

Ottauquechee River Watershed Stream Geomorphic Assessment Bridgewater and Woodstock, Vermont January 29, 2013



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Sacha Pealer

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1.0 EXECUTIVE SUMMARY

A stream geomorphic assessment of the Ottauquechee River was conducted by Bear Creek Environmental, LLC (BCE) in summer 2012. The study was funded by the State of Vermont Ecosystem Restoration Program and prepared under contract to Two Rivers-Ottauquechee Regional Commission (TRORC). A planning strategy based on fluvial geomorphic science (see glossary at end of report for associated definitions) was chosen because it provides a holistic, watershed-scale approach to identifying the stressors on river ecosystem health. The stream geomorphic assessment data can be used by resource managers, community watershed groups, municipalities and others to identify how changes to land-use alter the physical processes and habitat of rivers. The stream geomorphic assessment data will be used to help focus stream restoration activities within the watershed and assist with town planning.

The Ottauquechee River watershed was divided into nineteen reaches for the 2012 assessment, eighteen on the main stem and one on Reservoir Brook, a tributary to the Ottauquechee River. The study encompassed approximately nineteen miles of stream channel. This assessment was helpful in identifying major stressors to geomorphic stability in the Ottauquechee River watershed. The primary problem relating to geomorphic stability and habitat condition in the watershed is channel straightening and corridor encroachment associated with the existence of major roads and development. In some cases, this encroachment has limited floodplain access and has caused moderate to extreme channel degradation (lowering of the bed) resulting in sediment build up, channel widening, and planform adjustment (lateral movement). There are approximately 11.4 miles, or about 60%, of the Ottauquechee River in the study area that run parallel to U.S. Route 4 where the high road embankment is completely restricting floodplain access. Channel straightening has resulted in a reduction in habitat quality and diversity. A lack of high quality streamside buffers along the Ottauquechee River and parts of Reservoir Brook are exacerbating bank instability and erosion.

A list of 35 potential restoration and conservation projects was developed during project identification. Types of projects include: river corridor protection through easements, improving riparian buffers, improved stormwater management, and alternative analyses for the removal of an old road, a windrow/berm, and two old bridge abutments. Phase 3 surveys for active restoration projects may be required at some point in the near future for project design and permitting.

2.0 LOCAL PLANNING PROGRAM OVERVIEW

There are many scientific terms used in this river corridor plan, and the reader is encouraged to refer to the glossary at the end of the document. Important terms that are in the glossary are shown in italics the first time they are used in the text.

2.1 Overview

This project focuses on the Ottauquechee River watershed in Bridgewater and Woodstock, Vermont. One *tributary* (Reservoir Brook) and the main stem of the Ottauquechee River were assessed using the Vermont Agency of Natural Resources Phase 2 Stream Geomorphic Assessment protocol during summer 2012 for a total of nineteen river miles. The Vermont River Management program has developed state-of-the-art Stream Geomorphic Assessment (SGA) protocols that utilize the science of *fluvial geomorphology* (fluvial = water, geo = earth, and morphology = the study of structure or form). Fluvial geomorphology focuses on the processes and pressures operating on river systems. The Vermont protocol includes three phases:

1. Phase 1 – Remote sensing and cursory field assessment;
2. Phase 2 – Rapid habitat and rapid geomorphic assessments to provide field data to characterize the current physical condition of a river; and
3. Phase 3 – Detailed survey information for designing “active” channel management projects.

2.2 River Corridor Planning Team

The river corridor planning team for the Ottauquechee River watershed is comprised of the Two Rivers-Ottauquechee Commission (TRORC) and the Vermont Agency of Natural Resources. Funding for the project is provided through the State of Vermont Ecosystem Restoration Program. Pete Fellows (TRORC), Sacha Pealer (Vermont River Management Program), Marie Caduto (ANR Watershed Coordinator), and Todd Menees (ANR Stream Alternation Engineer) make up the steering committee for the project. Gretchen Alexander and Blaine Hastings from the Vermont River Management Program of VANR provided a quality control/assurance review of the stream geomorphic assessment data.

2.3 Local Project Objectives

The stream geomorphic assessment data are useful to resource managers, community watershed groups, municipalities and others for identifying how changes to land-use alter the physical processes and *habitat* of rivers. Characterizing stream type, identifying stressors in the watershed, and assessing the health of aquatic habitat and the riparian corridor are essential for the preparation of an effective and long-term river corridor plan. Two Rivers-Ottauquechee Regional Commission, in collaboration with towns and other partners, has the opportunity to

address and mitigate major watershed stressors through the design and implementation of *restoration* and protection projects outlined in this corridor plan.

The newly updated Vermont Agency of Natural Resources Basin 10 Water Quality Management Plan (2012a) indicates the need to complete a full set of River Corridor / Fluvial Erosion Hazard and Special Flood Hazard Area maps for Basin 10, which includes the Ottauquechee River watershed. According to the Plan, the main problems the basin faces are a lack of high quality *riparian buffers*, excessive sediment, flow alterations, and storm water runoff. Currently few waters in the Basin are considered impaired, increasing the need to protect and manage the Basin through river corridor protection. The 2012 Phase 2 geomorphic assessment is the first Phase 2 assessment completed in the watershed and therefore focused on the main stem of the Ottauquechee River in order to gain an understanding of the basic geomorphic processes occurring in the watershed.

2.4 Goals of the Vermont River Management Program

The State of Vermont's River Management Program has set out several goals and objectives that are supportive of the local initiative in the Ottauquechee River Watershed. The state management goal is to, "manage toward, protect, and restore the fluvial geomorphic equilibrium condition of Vermont rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner" (Vermont Agency of Natural Resources, 2009b). The objectives of the Program include fluvial erosion hazard mitigation and sediment and nutrient load reduction, as well as aquatic and riparian habitat protection and restoration. The Program seeks to conduct river corridor planning in an effort to remediate the geomorphic instability that is largely responsible for problems in a majority of Vermont's rivers. Additionally, the Vermont River Management Program has set out to provide funding and technical assistance to facilitate an understanding of river instability and the establishment of well-developed and appropriately scaled strategies to protect and restore river equilibrium.

2.5 Preliminary Project Identification and Prioritization

2.5.1 Reach Level and Site Specific Opportunities

The stream *reaches* evaluated in this study present a variety of planning and management strategies which can be classified under one of the following categories: Active Geomorphic Restoration and Passive Geomorphic Restoration.

Active Geomorphic Restoration implies the management of rivers to a state of geomorphic equilibrium through active, physical alteration of the channel and/or *floodplain*. Often this approach involves the removal or reduction of human constructed constraints or the construction of *meanders*, floodplains or stable banks. Active riparian buffer revegetation and long-term protection of a river corridor is essential to this alternative.

Passive Geomorphic Restoration allows rivers to return to a state of geomorphic equilibrium by removing factors adversely impacting the river and subsequently using the river's own energy and watershed inputs to re-establish its meanders, floodplains and equilibrium conditions. In many cases, passive restoration projects may require varying degrees of active measures to achieve ideal results. Active riparian buffer revegetation and long-term protection of a river corridor are also essential to this alternative.

There are a number of federal, state, and local programs available for river restoration and protection. These programs are as follows:

- ANR River Corridor Easement Program (RCE)
- Ecosystem Restoration Program (formerly called Clean & Clear)
- Conservation Reserve Enhance Program (CREP)
- Trees for Streams (TFS)
- Environmental Quality Incentives Program (EQIP)
- Wildlife Habitat Incentives Program (WHIP)
- Wetland Reserve Program (WRP)
- Connecticut River Watershed Council (CRWC)

River Corridor Easement

The River Corridor Easement is designed to promote the long-term physical stability of the river by allowing the river to achieve a state of equilibrium (where sediment and water loads are in balance). River corridor easements are vital for a passive geomorphic restoration approach and can also be used for conserving rivers that are in good condition (equilibrium). Rivers that are in equilibrium have access to their floodplains and therefore experience less *erosion* and negative impacts from flooding events. Corridor easements are a high priority for reaches that are not in equilibrium; these channels are experiencing channel adjustments, which are causing conflicts with current/future land-use expectations. Providing an easement on these reaches reduces the conflict and provides a long-term solution to sediment storage and flood water attenuation needs.

- Easements are in perpetuity, meaning the agreement stays with the land forever.
- A onetime payment is received by the landowner for transferal of channel management rights to a second party (a land trust).
- Transferal of channel management rights means that the landowner would no longer be able to rock line river banks or remove gravel for personal use.
- A RCE requires a minimum 50 foot buffer that floats with the river. No active land-use is allowed within the buffer. The buffer can be actively planted or allowed to revegetate passively.

- The easement does not take away the agricultural land-use rights, so the landowner could continue to crop or pasture the farm land mapped outside of the buffer, yet within the corridor, for as long as the river allows.

Ecosystem Restoration Program

The Ecosystem Restoration Program, formerly called the Clean and Clear Program, is a Vermont program designed to improve water quality by addressing one or more of the following areas: stream stability, protecting against flood hazards, enhancing in-stream and riparian habitat, reducing stormwater runoff, restoring riparian wetlands, enhance the environmental and economic sustainability of agricultural lands. Funding is available for project identification, project development and project implementation. Vermont municipalities, local or regional governmental agencies, non-profit organizations, and citizens groups are eligible to receive funding.

Conservation Reserve Enhancement Program

The USDA Farm Service administers a program called the Conservation Reserve Enhancement Program that helps agricultural producers to take farmland out of production in sensitive areas, such as river corridors. This helps to improve water quality and restore wildlife habitat.

- CREP can be either a 15 or 30 year contract to plant trees.
- 90% of the practice costs are covered with the remaining 10% either resting with the participants or could be paid by the US Partners for Fish and Wildlife. Examples of the practice costs include fencing, watering facilities, and trees. There are some costs that are capped, but generally all the practice costs can be paid through the program.
- To provide additional incentives to enroll in CREP, the program offers upfront and annual rental payments for the land where agricultural production is lost during the contract period.

Trees for Streams

Programs offered by the US Fish and Wildlife Service or through State funding to work with local partners and landowners to restore native streamside vegetation along river banks.

Environmental Quality Incentives Program

EQIP is a voluntary program available through the Natural Resources Conservation Service (NRCS) that provides financial and technical assistance to implement conservation practices to meet local environmental regulations. Owners of land in agricultural or forest production are eligible for the program. Contracts with landowners can be up to ten years in length.

Wildlife Habitat Incentives Program

WHIP is a voluntary program offered to landowners to improve wildlife habitat on their land. Owners of agricultural land, nonindustrial private forest land, and Native American land are eligible. Technical assistance and up to 75 percent cost-share is available to improve fish and wildlife habitat.

Wetland Reserve Program

WRP is a voluntary program offered by NRCS to landowners to protect, restore and enhance wetlands on their property. NRCS provides technical assistance and financial support for projects that establish long-term conservation and wildlife practices and protection.

Connecticut River Watershed Council

Restoration, protection, and enhancement of the river, wetlands, and shore lands within the Connecticut River watershed are supported by funds from the Connecticut River Watershed Council (CRWC). Typical projects include guiding development, preventing erosion, restoring stream passage, and making sure hydropower and industrial permits are aligned to protect natural heritage for future generations.

2.5.2 Watershed-Level Opportunities

There are a number of watershed-level opportunities available to improve the geomorphic stability and water quality of the Ottauquechee watershed. Watershed opportunities include the development and adoption of Fluvial Erosion Hazard Zones, improved stormwater treatment, and community stream clean-up activities.

Fluvial Erosion Hazard Zones

The purpose of defining Fluvial Erosion Hazard Zones is to prevent increases in man-made conflicts that can result from development in identified fluvial erosion hazard areas; minimize property loss and damage due to fluvial erosion; and prohibit land-uses and development in fluvial erosion hazard areas that pose a danger to health and safety. The basis of a Fluvial Erosion Hazard Zone is a defined river corridor which includes the course of a river and its adjacent lands. The width of the corridor is defined by the lateral extent of the river meanders, called the meander belt width, which is governed by valley landforms, *surficial geology*, and the length and slope requirements of the river channel. The width of the corridor is also governed by the stream type and *sensitivity* of the stream. River corridors, as defined by the Vermont Agency of Natural Resources (2008b), are intended to provide landowners, land-use planners, and river managers with a meander belt width which would accommodate the meanders and slope of a balanced or equilibrium channel, which when achieved, would serve to maximize channel stability and minimize fluvial erosion hazards. Information collected during the Phase 2 Assessment including reach sensitivity, reach condition, and stream type is used to develop these zones. The development of FEH overlay districts on the municipal level are recommended by the Vermont River Management Program (2010b)

to improve stream stability, reduce flood losses, and enhance public safety. Additional information about FEH zones is available at (http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_vtfehqa.pdf).

Stormwater Management

Stormwater runoff rates are of particular concern in urbanized and agricultural watersheds because stormwater runs off from impervious surfaces rather than naturally infiltrating the soil. The cumulative effect of the increased frequency, volume, and rate of stormwater runoff results in increases in wash-off pollutant loading to streams and destabilization of stream channels.

3.0 BACKGROUND WATERSHED INFORMATION

3.1 Geographic Setting

3.1.1 Watershed Description

The Ottauquechee River is one of the major rivers in Vermont that drains into the Connecticut River (Figure 3.1). The 41-mile long river drains approximately 185 square miles of land. Generally flowing from west to east, the Ottauquechee River originates on the eastern slopes of the Green Mountain Range in Killington, Vermont, and empties into the Connecticut River in North Hartland, Vermont. Most of its tributaries are flashy mountain streams.

From its source in Killington, the Ottauquechee River main stem flows northeasterly down the mountainside to the valley floor where it begins to flow south along US Route 4. In West Bridgewater the river changes to an eastwardly direction after the confluence with Reservoir Brook. The river generally flows through a narrow valley until the North Branch of the Ottauquechee River enters from the north. From there, the main stem continues on an eastwardly path through a broader valley, with some narrower sections. As the river flows from Bridgewater to Woodstock several tributaries enter – Broad Brook, Pinney Hollow Brook, Kedron Brook, and Barnard Brook. Before the confluence with the Connecticut River the Ottauquechee River flows over the Taftsville dam (Central Vermont Public Service Corp), the Quechee Mills dam (Simon Pearce Inc.), the Dewey Mills dam (Green Mountain Power), and the North Hartland dam (U.S. Army Corps of Engineers). The North Hartland Flood Control Reservoir is created by the North Hartland dam (Vermont Agency of Natural Resources, 2000).

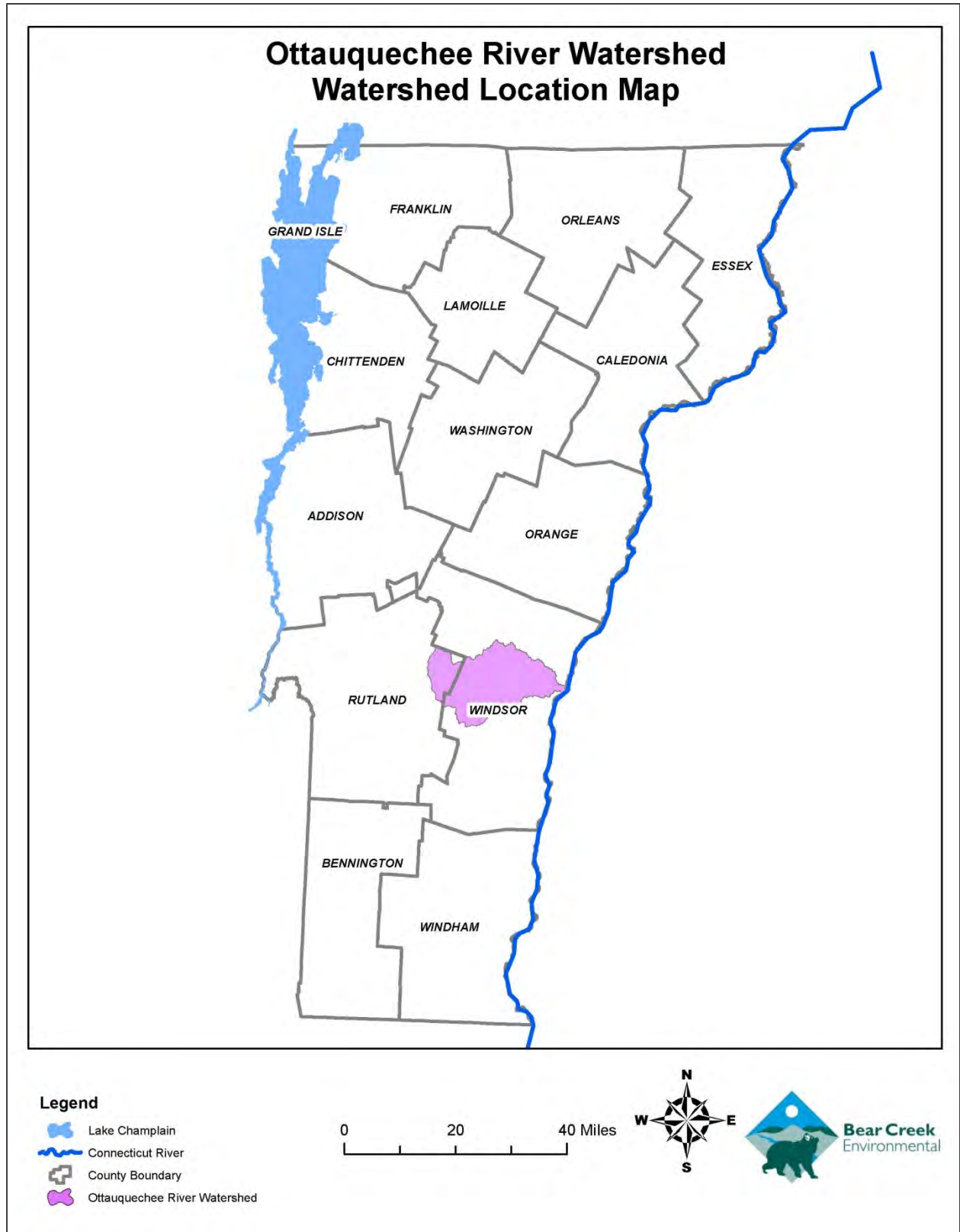


Figure 3.1. Watershed Location Map for Ottauquechee River watershed.

3.1.2 Political Jurisdictions

The Ottauquechee River watershed is located in the following towns within Rutland and Windsor County: Killington, Bridgewater, Woodstock, Pomfret, Hartford, and Hartland and the villages of Woodstock and Quechee. The 2012 Phase 2 assessment focused on the river channel and *riparian corridor* within the towns of Bridgewater and Woodstock. A short section of the main stem of the Ottauquechee River above the Bridgewater town line in Killington, Vermont was included in the 2012 assessment work.

3.1.3 Land-Use

A land cover layer (2002) was obtained from the Vermont Center for Geographic Information (VCGI) to present land-use within the Ottauquechee River watershed for the river corridor plan. The 2002 land cover data indicates that the watershed is 75% forested, 10% urban (mostly Village of Woodstock), and 7% agricultural (Figure 3.2). While the Ottauquechee River watershed is dominated by forested land, agriculture and developed land are sub-dominant land-uses. Developed areas are concentrated within the river corridor of the main stem, especially in Woodstock. The *headwaters* of the Ottauquechee River are primarily located within the Killington Ski Resort developed area.

3.2 Geologic Setting

The Ottauquechee River flows through a gentle *gradient* valley, except for the most upstream areas. Most of the main stem has a channel slope less than one percent. The upper main stem of the Ottauquechee River originates in the Gifford Woods State Park in Killington, where the valley slope is very steep and averages about six percent. The valley gradient of the main stem drops to moderate (1-3 percent slope) as the river flows to the east of Route 100 prior to reaching an expansive wetland. Just above the Killington/Bridgewater line the valley slope once again becomes moderate, and remains moderate for just over a mile before becoming gentle. This gentle gradient persists downstream of West Bridgewater and through the town of Woodstock. To the east of Woodstock/Hartford town lines, the river flows through the Quechee Gorge at which point the Ottauquechee River is impounded by man-made dams.

The Ottauquechee River watershed is located in two geo-physiographic regions. The upper part of the watershed is located in the Green Mountain Province, which is underlain by schists and phylites. The lower part of the watershed is located in the Connecticut Valley-Gaspé Basin Province, which contains thick sedimentary calcareous deposits (Doolan, 1996). The bedrock geology of this region is predominantly made up of metamorphosed sedimentary rocks and volcanic intrusions (Van Diver, 1987). This region was later worked by glaciation and now contains significant glacial drift deposits that have been down cut by the flowing rivers and streams (Van Diver, 1987).

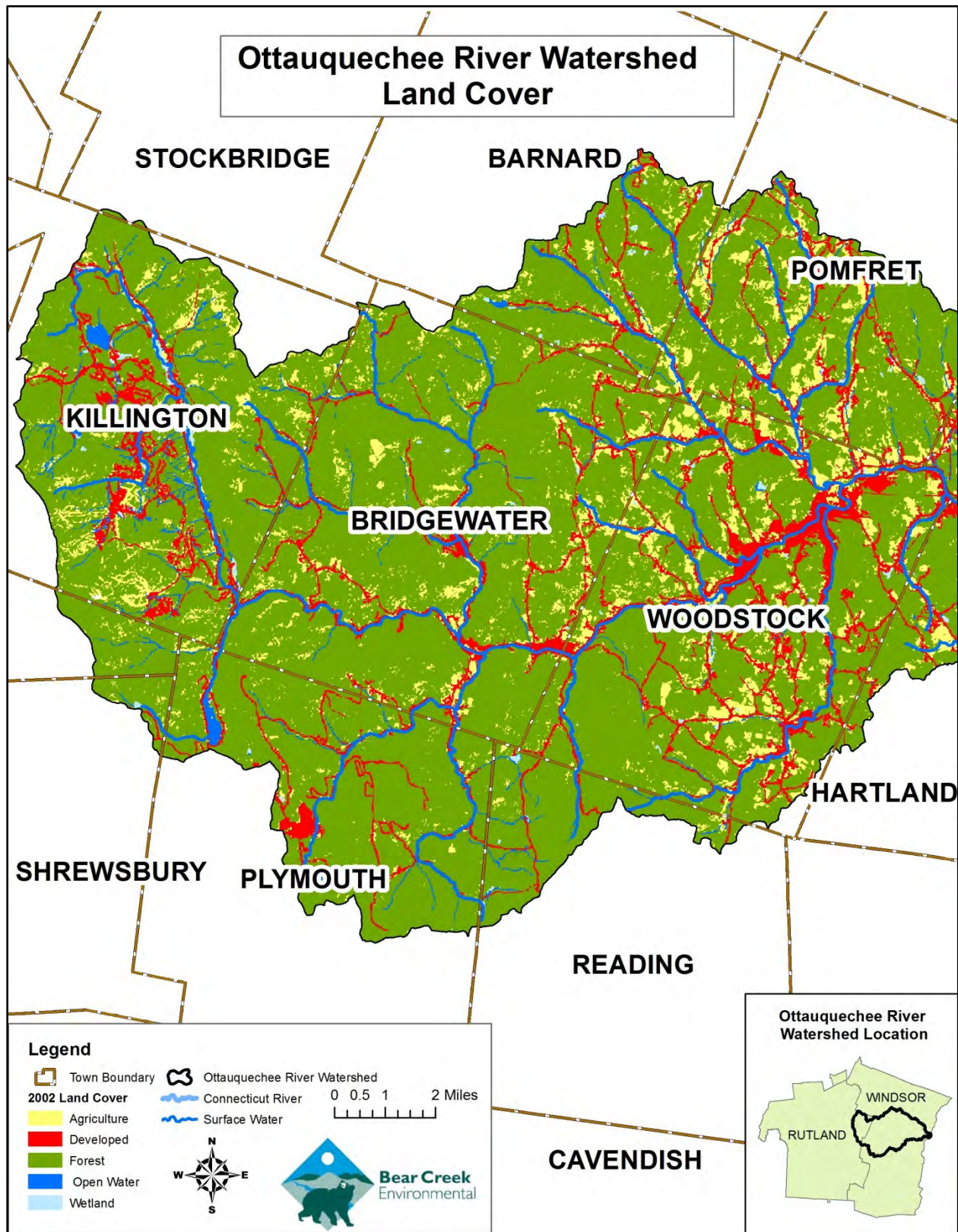


Figure 3.2. Land Cover and Land-Use Map for the Ottauquechee River watershed included in the 2012 assessment.

Natural Resource Conservation Service (NRCS) soils information for the Ottauquechee River watershed was acquired from the Vermont Center for Geographic Information. The dominant *surficial sediments* (sediment deposits above bedrock) within the Ottauquechee River valley are primarily glacial till, ice-contact deposits, and alluvium. Sub-dominant surficial sediments include glacial till, ice-contact deposits, alluvium, glacial lake, and other deposits.

3.3 Geomorphic Setting

Two Rivers-Ottauquechee Regional Commission conducted a Phase 1 assessment of the Ottauquechee River watershed that was completed in spring 2012. The Phase 1 assessment included breaking the watershed into 100 *reaches*. Each reach represents a similar section of the stream based on physical attributes such as valley confinement, slope, sinuosity, bed material, dominant *bedform*, land-use, and other hydrologic characteristics. Each point in Figure 3.3 represents the downstream end of the reach.

This report summarizes the 2012 Phase 2 study of the Ottauquechee River watershed, which focused on the Ottauquechee River main stem and the lower reach of Reservoir Brook. The combined length of the 19 stream reaches assessed during the Phase 2 study is approximately 19 miles (Figure 3.3), with approximately 9.3 miles in Woodstock (Figure 3.4), 8.7 miles in Bridgewater (Figure 3.5), and 1.2 miles in Killington (Figure 3.5).

Reaches were divided further into *segments* during the Phase 2 investigation based on changes in channel conditions. A segment is distinct in one or more of the following parameters: degree of floodplain encroachment or channel alteration, *grade control* occurrence (e.g. ledge), channel dimensions, channel sinuosity and slope, *riparian buffer* and corridor conditions, and degree of flow regulation. The 19 Phase 2 reaches studied in 2012 were broken further into 48 segments based on field observations. Segments are labeled using letter notation (i.e. R15-A is the most downstream segment on Reach 15). The most downstream segment within a reach is labeled "A", the second from the reach point is "B, etc.

3.4 Hydrology

In order to better understand the flood history of the Ottauquechee River, long-term data from the U.S. Department of the Interior, U.S. Geological Survey (USGS), were obtained (USGS 2012). There are two USGS *gaging stations* within the Ottauquechee River watershed. The most upstream gage is located in West Bridgewater within the 2012 Stream Geomorphic Assessment project area and has a *drainage* area of 23.4 square miles (see Figure 3.5). The lower gage has a drainage area of 221 square miles and is on a regulated stretch of river downstream of the North Hartland, VT flood control dam. The flood control dam is owned by the US Army Corps of Engineers, and is located about one-quarter mile upstream of the confluence with the Connecticut River.

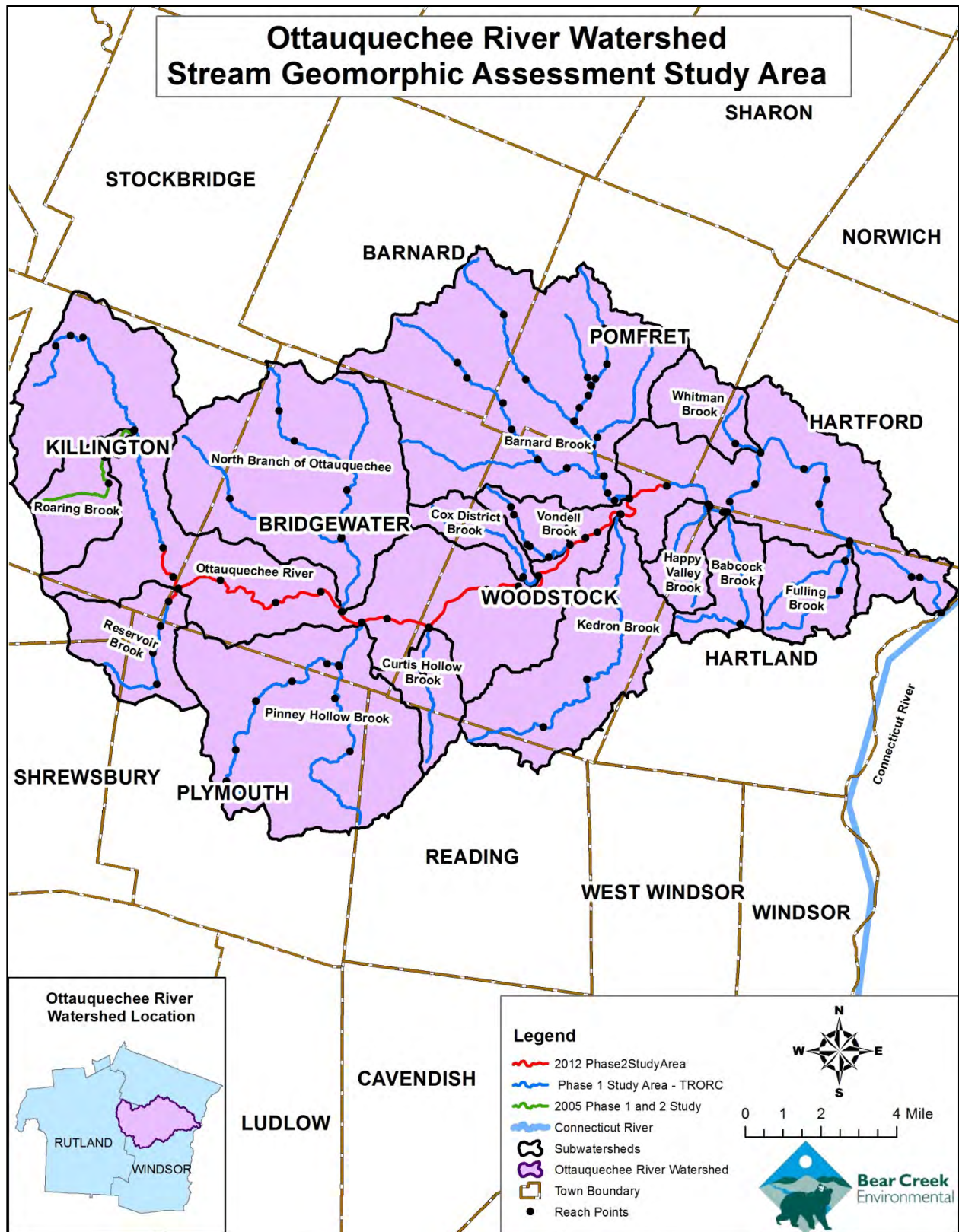


Figure 3.3. Ottauquechee River Stream Geomorphic Assessment Study Area

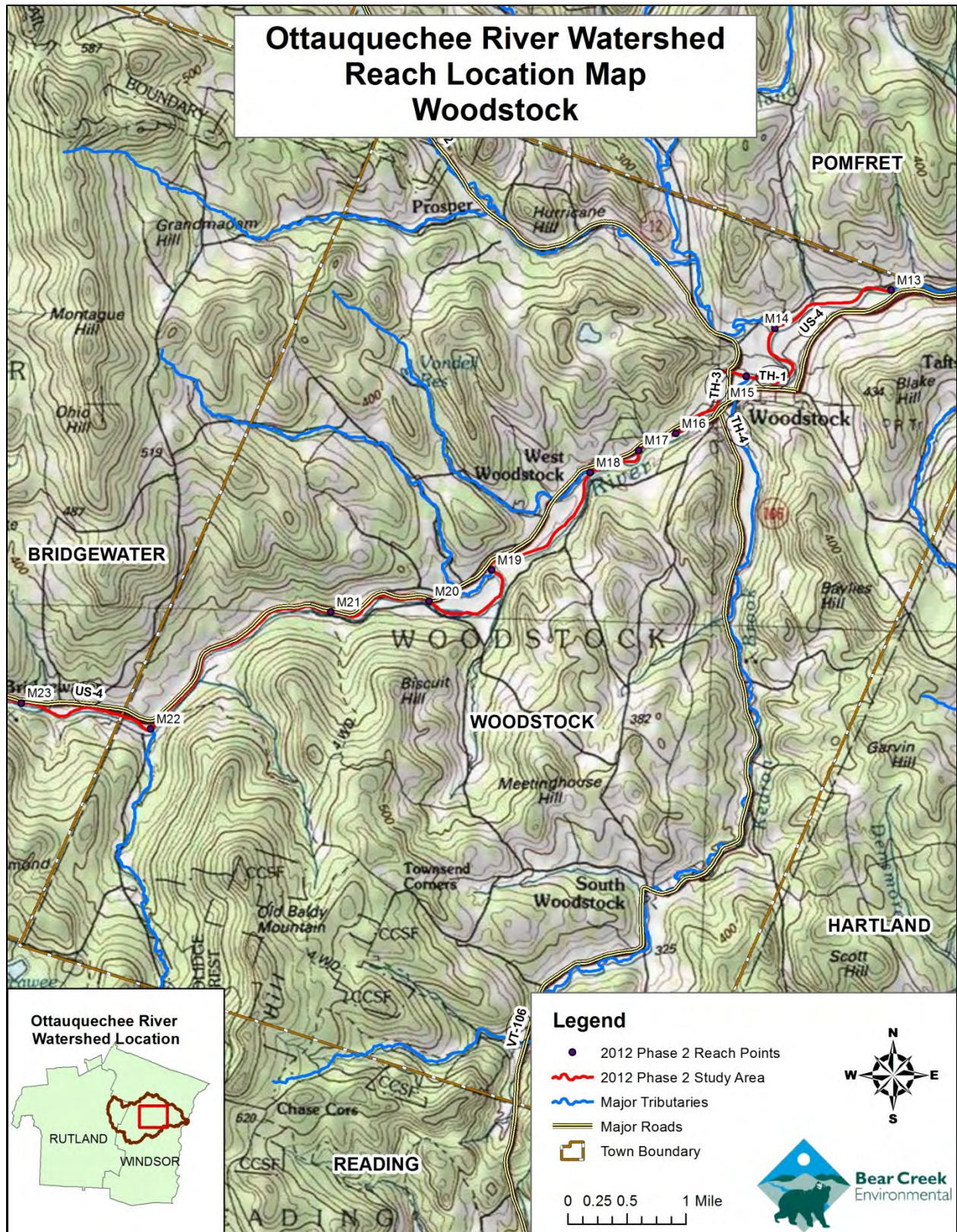


Figure 3.4. Reach Location Map for Woodstock, Vermont

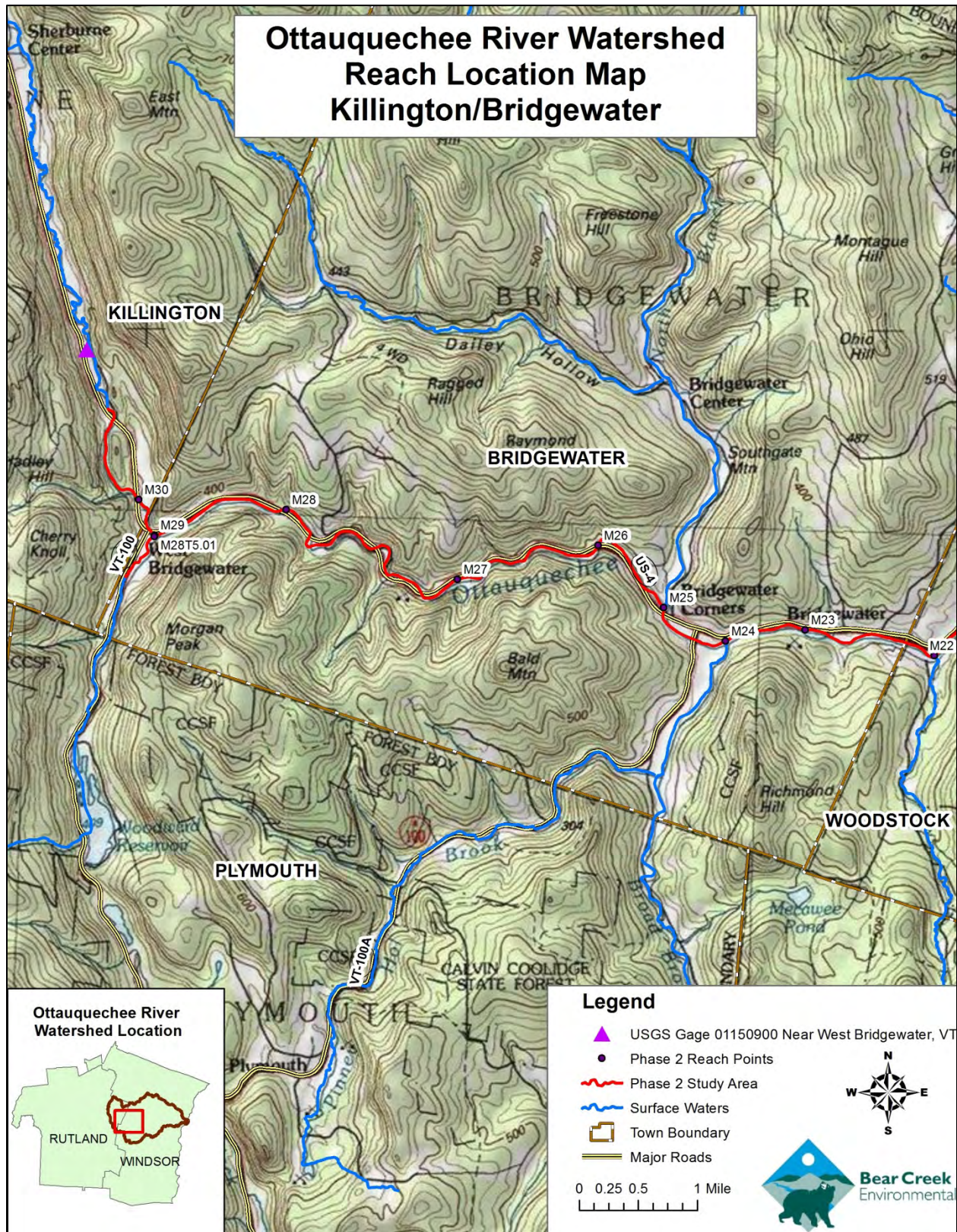


Figure 3.5. Reach Location Map for Killington/Bridgewater, Vermont

Peak discharge records are available for the Ottauquechee River at the West Bridgewater gage from 1985 through 2010. Figure 3.6 shows the annual peak flows for the Ottauquechee River USGS gage near West Bridgewater, Vermont for the 27 years of record. Although provisional, the 2011 peak discharge of 9070 cubic feet per second (cfs) illustrates the magnitude of the flood event caused by Tropical Storm Irene in August 2011. The second highest peak flow event on record for the USGS gage near West Bridgewater is 1960 cfs in 1996. According to Scott Olson of the USGS, the 2011 annual peak discharge is provisional and is based on high water marks in the vicinity of the gage. The 2011 peak discharge took place on August 28, 2011 and was attributed to Tropical Storm Irene. Tropical Storm Irene caused widespread flooding in Vermont with many areas receiving more than 7 inches of rain. Flood levels equaled or approached the historic flood of 1927 (Vermont Agency of Natural Resources, 2012b).

Of all the natural hazards experienced in Vermont, flooding is the most frequent, damaging, and costly. During the period of 1995-1998 alone, flood losses in Vermont totaled nearly \$57 Million (Vermont Agency of Natural Resources, 2010b). The Vermont Agency of Administration (2012) states that over 733 million dollars has been estimated in funding resources for Tropical Storm Irene recovery. While some flood losses are caused by inundation (i.e. waters rise, fill, and damage low-lying structures), most flood losses in Vermont are caused by “fluvial erosion”. Fluvial erosion is caused by rivers and streams, and can range from gradual bank erosion to catastrophic changes in river channel location and dimension during flood events (Vermont Agency of Natural Resources, 2010b). The VANR (2010b) attribute the high cost and frequency of fluvial erosion in Vermont to its geography (mountainous setting with narrow valleys and extreme climate) and past land-use practices (forest clearing).

Based on provisional data from the USGS, there were no extreme flood events during 2012. Figure 3.7 shows the 2012 annual hydrograph for the Ottauquechee River near West Bridgewater, Vermont, during which the Phase 2 stream geomorphic assessment field work took place. The highest flows in 2012 occurred during the spring and late fall and were associated with snow melt and/or rainfall. The lowest flows occurred during August and September. In fact, the 7 consecutive day low flow that has a chance of occurring every 10 years (7Q10) took place during summer 2012.

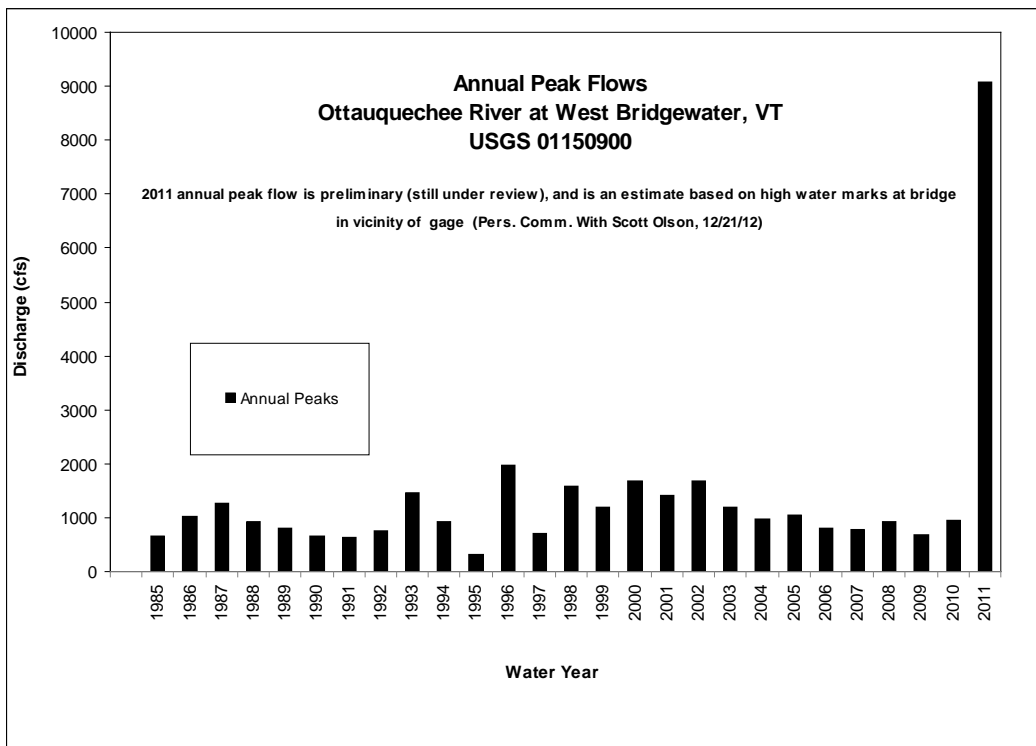


Figure 3.6. Annual Peak Flows for Ottauquechee main stem at West Bridgewater, Vermont.

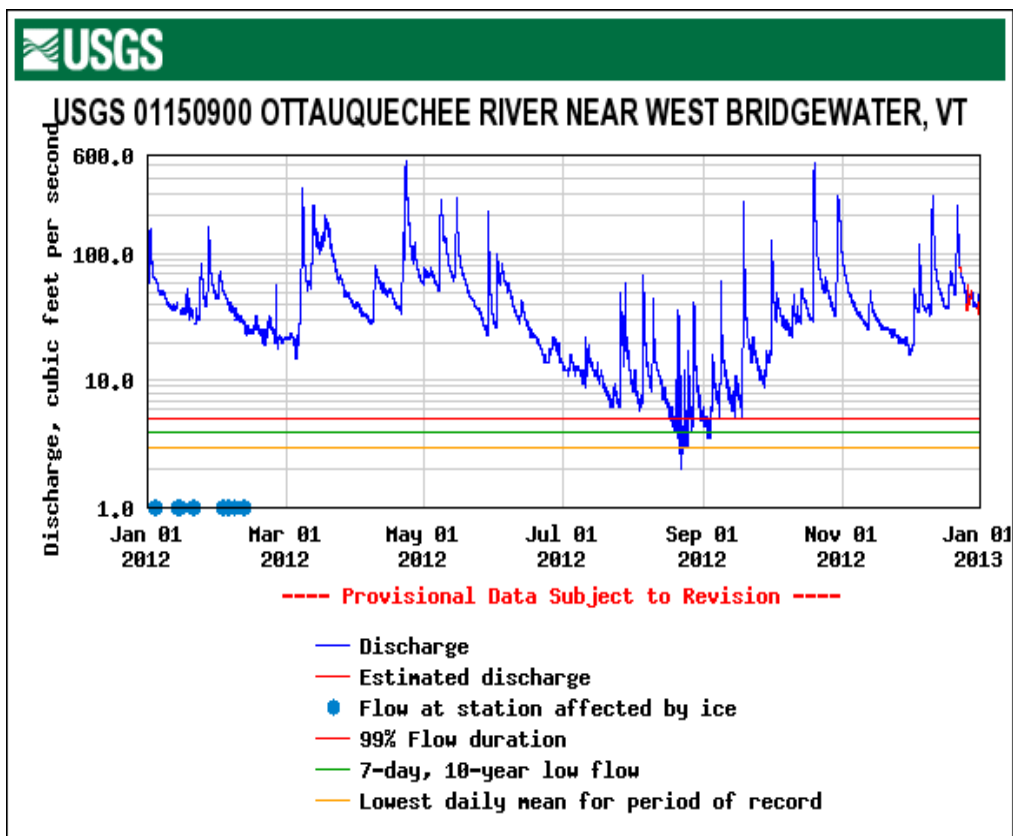


Figure 3.7. Annual hydrograph (2012) for the Ottauquechee River near West Bridgewater, Vermont.

3.5 Ecological Setting

The Ottauquechee River watershed lies within both the Southern Green Mountain and Southern Vermont Piedmont biophysical regions (Appendix A, page 1). The upper 11 reaches of the Ottauquechee River watershed included in this assessment lie within the Southern Green Mountain region. This region is characterized by Thompson and Sorenson (2000) as being hilly with numerous wetlands and rivers. The climate is moderate for Vermont and the elevation leads to a high average annual precipitation. Over 70 inches of rain and snow fall are seen in higher elevations and there are only a few areas that receive less than 50 inches per year. Northern hardwood forest is the dominant community in the Southern Green Mountain biophysical region.

The lower eight reaches of the Ottauquechee River watershed included in this assessment lie within the Southern Vermont Piedmont biophysical region. This region is characterized by rolling foothills with numerous rivers. The majority of the Southern Vermont Piedmont region lies within the Connecticut River watershed. The climate is mild for Vermont and some of the warmest winter temperatures in the state are observed here. The highest average annual rainfall for this region is around 50 inches in the hills, whereas some lower elevation areas like White River Junction only receive about 36 inches. In the Connecticut River valley, pine and oak are common.

The Vermont Significant Wetland Inventory GIS layer provides important information about the distribution of wetland habitat within the Ottauquechee River watershed (Appendix A, page 1). Extensive areas of wetland habitat exist near the Ottauquechee River in Killington along Route 4, just upstream of the 2012 study area, as well as along the lower part of Reservoir Brook.

According to Thompson and Sorenson (2000), black bear, white-tailed deer, bobcat, fisher, beaver, and red squirrel are common animals in the Southern Green Mountain biophysical region. In the Southern Vermont Piedmont region white-tailed deer, eastern cottontail, porcupine, and a variety of other small mammals are common. Rivers in this region provide habitat for some rare invertebrates, such as the cobblestone tiger beetle and a wide array of mussel species (Thompson and Sorenson, 2000). Wild brook, brown, and rainbow trout are found in the Ottauquechee River. Brook trout are more abundant in upstream headwater areas where forest canopy cover maintains cooler water temperatures; brown and rainbow trout are found in lower reaches. Trout is stocked under special regulations between Bridgewater Corners and Taftsville because the habitat is not suitable to support sustainable wild trout populations or such populations are not abundant enough to meet angler use (Vermont Agency of Natural Resources, 2012a).

Important public lands included in the Ottauquechee River watershed include: the Ottauquechee Wildlife Management Area in Bridgewater, the Coolidge State Forest, the Woodstock Town Forest, the Appalachian Trail Corridor, and the Quechee Recreation Area.

4.0 METHODS

A summary of the Phase 1, Phase 2, and Bridge and *Culvert* methodologies is provided in the following sections.

4.1 Phase 1 Methodology

The Phase 1 assessment followed procedures specified in the Vermont Stream Geomorphic Assessment Phase 1 Handbook (Vermont Agency of Natural Resources, 2007), and used version 4.59 of the Stream Geomorphic Assessment Tool (SGAT). SGAT is an ArcView extension. Phase 1, the remote sensing phase, involves the collection of data from topographic maps and aerial photographs, from existing studies, and from very limited field studies, called “windshield surveys”. The Phase 1 assessment provides an overview of the general physical nature of the watershed. As part of the Phase 1 study, stream reaches are determined based on geomorphic characteristics such as: valley confinement, valley slope, geologic materials, and tributary influence.

4.2 Phase 2 Methodology

The Phase 2 assessment of the Ottauquechee River watershed followed procedures specified in the Vermont Stream Geomorphic Assessment (SGA) Phase 2 Handbook (Vermont Agency of Natural Resources, 2009b), and used version 4.59 of the SGAT Geographic Information System (GIS) extension to index impacts within each reach. The geomorphic condition for each Phase 2 reach is determined using the Rapid Geomorphic Assessment (RGA) protocol, and is based on the degree of departure of the channel from its reference stream type (Vermont Agency of Natural Resources, 2009b). The study used the 2008 Rapid Habitat Assessment (RHA) protocol (Vermont Agency of Natural Resources, 2008a; Milone and MacBroom, Inc., 2008).

Reaches determined during Phase 1 were broken up further into segments for the Phase 2 geomorphic assessment as necessary. Topographic maps and orthophotos were used as a first cut in delineating segment breaks. Attributes that were considered when determining segment breaks include: grade controls, changes in channel dimensions, changes in dominant bed material, slope, entrenchment or sinuosity, signs of *planform* changes, presence of beaver dams, and evidence of *aggradation* and *degradation*. The reaches were walked or floated and features were mapped using a GPS unit in accordance with the most current version of the Phase 2 protocol. The *bankfull* width and depth were measured occasionally along the reach to track changes in bankfull dimensions. Once segment breaks were determined, the Phase 2 field forms were completed accordingly.

Valley walls delineated during Phase 1 were field-verified using a range finder and submeter GPS unit (MobileMapper 100 series). Human caused changes in valley width due to permanent high embankments that serve as artificial valley walls were also mapped on field sketches with

reference to topographic maps and/or orthophotographs. The valley walls were used to evaluate Phase 2 confinement. Adjacent terraces and valley walls were evaluated in terms of their proximity to the channel. The location, total height and height above water surface were recorded for channel spanning grade controls, both natural and human constructed.

Channel dimensions and bed substrate composition were measured at one to three representative locations within each segment. The channel dimensions and substrate composition were recorded on the Cross-section Worksheet and summarized on the Rapid Stream Assessment Field Notes form under Step 2. Stream type was evaluated based on the channel dimension data, bed substrate composition results, and confirmed channel slope. Stream banks were evaluated in terms of their typical slope and dominant texture. Areas of bank erosion, mass failures, and gullies were mapped and pertinent information regarding the height and length of such features was recorded. Areas lacking adequate riparian buffers (<25 feet) were mapped and notes were made about the types of vegetation comprising existing riparian buffers. River corridor encroachments including roads, railroads, improved paths, and development were mapped according to their locations, and the height of these encroachments was recorded. Notes were also taken concerning river corridor land-use activities.

The locations of springs, seeps, small tributaries, adjacent wetlands, debris jams, beaver dams and channel constrictions were recorded and evaluated in terms of how they may be affecting channel flows. Locations of stormwater inputs from *urban runoff*, agricultural drainage and road ditching were noted to determine the extent of increased flow status during a storm event. Similarly, locations of flow regulations and water withdrawals were mapped to evaluate potential decreases in channel flows.

Depositional features were mapped to assess the sediment transport regime and storage capacity of the segment. Channel migration features were also mapped in order to determine the amount of channel planform adjustment the segment was undergoing. Sections of the stream where the channel does not appear to be following the natural path of the river and may have been *straightened* (see *channelization*) were noted, along with locations where material has been removed from the channel in order to assess the extent to which stream power and morphology have been altered. *Steep riffles* and *headcuts* were mapped and used as indicators of active geomorphic processes.

RHA and RGA field forms were completed for the Phase 2 reaches. The appropriate RHA and RGA forms were selected based on segment characteristics and scored according to the data collected from the field assessment. A segment score and corresponding condition were determined for both the RHA and the RGA. Additionally for the RGA, major geomorphic processes were identified, the stage of channel evolution was determined, and a stream sensitivity rating was assigned.

The RHA is used to evaluate the physical components of a stream (channel bed, banks, and riparian vegetation) and how the physical condition of the stream affects aquatic life. The RHA results can be used to compare physical habitat condition between sites, streams, or watersheds, and they can also serve as a management tool in watershed planning.

To assure a high level of confidence in the Phase 2 SGA data, strict quality assurance/quality control (QA/QC) procedures were followed by BCE. These procedures involved a thorough in-house review of all data, which took place during November 2012. The Project Team conducted the assessment according to the approved Quality Assurance procedures specified in the Phase 2 handbook. Gretchen Alexander and Blaine Hastings of the State of Vermont Watershed Management Division conducted a QA/QC review of the data collected by Bear Creek Environmental (BCE) for the Ottauquechee River in December 2012. A summary report of the QA/QC can be found on pages 148 through 162 of Appendix C.

4.3 Bridge and Culvert Methodology

Bridge assessments were conducted by BCE on all public and private crossings within the selected Phase 2 reaches. The Agency of Natural Resources Bridge and Culvert protocols (Vermont Agency of Natural Resources, 2009a) were followed. Latitude and Longitude at each of the structures was determined using a MobileMapper 100 GPS unit. The assessment included photo documentation of the inlet, outlet, upstream, and downstream of each of the structures.

A total of 19 stream crossings (all bridges) were evaluated by BCE in 2012. The Vermont Culvert Geomorphic Compatibility Screening Tool (Milone and MacBroom, Inc. 2008) was used to determine geomorphic compatibility for each bridge. Bridges are not typically screened for geomorphic compatibility in the VTANR protocol because they are usually more robust and have less impact on stream channel function than culverts. Bridges also do not have potential to become perched above the water surface, because the bottom of the structure is natural substrate. Bridges in this study were screened using the geomorphic compatibility tool that was modified by BCE to exclude the slope parameter. Tables 1 and 2 in Appendix B explain how each bridge was scored using the Screening Tool. The compatibility rating is based on four criteria: structure width in relation to bankfull channel width, sediment continuity, river approach angle, and erosion & armoring and the ratings span the following range:

- Fully Compatible
- Mostly Compatible
- Partially Compatible
- Mostly incompatible
- Fully Incompatible

5.0 RESULTS

5.1 Stream Types

Reference stream types are based on the valley type, geology and climate of a region and describe what the channel would look like in the absence of human-related changes to the channel, floodplain, valley width, and/or watershed. Table 1 shows the typical characteristics used to determine reference stream types (Vermont Agency of Natural Resources, 2009b). Reference reach typing was based on both the Rosgen (1996) and the Montgomery and Buffington (1997) classification systems. Stream and valley characteristics including valley confinement, and slope were determined from digital United States Geological Survey (USGS) topographic maps (Table 2).

Table 1. Reference Stream Type			
Stream Type	Confinement	Valley Slope	Bed Form
A	Narrowly Confined	Very steep > 6.5 %	Cascade
A	Confined	Very steep 4.0 - 6.5 %	Step-Pool
B	Confined or Semi-confined	Steep 3.0 – 4.0 %	Step-Pool
B	Confined, Semi-confined or Narrow	Moderate to Steep 2.0 – 3.0 %	Plane Bed
C or E	Unconfined (Narrow, Broad or Very Broad)	Moderate to Gentle <2.0 %	Riffle-Pool or Dune-Ripple
D	Unconfined (Narrow, Broad or Very Broad)	Moderate to Gentle <4.0 %	Braided Channel
F	Confined or Semi-confined	Moderate to Gentle <4.0 %	Variable

Table 2 lists the reference stream types for assessed reaches in the Ottauquechee River watershed. Many reaches assessed for Phase 2 in the Ottauquechee River watershed are “C” channels by reference. Reference “C” channels have unconfined valleys with moderate to gentle valley slopes and moderate to high width to depth ratios and sinuosity. The confinement of the assessed portion of the Ottauquechee River ranges from Very Broad to Semi-Confined. All reaches have a reference bedform of *riffle-pool* except for M30, which was *plane bed*. The reference reach characteristics were refined during the Phase 2 Assessment.

During the Phase 2 assessment, the nineteen assessed reaches were broken into 48 segments based on detailed field observations. The existing stream type is based on channel dimensions measured during the Phase 2 assessment. A map of the reference and existing stream type for each assessed reach/segment is included on page 2 of Appendix A.

Some of the segments in the 2012 assessment have the same reference and existing stream type. However, the existing stream type differs from the reference stream type in more than half of the assessed segments. This indicates that a stream type departure has taken place in those areas. A stream type departure occurs when the channel dimensions deviate so far from the reference condition that the existing stream type is no longer the reference stream type. These stream type departures represent a significant change in floodplain access and stability. Watersheds which have lost attenuation or sediment storage areas due to human related constraints are generally more sensitive to erosion hazards, transport greater quantities of sediment and nutrients to receiving waters, and lack the sediment storage and distribution processes that create and maintain habitat (Vermont Agency of Natural Resources, 2009b).

Table 2: Geomorphic Setting of 2012 Assessed Reaches

Stream	Reach ID	Reference Stream Type	Reference Confinement	Valley Slope (%)	Bedform
Ottauquechee River	M13	C	Very Broad	0.24	Riffle-Pool
	M14	C	Very Broad	0.25	Riffle-Pool
	M15	C	Very Broad	0.39	Riffle-Pool
	M16	B	Semi-Confined	0.32	Riffle-Pool
	M17	C	Narrow	0.54	Riffle-Pool
	M18	C	Very Broad	0.44	Riffle-Pool
	M19	C	Very Broad	0.34	Riffle-Pool
	M20	C	Broad	0.33	Riffle-Pool
	M21	C	Broad	0.18	Riffle-Pool
	M22	C	Narrow	0.69	Riffle-Pool
	M23	C	Semi-Confined	0.41	Riffle-Pool
	M24	C	Broad	0.67	Riffle-Pool
	M25	C	Narrow	0.44	Riffle-Pool
	M26	B	Narrow	0.53	Riffle-Pool
	M27	C	Narrow	0.83	Riffle-Pool
	M28	C	Narrow	0.71	Riffle-Pool
	M29	C	Broad	2.44	Riffle-Pool
	M30	C	Narrow	1.06	Plane Bed
	Reservoir Brook	M28.T5.01	C	Very Broad	1.63

5.2 Geomorphic Condition

The stream condition is determined using the scores on the rapid assessment field forms, and is defined in terms of departure from the reference condition. There are four categories to describe the condition (reference, good, fair and poor). These ratings are defined below.

- Reference – no departure
- Good – minor departure
- Fair – major departure
- Poor – severe departure

A map of the existing geomorphic condition for each segment is depicted on page 3 of Appendix A. Geomorphic condition is determined based on the degree (if any) of channel degradation, aggradation, widening and planform adjustment. Degradation is the term used to describe the process whereby the stream bed lowers in elevation through erosion, or scour, of bed material. Aggradation is a term used to describe the raising of the bed elevation through an accumulation of sediment. The planform of a channel is its shape as seen from the air. Planform change can be the result of a straightened course imposed on the river through different channel management activities, or a channel response to other *adjustment processes* such as aggradation and widening. Channel widening is a result of channel degradation or sediment build-up in the channel. In both situations the stream's energy is concentrated into both banks.

Segment M30-D is the only fully assessed segment along the main stem of the Ottauquechee River that is in "good" geomorphic condition. The middle segment of Reservoir Brook (M28T5.01-B) is also in "good" geomorphic condition. These segments are all located in areas where there are minimal to no corridor encroachments and buffer conditions are excellent. The segment on Reservoir Brook (M28T5.01-B) is surrounded by a wetland as well. Twenty-six segments along the main stem of the Ottauquechee and two segments along Reservoir Brook are in "fair" geomorphic condition. Seventeen segments along the main stem are in "poor" geomorphic condition. Many segments are in "fair" or "poor" condition as a result of varying degrees of corridor encroachment, channel straightening, human-caused change in valley type, floodplain loss, erosion, and aggradation. Two segments on the main stem, both in M30, were not fully assessed and therefore, did not receive a full geomorphic assessment. M30-E was not fully assessed because it is currently impounded by a beaver dam. When a segment is not assessed, administrative judgment of the geomorphic condition is given. M30-E appears to be in "fair" geomorphic condition. Segment M30-B was not fully assessed because of a very short (700 feet in length) change in stream type. M30-B was judged to be in "good" geomorphic condition.

Functioning floodplains play a crucial role in providing long-term stability to a river system. Natural and anthropogenic impacts may alter the equilibrium of sediment and discharge in natural stream systems and set in motion a series of morphological responses (aggradation,

degradation, widening, and/or planform adjustment) as the channel tries to reestablish a dynamic equilibrium. Small to moderate changes in slope, discharge, and/or sediment supply can alter the size of transported sediment as well as the geometry of the channel; while large changes can transform reach level channel types (Ryan, 2001). Human-induced practices that have contributed to stream instability within the Ottauquechee River watershed include:

- Channelization and bank armoring
- Removal of woody riparian vegetation
- Floodplain encroachments

These anthropogenic practices have altered the balance between water and sediment discharges within the Ottauquechee River watershed. The sediment regime is the quantity, size, transport, sorting, and distribution of sediments. The sediment regime may be influenced by the proximity of sediment sources, the hydrologic characteristics of the region, and the valley, floodplain, and stream morphology (ANR, 2010a). Sediment can be supplied to the river through bank erosion, large flooding events, and stormwater inputs. A sediment regime map depicting the reference and existing sediment regimes can be found on page 4 of Appendix A. Reference and existing sediment regimes were derived from the Agency of Natural Resources Data Management System according to the sediment regime criteria established by the Vermont Agency of Natural Resources (2010a).

Of the 46 fully assessed segments, 43 of the segments have a reference sediment regime of Coarse Equilibrium & Fine Deposition (*Equilibrium*). *Equilibrium* channels are unconfined on at least one side, and they transport and deposit sediment in equilibrium, wherein the stream power is balanced by the sediment load, sediment size, and boundary resistance. The three segments in Reach 26 have transport as their dominant reference sediment regime. *Transport* channels are typically in confined valleys, and do not supply appreciable quantities of sediment to downstream reaches. These channels have confining valley walls with limited sediment storage capacity due to both channel slope and entrenchment (Vermont Agency of Natural Resources, 2010a).

Changes in hydrology (such as development and agriculture within the riparian corridor) and sediment storage within the watershed have altered the reference sediment regime types for many of the segments of the Ottauquechee River main stem. The majority of the segments have undergone a transformation from a reference sediment regime of Coarse Equilibrium & Fine Transport or Transport to a departure sediment regime (Appendix A, page 4). The analysis of sediment regimes at the watershed level is useful for summarizing the stressors affecting geomorphic condition of river channels. Sediment regime mapping provides a context for understanding the sediment transport and channel evolution processes.

Channel morphologic responses to these anthropogenic practices and changes in sediment regimes contribute to channel adjustment that may further create unstable channels. All three

adjustment processes, aggradation, widening and planform migration as a result of historic degradation within the channel are present within the Ottauquechee River watershed. In many areas, the placement of Route 4 has significantly changed the river's valley width, floodplain access, and its ability to meander. Figure 5.1 shows an example of the change in confinement due to Route 4.

The reach condition ratings of the Ottauquechee River watershed indicate that most of the reaches/segments are actively or have historically undergone a process of minor or major geomorphic adjustment. Many of the reaches studied in the Ottauquechee River watershed are undergoing a channel evolution process in response to large scale changes in its sediment, slope, and/or discharge associated with the human influences on the watershed.

Both the "D" stage and "F" stage channel evolution models (Vermont Agency of Natural Resources, 2009b; Vermont Agency of Natural Resources, 2004) are helpful for explaining the channel adjustment processes underway in the Ottauquechee River watershed. The "F" stage channel evolution model is used to understand the process that occurs when a stream degrades (*incises*). The common stages of the "F" channel evolution stage, as depicted in Figure 5.2 include:

- Stable (F-I) - a pre-disturbance period
- Incision (F-II) – channel degradation (head cutting)
- Widening (F-III) – bank failure
- Stabilizing (F-IV) – channel narrows through sediment build up and moves laterally building juvenile floodplain
- Stable (F-V) - gradual formation of a stable channel with access to its floodplain at a lower elevation

The "D-stage" channel evolution model applies to reaches where there may have been some minor historic incision; however, the more dominant active adjustment process is aggradation, which in turn leads to channel widening and planform adjustment. The D-stage adjustment process typically occurs in unconfined, low to moderate gradient valleys where the stream is not entrenched and has access to its floodplain or flood prone area at the 1-2 year flood stage.

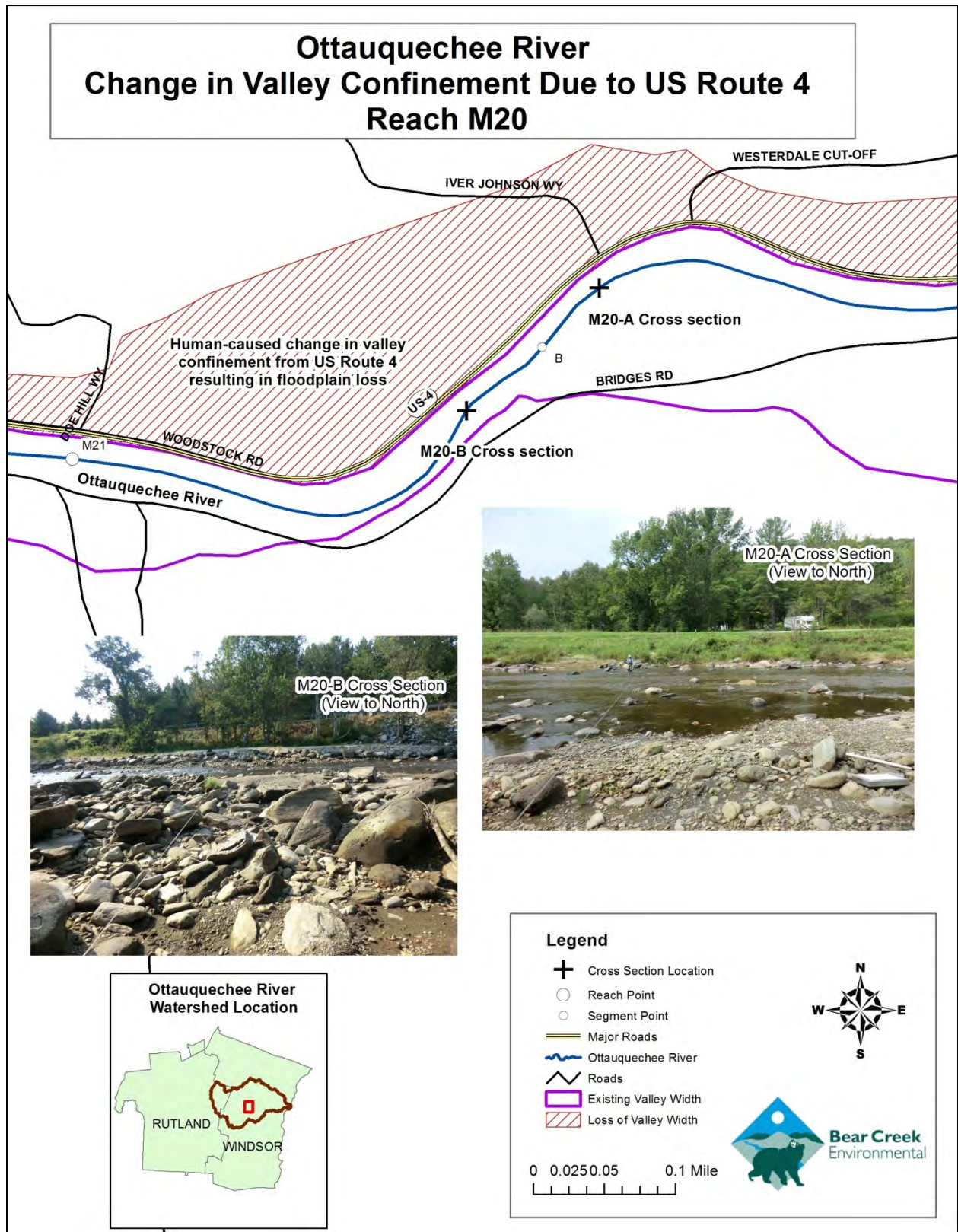


Figure 5.1. Loss of valley width (and floodplain) from US Route 4

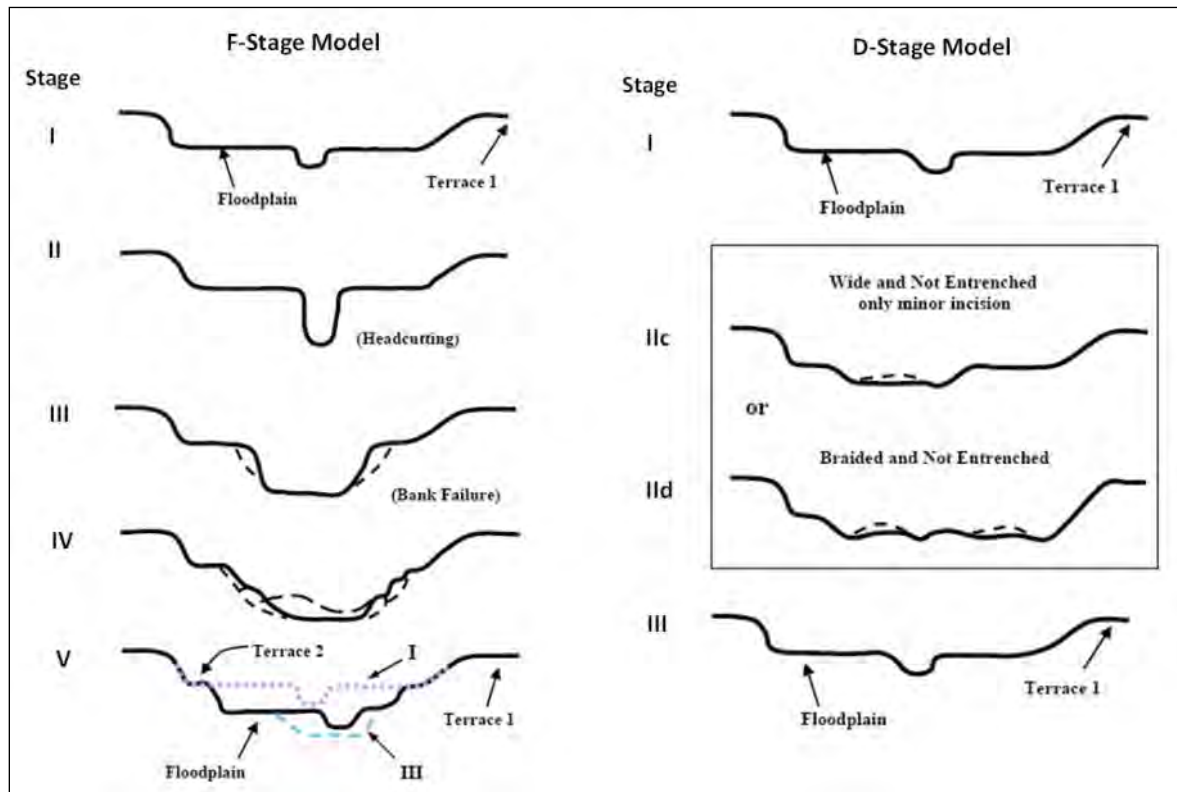


Figure 5.2 Typical channel evolution models for F-Stage and D-Stage
(Vermont Agency of Natural Resources, 2009b)

When stream channels are altered through straightening, it can set this evolution process into motion and cause adjustment processes to occur. The bed erosion that occurs when a meandering river is straightened in its valley is a problem that translates to other sections of the stream. Localized incision will travel upstream and into tributaries, thereby eroding sediments from otherwise stable streambeds. These bed sediments will move into and clog reaches downstream, leading to lateral scour and erosion of the stream banks. Channel evolution processes may take decades to play out. Even landowners that have maintained wooded areas along their stream and riverbanks may have experienced eroding banks as stream channel slopes adjust to match the valley slopes. It is difficult for streams to attain a new equilibrium where the placement of roads and other infrastructure has resulted in little or no valley space for the stream to access or to create a floodplain.

The channel evolution stage for each Phase 2 segment was determined based on field data and observations. A summary of the channel evolution stage by segment is provided on pages 1 through 3 of Appendix C. In terms of the channel evolution model, one segment on the Ottauquechee River and one segment on Reservoir Brook are in stage I of the “F-stage” channel evolution model. This means that these reaches have not undergone a channel incision process, and generally the sediment transport capacity is in equilibrium with the sediment load.

M28T5.01-B and M30-D are the segments in stage I. Both those segments, as mentioned above, are in relatively undisturbed areas.

In contrast, many segments have undergone historic degradation and are in stage II of the “F-stage” channel evolution model. These segments have generally lost floodplain access as a result of corridor encroachments. These segments remain in the F-II stage because extensive rip rap and/or channel straightening have prevented channel widening. Stream power is increased within the channel due to the loss of floodplain access. Segments in stage F-II are M15-C, M22-A, M27-E, M28-A, M28-B, M30-A, and M28T5.01-C.

Thirty-one of 48 segments are in stage III of the “F-stage” channel evolution model. Most of these segments have undergone historic incision. The placement of Route 4 likely led to this incision and the subsequent loss of floodplain access. In stage F-III, the entrenched channel begins to widen and migrate laterally through bank erosion caused by the increased stream power.

Two segments on the Ottauquechee main stem have moved into stage IV of the “F-stage” channel evolution model. This means that the channel has stabilized itself by changes in its migration pattern and building a new floodplain at a lower elevation. The two segments where a ‘new’ floodplain was observed were M19-A and M19-B.

Four segments within the Ottauquechee River study area fall into the “D-stage” channel evolution model, where the more dominant active adjustment process is aggradation. This buildup of sediment leads to channel widening and planform adjustment. In the D-IIc stage, the channel becomes extremely depositional. The channel width narrows through aggradation as *bar* features develop. Transverse (*diagonal*) bars may be common. M30-C is in stage D-IIc. Segments in stage D-IId (M27-B, M27-F, M28T5.01-A) exhibit a high amount of aggradation and as a result are widening. Segments in the “D-stage” channel evolution model show minor to no incision.

A stream sensitivity rating was determined based on existing stream type, dominant sediment size, and geomorphic condition. Stream sensitivity ratings help identify the likelihood that a segment will undergo vertical and lateral adjustments driven by natural or human-induced fluvial processes (ANR, 2010a). The sensitivity ratings are as follows: Very Low, Low, Moderate, High, Very High, and Extreme. All assessed segment on the Ottauquechee River main stem and Reservoir Brook had a minimum sensitivity of High because most segments are undergoing major or extreme channel adjustments. Eleven segments are assigned a rating of Extreme, seventeen are Very High, and eighteen are High. Maps showing stream sensitivities can be found on pages 5 and 6 of Appendix A.

5.3 Habitat Condition

The habitat condition for each segment within the Ottauquechee River 2012 study area is presented on page 3 of Appendix A. Three segments (M30-C, M28T5.01-B, and M27-F) in the 2012 study are in “good” habitat condition. This is mainly because they have minimal to no corridor encroachments, allowing for high quality vegetated banks and buffers. The segments in “good” condition have high amounts of large woody debris in the channel, many deep *pools*, and good canopy cover, all of which provide habitat for aquatic life. Thirty-nine segments are in “fair” habitat condition and four segments are in “poor” habitat condition. The segments in “poor” condition are M14-B, M15-A, M15-B, and M24-A. Segments are in “fair” or “poor” geomorphic condition mainly a result of corridor encroachments, poor bank and buffer vegetation, invasive plants, thick algae cover, erosion and revetments, and channel straightening. Three of the segments in “poor” condition and four of the segments in “fair” condition exhibit a stream habitat type departure. The influence of corridor encroachments, such as Route 4, has led to a bedform departure from a reference type of riffle-pool to plane bed, which lacks key pool and *riffle* features that provide good fish habitat. Many other segments lacked strong riffle-pool bedform features and a plane bed bedform was considered subdominant.

The map on page 3 in Appendix A includes both the geomorphic and habitat condition maps side by side. Overall, the habitat and geomorphic conditions were similar, implying that the ecological health of the Ottauquechee River and Reservoir Brook are related to the geomorphic condition of the stream.

5.4 Reach/Segment Descriptions

A description of each reach/segment is provided in this section along with a list of recommendations for restoration and protection strategies. The reaches/segments are listed from downstream to upstream. The reaches are broken into sections based on the stream they are located in: Ottauquechee River main stem and Reservoir Brook. Phase 2 Segment Summary Reports from the Agency of Natural Resources’ Data Management System, which contain all the data for the Phase 2 steps, are included on pages 4 through 147 of Appendix C.

Proposed project locations are provided on maps on pages 1 through 6 in Appendix D. Further recommended project detail tables and photos are provided on pages 7 through 21 in Appendix D. The Phase 2 stream geomorphic assessment provides a picture of the condition of the channel and the adjustment process occurring; however, it is not a comprehensive study for determining site specific actions. The Phase 2 study provides a foundation for project development, and additional work is recommended to further develop these projects.

The conditions encountered in the summer 2012 data collection were influenced by Tropical Storm Irene (TSI), which occurred in August 2011. In many areas, sediment deposition in the

channel and floodplain may have affected results by changing channel dimensions. Post-flood recovery efforts also affected channel dimensions in some locations and included, but were not limited to, dredging, gravel extraction, windrowing, and creation of berms. In every case, an effort was made to measure channel cross sections in locations that were the least impacted by the flood. Any uncertainties in accurate channel dimensions were noted. According to the Vermont Fish and Wildlife Department (2012), approximately 48,500 feet of in stream habitat in the Ottauquechee River watershed were estimated to have been majorly impacted by post-flood channel alterations.

Ottauquechee River Main Stem

M13

The lowest Phase 2 reach of the Ottauquechee River main stem begins approximately 1,000 feet upstream of where the Woodstock-Pomfret town boundary line intersects the Ottauquechee River and continues 5,900 feet upstream to the confluence of the Ottauquechee and Barnard Brook. This reach has a reference confinement of Very Broad; however, River Road restricts the confinement for the lower 1,100 feet. M13 is characterized by many adjacent farm fields. Figure 5.3 shows typical low banks, sparse buffers, and high aggradation for the reach.

M13 is in **fair** geomorphic condition. Unlike most of the upstream reaches of the Ottauquechee River, M13 is characterized by good floodplain access. One of the major processes occurring here is **aggradation**. As a response to aggradation the river is showing signs of **planform adjustment** as well.

M13 is in **fair** habitat condition. This reach has several long, deep pools which are good for fish habitat; however, it lacks **large woody debris** and adequate **bank** and **buffer vegetation**. The majority of the northern bank and about a quarter of the southern bank have narrow buffers of less than 25 feet. Japanese knotweed, an invasive herbaceous plant, is present in this reach.

M13 Data Summary		Reference	Existing
Length: 5,889 ft	Confinement	Very Broad	Broad
Drainage Area: 185 sq. mi.	Stream Type	C	C
Evolution Stage: F-III	Dominant Bed Material	Cobble	Cobble
Sensitivity: High	Dominant Bedform	Riffle-Pool	Riffle-Pool
	Entrenchment Ratio	> 2.2	6.9
	Incision Ratio	< 1.2	1.1
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Invasive Plants, Channel Straightening		



Figure 5.3. Typical low banks, sparse buffer (left bank), and high aggradation in M13.

M13 Project Identification:

- **Passive Restoration** by protecting the river corridor through easements. (Map 1: Project #1)
- **Passive Restoration** by planting trees within the riparian corridor in areas where buffers are less than 25 feet wide. (Map 1: Projects #2 & 5)
- **Passive Restoration** by supplementing existing buffers with more trees and allowing natural regeneration of vegetation. (Map 1: Projects #3 & 4)

M14

This reach was split into two segments to account for a change in floodplain access resulting in a change in stream type. The reference confinement in this reach is Very Broad and is not significantly changed by human impacts.

M14-A

This segment begins where Barnard Brook enters the Ottauquechee and continues 3,800 feet upstream to where the river becomes straight, or directly across from a motel on Woodstock Road. M14-A, accounting for two-thirds of the reach, has good floodplain access while the upstream segment (M14-B) does not have access to its floodplain (Figure 5.4).



Figure 5.4. High banks in M14-B (left) and lower banks in M14-A (right).

M14-A is in **fair** geomorphic condition with **aggradation** and **widening** as the major processes (See Figure 5.5). In some areas, rip rap along the banks is preventing widening and planform adjustment. This segment is in **fair** habitat condition mainly because of its extensive bank erosion and lack of adequate riparian buffers. Japanese knotweed is abundant along the banks.

M14-A Data Summary		Reference	Existing
Length: 3,769 ft Drainage Area: 144 sq. mi. Evolution Stage: F-III Sensitivity: High	Confinement	Very Broad	Very Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	7.4
	Incision Ratio	< 1.2	1.3
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Invasive Plants, Erosion, Revetments, Encroachments, Channel Straightening		



Figure 5.5. Widening and aggradation are occurring in M14-A. Rip rap prevents planform adjustment.

M14-B

This segment begins across from a motel on Woodstock Road and continues upstream 1,150 feet to the confluence with Kedron Brook, or about 800 feet downstream of the Elm Street Bridge. M14-B is in **fair** geomorphic condition with major **widening** as the primary process. **Historic incision** as a result of extensive channel straightening has led to the stream type departure. The river can no longer access its floodplain in this area (See Figure 5.6). This segment is in **poor** habitat condition mainly because of its lack of adequate riparian buffers, pools, and large woody debris. This segment is also largely incised. Streambed incision is associated with accelerated stream bank erosion, which increases deposition and embeddedness in downstream locations, resulting in aquatic habitat loss (Vermont Agency of Natural Resources, 2008a). The outfall from the Woodstock Wastewater Treatment Facility (WWTF) is within M14-B. The Woodstock WWTF processes approximately 275,000 gallons per day (http://www.townofwoodstock.org/Town_of_Woodstock_VT_Sewer_Service.aspx).



Figure 5.6. High banks in M14-B restrict floodplain access.

M14-B Data Summary		Reference	Existing
Length:	1,143 ft	Confinement	Very Broad
Drainage Area:	143 sq. mi.	Stream Type	C
Evolution Stage:	F-III	Entrenchment Ratio	> 2.2
Sensitivity:	High	Incision Ratio	< 1.2
		Dominant Bed Material	Cobble
		Dominant Bedform	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Erosion, Revetments, Channel Straightening		

M14 Project Identification:

- None

M15

This reach was split into three segments to account for floodplain accessibility and stream type changes. This reach is located in an urban area (See Figure 5.7).



Figure 5.7. Human impacts are common in the vicinity of the Elm Street Bridge.

M15-A

This segment begins at the confluence with Kedron Brook and continues upstream 800 feet to just downstream of the Elm Street Bridge. M15-A is in **fair** geomorphic condition with **widening** as the main process occurring. Extensive channel straightening led to extreme **historic incision**, which resulted in the loss of floodplain access and a stream type departure. Extensive straightening also limits natural planform adjustment. M15-A is in **poor** habitat condition for a multitude of reasons, some of which are poor bank and buffer vegetation, a lack of large woody debris, and an absence of pools. Japanese knotweed is abundant along the southern bank. This segment exhibits a stream habitat type departure from its reference type of riffle-pool to plane bed.

M15-A Data Summary		Reference	Existing
Length: 806 ft	Confinement	Very Broad	Broad
Drainage Area: 127 sq. mi.	Stream Type	C	F
Evolution Stage: F-III	Entrenchment Ratio	> 2.2	1.2
Sensitivity: Very High	Incision Ratio	< 1.2	2.5
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Plane Bed
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Invasive Plants, Erosion, Revetments, Encroachments, Channel Straightening		

M15-B

The middle and longest segment (M15-B) begins just below the Elm Street Bridge and makes its way through Woodstock from the Elm Street Bridge to just below the Recreation Center Bridge. The river has moderate floodplain access throughout this segment and does exhibit a stream type departure, but it is less severe than other segments. The segment is in **poor** geomorphic condition. Tropical Storm Irene likely contributed to the significant **aggradation** in this segment (Figure 5.8). M15-B is in **poor** habitat condition as a result of poor bank and buffer vegetation, a limited amount of pools, and reduced bank canopy.



Figure 5.8. Typical aggradation and no buffer area adjacent to the river in M15-B.

M15-B Data Summary		Reference	Existing
Length: 3,499 ft	Confinement	Very Broad	Narrow
Drainage Area: 127 sq. mi.	Stream Type	C	B
Evolution Stage: F-III	Entrenchment Ratio	> 2.2	1.8
Sensitivity: Very High	Incision Ratio	< 1.2	1.9
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Invasive Plants, Revetments, Constrictions, Encroachments, Channel Straightening		

M15-C

The upper segment begins just below the Recreation Center Bridge and continues upstream 700 feet. The segment is in **fair** geomorphic condition and has undergone extreme **historic incision** as a result of extensive historic channel alteration (See Figure 5.9). The river no longer has access to its floodplain here and exhibits a major stream type departure. Extensive straightening is restricting other geomorphic processes. M15-C is in **fair** habitat condition mainly because of a lack of adequate bank and buffer vegetation and bank erosion.



Figure 5.9. Extensive channel straightening seen through rip rap and hard bank armoring.

M15-C Data Summary		Reference	Existing
Length: 723 ft Drainage Area: 127 sq. mi. Evolution Stage: F-II Sensitivity: Very High	Confinement	Broad	Semi-Confined
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.3
	Incision Ratio	< 1.2	3.1
	Dominant Bed Material	Cobble	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Revetments, Constriction, Channel Straightening		

M15 Project Identification:

- **Passive Restoration** by planting trees within the riparian corridor in areas where buffers are less than 25 feet wide. (Map 1: Project #7)

M16

This short reach begins about 600 feet above the Recreation Center Bridge and continues upstream for 1,900 feet until the valley widens again. The reach is semi-confined, making the reference stream type different than most of the other reaches that were assessed in this project. Route 4 runs directly along the northern bank of the river and cuts out about one-third of the valley width and restricts what little floodplain access the river historically had here (See Figure 5.10).

M16 is in **fair** geomorphic condition with **widening** as the major processes occurring. This reach is likely naturally straight in some places because of the valley confinement, although there is evidence of some channel straightening. The placement of Route 4 has led to **historic incision**, which is responsible for the loss of floodplain access and stream type departure. The southern bank has two mass failures, which were influenced by Tropical Storm Irene. M16 is in **fair** habitat condition, almost scoring in the ‘good’ category. Compared to upstream and downstream reaches, M16 had many refuge areas for aquatic life and several deep pools. The lack of adequate stream bank vegetation on the northern bank and decreased vegetation from the mass failures on the southern bank lowered the habitat score.

M16 Data Summary		Reference	Existing
Length: 1,867 ft Drainage Area: 127 sq. mi. Evolution Stage: F-III Sensitivity: Very High	Confinement	Semi-Confined	Semi-Confined
	Stream Type	B	F
	Entrenchment Ratio	1.4 – 2.2	1.1
	Incision Ratio	< 1.2	1.6
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Invasive Plants, Erosion, Revetments, Mass Failures, Encroachments, Channel Straightening		



Figure 5.10. Route 4 running along northern edge of M16.

M16 Project Identification:

- **Stormwater Management** by evaluating stormwater management. Runoff from College Hill Road has created two gullies that are allowing excess stormwater to enter the river. (Map 2: Project #1)

M17

This reach begins as the valley widens and continues upstream 2,700 feet to where Vondell Brook enters the Ottauquechee River. Route 4, which parallels this reach to the north, changes the natural confinement of this reach from unconfined to confined. In addition to that, Route 4 restricts floodplain access and has caused **historic incision** leading to a stream type departure. M17 is in **fair** geomorphic condition with **aggradation** as the main adjustment process. M17 is in **fair** habitat condition as a result of extensive bank erosion and a lack of adequate vegetated buffers. There is a very large mass failure on the southern bank at the lower end of the reach, which was exacerbated by Tropical Storm Irene (See Figure 5.11). Japanese knotweed is present in this reach, especially on the southern bank.



Figure 5.11. Mass failure on the southern bank at downstream end of M17.

M17 Data Summary		Reference	Existing
Length: 2,659 ft Drainage Area: 126 sq. mi. Evolution Stage: F-III Sensitivity: Very High	Confinement	Narrow	Semi-Confined
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.2
	Incision Ratio	< 1.2	2.5
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Invasive Plants, Erosion, Revetments, Mass Failures, Encroachments, Channel Straightening		

M17 Project Identification:

- **Passive Restoration** by protecting the river corridor through easements. (Map 2: Project #2)
- **Passive Restoration** by planting trees along the bank adjacent to parking lot. (Map 2: Project #3)

M18

This reach was split into two segments mainly because of a change in channel confinement.

M18-A

This segment begins where Vondell Brook enters the Ottauquechee and continues upstream 4,800 feet past Woodstock Union High School to the end of a farm field on the northern bank. The river does not have access to its floodplain. This floodplain loss is as a result of **historic incision** caused by extensive channel straightening. M18-A is in **poor** geomorphic condition with **aggradation** and **widening** as the main processes occurring (See Figure 5.12). This segment is in **fair** habitat condition as a result of a limited amount of large woody debris, channel morphology, and narrow vegetated buffers.



Figure 5.12. Major aggradation in M18-A.

M18-A Data Summary		Reference	Existing
Length:	4,770 ft	Confinement	Very Broad
Drainage Area:	123 sq. mi.	Stream Type	C
Evolution Stage:	F-III	Entrenchment Ratio	> 2.2
Sensitivity:	Extreme	Incision Ratio	< 1.2
		Dominant Bed Material	Cobble
		Dominant Bedform	Riffle-Pool
Major Stressors:		Poor Buffers, Constriction, Encroachments, Channel Straightening	

M18-B

This segment begins at the end of the farm field on the northern bank and continues 2,200 feet upstream until the confluence of Cox District Brook with the Ottauquechee River. Similar to M18-A, this segment does not have access to its floodplain. This is as a result of **historic incision** caused by extensive channel straightening. The segment is in **poor** geomorphic condition. The river is widening here (See Figure 5.13). Although there is excessive **aggradation** in this segment, the bars will need to build some more in order for this segment to progress into stage F-IV. This segment is in **fair** habitat condition as a result of extensive bank erosion, reduced buffer widths, and streambed incision. In some areas the stream habitat type has departed from its reference riffle-pool to plane bed.



Figure 5.13. M18-B is widening.

M18-B Data Summary		Reference	Existing
Length: 2,183 ft	Confinement	Broad	Broad
Drainage Area: 123 sq. mi.	Stream Type	C	F
Evolution Stage: F-III	Entrenchment Ratio	> 2.2	1.3
Sensitivity: Extreme	Incision Ratio	< 1.2	1.7
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Buffers, Invasive Plants, Erosion, Mass Failure, Encroachments, Channel Straightening		

M18 Project Identification:

- **Passive Restoration** by planting trees within the riparian corridor in areas where buffers are less than 25 feet wide. (Map 2: Projects #4 & 5)
- **Passive Restoration** by protecting the river corridor through easements. (Map 2: Project #5)

M19

The reach was split into two segments to account for a change in buffer type.

M19-A

This segment begins at the confluence of Cox District Brook and the Ottauquechee River and continues upstream 3,700 feet until Fletcher Hill Road comes close to the southern river bank. M19-A is in **poor** geomorphic condition. The river here has undergone minor **historic incision**. **Aggradation** and **widening** are the main processes occurring here. The channel is currently trying to build a new floodplain; however, some material has been removed from the channel through *dredging* and is limiting this natural process (See Figure 5.14). M19-A is in **fair** habitat condition. Bank erosion, lack of large woody debris, and extreme aggradation are some of the factors contributing to this. Storm water inputs were identified near Fletcher Hill Road and Riverside Park Road.



Figure 5.14. Flood work is limiting natural geomorphic processes.

M19-A Data Summary		Reference	Existing
Length: 3,692 ft		Confinement	Very Broad
Drainage Area: 118 sq. mi.		Stream Type	C
Evolution Stage: F-IV		Entrenchment Ratio	> 2.2
Sensitivity: High		Incision Ratio	< 1.2
		Dominant Bed Material	Cobble
		Dominant Bedform	Riffle-Pool
Major Stressors:		Invasive Plants, Erosion, Mass Failure, Channel Straightening	

M19-B

This segment begins where Fletcher Hill Road comes close to the southern bank and continues 1,350 feet upstream to just below the Lincoln Corners Covered Bridge. Fletcher Hill Road runs directly along the entire southern bank of this segment. This segment is in **fair** geomorphic condition with minor **historic incision**. Major **aggradation** and extreme **widening** are the main processes occurring in this segment. The river is building a new floodplain. This segment is in **fair** habitat condition mainly because of a lack of adequate vegetated buffers and large woody debris. Figure 5.15 shows a typical channel in this M19-B.



Figure 5.15. Typical channel in M19-B shows major aggradation and extreme widening.

M19-B Data Summary		Reference	Existing
Length: 1,349 ft Drainage Area: 118 sq. mi. Evolution Stage: F-IV Sensitivity: Very High	Confinement	Very Broad	Broad
	Stream Type	C	B
	Entrenchment Ratio	> 2.2	2.1
	Incision Ratio	< 1.2	1.4
	Dominant Bed Material	Cobble	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Invasive Plants, Erosion, Encroachments, Channel Straightening		

M19 Project Identification:

- **Passive Restoration** by protecting the river corridor through easements. (Map 3: Project #1)
- **Stormwater Management** of excess stormwater entering the river off of Riverside Park Road. (Map 3: Project #2)

M20

This reach was split into two segments to account for a buffer change. Route 4 runs directly next to the northern bank for the whole reach and several storm water inputs were identified.

M20-A

This segment begins just below the Lincoln Corners Covered Bridge and continues 2,800 feet upstream along Route 4 until the farm fields on the southern bank change to forest. M20-A is in **poor** geomorphic condition. Route 4 not only changes the natural confinement of the river here, but it also restricts the river’s access to its floodplain. This has led to **historic incision**, which has led to a stream type departure. The major processes occurring here are **widening** and **aggradation** (See Figure 5.16). M20-A is in **fair** habitat condition because of a lack of large woody debris, a largely incised streambed, and a lack of adequate bank and buffer vegetation.

M20-A Data Summary		Reference	Existing
Length: 2,832 ft Drainage Area: 116 sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Broad	Broad
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.2
	Incision Ratio	< 1.2	1.9
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Erosion, Revetments, Constriction, Encroachments, Channel Straightening		



Figure 5.16. M20-A exhibits extreme aggradation.

M20-B

This segment begins where the southern bank becomes forested and continues upstream for 2,000 feet until the valley becomes a bit narrower. This is approximately where Doe Hill Way intersects Route 4. This segment is in **poor** geomorphic condition. Route 4 has cut off access to some of its floodplain and led to extreme **historic incision**, resulting in a stream type departure. Extreme **widening** and major **planform adjustment** are the main processes occurring here. This segment is in **fair** habitat condition because of its lack of adequate vegetated banks and buffers and a largely incised streambed.

M20-B Data Summary		Reference	Existing
Length: 2,036 ft Drainage Area: 116sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Broad	Semi-Confined
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.2
	Incision Ratio	< 1.2	2.6
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Erosion, Revetments, Mass Failures, Encroachments, Channel Straightening		

M20 Project Identification:

- **Passive Restoration** by protecting the river corridor through easements. (Map 3: Project #3)

M21

This reach was split into four segments to account for land-use changes and confinement changes. Route 4 runs directly along the northern bank of this whole reach and several storm water inputs were identified.

M21-A

This segment begins approximately where Doe Hill Way intersects Route 4 and continues upstream 1,700 feet along a residential area until the southern bank becomes forested. Route 4 runs directly along the northern bank for the entire length of the segment. There is an old bridge abutment that is constricting the channel and causing additional deposition (See Figure 5.17).



Figure 5.17. Old bridge abutment causing deposition in M21-A.

This segment is in **poor** geomorphic condition. Route 4 has cut off access to some of its floodplain and led to **historic incision**, resulting in a stream type departure. Floodplain access is now completely restricted. Major **aggradation**, **widening**, and **planform adjustment** are the main processes occurring here as the channel responds to incision and straightening. This segment is in **fair** habitat condition because of its lack of adequate vegetated banks and buffers and a largely incised streambed.

M21-A Data Summary		Reference	Existing
Length: 1,680 ft Drainage Area: 114sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Broad	Narrow
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.3
	Incision Ratio	< 1.2	2.8
	Dominant Bed Material	Cobble	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:		Poor Bank Vegetation, Poor Buffers, Revetments, Constriction, Encroachments, Channel Straightening	

M21-B

This segment begins where the southern bank becomes forested and continues upstream 3,200 feet until the southern bank changes to cropland. Route 4 runs directly along the northern bank for the whole segment. Route 4 has significantly impacted the confinement, changing the valley type from unconfined to confined. Figure 5.18 shows the typical channel in this segment.

This segment is in **poor** geomorphic condition. Route 4 has cut off access to some of its floodplain and led to **historic incision**, resulting in a stream type departure. Floodplain access is now completely restricted. Major **aggradation** and **planform adjustment** are the main processes occurring here as the channel responds to incision. **Widening** is extreme. This segment is in **fair** habitat condition because of its lack of an adequate vegetated northern bank and buffer, largely incised streambed, and a lack of refuge areas. A stream habitat type departure from the reference riffle-pool to plane bed is observed here.

M21-B Data Summary		Reference	Existing
Length: 3,185ft Drainage Area: 114sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Narrow	Narrowly Confined
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.2
	Incision Ratio	< 1.2	2.5
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Plane Bed
Major Stressors:		Poor Bank Vegetation, Poor Buffer, Erosion, Encroachments, Channel Straightening	



Figure 5.18. Typical channel in M21-B.

M21-C

This segment begins where the southern bank changes from forest to cropland and continues 2,950 feet upstream to where the southern bank becomes forested again. This is approximately where Larry Curtis Road becomes continuous with the river bank. Figure 5.19 shows a typical channel in this segment.

This segment is in **poor** geomorphic condition. Route 4 has cut off access to some of its floodplain and led to **historic incision**, resulting in a stream type departure. Floodplain access is now completely restricted. Major **aggradation, widening, and planform adjustment** are the main processes occurring here as the channel responds to incision. This segment is in **fair** habitat condition because of its lack of adequate vegetated banks and buffers. In addition to that, the largely incised streambed and lack of large woody debris lower the rating.



Figure 5.19. Typical M21-C channel looking downstream.

M21-C Data Summary		Reference	Existing
Length:	2,945 ft	Broad	Broad
Drainage Area:	114sq. mi.	C	F
Evolution Stage:	F-III	> 2.2	1.2
Sensitivity:	Extreme	< 1.2	2.2
		Cobble	Gravel
		Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Erosion, Revetments, Tributary Rejuvenation, Encroachments, Channel Straightening		

M21-D

This segment begins where the southern bank changes from cropland back to forest and continues 2,800 feet upstream to the reach break at the confluence with Curtis Hollow Brook. Several storm water inputs were identified in this segment, which are coming from Route 4 and Larry Curtis Road. This segment is in **poor** geomorphic condition. Route 4 has cut off access to some of its floodplain and led to **historic incision**, resulting in a stream type departure. Floodplain access is now completely restricted. Major **aggradation** and **planform adjustment** are the main processes occurring as the channel responds to incision. **Widening** is extreme. This segment is in **fair** habitat condition because of its lack of an adequate vegetated northern bank and buffer. In addition to that, the largely incised streambed and a lack of large woody debris lower the rating. Figure 5.20 shows the major aggradation and lack of buffer.



Figure 5.20. Typical channel in M21-D looking upstream. High aggradation. Lack of adequate buffer along Route 4.

M21-D Data Summary		Reference	Existing
Length: 2,782 ft Drainage Area: 114sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Broad	Narrow
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.2
	Incision Ratio	< 1.2	3.3
	Dominant Bed Material	Cobble	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Invasive Plants, Erosion, Revetments, Tributary Rejuvenation, Encroachments, Channel Straightening		

M21 Project Identification:

- **Active Restoration** by removing the old bridge abutment in M21-A. (Map 3: Project #4)
- **Passive Restoration** by protecting the river corridor through easements. (Map 3: Project #5)

M22

This reach runs through Bridgewater Village and was split into two segments because of a land-use change on the southern bank and a substrate size change.

M22-A

Segment M22-A begins where Curtis Hollow Brook enters the Ottauquechee River and continues 2,200 feet upstream to where the southern corridor changes from residential to forest. The end of the segment is located just upstream of the Bridgewater Village/Curtis Hollow Road Bridge. This bridge is causing significant upstream and downstream deposition (See Figure 5.21).

This segment is in **fair** geomorphic condition. Significant channel straightening and alteration in this segment led to **historic incision**. There is now a complete loss of floodplain access and a stream type departure. Major **aggradation** and **planform adjustment** are the dominant active adjustment processes. Natural widening is limited by rip rap on both stream banks in some locations. This segment is in **fair** habitat condition and exhibits a habitat type departure from its reference riffle-pool sequence to plane bed (See Figure 5.22). A lack of adequate buffer vegetation and an extremely incised streambed have contributed to the habitat departure.



Figure 5.21. Bridgewater Village/Curtis Hollow Road Bridge causing upstream and downstream deposition in M22-A.



Figure 5.22. Typical channel in M22-A exhibits high aggradation and plane bed features.

M22-A Data Summary		Reference	Existing
Length: 2,176 ft Drainage Area: 103 sq. mi. Evolution Stage: F-II Sensitivity: Very High	Confinement	Broad	Narrow
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.3
	Incision Ratio	< 1.2	2.5
	Dominant Bed Material	Cobble	Gravel
	Dominant Bedform	Riffle-Pool	Plane Bed
Major Stressors:	Poor Buffers, Invasive Plants, Erosion, Revetments, Constriction, Encroachments, Channel Straightening		

M22-B

This segment begins just above the Bridgewater Village/Curtis Hollow Road Bridge and continues 4,100 feet upstream to where the river valley narrows and Route 4 becomes continuous with the northern bank. In the upper part of this segment, Route 4 is significantly impacting the valley width, changing the confinement from unconfined to confined. This segment is in **poor** geomorphic condition. Channel alteration has led to extreme **historic incision**, resulting in a stream type departure. Floodplain access is now completely restricted. Major **aggradation, widening, and planform adjustment** are processes occurring here as the channel responds to incision (See Figure 5.23).



Figure 5.23. Extreme aggradation, widening, and planform adjustment in M22-B.

Segment M22-B is in **fair** habitat condition because of a lack of adequate buffer vegetation and large woody debris and an extremely incised streambed. In some areas the river exhibits a habitat type departure from its reference riffle-pool to plane bed; however, riffle-pool is dominant.

M22-B Data Summary		Reference	Existing
Length: 4,096 ft Drainage Area: 103sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Narrow	Semi-Confined
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.2
	Incision Ratio	< 1.2	2.4
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Invasive Plants, Mass Failure, Tributary Rejuvenation, Encroachments, Channel Straightening		

M22 Project Identification:

- **Passive Restoration** by planting trees where the buffer is less than 25 feet wide. (Map 4: Project #1)
- **Passive Restoration** by protecting the river corridor through easements. (Map 4: Projects #1, 2 & 3)

M23

This reach was split into two segments because of a change in valley width and reference stream type.

M23-A

Segment M23-A begins where the valley becomes narrow and Route 4 becomes adjacent to the northern bank again. It continues 1,800 feet upstream to where the valley becomes a bit wider, approximately across from the intersection of Robinson Road and Route 4. This segment is a subreach because it has a reference stream type that is different from the majority of the reach. M23-A is in **fair** geomorphic condition. Unlike many upstream and downstream segments, M23-A has access to its floodplain and does not exhibit a stream type departure. Major **widening** is occurring here; however in some locations it is limited by rip rap on the northern stream bank (See Figure 5.24). This segment is in **fair** habitat condition because of a lack of adequate buffer vegetation and large woody debris and major bank erosion.

M23-A Data Summary		Reference	Existing
Length: 1,763 ft	Confinement	Semi-Confined	Semi-Confined
Drainage Area: 100 sq. mi.	Stream Type	B	B
Evolution Stage: F-III	Entrenchment Ratio	1.4 – 2.2	1.8
Sensitivity: High	Incision Ratio	< 1.2	1.3
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Invasive Plants, Erosion, Revetments, Encroachments, Channel Straightening		

M23-B

This segment begins where the valley becomes a bit wider, approximately across from the intersection of Robinson Road and Route 4, and continues upstream 2,000 feet to the confluence of Broad Brook and the Ottauquechee. This segment is in **fair** geomorphic condition. The presence of Route 4 and River Road limit floodplain access and have caused a stream type departure, although less severe than downstream segments. Major **historic incision** has occurred here. The river is responding through **aggradation** and major **widening** especially along the southern bank (See Figure 5.25). This segment is in **fair** habitat condition because of a lack of adequate buffer vegetation (northern bank) and large woody debris and major bank erosion (southern bank). Large patches of dense algal growth are seen in this segment (See Figure 5.26).



Figure 5.24. Major widening seen in M23-A.

M23-B Data Summary		Reference	Existing
Length:	1,999 ft	Narrow	Semi-Confined
Drainage Area:	100 sq. mi.	C	B
Evolution Stage:	F-III	> 2.2	1.6
Sensitivity:	High	< 1.2	1.8
		Dominant Bed Material	Cobble
		Dominant Bedform	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Invasive Plants, Revetments, Encroachments, Channel Straightening		

M23 Project Identification:

- None



Figure 5.25. Typical channel in M23-B. Major aggradation.



Figure 5.26. Dense algal growth seen on streambed in M23-B.

M24

Reach M24 runs through Bridgewater Corners. This reach was split into two segments because of a change in valley confinement.

M24-A

This segment begins at the confluence with Broad Brook and continues upstream 1,850 feet to approximately 300 feet above the Route 100A bridge. M24-A is in **fair** geomorphic condition. The presence of Route 4 changes the valley confinement and significantly limits floodplain access. Major **historic incision** has occurred here. **Aggradation** and **planform adjustment** are the main processes occurring here in response to channel straightening (See Figure 5.27). Widening is minor. This segment is in **fair** habitat condition because of a lack of adequate bank and buffer vegetation (southern bank), large woody debris, and pools. Most of the segment exhibits a habitat type departure from the reference riffle-pool to plane bed. Major bank erosion (southern bank) is contributing to its rating as well.



Figure 5.27. Typical channel in M24-A includes major aggradation. Route 100A bridge is upstream.

M24-A Data Summary		Reference	Existing
Length:	1,848 ft	Confinement	Very Broad
Drainage Area:	73 sq. mi.	Stream Type	C
Evolution Stage:	F-III	Entrenchment Ratio	> 2.2
Sensitivity:	High	Incision Ratio	< 1.2
		Dominant Bed Material	Cobble
		Dominant Bedform	Riffle-Pool
			Plane Bed
Major Stressors:		Poor Bank Vegetation, Poor Buffers, Invasive Plants, Erosion, Revetments, Constriction, Encroachments, Channel Straightening	

M24-B

This segment begins 300 feet above the Route 100A bridge and continues 1,850 feet upstream past the Long Trail Brewery and under Route 4 until the confluence with the North Branch of the Ottauquechee near Bridgewater Center Road. M24-B is in **fair** geomorphic condition. Although the presence of Route 4 changes the valley confinement in this segment, it does not significantly limit floodplain access because it is located further away from the channel than in most other segments. No stream type departure is seen here. Major **historic incision** has occurred in this segment as a result of channel straightening. **Aggradation, widening, and planform adjustment** are the major processes occurring here in response to channel straightening (See Figure 5.28).



Figure 5.28. Significant aggradation in M24-B. Long Trail Brewery seen beyond the northern bank.

Segment M24-B is in **fair** habitat condition because of a lack of adequate bank and buffer vegetation (northern bank) and large woody debris. There are also two mass failures on the southern bank (See Figure 5.29).



Figure 5.29. Mass failure on southern bank in M24-B.

M24-B Data Summary		Reference	Existing
Length:	1,858 ft	Confinement	Broad
Drainage Area:	73 sq. mi.	Stream Type	C
Evolution Stage:	F-III	Entrenchment Ratio	> 2.2
Sensitivity:	High	Incision Ratio	< 1.2
		Dominant Bed Material	Cobble
		Dominant Bedform	Riffle-Pool
Major Stressors:		Poor Buffer, Invasive Plants, Erosion, Constriction, Mass Failures, Encroachments, Channel Straightening	

M24 Project Identification:

- **Passive Restoration** by planting trees within the riparian corridor in areas where buffers are less than 25 feet wide. (Map 5: Project #1)

M25

This reach was split into three segments because of changes in confinement and stream type. M25 is mainly forested on its eastern bank and Route 4 is adjacent to its western bank.

M25-A

This segment begins at the confluence of the Ottauquechee River with the North Branch of the Ottauquechee River and continues 1,500 feet upstream to where the channel becomes straight and where Route 4 becomes continuous with the western bank of the river. This segment is in **fair** geomorphic condition. **Widening** and **planform adjustment** are the two major processes occurring as the channel adjusts to being historically straightened. Historic incision and aggradation are minor (See Figure 5.30). Although Route 4 limits floodplain access in this segment, it is minor and there is no stream type departure.



Figure 5.30. Aggradation and incision are minor in M25-A.

M25-A is in **fair** habitat condition because the western banks and buffers lack adequate vegetation. In addition to that, there is a lack of large woody debris, limited refuge areas, and some algal growth on the substrate.

M25-A Data Summary		Reference	Existing
Length: 1,502 ft		Broad	Broad
Drainage Area: 45 sq. mi.		C	C
Evolution Stage: F-III		> 2.2	4.3
Sensitivity: Very High		< 1.2	1.3
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Channel Straightening		

M25-B

This segment begins where Route 4 becomes directly adjacent to the western bank and continues upstream 1,400 feet until Route 4 gently curves away from the western bank, allowing some floodplain access. The valley in this segment is narrower than the downstream segment, M25-A. Route 4 significantly alters the confinement in this segment, changing it from unconfined to confined (See Figure 5.31).



Figure 5.31. Placement of Route 4 significantly altering confinement in M25-B.

M25-B is in **poor** geomorphic condition. The placement of Route 4 cut off floodplain access and led to extreme **historic incision**. A severe stream type departure exists here. **Widening, planform adjustment, and aggradation** are the major process occurring in this segment, especially in the short braided section. M25-B is in **fair** habitat condition because of the extensive straightening and rip rap and lack of a buffer on the western bank. Refuge areas are absent.

M25-B Data Summary		Reference	Existing
Length: 1,418 ft Drainage Area: 45 sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Narrow	Narrowly Confined
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.3
	Incision Ratio	< 1.2	3.8
	Dominant Bed Material	Gravel	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:		Poor Bank Vegetation, Poor Buffer, Erosion, Revetments, Constriction, Encroachments, Channel Straightening	

M25-C

This segment begins where the river gains floodplain access and continues upstream 1,700 feet until the next Route 4 bridge crossing. This segment is in **fair** geomorphic condition, exhibiting major **historic incision** as a result of channel straightening. The placement of Route 4 changes the valley type from unconfined to confined, limiting floodplain access and causing a stream type departure (See Figure 5.32). Major **planform adjustment** is occurring here as a result of channel straightening and **aggradation**. This segment is in **fair** habitat condition because of a lack of an adequate buffer on the western and southern banks. Large woody debris is limited as well.

M25-C Data Summary		Reference	Existing
Length: 1,717 ft Drainage Area: 45 sq. mi. Evolution Stage: F-III Sensitivity: Very High	Confinement	Narrow	Semi-Confined
	Stream Type	C	B
	Entrenchment Ratio	> 2.2	1.6
	Incision Ratio	< 1.2	1.7
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:		Poor Bank Vegetation, Poor Buffer, Encroachments, Channel Straightening	

M25 Project Identification:

- **Stream Clean-Up** by removing propane tank from channel in M25-A. (Map 5: Project #2)
- **Passive Restoration** by planting trees within the riparian corridor in areas where buffers are less than 25 feet wide. (Map 5: Project #3)



Figure 5.32. Floodplain access is not completely limited by Route 4 in M25-C. Sparse buffer on western bank.

M26

This reach was split into three segments because of confinement changes and a reference stream type change. Route 4 is in the northern corridor for the whole reach and for the most part is directly adjacent to the northern bank of the river. The southern corridor is forested.

M26-A

This segment begins at a Route 4 bridge crossing and continues 1,700 feet upstream until the valley becomes slightly narrower. Although the segment is semi-confined, the reference stream type is C. Segment 26-A is a sub-reach because the channel is slightly entrenched, while the majority of the reach is moderately entrenched and is a “B” channel by reference. M26-A is in **fair** geomorphic condition. As a result of channel straightening major **historic incision** has occurred. A 275-foot *berm* is located along the north bank and was apparently built to protect infrastructure (such as homes) from high water. The placement of the berm cuts off floodplain access (See Figures 8.33 and 8.34) and may lead to further incision of the channel. The berm apparently was not effective in protection against a large flood event, as indicated by a property buyout following Tropical Storm Irene in this vicinity. As seen in Figure 5.33, the *floodprone* water level (red line) is above the height of the berm. Major **aggradation**, **widening**, and **planform adjustment** are the main processes happening. This segment is in **fair**

habitat condition because of a lack of an adequate northern buffer for much of the reach as well as some erosion on the southern bank.

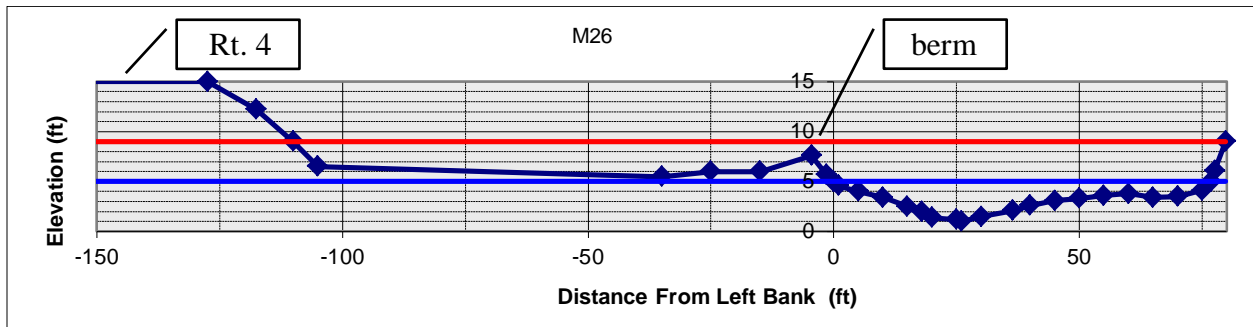


Figure 5.33. M26-A cross section shows the berm on the left bank. A human elevated incision ratio was calculated.



Figure 5.34. Berm along northern bank in M26-A.

M26-A Data Summary		Reference	Existing
Length: 1,684 ft	Confinement	Semi-Confined	Semi-Confined
Drainage Area: 44 sq. mi.	Stream Type	C	C
Evolution Stage: F-III	Entrenchment Ratio	1.4 – 2.2	2.5
Sensitivity: High	Incision Ratio	< 1.2	1.1
	<i>Human Elevated IR</i>		1.65 (top of berm)
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Erosion, Constriction, Berm, Encroachments, Channel Straightening		

M26-B

This segment begins 1,700 feet above the Route 4 bridge and continues 815 feet upstream. This segment is in **poor** geomorphic condition with extreme **historic incision** resulting in a stream type departure. The channel is undergoing major **widening** and **planform adjustment** as seen through the highly eroded southern bank. Major **aggradation** is occurring in this segment as well. M26-B is in **poor** habitat condition because the northern bank and buffer lack adequate vegetation. Channel alterations have caused the reference riffle-pool habitat type to depart to plane bed. Extensive erosion and revetments are contributing to a low habitat rating. Figure 5.35 shows a typical channel for M26-B.



Figure 5.35. Route 4 adjacent to the north and highly eroded southern bank. Plane bed habitat type.

M26-B Data Summary		Reference	Existing	
Length:	815 ft	Confinement	Semi-Confined	Narrowly Confined
Drainage Area:	44 sq. mi.	Stream Type	B	F
Evolution Stage:	F-III	Entrenchment Ratio	1.4 – 2.2	1.1
Sensitivity:	Extreme	Incision Ratio	< 1.2	2.6
		Dominant Bed Material	Gravel	Gravel
		Dominant Bedform	Riffle-Pool	Plane Bed
Major Stressors:		Poor Bank Vegetation, Poor Buffer, Erosion, Revetments, Encroachments, Channel Straightening		

M26-C

This is the longest segment in M26. It begins approximately 500 feet downstream of where Rogers Road intersects Route 4 and continues upstream for 4,850 feet until 650 feet upstream of the Gunderson Road bridge. Several storm water inputs were identified in this segment (See Figure 5.36).



Figure 5.36. Storm water runoff from Route 4 on the northern bank.

The natural confinement in this segment alternates between unconfined and confined several times. In areas where the valley is naturally unconfined, the placement of Route 4 changes the valley type from unconfined to confined. This segment is in **fair** geomorphic condition. Route 4 has cut off access to some of the river’s floodplain and led to **historic incision**, resulting in a stream type departure. Major **planform adjustment** and **aggradation** are the main processes occurring here. M26-C is in **fair** habitat condition because of a lack of adequate northern bank and buffer vegetation. There is a high amount of erosion and bank revetments as well. There is a habitat type departure from riffle-pool to plane bed.

M26-C Data Summary		Reference	Existing
Length: 4,854 ft Drainage Area: 44 sq. mi. Evolution Stage: F-III Sensitivity: Very High	Confinement	Narrow	Semi-Confined
	Stream Type	B	F
	Entrenchment Ratio	1.4 – 2.2	1.2
	Incision Ratio	< 1.2	2.0
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Plane Bed
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Erosion, Revetments, Constriction, Mass Failure, Encroachments, Channel Straightening		

M26 Project Identification:

- **Active Restoration** by removing the berm in M26-A (Map 5: Project #4).

M27

This reach was split into six segments to account for stream type changes because of the placement of Route 4. Segments M27-A, M27-C, and M27-E all exhibit stream type departures. Segments M27-B, M27-D, and M27-F do not exhibit stream type departures. For simplicity, these segments will be grouped together for the descriptions.

M27-A, M27-C, M27-E (Stream Type Departures)

These segments are located where Route 4 runs directly adjacent to the Ottauquechee River. Figure 5.37, the cross section from M27-C, shows that Route 4 significantly cuts off the valley, changing from unconfined to confined, and limits floodplain access resulting in stream type departures. M27-A and M27-E are both in **fair** geomorphic condition and M27-C is in **poor** geomorphic condition. In general, these segments are seeing minor to major **widening** and **planform adjustment**. M27-E has **historically incised**. Extensive channel straightening with bank armoring limits widening in some places. These segments are all in **fair** habitat condition because of a lack of adequate bank and buffer vegetation and extensive riprap and erosion. Figures 8.38 and 8.39 shows a typical channels for all three segments.

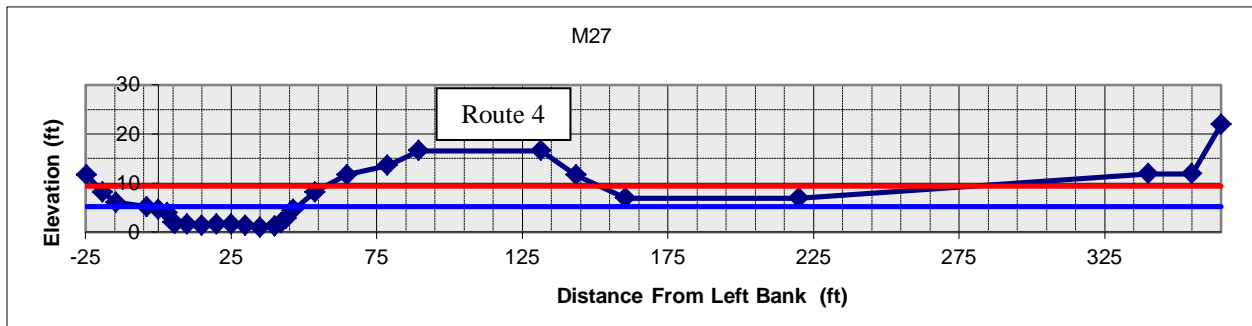


Figure 5.37. Cross section from M27-C shows how Route 4 significantly limits floodplain access.

M27-A Data Summary		Reference	Existing
Length:	1,175 ft	Confinement	Narrow
Drainage Area:	42 sq. mi.	Stream Type	C
Evolution Stage:	F-III	Entrenchment Ratio	> 2.2
Sensitivity:	Very High	Incision Ratio	< 1.2
		Dominant Bed Material	Cobble
		Dominant Bedform	Riffle-Pool
Major Stressors:		Poor Bank Vegetation, Poor Buffer, Erosion, Revetments, Encroachments, Channel Straightening	



Figure 5.38. Typical channel for segments M27-A, M27-C, and M27-E. (Photo from M27-E.)



Figure 5.39. Typical channel for segments M27-A, M27-C, and M27-E. (Photo from M27-C.)

M27-C Data Summary		Reference	Existing
Length: 996 ft Drainage Area: 42 sq. mi. Evolution Stage: F-III Sensitivity: High	Confinement	Narrow	Semi-Confined
	Stream Type	C	B
	Entrenchment Ratio	> 2.2	1.5
	Incision Ratio	< 1.2	1.4
	<i>Human Elevated IR</i>		3.7 (Route 4)
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Erosion, Revetments, Encroachments, Channel Straightening		
M27-E Data Summary		Reference	Existing
Length: 1,096 ft Drainage Area: 42 sq. mi. Evolution Stage: F-II Sensitivity: Very High	Confinement	Narrow	Narrowly Confined
	Stream Type	C	B
	Entrenchment Ratio	> 2.2	1.5
	Incision Ratio	< 1.2	1.5
	<i>Human Elevated IR</i>		3.1 (Route 4)
	Dominant Bed Material	Cobble	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Revetments, Encroachments, Channel Straightening		

M27-B, M27-D, M27-F

These three segments are located where the river in M27 is not adjacent to Route 4. They meander away from the road and each has at least one bridge crossing. These segments, although still impacted by the placement of Route 4, still have adequate floodplain access and do not exhibit stream type departures. They are in **fair** geomorphic condition with major to extreme **aggradation** and **planform adjustment**. M27-D has undergone major **historic incision**. Minor **widening** is occurring in these segments. Figure 5.40 shows aggradation in M27-D. The floodplain in M27-F is a sediment attenuation area.

M27-B and M27-D are in **fair** habitat condition and M27-F is in **good** habitat condition. Each segment has adequate bank and buffer vegetation and deep pools. M27-F has more habitat refuge areas than the other two segments. Figure 5.41 shows good banks and buffers in M27-F.

M27-B Data Summary		Reference	Existing
Length: 2,402 ft Drainage Area: 42 sq. mi. Evolution Stage: D-IIId Sensitivity: High	Confinement	Narrow	Semi-Confined
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	2.2
	Incision Ratio	< 1.2	1.0
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:		Constriction, Mass Failure, Encroachments, Channel Straightening	

M27-D Data Summary		Reference	Existing
Length: 2,279 ft Drainage Area: 42 sq. mi. Evolution Stage: F-III Sensitivity: Very High	Confinement	Narrow	Narrow
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	2.9
	Incision Ratio	< 1.2	1.7
	Dominant Bed Material	Cobble	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:		Invasive Plants, Erosion, Encroachments	

M27-F Data Summary		Reference	Existing
Length: 3,764 ft Drainage Area: 42 sq. mi. Evolution Stage: D-IIId Sensitivity: High	Confinement	Narrow	Narrow
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	4.2
	Incision Ratio	< 1.2	1.1
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:		Erosion, Revetments (near bridges), Constrictions, Mass Failure, Encroachments	



Figure 5.40. Aggradation in M27-D.



Figure 5.41. Good buffers in M27-F. Major aggradation is seen in *side bars* on both banks.

M27 Project Identification:

- **Passive Restoration** by protecting the river corridor through easements. (Map 5: Project #4)
- **Passive Restoration** by supplementing existing streamside buffer. (Map 6: Project #1)
- **Passive Restoration** by protecting the river corridor and sediment attenuation area through easements. (Map 6: Project #2)

M28

This reach was split into three segments to account for stream type changes. Route 4 runs adjacent to the northern bank for most of the upper and lower segments. The southern corridor is forested with an old overgrown road (Standish Road) along the river's edge.

M28-A

This segment begins just below the Route 4 crossing near where Standish Road intersects Route 4 and continues 2,600 feet upstream to where the river gains more floodplain access because it moves away from Route 4. This segment is in **fair** geomorphic condition. The placements of Route 4 and Standish Road have limited floodplain access, changed the confinement from unconfined to confined, and led to extreme **historic incision** (See Figure 5.42). This segment exhibits a stream type departure because of this. Abundant rip rap and channel straightening are limiting widening. **Aggradation** and **planform adjustment** are major. This segment is in **fair** habitat condition because of a lack of adequate northern bank and buffer vegetation, extensive erosion and riprap, and a low amount of large woody debris. Some areas exhibit a habitat departure from riffle-pool to plane bed. Figure 5.43 shows a rip rap near the Route 4 crossing and Figure 5.44 shows a stormwater input in M28-A.

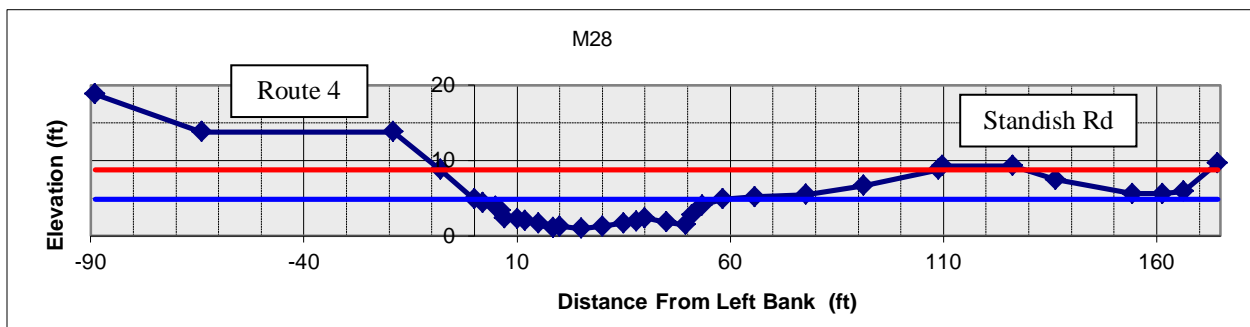


Figure 5.42. Cross section in M28-A shows Route 4 to the left of the channel and old Standish Road to the right. Floodplain access is limited.



Figure 5.43. Extensive riprap above Route 4 bridge crossing.

M28-A Data Summary		Reference	Existing
Length: 2,611 ft Drainage Area: 38 sq. mi. Evolution Stage: F-II Sensitivity: High	Confinement	Narrow	Semi-Confined
	Stream Type	C	B
	Entrenchment Ratio	> 2.2	2.0
	Incision Ratio	< 1.2	1.1
	<i>Human Elevated IR</i>		2.1 (Standish Road)
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Erosion, Revetments, Constriction, Encroachments, Channel Straightening		



Figure 5.44. Storm water input along Route 4 in M28-A.

M28-B

This segment begins where the river gains floodplain access and continues 2,700 feet upstream until Route 4 becomes adjacent to the northern bank again. In this segment, Route 4 is limiting floodplain access and changing the confinement from unconfined to confined, but the change is not significant enough to cause a stream type departure. This segment is in **fair** geomorphic condition. It has undergone minor **historic incision**. Several locations were identified in M28-B where the channel has been altered by riprap, dredging, or windrowing. **Planform adjustment** is major. There are two major road ditches running towards the river from Route 4 allowing storm water to flow directly into the river (See Figure 5.45). An old bridge abutment in M28-B is a channel constriction that is contributing to geomorphic stability through upstream and downstream deposition and streambed scour. M28-B is in **fair** habitat condition because of a lack of an adequate northern buffer and extensive bank erosion and revetments.

M28-B Data Summary		Reference	Existing
Length: 2,708 ft		Confinement: Narrow	Semi-Confined
Drainage Area: 38 sq. mi.		Stream Type: C	C
Evolution Stage: F-II		Entrenchment Ratio: > 2.2	3.5
Sensitivity: High		Incision Ratio: < 1.2	1.2
		Dominant Bed Material: Cobble	Cobble
		Dominant Bedform: Riffle-Pool	Riffle-Pool
Major Stressors:		Poor Buffer, Invasive Plants, Erosion, Revetments, Constriction, Encroachments, Channel Straightening	



Figure 5.45. Road ditch from Route 4.

M28-C

This segment begins where the river becomes *bifurcated*, following several paths around two large *islands*. The segment ends 1,200 feet upstream at the confluence with Reservoir Brook in West Bridgewater.

This segment is in **poor** geomorphic condition because of extensive straightening and floodplain encroachment. Route 4 is limiting floodplain access (See Figure 5.46) and changing the valley

from unconfined to confined. As a result, a stream type departure is seen here. This segment is exhibiting extreme **historic incision, aggradation, widening, and planform adjustment**. Aggradation is so extreme that the islands are connected by deposition (See Figure 5.47). This segment is in **fair** habitat condition because of a lack of an adequate northern buffer and extensive bank erosion and revetments.

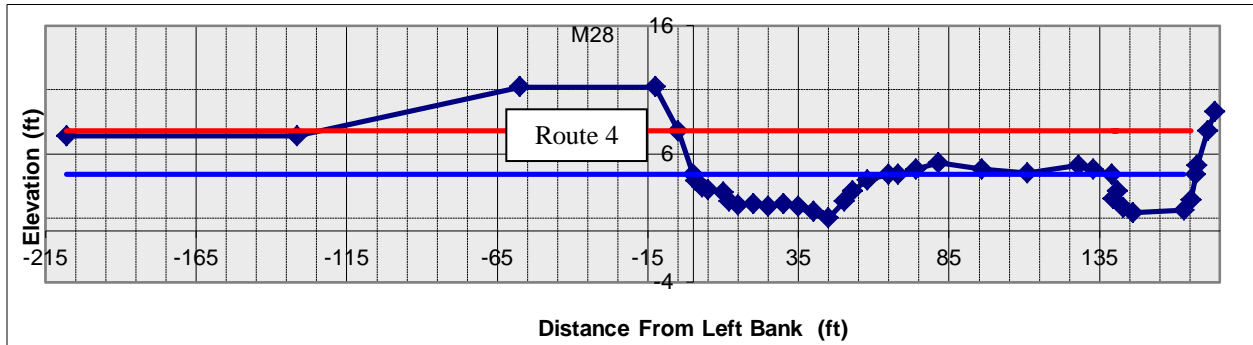


Figure 5.46. Cross section in M28-C shows that Route 4 is cutting off floodplain access. A human elevated incision ratio was calculated.



Figure 5.47. Islands are connected by major aggradation.

M28-C Data Summary		Reference	Existing
Length: 1,192 ft Drainage Area: 38 sq. mi. Evolution Stage: F-III Sensitivity: High	Confinement	Narrow	Semi-Confined
	Stream Type	C	B
	Entrenchment Ratio	> 2.2	1.8
	Incision Ratio	< 1.2	2.0
	<i>Human Elevated IR</i>		3.0 (Route 4)
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffer, Erosion, Revetments, Encroachments, Channel Straightening		

M28 Project Identification:

- **Active Restoration** by removing the part of Standish road that is not used anymore because it restricts floodplain access. (Map 6: Project #3).
- **Active Restoration** by removing the old bridge abutment in M28-B. (Map 6: Project #4)

M29

This reach begins at the confluence with Reservoir Brook in West Bridgewater and continues upstream 1,900 feet until the Route 4 bridge crossing near Hadley Hill Road. Route 4 has some effect on valley width, but does not change the confinement. This reach has been extensively straightened and altered. This reach is in **poor** geomorphic condition. Accurate channel data was not able to be determined because of significant flood damage and flood work alterations. Major **historic incision** has occurred here with extreme **aggradation** and major **planform adjustment** as the current processes. Widening is limited by rip rap in some places. Figure 5.48 shows that channel work has been done as well as a stream crossing for heavy machinery.

M29 is in **fair** habitat condition because of a lack of an adequate western buffer and extensive bank erosion and revetments. In some areas the reference riffle-pool habitat type has changed to braided.

M29 Data Summary		Reference	Existing
Length: 1,929 ft Drainage Area: 29 sq. mi. Evolution Stage: F-III Sensitivity: High	Confinement	Broad	Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	7.5
	Incision Ratio	< 1.2	1.8
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	Poor Bank Vegetation, Poor Buffers, Erosion, Revetments, Constriction, Encroachments, Channel Straightening		

M29 Project Identification:

- **Active Restoration** by remediating an iron seep. (Map 6: Project #5)
- **Passive/Active Restoration** by creating floodplain and planting trees in areas with buffers less than 25 feet wide. (Map 6: Project 6)



Figure 5.48. M29 exhibits channel alterations and a stream crossing for heavy machinery.

M30

This reach exhibited a variety of different stream types and was split into five segments.

M30-A

The most downstream segment begins just below the Route 4 bridge crossing near Hadley Hill Road and continues upstream approximately 1,100 feet until the river valley becomes significantly narrower. This segment is characterized by a channel *avulsion* and an active head cut (See Figure 5.49).

This segment is in **poor** geomorphic condition. Accurate channel data was not able to be determined because of significant flood damage. The entrenchment ratio was unable to be determined because bankfull elevation was impossible to identify. Administrative judgment

was used to determine stream type. Floodplain access is extremely unlikely in this segment so an F stream type was assigned. It is clear that the channel is **actively incising** because of an active head cut. M30-A exhibits extreme **widening** and **planform adjustment**. Aggradation is minor here. This segment is in **fair** habitat condition because of extensive bank erosion and minimal vegetation on the stream banks.

M30-A Data Summary		Reference	Existing
Length: 1,072 ft Drainage Area: 28 sq. mi. Evolution Stage: F-II Sensitivity: High	Confinement	Broad	Narrow
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	N/A
	Incision Ratio	< 1.2	> 2.0
	Dominant Bed Material	Cobble	Boulder
	Dominant Bedform	Riffle-Pool	Step-Pool
Major Stressors:	Poor Bank Vegetation, Erosion, Revetments, Constrictions, Tributary Rejuvenation, Encroachments		

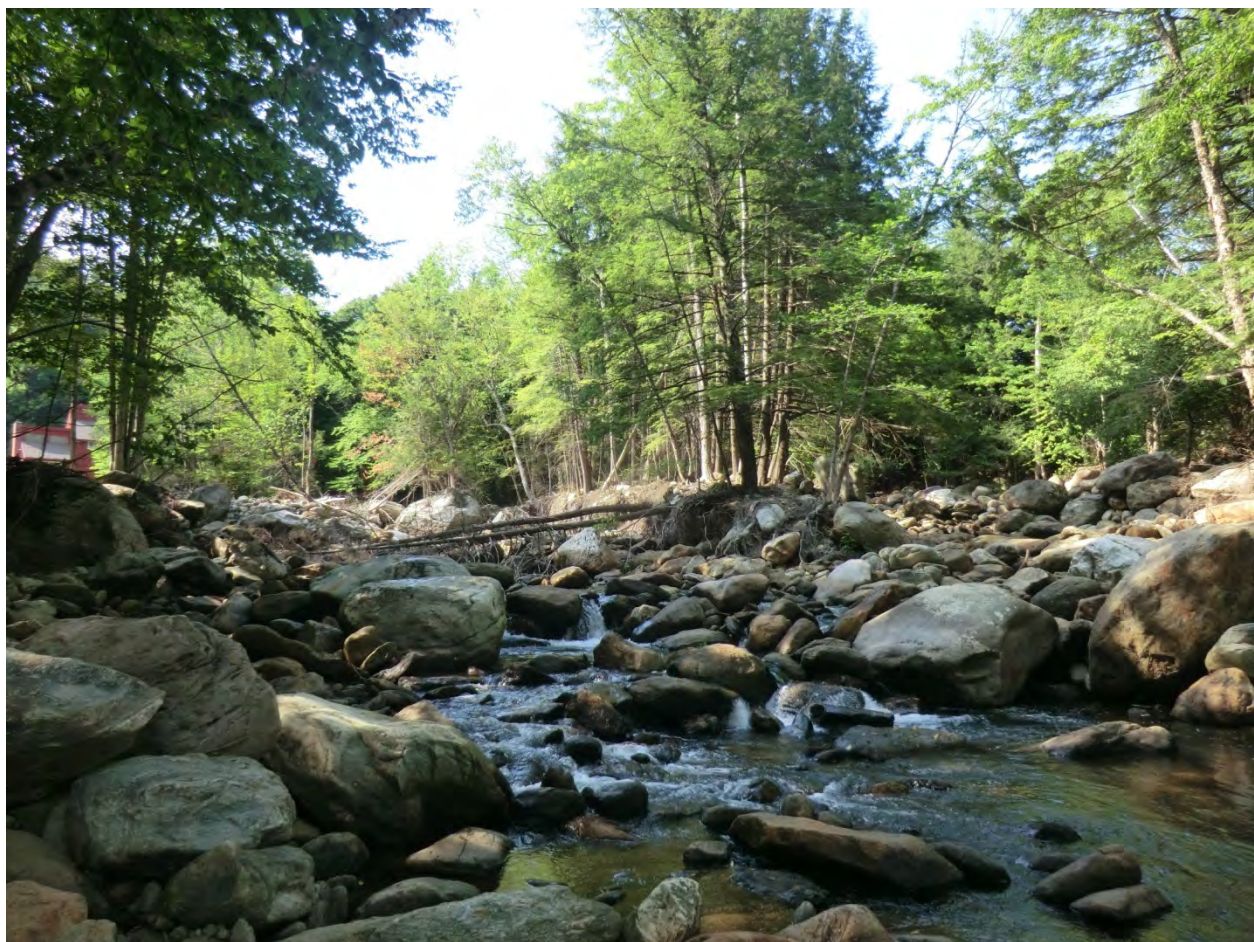


Figure 5.49. Channel avulsion is seen looking upstream in M30-A.

M30-B

This segment begins as the valley becomes narrowly confined and continues 714 feet upstream. This segment’s stream habitat type is *step-pool* by reference. The segment ends where the river changes from a step-pool habitat type to plane bed. M30-B was not fully assessed because the segment is very short and is geomorphically stable. The substrate is dominated by very large boulders. Bedrock almost spans the channel in many places. Although no true channel spanning bedrock grade controls were present, the large boulders and bedrock are providing resistance to incision. M30-B has excellent vegetated banks and buffers. Administrative judgment was used to determine stream type, dominant bed material, and dominant bedform.

*M30-B Data Summary	*NOT ASSESSED	Reference	Existing
Length: 714 ft	Confinement	Semi-Confined	Semi-Confined
Drainage Area: 28 sq. mi.	Stream Type	B	B
Evolution Stage: N/A	Entrenchment Ratio	> 2.2	N/A
Sensitivity: N/A	Incision Ratio	< 1.2	N/A
	Dominant Bed Material	Boulder	Boulder
	Dominant Bedform	Step-Pool	Step-Pool
Major Stressors:	N/A		

M30-C

This segment begins where the stream habitat type changes from step-pool to plane bed and continues 1,200 feet upstream to where the valley becomes a bit narrower. Although the segment is semi-confined, a C stream type exists because the floodplain takes up the whole valley. This segment is in **fair** geomorphic condition and exhibits major **aggradation**. The segment is impacted by sediment from road washouts off of East Mountain Road. This segment is in **good** habitat condition because it exhibits a low amount of bank erosion and has excellent vegetated banks and buffers; however there is some fine sediment filling pools. This segment is plane bed by reference. Figure 5.50 depicts a typical channel in M30-C.

M30-C Data Summary	Reference	Existing
Length: 1,236 ft	Confinement	Semi-Confined
Drainage Area: 28 sq. mi.	Stream Type	C
Evolution Stage: D-IIc	Entrenchment Ratio	> 2.2
Sensitivity: Very High	Incision Ratio	< 1.2
	Dominant Bed Material	Gravel
	Dominant Bedform	Plane Bed
Major Stressors:	Sediment	



Figure 5.50. M30-C exhibits plane bed features as well as aggradation. Banks and buffers are well-vegetated.

M30-D

This segment begins as the valley becomes slightly narrower upstream of M30-C and continues 1,200 feet upstream until about 300 feet below the Route 4 bridge crossing near where East Mountain Road intersects Route 4. This segment is a subreach because it has a reference stream type that is different from most of the reach. M30-D is in **good** geomorphic condition and is not incised. The main process occurring is **aggradation**. The segment is in **fair** habitat condition because of the increase in fine sediment. Figure 5.51 shows a typical channel for the segment and limited riffle formation.

M30-D Data Summary		Reference	Existing
Length:	1,170 ft	Semi-Confined	Semi-Confined
Drainage Area:	28 sq. mi.	B	B
Evolution Stage:	F-I	1.4 – 2.2	2.0
Sensitivity:	High	< 1.2	1.0
		Dominant Bed Material	Gravel
		Dominant Bedform	Plane Bed
Major Stressors:		Encroachment, Sediment	



Figure 5.51. Typical channel in M30-D.

M30-E

This segment begins about 300 feet below the Route 4 bridge crossing near where East Mountain Road intersects Route 4 at the Skyeship Base and continues about 900 feet upstream. This segment was not fully assessed because it is currently impounded by a beaver dam located 100 feet above the bridge. Figure 5.52 shows the beaver dam.

M30-E Data Summary		Reference	Existing
Length:	937 ft	Confinement	Very Broad
Drainage Area:	28 sq. mi.	Stream Type	E
Evolution Stage:	N/A	Entrenchment Ratio	> 2.2
Sensitivity:	N/A	Incision Ratio	< 1.2
		Dominant Bed Material	Sand
		Dominant Bedform	Dune-Ripple
Major Stressors:		Road Encroachment	



Figure 5.52. Beaver dam upstream of Route 4 bridge crossing.

M30 Project Identification:

- **Passive Restoration** by protecting the river corridor through easements (Map 6: Project #7)
- **Stormwater Management** of the runoff from East Mountain Road. (Map 6: Project #8)

Tributary to the Ottauquechee River – Reservoir Brook

Reservoir Brook is one of the Ottauquechee River’s tributaries. Immediately below its source in Plymouth, Reservoir Brook flows into the Woodward Reservoir. From there it flows northward into Bridgewater, running along Route 100A for about 2 miles before entering the Ottauquechee. Reservoir Brook is a total of three miles long and drains seven square miles of land (Vermont Agency of Natural Resources, 2000).

M28T5.01

One reach was assessed on Reservoir Brook. This reach was split into three segments to account for changes in channel dimensions and buffer types.

M28T5.01-A

The most downstream reach on Reservoir Brook begins at the confluence with the Ottauquechee River just downstream of West Bridgewater and continues upstream 900 feet until a beaver dam. This segment is in **fair** geomorphic condition. **Aggradation** and **planform adjustment** are the major processes occurring here. Planform adjustment is seen through *mid-channel bars*, an island, and a short area of braiding. The lower portion of this segment has been straightened and floodplain access is limited. This segment is in **fair** habitat condition because of a lack of adequate western bank and buffer vegetation and extensive riprap. Several stormwater inputs were identified (See Figure 5.53).



Figure 5.53. Stormwater input in M28T5.01-A. Major aggradation, poor buffer, and riprap are seen here.

M28T5.01-A Data Summary		Reference	Existing
Length: 877 ft Drainage Area: 7.5 sq. mi. Evolution Stage: D-IId Sensitivity: Very High	Confinement	Very Broad	Very Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	5.6
	Incision Ratio	< 1.2	1.0
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:		Poor Bank Vegetation, Poor Buffer, Erosion, Revetments, Mass Failure, Encroachments, Channel Straightening	

M28T5.01-B

This segment begins at the beaver dam and continues upstream 760 feet until the river starts to move closer to Route 100, approximately 100 feet downstream of a private field access bridge. The beaver dam only impounds about 130 feet of the channel upstream of the dam under base flow conditions. This segment is in **good** geomorphic condition with only minor **aggradation** and **widening** occurring. The stream can easily access its wide floodplain and has limited human influences. The segment is in **good** habitat condition because of its good bank and buffer vegetation and great floodplain access. Large woody debris and deep pools are abundant. Invasive Japanese barberry and abundant invasive phragmites are present mainly in the eastern buffer. There is one stormwater input in this segment. Figure 5.54 shows a typical channel for this segment.

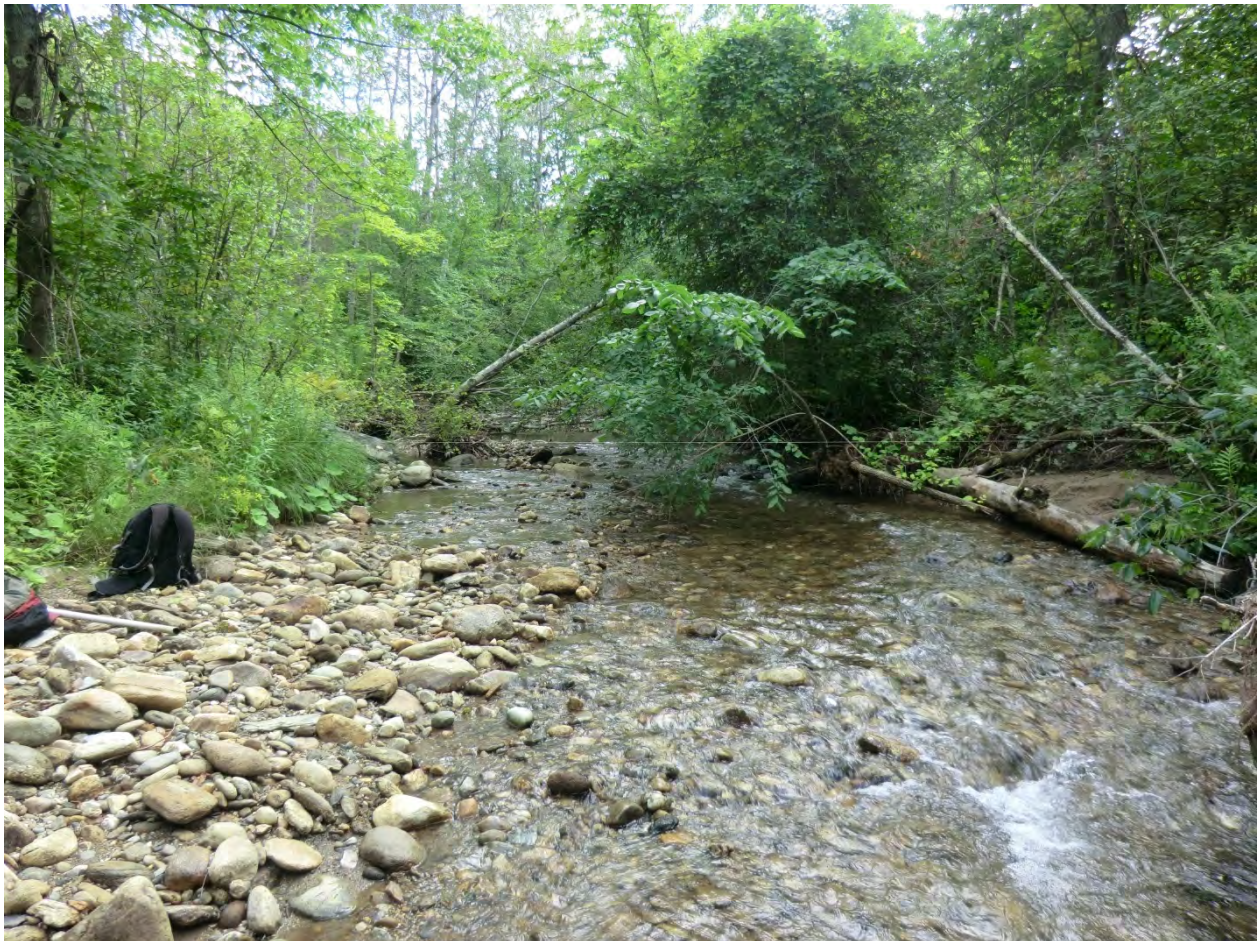


Figure 5.54. A typical channel in M28T5.01-B upstream of the beaver dam. Excellent vegetated banks and buffers.

M28T5.01-B Data Summary		Reference	Existing
Length: 760 ft Drainage Area: 7.5 sq. mi. Evolution Stage: F-I Sensitivity: High	Confinement	Very Broad	Very Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	14.1
	Incision Ratio	< 1.2	1.0
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:		Invasive Plants	

M28T5.01-C

This segment begins about 100 feet below a private field access bridge and continues 800 feet upstream until the eastern corridor changes from a field to forest. Route 100 runs adjacent to the western bank. This segment is in **fair** geomorphic condition with **incision** and **planform adjustment** as the major processes occurring. The incision is a result of extensive channel straightening as evident by windrowing and rip rap (See Figure 5.55). The windrowing restricted some floodplain access, but there is no stream type departure. This segment is in **fair** habitat condition because of a lack of bank and buffer vegetation, large woody debris, and deep pools. Extensive channel straightening has led to a stream habitat type departure from riffle-pool to plane bed.

M28T5.01-C Data Summary		Reference	Existing
Length: 802 ft Drainage Area: 7.5 sq. mi. Evolution Stage: F-II Sensitivity: Very High	Confinement	Very Broad	Very Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	12.0
	Incision Ratio	< 1.2	1.5
	<i>Human Elevated IR</i>		1.8 <i>(windrow/berm)</i>
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Plane Bed
Major Stressors:		Poor Bank Vegetation, Poor Buffers, Erosion, Revetments, Windrow/Berm, Encroachments, Channel Straightening	

M28T5.01 Project Identification

- **Passive Restoration** by planting trees in areas with buffers less than 25 feet wide (Map 6: Project #9).
- **Passive Restoration** by protecting the river corridor and wetland through easements (Map 6: Project #10).
- **Active/Passive Restoration** with an alternatives analysis for the removal of the windrow/berm and planting trees in areas with buffers less than 25 feet wide (Map 6: Project #11).



Figure 5.55. Channel straightening along Route 100 in M28T5.01-C.

5.5 Stream Crossings

Table 3 in Appendix B summarizes the data collected for the assessed structures within the Phase 2 study area. The maps on pages 4 and 5 in Appendix B show the location and geomorphic compatibility rating of each structure. Of the 19 bridges assessed, six were determined to be “mostly incompatible,” eleven were “partially compatible,” and two were “mostly compatible.” This information can be used by municipalities and the Vermont Agency of Transportation to prioritize bridge replacements.

6.0 PROJECT IDENTIFICATION AND IMPLEMENTATION

6.1 Site Level Opportunities

Site specific projects were identified using the criteria outlined by the VANR in Chapter 6 – Preliminary Identification and Prioritization (Vermont Agency of Natural Resources 2010a). This planning guide is intended to aid in the development of projects that protect and restore river

equilibrium. Project maps, tables, and photos (Appendix D) have been developed for the Ottauquechee River watershed. These maps were created using indexed data from the Phase 2 Stream Geomorphic Assessments along with existing data available from the Vermont Center for Geographic Information.

A total of 35 projects were identified by BCE to promote the restoration or protection of channel stability and aquatic habitat in the Ottauquechee River watershed. The projects are broken down by category as follows: 24 passive restoration (streamside plantings, natural buffer regeneration, and corridor easements); 3 stormwater improvement projects; 1 stream clean-up; and 7 active restoration (two alternative analyses for old bridge abutment removals, two berm/windrow removal alternatives analyses, one road removal alternatives analysis, the remediation of an iron seep, and one floodplain creation project). Information from the Phase 2 stream geomorphic assessment and bridge and culvert assessments could be used to inform the Towns of Woodstock, Bridgewater, and Killington of which stream crossings are contributing to localized instability.

As indicated multiple times in the report, Route 4 cuts off the Ottauquechee River's historical floodplain to varying degrees in many locations. Given that Route 4 is a major highway in Vermont, it is assumed that its placement is unchangeable. Project potential is limited in many areas by this factor.

6.2 Next Steps

There are many opportunities available to work towards restoring the Ottauquechee River and Reservoir Brook to stable conditions. Preliminary reach level and site level projects have been identified and will form the basis for future project development. These preliminary projects include: protection of the river corridor through easements, streamside plantings, windrow/berm removal, investigation of old road and bridge abutment removals, and improving stormwater runoff. On the watershed level, the development and implementation of fluvial erosion hazard zones is recommended to avoid conflicts regarding land-use and to save money spent on flood damage and river maintenance. The Towns of Killington, Bridgewater, and Woodstock could pursue the opportunity to work with the Two Rivers-Ottauquechee Regional Commission and the Vermont Agency of Natural Resources to develop Fluvial Erosion Hazard Zones for the land surrounding the Ottauquechee River main stem and tributaries. The following are recommendations for next steps.

- 1.** Project partners to provide outreach to private landowners and the public about the plan and potential projects.
- 2.** TRORC in collaboration with the Vermont Agency of Natural Resources will develop Fluvial Erosion Hazard Zones for the existing Phase 2 data on the main stem of the Ottauquechee River and Reservoir Brook.
- 3.** Work with regulatory agencies on project design and permitting.

4. Acquire funding and hire contractors (river scientists and engineers) to prepare project design and implementation strategies for selected high priority projects (refer to Section 9.1).
5. Obtain funding and perform Phase 2 assessment of tributaries to the Ottauquechee River.
6. Funding was awarded in 2012 to TROTC and the Town of Plymouth for Phase 2 assessment work and FEH mapping of Reservoir Brook, Broad Brook, and Pinney Hollow Brook through the Ecosystem Restoration Program. This work is expected to take place in 2013.

For additional information about river restoration and protection opportunities within the Ottauquechee River watershed please contact:

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(802) 457-4728 128 King Farm Road
pfellows@trorc.org Woodstock, VT 05091



7.0 LIST OF ACRONYMS AND GLOSSARY OF TERMS

List of Acronyms

BCE – Bear Creek Environmental, LLC
CREP – Conservation Reserve Enhancement Program
CRWC – Connecticut River Watershed Council
EQIP – Environmental Quality Incentives Program
ERP – Ecosystem Restoration Program
FEH – Fluvial Erosion Hazard Zone
GIS – Geographic Information System
NWI – National Wetlands Inventory
QA/QC – quality assurance/quality control
RCE – ANR River Corridor Easement Program
RHA- Rapid Habitat Assessment
RGA-Rapid Geomorphic Assessment
SGA – Stream Geomorphic Assessment
SGAT – Stream Geomorphic Assessment Tool
TFS – Trees for Streams
TRORC – Two Rivers-Ottauquechee Regional Commission
USGS – United States Geological Survey
VANR – Vermont Agency of Natural Resources
VTDEC – Vermont Department of Environmental Conservation
WHIP – Wildlife Habitat Incentives Program
WRP – Wetland Reserve Program

Glossary of Terms

Adapted from:

Restoration Terms, by Craig Fischenich, February, 2000, USAE Research and Development Center, Environmental Laboratory, 3909 Halls Ferry Rd., Vicksburg, MS 39180

And

Vermont Stream Geomorphic Assessment Handbook, Appendix Q, 2009, VT Agency of Natural Resources, Waterbury, VT.

http://www.vtwaterquality.org/rivers/docs/assessmenthandbooks/rv_apxgglossary.pdf

Adjustment Process – type of change that is underway due to natural causes or human activity that has or will result in a change to the valley, floodplain, and/or channel condition (e.g., vertical, lateral, or channel plan form adjustment processes).

Aggradation - A progressive buildup or rising of the channel bed and floodplain due to sediment deposition. The geologic process by which streambeds are raised in elevation and floodplains are formed. Aggradation indicates that the stream discharge and/or bed load characteristics are changing. Opposite of degradation.

Alluvial Fan – A fan-shaped accumulation of alluvium (alluvial soils) deposited at the mouth of a ravine or at the juncture of a tributary stream with the main stem where there is an abrupt change in slope.

Alluvial Soils – Soil deposits from rivers.

Alluvium – A general term for detrital deposits made by streams on riverbeds, floodplains, and alluvial fans.

Avulsion – A change in channel course that occurs when a stream suddenly breaks through its banks, typically bisecting an overextended meander arc.

Bank Stability – The ability of a stream bank to counteract erosion or gravity forces.

Bankfull Channel Depth - The maximum depth of a channel within a riffle segment when flowing at a bankfull discharge.

Bankfull Channel Width - The top surface width of a stream channel when flowing at a bankfull discharge.

Bankfull Discharge - The stream discharge corresponding to the water stage that overtops the natural banks. This flow occurs, on average, about once every 1 to 2 years and given its frequency and magnitude is responsible for the shaping of most stream or river channels.

Bar – An accumulation of alluvium (usually gravel or sand) caused by a decrease in sediment transport capacity on the inside of meander bends or in the center of an over wide channel.

Berms – Mounds of dirt, earth, gravel or other fill built parallel to the stream banks designed to keep flood flows from entering the adjacent floodplain.

Bifurcated Channel – a river channel that has split into two branches as a result of planform adjustment (i.e. split flow due to island).

Cascade – River bed form where the channel is very steep with narrow confinement. There are often large boulders and bedrock with waterfalls.

Channelization – The process of changing (usually straightening) the natural path of a waterway.

Culvert – A buried pipe that allows flows to pass under a road.

Degradation – (1) A progressive lowering of the channel bed due to scour. Degradation is an indicator that the stream's discharge and/or sediment load is changing. The opposite of aggradation. (2) A decrease in value for a designated use.

Delta Bar – A deposit of sediment where a tributary enters the main stem of a river.

Depositional Features – Types of sediment deposition and storage areas in a channel (e.g. mid-channel bars, point bars, side bars, diagonal bars, delta bars, and islands).

Diagonal Bar – Type of depositional feature perpendicular to the bank that is formed from excess sedimentation and within the channel and from the development of steep riffles.

Drainage Basin – The total area of land from which water drains into a specific river.

Dredging – Removing material (usually sediments) from wetlands or waterways, usually to make them deeper or wider.

Erosion – The wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces.

Floodplain – Land built of sediment that is regularly covered with water as a result of the flooding of a nearby stream.

Floodprone Width – the wetted width of the channel when the water level is twice the maximum bankfull depth. For most channels this is associated with less than a 50 year return period (Rosgen, 1996).

Fluvial Geomorphology – the physics of flowing water, sediments, and other products of watersheds in relation to various land forms.

Gaging Station – A particular site in a stream, lake, reservoir, etc., where hydrologic data are obtained.

Grade Control - A fixed feature on the streambed that controls the bed elevation at that point, effectively fixing the bed elevation from potential incision; typically bedrock, dams or culverts.

Gradient – Vertical drop per unit of horizontal distance.

Habitat – The local environment in which organisms normally grow and live.

Headwater – Referring to the source of a stream or river.

Head Cut – Sudden change in elevation or knickpoint at the leading edge of a gully

Incised River – A river that erodes its channel by the process of degradation to a lower base level than existed previously or is consistent with the current hydrology.

Islands – Mid-channel bars that are above the average water level and have established woody vegetation.

Lacustrine Soils- Soil deposits from lakes.

Meander - The winding of a stream channel, usually in an erodible alluvial valley. A series of sine-generated curves characterized by curved flow and alternating banks and shoals.

Meander Migration – The change of course or movement of a channel. The movement of a channel over time is natural in most alluvial systems. The rate of movement may be increased if the stream is out of balance with its watershed inputs.

Meander Belt Width – The horizontal distance between the opposite outside banks of fully developed meanders determined by extending two lines (one on each side of the channel) parallel to the valley from the lateral extent of each meander bend along both sides of the channel.

Meander Wavelength - The lineal distance downvalley between two corresponding points of successive meanders of the same phase.

Meander Wavelength Ratio – The meander wavelength divided by the bankfull channel width.

Meander Width Ratio – The meander belt width divided by the bankfull channel width.

Mid-Channel Bar – Sediment deposits (bar) located in the channel away from the banks, generally found in areas where the channel runs straight. Mid-channel bars caused by recent channel instability are unvegetated.

Planform - The channel shape as if observed from the air. Changes in planform often involve shifts in large amount of sediment, bank erosion, or the migration of the channel.

Plane Bed – Channel lacks discrete bed features (such as pools, riffles, and point bars) and may have long stretches of featureless bed.

Point Bar –The convex side of a meander bend that is built up due to sediment deposition.

Pool -- A habitat feature (section of stream) that is characterized by deep, low-velocity water and a smooth surface.

Reach - Section of river with similar characteristics such as slope, confinement (valley width), and tributary influence.

Restoration – The return of an ecosystem to a close approximation of its condition prior to disturbance.

Riffle - A habitat feature (section of stream) that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.

Riffle-pool - Channel has undulating bed that defines a sequence of riffles, runs, pools, and point bars. Occurs in moderate to low gradient and moderately sinuous channels, generally in unconfined valleys with well-established floodplains.

Riparian Buffer – The width of naturally vegetated land adjacent to the stream between the top of the bank and the edge of other land-uses. A buffer is largely undisturbed and consists of the trees, shrubs, groundcover plants, duff layer, and naturally uneven ground surface.

Riparian Corridor – Lands defined by the lateral extent of a stream’s meanders necessary to maintain a stable stream dimension, pattern, profile, and sediment regime.

Segment – A relatively homogeneous section of stream contained within a reach that has the same reference stream characteristics but is distinct from other segments in the reach.

Sensitivity – The valley, floodplain and/or channel condition’s likelihood to change due to natural causes and/or anticipated human activity.

Side Bar – Unvegetated sediment deposits located along the margins or the channel in locations other than the inside of channel meander bends.

Step-Pool – Characterized by longitudinal steps formed by large particles (boulder/cobbles) organized into discrete channel-spanning accumulations that separate pools, which contain smaller sized materials. Often associated with steep channels in confined valleys.

Steep Riffle – Associated with aggradation where sediment has dropped out to form a steep face of sediment on the downstream side.

Surficial Sediment/Geology – Sediment that lies on top of bedrock.

Tributary – A stream that flows into another stream, river, or lake.

Tributary Rejuvenation – As the bed of the main stem is lowered, head cuts (incision) begin at the mouth of the tributary and move upstream.

Urban Runoff – Storm water from city streets and gutters that usually carries a great deal of litter and organic and bacterial wastes into the receiving waters.

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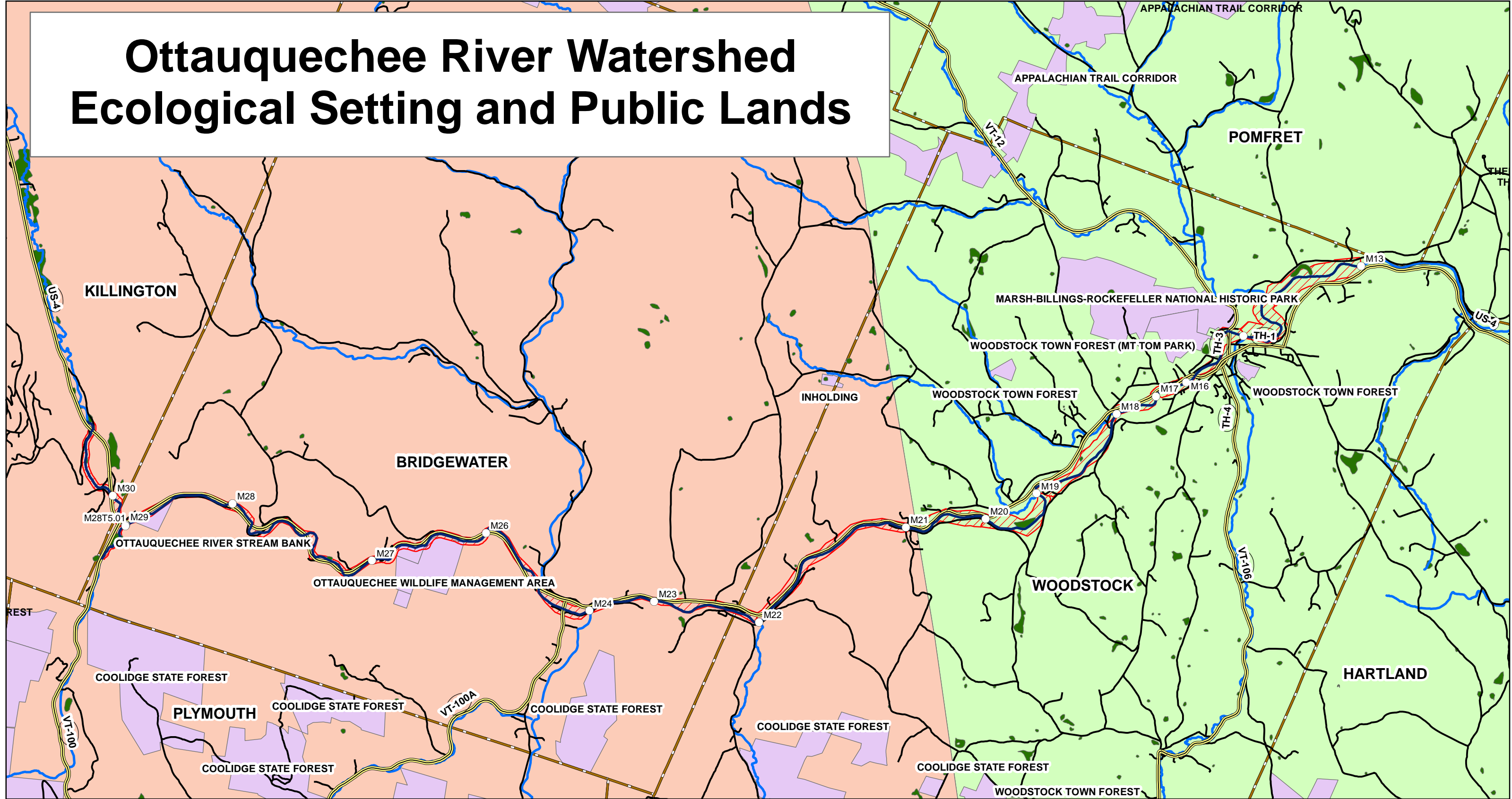
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APPENDIX A

Maps

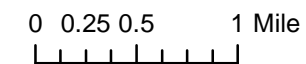
Ottauquechee River Watershed Ecological Setting and Public Lands



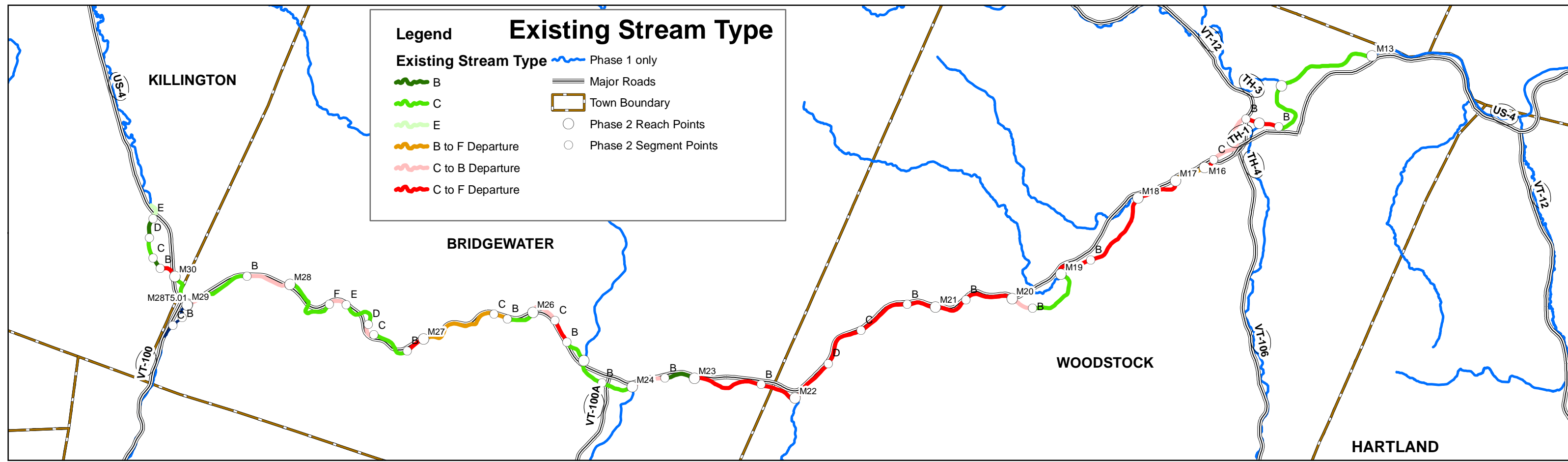
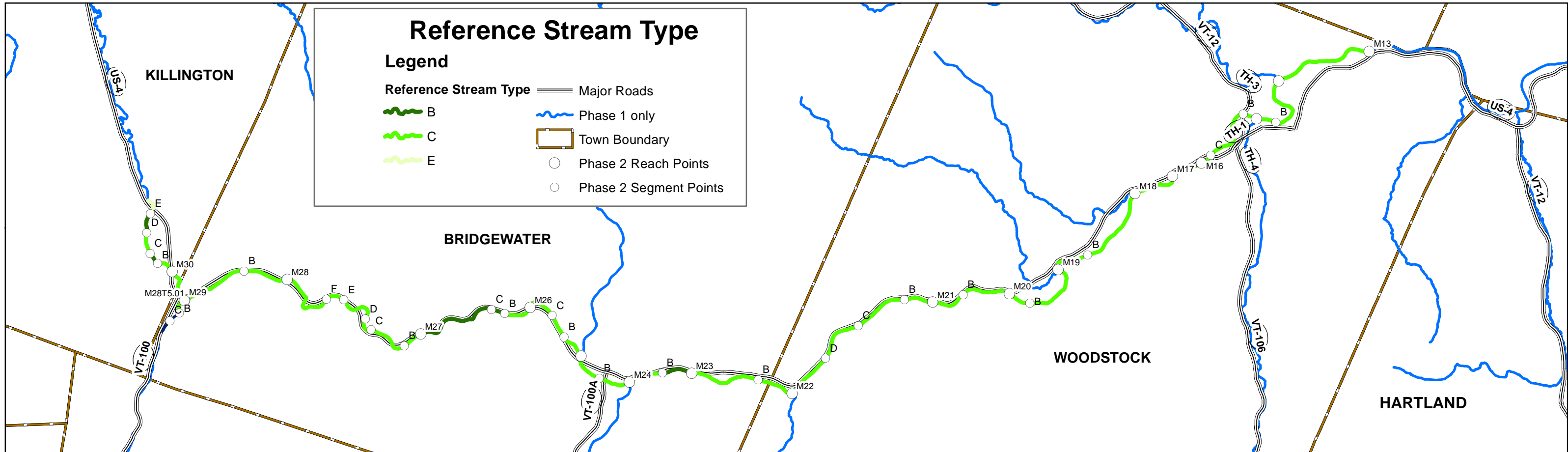
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- Phase 2 Study Area
- Phase 1 only
- Major Roads
- Roads
- Phase 2 Reach Points
- 2012 River Corridor
- Vermont Significant Wetland Inventory
- Public Lands

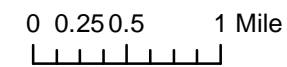
- Town Boundary
- Biophysical Regions**
- Southern Green Mountains
- Southern Vermont Piedmont

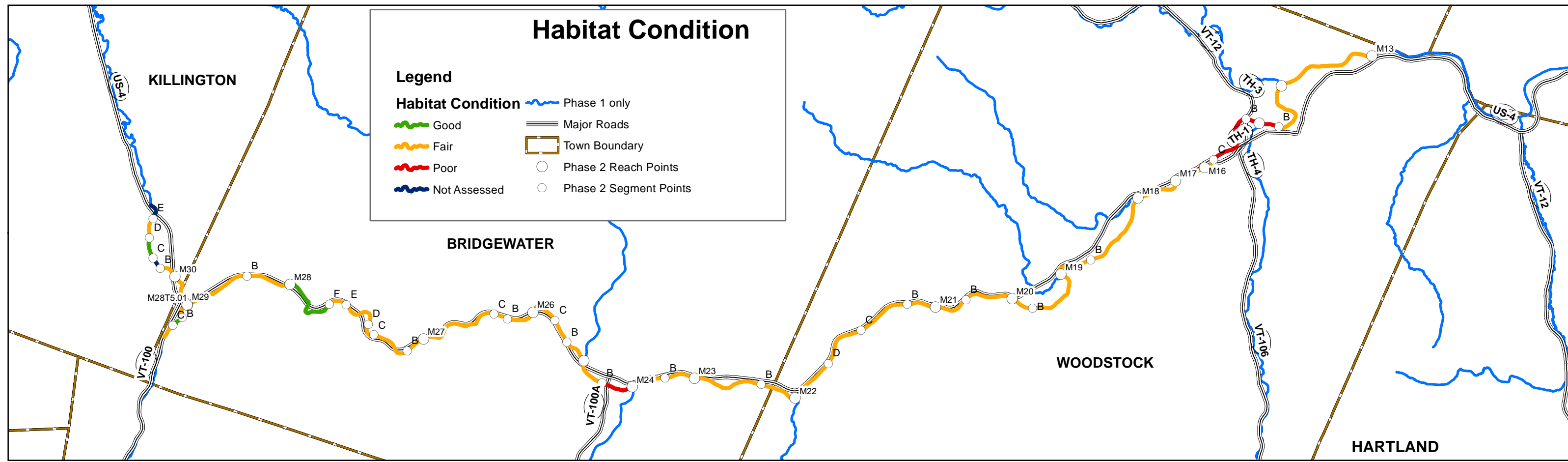
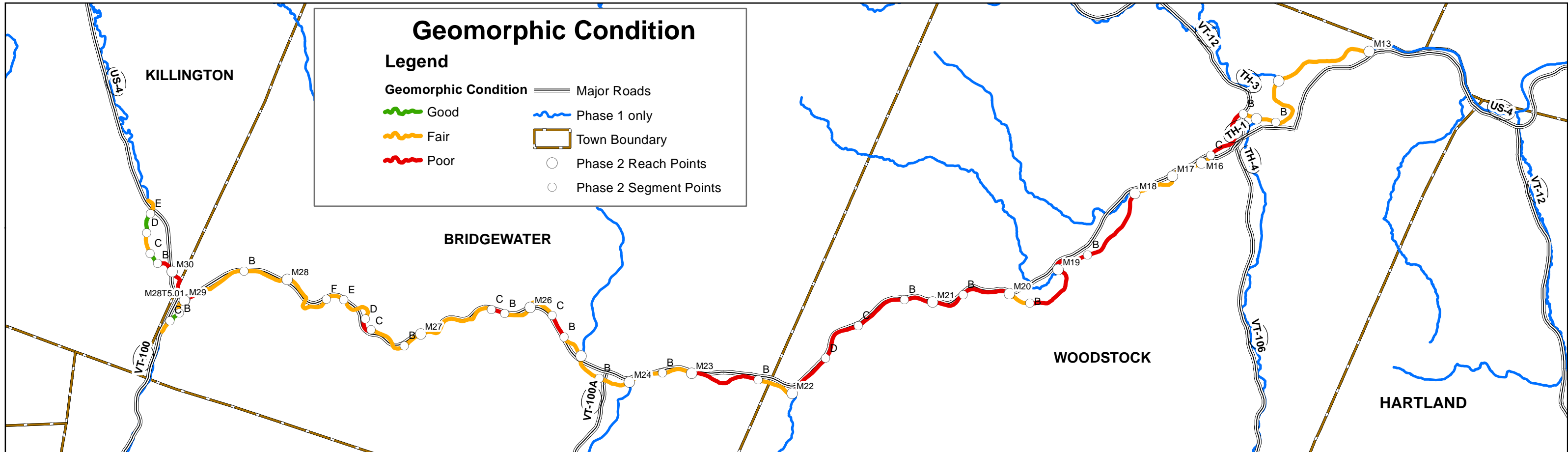


Bear Creek
Environmental

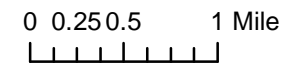


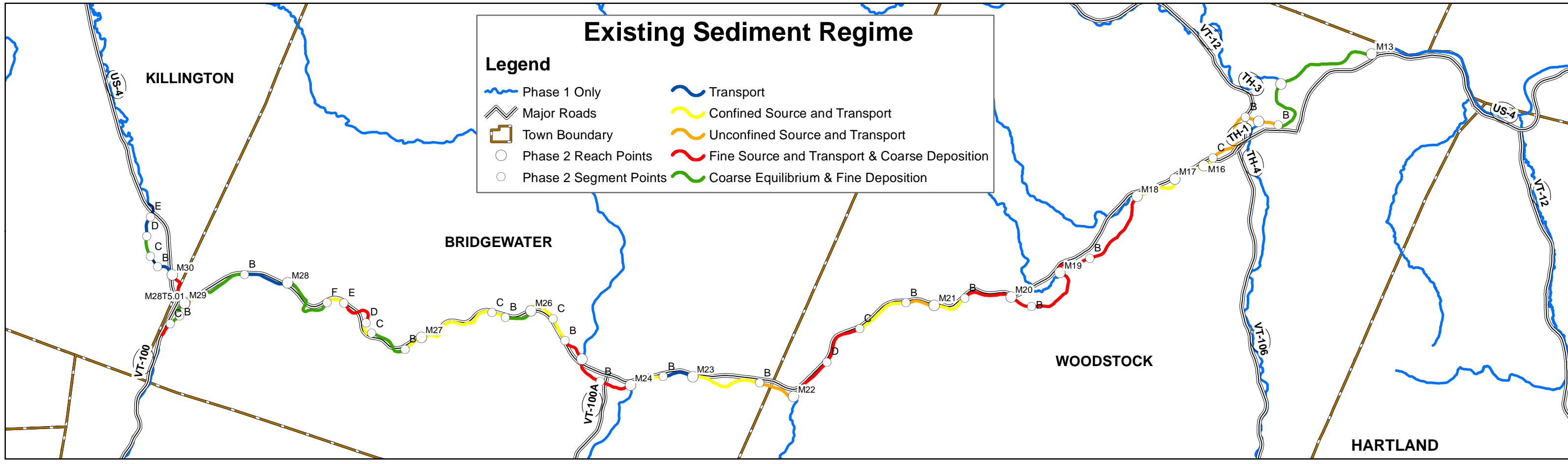
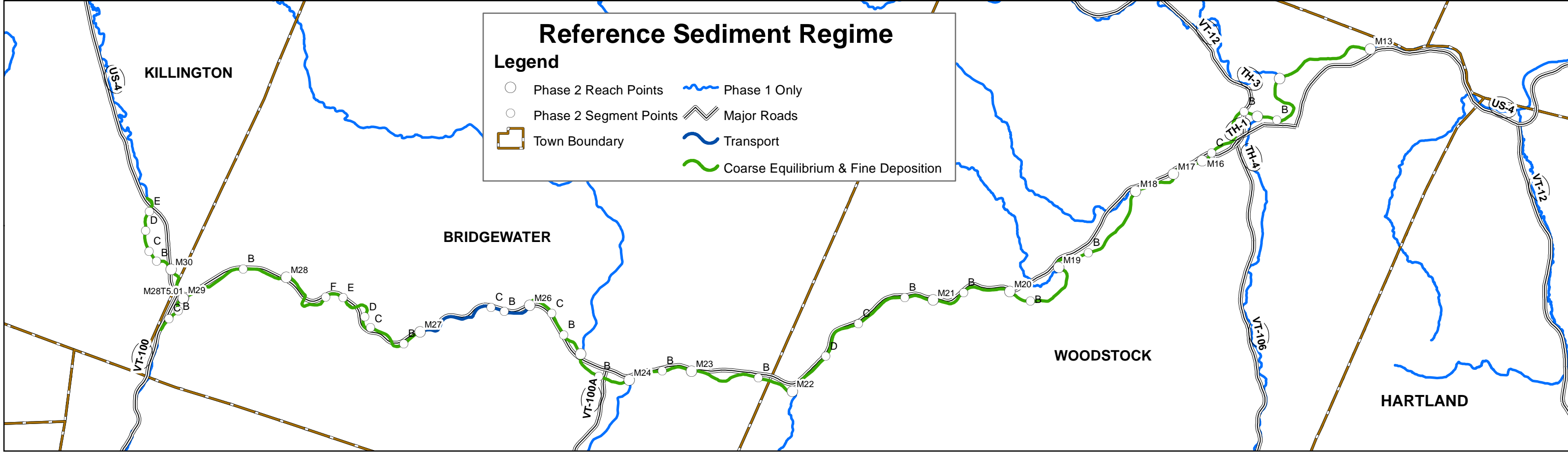
**Ottauquechee River - 2012 Study Area
Stream Type**



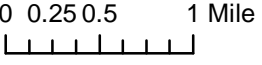


Ottauquechee River - 2012 Study Area Condition

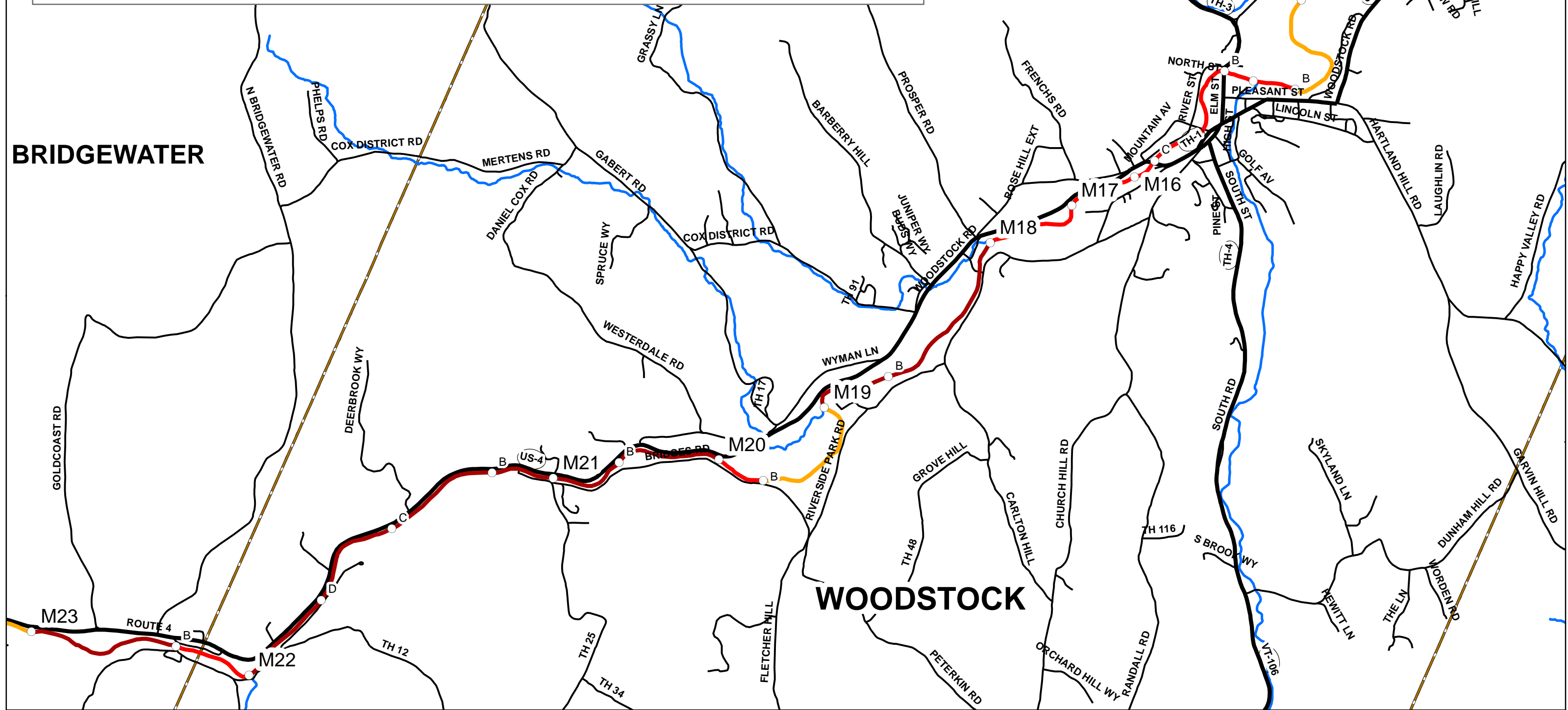




**Ottauquechee River - 2012 Study Area
Sediment Regime**

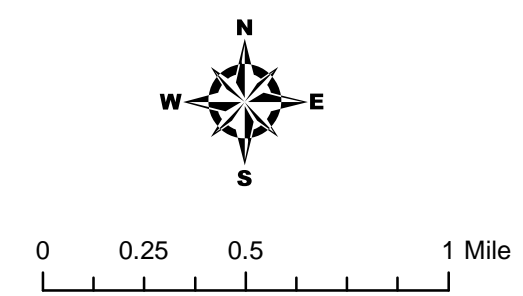


Ottauquechee River Watershed 2012 Stream Sensitivity in Woodstock



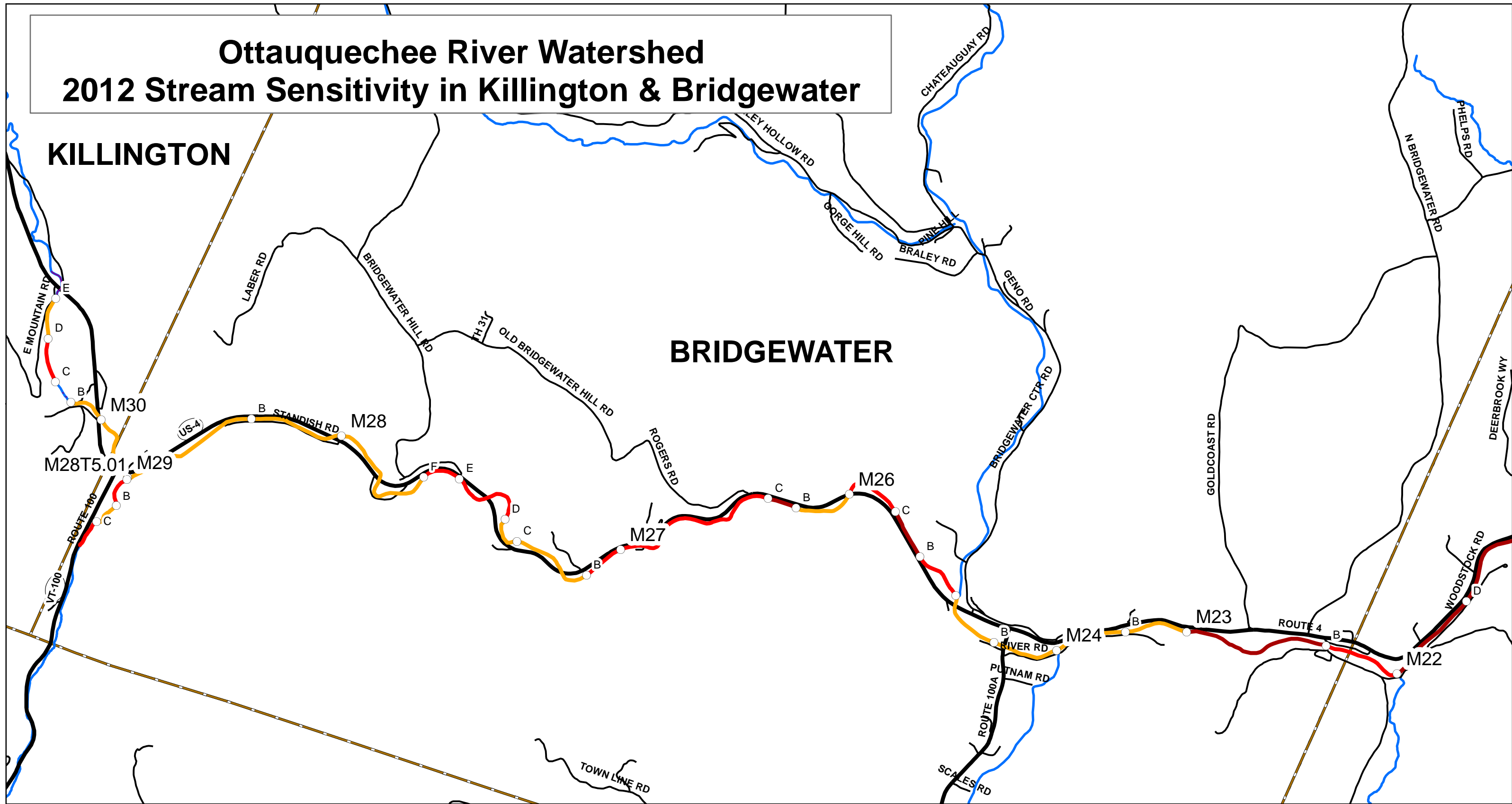
Legend

	Phase 1 Only		Town Boundary	Sensitivity		Moderate
	Major Roads		Phase 2 Reach Points			Low
	Roads		Segment Point			Very Low
						High



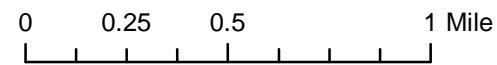
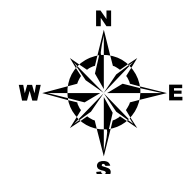
**Bear Creek
Environmental**

Ottauquechee River Watershed 2012 Stream Sensitivity in Killington & Bridgewater



Legend

Phase 1 Only	Town Boundary	Sensitivity	Moderate
Major Roads	Phase 2 Reach Points	Extreme	Low
Roads	Segment Point	Very High	Very Low
		High	



APPENDIX B

Bridge & Culvert Assessment Data

Table 1. Scoring Table (Vermont Culvert Geomorphic Compatibility Screen Tool, adapted by BCE for bridges)				
Score	% Bankfull Width	Sediment Continuity	Approach Angle	Erosion and Armoring
5	%BFW \geq 120	No upstream deposition or downstream bed scour	Naturally Straight	No erosion or armoring
4	$100 \leq$ %BFW $<$ 120	Either upstream deposition or downstream bed scour, without upstream deposits taller than 0.5 bankfull height or high downstream banks	n/a	No erosion and intact armoring, or low upstream or downstream erosion without armoring
3	$75 \leq$ %BFW $<$ 100	Either upstream deposition or downstream bed scour, with either upstream deposits taller than 0.5 bankfull height or high downstream banks	Mild bend	Low upstream or downstream erosion with armoring
2	$50 \leq$ %BFW $<$ 75	Both upstream deposition and downstream bed scour, without upstream deposits taller than 0.5 bankfull height or high downstream banks	Channelized Straight	Low upstream and downstream erosion
1	$30 \leq$ %BFW $<$ 50	Both upstream deposition and downstream bed scour, with upstream deposits taller than 0.5 bankfull height or high downstream banks	n/a	Severe upstream or downstream erosion
0	%BFW $<$ 30	Both upstream deposition and downstream bed scour, with upstream deposits taller than 0.5 bankfull height and high downstream banks	Sharp Bend	Severe upstream and downstream erosion, or failing armoring upstream or downstream

Table 2. Compatibility Rating Results (Vermont Culvert Geomorphic Compatibility Screen Tool, adapted by BCE for bridges)			
Category Name	Screen Score	Threshold Conditions	Description of Structure-channel Geomorphic Compatibility
Fully Compatible	$16 < GC \leq 20$	n/a	Structure fully compatible with natural channel form and process. There is a low risk of failure. No replacement anticipated over the lifetime of the structure. A similar structure is recommended when replacement is needed.
Mostly Compatible	$12 < GC \leq 16$	n/a	Structure mostly compatible with current channel form and process. There is a low risk of failure. No replacement anticipated over the lifetime of the structure. Minor design adjustments recommended when replacement is needed to make fully compatible.
Partially Compatible	$8 < GC \leq 12$	n/a	Structure compatible with either current form or process, but not both. Compatibility likely short term. There is a moderate risk of structure failure and replacement may be needed. Re-design suggested to improve geomorphic compatibility.
Mostly Incompatible	$4 < GC \leq 8$	% Bankfull Width + Approach Angle scores ≤ 2	Structure mostly incompatible with current form and process, with a moderate to high risk of structure failure. Re-design and replacement planning should be initiated to improve geomorphic compatibility.
Fully Incompatible	$0 \leq GC \leq 4$	% Bankfull Width + Approach Angle scores ≤ 2 AND Sediment Continuity + Erosion and Armoring scores ≤ 2	Structure fully incompatible with channel and high risk of failure. Re-design and replacement should be performed as soon as possible to improve geomorphic compatibility.

Table 3. Ottawaquechee River Bridge Assessment (2012)

Reach/ Segment Number	Town	Road Name	Structure ID ¹	Percent Bankfull Channel Width ²		Phase 2 Notes	Scoring					Category
				Constriction	Span ³		% Bankfull Width	Sediment Continuity	Approach Angle	Erosion & Armoring	Total Score	
M15-B	Woodstock	Elm Street	200241001514242	87	100	Deposition above and below. Scour pool above. Old pipes and wires underneath.	3	3	3 Mild Bend	0	9	Partially Compatible
M15-B	Woodstock	Mountain Avenue	101424007314241	107	112	Not a channel constriction. Deposition above and below. Scour pool throughout. Abutment beginning to deteriorate.	4	3	3 Mild Bend	0	10	Partially Compatible
M15-C	Woodstock	Church Street	200020005014242	91	182 ⁴	Deposition above and below. Scour above and below along footer.	3	1	2 Channelized Straight	0	6	Mostly Incompatible
M18-A	Woodstock	Mill Road	101424003014241	124	159	Not a channel constriction. Deposition above. <i>Wider than reference bankfull width, but narrower than actual bankfull width</i>	5	4	2 Channelized Straight	2	13	Mostly Compatible
M20-A	Woodstock	Bridges Road (covered bridge)	101424002514241	110	123	Not a channel constriction. Deposition above and below. Scour pool throughout. Abutments intact.	4	2	2 Channelized Straight	0	8	Mostly Incompatible
M22-A	Bridgewater	Curtis Hollow Road	101405005114051	63	65	Deposition above and below. Pier splits channel in two – one side filled is with sediment. Scour along base of pier.	2	4	2 Channelized Straight	2	10	Partially Compatible
M24-A	Bridgewater	Route 100A	200149001414052	124	129	Not a channel constriction. Mid-channel bar starts above bridge and ends below.	5	4	2 Channelized Straight	0	11	Partially Compatible
M24-B	Bridgewater	Route 4	200020004514052	59	83	Deposition throughout. Scour around pier. Poorly aligned.	2	1	2 Channelized Straight	0	5	Mostly Incompatible
M26-A	Bridgewater	Route 4	200020004414052	81	96	Deposition above and below. Scour pool above and below. Pier splits channel in two – one side is filled with sediment.	3	5	2 Channelized Straight	2	12	Partially Compatible
M26-C	Bridgewater	Gunderson Road	101405004814051	90	94	Deposition below. Poorly aligned. The wing walls are being undermined and storm water drainage is causing erosion.	3	4	2 Channelized Straight	0	9	Partially Compatible

Table 3. Ottauquechee River Bridge Assessment (2012)

Reach/ Segment Number	Town	Road Name	Structure ID ¹	Percent Bankfull Channel Width ²		Phase 2 Notes	Scoring					Category
				Constriction	Span ³		% Bankfull Width	Sediment Continuity	Approach Angle	Erosion & Armoring	Total Score	
M27-B	Bridgewater	Route 4	200020004214052	60	120	Deposition above and below. Pier splits channel in two – one side is filled with sediment. Scour along the pier.	2	3	2 Channelized Straight	1	8	Mostly Incompatible
M27-D	Bridgewater	Route 4	200020004014052	102	143	Not a channel constriction. Deposition above and below. Scour pool above. Scour along abutment.	4	4	5 Naturally Straight	2	15	Mostly Compatible
M27-F	Bridgewater	Mountainside Road	na	69	69 ⁴	Deposition above and below. Scour pool throughout. Scour on the abutments and wing walls. Poor alignment	2	1	5 Naturally Straight	1	9	Partially Compatible
M27-F	Bridgewater	Route 4	200020003914052	99	99	Deposition above and below. Pier splits channel in two. Scour along the pier. Poor alignment.	3	1	0 Sharp Bend	1	5	Mostly Incompatible
M28-A	Bridgewater	Route 4	200020003814052	92	103	Deposition below. Scour along the two piers. Poor alignment.	3	4	3 Mild Bend	0	10	Partially Compatible
M29	Bridgewater	Route 4	200020003514052	84	149	Deposition above and below. Scour along the two piers. Poor alignment.	3	4	3 Mild Bend	0	10	Partially Compatible
M30-A	Killington	Route 4	200020003411212	62	332	Deposition above. Scour pool above. Poor alignment.	2	3	2 Channelized Straight	0	7	Mostly Incompatible
M30-E	Killington	Route 4	200020003311212	74	122	Deposition below. Scour pool above and below (could be related to upstream beaver dam). Poor alignment.	2	4	3 Mild Bend	0	9	Partially Compatible
M28T5.01-C (Reservoir Brook)	Bridgewater	Private	na	79	88 ⁴	Deposition below.	3	5	2 Channelized Straight	0	10	Partially Compatible

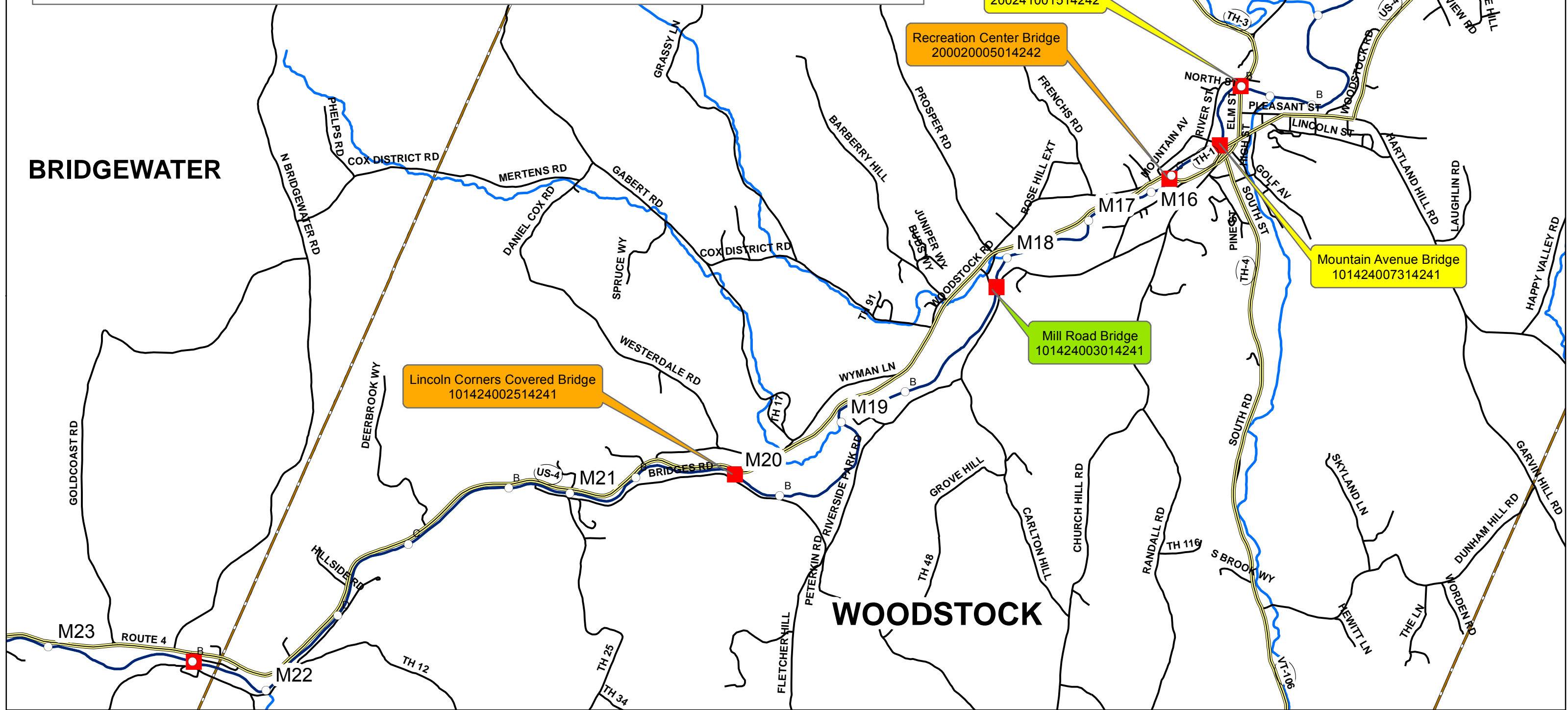
¹The structure ID is the identification number provided by the 2010 "TransStructures_TRANSTRUC" shapefile from the Vermont Center for Geographic Information, unless no number was available.

²Percent Bankfull Channel Width percentages are calculated based on the reference channel width for each reach. The constriction percentage is calculated by dividing the present constriction width by the reference channel width. The span percentage is calculated by dividing the bridge span by the reference channel width.

³The bridge span used for this calculation is based on the bridge span provided by the 2010 "TransStructures_TRANSTRUC" shapefile from the Vermont Center for Geographic Information, unless otherwise noted.

⁴The bridge span used for the Church Street bridge was measured in the field; the bridge was replaced in 07/08. The bridge span for Mountainside Road and the private bridge were measured in the field because no structure ID was available from VCGI.

Ottawaquechee River Watershed 2012 Bridge Assessments in Woodstock



Legend

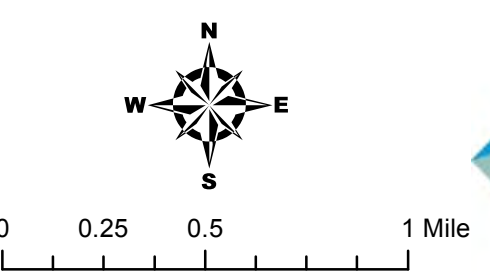
- Bridge (Red square)
- Phase 2 Reach Points (White circle)
- Segment Point (White circle)
- Town Boundary (Black outline)
- Phase 2 Study Area (Blue wavy line)
- Phase 1 only (Light blue wavy line)
- Major Roads (Yellow line)
- Roads (Black line)

Geomorphic Compatibility Rating:

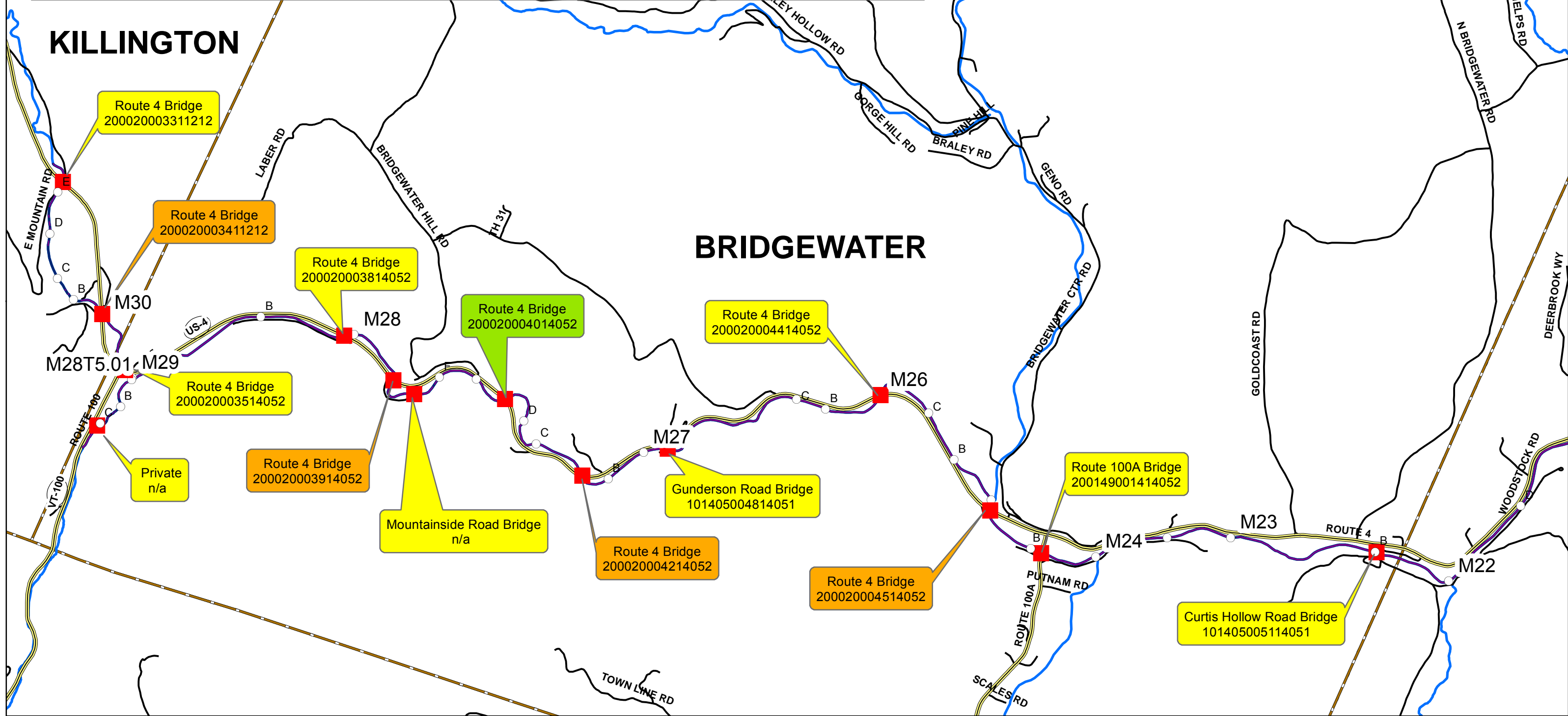
- Fully Compatible (Light Blue)
- Mostly Compatible (Light Green)
- Partially Compatible (Yellow)
- Mostly Incompatible (Orange)
- Fully Incompatible (Red)

The ID numbers are provided by the 2010 "TransStructures_TRANSTRUC" shapefile from the Vermont Center for Geographic Information, unless no number was available.

Geomorphic Compatibility Rating is adapted from the Vermont Culvert Geomorphic Compatibility Screening Tool (Milone and MacBroom, Inc. 2008).



Ottauquechee River Watershed 2012 Bridge Assessments in Killington & Bridgewater



Legend

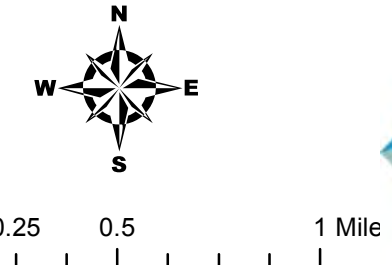
- Bridge
- Phase 2 Reach Points
- Segment Point
- Town Boundary
- ~ Phase 2 Study Area
- ~ Phase 1 only
- = Major Roads
- = Roads

Geomorphic Compatibility Rating:

- Fully Compatible
- Mostly Compatible
- Partially Compatible
- Mostly Incompatible
- Fully Incompatible

The ID numbers are provided by the 2010 "TransStructures_TRANSTRUC" shapefile from the Vermont Center for Geographic Information, unless no number was available.

Geomorphic Compatibility Rating is adapted from the Vermont Culvert Geomorphic Compatibility Screening Tool (Milone and MacBroom, Inc. 2008).



APPENDIX C

Phase 2 Geomorphic Assessment Data

**Table 1. Stream Type and Channel Evolution Stage Summary
Ottawaquechee River Watershed**

Segment Number	Entrenchment Ratio	Width to Depth Ratio	Reference Stream Type	Incision Ratio	Existing Stream Type	Channel Evolution Stage	Active Adjustment Process
Ottawaquechee River							
M13	6.9	24.3	C	1.1	C	F-III	Aggradation Widening Planform
M14-A	7.4	22.2	C	1.3	C	F-III	Aggradation Widening Planform
M14-B	1.2	25.0	C	2.5	F	F-III	Aggradation Widening Planform
M15-A	1.2	25.0	C	2.5	F	F-III	Aggradation Widening Planform
M15-B	1.8	32.3	C	1.9	B	F-III	Aggradation Widening Planform
M15-C	1.3	19.1	C	3.1	F	F-II	Aggradation Widening Planform
M16	1.1	27.4	B	1.6	F	F-III	Aggradation Widening Planform
M17	1.2	29.3	C	2.5	F	F-III	Aggradation Widening Planform
M18-A	1.2	53.9	C	2.1	F	F-III	Aggradation Widening Planform
M18-B	1.3	55.6	C	1.7	F	F-III	Aggradation Widening Planform
M19-A	7.6	48.2	C	1.6	C	F-IV	Aggradation Widening Planform
M19-B	2.1	54.0	C	1.4	B	F-IV	Aggradation Widening Planform
M20-A	1.2	33.0	C	1.9	F	F-III	Aggradation Widening Planform
M20-B	1.1	39.9	C	2.6	F	F-III	Aggradation Widening Planform
M21-A	1.3	33.1	C	2.8	F	F-III	Aggradation Widening Planform
M21-B	1.2	40.6	C	2.5	F	F-III	Aggradation Widening Planform
M21-C	1.2	30.7	C	2.2	F	F-III	Aggradation Widening Planform

**Table 1. Stream Type and Channel Evolution Stage Summary
Ottawaquechee River Watershed**

Segment Number	Entrenchment Ratio	Width to Depth Ratio	Reference Stream Type	Incision Ratio	Existing Stream Type	Channel Evolution Stage	Active Adjustment Process
M21-D	1.2	34.7	C	3.3	F	F-III	Aggradation Widening Planform
M22-A	1.3	24.9	C	2.5	F	F-II	Aggradation Widening Planform
M22-B	1.2	36.8	C	2.4	F	F-III	Aggradation Widening Planform
M23-A	1.8	32.2	Bc	1.3	Bc	F-III	Aggradation Widening Planform
M23-B	1.6	33.0	C	1.8	Bc	F-III	Aggradation Widening Planform
M24-A	7.6	28.9	C	1.4	C	F-III	Aggradation Widening Planform
M24-B	3.5	35.3	C	1.6	C	F-III	Aggradation Widening Planform
M25-A	4.3	27.9	C	1.3	C	F-III	Aggradation Widening Planform
M25-B	1.3	26.7	C	3.8	F	F-III	Aggradation Widening Planform
M25-C	1.6	26.9	C	1.7	Bc	F-III	Aggradation Widening Planform
M26-A	2.5	37.5	C	1.1 ¹ HEF: 1.6	C	F-III	Aggradation Widening Planform
M26-B	1.1	26.0	B	2.6	F	F-III	Aggradation Widening Planform
M26-C	1.2	25.3	B	2.0	F	F-III	Aggradation Widening Planform
M27-A	1.2	31.8	C	4.9	F	F-III	Aggradation Widening Planform
M27-B	2.2	39.3	C	1.0	C	D-IId	Aggradation Widening Planform
M27-C	1.5	17.0	C	1.4 ² HEF: 3.7	Bc	F-III	Aggradation Widening Planform
M27-D	2.9	29.0	C	1.7	C	F-III	Aggradation Widening Planform

**Table 1. Stream Type and Channel Evolution Stage Summary
Ottawaquechee River Watershed**

Segment Number	Entrenchment Ratio	Width to Depth Ratio	Reference Stream Type	Incision Ratio	Existing Stream Type	Channel Evolution Stage	Active Adjustment Process
M27-E	1.5	16.6	C	1.5 ² HEF: 3.1	Bc	F-II	Aggradation Widening Planform
M27-F	4.2	27.6	C	1.1	C	D-IIId	Aggradation Widening Planform
M28-A	2.0	22.1	C	1.1 ¹ HEF: 2.1	Bc	F-II	Aggradation Widening Planform
M28-B	3.5	23.2	C	1.2	C	F-II	Aggradation Widening Planform
M28-C	1.8	46.2	C	2.0 ² HEF: 3.0	Bc	F-III	Aggradation Widening Planform
M29	7.5	24.1	Cb	1.8	Cb	F-III	Aggradation Widening Planform
M30-A ³	< 1.4	NA	C	> 2.0	F	F-II	Incision Aggradation Widening Planform
M30-B ⁴	NA	NA	B	NA	B	NA	NA
M30-C	2.9	25.6	C	1.1	C	D-IIc	Aggradation Widening Planform
M30-D	2.0	18.7	Bc	1.0	Bc	F-I	Aggradation Planform
M30-E ⁴	NA	NA	E	NA	E	NA	NA
Reservoir Brook							
M28T5.01-A	5.6	23.0	C	1.0	C	D-IIId	Aggradation Widening Planform
M28T5.01-B	14.1	16.0	C	1.0	C	F-I	Aggradation Widening Planform
M28T5.01-C	12.0	13.2	C	1.5 ² HEF: 1.8	C	F-II	Aggradation Widening Planform
¹ HEF = Human Elevated Floodplain incision calculated to show change in incision as a result of a berm in M26-A or old Standish Road in M28-A. ² HEF = Human Elevated Floodplain incision ratio calculated to show change in incision as a result of major road being elevated above the natural floodplain. ³ Accurate channel data was not able to be determined because of flood impacts. Channel data and adjustment processes determined using best judgment. ⁴ Segment not assessed. M30-B too short; stable system. M30-E impounded by beaver dam. Stream type determined using best judgment.							
<p align="center"> Bold Red lettering – denotes severe adjustment process Bold Black lettering – denotes major adjustment process Black lettering (no bold) – denotes minor adjustment process Red denotes severe incision ratio (≥2.0) Blue denotes moderate incision ratio (1.4 – <2.0) Green denotes a stream type departure </p>							



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M13-0	Organization:	Bear Creek Environmental
Segment Length(ft):	5,889	Observers:	MN, EK
Rain:	Yes	Completion Date:	10/5/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

- Step 0 - Location: **This reach begins approximately 1,000 feet upstream of where the Woodstock-Pomfret town boundary line intersects the Ottauquechee River and continues 5,900 feet upstream to the confluence of the Ottauquechee and Barnard Brook.**
- Step 5 - Notes: **There is very minor human-caused change in valley width. The confinement ratio went from 10.4 to 9.8. This changed the confinement from Very Broad to Broad.**
- Step 7 - Narrative: **Major aggradation and planform adjustment. Minor widening. Numerous diagonal bars and some locational braiding under low flow conditions. Bank heights are variable in this reach. Used cross section that is representative. Good floodplain access in most locations. The RGA indicates that there is a significant human-caused change in confinement (Step 7.1) because there is a change in valley type from Very Broad to Broad. This change was very insignificant, Confinement Ratio changing from 10.4 to 9.8), and therefore was not weighted heavily.**

Step 1. Valley and Floodplain

1.1 Segmentation:	None	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Steep	Steep	Valley Width (ft): 1,271
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Never
Road:	1,246		0		Texture:
Railroad:	0		0		N.E.
Imp. Path:	0		0		N.E.
Dev.:	787		0		In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M13-0**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	122.05	2.11 Riffle/Step Spacing:	483 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	7.03	2.12 Substrate Composition		Bed:	6.6 inches
2.3 Mean Depth (ft.):	5.02	Bedrock:	0.0 %	Bar:	4.3 inches
2.4 Floodprone Width (ft.):	848.10	Boulder:	0.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	7.92	Cobble:	55.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	37.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	24.31	Fine Gravel:	5.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	6.95	Sand:	3.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.13	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	16	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope: Steep					
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	466.4	1,361.9	Dominant:	Herbaceous	Shrubs/Sapling
Material Type:	Sand	Sand	Erosion Height (ft.):	7.0	5.3	Sub-dominant:	Shrubs/Sapling	Deciduous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	765.0	732.2	Canopy %:	1-25	51-75
Material Type:	Boulder/Cobbl	Boulder/Cobbl			Mid-Channel Canopy:	Open		
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	26-50	Dominant
Sub-Dominant	>100	>100	Sub-dominant
W less than 25	4,187	1,372	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Herbaceous	Gullies
Sub-Dominant	Shrubs/Sapling	Deciduous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Hay	Hay	Mass Failures	
Sub-Dominant	Forest	Forest	Height	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: Ottauquechee Mainstem Reach: M13-0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: Minimal	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: 10	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 3 Delta: 2	Flood chutes: 0 Avulsion: 0	5.5 Straightening: Straightening
Point: 2 Island: 0	5.3 Steep Riffles and Head Cuts Head Cuts: 0	Straightening Length (ft.): 5,323
Side: 5 Braiding: 1	Steep Riffles: 5 Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		16	None	No	Geomorphic Rating	0.54
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		13	None	No	Channel Evolution Stage	III
7.4 Change in Planform		7	None	No	Geomorphic Condition	Fair
Total Score		43			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M14-A	Organization:	Bear Creek Environmental
Segment Length(ft):	3,769	Observers:	MN, EK
Rain:	Yes	Completion Date:	10/5/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

- Step 0 - Location: **This segment begins where Barnard Brook enters the Ottauquechee and continues 3,800 feet upstream to where the river becomes straight, or directly across from a motel on Woodstock Road.**
- Step 5 - Notes: **Minor human-caused change in valley width, but no change in valley type. Phase 1 and 2 valley type is very broad. M14-A has moderate sinuosity and had deposition on the inside of meander bends.**
- Step 7 - Narrative: **Minor historic incision. Channel planform being held in place by rip rap. Some widening as evident by bank erosion in rapped sections. Major aggradation, diagonal bars, and steep riffles.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Steep	Steep	Valley Width (ft): 2,944
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Never	Confinement Type: VB
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 1,102 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 1,033 0				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M14-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	114.10	2.11 Riffle/Step Spacing:	463 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	7.00	2.12 Substrate Composition		Bed:	10 inches
2.3 Mean Depth (ft):	5.14	Bedrock:	0.0 %	Bar:	6.2 inches
2.4 Floodprone Width (ft.):	840.00	Boulder:	1.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	8.85	Cobble:	50.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	41.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	22.20	Fine Gravel:	2.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	7.36	Sand:	6.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.26	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Moderate	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Complete	# Large Woody Debris:	0	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Moderate				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	848.4	1,451.2	Dominant:	Herbaceous	Herbaceous
Material Type:	Sand	Sand	Erosion Height (ft.):	6.5	5.3	Sub-dominant:	Shrubs/Sapling	Shrubs/Sapling
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	1,136.0	2,124.9	Canopy %:	51-75	26-50
Material Type:	Gravel	Gravel				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	51-100
Sub-Dominant	0-25	51-100
W less than 25	2,377	2,027
Buffer Vegetation Type		
Dominant	Herbaceous	Herbaceous
Sub-Dominant	Deciduous	Deciduous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Crop	Crop	Mass Failures	
Sub-dominant	Forest	Residential	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M14-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 0
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 1
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 5	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 3	Delta: 1	Flood chutes: 0	Avulsion: 0	5.5 Straightening: With Windrowing
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 3,190
Side: 7	Braiding: 0	Steep Riffles: 3	Trib Rejuv.: Yes	5.5 Dredging: Gravel Mining

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		11	None	No	Geomorphic Rating	0.50
7.2 Channel Aggradation		9	None	No	Channel Evolution Model	F
7.3 Widening Channel		11	None	No	Channel Evolution Stage	III
7.4 Change in Planform		9	None	No	Geomorphic Condition	Fair
Total Score		40			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M14-B	Organization:	Bear Creek Environmental
Segment Length(ft):	1,143	Observers:	MN, EK
Rain:	Yes	Completion Date:	10/2/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins across from a motel on Woodstock Road and continues upstream 1,150 feet upstream to the confluence with Kedron Brook, or about 800 feet downstream of the Elm Street bridge.**

Step 5 - Notes: **The section of the Ottauquechee River starting just below the Elm Street bridge in Woodstock and continuing downstream 1,950 feet is a section that has incised and lost its floodplain access as a result of channel straightening. During the Phase 1 assessment, this area was split by a reach break because of the confluence with Kedron Brook. The upper section, M15-A could not be properly assessed because there was no riffle present, so the cross section was done just below the reach break in M14-B. We felt this cross section was a representative cross section for both segments because the channel dimensions on the main stem were similar for both short segments.**

There is only a minor human-caused change in valley confinement in Segment M14-B. The valley confinement is very broad for both Phase 1 and 2.

Step 7 - Narrative: **Extreme historic incision. The channel evolution stage is late F-II or early F-III.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Very Steep	Very Steep	Valley Width (ft): 2,811
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Confinement Type: VB
Berm:	0		0		In Rock Gorge: No
Road:	0		0		Human Caused Change in Valley Width?: Yes
Railroad:	0		0		
Imp. Path:	0		0		
Dev.:	0		0		
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M14-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	118.60	2.11 Riffle/Step Spacing:	1140 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	5.87	2.12 Substrate Composition		Bed:	11.6 inches
2.3 Mean Depth (ft):	4.75	Bedrock:	0.0 %	Bar:	5.06 inches
2.4 Floodprone Width (ft.):	146.90	Boulder:	13.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	14.57	Cobble:	45.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	22.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	24.97	Fine Gravel:	9.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.24	Sand:	9.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	2.48	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Eroded	# Large Woody Debris:	0	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	1,049.5	0.0
Material Type:	Sand	Sand	Erosion Height (ft.):	5.8	0.0
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap
Lower			Revetment Length:	173.3	998.1
Material Type:	Boulder/Cobbl	Boulder/Cobbl			
Consistency:	Non-cohesive	Non-cohesive			

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	0-25	Dominant
Sub-Dominant	None	None	Sub-dominant
W less than 25	794	795	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Shrubs/Sapling	Gullies
Sub-Dominant	Deciduous	Deciduous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Crop	Residential	Mass Failures	
Sub-Dominant	None	None	Height	
W less than 25	794	795	Gullies Number	0
Buffer Vegetation Type			Gullies Length	0
Dominant	Herbaceous	Shrubs/Sapling		
Sub-Dominant	Deciduous	Deciduous		



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M14-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 0
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 1
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: 0	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0 Delta: 1	Flood chutes: 1 Avulsion: 0	5.5 Straightening: Straightening
Point: 0 Island: 0	5.3 Steep Riffles and Head Cuts Head Cuts: 0	Straightening Length (ft.): 1,131
Side: 2 Braiding: 0	Steep Riffles: 0 Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		2	C to F	Yes	Geomorphic Rating	0.47
7.2 Channel Aggradation		13	None	No	Channel Evolution Model	F
7.3 Widening Channel		11	None	No	Channel Evolution Stage	III
7.4 Change in Planform		12	None	No	Geomorphic Condition	Fair
Total Score		38			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M15-A	Organization:	Bear Creek Environmental
Segment Length(ft):	806	Observers:	PD, EK
Rain:	Yes	Completion Date:	10/2/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: This segment begins at the confluence with Kedron Brook and continues upstream 800 feet to just downstream of the Elm Street bridge.

Step 5 - Notes: The section of the Ottauquechee River starting just below the Elm Street bridge in Woodstock and continuing downstream 1,950 feet is a section that has incised and lost its floodplain access as a result of channel straightening. During the Phase 1 assessment, this area was split by a reach break because of the confluence with Kedron Brook. The upper section, M15-A could not be properly assessed because there was no riffle present, so the cross section was done just below the reach break in M14-B. We felt this cross section was a representative cross section for both segments because the channel dimensions on the main stem were similar for both short segments.

River Road and Pleasant Street are creating a human-caused change in valley confinement from very broad to broad.

This segment is very short and the only two photos were taken. The entire segment can be seen in the upstream photo from the cross section (in M14-B, but used for M15-A as well). You can see some of the segment in the photo looking downstream from the Elm Street bridge as well.

Step 7 - Narrative: Historic channel straightening; higher banks than upstream segment. This segment was a much higher incision ratio than upstream segment M15-B. Plane bed dominates the segment and the channel is widening with extensive erosion on the left bank. Planform is completely altered by straightening.

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Very Steep	Very Steep	Valley Width (ft): 1,048
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Never	Confinement Type: BD
Berm: 0 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 94 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 244 560				

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	3.0	1.0	Yes	



Phase 2 Segment Summary Report

Ottauquechee

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Stream: **Ottauquechee Mainstem** Reach: **M15-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	118.60	2.11 Riffle/Step Spacing:	798 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	5.87	2.12 Substrate Composition		Bed:	11.6 inches
2.3 Mean Depth (ft):	4.75	Bedrock:	0.0 %	Bar:	5.06 inches
2.4 Floodprone Width (ft.):	146.90	Boulder:	13.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	14.57	Cobble:	45.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	22.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	24.97	Fine Gravel:	9.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.24	Sand:	9.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	2.48	Silt and Smaller:	2.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Eroded	# Large Woody Debris:	0	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	303.3	0.0	
Material Type:	Sand	Sand	Erosion Height (ft.):	9.6	0.0	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Multiple	
Lower			Revetment Length:	494.8	617.8	
Material Type:	Boulder/Cobbl	Boulder/Cobbl				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Herbaceous	Invasives
				Sub-dominant:	Deciduous	Deciduous
				Bank Canopy		
				Canopy %:	1-25	26-50
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	26-50	Dominant
Sub-Dominant	None	0-25	Sub-dominant
W less than 25	522	106	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Invasives	Gullies
Sub-Dominant	None	Deciduous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Commercial	Residential	Mass Failures		
Sub-Dominant	None	Shrubs/Sapling	Height		
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Buffer Vegetation Type	None		Gullies Length	0	
Dominant	None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M15-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 0
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 3
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 0	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 0	Flood chutes: 0	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 806
Side: 2	Braiding: 0	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		4	C to F	Yes	Geomorphic Rating	0.36
7.2 Channel Aggradation		9	None	No	Channel Evolution Model	F
7.3 Widening Channel		9	None	No	Channel Evolution Stage	III
7.4 Change in Planform		7	None	No	Geomorphic Condition	Fair
Total Score		29			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M15-B	Organization:	Bear Creek Environmental
Segment Length(ft):	3,499	Observers:	PD, EK
Rain:	Yes	Completion Date:	10/2/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

- Step 0 - Location: **The middle and longest segment (M15-B) begins just below the Elm Street bridge and makes its way through Woodstock from the Elm Street bridge to just below the Church Street bridge.**
- Step 5 - Notes: **There is a human-caused change in valley width from very broad to narrow due to River Street on the left side (north-west) and Church Street on the right (south-east).**
- Step 7 - Narrative: **Channel has incised, but RAF was more distinct than upstream segments and incision ratio is probably more accurate. There is major aggradation as a result of TSI. Channel has widened and planform adjustment is major. There is a stream type departure from a C to B.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Very Steep	Extr. Steep	Valley Width (ft): 544
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Never	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Sometimes	Confinement Type: NW
Berm: 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 3,499				Human Caused Change in Valley Width?: Yes
Railroad: 0				
Imp. Path: 0				
Dev.: 0				
1.6 Grade Controls: None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M15-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 0
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 5
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	118.5	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above, Scour Below
Bridge	96	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0	Delta: 0	Flood chutes: 5	Avulsion: 0	5.5 Straightening: Straightening
Point: 2	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 3,403
Side: 3	Braiding: 0	Steep Riffles: 4	Trib Rejuv.: No	5.5 Dredging: Gravel Mining

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		7	C to B	Yes	Geomorphic Rating	0.34
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		7	None	No	Channel Evolution Stage	III
7.4 Change in Planform		6	None	No	Geomorphic Condition	Poor
Total Score		27			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M15-C	Organization:	Bear Creek Environmental
Segment Length(ft):	723	Observers:	PD, EK
Rain:	Yes	Completion Date:	10/3/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **The upper segment begins just below the Church Street bridge and continues upstream 700 feet.**

Step 5 - Notes: **There is a human-caused change in valley width from broad to semi-confined from US Route 4.**

Step 7 - Narrative: **Extensive historic channel alteration has led to extreme incision and a stream type departure from a C to F. Minor aggradation as sediment is moving through this transport segment. Extensive rip rap is preventing widening. Planform is a major adjustment process due to extensive straightening.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Very Steep	Valley Width (ft): 315
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Sometimes	Confinement Type: SC
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 573 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 723				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M15-C**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	113.60	2.11 Riffle/Step Spacing:	261 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	7.99	2.12 Substrate Composition		Bed:	18.8 inches
2.3 Mean Depth (ft.):	5.95	Bedrock:	0.0 %	Bar:	6.1 inches
2.4 Floodprone Width (ft.):	144.60	Boulder:	29.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	24.39	Cobble:	33.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	25.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	19.09	Fine Gravel:	3.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.27	Sand:	10.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	3.05	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Complete	# Large Woody Debris:	7	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Steep				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	67.5	117.0	Dominant:	Herbaceous	Herbaceous
Material Type:	Boulder/Cobbl	Boulder/Cobbl	Erosion Height (ft.):	12.0	8.3	Sub-dominant:	Shrubs/Sapling	Deciduous
Consistency:	Cohesive	Cohesive	Revetment Type:	Multiple	Multiple	Bank Canopy		
Lower			Revetment Length:	667.7	564.5	Canopy %:	26-50	26-50
Material Type:	Boulder/Cobbl	Boulder/Cobbl				Mid-Channel Canopy:	Open	
Consistency:	Cohesive	Cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	0-25	Dominant
Sub-Dominant	None	51-100	Sub-dominant
W less than 25	621	361	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Herbaceous	Gullies
Sub-Dominant	Deciduous	Deciduous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Residential	Residential	Mass Failures		
Sub-Dominant	Other	None	Height		
Amount	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Failures	None		Gullies Length	0	
Gullies	None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M15-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type: None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 2
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 3 Urb Strm Wtr Pipe: 1
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	100	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above, Scour Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid:	1 Delta: 0	Flood chutes: 2	Avulsion: 0	5.5 Straightening: Straightening
Point:	0 Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 701
Side:	4 Braiding: 0	Steep Riffles: 1	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		2	C to F	Yes	Geomorphic Rating	0.44
7.2 Channel Aggradation		13	None	No	Channel Evolution Model	F
7.3 Widening Channel		12	None	No	Channel Evolution Stage	II
7.4 Change in Planform		8	None	No	Geomorphic Condition	Fair
Total Score		35			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M16-0	Organization:	Bear Creek Environmental
Segment Length(ft):	1,867	Observers:	Mary, Emily
Rain:	Yes	Completion Date:	9/25/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **The upper segment begins just below the Church Street bridge and continues upstream 700 feet.**

Step 5 - Notes: **There is a minor human-caused change in valley confinement from US Route 4; however the Phase 1 and 2 valley types are both semi-confined.**

Step 7 - Narrative: **Major degradation, but not as severe as upstream reaches. The same is true for the other processes. There were a few large bars, but nothing like what was observed upstream. The w/d ratio in this segment was < 30, which indicates that the river is undergoing minor widening. Upstream segments/reaches had w/d ratios greater than 30, which indicates that they are undergoing major or extreme (>40) widening. Abundant erosion on the right bank. Some of left bank is rip rapped preventing widening on that side. Reach is most likely naturally straight in places due to natural 'semi-confined.'**

Step 1. Valley and Floodplain

1.1 Segmentation:	None	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Very Steep	Steep	Valley Width (ft): 232
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Sometimes
Road:	1,531		0		Sometimes
Railroad:	0		0		Texture:
Imp. Path:	0		0		N.E.
Dev.:	0		1,425		N.E.
					In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M16-0**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	129.00	2.11 Riffle/Step Spacing:	304 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	6.55	2.12 Substrate Composition		Bed:	14.6 inches
2.3 Mean Depth (ft.):	4.71	Bedrock:	3.0 %	Bar:	5.8 inches
2.4 Floodprone Width (ft.):	147.60	Boulder:	15.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	10.35	Cobble:	42.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	15.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	27.39	Fine Gravel:	16.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.14	Sand:	8.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.58	Silt and Smaller:	1.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	9	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	61.8	693.0	
Material Type:	Sand	Sand	Erosion Height (ft.):	6.0	9.9	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	
Lower			Revetment Length:	1,106.4	0.0	
Material Type:	Mix	Silt				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Herbaceous	Deciduous
				Sub-dominant:	Deciduous	Herbaceous
				Bank Canopy		
				Canopy %:	1-25	51-75
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	>100
Sub-Dominant	26-50	None
W less than 25	58	0
Buffer Vegetation Type		
Dominant	Herbaceous	Coniferous
Sub-Dominant	Deciduous	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	Mass Failures	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Height		230.34
Sub-dominant	None	None	Gullies Number	2	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Length	5	
Failures	Multiple	13.0			
Gullies	Multiple	2.5			



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M16-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Other	162	Yes	Yes	No	Yes	Deposition Above, Scour Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0	Delta: 3	Flood chutes: 3	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,153
Side: 4	Braiding: 0	Steep Riffles: 1	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Confined	Score	STD	Historic		
7.1 Channel Degradation		9	B to F	Yes	Geomorphic Rating	0.52
7.2 Channel Aggradation		11	None	No	Channel Evolution Model	F
7.3 Widening Channel		10	None	No	Channel Evolution Stage	III
7.4 Change in Planforml		12	None	No	Geomorphic Condition	Fair
Total Score		42			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M17-0	Organization:	Bear Creek Environmental
Segment Length(ft):	2,659	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	9/20/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This reach begins as the valley widens and continues upstream 2,700 to where Vondell Brook enters the Ottauquechee River.**

Step 5 - Notes: **There is a human-caused change in valley width from narrow to semi-confined because of US Route 4.**

Step 7 - Narrative: **Extreme incision, but RAF may actually be lower than what was measured in cross section. Fill in the floodplain (parking area) made it difficult to identify. Entrenchment from development and Route 4 has cause a stream type departure from a C to F. Aggradation was major, but areas of the reach were much less aggradational than upstream reaches. Reach regains sinuosity downstream so is not straightened throughout. Major widening, but not as extensive as upstream reaches. The same is true for planform change.**

Step 1. Valley and Floodplain

1.1 Segmentation: None	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Very Steep	Steep	Valley Width (ft): 347
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Sometimes	Confinement Type: SC
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 2,369 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 2,503 0				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

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Stream: **Ottauquechee Mainstem** Reach: **M17-0**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	126.20	2.11 Riffle/Step Spacing:	361 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	6.06	2.12 Substrate Composition		Bed:	11.1 inches
2.3 Mean Depth (ft):	4.30	Bedrock:	0.0 %	Bar:	7.1 inches
2.4 Floodprone Width (ft.):	147.70	Boulder:	1.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	15.40	Cobble:	23.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	54.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	29.35	Fine Gravel:	13.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.17	Sand:	8.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	2.54	Silt and Smaller:	1.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	9	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Moderate				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	976.5	962.1	Dominant:	Herbaceous	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	6.8	21.3	Sub-dominant:	Deciduous	Shrubs/Sapling
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	Bank Canopy		
Lower			Revetment Length:	638.9	0.0	Canopy %:	1-25	51-75
Material Type:	Mix	Mix				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	>100	Dominant
Sub-Dominant	51-100	None	Sub-dominant
W less than 25	2,027	0	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Deciduous	Gullies
Sub-Dominant	Deciduous	Shrubs/Sapling	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Commercial	Forest	Mass Failures		612.89
Sub-Dominant	Residential	None	Height		34.9
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Buffer Vegetation Type	Multiple	30.0	Gullies Length	0	
Dominant	None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M17-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: Minimal	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 2 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 1	Flood chutes: 6	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,897
Side: 8	Braiding: 0	Steep Riffles: 3	Trib Rejuv.: No	5.5 Dredging: Gravel Mining

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		3	C to F	Yes	Geomorphic Rating	0.38
7.2 Channel Aggradation		9	None	No	Channel Evolution Model	F
7.3 Widening Channel		9	None	No	Channel Evolution Stage	III
7.4 Change in Planform		9	None	No	Geomorphic Condition	Fair
Total Score		30			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M18-A	Organization:	Bear Creek Environmental
Segment Length(ft):	4,770	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	9/14/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where Vondell Brook enters the Ottauquechee and continues upstream 4,800 feet past Woodstock Union High School to the end of a farm field on the northern bank.**

Step 5 - Notes: **There is a human-caused change in valley width from very broad to broad from US Route 4.**

Step 7 - Narrative: **Extreme incision and major aggradation from Irene has led to extreme widening. Planform is completely altered by straightening. There are many flood chutes, steep riffles, and large bars. There is no buffer for much of the left side, but trees or willows are on the near bank. The river is building a new floodplain on the large bars. The channel evolution stage is late F-III or early F-IV. The bars need to build some more to create a juvenile floodplain at the bankfull elevation.**

Step 1. Valley and Floodplain

1.1 Segmentation: Valley Width	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Very Steep	Very Steep	Valley Width (ft): 901
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Sometimes	Confinement Type: BD
Berm: 494 3 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 1,855 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 2,868				

1.6 Grade Controls: **None**



Phase 2 Segment Summary Report

Ottauquechee

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Stream: **Ottauquechee Mainstem** Reach: **M18-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	166.00	2.11 Riffle/Step Spacing:	386 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.70	2.12 Substrate Composition		Bed:	15.4 inches
2.3 Mean Depth (ft):	3.08	Bedrock:	0.0 %	Bar:	9.4 inches
2.4 Floodprone Width (ft.):	192.50	Boulder:	2.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	10.10	Cobble:	43.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	36.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	53.90	Fine Gravel:	9.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.16	Sand:	10.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	2.15	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	8	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Moderate	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type <u>Left</u> <u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	707.8	1,010.9	Dominant: Deciduous Deciduous
Material Type:	Mix	Mix	Erosion Height (ft.):	3.2	3.7	Sub-dominant: Shrubs/Sapling None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Multiple	Bank Canopy
Lower			Revetment Length:	618.1	299.8	Canopy %: 51-75 76-100
Material Type:	Boulder/Cobbl	Boulder/Cobbl				Mid-Channel Canopy: Open
Consistency:	Non-cohesive	Non-cohesive				

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	26-50	26-50	Dominant
Sub-Dominant	0-25	>100	Sub-dominant
W less than 25	2,740	559	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Deciduous	Gullies
Sub-Dominant	None	None	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	
Sub-Dominant	None	Residential	Height	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M18-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	135	Yes	Yes	No	Yes	Deposition Above

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid:	2 Delta: 1	Flood chutes: 17	Avulsion: 0	5.5 Straightening: Straightening
Point:	2 Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 4,474
Side:	16 Braiding: 0	Steep Riffles: 6	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection:		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		3	C to F	Yes	Geomorphic Rating	0.26
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		3	None	No	Channel Evolution Stage	III
7.4 Change in Planforml		8	None	No	Geomorphic Condition	Poor
Total Score		21			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M18-B	Organization:	Bear Creek Environmental
Segment Length(ft):	2,183	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	9/14/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins at the end of the farm field on the northern bank and continues 2,200 feet upstream until the confluence of Cox District Brook with the Ottauquechee River.**

Step 5 - Notes: **Segment M18-B is one of the few segment on the Ottauquechee Rive that does not have a valley confinement change because of US Route 4. The Phase 1 and 2 confinement is Broad.**

Step 7 - Narrative: **Channel is very entrenched as it has lost floodplain access on the right side for most of the segment. There is a stream type departure from a C to F with major incision. The incision and aggradation from Irene has caused extreme widening and now the channel is building a new floodplain. There are very large flood chutes in the riffle sections and the rest of the channel is mostly plane bed. Extensive erosion when rip rap is not present. The channel evolution stage is late F-III or early F-IV. The bars need to build some more to have a juvenile floodplain at a lower elevation.**

Step 1. Valley and Floodplain

1.1 Segmentation: Valley Width	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Very Steep	Very Steep	Valley Width (ft): 952
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>
Berm:	0	0	0	Within 1 Bankfull W: Sometimes
Road:	1,082	0	0	Texture:
Railroad:	0	0	0	N.E.
Imp. Path:	0	0	0	N.E.
Dev.:	1,759	0	0	In Rock Gorge: No
				Human Caused Change in Valley Width?: No
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M18-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	171.10	2.11 Riffle/Step Spacing:	739 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.30	2.12 Substrate Composition		Bed:	17.1 inches
2.3 Mean Depth (ft.):	3.08	Bedrock:	0.0 %	Bar:	7.1 inches
2.4 Floodprone Width (ft.):	224.20	Boulder:	16.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	7.20	Cobble:	35.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	23.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	55.55	Fine Gravel:	10.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.31	Sand:	16.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.67	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	15	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Moderate	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type <u>Left</u> <u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	723.6	1,330.8	Dominant: Shrubs/Sapling Deciduous
Material Type:	Sand	Mix	Erosion Height (ft.):	8.5	5.3	Sub-dominant: Herbaceous Shrubs/Sapling
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	Bank Canopy
Lower			Revetment Length:	437.7	0.0	Canopy %: 26-50 51-75
Material Type:	Boulder/Cobbl	Boulder/Cobbl				Mid-Channel Canopy: Open
Consistency:	Non-cohesive	Non-cohesive				

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	51-100	26-50	Dominant
Sub-Dominant	26-50	>100	Sub-dominant
W less than 25	0	210	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Deciduous	Deciduous	Gullies
Sub-Dominant	Herbaceous	Shrubs/Sapling	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Residential	Residential	Mass Failures	198.38	
Sub-Dominant	None	None	Height	10.0	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Failures	One	10.0	Gullies Length	0	
Gullies	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M18-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: None	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 3
4.3 Flow Status: Moderate	Impoundments: None	Other: 1 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: 2	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0 Delta: 0	Flood chutes: 4 Avulsion: 0	5.5 Straightening: Straightening
Point: 1 Island: 0	5.3 Steep Riffles and Head Cuts Head Cuts: 0	Straightening Length (ft.): 1,897
Side: 3 Braiding: 0	Steep Riffles: 1 Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		4	C to F	Yes	Geomorphic Rating	0.21
7.2 Channel Aggradation		4	None	No	Channel Evolution Model	F
7.3 Widening Channel		2	None	No	Channel Evolution Stage	III
7.4 Change in Planform		7	None	No	Geomorphic Condition	Poor
Total Score		17			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M19-A	Organization:	Bear Creek Environmental
Segment Length(ft):	3,692	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	9/14/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins at the confluence of Cox District Brook and the Ottauquechee River and continues upstream 3,700 feet until Fletcher Hill Road comes close to the southern river bank.**

Step 5 - Notes:

Step 7 - Narrative: **Major incision and aggradation. Aggradation from Irene has filled in channel and led to extreme widening and major planform change. Channel is trying to build new flood plain, but some material has been removed in places and channel dredging may have occurred in some places. Channel evolution stage is early IV.**

Step 1. Valley and Floodplain

1.1 Segmentation: Banks and Buffers	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Very Steep	Extr. Steep	Valley Width (ft): 1,827
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Sometimes	Confinement Type: VB
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 983 0				
1.6 Grade Controls: None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M19-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	154.12	2.11 Riffle/Step Spacing:	271 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.90	2.12 Substrate Composition		Bed:	14.5 inches
2.3 Mean Depth (ft):	3.20	Bedrock:	0.0 %	Bar:	6.4 inches
2.4 Floodprone Width (ft.):	1,168.00	Boulder:	11.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	8.00	Cobble:	46.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	20.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	48.16	Fine Gravel:	6.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	7.58	Sand:	16.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.63	Silt and Smaller:	1.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	12	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Moderate				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	365.5	1,597.1	Dominant:	Shrubs/Sapling	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	3.0	6.3	Sub-dominant:	Herbaceous	Shrubs/Sapling
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	None	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	0.0	567.4	Canopy %:	51-75	51-75
Material Type:	Boulder/Cobbles	Boulder/Cobbles				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	51-100	51-100	Dominant
Sub-Dominant	None	None	Sub-dominant
W less than 25	270	918	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Deciduous	Herbaceous	Gullies
Sub-Dominant	Herbaceous	Deciduous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	Mass Failures	<u>Left</u>	<u>Right</u>
Dominant	Crop	Residential	Height		49.89
Sub-Dominant	Forest	Forest	Gullies Number	1	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Length	0	
Failures	One	10.0			
Gullies	One	4.0			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M19-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 4 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0	Delta: 0	Flood chutes: 8	Avulsion: 0	5.5 Straightening: Straightening
Point: 2	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 3,074
Side: 13	Braiding: 0	Steep Riffles: 3	Trib Rejuv.: No	5.5 Dredging: Gravel Mining

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		8	None	Yes	Geomorphic Rating	0.31
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		4	None	No	Channel Evolution Stage	IV
7.4 Change in Planform		7	None	No	Geomorphic Condition	Poor
Total Score		25			Stream Sensitivity	High



Phase 2 Segment Summary Report Ottawaquechee

Stream:	Ottaquechee Mainstem	SGAT Version:	4.56
Reach:	M19-B	Organization:	Bear Creek Environmental
Segment Length(ft):	1,349	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	9/10/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where Fletcher Hill Road comes close to the southern bank and continues 1,350 feet upstream to just below the Bridges Road covered bridge.**

Step 5 - Notes: **US Route 4 has resulted in a change in valley confinement from very broad to broad.**

Step 7 - Narrative: **Minor incision. Aggradation and high flows from Irene has most likely caused extreme widening. Aggradation is major as seen through steep riffles and diagonal bars. Large side bar has been excavated and material pushed up onto bank. Planform is major as aggradation has impacted thalweg lining up. Channel is trying to build a new floodplain, but now material has been removed. Segment is a C by reference based on valley width, but could be a B by reference because there is a natural high terrace. The channel evolution stage is early F-IV.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Banks and Buffers	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Steep	Extr.Steep	Valley Width (ft): 898
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W: Sometimes Sometimes
Berm:	0		0		Texture: N.E. N.E.
Road:	0		0		In Rock Gorge: No
Railroad:	0		0		Human Caused Change in Valley Width?: Yes
Imp. Path:	0		0		
Dev.:	711		0		
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M19-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	185.80	2.11 Riffle/Step Spacing:	244 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.55	2.12 Substrate Composition		Bed:	10.24 inches
2.3 Mean Depth (ft.):	3.44	Bedrock:	0.0 %	Bar:	6.92 inches
2.4 Floodprone Width (ft.):	390.00	Boulder:	4.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	6.28	Cobble:	30.0 %	Stream Type:	B
Human Elev FloodPln (ft.):		Coarse Gravel:	39.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	54.01	Fine Gravel:	12.0 %	Subclass Slope:	c
2.7 Entrenchment Ratio:	2.10	Sand:	15.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.38	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	1	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Moderate			
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	418.9	257.6	Dominant:	Herbaceous	Deciduous
Material Type:	Sand	Boulder/Cobble	Erosion Height (ft.):	6.6	4.0	Sub-dominant:	Deciduous	None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	22.7	309.4	Canopy %:	1-25	51-75
Material Type:	Boulder/Cobble	Sand				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	0-25
Sub-Dominant	None	26-50
W less than 25	961	984
Buffer Vegetation Type		
Dominant	Herbaceous	Herbaceous
Sub-Dominant	Deciduous	Deciduous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Crop	Mass Failures	
Sub-dominant	None	Residential	Height	
(Legacy)	<u>Amount</u>	<u>Mean Height</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottawaquechee

Stream: **Ottawaquechee Mainstem** Reach: **M19-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	Minimal	4.5 Flow Regulation Type	None	4.7 Stormwater Inputs	
4.2 Adjacent Wetlands:	None	Flow Reg. Use:		Field Ditch:	0 Road Ditch: 0
4.3 Flow Status:	Moderate	Impoundments:	None	Other:	0 Tile Drain: 0
4.4 # of Debris Jams:	0	Impoundment Loc.:		Overland Flow:	1 Urb Strm Wtr Pipe: 0
		4.6 Up/Down Strm flow reg.:	None	4.9 # of Beaver Dams:	0
		(old) Upstrm Flow Reg.:		Affected Length (ft):	0
4.8 Channel Constrictions:	None				

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing:	No
Mid:	0 Delta: 0	Flood chutes:	2	5.5 Straightening:	Straightening
Point:	0 Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.):	1,327
Side:	5 Braiding: 0	Steep Riffles:	3	5.5 Dredging:	Gravel Mining
		Trib Rejuv.:	No		

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradient Type	<u>Left</u> <u>Right</u>
6.2 Pool Substrate:		6.5 Channel Flow Status:		6.8 Bank Stability:	
6.3 Pool Variability:		6.6 Channel Alteration:		6.9 Bank Vegetation Protection	
Total Score:	0	6.7 Channel Sinuosity:		6.10 Riparian Veg. Zone Width:	
Habitat Rating:	0.00				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		13	C to B	Yes	Geomorphic Rating	0.36
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		2	None	No	Channel Evolution Stage	IV
7.4 Change in Planform		8	None	No	Geomorphic Condition	Fair
Total Score		29			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M20-A	Organization:	Bear Creek Environmental
Segment Length(ft):	2,832	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	8/31/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins just below the Bridges Road covered bridge and continues 2,800 feet upstream along Route 4 until the farm fields on the southern bank change to forest.**

Step 5 - Notes:

Step 7 - Narrative: **Extreme degradation with entrenchment <2 and a stream type departure from a C to F. Aggradation is major as sediments deposited from Irene work their way through. Abundant erosion as banks slough off creating side bars with flood chutes behind them. Planform is adjusting to extreme widening, aggradation, and trying to build a new floodplain. The channel evolution stage is late F-III or early F-IV.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Banks and Buffers	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Very Steep	Extr. Steep	Valley Width (ft): 642
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W: Sometimes
Berm:	0		0		Texture: N.E.
Road:	513		0	0	N.E.
Railroad:	0		0	0	In Rock Gorge: No
Imp. Path:	0		0	0	Human Caused Change in Valley Width?: Yes
Dev.:	57		2,027	2,027	

1.6 Grade Controls: **None**



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M20-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	130.20	2.11 Riffle/Step Spacing:	215 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	5.60	2.12 Substrate Composition		Bed:	18.2 inches
2.3 Mean Depth (ft):	3.94	Bedrock:	0.0 %	Bar:	10.9 inches
2.4 Floodprone Width (ft.):	155.50	Boulder:	15.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	10.80	Cobble:	11.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	42.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	33.05	Fine Gravel:	11.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.19	Sand:	21.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.93	Silt and Smaller:	%	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	5	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Moderate	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	950.3	518.4	
Material Type:	Sand	Mix	Erosion Height (ft.):	3.3	2.5	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Hard Bank	
Lower			Revetment Length:	724.0	40.0	
Material Type:	Boulder/Cobbles	Boulder/Cobbles				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Herbaceous	Deciduous
				Sub-dominant:	Shrubs/Sapling	None
				Bank Canopy		
				Canopy %:	0	76-100
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	26-50	Dominant
Sub-Dominant	None	0-25	Sub-dominant
W less than 25	2,115	401	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Deciduous	Gullies
Sub-Dominant	Deciduous	Herbaceous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Residential	Crop	Mass Failures		
Sub-Dominant	Forest	Forest	Height		
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Failures	None		Gullies Length	0	
Gullies	None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M20-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type: None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 2 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	117	Yes	Yes	No	Yes	Deposition Above, Deposition Below, Scour Above

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid:	3	Flood chutes:	5	Avulsion: 0
Point:	1	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	5.5 Straightening: Straightening
Side:	11	Steep Riffles:	5	Trib Rejuv.: No
				Straightening Length (ft.): 2,803
				5.5 Dredging: Dredging

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		3	C to F	Yes	Geomorphic Rating	0.29
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		7	None	No	Channel Evolution Stage	III
7.4 Change in Planform		6	None	No	Geomorphic Condition	Poor
Total Score		23			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M20-B	Organization:	Bear Creek Environmental
Segment Length(ft):	2,036	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	8/31/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the southern bank becomes forested and continues upstream for 2,000 feet until the valley becomes a bit narrower. This is approximately where Doe Hill Way intersects Route 4.**

Step 5 - Notes: **US Route 4 has resulted in a change in valley confinement from broad to semi-confined!**

Step 7 - Narrative: **Stream type departure from a C to F due to road encroachment and degradation (incision = 2.6). Incision ratio may be overexaggerated - used the top of the road for RAF as no other feature was available. Extreme widening and major planform change due to channel straightening and adjusting to aggradation from Irene. Cross section location was altered by post flood work.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Banks and Buffers	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Very Steep	Very Steep	Valley Width (ft): 257
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0	0	Never
Road:	1,864		0	168	Sometimes
Railroad:	0		0	0	Never
Imp. Path:	0		0	0	Sometimes
Dev.:	1,576		0	0	Never
1.6 Grade Controls:	None	Texture:	N.E.	N.E.	In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes



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Phase 2 Segment Summary Report

Ottawaquechee

Stream: **Ottawaquechee Mainstem** Reach: **M20-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	139.90	2.11 Riffle/Step Spacing:	232 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	5.80	2.12 Substrate Composition		Bed:	12.3 inches
2.3 Mean Depth (ft):	3.51	Bedrock:	1.0 %	Bar:	10.1 inches
2.4 Floodprone Width (ft.):	160.40	Boulder:	6.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	15.10	Cobble:	33.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	37.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	39.86	Fine Gravel:	13.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.15	Sand:	10.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	2.60	Silt and Smaller:	%	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	7	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope: Steep					
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	188.0	749.8	Dominant:	Herbaceous	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	4.8	3.2	Sub-dominant:	Deciduous	Bare
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	620.9	360.5	Canopy %:	1-25	51-75
Material Type:	Boulder/Cobbl	Boulder/Cobbl				Mid-Channel Canopy:	Open	
	e	e						
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	>100
Sub-Dominant	None	None
W less than 25	1,141	0
Buffer Vegetation Type		
Dominant	Herbaceous	Deciduous
Sub-Dominant	Deciduous	Herbaceous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	127.84
Sub-dominant	None	None	Height	13.1
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	Multiple	13.5	Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M20-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 4	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 1	Flood chutes: 4	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 2,001
Side: 6	Braiding: 0	Steep Riffles: 7	Trib Rejuv.: Yes	5.5 Dredging: Dredging, Gravel Mining

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		2	C to F	Yes	Geomorphic Rating	0.28
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		4	None	No	Channel Evolution Stage	III
7.4 Change in Planform		9	None	No	Geomorphic Condition	Poor
Total Score		22			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report Ottawaquechee

Stream:	Ottaquechee Mainstem	SGAT Version:	4.56
Reach:	M21-A	Organization:	Bear Creek Environmental
Segment Length(ft):	1,680	Observers:	PD,EK
Rain:	Yes	Completion Date:	8/29/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins approximately where Doe Hill Way intersects Route 4 and continues upstream 1,700 feet along a residential area until the southern bank becomes forested.**

Step 5 - Notes: **US Route 4 has resulted in a change in valley confinement from broad to narrow.**

Step 7 - Narrative: **Stream type departure from C to F due to channel incision and encroachment of road. Extreme degradation and major aggradation due to sediment load from TSI. Major widening and planform adjustment as channel adjusts to incision and aggradation.**

Step 1. Valley and Floodplain

1.1 Segmentation: Banks and Buffers	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Very Steep	Valley Width (ft): 446
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Never	Confinement Type: NW
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 565 0 991 0		Human Caused Change in Valley Width?: Yes		
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 1,393				
1.6 Grade Controls: None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem**

Reach: **M21-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	124.70	2.11 Riffle/Step Spacing:	329 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	5.00	2.12 Substrate Composition		Bed:	15.4 inches
2.3 Mean Depth (ft.):	3.77	Bedrock:	0.0 %	Bar:	9.1 inches
2.4 Floodprone Width (ft.):	156.20	Boulder:	8.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	13.80	Cobble:	30.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	32.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	33.08	Fine Gravel:	14.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.25	Sand:	16.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	2.76	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	3	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	205.8	219.6	
Material Type:	Sand	Sand	Erosion Height (ft.):	8.0	2.6	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap	
Lower			Revetment Length:	842.5	380.2	
Material Type:	Boulder/Cobbl	Boulder/Cobbl				
Consistency:	Cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Herbaceous	Deciduous
				Sub-dominant:	Shrubs/Sapling	Herbaceous
				Bank Canopy		
				Canopy %:	0	76-100
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	26-50	Dominant
Sub-Dominant	26-50	0-25	Sub-dominant
W less than 25	925	618	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Deciduous	Deciduous	Gullies
Sub-Dominant	None	Herbaceous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Residential	Residential	Mass Failures		
Sub-Dominant	Forest	Pasture	Height		
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Failures	None		Gullies Length	0	
Gullies	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M21-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 0
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Old Abutment	114	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 0	Flood chutes: 4	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,362
Side: 5	Braiding: 0	Steep Riffles: 3	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		3	C to F	Yes	Geomorphic Rating	0.29
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		7	None	No	Channel Evolution Stage	III
7.4 Change in Planforml		7	None	No	Geomorphic Condition	Poor
Total Score		23			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M21-B	Organization:	Bear Creek Environmental
Segment Length(ft):	3,185	Observers:	PD,EK
Rain:	Yes	Completion Date:	8/29/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the southern bank becomes forested and continues upstream 3,200 feet until the southern bank changes to cropland.**

Step 5 - Notes: **US Route 4 has resulted in change in valley confinement from narrow to narrowly confined.**

Step 7 - Narrative: **Extreme incision leading to entrenchment <2 and a stream type departure from a C to an F. RAF was not distinct so the incision ratio may have been overestimated. We used the top of Route 4 for the RAF. Major aggradation was seen through large and sedimented steep riffles and diagonal bars. Widening is extreme and is a result of channel alteration and aggradation. Planform adjustment is major as well. The channel evolution stage is late F-III.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Banks and Buffers	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Very Steep	Extr. Steep	Valley Width (ft): 195
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Never
Road:	3,185		0		Sometimes
Railroad:	0		0		Texture:
Imp. Path:	0		0		N.E.
Dev.:	2,306		0		N.E.
					In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M21-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	145.50	2.11 Riffle/Step Spacing:	285 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	5.10	2.12 Substrate Composition		Bed:	17.8 inches
2.3 Mean Depth (ft.):	3.58	Bedrock:	8.0 %	Bar:	7.4 inches
2.4 Floodprone Width (ft.):	168.00	Boulder:	10.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	12.70	Cobble:	43.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	19.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	40.64	Fine Gravel:	5.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.15	Sand:	15.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	2.49	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	2	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Steep				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	880.4	830.3	Dominant:	Herbaceous	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	1.1	3.1	Sub-dominant:	None	Coniferous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	Bank Canopy		
Lower			Revetment Length:	326.9	0.0	Canopy %:	0	76-100
Material Type:	Mix	Mix				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	>100
Sub-Dominant	26-50	None
W less than 25	2,516	0
Buffer Vegetation Type		
Dominant	Herbaceous	Deciduous
Sub-Dominant	None	Coniferous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	
Sub-dominant	None	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M21-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: 7	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0 Delta: 0	Flood chutes: 2 Avulsion: 0	5.5 Straightening: Straightening
Point: 0 Island: 0	5.3 Steep Riffles and Head Cuts Head Cuts: 0	Straightening Length (ft.): 3,185
Side: 5 Braiding: 1	Steep Riffles: 5 Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		2	C to F	Yes	Geomorphic Rating	0.24
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		4	None	No	Channel Evolution Stage	III
7.4 Change in Planform		7	None	No	Geomorphic Condition	Poor
Total Score		19			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M21-C	Organization:	Bear Creek Environmental
Segment Length(ft):	2,945	Observers:	PD,EK
Rain:	Yes	Completion Date:	8/29/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **Segment begins where valley widens out and southern buffer becomes more agricultural and continues upstream for 2,945 feet until southern buffer is forested again.**

Step 5 - Notes: **US Route 4 has resulted in a change of confinement ratio from 8.15 to 6.14; however, Phase 1 and 2 valley widths are broad.**

Step 7 - Narrative: **Incision ratio good, but RAF was not distinct. Entrenchment was extreme and there is a stream type departure from a C to an F. This is likely because of the placement of Route 4. Widening is major though being prevented by rip rap. Planform adjustment is major due to major aggradation as seen by many diagonal bars and steep riffles. Planform alteration also due to straightening.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Valley Width	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Very Steep	Very Steep	Valley Width (ft): 645
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Never
Road:	1,971		0	0	Texture:
Railroad:	0		0		N.E.
Imp. Path:	0		0		N.E.
Dev.:	549		0		In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M21-C**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	121.70	2.11 Riffle/Step Spacing:	331 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	5.20	2.12 Substrate Composition		Bed:	16.5 inches
2.3 Mean Depth (ft.):	3.97	Bedrock:	0.0 %	Bar:	11.1 inches
2.4 Floodprone Width (ft.):	144.00	Boulder:	12.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	11.60	Cobble:	31.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	32.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	30.65	Fine Gravel:	5.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.18	Sand:	20.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	2.23	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	13	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Moderate	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	176.9	966.7	
Material Type:	Boulder/Cobbles	Sand	Erosion Height (ft.):	1.8	2.3	
Consistency:	Cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	
Lower			Revetment Length:	1,315.5	0.0	
Material Type:	Boulder/Cobbles	Boulder/Cobbles				
Consistency:	Cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Herbaceous	Deciduous
				Sub-dominant:	None	Shrubs/Sapling
				Bank Canopy		
				Canopy %:	0	76-100
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	26-50
Sub-Dominant	None	>100
W less than 25	2,556	99
Buffer Vegetation Type		
Dominant	Deciduous	Deciduous
Sub-Dominant	None	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Crop	Mass Failures	
Sub-dominant	None	Forest	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Stream Geomorphic Assessment

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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M21-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 2 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 4	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 3	Flood chutes: 1	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 2,945
Side: 10	Braiding: 1	Steep Riffles: 4	Trib Rejuv.: Yes	5.5 Dredging: Dredging,Gravel Mining

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		3	C to F	Yes	Geomorphic Rating	0.29
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		7	None	No	Channel Evolution Stage	III
7.4 Change in Planform		7	None	No	Geomorphic Condition	Poor
Total Score		23			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M21-D	Organization:	Bear Creek Environmental
Segment Length(ft):	2,782	Observers:	PD,EK
Rain:	Yes	Completion Date:	8/29/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the southern bank changes from cropland back to forest and continues 2,800 feet upstream to the reach break at the confluence with Curtis Hollow Brook.**

Step 5 - Notes: **US Route 4 has resulted in a change in valley confinement from broad to narrow.**

Step 7 - Narrative: **Extreme historic incision and entrenchment, which has caused a stream type departure from a C to an F. Aggradation and widening are major due to channel alteration and aggradation. More aggradational on downstream end. Thalweg is not in line with planform - planform is altered due to straightening and channel adjusting from aggradation.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Valley Width	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Hilly	Extr.Steep	Valley Width (ft): 445
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Never
Road:	0		1,752	0	Sometimes
Railroad:	0		0		Texture:
Imp. Path:	0		0		N.E.
Dev.:	2,184		0		N.E.
					In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



Stream Geomorphic Assessment



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M21-D**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	116.00	2.11 Riffle/Step Spacing:	313 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.50	2.12 Substrate Composition		Bed:	15.2 inches
2.3 Mean Depth (ft):	3.34	Bedrock:	0.0 %	Bar:	9.4 inches
2.4 Floodprone Width (ft.):	144.00	Boulder:	7.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	14.90	Cobble:	39.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	24.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	34.73	Fine Gravel:	16.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.24	Sand:	14.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	3.31	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	8	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Moderate	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type <u>Left</u> <u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	146.2	933.7	Dominant: Herbaceous Deciduous
Material Type:	Sand	Mix	Erosion Height (ft.):	8.0	6.6	Sub-dominant: Shrubs/Sapling Herbaceous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap	Bank Canopy
Lower			Revetment Length:	690.2	444.2	Canopy %: 1-25 51-75
Material Type:	Boulder/Cobbl	Boulder/Cobbl				Mid-Channel Canopy: Open
Consistency:	Non-cohesive	Non-cohesive				

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	0-25	Dominant
Sub-Dominant	26-50	26-50	Sub-dominant
W less than 25	1,156	1,559	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Deciduous	Gullies
Sub-Dominant	Deciduous	Herbaceous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	
Sub-Dominant	None	Residential	Height	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M21-D**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	Abundant	4.5 Flow Regulation Type	None	4.7 Stormwater Inputs	
4.2 Adjacent Wetlands:	None	Flow Reg. Use:		Field Ditch:	0 Road Ditch: 2
4.3 Flow Status:	Moderate	Impoundments:	None	Other:	0 Tile Drain: 0
4.4 # of Debris Jams:	0	Impoundment Loc.:		Overland Flow:	5 Urb Strm Wtr Pipe: 0
		4.6 Up/Down Strm flow reg.:	None	4.9 # of Beaver Dams:	0
		(old) Upstrm Flow Reg.:		Affected Length (ft):	0
4.8 Channel Constrictions:	None				

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing:	No
Mid:	3 Delta: 2	Flood chutes: 2	Avulsion: 0	5.5 Straightening:	Straightening
Point:	0 Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.):	2,546
Side:	7 Braiding: 0	Steep Riffles: 4	Trib Rejuv.: Yes	5.5 Dredging:	None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradient Type	<u>Left</u> <u>Right</u>
6.2 Pool Substrate:		6.5 Channel Flow Status:		6.8 Bank Stability:	
6.3 Pool Variability:		6.6 Channel Alteration:		6.9 Bank Vegetation Protection	
Total Score:	0	6.7 Channel Sinuosity:		6.10 Riparian Veg. Zone Width:	
Habitat Rating:	0.00				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		3	C to F	Yes	Geomorphic Rating	0.32
7.2 Channel Aggradation		8	None	No	Channel Evolution Model	F
7.3 Widening Channel		7	None	No	Channel Evolution Stage	III
7.4 Change in Planform		8	None	No	Geomorphic Condition	Poor
Total Score		26			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M22-A	Organization:	Bear Creek Environmental
Segment Length(ft):	2,176	Observers:	Pam, Emily
Rain:	No	Completion Date:	8/22/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where Curtis Hollow Brook enters the Ottauquechee River and continues 2,200 feet upstream to where the southern corridor changes from residential to forest. This is located just upstream of the Curtis Hollow Road bridge.**

Step 5 - Notes:

Step 7 - Narrative: **Extreme historic incision due to channel and floodplain alteration. Widening is minor and being controlled by rip rap on both banks. Bed form has changed to plane bed through most of segment and large diagonal bars with steep riffles in rest of segment. Major aggradation. Planform adjustment is major due to straightening and aggradation. Segment is one percentage point away from being in "poor" condition with "extreme" sensitivity.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Banks and Buffers	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Steep	Very Steep	Valley Width (ft): 551
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Never
Road:	1,974		0		Never
Railroad:	0		0		Texture:
Imp. Path:	0		0		N.E.
Dev.:	2,124		0		N.E.
					In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	3.0	2.0	Yes	



Stream Geomorphic Assessment



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M22-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	92.80	2.11 Riffle/Step Spacing:	320 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.80	2.12 Substrate Composition		Bed:	17 inches
2.3 Mean Depth (ft.):	3.73	Bedrock:	0.0 %	Bar:	7.9 inches
2.4 Floodprone Width (ft.):	118.80	Boulder:	2.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	12.20	Cobble:	5.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	25.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	24.88	Fine Gravel:	47.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.28	Sand:	17.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	2.54	Silt and Smaller:	3.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	11	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Steep				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	138.2	637.1	Dominant:	Shrubs/Sapling	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	2.0	3.4	Sub-dominant:	Deciduous	Herbaceous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	673.8	558.8	Canopy %:	26-50	51-75
Material Type:	Mix	Mix				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	26-50	0-25	Dominant
Sub-Dominant	0-25	26-50	Sub-dominant
W less than 25	533	1,347	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Herbaceous	Gullies
Sub-Dominant	Shrubs/Sapling	None	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Residential	Hay	Mass Failures		
Sub-Dominant	None	Residential	Height		
Amount	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Failures	None		Gullies Length	0	
Gullies	None				



Stream Geomorphic Assessment

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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M22-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type Small Withdrawal	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use: Other	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 3 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	63	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0	Delta: 0	Flood chutes: 0	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,987
Side: 5	Braiding: 0	Steep Riffles: 2	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		3	C to F	Yes	Geomorphic Rating	0.35
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		12	None	No	Channel Evolution Stage	II
7.4 Change in Planform		7	None	No	Geomorphic Condition	Fair
Total Score		28			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M22-B	Organization:	Bear Creek Environmental
Segment Length(ft):	4,096	Observers:	Pam, Emily
Rain:	No	Completion Date:	8/22/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins just above the Curtis Hollow Road bridge and continues 4,100 feet upstream to where the river valley narrows and Route 4 becomes continuous with the northern bank.**

Step 5 - Notes: **US Route 4 has resulted in a change in channel confinement from narrow to semi-confined.**

Step 7 - Narrative: **Extreme historic incision from channel alteration has led to major widening. Aggradation is major from Irene & contributing to major widening & planform change. Large flood chutes present.**

Step 1. Valley and Floodplain

1.1 Segmentation: Banks and Buffers	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Steep	Very Steep	Valley Width (ft): 392
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Sometimes	Confinement Type: SC
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 3,922 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 3,635 0				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M22-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	116.40	2.11 Riffle/Step Spacing:	338 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.60	2.12 Substrate Composition		Bed:	13.3 inches
2.3 Mean Depth (ft.):	3.16	Bedrock:	1.0 %	Bar:	8 inches
2.4 Floodprone Width (ft.):	141.40	Boulder:	10.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	11.20	Cobble:	40.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	25.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	36.84	Fine Gravel:	11.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.21	Sand:	12.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	2.43	Silt and Smaller:	1.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Moderate	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	12	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	0.0	640.5	
Material Type:	Sand	Sand	Erosion Height (ft.):	0.0	2.9	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	
Lower			Revetment Length:	556.6	0.0	
Material Type:	Boulder/Cobbl	Boulder/Cobbl				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Shrubs/Sapling	Deciduous
				Sub-dominant:	Herbaceous	None
				Bank Canopy		
				Canopy %:	1-25	76-100
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	0-25	>100	Dominant	Residential	Forest	Mass Failures	139.15
Sub-Dominant	26-50	51-100	Sub-dominant	Shrubs/Sapling	None	Height	20.0
W less than 25	846	115	(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Buffer Vegetation Type			Failures	One	20.0	Gullies Length	0
Dominant	Herbaceous	Deciduous	Gullies	None			
Sub-Dominant	None	None					

3.3 Riparian Corridor



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M22-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type Small Withdrawal	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use: Other	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 5	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: Yes
Mid: 4	Delta: 3	Flood chutes: 2	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 3,463
Side: 12	Braiding: 0	Steep Riffles: 3	Trib Rejuv.: Yes	5.5 Dredging: Gravel Mining

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		3	C to F	Yes	Geomorphic Rating	0.28
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		7	None	No	Channel Evolution Stage	III
7.4 Change in Planform		6	None	No	Geomorphic Condition	Poor
Total Score		22			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M23-A	Organization:	Bear Creek Environmental
Segment Length(ft):	1,763	Observers:	Mary, Emily
Rain:	Yes	Completion Date:	9/11/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the valley becomes narrow and Route 4 becomes adjacent to the northern bank again. It continues 1,800 feet upstream to where the valley becomes a bit wider, approximately across from where Robinson Road intersects Route 4.**

Step 5 - Notes:

Step 7 - Narrative: **This segment is undergoing minor aggradation, and planform adjustment. Minor historic incision. The major process occurring is widening, as seen through a high w/d ratio and extensive erosion. In some areas widening and planform adjustment is limited by rip rap on left bank.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr. Steep	Very Steep	Valley Width (ft): 281
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W: Sometimes
Berm:	0		0		Texture: N.E.
Road:	1,534		0		N.E.
Railroad:	0		0		In Rock Gorge: No
Imp. Path:	0		0		Human Caused Change in Valley Width?: Yes
Dev.:	0		0		
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

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Stream: **Ottauquechee Mainstem** Reach: **M23-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	97.00	2.11 Riffle/Step Spacing:	208 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	5.00	2.12 Substrate Composition		Bed:	15.9 inches
2.3 Mean Depth (ft):	3.01	Bedrock:	0.0 %	Bar:	11 inches
2.4 Floodprone Width (ft.):	170.50	Boulder:	13.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	6.50	Cobble:	40.0 %	Stream Type:	B
Human Elev FloodPln (ft.):		Coarse Gravel:	15.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	32.23	Fine Gravel:	16.0 %	Subclass Slope:	c
2.7 Entrenchment Ratio:	1.76	Sand:	16.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.30	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	B
2.10 Riffles Type:	Eroded	# Large Woody Debris:	1	Reference Bed Material:	Cobble
				Reference Subclass Slope:	c
				Reference Bedform:	Riffle-Pool

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Moderate	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	401.9	802.4	
Material Type:	Sand	Sand	Erosion Height (ft.):	2.3	1.9	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	
Lower			Revetment Length:	573.6	0.0	
Material Type:	Mix	Boulder/Cobble				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Herbaceous	Deciduous
				Sub-dominant:	Shrubs/Sapling	None
				Bank Canopy		
				Canopy %:	0	76-100
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	>100
Sub-Dominant	26-50	None
W less than 25	1,528	0
Buffer Vegetation Type		
Dominant	Herbaceous	Deciduous
Sub-Dominant	Shrubs/Sapling	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	Mass Failures	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Height		
Sub-dominant	Shrubs/Sapling	None	Gullies Number	0	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Length	0	
Failures	None				
Gullies	None				



Stream Geomorphic Assessment

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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M23-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 0	Flood chutes: 2	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,763
Side: 6	Braiding: 0	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Confined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		12	None	Yes	Geomorphic Rating	0.60
7.2 Channel Aggradation		13	None	No	Channel Evolution Model	F
7.3 Widening Channel		10	None	No	Channel Evolution Stage	III
7.4 Change in Planform		13	None	No	Geomorphic Condition	Fair
Total Score		48			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M23-B	Organization:	Bear Creek Environmental
Segment Length(ft):	1,999	Observers:	Mary, Emily
Rain:	Yes	Completion Date:	9/11/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the valley becomes a bit wider, approximately across from where Robinson Road intersects Route 4, and continues upstream 2,000 feet to where Broad Brook enters the Ottauquechee.**

Step 5 - Notes: **US Route 4 has resulted in a change in valley confinement from narrow to semi-confined.**

Step 7 - Narrative: **Major historic incision, major aggradation as evident by mid channel bars and diagonal bars. Channel is widening especially along right bank. Minor planform adjustment.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 319
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Never	Confinement Type: SC
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 396 0 1,377 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 0				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M23-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	109.50	2.11 Riffle/Step Spacing:	211 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.90	2.12 Substrate Composition		Bed:	13.8 inches
2.3 Mean Depth (ft):	3.32	Bedrock:	0.0 %	Bar:	5.1 inches
2.4 Floodprone Width (ft.):	171.00	Boulder:	11.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	8.60	Cobble:	46.0 %	Stream Type:	B
Human Elev FloodPln (ft.):		Coarse Gravel:	21.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	32.98	Fine Gravel:	12.0 %	Subclass Slope:	c
2.7 Entrenchment Ratio:	1.56	Sand:	10.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.76	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	1	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Moderate			
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	61.6	296.8	Dominant:	Shrubs/Sapling	Deciduous
Material Type:	Sand	Mix	Erosion Height (ft.):	2.0	3.8	Sub-dominant:	Deciduous	None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	Bank Canopy		
Lower			Revetment Length:	742.3	0.0	Canopy %:	1-25	76-100
Material Type:	Boulder/Cobbl	Boulder/Cobbl				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	26-50
Sub-Dominant	51-100	None
W less than 25	965	196
Buffer Vegetation Type		
Dominant	Herbaceous	Deciduous
Sub-Dominant	Deciduous	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Residential	Mass Failures	
Sub-dominant	None	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: Ottauquechee Mainstem Reach: M23-B

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: Minimal	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: 6	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 5 Delta: 2	Flood chutes: 2 Avulsion: 0	5.5 Straightening: Straightening
Point: 0 Island: 0	5.3 Steep Riffles and Head Cuts Head Cuts: 0	Straightening Length (ft.): 1,835
Side: 9 Braiding: 0	Steep Riffles: 0 Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		7	C to B	No	Geomorphic Rating	0.46
7.2 Channel Aggradation		9	None	No	Channel Evolution Model	F
7.3 Widening Channel		8	None	No	Channel Evolution Stage	III
7.4 Change in Planform		13	None	No	Geomorphic Condition	Fair
Total Score		37			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M24-A	Organization:	Bear Creek Environmental
Segment Length(ft):	1,848	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	8/16/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins at the confluence with Broad Brook and continues upstream 1,850 feet to approximately 300 feet above the Route 100A bridge.**

Step 5 - Notes: **US Route 4 has resulted in a change in valley confinement from very broad to broad. Could not find bankfull elevation. Bankfull elevation in cross section was based on good bankfull elevations further upstream.**

Step 7 - Narrative: **Major historic incision, but RAF may be higher due to fines deposited. Major aggradation - diagonal bars and steep riffles. One long continuous riffle/plane bed feature. Minor widening. Major planform adjustment due to channel straightening. Channel is wider than upstream reach. Tire tracks on right bank indicate some channel work may have been done. Sediment piled on left bank; tire tracks may be associated with intake pipe newly installed. River Road washed out during tropical storm Irene.**

Step 1. Valley and Floodplain

1.1 Segmentation: Valley Width	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 813
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Sometimes	Confinement Type: BD
Berm: 0 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 1,716 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 753				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M24-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	91.70	2.11 Riffle/Step Spacing:	537 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.95	2.12 Substrate Composition		Bed:	13.9 inches
2.3 Mean Depth (ft):	3.17	Bedrock:	0.0 %	Bar:	12.3 inches
2.4 Floodprone Width (ft.):	694.20	Boulder:	9.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	5.55	Cobble:	63.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	15.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	28.93	Fine Gravel:	6.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	7.57	Sand:	7.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	1.41	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	7	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Steep				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	79.4	603.1	Dominant:	Deciduous	Deciduous
Material Type:	Mix	Mix	Erosion Height (ft.):	3.0	3.4	Sub-dominant:	Shrubs/Sapling	Shrubs/Sapling
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	None	Multiple	Bank Canopy		
Lower			Revetment Length:	0.0	508.1	Canopy %:	51-75	26-50
Material Type:	Boulder/Cobbl	Boulder/Cobbl				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	51-100	0-25	Dominant
Sub-Dominant	26-50	26-50	Sub-dominant
W less than 25	312	942	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Deciduous	Gullies
Sub-Dominant	Deciduous	Herbaceous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Industrial	Residential	Mass Failures		
Sub-Dominant	Forest	Forest	Height		
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Failures	None		Gullies Length	0	
Gullies	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M24-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type Small Withdrawal	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: Minimal	Flow Reg. Use: Other	Field Ditch: 0 Road Ditch: 0
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	107	Yes	Yes	No	Yes	Deposition Above, Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: Yes
Mid: 1	Delta: 1	Flood chutes: 0	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,782
Side: 6	Braiding: 0	Steep Riffles: 3	Trib Rejuv.: No	5.5 Dredging: Dredging

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		10	None	Yes	Geomorphic Rating	0.44
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		12	None	No	Channel Evolution Stage	III
7.4 Change in Planforml		7	None	No	Geomorphic Condition	Fair
Total Score		35			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M24-B	Organization:	Bear Creek Environmental
Segment Length(ft):	1,858	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	8/16/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins 300 feet above the Route 100A bridge and continues 1,850 feet upstream past the Long Trail Brewery and under Route 4 until the confluence with the North Branch of the Ottauquechee near Bridgewater Center Road.**

Step 5 - Notes: **US Route 4 has resulted in a change in valley confinement from broad to narrow.**

Step 7 - Narrative: **Major historic incision from straightening, but RAF may be higher due to fines present. Aggradation is major due to steep riffles and diagonal bars. Excess aggradation has led to major widening (w/d = 35). Planform change is major from straightening and channel is trying to adjust from deposition. Abundant erosion on right bank.**

Step 1. Valley and Floodplain

1.1 Segmentation: Valley Width	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Very Steep	Valley Width (ft): 359
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Sometimes	Confinement Type: NW
Berm: 0 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 1,437 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 1,784				
1.6 Grade Controls: None				



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Phase 2 Segment Summary Report

Ottawaquechee

Stream: **Ottawaquechee Mainstem** Reach: **M24-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	109.80	2.11 Riffle/Step Spacing:	279 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.70	2.12 Substrate Composition		Bed:	22.4 inches
2.3 Mean Depth (ft):	3.11	Bedrock:	0.0 %	Bar:	13.8 inches
2.4 Floodprone Width (ft.):	385.30	Boulder:	21.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	7.50	Cobble:	36.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	26.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	35.31	Fine Gravel:	7.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	3.51	Sand:	10.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.60	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	7	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Moderate	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type <u>Left</u> <u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	267.5	913.5	Dominant: Deciduous Coniferous
Material Type:	Sand	Mix	Erosion Height (ft.):	2.3	4.3	Sub-dominant: Shrubs/Sapling Deciduous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Rip-Rap	Bank Canopy
Lower			Revetment Length:	287.5	81.1	Canopy %: 51-75 76-100
Material Type:	Boulder/Cobbles	Boulder/Cobbles				Mid-Channel Canopy: Open
Consistency:	Non-cohesive	Non-cohesive				

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	51-100	Dominant
Sub-Dominant	26-50	0-25	Sub-dominant
W less than 25	636	441	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Coniferous	Gullies
Sub-Dominant	Deciduous	Deciduous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Commercial	Forest	Mass Failures		84.18
Sub-Dominant	Residential	Residential	Height		23.7
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Failures	Multiple	25.0	Gullies Length	0	
Gullies	None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M24-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type: None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: Minimal	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	51	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above, Alignment

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 1	Flood chutes: 3	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,458
Side: 9	Braiding: 0	Steep Riffles: 2	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		8	None	Yes	Geomorphic Rating	0.38
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		7	None	No	Channel Evolution Stage	III
7.4 Change in Planform		8	None	No	Geomorphic Condition	Fair
Total Score		30			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M25-A	Organization:	Bear Creek Environmental
Segment Length(ft):	1,502	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	8/14/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins at the confluence of the Ottauquechee River with the North Branch of the Ottauquechee River and continues 1,500 feet upstream to where the channel becomes straight and where Route 4 becomes continuous with the western bank of the river**

Step 5 - Notes:

Step 7 - Narrative: **Historic channel alteration has led to major planform change. Channel seems incised, but deposition on top of bank made it difficult to be certain of RAF elevation. No stream type departure - floodprone goes out to Route 4. Widening is major (w/d = 32) and erosion is extensive with steep banks on left bank in upstream end. Deposition within channel is not as severe as upstream; minor aggradation with one diagonal bar in upstream end and some side bars.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 531
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Sometimes	Confinement Type: BD
Berm: 24 4 0	Texture:	Sand	N.E.	In Rock Gorge: No
Road: 754 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 0				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M25-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	76.80	2.11 Riffle/Step Spacing:	300 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.90	2.12 Substrate Composition		Bed:	12.8 inches
2.3 Mean Depth (ft.):	2.75	Bedrock:	0.0 %	Bar:	7 inches
2.4 Floodprone Width (ft.):	329.30	Boulder:	10.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	5.10	Cobble:	27.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	33.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	27.93	Fine Gravel:	13.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	4.29	Sand:	15.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.31	Silt and Smaller:	2.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	4	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Moderate				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	102.9	195.3	Dominant:	Deciduous	Herbaceous
Material Type:	Sand	Sand	Erosion Height (ft.):	4.3	4.0	Sub-dominant:	None	Shrubs/Sapling
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	None	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	0.0	238.9	Canopy %:	76-100	1-25
Material Type:	Mix	Mix				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	>100	0-25	Dominant
Sub-Dominant	None	26-50	Sub-dominant
W less than 25	0	669	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Deciduous	Herbaceous	Gullies
Sub-Dominant	None	Deciduous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Residential	Mass Failures	
Sub-Dominant	None	Forest	Height	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Buffer Vegetation Type			Gullies Length	0
Dominant	None			
Sub-Dominant				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M25-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: 1	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0 Delta: 0	Flood chutes: 1 Avulsion: 0	5.5 Straightening: Straightening
Point: 1 Island: 0	5.3 Steep Riffles and Head Cuts Head Cuts: 0	Straightening Length (ft.): 1,466
Side: 4 Braiding: 0	Steep Riffles: 1 Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		12	None	Yes	Geomorphic Rating	0.50
7.2 Channel Aggradation		11	None	No	Channel Evolution Model	F
7.3 Widening Channel		9	None	No	Channel Evolution Stage	III
7.4 Change in Planform		8	None	No	Geomorphic Condition	Fair
Total Score		40			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M25-B	Organization:	Bear Creek Environmental
Segment Length(ft):	1,418	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	8/14/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where Route 4 becomes directly adjacent to the western bank and continues upstream 1,400 feet until Route 4 gently curves away from the western bank, allowing some floodplain access.**

Step 5 - Notes: **Part of flow during tropical storm Irene went behind house/farm and re-entered the river at the new riprap section on the right bank.**

Change in valley confinement from narrow to narrowly confined from US Route 4.

Step 7 - Narrative: **According to landowner areas where mid channel bars now exist used to be the right bank - root wad is now in channel at top of mid channel bar. Deposition on bars came down during TSI. Landowner said he lost about 20 feet of right bank. Flow is now split there and is very aggradational. Extreme historic incision due to road. Widening, aggradation, and planform adjustment are major in braided area.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 112
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Never	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Never	Confinement Type: NC
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 1,418 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 574				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M25-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	72.20	2.11 Riffle/Step Spacing:	628 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.60	2.12 Substrate Composition		Bed:	11.5 inches
2.3 Mean Depth (ft.):	2.70	Bedrock:	0.0 %	Bar:	4.6 inches
2.4 Floodprone Width (ft.):	93.10	Boulder:	9.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	13.50	Cobble:	44.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	22.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	26.74	Fine Gravel:	7.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.29	Sand:	18.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	3.75	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	9	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep		
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u> <u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	415.7	237.7	Dominant:	Coniferous Bare
Material Type:	Sand	Boulder/Cobble	Erosion Height (ft.):	5.0	5.0	Sub-dominant:	Deciduous Herbaceous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	None	Rip-Rap	Bank Canopy	
Lower			Revetment Length:	0.0	948.3	Canopy %:	76-100 0
Material Type:	Bedrock	Boulder/Cobble				Mid-Channel Canopy:	Open
Consistency:	Cohesive	Non-cohesive					

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	>100	0-25
Sub-Dominant	None	None
W less than 25	0	1,180
Buffer Vegetation Type		
Dominant	Mixed Trees	None
Sub-Dominant	None	Herbaceous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Residential	Mass Failures	
Sub-dominant	None	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M25-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 2
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Other	45	Yes	Yes	Yes	Yes	Deposition Below, Scour Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 0	Flood chutes: 2	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,418
Side: 3	Braiding: 0	Steep Riffles: 4	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection:		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		2	C to F	Yes	Geomorphic Rating	0.28
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		8	None	No	Channel Evolution Stage	III
7.4 Change in Planforml		6	None	No	Geomorphic Condition	Poor
Total Score		22			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M25-C	Organization:	Bear Creek Environmental
Segment Length(ft):	1,717	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	8/14/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the river gains floodplain access and continues upstream 1,700 feet until the next Route 4 bridge crossing.**

Step 5 - Notes: **Change in valley confinement from narrow to semi-confined due to US Route 4. Deposition in floodplain from TSI reported by landowner. Some of the sediment was removed from the floodplain.**

Top of reach has failing revetment.

Step 7 - Narrative: **Major incision from historic channel straightening has led to a stream type departure from a C to B. Would have floodplain access if not for incision. Road embankment has changed confinement. Minor widening, but planform is major due to straightening. Aggradation causing changes in the channel thalweg. Some flood work may have been done in the channel, but not significant and not throughout the whole segment.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 197
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Never	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Never	Confinement Type: SC
Berm: 0 0	Texture:	Other	N.E.	In Rock Gorge: No
Road: 891 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 1,619				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M25-C**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	72.00	2.11 Riffle/Step Spacing:	381 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.90	2.12 Substrate Composition		Bed:	14.4 inches
2.3 Mean Depth (ft):	2.68	Bedrock:	0.0 %	Bar:	11.8 inches
2.4 Floodprone Width (ft.):	116.40	Boulder:	15.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	6.80	Cobble:	29.0 %	Stream Type:	B
Human Elev FloodPln (ft.):		Coarse Gravel:	33.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	26.87	Fine Gravel:	7.0 %	Subclass Slope:	c
2.7 Entrenchment Ratio:	1.62	Sand:	16.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.74	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	4	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep			
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	212.2	121.6	Dominant:	Coniferous	Herbaceous
Material Type:	Mix	Sand	Erosion Height (ft.):	4.7	2.0	Sub-dominant:	Deciduous	Deciduous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	Bank Canopy		
Lower			Revetment Length:	180.0	0.0	Canopy %:	76-100	1-25
Material Type:	Boulder/Cobbl	Gravel				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	>100	0-25	Dominant
Sub-Dominant	>100	>100	Sub-dominant
W less than 25	209	950	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Coniferous	Herbaceous	Gullies
Sub-Dominant	Deciduous	None	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Forest	Residential	Mass Failures		
Sub-Dominant	None	None	Height		
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Buffer Vegetation Type			Gullies Length	0	
Dominant	None				
Sub-Dominant	None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M25-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 1	Flood chutes: 0	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,505
Side: 7	Braiding: 0	Steep Riffles: 3	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		8	C to B	Yes	Geomorphic Rating	0.45
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		13	None	No	Channel Evolution Stage	III
7.4 Change in Planform		8	None	No	Geomorphic Condition	Fair
Total Score		36			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream: **Ottauquechee Mainstem**
Reach: **M26-A**
Segment Length(ft): **1,684**
Rain: **Yes**

SGAT Version: **4.56**
Organization: **Bear Creek Environmental**
Observers: **Pam, Sacha Peeler, Jeff Crocker**
Completion Date: **8/9/2012**
Quality Control Status - Consultant: **Provisional**
Quality Control Status - Staff: **Provisional**

- Step 0 - Location: **This segment begins at a Route 4 bridge crossing and continues 1,700 feet upstream until the valley becomes slightly narrower.**
- Step 5 - Notes: **Floodplain (RAF) is higher than before flood because of flood deposits. Incision using floodplain elevation is 1.13, while IRhef is 1.65 due to berm on left bank.**
- Step 7 - Narrative: **Channel has been straightened and pushed up against valley wall. Major incision from top of berm, but minor without berm. Berm is not continuous and could be outflanked by a high flow event. During TSI the berm was outflanked and nearby homes were damaged. Major aggradation as seen through steep riffles and diagonal bars. Major widening (w/d 35). Planform is changing as bars are being built up.**

Step 1. Valley and Floodplain

1.1 Segmentation: Valley Width	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 163
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Always	Confinement Type: SC
Berm: 275 7 0	Texture:	N.E.	Bedrock	In Rock Gorge: No
Road: 1,452 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 639 0				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M26-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	76.80	2.11 Riffle/Step Spacing:	271 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.00	2.12 Substrate Composition		Bed:	8.9 inches
2.3 Mean Depth (ft.):	2.05	Bedrock:	0.0 %	Bar:	8 inches
2.4 Floodprone Width (ft.):	189.80	Boulder:	5.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	4.50	Cobble:	46.0 %	Stream Type:	C
Human Elev FloodPln (ft.):	6.60	Coarse Gravel:	28.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	37.46	Fine Gravel:	11.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	2.47	Sand:	10.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.13	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	1.65	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	C
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	19	Reference Bed Material:	Cobble
				Reference Subclass Slope:	None
				Reference Bedform:	Riffle-Pool

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	0.0	548.7	
Material Type:	Boulder/Cobbl e	Boulder/Cobbl e	Erosion Height (ft.):	0.0	8.7	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	
Lower			Revetment Length:	31.7	0.0	
Material Type:	Boulder/Cobbl e	Boulder/Cobbl e				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Shrubs/Sapling	Deciduous
				Sub-dominant:	Deciduous	None
				Bank Canopy		
				Canopy %:	26-50	76-100
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	>100
Sub-Dominant	26-50	None
W less than 25	589	0
Buffer Vegetation Type		
Dominant	Herbaceous	Deciduous
Sub-Dominant	Deciduous	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	
Sub-dominant	None	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M26-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type: None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	56	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above, Scour Below, Alignment

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 4	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0	Delta: 1	Flood chutes: 1	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,684
Side: 3	Braiding: 0	Steep Riffles: 4	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Confined	Score	STD	Historic		
7.1 Channel Degradation		7	None	Yes	Geomorphic Rating	0.36
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		9	None	No	Channel Evolution Stage	III
7.4 Change in Planform		7	None	No	Geomorphic Condition	Fair
Total Score		29			Stream Sensitivity	High



Phase 2 Segment Summary Report Ottauquechee

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M26-B	Organization:	Bear Creek Environmental
Segment Length(ft):	815	Observers:	Pam, Emily
Rain:	Yes	Completion Date:	8/13/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins 1,700 feet above the Route 4 bridge and continues 815 feet upstream.**

Step 5 - Notes:

Step 7 - Narrative: **Major widening as seen through high erosive banks exacerbated by TSI. Extreme incision and departure from riffle/pool to plane bed conditions as a result of channel alteration. Pools filled in with sediment and diagonal bars/steep riffles are present indicating major aggradation.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Corridor Encroachment	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 103
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Never
Road:	815		0		Sometimes
Railroad:	0		0		Bedrock
Imp. Path:	0		0		Sand
Dev.:	0		0		In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M26-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	73.80	2.11 Riffle/Step Spacing:	460 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.00	2.12 Substrate Composition		Bed:	5.96 inches
2.3 Mean Depth (ft.):	2.84	Bedrock:	0.0 %	Bar:	5.66 inches
2.4 Floodprone Width (ft.):	81.80	Boulder:	0.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	10.40	Cobble:	4.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	59.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	25.99	Fine Gravel:	30.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.11	Sand:	7.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	2.60	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	9	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Undercut	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	0.0	723.6	
Material Type:	Sand	Sand	Erosion Height (ft.):	0.0	10.0	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	
Lower			Revetment Length:	805.5	0.0	
Material Type:	Sand	Mix				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Herbaceous	Bare
				Sub-dominant:	Shrubs/Sapling	Herbaceous
				Bank Canopy		
				Canopy %:	0	1-25
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	>100	Dominant
Sub-Dominant	>100	None	Sub-dominant
W less than 25	706	0	(Legacy)
Buffer Vegetation Type			Failures
Dominant	None	Deciduous	Gullies
Sub-Dominant	Herbaceous	Shrubs/Sapling	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	
Sub-Dominant	None	None	Height	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Buffer Vegetation Type			Gullies Length	0
Dominant	None			
Sub-Dominant	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M26-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 0	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 0	Flood chutes: 0	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 815
Side: 3	Braiding: 0	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Confined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		2	B to F	Yes	Geomorphic Rating	0.29
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	F
7.3 Widening Channel		8	None	No	Channel Evolution Stage	III
7.4 Change in Planform		7	None	No	Geomorphic Condition	Poor
Total Score		23			Stream Sensitivity	Extreme



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M26-C	Organization:	Bear Creek Environmental
Segment Length(ft):	4,854	Observers:	PD,EK
Rain:	Yes	Completion Date:	8/13/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This is the longest segment in M26. It begins approximately 500 feet downstream of where Rogers Road intersects Route 4 and continues upstream for 4,850 feet until 650 feet upstream of the Gunderson Road bridge.**

Step 5 - Notes: **US Route 4 has resulted in a change in valley width from narrow to semi-confined.**

Step 7 - Narrative: **Channel historically straightened and road encroachment has caused extreme incision. Stream type departure from B to F. The segment was borderline confined, but average valley width came out to be unconfined. Widening is minor, but there are areas with erosion. Planform change is major due to historic straightening.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 170
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Sometimes	Confinement Type: SC
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 4,669 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 186 487				
1.6 Grade Controls: None				



Stream Geomorphic Assessment



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M26-C**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	70.80	2.11 Riffle/Step Spacing:	301 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.00	2.12 Substrate Composition		Bed:	7.8 inches
2.3 Mean Depth (ft.):	2.80	Bedrock:	0.0 %	Bar:	9 inches
2.4 Floodprone Width (ft.):	83.20	Boulder:	9.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	8.00	Cobble:	36.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	33.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	25.29	Fine Gravel:	9.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.18	Sand:	13.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	2.00	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	30	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep		
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u> <u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	405.8	1,689.7	Dominant:	Herbaceous Deciduous
Material Type:	Mix	Gravel	Erosion Height (ft.):	7.8	4.8	Sub-dominant:	Shrubs/Sapling None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Multiple	Bank Canopy	
Lower			Revetment Length:	3,314.7	182.3	Canopy %:	1-25 51-75
Material Type:	Gravel	Boulder/Cobble				Mid-Channel Canopy:	Open
Consistency:	Non-cohesive	Non-cohesive					

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	>100
Sub-Dominant	51-100	0-25
W less than 25	2,335	148
Buffer Vegetation Type		
Dominant	Herbaceous	Deciduous
Sub-Dominant	None	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	64.13
Sub-dominant	Forest	Residential	Height	11.0
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	One	11.0	Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M26-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 6
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 4 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.: None	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	62	Yes	Yes	Yes	Yes	Deposition Below, Alignment

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 4	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 2	Flood chutes: 1	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 3,808
Side: 5	Braiding: 0	Steep Riffles: 7	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		3	B to F	Yes	Geomorphic Rating	0.35
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		11	None	No	Channel Evolution Stage	III
7.4 Change in Planforml		7	None	No	Geomorphic Condition	Fair
Total Score		28			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M27-A	Organization:	Bear Creek Environmental
Segment Length(ft):	1,175	Observers:	Mary, Emily
Rain:	Yes	Completion Date:	8/21/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins about 650 feet upstream of the Gunderson Road bridge and continues 1,175 feet upstream. The segment ends approximately across from where Raymond Hill Road intersects Route 4.**

Step 5 - Notes: **US Route 4 is resulting in a change in valley width from narrow to semi-confined.**

Step 7 - Narrative: **Minor historic incision; human caused change in valley type from Route 4. Currently widening where poor vegetated root structure. Major planform adjustment with braiding within short section of segment.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Corridor Encroachment	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 152
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Never
Road:	963		0		Always
Railroad:	0		0		Texture:
Imp. Path:	0		0		N.E.
Dev.:	0		1,175		N.E.
					In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	84.00	2.11 Riffle/Step Spacing:	153 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.30	2.12 Substrate Composition		Bed:	10.4 inches
2.3 Mean Depth (ft.):	2.64	Bedrock:	0.0 %	Bar:	N/A inches
2.4 Floodprone Width (ft.):	97.30	Boulder:	5.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	16.20	Cobble:	47.0 %	Stream Type:	F
Human Elev FloodPln (ft.):		Coarse Gravel:	27.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	31.82	Fine Gravel:	16.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	1.16	Sand:	5.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	4.91	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	5	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep			
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	454.5	329.1	Dominant:	Deciduous	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	4.8	4.0	Sub-dominant:	Herbaceous	None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	Bank Canopy		
Lower			Revetment Length:	459.3	0.0	Canopy %:	1-25	76-100
Material Type:	Boulder/Cobbl	Boulder/Cobbl				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	51-100	>100
Sub-Dominant	0-25	None
W less than 25	486	0
Buffer Vegetation Type		
Dominant	Shrubs/Sapling	Coniferous
Sub-Dominant	Deciduous	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	
Sub-dominant	None	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 2	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 2	Delta: 1	Flood chutes: 0	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,175
Side: 3	Braiding: 1	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		12	C to F	Yes	Geomorphic Rating	0.45
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		8	None	No	Channel Evolution Stage	III
7.4 Change in Planform		9	None	No	Geomorphic Condition	Fair
Total Score		36			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M27-B	Organization:	Bear Creek Environmental
Segment Length(ft):	2,402	Observers:	Mary, Emily
Rain:	Yes	Completion Date:	8/21/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins approximately where Raymond Hill Road intersects Route 4 and continues 2,400 feet upstream (under Route 4) to where the river loses floodplain access again. This is in front of a house adjacent to the river that is across from where P**

Step 5 - Notes: **US Route 4 has resulted in a change in valley confinement from narrow to semi-confined.**

Step 7 - Narrative: **Major aggradation and planform adjustment. Deposition from flood moving through reach and in floodplain. Sections near Route 4 above segment 27B are transporting sediment through. Channel widening due to aggradation (large bars) and not degradation, which is why D model was chosen. In many areas bedrock was seen on the bank and in some places on the stream bed; however, no 'true' grade controls (bedrock completely spanning channel) were identified in the field. Good bankfull indicator at cross section.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Very Steep	Valley Width (ft): 206
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Sometimes	Confinement Type: SC
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 2,402 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 260 805				
1.6 Grade Controls: None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	81.80	2.11 Riffle/Step Spacing:	236 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.70	2.12 Substrate Composition		Bed:	9.9 inches
2.3 Mean Depth (ft.):	2.08	Bedrock:	10.0 %	Bar:	7.9 inches
2.4 Floodprone Width (ft.):	177.20	Boulder:	4.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	3.70	Cobble:	48.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	19.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	39.33	Fine Gravel:	8.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	2.17	Sand:	11.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.00	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Moderate	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	13	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Steep				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	145.9	272.9	Dominant:	Deciduous	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	7.0	5.3	Sub-dominant:	Coniferous	Coniferous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	250.5	340.5	Canopy %:	76-100	76-100
Material Type:	Mix	Mix				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	>100	>100
Sub-Dominant	None	51-100
W less than 25	0	316
Buffer Vegetation Type		
Dominant	Deciduous	Coniferous
Sub-Dominant	Coniferous	Deciduous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	Mass Failures	<u>Left</u>	<u>Right</u>
Dominant	Forest	Forest	Height		24.57
Sub-dominant	None	Residential	Gullies Number	0	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Length	0	
Failures	One	50.0			
Gullies	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type: None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	40.5	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above, Scour Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 0	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid:	2	Flood chutes:	3	5.5 Straightening: Straightening
Point:	1	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,217
Side:	8	Steep Riffles:	0	5.5 Dredging: None
			Trib Rejuv.: No	

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		16	None	No	Geomorphic Rating	0.46
7.2 Channel Aggradation		6	None	No	Channel Evolution Model	D
7.3 Widening Channel		7	None	No	Channel Evolution Stage	Ild
7.4 Change in Planform		8	None	No	Geomorphic Condition	Fair
Total Score		37			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M27-C	Organization:	Bear Creek Environmental
Segment Length(ft):	996	Observers:	Mary, Emily
Rain:	Yes	Completion Date:	8/20/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

- Step 0 - Location: **This segment begins near a house adjacent to the river that is approximately across from where Pearson Road intersects Route 4. The segment continues about 1,000 feet upstream to where it begins to move away from Route 4, gaining more floodplain access.**
- Step 5 - Notes: **US Route 4 has resulted in a change in valley confinement from narrow to semi-confined. Not fully confident in bankfull feature at location of cross section. Elevation of RAF was unclear because of rip rap and Route 4. In order to better understand the impact Route 4 is having on the stream a human elevated floodplain incision ratio was added to Step 2.**
- Step 7 - Narrative: **Stream type departure due to floodplain encroachment from the road and rip rap (C to B). Segment has been completely straightened. Difficult to tell bankfull elevation due to rip rap and recently abandoned floodplain is not apparent due to filling of floodplain from Route 4. Default to poor.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Corridor Encroachment	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 165
1.3 Corridor Encroachments:		Continuous w/ Bank:	Sometimes	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Always
Road:	996		0		Never
Railroad:	0		0		Texture:
Imp. Path:	0		0		N.E.
Dev.:	479		0		N.E.
					In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-C**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	51.72	2.11 Riffle/Step Spacing:	185 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.20	2.12 Substrate Composition		Bed:	11.8 inches
2.3 Mean Depth (ft.):	3.04	Bedrock:	5.0 %	Bar:	3.22 inches
2.4 Floodprone Width (ft.):	78.00	Boulder:	10.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	5.90	Cobble:	49.0 %	Stream Type:	B
Human Elev FloodPln (ft.):	15.60	Coarse Gravel:	22.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	17.01	Fine Gravel:	4.0 %	Subclass Slope:	c
2.7 Entrenchment Ratio:	1.51	Sand:	9.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.40	Silt and Smaller:	1.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	3.71	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	3	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep			
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	183.3	153.9	Dominant:	Deciduous	Bare
Material Type:	Mix	Boulder/Cobble	Erosion Height (ft.):	5.0	4.0	Sub-dominant:	None	Herbaceous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	130.0	833.6	Canopy %:	76-100	0
Material Type:	Boulder/Cobble	Boulder/Cobble				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	>100	0-25
Sub-Dominant	None	None
W less than 25	0	817
Buffer Vegetation Type		
Dominant	Deciduous	None
Sub-Dominant	None	Herbaceous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Residential	Mass Failures	102.48
Sub-dominant	None	None	Height	10.0
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	One	10.0	Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 0	Flood chutes: 0	Avulsion: 0	5.5 Straightening: With Windrowing
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 797
Side: 4	Braiding: 0	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		12	C to B	No	Geomorphic Rating	0.54
7.2 Channel Aggradation		12	None	No	Channel Evolution Model	F
7.3 Widening Channel		10	None	No	Channel Evolution Stage	III
7.4 Change in Planform		9	None	No	Geomorphic Condition	Poor
Total Score		43			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M27-D	Organization:	Bear Creek Environmental
Segment Length(ft):	2,279	Observers:	Mary, Emily
Rain:	Yes	Completion Date:	8/20/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the river moves away from Route 4 gaining more floodplain access and continues 2,279 feet upstream (under Route 4) to where the northern bank becomes continuous with Route 4 again. This is across from where Bridgewater Hill Road**

Step 5 - Notes: **Large bar features**

Step 7 - Narrative: **Historic incision, large bars (mid channel and diagonal) indicating major aggradation. Channel is widening. Significant flood chutes showing planform adjustment. Sediment deposition in floodplain. Aggradation area as river gets away from Route 4 and has floodplain access adjacent to channel. Route 4 is human caused change in valley width.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 311
1.3 Corridor Encroachments:		Continuous w/ Bank:	Sometimes	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W: Sometimes Sometimes
Berm:	0		0		Texture: N.E. N.E.
Road:	2,279		0		In Rock Gorge: No
Railroad:	0		0		Human Caused Change in Valley Width?: Yes
Imp. Path:	0		0		
Dev.:	0		1,592		

1.6 Grade Controls: **None**



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-D**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	66.30	2.11 Riffle/Step Spacing:	161 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.40	2.12 Substrate Composition		Bed:	15 inches
2.3 Mean Depth (ft):	2.29	Bedrock:	0.0 %	Bar:	6.14 inches
2.4 Floodprone Width (ft.):	191.00	Boulder:	13.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	7.40	Cobble:	33.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	25.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	28.95	Fine Gravel:	16.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	2.88	Sand:	13.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.68	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Moderate	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	9	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep		
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u> <u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	700.9	271.6	Dominant:	Deciduous Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	5.2	4.3	Sub-dominant:	Coniferous Shrubs/Sapling
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	Bank Canopy	
Lower			Revetment Length:	198.4	0.0	Canopy %:	76-100 76-100
Material Type:	Boulder/Cobbles	Boulder/Cobbles				Mid-Channel Canopy:	Open
Consistency:	Non-cohesive	Non-cohesive					

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	>100	51-100
Sub-Dominant	51-100	>100
W less than 25	394	97
Buffer Vegetation Type		
Dominant	Deciduous	Deciduous
Sub-Dominant	None	Herbaceous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Forest	Mass Failures	35.06
Sub-dominant	Residential	Residential	Height	30.0
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	One	30.0	Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-D**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type: None	4.7 Stormwater Inputs: None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 1	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Old Abutment	60	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below
Bridge	69	Yes	Yes	No	Yes	Deposition Above, Deposition Below, Scour Above

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 4	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 2	Delta: 0	Flood chutes: 4	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 387
Side: 3	Braiding: 0	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection:		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		7	None	Yes	Geomorphic Rating	0.43
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		12	None	No	Channel Evolution Stage	III
7.4 Change in Planform		8	None	No	Geomorphic Condition	Fair
Total Score		34			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M27-E	Organization:	Bear Creek Environmental
Segment Length(ft):	1,096	Observers:	Mary, Emily
Rain:	Yes	Completion Date:	8/20/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where Route 4 is directly adjacent to the northern bank (where Bridgewater Hill Road intersects Route 4) and continues about 1,100 feet upstream to where the river moves away from Route 4, gaining more floodplain access.**

Step 5 - Notes: **The area on the opposite side of Route 4 is a 'wetland' area that appears to possibly have been an old channel – we measured an elevation below bankfull. In our cross section, there is a 'floodplain edit' at the distance -127. This was done so that the area below bankfull would not be included in the bank full cross sectional area because the wetland is not hydraulically connected to the river (because of the placement of Route 4). The RAF we chose on the right side of the channel may not be the 'true' RAF because it is narrow and the valley wall is so close. Because of this uncertainty we are including the HEF incision ratio, which was calculated from the elevation of Route 4. Route 4 is likely a major driver in the incision since it takes up about a third of the valley here.**

Step 7 - Narrative: **Historic incision - has become sediment transport reach. Large trees on right bank and rip rap on left bank are preventing channel from widening. Stable 'Bc' with bench along right bank.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Corridor Encroachment	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Very Steep	Valley Width (ft): 127
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
					Never
					Sometimes
Berm:	0		0		Texture:
					N.E.
Road:	1,096		0		N.E.
					In Rock Gorge: No
Railroad:	0		0		Human Caused Change in Valley Width?: Yes
Imp. Path:	0		0		
Dev.:	0		0		
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-E**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	55.20	2.11 Riffle/Step Spacing:	217.5 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.60	2.12 Substrate Composition		Bed:	9.4 inches
2.3 Mean Depth (ft.):	3.33	Bedrock:	0.0 %	Bar:	7.1 inches
2.4 Floodprone Width (ft.):	85.30	Boulder:	0.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	6.80	Cobble:	29.0 %	Stream Type:	B
Human Elev FloodPln (ft.):	14.20	Coarse Gravel:	40.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	16.58	Fine Gravel:	18.0 %	Subclass Slope:	c
2.7 Entrenchment Ratio:	1.55	Sand:	13.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.48	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	3.09	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Eroded	# Large Woody Debris:	10	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	0.0	40.4
Material Type:	Boulder/Cobble	Sand	Erosion Height (ft.):	0.0	3.0
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None
Lower			Revetment Length:	1,096.3	0.0
Material Type:	Boulder/Cobble	Mix			
Consistency:	Non-cohesive	Non-cohesive			

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	>100
Sub-Dominant	None	None
W less than 25	990	0
Buffer Vegetation Type		
Dominant	None	Deciduous
Sub-Dominant	Herbaceous	Coniferous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	
Sub-dominant	None	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-E**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 0	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0	Delta: 0	Flood chutes: 1	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,096
Side: 2	Braiding: 0	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		6	C to B	Yes	Geomorphic Rating	0.63
7.2 Channel Aggradation		14	None	No	Channel Evolution Model	F
7.3 Widening Channel		17	None	No	Channel Evolution Stage	II
7.4 Change in Planform		13	None	No	Geomorphic Condition	Fair
Total Score		50			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M27-F	Organization:	Bear Creek Environmental
Segment Length(ft):	3,764	Observers:	Mary, Emily
Rain:	Yes	Completion Date:	8/20/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

- Step 0 - Location: **This segment begins where the river moves away from Route 4 and continues upstream 3,764 feet until about 250 feet below the next Route 4 bridge crossing (reach break between M27 and M28).**
- Step 5 - Notes: **Generally good floodplain access in segment. Loss of floodplain access at impending neck cut-off, then floodplain access is regained downstream in vicinity of houses. A lot of debris jams from flooding.**
- Step 7 - Narrative: **Extreme aggradation and planform adjustment with low incision. Therefore, D model chosen. Impending neck cutoff, high lateral bank erosion. Significant sediment from flood in floodplain. Multiple unvegetated mid channel bars and diagonal bars.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 270
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Sometimes	Confinement Type: NW
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 1,806 0 1,352 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 985 0				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-F**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	71.20	2.11 Riffle/Step Spacing:	224 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.95	2.12 Substrate Composition		Bed:	20.6 inches
2.3 Mean Depth (ft):	2.58	Bedrock:	0.0 %	Bar:	5.2 inches
2.4 Floodprone Width (ft.):	299.00	Boulder:	16.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	5.45	Cobble:	51.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	13.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	27.60	Fine Gravel:	8.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	4.20	Sand:	11.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.10	Silt and Smaller:	1.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Moderate	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	76	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep			
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	773.4	498.1	Dominant:	Deciduous	Deciduous
Material Type:	Mix	Gravel	Erosion Height (ft.):	30.5	5.7	Sub-dominant:	Shrubs/Sapling	Shrubs/Sapling
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Multiple	Bank Canopy		
Lower			Revetment Length:	268.9	299.9	Canopy %:	76-100	76-100
Material Type:	Boulder/Cobbles	Boulder/Cobbles				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	>100	>100	Dominant
Sub-Dominant	51-100	51-100	Sub-dominant
W less than 25	261	191	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Mixed Trees	Mixed Trees	Gullies
Sub-Dominant	Herbaceous	Herbaceous	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Forest	Residential	Mass Failures	350.95	
Sub-Dominant	Residential	Forest	Height	40.0	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Failures	One	40.0	Gullies Length	0	
Gullies	None				



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M27-F**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 2
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	67	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above, Alignment
Bridge	47	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above, Scour Below, Alignment

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 6	5.2 Other Features	Neck Cutoff: 1	5.4 Stream Ford or Animal Crossing: No
Mid: 5	Delta: 0	Flood chutes: 5	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 79
Side: 19	Braiding: 1	Steep Riffles: 4	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		13	None	No	Geomorphic Rating	0.43
7.2 Channel Aggradation		5	None	No	Channel Evolution Model	D
7.3 Widening Channel		11	None	No	Channel Evolution Stage	Ild
7.4 Change in Planform		5	None	Yes	Geomorphic Condition	Fair
Total Score		34			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M28-A	Organization:	Bear Creek Environmental
Segment Length(ft):	2,611	Observers:	PD,EK
Rain:	Yes	Completion Date:	8/7/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

- Step 0 - Location: **This segment begins just below the Route 4 crossing near where Standish Road intersects Route 4 and continues 2,600 feet upstream to where the river gains more floodplain access because it moves away from Route 4.**
- Step 5 - Notes: **Standish Road is reducing floodplain access on right side of channel. Consider removing this old road to regain floodplain access. A human-elevated floodplain incision ratio was added under Step 2 for this segment to further explain how Standish Road is impacting (and cutting off) floodplain access.**
- Step 7 - Narrative: **Channel has received abundant sediment as seen by enlarged bars and fine deposition in floodplain and on old road. Channel is sandwiched between Route 4 and Standish Road causing a stream type departure from a C to a B. Extreme incision from top of old road. Erosion is being prevented by abundant rip rap. New rip rap on downstream end above bridge - did the bank fail? Major planform change due to straightening in past.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Channel Dimensions	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 179
1.3 Corridor Encroachments:		Continuous w/ Bank:	Sometimes	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0	0	Sometimes
Road:	206		0	2,289	Sometimes
Railroad:	0			0	Texture:
Imp. Path:	0			0	N.E.
Dev.:	386			0	N.E.
					In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M28-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	58.20	2.11 Riffle/Step Spacing:	246 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.90	2.12 Substrate Composition		Bed:	11.6 inches
2.3 Mean Depth (ft.):	2.63	Bedrock:	0.0 %	Bar:	11.5 inches
2.4 Floodprone Width (ft.):	116.90	Boulder:	1.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	4.20	Cobble:	41.0 %	Stream Type:	B
Human Elev FloodPln (ft.):	8.30	Coarse Gravel:	31.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	22.13	Fine Gravel:	13.0 %	Subclass Slope:	c
2.7 Entrenchment Ratio:	2.01	Sand:	12.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.08	Silt and Smaller:	2.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	2.13	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	24	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	822.0	1,387.9	
Material Type:	Gravel	Gravel	Erosion Height (ft.):	3.9	4.4	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Multiple	
Lower			Revetment Length:	819.0	901.5	
Material Type:	Gravel	Gravel				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Herbaceous	Shrubs/Sapling
				Sub-dominant:	None	Herbaceous
				Bank Canopy		
				Canopy %:	1-25	51-75
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	>100	Dominant
Sub-Dominant	51-100	0-25	Sub-dominant
W less than 25	1,422	949	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Mixed Trees	Gullies
Sub-Dominant	None	None	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>		<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures		
Sub-Dominant	Forest	Residential	Height		
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0	
Buffer Vegetation Type			Gullies Length	0	
Dominant	None				
Sub-Dominant					



Phase 2 Segment Summary Report

Ottauquechee

Stream: Ottauquechee Mainstem Reach: M28-A

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type: None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 2
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.: None	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	60	Yes	Yes	Yes	Yes	Deposition Below, Scour Below, Alignment

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 0	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 2	Flood chutes: 4	Avulsion: 0	5.5 Straightening: Straightening
Point: 1	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 2,465
Side: 3	Braiding: 0	Steep Riffles: 2	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		5	C to B	Yes	Geomorphic Rating	0.40
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	F
7.3 Widening Channel		12	None	No	Channel Evolution Stage	II
7.4 Change in Planform		8	None	No	Geomorphic Condition	Fair
Total Score		32			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M28-B	Organization:	Bear Creek Environmental
Segment Length(ft):	2,708	Observers:	PD,EK
Rain:	Yes	Completion Date:	8/2/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the river gains floodplain access and continues 2,700 feet upstream until Route 4 becomes adjacent to the northern bank again.**

Step 5 - Notes:

Step 7 - Narrative: **Very slightly incised, but adequate floodplain access. A stormwater swale has been dredged to provide flow of stormwater into stream, and this material was placed along the stream bank at point of entry. Big flood chute in upstream end. Straightened so planform is major adjustment. Low w/d ratio indicates minor widening; however, bank erosion was noted along 1/3 to 1/2 of the segment length. This suggests channel evolution is early F-II. There is less aggradation than upstream and downstream segments. Unsure of how much Route 4 repairs (rip rap) after Irene may have affected downstream portion of segment.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>
Berm:	0		0	
Road:	1,914	0	790	0
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	461		0	

1.4 Adjacent Side

Hillside Slope:

Continuous w/ Bank:

Within 1 Bankfull W:

Texture:

Left

Right

Extr.Steep

Extr.Steep

Never

Sometimes

Never

Sometimes

N.E.

Sand

Human Caused Change in Valley Width?: **Yes**

1.5 Valley Features

Valley Width (ft): **202**

Width Determination: **Measured**

Confinement Type: **SC**

In Rock Gorge: **No**

1.6 Grade Controls: **None**



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M28-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	67.80	2.11 Riffle/Step Spacing:	189 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.00	2.12 Substrate Composition		Bed:	11.8 inches
2.3 Mean Depth (ft):	2.92	Bedrock:	2.0 %	Bar:	14.1 inches
2.4 Floodprone Width (ft.):	235.30	Boulder:	9.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	4.70	Cobble:	41.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	16.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	23.22	Fine Gravel:	14.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	3.47	Sand:	18.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.17	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Complete	# Large Woody Debris:	14	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type <u>Left</u> <u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	1,324.3	1,158.4	Dominant: Deciduous Deciduous
Material Type:	Mix	Sand	Erosion Height (ft.):	5.0	5.0	Sub-dominant: Herbaceous Coniferous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Multiple	Bank Canopy
Lower			Revetment Length:	691.5	59.3	Canopy %: 51-75 76-100
Material Type:	Boulder/Cobbles	Boulder/Cobbles				Mid-Channel Canopy: Open
Consistency:	Non-cohesive	Non-cohesive				

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	>100	Dominant
Sub-Dominant	None	None	Sub-dominant
W less than 25	1,000	0	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Deciduous	Gullies
Sub-Dominant	None	Shrubs/Sapling	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Forest	Mass Failures	
Sub-Dominant	Forest	None	Height	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M28-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 2
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.: None	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Old Abutment	42	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above, Scour Below, Alignment

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0	Delta: 2	Flood chutes: 1	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 2,708
Side: 12	Braiding: 0	Steep Riffles: 5	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		13	None	Yes	Geomorphic Rating	0.59
7.2 Channel Aggradation		13	None	No	Channel Evolution Model	F
7.3 Widening Channel		12	None	No	Channel Evolution Stage	II
7.4 Change in Planform		9	None	No	Geomorphic Condition	Fair
Total Score		47			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M28-C	Organization:	Bear Creek Environmental
Segment Length(ft):	1,192	Observers:	PD,EK
Rain:	Yes	Completion Date:	8/7/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the river becomes bifurcated, following several paths around two large islands. The segment ends 1,200 feet upstream where Reservoir Brook enters the Ottauquechee River.**

Step 5 - Notes: **This segment is a 'bifurcated' channel (versus braided). The river has split into two channels here as a result of planform adjustment. There are two islands in this segment, one after another as you move downstream. They are 'connected' by a large amount of aggradation. There is stream flow on both sides of the islands. The islands are vegetated and have large trees on them. A human-elevated floodplain incision ratio was added under Step 2 for this segment to further explain how Route 4 is impacting (and cutting off) floodplain access.**

Step 7 - Narrative: **Channel straightening is extensive; islands were formed. Flow on both sides of islands. Irene brought down abundant material that deposited in between two islands and in the right channel. Stream type departure from a C to a B as a result of Route 4.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Planform and Scope	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 155
1.3 Corridor Encroachments:		Continuous w/ Bank:	Sometimes	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Confinement Type: SC
Berm:	0		0		In Rock Gorge: No
Road:	1,188		0		Human Caused Change in Valley Width?: Yes
Railroad:	0		0		
Imp. Path:	0		0		
Dev.:	1,068		0		
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M28-C**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	96.00	2.11 Riffle/Step Spacing:	216 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.40	2.12 Substrate Composition		Bed:	12.4 inches
2.3 Mean Depth (ft.):	2.08	Bedrock:	0.0 %	Bar:	16.2 inches
2.4 Floodprone Width (ft.):	175.90	Boulder:	14.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	6.80	Cobble:	43.0 %	Stream Type:	B
Human Elev FloodPln (ft.):	10.20	Coarse Gravel:	24.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	46.15	Fine Gravel:	9.0 %	Subclass Slope:	c
2.7 Entrenchment Ratio:	1.83	Sand:	10.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	2.00	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	3.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	45	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	886.9	413.4	
Material Type:	Boulder/Cobbles	Boulder/Cobbles	Erosion Height (ft.):	5.0	3.0	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	
Lower			Revetment Length:	254.6	0.0	
Material Type:	Gravel	Mix				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Deciduous	Deciduous
				Sub-dominant:	Herbaceous	Coniferous
				Bank Canopy		
				Canopy %:	26-50	76-100
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	>100	Dominant
Sub-Dominant	51-100	None	Sub-dominant
W less than 25	750	22	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Deciduous	Gullies
Sub-Dominant	None	Shrubs/Sapling	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Bare	Forest	Mass Failures	
Sub-Dominant	Residential	None	Height	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M28-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.: None	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 0	Flood chutes: 1	Avulsion: 0	5.5 Straightening: Straightening
Point: 0	Island: 2	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 904
Side: 5	Braiding: 1	Steep Riffles: 1	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		4	C to B	Yes	Geomorphic Rating	0.16
7.2 Channel Aggradation		3	None	No	Channel Evolution Model	F
7.3 Widening Channel		4	None	No	Channel Evolution Stage	III
7.4 Change in Planform		2	None	No	Geomorphic Condition	Poor
Total Score		13			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M29-0	Organization:	Bear Creek Environmental
Segment Length(ft):	1,929	Observers:	MN, EK
Rain:	Yes	Completion Date:	8/7/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This reach begins at the confluence with Reservoir Brook and continues upstream 1,900 feet until the Route 4 bridge crossing near Hadley Hill Road.**

Step 5 - Notes:

Step 7 - Narrative: **Major historic degradation with extreme aggradation (numerous unvegetated mid-channel bars and diagonal bars). Excessive sediment in floodplain. Minor widening (rip rap preventing widening especially at lower and upper end of segment. Major planform adjustment.**

Step 1. Valley and Floodplain

1.1 Segmentation:	None	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 356
1.3 Corridor Encroachments:		Continuous w/ Bank:	Sometimes	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W: Sometimes Never
Berm:	0		0		Texture: N.E. N.E.
Road:	1,399		0		In Rock Gorge: No
Railroad:	0		0		Human Caused Change in Valley Width?: Yes
Imp. Path:	0		0		
Dev.:	365		947		

1.6 Grade Controls:

Type	Location	Total Height	Total Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	2.0	1.0	Yes	



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M29-0**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	52.20	2.11 Riffle/Step Spacing:	122 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.50	2.12 Substrate Composition		Bed:	11.2 inches
2.3 Mean Depth (ft):	2.17	Bedrock:	0.0 %	Bar:	N/A inches
2.4 Floodprone Width (ft.):	391.70	Boulder:	19.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	6.30	Cobble:	48.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	24.0 %	Bed Material:	Cobble
2.6 Width/Depth Ratio:	24.06	Fine Gravel:	2.0 %	Subclass Slope:	b
2.7 Entrenchment Ratio:	7.50	Sand:	7.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.80	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Moderate	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	10	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope: Steep			
Bank Texture			<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u> <u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	1,365.8 136.6	Dominant:	Deciduous Herbaceous
Material Type:	Sand	Mix	Erosion Height (ft.):	5.0 6.9	Sub-dominant:	Coniferous Bare
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap Multiple	Bank Canopy	
Lower			Revetment Length:	211.3 747.8	Canopy %:	76-100 1-25
Material Type:	Boulder/Cobbles	Boulder/Cobbles			Mid-Channel Canopy:	Open
Consistency:	Non-cohesive	Non-cohesive				

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	>100	0-25
Sub-Dominant	0-25	26-50
W less than 25	0	1,360
Buffer Vegetation Type		
Dominant	Deciduous	None
Sub-Dominant	Coniferous	Herbaceous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Residential	Mass Failures	
Sub-dominant	Industrial	Commercial	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M29-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant	4.5 Flow Regulation Type: None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 0
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 1
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	48	Yes	Yes	Yes	Yes	Deposition Above, Deposition Below, Scour Above, Alignment

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 5	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: Yes
Mid:	4 Delta: 0	Flood chutes: 0	Avulsion: 1	5.5 Straightening: Straightening
Point:	1 Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 1,929
Side:	5 Braiding: 1	Steep Riffles: 5	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		7	None	Yes	Geomorphic Rating	0.34
7.2 Channel Aggradation		3	None	No	Channel Evolution Model	F
7.3 Widening Channel		11	None	No	Channel Evolution Stage	III
7.4 Change in Planform		6	None	No	Geomorphic Condition	Poor
Total Score		27			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M30-A	Organization:	Bear Creek Environmental
Segment Length(ft):	1,072	Observers:	MN, EK
Rain:	Yes	Completion Date:	7/25/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

- Step 0 - Location: **This reach begins at the confluence with Reservoir Brook and continues upstream 1,900 feet until the Route 4 bridge crossing near Hadley Hill Road.**
- Step 5 - Notes: **Channel dimensions are enlarged. Segment appears to be flood affected; however, Pete Fellows reports that enlarged channel dimensions in this segment existed prior to Tropical Storm Irene. Bankfull elevation could not be accurately determined. Incision ratio most likely >2.0 and floodplain access is poor. To get channel enlargement we used the RTOB. In this segment, the channel splits into three channels as a result of planform adjustment. This is a "trifurcated" channel.**
- Step 7 - Narrative: **This segment is actively incising as evident by active headcut and freshly eroded vertical banks. A channel avulsion has occurred here. Widening and planform adjustment are extreme. A trifurcated channel is seen here. Aggradation is minor because this is a sediment transport segment.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Valley Width	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Steep	Extr.Steep	Valley Width (ft): 240
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0	0	Never
Road:	338		0	416	Never
Railroad:	0		0	0	Texture:
Imp. Path:	0		0	0	N.E.
Dev.:	0		703	0	N.E.
					In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	8.0	5.0	Yes	



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M30-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	2.11 Riffle/Step Spacing: 80 ft.	2.13 Average Largest Particle on
2.2 Max Depth (ft.):	2.12 Substrate Composition	Bed:
2.3 Mean Depth (ft):	Bedrock: 0.0 %	Bar:
2.4 Floodprone Width (ft.):	Boulder: 51.0 %	2.14 Stream Type
2.5 Aband. Floodpn (ft.):	Cobble: 35.0 %	Stream Type: F
Human Elev FloodPln (ft.):	Coarse Gravel: 10.0 %	Bed Material: Boulder
2.6 Width/Depth Ratio: 0.00	Fine Gravel: 3.0 %	Subclass Slope: b
2.7 Entrenchment Ratio: 0.00	Sand: 1.0 %	Bed Form: Step-Pool
2.8 Incision Ratio: 0.00	Silt and Smaller: 0.0 %	Field Measured Slope:
Human Elevated Inc. Rat.: 0.00	Silt/Clay Present: No	2.15 Sub-reach Stream Type
2.9 Sinuosity:	Detritus: 0.0 %	Reference Stream Type:
2.10 Riffles Type:	# Large Woody Debris: 20	Reference Bed Material:
		Reference Subclass Slope:
		Reference Bedform:

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope: Steep					
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type <u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	198.2	127.9	Dominant:	Deciduous	Deciduous
Material Type:	Mix	Mix	Erosion Height (ft.):	6.2	5.0	Sub-dominant:	None	None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	Multiple	Bank Canopy		
Lower			Revetment Length:	121.4	223.4	Canopy %:	76-100	76-100
Material Type:	Mix	Mix				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	>100	>100
Sub-Dominant	26-50	26-50
W less than 25	0	128
Buffer Vegetation Type		
Dominant	Deciduous	Mixed Trees
Sub-Dominant	None	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Forest	Mass Failures	
Sub-dominant	Residential	Residential	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M30-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Old Abutment	48	Yes	No	Yes	Yes	Deposition Above, Deposition Below, Scour Below
Bridge	35	Yes	Yes	Yes	Yes	Deposition Above, Scour Below, Alignment

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: 0	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0 Delta: 0	Flood chutes: 0 Avulsion: 1	5.5 Straightening: Straightening
Point: 0 Island: 2	5.3 Steep Riffles and Head Cuts Head Cuts: 1	Straightening Length (ft.): 236
Side: 0 Braiding: 2	Steep Riffles: 0 Trib Rejuv.: Yes	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: 0	6.4 Sediment Deposition:	Stream Gradient Type: Left Right
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection:
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:
Habitat Rating: 0.00		
Habitat Stream Condition:		

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		2	C to F	No	Geomorphic Rating	0.30
7.2 Channel Aggradation		13	None	No	Channel Evolution Model	F
7.3 Widening Channel		5	None	No	Channel Evolution Stage	II
7.4 Change in Planform		4	None	No	Geomorphic Condition	Poor
Total Score		24			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M30-B	Organization:	Bear Creek Environmental
Segment Length(ft):	714	Observers:	MN, EK
Rain:	Yes	Completion Date:	7/25/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional
		Why Not Assessed:	Other (to be explained in comments)

Step 0 - Location: **This segment begins as the valley becomes narrowly confined and continues 714 feet upstream.**

Step 5 - Notes: **There were two reasons that a cross section was not done in this segment. First of all, the segment was very short (714 feet). Secondly, the segment was noted to be in "good" geomorphic condition with little bank erosion, forested buffers, and the presence of large boulders and bedrock on the bed. Bedrock almost spans the channel in many places. Although no true channel spanning bedrock grade controls were present, the large boulders and bedrock are providing resistance to incision. "Other" was selected for reason not assessed, because the segment was not a "true" bedrock gorge.**

Step 7 - Narrative:

Step 1. Valley and Floodplain

1.1 Segmentation: Subreach	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr. Steep	Extr. Steep	Valley Width (ft): 153
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Sometimes	Sometimes	Confinement Type: SC
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 0 0				Human Caused Change in Valley Width?: No
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 0 0				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M30-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):		2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):		2.12 Substrate Composition		Bed:	
2.3 Mean Depth (ft):		Bedrock:	%	Bar:	
2.4 Floodprone Width (ft.):		Boulder:	%	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):		Cobble:	%	Stream Type:	B
Human Elev FloodPln (ft.):		Coarse Gravel:	%	Bed Material:	Boulder
2.6 Width/Depth Ratio:	0.00	Fine Gravel:	%	Subclass Slope:	None
2.7 Entrenchment Ratio:	0.00	Sand:	%	Bed Form:	Step-Pool
2.8 Incision Ratio:	0.00	Silt and Smaller:	%	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:		2.15 Sub-reach Stream Type	
2.9 Sinuosity:		Detritus:	0.0 %	Reference Stream Type:	B
2.10 Riffles Type:		# Large Woody Debris:		Reference Bed Material:	Boulder
				Reference Subclass Slope:	None
				Reference Bedform:	Step-Pool

Step 3. Riparian Features

3.1 Stream Banks					Typical Bank Slope:	Steep		
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	0.0	47.9	Dominant:	Coniferous	Coniferous
Material Type:	Mix	Mix	Erosion Height (ft.):	0.0	6.1	Sub-dominant:	None	None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	None	None	Bank Canopy		
Lower			Revetment Length:	0.0	0.0	Canopy %:	76-100	76-100
Material Type:	Bedrock	Boulder/Cobble				Mid-Channel Canopy:	Closed	
Consistency:	Cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	>100	>100
Sub-Dominant	None	None
W less than 25	0	0
Buffer Vegetation Type		
Dominant	Coniferous	Coniferous
Sub-Dominant	None	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Forest	Mass Failures	
Sub-dominant	None	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottawaquechee

Stream: **Ottawaquechee Mainstem** Reach: **M30-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: None	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal:	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: Delta:	Flood chutes: 1	5.5 Straightening: None
Point: Island:	5.3 Steep Riffles and Head Cuts Head Cuts: 0	Straightening Length (ft.): 0
Side: Braiding: 0	Steep Riffles: 0	5.5 Dredging: None
	Trib Rejuv.:	

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Score</u>	<u>STD</u>	<u>Historic</u>	
7.1 Channel Degradation				Geomorphic Rating
7.2 Channel Aggradation				Channel Evolution Model
7.3 Widening Channel				Channel Evolution Stage
7.4 Change in Planform				Geomorphic Condition
Total Score				Stream Sensitivity

Good



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M30-C	Organization:	Bear Creek Environmental
Segment Length(ft):	1,236	Observers:	MN, EK
Rain:	Yes	Completion Date:	7/25/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins where the stream habitat type changes from step-pool to plane bed and continues 1,200 feet upstream to where the valley becomes a bit narrower.**

Step 5 - Notes: **Bimodal particle distribution; road material (asphalt) in bar. Affected by tropical storm Irene. Right corridor has sandy deposition from tributary (that flows from Mountain Road).**

Step 7 - Narrative: **Major aggradation - receiving significant amount from road washouts (East Mountain Road). Not incised. Some build up of sediment in the channel, but not extreme.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Subreach	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 192
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Never
Road:	0		0		Sometimes
Railroad:	0		0		Never
Imp. Path:	0		0		Sometimes
Dev.:	0		0		Never
		Texture:	N.E.	N.E.	In Rock Gorge: No
					Human Caused Change in Valley Width?: No
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M30-C**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	67.90	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.50	2.12 Substrate Composition		Bed:	N/A
2.3 Mean Depth (ft.):	2.65	Bedrock:	0.0 %	Bar:	N/A
2.4 Floodprone Width (ft.):	199.20	Boulder:	0.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	3.70	Cobble:	3.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	44.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	25.62	Fine Gravel:	18.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	2.93	Sand:	24.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	1.06	Silt and Smaller:	11.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	Yes	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Not Applicable	# Large Woody Debris:	22	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Steep				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	126.8	0.0	Dominant:	Deciduous	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	4.0	0.0	Sub-dominant:	None	None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	None	None	Bank Canopy		
Lower			Revetment Length:	0.0	0.0	Canopy %:	76-100	76-100
Material Type:	Sand	Sand				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	>100	>100
Sub-Dominant	None	None
W less than 25	0	0
Buffer Vegetation Type		
Dominant	Deciduous	Deciduous
Sub-Dominant	None	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Forest	Mass Failures	
Sub-dominant	None	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M30-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: Minimal	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 1
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 1	Impoundment Loc.:	Overland Flow: 1 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: 0	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 0 Delta: 3	Flood chutes: 3 Avulsion: 0	5.5 Straightening: None
Point: 0 Island: 0	5.3 Steep Riffles and Head Cuts Head Cuts: 0	Straightening Length (ft.): 0
Side: 3 Braiding: 0	Steep Riffles: 0 Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Plane Bed	Score	STD	Historic		
7.1 Channel Degradation		18	None	No	Geomorphic Rating	0.64
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	D
7.3 Widening Channel		13	None	No	Channel Evolution Stage	IIc
7.4 Change in Planform		13	None	No	Geomorphic Condition	Fair
Total Score		51			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Ottauquechee Mainstem	SGAT Version:	4.56
Reach:	M30-D	Organization:	Bear Creek Environmental
Segment Length(ft):	1,170	Observers:	MN, EK
Rain:	Yes	Completion Date:	7/25/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins as the valley becomes slightly narrower upstream of M30-C and continues 1,200 feet upstream until about 300 feet below the Route 4 bridge crossing near where East Mountain Road intersects Route 4.**

Step 5 - Notes: **Mostly pools, only 2 riffles**

Step 7 - Narrative: **Evidence of enlarged bars, mid channel bars, and along banks at cross section location. Not incised, major aggradation.**

Step 1. Valley and Floodplain

1.1 Segmentation: Subreach	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 143
1.3 Corridor Encroachments:	Continuous w/ Bank:	Sometimes	Sometimes	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>
Berm:	0		0	
Road:	451	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	
1.6 Grade Controls: None	Texture:	N.E.	N.E.	In Rock Gorge: No
				Human Caused Change in Valley Width?: Yes



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M30-D**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	56.30	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	4.00	2.12 Substrate Composition		Bed:	N/A
2.3 Mean Depth (ft.):	3.01	Bedrock:	0.0 %	Bar:	N/A
2.4 Floodprone Width (ft.):	114.80	Boulder:	1.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	4.00	Cobble:	8.0 %	Stream Type:	B
Human Elev FloodPln (ft.):		Coarse Gravel:	34.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	18.70	Fine Gravel:	41.0 %	Subclass Slope:	c
2.7 Entrenchment Ratio:	2.04	Sand:	12.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	1.00	Silt and Smaller:	4.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	B
2.10 Riffles Type:	Not Applicable	# Large Woody Debris:	38	Reference Bed Material:	Gravel
				Reference Subclass Slope:	c
				Reference Bedform:	Plane Bed

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Steep				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	131.9	99.1	Dominant:	Deciduous	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	3.0	3.0	Sub-dominant:	None	None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	None	None	Bank Canopy		
Lower			Revetment Length:	0.0	0.0	Canopy %:	76-100	76-100
Material Type:	Sand	Sand				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	>100	>100
Sub-Dominant	None	None
W less than 25	0	136
Buffer Vegetation Type		
Dominant	Deciduous	Deciduous
Sub-Dominant	None	None

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Forest	Mass Failures	
Sub-dominant	None	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M30-D**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: None	4.5 Flow Regulation Type None	4.7 Stormwater Inputs
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: 0 Road Ditch: 3
4.3 Flow Status: Moderate	Impoundments: None	Other: 0 Tile Drain: 0
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: 0 Urb Strm Wtr Pipe: 0
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0
4.8 Channel Constrictions: None		

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 0	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 3	Flood chutes: 1	Avulsion: 0	5.5 Straightening: None
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 0
Side: 3	Braiding: 0	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Plane Bed	Score	STD	Historic		
7.1 Channel Degradation		18	None	No	Geomorphic Rating	0.70
7.2 Channel Aggradation		8	None	No	Channel Evolution Model	F
7.3 Widening Channel		16	None	No	Channel Evolution Stage	I
7.4 Change in Planform		14	None	No	Geomorphic Condition	Good
Total Score		56			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream: **Ottauquechee Mainstem**
Reach: **M30-E**
Segment Length(ft): **937**
Rain: **Yes**

SGAT Version: **4.56**
Organization: **Bear Creek Environmental**
Observers: **MN, EK**
Completion Date: **7/23/2012**
Quality Control Status - Consultant: **Provisional**
Quality Control Status - Staff: **Provisional**
Why Not Assessed: **beaver dam**

Step 0 - Location: **This segment begins about 300 feet below the Route 4 bridge crossing near where East Mountain Road intersects Route 4 and continues about 900 feet upstream.**

Step 5 - Notes:

Step 7 - Narrative:

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>
Berm:	0			0	
Road:	711		0	0	
Railroad:	0			0	
Imp. Path:	0			0	
Dev.:	333			90	

1.6 Grade Controls: **None**

1.4 Adjacent Side

Hillside Slope:

Continuous w/ Bank:

Within 1 Bankfull W:

Texture:

Left

Right

Extr.Steep

Very Steep

Never

Never

Never

Never

Bedrock

N.E.

1.5 Valley Features

Valley Width (ft): **339**

Width Determination: **Measured**

Confinement Type: **BD**

In Rock Gorge: **No**

Human Caused Change in Valley Width?: **Yes**



Phase 2 Segment Summary Report

Ottawaquechee

Stream: **Ottawaquechee Mainstem** Reach: **M30-E**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	2.11 Riffle/Step Spacing:	2.13 Average Largest Particle on
2.2 Max Depth (ft.):	2.12 Substrate Composition	Bed:
2.3 Mean Depth (ft):	Bedrock: %	Bar:
2.4 Floodprone Width (ft.):	Boulder: %	2.14 Stream Type
2.5 Aband. Floodpn (ft.):	Cobble: %	Stream Type: E
Human Elev FloodPln (ft.):	Coarse Gravel: %	Bed Material: Sand
2.6 Width/Depth Ratio: 0.00	Fine Gravel: %	Subclass Slope: None
2.7 Entrenchment Ratio: 0.00	Sand: %	Bed Form: Dune-Ripple
2.8 Incision Ratio: 0.00	Silt and Smaller: %	Field Measured Slope:
Human Elevated Inc. Rat.: 0.00	Silt/Clay Present:	2.15 Sub-reach Stream Type
2.9 Sinuosity:	Detritus: 0.0 %	Reference Stream Type: E
2.10 Riffles Type:	# Large Woody Debris:	Reference Bed Material: Sand
		Reference Subclass Slope: None
		Reference Bedform: Dune-Ripple

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope: Steep					
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type <u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	90.4	227.2	Dominant: Herbaceous	Herbaceous	
Material Type:	Sand	Sand	Erosion Height (ft.):	5.1	3.9	Sub-dominant: Shrubs/Sapling	Shrubs/Sapling	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	Rip-Rap	Bank Canopy		
Lower			Revetment Length:	48.1	71.5	Canopy %:	26-50	1-25
Material Type:	Silt	Silt			Mid-Channel Canopy: Open			
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	0-25	0-25	Dominant
Sub-Dominant	26-50	26-50	Sub-dominant
W less than 25	191	463	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Herbaceous	Gullies
Sub-Dominant	Shrubs/Sapling	Shrubs/Sapling	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Commercial	Mass Failures	
Sub-Dominant	Forest	None	Height	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Buffer Vegetation Type	None		Gullies Length	0
Dominant	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Ottauquechee Mainstem** Reach: **M30-E**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal	4.5 Flow Regulation Type: None	4.7 Stormwater Inputs: None
4.2 Adjacent Wetlands: Abundant	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 1
	(old) Upstrm Flow Reg.:	Affected Length (ft): 500

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	50			Yes	No	

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal:	5.2 Other Features Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: Delta:	Flood chutes: 0	Avulsion: 0
Point: Island:	5.3 Steep Riffles and Head Cuts Head Cuts: 0	5.5 Straightening: None
Side: Braiding: 0	Steep Riffles: 0	Trib Rejuv.: 5.5 Dredging: None
		Straightening Length (ft.): 0

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type: <u>Left</u> <u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection
Total Score:	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:
Habitat Rating:		
Habitat Stream Condition:		

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Score</u>	<u>STD</u>	<u>Historic</u>	Geomorphic Rating
7.1 Channel Degradation				Channel Evolution Model
7.2 Channel Aggradation				Channel Evolution Stage
7.3 Widening Channel				Geomorphic Condition: Fair
7.4 Change in Planforml				Stream Sensitivity
Total Score				



Phase 2 Segment Summary Report Ottauquechee

Stream:	Reservoir Brook	SGAT Version:	4.56
Reach:	M28T5.01-A	Organization:	Bear Creek Environmental
Segment Length(ft):	877	Observers:	MN, EK
Rain:	Yes	Completion Date:	8/7/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

Step 0 - Location: **The most downstream reach on Reservoir Brook begins at the confluence with the Ottauquechee River and continues upstream 900 feet until a beaver dam.**

Step 5 - Notes:

Step 7 - Narrative: **Major aggradation especially in upper part of segment (diagonal bars, mid-channel bar). Major planform adjustment - island and braiding. Channelized (straightened along Cedar Brook). Minor widening due to aggradation. Possible floodplain filling at Cedar Brook because of condos.**

Step 1. Valley and Floodplain

1.1 Segmentation: Other Reason	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 365
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Sometimes	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Sometimes	Confinement Type: VB
Berm: 0 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 0 0				Human Caused Change in Valley Width?: Yes
Railroad: 0 0				
Imp. Path: 0 0				
Dev.: 533 0				
1.6 Grade Controls: None				



Phase 2 Segment Summary Report

Ottauquechee

Page 2

Stream: **Reservoir Brook** Reach: **M28T5.01-A**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	44.00	2.11 Riffle/Step Spacing:	102 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	2.80	2.12 Substrate Composition		Bed:	7.7 inches
2.3 Mean Depth (ft.):	1.91	Bedrock:	0.0 %	Bar:	4 inches
2.4 Floodprone Width (ft.):	247.00	Boulder:	0.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	2.80	Cobble:	31.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	50.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	23.04	Fine Gravel:	11.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	5.61	Sand:	8.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.00	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Moderate	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	29	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks				Typical Bank Slope:	Steep	
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	102.8	92.4	
Material Type:	Sand	Sand	Erosion Height (ft.):	3.1	2.8	
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Rip-Rap	None	
Lower			Revetment Length:	291.4	0.0	
Material Type:	Mix	Mix				
Consistency:	Non-cohesive	Non-cohesive				
				Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
				Dominant:	Shrubs/Sapling	Coniferous
				Sub-dominant:	Herbaceous	Shrubs/Sapling
				Bank Canopy		
				Canopy %:	26-50	76-100
				Mid-Channel Canopy:	Open	

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	26-50	>100
Sub-Dominant	0-25	None
W less than 25	523	0
Buffer Vegetation Type		
Dominant	Shrubs/Sapling	Coniferous
Sub-Dominant	Herbaceous	Mixed Trees

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	Mass Failures	<u>Left</u>	<u>Right</u>
Dominant	Shrubs/Sapling	Forest	Height		42.73
Sub-dominant	Residential	None	Gullies Number	0	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Length	0	
Failures	One	18.0			
Gullies	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Reservoir Brook** Reach: **M28T5.01-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	Minimal	4.5 Flow Regulation Type	None	4.7 Stormwater Inputs	
4.2 Adjacent Wetlands:	Minimal	Flow Reg. Use:		Field Ditch:	0 Road Ditch: 1
4.3 Flow Status:	Moderate	Impoundments:	None	Other:	0 Tile Drain: 0
4.4 # of Debris Jams:	0	Impoundment Loc.:		Overland Flow:	0 Urb Strm Wtr Pipe: 1
		4.6 Up/Down Strm flow reg.:	None	4.9 # of Beaver Dams:	1
		(old) Upstrm Flow Reg.:		Affected Length (ft):	155
4.8 Channel Constrictions:	None				

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing:	No
Mid:	1 Delta: 0	Flood chutes: 3	Avulsion: 0	5.5 Straightening:	Straightening
Point:	0 Island: 1	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.):	386
Side: 7	Braiding: 1	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging:	None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradient Type	<u>Left</u> <u>Right</u>
6.2 Pool Substrate:		6.5 Channel Flow Status:		6.8 Bank Stability:	
6.3 Pool Variability:		6.6 Channel Alteration:		6.9 Bank Vegetation Protection	
Total Score:	0	6.7 Channel Sinuosity:		6.10 Riparian Veg. Zone Width:	
Habitat Rating:	0.00				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		16	None	No	Geomorphic Rating	0.54
7.2 Channel Aggradation		7	None	No	Channel Evolution Model	D
7.3 Widening Channel		12	None	No	Channel Evolution Stage	Ild
7.4 Change in Planforml		8	None	No	Geomorphic Condition	Fair
Total Score		43			Stream Sensitivity	Very High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Reservoir Brook	SGAT Version:	4.56
Reach:	M28T5.01-B	Organization:	Bear Creek Environmental
Segment Length(ft):	760	Observers:	MN, EK
Rain:	Yes	Completion Date:	7/30/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

- Step 0 - Location: **This segment begins at the beaver dam and continues upstream 760 feet until the river starts to move closer to Route 100A, approximately 100 feet downstream of a private field access bridge to camps 307 & 309 (along Rt. 100A).**
- Step 5 - Notes: **Beaver dam impounding flow at upstream end of M28T5.01-B. Abundant wetlands and CPOM. Invasive phragmites. Although there is a human-caused change in valley width (not enough to change type), there are no encroachments listed for this segment. Route 100A is causing the minor human-caused change in valley width. Route 100A is located outside of the Phase 1 corridor, so there is an error in the automatic DMS QA Check indicating that there should be encroachments if there is a human-caused change in valley width.**
- Step 7 - Narrative: **Minor aggradation & widening; not much planform adjustment.**

Step 1. Valley and Floodplain

1.1 Segmentation:	Other Reason	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan:	None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 591
1.3 Corridor Encroachments:		Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u>	<u>One</u>	<u>Height</u>	<u>Both</u>	<u>Height</u>	Within 1 Bankfull W:
Berm:	0		0		Never
Road:	0		0		Never
Railroad:	0		0		Never
Imp. Path:	0		0		Never
Dev.:	0		0		Never
		Texture:	N.E.	N.E.	In Rock Gorge: No
					Human Caused Change in Valley Width?: Yes
1.6 Grade Controls:	None				



Phase 2 Segment Summary Report

Ottauquechee

Stream: **Reservoir Brook** Reach: **M28T5.01-B**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	38.00	2.11 Riffle/Step Spacing:	102 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.50	2.12 Substrate Composition		Bed:	7.9 inches
2.3 Mean Depth (ft.):	2.37	Bedrock:	0.0 %	Bar:	4.1 inches
2.4 Floodprone Width (ft.):	537.00	Boulder:	1.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	3.50	Cobble:	24.0 %	Stream Type:	C
Human Elev FloodPln (ft.):		Coarse Gravel:	48.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	16.03	Fine Gravel:	18.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	14.13	Sand:	9.0 %	Bed Form:	Riffle-Pool
2.8 Incision Ratio:	1.00	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	0.00	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Moderate	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Complete	# Large Woody Debris:	24	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Steep				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type	<u>Left</u>	<u>Right</u>
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	120.8	114.3	Dominant:	Deciduous	Deciduous
Material Type:	Sand	Sand	Erosion Height (ft.):	3.6	3.7	Sub-dominant:	None	None
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	None	None	Bank Canopy		
Lower			Revetment Length:	0.0	0.0	Canopy %:	76-100	76-100
Material Type:	Gravel	Gravel				Mid-Channel Canopy:	Closed	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>	Corridor Land
Dominant	51-100	>100	Dominant
Sub-Dominant	>100	None	Sub-dominant
W less than 25	0	0	(Legacy)
Buffer Vegetation Type			Failures
Dominant	Herbaceous	Herbaceous	Gullies
Sub-Dominant	Shrubs/Sapling	Shrubs/Sapling	

3.3 Riparian Corridor

	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Forest	Shrubs/Sapling	Mass Failures	
Sub-Dominant	Hay	None	Height	
W less than 25	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Buffer Vegetation Type			Gullies Length	0
Dominant	None			
Sub-Dominant	None			



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Phase 2 Segment Summary Report

Ottauquechee

Stream: Reservoir Brook Reach: M28T5.01-B

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	None	4.5 Flow Regulation Type	None	4.7 Stormwater Inputs	
4.2 Adjacent Wetlands:	Abundant	Flow Reg. Use:		Field Ditch:	0 Road Ditch: 1
4.3 Flow Status:	Moderate	Impoundments:	None	Other:	0 Tile Drain: 0
4.4 # of Debris Jams:	0	Impoundment Loc.:		Overland Flow:	0 Urb Strm Wtr Pipe: 0
		4.6 Up/Down Strm flow reg.:	None	4.9 # of Beaver Dams:	0
		(old) Upstrm Flow Reg.:		Affected Length (ft):	0
4.8 Channel Constrictions:	None				

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing:	No
Mid:	2 Delta: 1	Flood chutes: 1	Avulsion: 0	5.5 Straightening:	None
Point:	0 Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.):	0
Side:	6 Braiding: 0	Steep Riffles: 0	Trib Rejuv.: No	5.5 Dredging:	None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradient Type	<u>Left</u> <u>Right</u>
6.2 Pool Substrate:		6.5 Channel Flow Status:		6.8 Bank Stability:	
6.3 Pool Variability:		6.6 Channel Alteration:		6.9 Bank Vegetation Protection	
Total Score:	0	6.7 Channel Sinuosity:		6.10 Riparian Veg. Zone Width:	
Habitat Rating:	0.00				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	<u>Unconfined</u>	<u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation		16	None	No	Geomorphic Rating	0.65
7.2 Channel Aggradation		11	None	No	Channel Evolution Model	F
7.3 Widening Channel		11	None	No	Channel Evolution Stage	I
7.4 Change in Planform		14	None	No	Geomorphic Condition	Good
Total Score		52			Stream Sensitivity	High



Phase 2 Segment Summary Report **Ottauquechee**

Stream:	Reservoir Brook	SGAT Version:	4.56
Reach:	M28T5.01-C	Organization:	Bear Creek Environmental
Segment Length(ft):	802	Observers:	MN, EK
Rain:	Yes	Completion Date:	7/30/2012
		Quality Control Status - Consultant:	Provisional
		Quality Control Status - Staff:	Provisional

- Step 0 - Location: **This segment begins about 100 feet below a private field access bridge and continues 800 feet upstream until the eastern corridor changes from a field to forest. Route 100A runs adjacent to the western bank.**
- Step 5 - Notes: **A human-elevated floodplain incision ratio was added under Step 2 for M28T5.01-C to further show how the windrowing is impacting the stream channel.**
- Step 7 - Narrative: **Major incision - windrowing may have increased incision ratio. Windrowed material not very stable. Because of channelization and windrowing floodplain access has been limited (but not restricted) on the right bank.**

Step 1. Valley and Floodplain

1.1 Segmentation: Planform and Scope	1.4 Adjacent Side	<u>Left</u>	<u>Right</u>	1.5 Valley Features
1.2 Alluvial Fan: None	Hillside Slope:	Extr.Steep	Extr.Steep	Valley Width (ft): 456
1.3 Corridor Encroachments:	Continuous w/ Bank:	Never	Never	Width Determination: Measured
<u>Length (ft)</u> <u>One</u> <u>Height</u> <u>Both</u> <u>Height</u>	Within 1 Bankfull W:	Never	Never	Confinement Type: VB
Berm: 0	Texture:	N.E.	N.E.	In Rock Gorge: No
Road: 788				Human Caused Change in Valley Width?: Yes
Railroad: 0				
Imp. Path: 0				
Dev.: 0				
1.6 Grade Controls: None				



Stream Geomorphic Assessment



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Phase 2 Segment Summary Report

Ottauquechee

Stream: **Reservoir Brook** Reach: **M28T5.01-C**

Step 2. Stream Channel

2.1 Bankfull Width (ft.):	29.20	2.11 Riffle/Step Spacing:	151 ft.	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	3.70	2.12 Substrate Composition		Bed:	12.6 inches
2.3 Mean Depth (ft):	2.22	Bedrock:	0.0 %	Bar:	2.3 inches
2.4 Floodprone Width (ft.):	350.00	Boulder:	2.0 %	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	5.40	Cobble:	31.0 %	Stream Type:	C
Human Elev FloodPln (ft.):	9.60	Coarse Gravel:	48.0 %	Bed Material:	Gravel
2.6 Width/Depth Ratio:	13.15	Fine Gravel:	11.0 %	Subclass Slope:	None
2.7 Entrenchment Ratio:	11.99	Sand:	8.0 %	Bed Form:	Plane Bed
2.8 Incision Ratio:	1.46	Silt and Smaller:	0.0 %	Field Measured Slope:	
Human Elevated Inc. Rat.:	2.59	Silt/Clay Present:	No	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	Low	Detritus:	0.0 %	Reference Stream Type:	
2.10 Riffles Type:	Sedimented	# Large Woody Debris:	3	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks			Typical Bank Slope:	Steep				
Bank Texture			Bank Erosion	<u>Left</u>	<u>Right</u>	Near Bank Vegetation Type <u>Left</u>	<u>Right</u>	
Upper	<u>Left</u>	<u>Right</u>	Erosion Length (ft.):	293.0	593.5	Dominant:	Bare	Deciduous
Material Type:	Mix	Mix	Erosion Height (ft.):	4.6	3.3	Sub-dominant:	Deciduous	Herbaceous
Consistency:	Non-cohesive	Non-cohesive	Revetment Type:	Multiple	None	Bank Canopy		
Lower			Revetment Length:	138.0	0.0	Canopy %:	1-25	1-25
Material Type:	Mix	Mix				Mid-Channel Canopy:	Open	
Consistency:	Non-cohesive	Non-cohesive						

3.2 Riparian Buffer

Buffer Width	<u>Left</u>	<u>Right</u>
Dominant	0-25	0-25
Sub-Dominant	26-50	None
W less than 25	474	547
Buffer Vegetation Type		
Dominant	None	Herbaceous
Sub-Dominant	Deciduous	Deciduous

3.3 Riparian Corridor

Corridor Land	<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>
Dominant	Residential	Residential	Mass Failures	
Sub-dominant	Bare	None	Height	
(Legacy)	<u>Amount</u>	<u>Mean Hieght</u>	Gullies Number	0
Failures	None		Gullies Length	0
Gullies	None			



Phase 2 Segment Summary Report

Ottauquechee

Stream: Reservoir Brook Reach: M28T5.01-C

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: None	4.5 Flow Regulation Type None	4.7 Stormwater Inputs None
4.2 Adjacent Wetlands: None	Flow Reg. Use:	Field Ditch: Road Ditch:
4.3 Flow Status: Moderate	Impoundments: None	Other: Tile Drain:
4.4 # of Debris Jams: 0	Impoundment Loc.:	Overland Flow: Urb Strm Wtr Pipe:
	4.6 Up/Down Strm flow reg.: None	4.9 # of Beaver Dams: 0
	(old) Upstrm Flow Reg.:	Affected Length (ft): 0

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	25	Yes	No	Yes	No	Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal: 1	5.2 Other Features	Neck Cutoff: 0	5.4 Stream Ford or Animal Crossing: No
Mid: 1	Delta: 0	Flood chutes: 0	Avulsion: 0	5.5 Straightening: With Windrowing
Point: 0	Island: 0	5.3 Steep Riffles and Head Cuts	Head Cuts: 0	Straightening Length (ft.): 785
Side: 1	Braiding: 0	Steep Riffles: 1	Trib Rejuv.: No	5.5 Dredging: None

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradient Type	<u>Left</u>	<u>Right</u>
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score: 0	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating: 0.00				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic		
7.1 Channel Degradation		10	None	No	Geomorphic Rating	0.54
7.2 Channel Aggradation		13	None	No	Channel Evolution Model	F
7.3 Widening Channel		12	None	No	Channel Evolution Stage	II
7.4 Change in Planforml		8	None	No	Geomorphic Condition	Fair
Total Score		43			Stream Sensitivity	Very High

To: Bear Creek Environmental
From: Gretchen Alexander and Blaine Hastings, VT DEC River Management
Date: 12/14/12
QA Response Prepared by Emily Kinghorn and Mary Nealon of Bear Creek Environmental
Date: 12/21/12
RMP Response Review: 01/02/2013
QA Response #2 Prepared by Emily Kinghorn and Mary Nealon: 01/03/2013
RMP Response Review: 01/04/2013

Ottauquechee River Phase 2 QA

The questions raised in this Quality Assurance assessment are meant to address potential discrepancies within the data set, uncover data entry errors, or otherwise clarify and confirm those observations that might not have been expected. It is important to take into consideration how data might be viewed or interpreted by the myriad of users who are familiar with the science and protocols but may be unfamiliar with the assessed reaches. While providing notes and comments, try to anticipate the types of questions that may arise due to outliers and exceptions observed within the reach. While attempting to clarify the data for those users wishing to utilize it years after collected, it's better to err on the side of making excessive comments than it is for them to be insufficient.

After reviewing the comments below, please update this document in a second color with what steps were (or were not) taken to address the comments/questions.

General Comments:

In step 2, for reaches that are noted as significantly impacted by flooding, you have the option to record a channel enlargement %. A memo circulated at the beginning of the field season in response to Tropical Storm Irene provides the following guidance in this regard:

An incision ratio will be calculated as usual but an alternate measure for channel enlargement should also be used when channel dimensions have been significantly altered and/or corroborating bankfull indicators are not present.

Note this method is NEW to SGA protocols:

The **channel enlargement measure (E)** is a comparison of the channel's cross sectional area from the current top of bank (A_{tob}) to the cross sectional area predicted by the Vermont regional hydraulic geometry curve (A_{curve}) as a percentage, using this equation:

$$E = A_{\text{tob}} / A_{\text{curve}} \times 100$$

An approximate value of 100% for E could be interpreted as a clue that the stream channel may have retained equilibrium capacity. A value of 300%, for example, could indicate channel enlargement. However, there are obvious problems with this method because of limitations of the regional hydraulic geometry curve (see Appendix J of SGA Handbook). Also, this measure alone will not directly indicate degree of incision or floodplain access. This method is simply another descriptor to help qualify the data.

When reviewing the data for this project, I came upon several reaches where the checkbox had been selected for channel dimensions significantly affected by flooding, but the channel enlargement % shows as 0%. It was not clear to me whether you had manually entered 0%, or if this is the default that shows up when no data is entered. This seems to be the case in all reaches *except* for: M22-B, M25-A, M25-B, M25-C, M26-A, M26-B, M27-A, M27-E, M29, M30-A, M30-B, M30-C, M30-D, M30-E, M28T5.01-B (please check all others).

I have two comments on this:

1. Can you verify for the reaches where significant flood impacts have been noted but the channel enlargement value is 0% that you indeed entered 0%, and indicate this with a comment in the comment box below the percentage? Also, please make sure that you are making this calculation using the TOB area (not the bankfull area, as was provided by you in the hydraulic geometry spreadsheet for helping to verify bankfull elevations).

The DMS defaults to 0% if no channel enlargement percentage is entered. Data sheets do not use the word “significant”. We have gone through and revised Step 2.14 to consider channel dimensions that appeared to be **significantly** changed by flooding or floodwork. Thank you. Also, thanks for noting the exclusion of this option from the data sheets. We will look into including them for easier protocol adherence in the field.

2. If you marked a reach as flood impacted and did not enter a channel enlargement value (the 0% is showing up as default), then please calculate a percentage using the formula above. Channel enlargement values are entered for segments marked as flood impacted, where bankfull indicators were not discernible. Thank you.

Reach specific comments:

M13-0

Step 0 – no segment location noted. Entered.

Step2:

Values for “Recently Abandoned Floodplain” and “Floodprone Width” look to be switched. Yes, they were accidentally switched. The correction has been made.

Entrenchment ratio is recorded as 0.06, should be 6.95. When we made the above switch, the entrenchment ratio calculation was corrected as well.

Incision ratio is recorded as 120.64, should be 1.13. When we made the above switch, the incision ratio calculation was corrected as well.

Meander migration: “multiple” types indicated in Phase 1, but only one instance of braiding observed in Phase 2. Update Phase 1 accordingly. Impact “Migration” with sub-impact “Migration” was identified in Phase 1. Impact “Migration” with sub-impact “Braiding” was identified in Phase 2. This step is a result of an FIT input and cannot be changed manually. The

impact rating was updated from “not significant” to “low” based on the identification of a braided section in Phase 2. OK.

M14-A

Step 0 – no segment location noted. Entered.

Step 5 comment:

I think what you meant to write was “Minor human-caused change in valley **width**, but no change in valley type” Yes. The change has been made.

M14-B

Step 0 – no segment location noted. Entered.

Step 2:

It is noted that this cross section is the same as M15-B. Please justify why you felt this was appropriate in the Step 5 comments for both reaches. We are assuming that you meant M15-A because we used the same cross section for M14-B and M15-A. Justification was entered in Step 5 for M14-B and M15-A. “The section of the Ottauquechee River starting just below the Elm Street Bridge in Woodstock and continuing downstream 1,950 feet is a section that has incised and lost its floodplain access as a result of channel straightening. During the Phase 1 assessment, this area was split by a reach break because of the confluence with Kedron Brook. The upper section, M15-A could not be properly assessed because there was no riffle present, so the cross section was done just below the reach break in M14-B. We felt this cross section was a representative cross section for both segments because the channel dimensions on the main stem were similar for both short segments.” Thank you.

The bedform in step 2 is noted as riffle-pool, and yet the bedform in step 6 habitat assessment is noted as planebed (as a habitat departure). Reach photos and other data appear to support a dominantly planebed condition – was the step 2 bedform entry an oversight or are there other reasons you felt it should remain riffle-pool? This segment is plane-bed dominant and was an oversight. We changed the location of the segment break between M14-A and M14-B at a later date. With the old segment break, M14-B was riffle-pool dominant. With the new segment break, M14-B is plane-bed dominant. This has been changed in the DMS. Thank you.

M15-A

No photos from 15A? Segment 15-A is very short, about 800 feet. The whole segment can be seen in the upstream photo from the cross section in M14-B (also used for M15-A) as well as the downstream photo from the Elm Street bridge. OK. Just be sure this is noted somewhere should someone be looking for them in the future. I have entered a comment about this in Step 5. Great, thanks!

Step 0 – no segment location noted. Entered.

Step 7 comment: “much more incised” compared to what? Upstream? This segment has a much higher incision ratio than upstream segment M15-B. This has been changed in the DMS. Thanks.

M15-B

Step 0 – no segment location noted. **Entered.**

Step 7:

It feels a little strange to have a reach in such poor condition be characterized as early stage IV. I know we discussed this scenario on the phone. Perhaps it would be helpful to add more justification for keeping it in IV in the comments, noting observations that made you feel new floodplain was starting to develop. In the photos I could see a few places where bars are large and extend a long distance from the wetted channel – perhaps this is what you were keying in on?

We have looked back at the cross-section and photos for Segment 15-B, and have updated Step 7 to indicate this segment is in Stage F-III. While there is an indication that there are flood chutes and bars formation, there is not an evident juvenile floodplain. Seems more agreeable to observations, thanks.

M15-C

Step 0 – no segment location noted. **Entered.**

The step 2 bedform is noted as step-pool, but the RHA bedform does not note a habitat type departure. Please explain. Do you think there has been a bedform departure from riffle-pool to step-pool due to human caused change in confinement? If so, please update step 6. **The segment is very short (723 feet). We looked at the photos and habitat notes, and think riffle-pool is a better descriptor for the dominant bedform. The large substrate in the upper part of the segment is creating a couple of steps and pools, and step-pool is the sub-dominant bedform. In fact, the pools in the upper segment are deep and creating nice habitat. The lower portion is a long riffle with pocket pools. Sounds good, thanks.**

M16-0

Step 0 – no segment location noted. **Entered.**

Step 7 comment: What do you mean by “W/d ratio was less than 30; therefore, stream channel is widening”. This statement seems to imply that if the w/d ratio was greater than 30, you would have concluded that it was not over-widened. I think maybe you are trying to say that the channel is over-widened, but not as severely compared to upstream reaches? Please clarify what you are getting at here. **We have revised the comment in Step 7 to be clearer. There is minor widening in this segment compared with major widening in upstream reaches. The language still sounds like 30 is a threshold above which indicates widening. Be sure to explicitly say a W/D <30 is less than upstream, but there is still minor widening. “The w/d ratio in this segment was < 30, which indicates that the river is undergoing minor widening. Upstream segments/reaches had w/d ratios greater than 30, which indicates that they are undergoing major or extreme (>40) widening.” Entered into Step 7 comments. OK.**

Channel Bars: Phase 1 suggest “delta” as the dominant bar type, but Phase 2 found a point, diagonal, and several side bars in addition to deltas for this reach. For these features, if they are found in Phase 2 (step 5.1) their potential to exist should be updated for Phase 1 (while recognizing the differing degree of specificity between Phase 1 and 2). Update Phase 1 bars to “multiple” in step 6.3. **Phase 1 was updated to indicate “multiple.” Thank you.**

M17-0

Step 0 – no segment location noted. **Entered.**

Step 7: It is included in your x.s worksheet, but please include a comment here that you are unsure of RAF elevation because of obvious fill in the floodplain (parking area). **Comment added under Step 7.**

Channel Bars: Phase 1 data displays “multiple” bars, which suggests there are several types of bars but no one dominant type. However, Phase 2 found 8 of the 12 to be side bars for this reach. For these features, if they are found in Phase 2 (step 5.1) this should be reflected in Phase 1. Consider updating Phase 1 bars to “side” in step 6.3. **Side bar was not an option in the Phase 1 Step 6.3 dropdown menu at the time the Phase 1 data were updated. We appreciate you working with the DMS administrators to resolve this. Following this fix, Phase 1 was updated to indicate “side.” Thank you.**

M18-A

Step 0 – no segment location noted. **Entered.**

M18-B

Step 0 – no segment location noted. **Entered.**

Step7: Small typo in comment “bars need to **be** some more to have a juvenile floodplain at a lower elevation.” Think you intended “build”. **Yes, changed in DMS. Thank you.**

M19-A

Step 0 – no segment location noted. **Entered.**

Step 2:

Bankfull width recorded on cross-section worksheet dimensions table is 154.12, but it looks like it is actually 153.3 ft. Inconsistency is also reflected in entrenchment ratio recorded on cross-section worksheet. **Our RBF and LBF elevations differ by 0.1 feet. This is because we found two good features. We used the LBF elevation for our “bankfull elevation” in the cross section. Since the RBF elevation is lower, the computer calculated a wider width than our measured width, also changing the entrenchment ratio. We have changed Step 2 in the DMS to reflect what our cross section indicates. OK.**

x.s worksheet: can you estimate a distance to the left valley wall from your map? **Distance estimated using measuring tool in ArcMap. Cross section re-uploaded to DMS. I see the update, thanks.**

M19-B

Step 0 – no segment location noted. **Entered.**

x.s section worksheet: contains a note to yourself to check map for location of Ph1 and Ph2 valley wall, but doesn't appear that you have updated the x.s worksheet with this info. yet. **Information has been updated and cross section re-uploaded to DMS.**

M20-A

Step 0 – no segment location noted. **Entered.**

Step 1.5: Valley width seems much too wide and doesn't match your shapefile or x.s. Please revise value and confinement accordingly. **Re-checked the average valley width using our shapefile and got an average that is 30 feet narrower. The new average phase 2 valley width has been updated in the DMS. The valley type was not changed. The Phase 2 valley width at our cross section is 87 feet narrower than the new average Phase 2 valley width for the segment. The location of the cross section was limited by location of riffles and identifying good bankfull features. Thank you for revisiting.**

M20-B

Step 0 – no segment location noted. **Entered.**

M21

RAF adjusted to be elevation of US Route 4 rather than very narrow flat feature at lower elevation for segments A, C and D. This new incision ratio makes more sense in light of the "F" stream type. Cross sections re-uploaded to DMS. **OK.**

M21-A

Step 2:

Bankfull width recorded on cross-section worksheet dimensions table is 124.70, but it looks like it is actually 125.7 ft. **This was a typo when entering into the DMS. Step 2 in the DMS now says 124.7 feet for bankfull width. Thank you.**

W/D looks correct in Phase 2, step 2 data of DMS but does not agree with what is recorded in cross-section worksheet. **W/D ratio is updated after above fix.**

M21-B

Step 6: Your step 2 bedform is noted as planebed, but you do not indicate a SHTD in step 6 from rifle-pool to planebed. Please address. **We have revised Step 6 to indicate a SHTD. Thank you.**

M21-C

Step 2: The dominant bedform is noted as riffle-pool with planebed being subdominant. From the photos of the segment, the bed appears predominantly planebed. Did you feel there were distinct riffles, perhaps not captured in the photos? **In the field we debated which bedform is dominant (riffle-pool versus plane bed). There are distinct riffles and we were able to determine**

riffle spacing. Photo # M21Cp5 and M21Cp2 show distinct riffles. Pools are typically shallow and more run-like, and that is why we chose plane bed as subdominant. We added an explanation in Step 6. Please see RGA Step 7. Sounds good.

M21-D

M22-A

Step 0 – no segment location noted. Entered.

Meander migration: “multiple” types indicated in Phase 1, but only flood chutes (two) were observed in Phase 2. Update Phase 1 accordingly. Impact “Migration” with sub-impact “Migration” was identified in Phase 1. Two impacts “Migration” with sub-impact “Flood Chute” were identified in Phase 2 in M22-B. This step is a result of an FIT input and cannot be changed manually. The impact rating was updated from “not significant” to “low” based on the identification of flood chutes in Phase 2. OK.

M22-B

Step 0 – no segment location noted. Entered.

Meander migration: see comment in M22-A. See comment for M22-A.

M23-A

Step 0 – no segment location noted. Entered.

Step 2.14 notes that the channel dimensions were significantly changed by flooding, but the notes on your x.s sheet say the opposite. Please address. The note in the cross section spreadsheet indicates that the dimensions were not “substantially” changed by flooding – there was some minor deposition on the floodplain, which we felt was necessary to mention. In regards to the comment you have made, we have updated the DMS to indicate that the cross section was **not** “significantly” changed by major flooding under Step 2.14. We have mentioned the minor floodplain deposition under the Step 2.14 comments. Looks good, thanks.

Step 7.5 – no channel process narrative entered. Please fill-in. Entered. Looks good, thanks.

M23-B

Step 0 – no segment location noted. Entered.

Step 2: Photos seem to indicate quite a bit of plane bed bedform. Did you consider this as a subdominant bedform? Yes, we agree that we should have selected plane bed as subdominant. RGA Step 7.2 supports that selection. OK.

M24-A

Step 0 – no segment location noted. Entered.

x.s worksheet contains a note for you to update the left and right vw locations with information from your map, but does not appear that you have done that yet. **This information has been updated and the cross section has been re-uploaded. Thanks.**

Would be good to include comment from x.s sheet indicating bankfull location uncertainty somewhere in the DMS comments – perhaps in step 2 under flood impacts or in step 5 (since there is space there). **Comment entered under Step 5. Thanks.**

Channel Bars: Phase 1 data displays “multiple” bars, which suggests there are several types of bars but no one dominant type. However, Phase 2 found 15 of the 22 to be side bars for this reach. For these features, if they are found in Phase 2 (step 5.1) this should be reflected in Phase 1. Consider updating Phase 1 bars to “side” in step 6.3. **Phase 1 was updated to indicate “side.” Thank you.**

M24-B

Step 0 – no segment location noted. **Entered.**

Channel Bars: See comment for M24-A. **Phase 1 was updated to indicate “side.” Thank you.**

M25-A

Step 0 – no segment location noted. **Entered.**

Channel Bars: Phase 1 suggest “diagonal” as the dominant bar type, but Phase 2 shows only 5 of the 24 to be “diagonal” for this reach. Update Phase 1 bars to “multiple” in step 6.3. **Dominant deposition type updated to “multiple.” Thanks.**

M25-B

Step 0 – no segment location noted. **Entered.**

Is that a snowmobile adjacent to the rank 5 pool?! **Something like that!**

Channel Bars: See comment for M25-A **Dominant deposition type updated to “multiple.” Thanks.**

M25-C

Step 0 – no segment location noted. **Entered.**

Did you happen to notify anybody about the propane tank you observed in the stream? **No, but it will be included as a potential cleanup project in our report.**

x.s spreadsheet – in your note about “no good bars” are you referring to average largest particle measurements? Please clarify. **There is a “no good bars” comment for M25-B cross section and we assumed this is the one you are referring to. This comment is referring to average largest particle measurements and is now clarified and re-uploaded to the DMS. OK.**

Channel Bars: See comment for M25-A **Dominant deposition type updated to “multiple.”** Thanks.

M26-A

Step 0 – no segment location noted. **Entered.**

Step 2.8 calculates the incision ratio resulting from the natural RAF as well as the human elevated floodplain. It looks like you currently have the HEF recorded in the natural RAF slot – please revise so that correct HEF and RAF elevations are populated in step 2.5 so that both incision ratios get calculated correctly. **Updated. Thank you.**

Step 7 comments: is the berm continuous? Worth noting whether or not you think the river can outflank the berm and access floodplain (will help with potential restoration project prioritization). **The berm is not continuous and the river could outflank the berm in a high flow event. The berm is below the floodprone elevation, and during TSI the berm was outflanked resulting in flood damage to nearby homes. Comment has been added to Step 7. OK.**

Channel Bars: Phase 1 suggest “diagonal” as the dominant bar type, but Phase 2 shows only 8 of the 25 to be “diagonal” for this reach. Update Phase 1 bars to “multiple” in step 6.3. **Updated to “multiple.”** Thanks.

M26-B

Step 0 – no segment location noted. **Entered.**

Step 7.7: An F4 stream type in poor condition should have an extreme sensitivity, not very high. Please revise. **Revised – indicates “extreme” sensitivity now. Thank you.**

Channel Bars: See comment for M26-A. **Updated to “multiple.”** Thanks.

M26-C

Step 0 – no segment location noted. **Entered.**

Step 7 comment notes a STD from C to B, but it’s actually a B to F. Please revise. **Stream type departure is from B to F. Comments were changed. Thank you.**

Channel Bars: See comment for M26-A. **Updated to “multiple.”** Thanks.

M27-A

Step 0 – no segment location noted. **Entered.**

Groundwater: The reach as a whole was classified as having “Abundant” groundwater inputs, but 4 of 6 segments (such as this one) were found to have minimal springs/seeps and no wetland inputs in Phase 2. Phase 1 groundwater characterization should *generally* agree with Phase 2 findings (step 4.4) - consider updating Phase 1 classification (step 4.4) or providing comments for your reasoning. **We made this decision based on segment lengths, not number of segments. Based on the segment lengths, GW was ‘extensive’ for 3375 feet, ‘present’ for 3764 feet, and**

'minimal' for 4573 feet. The 'present' category is not an option under Phase 2 Step 4.1 or in Phase 1, but perhaps it should be. The only time that present can be entered is under Phase 2 Step 6. We remember observing extensive groundwater inputs for this reach, and believe extensive makes more sense than minimal (although if present were an option, we would have selected that). An explanation has been entered into Step 7 in the Phase 1 database. Sound reasoning on relative segment lengths. Thank you for commenting.

M27-B

Step 0 – no segment location noted. Entered.

Step 2.14 – I find it confusing that you checked the box indicating that the channel dimensions were significantly impacted by major flooding, but then included a comment that there was only a minor change in channel dimensions due to flooding. Could you please clarify your intent? Note on cross section indicates that the dimensions were not “substantially” changed by flooding – there was some minor deposition on the floodplain, which we felt was necessary to mention. In regards to the comment you have made, we have updated the DMS to indicate that the cross section was **not** “significantly” changed by major flooding under Step 2.14. Under Step 2.14 comments we have mentioned the minor deposition. Looks good, thanks.

Step 7: In your selection of the D CEM, did you feel that the presence of bedrock was the primary factor preventing incision? There are no grade controls noted in step 1.6. Or is this more a case of excessive aggradation driving the process? Please clarify. Bedrock was present in this segment; however, there was no evidence of the bedrock being channel spanning. Floodplain access was superb. Channel widening was attributed to aggradation and not degradation, D CEM makes sense. A more detailed explanation was added to Step 7 in the DMS. Good, thanks.

Groundwater: The reach as a whole was classified as having “Abundant” groundwater inputs, but 4 of 6 segments (including this one) were found to have minimal springs/seeps and no wetland inputs in Phase 2. Phase 1 groundwater characterization should *generally* agree with Phase 2 findings (step 4.4) - consider updating Phase 1 classification (step 4.4) or providing comments for your reasoning. See M27-A. Yes. Thanks.

M27-C

Step 0 – no segment location noted. Entered.

x.s worksheet notes uncertainly regarding bankfull indicator and RAF – good to note this somewhere in comments in DMS as well. Also, note included in x.s worksheet to locate right vw from map, but worksheet does not appear to be updated with this information yet. Please address. Comment added under Step 5. RVW location updated on cross section and uploaded to DMS. Thanks.

Groundwater: The reach as a whole was classified as having “Abundant” groundwater inputs, but 4 of 6 segments (such as this one) were found to have minimal springs/seeps and no wetland inputs in Phase 2. Phase 1 groundwater characterization should *generally* agree with Phase 2 findings (step 4.4) - consider updating Phase 1 classification (step 4.4) or providing comments for your reasoning. See M27-A.

A human-elevated floodplain incision ratio was added under Step 2 for this segment to further explain how Route 4 is impacting (and cutting off) floodplain access. Comments were added to Step 5. This is useful, especially given the difficulty in bankfull indicators and RAF identification.

M27-D

Step 0 – no segment location noted. **Entered.**

M27-E

Step 0 – no segment location noted. **Entered.**

A human-elevated floodplain incision ratio was added under Step 2 for this segment to further explain how Route 4 is impacting (and cutting off) floodplain access. Comments were added to Step 5. OK. It looks like there is a fairly well defined RAF at a lower elevation on the opposite side of stream than Rt. 4. Given this limited RAF access, do you still think Rt. 4 is a major driver of incision? If so, this may still be useful information. Please add additional information in comment clarifying this (as HEF is mainly used when RAF cannot be located, like M27-C, or has been cut off by encroachment, like M28-A). The area on the opposite side of Route 4 that you are referring to is a ‘wetland’ area that appears to possibly have been an old channel – we measured an elevation below bank full. In our cross section, you can see that there is a ‘floodplain edit’ at the distance -127. We did this so that the area below bank full would not be included in the bank full cross sectional area because the wetland is not hydraulically connected to the river (because of the placement of Route 4). The RAF we chose on the right side of the channel may not be the ‘true’ RAF because it is narrow and the valley wall is so close. Because of this uncertainty we are including the HEF. Route 4 is still likely a major driver in the incision since it takes up about a third of the valley here. A note explaining this has been added to Step 5 comments. OK. I was referring to the RAF above the right bank (I wasn’t very clear, sorry), but if it seems too narrow to offset the effects of Route 4 HEF so much so that it is still a major driver of incision, then this is good. Thanks for adding further comment.

M27-F

Step 0 – no segment location noted. **Entered.**

Step 7: just confirming here that your choice of D CEM was influenced by excessive aggradation despite the lack of any grade controls. This seems reasonable. **Yes, you are correct. OK.**

Groundwater: The reach as a whole was classified as having “Abundant” groundwater inputs, but 4 of 6 segments (such as this one) were found to have minimal springs/seeps and no wetland inputs in Phase 2. Phase 1 groundwater characterization should *generally* agree with Phase 2 findings (step 4.4) - consider updating Phase 1 classification (step 4.4) or providing comments for your reasoning. **See M27-A.**

M28-A

Step 0 – no segment location noted. **Entered.**

Channel Bars: Phase 1 suggest “delta” as the dominant bar type, but Phase 2 shows only 4 of the 29 to be “delta” for this reach. Update Phase 1 bars to “multiple” in step 6.3. Updated to “multiple.” Thank you.

A human-elevated floodplain incision ratio was added under Step 2 for this segment to further explain how old Standish Road is impacting (and cutting off) floodplain access. Since this is not a Phase 2 valley wall, this will have good potential for a restoration project. Comments were added to Step 5. Good. Thanks.

M28-B

Step 0 – no segment location noted. Entered.

Step 7: Please indicate your reasoning for selecting CEM stage 2. Incision is minor and you indicate there is good floodplain access – is it possible this reach is in equilibrium (stage 1?). I suspect you selected stage II to acknowledge slight incision – worth explaining your reasoning in step 7 notes. This reach appears to have been historically straightened. About one-quarter of the left bank is armored. There is a human-caused change in valley width from narrow to semi-confined. About 1/3 to 1/2 of each bank was eroded. Although the incision ratio was 1.18, we would be hesitant to put this in Stage F-I, indicating it is in equilibrium. The width to depth ratio was low and bank erosion was moderate, suggesting this segment may be in early stage F-II. We have added a comment to Step 7.

Channel Bars: See comment for M28-A. Updated to “multiple.”

M28-C

Step 0 – no segment location noted. Entered.

Step2:

Add comment clarifying choice to classify as a “Bc” stream type, despite a braided channel and very high W/D. After reviewing definitions for braiding in the Phase 1 and 2 manuals, Rosgen (1996) and online we have concluded that M28-C is not a braided system. Although islands are present, they are vegetated with large trees and are not shifting. These islands appear to have resulted from planform adjustment rather than aggradation. In order to be a “D” stream type, these multiple channels would be expected to divide and recombine multiple times. This, however, is not the case as there are only two islands that are not side by side within the channel. This is more of a ‘bifurcated’ channel than a braided channel. We have updated the dominant bedform to be riffle-pool and comments are added to Step 5. Makes sense per our discussion-thanks. The term “braiding” in Step 0 - Location comments also need updated. Changed the wording – thanks! Great.

A human-elevated floodplain incision ratio was added under Step 2 for M28-C to further explain how Route 4 is impacting (and cutting off) floodplain access. Comments were added to Step 5. Good, thanks.

M29-0

x.s worksheet includes note to check location of RVW, but does not appear to be updated yet. **Cross section updated and re-uploaded to DMS. Thank you.**

Also, thank you for calculating channel enlargement %. However, in the P2 Step 2 notes you comment that it was calculated using LTOB, but in x-section comment you say it is RAF (and there is no LTOB identified). Are these the same? Please edit where needed to be consistent. **Yes, these are the same. Edited the Step 2 notes. Thanks.**

M30-A

There is no data entered in all of step 2! It is evident that a cross section was completed – if you intentionally left this blank due to uncertainty please make note of it in comments. **The comments about this are included at the bottom of Step 2 in the “flood affected” section as well as in Step 5. Bankfull features were not discernible in this segment. OK.**

This segment originally indicated that “braided” was the subdominant bedform. Similarly to M28-C, we have updated this to indicate that it is not the case. In this segment the river is actually “trifurcated.” ☺ **Comments were added to Step 5.**

Step 7.5 process narrative blank – please provide some content here. **Step 7.5 comments have been entered. “Braiding” is again still used to describe segment in these comments. Please update. Changed wording – thanks! OK.**

M30-B

Step 2:

Segment was not fully assessed due to flood impacts. Because you selected the “administrative judgment” option, it is not possible to view any other data that you may have collected for the reach. Was there other data collected that is not being displayed? If so, perhaps we can mark the reach as assessed, but explain in the step 5 comments that it was not possible to perform a cross section due to severe flood impacts (like in M30-A)? If no other data was collected and you decide to stick with administrative judgment, please provide more comments/justification for the stream type selected, as I can not access any comments about why this segment was not assessed. Any photos of this segment? Is it a rock gorge? **If you uncheck “segment not assessed” in step 0, you’ll be able to see the information in the other steps. We assessed this reach with Sacha and agreed that no cross section was needed in this very short segment because it’s stable and in good geomorphic condition. The substrate is dominated by very large boulders, and the bedform is step-pool. Bedrock almost spans the channel in many places. Although no true channel spanning bedrock grade controls were present, the large boulders and bedrock are providing resistance to incision. “Other” was selected for reason not assessed, because the segment was not a “true” bedrock gorge. We have provided an explanation regarding this reason in Step 5. Thanks for explaining. Could you explicitly add the connection to large boulders/bedrock-type features and stability of “good” condition as reasoning for no cross-section? There were two reasons that a cross section was not done in this segment. First of all, the segment was very short (714 feet). Secondly, the segment was noted to be in “good” geomorphic condition with little bank erosion, forested buffers, and the presence of large boulders and bedrock on the bed (resistant to incision). Updated comments in Step 5 to be more clear. (To see this, uncheck**

“segment not assessed” in Step 0 and then “save.” Then you can navigate to Step 5.) Much more clear. Thanks!

M30C

Step 0 – no segment location noted. Entered.

Step 6 – are you suggesting that this segment is planebed by reference? Just want to be sure this is the case and not an oversight. If so, please make it a subreach (for different reference bedform). If not, please revise step 6 to be a SHTD and use appropriate habitat form. This segment is plane-bed by reference. M30 was split into five segments, exhibiting four different reference stream types; therefore, it was difficult to determine a reference stream type for the entire reach. M30-C, a C4 plane-bed by reference, was used as the reference stream type for the reach because it was the longest segment. Since a C4 plane-bed is the reach’s reference stream type, M30-C is not a subreach. The Phase 1 reference stream type was entered incorrectly into the DMS as “riffle-pool” and has been changed to “plane bed.” This makes M30-B, M30-D, and M30-E subreaches. OK. I see the sub-reaches were defined in the other segments. Thanks.

M30-D

Step 0 – no segment location noted. Entered.

x.s worksheet contains a note to yourself to check the road distance beyond right vw, but it is apparent whether or not you did this. If it is complete, please remove from your notes for clarity sake. This has been completed, removed from the notes, and the cross section has been re-uploaded to the DMS. Thank you.

M30-E

Step 0 – no segment location noted. Entered. “This segment ~~was~~ begins about 300 feet...” Changed wording. Thanks.

M28T5.01-A

x.s worksheet – what do you mean by the term “floodplain edit”? Please label “dirt pile” in x.s. notes. I’m assuming that you are not including the “dirt pile” as the HEF given that it would not constrict flood flows, yes? The dirt pile has been labeled in the cross section and the cross section has been re-uploaded. You are correct – the dirt pile would not restrict flood flows and is explained in the comments on the cross section. The term “floodplain edit” has been removed from the cross section to avoid confusion – it was just used to indicate that you could use a floodplain edit in the cross section worksheet to view the cross section without the dirt pile. Is more clear now, thanks.

M28T5.01-B

Because there is no human caused change in valley width identified, Phase 1 valley width should be updated with Phase 2 measured valley width. There is a minor human-caused change in valley width as a result of Route 100A. Step 1.5 has been updated to indicate this. This change caused a QA conflict in the DMS regarding encroachments, but has been explained in the comments: Route 100A lies outside of the Phase 1 corridor, but still is causing a change in valley width. Thanks for updating...but I’m not sure I see the explanation in any of the comments.?

The explanation was entered in the comments under the DMS QA Check (you have to click on the 'complete' button for X.3 Fix Conflicting Data to see it. I have added an explanation to Step 5 so that it is easier to find. Oh, my apologies for missing that. Thanks.

M28T5.01-C

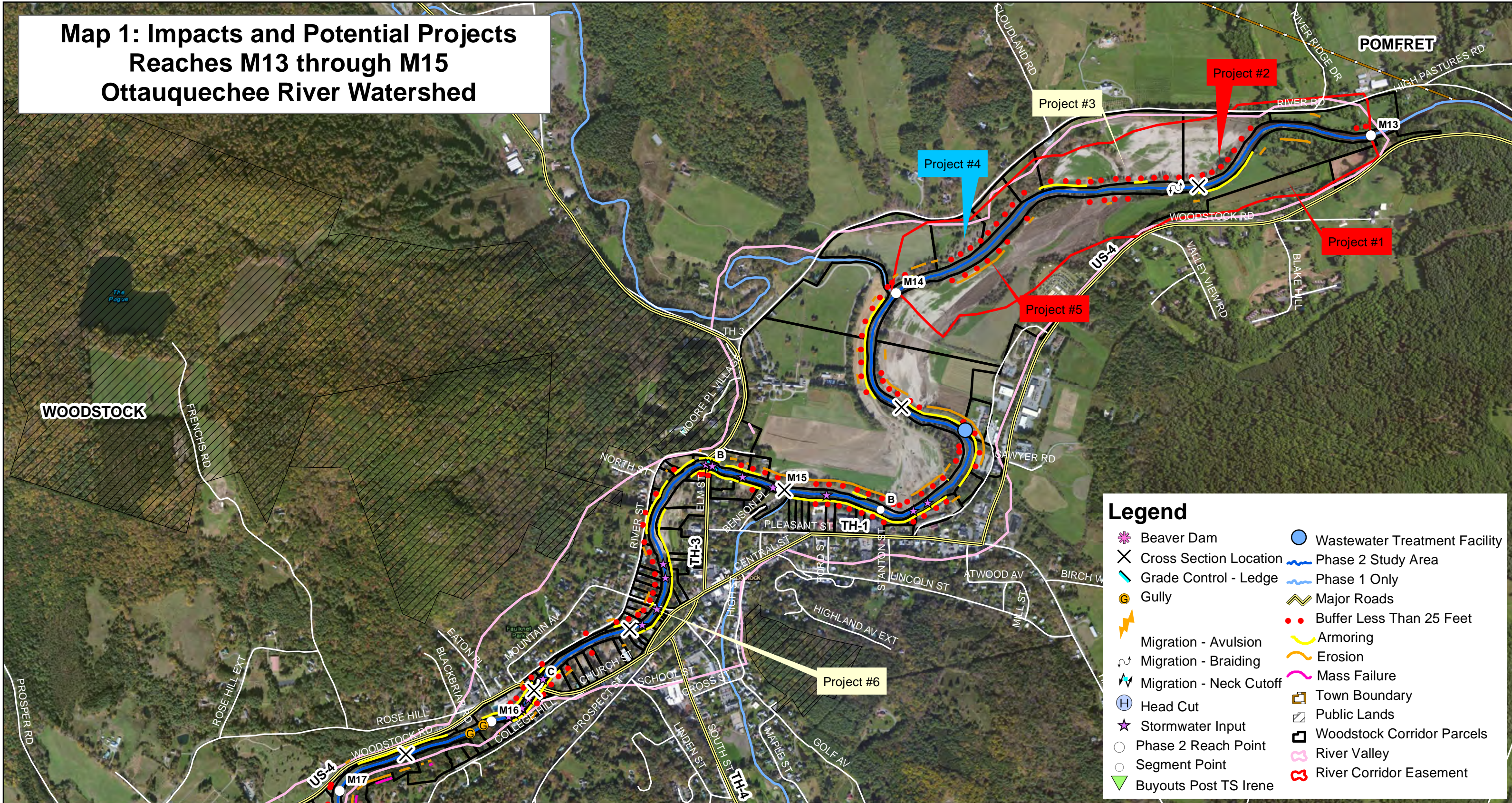
Step 2 notes dominant bedform as planebed, but step 6 does not indicate a SHTD to planebed. Please address. This was an oversight – the hard copy of our RHA indicates a stream habitat type departure. This has been updated in the DMS.

A human-elevated floodplain incision ratio was added under Step 2 for M28T5.01-C to further show how the windrowing is impacting the stream channel. Comments were added to Step 5. OK.

APPENDIX D

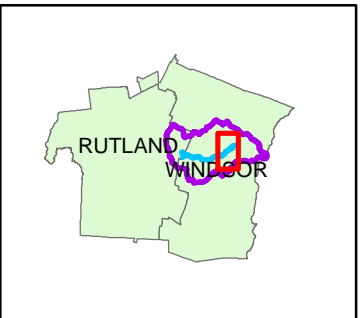
Potential Project Locations & Descriptions

Map 1: Impacts and Potential Projects Reaches M13 through M15 Ottauquechee River Watershed



Legend

	Beaver Dam		Wastewater Treatment Facility
	Cross Section Location		Phase 2 Study Area
	Grade Control - Ledge		Phase 1 Only
	Gully		Major Roads
	Migration - Avulsion		Buffer Less Than 25 Feet
	Migration - Braiding		Armoring
	Migration - Neck Cutoff		Erosion
	Head Cut		Mass Failure
	Stormwater Input		Town Boundary
	Phase 2 Reach Point		Public Lands
	Segment Point		Woodstock Corridor Parcels
	Buyouts Post TS Irene		River Valley
			River Corridor Easement



- ### Projects:
1. River Corridor Easements - Reach 13
 2. Streamside Planting
 3. Supplement Existing Plantings as Needed
 4. Allow Natural Regeneration of Buffer
 5. Streamside Planting (CREP)
 6. Streamside Planting - M15 (Woodstock Village)

Project Priority:

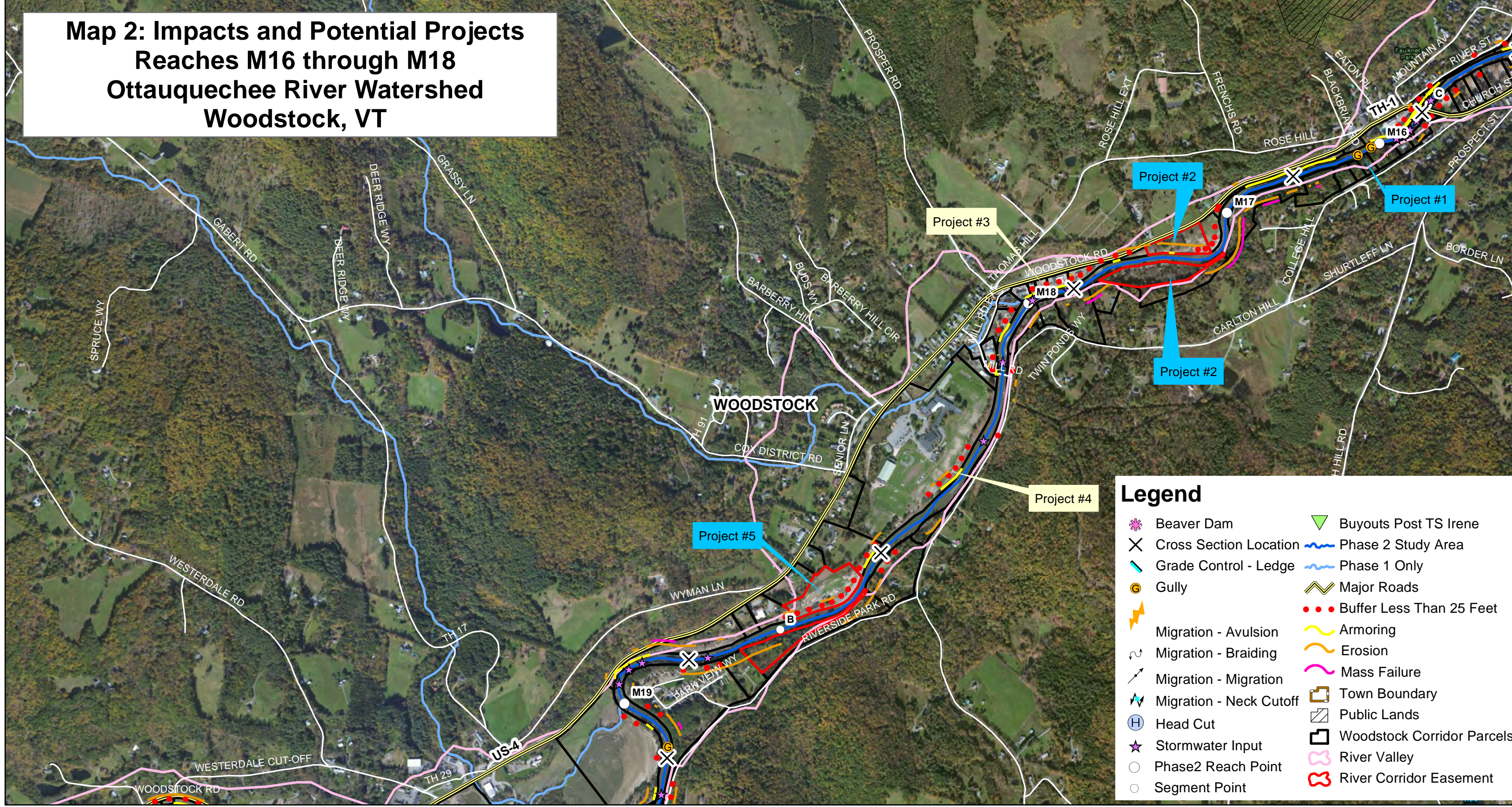
- Low
- Moderate
- High

0 250 500 1,000 Feet
1 inch = 1,000 feet

Background is Bing Imagery

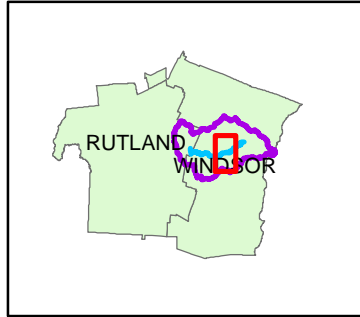
Bear Creek
Environmental

Map 2: Impacts and Potential Projects Reaches M16 through M18 Ottauquechee River Watershed Woodstock, VT



Legend

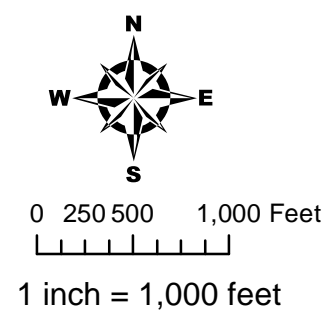
Beaver Dam	Buyouts Post TS Irene
Cross Section Location	Phase 2 Study Area
Grade Control - Ledge	Phase 1 Only
Gully	Major Roads
Migration - Avulsion	Buffer Less Than 25 Feet
Migration - Braiding	Armoring
Migration - Migration	Erosion
Migration - Neck Cutoff	Mass Failure
Head Cut	Town Boundary
Stormwater Input	Public Lands
Phase2 Reach Point	Woodstock Corridor Parcels
Segment Point	River Valley
	River Corridor Easement



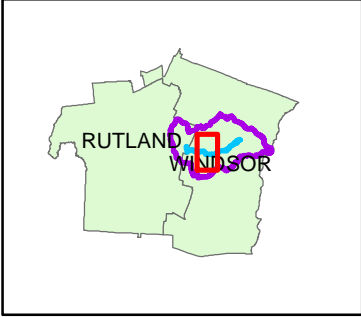
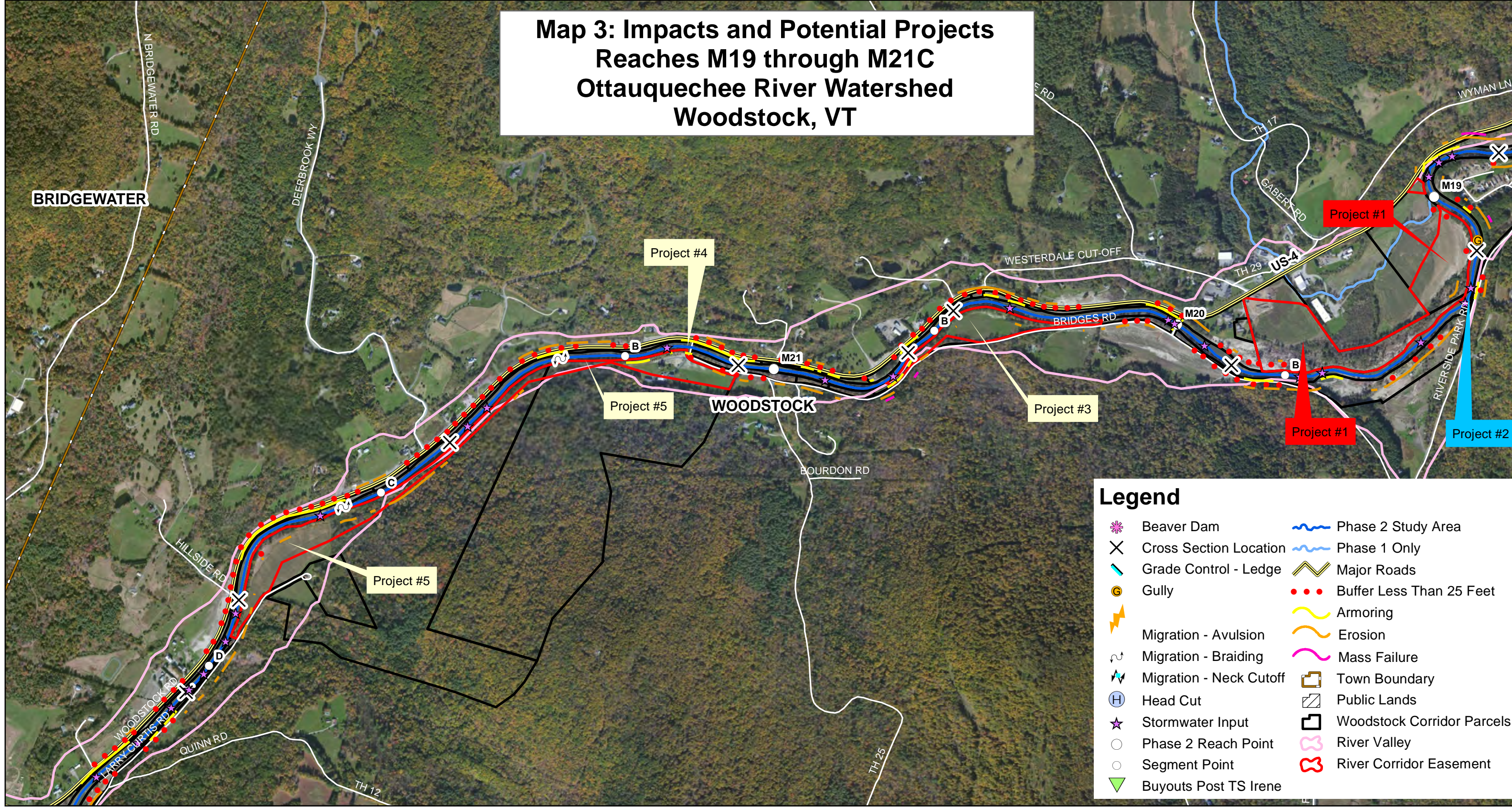
- ### Projects:
1. Gully Remediation/Stormwater Management
 2. River Corridor Easement
 3. Streamside Planting - Live Stakes in Rip Rap
 4. Streamside Planting
 5. River Corridor Easement/Streamside Planting

Project Priority:

- Low
- Moderate
- High



Map 3: Impacts and Potential Projects Reaches M19 through M21C Ottauquechee River Watershed Woodstock, VT

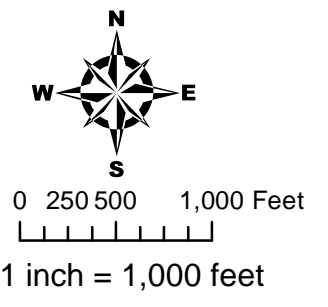


Projects:

1. River Corridor Easement
2. Stormwater Management - Riverside Park Road
3. River Corridor Easement
4. Alternatives Analysis for Bridge Abutment Removal
5. River Corridor Easement

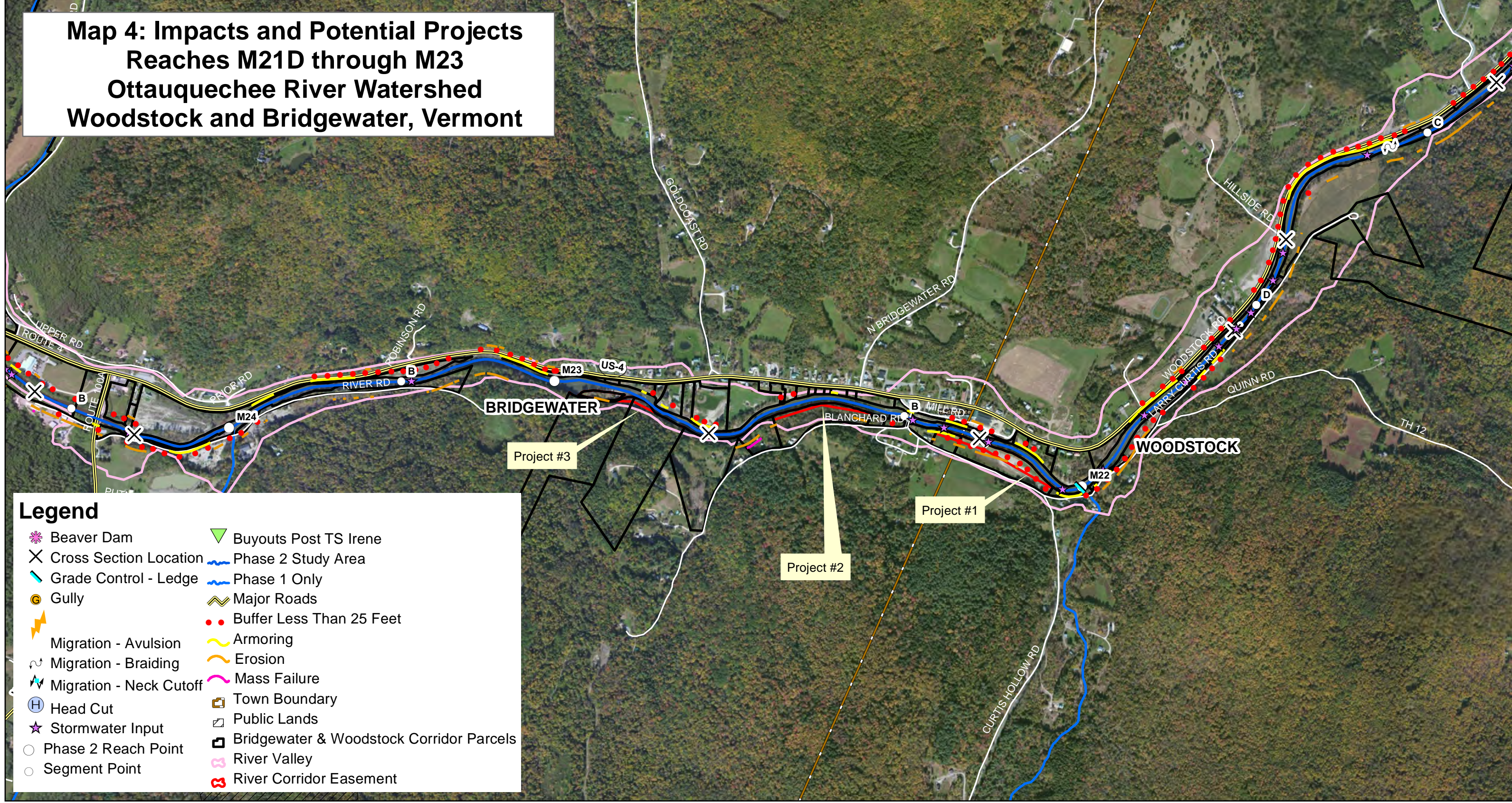
Project Priority:

- Low
- Moderate
- High



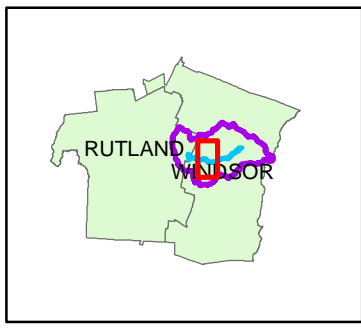
Background is Bing Imagery

Map 4: Impacts and Potential Projects Reaches M21D through M23 Ottauquechee River Watershed Woodstock and Bridgewater, Vermont



Legend

Beaver Dam	Buyouts Post TS Irene
Cross Section Location	Phase 2 Study Area
Grade Control - Ledge	Phase 1 Only
Gully	Major Roads
Migration - Avulsion	Buffer Less Than 25 Feet
Migration - Braiding	Armoring
Migration - Neck Cutoff	Erosion
Head Cut	Mass Failure
Stormwater Input	Town Boundary
Phase 2 Reach Point	Public Lands
Segment Point	Bridgewater & Woodstock Corridor Parcels
	River Valley
	River Corridor Easement



- ### Projects:
1. River Corridor Easement/Streamside Planting
 2. River Corridor Easement
 3. River Corridor Easement

Project Priority:

- Low
- Moderate
- High

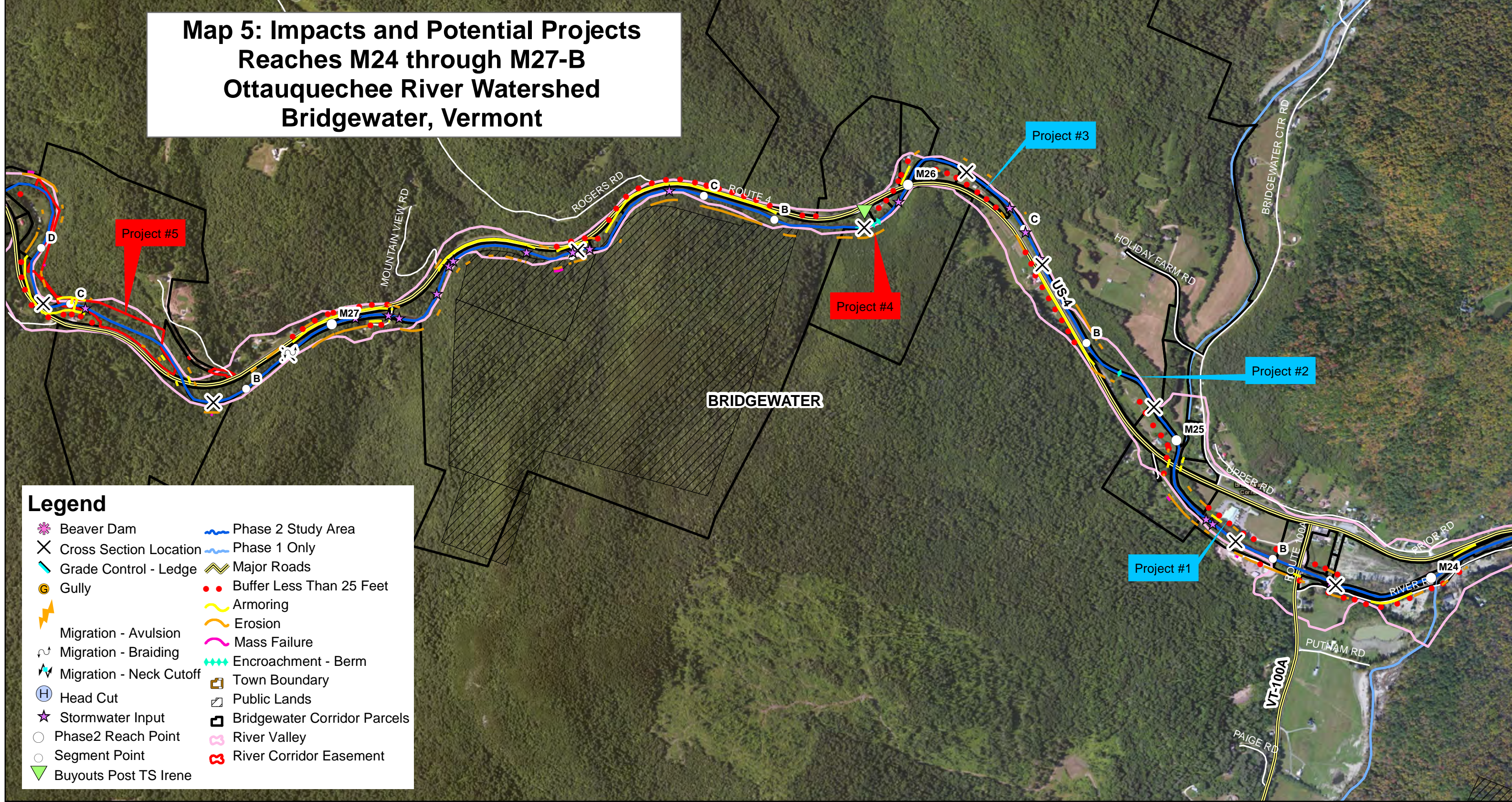
0 250 500 1,000 Feet

1 inch = 1,000 feet

Background is Bing Imagery

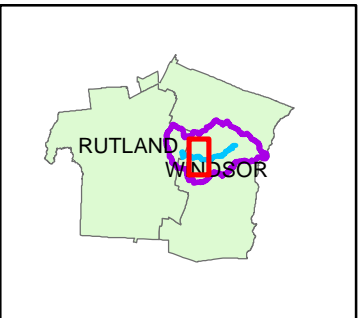
Bear Creek
Environmental

Map 5: Impacts and Potential Projects Reaches M24 through M27-B Ottauquechee River Watershed Bridgewater, Vermont



Legend

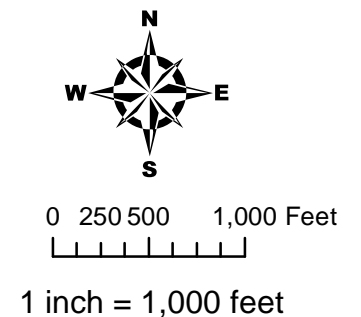
✿ Beaver Dam	Phase 2 Study Area
✕ Cross Section Location	Phase 1 Only
▬ Grade Control - Ledge	Major Roads
Ⓞ Gully	••• Buffer Less Than 25 Feet
⚡ Migration - Avulsion	Armoring
⤿ Migration - Braiding	Erosion
⚡ Migration - Neck Cutoff	Mass Failure
Ⓜ Head Cut	Encroachment - Berm
★ Stormwater Input	▭ Town Boundary
○ Phase2 Reach Point	▨ Public Lands
○ Segment Point	▭ Bridgewater Corridor Parcels
▽ Buyouts Post TS Irene	Ⓜ River Valley
	Ⓜ River Corridor Easement



- ### Projects:
1. Streamside Planting
 2. Propane Tank Removal
 3. Streamside Planting
 4. Alternatives Analysis for Berm Removal
 5. River Corridor Easement

Project Priority:

- Low (Yellow)
- Moderate (Blue)
- High (Red)

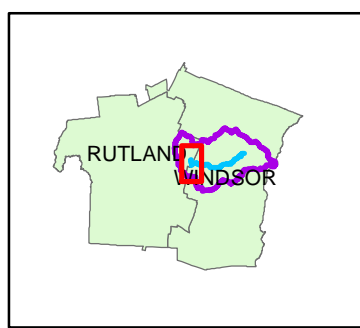
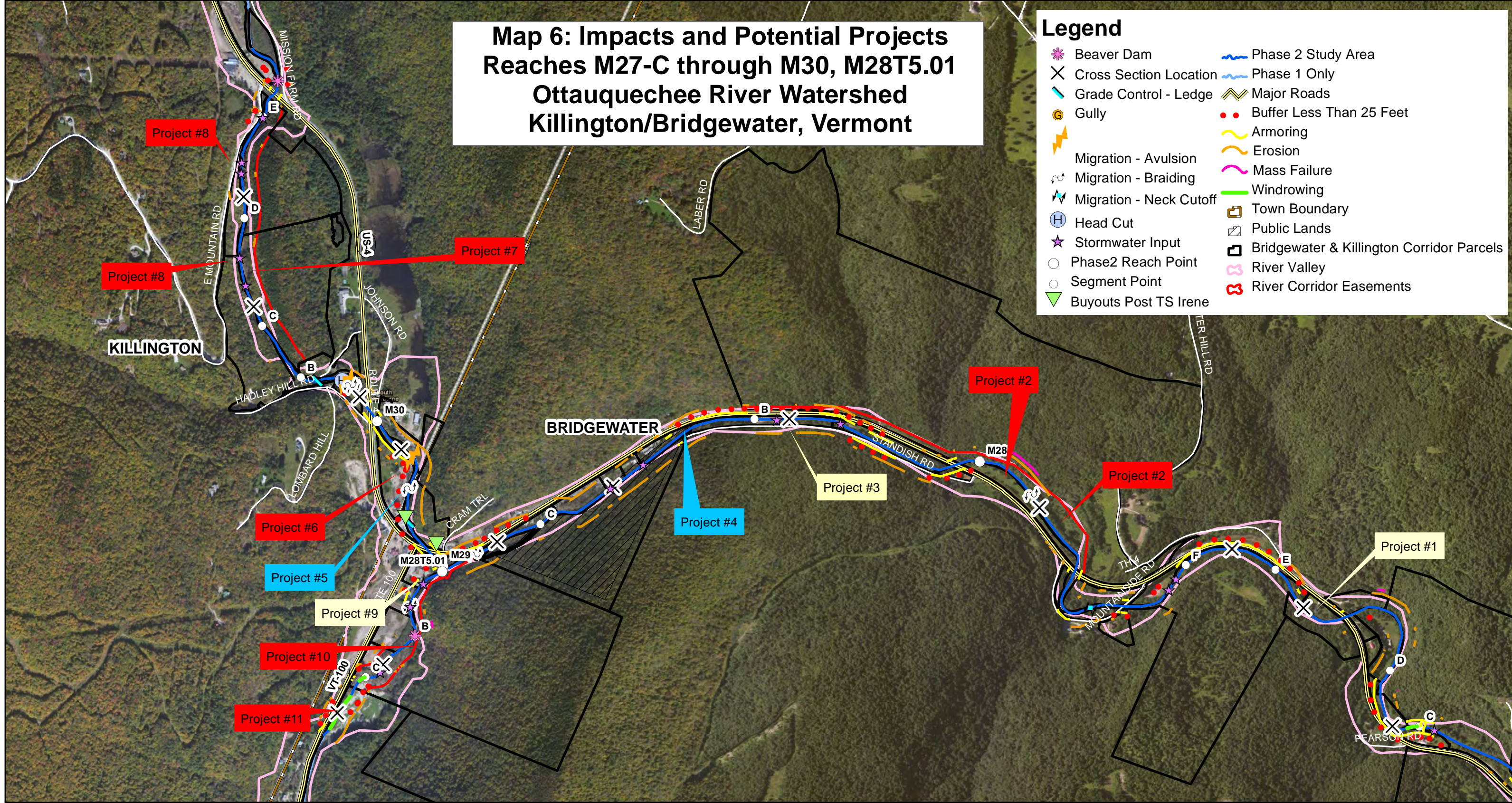


Background is Bing Imagery

Map 6: Impacts and Potential Projects Reaches M27-C through M30, M28T5.01 Ottauquechee River Watershed Killington/Bridgewater, Vermont

Legend

- Beaver Dam
- Cross Section Location
- Grade Control - Ledge
- Gully
- Migration - Avulsion
- Migration - Braiding
- Migration - Neck Cutoff
- Head Cut
- Stormwater Input
- Phase2 Reach Point
- Segment Point
- Buyouts Post TS Irene
- Phase 2 Study Area
- Phase 1 Only
- Major Roads
- Buffer Less Than 25 Feet
- Armoring
- Erosion
- Mass Failure
- Windrowing
- Town Boundary
- Public Lands
- Bridgewater & Killington Corridor Parcels
- River Valley
- River Corridor Easements

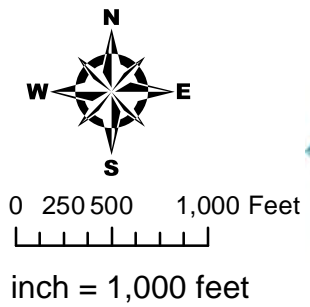


Projects:

1. Supplemental Streamside Plantings
2. River Corridor Easement/Sediment Attenuation Area
3. Investigate Removal of Standish Road
4. Old Bridge Abutment Removal
5. Remediate Iron Seep
6. Streamside Planting, Floodplain Creation
7. River Corridor Easement
8. Stormwater Improvement
9. Streamside Planting
10. River Corridor Easement
11. Remove Windrow/Berm & Streamside Planting

Project Priority:

- Low
- Moderate
- High



**Table 1. Ottauquechee River Main Stem
Map 1: M13 through M15
Site Level Opportunities for Restoration and Protection
Woodstock, Vermont**

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Potential Partners/Programs
Project #1 M13	Passive Restoration	Agricultural fields along river corridor are a sediment attenuation area	Protect river corridor through easement	High Priority	Improved habitat and water quality	Cost of easement	Landowners, TRORC, VANR, Town of Woodstock RCE
Project #2 M13	Passive Restoration	Agricultural fields along channel lack adequate buffer along northern bank	Streamside plantings	High Priority	Improved habitat and water quality	Cost of plantings	Landowners, TRORC, VANR, Town of Woodstock CREP, TFS, WHIP, CRWC
Project #3 M13	Passive Restoration	Area along agricultural fields that has newly planted trees	Supplement existing plantings as needed	Low Priority	Improved habitat and water quality	Cost of plantings	Landowners, TRORC, VANR, Town of Woodstock TFS, CRWC
Project #4 M13	Passive Restoration	Area along fence that does not have adequate buffer	Allow vegetation to naturally regenerate over time	Moderate Priority	Improved habitat and water quality	None	Landowners
Project #5 M13	Passive Restoration	Southern bank along agricultural field lacks adequate buffer	Streamside plantings	High Priority	Improved habitat and water quality	Cost of plantings	Landowners, TRORC, VANR, Town of Woodstock CREP, TFS, WHIP, CRWC
Project #6 M15	Passive Restoration	Residential areas in Woodstock Village where buffer is not adequate	Streamside plantings	Low Priority	Improved habitat and water quality	Cost of plantings	Landowners, TRORC, VANR, Village of Woodstock TFS, CRWC

Photos of Proposed Project Locations – Map 1
(No photo available for Project #5 - Streamside Plantings)



Project #1 – Protect River Corridor



Project #2 – Streamside Plantings



Project #3 – Supplement Existing Plantings



Project #4 – Natural Buffer Regeneration



Project #6 – Streamside Plantings in Woodstock



**Table 2. Ottauquechee River Main Stem
Map 2: M16 through M18
Site Level Opportunities for Restoration and Protection
Woodstock, Vermont**

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Potential Partners/Programs
Project #1 M16	Stormwater Management	Two gullies have formed likely from stormwater runoff from College Hill Road.	Evaluate stormwater management practices. Remediation of gullies through stormwater management.	Moderate Priority	Improved water quality	Unknown	Landowners, TRORC, VANR, Town of Woodstock ERP
Project #2 M17	Passive Restoration	Tree farm located in northern and southern river corridor. Some areas have floodplain access.	Protect river corridor through easement	Moderate Priority	Improved habitat and water quality	Cost of easement	Landowners, TRORC, VANR, Town of Woodstock RCE
Project #3 M17	Passive Restoration	Rip rapped area along parking lot is lacking adequate bank vegetation.	Streamside plantings with live stakes in rip rap	Low Priority	Improved habitat and water quality	Cost of plantings	Landowner, TRORC, ANR, Town of Woodstock TFS, CRWC
Project #4 M18-A	Passive Restoration	Areas along WUHS fields lack adequate buffers. There is limited floodplain access and a conflict with existing land use (sports fields).	Streamside plantings, away from channel - river is widening	Low Priority	Improved habitat and water quality	Cost of plantings	TRORC, VANR, Town of Woodstock TFS, CRWC
Project #5 M18-A	Passive Restoration	Area along cow pasture that does not have adequate buffer. Limited areas of floodplain access in segment.	Protect river corridor through easement and/or streamside plantings	Moderate Priority	Improved habitat and water quality	Cost of easement and plantings	Landowners, TRORC, VANR, Town of Woodstock RCE, CREP, TFS, WHIP, CRWC

Photos of Proposed Project Locations – Map 2

(No photo available for Project #2 – Protect River Corridor)



Project #1 – Stormwater Management and Gully Remediation



Project #3 – Live Stakes in Rip Rap



Project #4 – Streamside Plantings (left)



Project #5 – Streamside Plantings and Protect River Corridor

**Table 3. Ottauquechee River Main Stem
Map 3: M19 through M21-C
Site Level Opportunities for Restoration and Protection
Woodstock, Vermont**

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Potential Partners/Programs
Project #1 M19-A	Passive Restoration	Agricultural fields in northern river corridor are a sediment attenuation area.	Protect river corridor through easement	High Priority	Improved habitat, water quality, and geomorphic stability	Cost of easement	Landowners, TRORC, VANR, Town of Woodstock RCE
Project #2 M19-A	Stormwater Management	Runoff from Riverside Park Road is causing excess stormwater to enter the river.	Evaluate stormwater management	Moderate Priority	Improved water quality	Unknown	Landowner, TRORC, VANR, Town of Woodstock ERP
Project #3 M20-A	Passive Restoration	Southern river corridor, poor floodplain access	Protect river corridor through easement	Low Priority	Improved habitat and water quality	Cost of easement	Landowners, TRORC, VANR, Town of Woodstock RCE
Project #4 M21-A	Active Restoration	Old bridge abutment channel constriction is causing upstream and downstream deposition.	Alternative analysis for the removal of the abutment	Low Priority	Improved habitat and geomorphic stability	Cost of analysis and high cost of removal	Landowner, TRORC, VANR, Town of Woodstock ERP, CRWC
Project #5 M21-B & M21-C	Passive Restoration	Southern forested river corridor and agricultural field, poor floodplain access	Protect river corridor through easement	Low Priority	Improved habitat and water quality	Cost of easement	Landowners, TRORC, VANR, Town of Woodstock RCE

Photos of Proposed Project Locations – Map 3

(No photo available for Project #1 – Protect River Corridor)



Project #2 – Riverside Park Road



Project #3 – Protect River Corridor



Project #4 – Investigate Abutment Removal



Project #5 – Protect River Corridor (left)

**Table 4. Ottauquechee River Main Stem
Map 4: M21-D through M23
Site Level Opportunities for Restoration and Protection
Woodstock, Vermont**

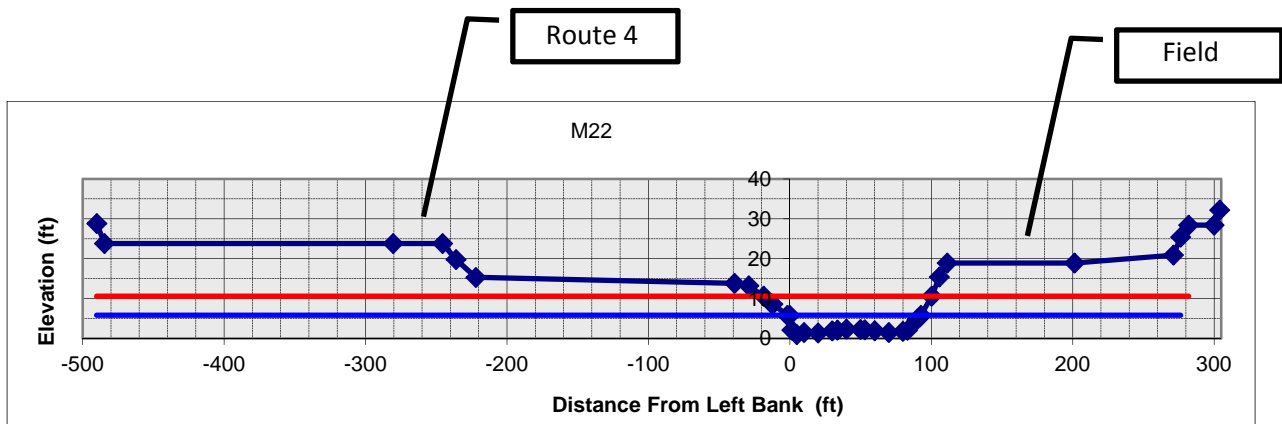
Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Potential Partners/Programs
Project #1 M22-A	Passive Restoration	Area in southern river corridor has no buffer, some floodplain access in short areas of this segment, may be a land use conflict	Protect river corridor through easement and streamside plantings	Low Priority	Improved habitat and water quality	Cost of easement and plantings	Landowner, TRORC, VANR, Town of Woodstock RCE, TFS
Project #2 M22-B	Passive Restoration	Forested area in southern river corridor, poor floodplain access	Protect river corridor through easement	Low Priority	Improved habitat and water quality	Cost of easement	Landowners, TRORC, VANR, Town of Bridgewater RCE
Project #3 M22-B	Passive Restoration	Forested area in southern corridor, poor floodplain access	Protect river corridor through easement	Low Priority	Improved habitat and water quality	Cost of easement	Landowners, TRORC, VANR, Town of Bridgewater RCE

Photos of Proposed Project Locations – Map 4

(No photo available for Projects #1 & 2 – Protect River Corridor & Streamside Plantings)



Project #3 – Protect River Corridor (right)



Poor floodplain access (red line) in M22-A indicates Low Priority for river corridor easements.

**Table 5. Ottauquechee River Main Stem
Map 5: M24 through M27-B
Site Level Opportunities for Restoration and Protection
Woodstock, Vermont**

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Potential Partners/Programs
Project #1 M24-B	Passive Restoration	Area along northern bank without adequate buffer, moderate floodplain access	Streamside plantings	Moderate Priority	Improved habitat and water quality	Cost of plantings	Landowner, TRORC, VANR, Town of Bridgewater TFS, CRWC
Project #2 M25-A	Stream Clean-Up	A small propane tank is located along the eastern stream bank.	Remove propane tank	Moderate Priority	Improved water quality	Cost of trash removal	Landowner, TRORC, VANR, Town of Bridgewater ERP
Project #3 M25-C	Passive Restoration	Area along southern bank does not have adequate buffer, moderate floodplain access	Streamside plantings	Moderate Priority	Improved habitat and water quality	Cost of plantings	Landowners, TRORC, VANR, Town of Bridgewater TFS, CRWC
Project #4 M26-A	Active Restoration	A 275-foot berm (not continuous) is limiting floodplain access at lower flows. Land was bought out after Tropical Storm Irene.	Alternatives analysis for the removal of the berm, protect river corridor through easement	High Priority	Improved geomorphic stability	Cost of analysis and potential berm removal and easement	Landowner, TRORC, VANR, Town of Bridgewater ERP, RCE, CRWC
Project #5 M27-B & M27-C	Passive Restoration	Forested area along northern river corridor, good floodplain access	Protect river corridor through easement	High Priority	Improved habitat and water quality	Cost of easement	Landowners, TRORC, VANR, Town of Bridgewater RCE, land trust

Photos of Proposed Project Locations – Map 5

(No photo available for Project #5 – Protect River Corridor)



Project #1 – Streamside Plantings



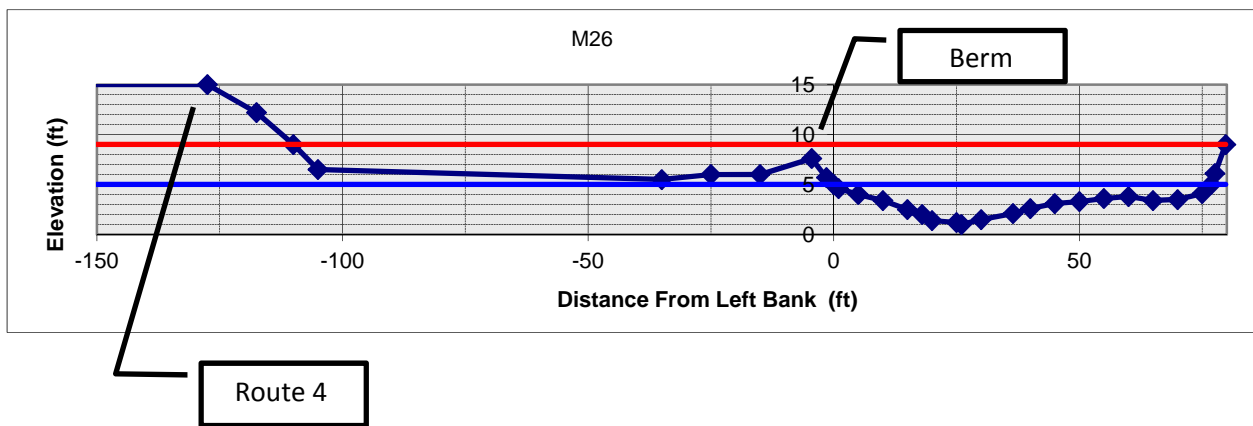
Project #2 – Remove Propane Tank



Project #3 – Streamside Plantings



Project #4 – Alternatives Analysis - Berm



Project #4 – Alternatives Analysis – Berm Removal

**Table 6a. Ottauquechee River Main Stem & Reservoir Brook
Map 6: M27-C through M30, M28T5.01
Site Level Opportunities for Restoration and Protection
Bridgewater and Killington, Vermont**

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Potential Partners/Programs
Project #1 M27-D	Passive Restoration	Area along river that may benefit from buffer plantings	Supplement with streamside plantings as needed	Low Priority	Improved habitat and water quality	Cost of plantings	Landowner, TRORC, VANR, Town of Bridgewater TFS, CRWC
Project #2 M27-F	Passive Restoration	Northern river corridor provides great floodplain access and is a sediment attenuation area.	Protect river corridor through easement	High Priority	Improved habitat, water quality, and geomorphic stability	Cost of easement	Landowner, TRORC, VANR RCE, land trust
Project #3 M28-A	Active Restoration	Area of Standish Road restricts floodplain access. Land-use conflict.	Alternatives analysis for the removal of Standish Road	Low Priority	Improved geomorphic stability	Cost of analysis and high cost of removal	Landowner, TRORC, VANR, Town of Bridgewater ERP, CRWC
Project #4 M28-B	Active Restoration	Old bridge abutment channel constriction causing deposition above & below, scour above & below. Poorly aligned.	Alternatives analysis for the removal of the abutment	Moderate Priority	Improved geomorphic stability	Cost of analysis and high cost of removal	Landowner, TRORC, VANR, Town of Bridgewater ERP, CRWC
Project #5 M29	Active Restoration	Iron discharge from pipe	Remediate iron seep	Moderate Priority	Improved water quality	Unknown	Landowner, TRORC, VANR, Town of Killington ERP
Project #6 M29	Active/ Passive Restoration	Area along western bank does not have adequate buffer. Possibility of lowering banks to improve floodplain access.	Creation of floodplain and streamside plantings	High Priority	Improved habitat and water quality	Cost of floodplain creation and plantings	Landowner, TRORC, VANR, Town of Killington ERP, TFS, WHIP, CRWC

**Table 6b. Ottauquechee River Main Stem & Reservoir Brook
Map 6: M27-C through M30, M28T5.01
Site Level Opportunities for Restoration and Protection
Bridgewater and Killington, Vermont**

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Potential Partners/Programs
Project #7 M30-B, M30-C, M30-D	Passive Restoration	Eastern forested river corridor provides good floodplain access	Protect river corridor through easement	High Priority	Improved habitat and water quality	Cost of easement	Landowners, TRORC, VANR, Town of Killington RCE
Project #8 M30-C & M30-D	Stormwater Management	Runoff from East Mountain Road is causing excess stormwater to enter the river.	Evaluate stormwater management	High Priority	Improved water quality	Unknown	Landowners, TRORC, VANR, Town of Killington ERP
Project #9 M28T5.01-A	Passive Restoration	Area along western bank does not have adequate buffer, possible land use conflict	Streamside plantings	Low Priority	Improved habitat and water quality	Cost of plantings	Landowner, TRORC, VANR, Town of Bridgewater TFS, CRWC
Project #10 M28T5.01-B	Passive Restoration	Forested river corridor contains wetland, good floodplain access	Protect river corridor through easement	High Priority	Improved habitat and water quality	Cost of easement	Landowner, TRORC, VANR, Town of Bridgewater RCE, WRP
Project #11 M28T5.01-C	Active/ Passive Restoration	Windrow/berm section along Route 100A limits floodplain access. Poor bank and buffer vegetation.	Alternatives analysis for the removal of the windrow/berm and streamside plantings	High Priority	Improved habitat, water quality, and geomorphic stability	Cost of analysis and possible windrow removal and plantings	Landowners, TRORC, VANR, Town of Bridgewater ERP, TFS, CRWC

Photos of Proposed Project Locations – Map 6 (Page 1/3)



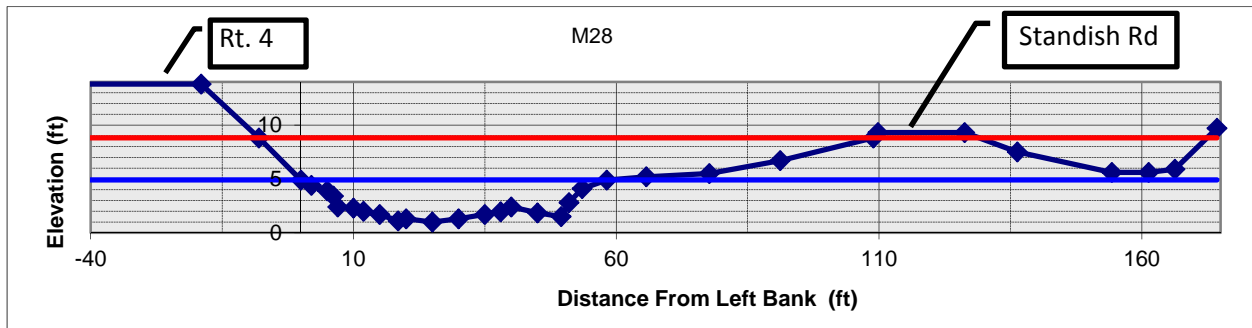
Project #1 – Supplemental Streamside Plantings



Project #2 – Protect River Corridor



Standish Road in River Corridor



Project #3 – Investigate Removal of Standish Rd

Photos of Proposed Project Locations – Map 6 (Page 2/3)

(No photo available for Project #8 – Stormwater Management of East Mountain Road)



Project #4 – Investigate Abutment Removal



Project #5 – Remediate Iron Seep



Project #6 – Create Floodplain/Streamside Plantings



Project #7 – Protect River Corridor

Photos of Proposed Project Locations – Map 6 (Page 3/3)
Reservoir Brook



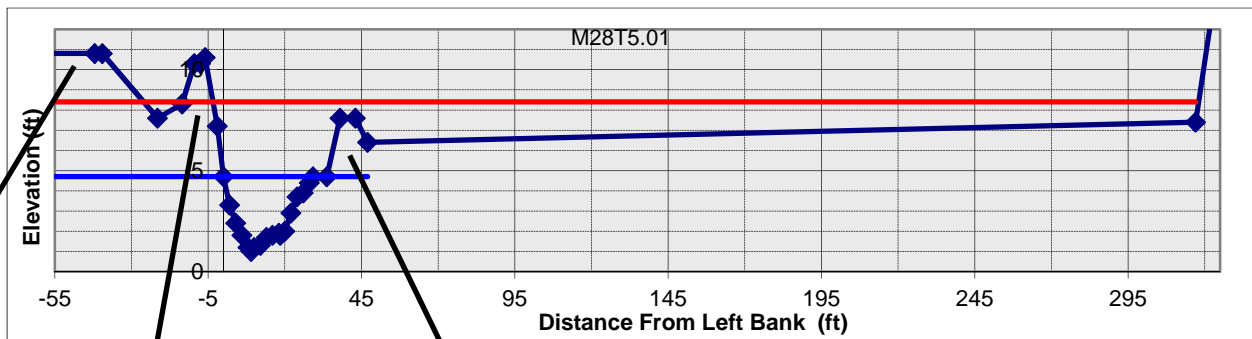
Project #9 – Streamside Plantings



Project #10 – Protect River Corridor



Project #11 – Investigate Windrow/Berm Removal



Route 100A

Berm/
windrow

Berm/
windrow