and restoring passage for wildlife.
- √ The LOD on either side of the road are narrow.
- √ The arch was pre-cast and then installed from overhead, thus minimizing contact and disturbance to the wetland during installation.
- √ Retaining walls on either side of the road limit fill.
- √ The temporary sandbag cofferdams helped to contain sediment during construction.

Example 7.5: Multi-Span Bridge Crossing

This driveway crossing was elevated above the existing grade of an old cart path that led to a small upland area near the rear of the property. By utilizing the existing crossing, the applicant avoided almost all other wetland impacts on a large piece of property. While not always typical for driveway crossings, this example does a great job of spanning the wetland.



How wetland impacts were minimized:

- √ The driveway was built on an old cart path where the vegetation had been previously disturbed.
- √ The existing crossing culvert remained in place to reduce disturbance to the wetland and to maintain existing hydrological conditions.
- √ All of the river and forested wetland, and some of the river bank, were spanned.
- √ The pre-cast bridge structures were installed from overhead by crane, which limited the length of time the wetland area was disturbed.
- √ The roadway leading up to the bridge was constructed of gravel, a porous material, which promotes water infiltration, reduces runoff and provides groundwater recharge.
- √ The original tree canopy was maintained where possible, and there were a number of transition plantings added surrounding the disturbed area.
- √ LOD were confined to within the existing cart path corridor.

Construction Considerations

- Sequence and duration of project – Work within waterways should be limited to the low-flow period during the growing season and should be completed by October 1.
    - Schedule work to minimize stream sedimentation, flow interruption and disturbance of fish during sensitive seasons; carefully consider the time and duration of culvert or stream crossing installation or repair. In general, in-stream work to be scheduled so that it does not coincide with fish migrations, spawning and egg incubation periods. Consult with local fish or water resource biologists in order to plan for best times to avoid fish mating and migration activities in a particular stream.
    - Consult with NHFG fish survey records to learn of documented fisheries at your particular stream.
- Diversion of flow – In some crossing situations, river or stream flow may need to be diverted during construction. Plan ahead and include information on the plans about flow diversion to minimize impacts while considering the following issues:
    - Duration of the proposed construction.
    - Dewatering.
    - Quantity of flow.
    - Design of the diversion device.
- To ensure minimization of wetland impacts, it is important to plan ahead and include information about flow diversion in a wetland application package.
- Phasing of work – Include information in the application if a project will be constructed in phases and try to limit the amount of time wetlands will be impacted.
- Sediment and erosion controls for dewatering – all controls must be in place prior to beginning of work and must be maintained for the life of the project.

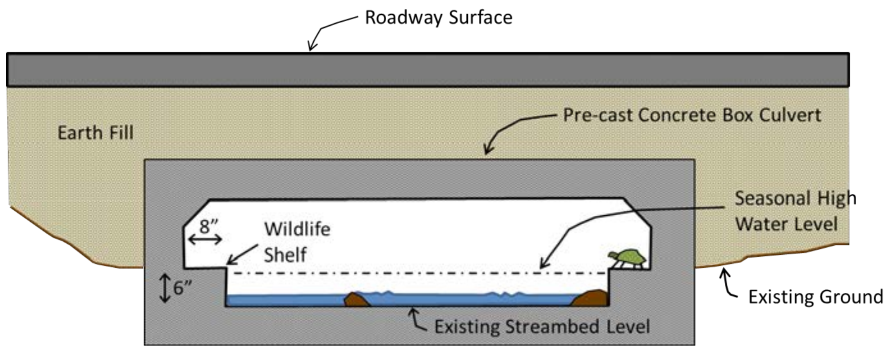
Blanding's turtle – credit: Michael Marchand

Wildlife Crossings

The following are two examples of wildlife crossing structures that could be used in conjunction with or alongside another wetland crossing. Wildlife crossing structures can be used when a wetland is being crossed or when any wildlife habitat is being bisected. It is important to first research what types of wildlife live in the area and what paths they travel. This information helps determine where to locate a wildlife crossing and what type of structure is most suitable. Studies show that if wildlife can see through to the other end of a crossing, they are more likely to use it. Please consider this when designing a wildlife crossing structure. It is also important to consider design elements, such as the volume of water during various storm events, that the wildlife crossing structure will need to accommodate.

Example 7.6: Modified Box Culvert Crossing

While a modified box culvert with a shelf may need to be special ordered, they are available or can be built. The designer may consider adding concrete or stone blocks inside a standard culvert to build wildlife passage shelves.



2' x 8' MODIFIED BOX CULVERT

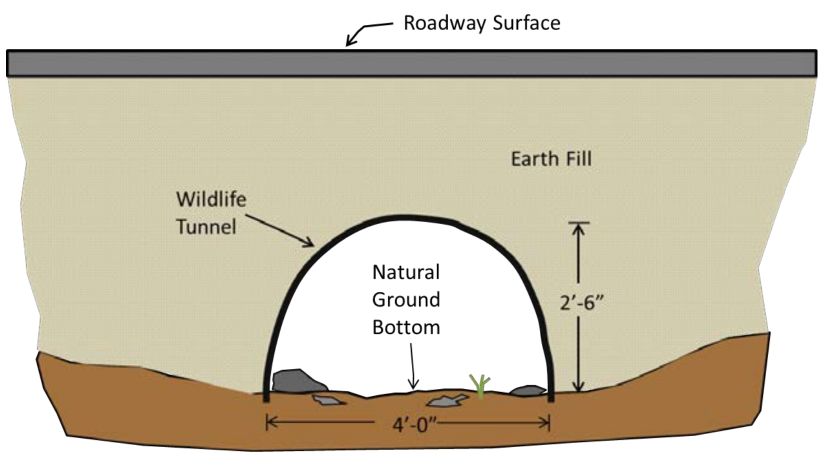
How wetland impacts were minimized:

- √ This structure allows movement of water.
- √ There is a shelf for small amphibians (frogs, salamanders, etc.) to use for travel inside the structure.
- √ The shelf is level with the final soil grade, which allows small mammals easy access and use.
- √ The shelf adds little cost to the overall project when incorporated from the beginning.

Example 7.7: Polyethylene Arch Crossing

How wetland impacts were minimized:

- √ The arch was built alongside a wetland driveway culvert.
- √ A natural ground bottom allows easy travel for small and medium-sized animals.
- √ A larger tunnel allows more light to filter inside, which creates a more natural environment.



4' x 2'- 6" ARCH

Chapter 8 – Streambank and Shoreline Stabilization

Root wad stabilization on Mascoma River, West Lebanon, NH – credit: Stefanie Giallongo

There are three primary strategies commonly utilized for bank stabilization projects: vegetative stabilization or bioengineering, stream flow diversion and hard-armor (i.e., riprap or retaining wall). Env-Wt 514 dictates specific criteria for shoreline projects, requiring that they be the least intrusive, but practical stabilization method. The resource and riparian functions of the stream system to be evaluated as part of this review.

Preference is given to bioengineered approaches including vegetative stabilization and diversion methods, as they most closely emulate natural riverine systems, provide a variety of habitat types and support water quality. However, in some instances, structural solutions (hard-armor) are necessary to protect vital infrastructure and public safety. Some of these methods may be used in combination.

To fully understand the dynamics of the project site, and to minimize future complications, the project should be assessed in the context of the broader watershed down to the local variables immediately up and downstream. It's important to understand that rivers and streams meander naturally within their valley. The width of the meander is dependent upon valley confinement and stream type (i.e., slope, channel geometry, substrate material, etc.). Lateral migration, sometimes perceived as destabilization, of a stream may be within the normal range of that system's natural meander. However, instability can arise from skewed or undersized infrastructure, hardened banks upstream of the subject site or recent changes in hydrology caused by a change in land use within the watershed. Alternative analyses should aim to address the cause of the destabilization and consider replacement or realignment of problem infrastructure, if applicable (see Chapter 7 – Stream and Wetland Crossing for information on well-designed stream crossings). The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Planning and Site Selection

If it is determined that a bank stabilization project is necessary and nearby infrastructure will remain in its current configuration, then certain hydraulic and geomorphic variables need to be well-understood. This chapter is intended to suggest methods to avoid and minimize impacts to riverine resources, not to provide technical guidance and specifications for design. It is important to emphasize that successful implementation of any bank stabilization project requires thorough analysis of hydraulic and geomorphic measurements, extensive training and experience.

Goals and Objectives

- Provide immediate and long-term stability to the stream bank to prevent further erosion, water quality degradation and land loss.
- Identify and correct the cause of the destabilization (i.e., undersized or misaligned infrastructure, upstream

bank hardening, etc.)

- Utilize natural stabilization principles as much as possible.
- When conditions are impracticable for vegetative methods, consider a combination of structural (hard-armor) and bioengineered strategies.
- Allow for stakeholder input to gain support for the current project and potential similar projects in the future.
- Additionally, for rivers fourth-order size and greater, and most designated rivers and river segments, in order to protect water quality and wildlife habitat, the Shoreland Water Quality Protection Act (SWQPA) regulates the removal of ground cover, shrubs and trees within 150 feet of protected waters. This distance is measured from the reference line (high water line). Any earthwork or structures on the bank, in the water or on the bed of a waterbody are regulated by the NHDES Wetlands Bureau and are subject to different requirements. To see if your rivers and streams are protected under the SWQPA, review this list by town on the Consolidated List of Waterbodies subject to the SWQPA.

Reference Reach

A reference reach may be found immediately up- or downstream of the project site, or located elsewhere in the watershed. It should be comparable in hydraulic and geomorphic conditions as the subject stream.

Reference reaches are typically 7-10 times the bankfull width in length and unaffected by existing infrastructure or disturbance.

Shoreland Woodland Buffer Requirements

- On a given lot, at least 25% of the woodland buffer area located between 50 feet and 150 feet from the reference line shall be maintained as natural woodland where all existing native ground cover, shrubs and trees are allowed to grow. (RSA 483-B:9) See NHDES Shoreland Water Quality Protection Act Summary of Minimum Standards.

Shoreland Waterfront Buffer Requirements

- Within 50 feet of the reference line, ground cover and shrubs may not be removed, landscaped or converted to lawn; they may only be trimmed to a height of no less than three feet. Trees may also be pruned as long as the health of the tree is not endangered, and trees may be removed provided the remaining trees comply with the point score requirement. (RSA 483-B:9) See NHDES fact sheet on Vegetation Management for Water Quality.

Natural (Bioengineered) Bank Stabilization

This approach to bank stabilization utilizes native vegetation and natural materials such as wood, brush and coconut fiber rolls (coir logs). This method provides a variety of habitat benefits for both aquatic and terrestrial species plus water quality improvements from increased shade and erosion protection. Natural bank stabilization designs provide immediate soil stabilization, reduce surface erosion, allow for native vegetation to reestablish, improve habitat for aquatic species and terrestrial species in the riparian zone.

Streambank stabilization with brush layering during and post project – credit: Craig Rennie

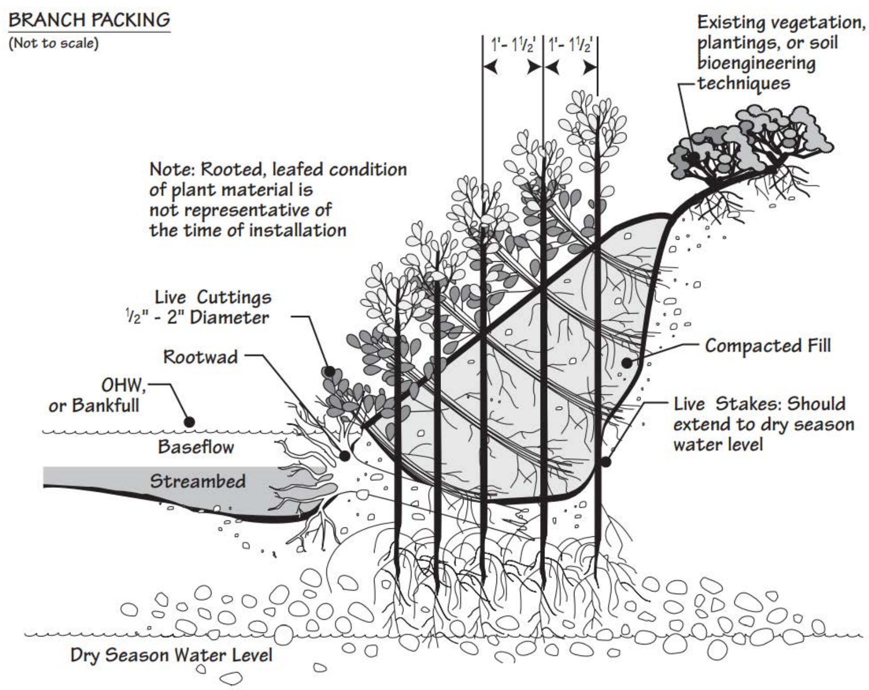
Design

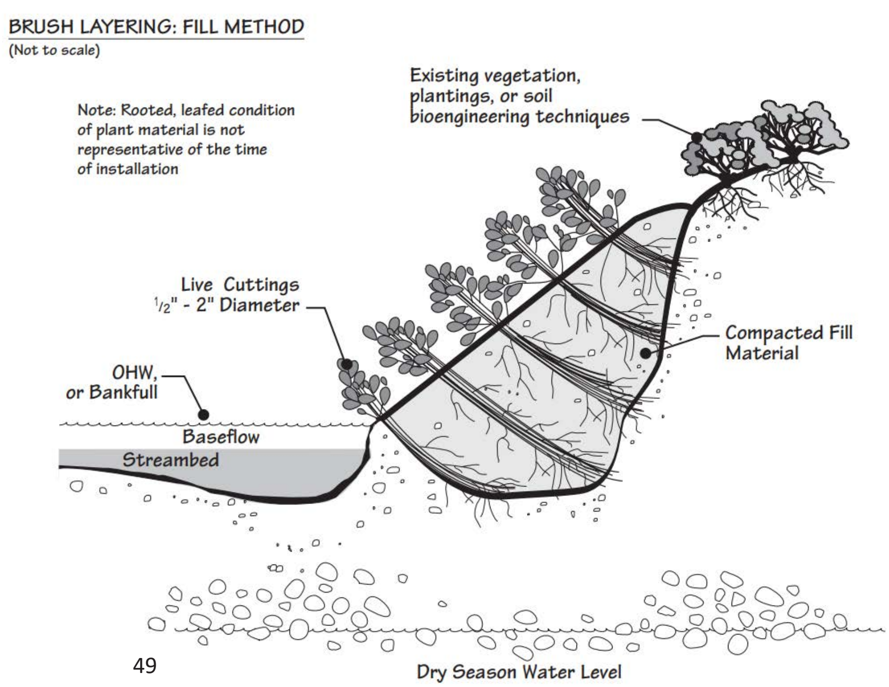
- Identify a reference reach to determine design parameters for the subject site.
- Assess potential impacts to downstream infrastructure and natural resources; avoid damaging one resource as a result of an effort to improve another.
- Determine other constraints on the project such as accessibility and valley confinement.
- Calculate the anticipated flows, flood elevations, velocity and shear stresses to determine whether or not vegetative and diversion methods are physically practical.

Note on examples: Illustrations 8.1-8.7 used with permission from United States Forest Service Soil Bioengineering Guide for Streambank and Lakeshore Stabilization (USFS, 2003) and National Resources Conservation Service National Engineering Handbook (NEH, 2007).

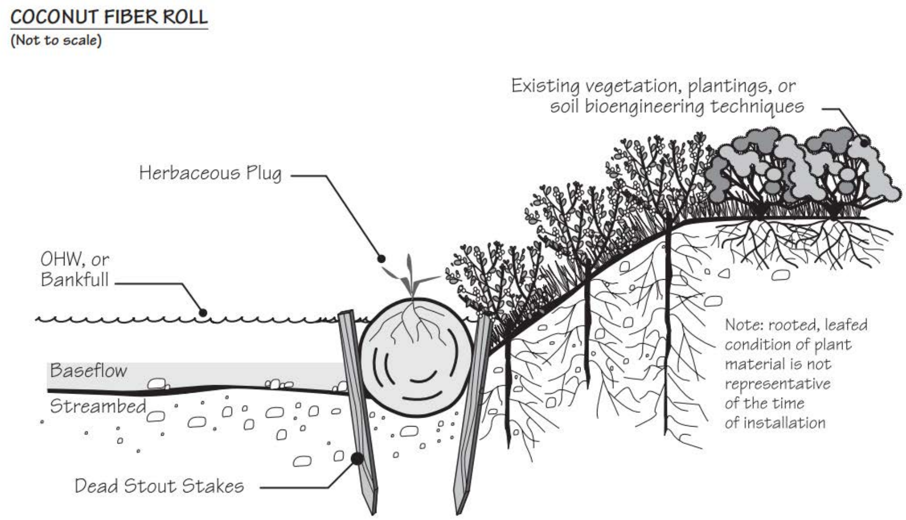
Example 8.1: Branch Packing and Brush Layering

This example depicts vegetative bank stabilization strategies best suited for stabilizing the face of a bank at small, localized areas using native live stakes in alternating layers of compacted backfill material. Over time, the live stakes will spread and form a stable bank. Branch packing is often combined with a toe stabilizing technique such as root wads. Root wads at the toe of a bank work to divert and dissipate the erosive forces (shear stress). Root wads should be adequately anchored to the bank to prevent dislodging. Branch packing and brush layering alone are generally not effective on the outside of meander bends, where shear stress is greatest.





Example 8.2: Coconut Fiber Roll



Coconut fiber rolls are cylindrical, typically 12-inches in diameter, and composed of biodegradable material (i.e., coconut husk fibers and twine woven from coconut fiber). This method is best suited for stabilizing the toe of a slope without much disturbance to the existing bank. It should be anchored with stakes and follow the existing curvature and contour of the bank. Coconut fiber rolls are effective at trapping sediment within and behind it, promoting suitable conditions for vegetation to establish on the slope. Coconut fiber rolls are well-suited for lakeshore stabilization as well.

Make Your Own Coconut Fiber Log

What you'll need: Coconut fiber mat or jute; straw; lengths of branch cuttings.

Steps:

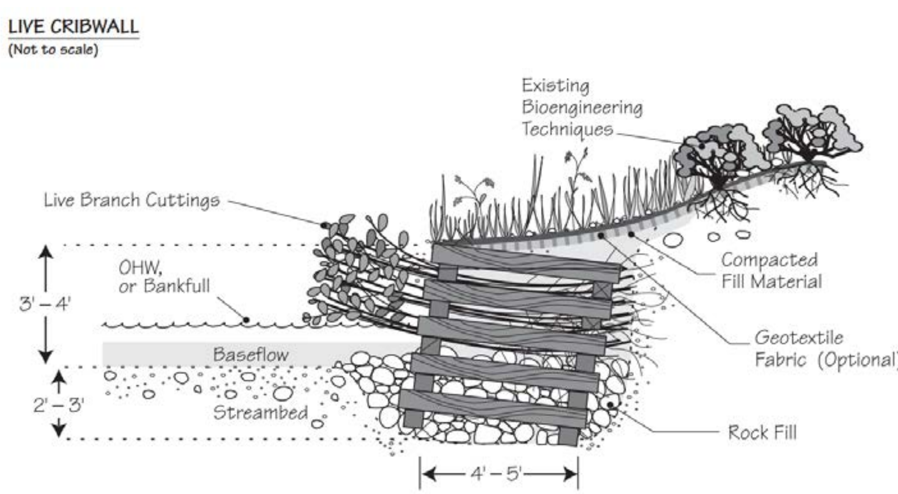
1. Cut the mat to length, plus 2 feet. It will be 8 feet wide.
2. Lay the mat flat and cover with a layer of straw, leaving 1 foot at each end uncovered.
3. Place the cuttings lengthwise along one edge.
4. Fold the empty edges inward along the 8-foot border and roll up the mat starting at the opposite edge of the cuttings.

Note: When installing, start at the downstream end of the project. Overlap the next log by 18 inches and place it on the stream side of the previous log. Longer sections are stronger than multiple shorter sections. Secure the log with anchoring cables or stakes every 2-2.5 feet.

Example 8.3: Live Crib Wall

Live crib walls are appropriate where space is limited, in nearly vertical settings and where stronger protection is warranted at the outside of meander bends. They are more complex and expensive to design and construct, though they offer immediate protection above and below the water level, and provide excellent habitat.

Live crib walls consist of a box-like structure of arranged, untreated logs or timber that is filled with rock, soil and live branch cuttings above the ordinary high water mark or bankfull elevation. Over time, the branch cuttings will establish root mass and vegetation offering long-term stabilization and structure to steep banks as well as habitat for aquatic and terrestrial species.

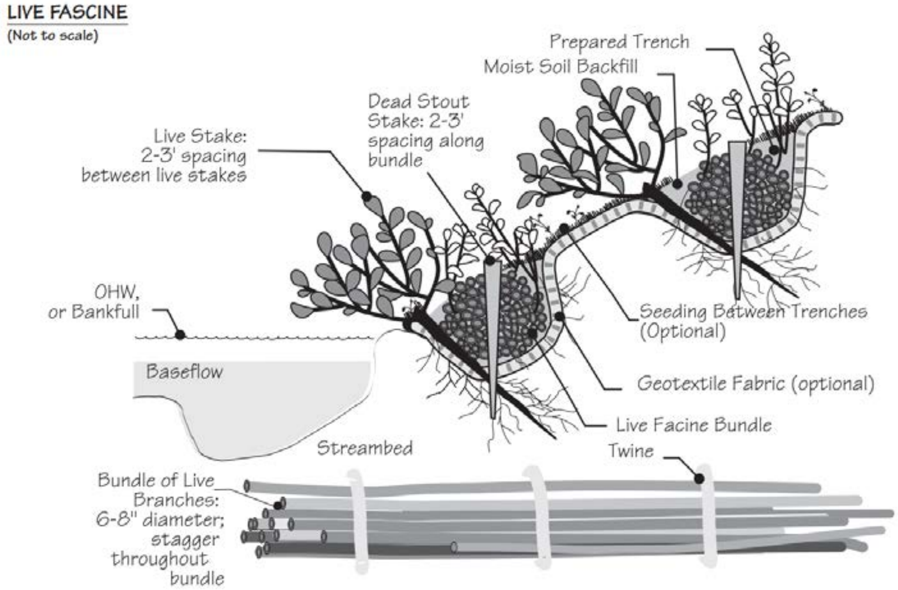


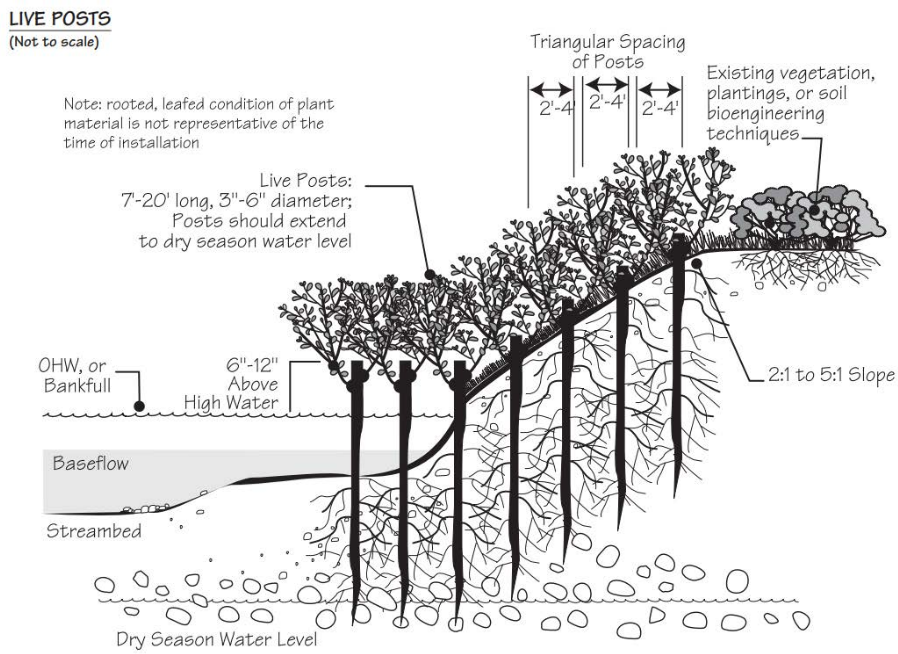
Example 8.4: Live Fascine, Live Posts, Live Stakes

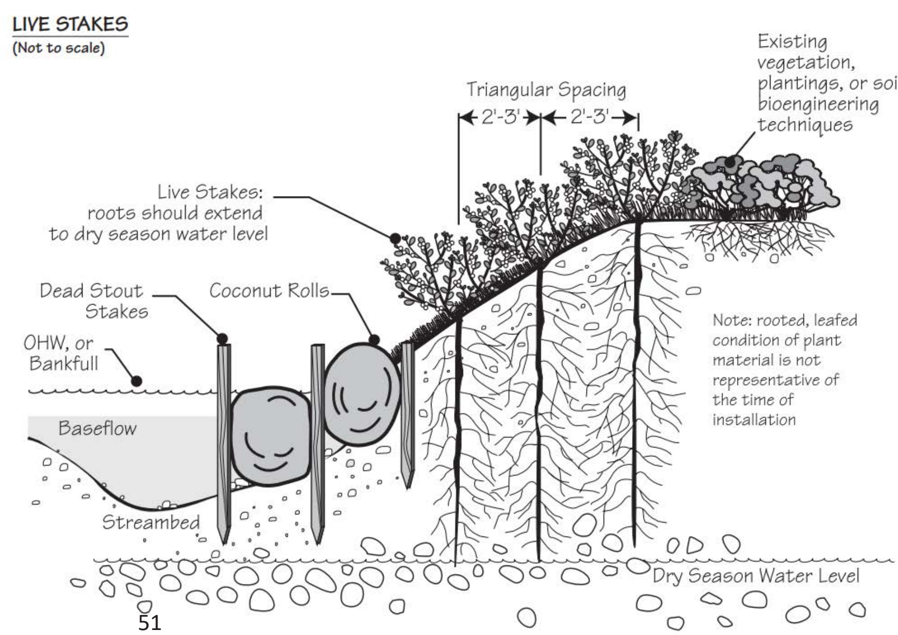
Live fascines, wattles, posts and stakes are all designed to control surface erosion and generate root mass for long-term stabilization of a bank. A fascine or a wattle is a long bundle of branch cuttings while posts and stakes are typically individual pieces installed in a bank for a similar purpose.

These methods trap soil on the bank, above the ordinary high water mark or bankfull elevation, and protect slopes from slumping and sliding. Installation results in little disturbance to the site, offers immediate protection from surface erosion and relatively quick colonization of native riparian vegetation. Live posts are typically 7-20 feet long and 3-5 inches in diameter. Live stakes are smaller – approximately 2-3 feet long and 1-2 inches in diameter. Live posts and stakes are made from fast-rooting species and offer a quick and effective solution in uncomplicated conditions.

Planting live stakes along the Ammonoosuc River in Lisbon, NH – credit: NHDES Staff





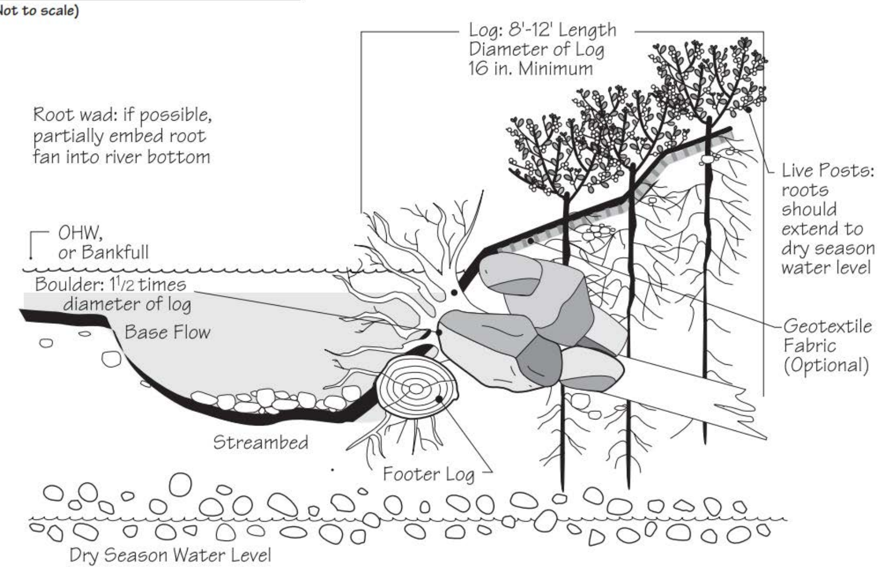


Example 8.5: Root Wad with Footer Section

Root wads are designed to keep the current off of the bank. They can be used in areas of high shear stress along streambanks, or on shorelines of lakes and ponds that are subject to wind and wave erosion.

Root wads should be installed at an angle to the bank, facing upstream and pitched slightly towards the stream bed. Once installed with footer logs and boulders, the root wad should be backfilled with a combination of other soil biostabilization techniques.

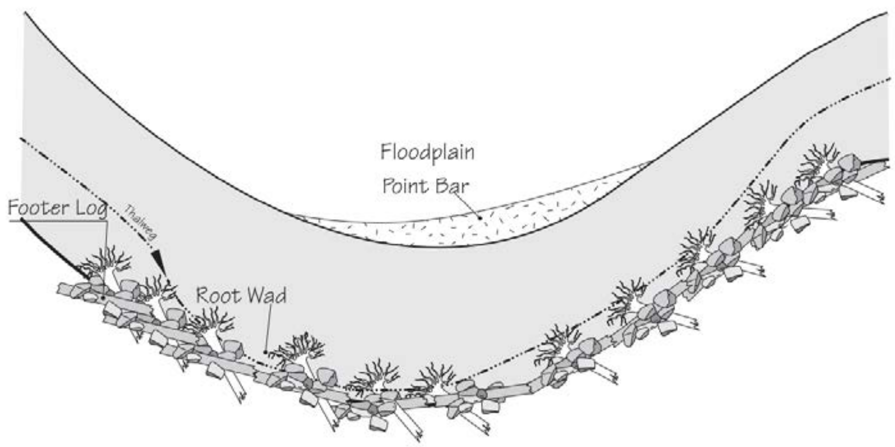
ROOT WAD WITH FOOTER: SECTION
(Not to scale)



How wetland impacts were minimized:

By utilizing natural materials and bioengineered designs, immediate erosion protection is achieved. In addition, long-term improvements to aquatic and terrestrial habitat, riparian transition vegetation and water quality can be realized.

ROOT WAD WITH FOOTER: PLAN VIEW
(Not to scale)



- √ Biostabilization provides immediate and long-term protection from erosion and sedimentation.
- √ Natural materials and bioengineered designs promote colonization of native riparian vegetation.
- √ By assessing and emulating a reference reach, habitat and ecological improvements are provided for indigenous aquatic and terrestrial species.
- √ Riprap application is kept to a minimum, only where anticipated shear stress exceeds the allowable threshold for vegetative methods.
- √ Thermal impacts to water quality were minimized by using wood and vegetation (in lieu of stone), which will improve water quality for cold-water species.

Structural (Hard-Armor) Bank Stabilization

Certain applications call for structural solutions to bank erosion problems. When space is limited, there is imminent threat to public infrastructure or when velocity and shear stress exceeds the threshold for vegetative methods, stone is an effective measure. There is no establishment period relative to integrated bioengineered methods. When possible, stone can be applied **in combination with bioengineered methods**. It is particularly effective along the toe of an eroding bank, where a more naturalized strategy could be employed above the toe, on the face of the bank.

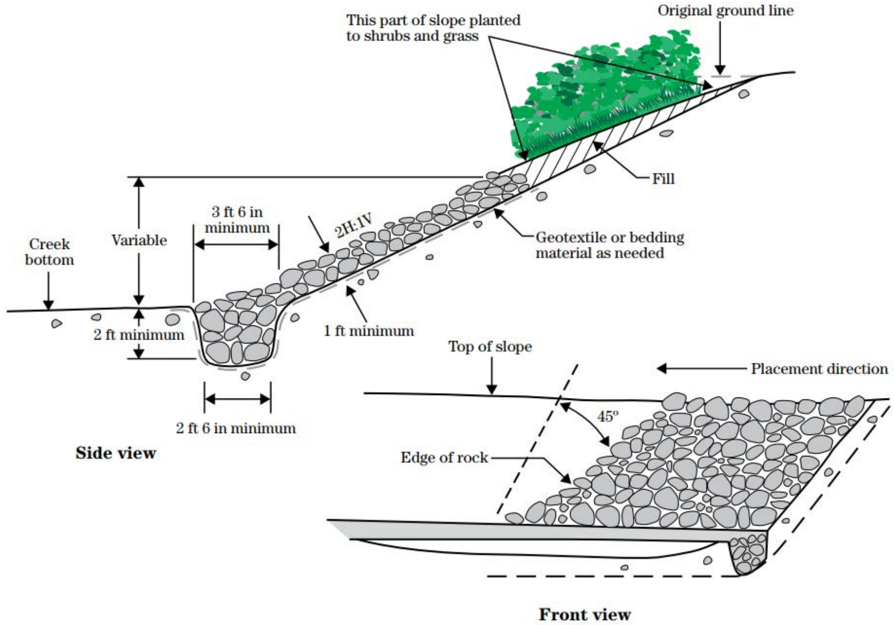
Leighton Brook bank stabilization, Epsom, NH – credit: NHDES Staff

Design

- To prevent undermining and structural failure, stone applications should always be **tied-back or keyed-into the bank and overlapping the area of erosion**. Detailed specification to this affect should be included in project plans.
- Whenever possible, **stone should be minimized to the toe of slope and located landward of the normal high-water mark or bankfull elevation**.
- Permit applications for riprap should include designation of minimum and maximum stone sizes and gradation, riprap thickness, cross-section and plan views of the proposed installation.
- When selecting stone gradation, consider the anticipated velocity and shear stress at that location, the gradation of the natural stream substrate adjacent to the project area and potential implications to riparian habitat.
- When possible, use stone in combination with other biostabilization techniques:
    - The joints or open spaces between the rocks could be planted with native vegetation (i.e., live stakes or posts), which will disguise the riprap, stabilize the soils beneath the riprap, provide riparian habitat and improve thermal conditions in that area.
- Avoid the use of angular riprap where possible, or top-dress angular riprap with rounded stone, riparian vegetation or loam and seed.
- Understand the adverse effects of hard-armor, which include: disruption of the natural local sediment transport regime and the potential to exacerbate downstream erosion, elimination of riparian vegetation and supporting habitat, and thermal effects to water quality.
- For riprap applications in excess of 100 linear feet, project plans should be stamped by a professional engineer.

Example 8.6: Typical Riprap Section

The portion of the bank between the normal high water elevation and the Top of Bank is planted with shrubs and grass. Rip rap armoring is installed down to the toe of slope of the bank. Rip rap stone is installed over geotextile fabric or bedding materials (as needed), at a slope of two to one, and at a minimum thickness of one foot. At the toe of slope, the rip rap is keyed-in in a trench to a minimum depth of two feet. The bottom of the trench is a minimum of two and a half feet wide. The top of the trench is a minimum of three and a half feet wide. The only rip rap in the stream is within the trench along the toe of slope.

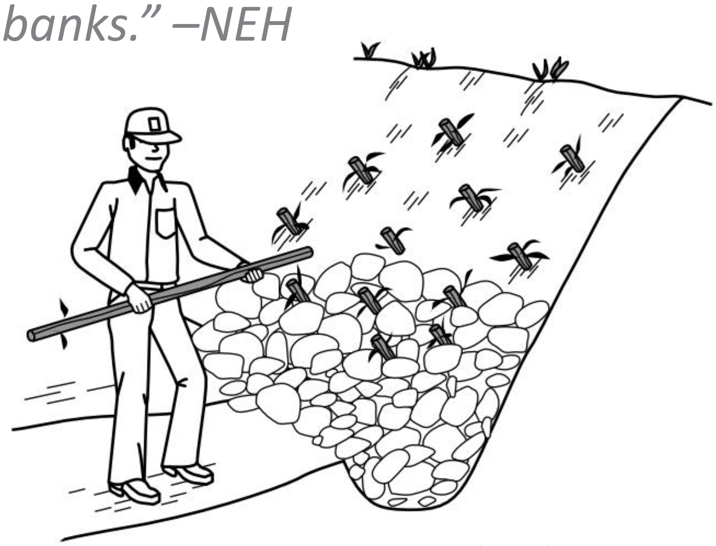


Example 8.7: Joint Planting

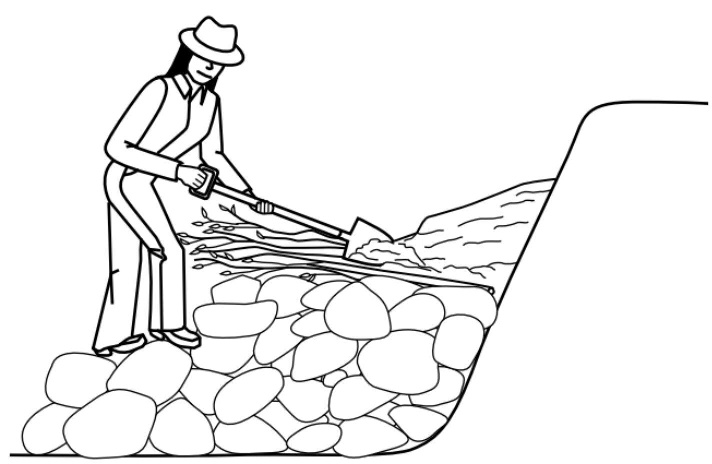
Combining structural stabilization with bioengineered techniques can lead to achieving the benefits of both strategies. This example depicts three different methods for combining structural and biostabilization (i.e., vertical bundles backfilled with a stone toe, a brush layer over a stone toe and a stone toe supplemented with joint plantings).

"The inert rock material often provides immediate toe protection, while the living plant materials protect, reinforce and stabilize the banks." –NEH

Vertical bundle and stone toe



Toe-in and live stakes



Brush layer over stone toe

How wetland impacts were minimized:

- √ Hard-armor is applied only in locations where vegetative stabilization methods are impractical.
- √ Biostabilization measures are used in combination with hard-armor to achieve desired habitat and water quality benefits.
- √ Over time, the vegetation will reinforce the stability of the slope and establish cover and shading to support riparian habitat and water quality.

Construction

- Before any disturbance to the watercourse or riparian transition, time of year considerations must be made to avoid impacts to certain aquatic organisms (i.e., spawning and migratory fish).
- Work in the watercourse should be confined to the low-flow season of July-October.
- Include information in the application if a project will be constructed in phases, and try to limit the amount of time that the stream will be impacted.
- As a general rule of thumb, work from the toe of slope to the top of bank, starting the project at the downstream extent then progressing upstream. Certain site-specific conditions may preclude this general rule.
- Always design and install structures to be tied-back into the bank, keyed-in at the toe of slope and at the up- and downstream extent of the project.

Crib wall construction, McQuesten Brook, Bedford, NH – credit: NHDES Staff

- All sediment and erosion controls (including those for dewatering) must be in place prior to the beginning of work and must be maintained for the life of the project.
- Do not clear any more of the bank or upland area than is absolutely necessary for the project.

Diversion of flow

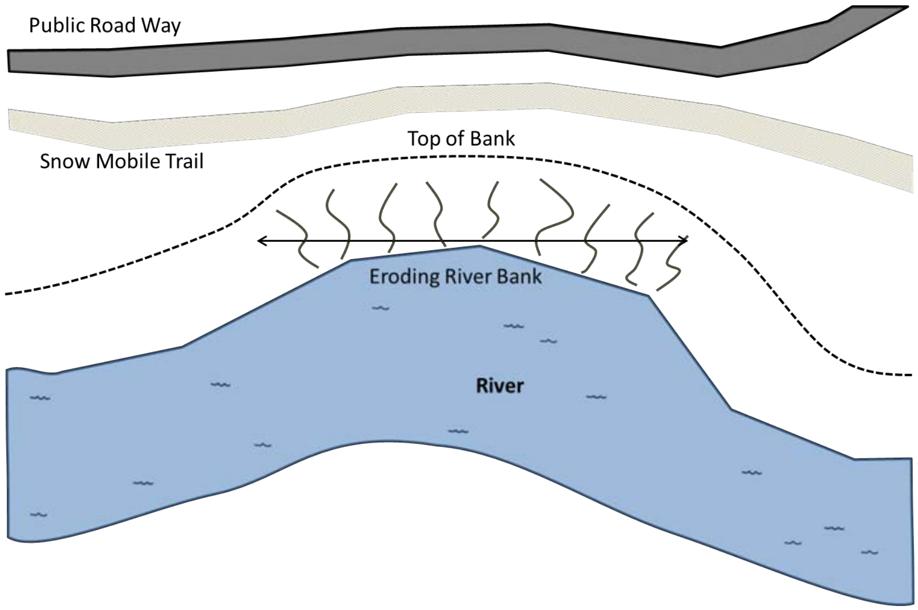
- In most situations, stream flow will need to be diverted, and the work area dewatered, during construction.
- Plan ahead and include information on the project plans about flow diversion to minimize impacts while considering the following issues:
    - Duration of the proposed construction.
    - Design of the diversion device.
    - Dewatering the work area.
    - Erosion controls and location to where dewatering will be directed.

To ensure minimization of impacts, it is important to plan ahead and include information about flow diversion in a wetland application package.

- Cofferdams, sandbags, silt curtains, or a combination of the three, should be installed when working in a watercourse.
- Closely monitor the stability of areas to where water is diverted.
- Drive sheeting right before beginning work in the area, and remove it immediately afterward to minimize disturbance to the watercourse as much as possible.
- Take advantage of already-cleared upland spaces for access, material and equipment staging and storing.

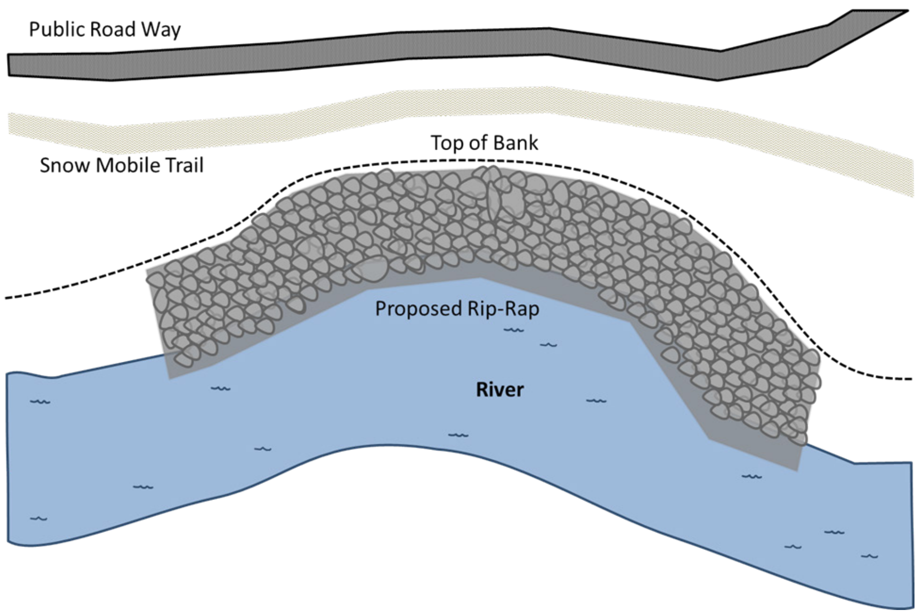
Example 8.8: Identifying the Problem

In this example, the river is eroding the bank in a section that will damage the adjacent snowmobile trail and roadway. The social and economic impacts of rerouting or repairing the road and loss of access for residents would be costly if the bank were to be left untreated. The river ecosystem would also be impacted due to increased turbidity from the high sediment load.



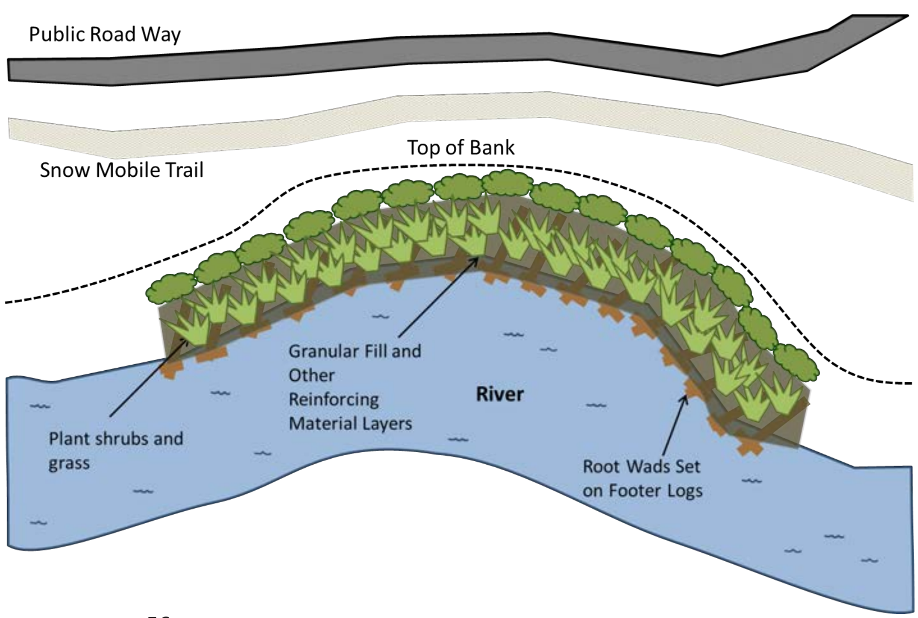
Example 8.8a: Structural (hard-armor) Option

This method would have been a quick and efficient way to stabilize the river bank but it was not the best or most practicable. The habitat functionality of this method is poor because it does not allow for vegetation to establish and the rocks will infringe on the aquatic habitat. Due to this particular project not needing immediate stabilization, amongst other factors, a more natural method of bank stabilization was investigated.



Example 8.8b: Natural Bank Stabilization Option

This method closely resembles the natural river bank and restores much of its functionality, making it the best option for this particular project. A natural, bioengineered river bank provides habitat for terrestrial species as well as shade and food for aquatic species.



Chapter 9 – Plantings

Plantings are an extremely important part of any project proposed in or near wetlands. Plantings can provide a vegetative barrier to mitigate impacts to wetlands. Planted transitions along streams and wetlands can provide improved stormwater quality, wildlife habitat, and screening from noise, light and other disturbances. A planted transition helps slow the flow of water, promote infiltration of runoff, stabilize watercourses, and allows sediment to settle out before it reaches the wetland. A dense ground cover of grasses can also help filter polluted water before it enters the wetland. A careful selection of plantings provide shelter, food and breeding sites for wildlife, and a tree canopy helps regulate temperatures in a wetland by shading the water during summer. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Planning and Design

Planting design should take into account the physical conditions of the site, including light levels and soil moisture, to help in plant selection. Site conditions should be thoroughly examined to ensure appropriate planting zones. To ensure proper plant selection and viability, the use of a landscape professional is recommended. Considerations for planting design should include height, growth rate, rooting depth, light preference, soil preference and potential wildlife habitat. A good planting scheme would achieve vegetative stabilization of disturbed site areas, improve water quality, include considerations of wildlife habitat, and provide aesthetic and functional screening. The scheme should consist of groundcovers, perennial herbs, shrubs, and a mixture of evergreen and deciduous trees that are appropriate to the specific site location.

Selected planting materials should consist of native or naturalized species instead of cultivars. Plant materials should be locally-sourced, as available. Cuttings can be propagated in advance to provide rooted plantings, or live stakes can be installed and rooted in-situ. It is important to plan ahead and have plantings ready because it is sometimes difficult to find appropriate species.

Planting designs should include trees, shrubs and ground covers that are representative of the density and species composition of existing stands of vegetation in the local area. Seed mixes should consist of species appropriate to the area and be applied in accordance with manufacturers' specifications. Seed mixes can be combined or customized to achieve appropriate species diversity. Seed mixes should provide a wide variety of native species similar to the undisturbed local habitat.

The NHDES Native Shoreland/Riparian Buffer Plantings for New Hampshire (2006) and Native Plants for New England Rain Gardens (2016) provide good references of common species and their growth habits. Additional plantings references can be found in the References and Resources section of this Manual.

Installation of large, woody vegetation, such as trees and shrubs, should be avoided on detention or infiltration basin fill embankments, on dams and near basin outlet structures. Trees should not be planted within 10 feet of an underground infiltration system.

Generally, the best time to plant is during spring (May 1–June 15) or fall (September 1–November 15). Plantings can be installed during the dry summer months if they are balled and burlapped and regularly watered. Transplanted trees or shrubs should be planted during early spring before leaves appear, in late fall, or in early winter. Be sure to check each species for the recommended planting season.

The location of existing utilities should be verified prior to planting installations. Plant materials should be reviewed prior to installation to verify overall health.

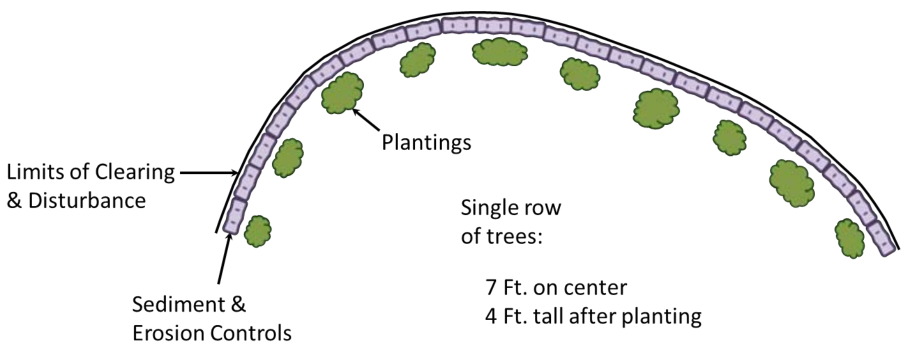
Planting Plan Information

Planting plans should include proposed species names (both common and scientific names), a legend, proposed height and spacing, and planting schedule. Details should be included to illustrate how each type of planting will be installed at the specified location. Plan notes should also describe site preparation, sediment and erosion controls, and planting site maintenance, including mulching, fertilizing, inspections and replanting, when necessary.

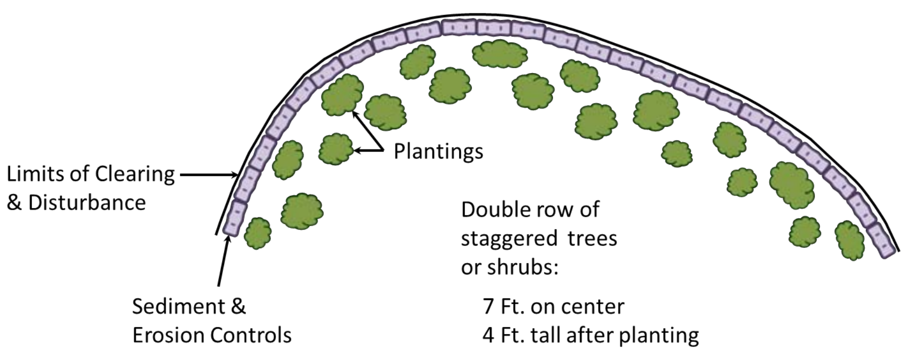
Planting Methods

The following drawings illustrate two possible methods of installing plantings, the relationship of the plants to the wetland project's LOD, and the sediment and erosion controls.

Example 9.1a: Planting Methods (Option 1)



Example 9.1b: Planting Methods (Option 2)



Site Preparation

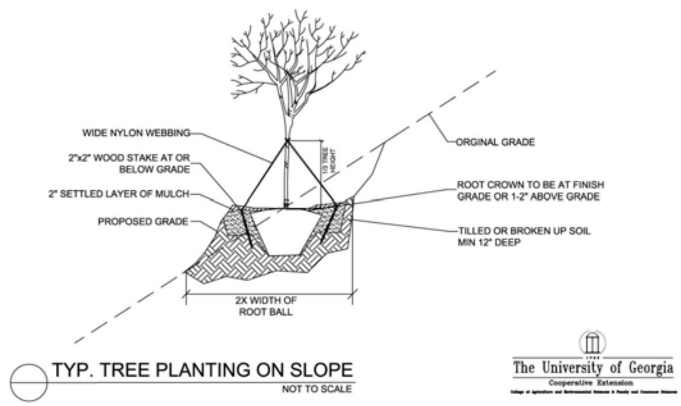
Soil conditions can be amended to facilitate growth and achieve vegetative stabilization of site areas. Fertilizers and pesticide applications should be limited adjacent to wetlands and surface waters, and should be applied in accordance with Shoreland Protection zone requirements, as applicable.

Eliminating any invasive species that are currently growing in areas to be planted is recommended because they often overtake native species. Also, be mindful of exposed mineral soils (disturbed areas), are especially susceptible to colonization by invasive species. Precautions must be taken to prevent import or transport of soil or seed stock containing nuisance or invasive species. See the New Hampshire Department of Agriculture's Prohibited Invasive Species List for a list of invasive plant species that are prohibited in the State of New Hampshire and the Invasive Plant Species Watch List for a list of nuisance and invasive plant species that should be avoided.

Tree and Shrub Installation

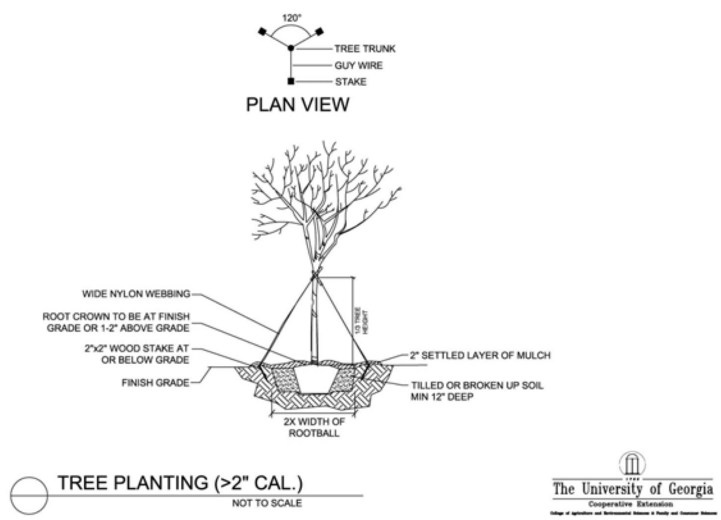
The following examples illustrate best management practices for planting trees and shrubs. Be sure to verify any specific growth requirements for the species proposed to be planted.

Dormant stakes are best installed in the spring, by June 1, or in the fall, between September 15 and October 30.



Site restoration after planting

After site construction is complete, final grading and landscaping should be completed as soon as possible to minimize erosion and help ensure that invasive species don't take root and spread. It is important to plan project completion and planting installation for the appropriate season. All exposed soil areas should be stabilized by seeding and mulching during the growing season; or if not within the growing season, by mulching with tackifiers. Sediment and erosion controls should be removed once all disturbed areas have been stabilized.



Planting Maintenance

Plantings may benefit from application of light mulching to retain soil moisture. Mulch used within planting areas should be a non-seed-bearing organic material. Dry soil conditions may require additional watering until established.

All plantings and seeded areas should be monitored to ensure survival. Remedial planting measures should be considered if plantings or germination do not achieve, at minimum, 75% vegetative coverage of bare soils after two growing seasons. Remedial measures may include replanting, relocating plantings, removal of invasive species, changing soil composition and depth, changing the elevation of the wetland surface, and changing the hydrologic regime.

Log grade control structures during and after installation, Hebron, NH – credit: Sean Sweeney

Chapter 10 – Construction and Maintenance

Good construction and maintenance planning are essential to the successful completion of any project. Although it may not seem necessary to think about construction or maintenance until the actual work begins on a project site, detailed forethought will prevent problems, save time and ensure a successful project. Construction and maintenance planning are crucial with larger projects due to the increased area of impacted land. The applicant must maintain regular contact with construction crews to confirm they are implementing the approved permit design and best management practices have been utilized. If the plans are not followed as approved, the permittee is responsible for wetland and/or water quality impacts that may occur. Many best management practices to help the permittee limit construction impacts and properly maintain the project site are discussed on the next few pages. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Prior to Construction the Applicant Should:

- Confirm that all necessary permits have been obtained (municipal, state, and federal).
- Read all permit conditions and ask questions if they are unclear.
- Post the permit in a secured and prominent location.
- Have a copy of the approved plans and permit at the site.
- Confirm that easements and permissions for access have been obtained.
- Include all contractors in all pre-construction meetings. Make sure all contractors are aware of sensitive wetland and habitat areas that must be avoided per NHDES-approved permit plans and conditions.

Timing and Sequence

A good project design can be overshadowed by poor sequencing of construction if the construction activities fail to avoid or reduce wetland impacts. While sequence and timing of construction work is often dependent on the contractor's schedule, it is always important for them to employ best management practices.

- Limit construction activities within vegetated wetlands, and flowing and standing water wetlands to the low-flow period of July through October, unless there are overriding breeding or migratory issues.
- Schedule all construction adjacent to or within wetlands during dry periods – or at least not immediately prior to predicted heavy rain events.
- Work should be carried out to avoid impacts to wildlife, including avoiding discharges to spawning and nursery areas during spawning seasons and to migratory waterfowl breeding and nesting areas.
- Construction operations should be coordinated between contractors to limit the timeframe of construction disturbance.

Construction sequence notes must be detailed enough to demonstrate to NHDES that the applicant has considered the construction activities with respect to the protection of wetlands. The notes should specify all construction steps that may affect wetlands and the order in which steps will occur, including the following:

1. Demarcation of project limits and wetland boundaries.
2. Installation of erosion and sediment controls.
3. Development of access ways and staging areas.
4. Site preparation.
5. Removal and disposal of items.
6. Dewatering.
7. Grading.
8. Construction and building of drainage systems and structures.
9. Temporary and permanent site stabilization.
10. Restoration and plantings.
11. Removal of temporary erosion and sediment controls after vegetative stabilization.

Adequate soil erosion and sediment controls and demarcations must be installed before the start of all construction activities. Temporary stormwater basins should be stabilized, and stormwater drainage systems and control facilities should be installed. Floodplain compensation areas must be constructed and functional prior to any floodplain filling. Grading and ground disturbance should be limited and the areas restabilized as soon as possible following construction activities. Construction activities should be performed during periods of low-flow and dry conditions. Timing of seeding and planting installations should consider dry periods, which require additional watering, or cold weather, which limits germination and vegetative growth.

Clearing

- Clearing of large lots should be performed in phases so that the land is not stripped of vegetation all at once. Areas should be stabilized prior to advancing to additional phases.
- Schedule tree removal operations to avoid impacts to wildlife.
- Coordinate clearing project timing with the US Fish and Wildlife Service to minimize impacts on endangered or

threatened species. NHFG maintains a list of endangered and threatened wildlife in New Hampshire.

- Perform clearing operations in frozen or sufficiently dry conditions, as available, to avoid rutting impacts and soil disturbance.
- Preserve the existing tree canopy and use selective clearing to minimize clearing of vegetation.
- Avoid removing trees or other vegetation along streams and adjacent to wetlands during construction.

Protection During Construction

- Properly install all sediment, turbidity and erosion controls in accordance with the New Hampshire Stormwater Manual Volume 3, Erosion and Sediment Controls During Construction and with manufacturers' specifications.
- All in-stream work should be conducted during low-flow conditions and in a manner that does not impact water quality.
- Control water flow through or around the work area. Install flow bypass or diversion for streams. The use of cofferdams with bypass, use of pumps, dewatering basins, diversion pipe, stabilized diversion swale or a combination of practices may be necessary. Construction operations should not be performed in flowing water.
- Divert runoff around excavations by using diversion berms or by using stabilized ditches and/or check dams.
- Sediment and erosion controls should also be monitored and maintained prior to large forecasted storm events to confirm adequate functioning.
- Sediment and erosion controls should be evaluated on a daily to weekly basis and after any storm event.
- Install erosion control blankets, such as jute or other types of non-plastic matting, to prevent erosion on steep slopes. If erosion control blanket are utilized, NHFG recommends avoiding, whenever practicable, the use of welded plastic or 'biodegradable plastic' netting or thread with synthetic netting and thread in erosion control matting as these materials have been documented to entangle and kill snakes, birds and other wildlife. Instead NHFG recommends that project applicants use 'wildlife friendly' erosion control mesh such as woven organic material (e.g., coco or jute matting) or other materials that don't include a welded plastic component. This recommendation is especially important within "priority resource areas."
- Use temporary matting and timber mats and other standard conditions for Use of Heavy Equipment in Wetlands (Env Wt 307.15).
- Use low-ground-pressure tracks or wide-tire vehicles when working in or near wetlands to reduce rutting and soil disturbance.
- If dewatering operations are necessary, pump all water to sediment basins that are located in uplands, lined with hay bales or other acceptable sediment trapping liners, and set back as far as possible from wetlands and surface waters, with a preferred undisturbed vegetated transition of at least 50 feet and a minimum undisturbed vegetative transition of 20 feet.
- Within three days of final grading or temporary suspension of work in an area that is in or adjacent to wetlands or surface waters, all exposed soil areas to be stabilized by seeding and mulching during the growing season, or if not within the growing season, by mulching with tackifiers. Stabilization to include mulching with tackifiers on slopes less than 3:1 or netting and pinning on slopes steeper than 3:1.

Site Stabilization, Restoration and Maintenance

Site stabilization, restoration and maintenance efforts must be considered during the initial planning and design phases and should be included in the application submittal. A project site must be effectively stabilized, revegetated and maintained to prevent soil erosion, and to prevent sediment from running into wetlands. Refer to Chapter 9 – Plantings of this manual for additional information on site stabilization and maintenance.

Slope stabilization using coir logs and live plantings – credit: Stefanie Giallongo

Below are some good tips to follow:

- Complete restoration efforts immediately after completing the construction of the project.
- Replant disturbed soils and restore the area as close as possible to its original topography and hydrology, if required.
- Replant any and all disturbed vegetation with native species similar to those within the wetland prior to impact.

Erosion and sedimentation controls – credit: NHDES Staff

Piscataqua River Bridge, Portsmouth, NH – credit: Jay Aube

Chapter 11 – Tidal Projects

From the productive salt marshes, to the cod drying racks on the Isle of Shoals, to the protected inlets and natural jetties, the Seacoast has always been a special place to the people of New Hampshire. Although New Hampshire has just over 18 miles of Atlantic coastline, the state's two major estuaries, Great Bay and Hampton-Seabrook Estuary, have nearly 220 miles of estuarine shoreline. Although the coastal watersheds of New Hampshire represent only 9% of the state, these 525,000 acres provide essential habitat for more than 130 rare species, including many that occur nowhere else in New Hampshire (Zankel et al., 2006). There are also 1,800 miles of rivers and streams, ranging from headwater streams that support cold-water fisheries in the upper coastal watershed to large, meandering tidal rivers near the coast. In addition to the habitat value of this area, it is also the fastest growing area of New Hampshire and a significant tourist destination. The defining challenge of New Hampshire's coast and estuaries is the tide exacerbated by sea level rise and storm surges.

"Where and how we build and rebuild as the coastal population and economy continue to grow have critical implications for how coastal New Hampshire will withstand projected coastal hazards. Should we choose to build using the same strategies and techniques as we have in the past, we will exacerbate our exposure to these hazards by placing structures, facilities, and people directly at risk. Alternatively, if we incorporate projected flood risks into our planning, design, construction, and conservation practices today, we will greatly reduce exposure to flood hazards, resulting in saved lives and property and lower response and recovery costs."

–New Hampshire Coastal Risk and Hazards Commission, Final Report

The purpose of these BMPs is to protect the public trust, public health and safety, and natural resource functions of New Hampshire's coastal lands, and tidal wetlands and surface waters, and to preserve the integrity of such areas, by establishing standards for resource analysis and management, site alteration, and design and construction of structures, in order to preserve the productive and protective functions of this area and prevent unreasonable encroachment on surface waters of the state.

Tidal Docking Structures

Docking structures located in tidal waters have unique requirements that dictate their design. They must be built to accommodate the rise and fall of the tide, and withstand wave energy and winter ice flow. They may extend out from high rocky shorelines or from low uplands and across salt marsh areas. Docks may cross vegetated shallows or mud flats. Based on the nature of the tidal system where they are located, they may not provide access to water for the entire tidal cycle. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Planning and Site Selection

The first step in siting a pier is to determine if a location is available that will avoid or minimize putting the pier over wetland vegetation. Avoidance is especially critical over existing historically-present eelgrass beds and in land containing shellfish. Below are standard coastal dock designs that use avoidance and minimization techniques.

Pier Height
Piers allow for better light penetration to underlying vegetation and assist in preventing storm damage. It is important to allow lateral passage under the pier for coastal tide waters. Floats should be located at the end of the pier in deeper water.

Pier Length
Shorter piers produce less adverse shading effects on vegetation than longer piers.

Pier Width
Narrower piers provide less adverse shading effects on plant productivity than wider piers.

Plank Spacing
Planks should be spaced to allow for light penetration. Designs shall incorporate ADA requirements whenever feasible.

Orientation
If placing the pier over wetlands vegetation cannot be avoided, the pier should be oriented as close to a north-south orientation as possible (consistent with site constraints and environmental and navigational considerations). Research indicates a north-south orientation is least likely to adversely affect aquatic vegetation through shading.

All docking structures must be at least 20 feet from the abutting property line, whether in tidal or in non-tidal waters. Location of a docking structure closer than 20 feet to an abutting property line is allowed if written, notarized concurrence is obtained from the affected abutter(s).

Design

The standard tidal dock consists of a permanent pier, a hinged ramp connects to a float, with the vessels tied to the float. This is necessary to accommodate the daily tidal fluctuation. Variations depend on site conditions and include: A ramp directly from the shore to a float. A float or string of floats anchored directly to shore. A permanent pier alone or with a ladder to a float.

Restrictions on the size and design of tidal docks and permanent piers are described in the NHDES wetland rules.

- A ramp directly from the shore to a float.
- A float or string of floats anchored directly to shore.
- A permanent pier alone or with a ladder to a float.
- Decking on permanent piers must provide spacing between boards to prevent total shading beneath the structure. Designs shall incorporate ADA requirements whenever feasible.

Restrictions on the size and design of tidal docks and permanent piers:

- The allowable length of a tidal dock is determined by the minimum length needed to reach useable water for at least a majority of the tidal cycle. The maximum length of a permanent pier is 100 feet and no more than 150 feet for the overall structure.

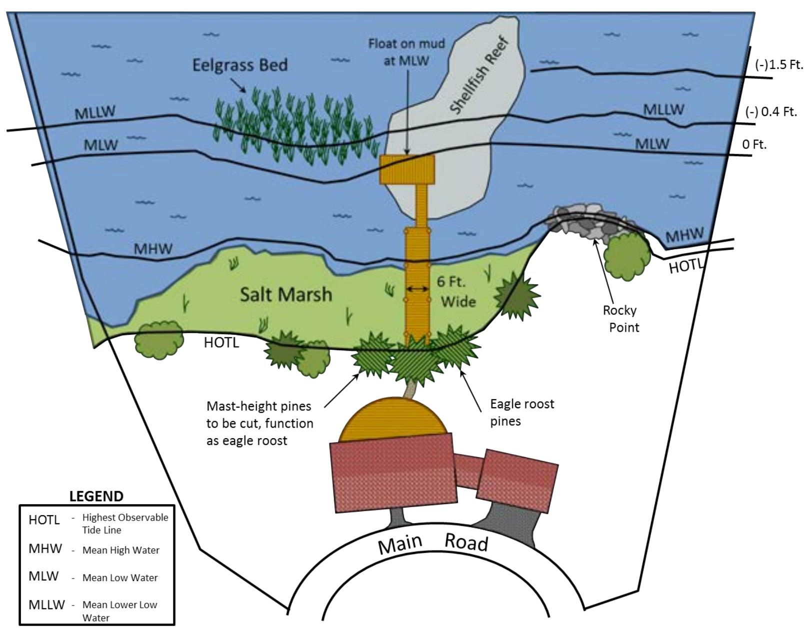
- Private docks have a maximum width of four feet; those for industrial use may be wider.
- The height of a permanent pier must be at least equal to the width to avoid shading the substrate or vegetation below.

Construction Tips

- Avoid impacts on salt marshes and tidal buffer zone vegetation adjacent to wetlands by performing work from the completed portions of the dock/pier or floating platform.
- Install pilings by pile driving or auguring from a barge. Piles installed through "jetting" can greatly disturb the area.
- Use low ground-pressure machinery and matting to reduce impacts to tidal wetlands. Do not use fill to provide footing for equipment.
- Reduce the risk of contaminating tidal resources as much as possible by keeping construction materials away from the area.

Example 11.1a: Tidal Dock – Original Plan

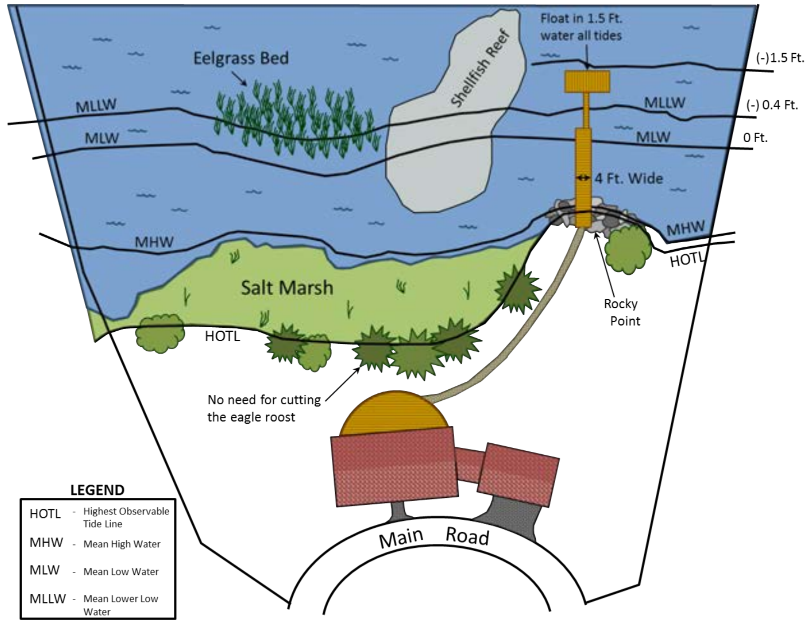
In this example, the applicant proposes to build through a salt marsh to place a float in a shellfish reef. The access path would require cutting down an eagle roosting tree in the tidal buffer zone and shoreland protection zone. Turbidity, or the clouding of water due to disturbed sediments, restrictions were not implemented. It harms vegetation by reducing light penetration and harms fish by clogging gills and hurts fish eggs, larvae and shellfish by causing abrasions from sediments. Time-of-year restrictions are not considered.



Example 11.1b: Tidal Dock – Revised Plan

How wetland impacts were minimized:

- √ The tidal dock was moved out of the tidal marsh and the shellfish reef. The new location avoid impacts to vegetation where possible.
- √ The eagle roosting tree in the tidal buffer zone remains uncut.
- √ The width of the pier was reduced.



Sand Dunes

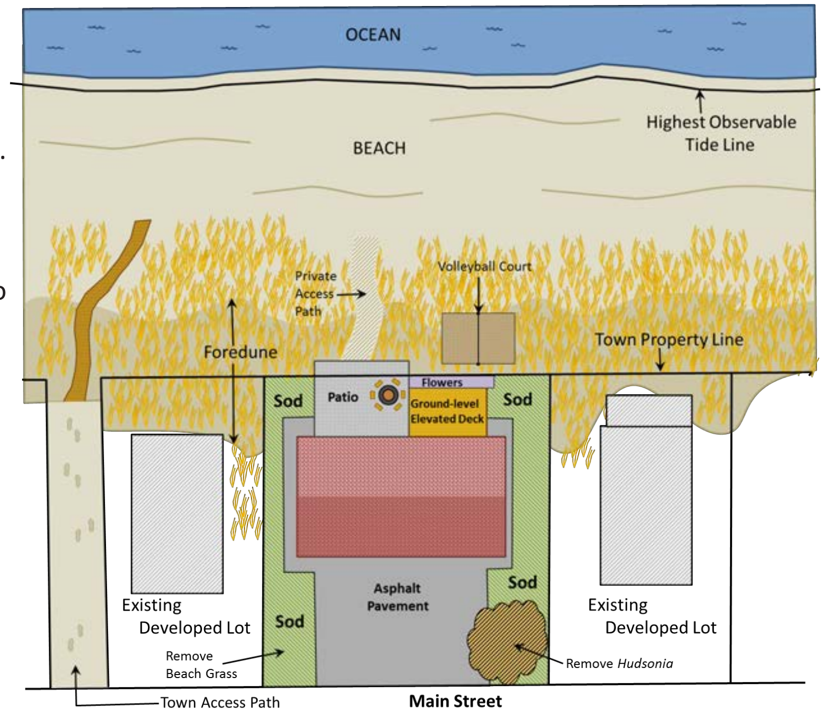
Why are sand dunes important?

Dunes enable coastal resiliency against storm surge and flooding, protecting property and infrastructure. Dunes provide essential habitat for wildlife, particularly endangered plant and avian species. Dunes supply sand to eroding beaches and enhance the accretion of sand for nearshore sandbars under storm conditions.

Piping plover in dune grass – credit: NHDES

Example 11.2a: Sand Dune Lot Development – Original Plan

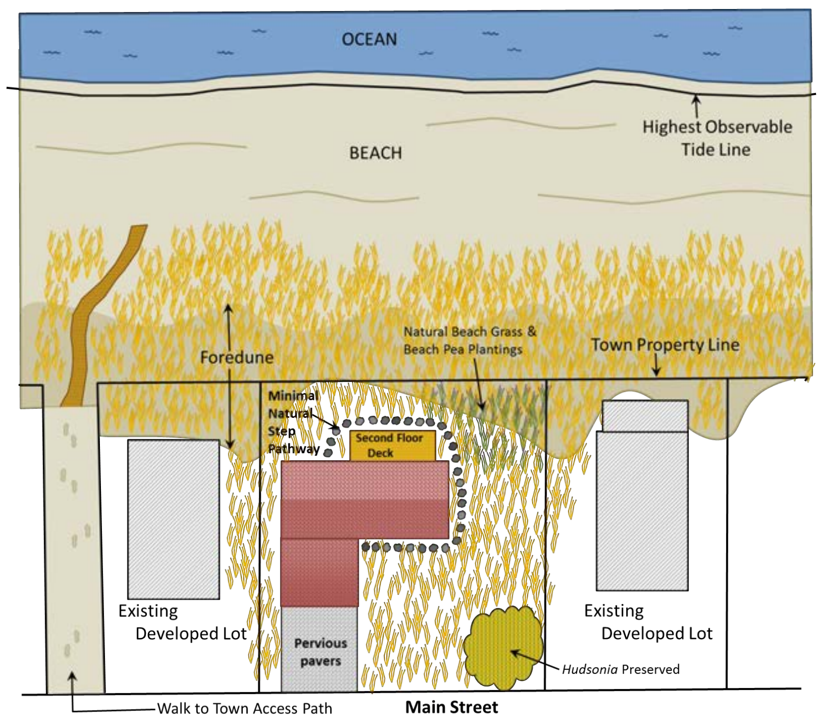
The applicant has proposed to completely alter the lot with asphalt, sod and various structures. This not only reduces the functionality and value of the resource, but it increases impervious surfaces, encroaches onto Town property and diminishes wildlife habitat. This project will also lead to adverse impacts to a state protected plant species.



Example 11.2b: Sand Dune Lot Development – Revised Plan

How sand dune impacts were minimized:

- √ All structures have been relocated within the property boundaries.
- √ The size of the dwelling has been reduced and reconfigured.
- √ Hudsonia is preserved. Hairy Hudsonia (*Hudsonia tomentosa*) is a threatened dune plant in New Hampshire that has been lost as a result of development.
- √ Beach grass and native dune vegetation was planted.
- √ The private access path was eliminated, given the close proximity to the town access path.
- √ The size of the driveway was reduced and constructed with pervious pavers.
- √ The deck was elevated to the second floor reducing the amount of pervious surface.



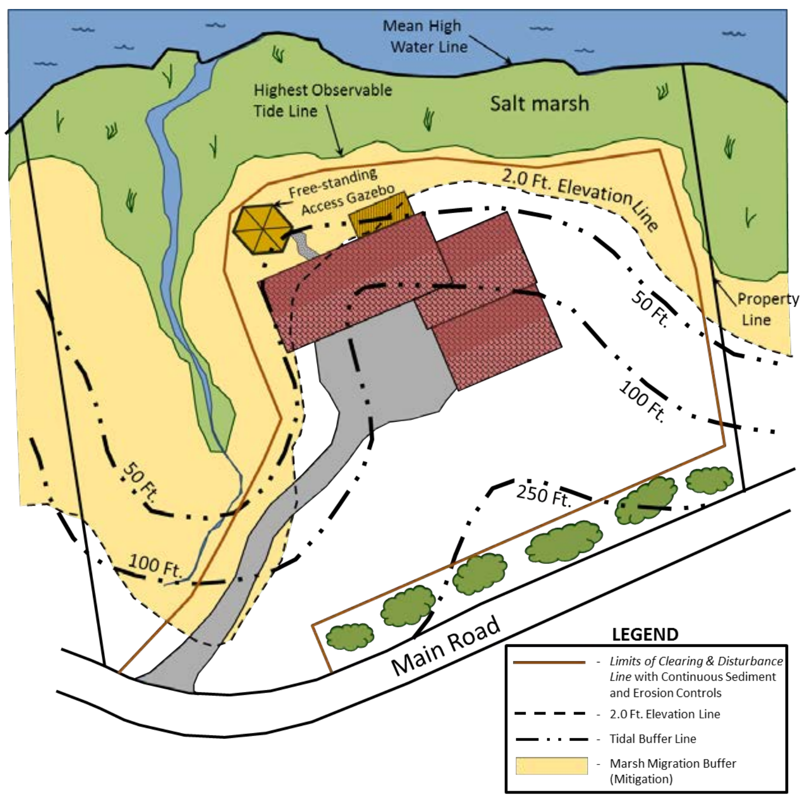
Tidal Marshes

Salt marshes are important transitional habitat between the ocean and the land; they are estuaries where fresh and salt waters mix. Salt marshes are among the most productive ecosystems on Earth. The position of salt marshes on the landscape and their productivity make them important not only as a part of the natural world but also to humans. There are about 6,200 acres of salt marsh in New Hampshire, many of which have been damaged by management actions that have had unintented consequences, such as restricted tidal flow, filling, ditching and increased freshwater flows.

Inlet of Little River Salt Marsh, Hampton, NH – credit: Jen Drociak

Example 11.3a: Salt Marsh Lot – Original Plan

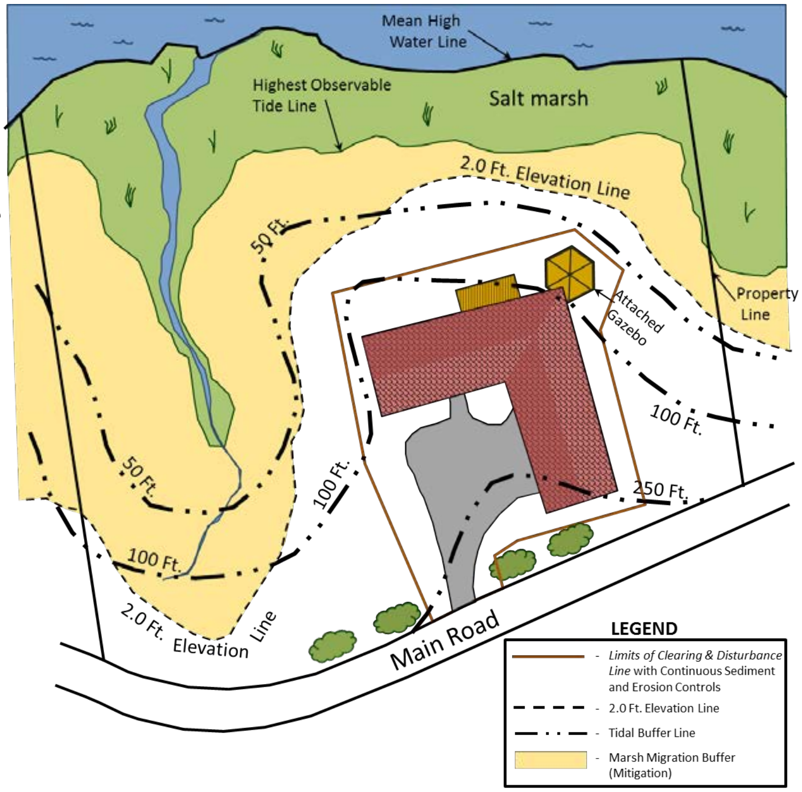
The house and accessory structures in this example are encroaching upon the Marsh Migration Buffer.



Example 11.3b: Salt Marsh Lot – Revised Plan

How wetland impacts were minimized:

- √ The house and LOD were moved out of the Marsh Migration Buffer.
- √ The length of the driveway was reduced.



Awcomin Marsh, Rye, NH – credit: Jen Drociak

Chapter 12 – Non-Tidal Shoreline Structures

New Hampshire has an abundance of lakes, ponds and rivers that provide great opportunities for recreational activities such as fishing, boating and swimming. They also serve as sources of drinking water in some areas and are important habitat for various aquatic species. The public waters of New Hampshire are valuable resources held in trust by the state. Installing a dock disturbs lands that are subject to RSA 482-A. The law was originally enacted over 50 years ago to protect commerce, navigation and recreation, as well as habitats and reproduction areas for plants, fish and wildlife. Applying for a permit allows NHDES to work with you to minimize any adverse impacts. In order to help ensure fair, safe and practical use of public waters, the State has specific rules and regulations pertaining to non-tidal docks. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Shoreland Woodland Buffer Requirements

- On a given lot, at least 25% of the woodland buffer area located between 50 feet and 150 feet from the reference line shall be maintained as natural woodland where all existing native ground cover, shrubs and trees are allowed to grow. (RSA 483-B:9)

Shoreland Waterfront Buffer Requirements

- Within 50 feet of the reference line, ground cover and shrubs may not be removed, landscaped or converted to lawn; they may only be trimmed to a height of no less than three feet. Trees may also be pruned as long as the health of the tree is not endangered, and trees may be removed provided the remaining trees comply with the point score requirement. (RSA 483-B:9) See NHDES fact sheet on Vegetation Management for Water Quality.

Planning and Site Selection

Docking structures located on inland freshwaters have specific design criteria and limitations that must be adhered to. There are several factors that one should first consider when planning a dock.

- How many feet of water frontage the property has.
- The size of the lake or pond.
- The allowed configuration of the dock.

- Whether or not the dock will be permanent or seasonal (permanent docks may only be approved on lakes greater than 1,000 acres).
- Unique physical hardships of the property such as insufficient water depth, not shared generally by nearby properties that require larger dimensions.
- Need for other structures such as breakwaters and boatlifts.
- Distance from proposed dock to abutting property lines or imaginary extension of the property line over the surface water.

Access for docks may require removal of vegetation, which may only be six feet wide and configured in a manner so as not to concentrate stormwater runoff or contribute to erosion. Try to locate docks in an area that would not require vegetation removal. Consider the location of the access path and accessory structures, and where they may be located, so as to minimize impacts to shorelands and wetlands.

Design and Configuration

The standard approvable configuration of a dock is a narrow, rectangular structure that is erected perpendicular to the shoreline in lakes and pond and parallel to the bank in rivers. Other nonstandard configurations may be approved if the applicant can demonstrate the need through proper documentation.

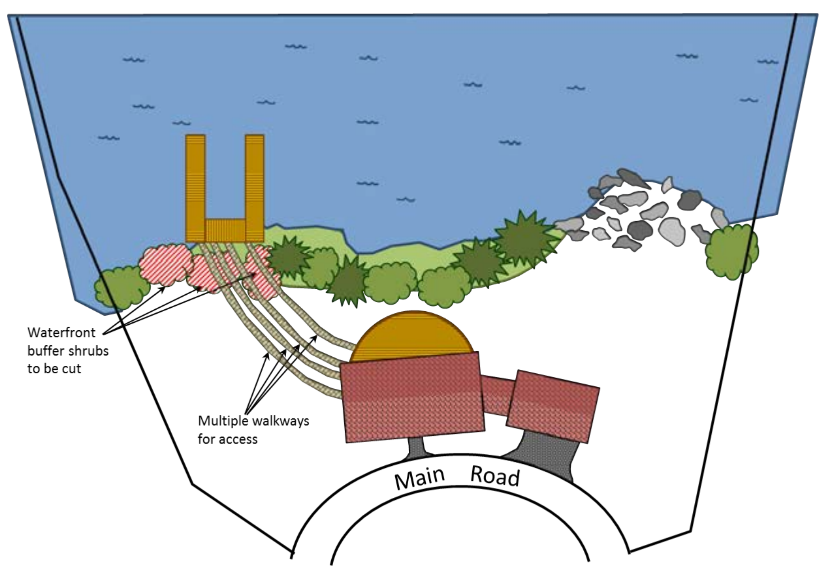
Typically, seasonal docks for lakes and ponds 1,000 acres or larger, and streams and rivers, may have a dock that is up to six feet in width by 40 feet in length. Seasonal docks located in lakes and ponds less than 1,000 acres may have a deck that is up to six feet in width by 30 feet in length. See NHDES fact sheet on Permitting for Freshwater Docking Structures.

Construction Tips

- Reduce the risk of contaminating water by inspecting machinery daily and refueling away from surface waters and wetlands.
- Use hand tools for vegetation removal if you need to make an access path to the dock.

Example 12.1a: Dock and Access Path – Original Plan

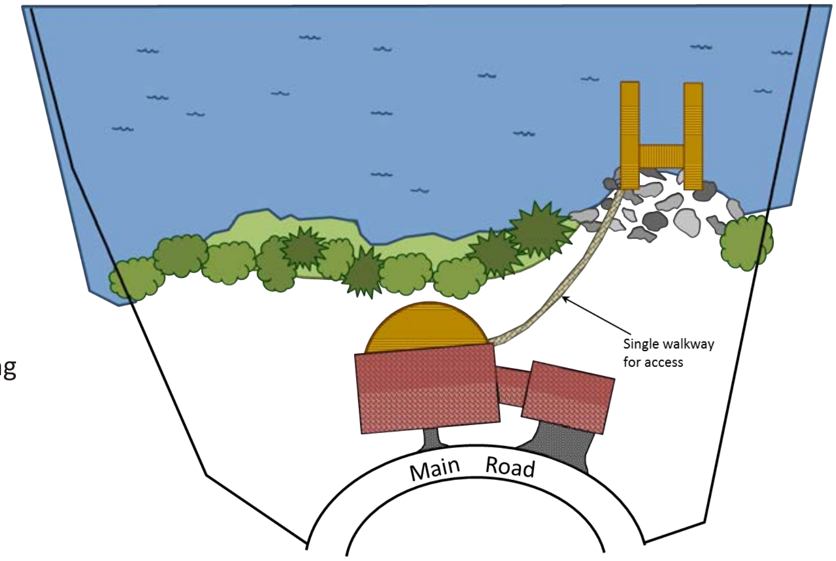
The design causes impacts to the shoreline and the waterfront buffer. Multiple paths and dock-walkway design increases foot traffic and impervious surface area.



Example 12.1b: Dock and Access Path – Revised Plan

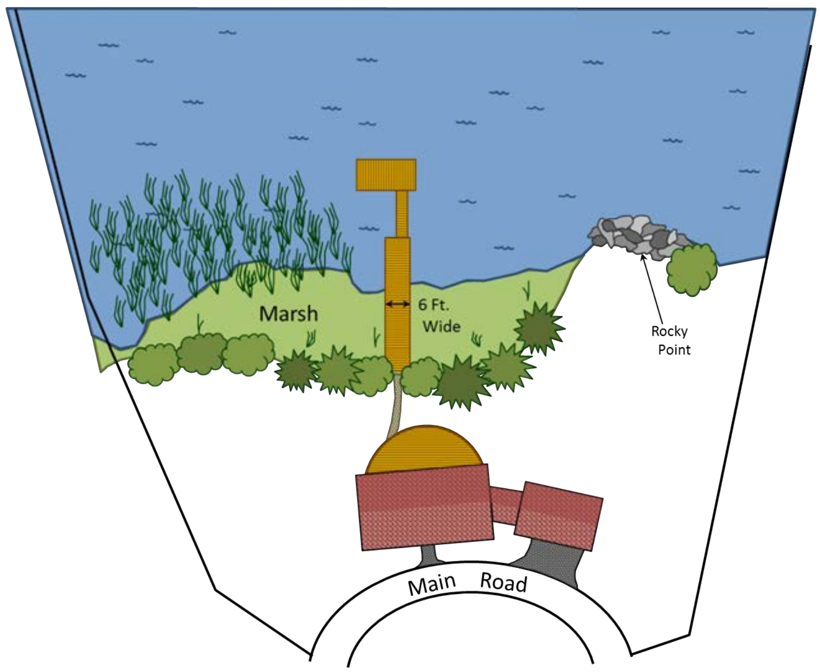
How wetland impacts were minimized:

- √ Dock is relocated away from established waterfront buffer.
- √ The connecting walkway is designed to allow access to reduce shoreline foot traffic impacts to one single path, reducing the amount of impervious surface.



Example 12.2a: Dock – Original Plan

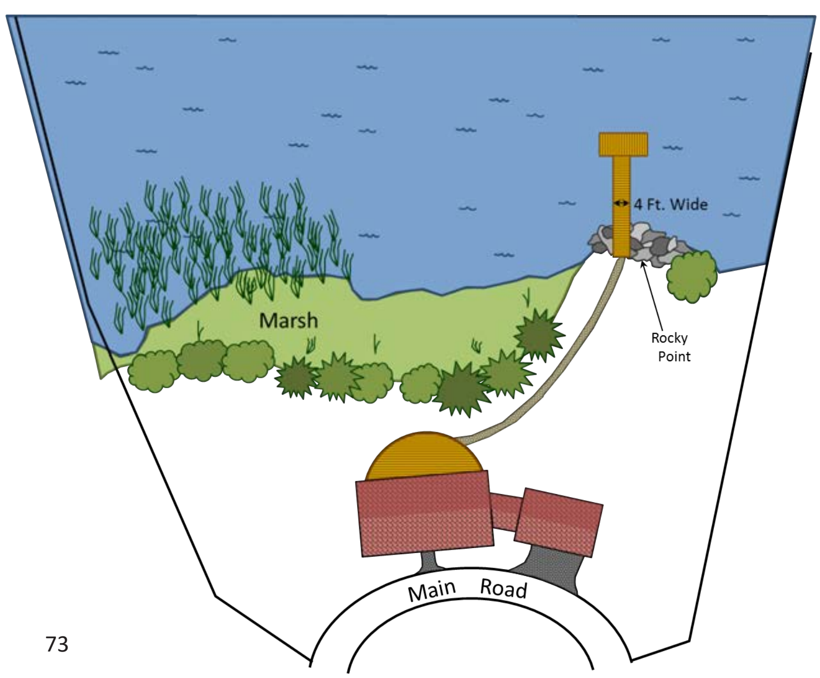
The dock is located in a marsh, which is a wetland that NHDES places emphasis on preserving.



Example 12.2b: Dock – Revised Plan

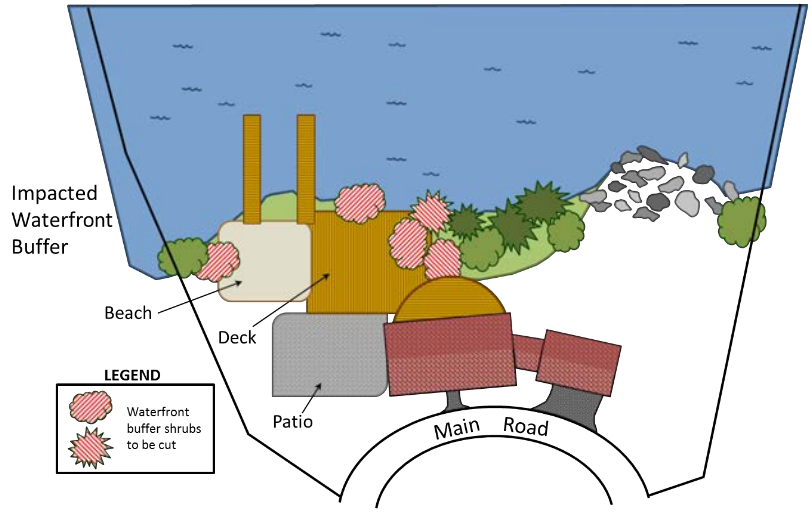
How wetland impacts were minimized:

- √ Moving the dock has avoided impacts to sensitive resources and provides access to deeper water.
- √ The dock is located at a rocky point with lower habitat value than the marsh.
- √ The footprint dimensions of the dock have been reduced from six to four feet to further minimize the impact overall.
- √ The walkway has been relocated away from waterfront buffer shrubs eliminating the need for their removal.



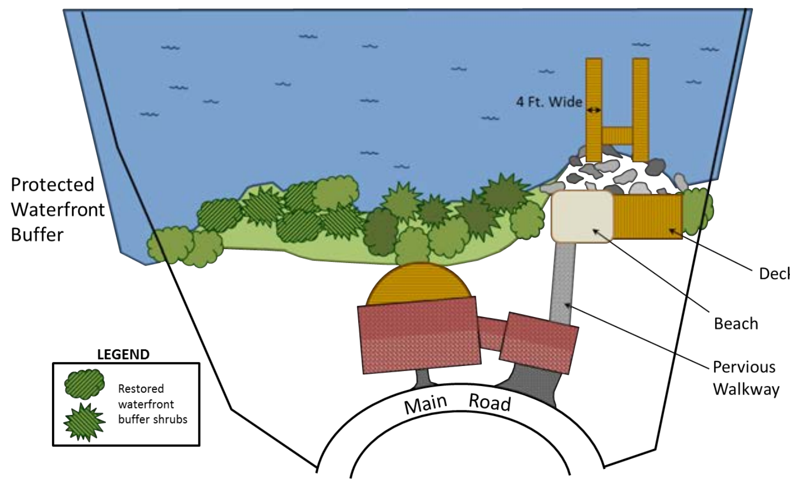
Example 12.3a: New Construction with Dock – Original Plan

New beach, deck and patio construction are located at the shoreline and take up a significant percentage of the shoreline frontage. The design requires removal of shrubs in the waterfront buffer. It also results in a significant increase on impervious surface from patio construction, which impacts the woodland buffer.



Example 12.3b: New Construction with Dock – Revised Plan

How wetland impacts were minimized:



- √ The deck, beach were reduced in size.
- √ The patio was eliminated from the plan.
- √ The beach and deck were relocated to a less sensitive area.
- √ Shrub layers in the established waterfront buffer were retained.
- √ Size of deck and beach were reduced, minimizing impact and impervious surface.
- √ The walkway was designed using pervious material to allow for water infiltration.

Chapter 13 – Utilities

This chapter is applicable to new utility projects reviewed under the standard application process. Projects that meet the exemption for utility maintenance shall follow the Utility Maintenance in and Adjacent to Wetlands and Waterbodies in New Hampshire – Best Management Practices Manual (2018). Utility installations are similar to other linear projects that NHDES permits, such as trails or roads. Utility lines include, but are not limited to: electric, water, oil, sewer, gas, cable and other fiber options. After the utility line is installed, a permanent utility easement remains or is held in free by the utility. Although all utility easements need to be accessible for periodic maintenance, they differ from trail and road projects because they are not subject to continuous human disturbance. As a result, most easements can be at least partially revegetated between maintenance cycles. Many overhead utility easements can be restored while maintaining the utility's clearance and safety standards and ensuring its ongoing reliable operation. The following recommendations are provided for the applicant to reduce despoliation to wetland functions, pursuant to RSA 482-A:1.

Common Construction Installation Methods

- Horizontal Directional Drilling.
- Elevation over wetland.
- Trench method.
- Overhead poles.
- Attachment to bridge or other structure.

Planning and Design

One of the first steps in the design of an underground utility that will cross a wetland area is to consider how to install the piping. The most wetland-friendly methods are by horizontal directional drilling (HDD) or another type of trenchless technology, such as jack and bore installation.

These methods, while expensive, will avoid or greatly minimize impacts to wetlands. In some situations, through proper pole placement in adjacent upland areas, it is possible to elevate the utility line over a wetland and avoid the need to dredge and fill. This method might be unsightly and is only appropriate to reduce impacts in certain situations. A better solution may be to attach the piping to a bridge or other structure that spans the wetland. The trench construction method is common and often very invasive, but has been used depending on the type and sensitivity of the wetland. For overhead utilities, the installation is fairly standard. The location of the poles is the most important aspect to limiting wetland impacts, although the limits of clearing are dictated by state and federal utility safety protocols.

During the planning and design stages of new utility projects, it is vital to identify techniques to protect wetland functions and values. These techniques can be implemented before, during or after construction. Although a technique may be employed post-construction, it should still be part of the original planning and design process. For example, construction sequencing and post-construction maintenance scheduling should be considered during the design stage and must be part of a final application submitted to and reviewed by NHDES.

Avoidance and Minimization Techniques

- Avoid both above- and below-ground wetland crossing impacts.
- Minimize the width of typical access roads through wetlands.
- Target existing corridors or developed areas, such as easements, roads, roadway shoulders, bridges or old railroad beds, as the first alternative preference.
- Try to avoid disturbing stream beds; if they must be disturbed, utilize a straight and narrow section with low banks.
- Avoid construction access or work in organic soils where possible.
- Consider spanning a wetland by locating utility poles on either side of the wetland, instead of disturbing the interior.
- If attaching utility lines to a bridge or other structure, be aware of possible floodplain constraints.
- If underground piping cannot be avoided, consider installing it in a crack-proof casing so that the area above the piping can be replanted with vegetation.
- Where possible, keep the size of cleared maintenance areas above and around utility lines to a minimum.
- For electric lines, consider suspending the wires above the wetland tree canopy.
- Avoid diversion of surface water and groundwater sources, which could affect nearby wetlands. Sub-draining effects from trench installation must be guarded against.

Construction Tips

The following pre- and post-construction Best Management Practices minimize wetland impacts. These practices should be considered during the initial planning and design phases.

Before Construction

- Administer pre-job briefings to ensure everyone is conducting work according to the environmental permit conditions.
- Ensure that soil erosion and sediment controls are properly installed and maintained.
- Have all necessary materials on hand before beginning work.
- Sequence driveway and utility installation within close proximity to limit the length of disturbance to wetlands, particularly for housing lots.

During Construction

- Limit construction to outside the breeding and migratory seasons of wetland wildlife, unless authorized by NHDES.
- Preserve all low-growing varieties of vegetation adjacent to wetlands to the fullest extent possible in order to minimize erosion potential.
- Limit construction activities to the low-flow periods, the appropriate time-of-year restrictions, or to when the soil is frozen.
- Use structures or devices to prevent sub-draining or groundwater movement along pipelines, such as anti-seepage collars, intermittent clay barriers, trench plugs or clay saddles.
- Conduct work manually, whenever feasible.

- For underground utilities through wetlands, install pipe sleeves that wires or smaller pipes can be placed within to allow for easy access for future utility maintenance and repair.
- Use wide-tired or tracked vehicles when working in or near wetlands to cause less rutting and soil disturbance.
- Use swamp mats in wetlands to minimize soil disturbance and rutting.
- If dewatering of trenches is necessary, water must be pumped to an acceptable, properly designed dewatering basin. See the New Hampshire Stormwater Manual Volume 3: Erosion and Sediment Controls During Construction.

Restoration and Maintenance

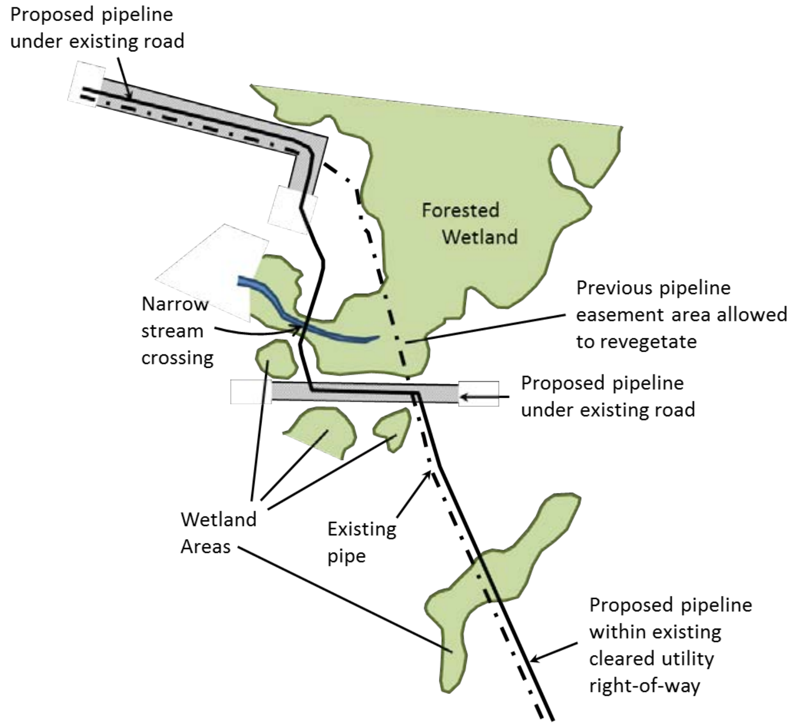
Restoration efforts must be considered during the initial planning and design phases and must be included in the application submittal. (See Standard condition in Env-Wt 307.12 Work Site Restoration.)

- Plan for restoration to be completed before the end of the growing season and as soon as possible after installing the utility.
- Utilize a seed mix comprised of native species that is appropriate to the site conditions in all temporary wetland impact areas.
- Stabilize all disturbed areas outside of the cleared maintenance zone with grasses and vegetation.
- Restore wetland soils and hydrology to pre-construction conditions and grades.
- Restore disturbed stream channels to original width and substrate.
- Maintain the area by hand cutting or mowing.
- Include the maintenance schedule for standard utility projects and the entity responsible for post-construction stabilization and restoration.
- Include methods for completing regular and emergency repairs to utility lines.

Granite Reliable Wind Farm, Millsfield, NH – credit: Craig Rennie

Example 13.1: Enlarged Pipeline Avoidance and Minimization

This overhead view of a proposed enlarged pipeline illustrates several avoidance and minimization techniques that were used in the initial project design, as well as additional techniques proposed to further minimize wetland impacts.

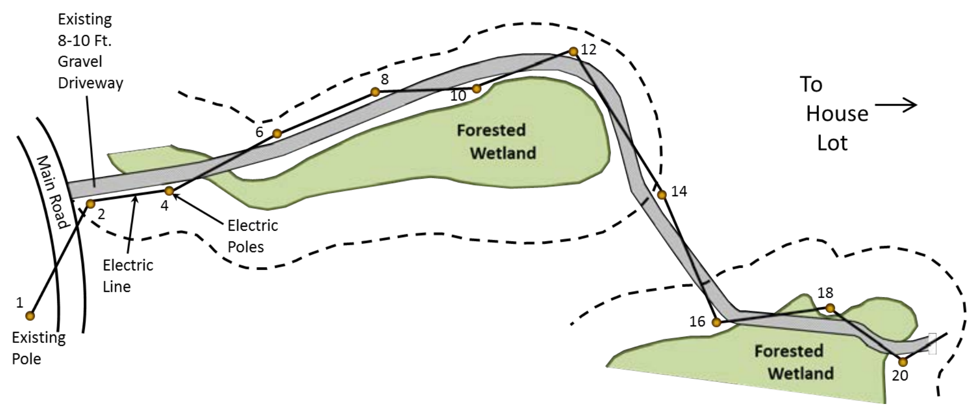


How wetland impacts were minimized:

- √ Existing utility easements and already disturbed road corridors were used to install new pipe.
- √ A narrow stream area was crossed to avoid bisecting the large forested wetland.
- √ Several other small wetland areas near the forested wetland were skirted to reach the narrow crossing.
- √ The existing utility easement through the large forested wetland was allowed to revegetate.

Example 13.2: Above-Ground Installation

This example shows the installation of an overhead utility to a single-family house. The electrical wiring follows an existing gravel driveway that was constructed over 30 years ago. The electric poles were installed at the same time that the driveway was upgraded, to limit construction disturbance.



How wetland impacts were minimized:

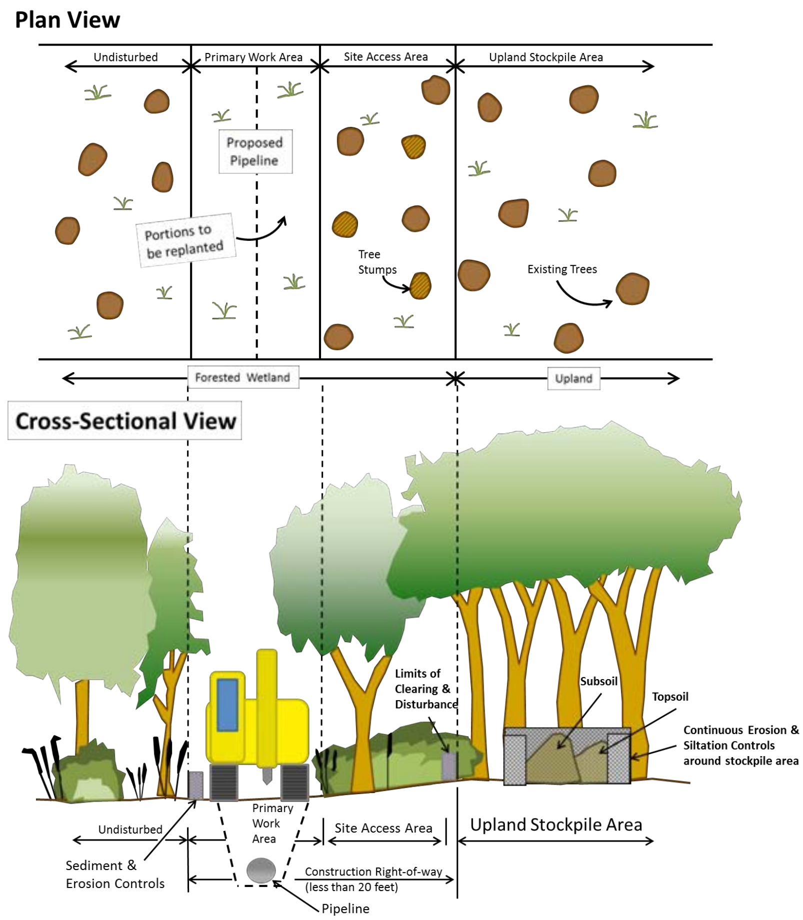
- √ The electric wires cross at narrow sections or skirt the edge of the wetlands.
- √ None of the approved poles were located in the wetlands.
- √ The proposed electric lines were located along an existing disturbed area.
- √ The electric lines zigzag back and forth across the driveway, which limits the amount of wetland and transition area disturbance.
- √ Most guy wires were installed further outside of the wetland areas.
- √ Wooden mats were used to reduce disturbance to wetland soils in especially sensitive areas when needed.
- √ The existing tree canopy was maintained along both sides of the gravel driveway.
- √ The approved tree cutting and brush cutting were completed by hand to limit disturbance to the wetland.

Construction Methods

There are a variety of methods that can be utilized to install utility pipes. NHDES needs to know which method will be utilized to determine the amount of impact a project will have on wetlands. The majority of utilities, with the possible exception of overhead electrical or telephone or cable television wires, are installed below ground. The below-ground piping is covered by soil, and much of the area (outside of the maintained zone) is vegetated. The following examples show various ways to avoid and minimize wetland impacts.

Example 13.3: Enlarged Pipeline Avoidance and Minimization

This diagram illustrates a proposed natural gas pipeline through a wetland area. The applicant has proposed the trenching method to install the pipeline. Often, the trenching method requires a wide construction right-of-way – sometimes over 100 feet for equipment and staging areas – outside of the wetland. In order to minimize impacts in this project, the proposed width of the disturbed area was limited to less than 20 feet. This was accomplished by using one small machine to dig, lay the pipe and backfill, instead of a larger machine that requires a greater width to operate.



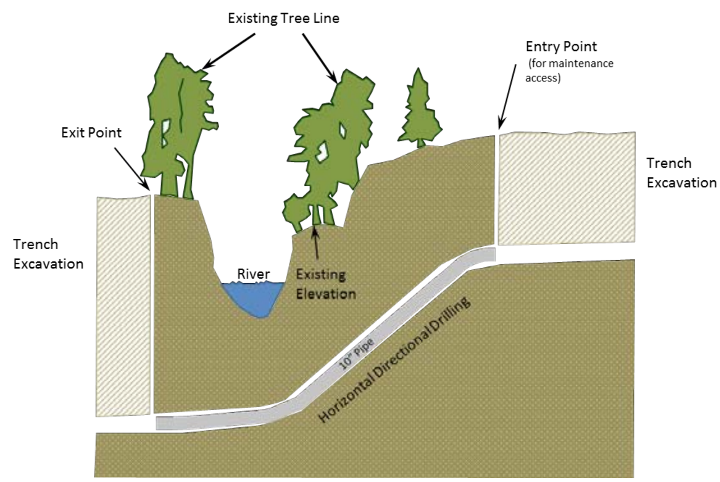
How wetland impacts were minimized:

- √ The primary work and stockpile areas were narrow.
- √ Limited vegetation was cleared for the stockpile area.
- √ Tight LOD on either side of the construction right-of-way were maintained.
- √ The existing tree canopy was maintained.
- √ The amount of overall disturbance was reduced by the use of small machinery in the wetland area.
- √ Tree stumps were left in place to allow for re-growth after the completion of the project.
- √ Separation of excavated topsoil from subsoil allowed for easy and correct replacement after the pipe was installed.
- √ The stockpile area was completely replanted upon completion of the project. The primary work area was lightly revegetated (no large, woody vegetation), thereby allowing a narrow corridor to be maintained for access to the pipeline.

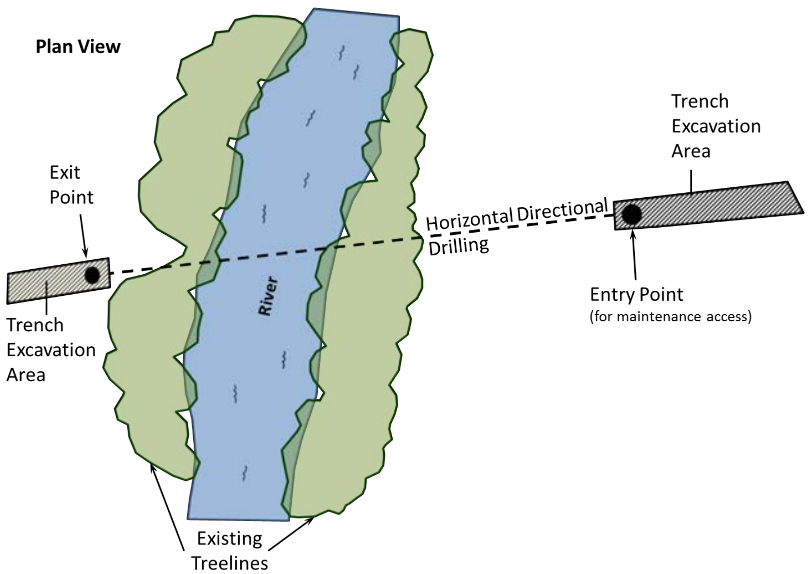
Example 13.4: Horizontal Directional Drilling

This example shows a cross section of land where the horizontal directional drilling method was used to install piping. Although expensive, this method was completed with the least amount of wetland impact. A guided drill head can bore horizontally under roads, wetlands, vegetation and buildings. This method is most commonly used for short spans under wetlands. Boring machines are able to drill through nearly any type of soil; however, the pipe installation method depends on the substrate, as well as the season. Once installed, the pipeline will be maintained in the same way, using a guided drill head (often with a camera attached) to find the problem area. A broken pipe may be replaced with a new pipe or sealed with chemical compounds.

Cross Sectional View



Plan View



How wetland impacts were minimized:

- √ There was no disturbance to wetland, wildlife, habitat or vegetation because entry and exit points were located outside of wetland areas.
- √ The pipe was installed a minimum of 10 feet below the river bottom to avoid impacts to the river.
- √ A small work area was required for the initial hole, and limited equipment was used. In some cases, pipe installation requires additional clearance areas.
- √ The work area was located outside of the 100-year floodplain.
- √ There is no cleared corridor to maintain.

References and Resources

This Manual should be used by applicants and consultants in conjunction with RSA 482-A, New Hampshire wetlands law and applicable rules, and other guidance materials developed by NHDES, including delineation manuals, assessment manuals, and best available scientific studies and technical guides.

Related NHDES Fact Sheets

WB-19 Permitting for Freshwater Docking Structures

WD-R & L-21 Managing Large Woody Material in Rivers and Streams

WD-SP-5 Vegetation Management for Water Quality

ID-4 Habitat-Sensitive Site Design and Development Practices to Minimize the Impact of Development on Wildlife

ID-5 Minimizing the Impact of Development on Wildlife: Actions for Local Municipalities

WD-WB-15 Permitting of Tidal Docks

WD-WB-16 Compensatory Mitigation Information and Checklist

WD-WB-17 Aquatic Resource Mitigation

Tools

Aquatic Restoration Mapper – Explore stream crossing data in your community.

National Wetlands Inventory (U.S. Fish & Wildlife Inventory)

New Hampshire Fish Survey – Database of fish survey records. (NHFG)

NH Method – Method for Inventorying and Evaluating Freshwater Wetlands in New Hampshire. (University of New Hampshire Cooperative Extension)

Vermont Geomorphic Assessment

Web Soil Survey, U.S. Department of Agriculture Natural Resources Conservation Service.

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Resources

Wetland Identification & Assessment Resources (NHDES)

Streams and Stream Crossing (NHDES)

New Hampshire Stream Crossing Initiative (NHDES, NHDOT, HSEM, NHFG, NHGS)

FEMA floodplain maps (NH Office of Strategic Initiatives)

Floodplain forests (UNH Cooperative Extension)

New Hampshire State Parks

Native Plants for New England Rain Gardens (SoakNH)

Native Shoreland/Riparian Buffer Plantings for New Hampshire (NHDES)

Prohibited Invasive Plant Species Rules (New Hampshire Department of Agriculture)

2014 Wetland Plant List (US Army Corps of Engineers)

Northcentral and Northeast 2016 Regional Wetland Plant List (US Army Corps of Engineers)

Best Management Practices

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Best Management Practices for Forestry: Protecting New Hampshire's Water Quality. UNH Cooperative Extension. 2005.

Best Management Practices for Roadside Invasive Plants. NHDOT. 2008.

Best Management Practices for Routine Roadway Maintenance Activities in New Hampshire. NHDOT. September 2018.

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