Great Brook Watershed
River Corridor Plan
Plainfield and Groton, Vermont
March 19, 2014

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Acknowledgement

Bear Creek Environmental, LLC would like to recognize the individuals who contributed their time and effort to the development of the corridor plan for Great Brook. Dan Currier of the Central Vermont Regional Planning Commission has coordinated the Great Brook corridor planning project and has contributed greatly to the preparation of this plan including helping with field work. Gretchen Alexander (River Scientist, Vermont Rivers Program) offered field assistance and provided the quality assurance/quality control evaluation. Sacha Pealer of the Vermont Rivers Program also offered field assistance. We would like to acknowledge George Springston who joined us in the field and provided valuable information regarding the geology and numerous landslides within the watershed. Our thanks also goes out to Rich Kirn of the Vermont Department of Fish and Wildlife, who contributed data of wild trout populations in Great Brook. Former Plainfield resident Matt Peters provided valuable local knowledge for our team and field assistance. Justin Kinney, as part of the Winooski Headwaters Group, aided in a site visit for project development. Roy Schiff of Milone and MacBroom has provided information regarding a gully stabilization project.

Dan Currier of CVRPC with Pam DeAndrea of BCE

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1.0 EXECUTIVE SUMMARY

A stream geomorphic assessment of the Great Brook was conducted by Bear Creek Environmental, LLC (BCE) under the direction of the Central Vermont Regional Planning Commission during 2012 and 2013. Funding for the project was provided through the State of Vermont Ecosystem Restoration Program and the Winooski Headwaters Fund. 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 Town of Plainfield experienced major flooding in 2011, and subsequently initiated steps to address flood resiliency by forming a Flood Advisory Committee. As part of the long term plan to mitigate the impact of flooding, a Phase 2 stream geomorphic assessment was recommended to develop river hazard zones. The stream geomorphic assessment data will be used to help focus stream restoration and protection activities within the watershed and assist the towns of Plainfield and Groton with flood resiliency planning.

Great Brook was divided into nine reaches for the assessment. The study encompassed approximately 8.5 miles of stream channel, and was helpful in identifying major stressors to geomorphic stability in the Great Brook 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 roads. 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 5.4 miles, or about 65 percent, of Great Brook in the study area, that runs parallel to Brook Road. In some places, the high road embankment is restricting floodplain access.

Mass failures are common along Great Brook and are contributing sediment and downed trees to the channel resulting in debris jams. Debris jams are important for channel stability and aquatic habitat. When located in the vicinity of an undersized stream crossing, a debris jam

may cause an erosion hazard or washout. Woody debris management in Great Brook has been a controversial issue over the past few years, and future conflicts can be reduced by providing stream crossings that allow sediment and debris to be transported through the crossing. Recommendations for replacing undersized structures are provided in this plan.

A list of 31 potential restoration and conservation projects was developed during project identification. Types of projects include: river corridor protection through easements, improving riparian buffers, bridge and culvert replacements, alternative analyses for the removal of old abutments, stream clean-up, and adopting best management practices for logging. Detailed 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 Great Brook watershed in Plainfield and Groton, Vermont. The main stem of Great Brook was assessed using the Vermont Agency of Natural Resources Phase 2 Stream Geomorphic Assessment protocol during the summers of 2012 and 2013 for a total of 8.5 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 Great Brook watershed is comprised of the Central Vermont Regional Planning Commission (CVRPC), Vermont Agency of Natural Resources (VANR), the Friends of the Winooski (FWR) and the Winooski Headwaters Group. The 2012 study was funded through the Winooski Headwaters Group under contract to the Friends of the Winooski River (FWR) while the 2013 field work and plan preparation was funded by The State of Vermont Ecosystem Restoration Program under contract to the Central Vermont Regional

Planning Commission (CVRPC). Gretchen Alexander from the Vermont Rivers 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. The Central Vermont Regional Planning Commission and the Friends of the Winooski River, in collaboration with towns and other partners, has the opportunity to address and mitigate major watershed stressors through the design and implementation of r*estoration* and protection projects outlined in this corridor plan.

The newly updated Water Quality Management Plan (WQMP) for the Winooski River (Vermont Agency of Natural Resources, 2012a) specifies the goal of proactively managing streams through identification and prioritization of stream restoration projects that will bring channels back to equilibrium conditions. Specifically, the WQMP includes recommendations to conduct Phase 2 geomorphic assessments in the Great Brook watershed. According to the Plan, one of the main problems the basin faces is river corridor encroachment and bank erosion as a result of human activities. The river corridor encroachment can then lead to a lack of high quality *riparian buffers*, excessive sediment, flow alterations, and storm water runoff.

The Town of Plainfield has experienced considerable flood damage adjacent to Great Brook over the past decade. Following the late May 2011 flood event, the Selectboard appointed a seven member committee to advise the town on flood policy. A Final Report of the Flood Advisory Committee (2013) provides seven management categories for mitigating the impact of future floods. Three of these management categories 1. River Hazard Zones, 2. Alternatives Analysis (i.e. alternatives to mitigate future flood hazards) and 3. Wood Debris Management are provided in the Great Brook Watershed Corridor Plan as a resource to the Town of Plainfield.

2.4 Goals of the Vermont Rivers Program

The State of Vermont's Rivers Program has set out several goals and objectives that are supportive of the local initiative in the Great Brook 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 Rivers 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.

3.0 BACKGROUND WATERSHED INFORMATION

3.1 Geographic Setting

3.1.1 Watershed Description

The Great Brook is a tributary to the Winooski River, one of the major rivers in Vermont that drains into Lake Champlain (Figure 3.1). The 9-mile long stream drains approximately 14 square miles of land. Generally flowing from southeast to northwest, Great Brook originates in western Groton, Vermont, and flows through the town of Plainfield, Vermont where it empties into the Winooski River. From its source in the *headwaters* of Signal Mountain in Groton, Great Brook flows west down the mountainside to the valley floor, where it begins to flow northwest along Brook Road. The river generally flows through a narrow valley until just upstream of the mouth in the Village of Plainfield where it empties into the Winooski River. As the river flows from Groton to the Winooski River in Plainfield, Great Brook is influenced by several tributaries. The valley walls of Great Brook are very steep in many locations leading to mass failures.

3.1.2 Political Jurisdictions

The Great Brook watershed is located in the following towns:

- Town of Orange (Orange County)
- Town of Groton (Caledonia County)
- Town of Plainfield (Washington County).

The 2012 and 2013 Phase 2 assessments focused on the river channel and *riparian corridor* within Plainfield and Groton.

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 Great Brook watershed for the river corridor plan. The 2002 land cover data indicates that the watershed is 85% forested, 8% urban, and 2% agricultural (Figure 3.2). While the Great Brook watershed is dominated by forested land, agriculture and developed land are sub-dominant land-uses. Developed areas are concentrated within the river corridor along roads and in the Village of Plainfield.

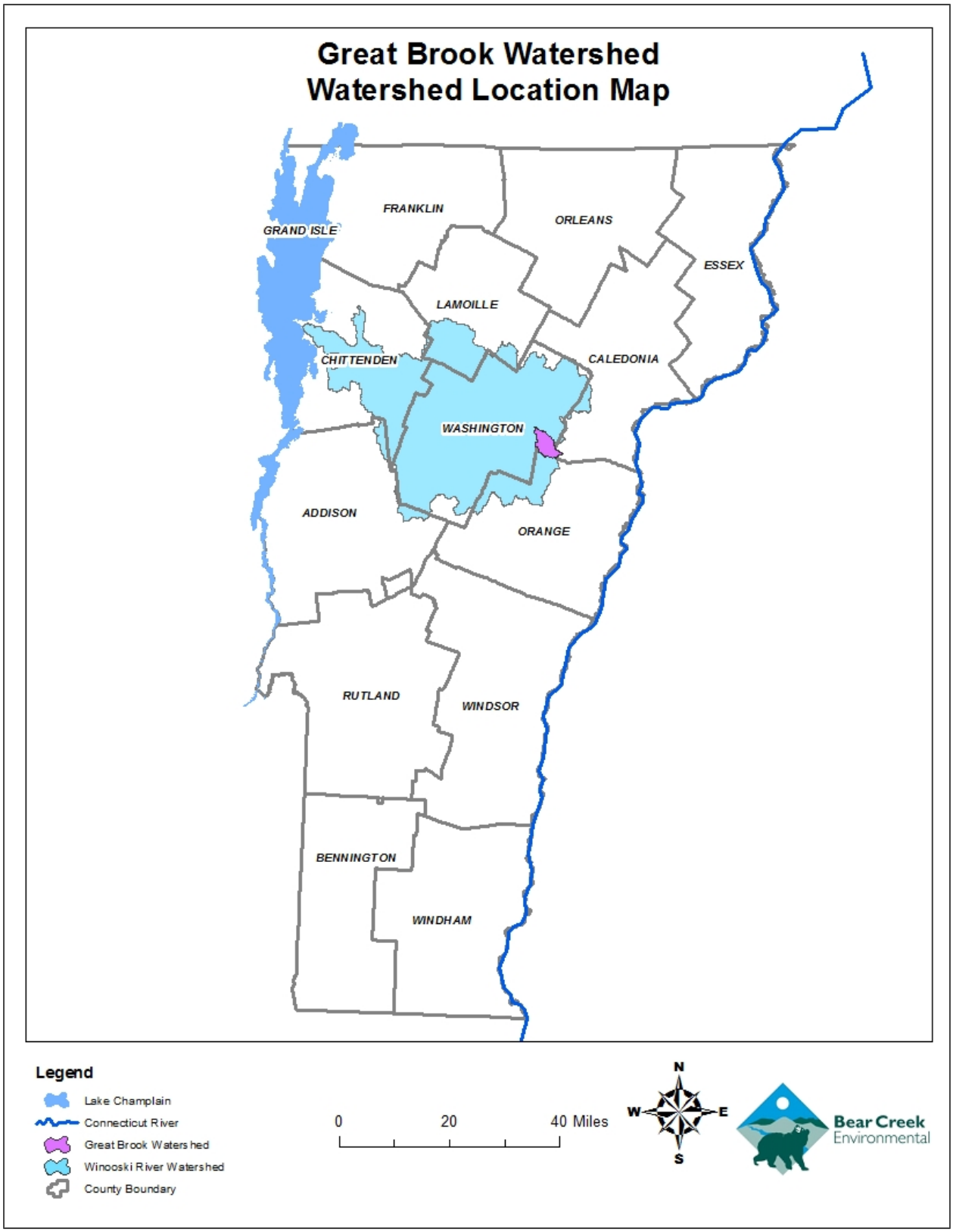

Figure 3.1. Watershed Location Map for Great Brook watershed.

3.2 Geologic Setting

The Great Brook flows through a moderate *gradient* valley, except for the most upstream areas. Most of the main stem has a channel slope between two and three percent. The most upper reach of Great Brook originates in Groton, where the valley slope is moderate with a slope of approximately three percent. The valley gradient then increases to steep (six percent slope) as the river flows west and drops to gentle (less than two percent) prior to crossing Brook Road. Once Great Brook crosses Brook Road, the slope becomes moderate (between 2 and 3 percent).This moderate gradient persists downstream through the Village of Plainfield to the Winooski River.

The Great Brook watershed is located in the Vermont Piedmont physiographic region. The upper part of the watershed (upstream of the Gore Road crossing) is contained within the Knox Mountain Pluton Formation, a Devonian age intrusive rock that consists of quartz rich, biotite-muscovite granite (Bedrock Geologic Map of Vermont, USGS, 2011). The central part of the watershed (from the Gore Road crossing to approximately 0.5 miles south of Fowler Road) lies in the Waits River Formation. This formation is a metasedimentary carbonaceous phyllite and limestone, which was formed during the lower Devonian and upper Silurian ages. The lower end of the Great Brook watershed (from approximately 0.5 miles south of Fowler Road to the mouth of Great Brook) contains bedrock within the Gile Mountain Formation, which is a lower Devonian metasedimentary/metavolcanic schist and quartzite. Both the Waits River and Gile Mountain formations are part of the Connecticut Valley Trough (Bedrock Geologic Map of Vermont, USGS, 2011).

In 2000 George Springston and Lori Barg conducted a field survey and mapping project of *surficial sediments* (sediment deposits above bedrock) of the Great Brook watershed. Their findings indicate that the dominant surficial sediment in the watershed is glacial till. Most of the till is a dense lodgement till. Other deposits include alluvium, lacustrine, and ice-contact sand and gravel (Springston & Barg, 2002). All of the surficial deposits in the Springston and Barg study area are of Late Wisconsin age or younger. The till was deposited under glacial ice. The ice-contact and lacustrine deposits found in the lower section of the Great Brook watershed represent deposits that were left behind during the retreat of glaciers from this area (Springston & Barg, 2002). Following the retreat of the glaciers and the draining of the glacial lakes, Great Brook and its tributaries then cut through the massive amounts of deposits leaving very steep side slopes of unstable material (Springston & Barg, 2002). The steep nature of the slopes and the unstable material has led to numerous mass failures (landslides) along Great Brook.

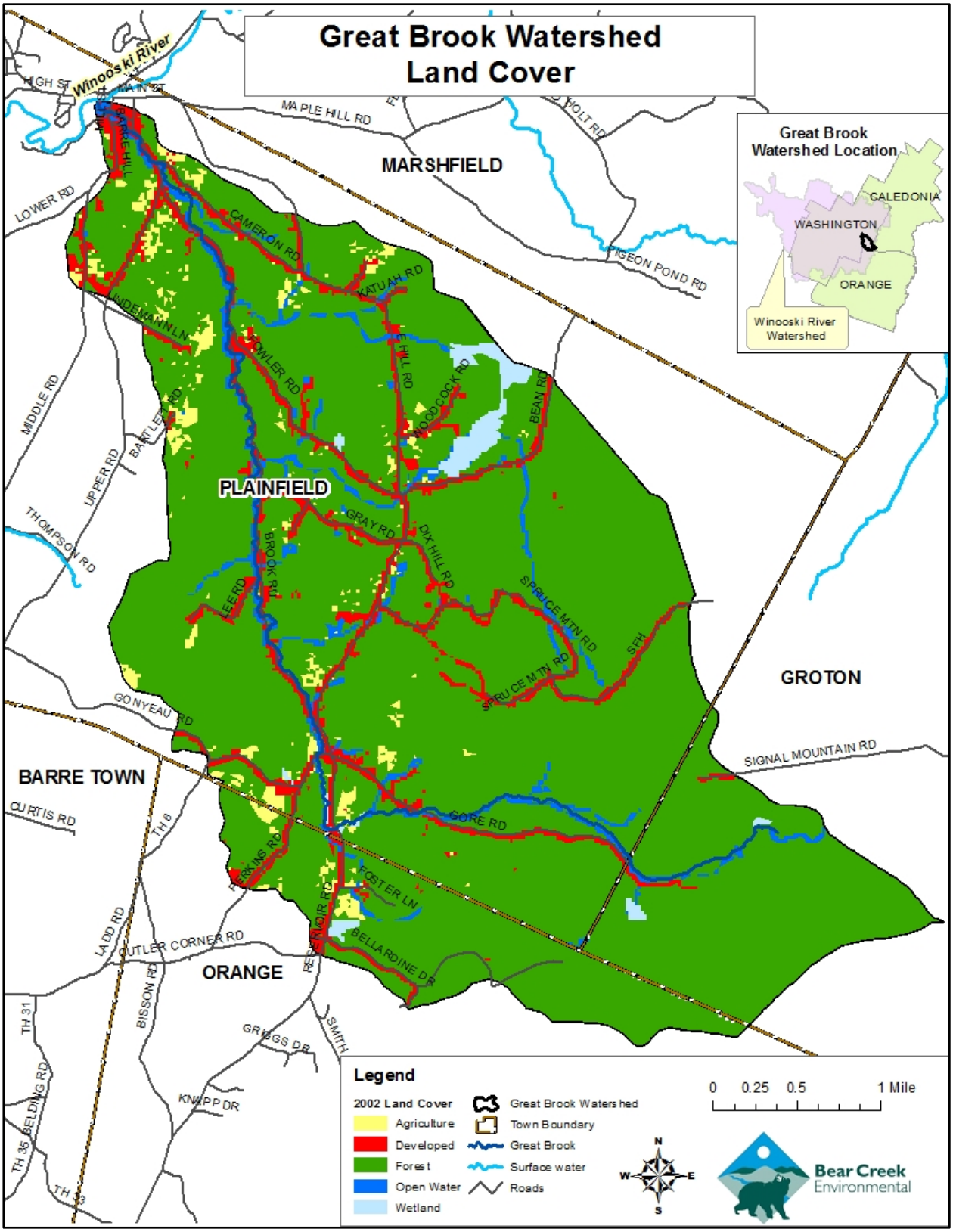

Figure 3.2. Land Cover and Land-Use Map for the Great Brook watershed.

In 2013, Mr. Springston was retained by CVRPC to conduct a more detailed study of 70 landslides/mass failure sites along Great Brook. The study showed that following two major floods in 2011 (one in May 2011 and Tropical Storm Irene in August 2011), many of the landslides that were stabilizing become active again due to extensive erosion from the floods (Springston and Thomas, 2014). A landslide hazard zone has been developed from the analysis that will be valuable for future planning along Great Brook.

3.3 Geomorphic Setting

A Phase 1 assessment of the Great Brook watershed was completed as part of the Upper Winooski River Watershed study by the Central Vermont Regional Planning Commission. The Phase 1 assessment included breaking the watershed into nine *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 and 2013 Phase 2 studies of Great Brook. The combined length of the eight stream reaches assessed during the Phase 2 study is approximately 8.5 miles. During the Phase 2 investigation, reaches were divided further into *segment*s based on changes in channel conditions (Figure 3.4). 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 eight Phase 2 reaches studied in 2012 and 2013 were broken further into 23 segments based on field observations. Segments are labeled using letter notation (i.e. M3.01-A is the most downstream segment on Reach M3.01). 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 Great Brook, long-term data from the U.S. Department of the Interior, U.S. Geological Survey (USGS), were obtained (USGS 2014). There are no USGS *gaging stations* in the Great Brook watershed, but peak flow data from the closest station with a similar *drainage area* (8.95 square miles) was reviewed. This station is located on the East Orange Branch in East Orange, Vermont. Although the drainage area was similar to Great Brook’s drainage area of 14 square miles, this station did not receive the magnitude of streamflows that Great Brook did in May 2011 and during Tropical Storm Irene in August 2011. The gaging station on the Sleepers River (drainage area = 43 square miles) near St. Johnsbury, Vermont was used to look at similar hydrology that impacted Great Brook during the May 2011 flood. The Dog River gaging station in Northfield Falls, Vermont (drainage area = 76 square miles), was also used to show the discharge during Tropical Storm Irene in August 2011.

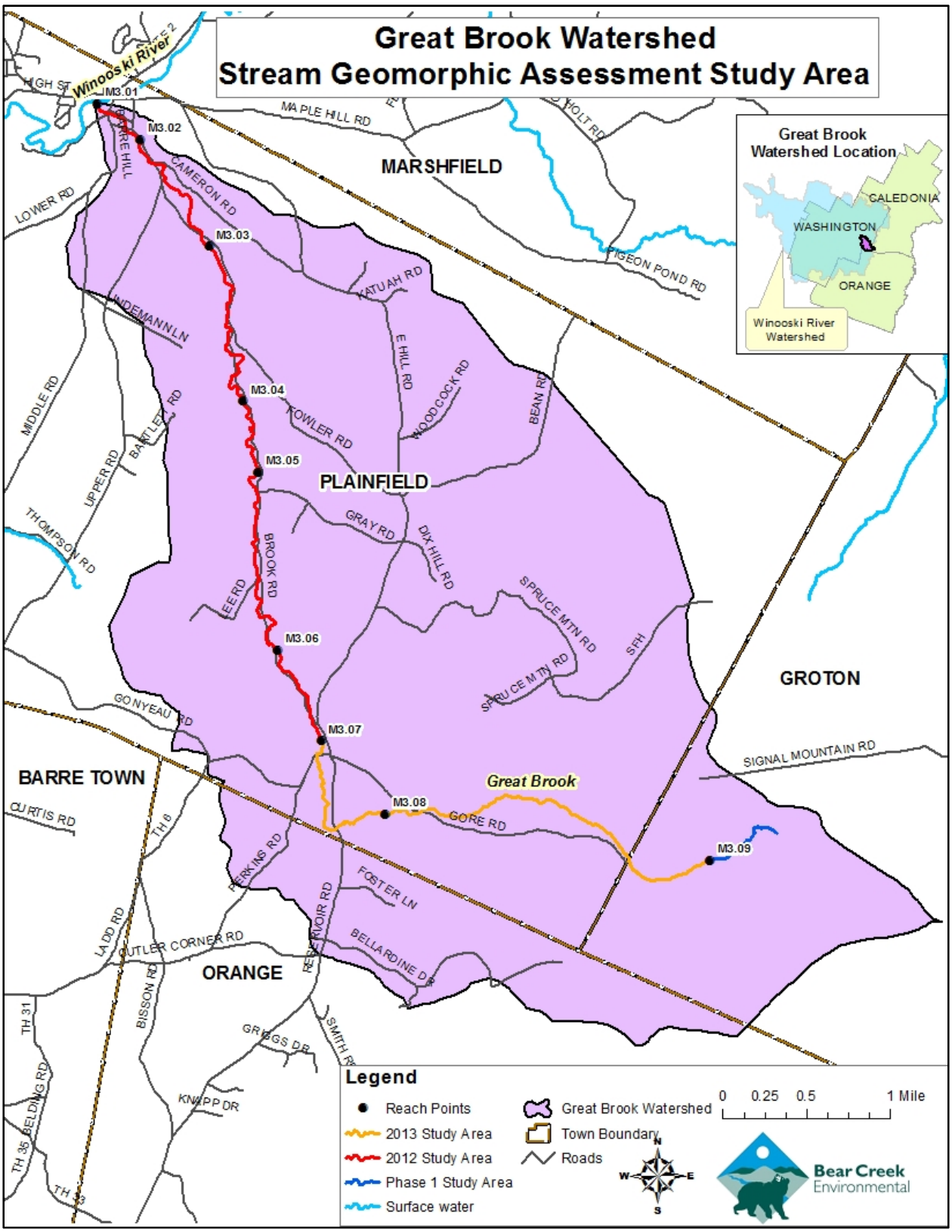

Figure 3.3. Great Brook Stream Geomorphic Assessment Study Area

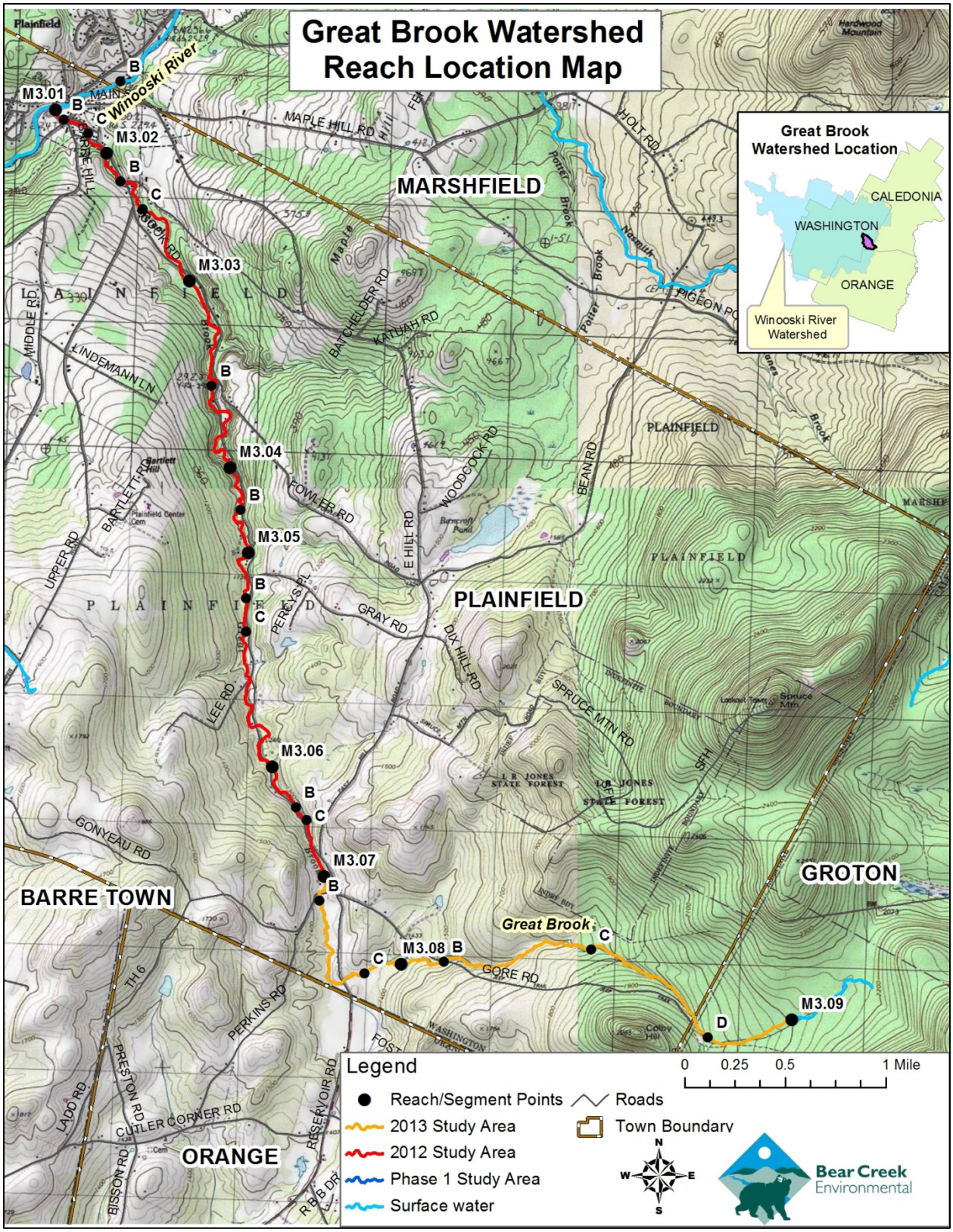

Figure 3.4. Reach Location Map for Great Brook watershed.

Peak discharge records are available for the East Orange Branch at the East Orange gage from 1959 through 2012. Figure 3.5 shows the annual peak flows for the East Orange Branch USGS gage in East Orange, Vermont for the 54 years of record (USGS 2014). Flood events higher than the 50 year recurrence interval did not occur in this watershed as it did in other parts of the state during the spring or summer of 2011. In the Sleepers River, the 2011 peak discharge of 9,360 cubic feet per second (cfs) illustrates the magnitude of the flood event on May 27, 2011 (Figure 3.6) (USGS 2014). The storm on May 26-27, 2011 caused widespread flooding in Plainfield, Vermont which received more than 5 inches of rain during the storm. In the nearby Dog River, the 2011 peak discharge took place on August 28, 2011 and was attributed to Tropical Storm Irene (Figure 3.7) (USGS 2014). For Tropical Storm Irene, flood levels for many areas in Vermont 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 2012-2013. Figure 3.8 shows the 2012 and 2013 annual hydrograph for the Sleepers River near St. Johnsbury, Vermont, during which the Phase 2 stream geomorphic assessment field work took place. The highest flows occurred in 2013 during the spring and mid-summer and were associated with snow melt and/or rainfall. The lowest flows occurred from July through early September of 2012.

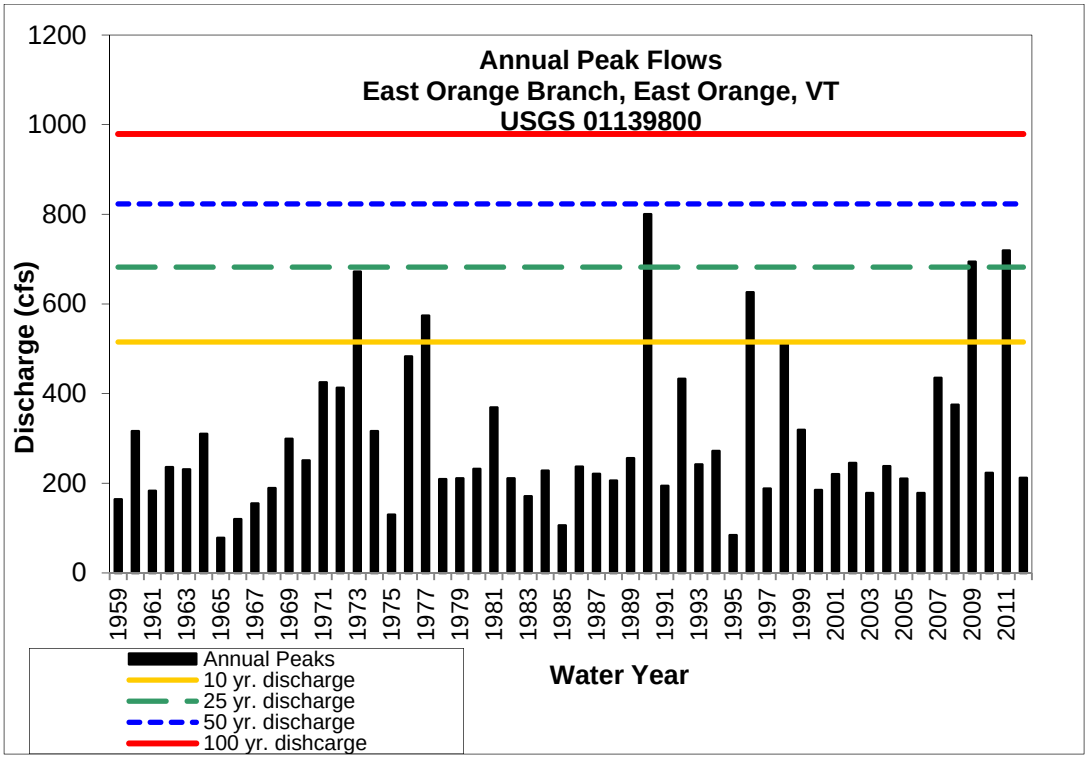

Figure 3.5. Annual Peak Flows for the East Orange Branch in East Orange, Vermont.

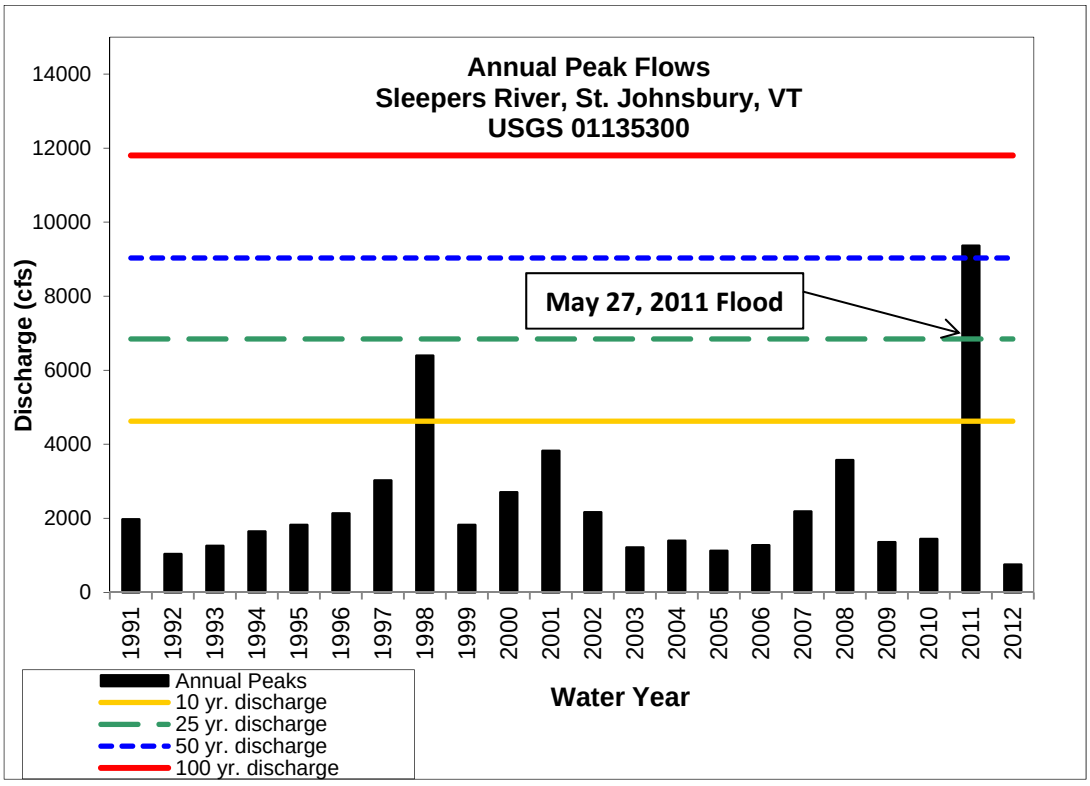

Figure 3.6. Annual Peak Flows for the Sleepers River near St. Johnsbury, Vermont.

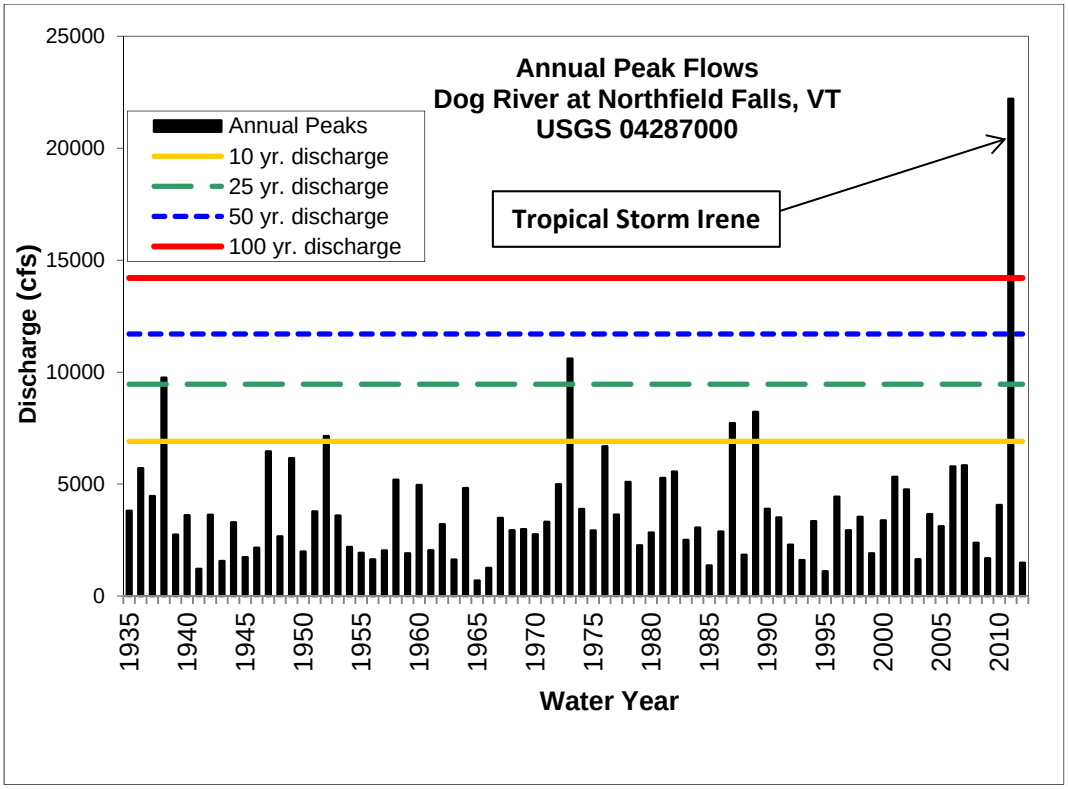

Figure 3.7. Annual Peak Flows for the Dog River near Northfield Falls, Vermont.

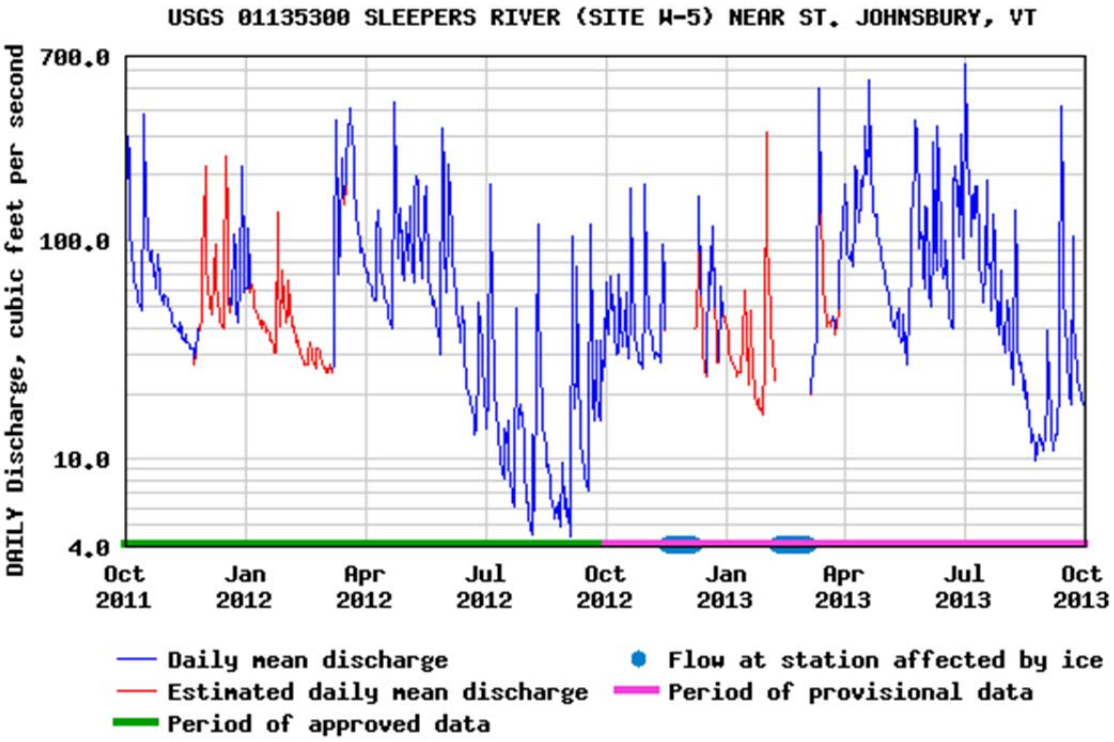

Figure 3.8. Daily discharge for the Sleepers River near St. Johnsbury, Vermont.

3.5 Ecological Setting

The Great Brook watershed lies within the Northern Vermont Piedmont biophysical region. This region is characterized by Thompson and Sorenson (2000) as hilly with numerous wetlands and rivers and as having one of the densest road networks in Vermont. The climate is moderate for Vermont and the elevation leads to a high average annual precipitation. The total precipitation was between 52 inches in the higher elevations of Walden and Danville and 36 inches in the Montpelier area and along the Connecticut and Passumpsic Rivers (Thompson and Sorenson, 2000). Northern hardwood forest is the dominant community in the Northern Vermont Piedmont biophysical region.

The Vermont Significant Wetland Inventory (VSWI) GIS layer provides important information about the distribution of wetland habitat within the Great Brook watershed (Appendix A, page 1). There are relatively few wetlands within the watershed according to the VSWI layer with the largest wetlands located in the northeastern section of the watershed. However, there is a large wetland in the upper part of the watershed in reach M3.09, which was observed during the 2013 Phase 2 assessment that is not included in the VSWI data.

According to Thompson and Sorenson (2000), the dense road network and associated development of the Northern Vermont Piedmont has fragmented wildlife habitat and travel corridors. Despite this fragmentation, there are abundant populations of white-tailed deer, beaver, coyote, fox, otter, mink, and squirrel. Bear and fisher populations are increasing in size. Moose are very common in the northern part of the region, while turkeys are prevalent in the south. The remote lakes in this region provide the largest concentration of loon nesting sites in Vermont (Thompson and Sorenson, 2000).

Deer wintering areas are present in the watershed with one deer wintering area overlapping with the river corridor for reaches M3.07 and M3.08 (Appendix A, page 1). Public lands within the watershed include the LR Jones State Forest and the Groton State Forest in the upper part of the watershed. Core habitat is abundant in the Great Brook watershed as shown on page 1 of Appendix A and represents those areas that are at least 100 meters from a zone of human disturbance.

The Vermont Department of Fish and Wildlife (VDFW) have conducted electrofishing surveys of wild trout populations in Great Brook since 1958. The surveys have shown that there are abundant wild trout populations (>1000 trout per mile; >20 lbs per acre) in Great Brook including brook trout (BKT), brown trout (BNT) and rainbow trout (RBT). The charts below (Figure 3.9 through 3.11) show that over the past 50 years the population and composition of wild trout have been relatively stable (Kirn, 2014). Various projects have been constructed to help improve fish passage within Great Brook, such as the placement of boulder weirs and improving passage through culverts (Milone and MacBroom,, Inc., 2011).

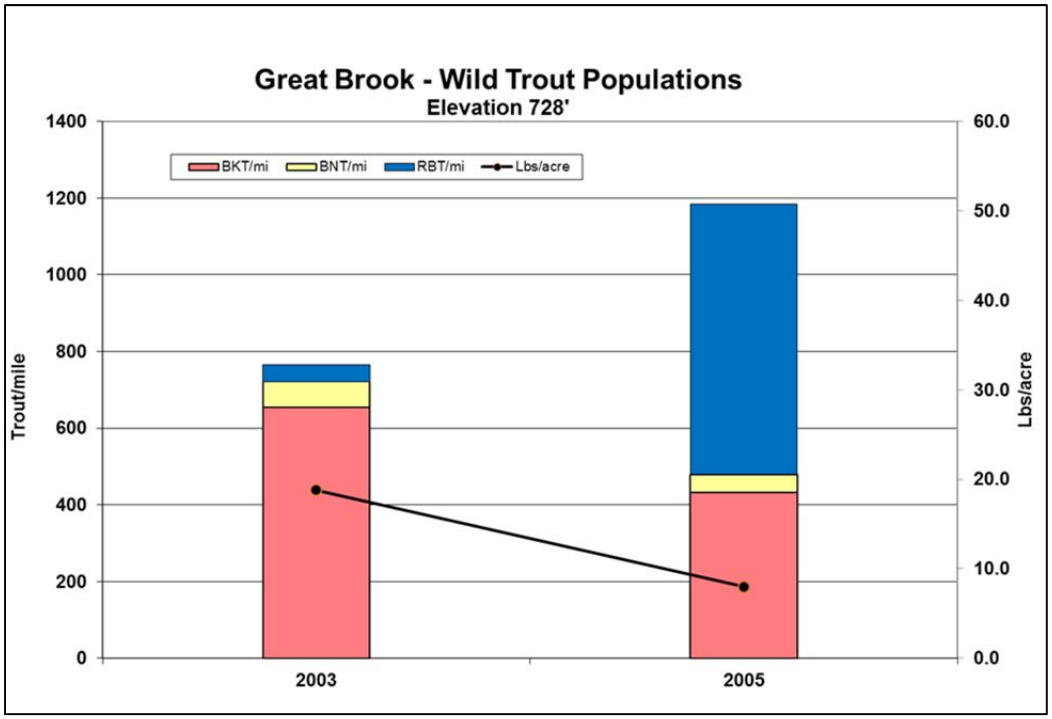

Figure 3.9. Great Brook Wild Trout Populations – Elevation 728 feet.

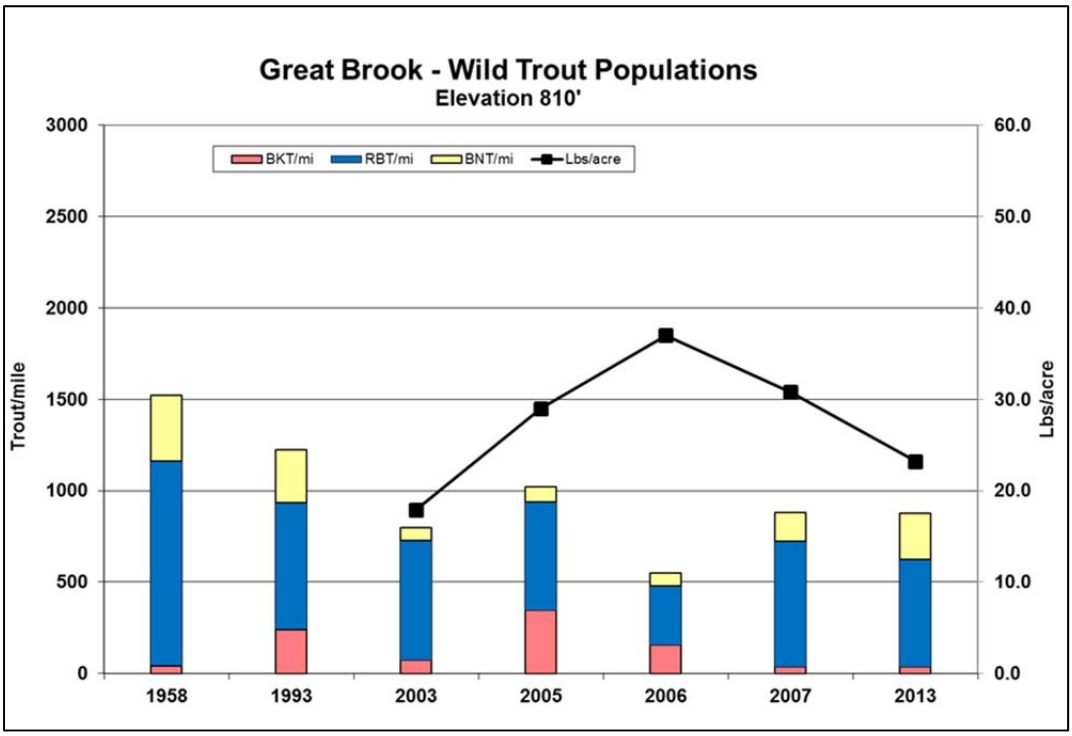

Figure 3.10. Great Brook Wild Trout Populations – Elevation 810 feet.

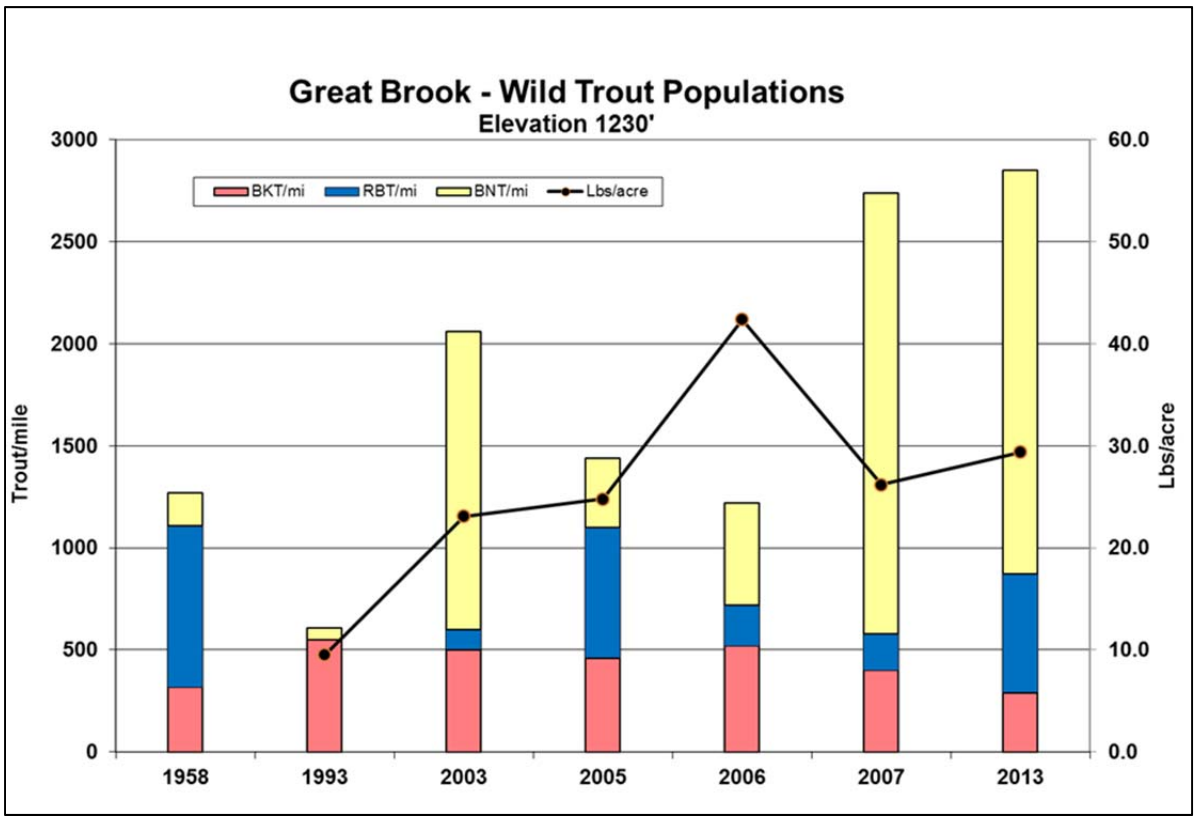

Figure 3.11 Great Brook Wild Trout Populations – Elevation 1230 feet.

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 Great Brook watershed followed procedures specified in the Vermont Stream Geomorphic Assessment (SGA) Phase 2 Handbook (Vermont Agency of Natural Resources, 2009b), and used version 10.0 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 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 May and October 2013. The Project Team conducted the assessment according to the approved Quality Assurance procedures specified in the Phase 2 handbook. Gretchen Alexander of the State of Vermont Watershed Management Division conducted a QA/QC review of the data collected by Bear Creek Environmental (BCE) for the Great Brook in April and November 2013. A summary report of the QA/QC can be found on pages 72 through 78 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 15 stream crossings (8 bridges and 7 culverts) were evaluated by BCE in 2012 and 2013. 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

Seven culverts were evaluated for Aquatic Organism Passage (AOP) using the Vermont Culvert Aquatic Organism Passage Screening Tool (Milone and MacBroom, 2009). Tables 3 through 5 in Appendix B explain how each culvert was scored using the screening tool. The screening guide has the four following categories:

- Full AOP for all organisms
- Reduced AOP for all aquatic organisms
- No AOP for all aquatic organisms except adult salmonids
- No AOP for all aquatic organisms

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 Great Brook watershed. Many reaches assessed for Phase 2 in the Great Brook 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 Great Brook ranges from Very Broad to Narrow on average. All reaches have a reference bedform of *riffle-pool* except for M3.08, which was *step-pool*. The reference reach characteristics were refined during the Phase 2 Assessment.

During the Phase 2 assessment, the eight assessed reaches were broken into 23 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 and 2013 assessment have the same reference and existing stream type. However, the existing stream type differs from the reference stream type in ten 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 2012/2013 Assessed Reaches

Stream	Reach ID	Reference Stream Type	Reference Confinement	Valley Slope (%)	Bedform
Great Brook	M3.01	C	Very Broad	2.2	Riffle-Pool
	M3.02	C	Broad	2.3	Riffle-Pool
	M3.03	C	Broad	2.3	Riffle-Pool
	M3.04	C	Narrow	2.6	Riffle-Pool
	M3.05	C	Broad	2.3	Riffle-Pool
	M3.06	B	Narrow	2.0	Riffle-Pool
	M3.07	C	Very Broad	1.9	Riffle-Pool
	M3.08	B	Very Broad	5.6	Step-Pool

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.

The segments in the upper part of the watershed along Gore Road (M3.07-C through M3.08-C) are in good condition. Segment M3.08-D is the only assessed segment on Great Brook that is in "reference" geomorphic condition. These segments are all located in areas where there are minimal to no corridor encroachments and buffer conditions are excellent. Thirteen segments along Great Brook are in "fair" geomorphic condition and five are in "poor" geomorphic condition (Appendix A, page 3). 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, mass failures, and aggradation.

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 Great Brook watershed include:

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

These anthropogenic practices have altered the balance between water and sediment discharges within the Great Brook 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 23 assessed segments, 16 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. Seven segments 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 all of the segments of the Great Brook downstream of the Gore Road crossing. 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 Great Brook watershed. In many areas, the placement of Brook Road has significantly changed the river's valley width, floodplain access, and its ability to meander. The floods that came through the area in May and August, 2011 have resulted in significant aggradation and planform change.

The reach condition ratings of the Great Brook 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 Great Brook 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 and impacts from flooding.

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 Great Brook 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-1) - 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.

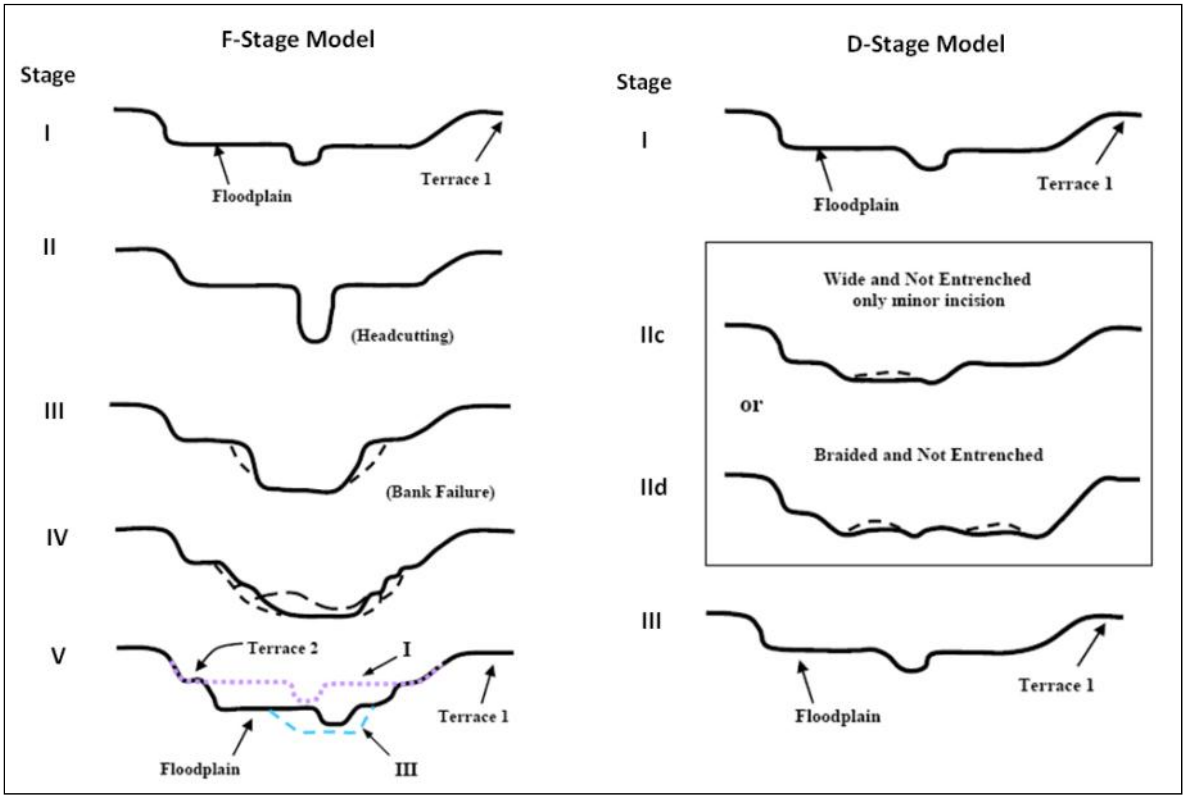

Figure 5.1 Typical channel evolution models for F-Stage and D-Stage
(Vermont Agency of Natural Resources, 2009b)

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 2 of Appendix C. In terms of the channel evolution model, four segments on Great 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. Those segments in stage 1 (M3.07-C, M3.08-B, M3.08-C and M3.08-D) are located 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 and may 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 M3.01-A, M3.01-B, M3.02-B, M3.06-B, M3.06-C, M3.07-A, and M3.08-A. Active incision is occurring at head cuts in some segments of Great Brook (M3.01-A, M3.02-A, M3.02-B, and M3.05-C).

Seven of 23 segments are in stage III of the "F-stage" channel evolution model. Most of these segments have undergone severe historic incision. The placement of Brook Road 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.

Five segments on Great Brook 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 segments where a 'new' floodplain was observed were M3.02-A, M3.02-C, M3.03-A, M3.03-B, and M3.04-B. Some of these segments are highly depositional and have become braided with many *bar* features including transverse (*diagonal*) bars. This buildup of sediment has led to channel widening and planform adjustment.

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. Except for the most upstream reach (M3.08), all assessed reaches on Great Brook had a minimum sensitivity of High because most segments are undergoing major or extreme channel adjustments. Seven segments are assigned a rating of

Extreme, four are Very High, eight are High, and four are Moderate. A map showing stream sensitivities is found on page5 of Appendix A.

5.3 Habitat Condition

The habitat condition for each segment within the Great Brook 2012 and 2013 study area is presented on page 3 of Appendix A. Seven segments in the study are in "good" habitat condition and were mostly in the upper part of the watershed above the most upstream Brook Road crossing (M3.05-B, M3.06-A, M3.06-C, M3.07-C, M3.08-B, M3-08-C, and M3.08-D). These segments 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 *pools*, and good canopy cover; all of which provide habitat for aquatic life. Thirteen segments are in "fair" habitat condition and one segment is in "poor" habitat condition. The segment in "poor" condition is M3.01-C and the segments in "fair" condition are M3.01-A, M3.01-B, M3.02-A through M3.05-A, M3.05-C, M3.06-B, M3.07-A, M3.07-B, and M3.08-A. Segments are in "fair" or "poor" habitat condition mainly as a result of corridor encroachments, poor bank and buffer vegetation, erosion and revetments, and channel straightening. One of the segments in "poor" condition and six of the segments in "fair" condition exhibit a stream habitat type departure. In M3.01-C, the influence of corridor encroachments 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. Due to excessive aggradation in the stream channel in segments M3.02-A, M3.02-C, M3.03-A, and M3.03-B, riffles have been sedimented and the riffle-pool bedform has been replaced by a braided condition.

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 Great Brook is related to the geomorphic condition of the stream.

As shown in Table 1 (Appendix C, pages 1 through 2), many of the segments have high width to depth ratios. This can be attributed to the geomorphic process of channel widening. The aggradation as a result of the increased flows from the storms in 2011 has likely led (in part) to the high width to depth ratios observed in Great Brook. A high width to depth ratio indicates that the channel is relatively wide and shallow. Wide, shallow channels tend to have a reduced number of deep pools, canopy cover in the center of the stream, undercut banks, and sometimes a higher water temperature (Foster, Stein, & Jones, 2001). These factors can contribute to a lower habitat score.

5.4 Reach/Segment Descriptions

A description of each segment is provided in this section along with a list of recommendations for restoration and protection strategies. The segments are listed from downstream to upstream. 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 3 through 71 of Appendix C.
Proposed project locations are provided on maps on pages 1 through 9 in Appendix D. Further recommended project detail tables and photos are provided on pages 10 through 18 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.

Great Brook

M3.01

The most downstream reach on Great Brook was split into three segments to account for changes in channel dimensions and floodplain accessibility. The reach is located in a higher density residential area than upstream reaches. The reference confinement here is Very Broad as the river valley opens up to the Winooski River valley. Human impacts, such as paved roads in the residential area of Plainfield, change the actual confinement to semi-confined in some locations.

M3.01-A
This segment begins at the confluence with the Winooski River and continues just under 400 feet upstream to approximately 150 feet downstream of the Mill Street Bridge in Plainfield. This segment has good floodplain access along its eastern bank (See Figure 5.2) and poor floodplain access along its western bank, which runs adjacent to some recreational fields (Figure 5.3). The segment is in **fair** geomorphic condition with minor incision, aggradation, widening, and planform adjustment. There is a headcut just upstream of the confluence with the Winooski River, which is contributing to a lower geomorphic score. Aggradation from the May 2011 flood buried larger material including rock weirs and now the channel is cutting through this deposited sediment. The segment is in **fair** habitat condition as a result of a lack of deep pools and areas where buffers are less than 25 feet wide. Patches of invasive Japanese knotweed were observed in this segment.

Figure 5.2. Low eastern bank provides good floodplain access in M3.01-A.

Figure 5.3. High western bank (left) in M301-A restricts floodplain access.

M3.01-A Data Summary		Reference	Existing
Length: 378 ft Drainage Area: 14 sq. mi. Evolution Stage: F-II Sensitivity: Very High	Confinement	Very Broad	Very Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	9.2
	Incision Ratio	< 1.2	1.1
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Poor Bank Vegetation, Poor Buffers, Invasive Plants, Erosion, Revetments, Headcut, Channel Straightening**		

M3.01-B

This segment begins approximately 150 feet downstream of the Mill Street Bridge in Plainfield and continues 800 feet upstream to 130 feet downstream of the Brook Road box culvert, or where the channel loses floodplain access. The segment is characterized by the abundance of rip rap and hard bank armoring on both banks. As a result of the channel straightening, the segment is undergoing major **incision** and is in **fair** geomorphic condition. The extensive armoring (Figure 5.4) is preventing the stream channel from progressing to the next stage of the channel evolution model, which is widening. Aggradation, widening, and planform adjustment are minor in M3.01-B. An old railroad abutment may be contributing to some geomorphic instability (Figure 5.5). M3.01-B is in **fair** habitat condition as a result of the extensive bank armoring and reduced buffer widths. Large patches of invasive Japanese knotweed were observed in this segment.

Figure 5.4. Extensive bank armoring upstream of the Mill Street bridge in Plainfield.

Figure 5.5. Old railroad abutment in M3.01-B may be contributing to geomorphic instability.

M3.01-B Data Summary		Reference	Existing
Length: 807 ft Drainage Area: 14 sq. mi. Evolution Stage: F-II Sensitivity: Very High	Confinement	Very Broad	Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	3.0
	Incision Ratio	< 1.2	1.7
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Poor Bank Vegetation, Poor Buffers, Invasive Plants, Revetments, Constriction, Encroachments, Channel Straightening**		

M3.01-C

This segment begins 130 feet downstream of the Brook Road box culvert and continues almost 800 feet upstream. M3.01-C has a naturally unconfined valley; however, the proximity of the southern valley wall (continuous with the bank) and the close location of Brook Road to the north drastically change the channel confinement from Very Broad to Semi-Confined (Figure 5.6). This confinement alteration is a major driver in geomorphic instability. M3.01-C is in **fair** geomorphic condition. Channel straightening which led to extreme **historic incision** has resulted in a loss of floodplain access and a stream type departure. **Aggradation** is major here, whereas widening and planform adjustment are minor processes because of extensive bank armoring (Figure 5.7). This segment is in **poor** habitat condition mainly because of its lack of adequate riparian buffers and refuge areas for aquatic life. 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). As a result of channel straightening, M3.01-C exhibits a stream habitat type departure from its reference type of riffle-pool to the existing plane bed, which lacks key pool and riffle features that provide good fish habitat.

Figure 5.6. Valley wall continuous on the southern bank (right) and Brook Road close by to the north (left) in M3.01-C.

Figure 5.7. High banks and extensive armoring in M3.01-C restrict floodplain access.

M3.01-C Data Summary		Reference	Existing
Length: 787 ft Drainage Area: 14 sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Very Broad	Semi-Confined
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.3
	Incision Ratio	< 1.2	2.1
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Plane Bed
Major Stressors:	**Poor Bank Vegetation, Poor Buffers, Invasive Plants, Erosion, Revetments, Constriction, Encroachments, Channel Straightening**		

M3.01 Project Identification:

- **Passive Restoration** by planting trees within the riparian corridor in areas where the buffer is less than 25 feet wide in M3.01-A and M3.01-C to enhance buffer and bank conditions (Map 1: Projects #1 & #4).
- **Active Restoration** by removing old railroad abutment in M3.01-B to improve geomorphic stability (Map 1: Project #2).
- **Active Restoration** by replacing Brook Road culvert in M3.01-C to improve geomorphic stability and reduce fluvial erosion hazards near culvert (Map 1: Project #3).

M3.02

This reach was split into three segments to account for changes in confinement and reference stream types. For the most part, Brook Road does not significantly change the natural confinement in this reach.

M3.02-A

The most downstream segment in M3.02 begins approximately 650 feet upstream of the Brook Road box culvert (in M3.01-C) and continues about 930 feet upstream to just below the next Brook Road crossing (near intersection of Brook Road and Cameron Road). The segment is characterized by two large mass failures along the western valley wall, which is continuous with the bank most of the time (Figure 5.8). M3.02-A is in **poor** geomorphic condition. Extreme **historic incision** has occurred here. **Aggradation**, **widening**, and **planform adjustment** are the main processes occurring at present as the river tries to regain equilibrium. The segment is in **fair** habitat condition as a result of a limited amount of deep pools, extensive bank erosion, and a lack of adequate canopy cover. A stream habitat type departure from the reference riffle-pool to the existing braided is seen in M3.02-A. Stream flows are braided even under low flow conditions (Figure 5.9).

Figur5.8. Large mass failure in M3.02-A.

Figure 5.9. M3.02-A is braided even under low flow conditions.

M3.02-A Data Summary		Reference	Existing
Length: 929 ft Drainage Area: 14 sq. mi. Evolution Stage: F-IV Sensitivity: Extreme	Confinement	Narrow	Semi-Confined
	Stream Type	C	D
	Entrenchment Ratio	> 2.2	1.2
	Incision Ratio	< 1.2	2.1
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Braided
Major Stressors:	**Poor Bank Vegetation (Mass Failure), Erosion, Revetments, Mass Failures, Headcut, Encroachments, Channel Straightening**		

M3.02-B

Segment M3.02-B begins about 100 feet downstream of the Brook Road crossing (near intersection with Cameron Road) and continues 1,200 feet upstream through a naturally semi-confined valley. The segment ends as the valley widens. At the downstream section of the segment, Brook Road and the Brook Road Bridge experienced damage during the May 2011, flood. This segment is in **fair** geomorphic condition and is currently undergoing major **incision**, **aggradation**, and **planform adjustment**. Widening is minor. The active incision is evident by a headcut (Figure 5.10) located mid-segment. At the downstream end of the segment, the northern valley wall is continuous with the bank, with Cameron Road running along the top of it. This area is heavily armored with either rip rap or cement blocks (Figure 5.11). M3.02-B is in

fair habitat condition as a result of a lack of large woody debris in the channel, bank erosion, and extensive channel alterations and straightening at the downstream end.

Figure 5.10. Headcut in M3.02-C is evidence of the active incision process.

Figure 5.11. Rip rap and bank armoring along Cameron Road, looking upstream from the Brook Road Bridge.

M3.02-B Data Summary		Reference	Existing
Length: 1,180 ft Drainage Area: 14 sq. mi. Evolution Stage: F-II Sensitivity: High	Confinement	Semi-confined	Semi-confined
	Stream Type	B	B
	Entrenchment Ratio	1.4 – 2.2	1.6
	Incision Ratio	< 1.2	1.4
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Step-Pool	Step-Pool
Major Stressors:	**Erosion, Revetments, Constriction, Mass Failure, Headcut, Channel Straightening**		

M3.02-C

This segment begins as the Semi-Confined valley in M3.02-B opens up to a Broad valley and continues 2,600 feet upstream. The segment ends at the reach point, which is approximately 450 feet upstream of the next Brook Road crossing. M3.02-C is in **poor** geomorphic condition. The major processes occurring are extreme **aggradation**, **widening**, and **planform adjustment**. The excessive amount of aggradation (Figure 5.12) has led to a braided channel and a stream type departure from the reference C type to the existing D type. There is a gully on the southwestern side of Brook Road just downstream from the Brook Road crossing. The remediation of this gully is in the conceptual design phase for stabilization to reduce sediment and phosphorus input to Great Brook and to protect Brook Road (Milone & MacBroom, 2013). The segment is in **fair** habitat condition as a result of excessive aggradation (exposed substrate), extensive bank erosion, and a lack of adequate canopy cover. Several mass failures were observed in this segment (Figure 5.13). A stream habitat type departure from the reference riffle-pool to the existing braided is seen in M3.02-C.

Figure 5.12. Excessive aggradation in M3.02-C dominates the streambed.

Figure 5.13. Multiple mass failures are present in M3.02-C.

M3.02-C Data Summary		Reference	Existing
Length: 2,630 ft Drainage Area: 14 sq. mi. Evolution Stage: F-IV Sensitivity: Extreme	Confinement	Broad	Broad
	Stream Type	C	D
	Entrenchment Ratio	> 2.2	1.6
	Incision Ratio	< 1.2	1.3
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Braided
Major Stressors:	**Erosion, Constriction, Mass Failures, Encroachments, Channel Straightening**		

M3.02 Project Identification:

- **Active Restoration** by arresting headcuts in segments M3.02-A and M3.02-B to prevent migration of incision upstream. (Map 1: Project #5)
- **Active Restoration** by replacing bridge at Brook Road crossing in M3.02-B. (Map1: Project #6)
- **Active Restoration** by lowering the elevation of land to create floodplain to improve flood and sediment storage in segment in M3.02-B. (Map 1: Project #7)
- **Passive Restoration** by protecting the river corridor through easement to maintain floodplain access and sediment attenuation in segment M3.02-C. (Map 2: Project #1)

M3.03

This reach was split into two segments to account for changes in channel dimensions. The placement of Brook Road, which generally runs to the east of the channel, has changed the confinement of the channel in M3.03. The natural Broad valley is limited to a Narrow valley as a result of the road.

M3.03-A

The downstream segment in M3.03 begins at the reach break, which is approximately 450 feet upstream of a bridge on Brook Road. The segment continues 3,300 feet upstream to just above where Fowler Road intersects Brook Road. This segment is characterized by its extreme instability, which is seen through braiding and massive quantities of sediment in the channel. Figures 5.14 and 5.15 show the steep freshly eroded banks and several mass failures along the western bank that can be seen from Brook Road. M3.03-A is in **poor** geomorphic condition. Extreme **historic incision** has occurred here. **Aggradation** and **widening** are also extreme and are the main processes occurring as the river tries to regain equilibrium and establish a new floodplain. **Planform adjustment** is major. The segment is in **fair** habitat condition as a result of a limited amount of deep pools, extensive bank erosion, a lack of adequate canopy cover and vegetated buffers, and extensive channel alterations as seen by rip rap along Brook Road (Figure 5.16). A 400-foot section at the lower end of the segment has been straightened with windrowing. A stream habitat type departure from the reference riffle-pool to the existing braided is seen in M3.03-A. Stream flows are braided even under low flow conditions.

Figure 5.14. High freshly eroded banks in M3.03-A.

Figure 5.15. Mass failure along the western bank in M3.03-A.

Figure 5.16. Rip rap along Brook Road in M3.03-A.

M3.03-A Data Summary		Reference	Existing
Length: 3,313 ft Drainage Area: 13 sq. mi. Evolution Stage: F-IV Sensitivity: Extreme	Confinement	Broad	Narrow
	Stream Type	C	D
	Entrenchment Ratio	> 2.2	1.3
	Incision Ratio	< 1.2	3.7
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Braided
Major Stressors:	**Poor Bank Vegetation, Poor Buffers, Erosion, Revetments, Mass Failures, Windrowing, Encroachments, Channel Straightening Stormwater Inputs**		

M3.03-B

This segment begins just above the intersection of Brook Road and Fowler Road and continues 3,200 feet upstream to the reach break, or where the naturally Broad valley becomes Narrow. M3.03-B is characterized by several large mass failures and multiple debris jams (Figure 5.17). The segment is in **poor** geomorphic condition. **Historic incision** has occurred here. **Aggradation**, **widening**, and **planform adjustment** are the main processes occurring as the river tries to regain equilibrium and establish a new floodplain. Two bridges in Brook Road are causing channel constrictions and adding to geomorphic instability (Figure 5.18). The segment is in **fair** habitat condition as a result of bank erosion and revetments, a lack of adequate canopy cover, poor buffer widths, and extensive channel alterations as seen by rip rap. Excessive quantities of sediment in the channel have resulted in a stream habitat type departure from the reference riffle-pool to the existing braided type.

Figure 5.17. Mass failure and debris jam seen in M3.03-B.

Figure 5.18. Looking downstream at undersized bridge along Brook Road in M3.03-B.

M3.03-B Data Summary		Reference	Existing
Length: 3,194 ft Drainage Area: 13 sq. mi. Evolution Stage: F-IV Sensitivity: Extreme	Confinement	Broad	Narrow
	Stream Type	C	D
	Entrenchment Ratio	> 2.2	1.4
	Incision Ratio	< 1.2	1.6
	Dominant Bed Material	Gravel	Cobble
	Dominant Bedform	Riffle-Pool	Braided
Major Stressors:	**Poor Buffers, Erosion, Revetments, Constrictions, Mass Failures, Encroachments, Channel Straightening**		

M3.03 Project Identification:

- **Passive Restoration** by protecting the river corridor through easement to maintain forested buffer in reach M3.03. (Map 3: Projects #1 & #3)
- **Active Restoration** by removing tire pile on western bank and stabilizing bank to improve bank vegetation and prevent tires from being washed downstream (Map 3: Project #2)

M3.04

This reach was split into two segments to account for changes in channel dimensions. The reach is characterized by a Narrow valley, which is limited by the location of Brook Road to the east.

M3.04-A

This segment begins as the Broad valley in M3.03 transitions to a naturally Narrow valley and continues 1,440 feet upstream along Brook Road to the point where the channel veers away from the road. This segment is characterized by several manmade boulder weirs (Figure 5.19) that were placed in the channel to prevent incision and help stabilize the channel. Several of these weirs are still intact; however a few have been blown out. M3.04-A is in **fair** geomorphic condition. Extreme **historic incision**, likely as a result of the placement of Brook Road, has led to a loss of floodplain access and a stream type departure from the reference C type to the existing F type in the majority of the segment. Short areas of M3.04-A offer floodplain access, but are not representative. **Aggradation**, **widening**, and **planform adjustment** are the major processes occurring in this segment. Widening in this segment is limited in most places because of the Narrow valley and the placement of Brook Road.

Figure 19. Intact boulder weir in M3.04-A installed to prevent incision.

M3.04-A is in **fair** habitat condition. Poor bank and buffer vegetation along Brook Road and freshly eroded banks that contribute sediment to the channel are contributing to a lower score (Figure 5.20). The presence of the boulder weirs has changed the reference stream habitat type of riffle-pool to the existing step-pool.

Figure 5.20. Fresh eroded banks are contributing to the large amount of sediment in the channel in M3.04-A.

M3.04-A Data Summary		**Reference**	**Existing**
Length: 1,441 ft Drainage Area: 10 sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Narrow	Narrow
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.1
	Incision Ratio	< 1.2	2.0
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Step-Pool
Major Stressors:	**Poor Bank Vegetation, Poor Buffers, Erosion, Revetments, Mass Failures, Encroachments, Channel Straightening, Stormwater Inputs**		

M3.04-B

This segment begins as the channel veers away from Brook Road and continues upstream 1,440 feet until the reach break with M3.05, which is approximately 1,000 feet downstream of the intersection of Brook Road and Gray Road. M3.04-B is in **poor** geomorphic condition. Major **historic incision** has limited floodplain access and resulted in a stream type departure from the

reference C type to the existing B type. The incision ratio is not as extreme as in M3.04-A; however, M3.04-B is undergoing major **aggradation**, **widening**, and **planform adjustment**. The width-to-depth ratio is much higher in this segment. In some locations, a juvenile floodplain has begun to develop as the river tries to regain equilibrium. A private driveway bridge is causing a channel constriction and is contributing to geomorphic instability (Figure 5.21). M3.04-B is in **fair** habitat condition as a result of the large amount of sediment in the channel and extensive erosion.

Figure 5.21. Private driveway bridge is causing upstream deposition in M3.04-B.

M3.04-B Data Summary		**Reference**	**Existing**
Length: 1,441 ft Drainage Area: 10 sq. mi. Evolution Stage: F-IV Sensitivity: High	Confinement	Narrow	Narrow
	Stream Type	C	B
	Entrenchment Ratio	> 2.2	1.4
	Incision Ratio	< 1.2	1.6
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Erosion, Mass Failures, Encroachments**		

M3.04 Project Identification:

- **Passive Restoration** by protecting the river corridor through easement to maintain forested buffer in reach M3.04. (Map 4: Project #1)

M3.05

This reach was split into three segments as a result of a change in confinement, channel dimensions, and reference stream types.

M3.05-A

The most downstream segment in M3.05 begins approximately 1,000 feet downstream of the intersection of Brook Road and Gray Road and continues 1,500 feet upstream to where the Narrow valley transitions to Semi-Confined. M3.05-A is characterized by multiple mass failures and the presence of glacial till on the streambed (Figure 5.22). This segment is in **fair** geomorphic condition and has undergone extreme **historic incision**, which has resulted in limited floodplain access and a stream type departure from the reference C type to the existing B type. **Aggradation**, **widening**, and **planform adjustment** are the major processes occurring. Figure 5.23 shows a typical view of the channel. M3.05-A is in **fair** habitat condition as a result of a limited number of deep pools, large amounts of sediment in the channel, and bank erosion. Overall, this segment has good bank and buffer vegetation.

Figure 5.22. Glacial till is seen on the streambed in M3.05-A.

Figure 5.23. Typical view of M3.05-A shows major sediment build up.

M3.05-A Data Summary		Reference	Existing
Length: 1,523 ft Drainage Area: 9 sq. mi. Evolution Stage: F-III Sensitivity: High	Confinement	Narrow	Narrow
	Stream Type	C	B
	Entrenchment Ratio	> 2.2	1.8
	Incision Ratio	< 1.2	2.0
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Erosion, Constriction, Mass Failures, Tributary Rejuvenation, Encroachments, Channel Straightening**		

M3.05-B

This segment is the naturally straight 900-foot long stretch of M3.05 that is located in a Semi-Confined valley. Brook Road does not change the valley type, but does reduce the natural valley width here by one third on average. M3.05-B is in **fair** geomorphic condition and has undergone major **historic incision** as a result of the placement of Brook Road. The incision has completely cut off access to the small amount of floodplain the channel likely had before the road was put in. A stream type departure from the reference B type to the existing F type has occurred. Aggradation, widening, and planform adjustment processes are minor here as the channel transports sediment from upstream to downstream. Figure 5.24 shows a typical channel in this segment. M3.05-B is in **good** habitat condition as a result of excellent buffer

widths and abundant refuge for aquatic life. A short area on the eastern bank has an area where the buffer is less than 25 feet wide.

Figure 5.24. Typical channel is straight with little aggradation in M3.05-B.

M3.05-B Data Summary		Reference	Existing
Length: 888 ft Drainage Area: 9 sq. mi. Evolution Stage: F-III Sensitivity: Extreme	Confinement	Semi-Confined	Semi-Confined
	Stream Type	B	F
	Entrenchment Ratio	1.4 – 2.2	1.2
	Incision Ratio	< 1.2	1.7
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Poor Buffers, Erosion, Mass Failures, Encroachments**		

M3.05-C

This segment begins as the Semi-Confined valley in M3.05-B opens up to a naturally Very Broad valley and continues 4,700 feet upstream to the reach break with M3.06. This is where the Very Broad valley transitions to Broad. M3.05-C could have been split into nine distinct segments; however, due to time constraints and short segment lengths the area was considered one segment. The segment displays varying degrees of departure from its reference stream type and geomorphic equilibrium. The reference stream type is a C. In general, the stream channel in this segment alternated several times between a C stream type with great floodplain access (Figure 5.25) and areas that exhibit a stream type departure to an F or B stream type with reduced floodplain access (Figure 5.26). The majority of the C stream type

was in the downstream end of the segment. A 180-foot section of stream channel in the middle of the segment was dominated by a large grade control area just downstream of the Lee Road Bridge (Figure 5.27). The most upstream 300 feet of the reach was characterized by a step-pool dominated bedform. In general, M3.05-C is in **fair** geomorphic condition. Extreme **historic incision** has led to the stream type departure in many locations and **aggradation**, **widening**, and **planform adjustment** are major processes. Three box culverts and one bridge are all channel constrictions adding to geomorphic instability in M3.05-C. The segment is in **fair** habitat condition as a result of bank erosion contributing to large amounts of sediment in the channel.

Figure 5.25. Area in M3.05-C with good floodplain access.

Figure 5.26. Area in M3.05-C with limited floodplain access.

Figure 5.27. Large grade control area downstream of Lee Road Bridge in M3.05-C.

M3.05-C Data Summary		Reference	Existing
Length: 4,713 ft Drainage Area: 9 sq. mi. Evolution Stage: F-III Sensitivity: Very High	Confinement	Very Broad	Broad
	Stream Type	C	F
	Entrenchment Ratio	> 2.2	1.2
	Incision Ratio	< 1.2	2.0
	Dominant Bed Material	Cobble	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Erosion, Revetments, Constrictions, Mass Failures, Tributary Rejuvenation, Headcut, Encroachments**		

M3.05 Project Identification:

- **Passive Restoration** by protecting the river corridor through easement to maintain forested buffer in M3.05-A. (Map 4: Project #1)
- **Passive Restoration** by protecting the river corridor through easement to maintain forested buffer in M3.05-C. (Map 5: Project #1)
- **Active Restoration** by replacing most downstream culvert at Brook Road crossing in M3.05-C causing geomorphic instability. (Map 5: Project #2)
- **Active Restoration** by replacing middle culvert at Brook Road crossing in M3.05-C causing geomorphic instability. (Map 6: Project #1)
- **Active Restoration** by replacing most upstream culvert at Brook Road crossing in M3.05-C causing geomorphic instability. (Map 6: Project #2)
- **Passive Restoration** by protecting the river corridor through easement to maintain floodplain access and sediment attenuation in M3.05-C. (Map 6: Project #3)

M3.06

This reach was split into three segments to account for changes in valley width, reference stream types, and channel dimensions.

M3.06-A

The most downstream segment in M3.06 begins at the reach break and continues 1,400 feet upstream through a naturally Broad valley to where the valley becomes Semi-Confined and the channel is directly adjacent to Brook Road. The placement of Brook Road changes the natural Broad valley type to Narrow in this segment, which limits the channel's ability to meander. M3.06-A is in **fair** geomorphic condition. The segment has undergone minor historic incision and is currently exhibiting minor aggradation and widening (Figure 5.28). A grade control is limiting vertical adjustment in the segment (Figure 5.29). **Planform adjustment** is major due to channel straightening. M3.06-A is in **good** habitat condition as a result of generally good bank and buffer vegetation, and an abundance of pools and large woody debris. An area along the western bank, which is directly adjacent to Brook Road, has no buffer.

Figure 5.28. Typical channel in M3.06-A has good floodplain access and minor aggradation.

Figure 5.29. The grade control in M3.06-A is limiting vertical adjustment.

M3.06-A Data Summary		Reference	Existing
Length: 1,409 ft Drainage Area: 7 sq. mi. Evolution Stage: F-III Sensitivity: High	Confinement	Broad	Narrow
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	3.6
	Incision Ratio	< 1.2	1.3
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Poor Buffers, Erosion, Revetments, Mass Failures, Encroachments, Channel Straightening, Stormwater Inputs**		

M3.06-B

This segment begins as the Broad valley in M3.06-A transitions to a Semi-Confined valley in M3.06-B and continues 450 feet upstream directly adjacent to Brook Road to where stream becomes less incised. This segment is characterized by its proximity to Brook Road. M3.06-B is in **fair** geomorphic condition and has undergone extreme **historic incision**. Aggradation and widening are minor. Widening is limited by the rip rap along Brook Road. **Planform adjustment** is the major process occurring here. M3.06-B is in **fair** habitat condition mainly because of the lack of adequate bank vegetation and buffer width (Figure 5.30).

Figure 5.30. Brook Road is directly adjacent to stream channel (left) in M3.06-B resulting in poor buffer widths and reduced bank vegetation.

M3.06-B Data Summary		Reference	Existing
Length: 459 ft Drainage Area: 7 sq. mi. Evolution Stage: F-II Sensitivity: High	Confinement	Semi-Confined	Narrowly Confined
	Stream Type	B	B
	Entrenchment Ratio	1.4 – 2.2	1.5
	Incision Ratio	< 1.2	2.8
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Poor Bank Vegetation, Poor Buffers, Erosion, Revetments, Tributary Rejuvenation, Encroachments, Channel Straightening**		

M3.06-C

The most upstream segment in M3.06 begins 600 feet downstream of the box culvert on Brook Road and continues 1,600 feet upstream to approximately 1,000 feet upstream of the same crossing. The downstream end of this segment is in close proximity to Brook Road, while the upper portion is further away from the road. M3.06-C is in **fair** geomorphic condition and has undergone major **historic incision**, which has not led to a stream type departure. There are many bedrock grade controls, which are limiting vertical adjustment in the upper portion of the segment (Figure 5.31). Aggradation and widening are minor, while **planform adjustment** is major due to channel straightening and the presence of a small island at the upstream end. M3.06-C is in **good** habitat condition mainly because the upstream portion of the segment is not influenced by Brook Road. Much of the segment has good vegetated banks and buffers except for in the vicinity of Brook Road, good canopy cover, and abundant refuge areas for aquatic life.

Figure 5.31. Several bedrock grade controls are limiting vertical adjustment in upstream section of M3.06-C.

M3.06-C Data Summary		Reference	Existing
Length: 1,605 ft Drainage Area: 7 sq. mi. Evolution Stage: F-II Sensitivity: High	Confinement	Semi-Confined	Semi-Confined
	Stream Type	B	B
	Entrenchment Ratio	1.4 – 2.2	1.8
	Incision Ratio	< 1.2	1.5
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Poor Buffers, Revetments, Constriction, Mass Failures, Encroachments, Channel Straightening**		

M3.06 Project Identification:

- **Passive Restoration** by protecting the river corridor through easement to maintain floodplain access and sediment attenuation in M3.06-A. (Map 6: Project #3)
- **Active Restoration** by relocating log landing to reduce the chance of cut logs entering the brook and causing debris jams and subsequent flooding or erosion hazards at stream crossings. (Map 6: Project #4)
- **Active Restoration** by replacing undersized culvert at Brook Road crossing in M3.06-C causing geomorphic instability. (Map 6: Project #5)

M3.07

This reach was split into three segments to account for changes in valley width, banks and buffers, and channel dimensions.

M3.07-A

This segment begins approximately 560 feet below Maxfield Road and continues for approximately 200 feet. M3.07-A is in **fair** geomorphic condition and was very variable with an "F" or "B" stream type bedrock control section (Figure 5.32), an island area where the channel has experienced bifurcation, and a predominantly "C" stream type on the downstream end (Figure 5.33). Due to its short length of approximately 760 feet, it was not feasible to further segment based on these variations. The numerous bedrock grade controls in the upstream section are preventing incision. However, in the downstream portion where the cross section was done, the channel has undergone major **historic incision**. Aggradation and widening are minor, while **planform adjustment** is major due to the channel bifurcation around the island area. The streambanks of the segment have been impacted by exposed glacial till, mass failures (Figure 5.34), and revetments. A gully has developed along a field that is contributing sediment to the stream channel (Figure 5.35). The habitat condition in M3.07-A is **fair** due to the lack of refuge habitat and undercut banks, compromised bank vegetation from revetments, and limited large woody debris.

Figure 5.32. Bedrock grade control section in M3.07-A preventing further incision.

Figure 5.33. "C" stream type in M3.07-A is dominant stream type.

Figure 5.34. Mass failure in M3.07-A contributing sediment to the stream channel.

Figure 5.35. Aggradation in channel due to sediment inputs from gully across field.

M3.07-A Data Summary		Reference	Existing
Length: 763 ft Drainage Area: 6 sq. mi. Evolution Stage: F-II Sensitivity: High	Confinement	Semi-Confined	Semi-Confined
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	2.6
	Incision Ratio	< 1.2	1.4
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Step-Pool	Step-Pool
Major Stressors:	**Mass Failures, Revetments, Gully**		

M3.07-B

Segment M3.07-B begins 175 feet above the Maxfield Road crossing and continues until approximately 760 feet upstream of the Brook Road crossing. The majority of the segment has an eastern buffer that is inadequate due to the presence of agricultural fields. The channel has undergone major **historic degradation** as a result of channel straightening which had set off a series of events in the channel evolution process. The stream channel is experiencing major **widening**, which is exacerbated by the lack of bank and riparian buffer vegetation causing extensive bank erosion (Figure 5.36). The increase in sediment through erosion has resulted in major **aggradation** and **planform adjustment** as the channel develops flood chutes around large depositional features (Figure 5.37). Due to the extent of the processes in segment M3.07-B, it is in **fair** geomorphic condition.

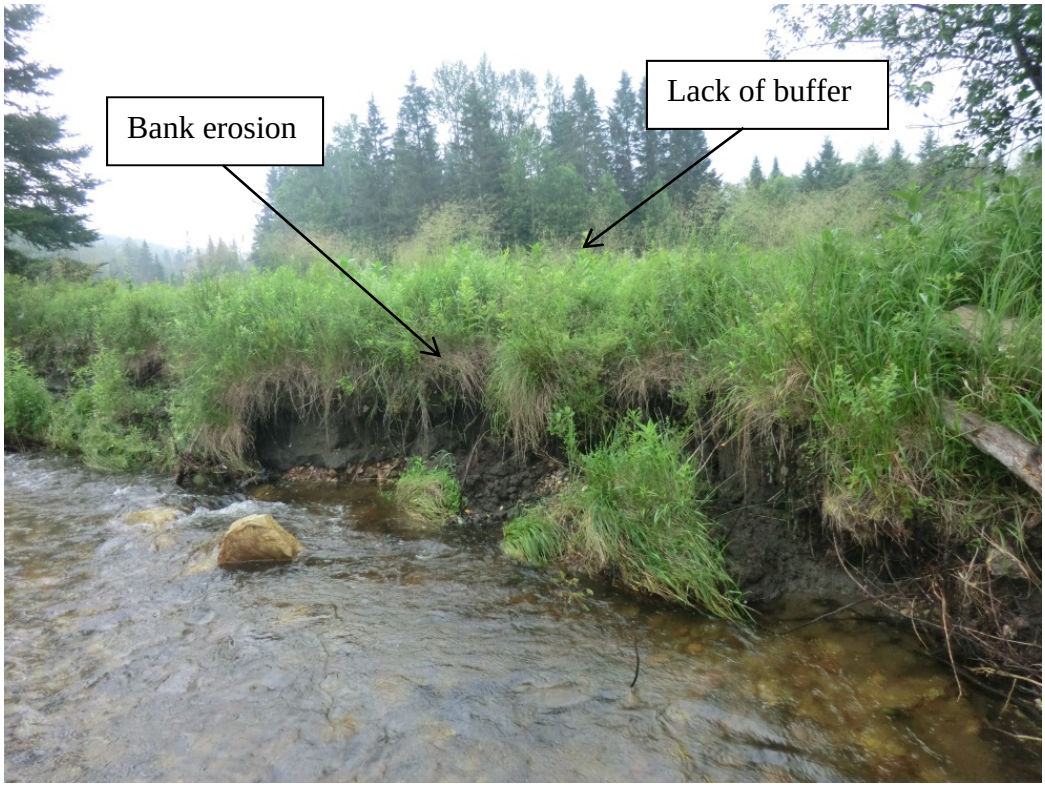

Figure 5.36. Lack of buffer on eastern bank of M3.07-B has led to extensive erosion as channel widens.

Figure 5.37. Large point bar in M3.07-B leading to planform adjustment.

M3.07-B Data Summary		Reference	Existing
Length: 3,607 ft Drainage Area: 6 sq. mi. Evolution Stage: F-III Sensitivity: Very High	Confinement	Very Broad	Very Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	2.6
	Incision Ratio	< 1.2	1.6
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Erosion, Poor Buffers, Poor Bank Vegetation, Constriction**		

M3.07-C

Approximately 760 feet upstream of the Brook Road crossing, Great Brook becomes more forested in segment M3.07-C. The channel is slightly incised in some locations, but there are still areas of good floodplain access resulting in a stable condition. **Aggradation** is as seen through numerous steep riffles and depositional features (Figure 5.38). The decrease in slope from upstream is what makes this segment more aggradational than upstream segments. Logging practices and mass failures upstream are most likely increasing the sediment load, which gets transported downstream and deposited in this segment. There is some bank instability due to erosion and one small mass failure increasing the sediment load in Great Brook (Figure 5.39). Segment M3.07-C is in **good** geomorphic condition due to the adequate floodplain access and lack of channel degradation. The habitat condition of segment M3.07-C

was also **good** due to the abundant large woody debris, numerous pools with nice cover, habitat debris jams, and well vegetated banks and buffers.

Figure 5.38. Diagonal bar in Segment M3.07-C.

Figure 5.39. Mass failure in M3.07-C contributing sediment to Great Brook.

M3.07-C Data Summary		Reference	Existing
Length: 1,117 ft Drainage Area: 6 sq. mi. Evolution Stage: F-I Sensitivity: Very High	Confinement	Very Broad	Very Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	2.6
	Incision Ratio	< 1.2	1.2
	Dominant Bed Material	Gravel	Gravel
	Dominant Bedform	Riffle-Pool	Riffle-Pool
Major Stressors:	**Mass failure, Sediment from upstream reaches**		

M3.07 Project Identification:

- **Active Restoration** by investigating and remediating gully contributing sediment to channel in M3.07-A; possible CREP project. (Map 7: Project #1)
- **Passive Restoration** by streamside planting along eastern bank in M3.07-B and protection of river corridor through easement; possible CREP project. (Map 7: Project #2)
- **Active Restoration** by replacing significantly undersized culvert at Brook Road crossing in M3.07-B causing geomorphic instability. (Map 7: Project #2)
- **Passive Restoration** by protecting the river corridor through easement to allow for natural buffer regeneration in M3.07-B and maintain forested buffer in M3.07-C. (Map 7: Project #4)

M3.08

This reach was split into four segments to account for changes in channel dimensions, valley width, and substrate size.

M3.08-A

This segment begins approximately 4,500 feet below the Gore Road crossing where the valley walls become narrower and continues until Gore Road. M3.08-A has experienced **historic incision** but has not undergone major widening yet and therefore may be in late stage F-II to early F-III. The channel alternates between having access and not having access to its floodplain, but most of the segment is incised (Figure 5.40). The channel is in **good** geomorphic condition with a dominant stream type of "B" and some areas with a "C" stream type. Bank erosion along the streambanks is causing an increase in sediment to the stream channel (Figure 5.41). Although M3.08-A has well vegetated banks and buffers, its habitat condition **fair** as a result of limited large woody debris, refuge areas, and undercut banks.

Figure 5.40. Incised channel in M3.08-A preventing floodplain access.

Figure 5.41. Localized bank erosion in M3.08-A contributing sediment to Great Brook.

M3.08-A Data Summary		Reference	Existing
Length: 1,250 ft Drainage Area: 3 sq. mi. Evolution Stage: F-II Sensitivity: Moderate	Confinement	Very Broad	Very Broad
	Stream Type	B	B
	Entrenchment Ratio	1.4 - 2.2	2.2
	Incision Ratio	< 1.2	1.6
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Step-Pool	Step-Pool
Major Stressors:	**Erosion**		

M3.08-B

This segment begins at the Gore Road crossing and continues for 4,300 feet. In this part of Great Brook, the dominant stressors are not from development as in downstream areas, but from increased sediment input as a result of mass failures and gullies along steep valley walls (Figures 5.42 and 5.43). This segment is variable with narrow channel areas that alternate with islands where the channel is bifurcated and experiencing major **aggradation** (Figure 5.44). The channel in segment M3.08-B is in **good** geomorphic condition with a variable stream type and valley width, but predominantly a "B" stream. The habitat condition is also **good** with abundant refuge areas, nice pools (Figure 5.45), and undercut banks.

Figure 5.42. Mass failure in M3.08-B causing instability in stream bank.

Figure 5.43. Gully in M3.08-B contributing sediment to Great Brook.

Figure 5.44. Streamflow around island in M3.08-B.

Figure 5.45. Pool habitat in M3.08-B.

M3.08-B Data Summary		Reference	Existing
Length: 4,300 ft Drainage Area: 3 sq. mi. Evolution Stage: F-I Sensitivity: Moderate	Confinement	Narrow	Narrow
	Stream Type	B	B
	Entrenchment Ratio	1.4 - 2.2	2.2
	Incision Ratio	< 1.2	1.0
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Step-Pool	Step-Pool
Major Stressors:	**Mass failures, Gullies, Undersized Culvert**		

M3.08-C

Segment M3.08-C is approximately 4,500 feet long and is very similar to segment M3.08-B except that it is slightly more entrenched and the overall valley is semi-confined. In the center of the segment there is a small area of channel bifurcation as seen in segment M3.08-B. Mass failures and gullies are also common in segment M3.08-C. The mass failures are a source of debris in the channel, which is susceptible to downstream transport during higher flows. One mass failure is located near a log landing resulting in accumulated debris on the steep valley slope (Figure 5.46). An old metal culvert has washed down from somewhere upstream and is in the stream channel (Figure 5.47). A washed out bridge and an old abutment is causing a channel constriction (Figure 5.48). Segment M3.08-C is in **good** geomorphic condition and stable with good floodplain access except for a small section at the downstream end of the segment. Aside from the mass failures along the banks, there is little impacting the habitat

condition of this segment resulting in a **good** habitat condition with abundant refuge, pools and large woody debris.

Figure 5.46. Mass failure in M3.08-C at log landing and accumulated debris.

Figure 5.47. Old washed out culvert in M3.08-C causing geomorphic instability.

Figure 5.48. Collapsed bridge with old abutment causing channel constriction in M3.08-C.

M3.08-C Data Summary		**Reference**	**Existing**
Length: 4,466 ft Drainage Area: 3 sq. mi. Evolution Stage: F-I Sensitivity: Moderate	Confinement	Semi-confined	Semi-confined
	Stream Type	B	B
	Entrenchment Ratio	1.4 - 2.2	1.5
	Incision Ratio	< 1.2	1.0
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Step-Pool	Step-Pool
Major Stressors:	**Mass failures, Gullies, Old Culvert, Constriction**		

M3.08-D

Segment M3.08-D begins approximately 650 feet southeast of the Plainfield/Groton town line where the valley becomes wider. The segment is 2,400 feet long and is characterized by a very broad valley that has a "reverse" nature, i.e., the slopes of the valley decrease as opposed to increase. The channel is a very unique system that has a step-pool bedform with nice mossy banks (Figure 5.49) and a "C" stream type with alternating braided/bifurcated sections (Figure 5.50). The braiding is most likely natural due to the flat topography. There is little geomorphic and habitat impact in the segment with great buffers except for the lower part of the segment, which is encroached by the logging road. A tributary enters the brook in this area with a perched culvert on the tributary that goes under the logging road (Figure 5.51). The top of the segment is located just below a beaver dam and large palustrine wetland (Figure 5.52). Fine sediment and gravel are slightly increased within the segment, which may be due to runoff from the logging road. Segment M3.08-D is in **reference** geomorphic condition with great

floodplain access and minimal geomorphic impacts. The habitat condition of this segment is **good** with high quality bank and buffer vegetation, abundant refuge, pools, large woody debris, and undercut banks.

Figure 5.49. Reference condition stream in segment M3.08-D, with great floodplain access and mossy banks.

Figure 5.50. Channel bifurcation around island in M3.08-D.

Figure 5.51. Tributary with perched culvert entering Great Brook in vicinity of lack of buffer from logging road in M3.08-D.

Figure 5.52. Palustrine wetland above Reach M3.08.

M3.08-D Data Summary		Reference	Existing
Length: 2,400 ft Drainage Area: 3 sq. mi. Evolution Stage: F-I Sensitivity: Moderate	Confinement	Very Broad	Very Broad
	Stream Type	C	C
	Entrenchment Ratio	> 2.2	118
	Incision Ratio	< 1.2	1.0
	Dominant Bed Material	Cobble	Cobble
	Dominant Bedform	Step-Pool	Step-Pool
Major Stressors:	**Lack of buffer, Stormwater Inputs**		

M3.08 Project Identification:

- **Passive Restoration** by protecting the river corridor through easements to maintain floodplain access and sediment attenuation in segment M3.08-A. (Map 8: Project #1)
- **Active Restoration** by replacing undersized culvert at Gore Road in M3.08-B to improve fish passage and geomorphic stability. (Map 8: Project #2)
- **Active Restoration** by remediating gully in M3.08-B to reduce sediment input to stream. (Map 8: Project #3)
- **Passive Restoration** by protecting the river corridor through easements to maintain floodplain access and sediment attenuation in segments M3.08-B, M3.08-C, and M3.08-D. (Maps 8 & 9: Projects #4 and Project #2, respectively)
- **Active Restoration** by removing washed out culvert at in M3.08-C to improve geomorphic stability although may be unfeasible due to remote location. (Map 9: Project #3)
- **Passive Restoration** by adopting best management practices for logging to avoid increased debris in channel and decrease sediment input in reach M3.08. (Map 9: Project #3)
- **Active Restoration** by removing old abutment and collapsed bridge in M3.08-C to improve geomorphic stability. (Map 9: Project #4)

5.5 Stream Crossings

Tables 7 and 8 in Appendix B summarize the data collected for the assessed structures within the Phase 2 study area. The map on page 9 in Appendix B shows the location and geomorphic compatibility rating of each structure. Of the 15 bridges and culverts assessed, one was determined to be fully incompatible, seven were “mostly incompatible,” six were “partially compatible,” and one was “mostly compatible.” This information can be used by municipalities and the Vermont Agency of Transportation to prioritize bridge replacements. Information from

the Phase 2 stream geomorphic assessment and bridge and culvert assessments can be used to inform Plainfield of which stream crossings are contributing to localized instability.

Stream crossings that have been recommended for replacement are in segments M3.01-C, M3.02-B, M3.05-C, M3.06-C, M3.07-B, and M3.08-A. The following parameters factored into the recommendations and their priority for replacement: flood damage, geomorphic compatibility, condition of structure, and whether fish passage had been improved by the placement of boulder weirs. All structures are culverts except for the one in M3.02-B, which is a bridge at Brook Road. One structure is located on Gore Road in M3.08-A, while the rest are located on Brook Road. The most downstream Brook Road crossing in M3.01-C contains an undersized culvert where flood damage and a channel avulsion occurred during the May 2011 flood event (Figure 5.53). The wing walls and the abutments have significant scour.

Figure 5.53. Box culvert crossing at Brook Road in segment M3.01-C recommended for replacement.

The bridge that was recommended for replacement is at the most downstream Brook Road crossing and is located in segment M3.02-B. The bridge is in poor condition with cracked wing walls and scour of abutments (Figure 5.54).

Figure 5.54. Cracked wing wall on bridge at Brook Road in segment M3.02-B recommended for replacement.

The three culverts in M3.05-C are recommended for replacement. Although it is in fairly good condition, the most downstream culvert is significantly undersized and fully incompatible with the stream geomorphology (Figure 5.55). There is a boulder weir at the downstream end that is controlling the tail water has improved fish passage. Another undersized culvert recommended for replacement is at the central Brook Road crossing is in M3.05-C. It is in poor condition and has a low clearance that has caused scour on the decking. It poses a greater risk for debris jams and fluvial erosion hazards (Figure 5.56). A boulder weir is also located at the downstream end of this structure that has improved fish passage. The most upstream crossing in segment M3.05-C is recommended for replacement due to its constrictive nature and its condition. There is significant scour on the wing walls with cracking and potential to fall down (Figure 5.57).

Figure 5.55. Box culvert at most downstream Brook Road crossing in segment M3.05-C.

Figure 5.56. Box culvert at center Brook Road crossing in segment M3.05-C with low clearance.

Figure 5.57. Box culvert at upstream Brook Road crossing in segment M3.05-C with cracked wing wall.

Great Brook crosses Brook Road again in segment M3.06-C where there is another undersized box culvert that is recommended for replacement. This culvert is in fair condition with failing hard bank armoring, especially at the base of the culvert and wing walls (Figure 5.58). A boulder weir has been placed at the downstream end of this structure and has improved fish passage. The final Brook Road crossing is located at a significantly undersized box culvert in segment M3.07-B. This culvert is recommended for replacement due its condition and constrictive nature (Figure 5.59), which has resulted in scour and deposition in the stream channel. The last culvert recommended for replacement is at the crossing on Gore Road in segment M3.08-A. This culvert has a poor alignment with the stream channel, no material throughout and has an outlet drop of approximately one foot that may be impeding fish passage (Figure 5.60). More details of recommendations on replacing the structures are included in the tables and maps in Appendix C.

Figure 5.58. Box culvert at Brook Road crossing in segment M3.06-C.

Figure 5.59. Box culvert at most upstream Brook Road crossing in segment M3.07-B.

Figure 5.60. Culvert at Gore Road crossing in segment M3.08-A causing potential fish passage issue.

6.0 WATERSHED AND SITE LEVEL PLANNING STRATEGIES

6.1 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)

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.

6.2 Watershed-Level Opportunities

There are a number of watershed-level opportunities available to improve the geomorphic stability and water quality of the Great Brook watershed. Watershed opportunities include the development and adoption of Fluvial Erosion Hazard Zones, improved stormwater treatment, and managing large woody debris in Great Brook.

Fluvial Erosion Hazard Zones

The purpose of defining Fluvial Erosion Hazard (FEH) 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.

Gretchen Alexander of the Vermont Rivers Program developed draft FEH zones for Great Brook using the Phase 2 Stream Geomorphic Assessment data. A map of Great Brook showing these draft zones dated March 18, 2014 is provided in the map pocket in the back of this corridor plan. 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. Improving stormwater management and construction practices in the Great Brook watershed is recommended to reduce siltation of critical aquatic habitat and improve geomorphic stability. An added benefit of stormwater management is the reduction of peak flows in the channel.

Woody Debris Management

The abundance of large woody debris in Great Brook has been a management concern of the Town of Plainfield. Trees, branches and root wads referred to as Large woody debris (LWD) can fall into a stream due to a variety of reasons including: bank erosion, mass failures, beaver activity, wind, disease, and natural mortality (Connecticut DEP, not dated). LWD offers important ecological benefits to aquatic organisms including providing fish habitat, improving water quality, and offering a source of nutrients and shelter to aquatic insects. The structure that large wood provides to the channel helps to stabilize the bed and banks and offers habitat complexity that is necessary for a healthy stream (New Hampshire DES, 2012). LWD, although important for having a diverse ecosystem, can form debris jams that block stream crossings resulting in a threat to infrastructure. Understanding when to remove LWD from streams and the permitting requirements for the removal is essential for making informed LWD management decisions.

Following Tropical Storm Irene, the Vermont Agency of Natural Resources adopted a stream alteration permitting process (May 2013) that requires a general permit (GP) for the removal of more than 10 cubic yards of instream materials within the top-of-bank to top-of-bank . If the quantity is greater than 10 cubic yards, authorization from a Vermont Stream Alteration Engineer is required. The authorization may be under the GP as a reported activity, a next flood protective measure, or initiated by the municipality as an emergency measure if there is an imminent threat. In the latter case, the applicant needs to meet the conditions in the general permit and get after the fact written authorization. Section E.2.1 (c) of the Stream Alteration Permit specifies the following: “Extending sediment and debris removal, horizontally or vertically, beyond that necessary to preserve life or to prevent sever damage to improved property is not a next-flood protective measure and must have prior authorization from the Secretary as a reported activity under Section C.2 or C.3 or with an individual stream alteration permit”.

Bear Creek Environmental contacted Mike Kline, Vermont State Rivers Program Manager, for guidance on when LWD should be removed from river or stream channel. Below in Table 3 is the guidance Mike Kline provided that the ANR adopted after Tropical Storm Irene. In addition, the Vermont ANR recommends leaving standing trees in the river corridor rather than removing them. According to Mike Kline, a common misperception is these standing trees could wash into the channel and be hazardous during the next flood. Standing trees reduce bank erosion and typically decrease flood risks by slowing the water down and helping to reduce erosion.

Table 3. Risk Level Guidance for Determining Large Woody Debris (LWD) Removal		
Risk Level	**Description**	**Action**
High	Channel spanning debris jams with altered flow path and high risk of avulsion. Remobilization of large amounts of debris and downstream structure clogging likely.	Remove debris jam
High to Moderate	Large mid-channel or bank accumulation of woody debris. Flow path may be altered, but risk of avulsion is low. Remobilization of large amount of debris and downstream structure clogging likely.	Remove debris jam
Moderate	Large mid-channel or bank accumulations of woody debris. Flow path may be altered, but risk of avulsion is low. Re-mobilization of large amount of debris is not likely.	Leave debris in place
Low	Bank accumulations of woody debris or individual embedded pieces of wood in channel. Flow path may be altered, but risk of avulsion is low. Re-mobilization of debris not likely.	Leave in place

The Plainfield Flood Advisory Committee (Final Report posted on January 31, 2013), recommended managing debris in a way that ensures public safety and infrastructure protection, while balancing the benefits of instream woody debris for habitat and stream stability. The Committee suggested focusing on mitigating debris jam threats through other options, such as the replacement of undersized structures at stream crossings. BCE is in agreement with replacing undersized structures to reduce debris jam risks, and has made recommendations for this strategy in Section 5.5 of this plan. A Vermont Stream Alteration Engineer should be contacted for further guidance and permitting requirements for debris jam removal.

6.3 Project Identification and Prioritization

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 and tables (Appendix D) have been developed for the Great Brook 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 31 projects were identified by BCE to promote the restoration or protection of channel stability and aquatic habitat in the Great Brook watershed. The projects are broken down by category as follows: 15 passive restoration (streamside plantings, natural buffer

regeneration, corridor easements, and adoption of best management practices for logging); 1 stream clean-up; and 16 active restoration (2 alternative analyses for old abutment removals; 1 removal of washed out culvert; 1 floodplain creation project; 1 project to arrest headcuts; 2 gully remediation projects; 1 project to relocate log landing, and 8 culvert replacements).

6.4 Next Steps

There are many opportunities available to work towards restoring Great Brook to stable conditions. Preliminary reach level and site level projects have been identified and will form the basis for future project development. 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 Vermont Rivers Program has developed draft Fluvial Erosion Hazard Zones for the land surrounding the Great Brook main stem. 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. Incorporate Fluvial Erosion Hazard Zones for Great Brook into town planning.
3. Acquire funding and hire contractors (river scientists and engineers) to prepare project design and implementation strategies for selected high priority projects.

Resources for developing potential projects and obtaining funding for project implementation in the Great Brook watershed are as follows:

Friends of the Winooski River
Contact: Ann Smith
P.O. Box 777
Montpelier, VT 05601
(802) 882-8276
asmithinvt@winooskiriver.org

Central Vermont Regional Planning Commission
Contact: Dan Currier
29 Main Street, Suite 4
Montpelier, VT 05602
(802) 229-0389
currier@cvregion.com

Vermont Rivers Program
Contact: Gretchen Alexander
111 West Street
Essex Junction, VT 05452
(802) 490-6150
Gretchen.Alexander@state.vt.us

Winooski Conservation District
Berlin Office
617 Comstock Road, Suite 1
Berlin, VT 05602
(802) 8284493 x110
info@winooskinrcd.org

7.0 LIST OF ACRONYMS AND GLOSSARY OF TERMS

List of Acronyms

BCE – Bear Creek Environmental, LLC
CVRPC – Central Vermont Regional Planning Commission
CREP – Conservation Reserve Enhancement Program
CRWC – Connecticut River Watershed Council
EQIP – Environmental Quality Incentives Program
ERP – Ecosystem Restoration Program
FEH – Fluvial Erosion Hazard Zone
FWR – Friends of the Winooski River
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
USGS – United States Geological Survey
VANR – Vermont Agency of Natural Resources
VTDEC – Vermont Department of Environmental Conservation
VDFW _ Vermont Department of Fish and Wildlife
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_apxqglossary.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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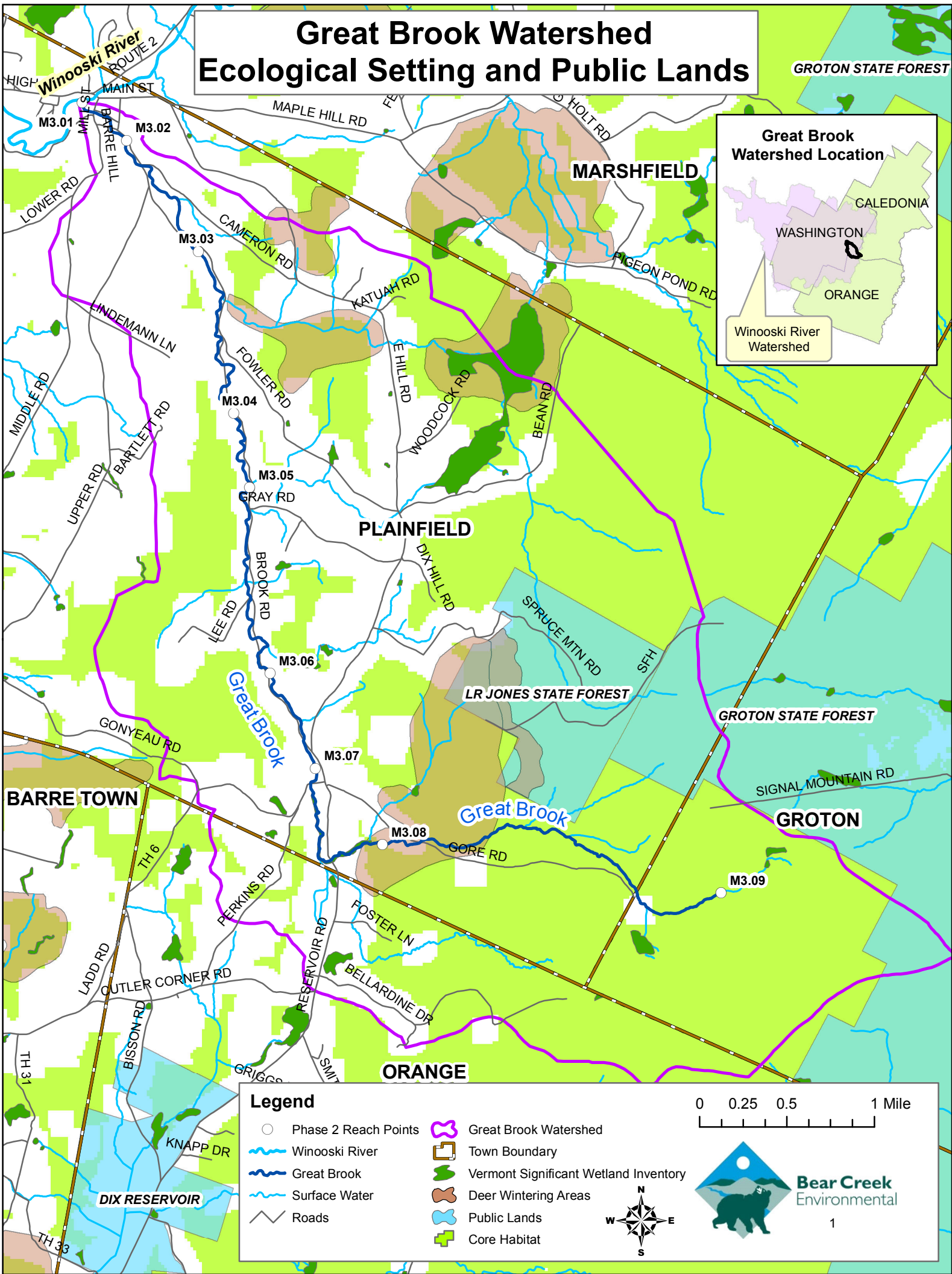
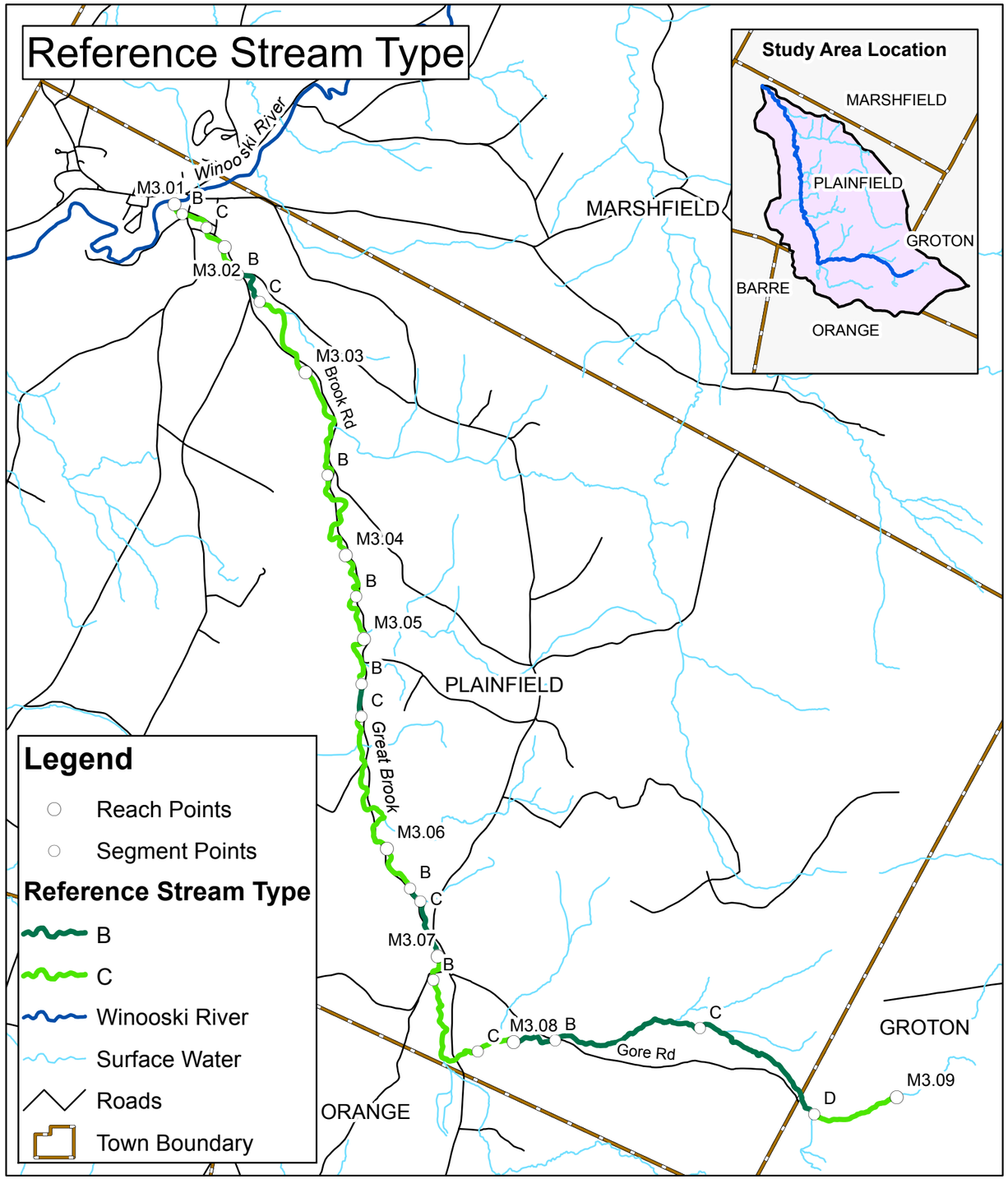
APPENDIX A

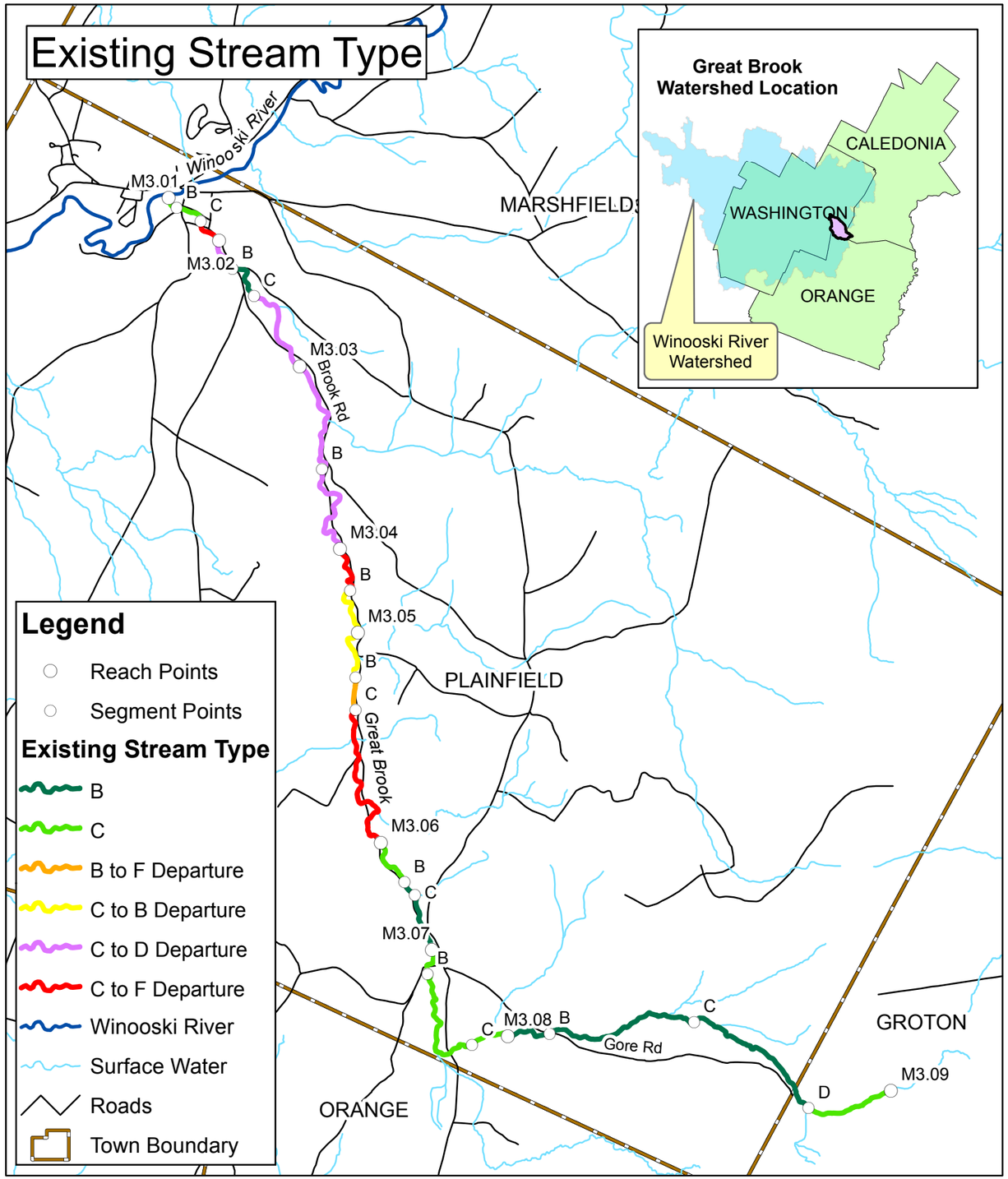
Maps


Great Brook Watershed
Ecological Setting and Public Lands
Great Brook Watershed Location
CALEDONIA
WASHINGTON
ORANGE
Winooski River Watershed
Winooski River
ROUTE 2
MAIN ST
MILL ST
BARRE HILL
LOWER RD
MAPLE HILL RD
HOLT RD
MARSHFIELD
GROTON STATE FOREST
M3.01
M3.02
M3.03
M3.04
M3.05
M3.06
M3.07
M3.08
M3.09
CAMERON RD
PIGEON POND RD
KATUAH RD
LINDEMANN LN
FOWLER RD
E HILL RD
WOODCOCK RD
BEAN RD
MIDDLE RD
BARTLETT RD
UPPER RD
GRAY RD
PLAINFIELD
DIX HILL RD
BROOK RD
LEE RD
SPRUCE MTN RD
SFH
LR JONES STATE FOREST
GROTON STATE FOREST
Great Brook
GONYEAU RD
BARRE TOWN
SIGNAL MOUNTAIN RD
GROTON
GORE RD
TH 6
PERKINS RD
FOSTER LN
RESERVOIR RD
LADD RD
CUTLER CORNER RD
BELLARDINE DR
BISSON RD
TH 31
ORANGE
KNAPP DR
DIX RESERVOIR
TH 33
Legend
Phase 2 Reach Points
Winooski River
Great Brook
Surface Water
Roads
Great Brook Watershed
Town Boundary
Vermont Significant Wetland Inventory
Deer Wintering Areas
Public Lands
Core Habitat
0 0.25 0.5 1 Mile
N
W
E
S
Bear Creek Environmental
1

Reference Stream Type



Existing Stream Type



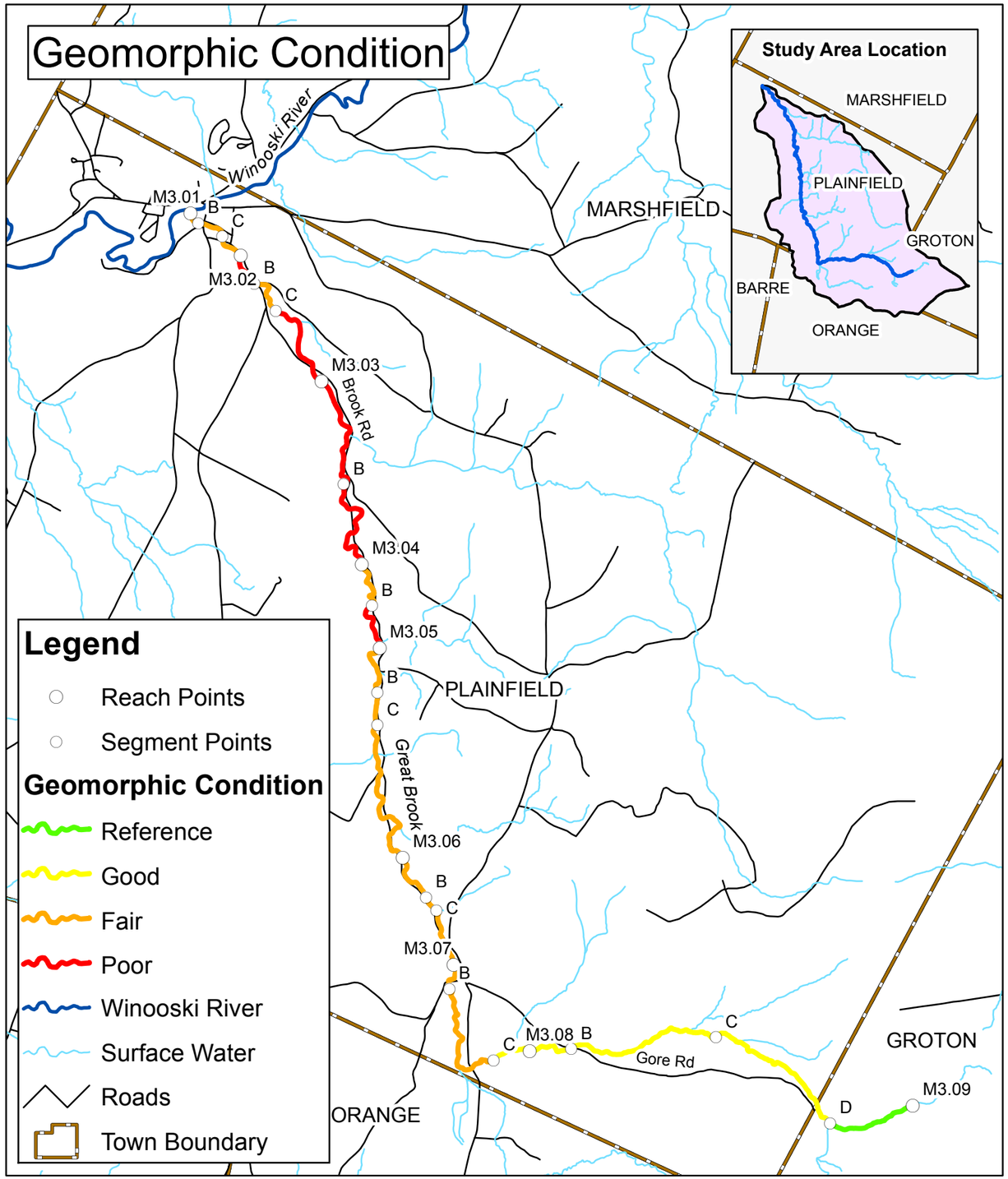
Great Brook Stream Type
Plainfield & Groton, Vermont

0 0.5 1 2 Miles

N W E S

Bear Creek Environmental

Geomorphic Condition



Habitat Condition

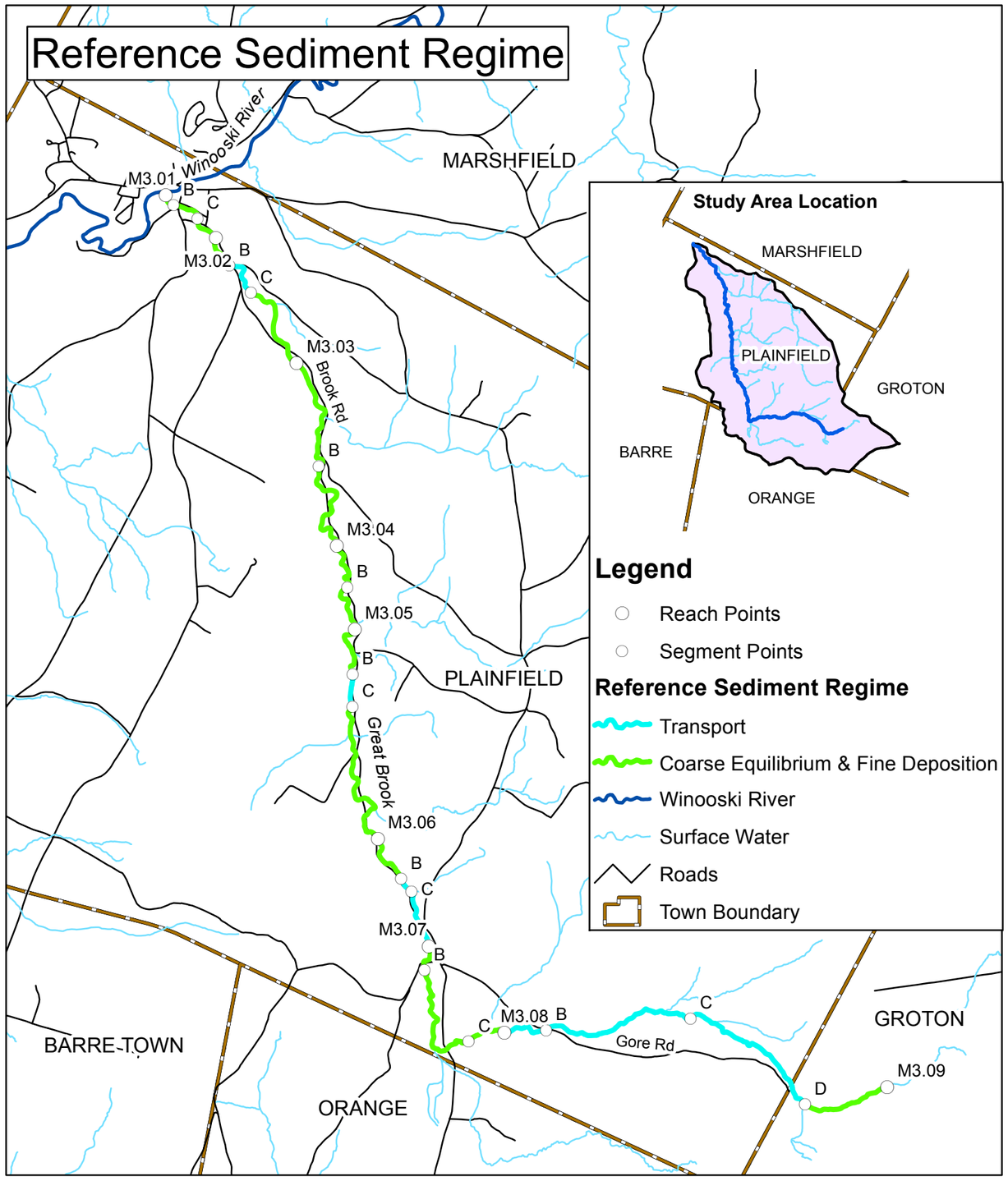
Great Brook Stream Condition
Plainfield & Groton, Vermont

0 0.5 1 2 Miles

N W E S

Bear Creek Environmental

Reference Sediment Regime



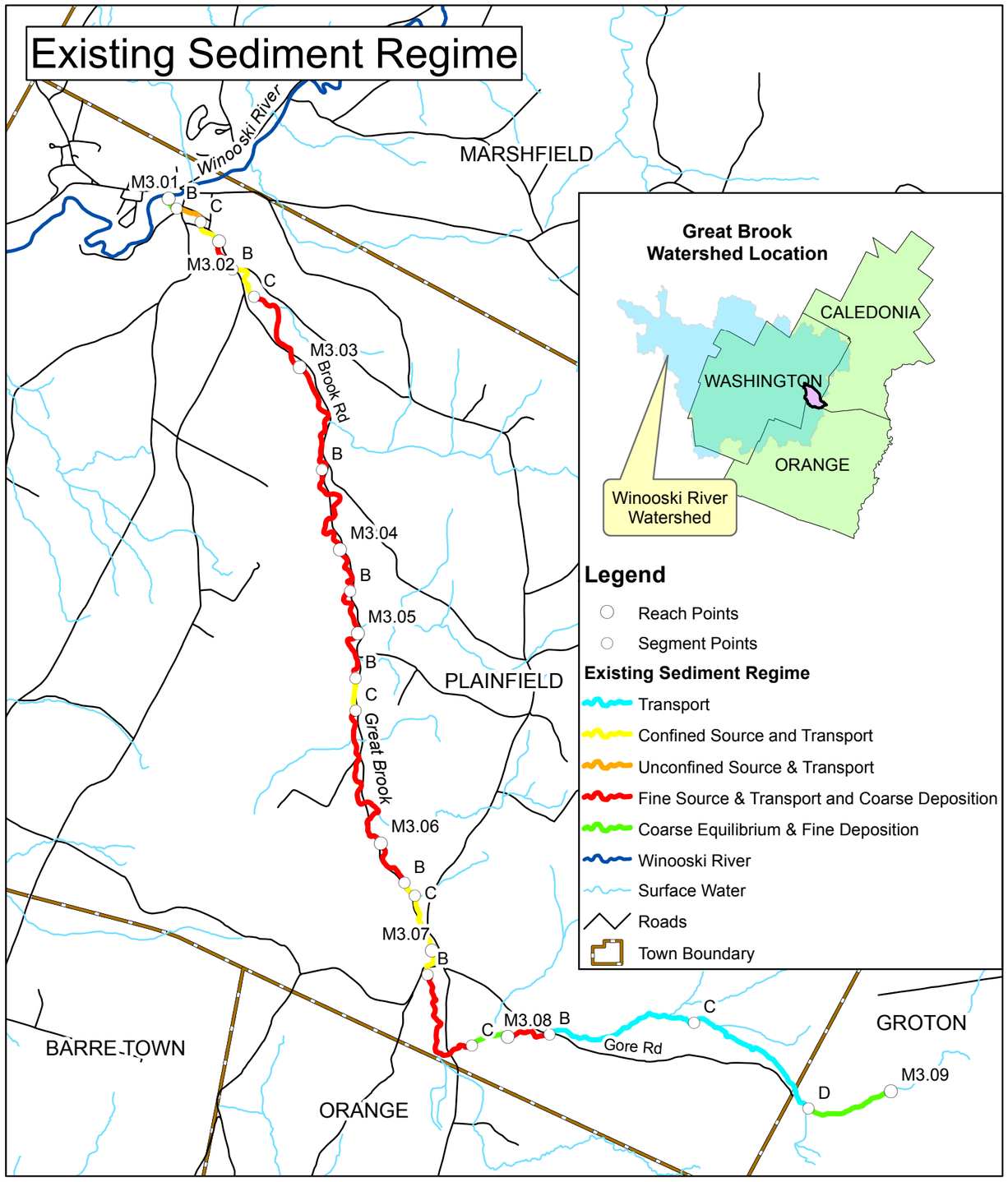
Legend

- Reach Points
- Segment Points

Reference Sediment Regime

- Transport
- Coarse Equilibrium & Fine Deposition
- Winooski River
- Surface Water
- Roads
- Town Boundary

Existing Sediment Regime



Legend

- Reach Points
- Segment Points

Existing Sediment Regime

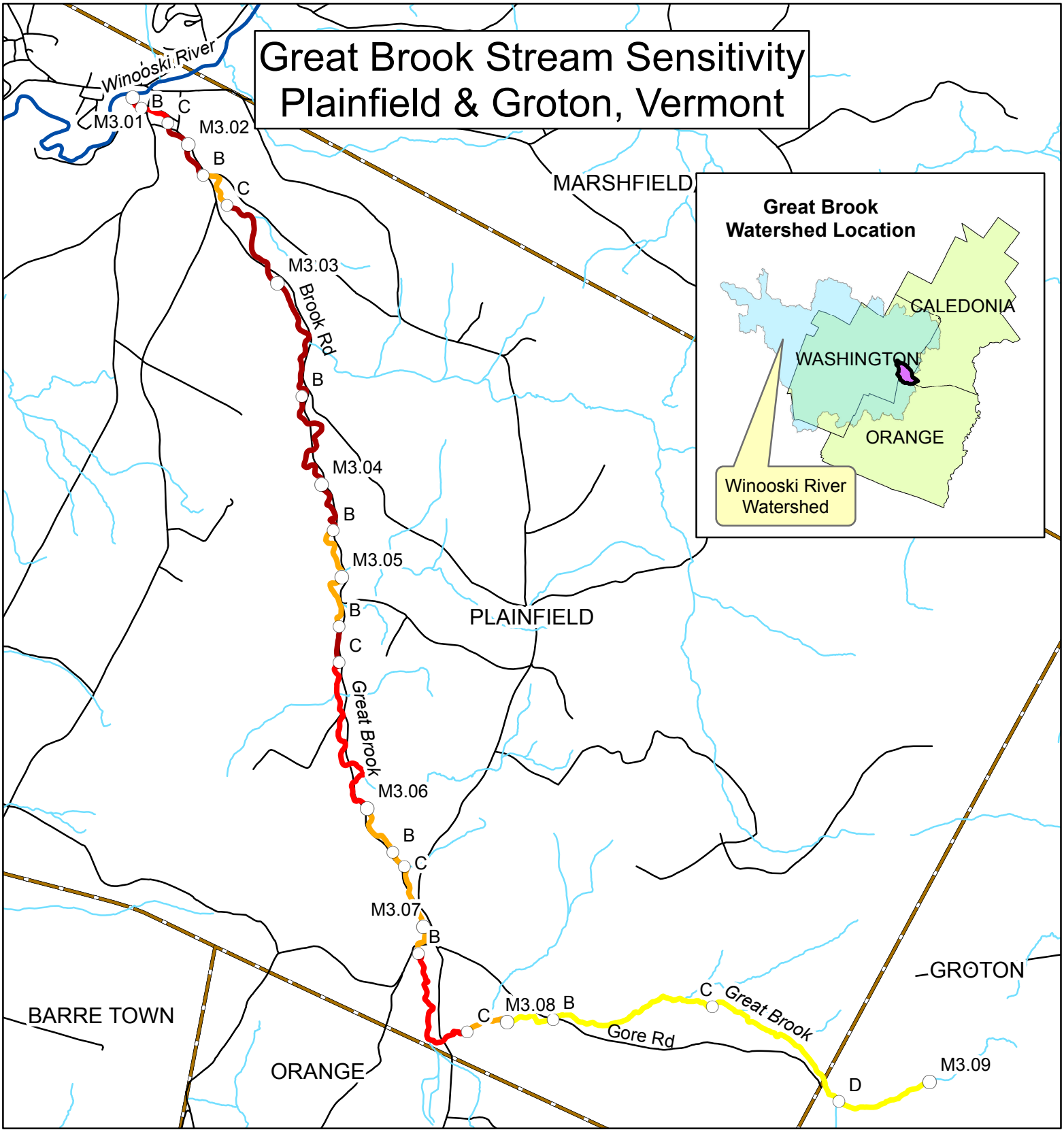
- Transport
- Confined Source and Transport
- Unconfined Source & Transport
- Fine Source & Transport and Coarse Deposition
- Coarse Equilibrium & Fine Deposition
- Winooski River
- Surface Water
- Roads
- Town Boundary

Great Brook Sediment Regime
Plainfield & Groton, Vermont

0 0.5 1 2 Miles

N W E S

Bear Creek Environmental



Legend

- Reach Points
- Segment Points
- Surface Water
- Winooski River

Stream Sensitivity

- Extreme
- Very High
- High
- Moderate

- Roads
- Town Boundary

N W E S

0 0.25 0.5 1 Miles

Bear Creek Environmental

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 ≥ 120	No upstream deposition or downstream bed scour	Naturally Straight	No erosion **or** armoring
4	100 ≤ %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 ≤ %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 ≤ %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 ≤ %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≤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≤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≤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≤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≤GC≤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. Scoring Table Vermont Culvert Geomorphic Compatibility Screen Tool (Milone & MacBroom, 2008)					
Score	**% Bankfull Width**	**Sediment Continuity**	**Slope**	**Approach Angle**	**Erosion and Armoring**
5	%BFW ≥ 120	No upstream deposition or downstream bed scour	Structure slope equal to channel slope, and no break in valley slope	Naturally Straight	No erosion **or** armoring
4	100 ≤ %BFW < 120	**Either** upstream deposition **or** downstream bed scour, **without** upstream deposits taller than 0.5 bankfull height **or** high downstream banks	n/a	n/a	No erosion **and** intact armoring, **or** low upstream **or** downstream erosion **without** armoring
3	75 ≤ %BFW < 100	**Either** upstream deposition **or** downstream bed scour, **with** either upstream deposits taller than 0.5 bankfull height **or** high downstream banks	Structure slope equal channel slope, with local break in valley slope	Mild bend	Low upstream **or** downstream erosion **with** armoring
2	50 ≤ %BFW < 75	**Both** upstream deposition **and** downstream bed scour, **without** upstream deposits taller than 0.5 bankfull height **or** high downstream banks	Structure slope higher or lower than channel slope, and no break in valley slope	Channelized Straight	Low upstream **and** downstream erosion
1	30 ≤ %BFW < 50	**Both** upstream deposition **and** downstream bed scour, **with** upstream deposits taller than 0.5 bankfull height **or** high downstream banks	n/a	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	Structure slope higher or lower than channel slope, with local break in valley slope	Sharp Bend	Severe upstream **and** downstream erosion, **or** failing armoring upstream **or** downstream

Table 4. Geomorphic Compatibility Rating Results Vermont Culvert Geomorphic Compatibility Screen Tool (Milone & MacBroom, 2008)			
Category Name	**Screen Score**	**Threshold Conditions**	**Description of Structure-channel Geomorphic Compatibility**
Fully Compatible	20<GC≤25	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	15<GC≤20	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	10<GC≤15	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	5<GC≤10	% 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≤GC≤5	% 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 5. Aquatic Organism Passage (AOP) Coarse Screen Tool (Milone & MacBroom, 2009)						
VT Aquatic Organism Passage Coarse Screen	**Full AOP**	**Reduced AOP**	**No AOP**			
Updated 2/25/2008	**for all aquatic organisms**	**for all aquatic organisms**	**for all aquatic organisms except adult salmonids**		**for all aquatic organisms including adult salmonids**	
AOP Function Variables / Values	**Green (if all are true)**	**Gray (if any are true)**	**Orange**		**Red**	
Culvert outlet invert type	at grade **OR** backwatered	cascade	free fall **AND**		free fall **AND**	
Outlet drop (ft)	= 0		> 0 , < 1 ft **OR**		≥ 1 ft **OR**	
Downstream pool present			= yes	(= yes **AND**	= no **OR**	(= yes **AND**
Downstream pool entrance depth / outlet drop			n/m	≥ 1)	n/a	< 1) **OR**
Water depth in culvert at outlet (ft)					< 0.3 ft	
Number of culverts at crossing	1	> 1				
Structure opening partially obstructed	= none	≠ none				
Sediment throughout structure	yes	no				

Notes:
Assessment completed during low flows
Outlet drop = invert of structure to water surface
Pool present variable is used alone if pool depths are not measured
n/m = not measured
n/a = not applicable

Table 6. Great Brook Bridge Assessment (2012 & 2013)
Geomorphic Compatibility

Reach/ Segment Number	Town	Road Name	Structure ID[1]	Percent Bankfull Channel Constriction Width[2]	Phase 2 Notes	Scoring						Priority for Replacement
						% Bankfull Width[3]	Sediment Continuity	Approach Angle	Erosion & Armoring	Total Score	Geomorphic Compatibility	
M3.01-B	Plainfield	Mill Street	101214002012141	30/42.3 = 71	Stream channel upstream and downstream of bridge is lined with hard bank armoring. Downstream hard bank armoring is failing. Many stormwater inputs were identified adjacent to this bridge.	2	2	2 Channelized Straight	0	**6**	Mostly Incompatible	See footnote [4]
M3.02-B	Plainfield	Brook Road	101214002212141	34/42.2 = 81	Failing rip rap upstream and downstream of structure. Significant scour along the footer and abutments. One of the upstream wing walls is cracked.	3	2	2 Channelized Straight	0	**7**	Mostly Incompatible	High (Poor condition)
M3.02-C	Plainfield	Brook Road	101214002312141	31.5/42.2 = 75	Failing rip rap upstream and downstream of structure.	3	3	3 Mild Bend	0	**9**	Partially Compatible	
M3.03-B	Plainfield	Brook Road	101214002412141	33.5/41 = 82	Scour around the footers of this structure.	3	2	5 Naturally Straight	3	**13**	Mostly Compatible	
M3.03-B	Plainfield	Brook Road	101214001212141	29.7/41 = 72	This bridge has recently been replaced. Remnants of the old bridge can be seen in the channel nearby.	2	3	3 Mild Bend	3	**11**	Partially Compatible	
M3.04-B	Plainfield	Private Driveway	N/A	25.5/36.2 = 70	Private driveway bridge. Rip rap upstream and downstream of structure is failing.	2	3	3 Mild Bend	0	**8**	Mostly Incompatible	
M3.05-C	Plainfield	Lee Road	101214002612141	22/33.9 = 65	Most of the rip rap upstream and downstream of this bridge failed during the 5/2011 flood.	2	1	3 Mild Bend	0	**6**	Mostly Incompatible	
M3.07-A	Plainfield	Maxfield Road	990031001212141	16.2/29.1 = 56	Structure in stable location on top of bedrock. Bedrock is obstructing structure. Failing armoring downstream. Scour below and along downstream wingwalls.	2	4	5 Naturally Straight	0	**11**	Partially Compatible	

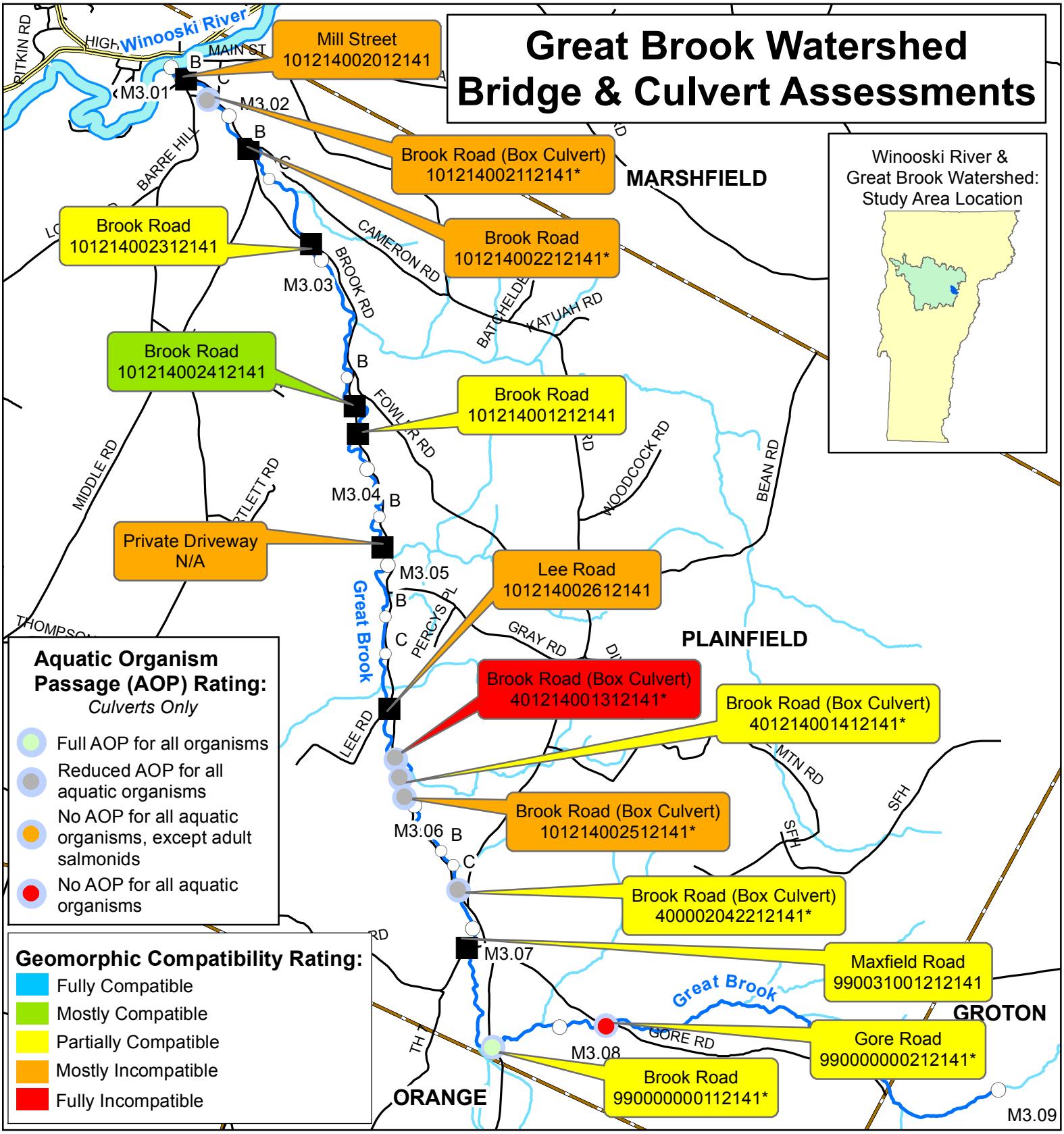
[1]The structure ID is the identification number provided by the 2010 "TransStructures_TRANSTRUC" shapefile from the Vermont Center for Geographic Information, unless no number was available. In this case, the SGAID is provided.
[2]Percent Bankfull Channel Width percentages are calculated based on the reference channel width for each reach. The percentage is calculated by dividing the present constriction width by the reference channel width.
[3]The % bankfull width is based on the constriction calculation.
[4] If the upstream Brook Road Culvert (101214002112141) is replaced, then this structure should be evaluated for risks from debris jams that would pass through the properly sized upstream bridge.

Table 7. Great Brook Culvert Assessment (2012 & 2013)
Geomorphic Compatibility and Aquatic Organism Passage (AOP)

Reach/ Segment Number	Town	Road Name	Structure Type and ID[1]	Percent Bankfull Channel Width[2]	Phase 2 Notes	Scoring (Geomorphic Compatibility - Milone & MacBroom, 2008; AOP – Milone & MacBroom, 2009)								Priority for Replacement
						% Bankfull Width	Sediment Continuity	Slope	Approach Angle	Erosion & Armoring	Total Score	Geomorphic Compatibility	AOP	
M3.01-C	Plainfield	Brook Road	101214002112141	21/42.30= 50	Poured concrete box culvert. Channel avulsion occurred on the right bank during the 5/2011 flood event. The wing walls and abutments have significant scour.	1	3	2	0 Sharp Bend	4	**10**	Mostly Incompatible	Reduced AOP	High (Previous flood damage)
M3.05-C	Plainfield	Brook Road	401214001312141	13.5/33.9 = 40	This poured concrete box culvert is generally in good condition. The boulder weir installed downstream is controlling the tail water and improves fish passage. On the downstream end, the rip rap is being undermined by erosion.	1	2	2	0 Sharp Bend	0	**5**	Fully Incompatible	Reduced AOP	Moderate (Good condition; Fish passage improved, but geomorphic incompatibility)
M3.05-C	Plainfield	Brook Road	401214001412141	17/33.9 = 50	This poured concrete box culvert is in fair condition. The culvert does not have a high clearance and there is significant scour on the decking. A large scour pool has formed downstream of the culvert. Boulder weir installed downstream.	2	2	5	3 Mild Bend	0	**12**	Partially Compatible	Reduced AOP	Moderate (Fair condition; Fish passage improved)
M3.05-C	Plainfield	Brook Road	101214002512141	22/33.9 = 65	This poured concrete box culvert is in fair condition. There is significant scour on the upstream wing wall, which has resulted in it cracking and almost falling down. One of the downstream wing walls is in a similar condition.	2	2	2	3 Mild Bend	0	**9**	Mostly Incompatible	Reduced AOP	Moderate (Fair condition; geomorphic incompatibility)
M3.06-C	Plainfield	Brook Road	400002042212141	16.0/29.9 = 54	This poured concrete box culvert is in fair condition. The hard bank armoring on the downstream end is failing, especially at the base of the culvert and the wing walls. Boulder weir installed downstream.	2	2	2	3 Mild Bend	0	**9**	Partially Compatible	Reduced AOP	Low (Fair condition; Fish passage improved)
M3.07-B	Plainfield	Brook Road	990000000112141	10/29.1 = 34	Bottom of this box culvert is deteriorating. Scour both above and below. Deposition above and poor alignment. Scour around culvert and wingwalls and failing armoring. Abundant erosion upstream.	1	1	2	3 Mild Bend	0	**7**	Mostly Incompatible	Full AOP	High (Poor condition and alignment; significantly undersized)
M3-08-A	Plainfield	Gore Road	990000000212141	10/21.4 = 47	Culvert looks newer. Deposition both above and below, but more abundant upstream. Scour pool downstream. Poor alignment. Outlet drop of approximately 1 foot creating potential fish passage issue.	1	2	2	5 Naturally Straight	0	**10**	Partially Compatible	No AOP Including Adult Salmonids	High (Poor alignment; No AOP)

[1]The 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. In this case the SGAID is provided.
[2]Percent Bankfull Channel Width percentages are calculated based on the reference channel width for each reach. The percentage is calculated by dividing the culvert width by the reference channel width.

Great Brook Watershed Bridge & Culvert Assessments



Aquatic Organism Passage (AOP) Rating:
Culverts Only

- Full AOP for all organisms
- Reduced AOP for all aquatic organisms
- No AOP for all aquatic organisms, except adult salmonids
- No AOP for all aquatic organisms

Geomorphic Compatibility Rating:

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

Legend

- Phase 1 Only
- Phase 2 Study Area
- Major Roads
- Roads
- Town Boundary
- Phase 2 Reach Point
- Segment Point
- Bridge
- Culvert

The ID numbers are provided by the 2010 "TransStructures_TRANSTRUC"shapefile from the Vermont Center for Geographic Information, unless no number was available. The SgaID (State of Vermont Data Management System) was used if no "TransStructures_TRANSTRUC" information was available.

Geomorphic Compatibility Rating for bridges is adapted from the Vermont Culvert Geomorphic Compatibility Screening Tool (Miloneand MacBroom, Inc. 2008).

Aquatic Organism Passage Rating for culverts is from the Vermont Culvert Aquatic Organism Passage Screening Tool (Milone and MacBroom, 2009).

*Structure is recommended for replacement.

0 0.25 0.5 Miles

N W E S

Bear Creek Environmental

APPENDIX C

Phase 2 Geomorphic Assessment Data

Table 1. Stream Type and Channel Evolution Stage Summary Great Brook Watershed							
Segment Number	**Entrenchment Ratio**	**Width to Depth Ratio**	**Reference Stream Type**	**Incision Ratio**	**Existing Stream Type**	**Channel Evolution Stage**	**Active Adjustment Process**
Great Brook Mainstem (2012)							
M3.01-A	9.2	18.8	C_b	1.1	C_b	F-II	Incision Aggradation Widening Planform
M3.01-B	3.0	14.3	C_b	1.7	C_b	F-II	**Incision** Aggradation Widening Planform
M3.01-C	1.3	15.3	C_b	2.1	F	F-III	**Aggradation** Widening Planform
M3.02-A	1.2	60.9	C_b	2.1	D	F-IV	**Aggradation** **Widening** **Planform**
M3.02-B	1.6	20.9	B	1.4	B	F-II	**Incision** **Aggradation** Widening **Planform**
M3.02-C	1.6	71.8	C_b	1.3	D	F-IV	**Aggradation** **Widening** **Planform**
M3.03-A	1.3	75.0	C_b	3.7	D	F-IV	**Aggradation** **Widening** **Planform**
M3.03-B	1.4	77.6	C_b	1.6	D	F-IV	**Aggradation** **Widening** **Planform**
M3.04-A	1.1	27.7	C_b	2.0	F	F-III	**Aggradation** **Widening** **Planform**
M3.04-B	1.4	55.8	C_b	1.6	B	F-IV	**Aggradation** **Widening** **Planform**
M3.05-A	1.8	19.0	C_b	2.0	B	F-III	**Aggradation** **Widening** **Planform**
M3.05-B	1.2	20.2	B	1.7	F	F-III	Aggradation Widening Planform
M3.05-C	1.2	21.3	C_b	2.0	F	F-III	**Aggradation** **Widening** **Planform**

Table 1. Stream Type and Channel Evolution Stage Summary Great Brook Watershed							
Segment Number	**Entrenchment Ratio**	**Width to Depth Ratio**	**Reference Stream Type**	**Incision Ratio**	**Existing Stream Type**	**Channel Evolution Stage**	**Active Adjustment Process**
M3.06-A	3.6	21.0	C_b	1.3	C_b	F-III	Aggradation Widening **Planform**
M3.06-B	1.5	16.8	B	2.8	B	F-II	Aggradation Widening **Planform**
M3.06-C	1.8	14.2	B	1.5	B	F-II	Aggradation Widening **Planform**
Great Brook Mainstem (2013)							
M3.07-A	2.5	22.0	C	1.4	C	F-II	**Incision** Aggradation **Planform**
M3.07-B	3.1	20.5	C	1.6	C	F-III	**Incision** **Aggradation** **Widening** **Planform**
M3.07-C	21.1	15.5	C	1.2	C	F-I	Incision **Aggradation** Widening Planform
M3.08-A	2.2	10.2	B_a	1.6	B_a	F-II	**Incision** Aggradation Widening Planform
M3.08-B	2.2	11.6	B_a	1.0	B_a	F-I	Aggradation Widening Planform
M3.08-C	1.5	21.6	B_a	1.0	B_a	F-I	Aggradation Widening
M3.08-D	118.4	14.5	C_a	1.0	C_a	F-I	Aggradation

Reference Ranges

	F Stream Type	B Stream Type	C Stream Type
Entrenchment Ratio	< 1.4	1.4 – 2.2	> 2.2
Width to Depth Ratio	> 12	< 12	< 12
Incision Ratio	< 1.2	< 1.2	< 1.2

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 no incision to minor incision (<1.4)
Orange denotes a stream type departure

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.01-A**
Segment Length(ft): **378**
Rain: **No**

SGAT Version: **3**
Organization:
Observers: **Mary, Sacha Pealer**
Completion Date: **10/25/2012**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **This segment begins approximately 150 feet downstream of the Mill Street bridge in downtown Plainfield and continues 378 downstream until the confluence with the Winooski River.**

Step 5 - Notes: **No significant human-caused change in valley width. Reach break is just upstream of confluence with Winooski. Location of headcut in FIT is just upstream of the reach break; actual physical location of headcut is slightly further downstream (closer to confluence with Winooski), but was indexed further upstream so that it shows up in the DMS for this segment. The channel appeared to be head cutting up through aggraded material located at the mouth of Great Brook.**

Step 7 - Narrative: **Minor incision throughout, although there is a headcut on Great Brook right at the confluence with the Winooski River, which is why segment is in F-II. However, it is unlikely that the headcut will cause more incision based on the location in the watershed (mouth of river). Minor widening, aggradation, and planform adjustment.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		18	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): **1,183**
Width Determination: **Measured**
Confinement Type: **VB**
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?
Weir		2.5	1.0		

Stream: **Great Brook** Reach: **M3.01-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**46.00**	2.11 Riffle/Step Spacing:	**99.5 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**3.40**	2.12 Substrate Composition		Bed:	**17.6**	**inches**
2.3 Mean Depth (tf):	**2.45**	Bedrock:	**0.0 %**	Bar:	**4.2**	**inches**
2.4 Floodprone Width (ft.):	**425.00**	Boulder:	**4.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**3.60**	Cobble:	**16.0 %**	Stream Type:	**C**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**37.0 %**	Bed Material:	**Gravel**	
2.6 Width/Depth Ratio:	**18.78**	Fine Gravel:	**15.0 %**	Subclass Slope:	**b**	
2.7 Entrenchment Ratio:	**9.24**	Sand:	**29.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**1.06**	Silt and Smaller:	**%**	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: **Moderate**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**192.5**	**59.0**	Dominant:	**Herbaceous**	**Deciduous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**5.4**	**3.0**	Sub-dominant:	**Shrubs/Sapling**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**None**	Bank Canopy		
Lower			Revetment Length:	**161.3**	**0.0**	Canopy %:	**26-50**	**51-75**
Material Type:	**Sand**	**Mix**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**51-100**
Sub-Dominant	**26-50**	**0-25**
W less than 25	**186**	**35**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Deciduous**
Sub-Dominant	**Deciduous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Residential**	**Residential**
Sub-dominant	**Forest**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Great Brook** Reach: **M3.01-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**None**	4.5 Flow Regulation Type		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:	**1**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**1**	Straightening Length (ft.):	**287**
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 Gradiant 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		**10**	**None**	**Yes**	Geomorphic Rating	**0.60**
7.2 Channel Aggradation		**12**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**13**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml		**13**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score		**48**			Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.01-B**
Segment Length(ft): **807**
Rain: **No**

SGAT Version: **3**
Organization:
Observers: **Mary, Emily, Sacha Pealer**
Completion Date: **10/28/2012**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Segment is807 feet long. This segment begins approx. 130 feet downstream of the Brook Road box culvert and continues approx. 800 feet downstream until valley opens up and the channel is less incised. ~ 380 feet upstream of confluence with Winooski R.**

Step 5 - Notes: **Human-caused change in valley width changes valley type from Very Broad to Broad, however channel is very limited by rip rap in many locations. Confinement ratio changes from 15.0 to 6.6.**

Step 7 - Narrative: **Major historic incision, likely as a result of the placement of Brook Road and Hudson Ave. Much of segment is armored by hard bank or rip rap. Low erosion. This is preventing widening in many places, so segment remains in stage F-II. Aggradation and planform adjustment are minor.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	719	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		807	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	N.E.	N.E.

1.5 Valley Features

Valley Width (ft):	280
Width Determination:	Measured
Confinement Type:	BD
In Rock Gorge:	No

Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls: **None**

Stream: **Great Brook** Reach: **M3.01-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**36.15**	2.11 Riffle/Step Spacing:	**78 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**3.30**	2.12 Substrate Composition		Bed:	**17.8**	**inches**
2.3 Mean Depth (tf):	**2.52**	Bedrock:	**0.0 %**	Bar:	**4.94**	**inches**
2.4 Floodprone Width (ft.):	**110.00**	Boulder:	**5.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**5.50**	Cobble:	**28.0 %**	Stream Type:	**C**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**37.0 %**	Bed Material:	**Gravel**	
2.6 Width/Depth Ratio:	**14.35**	Fine Gravel:	**9.0 %**	Subclass Slope:	**b**	
2.7 Entrenchment Ratio:	**3.04**	Sand:	**21.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**1.67**	Silt and Smaller:	**%**	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:	**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	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**0.0**	**145.8**	Dominant:	**Deciduous**	**Invasives**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**0.0**	**5.1**	Sub-dominant:	**Herbaceous**	**Deciduous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**603.9**	**641.7**	Canopy %:	**51-75**	**51-75**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**0-25**
Sub-Dominant	**51-100**	**26-50**
W less than 25	**280**	**280**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Invasives**
Sub-Dominant	**Herbaceous**	**Deciduous**

3.3 Riparian Corridor

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

Stream: **Great Brook** Reach: **M3.01-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**None**	4.5 Flow Regulation Type		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:	**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	**30**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Deposition 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:	**3**	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.):		**807**
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 Gradiant 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		**9**	**None**	**No**	Geomorphic Rating	**0.59**
7.2 Channel Aggradation		**12**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**14**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml		**12**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score		**47**			Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.01-C
Segment Length(ft): 787
Rain: Yes

SGAT Version: 3
Organization:
Observers: MN, Sacha Pealer, EK
Completion Date: 10/29/2012
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **This segment begins approximately 650 feet upstream of the Brook Road box culvert and continues approximately 130 feet downstream of it. This segment does not have good floodplain access. The segment ends as the channel gains some floodplain access.**

Step 5 - Notes: **Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Human-caused change in valley width (Brook Road) changes valley type from Very Broad to Semi-confined. Confinement ratio changes from 13.0 to 3.3.**

Step 7 - Narrative: **Extreme historic incision, probably related to placement of Brook Road. Major aggradation as seen by bars and steep riffles. Widening and planform adjustment are minor. Widening is limited by rip rap and hard bank armoring in some locations. Those locations are stuck in stage F-II.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions
1.2 Alluvial Fan: None
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	691	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	332		253	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Extr.Steep	Very Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Never
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): 139
Width Determination: Measured
Confinement Type: SC
In Rock Gorge: No
Human Caused Change in Valley Width?: Yes

1.6 Grade Controls: None

Stream: **Great Brook** Reach: **M3.01-C**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**36.00**	2.11 Riffle/Step Spacing:	**90.8 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**3.90**	2.12 Substrate Composition		Bed:	**14.6**	**inches**
2.3 Mean Depth (tf):	**2.36**	Bedrock:	**0.0 %**	Bar:	**N/A**	**inches**
2.4 Floodprone Width (ft.):	**47.30**	Boulder:	**12.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**8.30**	Cobble:	**30.0 %**	Stream Type:	**F**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**28.0 %**	Bed Material:	**Gravel**	
2.6 Width/Depth Ratio:	**15.25**	Fine Gravel:	**14.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.31**	Sand:	**16.0 %**	Bed Form:	**Plane Bed**	
2.8 Incision Ratio:	**2.13**	Silt and Smaller:	**%**	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:	**6**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**328.3**	**13.2**	Dominant:	**Coniferous**	**Herbaceous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**4.8**	**8.0**	Sub-dominant:	**Herbaceous**	**Shrubs/Sapling**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**249.0**	**253.0**	Canopy %:	**76-100**	**1-25**
Material Type:	**Mix**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**0-25**	**26-50**
W less than 25	**168**	**629**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Herbaceous**
Sub-Dominant	**Herbaceous**	**Shrubs/Sapling**

3.3 Riparian Corridor

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

Stream: **Great Brook** Reach: **M3.01-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **None**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type
Flow Reg. Use:
Impoundments: **None**
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **1**
Other: **0** Tile Drain: **0**
Overland Flow: **1** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	**21**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Alignment**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Diagonal: **1**
Mid: **3**
Delta: **1**
Point: **0**
Island: **0**
Side: **10**
Braiding: **1**

5.2 Other Features
Flood chutes: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **3**

Neck Cutoff: **0**
Avulsion: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **787**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**2**	**C to F**	**Yes**
7.2 Channel Aggradation	**9**	**None**	**No**
7.3 Widening Channel	**12**	**None**	**No**
7.4 Change in Planforml	**12**	**None**	**No**
Total Score	**35**		

Geomorphic Rating **0.44**
Channel Evolution Model **F**
Channel Evolution Stage **III**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.02-A**
Segment Length(ft): **929**
Rain: **No**

SGAT Version: **3**
Organization:
Observers: **Mary, Emily**
Completion Date: **10/29/2012**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Segment begins approx. 100 feet downstream of the Brook Road bridge near the intersection of Cameron Road and Brook Road. The valley widens (semi-confined in M3.02-B to narrow in this segment) and the segment is predominantly braided. Ends ~ 930 ft down**

Step 5 - Notes: **Braided segment. Two very large mass failures on left valley wall for most of segment. Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Human-caused change in valley width changes valley type from unconfined to confined (Narrow to Semi-confined). Confinement ratio changes from 5.0 to 3.5.**

Step 7 - Narrative: **Extreme historic incision; extreme aggradation, widening, and planform adjustment. Braided channel even under low flow conditions.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	610	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	137		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Extr.Steep	Very Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Never
Texture:	N.E.	N.E.

1.5 Valley Features

Valley Width (ft): **147**
Width Determination: **Measured**
Confinement Type: **SC**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls: **None**

Stream: **Great Brook** Reach: **M3.02-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**75.50**	2.11 Riffle/Step Spacing:	**65.6 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.30**	2.12 Substrate Composition		Bed:	**18.6**	**inches**
2.3 Mean Depth (tf):	**1.24**	Bedrock:	**0.0 %**	Bar:	**6.2**	**inches**
2.4 Floodprone Width (ft.):	**89.00**	Boulder:	**11.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**4.80**	Cobble:	**38.0 %**	Stream Type:	**D**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**19.0 %**	Bed Material:	**Gravel**	
2.6 Width/Depth Ratio:	**60.89**	Fine Gravel:	**8.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.18**	Sand:	**22.0 %**	Bed Form:	**Braided**	
2.8 Incision Ratio:	**2.09**	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:	**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	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**702.5**	**49.6**	Dominant:	**Herbaceous**	**Coniferous**
Material Type:	**Silt**	**Sand**	Erosion Height (ft.):	**3.9**	**2.6**	Sub-dominant:	**Coniferous**	**Deciduous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**311.7**	Canopy %:	**1-25**	**51-75**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**51-100**
Sub-Dominant	**None**	**0-25**
W less than 25	**0**	**264**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Residential**	Mass Failures		
Sub-dominant	**None**	**None**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**67.5**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.02-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		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:	**4**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**
Mid:	**13**	Delta:	**0**	Flood chutes:	**6**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**0**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**1**	Straightening Length (ft.):	**607**
Side:	**13**	Braiding:	**3**	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 Gradiant 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		**4**	**None**	**Yes**	Geomorphic Rating	**0.17**
7.2 Channel Aggradation		**3**	**C to D**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**2**	**None**	**No**	Channel Evolution Stage	**IV**
7.4 Change in Planforml		**5**	**None**	**No**	Geomorphic Condition	**Poor**
Total Score		**14**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.02-B
Segment Length(ft): 1,180
Rain: No

SGAT Version: 3
Organization:
Observers: Mary, Emily
Completion Date: 10/29/2012
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **This segment is the semi-confined 1,180 feet in reach M3.02. The segment ends approximately 100 feet downstream of the Brook Road bridge near the intersection of Cameron Road and Brook Road.**

Step 5 - Notes: **Subreach - this segment has a semi-confined valley with a B stream type by reference. Human-caused change in valley width is very minor and only occurs on the downstream end of the segment. Does not change valley type.**

Step 7 - Narrative: **Major incision - headcut present in this segment indicates incision is active. Major aggradation with some braiding at upper end of segment. Minor widening (although could be higher at upper end of segment). Major planform adjustment as a result of channel straightening in downstream half of segment. It's unclear whether incision and aggradation are active processes that are occuring in spearate parts of the reach or if the channel is head cutting through aggraded material.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions
1.2 Alluvial Fan: None
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	842	0	107	0
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	270		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Very Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): 100
Width Determination: Measured
Confinement Type: SC
In Rock Gorge: No
Human Caused Change in Valley Width?: Yes

1.6 Grade Controls: None

Stream: **Great Brook** Reach: **M3.02-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**45.40**	2.11 Riffle/Step Spacing:	**76.2 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**3.30**	2.12 Substrate Composition		Bed:	**18.8**	**inches**
2.3 Mean Depth (tf):	**2.17**	Bedrock:	**0.0 %**	Bar:	**6**	**inches**
2.4 Floodprone Width (ft.):	**73.40**	Boulder:	**25.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**4.50**	Cobble:	**29.0 %**	Stream Type:	**B**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**11.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**20.92**	Fine Gravel:	**11.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.62**	Sand:	**24.0 %**	Bed Form:	**Step-Pool**	
2.8 Incision Ratio:	**1.36**	Silt and Smaller:	**%**	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:	**B**	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**8**	Reference Bed Material:	**Cobble**	
				Reference Subclass Slope:	**None**	
				Reference Bedform:	**Step-Pool**	

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**795.1**	**233.9**	Dominant:	**Coniferous**	**Deciduous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**4.0**	**5.4**	Sub-dominant:	**Deciduous**	**Shrubs/Sapling**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**531.0**	**386.4**	Canopy %:	**76-100**	**76-100**
Material Type:	**Mix**	**Mix**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**0-25**	**0-25**
W less than 25	**153**	**324**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Deciduous**
Sub-Dominant	**Deciduous**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Residential**	**Forest**	Mass Failures		
Sub-dominant	**None**	**Residential**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**15.8**	Gullies Length		
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.02-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		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	**34**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Deposition Below,Scour Above,Scour Below**

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:	**7**	Delta:	**1**	Flood chutes:	**3**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**0**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**1**	Straightening Length (ft.):	**461**
Side:	**15**	Braiding:	**3**	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 Gradiant 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	**Confined**	Score	STD	Historic		
7.1 Channel Degradation		**7**	**None**	**No**	Geomorphic Rating	**0.45**
7.2 Channel Aggradation		**9**	**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		**36**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.02-C**
Segment Length(ft): **2,630**
Rain: **No**

SGAT Version: **3**
Organization:
Observers: **Mary, Emily, Matt Peters**
Completion Date: **10/29/2012**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **This segment begins approximately 450 feet upstream of the Brook Road bridge and continues 2,630 feet downstream to where the valley changes from broad to semi-confined.**

Step 5 - Notes: **Minor human-caused change in valley width overall, most affected is upstream portion of segment. Brook Road changes overall confinement ratio from 9.1 to 8.7, but does change valley type of Broad. Did not have access to most of this segment, so cross section location was limited. Braided throughout most of segment with many flood chutes.**

Step 7 - Narrative: **Extreme historic incision score because of entrenchment ratio less than 2. Area is currently slightly incised (IR = 1.34), although RAF was unclear. Segment is likely in F-IV. F-IV was chosen instead of F-III because the high w/d ratio indicates that the segment has already widened. Location of right valley wall and left terrace limit floodplain access, making entrenchment ratio 1.56. Extreme aggradation, widening, and planform adjustment. Braided even under low flow. Location of cross section was limited to a 100 foot section - downstream of there was not representative and we did not have permission to access the property for the majority of the segment.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Height
Berm:	0		0	
Road:	659	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	122		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Steep	Very Steep
Continuous w/ Bank:	Never	Sometimes
Within 1 Bankfull W:	Never	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): **366**
Width Determination: **Measured**
Confinement Type: **BD**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls: **None**

Stream: **Great Brook** Reach: **M3.02-C**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**80.37**	2.11 Riffle/Step Spacing:	**107.5 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.50**	2.12 Substrate Composition		Bed:	**18**	**inches**
2.3 Mean Depth (tf):	**1.12**	Bedrock:	**0.0 %**	Bar:	**6.1**	**inches**
2.4 Floodprone Width (ft.):	**125.00**	Boulder:	**13.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**3.35**	Cobble:	**36.0 %**	Stream Type:	**D**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**25.0 %**	Bed Material:	**Gravel**	
2.6 Width/Depth Ratio:	**71.76**	Fine Gravel:	**13.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.56**	Sand:	**11.0 %**	Bed Form:	**Braided**	
2.8 Incision Ratio:	**1.34**	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:	**Sedimented**	# Large Woody Debris:	**57**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**1,217.3**	**1,533.4**	Dominant:	**Deciduous**	**Coniferous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**4.2**	**4.4**	Sub-dominant:	**Shrubs/Sapling**	**Deciduous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**731.7**	**177.2**	Canopy %:	**51-75**	**51-75**
Material Type:	**Mix**	**Mix**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**26-50**	**>100**
Sub-Dominant	**51-100**	**0-25**
W less than 25	**123**	**0**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Coniferous**
Sub-Dominant	**Shrubs/Sapling**	**Deciduous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Forest**	Mass Failures		
Sub-dominant	**Shrubs/Sapling**	**Residential**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**68.3**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.02-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		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	**31.5**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Deposition Below**

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:	**15**	Delta:	**0**	Flood chutes:	**13**	Avulsion:	**0**	5.5 Straightening:		**Straightening**
Point:	**1**	Island:	**1**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):		**848**
Side:	**20**	Braiding:	**6**	Steep Riffles:	**9**	Trib Rejuv.:	**No**	5.5 Dredging:		**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant 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		**4**	**None**	**Yes**	Geomorphic Rating	**0.15**
7.2 Channel Aggradation		**2**	**C to D**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**2**	**None**	**No**	Channel Evolution Stage	**IV**
7.4 Change in Planforml		**4**	**None**	**No**	Geomorphic Condition	**Poor**
Total Score		**12**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.03-A**
Segment Length(ft): **3,313**
Rain: **No**

SGAT Version: **3**
Organization:
Observers: **Emily, Gretchen Alexander**
Completion Date: **10/25/2012**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **This segment begins just upstream of the intersection of Fowler Road and Brook Road. This is where the river channel seems to 'spill out' and has more aggradation and braiding than upstream areas. The segment continues 3,313 feet downstream.**

Step 5 - Notes: **Lower 800 feet of this segment is likely a straightened "F" stream type, but we did not have access to this area of the river. There was a short area with windrowing at the downstream end of the segment. Segment extremely flood affected (May 2011). Braided even under lower flows. Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Human-caused change in valley width results in a change in valley type from Broad to Narrow, changing confinement ratio from 8.1 to 5.8.**

Step 7 - Narrative: **Extreme historic incision; extreme aggradation; major widening and planform adjustment. Braided channel throughout most of segment.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both Height
Berm:	0		0
Road:	1,660	0	0
Railroad:	0		0
Imp. Path:	0		0
Dev.:	381		0

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Very Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Never
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): **239**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls: **None**

Stream: **Great Brook** Reach: **M3.03-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**108.70**	2.11 Riffle/Step Spacing:	**124.3 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.70**	2.12 Substrate Composition		Bed:	**17**	**inches**
2.3 Mean Depth (tf):	**1.45**	Bedrock:	**0.0 %**	Bar:	**8.8**	**inches**
2.4 Floodprone Width (ft.):	**143.70**	Boulder:	**6.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**10.00**	Cobble:	**32.0 %**	Stream Type:	**D**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**30.0 %**	Bed Material:	**Gravel**	
2.6 Width/Depth Ratio:	**74.97**	Fine Gravel:	**11.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.32**	Sand:	**19.0 %**	Bed Form:	**Braided**	
2.8 Incision Ratio:	**3.70**	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:	**Moderate**	Detritus:	**0.0 %**	Reference Stream Type:		
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**130**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**2,132.7**	**593.2**	Dominant:	**Coniferous**	**Bare**
Material Type:	**Sand**	**Boulder/Cobble**	Erosion Height (ft.):	**9.3**	**6.2**	Sub-dominant:	**None**	**Coniferous**
Consistency:	**Non-cohesive**	**Cohesive**	Revetment Type:	**None**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**1,949.5**	Canopy %:	**76-100**	**0**
Material Type:	**Mix**	**Mix**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**None**	**26-50**
W less than 25	**0**	**1,825**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**None**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Residential**	Mass Failures		
Sub-dominant	**None**	**None**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**37.5**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.03-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	**0**	Road Ditch:	**5**
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:	**3**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**
Mid:	**5**	Delta:	**1**	Flood chutes:	**9**	Avulsion:	**0**	5.5 Straightening:	**With Windrowing**
Point:	**0**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**2,954**
Side:	**17**	Braiding:	**1**	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 Gradiant 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		**4**	**None**	**No**	Geomorphic Rating	**0.19**
7.2 Channel Aggradation		**2**	**C to D**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**2**	**None**	**No**	Channel Evolution Stage	**IV**
7.4 Change in Planforml		**7**	**None**	**No**	Geomorphic Condition	**Poor**
Total Score		**15**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.03-B**
Segment Length(ft): **3,194**
Rain: **Yes**

SGAT Version: **3**
Organization:
Observers: **PD/GA MN/EK**
Completion Date: **10/28/2012**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Segment begins where narrow valley (M3.04-A) widens, becoming broad. The segment continues 3,194 feet downstream and is predominantly braided. The segment ends as the channel seems to 'spill out' even more, near the intersection of Fowler Rd and Brook R**

Step 5 - Notes: **Pebble count D50 close to gravel. Segment is likely dominated by gravel by reference as channel slope lessens. Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Human-caused change in valley width changes valley type from Broad to Narrow, changing confinement ratio from 6.6 to 4.8.**

Step 7 - Narrative: **Major historic incision and entrenchment ratio of 1.43 led to a poor score for degradation. Intermittent rejuvenating tributary was seen in this segment. Change in confinement from broad to narrow due to Brook Road and a stream type departure from a C to a D as a result of extreme aggradation associated with the May 2011 flood. High width to depth ratio indicates extreme widening and planform change is also extreme with numerous large flood chutes.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **Yes**
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Height
Berm:	36	0	0	
Road:	1,199	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	410		0	

1.6 Grade Controls: **None**

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): **199**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

Stream: **Great Brook** Reach: **M3.03-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**95.50**	2.11 Riffle/Step Spacing:	**110.9 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.90**	2.12 Substrate Composition		Bed:	**28.1**	**inches**
2.3 Mean Depth (tf):	**1.23**	Bedrock:	**0.0 %**	Bar:	**7**	**inches**
2.4 Floodprone Width (ft.):	**137.00**	Boulder:	**11.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**4.50**	Cobble:	**42.0 %**	Stream Type:	**D**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**32.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**77.64**	Fine Gravel:	**7.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.43**	Sand:	**8.0 %**	Bed Form:	**Braided**	
2.8 Incision Ratio:	**1.55**	Silt and Smaller:	**%**	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:	**129**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**797.2**	**739.4**	Dominant:	**Shrubs/Sapling**	**Coniferous**
Material Type:	**Sand**	**Mix**	Erosion Height (ft.):	**4.6**	**5.6**	Sub-dominant:	**None**	**Deciduous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**759.1**	**1,044.9**	Canopy %:	**1-25**	**51-75**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**>100**	**51-100**
W less than 25	**517**	**208**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Residential**	**Forest**
Sub-dominant	**Forest**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**62.5**
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Great Brook** Reach: **M3.03-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		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: **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	**29.7**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Deposition Below,Alignment**
Bridge	**33.5**	**Yes**	**Yes**	**Yes**	**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:	**11**	Delta:	**1**	Flood chutes:	**11**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**6**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**1,356**
Side:	**23**	Braiding:	**2**	Steep Riffles:	**10**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant 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		**5**	**None**	**Yes**	Geomorphic Rating	**0.24**
7.2 Channel Aggradation		**5**	**C to D**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**4**	**None**	**No**	Channel Evolution Stage	**IV**
7.4 Change in Planforml		**5**	**None**	**No**	Geomorphic Condition	**Poor**
Total Score		**19**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.04-A
Segment Length(ft): 1,441
Rain: Yes

SGAT Version: 3
Organization:
Observers: Pam, Emily, Gretchen Alexander, Matt Peters
Completion Date: 10/18/2012
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **Segment begins approx. 1,000 feet downstream of a private driveway bridge, where the channel becomes more incised. The segment continues 1,441 feet downstream to the reach break, which is also where the valley widens, changing from narrow to broad.**

Step 5 - Notes: **Step-pool bedform is related to the many human-made boulder weirs in this segment. Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Human-caused change in valley width (Brook Road) does not change valley type (Narrow) , but changes confinement ratio from 4.8 to 4.2. Some areas of this segment have greater floodplain access with more aggradation.**

Step 7 - Narrative: **Channel is predominantly an "F" stream type, but alternates with areas of greater floodplain access where it may be a "B" or "C." These areas are highly aggradational with major planform change including a channel avulsion. Mass failures are common on outside bends. New floodplains are developing in areas. Cross section done in representative F-III area, but some other areas of segment are likely in early F-IV. Major incision although RAF was not distinct and may have been overestimated. Major widening due to excessive aggradation. Rip rap is preventing widening in other locations.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions
1.2 Alluvial Fan: None
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Both Height
Berm:	14	0	0	
Road:	998	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Never
Texture:	Sand	N.E.

1.5 Valley Features
Valley Width (ft): 153
Width Determination: Measured
Confinement Type: NW
In Rock Gorge: No
Human Caused Change in Valley Width?: Yes

1.6 Grade Controls: None

Stream: **Great Brook** Reach: **M3.04-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**48.70**	2.11 Riffle/Step Spacing:	**139.5 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.70**	2.12 Substrate Composition		Bed:	**21.8**	**inches**
2.3 Mean Depth (tf):	**1.76**	Bedrock:	**0.0 %**	Bar:	**8.7**	**inches**
2.4 Floodprone Width (ft.):	**55.20**	Boulder:	**31.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**5.40**	Cobble:	**24.0 %**	Stream Type:	**F**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**31.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**27.67**	Fine Gravel:	**7.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.13**	Sand:	**7.0 %**	Bed Form:	**Step-Pool**	
2.8 Incision Ratio:	**2.00**	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:	**Moderate**	Detritus:	**0.0 %**	Reference Stream Type:		
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**26**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**610.7**	**187.2**	Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Material Type:	**Sand**	**Boulder/Cobble**	Erosion Height (ft.):	**9.1**	**4.4**	Sub-dominant:	**None**	**None**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**156.4**	**983.7**	Canopy %:	**76-100**	**26-50**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**None**	**51-100**
W less than 25	**0**	**845**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Shrubs/Sapling**
Sub-Dominant	**None**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Residential**	Mass Failures		
Sub-dominant	**None**	**Forest**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**55.0**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.04-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**Minimal**	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:	**1**	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:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**
Mid:	**9**	Delta:	**1**	Flood chutes:	**2**	Avulsion:	**2**	5.5 Straightening:	**Straightening**
Point:	**2**	Island:	**1**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**446**
Side:	**7**	Braiding:	**2**	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 Gradiant 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		**3**	**C to F**	**Yes**	Geomorphic Rating	**0.31**
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 Planforml		**7**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score		**25**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.04-B
Segment Length(ft): 1,441
Rain: Yes

SGAT Version: 3
Organization:
Observers: Pam, Emily
Completion Date: 10/15/2012
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **This segment begins approximately 1,000 feet downstream of the location on the river channel where Gray Road intersects Brook Road. The segment continues 1,441 feet downstream to where the channel generally becomes more incised.**

Step 5 - Notes: **Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Human-caused change in valley width (Brook Road) does not change valley type (Narrow) , but changes confinement ratio from 5.4 to 4.7. Not confident in bankfull elevation at location of cross section - used back of bar.**

Step 7 - Narrative: **Major degradation. Stream type departure from the reference C stream type to the existing B stream type. May 2011 flooding and previous events have resulted in major aggradation as seen by large built up bars. Extreme widening has resulted as sediment has built up and caused a high w/d ratio. Juvenile floodplain development in bar locations. Major planform change as channel seeks equilibrium through flood chute development.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions
1.2 Alluvial Fan: None
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	258	0	32	0
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	31		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Very Steep	Very Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Never
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): 169
Width Determination: Measured
Confinement Type: NW
In Rock Gorge: No
Human Caused Change in Valley Width?: Yes

1.6 Grade Controls: None

Stream: **Great Brook** Reach: **M3.04-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**58.00**	2.11 Riffle/Step Spacing:	**104.7 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.40**	2.12 Substrate Composition		Bed:	**19.4**	**inches**
2.3 Mean Depth (tf):	**1.04**	Bedrock:	**0.0 %**	Bar:	**7.7**	**inches**
2.4 Floodprone Width (ft.):	**82.30**	Boulder:	**14.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**3.80**	Cobble:	**40.0 %**	Stream Type:	**B**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**22.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**55.77**	Fine Gravel:	**11.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.42**	Sand:	**6.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**1.58**	Silt and Smaller:	**7.0 %**	Field Measured Slope:		
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type		
2.9 Sinuosity:	**Moderate**	Detritus:	**0.0 %**	Reference Stream Type:		
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**51**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**573.1**	**589.2**	Dominant:	**Coniferous**	**Coniferous**
Material Type:	**Clay**	**Sand**	Erosion Height (ft.):	**3.4**	**3.0**	Sub-dominant:	**None**	**None**
Consistency:	**Cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**89.1**	**29.3**	Canopy %:	**76-100**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**51-100**
Sub-Dominant	**None**	**>100**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**None**	**None**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Forest**	Mass Failures		
Sub-dominant	**None**	**Residential**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**20.8**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.04-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type		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	**25.5**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Deposition Below,Scour Above,Scour Below**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal:	**1**	5.2 Other Features	Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**	
Mid:	**7**	Delta:	**1**	Flood chutes:	**9**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**4**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**90**
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 Gradiant 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		**8**	**C to B**	**Yes**	Geomorphic Rating	**0.31**
7.2 Channel Aggradation		**7**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**3**	**None**	**No**	Channel Evolution Stage	**IV**
7.4 Change in Planforml		**7**	**None**	**Yes**	Geomorphic Condition	**Poor**
Total Score		**25**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.05-A
Segment Length(ft): 1,523
Rain: Yes

SGAT Version: 3
Organization:
Observers: Mary, Emily
Completion Date: 10/23/2012
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **This segment begins as the semi-confined valley in M3.05-B opens up to a narrow valley. This segment ends approximately 1,000 feet downstream of the location on the river where Gray Road intersects Brook Road.**

Step 5 - Notes: **Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Human-caused change in valley width (Brook Road) does not change valley type(Narrow), but changes the confinement ratio from 5.4 to 4.9.**

Step 7 - Narrative: **Extreme historic incision, major aggradation with steep riffles and diagonal bars. Major widening with significant bank erosion. Some large bars. Planform adjustment with flood chutes and high lateral bank erosion. Areas on bends further along in channel evolution process.**

Step 1. Valley and Floodplain

1.1 Segmentation: Valley Width
1.2 Alluvial Fan: None
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	472	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Extr.Steep	Very Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): 167
Width Determination: Measured
Confinement Type: NW
In Rock Gorge: No
Human Caused Change in Valley Width?: Yes

1.6 Grade Controls: None

Stream: **Great Brook** Reach: **M3.05-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**40.30**	2.11 Riffle/Step Spacing:	**82.4 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**3.10**	2.12 Substrate Composition		Bed:	**14**	**inches**
2.3 Mean Depth (tf):	**2.12**	Bedrock:	**0.0 %**	Bar:	**5**	**inches**
2.4 Floodprone Width (ft.):	**73.30**	Boulder:	**15.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**6.20**	Cobble:	**50.0 %**	Stream Type:	**B**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**22.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**19.01**	Fine Gravel:	**4.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.82**	Sand:	**9.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**2.00**	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:	**26**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Moderate**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**740.8**	**645.2**	Dominant:	**Coniferous**	**Coniferous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**6.5**	**3.2**	Sub-dominant:	**None**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**24.4**	Canopy %:	**76-100**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**26-50**
Sub-Dominant	**None**	**51-100**
W less than 25	**0**	**154**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**None**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Residential**	Mass Failures		
Sub-dominant	**None**	**None**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**28.0**	Gullies Length		
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.05-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		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:	**1**	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:	**3**	5.2 Other Features	Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**		
Mid:	**4**	Delta:	**0**	Flood chutes:	**5**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**3**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**254**
Side:	**11**	Braiding:	**1**	Steep Riffles:	**3**	Trib Rejuv.:	**Yes**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant 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		**3**	**C to B**	**Yes**	Geomorphic Rating	**0.35**
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 Planforml		**8**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score		**28**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.05-B
Segment Length(ft): 888
Rain: Yes

SGAT Version: 3
Organization:
Observers: Mary, Emily
Completion Date: 10/23/2012
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **This segment is located in M3.05 where the valley is semi-confined. Sediment transport segment.**

Step 5 - Notes: **Upstream end of segment is aggradational, but was included in the segment because the valley is semi-confined. Segment is generally sediment transport. Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Phase 1 valley width is semi-confined, Brook Road changes Phase II valley width, but still is semi-confined (human-caused change in valley width changes confinement ratio from 3.7 to 2.2). RAF was not clear at location of cross section, but was clear at a few feet upstream, so that elevation was used.**

Step 7 - Narrative: **Major historic incision; aggradation at top of segment - then becomes sediment transport segment with lower w/d ratio. Segment is widening through bank erosion. Minor planform adjustment - most of adjustment is taking place at top of segment where it is aggradational. Stage is early F-III since width to depth ratio is not very high.**

Step 1. Valley and Floodplain

1.1 Segmentation: Valley Width
1.2 Alluvial Fan: None
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Height
Berm:	0		0	
Road:	888	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Extr.Steep	Very Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): 73
Width Determination: Measured
Confinement Type: SC
In Rock Gorge: No
Human Caused Change in Valley Width?: Yes

1.6 Grade Controls: None

Stream: **Great Brook** Reach: **M3.05-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**38.80**	2.11 Riffle/Step Spacing:	**93.1 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**3.00**	2.12 Substrate Composition		Bed:	**18.8**	**inches**
2.3 Mean Depth (tf):	**1.92**	Bedrock:	**0.0 %**	Bar:	**5.9**	**inches**
2.4 Floodprone Width (ft.):	**45.30**	Boulder:	**17.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**5.00**	Cobble:	**42.0 %**	Stream Type:	**F**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**25.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**20.21**	Fine Gravel:	**6.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.17**	Sand:	**9.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**1.67**	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:	**B**	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**34**	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	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**504.6**	**208.2**	Dominant:	**Coniferous**	**Coniferous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**3.9**	**3.3**	Sub-dominant:	**None**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**32.5**	Canopy %:	**76-100**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**26-50**
Sub-Dominant	**None**	**0-25**
W less than 25	**0**	**336**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**None**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Residential**	Mass Failures		
Sub-dominant	**None**	**None**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**30.0**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.05-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type		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:	**1**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**
Mid:	**1**	Delta:	**1**	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.):	**153**
Side:	**13**	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 Gradiant 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		**8**	**B to F**	**Yes**	Geomorphic Rating	**0.55**
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 Planforml		**13**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score		**44**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.05-C**
Segment Length(ft): **4,713**
Rain: **No**

SGAT Version: **3**
Organization:
Observers: **Mary, Emily**
Completion Date: **10/25/2012**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **This segment begins approximately 250 feet upstream of the most upstream Brook Road crossing in M3.05. The segment continues 4,713 feet downstream until the valley significantly narrows.**

Step 5 - Notes: **See comments under Step 7 - alternates many times between F-II and F-III channel evolution stage with several stream types. Three box culverts and one bridge are all channel constrictions with multiple problems associated. A less representative cross section was done near the upper end of the segment in an area that exhibited a C stream type with an incision ratio of 1.85 and w/d of 14.8. Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Human-caused change in valley width changes confinement from Very Broad to Broad (confinement ratio from 10.3 to 6.8). Brook Road and Lee Road influence Phase II valley width.**

Step 7 - Narrative: **This segment could have been split into nine distinct segments. The reference stream type in this segment is a C. The segment displays varying degrees of departure from its reference stream type and geomorphic equilibrium. In general, the stream channel in this segment seemed to alternate between a C stream type with great floodplain access, an F or B stream type in Stage F-II, and an F or B stream type in Stage F-III. The majority of the C stream type was in the downstream end of the segment. The first 550 feet of this segment, located just upstream of M3.05-B, was likely a C stream type. This area was more sinuous than many parts of the reach and had great floodplain access. The next 400 feet was characterized by an F or B stream type in Stage F-III. This area was not sinuous and was likely historically straightened. A short 170-foot section upstream was an incised F or B stream type in Stage F-II. The next 180 feet of stream channel was dominated by a large grade control area, which is probably influencing the next 300 feet of C stream type with great floodplain access (near Lee Road bridge). Beginning about 200 feet upstream of the Lee Road bridge and continuing upstream for 850 feet was another area in Stage F-III. This area exhibited an F or B stream type. The next 850 feet was another F or B stream type in stage F-II. The next 950 feet was again characterized by good floodplain access and a C stream type (non representative cross section measured here). The most upstream 300 feet of the reach was characterized by a step-pool dominated bedform. The cross section was done in an area that exhibited an F stream type in Stage F-III and was considered the most representative for the segment. A less representative cross section was done in an area with a C stream type.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Valley Width**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

	Length (ft)	One	Height	Both	Height
Berm:	0			0	
Road:	1,454	0		246	0
Railroad:	0			0	
Imp. Path:	0			0	
Dev.:	244			0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Very Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): **231**
Width Determination: **Measured**
Confinement Type: **BD**
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		4.0	1.3		
Ledge		2.6	0.6		
Ledge		21.0	18.0		

Stream: **Great Brook** Reach: **M3.05-C**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**39.60**	2.11 Riffle/Step Spacing:	**100.7 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.70**	2.12 Substrate Composition		Bed:	**19.8**	**inches**
2.3 Mean Depth (tf):	**1.86**	Bedrock:	**5.0 %**	Bar:	**7.6**	**inches**
2.4 Floodprone Width (ft.):	**47.40**	Boulder:	**20.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**5.40**	Cobble:	**24.0 %**	Stream Type:	**F**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**18.0 %**	Bed Material:	**Gravel**	
2.6 Width/Depth Ratio:	**21.29**	Fine Gravel:	**14.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.20**	Sand:	**20.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**2.00**	Silt and Smaller:	**%**	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:	**89**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**1,842.6**	**1,757.1**	Dominant:	**Coniferous**	**Deciduous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**5.8**	**4.6**	Sub-dominant:	**Deciduous**	**Shrubs/Sapling**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**602.6**	**884.7**	Canopy %:	**76-100**	**51-75**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**26-50**
Sub-Dominant	**0-25**	**>100**
W less than 25	**788**	**903**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Deciduous**
Sub-Dominant	**Deciduous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Residential**	Mass Failures		
Sub-dominant	**Residential**	**Forest**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**36.3**	Gullies Length		
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.05-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		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	**22**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Deposition Below,Scour Above,Scour Below,Alignment**
Instream Culvert	**17**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Deposition Below,Scour Below**
Instream Culvert	**13.5**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Scour Below,Alignment**
Instream Culvert	**22.5**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Scour Above,Scour Below,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:		**No**	
Mid:	**17**	Delta:	**3**	Flood chutes:	**9**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**2**	Island:	**1**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**1**	Straightening Length (ft.):	**2,057**
Side:	**41**	Braiding:	**3**	Steep Riffles:	**6**	Trib Rejuv.:	**Yes**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant 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	**4**	**C to F**	**Yes**	Geomorphic Rating	**0.36**
7.2 Channel Aggradation	**8**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**9**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**8**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**29**			Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.06-A**
Segment Length(ft): **1,409**
Rain: **Yes**

SGAT Version: **3**
Organization:
Observers: **Pam, Emily**
Completion Date: **10/15/2012**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **This segment begins as the valley begins to widen (downstream of Segment M3.06-B) and continues approximately 1400 feet downstream. The segment ends just after the channel moves away from Brook Road, or about 250 feet downstream of a large mass failure o**

Step 5 - Notes: **Not confident in bankfull, but is at a similar elevation to upstream cross sections. Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Brook Road is not very elevated at cross section location, but was still considered a Phase 2 valley wall for the majority of the segment. Human-caused change in valley width results in a valley type change from Broad (Phase 1) to Narrow (Phase II). Confinement ratio changes from 6.3 to 4.0.**

Step 7 - Narrative: **Minor incision; segment has much better floodplain access than upstream segments. Aggradation is minor although there are some diagonal bars/steep riffles and one large point bar on the downstream end of the segment. Widening is minor but 2 mass failures are in segment indicating bank failure. Riprap is preventing more widening in spots. Planform change is major due to straightening. CE stage is early F-III since the wdith to depth ratio is not that high.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Height
Berm:	9	0	0	
Road:	1,185	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	185		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Very Steep	Extr.Steep
Continuous w/ Bank:	Never	Sometimes
Within 1 Bankfull W:	Never	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features

Valley Width (ft): **121**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls: **None**

Stream: **Great Brook** Reach: **M3.06-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**37.80**	2.11 Riffle/Step Spacing:	**110.8 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**3.20**	2.12 Substrate Composition		Bed:	**16.3**	**inches**
2.3 Mean Depth (tf):	**1.80**	Bedrock:	**1.0 %**	Bar:	**7.16**	**inches**
2.4 Floodprone Width (ft.):	**134.30**	Boulder:	**16.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**4.30**	Cobble:	**41.0 %**	Stream Type:	**C**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**19.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**21.00**	Fine Gravel:	**8.0 %**	Subclass Slope:	**b**	
2.7 Entrenchment Ratio:	**3.55**	Sand:	**15.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**1.34**	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:	**C**	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**26**	Reference Bed Material:	**Cobble**	
				Reference Subclass Slope:	**b**	
				Reference Bedform:	**Riffle-Pool**	

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**347.9**	**619.2**	Dominant:	**Deciduous**	**Coniferous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**3.3**	**3.2**	Sub-dominant:	**Herbaceous**	**None**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**None**	Bank Canopy		
Lower			Revetment Length:	**420.1**	**0.0**	Canopy %:	**26-50**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**26-50**	**None**
W less than 25	**396**	**0**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Coniferous**
Sub-Dominant	**Shrubs/Sapling**	**None**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Residential**	**Forest**	Mass Failures		
Sub-dominant	**None**	**None**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**90.0**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.06-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type		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:	**1**	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:	**0**	Delta:	**0**	Flood chutes:	**5**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**3**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**1,350**
Side:	**14**	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 Gradiant 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		**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	**III**
7.4 Change in Planforml		**9**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score		**47**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.06-B
Segment Length(ft): 459
Rain: Yes

SGAT Version: 3
Organization:
Observers: Pam, Emily, Dan Currier
Completion Date: 10/12/2012
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **This segment begins approximately 600 feet downstream of the Brook Road box culvert. The Phase 2 valley is very narrow (right valley wall close and Brook Road close on left). The segment ends about 460 feet downstream, where the valley begins to widen ag**

Step 5 - Notes: **RAF unclear because of location of Brook Road. Some places may have a B to F stream type departure. Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we feel that in this system it is acting as a confining feature (Phase 2 valley wall). Human caused change in valley width (Brook Road) changes confinement from semi-confined to narrowly confined (confinement ratio from 2.9 to 1.6).**

Step 7 - Narrative: **Channel has been straightened and entrenchment changed due to road. RAF was indistinct. The channel may have incised from the elevation of the road, but we are not confident. Incision ratio of 2.8 reflects road encroachment. Extreme degradation. Aggradation is minor except for large point bar, which is greater than 1/2 bankfull elevation. Widening is probably beginning, but is not a major process. Rip rap is preventing widening. Planform is major due to channel straightening. Could have a stream type departure from a B to F in places although cross section did not reveal that.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	459	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Extr.Steep
Continuous w/ Bank:	Never	Sometimes
Within 1 Bankfull W:	Never	Always
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): 47
Width Determination: Measured
Confinement Type: NC
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		3.7	2.2		
Ledge		5.0	3.3		

Stream: **Great Brook** Reach: **M3.06-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**33.20**	2.11 Riffle/Step Spacing:	**100 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**3.30**	2.12 Substrate Composition		Bed:	**18.6**	**inches**
2.3 Mean Depth (tf):	**1.98**	Bedrock:	**0.0 %**	Bar:	**6.54**	**inches**
2.4 Floodprone Width (ft.):	**48.70**	Boulder:	**21.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**9.20**	Cobble:	**42.0 %**	Stream Type:	**B**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**18.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**16.77**	Fine Gravel:	**9.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.47**	Sand:	**10.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**2.79**	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:	**13**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**72.5**	**219.9**	Dominant:	**Deciduous**	**Coniferous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**3.5**	**3.8**	Sub-dominant:	**Herbaceous**	**None**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**None**	Bank Canopy		
Lower			Revetment Length:	**136.6**	**0.0**	Canopy %:	**26-50**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**26-50**	**None**
W less than 25	**404**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Coniferous**
Sub-Dominant	**Deciduous**	**None**

3.3 Riparian Corridor

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

Stream: **Great Brook** Reach: **M3.06-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type		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:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**
Mid:	**0**	Delta:	**3**	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.):	**160**
Side:	**5**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**Yes**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant 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	**Confined**	Score	STD	Historic		
7.1 Channel Degradation		**3**	**None**	**Yes**	Geomorphic Rating	**0.45**
7.2 Channel Aggradation		**12**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**13**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml		**8**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score		**36**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.06-C**
Segment Length(ft): **1,605**
Rain: **Yes**

SGAT Version: **3**
Organization:
Observers: **Pam, Emily, Dan Currier**
Completion Date: **10/12/2012**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Segment begins approximately 1,000 feet upstream of the Brook Road box culvert and ends approximately 600 feet downstream of the same crossing. The downstream end is where the right valley wall comes close to the channel and Brook Road comes close on the**

Step 5 - Notes: **Short section on most upstream portion of this segment was aggradational with some braiding, but was not representative.**

Step 7 - Narrative: **Major historic degradation, but has not widened much yet. Aggradation is minor, but evidence of steep riffles and bar development present. Planform change is major due to straightening in about 1/3 the channel length and island formation on upstream end of segment. In downstream half of segment, rip rap is preventing widening. The stream channel may be more incised at the downstream end of the segment. Upstream 400' is not impacted by encroachment of Brook Road.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Height
Berm:	0		0	
Road:	1,116	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Always
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): **80**
Width Determination: **Measured**
Confinement Type: **SC**
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		7.4	4.1		
Ledge		5.5	3.0		
Ledge		1.7	0.4		

Stream: **Great Brook** Reach: **M3.06-C**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**30.80**	2.11 Riffle/Step Spacing:	**100.5 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.80**	2.12 Substrate Composition		Bed:	**19.4**	**inches**
2.3 Mean Depth (tf):	**2.17**	Bedrock:	**0.0 %**	Bar:	**6.1**	**inches**
2.4 Floodprone Width (ft.):	**56.80**	Boulder:	**15.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**4.10**	Cobble:	**41.0 %**	Stream Type:	**B**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**25.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**14.19**	Fine Gravel:	**2.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**1.84**	Sand:	**16.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**1.46**	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:	**42**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Moderate**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**260.9**	**463.6**	Dominant:	**Coniferous**	**Coniferous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**3.7**	**3.6**	Sub-dominant:	**Deciduous**	**None**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**282.7**	**230.9**	Canopy %:	**76-100**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**51-100**
W less than 25	**446**	**125**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Deciduous**	**None**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Forest**	Mass Failures		
Sub-dominant	**Residential**	**Residential**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**15.0**	Gullies Length		
Gullies	**None**				

Stream: **Great Brook** Reach: **M3.06-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		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: **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
Instream Culvert	**16**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition 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:	**1**	Delta:	**1**	Flood chutes:	**3**	Avulsion:	**0**	5.5 Straightening:		**Straightening**
Point:	**1**	Island:	**1**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):		**665**
Side:	**16**	Braiding:	**2**	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 Gradiant 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	**Confined**	Score	STD	Historic		
7.1 Channel Degradation		**10**	**None**	**Yes**	Geomorphic Rating	**0.52**
7.2 Channel Aggradation		**12**	**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		**42**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.07-A**
Segment Length(ft): **763**
Rain: **Yes**

SGAT Version: **3**
Organization:
Observers: **PD, AM, EE**
Completion Date: **7/16/2013**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Plainfield, begins directly below bridge on Maxfield Rd**

Step 5 - Notes: **B or F stream type subdominant in this segment. Mostly in upstream section where there are a series of bedrock grade controls. Grade controls preventing further incision. Bedrock on banks and revetments in vicinity of bridge are preventing widening. Some widening in area of some planform change where there is an island. Downstream of cross section there is some erosion along the right bank.**

Step 7 - Narrative: **Bedrock grade controls throughout top of segment preventing further incision in upstream section. Bedrock and revetments on banks are preventing widening in this section as well. Cross section was done on downstream end and showed an incision ratio of 1.4. Section of bifurcation where island has formed and there are two channels at higher flows. Stream type varies through segment, but "C" type is dominant. Section of grade controls just below bridge is probably an "F" or "B". Lots of fine sediment at DS end where grade controls end. Clay on banks on downstream end. Major planform change due to island area. Downstream area may be beginning to widen, the progression of channel evolution from upstream to downstream is most likely F-II, F-III, F-II-III.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Grade Controls**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Height
Berm:	0		0	
Road:	144	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	269		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Very Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): **90**
Width Determination: **Measured**
Confinement Type: **SC**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge		4.4	3.0		
Ledge		4.2	2.5		
Ledge		6.4	4.0		
Ledge		4.2	2.5		
Ledge		2.6	1.1		
Ledge		1.7	0.5		

Stream: **Great Brook** Reach: **M3.07-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**37.80**	2.11 Riffle/Step Spacing:	**49 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.50**	2.12 Substrate Composition		Bed:	**14.6**	**inches**
2.3 Mean Depth (tf):	**1.72**	Bedrock:	**1.0 %**	Bar:	**5.3**	**inches**
2.4 Floodprone Width (ft.):	**96.30**	Boulder:	**14.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**3.60**	Cobble:	**36.0 %**	Stream Type:	**C**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**25.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**21.98**	Fine Gravel:	**7.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**2.55**	Sand:	**15.0 %**	Bed Form:	**Step-Pool**	
2.8 Incision Ratio:	**1.44**	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:	**C**	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**10**	Reference Bed Material:	**Cobble**	
				Reference Subclass Slope:	**None**	
				Reference Bedform:	**Step-Pool**	

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**0.0**	**83.7**	Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**0.0**	**4.5**	Sub-dominant:	**Herbaceous**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**115.7**	**168.8**	Canopy %:	**51-75**	**51-75**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**26-50**
W less than 25	**0**	**82**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Herbaceous**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Forest**	Mass Failures		
Sub-dominant	**Residential**	**Residential**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**1**	
Failures	**Multiple**	**21.0**	Gullies Length	**300**	
Gullies	**One**	**2.0**			

Stream: **Great Brook** Reach: **M3.07-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type		4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**Minimal**	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:	**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	**16**	**Yes**	**Yes**	**Yes**	**Yes**	**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:	**1**	Flood chutes:	**3**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**0**	Island:	**1**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**6**	Braiding:	**2**	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 Gradiant 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	**Confined**	Score	STD	Historic		
7.1 Channel Degradation		**10**	**None**	**Yes**	Geomorphic Rating	**0.61**
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 Planforml		**8**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score		**49**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.07-B
Segment Length(ft): 3,607
Rain: Yes

SGAT Version: 3
Organization:
Observers: PD, AM, EE
Completion Date: 7/16/2013
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **upstream and downstream of bridge on Brook Rd in Plainfield right before the road becomes Reservoir Rd**

Step 5 - Notes: **Lack of buffer and straightening for agriculture in this segment has led to impacts of channel degradation and extensive erosion along the banks. Many depositional features as well including steep riffles, diagonal bars, and some features greater than 1/2 the bankfull depth. Many habitat debis jams and abundant large woody debris in this segment. Landowner interested in restoration project.**

Step 7 - Narrative: **Extensive erosion where there is a lack of buffer in segment. Very aggradational with high SBs & MCBs > 1/2 BF stage in height. Deposition causing change in planform and many flood chutes inside large bars. Major degradation and lack of buffer has led to unstable channel. Channel will most likely become wider as it tries to reach equilibrium.**

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions
1.2 Alluvial Fan: None
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Never
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): 631
Width Determination: Measured
Confinement Type: VB
In Rock Gorge: No
Human Caused Change in Valley Width?: No

1.6 Grade Controls: None

Stream: **Great Brook** Reach: **M3.07-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**30.40**	2.11 Riffle/Step Spacing:	**101 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.80**	2.12 Substrate Composition		Bed:	**10.1 inches**
2.3 Mean Depth (tf):	**1.48**	Bedrock:	**0.0 %**	Bar:	**3.3 inches**
2.4 Floodprone Width (ft.):	**95.00**	Boulder:	**4.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.60**	Cobble:	**9.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**54.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**20.54**	Fine Gravel:	**9.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**3.13**	Sand:	**23.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.64**	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:	**102**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**696.8**	**956.8**	Dominant:	**Herbaceous**	**Herbaceous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**4.3**	**4.6**	Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**187.5**	**190.6**	Canopy %:	**26-50**	**1-25**
Material Type:	**Gravel**	**Gravel**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**0-25**	**26-50**
W less than 25	**179**	**1,810**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Herbaceous**
Sub-Dominant	**Mixed Trees**	**Shrubs/Sapling**

3.3 Riparian Corridor

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

Stream: **Great Brook** Reach: **M3.07-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		4.7 Stormwater Inputs	
4.2 Adjacent Wetlands:	**Minimal**	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:	**1**	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
Instream Culvert	**10**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Scour Above,Scour Below,Alignment**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types	Diagonal:	**8**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**
Mid:	**6**	Delta:	**0**	Flood chutes:	**9**	Avulsion:	**0**	5.5 Straightening:		**Straightening**
Point:	**9**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):		**674**
Side:	**31**	Braiding:	**1**	Steep Riffles:	**10**	Trib Rejuv.:	**No**	5.5 Dredging:		**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant 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		**8**	**None**	**Yes**	Geomorphic Rating	**0.45**
7.2 Channel Aggradation		**9**	**None**		Channel Evolution Model	**F**
7.3 Widening Channel		**10**	**None**		Channel Evolution Stage	**III**
7.4 Change in Planforml		**9**	**None**		Geomorphic Condition	**Fair**
Total Score		**36**			Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.07-C
Segment Length(ft): 1,117
Rain: Yes

SGAT Version: 3
Organization:
Observers: PD, AM, EE
Completion Date: 7/16/2013
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **DS of bridge on Gore Rd in Plainfield**

Step 5 - Notes: **More aggradational than upstream segment, which is most likely due to the drop in slope from upstream.**

Step 7 - Narrative: **Slightly incised channel, but still areas of FP access. Given the amount of floodplain access, it is currently in a stable condition. Much more aggradational than upstream reach due to change in slope. Many steep riffles and one location of minor braiding around a MCB. Low w/d ratio, so channel has not widened much, but some erosion on both banks. Planform change is minor although there are a few flood chutes.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Banks and Buffers**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): 594
Width Determination: Estimated
Confinement Type: VB
In Rock Gorge: No
Human Caused Change in Valley Width?: No

1.6 Grade Controls: None

Stream: **Great Brook** Reach: **M3.07-C**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**29.20**	2.11 Riffle/Step Spacing:	**114.9 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.50**	2.12 Substrate Composition		Bed:	**10.5**	**inches**
2.3 Mean Depth (tf):	**1.88**	Bedrock:	**0.0 %**	Bar:	**4.5**	**inches**
2.4 Floodprone Width (ft.):	**616.00**	Boulder:	**3.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**3.10**	Cobble:	**41.0 %**	Stream Type:	**C**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**32.0 %**	Bed Material:	**Gravel**	
2.6 Width/Depth Ratio:	**15.53**	Fine Gravel:	**10.0 %**	Subclass Slope:	**None**	
2.7 Entrenchment Ratio:	**21.10**	Sand:	**12.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**1.24**	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:	**65**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**269.3**	**82.9**	Dominant:	**Deciduous**	**Deciduous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**2.4**	**3.3**	Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
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:	**Mix**	**Mix**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Pasture**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**One**	**20.0**
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Great Brook** Reach: **M3.07-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type		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:	**1**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**
Mid:	**5**	Delta:	**0**	Flood chutes:	**3**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**6**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**9**	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 Gradiant 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		**15**	**None**	**Yes**	Geomorphic Rating	**0.65**
7.2 Channel Aggradation		**10**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**15**	**None**	**No**	Channel Evolution Stage	**I**
7.4 Change in Planforml		**12**	**None**	**No**	Geomorphic Condition	**Good**
Total Score		**52**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.08-A**
Segment Length(ft): **1,250**
Rain: **Yes**

SGAT Version: **3**
Organization:
Observers: **PD, AM, DC**
Completion Date: **6/19/2013**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **directly DS of bridge on Gore Rd in Plainfield**

Step 5 - Notes: **Alternating areas of floodplain access, but most of segment is incised and may widen in the future. "C" stream type is subdominant.**

Step 7 - Narrative: **Historic degradation is major process in much of segment but there are areas of FP access on one side where the channel may be a "C". Low w/d ratio, but stream channel is not "E" like, more like a "B". Minor aggradation, exception DS end where there is a large bar. It's difficult to tell whether the insicion has caused a STD because ground is very hummocky. May have been a "C" where is now a "B". Erosion in spots, but not major widening yet. Segment may be in late F-II to early F-III.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	166	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Steep**	**Steep**
Continuous w/ Bank:	**Never**	**Never**
Within 1 Bankfull W:	**Sometimes**	**Never**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features
Valley Width (ft): **330**
Width Determination: **Measured**
Confinement Type: **VB**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge		**2.8**	**1.5**		

Stream: **Great Brook** Reach: **M3.08-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**22.00**	2.11 Riffle/Step Spacing:	**119 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**3.20**	2.12 Substrate Composition		Bed:	**17**	**inches**
2.3 Mean Depth (tf):	**2.16**	Bedrock:	**0.0 %**	Bar:	**12**	**inches**
2.4 Floodprone Width (ft.):	**47.50**	Boulder:	**26.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**5.10**	Cobble:	**26.0 %**	Stream Type:	**B**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**37.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**10.19**	Fine Gravel:	**7.0 %**	Subclass Slope:	**a**	
2.7 Entrenchment Ratio:	**2.16**	Sand:	**0.0 %**	Bed Form:	**Step-Pool**	
2.8 Incision Ratio:	**1.59**	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:	**11**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Moderate**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**312.0**	**276.0**	Dominant:	**Coniferous**	**Coniferous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**3.4**	**4.7**	Sub-dominant:	**Deciduous**	**Deciduous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**70.5**	Canopy %:	**76-100**	**76-100**
Material Type:	**Mix**	**Mix**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**None**	**0-25**
W less than 25	**0**	**44**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Great Brook** Reach: **M3.08-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type		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:	**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:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	**10**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Deposition Below,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:	**2**	Delta:	**0**	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:	**26**	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 Gradiant 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		**9**	**None**	**Yes**	Geomorphic Rating	**0.66**
7.2 Channel Aggradation		**14**	**None**		Channel Evolution Model	**F**
7.3 Widening Channel		**15**	**None**		Channel Evolution Stage	**II**
7.4 Change in Planforml		**15**	**None**		Geomorphic Condition	**Good**
Total Score		**53**			Stream Sensitivity	**Moderate**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.08-B**
Segment Length(ft): **4,300**
Rain: **Yes**

SGAT Version: **3**
Organization:
Observers: **PD, AM, DC**
Completion Date: **7/10/2013**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **directly US of bridge on Gore Rd in Plainfield**

Step 5 - Notes: **xsec done at average flow**

Step 7 - Narrative: **F I - F II. Short areas of incision, but predominantly not incised with FP access on at least one side of stream. stream type and valley width varies along segment, but mostly a "B". For the most part, the segment is in good condition, but there are localized spots where the channel is braided at higher flows with islands. At lower flows, the other channel appears as a large FC. May have been caused by higher runoff from logging area, but it's difficult to be sure. These braided areas may just be due to localized changes in slope. Areas with flood chutes have much higher w/d ratio.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Both Height
Berm:	17	4	0	
Road:	100	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): **118**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls: **None**

Stream: **Great Brook** Reach: **M3.08-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**28.00**	2.11 Riffle/Step Spacing:	**86.7 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**4.20**	2.12 Substrate Composition		Bed:	**18**	**inches**
2.3 Mean Depth (tf):	**2.41**	Bedrock:	**0.0 %**	Bar:	**7**	**inches**
2.4 Floodprone Width (ft.):	**60.70**	Boulder:	**19.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**4.20**	Cobble:	**44.0 %**	Stream Type:	**B**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**17.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**11.62**	Fine Gravel:	**5.0 %**	Subclass Slope:	**a**	
2.7 Entrenchment Ratio:	**2.17**	Sand:	**15.0 %**	Bed Form:	**Step-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:	**Low**	Detritus:	**0.0 %**	Reference Stream Type:		
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**90**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**616.3**	**545.8**	Dominant:	**Deciduous**	**Deciduous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**7.6**	**7.1**	Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Consistency:	**Cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**18.7**	**9.3**	Canopy %:	**76-100**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Cohesive**	**Cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**21.0**
Gullies	**Multiple**	**3.5**

	Left	Right
Mass Failures		
Height		
Gullies Number	**2**	
Gullies Length	**170**	

Stream: **Great Brook** Reach: **M3.08-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type		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:	**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: **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:	**16**	Delta:	**0**	Flood chutes:	**17**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**1**	Island:	**5**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**68**	Braiding:	**5**	Steep Riffles:	**14**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant 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		**16**	**None**		Geomorphic Rating	**0.65**
7.2 Channel Aggradation		**11**	**None**		Channel Evolution Model	**F**
7.3 Widening Channel		**13**	**None**		Channel Evolution Stage	**I**
7.4 Change in Planforml		**12**	**None**		Geomorphic Condition	**Good**
Total Score		**52**			Stream Sensitivity	**Moderate**

Phase 2 Segment Summary Report — Winooski - Montpelier to Cabot

Stream: **Great Brook**
Reach: **M3.08-C**
Segment Length(ft): **4,466**
Rain: **Yes**

SGAT Version: **3**
Organization:
Observers: **PD, AM, DC**
Completion Date: **6/18/2013**
Qualtiy Control Status - Consultant: **Passed**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Plainfield**

Step 5 - Notes:

Step 7 - Narrative: **Channel is in stable condition for the most part. There are some areas in the DS area of the segment of localized incision, but it is short lived. Minor aggradation in most of the segment as seen through steep riffles and small mid-channel bars as sediment makes its way through segment. There is an area in the center of the segment (~300' long) where braiding occurs around an island and the channel width is much wider. More aggradation in this location.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Extr.Steep	Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Sand	Sand

1.5 Valley Features
Valley Width (ft): **81**
Width Determination: **Measured**
Confinement Type: **SC**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls: **None**

Stream: **Great Brook** Reach: **M3.08-C**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**27.00**	2.11 Riffle/Step Spacing:	**70.7 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.20**	2.12 Substrate Composition		Bed:	**26**	**inches**
2.3 Mean Depth (tf):	**1.25**	Bedrock:	**0.0 %**	Bar:	**7.2**	**inches**
2.4 Floodprone Width (ft.):	**39.90**	Boulder:	**14.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**2.20**	Cobble:	**57.0 %**	Stream Type:	**B**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**15.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**21.60**	Fine Gravel:	**4.0 %**	Subclass Slope:	**a**	
2.7 Entrenchment Ratio:	**1.48**	Sand:	**9.0 %**	Bed Form:	**Step-Pool**	
2.8 Incision Ratio:	**1.00**	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:	**Low**	Detritus:	**0.0 %**	Reference Stream Type:		
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**178**	Reference Bed Material:		
				Reference Subclass Slope:		
				Reference Bedform:		

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**161.7**	**214.9**	Dominant:	**Deciduous**	**Deciduous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**5.4**	**3.6**	Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Consistency:	**Cohesive**	**Cohesive**	Revetment Type:	**Rip-Rap**	**None**	Bank Canopy		
Lower			Revetment Length:	**23.4**	**0.0**	Canopy %:	**76-100**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Forest**	Mass Failures		
Sub-dominant	**None**	**None**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**3**	
Failures	**Multiple**	**20.0**	Gullies Length	**335**	
Gullies	**Multiple**	**4.7**			

Stream: **Great Brook** Reach: **M3.08-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type		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:	**4**	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	**13.5**	**Yes**	**Yes**	**Yes**	**No**	**Deposition Above,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:	**13**	Delta:	**0**	Flood chutes:	**8**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**0**	Island:	**8**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**68**	Braiding:	**4**	Steep Riffles:	**15**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant 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	**Confined**	Score	STD	Historic		
7.1 Channel Degradation		**16**	**None**		Geomorphic Rating	**0.75**
7.2 Channel Aggradation		**12**	**None**		Channel Evolution Model	**F**
7.3 Widening Channel		**14**	**None**		Channel Evolution Stage	**I**
7.4 Change in Planforml		**18**	**None**		Geomorphic Condition	**Good**
Total Score		**60**			Stream Sensitivity	**Moderate**

Phase 2 Segment Summary Report Winooski - Montpelier to Cabot

Stream: Great Brook
Reach: M3.08-D
Segment Length(ft): 2,400
Rain: Yes

SGAT Version: 3
Organization:
Observers: PD, AM, DC
Completion Date: 6/18/2013
Qualtiy Control Status - Consultant: Passed
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **below wetland at the top of Gore Rd**

Step 5 - Notes:

Step 7 - Narrative: **Channel impacts are very minimal. There appears to be some fine sediment and gravel in channel that may be due to runoff from logging road. Very unique system that has a step-pool bed form with alternating braided sections. Braiding is most likely natural and not from excessive aggradation due to flat topography. Wetland just above the top of the reach. Many natural flood chutes that even cross in between braided channels. Lower part of segment is encroached by logging road and vegetation is herbaceous, not forested.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Hilly	Flat
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): 2,545
Width Determination: Estimated
Confinement Type: VB
In Rock Gorge: No
Human Caused Change in Valley Width?: No

1.6 Grade Controls: None

Stream: **Great Brook** Reach: **M3.08-D**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**20.10**	2.11 Riffle/Step Spacing:	**93 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.10**	2.12 Substrate Composition		Bed:	**28.6**	**inches**
2.3 Mean Depth (tf):	**1.39**	Bedrock:	**0.0 %**	Bar:	**N/A**	**inches**
2.4 Floodprone Width (ft.):	**2,380.00**	Boulder:	**46.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**2.10**	Cobble:	**33.0 %**	Stream Type:	**C**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**0.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**14.46**	Fine Gravel:	**5.0 %**	Subclass Slope:	**a**	
2.7 Entrenchment Ratio:	**118.41**	Sand:	**16.0 %**	Bed Form:	**Step-Pool**	
2.8 Incision Ratio:	**1.00**	Silt and Smaller:	**3.0 %**	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:	**C**	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**51**	Reference Bed Material:	**Cobble**	
				Reference Subclass Slope:	**a**	
				Reference Bedform:	**Step-Pool**	

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Moderate**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**40.2**	**101.6**	Dominant:	**Deciduous**	**Deciduous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**5.7**	**2.8**	Sub-dominant:	**Coniferous**	**Coniferous**
Consistency:	**Cohesive**	**Cohesive**	Revetment Type:	**None**	**None**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**0.0**	Canopy %:	**76-100**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**51-100**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

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

Stream: **Great Brook** Reach: **M3.08-D**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type		4.7 Stormwater Inputs	
4.2 Adjacent Wetlands:	**Minimal**	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:	**4**	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:	**2**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**
Mid:	**0**	Delta:	**0**	Flood chutes:	**9**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**3**	Island:	**4**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**23**	Braiding:	**5**	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 Gradiant 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		**19**	**None**		Geomorphic Rating	**0.84**
7.2 Channel Aggradation		**15**	**None**		Channel Evolution Model	**F**
7.3 Widening Channel		**17**	**None**		Channel Evolution Stage	**I**
7.4 Change in Planforml		**16**	**None**		Geomorphic Condition	**Reference**
Total Score		**67**			Stream Sensitivity	**Moderate**

To: Bear Creek Environmental
From: Gretchen Alexander, VT DEC River Management
Date: 4/5/13

Comments by BCE on 4/8/13

ANR e-mail correspondence on 4/11/13 indicated no further questions/comments after BCE's 4/8/13 response.

Great Brook 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:

Just for clarification, can you tell me what the difference is between what you have labeled as "Phase 1" valley wall and "Phase 2" valley wall? Is the Phase 1 valley wall what the confinement would be if there were no human caused changes in confinement? And for the locations where you noted Brook Road as the valley wall, this is a confining feature (not an administrative adjustment to the road) – correct? You are correct. The Phase 1 valley wall is what the confinement would be if there were no human-caused changes in confinement. Although Brook Road is not technically a Phase 2 valley wall (state numbered highway), we felt that in this system it is acting as a confining feature (Phase 2 valley wall). A note about this has been added to Step 5 comments where applicable.

Reach specific comments:

M3.01-A

Did you feel certain that the headcut noted near the mouth of the brook was indicative of a degradation process rather than an aggrdation process? Did you happen to get a photo? We did think this it was an aggradational feature, possibly a result of recent flooding. Both Mary and Sacha felt there was a head cut moving up through this agrraded feature (see photo below). We added an additional sentence to Step 5 in the DMS to describe this.

M3.01-B
No comments

M3.01-C
No comments

M3.02-A
No comments

M3.02-B
You note incision and aggradation both as active processes. Do you think it's likely that the channel is head-cutting back through aggraded material, or are aggrdation and incision happening in separate parts of the reach? I think this would be worth clarifying in your comments somewhere. Great Brook was a complicated system, and there was clearly a sharp change in slope in this segment. It's unclear whether aggradation and incision are happening in separate parts of the reach. It would make sense to go back and look at the head cuts we identified in 2012 to see if they have resolved or are continuing to move upstream. We have added a note to Step 7.

M3.02-C
Are the flooding alterations you noted in step 2 "natural" or are you aware of any dredging etc. in this reach? The flooding alterations we noted were natural. We did not see any signs of flood work in this segment. Comments were changed to clarify this.

M3.03-A
No comments

M3.03-B
No comments

M3.04-A
No comments

M3.04-B
No comments

M3.05-A
No comments

M3.05-B
No comments

M3.05-C
Thank you for the extensive comments in step 7. This was a complicated segment! We agree!

M3.06-A
According to the protocols, a C3 in Fair condition should be a High sensitivity rating (instead of Very High). Is there a reason you felt the sensitivity should be heightened for this segment? No. We have changed the sensitivity to High.

M3.06-B
No comments

M3.06-C
No comments

To: Bear Creek Environmental
From: Gretchen Alexander, VT DEC River Management
Date: 11/1/13

Great Brook Phase 2 QA – Reaches M3.07 and M3.08

Responses by Pam DeAndrea, Bear Creek Environmental 11/7/13

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.

M3.07-A

Step 5 comments – any comments to add?

Added comments about variability of stream type in segment and channel evolution stage.

Step 6 – please clarify in the step 6 comment box that this is a sub-reach with a reference step-pool bedform, so it does not constitute a stream habitat type departure as the data suggests.

SHTD Existing habitat type was changed to “No Departure” and a more descriptive comment that it is a sub-reach and not a habitat departure from reference was added.

Step 7 – Putting the segment in stage II CEM without checking “historic” for degradation can imply incision as an active process (presumably in the downstream portion of the reach where there is no grade control). Can you add some comments indicating what made you think incision might be active or what might be preventing progression to stage III? Perhaps the revetments noted?

Historic was originally checked as “Yes” for this segment indicating that the incision is no longer an active process. Bedrock and armoring along the banks on upstream end is preventing widening. There was a small section in the middle with some major planform change, where it is in stage F-III, but that was not dominant in the segment. The adjustment stages of the segment working from upstream to downstream are probably F-II, F-III, F-II-III. Erosion was limited except for downstream of the cross section. Comments were added in the DMS in steps 5 and 7 to further clarify the channel evolution stage.

M3.07-B

Step 5 comments – any comments to add?

Added some comments in Step 5 regarding characteristics of segment.

M3.07-C
Step 7 – You did not indicate degradation as historic – do you think it is still active, as stage II CEM might suggest? From the data it seems like an aggradational segment (bars, steep riffles). Can you add some comments to clarify thoughts on the dominant processes at play? Do you think it will start to widen, or do you think the level of floodplain access it has minimizes this potential?
Channel is just slightly incised and there are many areas of floodplain access in this segment. Stage F-I may be more appropriate for this segment. Given the amount of floodplain access in this segment, it is currently in a stable condition. Step 7 was updated in the DMS.

M3.08-A
Step 7 – similar to my comment in segment M3.07-C, do you think incision is an active process? If not, do you think the channel will start to widen? Or do you think floodplain access and the wet nature of the floodplain area (described as hummocky, although minimal springs and seeps noted in step 4.1) is facilitating enough flood storage to stall-out the CEM process? Some more narrative on this topic would be helpful.
Width to depth ratio was again low in this segment (10.2), indicating that the channel is not widening yet. However, there is some erosion (20% on left bank) indicating some widening in spots, so maybe channel is in F-II to early F-III. We did not see any headcuts or rejuvenating tributaries, so degradation is most likely historic. Incision was checked as historic in DMS. There is some floodplain access in spots, but overall the segment was incised and the CEM process will most likely not be stalled by the hummocky nature and flood storage potential. Updated comments in step 7 to be clearer.
Added comment in step 5.

M3.08-B
Some of the photo points attributed to this segment appear to actually be in segment D. Look at photo points starting at ID 90 – from your shapefile they are in segment D but they are labeled as segment B.
Good catch. Some of the photos were labeled with the incorrect segment letter, which carried over into our creation of the shapefile. The photos and the shapefile have been corrected.

M3.08-C
No comments

M3.08-D
x.s spreadsheet – not certain what you mean by “does not go up to 2.1” – please clarify.
This was just a note put on our cross section to say that we never hit floodprone, which was at 2.1 feet above bankfull. It appears that this segment is in a “Reverse” valley where the topography goes back down before it increases and hits a valley wall where the floodprone elevation would be. Comments in cross section were updated and re-uploaded to the DMS.

Do you think this should be a sub-reach in step 2 given that you have it in reference condition in step 7?

Yes this should be marked as a sub-reach. Most of the reach is "B" by reference, but this segment is "C" by reference. Step 2 was updated to indicate this segment is a sub-reach.

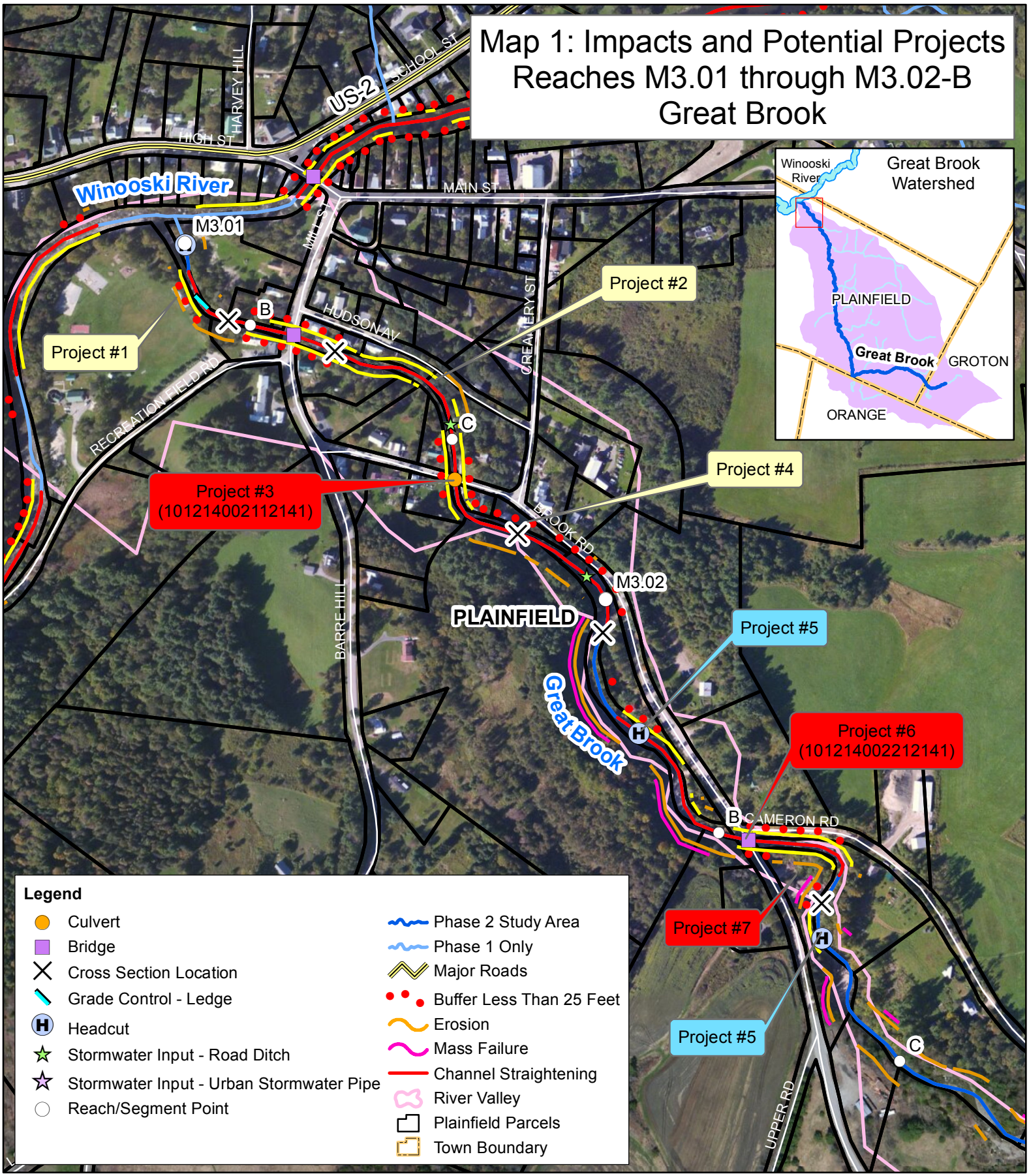
One of the photos for this segment mentions tributary rejuvenation, although you have trib. rejuv. as "no" in step 5.3. The presence of tributary rejuvenation implies incision – if you do think the trib. in the photo is rejuvenating, was this a localized section of incision given that you characterized the rest of the reach as un-incised?

This channel really was not incised. There was ample floodplain access. There were many ephemeral tribs/gullies entering Great Brook in this part of the watershed and it was difficult to tell at times whether they were gullies or tributaries. The one that was marked as a rejuvenating trib in the photo log seemed somewhat perched (see photo below), which is why it was probably marked as being a rejuvenating trib in the photo log comments. After more review of the photo, we decided that it was not rejuvenating. We changed the comment in the photo to just say tributary so as not to be misleading that the segment is incised.

APPENDIX D

Potential Project Locations & Descriptions

Map 1: Impacts and Potential Projects Reaches M3.01 through M3.02-B Great Brook



Legend

- Culvert
- Bridge
- Cross Section Location
- Grade Control - Ledge
- Headcut
- Stormwater Input - Road Ditch
- Stormwater Input - Urban Stormwater Pipe
- Reach/Segment Point
- Phase 2 Study Area
- Phase 1 Only
- Major Roads
- Buffer Less Than 25 Feet
- Erosion
- Mass Failure
- Channel Straightening
- River Valley
- Plainfield Parcels
- Town Boundary

Projects:

1. Streamside Plantings
2. Remove Old Abutment
3. Replace Culvert
4. Streamside Plantings
5. Arrest Headcuts
6. Replace Bridge
7. Floodplain Creation

Project Priority:

- Low
- Moderate
- High

N W E S

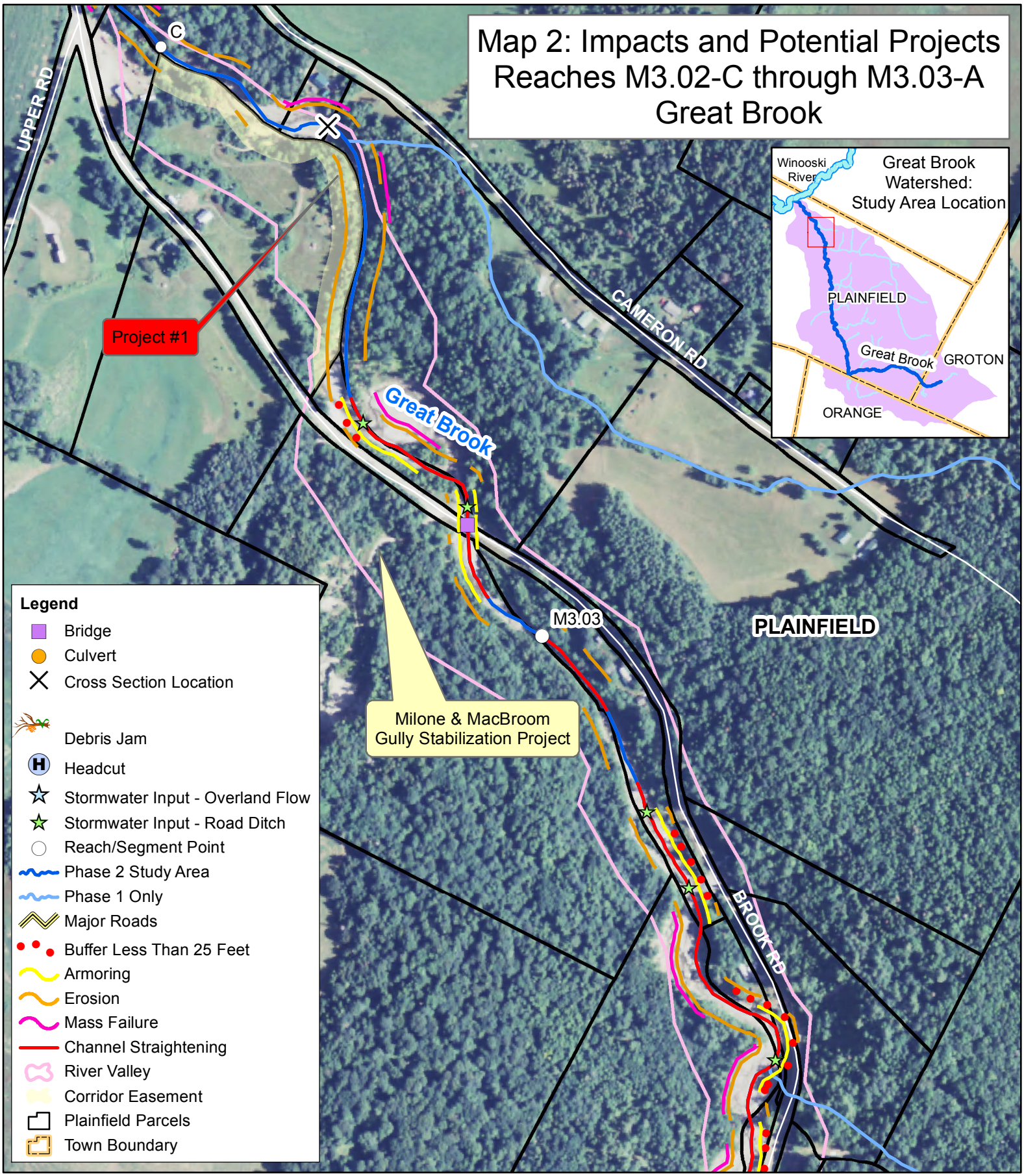
0 150 300 600 Feet

1 inch = 400 feet

Background is World Imagery

Bear Creek Environmental

Map 2: Impacts and Potential Projects Reaches M3.02-C through M3.03-A Great Brook



Projects:

1. River Corridor Easement

Project Priority:

- Low
- Moderate
- High

N
W E
S

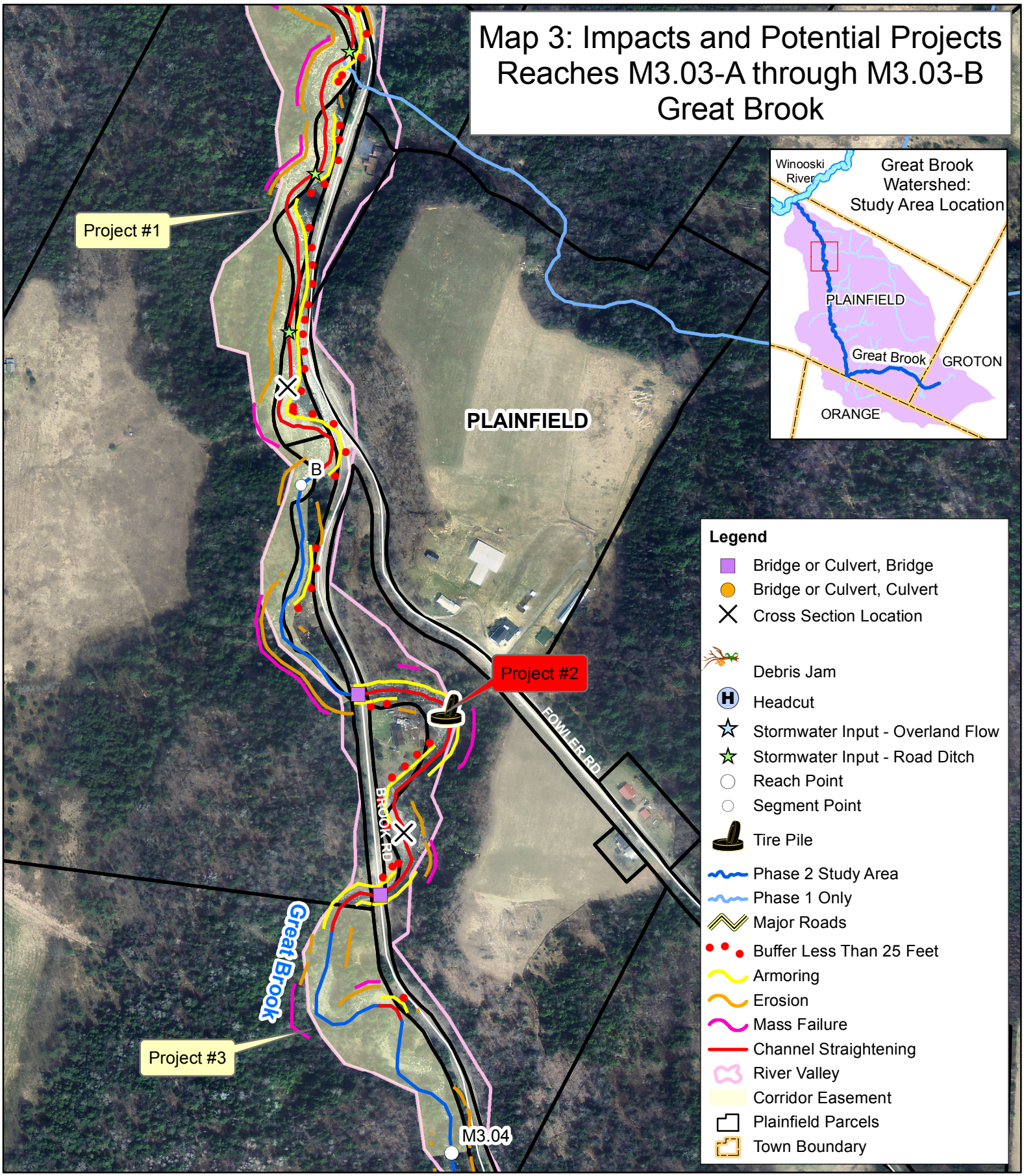
0 200 400 800 Feet

1 inch = 400 feet

Bear Creek Environmental

Background is USDA NAIP

Map 3: Impacts and Potential Projects Reaches M3.03-A through M3.03-B Great Brook



Projects:

1. River Corridor Easement
2. Stream Clean up
3. River Corridor Easement

Project Priority:

- Low
- Moderate
- High

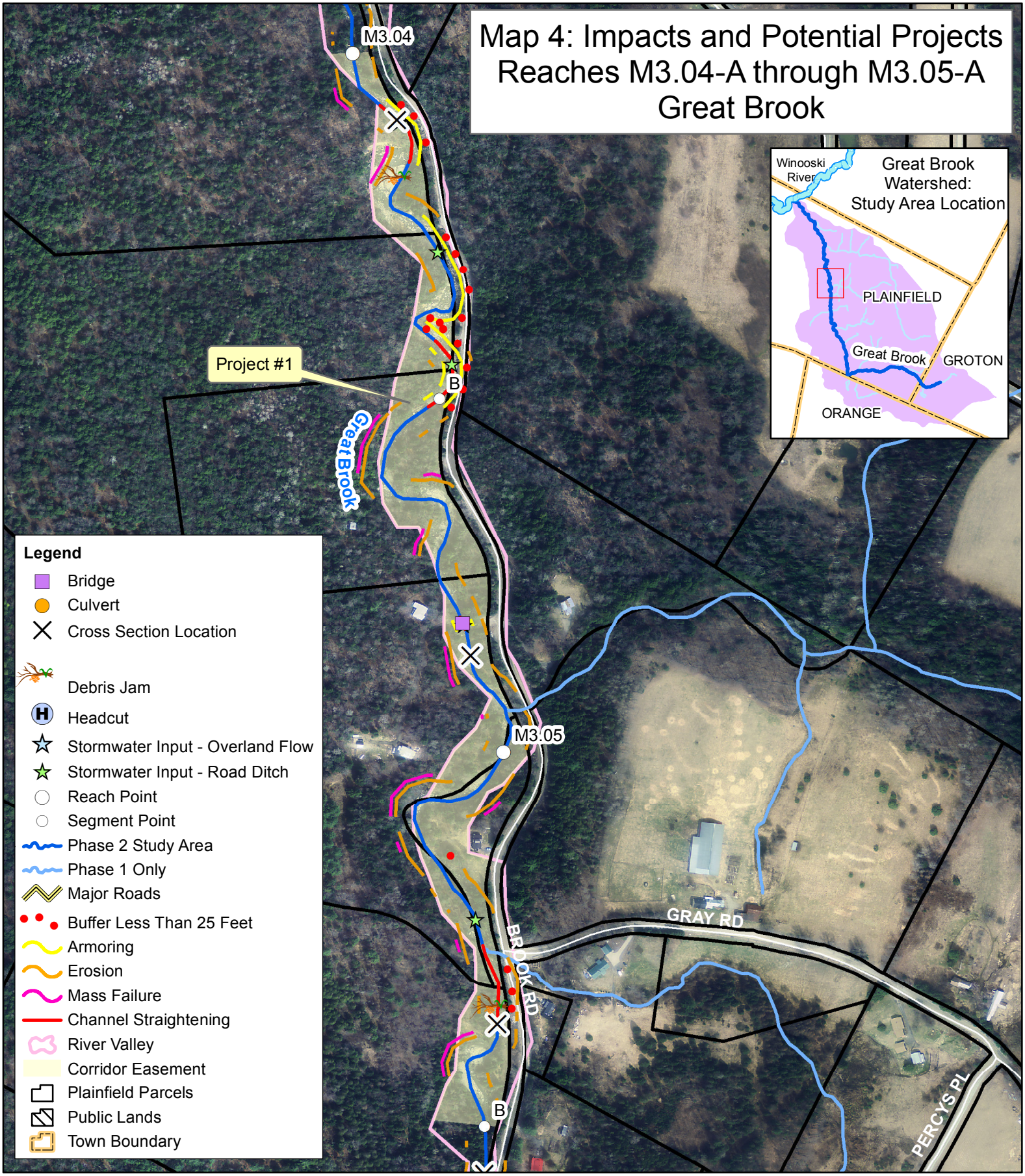
N W E S

0 200 400 800 Feet

1 inch = 400 feet

Bear Creek Environmental

Background is USGS Imagery



Projects:

1. River Corridor Easement

Project Priority:

- Low
- Moderate
- High

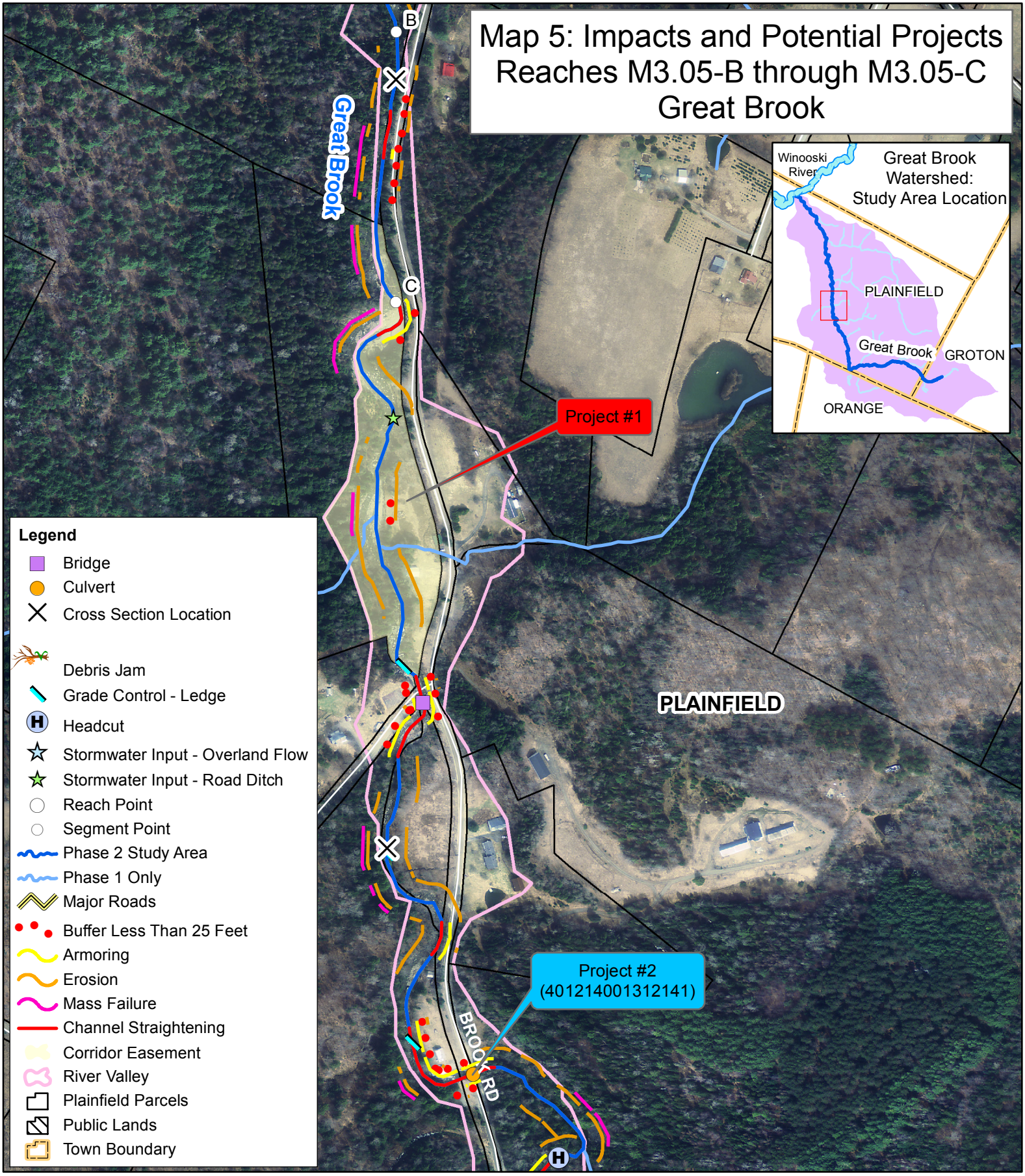
N W E S

0 200 400 800 Feet

1 inch = 400 feet

Bear Creek Environmental

Background is USGS Imagery



Projects:

1. River Corridor Easement
2. Replace Culvert

Project Priority:

- Low
- Moderate
- High

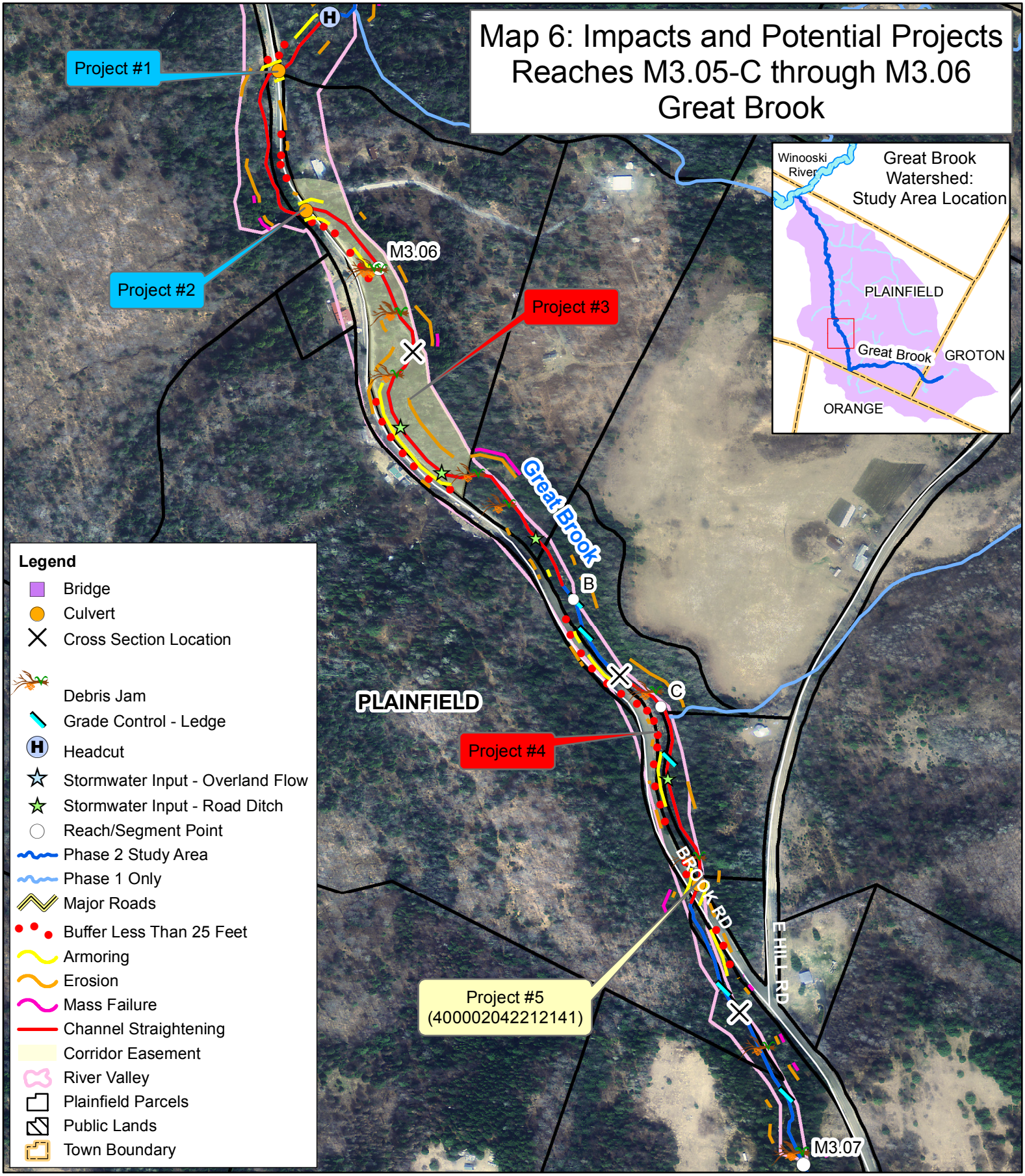
N
W E
S

0 200 400 800 Feet

1 inch = 400 feet

Bear Creek Environmental

Background is USGS Imagery



Projects:

1. Replace Culvert
2. Replace Culvert
3. River Corridor Easement
4. Relocate Log Landing
5. Replace Culvert

Project Priority:

- Low
- Moderate
- High

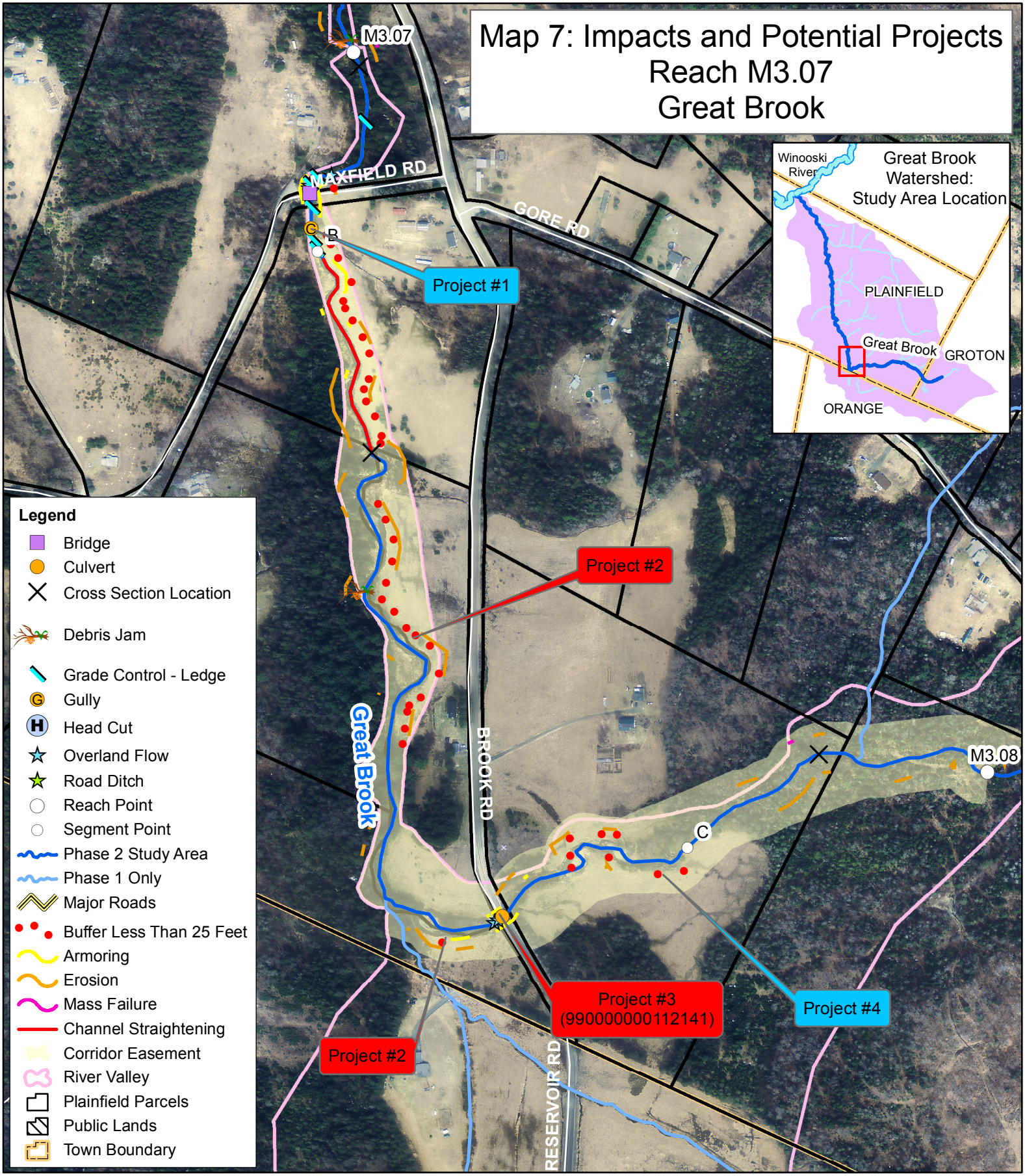
N W E S

0 200 400 800 Feet

1 inch = 400 feet

Bear Creek Environmental

Background is USGS Imagery



Projects:

1. Remediate Gully
2. River Corridor Easement & Streamside Planting
3. Replace Culvert
4. River Corridor Easement & Natural Buffer Regeneration

Project Priority:

- Low
- Moderate
- High

N W E S

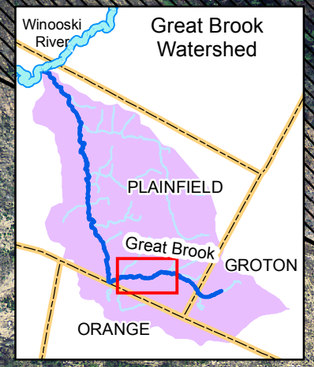
0 200 400 800 Feet

1 inch = 400 feet

Bear Creek Environmental

Background is USGS Imagery

Map 8: Impacts and Potential Projects
Reach M3.08-A and M3.08-B
Great Brook



Legend

- Bridge
- Culvert
- Cross Section Location
- Debris Jam
- Grade Control - Ledge
- Gully
- Head Cut
- Overland Flow
- Road Ditch
- Reach/Segment Point
- Phase 2 Study Area
- Phase 1 Only
- Major Roads
- Buffer Less Than 25 Feet
- Armoring
- Erosion
- Mass Failure
- Channel Straightening
- Corridor Easement
- River Valley
- Plainfield Parcels
- Public Lands
- Town Boundary

Project #1
Project #2
Project #3
Project #4
M3.08
B
C
G
Great Brook
GORE RD

Projects:

1. River Corridor Easement
2. Replace Culvert
3. Remediate Gully
4. River Corridor Easement

Project Priority:

- Low
- Moderate
- High

N
W E
S

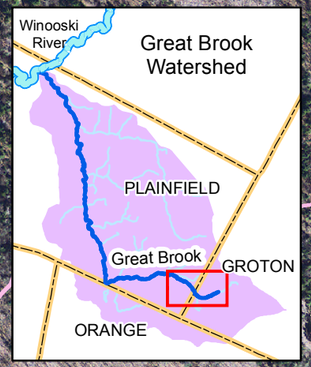
0 200 400 800 Feet

1 inch = 400 feet

Bear Creek Environmental

Background is USGS Imagery

Map 9: Impacts and Potential Projects
Reach M3.08-C and M3.08-D
Great Brook



Project #1

Project #2

GORE RD

Project #3

Project #4

Project #2

M3.09

Great Brook

Legend

- Bridge
- Culvert
- Cross Section Location
- Debris Jam
- Grade Control - Ledge
- Gully
- Head Cut
- Overland Flow
- Road Ditch
- Reach/Segment Point
- Phase 2 Study Area
- Phase 1 Only
- Major Roads
- Buffer Less Than 25 Feet
- Armoring
- Erosion
- Mass Failure
- Channel Straightening
- Corridor Easement
- River Valley
- Plainfield Parcels
- Public Lands
- Town Boundary

Projects:

1. Remove Washed Out Culvert
2. River Corridor Easement
3. Adopt Best Management Practices for Logging
4. Remove Collapsed Bridge & Old Abutment

Project Priority:

- Low
- Moderate
- High

N W E S

0 205 410 820 Feet

1 inch = 400 feet

Bear Creek Environmental

Background is VCGI 0.5 m color imagery 2012

Table 1. Great Brook Map 1: M3.01 through M3.02-B Site Level Opportunities for Restoration and Protection Plainfield, Vermont						
Project # Segment	**Type of Project**	**Site Description Including Stressors and Constraints**	**Project or Strategy Description**	**Feasibility and/or Priority**	**Benefits**	**Potential Partners/Programs**
Project #1 M3.01-A	Passive Restoration	Recreational area has limited buffer and bank vegetation.	Additional stream side plantings	Low Priority	Improved habitat and water quality by providing shade and preventing erosion	Landowner, CVRPC, VANR, WNRCD, FWR, Town of Plainfield TFS, WHIP
Project #2 M3.01-B	Active Restoration	Old abutment is adding to geomorphic instability. Hard bank armoring can be removed. Not listed as a channel constriction.	Alternatives analysis for the removal of the abutment	Armored throughout; Low Priority	Improved geomorphic stability	Landowner, CVRPC, VANR, Town of Plainfield ERP
Project #3 M3.01-C	Active Restoration	Undersized culvert has caused debris jam and flood damage along upstream property.	Investigate Replacement of culvert	High Priority	Improved geomorphic stability and reduced flood damage	Landowners, CVRPC, VANR, Town of Plainfield VTrans
Project #4 M3.01-C	Passive Restoration	Residential lawn has narrow to no buffer.	Streamside plantings	Low Priority	Improved habitat and water quality	Landowner, CVRPC, VANR, WNRCD, Town of Plainfield TFS, WHIP
Project #5 M3.02-A & M3.02-B	Active Restoration	Channel is downcutting into bed and causing headcuts in two locations.	Arrest headcuts with boulder weirs	Moderate Priority	Improved geomorphic stability	Landowners, CVRPC, VANR, Town of Plainfield ERP
Project #6 M3.02-B	Active Restoration	Bridge is in poor condition and has experienced flood damage.	Investigate Replacement of bridge	High Priority	Improved geomorphic stability and reduced flood damage	Landowners, CVRPC, VANR, Town of Plainfield VTrans
Project #7 M3.02-B	Active Restoration	Potential to lower elevation of land on inside of river bend to create more floodplain access	Create floodplain	High Priority	Improved sediment attenuation and geomorphic stability	Landowner, CVRPC, VANR, Town of Plainfield ERP
ERP = Ecosystem Restoration Program, TFS = Trees for Streams, WHIP = Wildlife Habitat Incentives Program, VTrans = Vermont Agency of Transportation						

Table 2. Great Brook
Maps 2, 3, & 4: M3.02-C through M3.05-A
Site Level Opportunities for Restoration and Protection
Plainfield, Vermont

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Priority	Benefits	Potential Partners/Programs
Map 2 Project #1 M3.02-C	Passive Restoration	Segment has good floodplain access and a wide valley.	Protect river corridor through easement	High Priority	Improved habitat and water quality	Landowner, CVRPC, VANR, Town of Plainfield, Vermont River Conservancy RCE
Map 3 Project #1 M3.03-A	Passive Restoration	Reach is well forested on western side of stream.	Protect river corridor through easement	Low Priority	Reduce future impact from potential development on mass failures; Improved habitat and water quality	Landowner, CVRPC, VANR, Town of Plainfield, Vermont River Conservancy RCE
Map 3 Project #2 M3.03-B	Stream Clean Up	A pile of old trash (mostly tires) sits along the western bank.	Clean up tire pile	High Priority	Improved water quality	Landowner, CVRPC, VANR, FWR, Town of Plainfield ERP
Map 3 Project #3 M3.03-B	Passive Restoration	Reach is well forested on western side of stream.	Protect river corridor through easement	Low Priority	Reduce future impact from potential development on mass failures; Improved habitat and water quality	Landowner, CVRPC, VANR, Town of Plainfield, Vermont River Conservancy RCE
Map 4 Project #1 M3.04-A, M3.04-B, M3.05-A	Passive Restoration	Reach is well forested on western side of stream.	Protect river corridor through easement	Low Priority	Reduce impact from development on mass failures; Improved habitat and water quality	Landowner, CVRPC, VANR, Town of Plainfield, Vermont River Conservancy RCE

RCE = River Corridor Easement, ERP = Ecosystem Restoration Program

Table 3. Great Brook
Map 5: M3.05-B through M3.05-C
Site Level Opportunities for Restoration and Protection
Plainfield, Vermont

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Priority	Benefits	Potential Partners/Programs
Project #1 M3.05-C	Passive Restoration	The stream channel runs through a wide valley and has moderate to good floodplain access in this area of M3.05-C.	Protect river corridor through easement	High Priority	Improved habitat and water quality	VANR, Town of Plainfield, Vermont River Conservancy RCE
Project #2 M3.05-C	Active Restoration	Undersized box culvert is generally in good physical condition. However, it is fully geomorphically incompatible.	Investigate replacement of culvert	Moderate Priority	Improved geomorphic stability; Reduce flooding and FEH hazards	Town of Plainfield, CVRPC, VANR VTrans

ERP = Ecosystem Restoration Program, RCE = River Corridor Easement, VTrans = Vermont Agency of Transportation

Table 4. Great Brook
Map 6: M3.05-C (upper) through M3.06
Site Level Opportunities for Restoration and Protection
Plainfield, Vermont

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Priority	Benefits	Potential Partners/Programs
Project #1 M3.05-C	Active Restoration	Undersized culvert will be in need of replacement soon. Cement is cracked in many locations. Culvert is partially geomorphically compatible and has reduced aquatic organism passage.	Investigate replacement of culvert	Moderate Priority	Improved fish passage and geomorphic stability; Reduce risk of flooding from debris jams	Town of Plainfield, CVRPC, VANR VTrans
Project #2 M3.05-C	Active Restoration	Undersized culvert will be in need of replacement soon. Cement is cracked in many locations. Culvert is mostly geomorphically incompatible and has reduced aquatic organism passage.	Investigate replacement of culvert	Moderate Priority	Improved fish passage and geomorphic stability; Reduce risk of flooding from debris jams	Town of Plainfield, CVRPC, VANR VTrans
Project #3 M3.05-C & M3.06-A	Passive Restoration	Majority of this site has good floodplain access (M3.06-A)	Protect river corridor through easement	High Priority	Improved habitat and water quality	Landowner, CVRPC, VANR, Town of Plainfield, Vermont River Conservancy RCE
Project #4 M3.06-C	Active Restoration	Log pile directly on stream bank making stream channel more vulnerable to debris jams at stream crossings.	Relocate Log Landing	High Priority	Reduce risk of flooding and fluvial erosion hazards at stream crossings.	Landowner, logging company, CVRPC, VANR, Town of Plainfield ERP
Project #5 M3.06-C	Active Restoration	Undersized culvert with failure of culvert and wing walls. The structure is partially geomorphically compatible.	Investigate replacement of culvert	Low Priority	Improved geomorphic stability; Reduce risk of flooding from debris jams	Town of Plainfield, CVRPC, VANR VTrans

ERP = Ecosystem Restoration Program, RCE = River Corridor Easement, VTrans = Vermont Agency of Transportation

Table 5. Great Brook
Map 7: M3.07-A through M3.07-C
Site Level Opportunities for Restoration and Protection
Plainfield, Vermont

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Benefits	Potential Partners/Programs
Project #1 M3.07-A	Active Restoration	Gully from field is bringing sediment to the stream channel.	Investigate source of gully and remediate	Moderate Priority	Improved habitat and water quality	Landowner, CVRPC, VANR, Town of Plainfield ERP
*Project #2 M3.07-B	Passive Restoration	Lack of buffer along eastern bank. Very broad valley.	Protect river corridor through easement and Streamside plantings	High Priority	Improved habitat and water quality	Landowner, CVRPC, VANR, Town of Plainfield ERP
Project #3 M3.07-B	Active Restoration	Undersized box culvert with deteriorated bottom and scour around culvert and wing walls. Culvert is poorly aligned with stream channel.	Investigate replacement of culvert	High Priority	Improved fish passage and geomorphic stability; Reduce risk of flooding from debris jams	Town of Plainfield, CVRPC, VANR VTrans
Project #4 M3.07-B, M3.07-C	Passive Restoration	Lack of buffer along both banks in M3.07-B, well forested in M3.07-C Very broad valley and good floodplain access in segment M3.07-C.	Protect river corridor through easement and natural buffer regeneration in M3.07-B	Moderate Priority	Improved habitat and water quality	Landowner, CVRPC, VANR, Vermont River Conservancy, Town of Plainfield RCE

ERP = Ecosystem Restoration Program, RCE = River Corridor Easement, VTrans = Vermont Agency of Transportation
*Indicates willing landowner

Table 6. Great Brook Map 8: M3.08-A and M3.08-B Site Level Opportunities for Restoration and Protection Plainfield, Vermont						
Project # Segment	**Type of Project**	**Site Description Including Stressors and Constraints**	**Project or Strategy Description**	**Technical Feasibility and Priority**	**Benefits**	**Potential Partners/Programs**
Project #1 M3.08-A	Passive Restoration	Very broad valley with well forested buffers.	Protect river corridor through easement	Moderate Priority	Improved habitat and water quality	Landowner, CVRPC, VANR, Vermont River Conservancy, Town of Plainfield RCE
Project #2 M3.08-A	Active Restoration	Undersized box culvert with poor alignment with stream channel and 1 foot drop creating a potential fish passage issue.	Investigate replacement of culvert	High Priority	Improved fish passage and geomorphic stability; Reduce risk of flooding from debris jams	Town of Plainfield, CVRPC, VANR VTrans
Project #3 M3.08-B	Active Restoration	Gully from pasture is a sediment source to stream channel.	Investigate source of gully and remediate	Moderate Priority	Improved habitat and water quality	Landowner, CVRPC, VANR, Town of Plainfield ERP
Project #4 M3.08-B, M3.08-C	Passive Restoration	Well forested banks and buffers.	Protect river corridor through easement	Low Priority	Improved habitat and water quality	Landowner, CVRPC, VANR, Vermont River Conservancy, Town of Plainfield RCE
ERP = Ecosystem Restoration Program, RCE = River Corridor Easement, VTrans = Vermont Agency of Transportation						

Table 7. Great Brook Map 9: M3.08-C and M3.08-D Site Level Opportunities for Restoration and Protection Plainfield and Groton, Vermont						
Project # Segment	**Type of Project**	**Site Description Including Stressors and Constraints**	**Project or Strategy Description**	**Technical Feasibility and Priority**	**Benefits**	**Potential Partners/Programs**
Project #1 M3.08-C	Active Restoration	Culvert from trail is washed out and in stream channel causing geomorphic instability.	Investigate removal of culvert	Low Priority	Improved geomorphic stability	Landowner, Town of Plainfield, CVRPC, VANR ERP
Project #2 M3.08-C, M3.08-D	Passive Restoration	Well forested banks and buffers.	Protect river corridor through easement	Low Priority M3.08-C Moderate Priority M3.08-D	Improved habitat and water quality	Landowners, CVRPC, VANR, Vermont River Conservancy, Town of Plainfield RCE
Project #3 M3.08-C	Passive Restoration	Logging practices may be contributing to increased debris and sediment in stream channel and exacerbating mass failure by log landing in upper M3.08-C.	Adopt best management practices for logging	Moderate Priority	Improved habitat and geomorphic stability	Logging company, CVRPC, VANR, Town of Plainfield
Project #4 M3.08-C	Active Restoration	Old wooden bridge has collapsed and is causing a potential fish passage issue. Old abutment with bridge is resulting in channel constriction causing scour below.	Investigate removal of old abutment and collapsed bridge	Low Priority	Improved habitat and geomorphic stability	Landowner, CVRPC, VANR, Town of Plainfield ERP
ERP = Ecosystem Restoration Program, RCE = River Corridor Easement						