Town of Dover
Road-Stream Crossing Management Plan

Produced by
The Housatonic Valley Association
2019

HVA

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Introduction

Partners, Funders and Advisors

Acknowledgments

We are pleased to present this 2019 Town of Dover Road-Stream Crossing Vulnerability Assessment. We wish to thank the following agencies, officials and individuals for their assistance with the development of this inventory, crossing assessments and municipal road-stream crossing mitigation prioritization results:

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Sincerely,

Supervisor Linda S. French
Deputy Supervisor Andrew J. House
Councilman Richard C. Yeno
Councilwoman Jane Meunier
Councilman Redmond Abrams II

"We're not on our journey to save the world but to save ourselves.
But in doing that you save the world.
— Joseph Campbell

Background on the Town of Dover, NY
2019

About the Town of Dover

The Town of Dover is located in southeastern Dutchess County, bordered on the east by the State of Connecticut, and approximately 90 miles from both New York City and Albany, NY. The Town separated from the Town of Pawling, NY in 1807 and comprises the unofficial hamlets of Dover Plains and Wingdale. Early settlement and industry centered on homestead farming, iron ore smelting and limestone and marble quarry production.

The introduction of the New York & Harlem Railroad with stops in Dover facilitated growth through the mid to late 1800s. In 1924, New York State constructed the Wingdale State Hospital (later named the Harlem Valley Psychiatric Center) that served as major employer for seven decades. During World War II, the federal government constructed a short-lived military defense plant that manufactured magnesium from local limestone.

The Town experienced increased residential development during the 1980's with an influx of families from downstate counties seeking housing and community-based culture. The state hospital's decommission in 1994 precipitated a period of economic uncertainty for residents and businesses that formerly supported the facility's day-to-day operations. In 2014, the campus was purchased and is currently a nonprofit university.

By the start of the new millennium, most of Dover's former state workforce were assimilated into new employment. During these challenging years, local businesses and regional employers helped sustain the Town's economy. Over the past decade, Dover has become a popular regional tourism venue for nature enthusiasts who visit the Dover Stone Church Preserve and hikes on the Dover-Pawling segment of the Appalachian Trail. In 2012, the NYS DEC, serving as lead agency, approved construction of a 1,100-megawatt natural gas-fired electricity generation plant on a former brownfield-type parcel. The completion and commission of this facility, the Cricket Valley Energy Center, are slated for late 2019. A community solar (panel) farm, approved in 2018, is also currently under construction.

As of July 2018, Dover's population is 8,699 and municipal leaders are currently working on an update of the Town's 1993 Master Plan and zoning to better utilize Routes 22 and 55 as economic drivers to facilitate new commercial development. Based on a steady uptick in home purchases and the Town's welcome of renewable energy production as a new sector of economic development, Dover is increasingly well-positioned to serve the requisites of a 21st Century community.

Background of the Town of Dover's Road-Stream Crossing Inventory and Vulnerability Assessments

From a bird's eye view, the Town of Dover is situated between Dutchess County's East and West Mountains, or topographically, between the orogenies of the Taconic Mountains and the Berkshires. The Town of Dover, named for its limestone that was reminiscent of the coccoliths of Dover, England, is comprised of the unofficial hamlets of Dover Plains and Wingdale and is the largest township of Dutchess County.

With the necessity of placing development on slopes as well as the valley bottom, the cumulative impacts of generational climate change over Dover's 212-year history has particularly stressed its transportation infrastructure. Moreover, climatic events in 2005, 2007 and 2009 and outer bands of hurricanes in 2011, 2012 and 2013 resulted in recurrent flooding in the Dover Plains hamlet along the Ten Mile River and intermittent road failures on East and West Mountains.

In 2010, Dover led the development of a FEMA-approved All Hazards Mitigation Plan (AHMP) with eight neighboring Eastern Dutchess County communities. In 2016, the Dover Town Board adopted the NYS Climate Smart Communities Pledge and established the Dover Climate Smart Task Force. To date, the Town has received two NYS DEC Climate Smart Communities Certification Program grants to implement municipal-sponsored and community-based efforts to ameliorate the negative impacts of local climate change and improve climate adaptation.

This publication was funded in part through a 2017 NYS DEC Climate Smart Communities Certification Program grant. It provides 2018 baseline vulnerability assessments of the Town's 124 road-stream crossings with flood risk modeling analysis by the University of Connecticut's Department of Civil and Environmental Engineering and habitat barrier status inspections by the North Atlantic Aquatic Connectivity Collaborative. Baseline results were presented publicly and then further reviewed with elected officials and public works representatives. From those discussions, a municipal prioritization schedule was developed to identify culverts with the shortest flood intervals and crossings (i.e., bridges) with the highest priorities for replacement based on deterioration and past flooding issues. With the completion of this report, town leaders now have research-based, objective and empirical findings to plan and implement the most time-sensitive road-stream crossing and culvert replacement/upgrade capital projects.

The Housatonic Valley Association, Inc. (HVA) played an invaluable role in assisting the Town of Dover with data collection, analyses and preparation of this report. HVA is "a tri-state nonprofit citizen's environmental group to conserve the natural character, environmental health and the economies of our region by protecting and restoring its land and water... for today and for future generations." (HVA, 2019). The Ten Mile River, that traverses the length of the Town of Dover, is a tributary of the Housatonic River that empties at the Long Island Sound. In our experience, there are no riverkeepers in America who love and strive harder to actualize their mission than HVA's devotion to the well-being of the Housatonic River and Dover's segment of the life-sustaining Ten Mile River and watershed.

I. Executive Summary

The Town of Dover has 101 miles of streams and rivers, and 154 miles of roads and other transportation corridors. At every intersection between these two long, linear networks, there is a bridge, culvert, or some other mechanism for carrying the road over the stream. Collectively, these structures are referred to as “road-stream crossings.” Just as roads are designed to accommodate levels and types of traffic and are built to those specifications, streams are also built to function in particular ways, shaping themselves based on their watershed, the climate and other factors. ***Road-Stream crossings that change the natural shape of a stream (most commonly because they are undersized and/or misaligned) are more vulnerable to flood damage, require more maintenance, and can also block the movement of fish and wildlife along the stream corridor.***

Because streams and transportation networks are linear systems laid over each other, intersections are common. There are 124 road-stream crossings in the Town of Dover alone. This is the case along the Ten Mile River and its tributaries in Dover, many of which are home to populations of rare species that indicate healthy, intact cold-water fluvial habitat, such as native brook trout (*Salvelinus fontinalis*), burbot (*Lota lota*) and slimy sculpin (*Cottus cognatus*). The results of ongoing research to identify flood risks and habitat barriers at road-stream crossings indicate that a significant proportion of these structures are management issues. Initial results of an ongoing study conducted by the Housatonic Valley Association (HVA) indicate that 56% of the non-bridge road-stream crossings (i.e., culverts) evaluated to date in the Housatonic watershed are considered moderate or worse barriers to fish and wildlife movement (n = 976). Furthermore, modeling by project partners at the University of Connecticut indicates that approximately 1 in 5 (18%) non-bridge structures evaluated fail (i.e., water over the road) in a 25-year recurrence interval flood or smaller (n = 594). Given the sheer number of problem structures, a strategic approach to restoring habitat connectivity and reducing flood risk at road-stream crossings is necessary.

Proportions of the non-bridge structures for which UConn flood risk analysis was performed (n = 594) that fail at the given flood intervals

Recurrence of Interval Failure	Number of Culverts	Percentage
2-Year	14	2%
5-Year	10	2%
10-Year	23	4%
25-Year	61	10%
50-Year	45	8%
100-Year	50	8%
200-Year	57	10%
Passing	334	56%

In 2015, HVA began a pilot project to develop road-stream management plans in seven towns in Northwest Connecticut (Canaan, Colebrook, Cornwall, Kent, Norfolk, Salisbury, and Sharon), in order to create a framework for strategic management of road-stream crossings. The primary objectives of this work are to help communities identify highest priority replacement projects based on conservation value, flood risk and maintenance need, encourage adoption of culvert design Best Management Practices, and create a new tool for securing financing for replacement projects. This project was expanded in 2017 and 2018 to include towns in New York and Massachusetts.

HVA'S ROAD-STREAM CROSSING MANAGEMENT PLANNING PROCESS

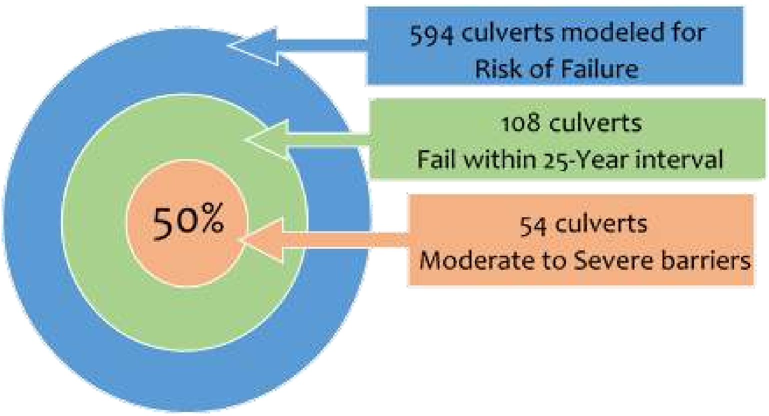
1) **Assessments of all road-stream crossings in Town:** Assessments for fish and wildlife passage (stream habitat continuity) are done using the NAACC protocol. Data collected in the field is uploaded to a regional online database which produces a "passability score" and barrier evaluation, ranking the site's ability to pass fish and wildlife and ranging from 0 (complete/ severe barrier) to 1 (no barrier, full passage).
2) **Flood Risk Analysis:** All closed-bottom structures (culverts) are assessed for flood resiliency, through a collaboration with UConn Department of Civil and Environmental Engineering (UConn), using a hydraulic capacity model that predicts failure (water overtopping the road) at various flood frequencies (2-, 10-, 25-, 50-, 100-, 200-year recurrence intervals).
3) **Road-Stream Crossing Inventory documents:** Town-wide inventory documents are developed for partner municipalities, containing maps, photos, all data collected in the field, and barrier status for each crossing, as well as the results of UConn's flood-risk analysis.
4) **Collaborative prioritization:** Inventory documents are used to guide prioritization workshops for each town, with representatives from the Board of Selectmen, Public Works and Emergency Services as well as other key stakeholders. These meetings allow for a better understanding of distinct flood-risk issues at specific sites in each town, such as frequent flooding or sediment/debris accumulation. Sites that exemplify the intersection of the three target issues, high flood risk, poorly connected habitat, and poor structure condition, were then selected in each town for further project development.
5) **Preliminary Design for Replacement (where funding is available):** Conceptual designs and implementation strategies for the highest priority replacement project in each town are developed in collaboration with a Project Engineer. Replacement projects are designed using the Stream Simulation method, which not only preserves safe roadways and minimizes expenses associated with more frequent repair and replacement, but reconnects critical habitat for ecologically and economically important native species like Eastern Brook Trout.
6) **Road-Stream Crossing Management Plans:** All of the above information, along with conclusions and management recommendations, is assembled as Road/Stream Crossing Management Plan document for each partner town. These documents are suitable for official municipal adoption as an annex to local Natural Hazard Mitigation plans.

This document is the product of a collaborative planning process meant to identify the highest priority road-stream crossing replacement projects at town-managed structures in the Town of Dover based on flood risk, potential to restore stream habitat connectivity, and maintenance need. Using a town-wide comprehensive Road-Stream Crossing Inventory as the launching point for collaborative prioritization, Town staff and officials in partnership with HVA and other stakeholders worked together to rank structures for replacement. In addition to information collected in the field, the Inventory document includes the results of flood risk modeling conducted by researchers at the University of Connecticut Department of Civil and Environmental Engineering (UConn), and an evaluation of the habitat barrier status of each structure conducted by the North Atlantic Aquatic Connectivity Collaborative (NAACC). Multiple stakeholder workshop meetings combined local knowledge of past flood events, the occurrence of species targeted for conservation (such as Eastern Brook Trout [*Salvelinus fontinalis*]), and structure condition with the results of this modeling to identify replacement projects most likely to achieve multiple benefits.

In addition to prioritizing structures for replacement, this document is also meant to provide information on Best Management/Design Practices for road-stream crossings that can simultaneously reduce flood risk, restore stream habitat connectivity, and reduce long-term infrastructure costs. Structures designed to conserve natural stream shape and function not only allow for the movement of aquatic and terrestrial organisms, but also require less long-term maintenance and are more resilient to large floods. Less maintenance and longer life-span mean that these structures are more cost-effective over the long term.

II. General Recommendations:

Wherever possible, build road-stream crossings that allow for natural stream function upstream, downstream and within the structure.



Proportion of culverts that fail in the 25-year flood interval and are considered moderate or worse barriers to fish and wildlife movement

There is significant overlap between flood risk and habitat barriers at non-bridge road-stream crossings; the results of HVA's regional study of the intersection of culvert barrier status and flood risk indicate that 56% of all culverts that fail in the 25-year flood interval or smaller are also considered moderate or worse barriers to fish and wildlife movement based on NAACC evaluation. A growing body of research indicates that design techniques that conserve stream shape and processes through a crossing structure accomplish multiple benefits- these structures reduce long-term maintenance costs, risk of failure during large floods, and restore stream habitat connectivity[1]. ***The Town of Dover should build road-stream crossings that conserve stream shape and process across the road elevation to the maximum extent possible with every replacement project, using the principles of Stream Simulation Design.***

Heavy rain from a thunderstorm, Town of Sharon. Photo source: Litchfield County Times

[1] Stream Simulation Working Group. (2008). *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings*. San Dimas Technology and Development Center: U.S. Department of Agriculture, Forest Service.

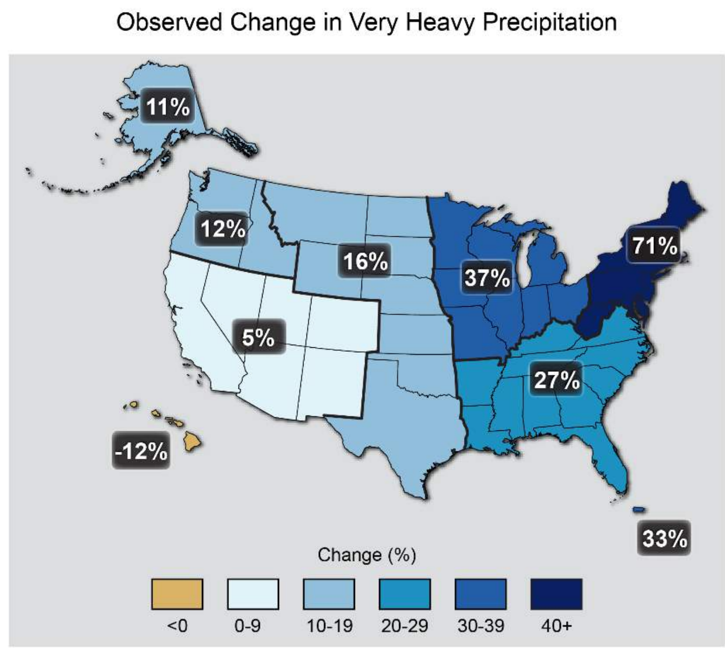
Gillespie, N., et al. (2014). Flood Effects on Road–Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs. Fisheries, 39(2), 62–76.

Levine, J. (2013). An Economic Analysis of Improved Road-Stream Crossings. Keene Valley, NY: The Nature Conservancy, Adirondack Chapter.

Massachusetts Division of Fish and Game, Division of Ecological Restoration. (2015). Economic & Community Benefits from Stream Barrier Removal Projects in Massachusetts.

Wherever possible, build road-stream crossings to pass the 100-year recurrence interval flood, based on the most up-to-date hydrologic information for the Northeast.

Climate change is increasing occurrences of intense rainfall and extreme precipitation events in northeastern U.S. towns, such as the Town of Dover[2]. Road-stream crossings are particularly susceptible to increased flood risk, especially if they were designed using outdated hydrologic information. Many structures in Dover were sized using design storms derived from National Weather Service Technical Paper 40 (TP-40)[3], which was released in 1961. The most recent NOAA Precipitation Atlas for the Northeastern United States (released in 2016)[4] shows a roughly 2-inch increase in the amount of rain expected during the 24-hour, 1% annual chance storm from TP-40. This trend is expected to continue as climate change progresses. ***Therefore, it is critical that the Town of Dover takes advantage of replacement projects to increase hydraulic capacity at road-stream crossings, using the best available hydrologic information.***



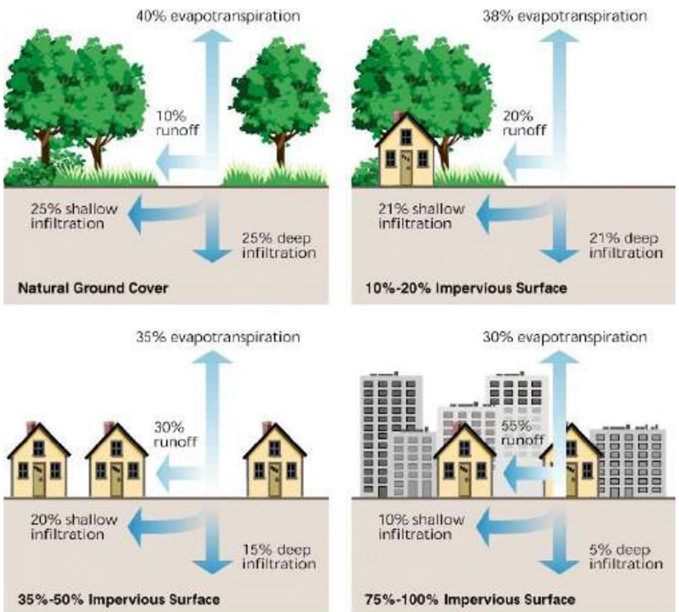
The map shows percent increases in the amount of precipitation falling in very heavy events (defined as the heaviest 1% of all daily events) from 1958 to 2012 for each region of the continental United States. The changes shown in this figure are calculated from the beginning and end points of the trends for 1958 to 2012. (Source: Melillo, J.M. et al., Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, as updated from Karl, T. R., et al. (2009): Global Climate Change Impacts in the United States. T.R. Karl, J.T. Melillo, and T.C. Peterson, Eds. Cambridge University Press.)

Always consider potential downstream impacts when right-sizing road-stream crossings

While increasing hydraulic capacity is critical to reducing maintenance costs and flood risk at individual structures, care must be taken to minimize risk to downstream property and infrastructure when doing so. Many undersized structures in road elevations currently serve as de-facto flood storage dams, reducing downstream flood peaks. Note that this is not a good

[2] Spierre, Susan G, and Cameron Wake. (2010). Trends in Extreme Precipitation Events for the Northeastern United States 1948-2007. *Carbon Solutions New England*.
New York State Department of Environmental Conservation. (2015). Observed and Projected Climate Change in New York State: An Overview. https://doi.org/10.7930/J0Z31WJ2
[3] Hershfield, David M. (May 1961). *Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from I to 100 Years*. Washington D.C.: Engineering Division, Soil Conservation Science, U.S. Department of Agriculture.
[4] Perica, Sanja, Sandra Pavlovic, Michael St Laurent, Carl Trypaluk, Dale Unruh, Deborah Martin, and Orlan Wilhite. (2015). *Precipitation-Frequency Atlas of the United States: Volume 10 Version 2.0: Northeastern States.* Silver Spring, Maryland: National Oceanic and Atmospheric Administration.

reason to leave undersized structures in place- road elevations are not designed to the same standards as dams, and failures can be catastrophic. ***The Town of Dover should consider road-stream replacements holistically, with the appropriate amount of analysis to understand potential risk to downstream property and infrastructure.*** In some cases, it may be necessary to increase hydraulically capacity starting at a downstream structure in a series and work upstream, or replace multiple structures at once.



Changes in proportion of rainfall that becomes runoff in different IC scenarios (Source: Stream Corridor Restoration: Principles, Processes, and Practices, 10/98, by the Federal Interagency Stream Restoration Working Group (FISRWG))

Consider restoring and protecting natural hydrology upstream of undersized structures through Green Infrastructure/Low Impact Development practices

Impervious surfaces like roofs, roads and parking lots cause runoff to enter the stream channel much faster than undeveloped landscapes, which generally allow water to soak into the ground. This often results in higher peak flows downstream of developed areas, which in turn put more strain on hydraulically inadequate structures. Green Infrastructure practices that capture and infiltrate stormwater runoff before it reaches the stream channel can help reduce flood risk and maintenance costs at structures downstream of developed areas. These practices can also restore and protect water quality. ***The Town of Dover should identify hydraulically inadequate structures downstream of areas with existing high concentrations of impervious cover and areas targeted for development, and consider the adoption of Green Infrastructure/LID practices in areas where impervious cover is contributing to higher peak flows.***

Use this document to track ongoing maintenance, replacement projects, and other factors that may change priorities

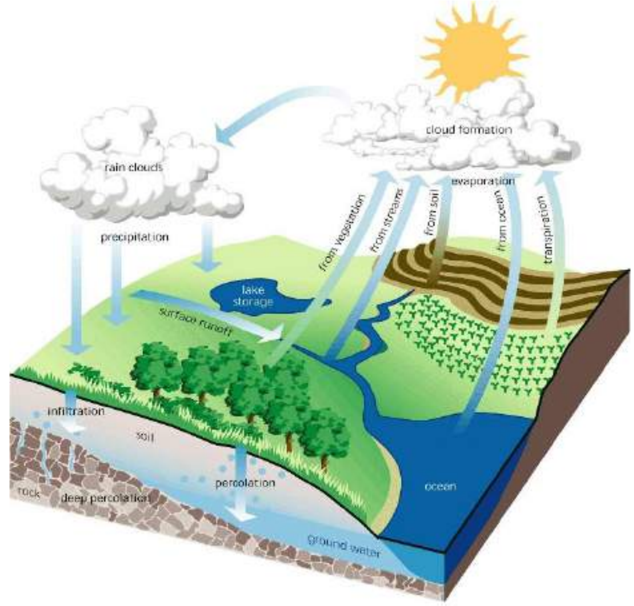
This document, particularly the Road-Stream Crossing Inventory section, should be updated periodically to reflect changing stream and structure conditions as well as ongoing maintenance and replacement projects. This is important for internal record-keeping and continuity of knowledge between staff, but is also extremely helpful for securing financing for replacement projects. For example, FEMA Hazard Mitigation Assistance through competitive grants or in the wake of the flood for projects like upsizing a road-stream crossing generally require a Cost-

Benefit Analysis; having comprehensive records of information such as required maintenance and associated costs, road closures during floods, and photographic documentation flood damage can be advantageous in this process. ***The Town of Dover should use this plan as a framework for keeping track of important information related to road-stream crossing management.***

III. How Streams Work

Adapted with permission from "Living in Harmony with Streams: A Citizen's Handbook to How Streams Work" (2012)[5]

Conserving natural stream processes through a crossing structure reduces flood risk and maintenance costs while maintaining stream habitat connectivity. This section presents general information about watersheds, the structure of streams, and the physical processes at work when water flows across the landscape to help users of this plan understand the elements of a natural stream, and how road-stream crossing design can conserve or change stream shape and behavior.



The Hydrologic Cycle (Source: Stream Corridor Restoration: Principles, Processes, and Practices, 10/98, by the Federal Interagency Stream Restoration Working Group (FISRWG))

Streams are complex systems that do complicated work. In their natural state, streams gather, store, and move water. However, it is important for understanding stream processes to realize that streams and rivers are not only moving water. Streams are also moving sediment and woody debris. The work of streams is the collection and movement of water, sediment and debris from the surrounding landscape.

Streams Come from Watersheds

A watershed is the area of land from which surface and subsurface waters drain to a common receiving body or outlet. A stream is the product of this land, the watershed, which supplies both water and sediment to the stream system. The physical characteristics of a watershed—climate, topography, soils, bedrock, vegetation and land use— affect how water reaches its streams and how those streams behave. These features also influence the potential for soil erosion and the delivery of sediment into the stream channels. A portion of the rain that falls, along with melting

[5] Friends of the Winooski River, White River Natural Resources Conservation District, Winooski Natural Resources Conservation District. (2010). *Living in Harmony with Streams: A Citizen's Handbook to How Streams Work*. Retrieved from: https://winooskiriver.org/images/userfiles/files/Stream%20Guide%201-25-2012%20FINAL.pdf

snow (precipitation) soaks into the ground and fills depressions. The excess water flows downhill into streams as surface runoff and subsurface flow.

Hydrologic Cycle

The transfer of water from precipitation to surface water and groundwater, to storage and runoff, and eventually back to the atmosphere is an ongoing cycle called the hydrologic cycle. In a climate like the northeastern United States, about 30-34 percent of precipitation runs off into surface waters; about 50 percent is returned to the air by evaporation from land and water and by plants emitting water vapor (transpiration); and about 16-20 percent seeps into the ground and recharges the groundwater supply.

Valley Slope

In hilly or mountainous watersheds such as those in the Northwest Hills, water flows quickly down steep slopes, producing “flashy” streams in which water levels rise rapidly. The steep slopes also facilitate the transport of sediment into the stream. In areas with gentler slopes, the storm flow enters streams over a longer period and will thus have peak flows that are lower.

Soils

Different types of soil absorb water differently. If the soil allows large amounts of rainfall to pass through it or infiltrate into the ground, then less water will run off as storm flow and more will enter the stream later as base flow. Soils with high clay content and frozen soils are less able to absorb water and thus cause more rapid runoff into streams.

Vegetation

Plants play a vital role in moderating the flow of water into streams and protecting against soil erosion. A rainstorm or heavy shower drops millions of tons of water on the land. When soil is exposed, the force of raindrops beats away at the surface, loosening soil particles and moving them downhill. When vegetation is present, leaves and stems intercept and reduce the impact of both falling and running water. This allows the water to either soak into the soil or to safely run off in a controlled manner. Forest soils are particularly porous and absorbent. Some of the water that infiltrates into the soil is drawn up by plant roots and transpired—or given off through the leaves as water vapor. This, in turn, renews the soil’s ability to absorb water.

Land Use

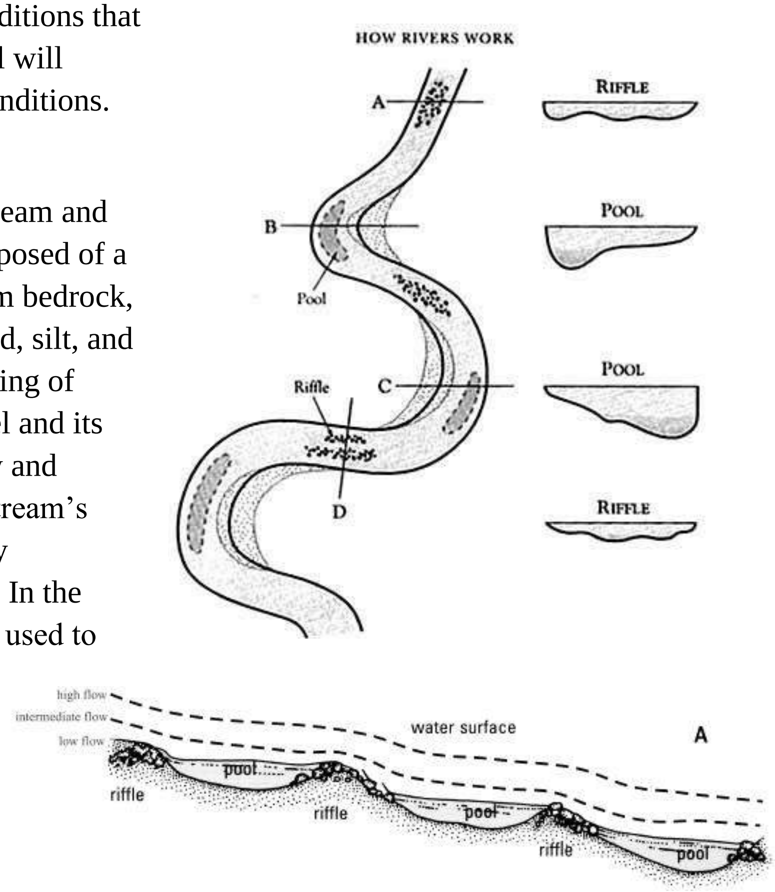
Land use refers to the way that people change the landscape, and encompasses development of towns and cities as well as agriculture, mining, timber harvesting and other activities. Land use changes in the watershed can impact the shape of the receiving stream by leaving soil more vulnerable to erosion. The erosion that occurs increases the amount of sediment delivered to a stream. This changes the pattern of water and disrupts the stream’s natural patterns of movement or equilibrium (to be explained more later on). If a disturbance, whether natural or man-made, is large enough, there can be impacts on the watershed that go beyond the initially affected area. It may take years, decades, or even centuries for a stream to reach a new equilibrium.

The Structures of Streams

Stream characteristics range from steep, swift-flowing mountain streams to flat, slow-flowing streams. The character of a stream is influenced by the amount of water it carries, the geology and soils it flows through, and the shape and slope of its valley. Each stream channel is formed, maintained, and altered by the stream itself through the processes of erosion and deposition of sediment. If something changes the conditions that have shaped the stream, then its channel will change in response to those different conditions.

Streambed and Channel

The streambed is the foundation of a stream and supports its banks. Streambeds are composed of a variety of materials, ranging in size from bedrock, large boulders, and rocks, to gravel, sand, silt, and clay particles. The scouring and depositing of these materials shape the stream channel and its floodplain. The banks within which low and moderate stream flows occur define a stream's channel. The deepest areas are generally connected, forming a low flow channel. In the unaltered stream, the term "bankfull" is used to describe the state at which the flow of the water completely fills the channel, just before it spills into the floodplain.



River pattern, dimension and profile

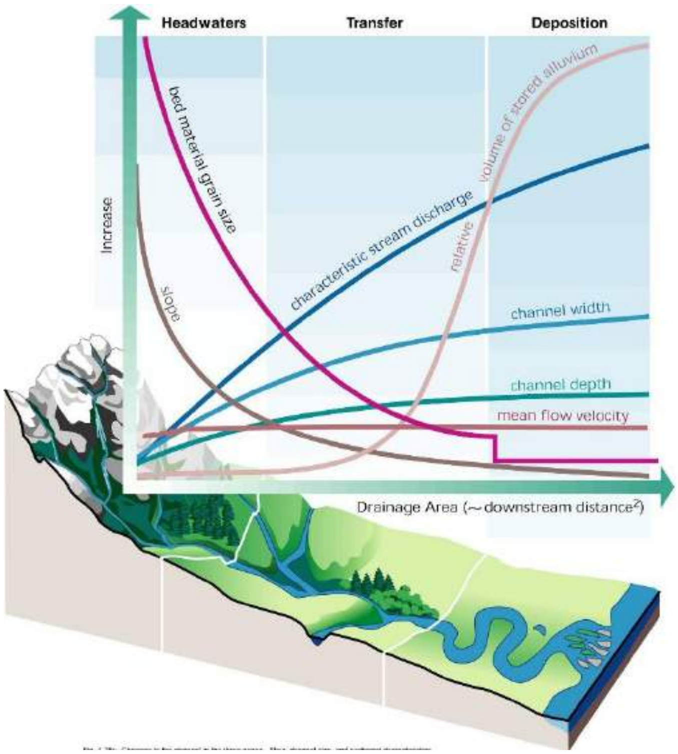
The structure of a channel is described by the following:

- Length of meandering or curving (pattern);
- Width and depth of the channel (dimension);
- The degree of slope (profile).

Some channels are relatively stable, while others actively adjust and change their shape. For example, the channel of a stream that is flowing through bedrock will change at a much slower rate (relatively stable) than one flowing through a sandy or highly erodible area (more actively depositing, adjusting or changing shape). Otherwise, adjustments in channel shape usually occur in response to changed conditions, such as increased water flow or a modification made within the stream channel or to the surrounding landscape. Most natural streams are dynamic; they may move around, and still maintain the same basic dimensions, meander pattern, and slope.

Meanders

The processes of erosion and deposition serve to lengthen a channel through a curving process known as “meandering.” Almost all streams naturally meander. Curves slow down the water and absorb energy, which helps reduce the potential for erosion. The velocity of a stream is greatest on the outside of a bend. The increased force of this water frequently results in erosion along this bank and a short distance downstream from the bend. On the inside of the bend, the stream velocity decreases, which results in the dropping out or deposition of sediment, usually sand and gravel, along this bank. Looking at the long-term history of a valley over hundreds or thousands of years, the stream moves back and forth across the valley bottom. This side-to-side or lateral migration of the channel, along with down-cutting that occurred in a stable, predictable way, actually formed the valleys we see today.



How Slope Affects a Stream’s Ability to Meander: The channel and behavior of a stream can vary considerably along its length. Mountain headwater streams flow swiftly down steep slopes. At lower elevations, the slope is generally gentler and the stream is more likely to meander (form curves) across its valley. (Source: Stream Corridor Restoration: Principles, Processes, and Practices, 10/98, by the Federal Interagency Stream Restoration Working Group (FISRWG))

Slope

The slope is the change in elevation or steepness of a streambed. The slope of the streambed contributes to how fast the water moves and, therefore, determines how much sediment of what size the water can carry. The steeper the slope, the faster the water moves and the more sediment bedload (i.e. sediments, silt, sand, gravel, boulders, and organic materials) can be moved through the\ channel. The term sediment is a general term to describe material that ranges in size from silt to sand to gravel to boulders. In flatter sections, the water will move more slowly, allowing finer sediment to deposit, referred to as “deposition.” The stream adjusts to the slope of the valley through this process of erosion and deposition.

Pools, Steps, and Riffles

Streams alternate between concentrated (convergent) flows and flows which are more spread out (divergent). Convergent flows are deeper, faster and more erosive. Pools are deeper areas that are scoured out during flood events. Sediments that are eroded from a pool will fall to the bottom of the stream when flows are shallower and slower, with less energy to move the sediment, forming a riffle. This alternating between bed erosion and deposition creates up and down “bed forms” that dissipate the energy of a flood and help maintain channel stability. In steeper streams, high-energy flows scour pools and move larger sediments, such as cobbles and boulders, downstream to form rocky steps rather than riffles. Streams are often classified or named from the type of bed forms they have, for example riffle-pool or step-pool streams.

Stream Reach

A reach is a segment of a stream with similar physical characteristics throughout its length. These characteristics are related to the stream’s structure and other physical processes such as valley slope and bed material. In Vermont, reaches vary greatly in length, from hundreds of yards to a few miles.

On the surface, streams appear to serve a simple function: to move water from one place to another. In reality, streams carry much more than just water; they also move materials like rocks and sand, woody debris, fish and wildlife, and—of course—paddlers. This section provides some basic background information on stream structure and function in order to better understand the issues associated with road-stream crossings and what we can do to remediate and/or prevent them.

Riparian Area/Riparian Buffer/Riparian Zone

These terms can refer to a number of things depending on the context in which they are used. Generally, they refer to the land immediately adjacent to a stream that includes vegetation, wildlife, and other natural features. Derived from the Latin word *ripa* meaning streambank, this area is where the water is separated or buffered from adjacent land uses. Once established, the plant roots in the buffer help stabilize the bank and the tree canopy provides shading to cool water temperatures. The buffer allows vegetation to filter sediments and excess nutrients.

Water on the broad floodplain of the East Branch Delaware River near Margaretville, NY. Photo courtesy of Delaware County Soil and Water Conservation District

The term “riparian” may also be applied legally to define the rights of landowners along a stream.

Floodplain

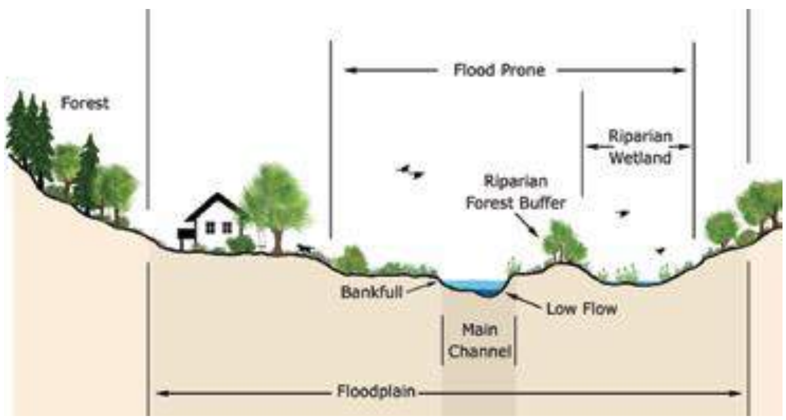
Floodplains are essential to the health of river systems. They are generally flat areas of land adjacent to the stream. These areas are constructed of material deposited by the stream, separated from the channel by a stream bank, and subject to flooding. Floodplains provide a place for water to go when it cannot be contained in the channel, such as during spring thaw or heavy precipitation.

A floodplain is formed by a stream that is eroding and depositing sediment. Over time, the stream channel moves or meanders across the floodplain. In turn, this causes erosion in some places and deposition of materials in other places. When water fans out across the floodplain, the speed of the water is decreased, thereby decreasing and dissipating the energy of the stream. This relieves pressure on stream banks and offers a place for the water to flow temporarily. The outcome is a reduction of the amount of flooding and erosion downstream. If no human development is located in the floodplain, then this area can perform its natural functions of storing and conveying floodwater and dissipating excess energy.

Vegetation also slows the water's velocity, and the roots hold soil in its place, reducing erosion. A stream that is no longer able to overflow onto its floodplain is often a stream with erosion problems.

Stream Corridor

Stream corridors are comprised of the channel, floodplains, and adjacent lands. They provide an area within which the channel can meander or curve so that sediments and the energy of flowing water are distributed more evenly—the condition of dynamic equilibrium. These are complex ecosystems that provide an avenue for wildlife movement and other important natural processes.



Cross Section Image of a Stream Corridor

How Streams Work

In the process of moving water and sediment downhill, a stream dissipates energy. This process results in the formation of a stream channel. The natural stability and balance in a river system depend on its ability to build and access a floodplain and create meanders and bed forms. These structures help evenly distribute a stream's energy and sediment load. The next few sections describe the physics of the energy flow of streams and how stream channels are constantly adjusting to keep their energy in a state of balance.

Streams start in headwater areas where there is tremendous potential energy because of generally steep slopes. The energy that develops in these headwater areas is used by the stream in the following ways:

Kinetic Energy

As the water begins flowing downhill, potential energy is converted to the energy of movement or motion—kinetic energy. This energy is what powers mills and hydroelectricity, or simply moves a boat downstream.

Friction

Up to 95 percent of a stream's energy is dissipated through friction with its bed, banks, and floodplain. Woody debris and vegetation in the channel and on the floodplain also break the water flow and increase roughness or friction. In addition, streams expend energy flowing around their curves (meandering).

Stream Flow

The amount of water carried by a stream can vary from none, in the case of streams that are dry during part of the year (ephemeral streams) to extreme flood conditions. Precipitation reaches the stream by two different pathways that affect the quantity, quality, and timing of stream flow: infiltration into the ground where it contributes to groundwater flow or "base flow;" and water that flows across the surface of the land, referred to as surface runoff or "storm flow." Stream flow at any one time consists of water from one or both sources.

Base Flow

Rainwater and snowmelt that soak into the ground recharge the groundwater. This water moves slowly through the soil and bedrock before eventually reaching the surface water. This regular, continuous discharge of groundwater that provides a steady supply of water to many streams and rivers is called base flow. Enormous amounts of water move slowly through the soil, creating the base flow in streams from rainwater that fell days, weeks, months, or even years before. Base flow enables many streams to flow year-round, even when there has been no recent rainfall. The amount of base flow varies with groundwater levels, so some streams have continuous flow during part of the year but dry up during dry periods and droughts.

Storm Flow

Some of the rainfall and snowmelt within a watershed flows quickly into the stream by moving over the land surface or through near-surface soil. This water is the main component of high stream flows during rainy weather and spring snow melt. This is called storm flow. Each stream has developed in response to the amount of water it carries and the way that water moves through the channel. The volume and timing of runoff into a stream is called its hydrology.

This is dependent on precipitation patterns and watershed characteristics. The flow processes within a stream channel are called hydraulics and are influenced by the characteristics of the channel. These characteristics include the stream's slope, the shape of the cross section of the channel, and roughness. Roughness is caused by the water coming in contact with sediments and vegetation, which causes friction, slowing the flow of water.

Sediment Transport

Stream energy not used by kinetic motion and friction is available for transporting sediment. The sediment in the channel comes from the surrounding landscape and erosion of the bed and banks.

A stream develops over time to handle a certain sediment load, which it transports and deposits in a fairly predictable pattern. Streams are constantly balancing the energy they have by meandering (curving), transporting, and depositing their load of sediments. This means that some erosion is natural and a normal function of how streams work.

When the energy or sediment inputs are changed, the energy balance is altered and the system must adjust. If a stream is slowed down, backed up, or spread out, it may lose the energy needed to transport its sediment load and sediments will deposit or drop out of the stream flow (deposition). Conversely, if the stream becomes steeper or is deepened and has more energy than is needed to transport the available sediment it will obtain additional sediment by eroding its bed or banks.

If the amount of sediment entering a stream increases, but there is no corresponding increase in water flow and energy to move the sediment, the sediment will deposit. This occurs at the tail end of a large flood, as it did in Tropical Storm Irene. Flows begin receding, along with the energy to move all the sediment that has entered the channels from numerous hillslope failures. Conversely, if the sediment flow decreases significantly (e.g., when it becomes trapped behind a dam), but the flow and energy are not also decreased, this excess energy works on the bed and banks, increasing erosion.

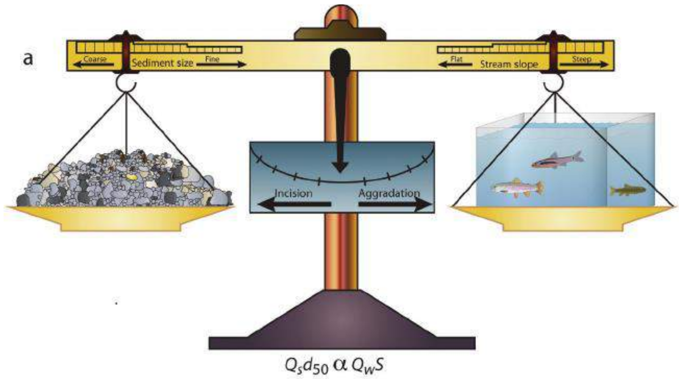
Dynamic Equilibrium

Despite frequent change, streams exhibit a dynamic form of stability. Streams are changing but generally in a slow and predictable manner. As long as the conditions that influence the stream's energy are relatively constant, then the stream for the most part stays in equilibrium. This process of establishing and maintaining a balanced condition is called dynamic equilibrium. In other words, the stream is moving and changing, but generally maintains its dimensions, pattern, and profile without dramatic changes in the pattern of its erosion and deposition processes.

When a natural stream achieves an equilibrium depth and slope, the shape of its channel is maintained by the following channel slope and channel roughness and/or resistance characteristics:

- The coarseness of the sediments in its bed; and/or
- The soil cohesiveness and soil binding properties of vegetative root systems on its banks.

The following diagram[6] illustrates the relationship between the water in a stream and the system's ability to transport sediment:



The relationship is shown as a balancing scale, with sediment load on one weighing pan and stream flow on the other. The hook holding the sediment pan slides along the horizontal arm to reflect adjustments according to sediment size. The hook holding the stream flow side adjusts to reflect changes in stream slope. Adjustments and changes in a stream system occur when there is an imbalance in the system's energy. When any one or more of the variables change, the system is no longer in balance.

When a stream is free to make adjustments, then one or more of the other variables in the system is likely to change until equilibrium is restored.

The diagram indicates how the variables will change. For example, if the slope increases (gets more steep), then the size of sediments being moved will get bigger. The process can take place suddenly during one storm event or it may occur gradually over hundreds or thousands of years.

The physical laws which govern the evolution of stream channels dictate that, in time and left in their natural state with no human development or interaction, rivers will self-adjust (erode and deposit) to an equilibrium condition. When these conditions are achieved across an entire watershed, they are associated with minimal erosion, storage of organic material and nutrients throughout the watershed, and aquatic and streamside (riparian) habitat diversity.

How Channels Change their Shape

Streams in dynamic equilibrium are considered to be stable. This is because they generally maintain consistency with respect to channel dimensions, pattern, and profile as presented earlier. Streams in (dynamic) equilibrium erode their banks, migrate over time across their floodplains, and experience small-scale adjustments in the formation of their channel. These

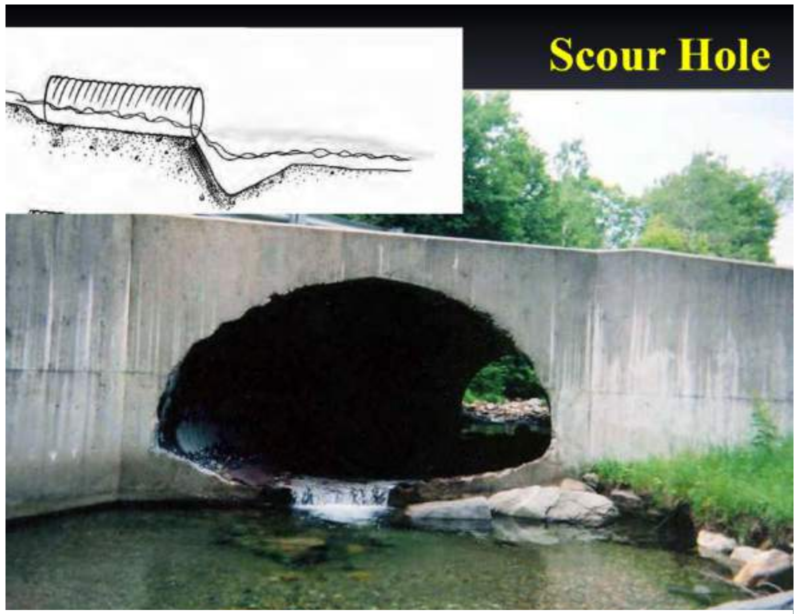
[6] Image from Lane's Balance of Sediment Supply & Sediment Size with Slope & Discharge: Lane, E.W. (1955). The Importance of Fluvial Morphology in Hydraulic Engineering. In Proceedings of the American Society of Civil Engineers 81(745): 1-17. Retrieved from: Using Beaver Dams to Restore Incised Stream Ecosystems - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Lanes-balance-a-describes-how-changes-in-sediment-load-sediment-size-slope-and_fig1_261215514 [accessed 30 Nov, 2018]

conditions change over time (are dynamic) based on water and sediment inputs that are driven by natural flood events. This evolution of channel form often takes place over decades or even generations.

Substantial changes in channel form are reactions to large-scale events such as major floods and human activities that take place in the stream corridor- like road crossings- and across the landscape. The following terminology is generally used to describe these adjustments to the formation of a stream channel.

Degradation, Incising, Scouring Down

All of these terms refer to situations when a stream has more energy than needed to move available sediment. In these cases, it will acquire additional sediment by eroding its bed or banks. Degradation is common at the downstream end of undersized culverts.



Scour hole downstream of an undersized culvert. Photo/diagram credit: UMASS River and Stream Continuity Program

Degradation is most visible in actively eroding banks or headcuts. A headcut is a small waterfall, often resulting from the deepening of a channel caused by dredging, excavation, or increased stream erosive power downstream of a natural or anthropogenic constriction. In the case of a "scour hole" below an undersized culvert, the degradation is generally confined to one spot as the culvert invert serves as grade control. This can lead to very wide, deep holes that undermine adjacent stream banks and "perched" culverts that block the movement of fish and wildlife upstream. In situations where a headcut is uncontrolled, the headcut and associated erosion will migrate upstream until it is stabilized.

Aggradation and Lateral (Width) Adjustments

When a stream does not have enough energy to transport its sediment load, it will **deposit sediments in its channel** through a process called "aggrading." As the streambed rises, the water spreads out, eroding laterally (lateral width adjustments), and thus widening the channel. Disequilibrium and channel evolution occur when moderate to major vertical adjustments have been set in motion. Aggradation is common upstream of road-stream crossings that constrict the natural stream channel, and can lead to erosion of adjacent stream banks as well as reduced hydraulic capacity as sediment and debris block the inlet of the crossing.

The rate of change in a stream channel, often referred to as the stream's "sensitivity," is a function of the erodibility of the bed and bank materials, the supply of sediments, and the frequency of flooding. A gravelly stream bed with non-cohesive banks in a flashy watershed may evolve in a much shorter time frame than a stream in clayey soils where flooding has not occurred very often.

Describing Channel "Conditions"

A stream reach is a section of stream with similar physical characteristics. The condition of stream reaches can vary from one that is in dynamic equilibrium to one where its channel structure has begun to evolve, adjust, or be "in adjustment." The Vermont Rivers Program describes three benchmarks along the gradient of physical condition. The following terminology and photographs describe these different conditions.

Reference Condition

Reference condition refers to a stream reach that is in or near dynamic equilibrium. That means it is maintaining its channel dimensions and watershed functions within the range of natural variability and is providing high quality aquatic and riparian habitats. Such conditions can typically be found in headwater sections of streams, where human influence is limited. When designing a road-stream crossing structure, it is instructive to identify and measure the closest nearby reference reach, and use that to develop specifications for rebuilding the stream channel through the crossing structure.

An understanding of the reference (natural) or stable condition provides a way of measuring if conditions are different from a stream's natural characteristics. A change or departure from the reference condition can be measured by various degrees of change as described below. This is often referred to as "degree of departure." (This is not so different from a physician judging one's health by reference to the characteristics of a healthy person.)

Undersized or misaligned structures can cause streams to become unstable upstream and downstream of a road-stream crossing. Knowledge of which stage of stream adjustment a particular stream reach may be in is critical for anticipating future conflicts with human infrastructure and in designing any restoration or protection strategies.

In Adjustment

The "in adjustment" condition refers to a stream reach where the channel structures and stream processes have deviated from the expected natural conditions. These unstable stream segments haven't evolved into a completely new stream type. However, the aquatic and riparian habitats of such a reach are in "fair" condition as they lack certain streambed features, cover types, and connections with related habitats (connectivity). Reaches that are in adjustment are poised for additional adjustments. When floods occur, major adjustments will take the channel either toward or further away from equilibrium or reference conditions. Further departures may even change the stream channel to a different type—that is, develop different structures and exhibit different processes.

Poor Condition

A stream reach in poor condition is said to be in "disequilibrium" or exhibiting a departure from its stream type. Such a stream reach is experiencing adjustments to a much greater degree and rate beyond the expected natural conditions of a reach in fair condition.

This means the reach is exhibiting a new stream type. For example, a reach that may have alternated between deposition and erosion (riffle and pool) has become completely erosional or completely depositional. In poor condition streams, habitat features may be disturbed beyond the range of some species' adaptability. Such a reach is expected to continue to undergo major adjustments until it evolves back to the reference stream condition or a new equilibrium.

IV. Road-Stream Crossings: Common Impacts to Streams and Best Management Practices

If not designed to mimic the natural stream channel, road-stream crossings can disrupt stream equilibrium and pose risks for human safety and ecological integrity. Below are some common impacts associated with road-stream crossings and how they relate to stream structure and function:

Undersized Crossings

A crossing that is too small relative to its bankfull width can lead to faster flows, which in turn can cause erosion at the inlet and outlet (see Outlet Drops and Scour & Erosion below). Undersized crossings are often accompanied by outlet drops and/or scour pools that result from excess flows.

Outlet Drops/Perched Culverts

Crossings that are undersized may have large drops at the outlet, which are called outlet drops or perched culverts. Such drops can be caused by erosion/scouring of the downstream stream bed

Shallow Crossings

Crossings that are undersized or improperly aligned can lead to high flows and erosion that can lead to the water inside the structure being too shallow. Inadequate depths can pose a barrier to fish passage. They also usually lack a substrate that matches stream bed. These crossings can be impassable or even dry for long periods of time.

Clogged Crossings

Undersized crossings are more likely to clog with debris. Beaver activity can exacerbate this problem. If not maintained, a clogged crossing will become impassable to fish for as long as the clog is present. Clogged inlets can also cause upstream ponding and/or flooding, and the formation of inlet drops.

Ponding

Ponding is the backup of water upstream of an undersized crossing. Typically, the ponded water upstream becomes stagnant, leading to increased temperatures, lower oxygen levels, and poor fish habitat. Ponding can lead to stream bank and road erosion, damage of surrounding property, and creation of wetland ecosystems. It may occur seasonally due to high waters/flooding, or year-round due to induced effects such as clogging.

Misaligned Crossings

A crossing whose inlet is skewed in relation to the stream is considered misaligned. Misaligned crossings can result from improper installation (e.g. installing a pipe perpendicular to the road, even though the stream approaches at an angle). Misaligned crossings have a higher probability of clogging, scouring or eroding, and producing ponding.

Scour and Erosion

Scour and erosion goes hand-and-hand with high flow and ponding, and is a consequence of all crossing insufficiencies besides shallow crossings. Scour pools often form at the downstream end of perched crossings, leading to the undercutting of the crossings, or in a worse case, the road. Eroded stream banks occur both upstream and downstream of the crossing. Lastly, scouring of natural substrate within the crossing degrades passage and natural habitat for aquatic and terrestrial life.

Lack of Substrate

It is recommended that metal, smooth, and unnatural materials, such as concrete, not be used when constructing a culvert. Many aquatic organisms maneuver through the stream by gripping or latching onto rocks. When implementing a substrate through a culvert one must match that of the natural stream. By doing so the natural conditions are maintained, stream continuity remains uninterrupted, and scour is avoided.

Aging Infrastructure

Many of the issues described above are associated with aging infrastructure. According to the National Bridge Inventory Database, of the 2,500 documented bridges in New York, at least 60% were built before 1970.[7] Although many have been repaired or reconstructed since then, this figure does give a sense of scale to the issues of aging infrastructure—and it does not include culverts.

Each of the above impacts above can contribute to increased flood risk and maintenance costs and reduce the ability of fish and wildlife to move through a crossing.

Undersized culverts, which constrict flow, are almost irresistible to beavers. Source: www.martinezbeavers.org/wordpress

Beaver Activity

The North American beaver population was hunted nearly to extinction by the early 1900s because beaver pelts were so valuable. Today beavers are ubiquitous and the dams they build create issues for road-stream crossing management in many towns. Beavers instinctively build dams in locations where they hear running water, making culverts prime locations. Small culvert pipes are much easier for a beaver to dam up than a wider structure or a bridge. **Therefore, the ideal way to address beaver issues is to install larger culverts and bridges, which will reduce maintenance costs associated with beaver dams and clogged culverts.**[8] In cases where culvert replacement is not feasible, the United States Forest Service (USFS) has reviewed several other options and are already commonly used in the Northeast:

Culvert fences are the most commonly used beaver device by the Forest Service, however they may block fish passage. USFS concludes that the best solution is culvert replacement. Source: www.beaversolutions.com

Devices to keep beavers from damming the culvert

- Culvert Fences: A box around the culvert inlet that is embedded in the sediment and rises a couple of feet above the water's surface. This is USFS's most commonly used beaver control method, however ***it is not recommended***, as the fencing results

[7] U.S. Department of Transportation Federal Highway Administration. National Bridge Inventory Database. *Updated annually with data from the Federal Highway Administration.* Data retrieved from: http://nationalbridges.com/index.php

[8] USDA Forest Service. (2005). *How to Keep Beavers from Plugging Culverts*. Retrieved from: https://www.fs.fed.us/t-d/pubs/pdfpubs/pdf05772830/pdf05772830dpi300.pdf

in reduced fish and aquatic organism passage, increased maintenance, and ice damage.

Devices to reduce water speed

- Corrugated or perforated tubing: A tube used to transport water through the culvert and dam in such a way that wholly or partially eliminates the cues that tell beavers to build. Respondents have reported a decrease in maintenance by using this device, though others were not successful.
- Clemson beaver pond levelers: Similar to the corrugated or perforated tubing; the perforations slow the flow of water, which helps reduce the sound of flowing that prompts beavers to build dams. This type of device has been used successfully.

Trapping/Shooting

- Trapping: Trapping beavers requires many considerations, including—but not limited to—animal behavior, site access, skills of the trapper, non-target animals, cost, and state/federal regulations.
- Shooting: Check with local authorities.

Repellants

- Not effective in reducing culvert problems, but can be used to protect riparian areas by making plants less attractive to beavers. Repellants that were tested included various deer repellents, hot sauce, textural repellents (like paint with sand), and using beaver odors to trick other beavers into thinking that an area is occupied. The effectiveness of repellents depends on many factors, including the size of the area to be protected and competition with other animals.

While the USFS report provides an overview of several options that are available to protect culverts from beaver dams, the best solution is to ***redesign and replace culverts*** that beavers have dammed. ***Right-sized culverts help prevent beavers from building dams.*** Reducing beaver dams is an added benefit of replacing culverts with Stream Simulation Design, which is explained in the next section.

Road-Stream Crossing Best Management Practices

State and federal agencies have developed design practices that allow for both fish and wildlife passage and better flood resiliency. The USFS provides the most comprehensive road-stream crossing design protocol geared towards aquatic organism passage known as Stream Simulation

Design (SSD)[9]. Each state generally has their own guidelines or standards regarding culverts and bridges. These state recommendations usually incorporate many of the same principles found in SSD.

Stream Simulation Design (SSD)

When a crossing must be replaced or repaired the current best practice is to follow SSD. The premise of SSD is to replicate natural channel dimensions and characteristics that are observed upstream through a crossing structure. This design allows wildlife movement and natural processes to continue as if the structure was not there at all. Components of SSD allow for a dynamic channel that can adjust during high water periods and allow proper hydraulic capacity as well as passage of varying sized debris. Barriers to wildlife passage are eliminated so that all organisms at every stage of life can move freely through the crossing. To achieve the goal of maintaining healthy ecological connectivity as well as safe transportation networks, crossings should be designed with the three SSD guiding principles in mind:

- **The design should fit both the stream and the road, not just the road.**
- **Minimum intervention in stream process results in the least risk of failure.**
- **Crossings should present no greater challenge to organism movement than the stream being crossed.**

Specific components of SSD that follow these principles include:

- **Structure width** is equivalent to or exceeds the bankfull width of the natural channel.
- **Structure substrate** should have similar mobility and stability properties to that of the natural bed material of the stream channel.
- Provide **sufficient hydraulic capacity and passage of debris** during a 100-year flood.

RECURRANCE INTERVALS

A flood recurrence interval, also known as a return period, is how we statistically describe a storm event based on historical observations. Recurrence intervals are generally identified as the -year flood (e.g. 100-year flood). However, this can be somewhat misleading. A 100-year flood, for example, would represent a storm with a 1% chance of happening on any given year, not a storm that only happens once in 100-years. Theoretically a 100-year storm could happen multiple times in one year. These statistical benchmarks will be changing as the intensity and frequency of our storms increase due to global climate change.

[9] Stream Simulation Working Group. (2008). *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings*. San Dimas Technology and Development Center: U.S. Department of Agriculture, Forest Service.

- Provide adequate space between 100-year flood water level and top of the structure utilizing a head-water-to-depth ratio less than .8, allowing **room for debris to pass without clogging the structure**.
- The stream within the structure should have the **capability to adjust dimensions** in response to a wide range of floods and sediment or wood inputs without compromising the movement needs of aquatic organisms or the hydraulic capacity of the structure.

Although SSD structures may have a higher initial cost, they may save significantly more money in the long run.[10] Long-term maintenance and replacement costs of both the structure and road must be assessed when planning a crossing, as well as costs associated with destruction of property, the disruption of transportation, emergency response, commerce, and tourism. Costs from these factors can dramatically overshadow those of constructing an improved structure.

New York Stream Crossing Guidelines

The New York State Department of Environmental Conservation (NYS DEC) developed some basic guidelines for replacing road-stream crossings to avoid stream fragmentation. [11,12] These guidelines are for people involved in designing and constructing road-stream crossings who want to protect and restore stream continuity.

The goal of these guidelines is to maintain natural conditions that don't restrict fish and wildlife passage through the stream, noting that "additional engineering design may be necessary to ensure structural integrity and appropriate hydraulic capacity."

Stream crossing designs that preserve natural stream conditions while marrying the needs of fish/wildlife with human transportation. Fish and wildlife in this case include invertebrates, fish, amphibians, reptiles and mammals, and they move on a daily and seasonal basis. The necessary reasons for moving upstream and downstream include: accessing coldwater habitats, feeding areas, and breeding/spawning/nursery areas, as well as the need for natural dispersal to maintain genetic diversity. Additional considerations include the impact of improperly designed crossings on adjacent riparian habitats.

Common road-stream crossing problems include undersized, shallow and perched crossings, and double (as opposed to single) culverts. Consequences of poor crossings include low flows, unnatural bed materials, scouring and erosion, high flows, clogging, and ponding. All of these

[10] Levine, J. (2013). *An Economic Analysis of Improved Road-Stream Crossings*. Keene Valley, NY: The Nature Conservancy, Adirondack Chapter.
Long, J. (2010). *The Economics of Culvert Replacement, Fish Passage in Eastern Maine* (p. 5). Natural Resource Conservation Services.
[11] New York State Department of Environmental Conservation. (ND) *Stream Crossings: Guidelines and Best Management Practices*. Retrieved from http://www.dec.ny.gov/permits/49066.html
[12] NYSDEC. (2011). *Stream Crossings*. Retrieved from: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/streamcrossing.pdf

consequences can degrade in-stream and riparian habitats and restrict fish and wildlife movement through a crossing.

Solving the aforementioned issues requires the proper sizing, placement and installation of road-stream crossings. Crossings should be:

- Large enough to accommodate fish, wildlife, and floods without changing the natural flow regime
- Open-bottomed or embedded into the stream bottom to maintain natural substrate and water depth

The NYS DEC also provides some basic stream crossing standards to support practical, effective and long-term solutions for protecting and restoring stream continuity. Ideal crossings are "invisible" to fish and wildlife. Bridges, open-bottom arches/culverts with sufficient span, and embedded box/pipe culverts with sufficient span are typically the best approaches. Below is a summary of the NYS DEC crossing standards:

Types of Crossings

- Structures should be placed in straight, unobstructed, well-defined stream reaches, and in straight, flat areas where streambed/bank characteristics can be easily replicated. Avoid wetlands when possible. Preferred crossing types, in descending order of preference, are:
  - Open-bottom arches (typically installed on concrete footings)
  - Box culverts (typically pre-cast concrete)
  - Arch or elliptical/squash culverts (metal, concrete, or plastic)
  - Circular culverts (metal, concrete or plastic)

- If a box or pipe culvert must be used, it should be:
  - Embedded to at least 20% of the culvert height on the downstream side
  - Used only on streams with slopes no steeper than 3% grade
  - Installed level

Capacity/Size

- Structure width should be 1.25 times the normal width of the streambed, and the capacity should accommodate high flows.

Length and Side Slopes

- Road and shoulder widths should be the minimum size necessary, and side slopes should be as steep as possible without compromising the structure and to minimize the length of the structure. A side slope grade of 2:1 is typically the steepest grade that can be vegetated.

Width

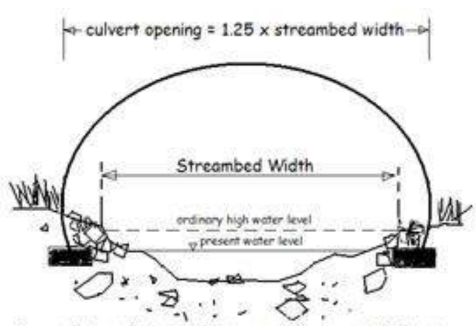
- The crossing opening, regardless of shape, should be at least 1.25 times the width of the stream channel bed, as measured from bank to bank at the ordinary high water level or edges of terrestrial, rooted vegetation

Depth and Velocity

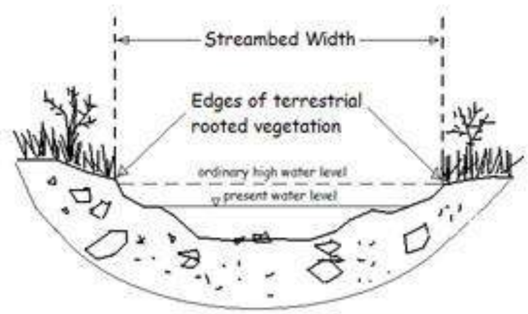
- These should both match the natural stream channel during low flows

Substrate

- Use natural substrate inside the crossing to match the rest of the stream channel. Substrate should resist displacement during floods



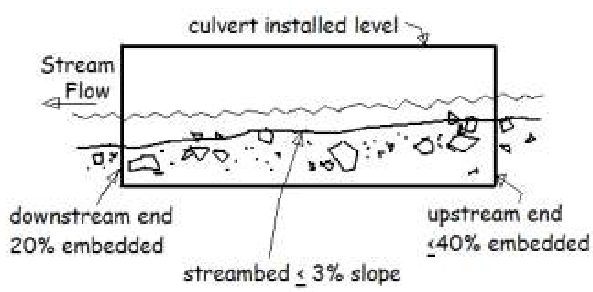
Correctly installed open-bottom arch culvert with footings



Determining Streambed Width

Installation

- Install culverts "in the dry" (may require piping, pumping, and/or use of cofferdams; duration of dewatering should be minimized).
- Closed-bottom culverts should have a streambed slope of less than 3% and the culvert should be installed level with at least 20% of the vertical rise embedded at the downstream invert.



Erosion Control

- Use rip rap as headwall protection to prevent scouring
- Control erosion and sediment with silt fencing, straw bales, etc. parallel to the stream (include these in projects plans)
- Minimize streambed and bank disturbance, and restore bed and bank to pre-construction conditions after crossing is installed.

Timing

- Instream work should generally occur during low flow conditions between June and September in order to minimize water quality and fisheries impacts. Contact the regional DEC office in the county of the project for more details.

Maintenance

- Crossings should be maintained—e.g. checked for structural deficiencies including undermining and debris buildup—at least once a year before high spring flows.

Permitting

- A NYS DEC permit is necessary for construction in:
    - All streams with water quality classifications of AA (drinking water), A (drinking water) or B (swimming and contact recreation), or C (fisheries and non-contact recreation), as well as those with a standard of (T), indicating that a stream supports a trout population, or (TS), for trout spawning (ECL Article 15-0501),
    - All navigable waters (ECL Article 15-0505),
    - NYS DEC regulated freshwater wetlands outside of the Adirondack Park (wetlands inside the Park are regulated by the Adirondack Park Agency; ECL Article 24).

Other potential permitting agencies include the Adirondack Park Agency and the U.S. Army Corps of Engineers. Contact the appropriate regional DEC Environmental Permits office, depending on which county the project is in. Other permits and approvals may also be necessary from other agencies, county or town government, etc.

Flood Risk Guidelines

In June 2018, the NYS DEC released the *New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act*[13] for a public review period. The document was developed under the Community Risk and Resiliency Act (CRRA) and is intended to mitigate future physical climate risk related to sea-level rise, storm surges, and flooding in New York. Applicants for projects involving new or replacement structures on roadways crossing inland streams, should demonstrate consideration of the higher of the following flood-risk management guidelines as part of a comprehensive risk-management approach[14]:

[13] New York State Department of Environmental Conservation. (2018). *New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act*. Retrieved from https://www.dec.ny.gov/docs/administration_pdf/nysfrm.pdf

[14] All the listed guidelines are for structures in nontidal areas. Structures in tidal areas should incorporate a range of sea-level rise projects, including the highest project.

Critical[15] Bridges

- The vertical flood elevation and corresponding flows that result from increasing current, relevant peak flows, e.g., Q_{50}, to account for projected peak flows for the full, expected service life of the infrastructure, and adding at least two feet of bridge freeboard. An additional foot of bridge freeboard should be considered for critical bridges. The projected Q_{100} flow should pass below the lowest chord without going into pressure flow.

Non-critical bridges

- The vertical flood elevation and corresponding flows that result from increasing current, relevant peak flows, e.g., Q_{50}, to account for projected peak flows for the full, expected service life of the infrastructure, and adding two feet of bridge freeboard. The projected Q_{100} flow should pass below the lowest chord without going into pressure flow.

Culverts on Critical Roadways

- The vertical flood elevation and corresponding flows that result from increasing current, relevant peak flows, e.g., Q_{50}, to account for projected peak flows for the full, expected service life of the infrastructure, and that allow the culvert to fully pass the design flood without increasing headwater and that provide at least two feet of roadway freeboard above the projected Q_{100} flood. An additional foot of roadway freeboard should be considered for culverts on critical roadways.
- The vertical flood elevation and corresponding flows resulting from the 0.2-percent annual chance flood.

Culverts on Non-Critical Roadways

- The vertical flood elevation and corresponding flows that result from increasing current, relevant peak flows, e.g., Q_{50}, to account for projected peak flows for the full, expected service life of the culvert, and that provide at least two feet of roadway freeboard above the projected checkflow.

Green Stormwater Infrastructure

With the rapid increase of impervious surfaces through urbanized areas, the implementation of green infrastructure can play a vital role in reducing flood risk to road-stream crossings. Green infrastructure practices can include; rain gardens, rooftop disconnects, bio-retention areas and basins, vegetated swales, pervious surfaces, rain cisterns and green roofs. All these techniques

[15] Critical transportation infrastructure includes structures to which any of the following apply:

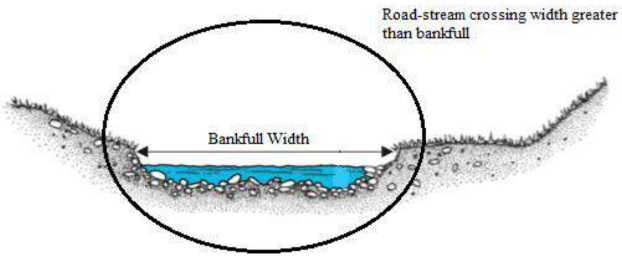
1) Transportation asset provides sole access to any of the following facilities and practical detour routes are not available in case of loss or closure of the asset: facilities designed for bulk storage of chemicals, hospitals/rest homes/correctional facilities/dormitories/patient care facilities, major power generation, transmission or substation facilities, major communications centers, major emergency service facilities.
2) Transportation asset is part of a designated evacuation route.

are geared towards the common goal of reducing stormwater runoff and allowing precipitation to recharge groundwater storage naturally. These techniques work best when installed in heavily developed areas where impervious cover is high and the density of road-stream crossings is great. During heavy precipitation events the peak high water will become lower and sustain for a greater duration due to these practices. This will benefit road-stream crossings and the infrastructure/people that live around them by minimizing the flood risk and possible costly damage that could occur. By funding green infrastructure projects, money will be saved in the way of damaged crossings, infrastructure and personal injury that could all result from a failed and/or flooded road-stream crossing.

Relationship between flood resilience and habitat continuity at road-stream crossings

A road-stream crossing deemed impassable to aquatic and terrestrial life is also likely to be at risk during flood events. When faced with excessive flows barrier structures may constrict and back up water, cause the stream to avulse (abandon the stream channel and create a new channel), and/or fail; potentially causing damage to the road-stream crossing, associated roadbed, and neighboring property. Conversely, the characteristics which make a structure passible to fish and wildlife also make it resilient to floods.

Road failure at a 3-m culvert placed within a 6-m bankfull width stream, GMNF



Barrier road-stream crossings are often undersized for the streams they are designed to pass. The U.S. Forest Service's Stream Simulation Design protocol recommends that the minimum width of a culvert should be at least the bankfull width of the reference stream channel[16]. In New York, the NYS DEC recommends that structures are at least 1.25 times the bankfull width of a natural reach in the stream. In Connecticut, the Department of Energy and Environmental Protection recommends that culvert width should span at least 1.2

[16] Stream Simulation Working Group. (2008). *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings*. San Dimas Technology and Development Center: U.S. Department of Agriculture, Forest Service, page 3-2.

times the bankfull width of the stream[17] and neighboring Massachusetts recommends the same minimum dimension in its River and Stream Crossing Standards[18]. This recommended structure width, along with other Stream Simulation Design principles, will generally allow for the conveyance of flood-level flows, natural sediment transport patterns, and the passage of fish and wildlife.

During storm events floodwaters may exceed the hydraulic capacity of undersized culverts causing the stream to overtop the structure. This is especially true if wood and debris accumulations clog the inlet of the culvert, reducing its capacity to convey flows and sediment. Many times this debris is not much larger than the diameter of the culvert and often not exceeding the bankfull width of the stream channel. These issues related to inlet clogging during high flows can be resolved by utilizing design principles mentioned above. Stream simulation channels, like that of a natural stream channel, are able to adjust dimensions through substrate movement and accommodate a wide range of flows as well as sediment and debris inputs. This process is able to happen while allowing for the movement of fish and wildlife. Many hydraulically designed structures are unable to handle the amount of water and debris during larger storms in addition to acting as barriers to aquatic organisms.

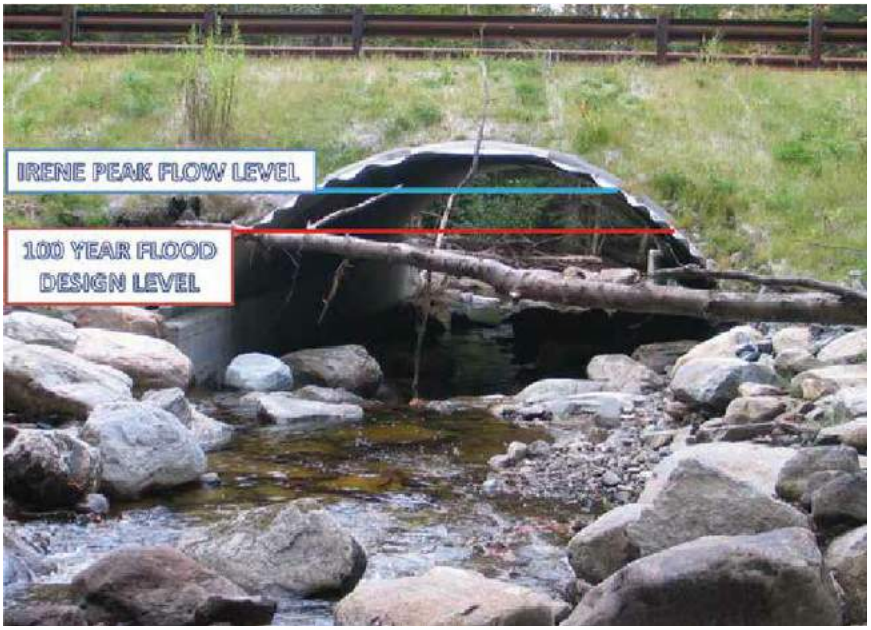
In the summer of 2011 Tropical Storm Irene dramatically impacted our region, rising rivers to record levels and causing considerable infrastructure damage across the northeast. The upper White River watershed of Vermont was hit particularly hard during the storm. The White River is Vermont's fourth largest subbasin and a major tributary to the Connecticut River. Between 2004 and 2007 the Vermont Fish and Wildlife Department assessed road-stream crossings throughout the state. Only 5% of these structures allowed for full passage of aquatic organisms and nearly 91% of structures significantly constricted the natural stream channel (a structure width to bankfull width ratio of less than 0.75). Of the 43 culverts surveyed in the upper White River watershed 15 failed during Irene[19]. All of these structures provided either reduced or no aquatic organism passage (AOP) and had culvert widths less than bankfull (an average culvert width-bankfull ratio of 0.54).

Nearby, in the Green Mountain National Forest, two Stream Simulation Design crossings had been installed before the 2011 storm. These culverts not only provided fish and wildlife passage, but survived Tropical Storm Irene and needed no follow-up maintenance. The previous structures at these sites were identified by U.S. Forest Service staff as barriers to eastern brook trout and other aquatic organisms. The hydraulically designed structures were also flagged as

[17] Connecticut Department of Environmental Protection Inland Fisheries Division. (2008). *Stream Crossing Guidelines.* Retrieved from: https://www.ct.gov/deep/lib/deep/fishing/restoration/StreamCrossingGuidelines.pdf
[18] River & Stream Continuity Partnership. (2012). Massachusetts River & Stream Crossing Standards, pg.10.
[19] Gillespie, N., Unthank, A., Campbell, L., Anderson, P., Gubernick, R., Weinhold, M., … Kirn, R. (2014). Flood Effects on Road–Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs. *Fisheries,* 39(2), 62–76.

risks for debris accumulation and potential failure during flood events. The survival of the replacement structures designed for fish and wildlife passage highlights the dual benefit of stream simulation principles as compared to that of the traditional hydraulic design approach. In short, road-stream crossings built with the intention of restoring stream connectivity also provide flood resiliency.

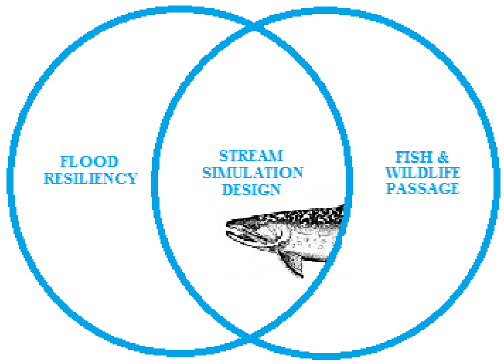
Double-barrel hydraulically designed culvert on Jenny Coolidge Brook, Green Mountain National Forest, VT



Replacement open bottom arch structure utilizing Stream Simulation Design after Tropical Storm Irene. Notice that there was no damage to the structure or road caused by the storm.

There are many other examples of AOP structures proving their flood resilience throughout the region. In the summer of 2003 a double box culvert catastrophically failed on Bronson Brook, a tributary of the Westfield River in Worthington, MA. This undersized crossing (structure-to-bankfull ratio of 0.67) was previously identified as a barrier to fish and wildlife. After its failure the culvert was replaced with an arch design that allowed for the movement of eastern Brook Trout and other species. This replacement structure and adjacent roadway has survived several major storms without damage, including Irene[20].

In 2014 the United States Geological Survey conducted a hydraulic assessment of existing culverts with alternative stream crossing designs in Massachusetts. These alternative structures were designed with Aquatic Organism Passage (AOP) in mind and followed many of the Stream Simulation Design principles. Of the seven sites assessed five of the existing structures were modelled to fail during the 50-year flood interval. None of the structures incorporating AOP design principles failed at that interval. On the extreme end, all existing structures failed during the 500-year flood, while only two of the AOP crossings failed to withstand those floodwaters[21].



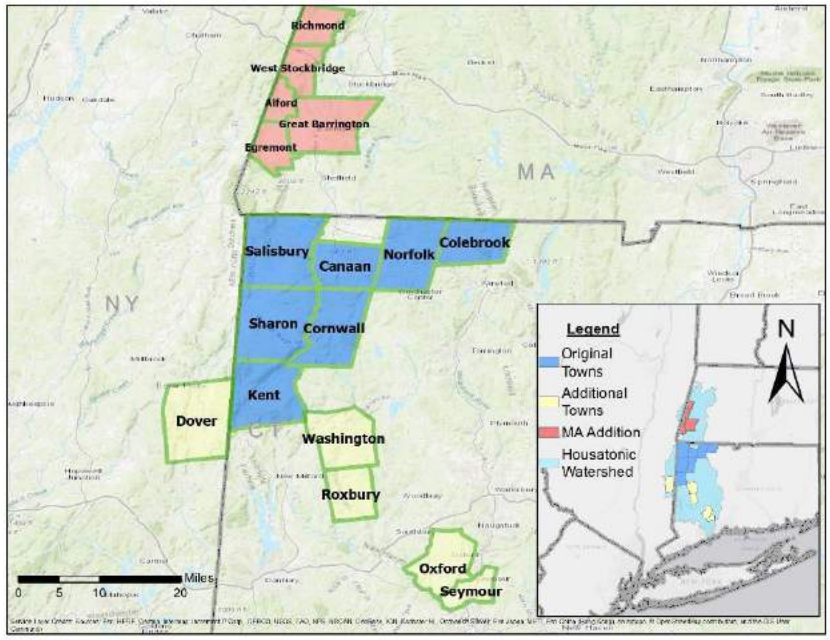
There is a strong correlation emerging between road-stream crossings that allow for fish and wildlife passage and greatly improved flood resiliency. The many considerations of Stream Simulation Design allow for rivers and streams to behave and respond through a structure as if it were not there; in turn reducing the damage caused during flood events and the maintenance needed after a storm.

[20] Gillespie, N., Unthank, A., Campbell, L., Anderson, P., Gubernick, R., Weinhold, M., … Kirn, R. (2014). Flood Effects on Road–Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs. *Fisheries,* 39(2), 62–76.

[21] Zarriello, P. J., & Barbaro, J. R. (2014). *Hydraulic Assessment of Existing and Alternative Stream Crossings Providing Fish and Wildlife Passage at Seven Sites in Massachusetts* (Scientific Investigations Report 2014-4146). U.S. Department of the Interior, U.S. Geological Survey.

V. Plan Development Process Summary

Field Assessments



Current HVA Road-Stream Crossing Management Plans project towns

The first step in developing a town-scale road stream crossing management plan is a comprehensive field assessment of all bridges and culverts in town. These stream crossing surveys entail collecting information about the stream channel and the crossing structure itself, which later help determine if crossings are barriers to fish and wildlife. Road-stream crossings were evaluated using the protocol developed by the North Atlantic Aquatic Connectivity Collaborative (NAACC); a partnership of universities, conservation organizations, and state and federal agencies focused on improving aquatic connectivity across a region spanning West Virginia to Maine.[22] Materials related to data collection using the NAACC protocol are included in Appendix B.

Following collection, this information is logged into a region-wide database (www.streamcontinuity.org/cdb2). After being input each crossing is assigned an "aquatic score" ranging from 0 (worst rating) to 1. This number is essentially a ranking on how well the crossing performs related to aquatic habitat continuity. Each crossing is also assigned a "terrestrial passability score" which represents the structure's suitability for passage of terrestrial organisms that may use streams and their banks as travel corridors.

Flood Risk Modeling

This study included an analysis of flood risk at all non-bridge structures (i.e., culverts) in the Town of Dover. Using a surface water runoff model developed by Dr. Emmanouil Anagnostou and Dr. Xinyi Shen at the University of Connecticut's Civil and Environmental Engineering

[22] NAACC (North Atlantic Aquatic Connectivity Collaborative). 2014. https://www.streamcontinuity.org/ (Accessed April 2018).

Department (UConn)[23] in combination with HVA's field data, this analysis predicts when a culvert will fail (indicated by water overtopping the road) during floods of different magnitudes. UConn's runoff model provides peak flows for the 2-, 5-, 10-, 25-, 50-, and 100-year flood events at each culvert, which are then combined with HVA's field data in a hydraulic model. The hydraulic model is used to determine stage height for each peak flow; this is then compared with road fill height to determine pass/fail. Protocols for field data collection and a description of UConn's methods are included as Appendix C.

Road-Stream Crossing Inventory documents

A comprehensive Road-Stream Crossing Inventory document was then created that includes the following information: 1) Field data collected during NAACC assessments including physical measurements, photos etc., 2) Barrier status/Aquatic Organism Passage (AOP) information from NAACC, and 3) Risk-of-Failure modeling conducted by our partners at UConn. The Town of Dover's Road-Stream Crossing Inventory is included in this document in Volume 1.

Replacement Project Prioritization

Road-Stream Crossing Inventory documents were then used as the basis for a replacement project prioritization developed in collaboration with each community based on: 1) Conservation value, particularly for cold-water habitat; 2) Flood risk (understood through UConn's modeling and local knowledge of past flood events), and; 3) Condition/management priority (understood through local knowledge and NAACC assessments).

Municipal Prioritization Workshops

HVA distributed copies of the Road-Stream Crossing Inventory document to key decision makers in each town. This generally included the First Selectman and Public Works Director. These individuals were encouraged to share the documents with other key figures for comment.

HVA then held workshop meetings with each town, which included at minimum representatives from the Board of Selectmen, Public Works/Highway and Emergency Services. These meetings were guided by the following questions, developed by HVA to gather local knowledge about flood risk and maintenance need:

- Which structures regularly flood the road?
- Has water over the road or other crossing failure blocked access for Town residents to essential services, such as Fire/EMS? If not, are you aware of any crossings where failure would block access for essential services?
- Which structures require regular sediment, debris and/or ice removal?
- Are you aware of structures that are in poor condition and need to be repaired or replaced?

[23] Shen, X., & Anagnostou, E. N. (2017). A framework to improve hyper-resolution hydrological simulation in snow-affected regions. *Journal of Hydrology*, 552, 1–12.

The goal of these workshops was to identify 5-10 high priority replacement projects. The best projects were those that were prioritized based on barrier status to fish and wildlife movement, were identified as flood risks by UConn modeling and local knowledge, and were identified as needing to be replaced in the near future by the town. One or two structures from the pool identified in the Workshop were chosen to prioritize for future replacement projects.

Materials related to the Town of Dover Municipal Prioritization Workshop are included as Appendix D.

Continuous Ranking

Finally, a ranking system was developed to rank potential replacement projects at all non-bridge structures in each town. This method was developed by Trout Unlimited and modified by HVA for this project. Ranked metrics included: Barrier Significance class, Hydraulic Capacity, Geomorphic Compatibility, Crossing Condition, Critical Linkages (when available)[24], and Town Priority. More details on the Continuous Ranking rubric are included as Appendix E.

[24] Critical Linkages Project. (2013). Conservation and Assessment Priority System. University of Massachusetts. Amherst, MA.

VI. Resources for Addressing Problem Crossings

This project identifies crossings that are both barriers to fish passage, are in poor condition, *and* pose a risk of flooding. With all of this information in hand, backed up by regional data, towns seeking funding to implement new designs can access funding sources that may not otherwise be available. Below is an overview of some existing programs that can help fund construction projects that address flood risk and/or habitat connectivity issues.

New York Grant Programs

Bridge New York Program

- Overview: This program provides assistance for local governments to rehabilitate and replace bridges and culverts statewide. The program is administered by the NYS Department of Transportation. The program emphasizes projects that address poor structural conditions; mitigate weight restrictions or long detours; facilitate economic development or increase competitiveness; and/or reduce the risk of flooding
- Award Size: $100,000 to $1 million
- Who is Eligible: Municipalities that can administer state funding
- Application Period:
- Website: https://www.dot.ny.gov/divisions/engineering/structures/bridgeny

Hudson River Estuary Program

- Overview: The New York State Department of Environmental Conservation provides funding through the Hudson River Estuary Program to implement priorities outlined in the Hudson River Estuary Action Agenda aimed at conserving or improving clean water; fish, wildlife and their habitats; waterway access; the resiliency of communities; and river scenery. These opportunities are announced as Hudson River Estuary Grants Program Request for Applications (RFAs) or as New England Interstate Water Pollution Control Commission Request for Proposals (RFPs).
- Average Award Size: $10,000 to $750,000 over two years
- Who is Eligible: Governmental entities, municipalities, and quasi-governmental entities (a local public authority or public benefit corporation, a county, city, town, village, or Indian tribe or nation residing within New York State, municipal corporations, soil and water conservation districts, school districts, community colleges, or any combination thereof), and not-for-profit corporations with a 501(c)(3) designation. Projects eligible for state assistance must be located within the Estuary Watershed Boundary (see website for details)
- Application Period:
- Website: http://www.dec.ny.gov/lands/5091.html

New York Climate Smart Communities Grant Program

- Overview: The Climate Smart Communities Grant Program is a competitive 50/50 matching grant program for municipalities. It was established in 2016 under Article 54, Title 15 of Environmental Conservation Law, an excerpt of which is below. The program funds climate change adaptation and mitigation projects and includes support for projects that are part of a strategy to become a Certified Climate Smart Community
- Award size: Up to $200,000 for Implementation projects (adaptation and non-power mitigation) and up to $100,000 for Certification projects (assessments and planning activities)
- Who is eligible: Any county, city, town, borough, village in the state of New York
- Application period: Due in July
- Website: http://www.dec.ny.gov/docs/administration_pdf/cscgrantsgeneral.pdf

Local Waterfront Revitalization Program

- Overview: Funding to advance the preparation or implementation of strategies for community and waterfront revitalization through the following grant categories:
    - Preparing or Updating a Local Waterfront Revitalization Program (LWRP)
    - Preparing an LWRP Component, including a Watershed Management Plan
    - Updating an LWRP to Mitigate Future Physical Climate Risks
    - Implementing a Local Waterfront Revitalization Program or a completed LWRP Component
- Award size: Variable, up to $2 million
- Who is eligible: Villages, towns, or cities and counties (with the consent and on behalf of one or more villages, towns, or cities) which are located along New York's coasts or inland waterways as designated pursuant to Executive Law, Article 42.
- Application period: Due in July
- Website: https://www.dos.ny.gov/opd/grantOpportunities/epf_lwrpGrants.html

National Grant Programs

National Fish and Wildlife Foundation's (NFWF) Bring Back the Natives grant program

- Overview: The Bring Back the Natives program invests in conservation activities that restore, protect and enhance native populations of sensitive or listed fish species across the United States, especially in areas on or adjacent to federal agency lands. The program emphasizes coordination between private landowners and federal agencies, tribes, corporations, and states to improve the ecosystem functions and health of watersheds. The end result is conservation of aquatic ecosystems, increase of in-stream flows, and partnerships that benefit native fish species throughout the United States. Priority habitats/species include native fish of the eastern U.S. rivers, including resilient populations of eastern brook trout. One of the priority activities targeted by this program is r*estoring connectivity*, i.e., the removal of culverts and passage barriers or flow restoration to connect fish to key spawning, rearing and refuge habitats.

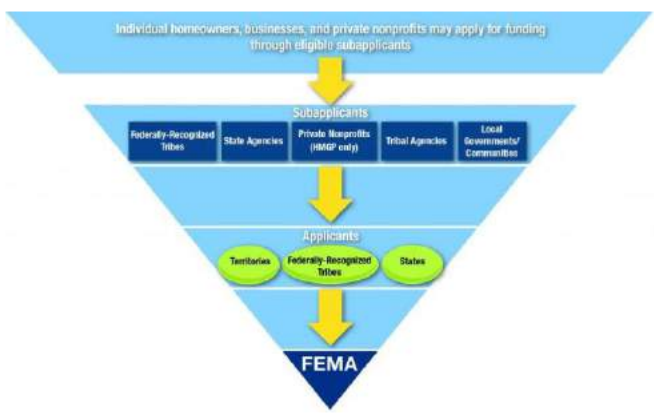
- Average award size: $50,000 to $100,000 (1:1 match requirement)
- Who is eligible: Local, state, federal, and tribal governments and agencies (e.g., townships, cities, boroughs), special districts (e.g., conservation districts, planning districts, utility districts), non-profit 501(c) organizations, schools and universities.
- Application period: Pre-proposal due date is mid-July; full proposal due date is early September
- Website: http://www.nfwf.org/bbn/Pages/home.aspx

FEMA Hazard Mitigation Grant Program (HMGP)

- Overview: The purpose of HMGP is to help communities implement hazard mitigation measures following a Presidential Major Disaster Declaration in the areas of the state, tribe, or territory requested by the Governor or Tribal Executive. The key purpose of this grant program is to enact mitigation measures that reduce the risk of loss of life and property from future disasters.
- Average award size: Amount available is dependent on the disaster; FEMA can fund up to 75% of the eligible costs of each project. (25% match requirement which include a combination of cash and in-kind sources)
- Who is eligible: Individuals, businesses and private nonprofits via local governments
- Application period: Dependent on the disaster
- Website: https://www.fema.gov/hazard-mitigation-grant-program

FEMA Flood Mitigation Assistance (FMA) Program

- Overview: Provides funding to States, Territories, federally-recognized tribes and local communities for projects and planning that reduces or eliminates long-term risk of flood damage to structures insured under the NFIP. FMA funding is also available for management costs. FEMA requires state, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for HMA mitigation projects.



- Who is eligible: Generally, local communities will sponsor applications on behalf of homeowners and then submit the applications to their State. All FMA grant applications must be submitted to FEMA by a State, U.S. Territory, or federally-recognized tribe.
- Application Period: Generally, October to January

- Website: https://www.fema.gov/flood-mitigation-assistance-grant-program

NOAA Community-based Restoration Program Funding

- Overview: NOAA's Restoration Center recognizes that habitat protection and restoration are essential elements of a strategy for sustainable commercial and recreational fisheries. Investing in habitat restoration projects leads to real, lasting differences for communities, businesses, and the environment. The Community-based Restoration Program supports restoration projects that use a habitat-based approach to rebuild productive and sustainable fisheries, contribute to the recovery and conservation of protected resources, promote healthy ecosystems, and yield community and economic benefits. Restoration includes activities that return degraded or altered marine, estuarine, coastal, and freshwater, migratory fish habitats to functioning conditions, and techniques that return NOAA trust species to their historic habitats.
- Award Size: $75,000 to $3 million (1:1 match encouraged)
- Who is Eligible: Eligible applicants are institutions of higher education, non-profit organizations, for profit organizations, foreign public entities and foreign organizations, and state, local and Indian tribal governments.
- Application Period: Pre-proposals due in January, Full proposals due in April
- Website: https://www.fisheries.noaa.gov/grant/coastal-and-marine-habitat-restoration-grants

Patagonia World Trout Initiative

- Overview: The World Trout Initiative funds only groups and efforts working to restore and protect wild, self-sustainable trout, salmon and other fish species within their native range. We believe that the best way to accomplish this over the long term is by ensuring that populations have high-quality habitats and adequate stream flows, can migrate between habitats without human intervention, are not negatively impacted by hatchery and aquaculture operations, have protection from harmful non-native species and disease, and are not overharvested. We look for innovative groups that produce measurable results and work on long-term solutions to root causes of the problem. Proposed projects should be quantifiable, with specific goals, objectives and action plans, and should include measures for evaluating success. Funding priorities applicable to road-stream crossings include projects that restore native river habitats, ensure in-stream flows that mimic natural stream flows, and provide unassisted fish passage (without human intervention) to and from historically accessible habitats; we give priority to long-term, low-maintenance and natural channel solutions
- Award Size: $5,000-$15,000
- Application Period: Generally, accepts application throughout the fiscal year (May 1 to April 30)
- Website: http://www.patagonia.com/world-trout-initiative.html

Trout Unlimited Embrace-a-Stream Matching Grant Program

- Overview: Embrace A Stream (EAS) is a matching grant program administered by TU that awards funds to TU chapters and councils for coldwater fisheries conservation. Project priorities include those that help restore stream habitat, improve fish passage, and protect water quality.
- Average award size: Approximately $4,200
- Application Period: Contact your regional EAS representative with intent to submit a proposal by April 15; Initial drafts of proposals due May 15; Final applications due July 1
- Website: www.tu.org/conservation/watershed-restoration-home-rivers-initiative/embrace-a-stream

Capital Planning for Infrastructure Resilience

Capital planning can help link a town's budget with its long-term improvement goals, leading to programs that prioritize projects and optimize financing. Capital planning happens at both the state and local level, and is an important tool for financing priority road-stream crossing replacement projects that will improve infrastructure resiliency. The road-stream crossing inventory provided here, in conjunction with local and state information, provides critical information for Public Works Departments and Boards of Selectmen to identify road-stream crossings to include in capital planning efforts.

Other state agencies and programs provide helpful guidelines for capital planning related to road-stream crossing replacements and flood resiliency. The Flood Ready Vermont program[25], for example, provides key content for helping municipalities update their municipal, capital, hazard mitigation, and emergency operations plans with an eye for flood resiliency.[26] The U.S. Federal Emergency Management Agency (FEMA) also provides helpful resources for integrating flood resiliency into local planning efforts, including not just capital planning, but also general planning, zoning ordinances, economic development strategies, and much more.[27] Federal regulations require that local hazard mitigation plans describe how localities will integrate the plan's requirements into other planning mechanisms. Doing so for capital planning can help leverage funds to ensure that public money for capital improvements are consistent with hazard mitigation goals.

[25] Flood Ready Vermont. More information at: http://floodready.vermont.gov/update_plans/municipal_plan/capital_program
[26] Flood Ready Vermont. "Update Your Plans". Retrieved from: http://floodready.vermont.gov/update_plans
[27] FEMA. *Integrating Hazard Mitigation into Local Planning: Case Studies and Tools for Community Officials.* (2013). https://www.fema.gov/media-library-data/20130726-1908-25045-0016/integrating_hazmit.pdf

Federal, State, Regional Technical Assistance and Important Contacts

Technical assistance is a key element for successful road-stream crossing surveys and replacement efforts. Various agencies and individuals have provided key insight for this project, and others are available to help take this information to the next level. Below is an overview of the federal, state, and regional groups available for technical assistance related to road-stream crossing projects:

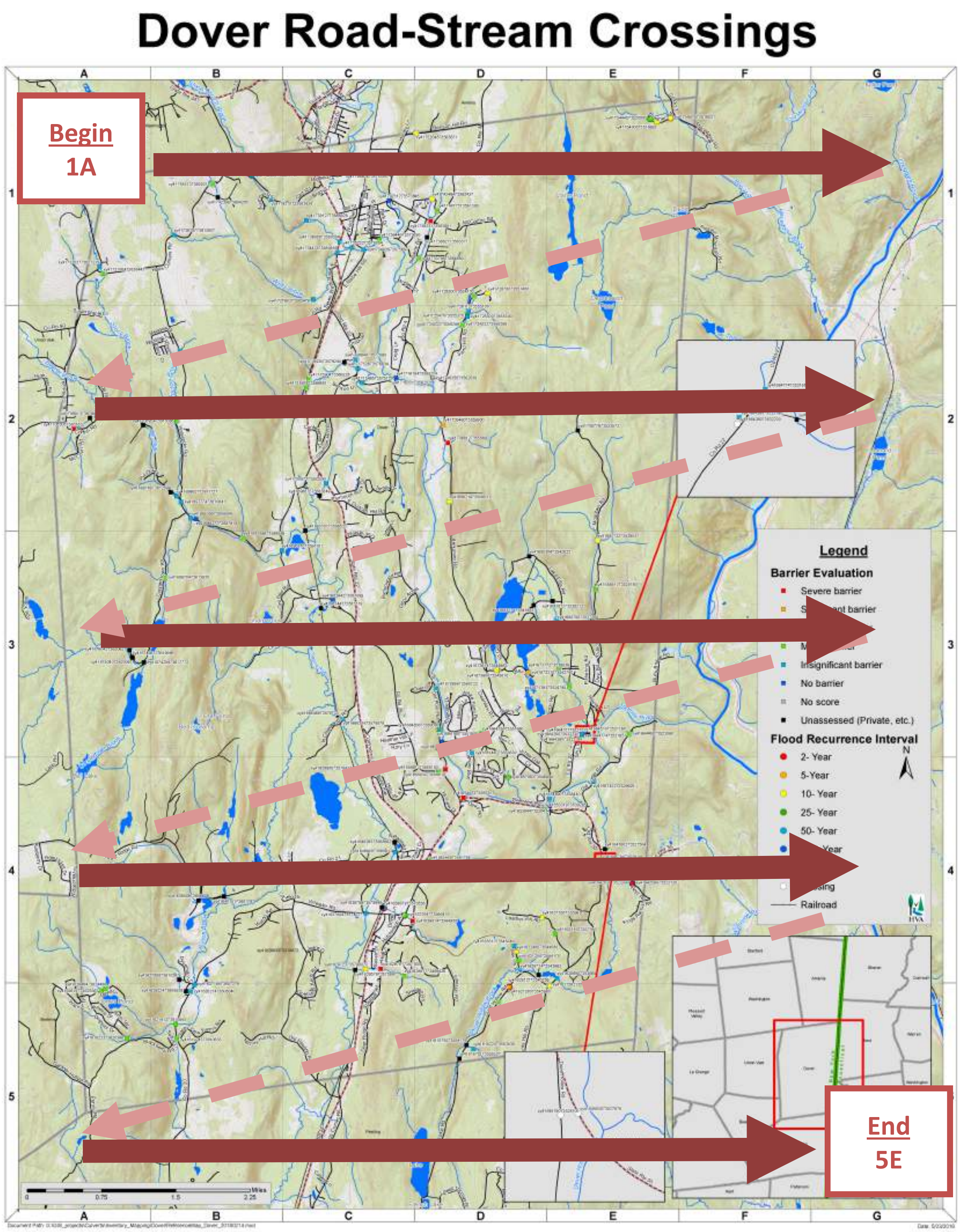
Federal ***State*** ***Regional***

Town of Dover Road-Stream Crossing Inventory

Reference Map(s)

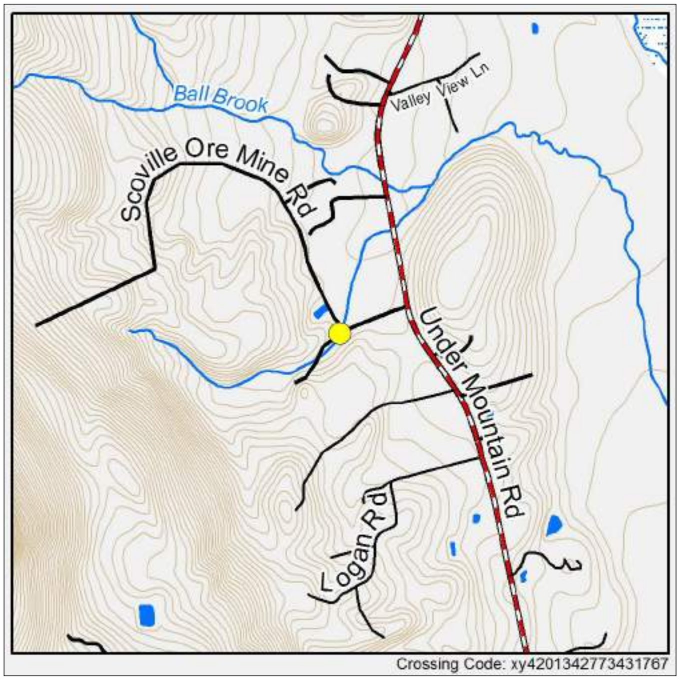
A Note on Organization

In each section of the Inventory (i.e. Town, State, Private/Other), crossings are organized based on their location on the Reference Map. Each section begins with crossings in 1A, and ends with 5E. See diagram below:



Interpretive Guide

Road: Scoville Ore Mine Road | **Stream:** Unnamed



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/ Maintenance: Not Ranked
Overall Ranking: *x* out of *x* town structures

Location

Subwatershed: Salmon Kill
Coordinates: 42.01355, -73.43162
Location Description: 2nd house on road with pond
Road Management: Town
Date Observed: 2014-05-20
Crossing Code: xy4201342773431767

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: Fair
Crossing Span: Severe Constriction
Alignment: Flow-Aligned

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Crossing Comments: Outlet pool partially due to 15" dam below with sealed off pipe in it (see additional photo DP in appendix) other small pipe from pool feeding into neighbor's pond (P).

ROAD: The road that the crossing is on. **STREAM:** The waterway that passes through the crossing.

RESULTS

Barrier Evaluation: A description of how severe of a barrier the crossing is to fish and wildlife passage.

Town Comments on Condition/Maintenance: Information about current conditions and scheduled maintenance and replacement, as discussed at a meeting with town officials and employees.

Overall Ranking: How the non-bridge crossing compares to other non-bridge structures for replacement prioritization, based on factors related to potential to reconnect habitat and its risk of failure in the event of a flood. A ranking of 1 indicates that structures is the highest priority for replacement.

LOCATION

Subwatershed: If the crossing is located within a priority subwatershed, it will be listed here.

Coordinates: GPS coordinates taken in the field.

Location Description: A brief description of landmarks or other identifying features to help locate the crossing.

Road Management: The entity (i.e. Town, State, Private, etc.) responsible for maintaining the structure and/or the road associated with it.

Date Observed: The date the crossing was assessed for habitat continuity (format: YYYY-MM-DD).

Crossing Code: A unique 16-digit identification code assigned to each crossing based on its coordinates.

PHOTOS: Photos taken of the stream above and below the crossing.

STREAM CHARACTERISTICS

Scour Pool: The size of the pool (if there is one) at the crossing outlet. A scour pool is considered "Large" if it is twice the width and/or the depth of an average-sized pool in the stream.

Bankfull Width: This is the average width of the stream channel above which any additional water would spill out into the flood plain (for details, see the NAACC protocol). This value helps determine the Crossing Span.

Bankfull Width Confidence: If Bankfull width was collected, the confidence in the value is also reported. High confidence is defined by certain requirements outlined in the NAACC protocol. If Bankfull width is

CROSSING CHARACTERISTICS:

Crossing Type: This refers to the type of crossing it is, i.e. culvert, bridge, etc.

Number of structures/cells: The number of individual culverts or bridge cells that make up the crossing. Structures are numbered by looking at the inlet and counting from left to right.

Condition: The overall state of the crossing from a structural perspective, i.e. how likely it is to collapse.

Crossing Span: How far the crossing spans across the stream, and whether or not it constricts the stream flow.

Alignment: The crossing can be flow-aligned or skewed. A crossing is "Skewed" if the stream enters it a 45° angle or more. Angle of skew is included when available.

Crossing Comments: Any additional comments pertaining to the crossing or its surroundings.

MAP KEY: Code to find the crossing on the Reference Map

ROAD

Road Photo: Taken of the road surface above the crossing structure.

Road Type: A description of the type of road and the number of lanes, where applicable.

Road Fill Height: The height (in feet) from the top of the culvert inlet to the surface of the road.

Return Interval Chart: Results of flood risk modeling performed by UCONN:

- **Return Interval:** A return interval of 2 years means that the river has a 1 in 2 (or 50%) chance of reaching a certain peak flow in that time frame. Likewise, a return interval of 5 years means the river has a 1 in 5 (or 20%) chance of reaching the peak flow, and so on.
- **Peak Flow**: The highest velocity at which the water is predicted to move through the crossing at a given return interval. It is expressed in cubic feet per second (cfs).
- **Road Height:** The height at which water from the stream would overtop the road.
- **Stage Height:** The maximum height that water is predicted to get in each return interval
- **Overtop:** If the Stage Height is greater than the road height, then the crossing is predicted to fail (i.e. water will flood the road surface)

INLET

Inlet Photo: A photo taken looking at the inlet of the crossing.

Inlet Shape: The shape of the inlet.

Inlet Type: The style of the inlet that influences how water enters the inlet (e.g. headwall, wingwalls, etc.).

Inlet Grade: Where the inlet is located in relation to the stream bottom

OUTLET

Outlet Photo: A photo taken looking at the outlet of the crossing.

Outlet Shape: The shape of the outlet.

Outlet Grade: Where the inlet is located in relation to the stream bottom

Drop to Stream Surface/Bottom: The distance (in feet) from the bottom of the structure to the surface of the water, and from the bottom of the structure to the stream bottom.

ADDITIONAL STRUCTURE INFORMATION

Material: The type of material the structure is made out of, e.g. concrete, plastic, stone, etc.

Slope Matches Stream: Based on a visual assessment of whether the slope of the structure matches the average slope of the stream upstream and downstream of the structure.

Crossing Slope: The slope of the structure expressed as a percentage. This is calculated only for crossings in target subwatersheds (see UCONN protocol for details).

Structure Comments: Any additional comments about the structure in question.

Physical Barriers/Severity: A description of any physical barriers such as debris, grates, etc. and its severity with regards to blocking fish movement (see NAACC protocol for more details).

Internal Structures: Internal structures like baffles and weirs are listed here.

Map Key: 4E

Road

Road Type: Unpaved, 2-Lane Road
Road Fill Height (feet): 1.6

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	59.8	3.97	0.66	No
5	108.3		1.87	No
10	162.7		4.04	Yes
25	269.3		10.37	Yes
50	387.0		20.47	Yes
100	548.9		39.34	Yes

Structure 1 of 1

Inlet

Inlet Shape: Round Culvert Embedded or with Persistent Water
Inlet Type: No data
Inlet Grade: No data

Outlet

Outlet Shape: Elliptical Culvert Embedded or with Persistent Water
Outlet Grade: No drop
Drop to Stream Surface/Bottom: 0/0.5

Material: No data
Slope Matches Stream: Yes (comparable)
Crossing Slope: 3.0%
Physical Barrier(s)/Severity: None
Internal Structures: None

Structure Comments: None

For additional data, see Appendix, page

Culvert Prioritization Results

Top 7 Crossings for Flood Risk

Town Roads

This chart is a summary of road-stream crossings with the shortest flood intervals (i.e. most likely to flood the road) based on modeling performed by the University of Connecticut. Note that only culverts within target watersheds—i.e. the Sandy Brook—were included in the model, and that this list only includes crossings on town-managed roads.

Photo	Flood Interval	Page #	Road	Map Key	Crossing Code
A	2-Year	258	Duell Hollow Road	5D	xy4162728073545980
B	2-Year	88	Cart Road	1B	xy4174593773598181
C	5-Year	114	Brasher Road	1E	xy4175457573516031
D	10-Year	112	Brasher Road	1E	xy4175400073518693
E	50-Year	118	Corbin Road	2A	xy4171076373625728
F	100-Year	226	Hoyt Road	4E	xy4164258073522120
G	100-Year	86	Cart Road	1B	xy4174565173597779

E

F

G

Municipal Prioritization Workshop Results

May 18, 2018

HVA distributed copies of the Road-Stream Crossing Inventory document to key decision makers in the Town of Dover, including the Town Supervisor and Highway Superintendent. These individuals were encouraged to share the documents with other key figures for comment.

HVA then held a meeting with the Town of Dover that included representatives from the Town Board, Highway Department, and Climate Smart Community Task Force. This meeting was guided by a set of questions developed by HVA to best understand the distinct flood-risk issues at specific sites. The goal of this meeting was to identify sites that were identified as risks by the town participants and determined to have a high potential for ecological restoration. Sites that exemplified the intersection of these two issues, flood resiliency and habitat restoration, were then selected for further project development.

Guiding Questions:

- Q#1: Which structures regularly flood the road?
- Q#2: Has water over the road or other crossing failure blocked access for Town residents to essential services, such as Fire/EMS?
- Q#3: Which structures require regular sediment, debris and/or ice removal?
- Q#4: Are you aware of structures that are in poor condition and need to be repaired or replaced?

Photo	Page #	Map Key	Road	Crossing Code	Notes
A	92	1C	N. Nellie Hill Road	xy4173493673575697	Town's highest priority for replacement (public safety), has flooded in the past, with water over the road in 2007, in disrepair, debris jams, town water line on west side
B	162	3C	N. Chippewalla Road	xy4166625473578878	#2 Priority for Public Safety: If that bridge fails, several families would be completely cut off from emergency services
C	232	4E	Old Forge Road	xy4165742273529925	#3 Priority for Public Safety: Old Forge Road, 4E: Last structure before Tenmile River, public safety issue, narrow and pipe is deteriorating (would cut off people if it failed)
D	114	1E	Brasher Road	xy4175457573516031	Beaver problems, never flooded though.

Municipal Prioritization Workshop Results

May 18, 2018

Photo	Page #	Map Key	Road	Crossing Code	Notes
E	00	2B	Ridge Road	xy4169777473610841	The other town road cited in Dutchess County's report is Ridge Rd. [and Mill River], with a condition rating of 4.981. A score of "5" puts the rating into "Good" so it is very close. If it requires less work to improve to "Good," it might be a good grant opportunity after Nellie Hill.
F	86	1B	Cart Road	xy4174565173597779	The 3 crossings on Cart road allow the stream crosses the road multiple times in a short period. The road washed out in Irene.
G	88	1B	Cart Road	xy4174593773598181	Was replaced in 2007, but the UConn results indicate it would still fail in a 2-year flood interval. Washed out in Irene.
H	90	1B	Cart Road	xy4174661273598982	Washed out in Irene.
I	260	5E	Duell Hollow Road	xy4162756273538128	Road gets damaged by flooding (avulsion).
J	158	3B	Cooperstown Road	xy4168670473613920	Washed out in Irene, structure will be replaced in 2018 and widened out.
K	188	3E	Weil Road	xy4167377273536836	Town wants to widen the structure (no flooding issues, other than Irene)
L	244	2D	Berkshire Road	xy4170681273558892	Needs to be replaced


A


B


C


E


E


F


G


H


I


J


K


L

Multiple-ranked Priority Stream Crossings

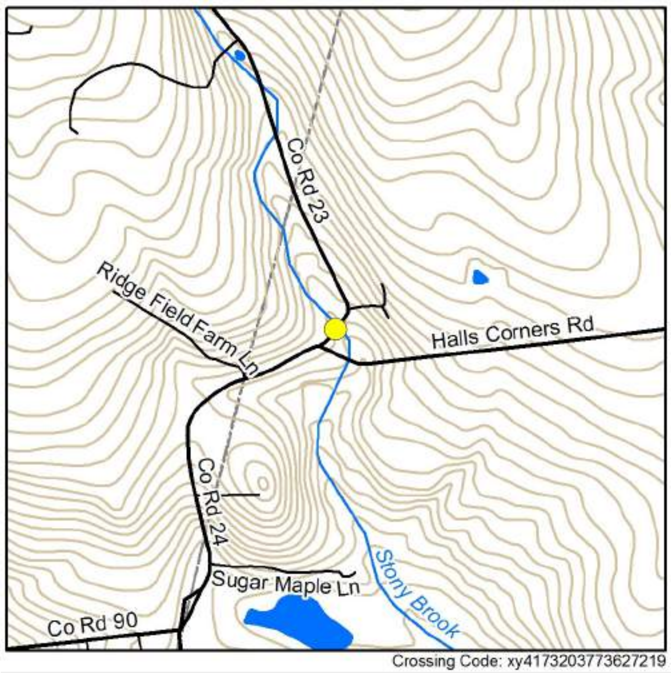
The following stream crossings were ranked on two of the previous priority lists: risk of failure priority and municipal priority.

Page #	Map Key	Road	Crossing Code	Risk of Failure Priority	Municipal Priority
88	1B	Cart Road	xy4174593773598181		
114	1E	Brasher Road	xy4175457573516031		
86	1B	Cart Road	xy4174565173597779		

Town-Managed Crossings

Entries are organized geographically by Map Index Key, beginning with 1A

Road: Chestnut Ridge Road   Stream: Stony Brook



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Not Ranked

Location

Coordinates: 41.732030, -73.627210
Location Description: 100' from intersection with 24.
Date Observed: 2017-10-16
Crossing Code: xy4173203773627219

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): 9.4
Bankfull Width Confidence: Low/ Estimated

Upstream

Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	63.29	N/A		
5	72.41			
10	77.85			
25	84.06			
50	88.27			
100	92.16			

Structure 1 of 1

Material: Concrete
Length (feet): 31.1
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Minor)
Slope: No data
Structure Comments: No data

Inlet

Outlet

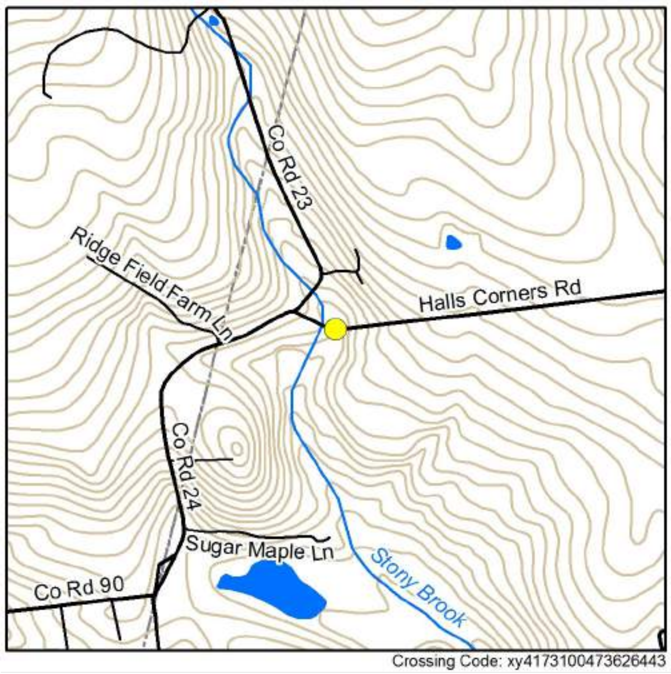
Inlet

Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
Width: 9.9, Height: 5.1
Substrate/Water Width: 7.2
Water Depth: 0.8
Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
Width: 9.9, Height: 4.9
Substrate/Water Width: 7.4
Water Depth: 0.6

For additional data, see Appendix



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 11 (Ranked 52 of 86)

Location

Coordinates: 41.731050, -73.626450
Location Description: Near 10 Halls Corners Road
Date Observed: 2017-10-16
Crossing Code: xy4173100473626443

Stream and Crossing

Crossing Characteristics

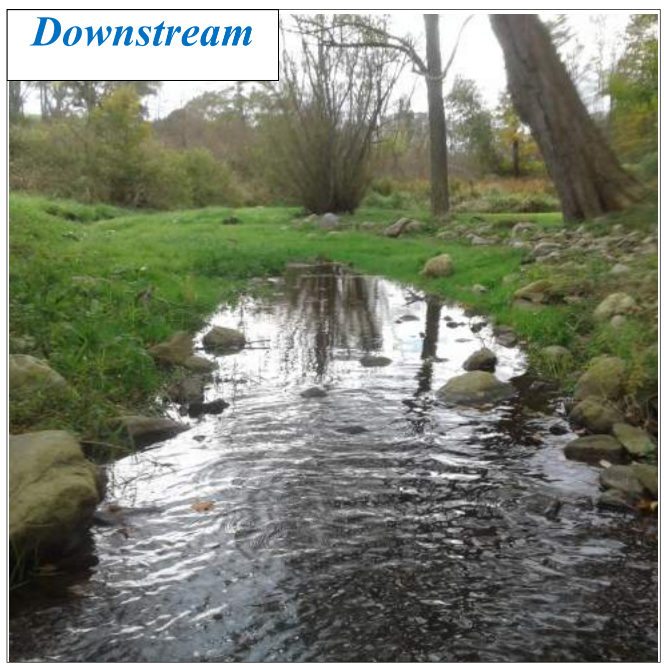
Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Small
Bankfull Width (feet): 5
Bankfull Width Confidence: Low/Estimated

Upstream

Downstream



Crossing Comments: Starts as round culvert and changes to bridge half way with free fall.

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 1.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	65.92	9.21	1.04	No
5	75.65		1.25	No
10	81.46		1.4	No
25	88.1		1.57	No
50	92.61		1.7	No
100	96.79		1.83	No

Structure 1 of 1

Material: Combination
Length (feet): 46.0
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Free Fall (Moderate)
Slope: 6.7%
Structure Comments: No data

Inlet

Outlet

Inlet

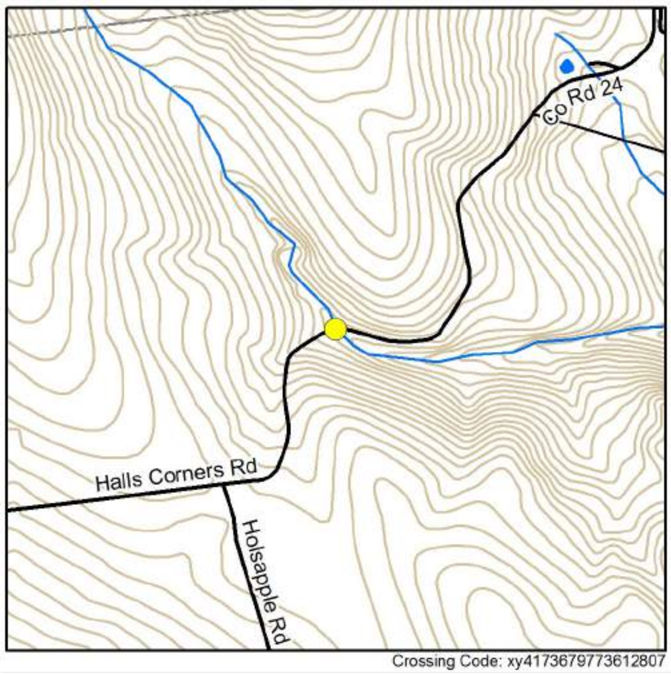
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 7.3, Height: 7.6
- Substrate/Water Width: 2.0
- Water Depth: 0.1
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 14.0, Height: 11.8
- Substrate/Water Width: 8.0
- Water Depth: 2.0

For additional data, see Appendix

Road: Halls Corners Road   Stream: Unnamed



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Not Ranked

Location

Coordinates: 41.736850, -73.612740
Location Description: Local ID TM-95
Date Observed: 2016-06-03
Crossing Code: xy4173679773612807

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 2.4

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	N/A	N/A		
5	N/A			
10	N/A			
25	N/A			
50	N/A			
100	N/A			

Structure 1 of 1

Material: Concrete
Length (feet): 39.0
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Fencing (Minor)
Slope: No data
Structure Comments: No data

Inlet

Outlet

Inlet

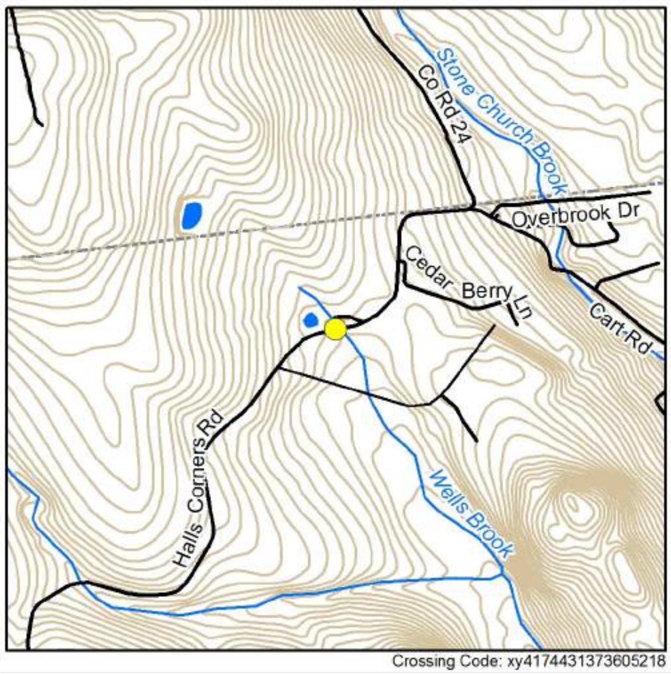
Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 9.0, Height: 6.0
- Substrate/Water Width: 9.0
- Water Depth: 1.0
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 9.0, Height: 6.0
- Substrate/Water Width: 9.0
- Water Depth: 0.8

For additional data, see Appendix

Road: Halls Corner Road   Stream: Wells Brook



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 11 (Ranked 52 of 86)

Location

Coordinates: 41.744300, -73.605350
Location Description: Local ID TM-94
Date Observed: 2016-06-03
Crossing Code: xy4174431373605218

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Skewed (>45°)
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Small
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road Type/Surface: Paved
Road Fill Height (feet): 2.5

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	19.3	5	0.44	No
5	21.15		0.52	No
10	22.22		0.56	No
25	23.43		0.62	No
50	24.23		0.66	No
100	24.96		0.7	No

Structure 1 of 1

Material: Concrete
Length (feet): 72.0
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 3.2%
Structure Comments: No data

Inlet

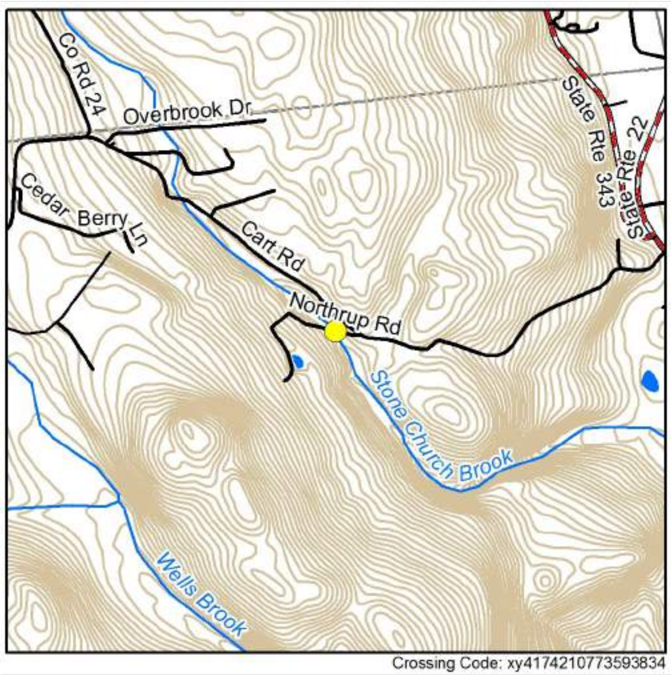
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 3.0, Height: 3.0
- Substrate/Water Width: 1.0
- Water Depth: 0.1
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 3.0, Height: 3.0
- Substrate/Water Width: 2.5
- Water Depth: 0.7

For additional data, see Appendix

Road: Northrup Road   Stream: Stone Church Brook



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 7 (Ranked 22 of 86)

Location

Coordinates: 41.742090, -73.593850
Location Description: Local ID TM-89
Date Observed: 2016-06-02
Crossing Code: xy4174210773593834

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: Poor
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Unknown
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: Culvert is rotting

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 1.5

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	244.5	7.67	4.96	No
5	274.44		5.55	No
10	294.38		5.95	No
25	319.14		6.45	No
50	337.23		6.83	No
100	354.95		7.21	No

Structure 1 of 1

Material: Metal
Length (feet): 23.5
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Minor)
Slope: 4.3%
Structure Comments: No data

Inlet

Outlet

Inlet

Inlet Shape/Type: Pipe Arch/Elliptical Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 8.0, Height: 6.5
- Substrate/Water Width: 7.0
- Water Depth: 0.6
- Abutment Height: No data

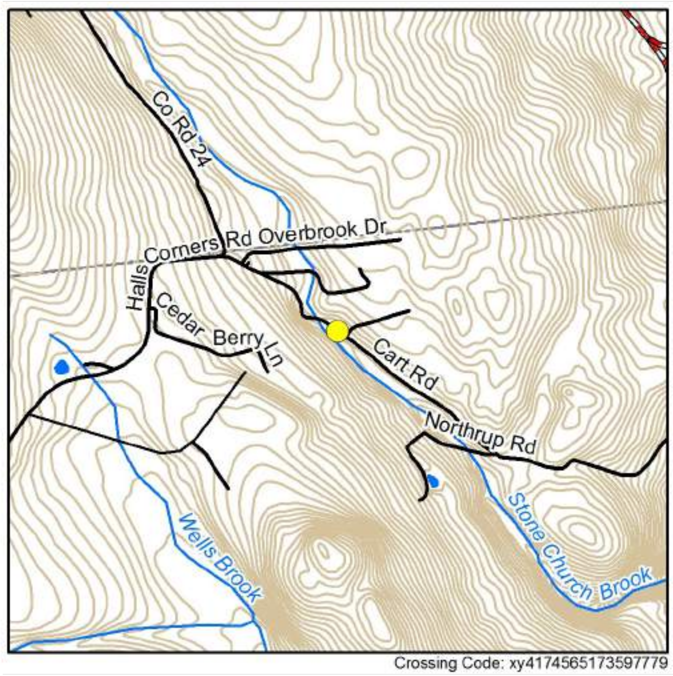
Outlet

Outlet Shape: Pipe Arch/Elliptical Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 8.3, Height: 6.7
- Substrate/Water Width: 7.1
- Water Depth: 0.6

For additional data, see Appendix

Road: Cart Road

Stream: Stone Church Brook



Results

Barrier Evaluation: Insignificant barrier

Town Comments on Condition/Maintenance: Cart Road washed out in Irene

Overall Ranking: Tier 2 (Ranked 4 of 86)

Location

Coordinates: 41.745570, -73.597690

Location Description: local ID TM-90

Date Observed: 2016-06-02

Crossing Code: xy4174565173597779

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert

Number of structures/cells: 1

Condition: Poor

Constriction: Spans Only Bankfull/Active Channel

Alignment: Skewed (>45°)

Internal Features/Structures: None

Stream Characteristics

Scour Pool: Unknown

Bankfull Width (feet): No data

Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 1.3

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	230.03	7.5	4.45	No
5	257.96		5.34	No
10	276.63		5.96	No
25	299.86		6.77	No
50	316.87		7.39	No
100	333.55		8.02	Yes

Structure 1 of 1

Material: Metal
Length (feet): 33.0
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 0.9%
Structure Comments: No data

Inlet

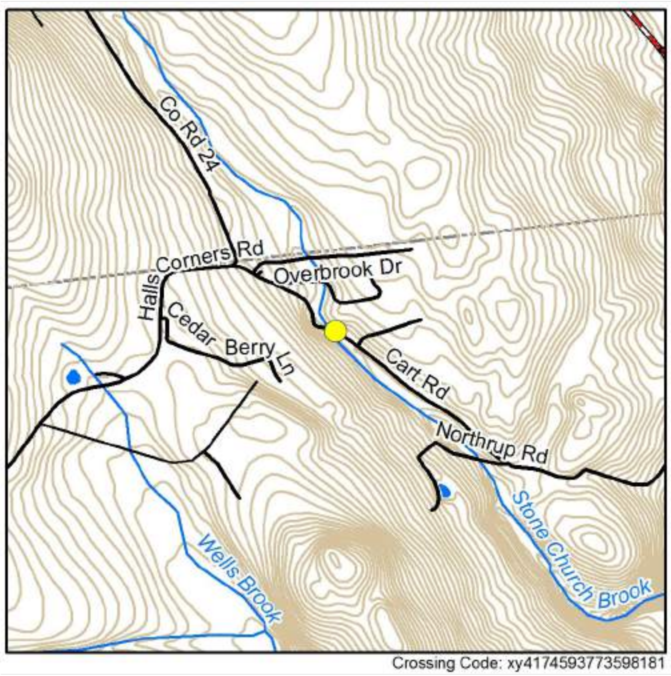
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 4.8, Height: 5.2
- Substrate/Water Width: 3.0
- Water Depth: 0.7
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 4.5, Height: 5.1
- Substrate/Water Width: 3.0
- Water Depth: 0.9

For additional data, see Appendix

Road: Cart Road   Stream: Stone Church Brook



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance:
Washed out in Irene, was replaced in 2007
Overall Ranking: Tier 1 (Ranked 1 of 86)

Location

Coordinates: 41.745930, -73.598210
Location Description: Local ID TM-91
Date Observed: 2016-06-02
Crossing Code: xy4174593773598181

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: Poor
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Small
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 1.1

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	227.96	5.1	6.83	Yes
5	255.55		8.15	Yes
10	274.03		9.07	Yes
25	297.03		10.28	Yes
50	313.89		11.19	Yes
100	330.43		12.12	Yes

Structure 1 of 1

Material: Plastic
Length (feet): 48.5
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 0.5%
Structure Comments: No data

Inlet

Outlet

Inlet

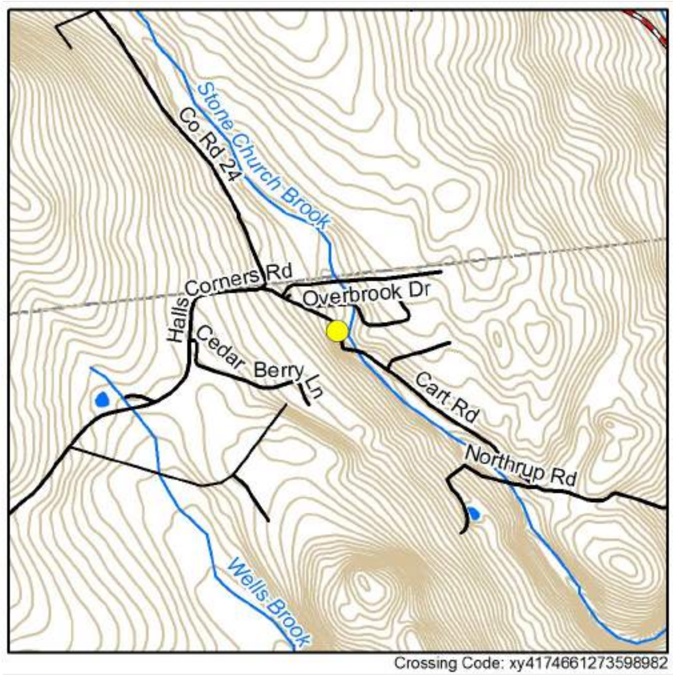
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 3.7, Height: 4.0
- Substrate/Water Width: 2.4
- Water Depth: 0.6
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 3.8, Height: 4.0
- Substrate/Water Width: 2.6
- Water Depth: 0.5

For additional data, see Appendix

Road: **Cart Road** Stream: **Stone Church Brook**



Results

Barrier Evaluation: Severe barrier
Town Comments on Condition/Maintenance:
Washed out in Irene
Overall Ranking: Tier 2 (Ranked 4 of 86)

Location

Coordinates: 41.746700, -73.598950
Location Description: Local ID TM-92
Date Observed: 2016-06-02
Crossing Code: xy4174661273598982

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data


Road

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 2.8

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	225.4	8.74	4.75	No
5	252.61		5.69	No
10	270.85		6.36	No
25	293.58		7.23	No
50	310.24		7.89	No
100	326.6		8.57	No

Structure 1 of 1

Material: Plastic
Length (feet): 64.7
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 1.2%
Structure Comments: No data


Inlet


Outlet

Inlet

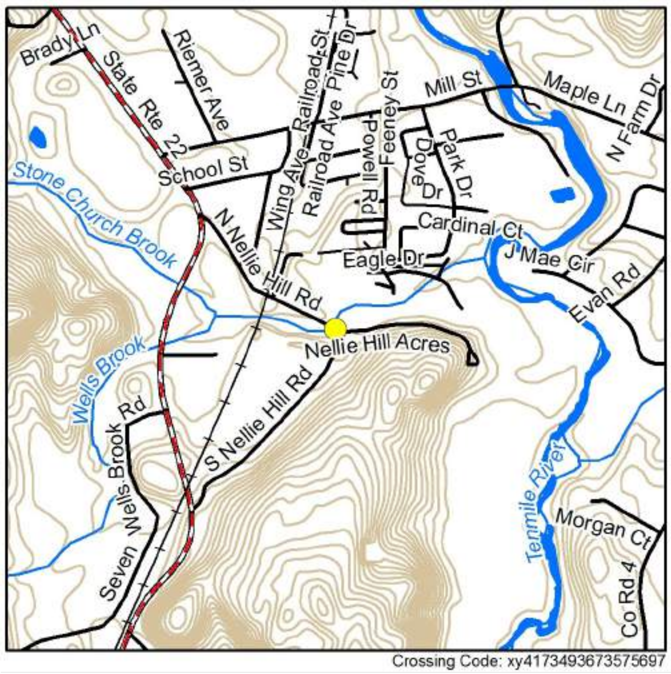
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 5.0, Height: 5.0
- Substrate/Water Width: 2.6
- Water Depth: 0.6
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 1.3/ 2.0
Dimensions:
- Width: 4.9, Height: 5.0
- Substrate/Water Width: 2.4
- Water Depth: 0.4

For additional data, see Appendix

Road: N Nellie Hill Road　　Stream: Wells Brook



Results

Barrier Evaluation: Insignificant barrier

Town Comments on Condition/Maintenance: Town's highest priority for replacement (public safety), has flooded in the past, with water over the road in 2007, in disrepair, debris jams, town water line on west side

Overall Ranking: Not Ranked

Location

Coordinates: 41.734930, -73.575660

Location Description: Local ID TM-83

Date Observed: 2016-06-02

Crossing Code: xy4173493673575697

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge

Number of structures/cells: 1

Condition: Poor

Constriction: Spans Only Bankfull/Active Channel

Alignment: Flow-Aligned

Internal Features/Structures: None

Stream Characteristics

Scour Pool: None

Bankfull Width (feet): No data

Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	543.27	N/A		
5	612.55			
10	657.07			
25	710.8			
50	748.96			
100	785.89			

Structure 1 of 1

Material: Concrete
Length (feet): 24.7
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: None
Slope: No data
Structure Comments: No data

Inlet

Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 19.5, Height: 4.6
- Substrate/Water Width: 19.5
- Water Depth: 0.8
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 19.0, Height: 4.3
- Substrate/Water Width: 19.0
- Water Depth: 0.6

For additional data, see Appendix

Road: Mill Street   Stream: Ten Mile River

Results

Barrier Evaluation: No barrier

Town Comments on Condition/Maintenance: Not Ranked

Overall Ranking: Not Ranked

Location

Coordinates: 41.742096, -73.571156

Location Description: Large bridge right before Mill street turns to Maple

Date Observed: 2017-06-28

Crossing Code: xy4174211273570845

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge Adequate

Number of structures/cells: 2

Condition: OK

Constriction: No data

Alignment: Flow-Aligned

Internal Features/Structures: No data

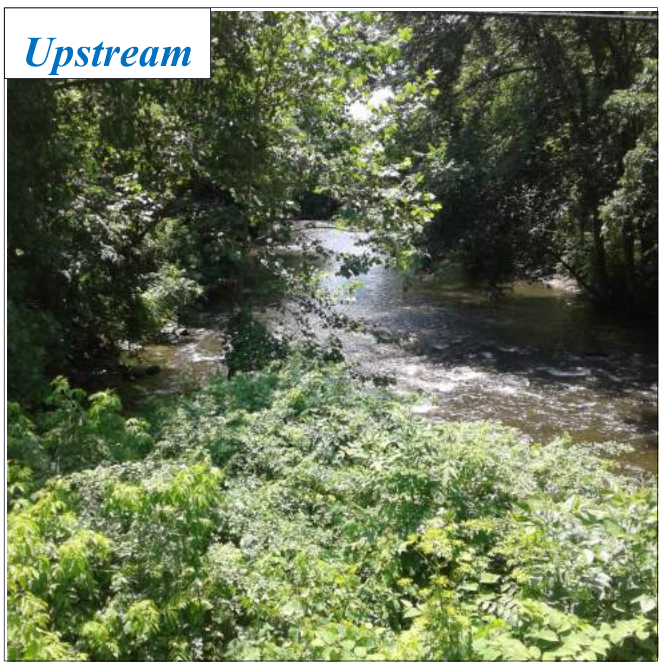
Stream Characteristics

Scour Pool: No data

Bankfull Width (feet): No data

Bankfull Width Confidence: No data

Upstream



Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	2859.38	N/A		
5	3764.72			
10	4478.96			
25	5495.51			
50	6334.21			
100	7241.31			

Structure 1 of 1

Material: No data
Length (feet): 0.0
Internal Features/Structures: No data
Dry Passage/Height:

Physical Barrier(s)/Severity:
Slope: No data
Structure Comments: No data

Inlet

Outlet

Inlet

Inlet Shape/Type:
Inlet Drop/Grade:
Dimensions:
- Width: 0.0, Height: 0.0
- Substrate/Water Width: 0.0
- Water Depth: 0.0
- Abutment Height: No data

Outlet

Outlet Shape:
Outlet Drop/Grade:
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 0.0, Height: 0.0
- Substrate/Water Width: 0.0
- Water Depth: 0.0

For additional data, see Appendix

Road: Benson Hill **Stream:** Unnamed

RESULTS

Barrier Evaluation: Moderate barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 12 (Ranked 65 of 86)

LOCATION

Coordinates: 41.752000, -73.565800
Location Description: Local ID TM-36
Date Observed: 2016-05-25
Crossing Code: xy4175204873565671

STREAM AND CROSSING

CROSSING CHARACTERISTICS

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Severe
Alignment: Flow-Aligned
Internal Features/Structures: None

STREAM CHARACTERISTICS

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: Cannot get to outlet due to barbed wire

Road

Road Type/Surface: Paved
Road Fill Height (feet): 1.5

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	8.23	3.88	0.38	No
5	9.02		0.46	No
10	9.59		0.53	No
25	10.35		0.62	No
50	10.93		0.69	No
100	11.52		0.77	No

Structure 1 of 1

Material: Plastic
Length (feet): 30.4
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 5.0%
Structure Comments: could not fully get to outlet to record outlet drop (free fall)-measurement is

Inlet

Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 2.0, Height: 2.0
- Substrate/Water Width: 1.3
- Water Depth: 0.2
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Unknown
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 2.0, Height: 2.0
- Substrate/Water Width: 1.3
- Water Depth: 0.2

For additional data, see Appendix

Road: Maple Lane   Stream: Unnamed

Results

Barrier Evaluation: Severe barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 6 (Ranked 14 of 86)

Location

Coordinates: 41.739200, -73.562600
Location Description: Local ID TM-34
Date Observed: 2016-05-25
Crossing Code: xy4173923173562651

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No upstream channel

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 5.8

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	123.07	12.04	5.48	No
5	141.01		6	No
10	152.6		6.32	No
25	166.64		6.7	No
50	176.66		6.96	No
100	186.37		7.21	No

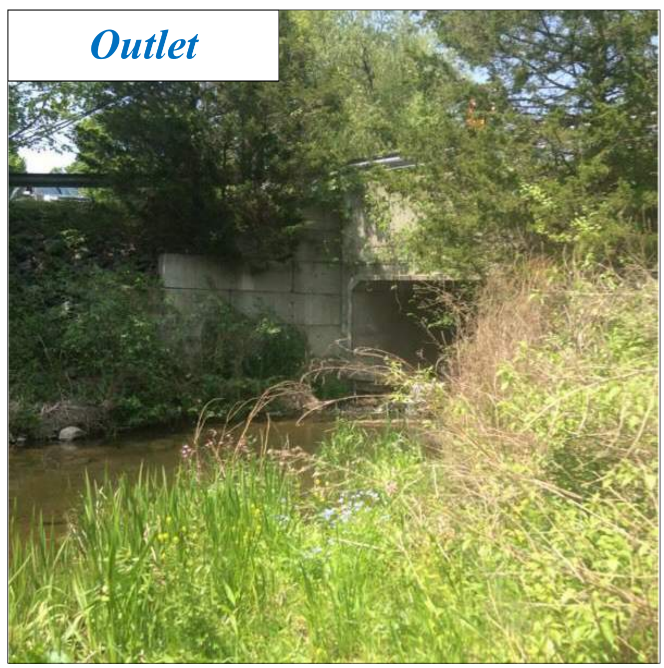
Structure 1 of 1

Material: Concrete
Length (feet): 42.4
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Moderate)
Slope: 1.7%
Structure Comments: No data

Inlet

Outlet



Inlet

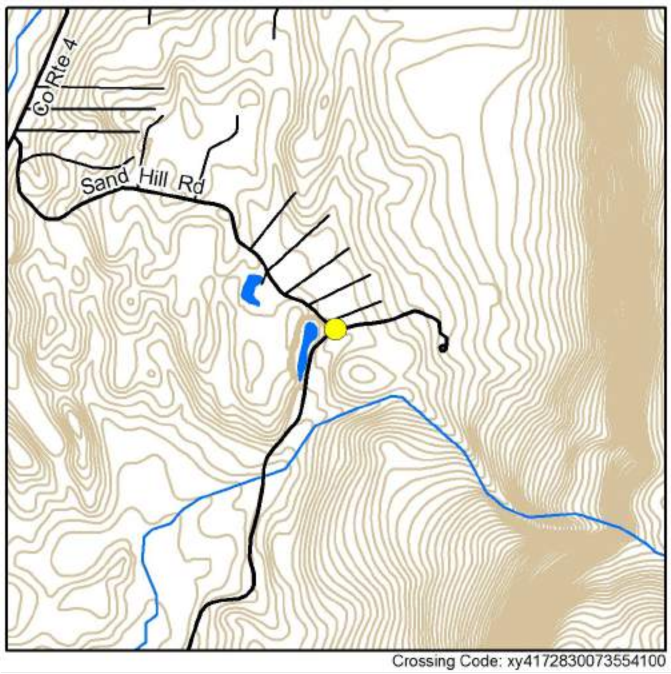
Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 10.4, Height: 5.9
- Substrate/Water Width: 5.9
- Water Depth: 0.2
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 1.4/ 1.8
Dimensions:
- Width: 10.4, Height: 5.9
- Substrate/Water Width: 5.9
- Water Depth: 0.2

For additional data, see Appendix

Road: Benson Road Stream: Unnamed



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 11 (Ranked 52 of 86)

Location

Coordinates: 41.728300, -73.554100
Location Description: local ID TM-42
Date Observed: 2016-05-26
Crossing Code: xy4172830073554100

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Skewed (>45°)
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 2.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	35.52	4.66	0.83	No
5	39.31		1.02	No
10	41.85		1.16	No
25	44.99		1.35	No
50	47.29		1.49	No
100	49.54		1.63	No

Structure 1 of 1

Material: Plastic
Length (feet): 39.0
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 0.9%
Structure Comments: No data

Inlet

Outlet

Inlet

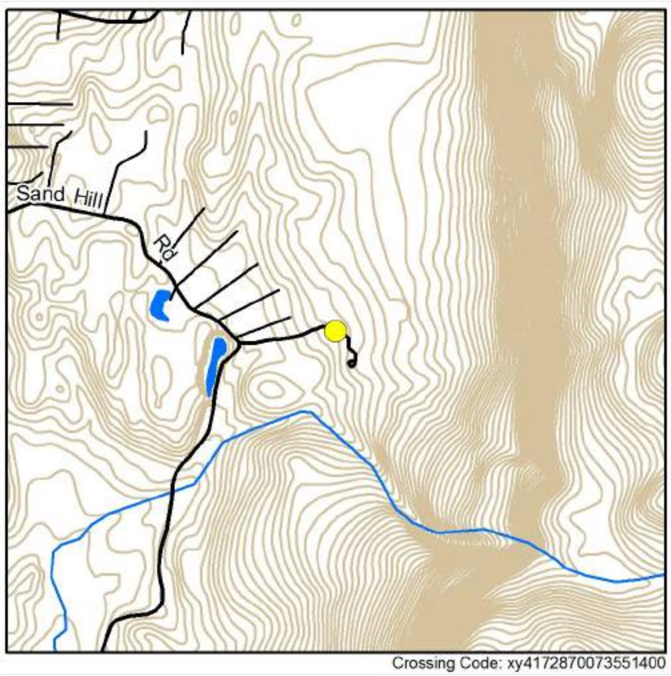
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 2.9, Height: 3.0
- Substrate/Water Width: 1.9
- Water Depth: 0.5
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 3.0, Height: 2.7
- Substrate/Water Width: 3.0
- Water Depth: 0.7

For additional data, see Appendix

Road: Benson Road **Stream:** Unnamed



Results

Barrier Evaluation: Moderate barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 12 (Ranked 65 of 86)

Location

Coordinates: 41.728700, -73.551400
Location Description: local ID TM-41
Date Observed: 2016-05-26
Crossing Code: xy4172870073551400

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: Outlet goes into a pond

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.7

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	10.1	3.65	0.14	No
5	11.07		0.18	No
10	11.7		0.2	No
25	12.45		0.24	No
50	12.98		0.26	No
100	13.5		0.28	No

Structure 1 of 1

Material: Plastic
Length (feet): 42.0
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Moderate)
Slope: 3.9%
Structure Comments: No data

Inlet

Outlet

Inlet

Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: Inlet Drop
Dimensions:
- Width: 3.0, Height: 3.0
- Substrate/Water Width: 1.5
- Water Depth: 0.1
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Cascade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 3.1, Height: 2.9
- Substrate/Water Width: 0.5
- Water Depth: 0.1

For additional data, see Appendix

Road: North Farm Road   Stream: Unnamed

Results
Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 7 (Ranked 22 of 86)

Location
Coordinates: 41.740800, -73.561400
Location Description: Local ID TM-38
Date Observed: 2016-05-25
Crossing Code: xy4174077573561380

Stream and Crossing

Crossing Characteristics
Crossing Type: Culvert
Number of structures/cells: 1
Condition: Poor
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics
Scour Pool: Small
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road Type/Surface: Paved
Road Fill Height (feet): 3.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	119.8	10.49	2.27	No
5	137.2		2.98	No
10	148.53		3.49	No
25	162.33		4.17	No
50	172.23		4.7	No
100	181.86		5.24	No

Structure 1 of 1

Material: Metal
Length (feet): 53.8
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Moderate)
Slope: No data
Structure Comments: No data

Inlet

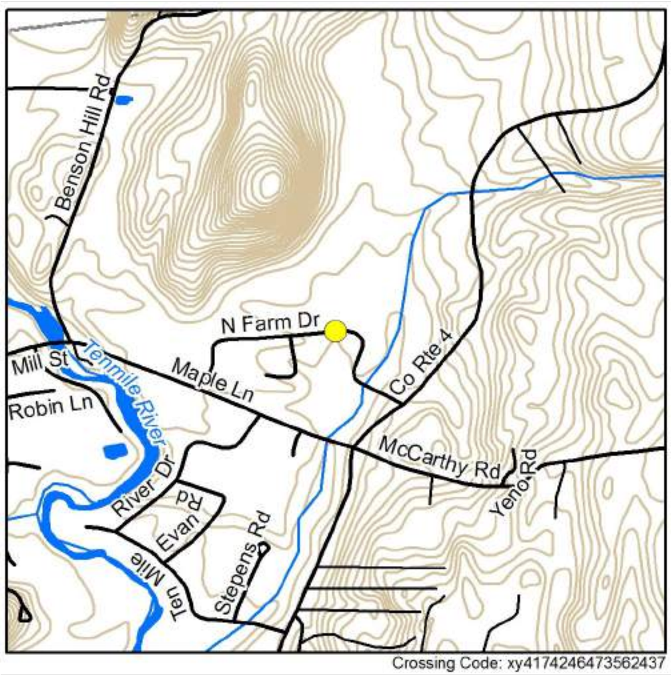
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 5.8, Height: 6.1
- Substrate/Water Width: 3.9
- Water Depth: 0.9
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 5.7, Height: 5.4
- Substrate/Water Width: 4.1
- Water Depth: 0.3

For additional data, see Appendix

Road: North Farm Road   Stream: Unnamed



Results

Barrier Evaluation: Moderate barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 7 (Ranked 22 of 86)

Location

Coordinates: 41.742400, -73.562400
Location Description: Local ID TM-37
Date Observed: 2016-05-25
Crossing Code: xy4174246473562437

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: Poor
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data


Upstream


Downstream

Crossing Comments: Caving in the middle of the road. Needs to be fixed or else possible cave-in soon. Has been an issue for many years

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 2.4

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	3.12	6.17	0.06	No
5	3.59		0.06	No
10	3.87		0.07	No
25	4.19		0.07	No
50	4.41		0.07	No
100	4.61		0.07	No

Structure 1 of 1

Material: Metal
Length (feet): 51.2
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 2.0%
Structure Comments: No data

Inlet

Outlet

Inlet

Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 3.3, Height: 3.0
- Substrate/Water Width: 0.8
- Water Depth: 0.2
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 0.3/ 0.7
Dimensions:
- Width: 3.0, Height: 3.1
- Substrate/Water Width: 1.1
- Water Depth: 0.1

For additional data, see Appendix

Road: **Poplar Hill Road** **Stream:** **Unnamed**

Results

Barrier Evaluation: Insignificant barrier

Town Comments on Condition/Maintenance: Not Ranked

Overall Ranking: Tier 11 (Ranked 52 of 86)

Location

Coordinates: 41.746400, -73.558360

Location Description: Near horse farm

Date Observed: 2017-11-07

Crossing Code: xy4174641473558421

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert

Number of structures/cells: 1

Condition: OK

Constriction: Spans Only Bankfull/Active Channel

Alignment: Flow-Aligned

Internal Features/Structures: None

Stream Characteristics

Scour Pool: Unknown

Bankfull Width (feet): 7

Bankfull Width Confidence: Low/ Estimated

Upstream

Downstream

Crossing Comments: Stormwater outfalls at inlet and outlet


Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 2.8

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	78.26	8	0.37	No
5	89.84		0.5	No
10	97.4		0.59	No
25	106.63		0.71	No
50	113.26		0.8	No
100	119.72		0.9	No

Structure 1 of 1

Material: Metal
Length (feet): 40.5
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 0.6%
Structure Comments: No data


Inlet


Outlet

Inlet

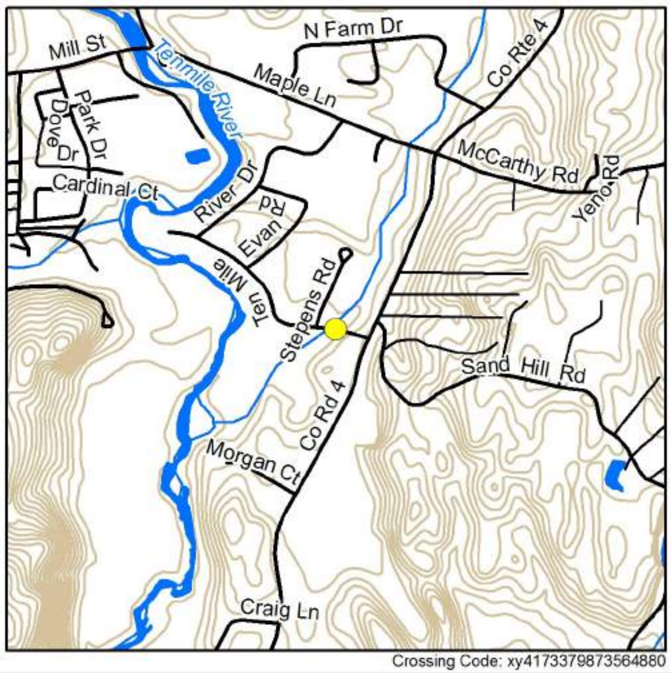
Inlet Shape/Type: Pipe Arch/Elliptical Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 8.2, Height: 5.0
- Substrate/Water Width: 8.2
- Water Depth: 0.4
- Abutment Height: No data

Outlet

Outlet Shape: Pipe Arch/Elliptical Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 8.2, Height: 4.8
- Substrate/Water Width: 8.2
- Water Depth: 0.3

For additional data, see Appendix

Road: Ten Mile River Road **Stream:** Unnamed



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 11 (Ranked 52 of 86)

Location

Coordinates: 41.733800, -73.564800
Location Description: Local ID TM-39
Date Observed: 2016-05-26
Crossing Code: xy4173379873564880

Stream and Crossing

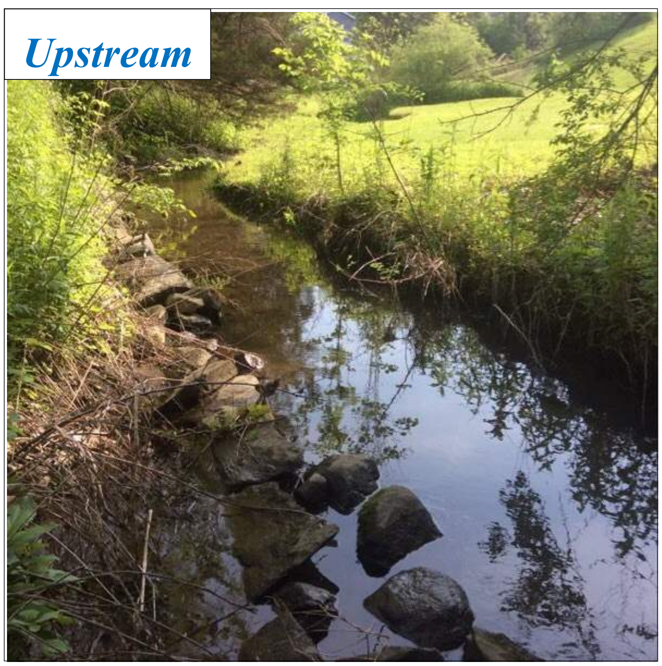
Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream



Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 1.7

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	139.58	8.91	1.85	No
5	159.25		2.37	No
10	172.04		2.75	No
25	187.6		3.24	No
50	198.74		3.63	No
100	209.57		4.02	No

Structure 1 of 1

Material: Metal
Length (feet): 52.7
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Minor)
Slope: 2.9%
Structure Comments: No data

Inlet

Outlet

Inlet

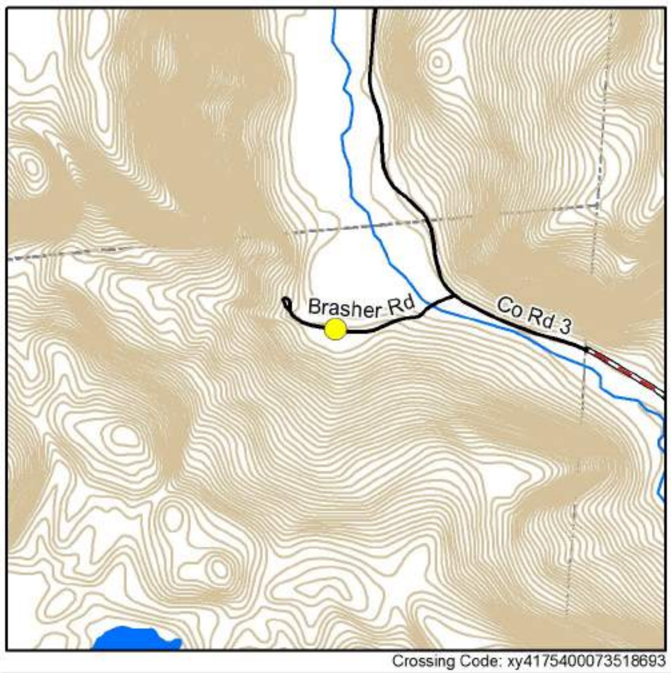
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: Perched
Dimensions:
- Width: 5.8, Height: 6.2
- Substrate/Water Width: 3.0
- Water Depth: 0.6
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 5.8, Height: 6.2
- Substrate/Water Width: 4.5
- Water Depth: 1.2

For additional data, see Appendix

Road: Brasher Road Stream: Unnamed



Results

Barrier Evaluation: Moderate barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 8 (Ranked 33 of 86)

Location

Coordinates: 41.753960, -73.518800
Location Description: 1000 feet from Bog Hollow Road
Date Observed: 2016-03-24
Crossing Code: xy4175400073518693

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Severe
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 0.8

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	23.63	2.08	0.48	No
5	46.65		1.4	No
10	72.92		2.78	Yes
25	125.11		6.32	Yes
50	183.01		11.27	Yes
100	263.12		19.58	Yes

Structure 1 of 1

Material: Plastic
Length (feet): 29.5
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 4.9%
Structure Comments: No data

Inlet

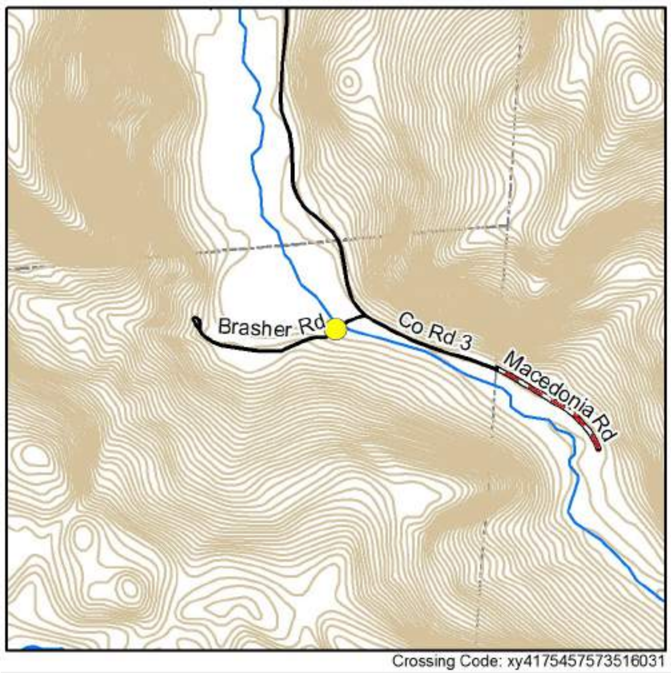
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 1.5, Height: 1.5
- Substrate/Water Width: 1.0
- Water Depth: 0.2
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 0.6/ 1.1
Dimensions:
- Width: 1.5, Height: 1.5
- Substrate/Water Width: 0.8
- Water Depth: 0.1

For additional data, see Appendix

Road: Brasher Road **Stream:** Bog Hollow Brook



Results

Barrier Evaluation: Moderate barrier
Town Comments on Condition/Maintenance: Beaver problems, never flooded though
Overall Ranking: Tier 1 (Ranked 1 of 86)

Location

Coordinates: 41.754650, -73.516040
Location Description: 500 feet from Bog Hollow Road
Date Observed: 2016-03-24
Crossing Code: xy4175457573516031

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: Poor
Constriction: Severe
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: Wetland pond upstream

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 1.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	441.48	6.33	2.61	No
5	828.04		6.7	Yes
10	1240.89		12.3	Yes
25	2012.83		25.44	Yes
50	2822.06		42.28	Yes
100	3889.06		68.47	Yes

Structure 1 of 1

Material: Metal
Length (feet): 20.0
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Debris/Sediment/Rock (Moderate)
Slope: 6.4%
Structure Comments: Vegetation and debris (due

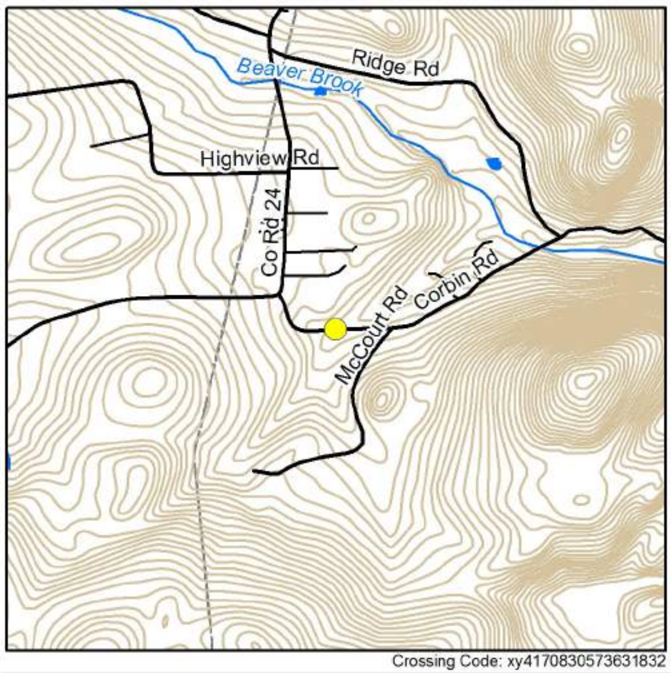
Inlet

Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 5.0, Height: 5.0
- Substrate/Water Width: 5.0
- Water Depth: 1.8
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 5.0, Height: 5.0
- Substrate/Water Width: 4.5
- Water Depth: 1.8

For additional data, see Appendix



Results

Barrier Evaluation: Severe barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 6 (Ranked 14 of 86)

Location

Coordinates: 41.708430, -73.631207
Location Description: 50 feet before 37 Corbin Road and telephone pole number 55
Date Observed: 2017-06-14
Crossing Code: xy4170830573631832

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): 4.3
Bankfull Width Confidence: High

Upstream

Downstream

Crossing Comments: No data

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	31.49	5.43	1.1	No
5	34.69		1.32	No
10	36.8		1.48	No
25	39.39		1.69	No
50	41.27		1.85	No
100	43.09		2.01	No

Structure 1 of 1

Material: Combination
Length (feet): 36.6
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 2.5%
Structure Comments: No data

Inlet

Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 3.0, Height: 2.9
- Substrate/Water Width: 1.7
- Water Depth: 0.2
- Abutment Height: No data

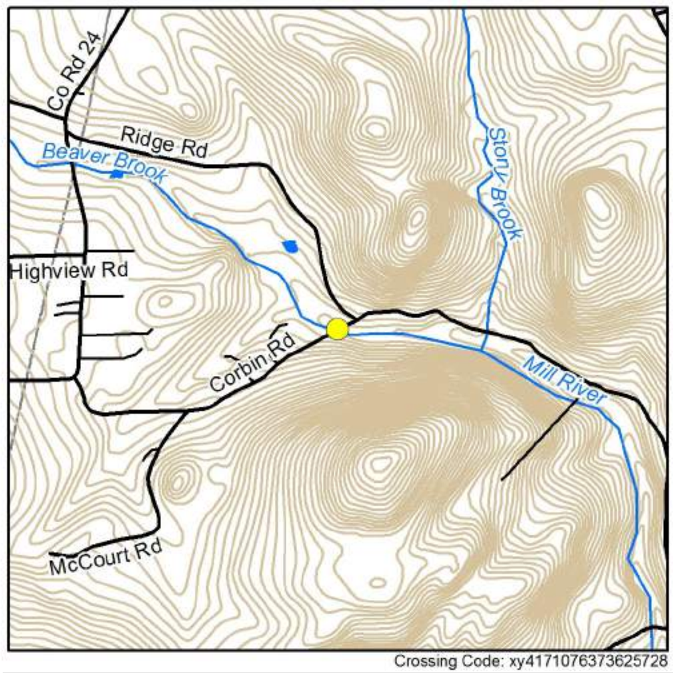
Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 1.1/ 1.7
Dimensions:
- Width: 2.9, Height: 3.1
- Substrate/Water Width: 1.2
- Water Depth: 0.3

For additional data, see Appendix

Road: Corbin Road

Stream: Beaver Brook



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 8 (Ranked 33 of 86)

Location

Coordinates: 41.710736, -73.625797
Location Description: Culvert past where Ridge Road and Corbin Road intersect
Date Observed: 2017-06-14
Crossing Code: xy4171076373625728

Stream and Crossing

Crossing Characteristics

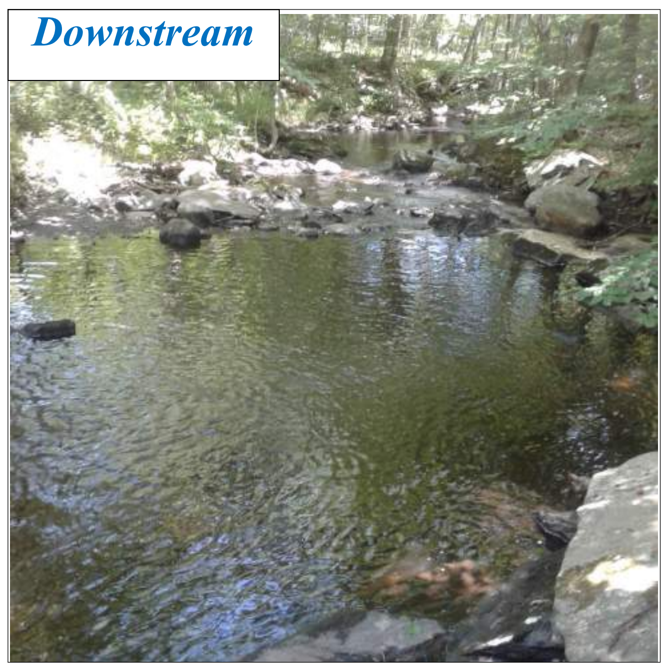
Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Severe
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): 28
Bankfull Width Confidence: High

Upstream

Downstream



Crossing Comments: No data

Road

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	339.09	6.91	5.53	No
5	373.67		5.98	No
10	398.3		6.29	No
25	430.24		6.7	No
50	454.3		7	**Yes**
100	478.54		7.31	**Yes**

Structure 1 of 1

Material: Combination
Length (feet): 20.5
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 3.1%
Structure Comments: No data

Inlet

Outlet

Inlet

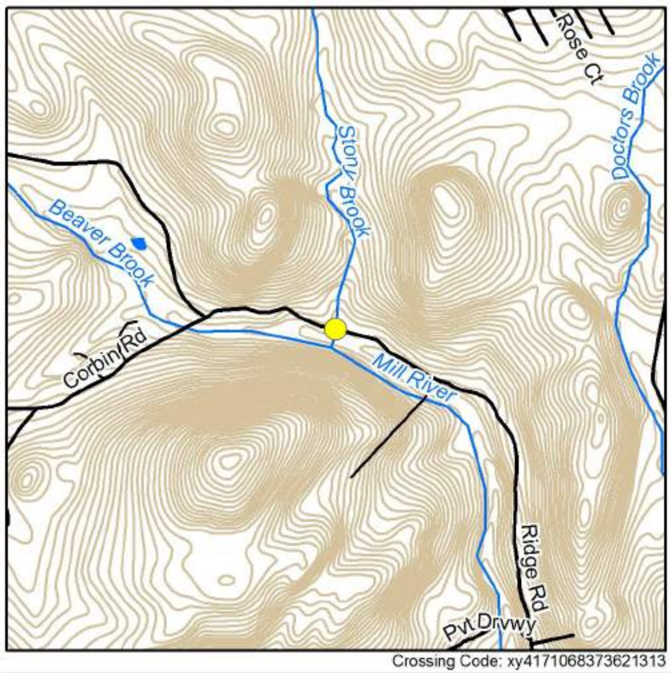
Inlet Shape/Type: Pipe Arch/Elliptical Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 9.3, Height: 5.9
- Substrate/Water Width: 9.2
- Water Depth: 0.3
- Abutment Height: No data

Outlet

Outlet Shape: Pipe Arch/Elliptical Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 2.4
Dimensions:
- Width: 9.8, Height: 5.5
- Substrate/Water Width: 9.2
- Water Depth: 2.0

For additional data, see Appendix

Road: Ridge Road **Stream:** Stony Brook



Results

Barrier Evaluation: Severe barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 5 (Ranked 10 of 86)

Location

Coordinates: 41.710615, -73.621233
Location Description: 100 feet east from 161 Ridge Road
Date Observed: 2017-06-14
Crossing Code: xy4171068373621313

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Severe
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): 29.1
Bankfull Width Confidence: High

Upstream

Downstream

Crossing Comments: 100 feet west of 161 Ridge Road

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	170.77	7.78	3.54	No
5	195.20		3.94	No
10	209.67		4.2	No
25	226.13		4.46	No
50	237.34		4.66	No
100	247.49		4.82	No

Structure 1 of 1

Material: Combination
Length (feet): 20.1
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 1.1%
Structure Comments: No data

Inlet

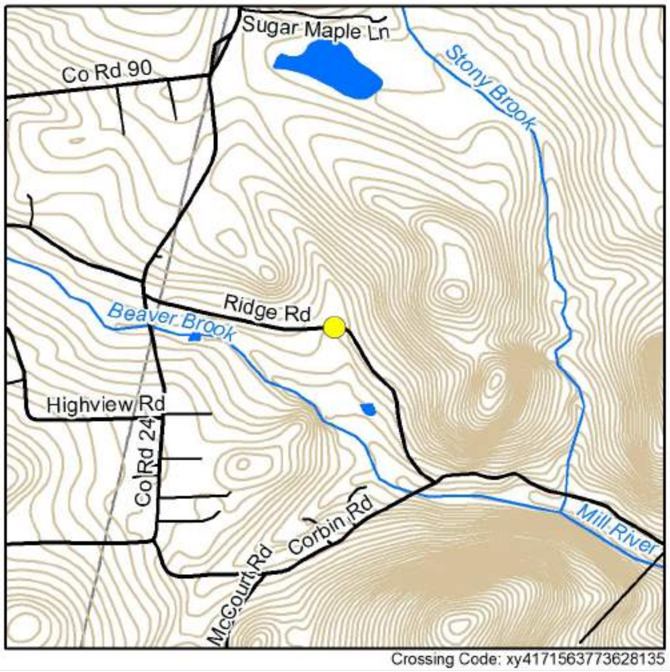
Inlet Shape/Type: Open Bottom Arch Bridge/ Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 9.9, Height: 6.6
- Substrate/Water Width: 9.1
- Water Depth: 0.2
- Abutment Height: No data

Outlet

Outlet Shape: Open Bottom Arch Bridge/Culvert
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 1.3/ 1.9
Dimensions:
- Width: 9.8, Height: 6.7
- Substrate/Water Width: 8.7
- Water Depth: 0.2

For additional data, see Appendix

Road: Ridge Road   Stream: Unnamed



Results

Barrier Evaluation: Significant barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 9 (Ranked 43 of 86)

Location

Coordinates: 41.715625, -73.628078
Location Description: 63 Ridge Road
Date Observed: 2017-06-14
Crossing Code: xy4171563773628135

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Unknown
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Unknown
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No flow; appears to be drainage for adjacent yard

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 0.1

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	9.94	1.6	0.49	No
5	11.08		0.6	No
10	11.92		0.68	No
25	13.04		0.81	No
50	13.9		0.91	No
100	14.78		1.03	No

Structure 1 of 1

Material: Plastic
Length (feet): 34.3
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: None
Slope: 4.5%
Structure Comments: No data

Inlet

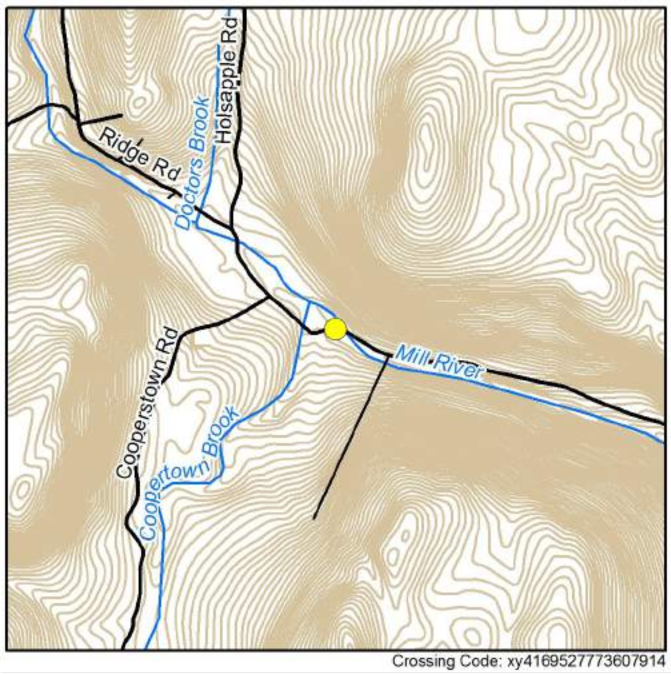
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: Unknown
Dimensions:
Width: 1.3, Height: 1.3
Substrate/Water Width: 0.0
Water Depth: 0.0
Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Unknown
Drop to Stream Surface/Bottom: 0.0/ 0.7
Dimensions:
Width: 1.3, Height: 1.3
Substrate/Water Width: 0.0
Water Depth: 0.0

For additional data, see Appendix

Road: Ridge Road **Stream:** Mill River



Results

Barrier Evaluation: No barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Not Ranked

Location

Coordinates: 41.695281, -73.608023
Location Description: One lane bridge on Ridge Road
Date Observed: 2017-06-16
Crossing Code: xy4169527773607914

Stream and Crossing

Crossing Characteristics

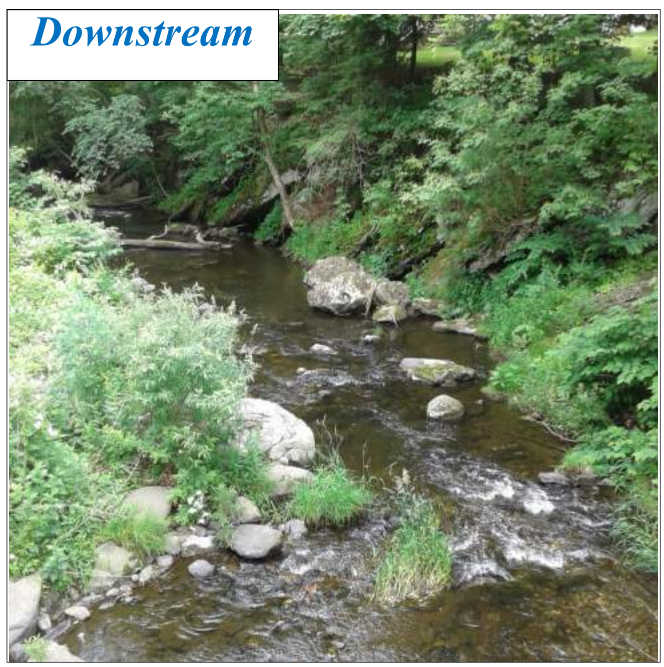
Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Spans Full Channel & Banks
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): 26.9
Bankfull Width Confidence: Low/ Estimated

Upstream

Downstream



Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	1174.75	N/A		
5	1287.64			
10	1357.44			
25	1439.24			
50	1496.01			
100	1549.76			

Structure 1 of 1

Material: Concrete
Length (feet): 17.3
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: None
Slope: No data
Structure Comments: No data

Inlet

Outlet

Inlet

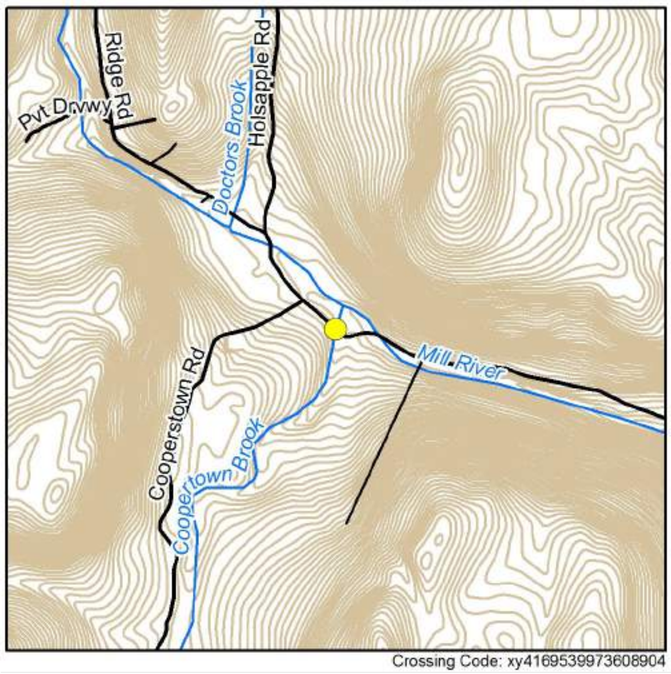
Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 43.5, Height: 10.8
- Substrate/Water Width: 25.7
- Water Depth: 0.5
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 42.0, Height: 10.7
- Substrate/Water Width: 25.2
- Water Depth: 0.5

For additional data, see Appendix

Road: Ridge Road **Stream:** Coopertown Brook



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Not Ranked

Location

Coordinates: 41.695372, -73.608679
Location Description: 456 Ridge Road bridge
Date Observed: 2017-06-16
Crossing Code: xy4169539973608904

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): 25.1
Bankfull Width Confidence: Low/Estimated

Upstream

Downstream

Crossing Comments: No data

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.0

<table>
<tr><th>Return Interval (Years)</th><th>Peak Flow (cfs)</th><th>Road Height (feet)</th><th>Stage Height (feet)</th><th>Overtop</th></tr>
<tr><td>2</td><td>477.38</td><td colspan="3" rowspan="6">N/A</td></tr>
<tr><td>5</td><td>524.75</td></tr>
<tr><td>10</td><td>555.28</td></tr>
<tr><td>25</td><td>592.23</td></tr>
<tr><td>50</td><td>618.51</td></tr>
<tr><td>100</td><td>643.89</td></tr>
</table>

Structure 1 of 1

Material: Concrete
Length (feet): 30.1
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: None
Slope: No data
Structure Comments: No data

Inlet

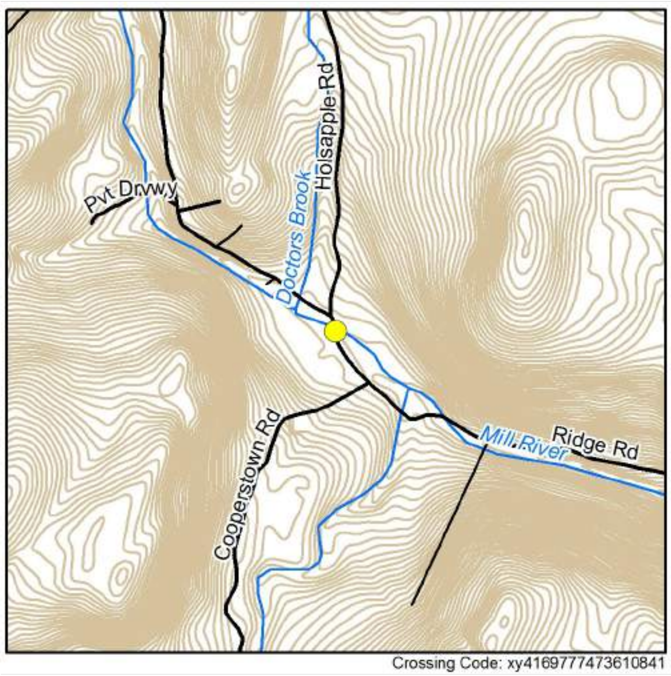
Inlet Shape/Type: Bridge with Abutments and Side Slopes
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 48.6, Height: 8.7
- Substrate/Water Width: 23.3
- Water Depth: 1.4
- Abutment Height: 2.3

Outlet

Outlet Shape: Bridge with Abutments and Side Slopes
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 50.0, Height: 8.8
- Substrate/Water Width: 24.3
- Water Depth: 1.0

For additional data, see Appendix

Road: Ridge Road **Stream:** Mill River



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Not Ranked

Location

Coordinates: 41.697975, -73.610833
Location Description: Bridge on Ridge Road facing the intersection of holsapple road
Date Observed: 2017-06-16
Crossing Code: xy4169777473610841

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Skewed (>45°)
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): 32.3
Bankfull Width Confidence: High

Upstream

Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	689.67			
5	757.41			
10	797.91		N/A	
25	844.36			
50	875.91			
100	905.19			

Structure 1 of 1

Material: Combination
Length (feet): 24.8
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: None
Slope: No data
Structure Comments: Outlet too deep to take adequate picture of outlet

Inlet

Outlet

Inlet

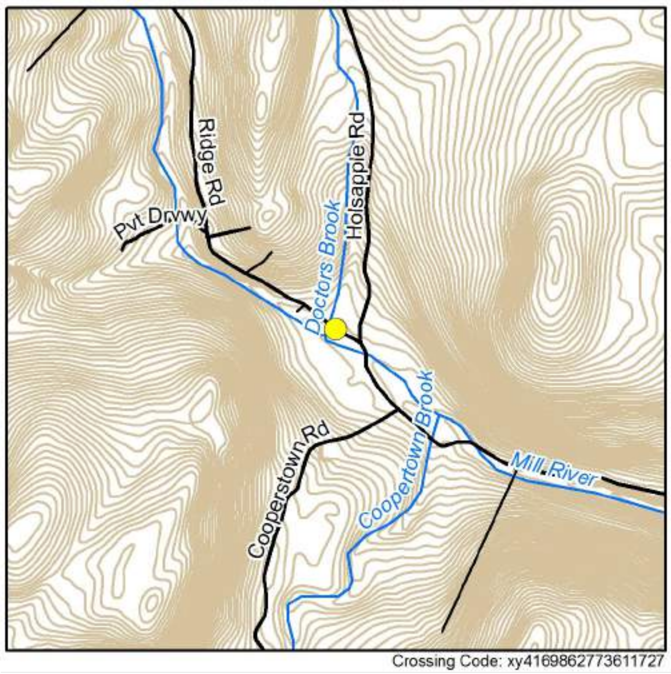
Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 23.9, Height: 5.7
- Substrate/Water Width: 20.2
- Water Depth: 0.6
- Abutment Height: No data

Outlet

Outlet Shape: Bridge with Side Slopes
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 23.6, Height: 7.7
- Substrate/Water Width: 19.4
- Water Depth: 1.6

For additional data, see Appendix

Road: Ridge Road   Stream: Doctors Brook



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Not Ranked

Location

Coordinates: 41.698690, -73.611700
Location Description: First bridge from the intersection of Holsapple Rd
Date Observed: 2017-05-31
Crossing Code: xy4169862773611727

Stream and Crossing

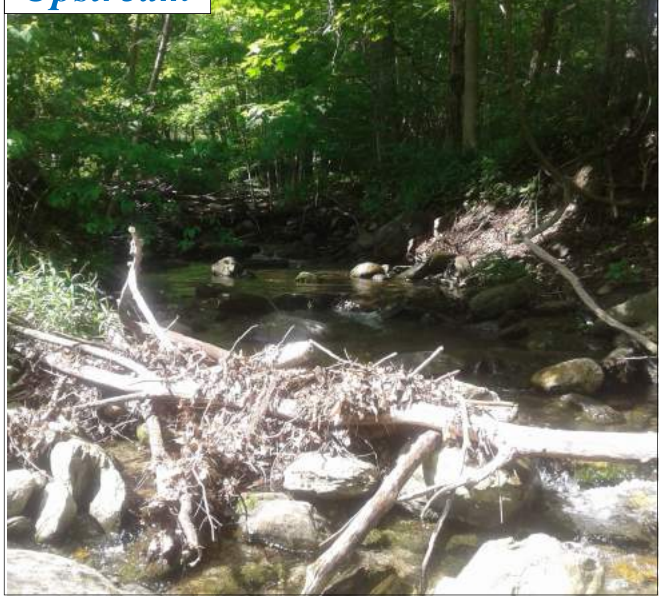
Crossing Characteristics

Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Severe
Alignment: Skewed (>45°)
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): 16.8
Bankfull Width Confidence: Low/ Estimated

Upstream



Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	115.75			
5	126.45			
10	132.86		N/A	
25	140.22			
50	145.23			
100	149.88			

Structure 1 of 1

Material: Combination
Length (feet): 20.0
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: No data
Structure Comments: No data

Inlet

Outlet

Inlet

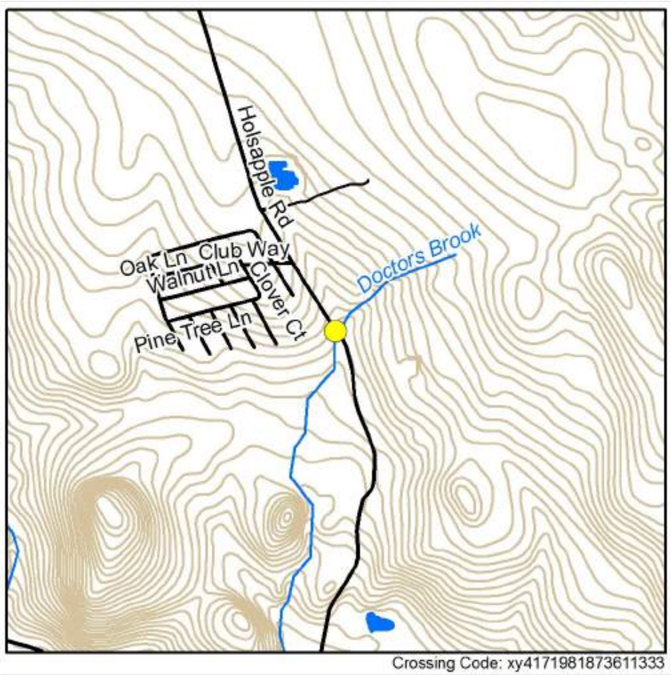
Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 8.9, Height: 5.2
- Substrate/Water Width: 8.9
- Water Depth: 1.0
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 8.7, Height: 5.2
- Substrate/Water Width: 8.7
- Water Depth: 0.5

For additional data, see Appendix

Road: Holsapple Road Stream: Doctors Brook



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 12 (Ranked 65 of 86)

Location

Coordinates: 41.719960, -73.611270
Location Description: Near 45 MPH speed limit sigh and a posted dirt road
Date Observed: 2017-05-24
Crossing Code: xy4171981873611333

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Small
Bankfull Width (feet): 10.1
Bankfull Width Confidence: Low/ Estimated


Upstream


Downstream

Crossing Comments: Gabions on both sides of the inlet..culverts are in close proximity of each other in the same stream..30' downstream is a natural cascade..downstream channel is


Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 2.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	23.67	7.62	1.77	No
5	26.23		1.91	No
10	27.86		2	No
25	29.82		2.11	No
50	31.21		2.18	No
100	32.54		2.25	No

Structure 1 of 1

Material: Metal
Length (feet): 50.3
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 1.6%
Structure Comments: Most of downstream left contains gabions


Inlet


Outlet

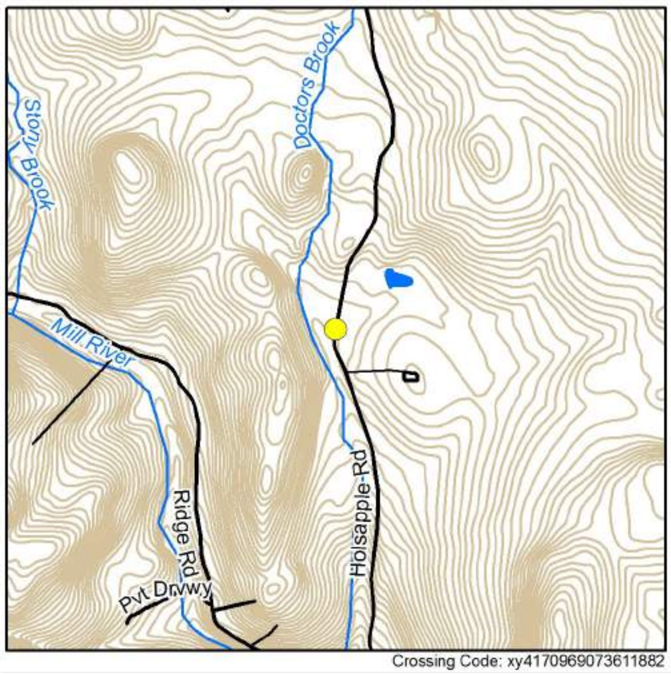
Inlet

Inlet Shape/Type: Pipe Arch/Elliptical Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 7.1, Height: 5.4
- Substrate/Water Width: 5.1
- Water Depth: 0.4
- Abutment Height: No data

Outlet

Outlet Shape: Pipe Arch/Elliptical Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 7.2, Height: 4.8
- Substrate/Water Width: 6.4
- Water Depth: 0.2

For additional data, see Appendix



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 10 (Ranked 47 of 86)

Location

Coordinates: 41.709690, -73.611850
Location Description: Approximately 100 yards north 377 Holsapple Road; Just before telephone pole # 47
Date Observed: 2017-05-24
Crossing Code: xy4170969073611882

Stream and Crossing

Crossing Characteristics

Crossing Type: Multiple Culvert
Number of structures/cells: 2
Condition: OK
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): 4.6
Bankfull Width Confidence: Low/Estimated

Upstream

Downstream

Crossing Comments: Upstream channel is densely populated with vegetation

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 3.2

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	37.33	5.94	3.08	No
5	41.17		3.42	No
10	43.59		3.63	No
25	46.46		3.89	No
50	48.48		4.08	No
100	50.41		4.26	No

Structure 1 of 2

Material: Metal
Length (feet): 40.1
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 1.6%
Structure Comments: No data

Inlet

Outlet

Inlet

Inlet Shape/Type: Pipe Arch/Elliptical Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 4.7, Height: 2.8
- Substrate/Water Width: 3.7
- Water Depth: 0.3
- Abutment Height: No data

Outlet

Outlet Shape: Pipe Arch/Elliptical Culvert
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 0.4/ 0.7
Dimensions:
- Width: 4.6, Height: 3.2
- Substrate/Water Width: 2.4
- Water Depth: 0.2

For additional data, see Appendix

Structure 2 of 2

Material: Plastic
Length (feet): 40.1
Dry Passage/Height (feet): Yes

Slope: 2.3%
Physical Barrier(s)/Severity: Dry (Moderate)
Structure Comments: Sedimentation at inlet and

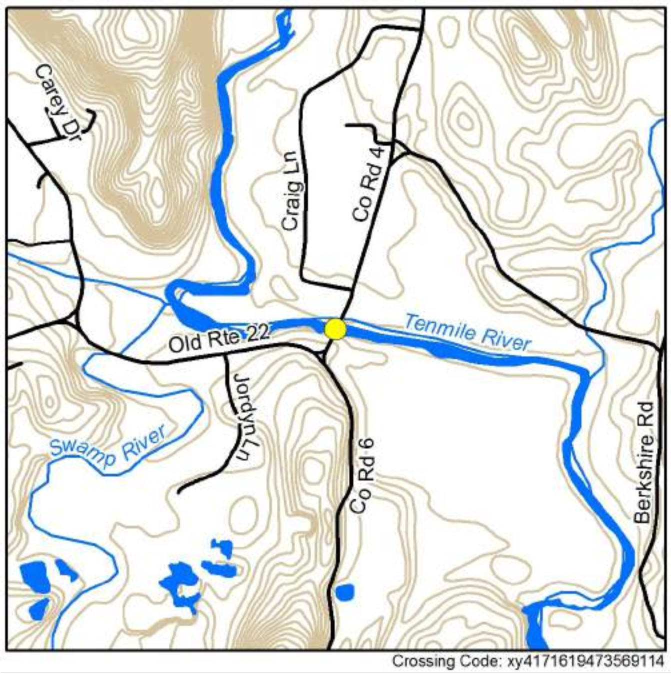
Inlet

Inlet Shape/Type: Round Culvert/ Projecting
Inlet Drop/Grade: At Stream Grade
Dimensions (feet):
Width: 2.6 , Height: 2.4
Substrate/Water Width: 0
Water Depth: 0

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Cascade
Drop to Stream Surface/Bottom (feet): 0.0/0.0
Dimensions (feet):
Width: 2.5, Height: 2.5
Substrate/Water Width: 0.0
Water Depth: 0.00

Road: Limekiln Road Stream: Ten Mile River



Results
Barrier Evaluation: No barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Not Ranked

Location
Coordinates: 41.716034, -73.569131
Location Description: Green colored bridge near "speed limit 40" sign
Date Observed: 2017-06-28
Crossing Code: xy4171619473569114

Stream and Crossing

Crossing Characteristics
Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Unknown
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics
Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: Difficult to measure bankfull due to water depth

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	5172.72	N/A		
5	6419.56			
10	7390.37			
25	8757.49			
50	9867.72			
100	11057.5			

Structure 1 of 1

Material: Combination
Length (feet): 36.0
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: No data
Structure Comments: Ridge near vertical abutment water is deeper on both sides

Inlet

Outlet

Inlet

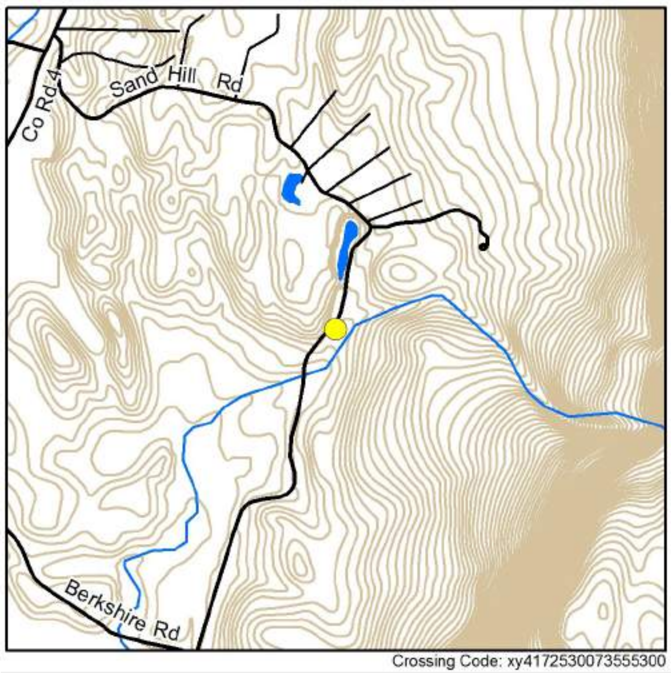
Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 123.4, Height: 13.9
- Substrate/Water Width: 123.4
- Water Depth: 0.7
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 121.2, Height: 13.9
- Substrate/Water Width: 121.2
- Water Depth: 0.6

For additional data, see Appendix

Road: Sand Hill Road Stream: Unnamed



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Not Ranked

Location

Coordinates: 41.725300, -73.555300
Location Description: local ID TM-44
Date Observed: 2016-05-26
Crossing Code: xy4172530073555300

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge
Number of structures/cells: 1
Condition: Poor
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Driveway
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	116.87	N/A		
5	127.04			
10	133.27			
25	140.52			
50	145.52			
100	150.24			

Structure 1 of 1

Material: Wood
Length (feet): 15.3
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: No data
Structure Comments: No data

Inlet

Outlet

Inlet

Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 7.3, Height: 3.5
- Substrate/Water Width: 7.3
- Water Depth: 0.5
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 6.5, Height: 3.7
- Substrate/Water Width: 6.5
- Water Depth: 0.2

For additional data, see Appendix

Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Not Ranked

Location

Coordinates: 41.716366, -73.562053
Location Description: 500 ft west of Berkshire and sandhill Road intersection
Date Observed: 2017-06-28
Crossing Code: xy4171635873562039

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: No data
Bankfull Width (feet): 7.5
Bankfull Width Confidence: Low/Estimated

Upstream

Downstream

Crossing Comments: Additional photo shows the fencing at the outlet

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	179.77	N/A		
5	197.65			
10	208.33			
25	220.57			
50	228.88			
100	236.59			

Structure 1 of 1

Material: Concrete
Length (feet): 25.1
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: Fencing (Minor)
Slope: No data
Structure Comments: Fencing at outlet

Inlet

Outlet

Inlet

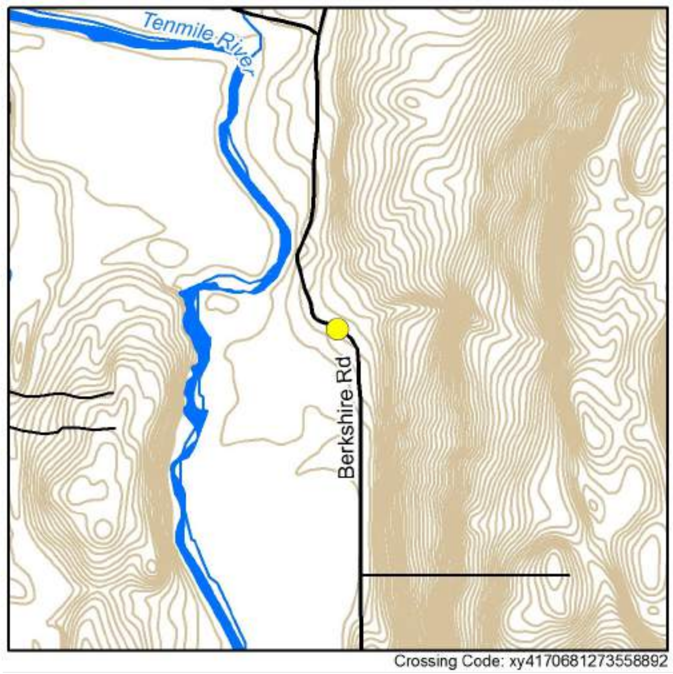
Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 12.3, Height: 5.5
- Substrate/Water Width: 11.5
- Water Depth: 1.0
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 12.3, Height: 5.1
- Substrate/Water Width: 12.0
- Water Depth: 0.4

For additional data, see Appendix

Road: Berkshire Road **Stream:** Unnamed



Results

Barrier Evaluation: Severe barrier
Town Comments on Condition/Maintenance:
Needs to be replaced
Overall Ranking: Tier 3 (Ranked 7 of 86)

Location

Coordinates: 41.706560, -73.558930
Location Description: Local ID TM-58
Date Observed: 2016-05-27
Crossing Code: xy4170681273558892

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 1.1

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	24.44	4.72	0.37	No
5	28.06		0.44	No
10	30.51		0.49	No
25	33.61		0.57	No
50	35.91		0.63	No
100	38.18		0.69	No

Structure 1 of 1

Material: Metal
Length (feet): 41.2
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Moderate)
Slope: 5.7%
Structure Comments: No data

Inlet

Outlet

Inlet

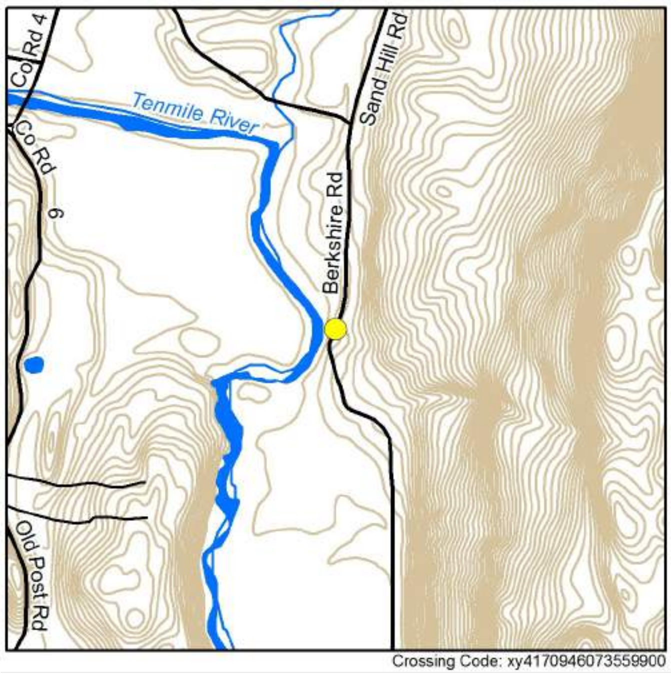
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 4.0, Height: 3.8
- Substrate/Water Width: 0.0
- Water Depth: 0.0
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Free Fall Onto Cascade
Drop to Stream Surface/Bottom: 2.7/ 2.7
Dimensions:
- Width: 4.0, Height: 3.8
- Substrate/Water Width: 0.0
- Water Depth: 0.0

For additional data, see Appendix

Road: Berkshire Road **Stream:** Unnamed



Results

Barrier Evaluation: Significant barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 5 (Ranked 10 of 86)

Location

Coordinates: 41.709460, -73.559900
Location Description: Local ID TM-59
Date Observed: 2016-05-27
Crossing Code: xy4170946073559900

Stream and Crossing

Crossing Characteristics

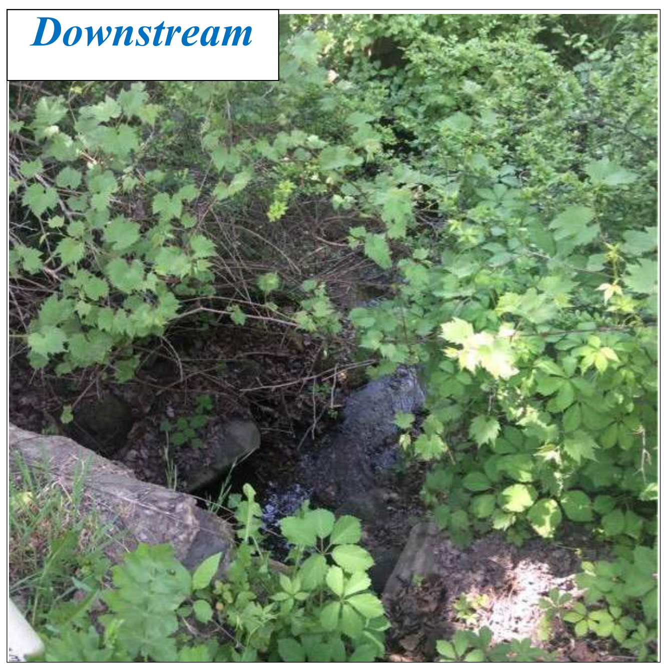
Crossing Type: Culvert
Number of structures/cells: 1
Condition: Poor
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream



Crossing Comments: Barbed wire prevents animals from entering stream

Road

Road

Road Type/Surface: Paved

Road Fill Height (feet): 2.2

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	2.6	5.27	0.2	No
5	3		0.2	No
10	3.26		0.2	No
25	3.56		0.2	No
50	3.78		0.21	No
100	3.98		0.21	No

Structure 1 of 1

Material: Metal

Length (feet): 20.5

Internal Features/Structures: None

Dry Passage/Height: No

Physical Barrier(s)/Severity: None

Slope: 9.1%

Structure Comments: No data

Inlet

Outlet

Inlet

Inlet Shape/Type: Round Culvert

Inlet Drop/Grade: Inlet Drop

Dimensions:

- Width: 2.9, Height: 3.0
- Substrate/Water Width: 1.1
- Water Depth: 0.2
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert

Outlet Drop/Grade: Free Fall

Drop to Stream Surface/Bottom: 0.7/ 1.0

Dimensions:

- Width: 3.0, Height: 3.0
- Substrate/Water Width: 1.1
- Water Depth: 0.3

For additional data, see Appendix

Road: Sand Hill Road Stream: Unnamed

Results
Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 11 (Ranked 52 of 86)

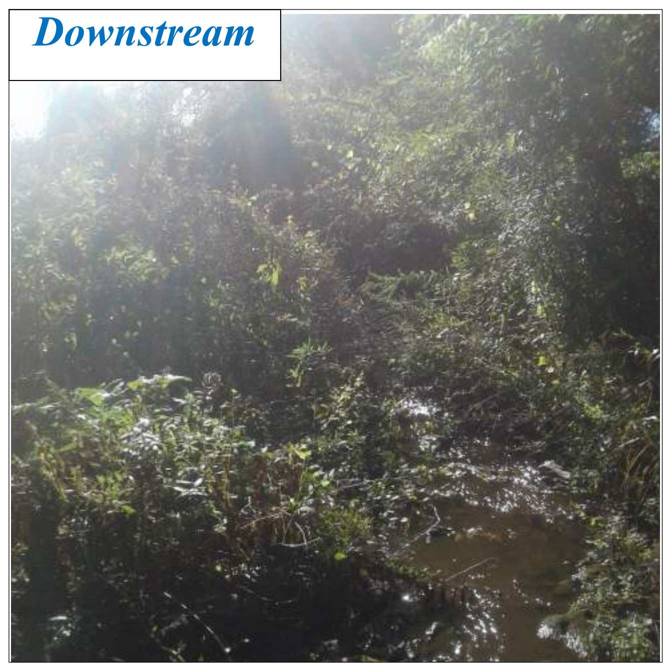
Location
Coordinates: 41.724020, -73.556800
Location Description: Next to agriculture field and 100 feet of 245 Sand Hill Rd driveway
Date Observed: 2017-10-12
Crossing Code: xy4172403273556286

Stream and Crossing

Crossing Characteristics
Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics
Scour Pool: Large
Bankfull Width (feet): 7
Bankfull Width Confidence: Low/ Estimated


Upstream


Downstream

Crossing Comments: There's a natural barrier 10 feet upstream of inlet

Road

Road Type/Surface: Paved
Road Fill Height (feet): 4.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	119.54	8.92	2.32	No
5	129.9		2.75	No
10	136.23		3.03	No
25	143.59		3.37	No
50	148.66		3.62	No
100	153.43		3.86	No

Structure 1 of 1

Material: Metal
Length (feet): 24.3
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 2.1%
Structure Comments: No data

Inlet

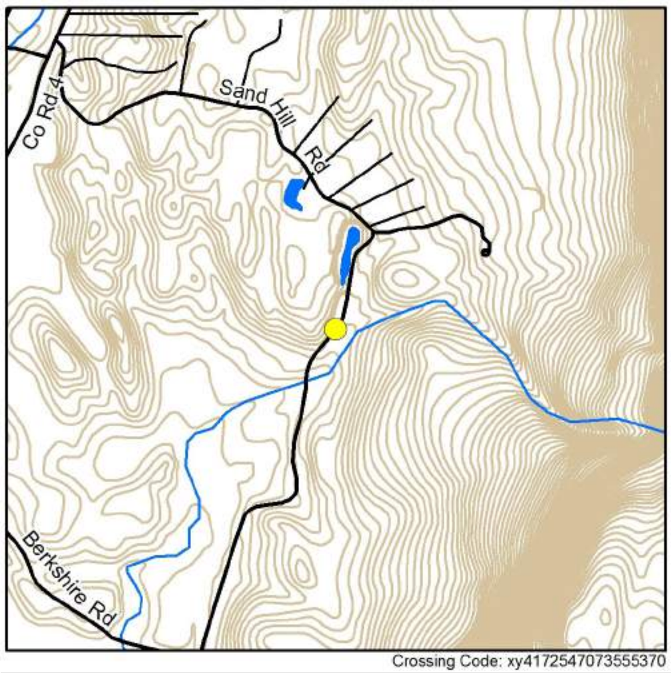
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 5.0, Height: 4.9
- Substrate/Water Width: 2.0
- Water Depth: 0.2
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 5.0, Height: 5.0
- Substrate/Water Width: 2.4
- Water Depth: 0.3

For additional data, see Appendix

Road: Sand Hill Road   Stream: Unnamed



Results
Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 12 (Ranked 65 of 86)

Location
Coordinates: 41.725390, -73.555390
Location Description: 100' from 229 Sand Hill Rd.
Date Observed: 2017-11-07
Crossing Code: xy4172547073555370

Stream and Crossing

Crossing Characteristics
Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics
Scour Pool: None
Bankfull Width (feet): 7
Bankfull Width Confidence: Low/ Estimated

Crossing Comments: No data

Road

ROAD

Road Type/Surface: Paved
Road Fill Height (feet): 0.8

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	116.87	4.84	2.55	No
5	127.04		2.94	No
10	133.27		3.2	No
25	140.52		3.5	No
50	145.52		3.71	No
100	150.24		3.92	No

STRUCTURE 1 OF 1

Material: Metal
Length (feet): 46.8
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 4.4%
Structure Comments: No data

Inlet

Outlet

INLET

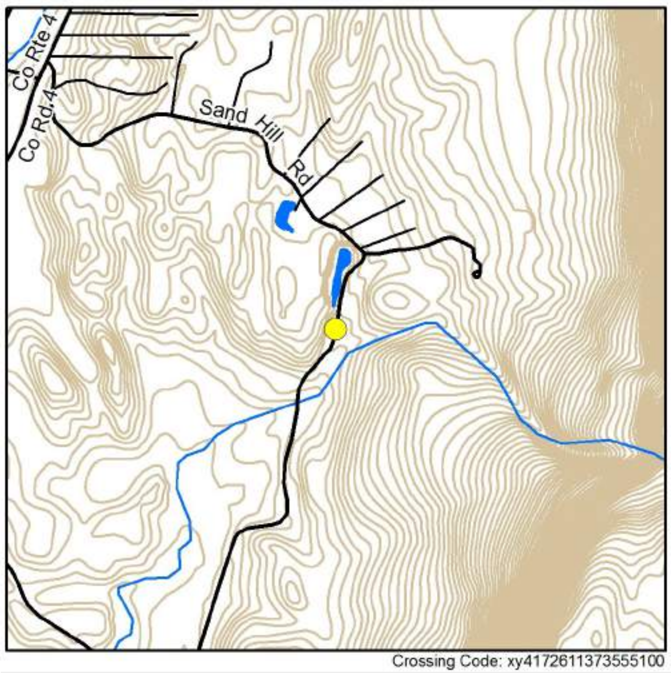
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 4.0, Height: 4.0
- Substrate/Water Width: 1.5
- Water Depth: 0.2
- Abutment Height: No data

OUTLET

Outlet Shape: Round Culvert
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 0.4/ 0.8
Dimensions:
- Width: 4.0, Height: 4.0
- Substrate/Water Width: 1.2
- Water Depth: 0.2

For additional data, see Appendix

Road: **Sand Hill Road** Stream: **Unnamed**



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 11 (Ranked 52 of 86)

Location

Coordinates: 41.725400, -73.555400
Location Description: local ID TM-43
Date Observed: 2016-05-26
Crossing Code: xy4172611373555100

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Skewed (>45°)
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Small
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 1.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	116.47	4.42	2.06	No
5	127.98		2.49	No
10	135.51		2.79	No
25	144.74		3.18	No
50	151.41		3.49	No
100	157.88		3.79	No

Structure 1 of 1

Material: Metal
Length (feet): 24.5
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Moderate)
Slope: 0.7%
Structure Comments: No data

Inlet

Outlet

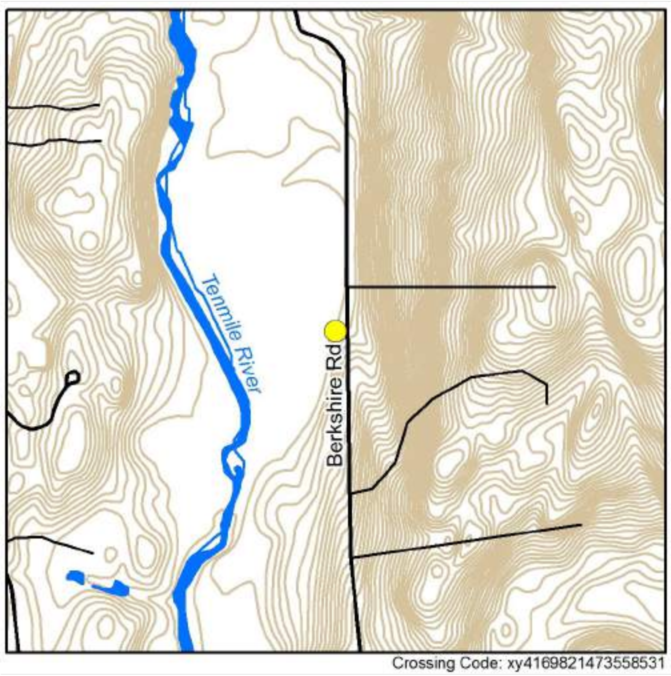
Inlet

Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 3.7, Height: 3.6
- Substrate/Water Width: 3.7
- Water Depth: 0.6
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 3.9, Height: 3.4
- Substrate/Water Width: 3.5
- Water Depth: 0.2

For additional data, see Appendix



Results

Barrier Evaluation: Moderate barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 8 (Ranked 33 of 86)

Location

Coordinates: 41.698220, -73.558330
Location Description: Local ID TM-57
Date Observed: 2016-05-27
Crossing Code: xy4169821473558531

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: Poor
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Small
Bankfull Width (feet): No data
Bankfull Width Confidence: No data


Upstream


Downstream

Crossing Comments: Culvert is rotting

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 1.7

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	21.76	4.21	0.66	No
5	25.26		0.91	No
10	27.6		1.1	No
25	30.51		1.36	No
50	32.64		1.56	No
100	34.73		1.78	No

Structure 1 of 1

Material: Metal
Length (feet): 23.5
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 5.8%
Structure Comments: No data

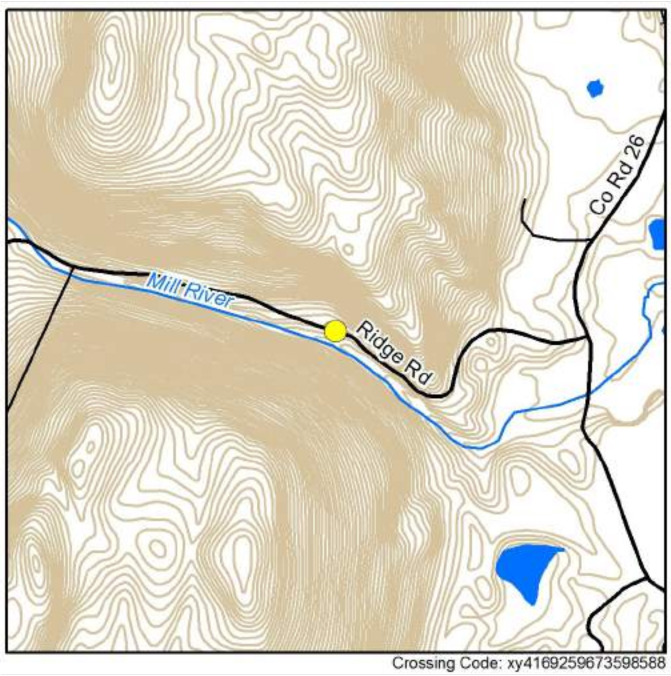
Inlet

Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: Inlet Drop
Dimensions:
- Width: 1.8, Height: 2.0
- Substrate/Water Width: 1.0
- Water Depth: 0.2
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 0.4/ 0.9
Dimensions:
- Width: 2.0, Height: 2.0
- Substrate/Water Width: 0.5
- Water Depth: 0.1

For additional data, see Appendix



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 12 (Ranked 65 of 86)

Location

Coordinates: 41.692447, -73.598294
Location Description: Culvert by telephone pole vz14
Date Observed: 2017-06-16
Crossing Code: xy4169259673598588

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Crossing Comments: No data


Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.2

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	12.84	8.11	0.91	No
5	14.39		1	No
10	15.37		1.07	No
25	16.54		1.14	No
50	17.36		1.19	No
100	18.15		1.24	No

Structure 1 of 1

Material: Metal
Length (feet): 50.6
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: None
Slope: 3.8%
Structure Comments: No water is flowing though the structure


Inlet

Inlet

Inlet Shape/Type: Pipe Arch/Elliptical Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
Width: 4.9, Height: 4.2
Substrate/Water Width: 0.0
Water Depth: 0.0
Abutment Height: No data


Outlet

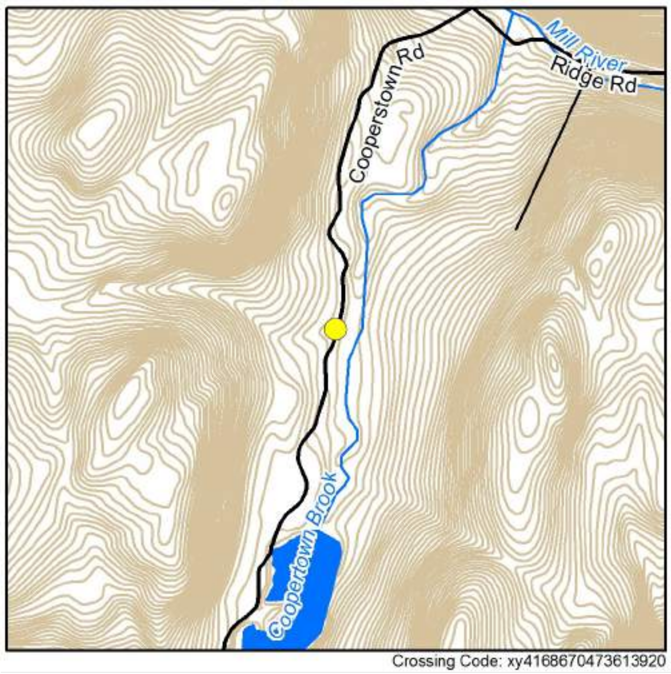
Outlet

Outlet Shape: Pipe Arch/Elliptical Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
Width: 5.2, Height: 4.2
Substrate/Water Width: 0.0
Water Depth: 0.0

For additional data, see Appendix

Road: Cooperstown Road

Stream: Coopertown Brook



Results

Barrier Evaluation: Minor barrier
Town Comments on Condition/Maintenance: Washed out in Irene, structure will be replaced in 2018 and widened out
Overall Ranking: Tier 5 (Ranked 10 of 86)

Location

Coordinates: 41.686748, -73.613996
Location Description: 50 feet from 101 Cooperstown Road mailbox
Date Observed: 2017-06-16
Crossing Code: xy4168670473613920

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Moderate
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 0.9

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	67.01	5.28	1.34	No
5	72.85		1.6	No
10	76.83		1.79	No
25	81.84		2.04	No
50	85.52		2.24	No
100	89.14		2.44	No

Structure 1 of 1

Material: Metal
Length (feet): 15.7
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 5.6%
Structure Comments: Outlet bottom rusted out

Inlet

Outlet

Inlet

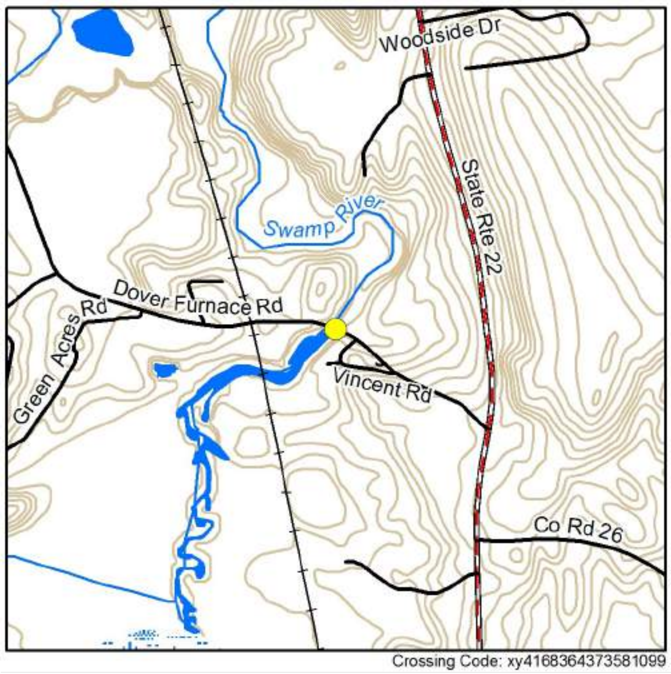
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
Width: 3.0, Height: 3.1
Substrate/Water Width: 1.9
Water Depth: 0.3
Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
Width: 2.9, Height: 3.5
Substrate/Water Width: 2.2
Water Depth: 0.7

For additional data, see Appendix

Road: Dover Furnace Road   Stream: Swamp River



Results

Barrier Evaluation: No barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Not Ranked

Location

Coordinates: 41.683730, -73.581090
Location Description: Bridge No. D-40
Date Observed: 2017-11-07
Crossing Code: xy4168364373581099

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Spans Full Channel & Banks
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	1802.65	N/A		
5	2056.09			
10	2226.98			
25	2441.49			
50	2599.65			
100	2755.6			

Structure 1 of 1

Material: Concrete
Length (feet): 30.5
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: None
Slope: No data
Structure Comments: No data

Inlet

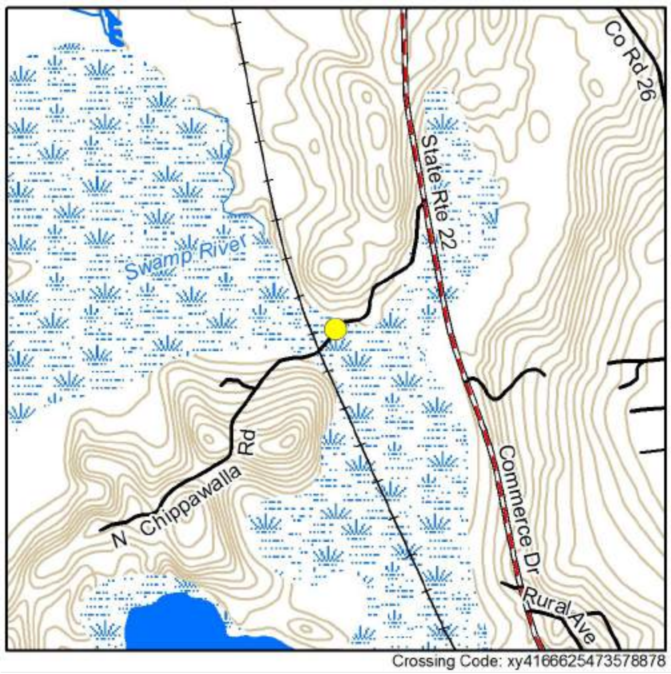
Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 46.0, Height: 10.8
- Substrate/Water Width: 46.0
- Water Depth: 1.0
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 46.5, Height: 13.0
- Substrate/Water Width: 46.5
- Water Depth: 2.1

For additional data, see Appendix

Road: North Chippewalla Road Stream: Swamp river



Results

Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: #2 Priority for Public Safety: If that bridge fails, several families would be completely cut off from emergency services
Overall Ranking: Not Ranked

Location

Coordinates: 41.666310, -73.579280
Location Description: 100 yards east of Metro north crossing
Date Observed: 2017-09-26
Crossing Code: xy4166625473578878

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge
Number of structures/cells: 1
Condition: OK
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 0.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	1016.14	N/A		
5	1203.36			
10	1339.95			
25	1522.11			
50	1663.4			
100	1808.97			

Structure 1 of 1

Material: Concrete
Length (feet): 19.0
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: None
Slope: No data
Structure Comments: No data

Inlet

Outlet

Inlet

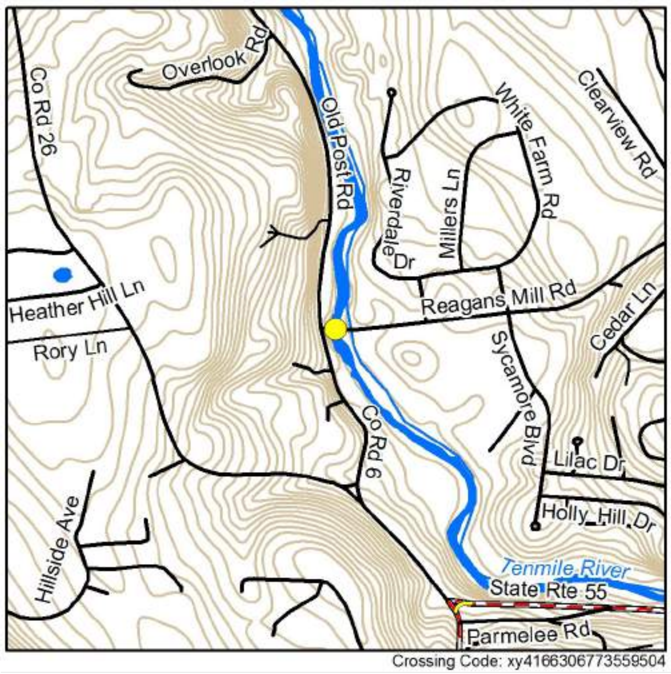
Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
Width: 18.2, Height: 7.2
Substrate/Water Width: 18.2
Water Depth: 0.7
Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
Width: 17.9, Height: 8.0
Substrate/Water Width: 17.9
Water Depth: 0.8

For additional data, see Appendix

Road: Reagans Mill Road   Stream: Tenmile River



Results

Barrier Evaluation: No barrier

Town Comments on Condition/Maintenance: Not Ranked

Overall Ranking: Not Ranked

Location

Coordinates: 41.663120, -73.559970

Location Description: Intersection of Reagan Hill Road and Old Route 22 (Route 6)

Date Observed: 2017-09-26

Crossing Code: xy4166306773559504

Stream and Crossing

Crossing Characteristics

Crossing Type: Bridge Adequate

Number of structures/cells: 1

Condition: OK

Constriction: No data

Alignment: Flow-Aligned

Internal Features/Structures: No data

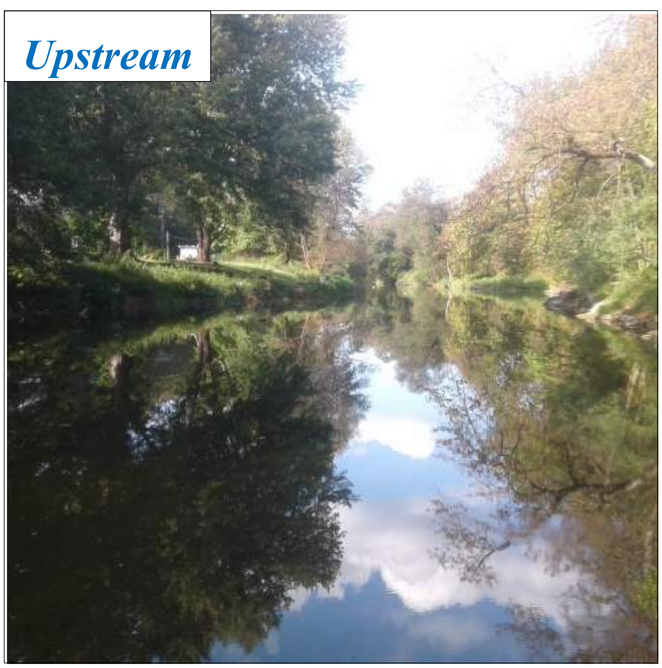
Stream Characteristics

Scour Pool: No data

Bankfull Width (feet): No data

Bankfull Width Confidence: No data

Upstream



Downstream

Crossing Comments: No data

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): -1.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	7.75	N/A		
5	8.93			
10	9.64			
25	10.45			
50	11			
100	11.51			

Structure 1 of 1

Material: No data
Length (feet): -1.0
Internal Features/Structures: No data
Dry Passage/Height:

Physical Barrier(s)/Severity:
Slope: No data
Structure Comments: No data

Inlet

Outlet

Inlet

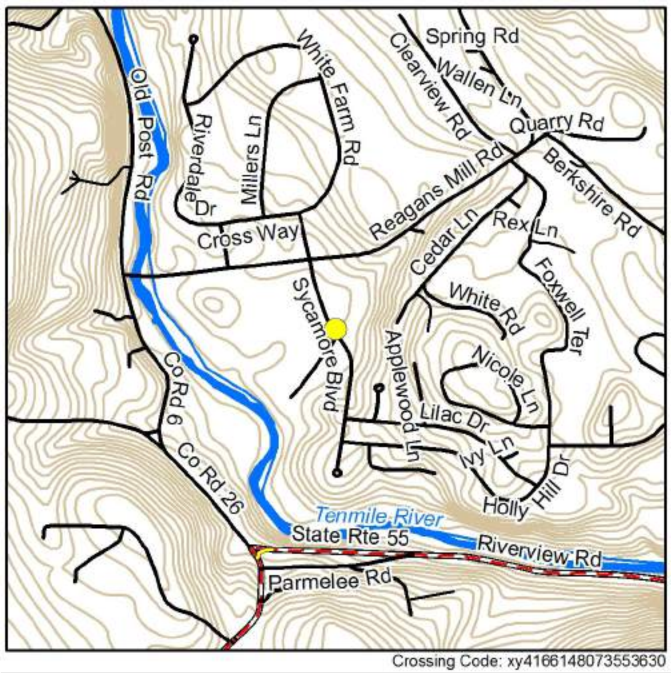
Inlet Shape/Type:
Inlet Drop/Grade:
Dimensions:
- Width: 0.0, Height: 0.0
- Substrate/Water Width: 0.0
- Water Depth: 0.0
- Abutment Height: No data

Outlet

Outlet Shape:
Outlet Drop/Grade:
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 0.0, Height: 0.0
- Substrate/Water Width: 0.0
- Water Depth: 0.0

For additional data, see Appendix

Road: Sycamore Boulevard **Stream:** Unnamed



Results
Barrier Evaluation: Insignificant barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 12 (Ranked 65 of 86)

Location
Coordinates: 41.661480, -73.553630
Location Description: Local ID TM-51
Date Observed: 2016-05-26
Crossing Code: xy4166148073553630

Stream and Crossing

Crossing Characteristics
Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Spans Only Bankfull/Active Channel
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics
Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data


Upstream


Downstream

Crossing Comments: There are storm drains on the outlet side and another culvert going underground on the inlet side

Road

Road Type/Surface: Paved
Road Fill Height (feet): 4.0

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	14.13	8.84	1.67	No
5	15.54		1.78	No
10	16.58		1.86	No
25	17.97		1.96	No
50	19.03		2.03	No
100	20.12		2.11	No

Structure 1 of 1

Material: Concrete
Length (feet): 52.0
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Moderate)
Slope: 0.2%
Structure Comments: No data

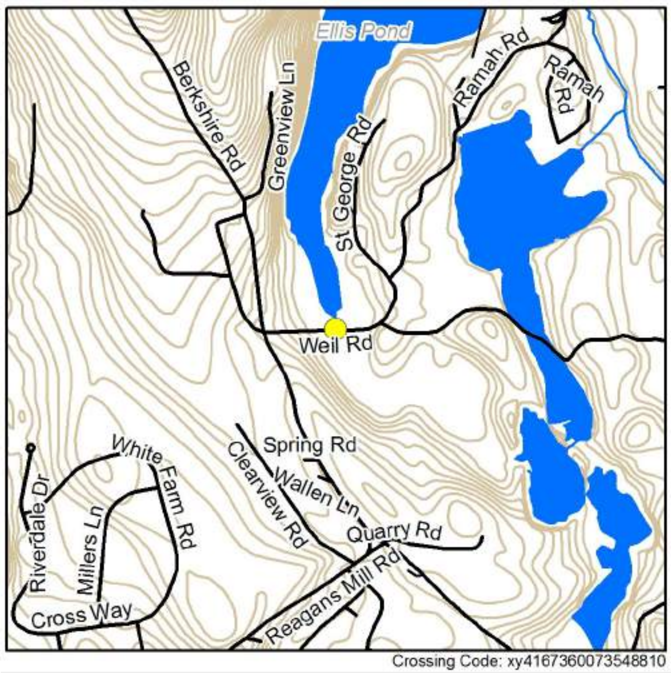
Inlet

Inlet Shape/Type: Box/Bridge with Abutments
Inlet Drop/Grade: At Stream Grade
Dimensions:
- Width: 6.0, Height: 5.1
- Substrate/Water Width: 6.0
- Water Depth: 0.1
- Abutment Height: No data

Outlet

Outlet Shape: Box/Bridge with Abutments
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 6.0, Height: 5.1
- Substrate/Water Width: 6.0
- Water Depth: 0.3

For additional data, see Appendix



Results

Barrier Evaluation: Moderate barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 12 (Ranked 65 of 86)

Location

Coordinates: 41.673600, -73.548810
Location Description: Local ID TM-55
Date Observed: 2016-05-27
Crossing Code: xy4167360073548810

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Severe
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Unknown
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No upstream channel-Ellis pond

Road

Road

Road Type/Surface: Paved
Road Fill Height (feet): 0.1

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	13.32	4.11	0.43	No
5	15.29		0.5	No
10	16.51		0.55	No
25	17.97		0.61	No
50	18.98		0.65	No
100	19.95		0.7	No

Structure 1 of 1

Material: Plastic
Length (feet): 37.5
Internal Features/Structures: None
Dry Passage/Height: Yes

Physical Barrier(s)/Severity: Dry (Moderate)
Slope: 8.1%
Structure Comments: No data

Inlet

Outlet

Inlet

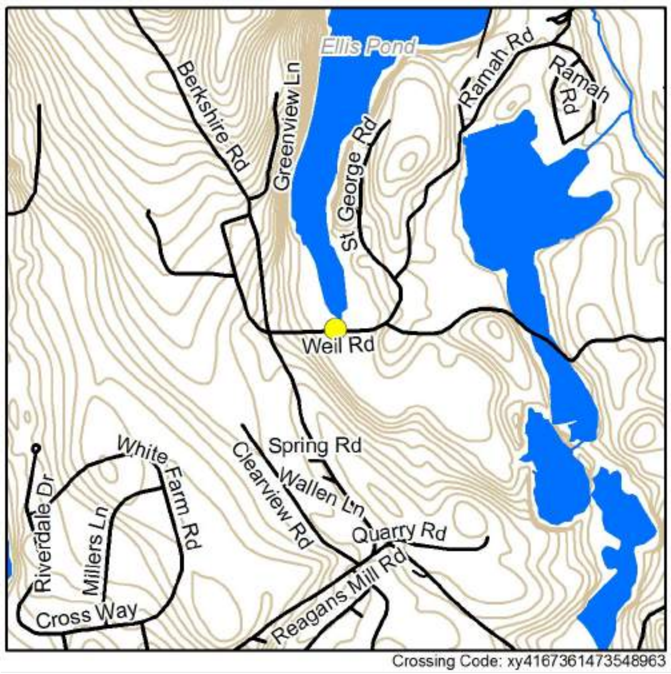
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: Perched
Dimensions:
- Width: 1.2, Height: 1.2
- Substrate/Water Width: 1.0
- Water Depth: 0.2
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 1.2, Height: 1.2
- Substrate/Water Width: 0.4
- Water Depth: 0.0

For additional data, see Appendix

Road: Weil Road Stream: Unnamed



Results

Barrier Evaluation: Moderate barrier
Town Comments on Condition/Maintenance: Not Ranked
Overall Ranking: Tier 12 (Ranked 65 of 86)

Location

Coordinates: 41.673600, -73.548810
Location Description: Local ID TM-56
Date Observed: 2016-05-27
Crossing Code: xy4167361473548963

Stream and Crossing

Crossing Characteristics

Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Severe
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics

Scour Pool: Large
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream

Downstream

Crossing Comments: No upstream channel

Road

Road Type/Surface: Paved
Road Fill Height (feet): 1.2

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	13.32	3.7	0.77	No
5	15.29		0.98	No
10	16.51		1.12	No
25	17.97		1.31	No
50	18.98		1.44	No
100	19.95		1.58	No

Structure 1 of 1

Material: Plastic
Length (feet): 37.5
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: None
Slope: 1.2%
Structure Comments: No data

Inlet

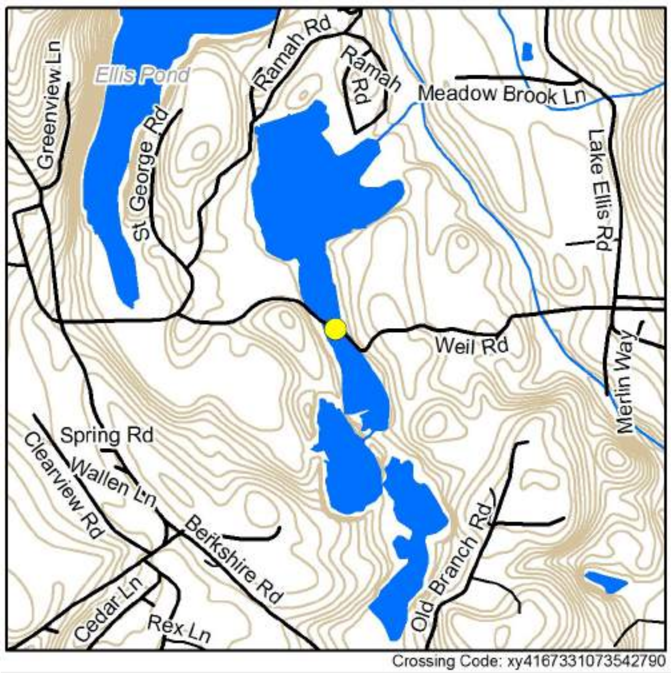
Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: Perched
Dimensions:
- Width: 1.2, Height: 1.3
- Substrate/Water Width: 1.2
- Water Depth: 0.6
- Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: At Stream Grade
Drop to Stream Surface/Bottom: 0.0/ 0.0
Dimensions:
- Width: 1.2, Height: 1.3
- Substrate/Water Width: 1.1
- Water Depth: 0.3

For additional data, see Appendix

Road: **Weil Road** Stream: **Lake Weil**



Results
Barrier Evaluation: Significant barrier
Town Comments on Condition/Maintenance:
Not Ranked
Overall Ranking: Tier 9 (Ranked 43 of 86)

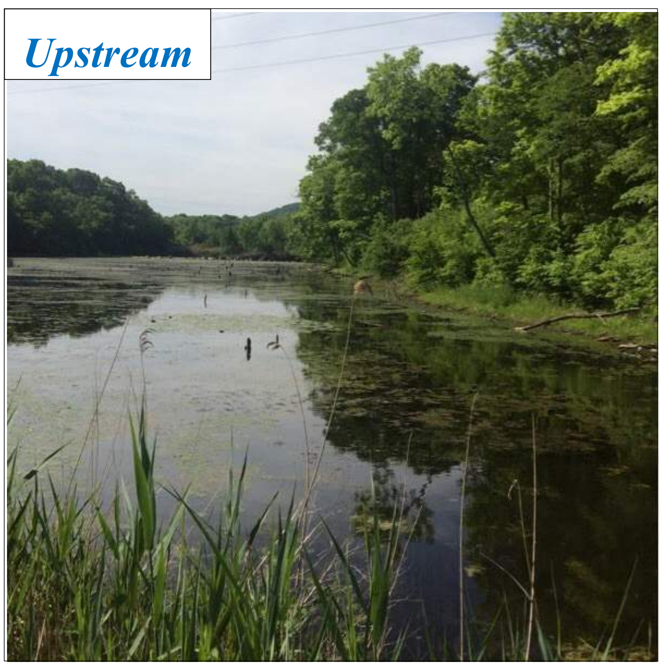
Location
Coordinates: 41.673310, -73.542790
Location Description: Lake Weil crossing
Date Observed: 2016-05-31
Crossing Code: xy4167331073542790

Stream and Crossing

Crossing Characteristics
Crossing Type: Culvert
Number of structures/cells: 1
Condition: OK
Constriction: Severe
Alignment: Flow-Aligned
Internal Features/Structures: None

Stream Characteristics
Scour Pool: None
Bankfull Width (feet): No data
Bankfull Width Confidence: No data

Upstream



Downstream

Crossing Comments: No upstream channel

Road

Road

Road Type/Surface: Unpaved
Road Fill Height (feet): 2.8

Return Interval (Years)	Peak Flow (cfs)	Road Height (feet)	Stage Height (feet)	Overtop
2	N/A	N/A		
5	N/A			
10	N/A			
25	N/A			
50	N/A			
100	N/A			

Structure 1 of 1

Material: Metal
Length (feet): 38.8
Internal Features/Structures: None
Dry Passage/Height: No

Physical Barrier(s)/Severity: Debris/Sediment/ Rock (Severe)
Slope: 1.3%
Structure Comments: No data

Inlet

Outlet

Inlet

Inlet Shape/Type: Round Culvert
Inlet Drop/Grade: At Stream Grade
Dimensions:
Width: 1.5, Height: 1.3
Substrate/Water Width: 1.5
Water Depth: 0.6
Abutment Height: No data

Outlet

Outlet Shape: Round Culvert
Outlet Drop/Grade: Free Fall
Drop to Stream Surface/Bottom: 0.8/ 1.8
Dimensions:
Width: 1.6, Height: 1.6
Substrate/Water Width: 0.5
Water Depth: 0.1

For additional data, see Appendix