Joiner Brook
River Corridor Plan
Bolton, Vermont
February 21, 2009

Prepared by: Bear Creek Environmental, LLC

Bear Creek Environmental

Prepared for: Town of Bolton, Vermont

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Acknowledgments

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The Bolton Planning and Conservation Commissions provided numerous hours of volunteer labor on the project. We would especially like to thank Amy Grover, of the Bolton Planning Commission, who helped with landowner outreach, contributed important information regarding the flood history of Joiner Brook, and provided overall coordination of the project. We would also like to thank Sharon Murray from the Bolton Conservation Commission for reviewing and providing feedback on the draft report. Funding for the project was provided by a grant from the Vermont Clean and Clear Program.

Gretchen Alexander of the Vermont River Management Program conducting Phase 2 field work on Joiner Brook in September 2008

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1.0 EXECUTIVE SUMMARY

The Town of Bolton hired Bear Creek Environmental, LLC to conduct Phase 2 assessment work on Joiner Brook from its confluence with the Winooski River up to its headwaters above Bolton Valley Resort. In total, approximately 4.8 miles of stream (6 lower reaches) were assessed as part of the Phase 2 field work. Fluvial erosion hazard zones were developed for an additional 1.1 stream miles to include the upper most reach (reach 7). The project was funded through a Vermont Clean and Clear Grant, and the Vermont Department of Environmental Conservation, River Management program, provided technical expertise for both the Phase 1 and 2 assessments.

In 2007, Bear Creek Environmental, LLC (BCE) under the direction of Central Vermont Trout Unlimited completed a Phase 1 Stream Geomorphic Assessment of the Mid-Winooski River Watershed including Joiner Brook, following the protocol developed by the Vermont Agency of Natural Resources (VANR). During Phase 1 the Winooski River watershed was divided into 129 reaches. Forty five of these reaches were only assessed for those parameters generated using the GIS Stream Geomorphic Assessment Tool (SGAT), while a full Phase 1 assessment was conducted on the remaining 84 reaches, including seven reaches on the main stem of Joiner Brook.

The Phase 2 stream geomorphic assessment of Joiner Brook included field observations and measurements that are used to verify the Phase 1 study, to determine the channel adjustment process, and the stream geomorphic condition, aquatic habitat condition, and quality of the riparian corridor. The collection and synthesis of this information can be used in watershed planning, for the establishment of erosion hazard zones, and for the identification of watershed improvement projects. A glossary of stream geomorphic assessment terms is included in Appendix A of this report to assist the reader. These definitions, adapted from Fishenich (2000), are from Appendix Q of the Vermont Agency of Natural Resources' Stream Geomorphic Handbook (2004).
A short summary of the Phase 2 results is as follows:

- The geomorphic condition of Joiner Brook is fair to good overall. The dominant adjustment processes in the Joiner Brook watershed are aggradation and planform adjustment. Six segments have undergone historic incision.

- The habitat condition of Joiner Brook is generally fair. Numerous natural and manmade obstructions are impeding the passage of aquatic organisms and there is a high percentage of exposed substrate due to aggradation. Overall, riparian buffers were of high quality. There are only isolated areas with poor riparian buffers. Pools are generally frequent and offer a range of cover and depth.
- A snowmaking weir used by Bolton Valley Resort, located in segment R10.S3.04-C, has caused the brook to historically incise immediately downstream of the structure due to sediment starvation. The structure is also causing major sediment accumulation upstream.

Eleven restoration and protection projects were identified using information collected as part of the Phase 2 assessment. A one hundred foot set back is recommended to prevent further development within the river corridor and to protect steep slopes from erosion. The Town of Bolton has adopted a one hundred foot set back for Joiner Brook under its current land use regulations. This setback also requires a 50 foot undisturbed buffer. The findings from this Phase 2 study support the existing regulations.

2.0 LOCAL PLANNING PROGRAM OVERVIEW

2.1 RIVER CORRIDOR PLANNING TEAM

The River Corridor planning Team for Joiner Brook is comprised of the Town of Bolton, the Vermont Department of Environmental Conservation (DEC), Bear Creek Environmental (BCE), volunteers and landowners. BCE completed the Phase 1 Assessment of Joiner Brook. Bear Creek Environmental was retained by the Town of Bolton as part of a grant with the Vermont River Management Program, to conduct a Phase 2 Stream Geomorphic Assessment of the Joiner Brook main stem. Gretchen Alexander and Sacha Pealer from the Vermont River Management Section of the Vermont Agency of Natural Resources (VANR) provided technical guidance for this project. The River Corridor Planning Team also hosted a field workshop for community members to explain the Phase 2 Stream Geomorphic methods on September 10, 2008 along the banks of Joiner Brook.

2.2 GOALS AND OBJECTIVES OF THE PROJECT

2.2.1 State River Management Goals and Objectives

The State of Vermont's River Management Program has set out several goals and objectives that are supportive of the local initiative in the Joiner 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, 2007c). The objectives of the Program are to avoid damage to investments due to fluvial erosion hazards, to reduce sediment and nutrient loads, and to restore and protect aquatic and riparian habitat. Additionally, the Vermont River Management Program has set out to provide funding and technical assistance to facilitate an understanding of river instability and the establishment of well developed and appropriately scaled strategies to protect and restore river equilibrium.

2.2.2 Local Goals and Objectives

Joiner Brook is an important resource for the Town of Bolton. The Bolton Planning and Conservation Commissions would like to use the results of the Phase 2 assessment to review future development in the Joiner Brook watershed. Bolton Valley Resort is located in the upper reaches of the watershed. Additional development activities have been recently completed and more are proposed in the vicinity of the resort (see Figure 1). In addition to Bolton Valley Resort, private homes, businesses and the local elementary school are located in the watershed. Roads and infrastructure that have sustained damages during past flood events provide reasonable cause for concern about the potential impacts of further development in the upper watershed. Stream Geomorphic Assessment data collection and analysis carried out by BCE will:

1. aid the Town of Bolton in the analysis of the fluvial geomorphic and biotic habitat conditions in the watershed,
2. result in preliminary project identification for the protection and restoration of important study reaches,
3. create a fluvial erosion hazard (FEH) corridor or setback regulation that , if incorporated under town land use regulations, may be used to regulate future development along Joiner Brook, and
4. lead to a watershed restoration plan to address and mitigate stressors affecting the watershed.

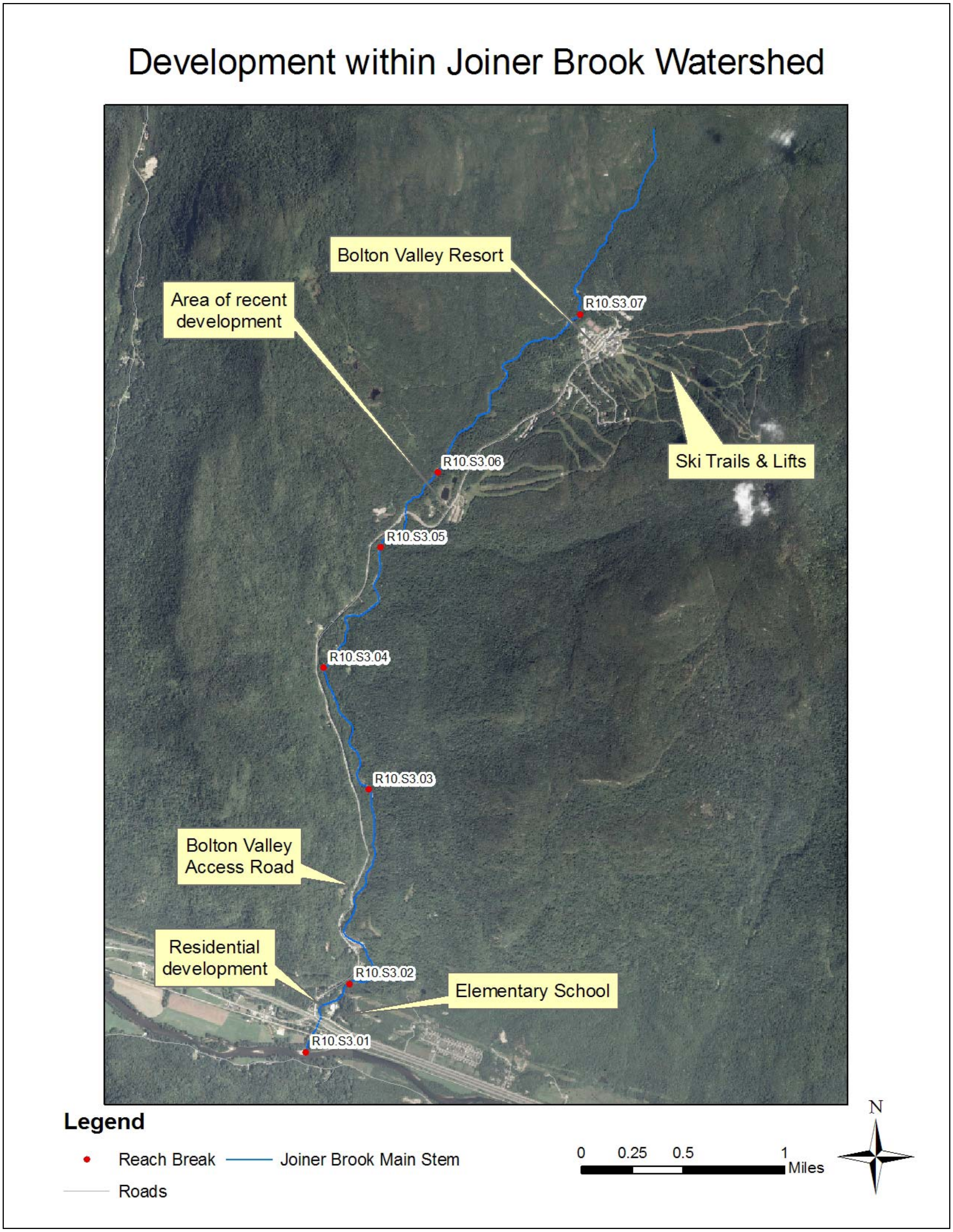

Figure 1. Areas within the Joiner Brook watershed with concentrated development.

3.0 BACKGROUND WATERSHED INFORMATION

3.1 Geographic Setting

The Joiner Brook watershed has an area of 9.28 square miles and lies within the Winooski River Watershed, which is one of the major rivers in Vermont within the Lake Champlain Basin (Figure 2). Located in Bolton, in the middle section of the Winooski River Watershed, Joiner Brook begins above Bolton Valley Resort, flows down Bolton Mountain and enters the Winooski River downstream from the Smilie School and beyond the bridges for Interstate 89 and the railroad. The Joiner Brook watershed lies within the region of the Chittenden County Regional Planning Commission.

The Joiner Brook watershed drains from approximately 2,700 feet in elevation at Bolton Mountain in a southerly direction and meets the Winooski River near the intersection of the Bolton Valley Access Road and US Route 2 at approximately 340 feet above sea level. The Phase 2 study area focuses on the lower 6 reaches on the main stem of Joiner Brook. Joiner Brook flows through a steep gradient valley. All reaches assessed for Phase 2 on Joiner Brook have a channel slope of greater than 3 percent.

The Joiner Brook watershed is dominated by forested land. However, within the watershed agricultural and urban (developed ski areas, residential, commercial, and industrial) land uses are also present. As shown in Figure 3, 88 percent of the Joiner Brook watershed is forest, four percent is agriculture, two percent is developed area, seven percent is water, and less than one percent is wetlands. The ski area is mostly classified as agricultural land according to the 2002 Land Cover/Land Use Dataset for Vermont which was used to generate Figure 3. It is worth noting that ski area development, including maintained ski trails, is the subdominant land use aside from forest in the upper-most subwatershed. Development is concentrated in the mid to upper portion of the watershed at Bolton Valley Ski Resort and at the lower end of the watershed in the vicinity of the Smilie Elementary School. The Bolton Valley Access Road parallels Joiner Brook from the base of the watershed up to Bolton Valley Resort.

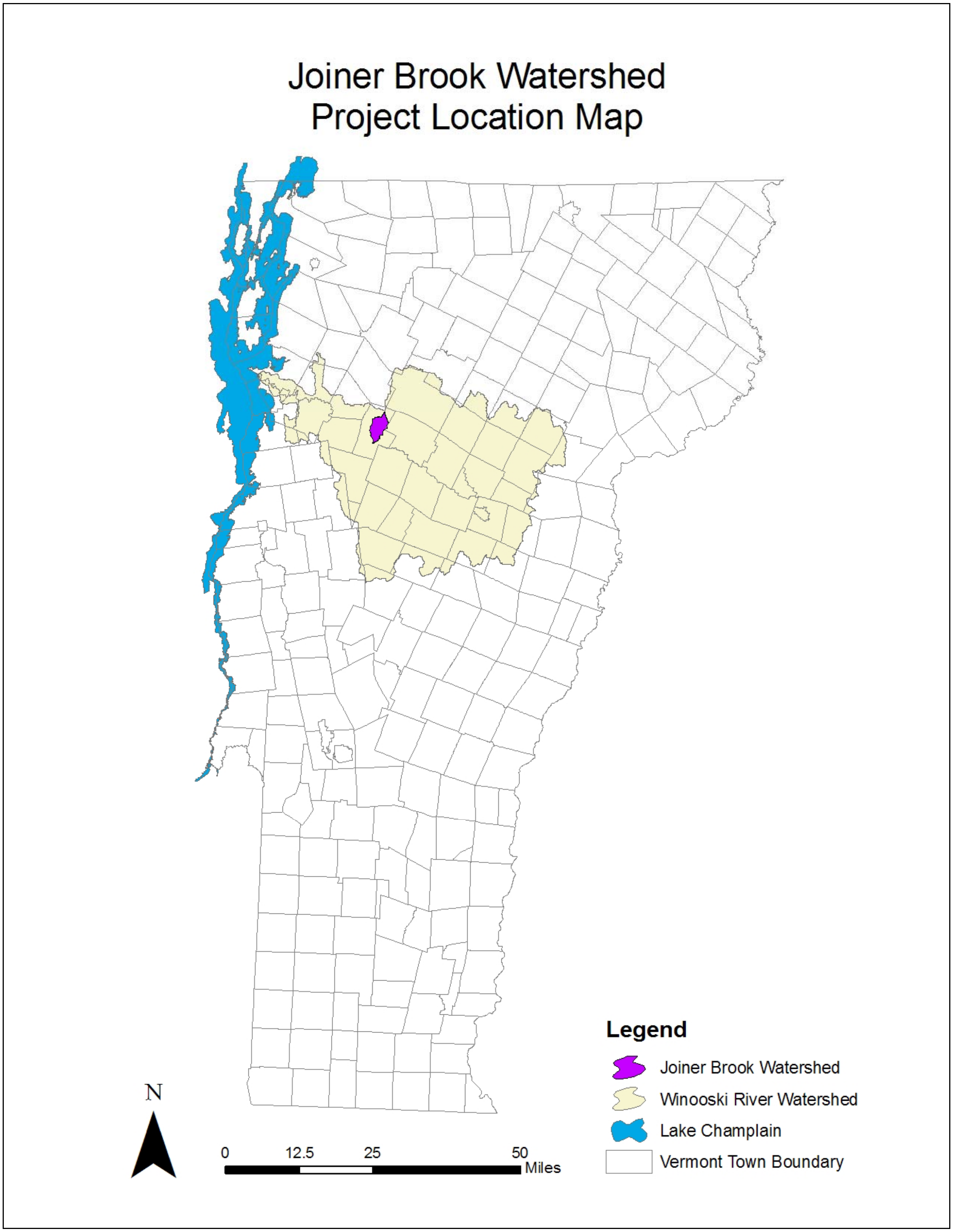

Figure 2. Project Location Map for the Joiner Brook Watershed

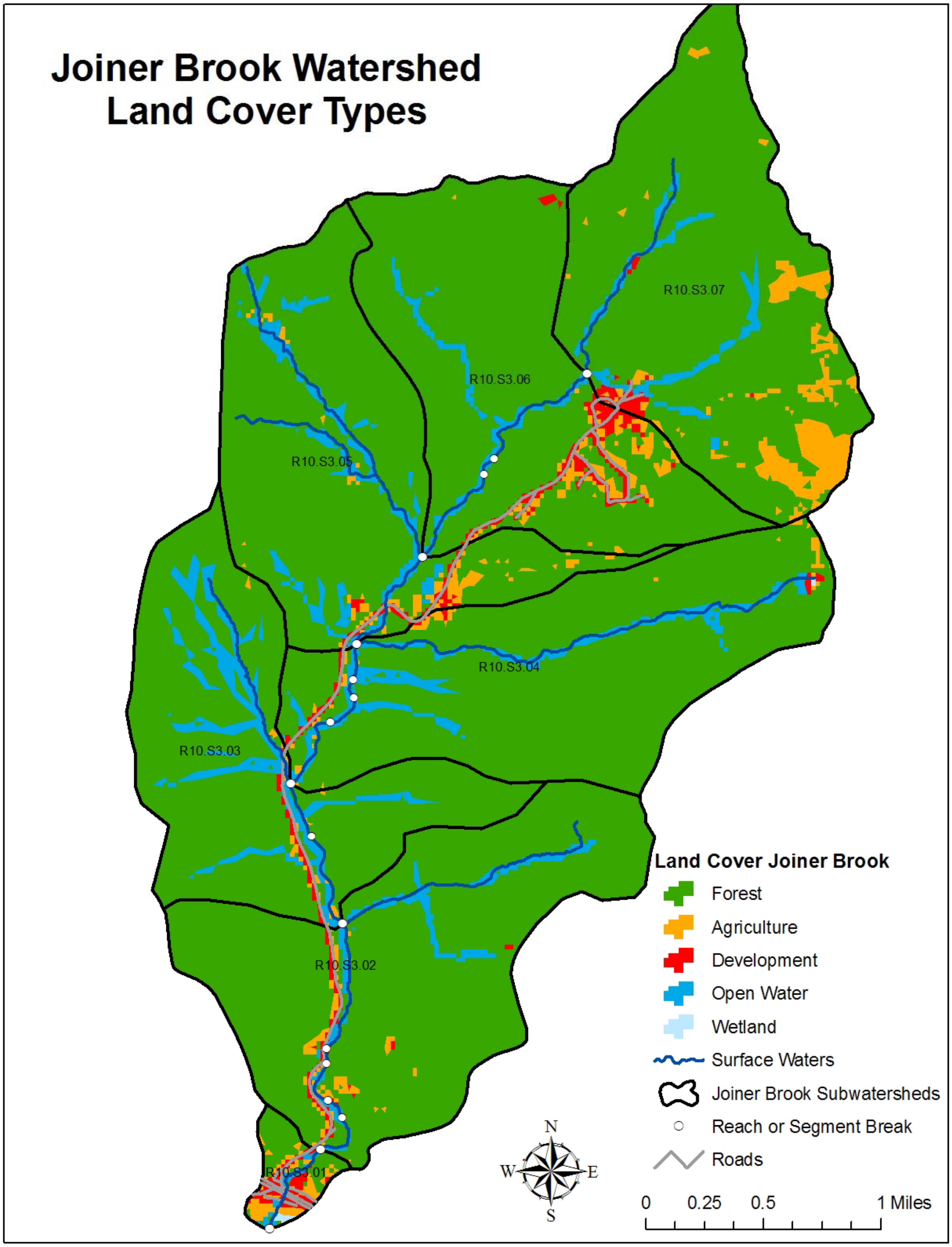

Figure 3. Land cover and land use map for the Joiner Brook Watershed

3.2 Geologic Setting

The Joiner Brook Watershed is located within the Green Mountain Province. The Green Mountains are composed of schists and phyllites, metamorphosed from ancient oceanic sediments, lava and oceanic crust and mantle. The Green Mountains were uplifted during the Taconic orogeny about 455 million years ago (Doolan, 1996). The Green Mountains have been covered with ice during historic glacial periods. The last large ice sheet, the Laurentide Ice Sheet, covered all of New England and advanced up the Winooski River valley (Wright and Larsen, 2004). As the climate warmed, the glacier slowly retreated and formed glacial Lake Winooski, covering the Winooski valley and many tributaries, with a surface elevation of approximately 915 feet (Van Diver, 1987). Following the retreat of the glacier, the Winooski River and its tributaries began eroding the glacial and lake sediments that were left behind (Wright and Larsen, 2004).

The dominant surficial sediments within the Joiner Brook Watershed are comprised of glacial till (Doll, 1970). Bedrock maps of the Joiner Brook watershed show that the watershed is primarily comprised of the Underhill Formation: a schist containing aggregations of granular white quartz with localized phyllite and gneissic facies (Doll, 1961). The Underhill schist is a relatively soft bedrock that erodes over time from the erosive forces of flowing water (Goss, 2005). This geology has provided a series of pools, cascades and waterfalls on Joiner Brook that are popular for swimming and recreation. According to Hungerford (2009), the potholes is "one of the best waterfall and swimming hole sites around". The potholes is located just upstream of the Smilie School where the Bolton Valley access road becomes steeper. Another significant series of waterfalls, the Upper Joiner Brook Falls is located near the "S" curve of the Bolton Valley access road.

3.3 Geomorphic Setting

The Joiner Brook Watershed was divided into 13 reaches for the Phase 1 assessment. Phase 2 Geomorphic Assessments were conducted on the six lowest reaches of the Joiner Brook main stem from just above Bolton Valley Resort to the confluence of the Winooski River near the intersection of the Bolton Valley Access Road and US Route 2 (Figure 4). Fluvial erosion hazard zones developed for the project include the entire mainstream through R10S3.07.

Reference stream types[1] 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. Reference stream typing was based on both the Rosgen (1996) and Montgomery and Buffington (1997) classification systems. Table 1 shows the typical characteristics used to determine reference stream types (VANR, 2007a). The reference stream types within the Joiner Brook watershed strongly reflect the steep stream valley. Coarse sediment and bedrock are prevalent along most of the stream.

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[1] Additional information about reference stream typing can be found on the Vermont Agency of Natural Resources web page - http://www.anr.state.vt.us/dec/waterq/rivers/docs/assessmenthandbooks/rv_weblinkpgphase1.pdf

While all of the reaches included in Phase 2 assessment have high valley slopes (>3 percent), most of these reaches are also unconfined and provide some floodplain access to the channel. Reference stream types for the assessed reaches are listed in Table 2. With the exception of R10.S3.05, all assessed reaches on Joiner Brook are classified as "C" channels by reference. These reaches have a moderate width to depth ratio and flow through unconfined valleys. Reach R10.S3.05 flows through a semi-confined valley and has a stream type of "B".

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

Table 2: Geomorphic Setting of Assessed Reaches

Reach ID	Reference Stream Type	Confinement	Valley Slope	Bed Form
R10.S3.01	C	Very Broad	3.18	Riffle-Pool
R10.S3.02	C	Broad	6.58	Step-Pool
R10.S3.03	C	Narrow	5.00	Step-Pool
R10.S3.04	C	Very Broad	4.68	Step-Pool
R10.S3.05	B	Semi-Confined	9.43	Step-Pool
R10.S3.06	C	Narrow	9.96	Step-Pool

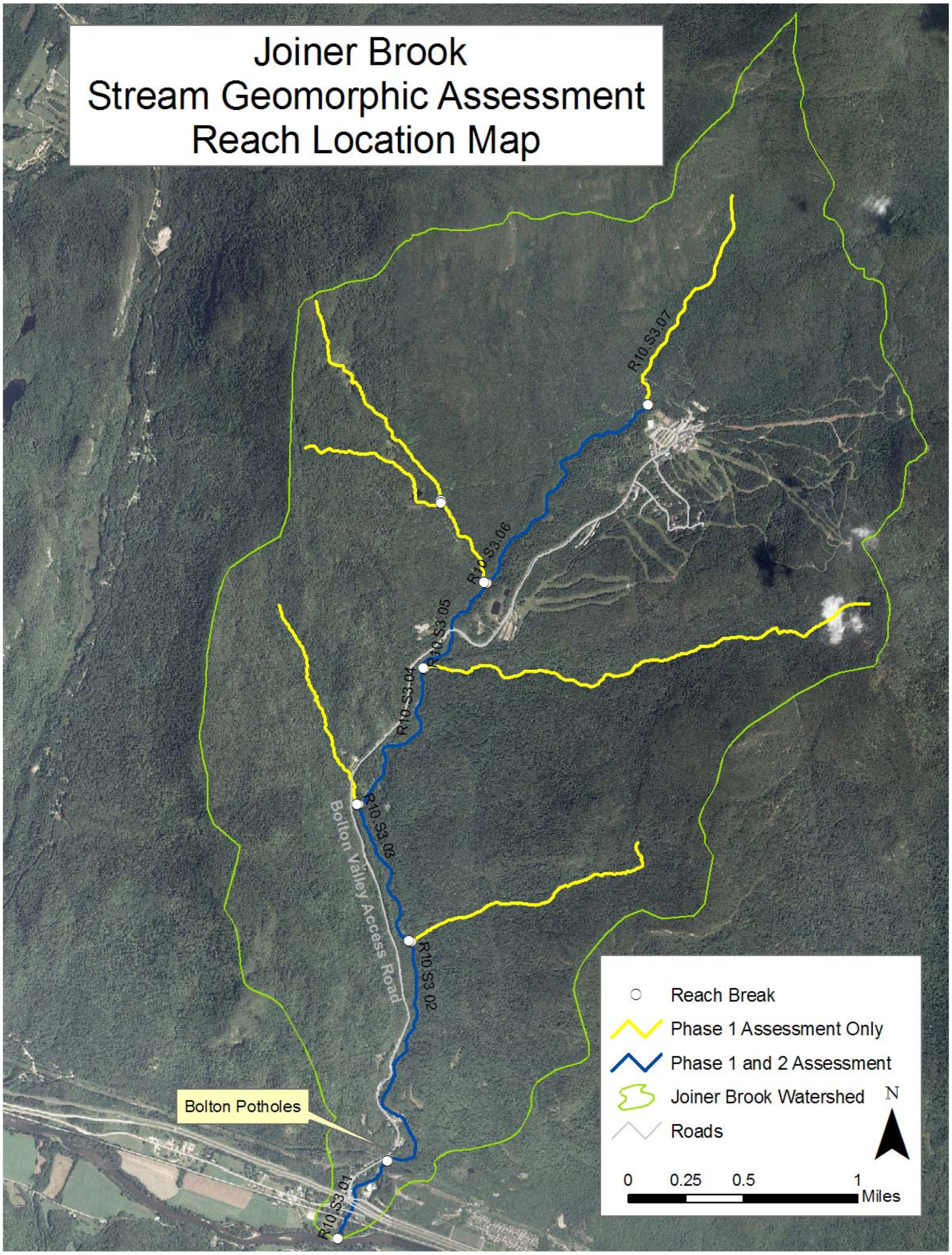


Figure 4. Reach location map for the Phase 2 Stream Geomorphic Assessment

There are no alluvial fans within the assessed reaches. There are multiple waterfalls and ledge grade controls located in the reaches included in the Phase 2 assessment. Segment R10S3.04-C also contains a human constructed weir used by Bolton Valley Resort for snowmaking operations.

3.4 Hydrology

In order to better understand the flood history of Joiner Brook, long term peak discharge data from the U.S. Department of the Interior, U.S. Geological Survey (USGS) gauge on the Mad River at Moretown, VT and the Dog River at Northfield Falls, VT was obtained. Both the Mad River and the Dog River are major tributaries to the Winooski River. The Joiner Brook watershed is a much smaller watershed compared with the Dog River and the Mad River. Nonetheless, the flow record from these gauges is useful information.

The Mad River gauge provides a continuous record of flow from 1928 through the present. The drainage area at the Mad River gauge is 139 square miles. A graph of the flood frequency analysis is provided in Figure 5 below. The long term record for Mad River shows a 10 year discharge occurred in water year[2] 1982 and was exceeded in water year 1976. Approximately a 25 year discharge occurred in 1998. During water year 1938, the peak discharge exceeded the projected 50 year discharge. The largest flood event on record occurred in November 1927 (water year 1928). The flood of 1927 was one of Vermont's greatest natural disasters. "The flood caused massive damage and loss of life in Bolton as well as the rest of the state. Farms were lost, roads washed out and bridges destroyed" (Excerpt from Memories of the 1927 Flood in Bolton, VT, by the "May" Family; McGrath 2009).

[2] A water year is a twelve month period from October 1 through September 30

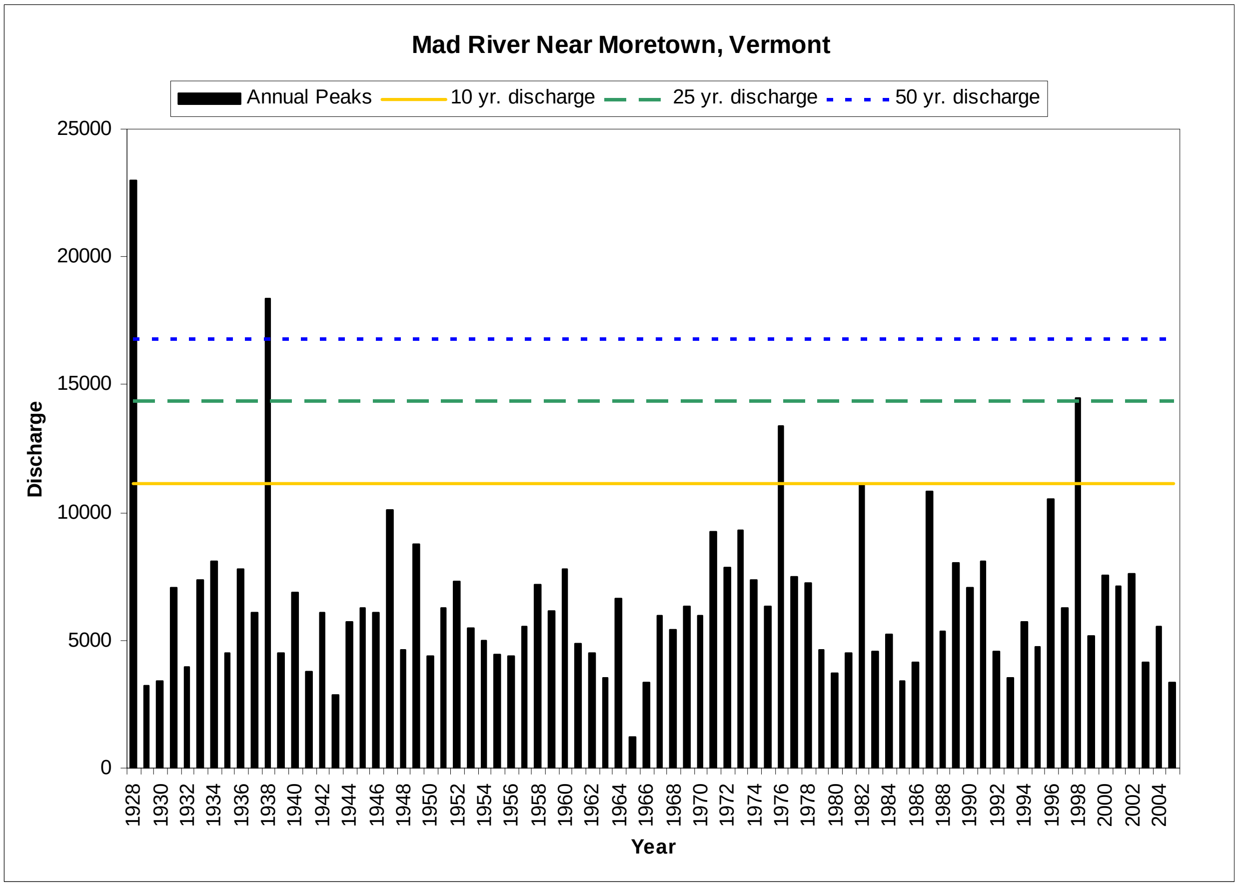


Figure 5: Flood frequency analysis for the Mad River

Long term peak discharge data from the U.S. Department of the Interior, U.S. Geological Survey (USGS) gauge on the Dog River at Northfield Falls, VT was also used. The gauge provides a continuous record of flow from 1935 through the present. The drainage area at the Dog River gauge is 76 square miles (approximately eight times the size of the Joiner Brook watershed).

A graph of the flood frequency analysis for the Dog River is provided in Figure 6. The Dog River record shows that the 10 year discharge was exceeded in water years 1952, 1976, 1987 and 1989 and between a 25 and 50 year discharge occurred in 1938. During water year 1973, the peak discharge exceeded the projected 50 year discharge. It is interesting that the 25 year discharge occurred on the Mad River in 1998, but in the Dog River not even the 10 year discharge was exceeded on the Dog River in that year. Localized precipitation events account for differences in high flow events between gauges. Flooding reported in 1973 in Bolton coincides with a projected peak discharge greater than a 50 year discharge on the Dog River in the same year.

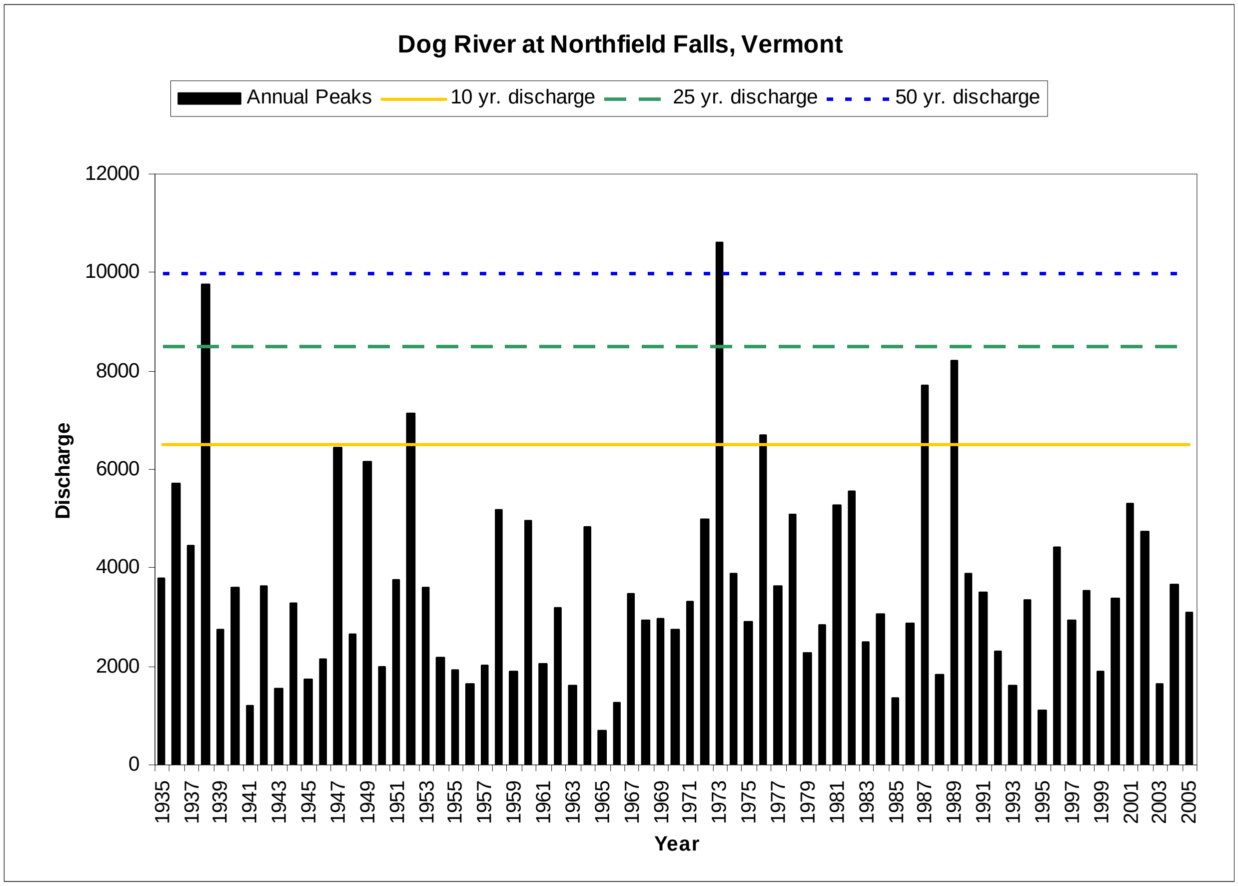


Figure 6: Flood frequency analysis for the Dog River

In recent history, roads and infrastructure in Bolton have sustained damages during flood events. Some of this damage has been from localized precipitation events that have caused flash flooding. Amy Grover, Town of Bolton Planning Commission, researched historic Town of Bolton reports and found mention of flooding in 1972 and 1973 in the 1974 town report. Joiner Brook underwent historic stream channel modifications in Bolton in response to flooding concerns.

Based on an interview with Bolton resident Duncan Galbraith, Amy Grover provided the following information about stream channel modification of Joiner Brook.

1. In the mid to late sixties, Joiner Brook was redirected and "channelized" to the west at the base of the watershed. This major excavation and site work was done when Smilie School was built (to help protect the school from flooding), when the Bolton Valley Access Road was built, and when Route 2 was relocated to allow for Interstate 89 to be constructed through Bolton.

2. This excavation work included the removal of a small hill on the westerly side, and grassy meadow areas where a now deceased but long time resident (Gordon Curtis) remembered bringing his family's cows to feed and go down the bank to drink water

from the brook. At that time, the westerly bank of Joiner Brook was located approximately where the current easterly bank is located.

3. After flooding in the early seventies, Mary Fraser, a local resident located near the base of the Bolton Valley Access Road on the west side of the brook, complained vehemently at town meeting in 1974 about the brook continuing to undermine, erode, and flood her property. As a result, the Town of Bolton approved funding to install rock rip rap, and fill. The brook was again channelized, moving it back toward the east. In addition to installing the large boulder rip rap, two bulldozers were used down in the brook to create a channel and to build up the banks with material from the brook bed. No additional material or excavation work is known since that time.

Flood damage in Bolton also occurred in July 1990. Employees and tourists and children from a day care were stranded after flash floods tore a 70 foot chasm across the Bolton Access Road in the vicinity of the "S" curve. (Hall, 1990 and Howland, 1990). The following excerpt from the Burlington Free Press (Newbeck, July 31, 2008) describes flood damages in Bolton:

Joiner Brook might not seem like a raging river but Town Clerk Deb LaRiviere remembers the last time the stream jumped its banks. "It was July 20, 1990," she said. "That date is embedded in my brain." Heavy rains caused the brook to overflow causing close to $2 million in damage to town property alone. Roughly a one-quarter-mile section of the Bolton Valley access road was destroyed and a temporary road had to be constructed to ferry down the people trapped above that section and to get the construction crews up to make repairs"

3.5 Ecological Setting

The Joiner Brook watershed lies within the Northern Green Mountains biophysical region. The Northern Green Mountains is characterized by Thompson and Sorenson (2005) as having high elevations and cool summers. The Green Mountains have a strong influence on the weather resulting in an abundance of precipitation in the form of both rain and snow. Northern hardwood forest is the dominant community in this biophysical region. The Northen Green Mountains provide important habitat for both aquatic and terrestrial animals. According to Thompson and Sorenson (2005), the Green Mountains provide extensive habitat for black bear, white-tailed deer, bob cat, fisher, beaver and red squirrel. Birds such as blackpoll warbles, Swainson's thrush and the rare Bicknell's thrush nest in the high elevation forests. Brook trout are native to the high elevation streams. "Brook trout occur naturally in the brook (Joiner Brook) and rainbow and brown trout from the Winooski spawn at the mouth of Joiner Brook" (Vermont Agency of Natural Resources, 2008c).

4.0 METHODS

4.1 Phase 1 Methodology

A Stream Geomorphic Assessment process is divided into three phases, based on VANR protocols. 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 remote sensing techniques allow for large watersheds (100-150 square miles) to be assessed within a few months time. The Phase 1 assessment provides an overview of the general physical nature of the watershed, identifies which reaches are in particular need. As noted in the Executive Summary, Joiner Brook was included in the Mid-Winooski River Watershed Phase 1assessment.

4.2 Phase 2 Methodology

The Phase 2 assessment was conducted by BCE following procedures specified in the Vermont Stream Geomorphic Assessment Handbook Phase 2 (Vermont Agency of Natural Resources 2007b), and used version 4.59 of the Stream Geomorphic Assessment Tool (SGAT) GIS extension to index impacts within each reach. New Rapid Habitat Assessment Protocols (Vermont Agency of Natural Resources, 2008a) were used to evaluate the habitat within the Phase 2 study reaches.

4.3 Bridge and Culvert

The Bridge and Culvert Assessment and Survey Protocols specified in Appendix G of the Vermont Stream Geomorphic Assessment Handbook (Vermont Agency of Natural Resources, 2007d) were followed. All assessment data were recorded on the Agency of Natural Resources (ANR) Bridge and Culvert Assessment – Geomorphic and Habitat Parameters data sheet, and were entered into the ANR DMS. An ArcView shapefiles of stream crossings for the State of Vermont "TRANS_TRANSTRUC_POINT" was downloaded from the Vermont Center for Geographic Information. This shapefile includes stream crossings on state and town roads.

The bankfull channel width from the Phase 2 fieldwork was used to determine the expected bankfull width in the vicinity of a particular structure. Latitude and Longitude at each of the structures was determined using a Garmin Etrex Vista GPS unit. The assessment included photo documentation of the inlet, outlet, upstream, and downstream of each of the structures. The Vermont Culvert Geomorphic Screening tool (2008a) and the Vermont Culvert Aquatic Organism Passage Screening Tool (2008b) developed by Milone and MacBroom, Inc. were used to identify culverts within the Joiner Brook watershed that are highest priority for replacement/retrofit due to geomorphic incompatibility and/or for being potential barriers to movement and migration of aquatic organisms. A modification to the Vermont Culvert Geomorphic Screening tool was made for bridges. The bridge scoring was modified to exclude slope. The following scoring was used for bridges: Fully compatible (17-20), Mostly compatible (13-16), Partially compatible (9-12), Mostly incompatible (5-8), and Fully incompatible (1-4).

4.4 River Corridor Plan

The Vermont Agency of Natural Resources River Corridor Planning Guide (2007c) and Draft 9 of Chapter 5 of the plan dated October 2, 2007 were followed to generate a series of stressor maps. These maps were created using indexed data from the Phase 1 and Phase 2 Stream Geomorphic Assessments along with existing data available from VCGI, including railroads, e911 roads, e911 buildings and e911 driveways. The stressor maps were then used to identify potential project locations that have few constraints to channel adjustment.

4.5 Quality Control/Quality Assurance Procedures

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 as well as automated and manual QC checks with the DEC River Management Program.

In November 2008, BCE completed its own in-house QA review after all the Phase 2 data were entered into the DMS and the Phase 1 data were updated. The Phase 1 DMS and ArcView shapefiles were updated by Mary Nealon and Pamela DeAndrea based on the Phase 2 field assessment work during the Phase 2 QA/QC process. The DMS and the ArcView shapefiles for the Joiner Brook Phase 2 study were submitted to Gretchen Alexander of the ANR for a Quality Assurance review in mid November 2008. Some minor revisions were made by Bear Creek Environmental to the DMS following this review.

5.0 RESULTS

A description of each reach/segment from downstream to upstream is provided in this section. The Phase 2 data are provided in Appendix B. In general, the Phase I channel widths for Joiner Brook were substantially less than the bankfull channel widths measured in phase 2. There is greater uncertainty in the phase 1 channel widths, so in order to calculate confinement for most segments; BCE used their best judgment based on phase 2 field conditions to determine the confinement type.

Reach R10.S3.01

Reach R10.S3.01 begins at the confluence of Joiner Brook and the Winooski River and continues upstream to the first bedrock waterfall. The average slope of greater than 2 percent is primarily due to waterfalls at the upper end of this reach. Most of the lowest reach on Joiner Brook is a Rosgen “C” stream type. This reach has undergone major historic incision as a result of extensive channelization, armoring, and windrowing. R10.S3.01has many encroachments and structures within the river corridor, including Smilie School, the Bolton Valley Access Road, Interstate 89, US Route 2, and railroad tracks. R10.S3.01 is in fair geomorphic condition with poor habitat quality due to lack of woody debris and bed substrate cover, obstructions blocking aquatic organism passage, poor hydrologic characteristics, extensive channelization and armoring, and lack of riparian buffers.


Straightened stream channel in R10.S3.01

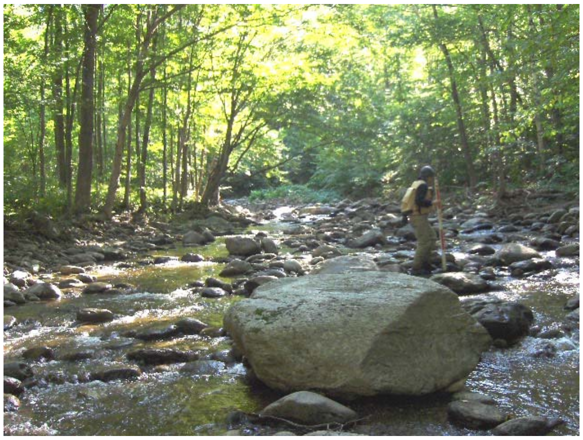
Within Reach R10.S3.01, there was major excavation and site work at the lower end of the brook in the mid to late 1960s. The brook was redirected and "channelized" to the west, when Smilie School was built (to help protect the school from flooding), when the Bolton Valley Access Road was built, and when RT 2 was relocated to allow for Interstate 89 to be constructed through Bolton. After flooding in the early 1970s, the Town of Bolton approved funding to riprap the brook, moving it back toward the east. In addition to installing the boulder riprap, bulldozers were used to create a channel and build up the banks with material from the brook.

Reach R10.S3.02

Reach R10.S3.02 was divided into five segments to account for alternating areas of bedrock gorge and stream channel. This reach begins at the top of a bedrock waterfall, continues upstream to the east of the Bolton Valley Access Road, and ends where a major tributary enters on the left bank.

R10.S3.02-A is a Rosgen “C” stream type. The segment transitions as follows: upper is confined with a step-pool bedform; mid is unconfined with a riffle-pool bedform; lower is confined with a step-pool bedform. This segment has undergone minor historic incision. There was a silt layer noted on the substrate, which is likely attributed to road runoff. Overall, R10.S3.02-A is in good geomorphic condition with dominant buffers of greater than 100 feet on both sides. The habitat ranked in the fair category due to lack of aquatic organism refuge and multiple channel obstructions.

S3.02-B was only partially assessed because it is a bedrock gorge and the field team could not walk the entire length of the segment. This segment has multiple waterfalls that have total heights in the range of 19 to 45 feet. There were also multiple large pools. R10.S3.02-B is in reference condition with the exception of the lack of a buffer on the right bank near the top of the segment.



Typical stream channel in R10.S3.02-A

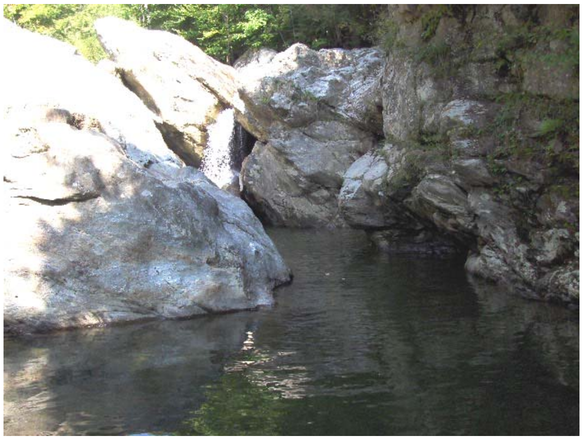
Bedrock gorge in R10.S3.02-B

Segment R10.S3.02-C is steeper than R10.S3.02-A, and also has larger substrate. This segment is a Rosgen "C" channel, though the entrenchment ratio closely borders a "B" channel. The habitat scored is in fair condition due to limited aquatic organism refuge, channel morphology, and lack of large woody debris. There are generally adequate buffers on both sides, though there are some minor areas where the buffer could be improved. This segment is in good geomorphic condition having undergone some minor historic incision and the planform is currently undergoing some minor adjustment.

Area of reduced riparian buffer in R10.S3.02-C

R10.S3.02-D was only partially assessed because it is a bedrock gorge. This segment has multiple waterfalls and large pools. Joiner Brook runs relatively close to the road in this location. A few stormwater inputs via road ditches and overland flow were mapped in this segment. R10.S3.02-D is in good condition with dominant buffers of greater than 100 feet on both sides.

R10.S3.02-E alternates between a "F" Rosgen stream type and a "B" Rosgen stream type by reference. This segment is in fair geomorphic condition and it is experiencing major aggradation and planform adjustment, particularly in areas where the valley wall opens up and is not continuous with banks. This segment has 18 stormwater road ditches impacting flow status and contributing sediment to Joiner Brook during runoff events. The habitat is also fair in this segment due to limited refuge habitat and many channel obstructions. R10.S3.02-E has dominant buffers of greater than 100 feet on both banks.



Bedrock gorge and waterfall in R10.S3.02-D

Typical channel in R10.S3.02-E

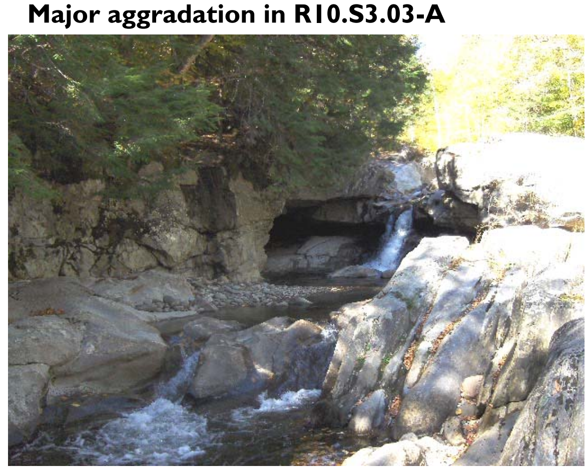
Reach R10.S3.03

Reach R10.S3.03 was split into two segments due to the presence of grade controls in the upstream segment. The reach begins where a tributary enters on the left bank and continues for 3,673 feet to the confluence of another major tributary entering on the right bank.

R10.S3.03-A is a Rosgen "C" channel in fair geomorphic condition with lots of exposed substrate. This segment is located to the east of the Bolton Valley Access Road and it is undergoing major aggradation and planform adjustment, evidenced by numerous mid-channel bars, large side bars and flood chutes. The habitat scored in the good category in this segment which has buffers greater than 100 feet on both sides.

Major aggradation in R10.S3.03-A

Segment R10.S3.03-B contained multiple bedrock waterfall grade controls. The substrate in the channel that was not bedrock was generally very large. Two cross-sections were surveyed in this segment. The upper cross section, located at the top of the segment upstream of the waterfall grade controls was more incised and had a lower width to depth ratio. The lower cross section was slightly incised and was more representative of the segment. R10.S3.03-B is a "B" stream type



Multiple waterfalls in R10.S3.03-B

in fair condition. Aggradation, planform adjustment and historic widening were noted in the riffles located between the waterfalls. The habitat was fair in this segment with limited refuge habitat and multiple channel obstructions (waterfalls). Buffers were greater than 100 feet on both banks.

Reach R10.S3.04

Reach R10.S3.04 begins above the confluence with a major tributary entering on the right bank and continues to just below the "S" curve on the Bolton Valley Access Road. This reach was split into four segments due to changes in valley confinement and changes in historic incision.

R10.S3.04-A is a Rosgen "C" channel in fair condition. This segment has a reference bedform of planebed, based on the field-measured slope of 3.5 percent. This segment has a historic incision ratio of 1.76, which may be contributing to the planebed features. The slope was lower in segment A than upstream segments (B-D). Segment R10.S3.04-A is very wide with low to moderate bank erosion. Aggradation, widening and planform adjustment were all active processes in this segment, evidenced by mid channel accumulation, active flood chutes and islands, and a high width to depth ratio. The habitat was fair in this segment as a result of the over-wide channel width, and dominant buffers were greater than 100 feet on both banks.

R10.S3.04-B is a "C" stream type in good geomorphic condition with large boulders at the very top of the segment. This segment is not incised and it appears to be holding the elevation of the bed. Active flood chutes indicate major planform adjustment is occurring within the segment. The habitat is fair in segment R10.S3.04-B because of negligible refuge habitat, lack of large woody debris and a high percentage of exposed substrate. There were frequent and deep pools with good cover in this segment.

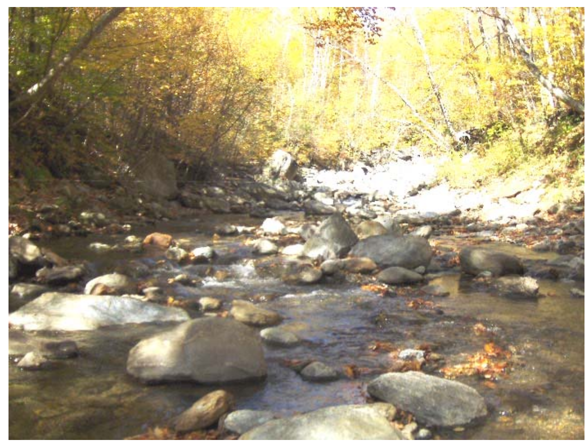
Active flood chute in R10.S3.04-A

Typical channel in R10.S3.04-B

R10.S3.04-C has lost access to its floodplain as a result of historic incision. This segment incised as a result of being sediment starved below a weir. The weir is used by Bolton Valley Resort for snowmaking water withdrawal operations. There are two-4 foot openings on the weir, making it a significant channel constriction. One of the openings is filled with sediment, and there is extensive sediment buildup both above and below the weir. This segment had one very large mid-channel bar which was created by the channel constriction. R10.S3.04-C has undergone a stream type departure from a reference "C" channel to an existing "F" channel due to historic incision. This segment is in fair geomorphic condition and fair habitat condition. Though the buffers are greater than 100 feet on both banks, the snowmaking weir has caused major alterations to the stream channel and its habitat, including floodplain inaccessibility, bank erosion, major aggradation and widening of the channel, and loss of refuge habitat.

The lower end of segment R10.S3.04-D is just upstream of the weir for Bolton Valley Resort's snowmaking water withdrawal. This segment has some localized impact from the operation of the snowmaking water withdrawal at the lower end. The right bank is unstable and lacks a buffer immediately upstream of the weir. R10.S3.04-D is a Rosgen "C" channel in good geomorphic condition with only localized impact at the lower end of the segment. This segment has fair habitat due to limited refuge habitat, lack of large woody debris and hydrologic characteristics. Dominant buffers are greater than 100 feet on both sides of this segment.

Snowmaking weir in R10.S3.04-C



Typical channel in R10.S3.04-D

Reach R10.S3.05

This reach begins just below the "S" curve of the Bolton Valley Access Road, crosses under the road, and continues upstream to the confluence with a tributary on the right bank. A long section of bedrock grade controls dominate the channel with a series of bedrock waterfalls. This reach is a "B" channel in fair condition. It has incised historically and currently aggradation and widening are major processes. This reach has some minor influence from stormwater inputs near the culvert at the Bolton Valley Access Road, but dominant buffers are greater than 100 feet on both sides. The habitat is also fair in this reach because of numerous

Typical channel in R10.S3.05

channel obstructions and limited refuge habitat.

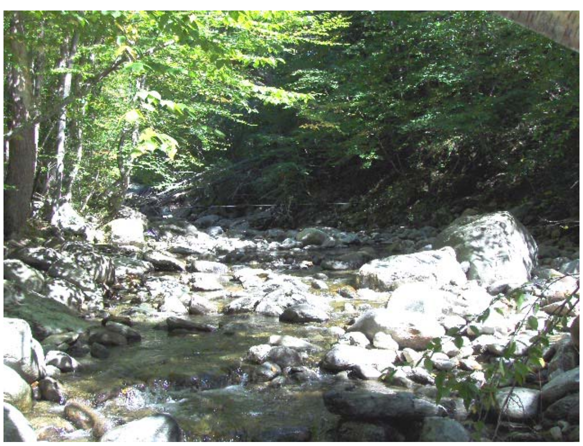
Reach R10.S3.06

Reach R10.S3.06 begins upstream of the confluence with a major tributary on the right bank above the Bolton Valley Access Road culvert, and continues upstream to the confluence with a minor tributary near Bolton Valley Resort Village. This reach was divided into three segments due to a bedrock gorge in the middle of the reach.

R10.S3.06-A extends for about 2,540 feet to the start of a very confined bedrock gorge. This segment is a Rosgen "B" channel in fair condition. Currently this segment is experiencing major aggradation and widening. The habitat in this segment is also fair as a result of limited refuge habitat and multiple channel obstructions. This segment has dominant buffers of greater than 150 feet.

Segment R10.S3.06-B was only partially assessed because it is a bedrock gorge and the field team could not walk the entire length of the segment. This segment is in reference geomorphic condition with buffers of greater than 100 feet on both banks, but it does present a major fish passage obstruction.

R10.S3.06-C is a "C" channel in fair condition due to current major aggradation and planform adjustment. Planform adjustment was particularly significant process in the downstream end of the segment. This segment has widened historically. The top of reach has a steeper gradient and less planform adjustment. The habitat was in fair condition as well in this segment as a result of limited refuge habitat and many channel obstructions. Buffers are greater than 100 feet on both sides of Joiner Brook in this segment.



Major aggradation in R10.S3.06-A

Typical channel in R10.S3.06-C

Reach R10.S3.07

Reach R10.S3.07 begins upstream of the confluence with the tributary near Bolton Valley Resort Village. This reach is very steep and is composed of large bounders with multiple grade controls and waterfalls. This reach was not assessed due to budgetary constraints. It is recommended that this reach be assessed in the future to provide baseline geomorphic and habitat conditions.

Typical channel at lower end of R10.S3.07

5.1 Rapid Geomorphic Assessment

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, 2007b). The reference stream type for each of the Phase 2 reaches was previously identified in Table 2. The six reaches of Joiner Brook that were assessed were further broken down into 16 segments based on different reference stream types. Of these 16 segments, Phase 2 RGAs were conducted on 13 segments, the remaining 3 segments were only partially assessed as they exist in bedrock gorges. Of the 13 segments where RGAs were evaluated, 4 segments rated in the good category and 9 segments rated in the fair category. Figure 7 illustrates the geomorphic condition of the streams in relation to the watershed.

The dominant adjustment processes in the Joiner Brook watershed are aggradation and planform adjustment. Several of the reaches studied in the Joiner Brook watershed are undergoing a channel evolution process in response to large scale changes in sediment, slope, and/or discharge associated with human influences on the watershed. Table 3 below summarizes the existing stream type, channel evolution stage, and the primary adjustment processes that are occurring for each study reach or segment.

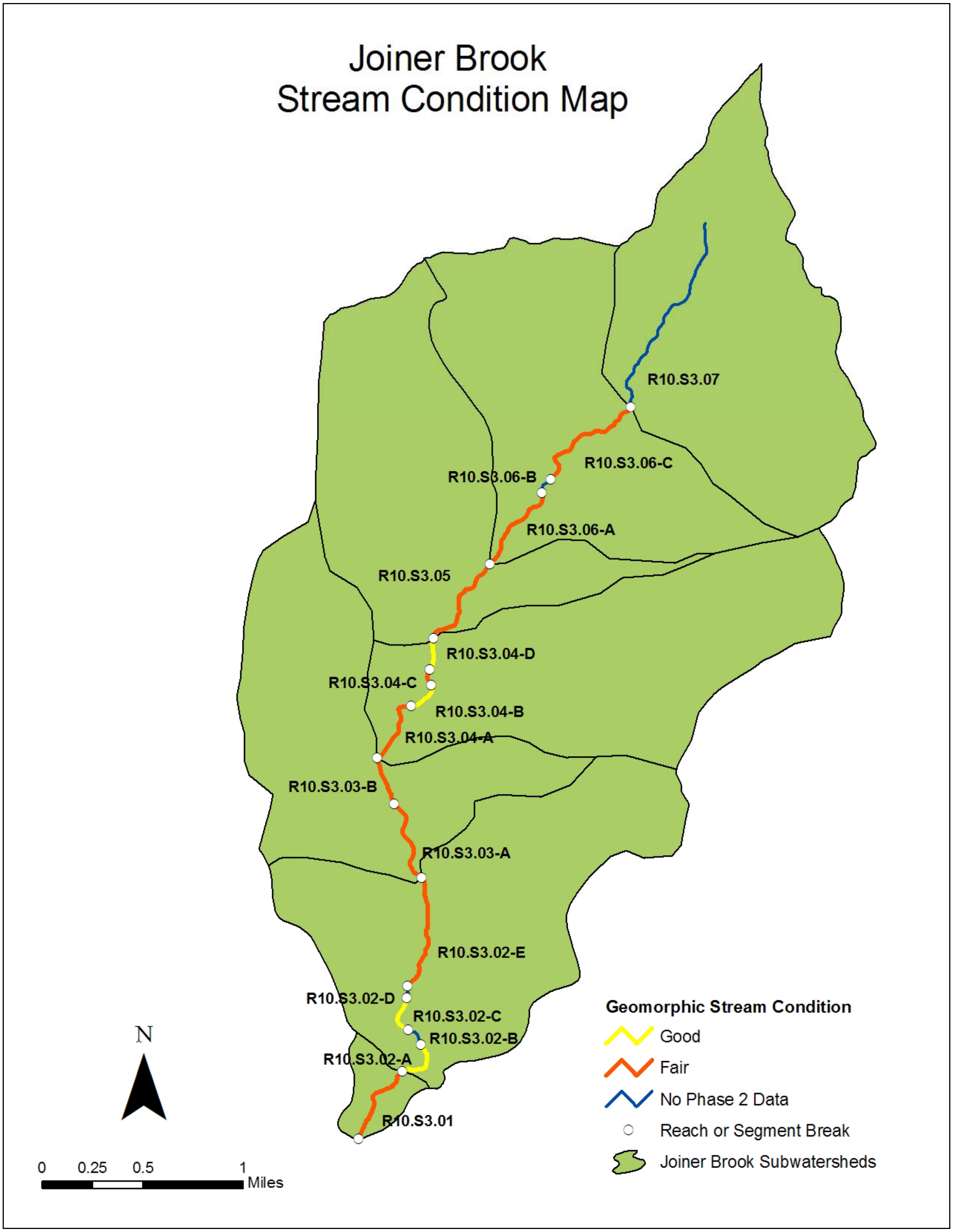


Figure 7. Reach condition map for the Phase 2 Geomorphic Assessment

Table 3. Stream Type and Channel Evolution Stage						
Segment Number	**Entrench -ment Ratio**	**Width to Depth Ratio**	**Reference Stream Type**	**Existing Stream Type**	**Channel Evolution Stage**	**Active Adjustment Process**
R10.S3.01	2.35	16.9	C4b	C4b	F II	**Aggradation** Widening Planform
R10.S3.02-A	3.22	25.9	C3b	C3b	F III	Aggradation Widening Planform
R10.S3.02-B	Partial Assessment – Bedrock Gorge					
R10.S3.02-C	2.24	13.9	C3b	C3b	F III	Aggradation Planform
R10.S3.02-D	Partial Assessment– Bedrock Gorge					
R10.S3.02-E	1.56	26.0	B4a	B4a	D IId	**Aggradation** Widening **Planform**
R10.S3.03-A	2.32	18.6	C3b	C3b	D IIc	**Aggradation** Widening **Planform**
R10.S3.03-B	1.56	43.6	B3a	B3a	D IId	**Aggradation** **Widening** **Planform**
R10.S3.04-A	6.50	49.4	C3b	C3b	F III	**Aggradation** **Widening** **Planform**
R10.S3.04-B	2.40	19.3	C3b	C3b	F I	**Planform** Widening
R10.S3.04-C	1.12	15.9	C3b	F3b	F III	**Aggradation** **Widening** Planform
R10.S3.04-D	2.75	22.0	C3b	C3b	F I	Planform Widening Aggradation
R10.S3.05	2.23	25.4	B3a	B4a	F III	**Aggradation** **Widening** Planform
R10.S3.06-A	1.69	16.0	B3a	B3a	D IId	**Aggradation** **Widening** Planform
R10.S3.06-B	Not Assessed – Bedrock Gorge					
R10.S3.06-C	2.99	38.3	C3b	C3b	D IId	**Aggradation** **Widening** **Planform**
Bold Red lettering - denotes extreme adjustment process **Bold Black lettering** – denotes major adjustment process Black lettering (no bold) – denotes minor adjustment process						

Both the "D" stage and "F" stage channel evolution model (Appendix C, ANR 2004) are helpful for explaining the channel adjustment processes underway in Joiner Brook. 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 8 include:

- A pre-disturbance period
- Incision – channel degradation
- Aggradation and channel widening
- The gradual formation of a stable channel with access to its floodplain at a lower elevation

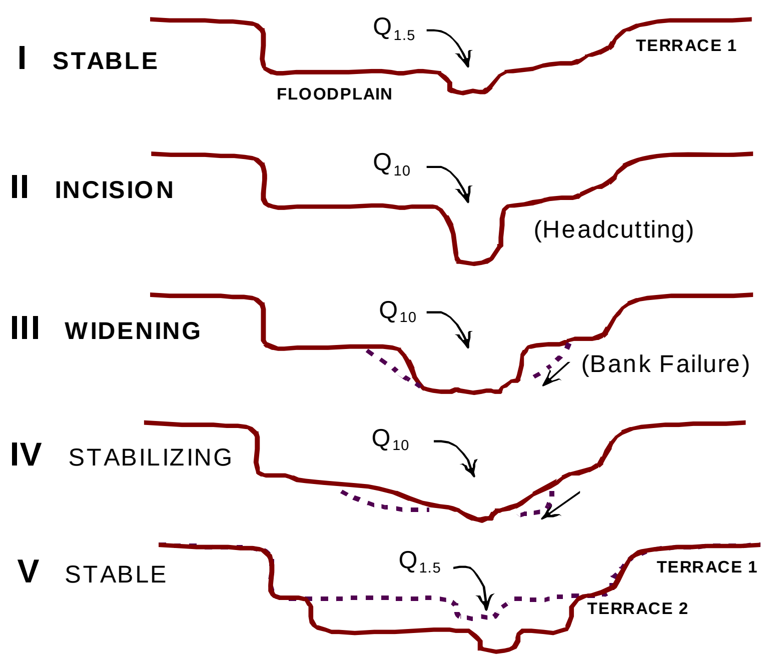


Figure 8. Typical Channel Evolution Model following incision

About half of Joiner Brook's assessed segments have undergone historic incision. Channel straightening and the impact of the snowmaking weir likely contributed to this historic incision. Reach R10S3.01 is in stage II of the "F" channel evolution model. Historic windrowing, berming and bank armoring are preventing this segment from widening and building a new floodplain. Segments that are currently in stage III of the "F" stage channel evolution model include R10.S3.02-A, R10.S3.02-C, R10.S3.04-A, R10.S3.04-C, and R10.S3.05. These segments have historically incised and are starting to or actively going through a widening process to create a floodplain at a lower elevation. Segment R10S3.04-C is located just below Bolton Valley Resort's snowmaking weir and has likely historically incised as a result of being sediment starved due to the weir. The numerous grade controls (see Figure 9) along the entire length of Joiner Brook have likely helped to control incision along the length of the river. Two segments (R10.S3.04-B and R10.S3.04-D) were noted to be in stage I of the "F" stage model indicating these segments are stable and are not significantly aggrading or degrading. A cascade with large boulders at the top of R10.S3.04-B appears to be acting to hold the elevation of the bed. Multiple bedrock grade controls in R10S3.05 are contributing to vertical stability in R10.S3.04-D.

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. Landowners and government agencies have repeatedly armored and bermed reaches of Vermont's rivers to contain floodwaters in channels. As shown in Figure 10, the lower reach of Joiner Brook is a good example of this management strategy. These efforts have proven to be temporary fixes at best, and in some cases have lead to disastrous property losses and natural resource degradation. A more effective solution is to limit encroachments within the riparian corridor and maintain a buffer of woody vegetation between the stream and adjacent land uses. Maintaining vegetated riparian corridors and offsetting development limits the conflict between property investments and the natural processes of flooding and channel migration that occurs gradually over time. Given room, a channel can adjust its shape and slope to changes in flow and sediment load. In general, the space provided by an established riparian corridor allows the river or stream system to be more resilient to watershed changes, thereby protecting the fish, wildlife, and humans that depend on Vermont's rivers and streams (Vermont Agency of Natural Resources 2005).

The segments assessed during the Phase 2 assessment on Joiner Brook that have not undergone historic incision and are under adjustment are best explained by the "D" stage evolution model. The more dominant active adjustment processes for the "D" stage channel evolution are aggradation, widening and planform change. Major aggradation (stage D II d) was noted in segments R10.S3.02-E, R10.S3.03-B, R10.S3.06-A and R10.S3.06-C making these areas important attenuation areas. Numerous stormwater inputs were mapped along the Joiner Brook access road. Sedimentation from the access road, mass failures and bank erosion are all likely contributing to aggradation in Joiner Brook.

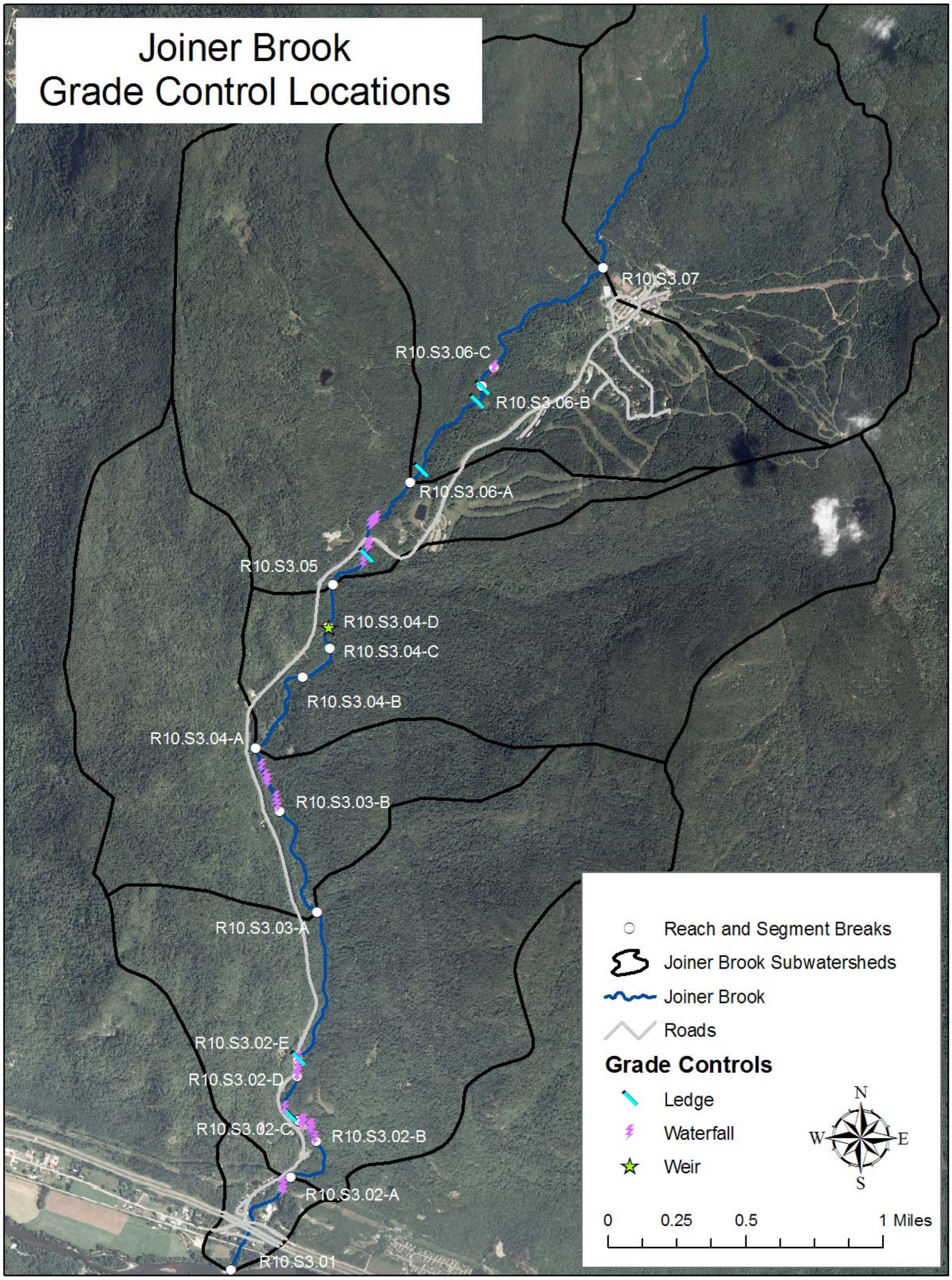


Figure 9. Grade Controls Locations on Joiner Brook

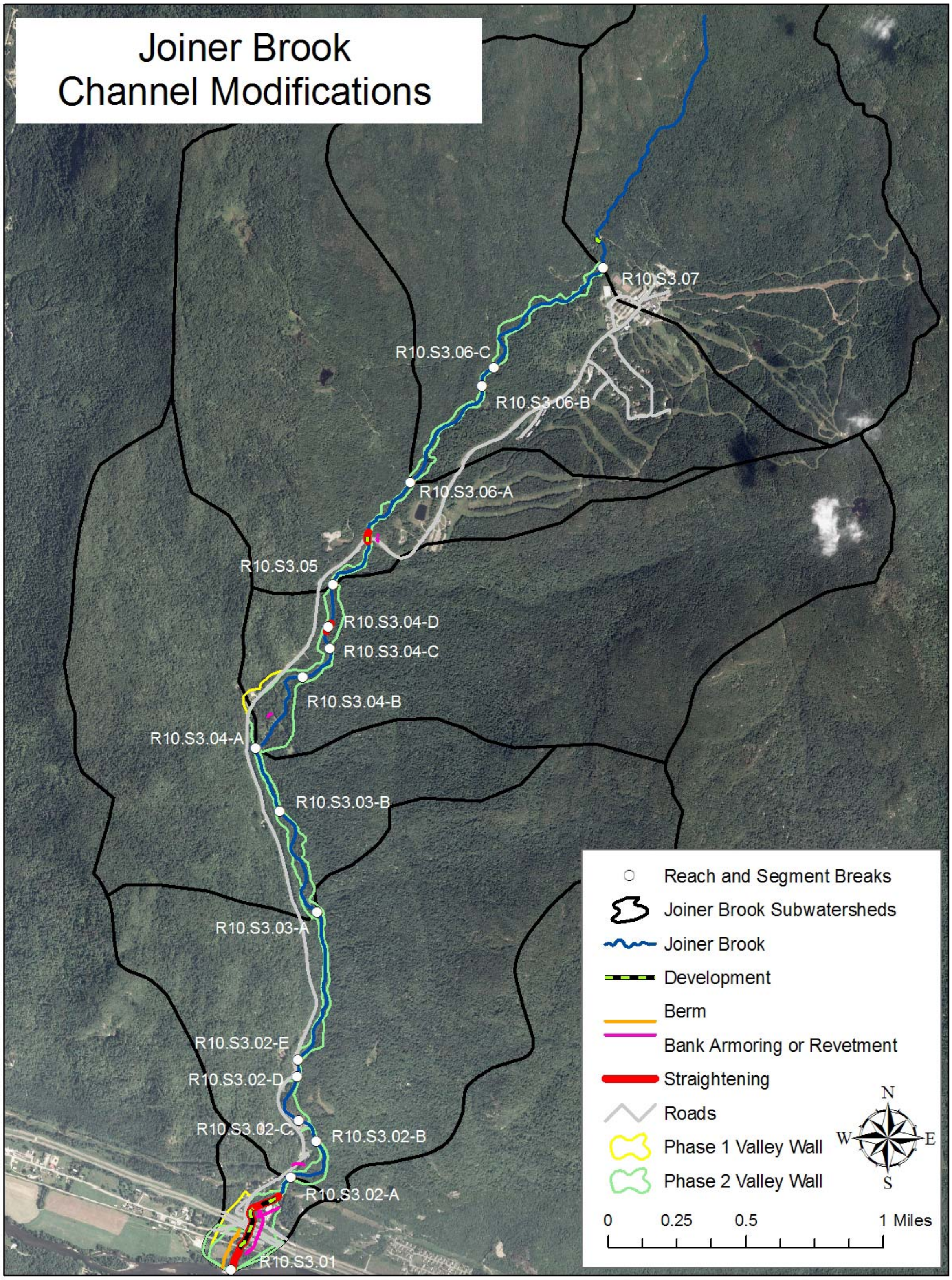


Figure 10. Channel modifications along Joiner Brook

5.2 Rapid Habitat Assessment

The Rapid Habitat Assessment (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 results can be used to compare physical habitat condition between sites, streams, or watersheds, and also serve as a management tool in watershed planning. New RHA protocols that include ten habitat parameters (woody debris cover, bed substrate cover, scour and deposition features, channel morphology, hydrologic characteristics, connectivity, river banks, and riparian area) were employed to assess the habitat of Joiner Brook.

The RHA scores for each of the habitat parameters are provided on page 37 of Appendix B. Some factors that contributed to the lower habitat score for these segments were lack of refuge areas, lack of high quality riparian buffers, abundant natural stream channel obstructions reducing aquatic organism passage, and a high percentage of exposed substrate due to aggradation. In general, the parameters that received the highest habitat ratings were bed substrate cover (e.g. embeddedness and stable sorted sediment) and scour and deposition features (e.g. pools, step spacing and formation).

Table 4 shows a comparison of the habitat condition based on the Rapid Habitat Assessment (RHA) and the geomorphic condition based on the Rapid Geomorphic Assesment (RGA). For seven of the segments both the RHA and RGA resulted in fair condition. The RGA was fair while the RHA was good for one segment (R10S3.03-A). This segment was undergoing major planform adjustment and aggradational processes, but had good bed substrate cover, stable banks, good pools, and high quality riparian buffers (see Figure 11) resulting in a higher habitat score.

Four of the segments (R10.S3.02-A, R10.S3.02-C, R10S3.04-B and R10S3.04-D) had a RGA score of good, while the habitat score was fair. In all four of these cases, the RHA score was at the high end of the fair category. Connectivity, hydrologic characteristics and woody debris scored low, while bed substrate cover, scour and deposition features, river banks and riparian area were generally in the good or reference categories.

One segment (R10S3.01) had an RGA score of fair and a habitat score of poor. The poor habitat score is attributed to extensive historic channelization and corridor encroachments resulting in lack of pools, poor woody debris cover, reduced bank vegetation and an inadequate riparian buffer (see Figure 12). A high percentage of exposed substrate and a low connectivity score from natural obstructions (waterfalls) also contributed to the poor habitat score for this reach.

Table 4. Comparison of RHA and RGA Scores for Phase 2 Reaches

Segment Number	Score RGA	Score RHA	Rating RGA	Rating RHA
R10.S3.01	0.51	0.33	Fair	Poor
R10.S3.02-A	0.65	0.63	Good	Fair

Table 4. Comparison of RHA and RGA Scores for Phase 2 Reaches				
Segment Number	**Score RGA**	**Score RHA**	**Rating RGA**	**Rating RHA**
R10.S3.02-C	0.71	0.58	Good	Fair
R10.S3.02-E	0.59	0.57	Fair	Fair
R10.S3.03-A	0.56	0.66	Fair	Good
R10.S3.03-B	0.48	0.53	Fair	Fair
R10.S3.04-A	0.38	0.51	Fair	Fair
R10.S3.04-B	0.73	0.63	Good	Fair
R10.S3.04-C	0.40	0.44	Fair	Fair
R10.S3.04-D	0.71	0.61	Good	Fair
R10.S3.05	0.43	0.51	Fair	Fair
R10.S3.06-A	0.60	0.63	Fair	Fair
R10.S3.06-C	0.46	0.59	Fair	Fair

Figure 11. Segment R10S3.03-A received a habitat rating of good due to deep pools, stable banks, and a high quality riparian zone.

Figure 12. Reach R10S3.01 rated "poor" for habitat. The segment lacked large woody debris, had a high percentage of exposed substrate and a shortage of pools where the channel had been historically straightened.

Natural and manmade obstructions are impeding passage of aquatic organisms throughout the study area. Figure 13 shows where there are culverts or natural barriers that are obstructions. Large waterfalls (higher than 10 feet) were found in segments R10.S3.01, R10.S3.02-B, R10.S3.02-C, R10.S3.02-D, R10.S3.02-E, R10.S3.03-B, R10.S3.05, R10.S3.06-A and R10.S3.06-B. Given the natural barriers to aquatic organism passage (e.g. waterfalls) the artificial barriers (culverts) are probably not the primary factor impeding fish passage on the Joiner Brook mainstem.

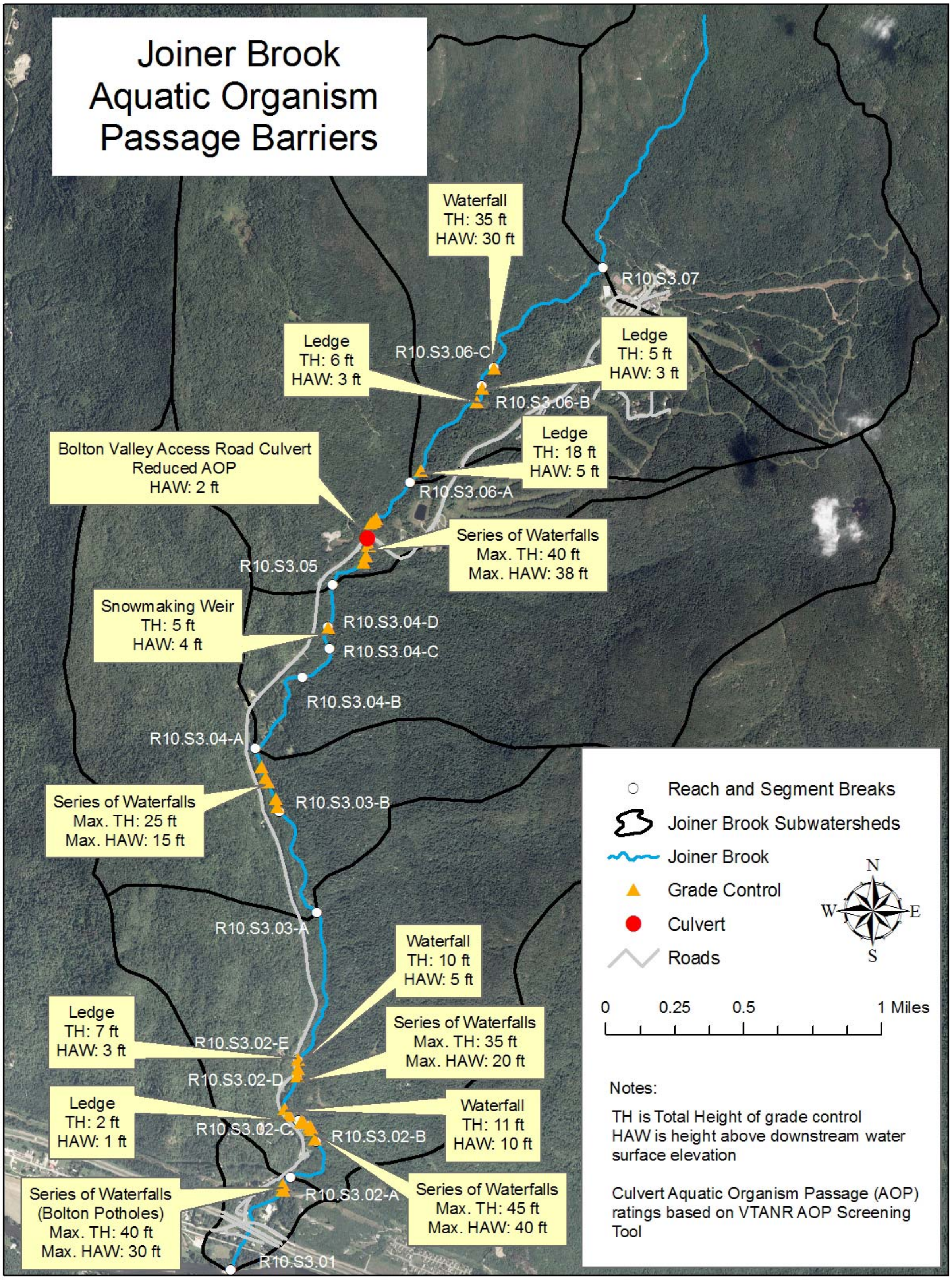


Figure 13. Aquatic organism passage barriers map

5.3 Bridge and Culvert Assessment

Table 5 summarizes the data collected for four bridges and one culvert that cross the main stem of Joiner Brook. The final column of the table includes a prioritization of structures for replacement or retrofit based on a review of the following three criteria: structure width in relation to bankfull channel width; aquatic organism passage; and geomorphic compatibility. In order to assist local municipalities with priorities for replacement of structures, priority lists were generated using geomorphic compatibility and aquatic organism passage screening tool developed by Milone and McBroom (2008a and 2008b).

The railroad bridge in reach R10S3.01 and the bridge in reach R10S3.04-A were both found to be partially compatible. Aquatic organism passage is not an issue for bridges, so these two structures were rated as low priority for replacement/retrofit. The Joiner Brook Lane Bridge and the Route 2 Bridge were both found to be mostly incompatible using the screening tool. Both of these bridges received low scores for percent bankfull width, approach angle, erosion and armoring. As shown in Figure 14, rock riprap in the channel and along the sides of the Route 2 structure is causing a channel constriction. The Route 2 Bridge could possibly be retrofitted by removing some of this material to allow for improved sediment transport through the structure. An old culvert sitting in the channel upstream of the Route 2 Bridge could be removed at the time the bridge is retrofitted.

Of the five structures that were assessed, the culvert within reach R10S3.05 that crosses the Bolton Valley Access Road is the highest priority for replacement/retrofit. This culvert is less than 50 percent of the bankfull channel width and a mid-channel bar is located upstream of the structure indicating the structure is undersized. The culvert has a cascade at the outlet thereby reducing aquatic organism passage (see Figure 15). Structures that are moderate or high priority for replacement/retrofit are included in the project identification table in Section 7.

Figure14. Route 2 bridge with reduced span.

Figure 15. Bolton Valley Access Rd. Culvert

Table 5. Joiner Brook Stream Crossing Structures

Reach/ Segment No.	SGA Structure No.	Structure Type	Road Name/ Location	Percent Channel Width[1]	AOP	Geomorphic Compatibility	Priority for Replacement
R10S3.01	200000000004012	Bridge	Railroad	81	NA	Partially compatible	Low
R10S3.01	100000000004011	Bridge	Joiner Brook Lane	51	NA	Mostly incompatible	Moderate
R10S3.01	200002000004012	Bridge	Route 2	55	NA	Mostly incompatible	Moderate for retrofit
R10S3.04-A	990000000504013	Bridge	Path	44	NA	Partially compatible	Low
R10S3.05	400401000204011	Culvert	Bolton Valley Access Road	22	Reduced	Mostly incompatible	Moderate

[1]Percent channel width based on cross section measured during Phase 2 assessment.

6.0 STRESSOR, DEPARTURE AND SENSITIVITY ANALYSIS

Stressor, departure and sensitivity maps are presented here as a means of displaying the effects of all significant physical processes occurring within the Joiner Brook watershed that were observed during the Phase 1 and Phase 2 Stream Geomorphic Assessments. These maps also provide an indication of the degree to which the channel adjustment processes within the watershed have been altered, at both the watershed scale and the reach scale. The analysis of existing and historic departures from equilibrium conditions along a stream network allows for the prediction of future channel adjustments within the watershed. This is helpful in developing and prioritizing potential protection and restoration projects.

6.1 Departure Analysis and Stressor Identification

6.1.1 Hydrologic Regime Stressors

The hydrologic regime is the timing, volume, and duration of flow events throughout the year and over time and is characterized by the input and manipulation of water at the watershed scale. When the hydrologic regime has been significantly changed, stream channels will respond by undergoing a series of channel adjustments. The land use within the watershed plays a role in the hydrology of the receiving waters. The percentage of urban and cropland development within the watershed are factors which change a watershed's response to precipitation. The most common effects of urban and cropland development is increasing peak discharges and runoff by reducing infiltration and travel time (United States Department of Agriculture 1986).

Wetlands account for less than one percent of the Joiner Brook watershed according to the 2002 Land Cover/Land Use Dataset for Vermont. Wetlands are characterized by their specific vegetation, hydrology and the presence of hydric soils. Hydric soils are classified by the Natural Resources Conservation Service (2009) as soils that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper parts. Wetlands and areas of hydric soils from the Natural Resources Conservation Service Chittenden County Soil Survey Data (2008) are displayed in Figure 16 as "intact wetlands" to provide the most recent locations of existing wetlands and areas of hydric soils. Analysis of hydric soils located where current land uses are agricultural or urban indicates some minor loss of wetlands within the Joiner watershed. The loss of wetlands decreases the attenuation of peak flows within the watershed. Based on hydric soils in areas that are urban or agricultural, the uppermost subwatersheds of Joiner Brook in the vicinity of Bolton Valley Resort have likely experienced wetland loss of approximately 1.6 percent of the subwatershed area in R10.S3.06 and 0.8 percent of the subwatershed area in R10.S3.07.

The Joiner Brook watershed has a modest network of roads as shown in Figure 16. Only one subwatershed within the study area has a road density greater than 10 miles per square mile (R10.S3.01). According to Foreman and Alexander (1998), increased peak flows in streams may be evident at road densities of 3.2 miles/ square mile. All other subwatersheds within the study area have road densities less than one mile per square mile. Numerous stormwater inputs from the Bolton Valley Access Road were mapped in the field. These stormwater inputs are responsible for increasing peak flows and for contributing sediment to Joiner Brook. Figure 16 shows segments in red where stormwater inputs per mile exceeded 10. This may contribute to localized increased flows resulting both from increased runoff and stormwater ditching in the lowest subwatershed.

6.1.2 Sediment Regime Stressors

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 regime, and the specific morphology of the valley, floodplain, and stream. The Sediment Load Indicators Map (Figure 17) shows the distribution of sediment load indicators in the Joiner Brook watershed at the watershed scale. The dominant watershed land cover/land use within the Joiner Brook watershed is forest. All of the six reaches evaluated in the study area had less than 5 percent cumulative watershed land cover/land use quantified as crop and/or urban. Bank erosion and mass failures contribute to sediment inputs along Joiner Brook. Bank erosion is defined as "an area of raw and barren soil where the vegetation does not have the ability to hold the soil and/or the soil has slumped or fallen into the channel". Mass failures can occur when "a perennial stream erodes into or undercuts a high erodible landform, such as glacial lacustrine terrace" (Vermont Agency of Natural Resources, 2007b).

Mass wasting sites were common during the Stream Geomorphic Assessment and were mapped in five segments. Eleven mass failures were mapped within the thirteen assessed Joiner Brook segments. The total length of mass failures on Joiner Brook is approximately 984 linear feet (4 percent of the total channel length of reaches R10.S3.01 through R10.S3.06). These mass failures represent a significant source of sediment within the Joiner Brook watershed. Localized areas of bank erosion and depositional features (steep riffles, mid channel bars, delta bars, flood chutes, and/or avulsions) are prevalent. As shown below in Figure 17, the majority of the segments on Joiner Brook have moderate bank erosion (5-20 percent of the length) and/or high depositional features (> 5 per mile).

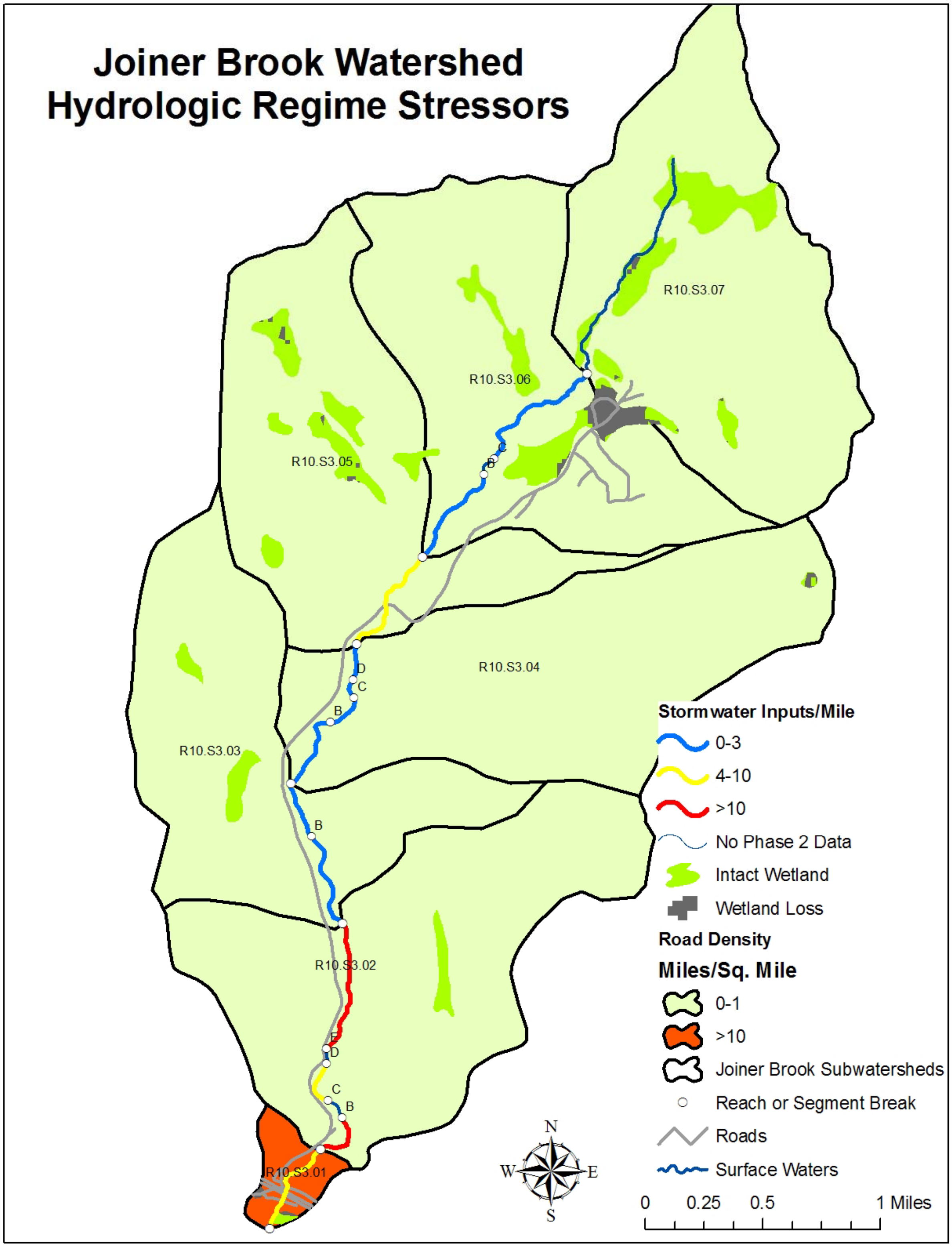


Figure 16. Land use map showing road density, stormwater influence, existing wetlands and lost wetlands.

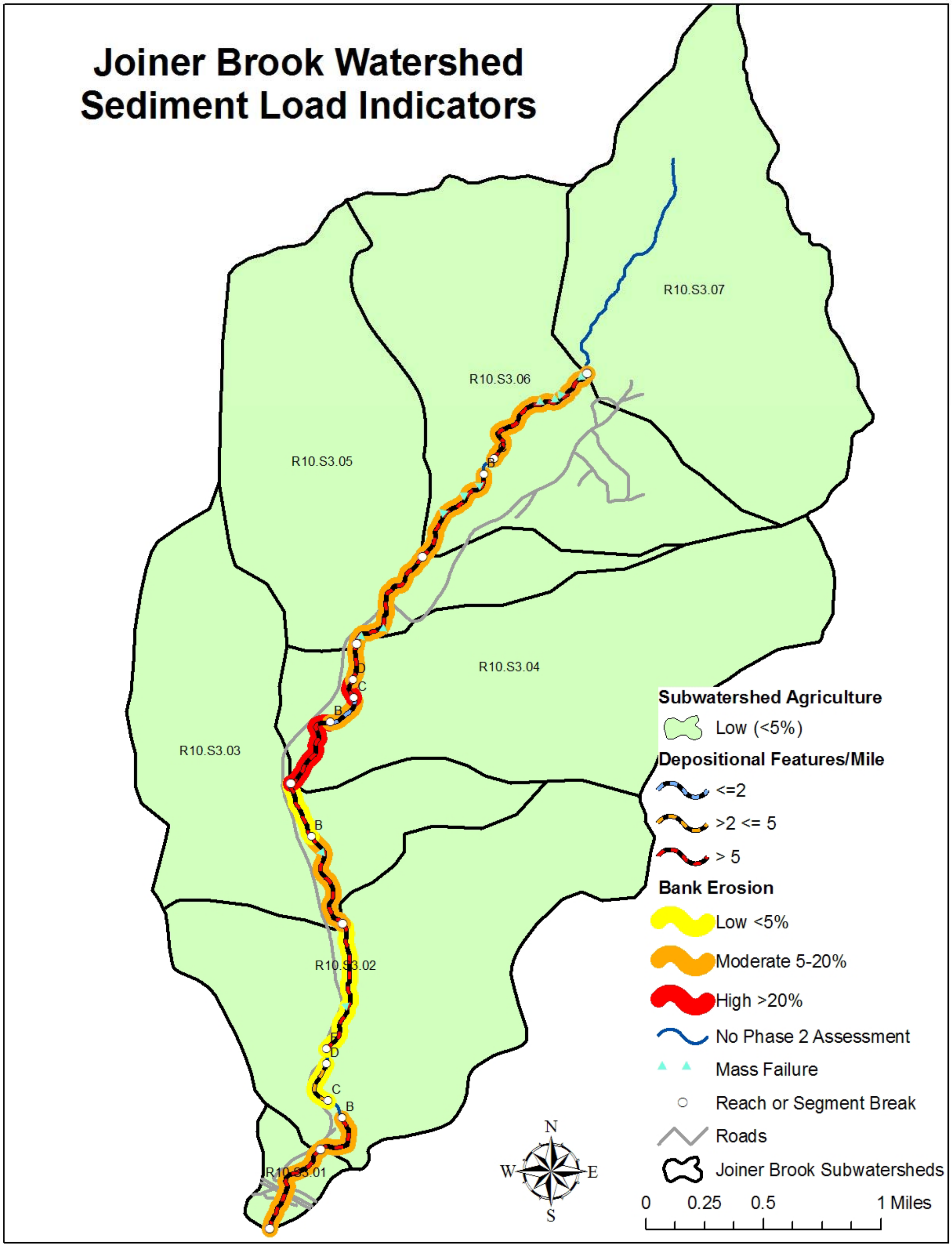


Figure 17. Sediment load indicators map showing cumulative subwatershed percent agriculture, depositional features per mile, bank erosion and mass failures.

6.1.3 Reach Scale Sediment Regime Stressors

The previously discussed alterations to flow and sediment load at the watershed scale serve as a pretext for understanding the timing and degree to which reach scale modifications are contributing to field observed channel adjustment. When the valley, floodplain, channel and channel boundary conditions are modified, a stream may change the way sediment is transported, sorted, stored and distributed. The stressors that alter these conditions either increase or decrease stream power and or increase or decrease the resistance of its boundary conditions. Understanding what factors are at play is helpful for determining why a reach is under adjustment and what types of management activities will be beneficial in returning the stream to equilibrium conditions.

6.1.4 Channel Slope Modifiers

Results from the Joiner Brook watershed indicate that primary stressors include straightening of the channel along with road and development encroachments (see Figure 18). Development in the upper reaches of the watershed has contributed to the loss of wetlands and increased runoff. Jeffrey Cueto, Vermont Department of Environmental Conservation, was contacted regarding historic dredging at Bolton Valley Resort's snowmaking water withdrawal. According to Mr. Cueto, some historic dredging at the snowmaking weir likely occurred, but nothing is on record with the DEC within the past 10 years. Historic dredging also likely occurred where the channel was straightened and bermed near the mouth of Joiner Brook.

6.1.5 Boundary Conditions and Riparian Modifiers

Riparian buffers provide many benefits. Some of these benefits are protecting and enhancing water quality, providing fish and wildlife habitat, providing streamside shading, and providing root structure to prevent bank erosion (see Figure 19). Most of Joiner Brook had sufficient riparian buffers. Three segments at the lower end of the watershed (R10.S3.01, R10.S3.02-B, and R10.S3.02-C) had 40 percent or more of the reach with little or no buffer on at least one bank. These stream reaches which lack a high quality riparian buffer are at a significantly higher risk of experiencing high rates of lateral erosion. Four segments have stream banks that are stabilized with rip rap or hard bank armoring where they are adjacent to human constructed infrastructure (R10.S3.01, R10.S3.02-A, R10.S3.04-A, and R10.S3.05).

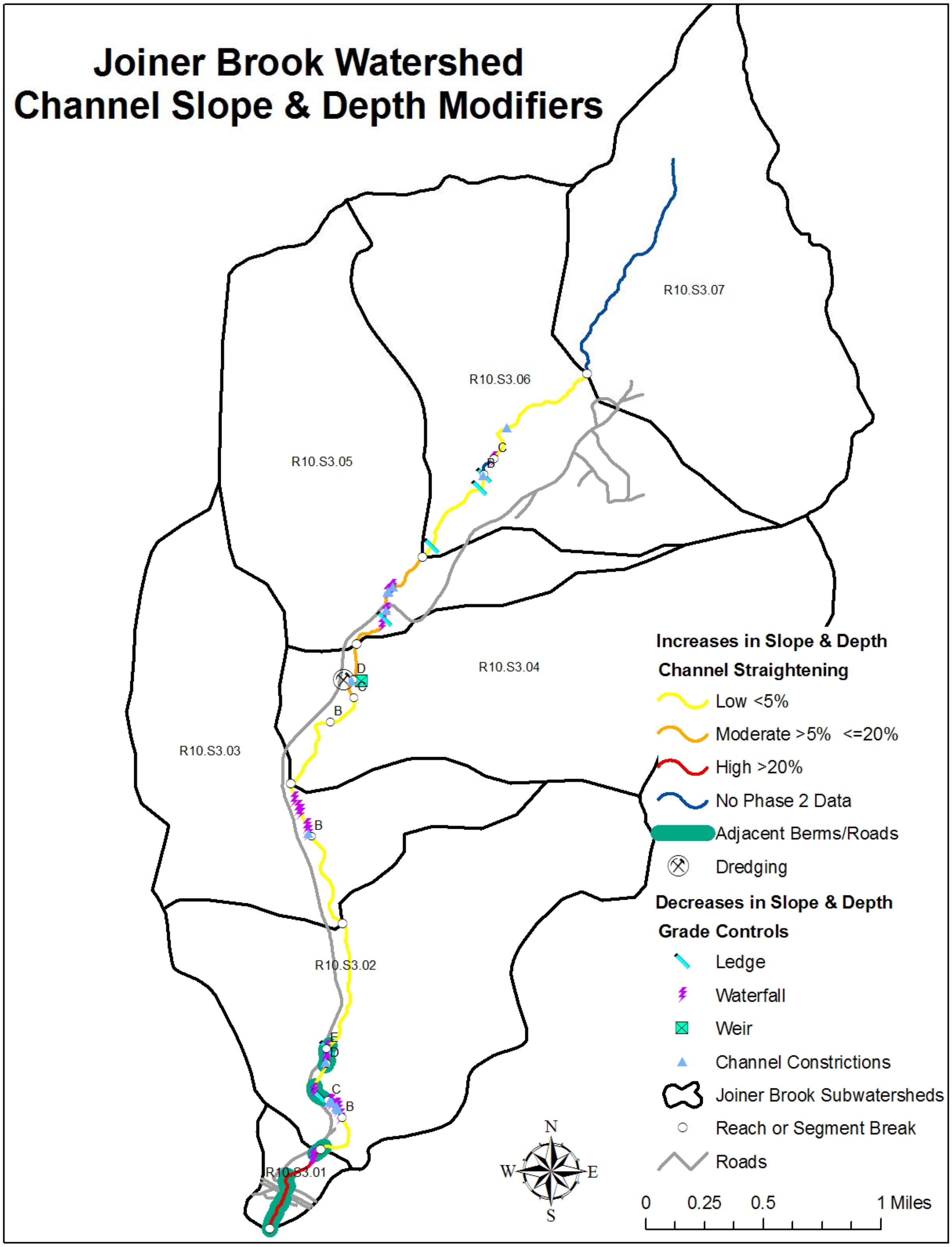


Figure 18. Channel slope and depth modifiers map showing stressors contributing to increases in slope and depth and stressors contributing to decreases in slope and depth.

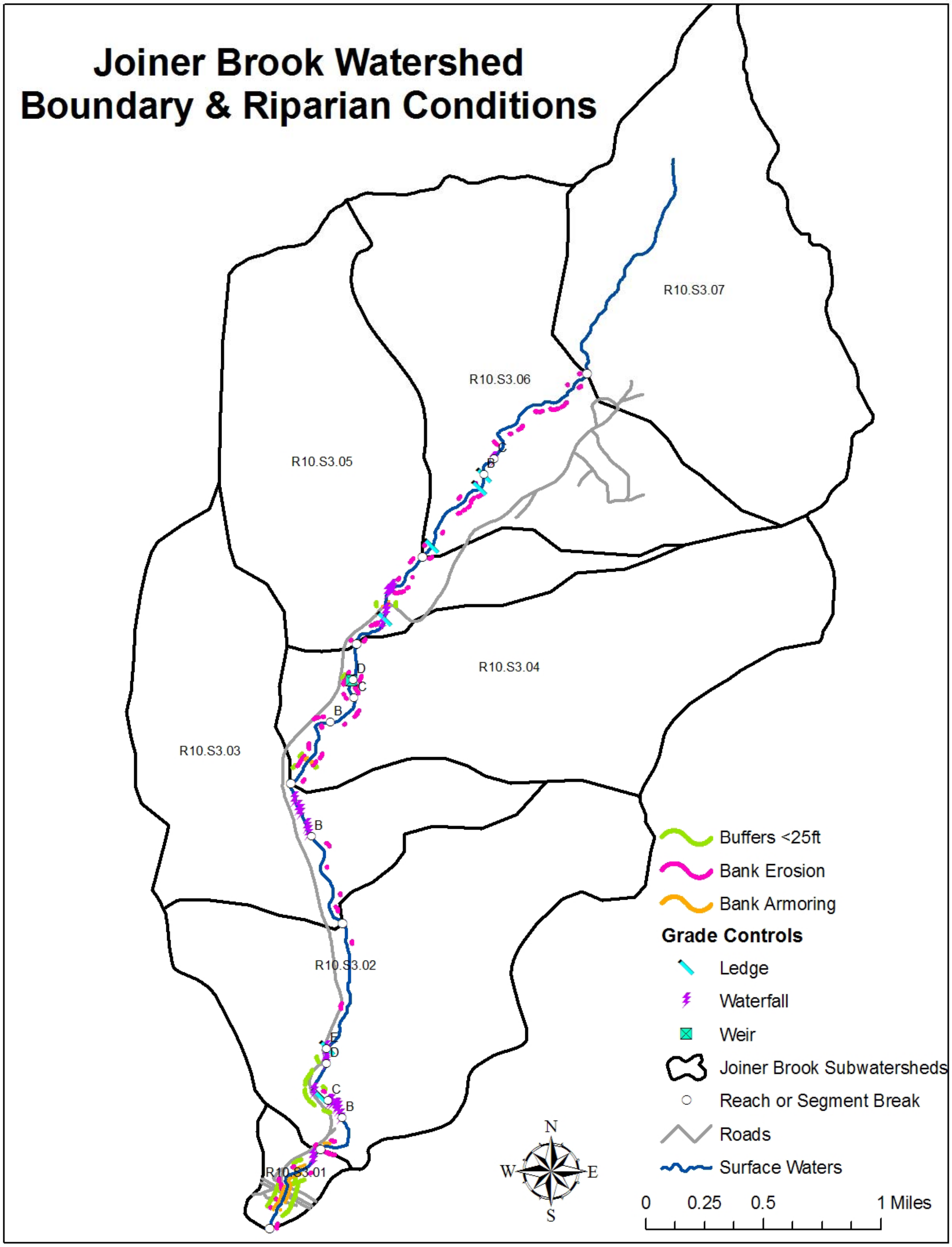


Figure 19. Boundary and riparian conditions map showing areas of buffers less than 25 feet, bank erosion, bank armoring and grade controls.

6.1.6 Constraints to Sediment Transport and Attenuation

Successful river corridor restoration and protection projects depend on a thorough understanding of the sources, volumes, and attenuation of flood flows and sediment loads within the stream network. If increased loads are transported through the network to a sensitive reach, where conflicts with human investments are creating a management expectation, little success can be expected unless the restoration design accommodates the increased load or finds a way to attenuate the loads upstream (Vermont Agency of Natural Resources, 2007c).

Within a reach, the principles of stream equilibrium dictate that stream power and sediment will tend to distribute evenly over time (Leopold, 1994). Changes or modifications to watershed inputs and hydraulic geometry create disequilibrium and lead to an uneven distribution of power and sediment. Large channel adjustments observed as dramatic erosion and deposition may be the result of this uneven distribution and may continue.

The reference sediment regime map (Figure 20) shows the Phase 1 reference stream sediment conditions for each segment of Joiner Brook's main stem. These reference type streams use available floodplain access as a means to store sediment within the watershed. All segments of Joiner Brook have a reference sediment regime of *Equilibrium Channels* or *Transport* reaches. *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 channel boundary resistance. *Transport* channels on the other hand are steep, dominated by bedrock and boulder/cobble substrates, typically are in confined valleys and they do not supply appreciable quantities of sediments to downstream reaches (VTANR, 2007c).

Changes in hydrology (primarily development within the riparian corridor) and sediment storage within the watershed have altered the reference sediment regime types for some reach segments (Figure 21). Sediment regime departures were derived from the sediment regime criteria established by the Vermont Agency of Natural Resources (2007c). Two segments (R10.S3.04-A and R10.S3.04-C) that were *Equilibrium Channel* type segments by reference have been converted to *Fine Source and Transport & Coarse Deposition* sediment regimes based on the Phase 2 Stream Geomorphic Assessment data. This means that most fine sediment entering the stream is either being transported through without being deposited as a result of channel incision and reduced floodplain access. R10.S3.04-C likely incised as a result of being sediment starved below the snowmaking weir. The cause of the incision in R10.S3.04-A is not known, but could be in response to historic straightening or an increase in stream power due to historic and/or present day land use changes.

One segment (R10.S3.05) that was *Transport* by reference has been converted to a *Confined Source and Transport* sediment regime due to increased sediment sourcing derived from an incised channel and mass wasting sites. Another segment (R10.S3.01) that was *Equilibrium Channel* by reference has been converted to an *Unconfined Source* *and Transport* sediment regime due to increased transport capacity derived from bank armoring and channel straightening in the vicinity of the elementary school. These channel management practices have resulted in reduced attenuation of flood waters and sediment.

The existing sediment regime for the Joiner Brook watershed includes reduced floodplain access, increased stream power, reduced boundary resistance, and lateral constraints at specific locations throughout the stream network. 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, 2007c). Segments and reaches of Joiner Brook that can act as attenuation assets are identified below to help in designing stream corridor protection and restoration projects within the stream network. These segments include:

R10.S3.01
R10.S3.02-E
R10.S3.03-A
R10.S3.03-B
R10.S3.04-A
R10.S3.05
R10.S3.06-A
R10.S3.06-C

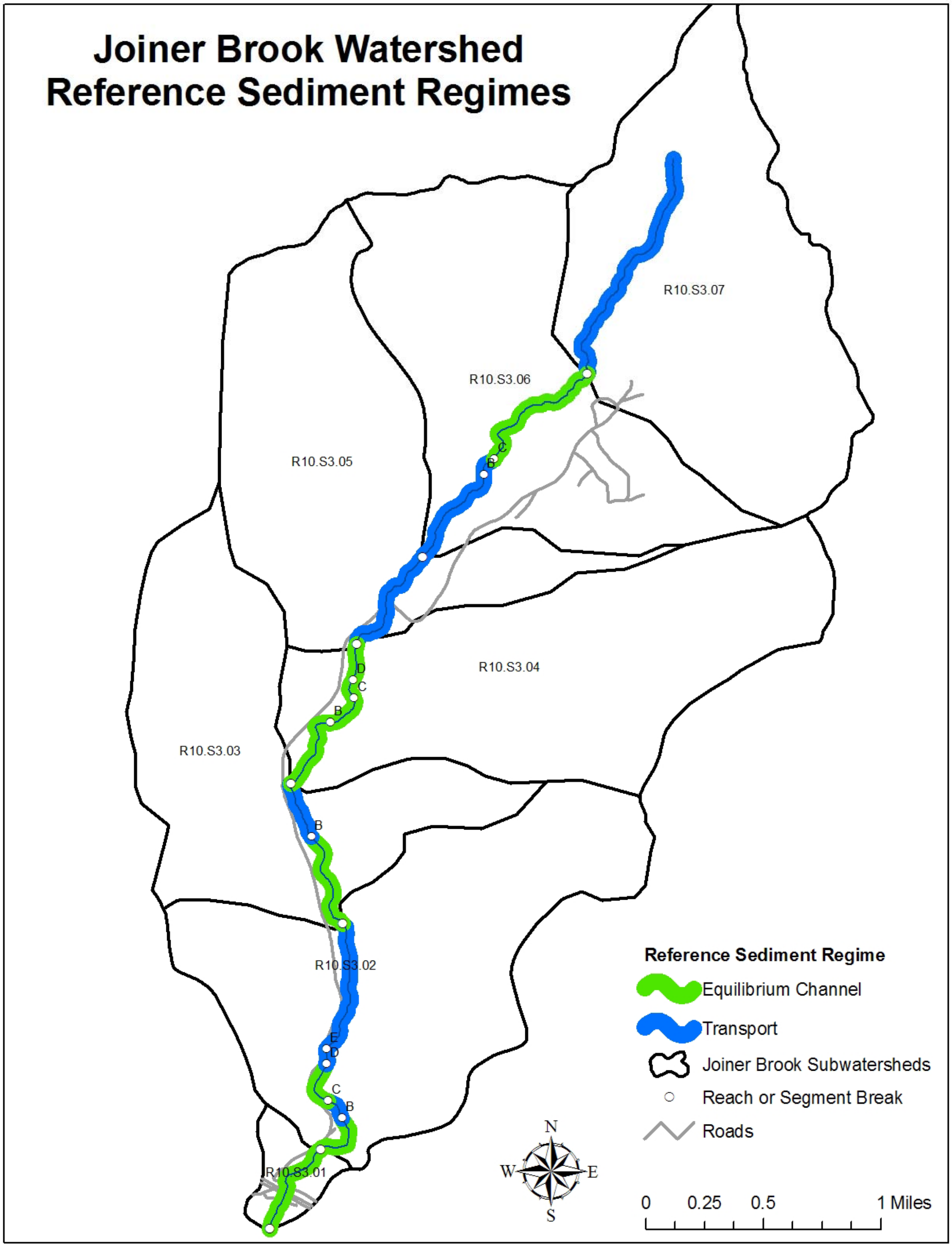


Figure 20. Reference sediment regime map

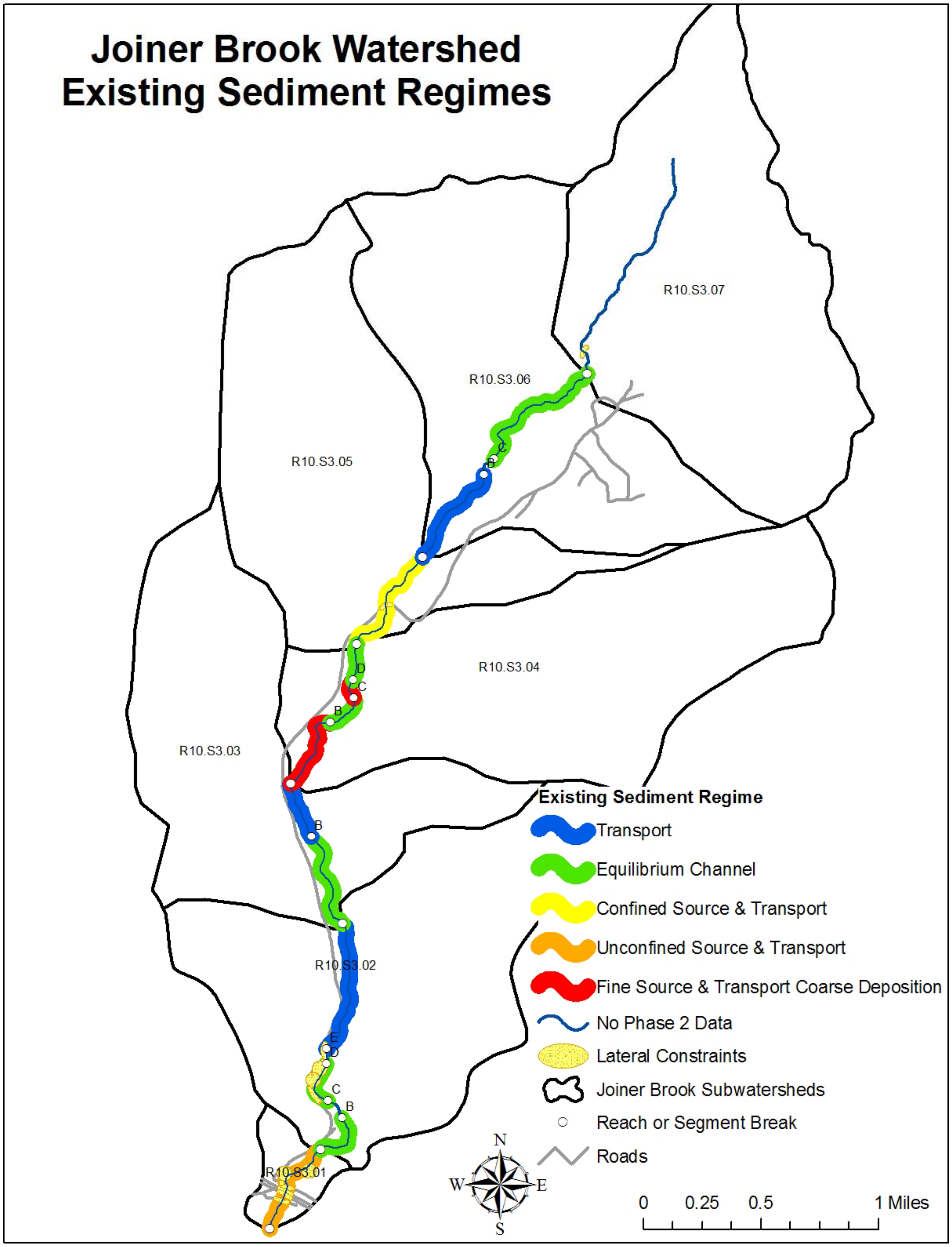


Figure 21. Existing sediment regime map

6.2 Sensitivity Analysis

Stream sensitivity refers to the likelihood that a stream will respond to a watershed or local disturbance or stressor, such as; floodplain encroachment, channel straightening or armoring, changes in sediment or flow inputs, and/or disturbance of riparian vegetation (Vermont Agency of Natural Resources, 2007b).

Assigning a sensitivity rating to a stream is done with the assumption that some streams, due to their setting and location within the watershed, are more likely to be in an episodic, rapid, and/or measurable state of change or adjustment. A stream's inherent sensitivity may be heightened when human activities alter the setting characteristics that influence a stream's natural adjustment rate including: boundary conditions; sediment and flow regimes; and the degree of confinement within the valley. Streams that are currently in adjustment, especially those undergoing degradation or aggradation, may become acutely sensitive (Vermont Agency of Natural Resources, 2007b).

There are many variables that are contributing to the sensitivity of the segments in the Joiner Brook watershed. Abundant bedrock and large bed substrates in many of the segments of Joiner Brook are more resistant to lateral and vertical adjustment and therefore seem to be in reality less sensitive streams. Additionally, bank vegetation and its soil holding roots, help to improve the boundary condition between water and land and have reduced the sensitivity of many sections of Joiner Brook that are well buffered. Removal of this vegetation tends to make stream segments more sensitive to channel adjustment.

The location and slope of a stream also affects is morphology and sensitivity. Streams that are transporting sediment through the channel are less sensitive than streams that are storing and responding to sediment. High gradient streams, like most segments on the Joiner Brook, with limited sediment supplies are less sensitive to minor changes in channel geometry or boundary conditions.

Additionally, flow regime and floodplain constrictions may be affecting the sensitivity of some Joiner Brook stream reaches. Changes in land use and land cover that increase impervious cover, peak discharges, and/or the frequency of high flows will heighten a stream's sensitivity to change and adjustment. Confinement becomes a significant sensitivity concern when structures such as roads, railroads, and berms significantly change the confinement ratio, reduce or restrict a stream's access to floodplain, and result in higher stream power during flood stage. Figure 22 is a map presenting the stream sensitivity, generalized according to stream type and condition as per the ANR protocol, and active adjustments for each reach segment on Joiner Brook. The stream sensitivity map also documents vertical channel adjustments currently going on within a reach segment. Major aggradation adjustment processes are displayed on the corridor where they were found to be actively occurring and not evaluated as historic. This information is helpful in prioritizing the implementation of the projects identified in section 7 of this report, as certain management actions may be influenced by these active adjustment processes. Current vertical channel adjustments exist in the following reaches:

Segment ID	Current Major Adjustment Process
R10.S3.01	Aggradation
R10.S3.02-E	Aggradation
R10.S3.03-A	Aggradation
R10.S3.03-B	Aggradation
R10.S3.04-A	Aggradation
R10.S3.04-C	Aggradation
R10.S3.05	Aggradation
R10.S3.06-A	Aggradation
R10.S3.06-C	Aggradation

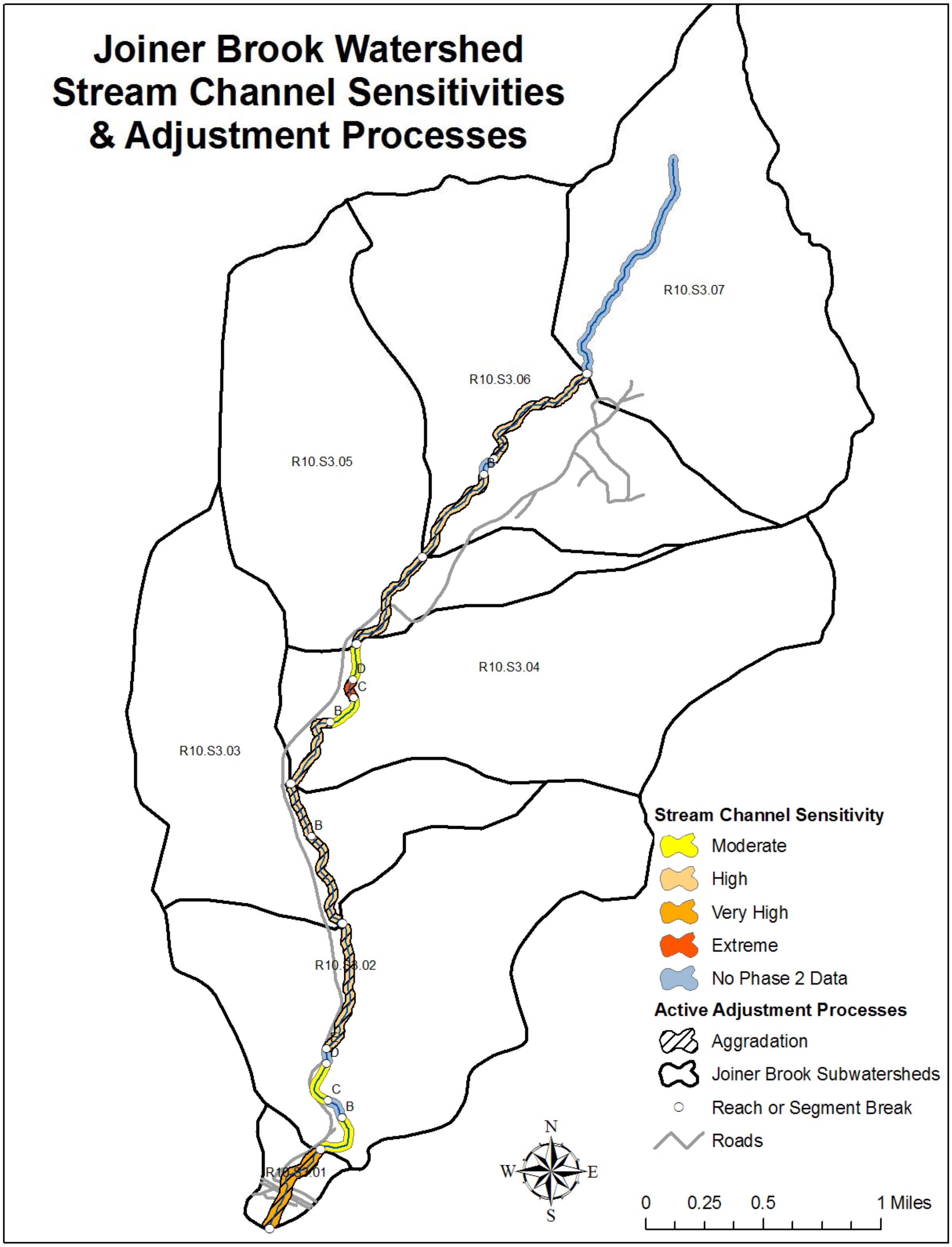


Figure 22. Joiner Brook Watershed Stream Sensitivity and Current Adjustment Map

7.0 PRELIMINARY PROJECT IDENTIFICATION AND PRIORITIZATION

The departure and sensitivity analyses presented in Section 6.0 of this report provide beneficial background for selecting potential projects that will effectively help the channel return to equilibrium conditions by assessing limiting factors and by identifying underlying causes of channel instability. 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, Passive Geomorphic Restoration, and Conservation.

<u>Active Geomorphic Restoration</u> 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.

<u>Passive Geomorphic Restoration</u> 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 the ideal results. Active riparian buffer revegetation and long-term protection of a river corridor is also essential to this alternative.

Conservation is a passive restoration option to consider when stream conditions are generally good and nearing a state of dynamic equilibrium. Typically, conservation is applied to minimally disturbed stream reaches where river structure and function and vegetation associations are relatively intact.

7.1 Watershed-Level Opportunities

7.1.1 Fluvial Erosion Hazard Zones

Of all types of natural hazards experienced in Vermont, flash flooding represents the most frequent disaster mode and has resulted in by far the greatest magnitude of damage suffered by private property and public infrastructure. While inundation-related flood loss is a significant component of flood disasters, the predominant mode of damage is associated with the dynamic, and oftentimes catastrophic, physical adjustment of stream channel dimensions and location during storm events due to bed and bank erosion, debris and ice jams, structural failures, flow diversion, or flow modification by man-made structures. These channel adjustments and their devastating consequences have frequently been documented wherein such adjustments are related to historic channel management activities, floodplain encroachments, adjacent land use practices and/or changes to watershed hydrology associated with land use and drainage.

The purpose of defining Fluvial Erosion Hazard Zones is to prevent increases in fluvial erosion resulting from uncontrolled development in identified fluvial erosion hazard areas; minimize property loss and damage due to fluvial erosion; prohibit land uses and development in fluvial erosion hazard areas that pose a danger to health and safety; and discourage the development of property that is unsuited for the intended purposes due to fluvial erosion hazards.

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 reference channel width, stream type and sensitivity of the stream. River corridors, defined through VTANR Stream Geomorphic Assessment (2007b), 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.

In general, the channel widths measured during the Phase 2 assessment were found to be greater than the reference channel widths established during Phase 1 based on Vermont Regional Hydraulic Geometry Curves (Vermont Agency of Natural Resources, 2006). Because the FEH Zones are in part based on these underestimated reference channel widths, alternatives to traditional FEH areas were also evaluated. It was found that a 100 foot setback from the top of the bank would adequately encompass the FEH corridor with some additional area to accommodate for the wider stream channel. For comparison purposes, Gretchen Alexander of the Vermont River Management Program also evaluated the FEH corridor using a channel width averaged between the Phase 1 reference width and the measured Phase 2 channel width. It was found that the FEH Zones based on the averaged Phase 1 and Phase 2 channel widths were very close to the width and location of a 100 foot setback from the top of the bank. The 100 foot setback better accounts for the inherent and unique variability of channel widths of Cb streams in extremely steep settings (Vermont Agency of Natural Resources, 2008b).

For the purposes of administering a more inclusive estimate of the true hazard area that is also easier to implement than mapped FEH zones given the forested nature of the watershed, BCE recommends that the Town of Bolton continues to employ a 100 foot setback zone, measured perpendicular from the top of the bank, as an area of potential flooding hazard. Although a standard setback that is not clipped to any valley walls may go beyond the channel's lateral requirements for achieving equilibrium, there are other added benefits to this measure, including the protection of forested buffers which are extremely important in steep watershed settings. Figure 23 displays the Draft Fluvial Erosion Hazards Zones and the estimated location of the 100 foot setbacks developed by the Vermont River Management Program for the Joiner Brook watershed. The 100 foot setback appears to be a more comprehensive alternative than the FEH corridor. FEH Zones have been established for all segments assessed during Phase 2 and for reach R10.S3.07 based on administrative judgments for stream type and condition.

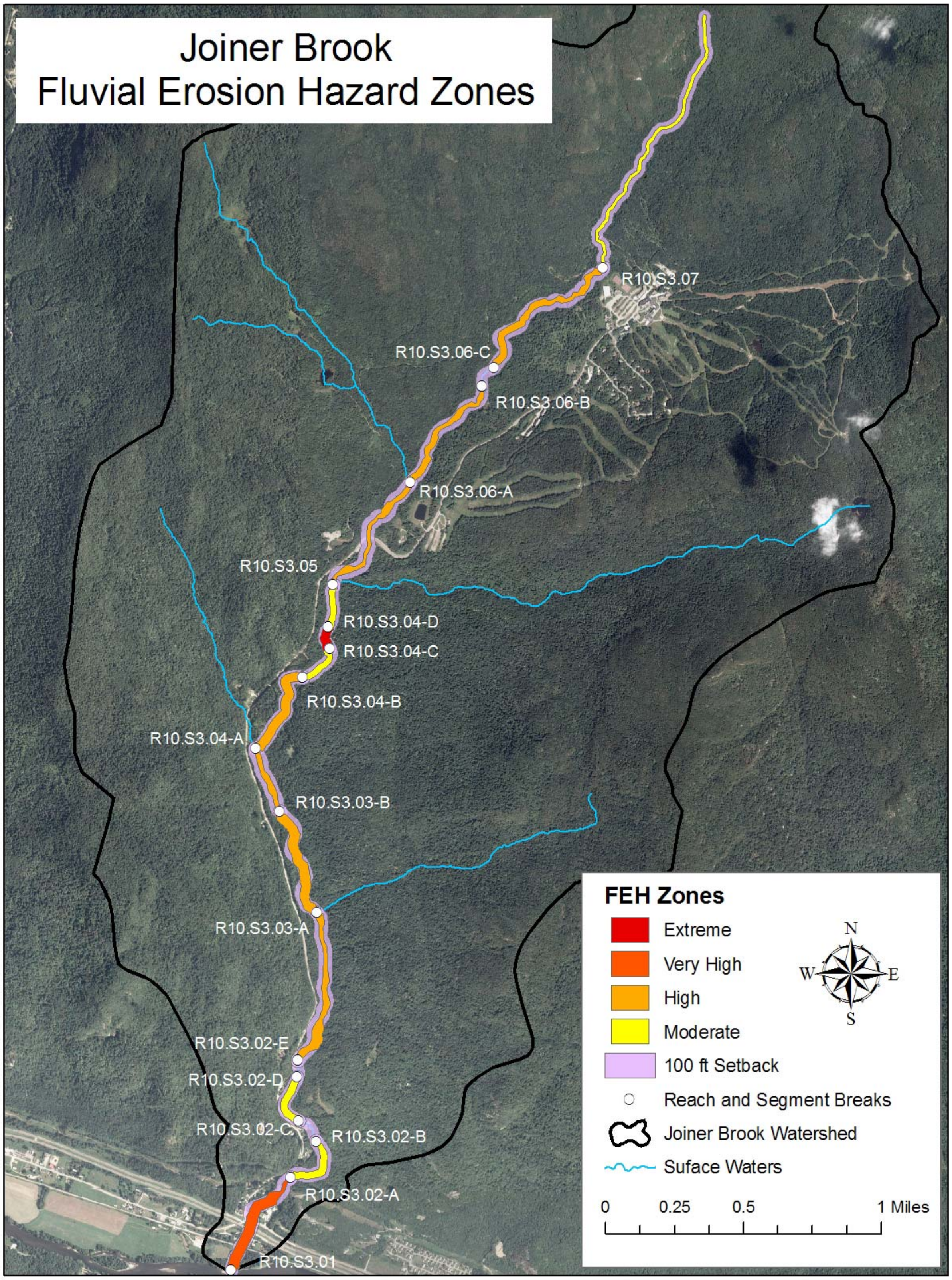


Figure 23. Draft Fluvial Erosion Hazard Zone Map for Joiner Brook.

7.1.2 Stormwater Management

Improving stormwater management and construction practices in the Joiner Brook watershed is recommended to reduce siltation of critical aquatic habitat and improve geomorphic stability. Another added benefit to stormwater management is the reduction of peak flows in the channel.

7.2 Reach and Site Level Opportunities

Eleven potential projects have been identified as high, moderate or low priority based on their effectiveness and feasibility (see Table 6 and Figure 24). These projects were identified using the criteria outlined by the ANR in Chapter 6 Preliminary Project Identification and Prioritization (Vermont Agency of Natural Resources, 2007c). This planning guide is intended to aid in the development of projects that protect and restore river equilibrium. Potential projects include: the continued implementation of setbacks to limit further development and protect river corridors, replacing or retrofitting stream crossing structures to allow for better sediment transport and aquatic organism passage, developing a stormwater improvement plan for the Bolton Valley Access Road, consider design alternatives for snowmaking weir, bank stabilization, and buffer improvements.

7.3 Next Steps

The Bolton Planning and Conservation Commissions, Bear Creek Environmental, LLC and the Vermont Agency of Natural Resources will host a public meeting on March, 12, 2009 to discuss the results of the Phase 2 Stream Geomorphic Assessment with concerned members of the community.

Joiner Brook has a very steep gradient and most of valley side slopes bordering the brook are also extremely steep. Given the current regulations the Town of Bolton has in place for development on steep slopes, BCE recommends a slope analysis of the watershed to compare undevelopable slopes with the 100 foot setback recommendation from this study. The results of a slope analysis may confirm that much of the area within 100 feet of the top of the bank is undevelopable, and it could provide additional areas of protection outside the 100 foot setback.

Additional Phase 2 Stream Geomorphic Assessment work is recommended for several reaches which are under development pressure or have existing development or encroachments within the river corridor. These reaches include the uppermost reach of the main stem of Joiner Brook (approximately 5,750 in length); the lower end of a tributary to Joiner Brook R10S3.03-S1.01 (about 900 feet that runs along the Bolton Valley Access Road) and the tributary to Joiner Brook that is located in the Bolton Valley Village (approximately 2,000 feet). SGAT would need to be rerun to include the Joiner Brook tributary located in the village.

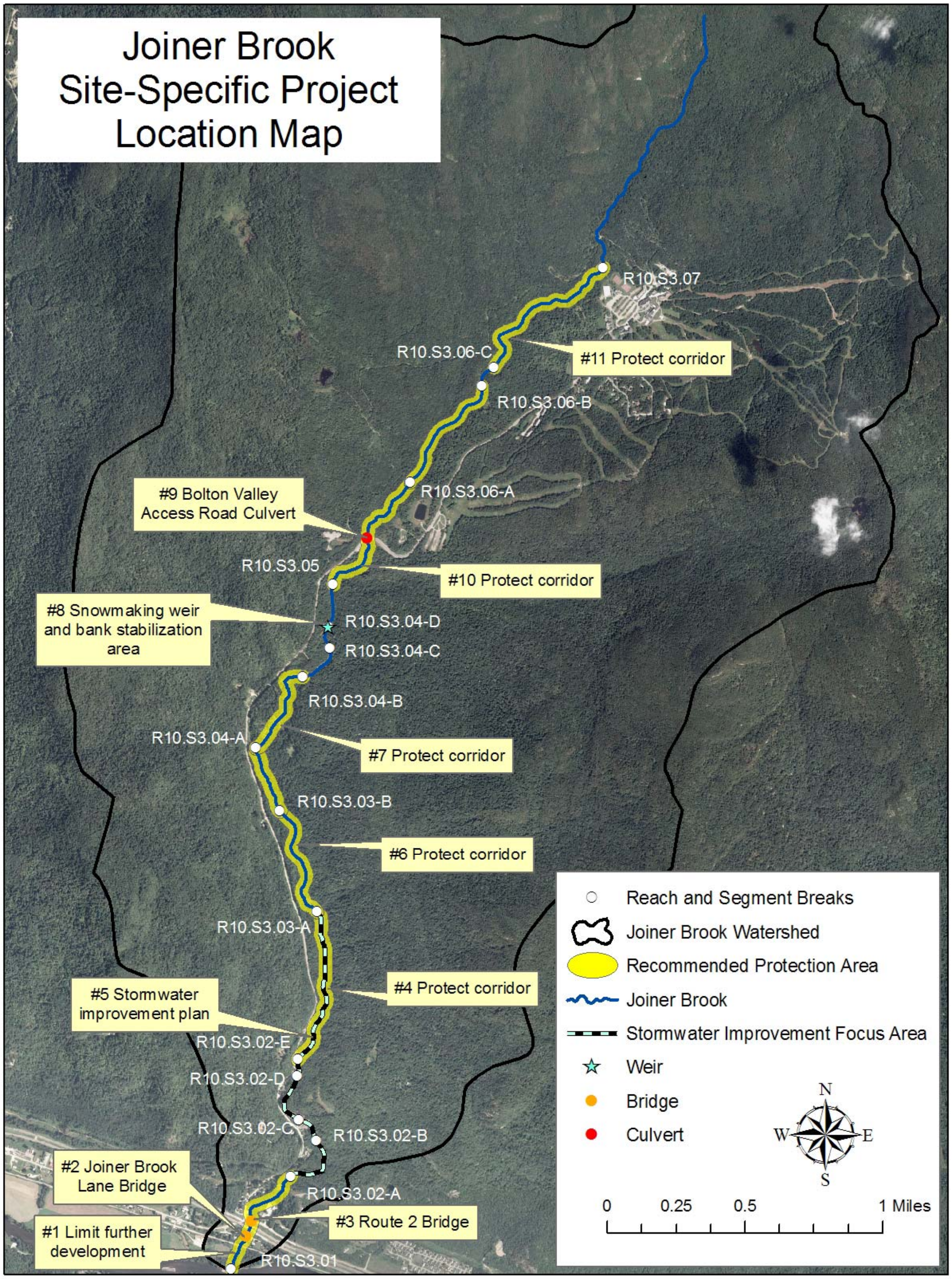


Figure 24. Site-specific project locations

Table 6. Joiner Brook Site Level Opportunities for Restoration and Protection

Project #, Reach	Condition and Channel Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners
# 1 R10.S3.01	Fair, FII	Bolton's elementary school, the Bolton Valley Access Road, I89, US Rt 2, and railroad encroach the channel	Limit further development within river corridor through corridor easements or setbacks	High priority to avoid further conflicts near infrastructure	Sediment attenuation asset; at mouth of tributary	Relatively low cost	No additional structures in corridor	Town of Bolton, ANR
# 2 R10.S3.01	Fair, FII	Joiner Brook Lane Bridge is undersized and was found to be mostly incompatible using the geomorphic screening tool	Replace Joiner Brook Lane Bridge with a structure that has a wider span	Moderate priority for replacement due to geomorphic incompatibility; structure is a bridge is not a problem in term of aquatic organism passage	Improved geomorphic compatibility	High cost for design, permitting and replacement	Wider span bridge may take up more space	Town of Bolton, ANR
# 3 R10.S3.01	Fair, FII	Route 2 Bridge has abutment span of 84 feet. Rock rip rap in channel and on sides of structure is causing a constriction	Retrofit bridge to improve sediment transport through structure; Remove old culvert in channel just upstream of bridge	Moderate priority to retrofit structure	Improved geomorphic compatibility	Moderate cost for design, permitting and retrofit	None	VTrans, ANR
#4 R10.S3.02-E	Fair, DIId	Runs to the east of Bolton Valley Access Road and is currently acting as a sediment attenuation area. There is a wide forested buffer.	Protect River Corridor through corridor easements or setbacks	High priority to protect this attenuation asset and wooded corridor	Flood and Sediment attenuation asset	Potentially high cost for easements; due to private ownership protection through zoning would be more cost effective	No additional structures in corridor and permanent vegetated buffer	Private landowners, Town of Bolton, Vermont River Conservancy
#5 R10.S3.02	Fair	Located to the east of Bolton Valley Access Road	Develop stormwater improvement plan for Joiner Brook access Road	High priority to reduce sedimentation	Flood and sediment attenuation asset	Moderate costs to design and maintain stormwater improvements	Not known	Town of Bolton, ANR
#6 R10.S3.03-A and R10.S3.03-B	Fair, DIIc Fair, DIId	Runs to the east of Bolton Valley Access Road and is currently acting as a sediment attenuation area. There is a wide forested buffer.	Protect River Corridor through corridor easements or setbacks	High priority to protect this attenuation asset and wooded corridor	Flood and sediment attenuation asset	Potentially high cost for easements; due to private ownership protection through zoning would be more cost effective	No additional structures in corridor	Private Landowners or Town of Bolton. VT River Conservancy

Table 6. Joiner Brook Site Level Opportunities for Restoration and Protection

Project #, Reach	Condition and Channel Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners
#7 R10.S3.04-A	Fair, FIII	Segment is located where the valley opens up and becomes broad and the slope drops. Segment has experienced major historic incision and is currently working to build a new floodplain.	Protect River Corridor through corridor easements or setbacks	Very high priority; this segment could provide valuable flood and sediment attenuation in the future.	Flood and sediment attenuation asset	Potentially high cost for easements; due to private ownership protection through zoning would be more cost effective.	Needs further investigation	Private landowners, Town of Bolton, Vermont River Conservancy
#8 R10.S3.04-D	Fair, FIII	Just upstream of Bolton Valley snowmaking weir the bank is unstable and lacks a buffer. The snowmaking weir is causing extreme geomorphic instability downstream of the weir.	Stabilize right bank and plant buffer. Consider changing design at snowmaking water withdrawal to lessen geomorphic and habitat impact.	High priority for improving design of snowmaking water withdrawal to minimize impact on habitat and stream stability	Improved habitat and geomorphic stability	High cost of redesigning snowmaking water withdrawal. Moderate cost of planting and stabilizing bank	Needs further investigation	Bolton Valley Resort,
#9 R10.S3.05	Fair, FIII	Located at the "S" curve on the Bolton Valley Access Road, stream crosses under road in reach. Culvert reached a rating of mostly incompatible and reduced aquatic organism passage using culvert screening tool. There are major natural obstructions to fish passage in reach	Replace culvert	Moderate priority for replacement. Culvert is a cascade put is not primary factor impeding fish passage.	Improved geomorphic stability	High cost for design, permitting and replacement of structure	None	Town of Bolton
#10 R10.S3.05	Fair, FIII	Located in the vicinity of the "S" curve on the Bolton Valley Access Road. The majority of the reach is fairly remote. Aggradation is occurring where valley widens.	Protect River Corridor through corridor easements or setbacks	High priority for conversation above "S" curve.	Flood and sediment attenuation asset	Potentially high cost for easements; due to private ownership, protection through zoning would be more cost effective.	No additional structures in corridor	Landowners, Town of Bolton, Vermont River Conservancy, ANR
#11 R10.S3.06-A and R10.S3.06-C	Fair, DIId Fair, DIId	Located west of the Bolton Valley Access Road. Aggradation and planform adjustment where valley widens.	Protect River Corridor through corridor easements or setbacks	High priority to protect this attenuation asset and wooded corridor	Flood and sediment attenuation asset	Potentially high cost for easements; due to private ownership; protection through zoning would be more cost effective	No additional structures in corridor	Landowners, Town of Bolton, Vermont River Conservancy, ANR

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APPENDIX A

Glossary of Terms

(From Vermont Agency of Natural Resources – Appendix Q, April 2004)

Glossary of Terms

Adapted from:
ERDC TN-EMRRP-SR-01 1
Glossary of Stream Restoration Terms
by Craig Fischenich.. February 2000
USAE Research and Development Center, Environmental Laboratory, 3909 Halls Ferry Rd., Vicksburg, MS 39180

OVERVIEW
Following is a glossary of terms commonly used in stream geomorphic assessment.

TERMS
Acre -- A measure of area equal to 43,560 ft 2(4,046.87 m2). One square mile equals 640 acres.
Adjustment process --or 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 raising 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 stream discharge and/or bed-load characteristics are changing. Opposite of degradation.
Algae -- Microscopic plants that grow in sunlit water containing phosphates, nitrates, and other nutrients. Algae, like all aquatic plants, add oxygen to the water and are important in the fish food chain.
Alluvial -- Deposited by running water.
Alluvium -- A general term for detrital deposits make by streams on riverbeds, floodplains, and alluvial fans; esp. a deposit of silt or silty clay laid down during time of flood. The term applies to stream deposits of recent time. It does not include subaqueous sediments of seas or lakes.
Anadromous -- Pertaining to fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn.
Aquatic ecosystem -- Any body of water, such as a stream, lake, or estuary, and all organisms and nonliving components within it, functioning as a natural system.
Armoring -- A natural process where an erosion-resistant layer of relatively large particles is established on the surface of the streambed through removal of finer particles by stream flow. A properly armored streambed generally resists movement of bed material at discharges up to approximately 3/4 bank-full depth.
Augmentation (of stream flow) – Increasing flow under normal conditions, by releasing storage water from reservoirs.
Avulsion -- A change in channel course that occurs when a stream suddenly breaks through its banks, typically bisecting an overextended meander arc.
Backwater -- (1) A small, generally shallow body of water attached to the main channel, with little or no current of its own, or (2) A condition in subcritical flow where the water surface elevation is raised by downstream flow impediments.
Backwater pool -- A pool that formed as a result of an obstruction like a large tree, weir, dam, or boulder.
Bank stability -- The ability of a streambank to counteract erosion or gravity forces.
Bankfull channel depth -- The maximum depth of a channel within a riffle segment when flowing at a bank-full discharge.
Bankfull channel width -- The top surface width of a stream channel when flowing at a bank-full discharge.
Bankfull discharge -- The stream discharge corresponding to the water stage that first overtops the natural banks. This flow occurs, on average, about once every 1 to 2 years.
Bankfull width -- The width of a river or stream channel between the highest banks on either side of a stream.
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 overwide channel.

Barrier -- A physical block or impediment to the movement or migration of fish, such as a waterfall (natural barrier) or a dam (man-made barrier).
Base flow -- The sustained portion of stream discharge that is drawn from natural storage sources, and not affected by human activity or regulation.
Bed load -- Sediment moving on or near the streambed and transported by jumping, rolling, or sliding on the bed layer of a stream. See also suspended load.
Bed material -- The sediment mixture that a streambed is composed of.
Bed material load -- That portion of the total sediment load with sediments of a size found in the streambed.
Bed roughness -- A measure of the irregularity of the streambed as it contributes to flow resistance. Commonly expressed as a Manning "n" value.
Bed slope -- The inclination of the channel bottom, measured as the elevation drop per unit length of channel.
Benthic invertebrates -- Aquatic animals without backbones that dwell on or in the bottom sediments of fresh or salt water. Examples: clams, crayfish, and a wide variety of worms.
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.
Biota -- All living organisms of a region, as in a stream or other body of water.
Boulder -- A large substrate particle that is larger than cobble, 256 mm in diameter.
Braided channel -- A stream characterized by flow within several channels, which successively meet and divide. Braiding often occurs when sediment loading is too large to be carried by a single channel.
Braiding (of river channels) -- Successive division and rejoining of riverflow with accompanying islands.
Buffer strip -- A barrier of permanent vegetation, either forest or other vegetation, between waterways and land uses such as agriculture or urban development, designed to intercept and filter out pollution before it reaches the surface water resource.
Canopy -- A layer of foliage in a forest stand. This most often refers to the uppermost layer of foliage, but it can be used to describe lower layers in a multistoried stand. Leaves, branches and vegetation that are above ground and/or water that provide shade and cover for fish and wildlife.
Cascade -- A short, steep drop in streambed elevation often marked by boulders and agitated white water.
Catchment -- (1) The catching or collecting of water, especially rainfall. (2) A reservoir or other basin for catching water. (3) The water thus caught. (4) A watershed.
Channel -- An area that contains continuously or periodically flowing water that is confined by banks and a streambed.
Channelization -- The process of changing (usually straightening) the natural path of a waterway.
Clay -- Substrate particles that are smaller than silt and generally less than 0.003 mm in diameter.
Coarse woody debris (CWD) -- Portion of a tree that has fallen or been cut and left in the woods. Usually refers to pieces at least 20 in. in diameter.
Cobble -- Substrate particles that are smaller than boulders and larger than gravels, and are generally 64-256 mm in diameter. Can be further classified as small and large cobble.
Confluence -- (1) The act of flowing together; the meeting or junction of two or more streams; also, the place where these streams meet. (2) The stream or body of water formed by the junction of two or more streams; a combined flood.
Conifer -- A tree belonging to the order Gymnospermae, comprising a wide range of trees that are mostly evergreens. Conifers bear cones (hence, coniferous) and have needle-shaped or scalelike leaves.
Conservation -- The process or means of achieving recovery of viable populations.
Contiguous habitat -- Habitat suitable to support the life needs of a species that is distributed continuously or nearly continuously across the landscape.

Cover – "cover" is the general term used to describe any structure that provides refugia for fish, reptiles or amphibians. These animals seek cover to hide from predators, to avoid warm water temperatures, and to rest, by avoiding higher velocity water. These animals come in all sizes, so even cobbles on the stream bottom that are not sedimented in with fine sands and silt can serve as cover for small fish and salamanders. Larger fish and reptiles often use large boulders, undercut banks, submerged logs, and snags for cover.

Critical shear stress -- The minimum amount of shear stress exerted by stream currents required to initiate soil particle motion. Because gravity also contributes to streambank particle movement but not on streambeds, critical shear stress along streambanks is less than for streambeds.

Crown -- The upper part of a tree or other woody plant that carries the main system of branches and the foliage.

Crown cover -- The degree to which the crowns of trees are nearing general contact with one another.

Cubic feet per second (cfs) -- A unit used to measure water flow. One cubic foot per second is equal to 449 gallons per minute.

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

Debris flow -- A rapidly moving mass of rock fragments, soil, and mud, with more than half of the particles being larger than sand size.

Deciduous -- Trees and plants that shed their leaves at the end of the growing season.

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.

Detritus -- is organic material, such as leaves, twigs, and other dead plant matter, that collects on the stream bottom. It may occur in clumps, such as leaf packs at the bottom of a pool, or as single pieces, such as a fallen tree branch.

Dike -- (1) (Engineering) An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands; a levee. (2) A low wall that can act as a barrier to prevent a spill from spreading. (3) (Geology) A tabular body of igneous (formed by volcanic action) rock that cuts across the structure of adjacent rocks or cuts massive rocks.

Dissolved oxygen (DO) -- The amount of free (not chemically combined) oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation.

Ditch -- A long narrow trench or furrow dug in the ground, as for irrigation, drainage, or a boundary line.

Drainage area -- The total surface area upstream of a point on a stream that drains toward that point. Not to be confused with watershed. The drainage area may include one or more watersheds.

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.

Ecology -- The study of the interrelationships of living organisms to one another and to their surroundings.

Ecosystem -- Recognizable, relatively homogeneous units, including the organisms they contain, their environment, and all the interactions among them.

Embankment -- An artificial deposit of material that is raised above the natural surface of the land and used to contain, divert, or store water, support roads or railways, or for other similar purposes.

Embeddedness -- is a measure of the amount of surface area of cobbles, boulders, snags and other stream bottom structures that is covered with sand and silt. An embedded streambed may be packed hard with sand and silt such that rocks in the stream bottom are difficult or impossible to pick up. The spaces between the rocks are filled with fine sediments, leaving little room for fish, amphibians, and bugs to use the structures for cover, resting, spawning, and feeding. A streambed that is **not** embedded has loose rocks that are easily removed from the stream bottom, and may even "roll" on one another when you walk on them.

Entrenchment ratio --The width of the flood-prone area divided by the bankfull width.

Epifaunal – “epi” means surface, and “fauna” means animals. Thus, “epifaunal substrate” is structures in the stream (on the stream bed) that provide surfaces on which animals can live. In this case, the animals are aquatic invertebrates (such as aquatic insects and other “bugs”). These bugs live on or under cobbles, boulders, logs, and snags, and the many cracks and crevices found in these structures. In general, older decaying logs are better suited for bugs to live on/in than newly fallen “green” logs and trees.
Ephemeral streams -- Streams that flow only in direct response to precipitation and whose channel is at all times above the water table.
Erosion -- 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.
Eutrophic -- Usually refers to a nutrient-enriched, highly productive body of water.
Eutrophication -- The process of enrichment of water bodies by nutrients.
Flash Flood -- A sudden flood of great volume, usually caused by a heavy rain. Also, a flood that crests in a short length of time and is often characterized by high velocity flows.
Floodplain -- Land built of sediment that is regularly covered with water as a result of the flooding of a nearby stream.
Floodplain (100-year) -- The area adjacent to a stream that is on average inundated once a century.
Floodplain Function – Flood water access of floodplain which effects the velocity, depth, and slope (stream power) of the flood flow thereby influencing the sediment transport characteristics of the flood (i.e., loss of floodplain access and function may lead to higher stream power and erosion during flood).
Flow -- The amount of water passing a particular point in a stream or river, usually expressed in cubic feet per second (cfs).
Fluvial -- Migrating between main rivers and tributaries. Of or pertaining to streams or rivers.
Ford -- A shallow place in a body of water, such as a river, where one can cross by walking or riding on an animal or in a vehicle.
Fry -- A recently hatched fish.
Gabion -- A wire basket or cage that is filled with gravel or cobble and generally used to stabilize streambanks.
Gaging station -- A particular site in a stream, lake, reservoir, etc., where hydrologic data are obtained.
Gallons per minute (gpm) -- A unit used to measure water flow.
Geographic information system (GIS) -- A computer system capable of storing and manipulating spatial data.
Geomorphology -- A branch of both physiography and geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place due to erosion of the primary elements and the buildup of erosional debris.
Glide -- A section of stream that has little or no turbulence.
Gradient -- Vertical drop per unit of horizontal distance.
Grass/forb -- Herbaceous vegetation.
Gravel -- An unconsolidated natural accumulation of rounded rock fragments, mostly of particles larger than sand (diameter greater than 2 mm), such as boulders, cobbles, pebbles, granules, or any combination of these.
Groundwater -- Subsurface water and underground streams that can be collected with wells, or that flow naturally to the earth's surface through springs.
Groundwater basin -- A groundwater reservoir, defined by an overlying land surface and the underlying aquifers that contain water stored in the reservoir. In some cases, the boundaries of successively deeper aquifers may differ and make it difficult to define the limits of the basin.
Groundwater recharge -- Increases in groundwater storage by natural conditions or by human activity. See also artificial recharge.
Groundwater table -- The upper surface of the zone of saturation, except where the surface is formed by an impermeable body.
Habitat -- The local environment in which organisms normally live and grow.

Habitat diversity -- The number of different types of habitat within a given area.
Habitat fragmentation -- The breaking up of habitat into discrete islands through modification or conversion of habitat by management activities.
Headwater -- Referring to the source of a stream or river.
High gradient streams -- typically appear as steep cascading streams, step/pool streams, or streams that exhibit riffle/pool sequences. Most of the streams in Vermont are high gradient streams.
Hydraulic gradient -- The slope of the water surface. See also streambed gradient.
Hydraulic radius -- The cross-sectional area of a stream divided by the wetted perimeter.
Hydric -- Wet.
Hydrograph -- A curve showing stream discharge over time.
Hydrologic balance -- An accounting of all water inflow to, water outflow from, and changes in water storage within a hydrologic unit over a specified period of time.
Hydrologic region -- A study area, consisting of one or more planning subareas, that has a common hydrologic character.
Hydrologic unit -- A distinct watershed or river basin defined by an 8-digit code.
Hydrology -- The scientific study of the water of the earth, its occurrence, circulation and distribution, its chemical and physical properties, and its interaction with its environment, including its relationship to living things.
Hyporheic zone -- The area under the stream channel and floodplain where groundwater and the surface waters of the stream are exchanged freely.
Improved paths – Paths that are maintained and typically involve paved, gravel or macadam surfaces.
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.
Incision ratio -- The low bank height divided by the bankfull maximum depth.
Infiltration (soil) -- The movement of water through the soil surface into the soil.
Inflow -- Water that flows into a stream, lake,
Instream cover -- The layers of vegetation, like trees, shrubs, and overhanging vegetation, that are in the stream or immediately adjacent to the wetted channel.
Instream flows -- (1) Portion of a flood flow that is contained by the channel. (2) A minimum flow requirement to maintain ecological health in a stream.
Instream use -- Use of water that does not require diversion from its natural watercourse. For example, the use of water for navigation, recreation, fish and wildlife, aesthetics, and scenic enjoyment.
Intermittent stream -- Any nonpermanent flowing drainage feature having a definable channel and evidence of scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two criteria.
Irrigation diversion -- Generally, a ditch or channel that deflects water from a stream channel for irrigation purposes.
Islands – mid-channel bars that are above the average water level and have established woody vegetation.
Lake – An inland body of standing water deeper than a pond, an expanded part of a river, a reservoir behind a dam
Landslide -- A movement of earth mass down a steep slope.
Large woody debris (LWD) -- Pieces of wood at least 6 ft. long and 1 ft. in diameter (at the large end) contained, at least partially, within the bankfull channel.
Levee -- An embankment constructed to prevent a river from overflowing (flooding).
Limiting factor -- A requirement such as food, cover, or another physical, chemical, or biological factor that is in shortest supply with respect to all resources necessary to sustain life and thus "limits" the size or retards production of a population.
Low gradient -- streams typically appear slow moving and winding, and have poorly defined riffles and pools. These streams are usually found in the large valley bottoms of the Champlain Valley and occasionally in high wet meadows. The lower reaches of the Otter Creek,

Lewis Creek, and Poultney River are all areas you are likely to find low gradient streams.
Macroinvertebrate -- Invertebrates visible to the naked eye, such as insect larvae and crayfish.
Macrophytes -- Aquatic plants that are large enough to be seen with the naked eye.
Mainstem -- The principal channel of a drainage system into which other smaller streams or rivers flow.
Mass movement -- The downslope movement of earth caused by gravity. Includes but is not limited to landslides, rock falls, debris avalanches, and creep. It does not however, include surface erosion by running water. It may be caused by natural erosional processes, or by natural disturbances (e.g., earthquakes or fire events) or human disturbances (e.g., mining or road construction).
Mean annual discharge -- Daily mean discharge averaged over a period of years. Mean annual discharge generally fills a channel to about one-third of its bank-full depth.
Mean velocity -- The average cross-sectional velocity of water in a stream channel. Surface values typically are much higher than bottom velocities. May be approximated in the field by multiplying the surface velocity, as determined with a float, times 0.8.
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 amplitude -- The distance between points of maximum curvature of successive meanders of opposite phase in a direction normal to the general course of the meander belt, measured between center lines of channels.
Meander belt width -- the distance between lines drawn tangential to the extreme limits of fully developed meanders. Not to be confused with meander amplitude.
Meander length -- The lineal distance downvalley between two corresponding points of successive meanders of the same phase.
Mid-channel Bars – bars 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.
Milligrams per liter (mg/l) -- The weight in milligrams of any substance dissolved in 1 liter of liquid; nearly the same as parts per million by weight.
Natural flow -- The flow past a specified point on a natural stream that is unaffected by stream diversion, storage, import, export, return flow, or change in use caused by modifications in land use.
Outfall -- The mouth or outlet of a river, stream, lake, drain or sewer.
Oxbow -- An abandoned meander in a river or stream, caused by cutoff. Used to describe the U-shaped bend in the river or the land within such a bend of a river.
Peat -- Partially decomposed plants and other organic material that build up in poorly drained wetland habitats.
Perched groundwater -- Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater with which it is not hydrostatically connected.
Perennial streams -- Streams that flow continuously.
Permeability -- The capability of soil or other geologic formations to transmit water.
pH -- The negative logarithm of the molar concentration of the hydrogen ion, or, more simply acidity.
Point bar -- The convex side of a meander bend that is built up due to sediment deposition.
Pond -- A body of water smaller than a lake, often artificially formed.
Pool -- A reach of stream that is characterized by deep, low-velocity water and a smooth surface.
Pool/riffle ratio -- The ratio of surface area or length of pools to the surface area or length of riffles in a given stream reach; frequently expressed as the relative percentage of each category. Used to describe fish habitat rearing quality.
Potential plant height -- the height to which a plant, shrub or tree would grow if undisturbed.

Probability of exceedence -- The probability that a random flood will exceed a specified magnitude in a given period of time.
Railroads – Used or unused railroad infrastructure.
Rapids -- A reach of stream that is characterized by small falls and turbulent, high-velocity water.
Reach -- A section of stream having relatively uniform physical attributes, such as valley confinement, valley slope, sinuosity, dominant bed material, and bed form, as determined in the Phase 1 assessment.
Rearing habitat -- Areas in rivers or streams where juvenile fish find food and shelter to live and grow.
Regime theory -- A theory of channel formation that applies to streams that make a part of their boundaries from their transported sediment load and a portion of their transported sediment load from their boundaries. Channels are considered in regime or equilibrium when bank erosion and bank formation are equal.
Restoration -- The return of an ecosystem to a close approximation of its condition prior to disturbance.
Riffle -- A reach of stream that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.
Riffle/step frequency -- ratio of the distance between riffles to the stream width.
Riparian area -- An area of land and vegetation adjacent to a stream that has a direct effect on the stream. This includes woodlands, vegetation, and floodplains.
Riparian buffer is the width of naturally vegetated land adjacent to the stream between the top of the bank (or top of slope, depending on site characteristics) 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. The buffer serves to protect the water body from the impacts of adjacent land uses.
Riparian corridor includes lands defined by the lateral extent of a stream's meanders necessary to maintain a stable stream dimension, pattern, profile, and sediment regime. For instance, in stable pool-riffle streams, riparian corridors may be as wide as 10-12 times the channel's bankfull width. In addition the riparian corridor typically corresponds to the land area surrounding and including the stream that supports (or could support if unimpacted) a distinct ecosystem, generally with abundant and diverse plant and animal communities (as compared with upland communities).
Riparian habitat -- The aquatic and terrestrial habitat adjacent to streams, lakes, estuaries, or other waterways.
Riparian -- Located on the banks of a stream or other body of water.
Riparian vegetation -- The plants that grow adjacent to a wetland area such as a river, stream, reservoir, pond, spring, marsh, bog, meadow, etc., and that rely upon the hydrology of the associated water body.
Ripple -- (1) A specific undulated bed form found in sand bed streams. (2) Undulations or waves on the surface of flowing water.
Riprap -- Rock or other material with a specific mixture of sizes referred to as a "gradation," used to stabilize streambanks or riverbanks from erosion or to create habitat features in a stream.
River channels -- Large natural or artificial open streams that continuously or periodically contain moving water, or which form a connection between two bodies of water.
River miles -- Generally, miles from the mouth of a river to a specific destination or, for upstream tributaries, from the confluence with the main river to a specific destination.
River reach -- Any defined length of a river.
River stage -- The elevation of the water surface at a specified station above some arbitrary zero datum (level).
Riverine -- Relating to, formed by, or resembling a river including tributaries, streams, brooks, etc.
Riverine habitat -- The aquatic habitat within streams and rivers.
Roads - Transportation infrastructure. Includes private, town, state roads, and roads that are dirt, gravel, or paved.
Rock -- A naturally formed mass of minerals.
Rootwad -- The mass of roots associated with a tree adjacent to or in a stream that provides refuge for fish and other aquatic life.

Run (in stream or river) -- A reach of stream characterized by fast-flowing, low-turbulence water.
Runoff -- Water that flows over the ground and reaches a stream as a result of rainfall or snowmelt.
Sand -- Small substrate particles, generally from 0.06 to 2 mm in diameter. Sand is larger than silt and smaller than gravel.
Scour -- The erosive action of running water in streams, which excavates and carries away material from the bed and banks. Scour may occur in both earth and solid rock material and can be classed as general, contraction, or local scour.
Sediment -- Soil or mineral material transported by water or wind and deposited in streams or other bodies of water.
Sedimentation -- (1) The combined processes of soil erosion, entrainment, transport, deposition, and consolidation. (2) Deposition of sediment.
Seepage -- The gradual movement of a fluid into, through, or from a porous medium.
Segment: A relatively homogenous section of stream contained within a reach that has the same reference stream characteristics but is distinct from other segments in the reach in one or more of the following parameters: degree of floodplain encroachment, presence/absence of grade controls, bankfull channel dimensions (W/D ratio, entrenchment), channel sinuosity and slope, riparian buffer and corridor conditions, abundance of springs/seeps/adjacent wetlands/stormwater inputs, and degree of channel alterations.
Sensitivity --of the valley, floodplain, and/or channel condition to change due to natural causes and/or anticipated human activity.
Shoals – unvegetated deposits of gravels and cobbles adjacent to the banks that have a height less than the average water level. In channels that are over-widened, the stream does not have the power to transport these larger sediments, and thus they are deposited throughout the channel as shoals.
Silt -- Substrate particles smaller than sand and larger than clay (3 to 60 mm).
Siltation -- The deposition or accumulation of fine soil particles.
Sinuosity -- The ratio of channel length to direct down-valley distance. Also may be expressed as the ratio of down-valley slope to channel slope.
Slope -- The ratio of the change in elevation over distance.
Slope stability -- The resistance of a natural or artificial slope or other inclined surface to failure by mass movement.
Snag -- Any standing dead, partially dead, or defective (cull) tree at least 10 in. in diameter at breast height and at least 6 ft tall. Snags are important riparian habitat features.
Spawning -- The depositing and fertilizing of eggs (or roe) by fish and other aquatic life.
Spillway -- A channel for reservoir overflow.
Stable channel -- A stream channel with the right balance of slope, planform, and cross section to transport both the water and sediment load without net long-term bed or bank sediment deposition or erosion throughout the stream segment.
Stone -- Rock or rock fragments used for construction.
Straightening -- the removal of meander bends, often done in towns and along roadways, railroads, and agricultural fields.
Stream -- A general term for a body of water flowing by gravity; natural watercourse containing water at least part of the year. In hydrology, the term is generally applied to the water flowing in a natural narrow channel as distinct from a canal.
Stream banks are features that define the channel sides and contain stream flow within the channel; this is the portion of the channel bank that is between the toe of the bank slope and the bankfull elevation. The banks are distinct from the streambed, which is normally wetted and provides a substrate that supports aquatic organisms. The top of bank is the point where an abrupt change in slope is evident, and where the stream is generally able to overflow the banks and enter the adjacent floodplain during flows at or exceeding the average annual high water.
Stream channel -- A long narrow depression shaped by the concentrated flow of a stream and covered continuously or periodically by water.

Stream condition -- Given the land use, channel and floodplain modifications documented at the assessment sites, the current degree of change in the channel and floodplain from the reference condition for parameters such as dimension, pattern, profile, sediment regime, and vegetation.

Stream gradient -- A general slope or rate of change in vertical elevation per unit of horizontal distance of the bed, water surface, or energy grade of a stream.

Stream morphology -- The form and structure of streams.

Stream order -- A hydrologic system of stream classification. Each small unbranched tributary is a first-order stream. Two first-order streams join to make a second-order stream. A third-order stream has only first-and second-order tributaries, and so forth.

Stream reach -- An individual segment of stream that has beginning and ending points defined by identifiable features such as where a tributary confluence changes the channel character or order.

Stream type -- Gives the overall physical characteristics of the channel and helps predict the reference or stable condition of the reach.

Streambank armoring – The installation of concrete walls, gabions, stone riprap, and other large erosion resistant material along stream banks.

Streambank erosion -- The removal of soil from streambanks by flowing water.

Streambank stabilization -- The lining of streambanks with riprap, matting, etc., or other measures intended to control erosion.

Streambed -- (1) The unvegetated portion of a channel boundary below the baseflow level. (2) The channel through which a natural stream of water runs or used to run, as a dry streambed.

Streamflow -- The rate at which water passes a given point in a stream or river, usually expressed in cubic feet per second (cfs).

Step (in a river system) -- A step is a steep, step-like feature in a high gradient stream (> 2%). Steps are composed of large boulders lines across the stream. Steps are important for providing grade-control, and for dissipating energy. As fast-shallow water flows over the steps it takes various flow paths thus dissipating energy during high flow events.

Substrate -- (1) The composition of a streambed, including either mineral or organic materials. (2) Material that forms an attachment medium for organisms.

Surface erosion -- The detachment and transport of soil particles by wind, water, or gravity. Or a group of processes whereby soil materials are removed by running water, waves and currents, moving ice, or wind.

Surface water -- All waters whose surface is naturally exposed to the atmosphere, for example, rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc., and all springs, wells, or other collectors directly influenced by surface water.

Suspended sediment -- Sediment suspended in a fluid by the upward components of turbulent currents, moving ice, or wind.

Suspended sediment load -- That portion of a stream's total sediment load that is transported within the body of water and has very little contact with the streambed.

Tailwater -- (1) The area immediately downstream of a spillway. (2) Applied irrigation water that runs off the end of a field.

Thalweg -- (1) The lowest thread along the axial part of a valley or stream channel. (2) A subsurface, groundwater stream percolating beneath and in the general direction of a surface stream course or valley. (3) The middle, chief, or deepest part of a navigable channel or waterway.

Tractive Force --The drag on a streambed or bank caused by passing water, which tends to pull soil particles along with the streamflow.

Transpiration -- An essential physiological process in which plant tissues give off water vapor to the atmosphere.

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

Turbidity -- A measure of the content of suspended matter that interferes with the passage of light through the water or in which visual depth is restricted. Suspended sediments are only one component of turbidity.

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

Variable stage stream -- Stream flows perennially but water level rises and falls significantly with storm and runoff events.

Velocity -- In this concept, the speed of water flowing in a watercourse, such as a river.

Washout -- (1) Erosion of a relatively soft surface, such as a roadbed, by a sudden gush of water, as from a downpour or floods. (2) A channel produced by such erosion.

Water quality -- A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Waterfall -- A sudden, nearly vertical drop in a stream, as it flows over rock.

Watershed -- An area of land whose total surface drainage flows to a single point in a stream.

Watershed management -- The analysis, protection, development, operation, or maintenance of the land, vegetation, and water resources of a drainage basin for the conservation of all its resources for the benefit of its residents.

Watershed project -- A comprehensive program of structural and nonstructural measures to preserve or restore a watershed to good hydrologic condition. These measures may include detention reservoirs, dikes, channels, contour trenches, terraces, furrows, gully plugs, revegetation, and possibly other practices to reduce flood peaks and sediment production.

Watershed restoration -- Improving current conditions of watersheds to restore degraded habitat and provide long-term protection to aquatic and riparian resources.

Weir -- A structure to control water levels in a stream. Depending upon the configuration, weirs can provide a specific "rating" for discharge as a function of the upstream water level.

APPENDIX B
STANDARD PHASE 2 DMS REPORTS

Project: Winooski Mid, Alder to Montp

Phase 2 Segment Summary

January 27, 2009 SGAT Version: 4.56

Stream: Joiner Brook Reach # R10.S3.01 Segment: 0 Completion Date: August 29, 2008

Organization: Bear Creek Environmental Observers: MN, PD, SP Why Not assessed: Rain: No

Segment Length (ft): 2,323 Segment Location: From confluence of the Winooski River to first bedrock waterfall.

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation None

1.2 Alluvial Fan None

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	767	0
height	7	0
Roads	429	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	342	809

1.4 Adjacent Side

	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) 346

Width Determination Measured

Confinement Type Broad

Rock Gorge? No

Human-caused Change? Yes

Step 2. Stream Channel

2.1 Bankfull Width 67

2.2 Max Depth (ft) 5.50

2.3 Mean Depth (ft) 3.97

2.4 Floodprone Width (ft) 157

Notes:

Most of the lower reach on Joiner Brook is a C4 stream type. The average slope of greater than 2% is due to waterfalls at the upper end of this reach. The existing width to depth ratio is higher at the downstream end of reach.

Step 2. (Contued)

2.5 Aband. Floodpln 8.30 ft.

Human Elev Floodpln 0.00 ft.

2.6 Width/Depth Ratio 16.88

2.7 Entrenchment Ratio 2.35

2.8 Incision Ratio 1.51

Human Elevated Inc Rat 0.00

2.9 Sinuosity Low

2.10 Riffles Type Sedimented

2.11 Riffle/Step Spacing (ft) 213

2.12 Substrate Composition

Bedrock	0 %
Boulder	12 %
Cobble	34 %
Coarse Gravel	24 %
Fine Gravel	14 %
Sand	16 %
Silt and smaller	0 %

Silt/Clay Present? No

Detritus 2 %

Large Woody 3

2.13 Average Largest Particle on

Bed 8.5 inches

Bar 10.5 inches

2.14 Stream Type

Stream Type: C

Bed Material: Gravel

Subclass Slope: b

Bed Form: Riffle-Pool

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope Steep

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	204	150
Erosion Height (ft)	5.13	5.57
Revetmt. Type	Multiple	Multiple
Revetmt. Length (ft)	803	861

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Invasives	Invasives

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy Open

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	>100	51-100
W less than 25	801	1,156

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Mixed Trees	Mixed Trees

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Residential	Residential
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

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 None

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg None

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	3
Other	0	Tile Drain	0
Overland Flow	1	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams 0

Affected Length (ft) 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	1	13
Diagonal	Delta	Island
2	2	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
3	0	No

5.4 Stream Ford or Animal No

5.5 Straightening With Windrowing

Straightening Length: 1,830

5.5 Dredging None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.01** Segment: **0** Completion Date: **August 29, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, PD, SP** Rain: **No**

Segment Length (ft): **2,323** Segment Location: **From confluence of the Winooski River to first bedrock waterfall.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Mid-segment	15.00	8.00	Yes	
Waterfall	Mid-segment	40.00	30.00	Yes	
Waterfall	Mid-segment	40.00	30.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	54.0	Yes	Yes	Yes	Yes
Problem	Deposition Above,Deposition Below				
Bridge	33.9	Yes	Yes	Yes	Yes
Problem	Deposition Below,Scour Below				
Bridge	45.0	Yes	Yes	Yes	Yes
Problem	Deposition Above				
Bedrock	5.00	Yes	No	Yes	Yes
Problem	Scour Below				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**8**	**None**	**Yes**
7.2 Channel Aggradation	**7**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**13**		**Yes**

Total Score **41**

Geomorphic Rating **0.5125**

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Major historic incision due to windrowing and riprapping. Major aggradation as evidenced by sedimented riffles and diagonal bars. Some limited widening (riprap prevented widening is some locations). Minor planform adjustment.

Project: Winooski Mid, Alder to Montp

Phase 2 Segment Summary

January 27, 2009 SGAT Version: 4.56

Stream: **Joiner Brook** Reach # **R10.S3.02** Segment: **A** Completion Date: **September 3, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, PD, GA** Why Not assessed: Rain: **No**

Segment Length (ft): **1,278** Segment Location: **Lower end of segment is at top of bedrock waterfalls and extends approximately 1200 feet**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Grade Controls**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	95	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **235**

Width Determination **Measured**

Confinement Type **Narrow**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **79**

2.2 Max Depth (ft) **5.00**

2.3 Mean Depth (ft) **3.04**

2.4 Floodprone Width (ft) **253**

Notes:

There was a silt layer noted on the substrate. This silt layer was likely attributed to road runoff. The segment transitions as follows: Upper is confined with step-pool; mid is unconfined with riffle-pool; lower is confined with step-pool.

Step 2. (Contued)

2.5 Aband. Floodpln **6.25** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **25.86**

2.7 Entrenchment Ratio **3.22**

2.8 Incision Ratio **1.25**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Sedimented**

2.11 Riffle/Step Spacing (ft) **92**

2.12 Substrate Composition

Bedrock	0%
Boulder	27%
Cobble	36%
Coarse Gravel	14%
Fine Gravel	7%
Sand	16%
Silt and smaller	0%

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **14**

2.13 Average Largest Particle on

Bed **16.2** inches

Bar **6.8** inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Cobble**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	183	101
Erosion Height (ft)	5.00	12.00
Revetmt. Type	None	Rip-Rap
Revetmt. Length (ft)	0	92

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	51-100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

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 **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	7
Other	0	Tile Drain	0
Overland Flow	1	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	11
Diagonal	**Delta**	**Island**
1	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.02** Segment: **A** Completion Date: **September 3,**

Organization: **Bear Creek Environmental** Observers: **MN, PD, GA** Rain: **No**

Segment Length (ft): **1,278** Segment Location: **Lower end of segment is at top of bedrock waterfalls and extends approximately 1200**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**12**		**No**
Total Score	**52**		
Geomorphic Rating	**0.65**		

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Minor historic degradation; active flood chutes indicating major planform adjustment; minor aggradation and widening.

Stream: **Joiner Brook** | Reach # **R10.S3.02** | Segment: **B** | Completion Date: **September 3, 2008**

Organization: **Bear Creek Environmental** | Observers: **MN, PD** | Why Not assessed: **bedrock gorge** | Rain: **No**

Segment Length (ft): **554** | Segment Location: **Downstream end of segment is approximately 1/3 mile up the Bolton Valley Access Road.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Grade Controls**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **88**

Width Determination **Measured**

Confinement Type **Narrowly**

Rock Gorge? **Yes**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

This segment has multiple waterfalls that have total heights in the range of 19 to 45 feet. There were also multiple large pools. We could not walk the entire length of this segment. The segment was in reference condition with the exception of the lack of a

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **G**

Bed Material: **Bedrock**

Subclass Slope: **None**

Bed Form: **Cascade**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	0-25
W less than 25	0	228

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	Residential
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	1	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.02** Segment: **B** Completion Date: **September 3,**

Organization: **Bear Creek Environmental** Observers: **MN, PD** Rain: **No**

Segment Length (ft): **554** Segment Location: **Downstream end of segment is approximately 1/3 mile up the Bolton Valley Access**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Waterfall	Mid-segment	27.00	25.00	Yes	
Waterfall	Mid-segment	19.00	15.00	Yes	
Waterfall	Mid-segment	19.00	15.00	Yes	
Waterfall	Mid-segment	45.00	40.00	Yes	
Waterfall	Mid-segment	30.00	25.00	Yes	
Waterfall	Mid-segment	25.00	10.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	10.0	Yes	No	Yes	Yes
Problem	Deposition Below,Scour Above,Scour				
Bedrock	14.0	Yes	No	Yes	Yes
Problem	Scour Above,Scour Below				
Bedrock	4.00	No	No	Yes	Yes
Problem	Scour Above,Scour Below				
Bedrock	5.00	No	No	Yes	Yes
Problem	Scour Above,Scour Below				
Bedrock	14.0	Yes	No	Yes	Yes
Problem	Deposition Above,Deposition Below,Scour				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Good**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Phase 2 Segment Summary

January 27, 2009 SGAT Version: 4.56

Project: Winooski Mid, Alder to Montp
Stream: Joiner Brook Reach # R10.S3.02 Segment: C Completion Date: September 10, 2008
Organization: Bear Creek Environmental Observers: MN, PD, GA Why Not assessed: Rain: No
Segment Length (ft): 1,041 Segment Location: Segment begins about 1/2 mile up the Bolton Valley Access Road and is located above

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation: Grade Controls
1.2 Alluvial Fan: None

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	369	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side

	Left	Right
Hillside Slope	Very Steep	Extremely
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft): 280
Width Determination: Measured
Confinement Type: Narrow
Rock Gorge?: No
Human-caused Change?: Yes

Step 2. Stream Channel

2.1 Bankfull Width: 54
2.2 Max Depth (ft): 6.45
2.3 Mean Depth (ft): 3.90
2.4 Floodprone Width (ft): 122

Notes:

Segment C is steeper than Segment A and has larger substrate.

The confinement type calculated using the valley width and the Phase 1 channel width is broad. When the Phase 2 channel width is

Step 2. (Contued)

2.5 Aband. Floodpln: 7.65 ft.
Human Elev Floodpln: 0.00 ft.
2.6 Width/Depth Ratio: 13.90
2.7 Entrenchment Ratio: 2.24
2.8 Incision Ratio: 1.19
Human Elevated Inc Rat: 0.00
2.9 Sinuosity: Low
2.10 Riffles Type: Complete
2.11 Riffle/Step Spacing (ft): 84

2.12 Substrate Composition

Substrate	%
Bedrock	0 %
Boulder	32 %
Cobble	48 %
Coarse Gravel	12 %
Fine Gravel	6 %
Sand	2 %
Silt and smaller	0 %

Silt/Clay Present?: No
Detritus: 2 %
Large Woody: 3

2.13 Average Largest Particle on

Bed	19.0	inches
Bar	7.1	inches

2.14 Stream Type

Stream Type: C
Bed Material: Cobble
Subclass Slope: b
Bed Form: Step-Pool
Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: Steep

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	25	0
Erosion Height (ft)	5.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	51-75

Mid-Channel Canopy: Open

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	None	>100
W less than 25	229	546

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Forest	Residential
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Abundant
4.2 Adjacent Wetlands: None
4.3 Flow Status: Moderate
4.4 # of Debris Jams: 0
4.5 Flow Regulation Type: None
Flow Regulation Use
Impoundments
Impoundmt. Location
4.6 Up/Down strm flow reg: None
(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	2
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams: 0
Affected Length (ft): 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	0	8
Diagonal	**Delta**	**Island**
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
4	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal: No
5.5 Straightening: None
Straightening Length: 0
5.5 Dredging: None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.02** Segment: **C** Completion Date: **September 10,**

Organization: **Bear Creek Environmental** Observers: **MN, PD, GA** Rain: **No**

Segment Length (ft): **1,041** Segment Location: **Segment begins about 1/2 mile up the Bolton Valley Access Road and is located above**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Ledge	Mid-segment	2.00	1.00	Yes	
Waterfall	Mid-segment	11.00	10.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	5.00	Yes	No	Yes	Yes

Problem Deposition Below,Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**Yes**
7.2 Channel Aggradation	**14**	**None**	**No**
7.3 Widening Channel	**17**		**No**
7.4 Change in Planform	**12**		**No**
Total Score	**57**		
Geomorphic Rating	**0.7125**		

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Minor historic incision; minor aggradation and planform adjustment (3 floodchutes within 1000 feet).

Phase 2 Segment Summary

January 27, 2009 SGAT Version: 4.56

Project: Winooski Mid, Alder to Montp
Stream: Joiner Brook | Reach # R10.S3.02 | Segment: D | Completion Date: September 3, 2008
Organization: Bear Creek Environmental | Observers: MN, PD | Why Not assessed: bedrock gorge | Rain: No
Segment Length (ft): 340 | Segment Location: Lower end of segment is approximately 0.7 miles up the Bolton Valley Access Road. Joiner

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation: **Grade Controls**
1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	339	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features
- Valley Width (ft): **90**
- Width Determination: **Estimated**
- Confinement Type: **Narrowly**
- Rock Gorge?: **Yes**
- Human-caused Change?: **No**

Step 2. Stream Channel

- 2.1 Bankfull Width: 0
- 2.2 Max Depth (ft): 0.00
- 2.3 Mean Depth (ft): 0.00
- 2.4 Floodprone Width (ft): 0

Notes:

Multiple waterfalls and large pools in segment. Joiner Brook is relatively close to the road in this location. Stormwater inputs via road ditches and overland flow were mapped in this segment.

Step 2. (Contued)

- 2.5 Aband. Floodpln: 0.00 ft.
- Human Elev Floodpln: 0.00 ft.
- 2.6 Width/Depth Ratio: 0.00
- 2.7 Entrenchment Ratio: 0.00
- 2.8 Incision Ratio: 0.00
- Human Elevated Inc Rat: 0.00
- 2.9 Sinuosity
- 2.10 Riffles Type
- 2.11 Riffle/Step Spacing (ft): 0
- 2.12 Substrate Composition

Silt/Clay Present?
Detritus: 0 %
Large Woody: 0

2.13 Average Largest Particle on
- Bed: 0.0
- Bar: 0.0

2.14 Stream Type
- Stream Type: **G**
- Bed Material: **Bedrock**
- Subclass Slope: **None**
- Bed Form: **Cascade**
- Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

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

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy: **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	26-50	None
W less than 25	0	71

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Residential	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps: **Minimal**
- 4.2 Adjacent Wetlands: **None**
- 4.3 Flow Status: **Moderate**
- 4.4 # of Debris Jams: **0**
- 4.5 Flow Regulation Type: **None**
  - Flow Regulation Use
  - Impoundments
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg: **None**
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	1
Other	0	Tile Drain	0
Overland Flow	2	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams: 0
Affected Length (ft): 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0

Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

- 5.4 Stream Ford or Animal: **No**
- 5.5 Straightening: **None**
  - Straightening Length: **0**
- 5.5 Dredging: **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Winooski Mid, Alder to Montp** **Phase 2 Reach Summary** January 27, 2009

Stream: **Joiner Brook** Reach # **R10.S3.02** Segment: **D** Completion Date: **September 3,**

Organization: **Bear Creek Environmental** Observers: **MN, PD** Rain: **No**

Segment Length (ft): **340** Segment Location: **Lower end of segment is approximately 0.7 miles up the Bolton Valley Access Road.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Mid-segment	35.00	20.00	Yes	
Waterfall	Mid-segment	0.00	0.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Good**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Stream: Joiner Brook | Reach # R10.S3.02 | Segment: E | Completion Date: September 3, 2008

Organization: Bear Creek Environmental | Observers: MN, PD, | Why Not assessed: | Rain: No

Segment Length (ft): 3,084 | Segment Location: The downstream end of the segment starts 3/4 of a mile up the Bolton Valley Access Road

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Grade Controls**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	128	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

- Valley Width (ft) **113**
- Width Determination **Measured**
- Confinement Type **Semi-confined**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width	75
2.2 Max Depth (ft)	4.65
2.3 Mean Depth (ft)	2.87
2.4 Floodprone Width (ft)	117

Notes:

Segment E alternates between a "F" Rosgen stream type and a "B" Rosgen stream type by reference.

Step 2. (Contued)

2.5 Aband. Floodpln	4.65 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	26.03
2.7 Entrenchment Ratio	1.56
2.8 Incision Ratio	1.00
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Sedimented
2.11 Riffle/Step Spacing (ft)	86

2.12 Substrate Composition

Bedrock	4 %
Boulder	14 %
Cobble	23 %
Coarse Gravel	25 %
Fine Gravel	15 %
Sand	19 %
Silt and smaller	0 %

- Silt/Clay Present? **No**
- Detritus **2** %
- # Large Woody **51**

2.13 Average Largest Particle on

- Bed **9.7** inches
- Bar **9.1** inches

2.14 Stream Type

- Stream Type: **B**
- Bed Material: **Gravel**
- Subclass Slope: **a**
- Bed Form: **Step-Pool**
- Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

B 4 a Step-Pool

3.3 old	Amount	Mean Height
Failures	One	20.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	40	40
Erosion Height (ft)	8.00	20.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	51-100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	Residential
Mass Failures	0	72
Height	0	20
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	None
4.3 Flow Status	Low
4.4 # of Debris Jams	0
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	18
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
7	0	29
Diagonal	**Delta**	**Island**
0	0	2

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
11	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
2	0	No

- 5.4 Stream Ford or Animal **No**
- 5.5 Straightening **None**
- Straightening Length: **0**
- 5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Winooski Mid, Alder to Montp** | **Phase 2 Reach Summary** | | January 27, 2009

Stream: **Joiner Brook** | Reach # **R10.S3.02** | Segment: **E** | Completion Date: **September 3,**

Organization: **Bear Creek Environmental** | Observers: **MN, PD,** | Rain: **No**

Segment Length (ft): **3,084** | Segment Location: **The downstream end of the segment starts 3/4 of a mile up the Bolton Valley Access**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Mid-segment	10.00	5.00	Yes	
Ledge	Mid-segment	7.00	3.00	Yes	

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**7**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**47**		
Geomorphic Rating	**0.5875**		

Channel Evolution Model **D**

Channel Evolution Stage **IId**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Major aggradation and planform adjustment especially in areas where valley wall opens up and is not continuous with the bank. Major side bars and flood chutes.

Project: Winooski Mid, Alder to Montp | **Phase 2 Segment Summary** | | January 27, 2009 | SGAT Version: 4.56

Stream: **Joiner Brook** | Reach # **R10.S3.03** | Segment: **A** | Completion Date: **October 13, 2008**

Organization: **Bear Creek Environmental** | Observers: **CS, MN** | Why Not assessed: | Rain: **No**

Segment Length (ft): **2,348** | Segment Location: **Downstream end of segment starts approximately 1.3 miles up the Bolton Valley Access**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Grade Controls**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **225**

Width Determination **Measured**

Confinement Type **Narrow**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **62**

2.2 Max Depth (ft) **4.60**

2.3 Mean Depth (ft) **3.34**

2.4 Floodprone Width (ft) **144**

Notes:

Lots of exposed substrate; numerous mid-channel bars and large side bars. Segment is very depositional.

The confinement type using the reference channel width is broad. Using the Phase 2

Step 2. (Contued)

2.5 Aband. Floodpln **5.50** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **18.56**

2.7 Entrenchment Ratio **2.32**

2.8 Incision Ratio **1.20**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **89**

2.12 Substrate Composition

Bedrock	0 %
Boulder	19 %
Cobble	47 %
Coarse Gravel	22 %
Fine Gravel	10 %
Sand	2 %
Silt and smaller	0 %

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **25**

2.13 Average Largest Particle on

Bed **17.6** inches

Bar **10.2** inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Cobble**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	25.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	182	0
Erosion Height (ft)	6.22	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	51-75	76-100

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	44	0
Height	25	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
12	0	18
Diagonal	**Delta**	**Island**
1	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
9	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.03** Segment: **A** Completion Date: **October 13, 2008**

Organization: **Bear Creek Environmental** Observers: **CS, MN** Rain: **No**

Segment Length (ft): **2,348** Segment Location: **Downstream end of segment starts approximately 1.3 miles up the Bolton Valley**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**7**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**45**		
Geomorphic Rating	**0.5625**		

Channel Evolution Model **D**

Channel Evolution Stage **IIc**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Major aggradation and planform adjustment with minor widening; Lots of exposed substrate; large side bars and numerous mid-channel bars. Flood chutes are evidence of planform adjustment.

Project: Winooski Mid, Alder to Montp

Phase 2 Segment Summary

January 27, 2009 SGAT Version: 4.56

Stream: **Joiner Brook** Reach # **R10.S3.03** Segment: **B** Completion Date: **October 7, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, CS** Why Not assessed: Rain: **No**

Segment Length (ft): **1,325** Segment Location: **Upper end of reach is almost 2 miles up the Bolton Access Road. The top of the reach ends**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Grade Controls**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Very Steep
Continuous w/	Always	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **110**

Width Determination **Measured**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **96**

2.2 Max Depth (ft) **4.00**

2.3 Mean Depth (ft) **2.20**

2.4 Floodprone Width (ft) **150**

Notes:

Multiple bedrock waterfalls (grade controls) in segment. Big material in channel. Two cross-sections surveyed in this segment. The upper cross section (located at the top of the segment) was more incised (IR of 1.48) and had a lower width to depth ratio(26.0). This

Step 2. (Contued)

2.5 Aband. Floodpln **4.80** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **43.64**

2.7 Entrenchment Ratio **1.56**

2.8 Incision Ratio **1.20**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **162**

2.12 Substrate Composition

Bedrock	7%
Boulder	16%
Cobble	35%
Coarse Gravel	29%
Fine Gravel	7%
Sand	6%
Silt and smaller	0%

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **3**

2.13 Average Largest Particle on

Bed **15.3** inches

Bar **10.2** inches

2.14 Stream Type

Stream Type: **B**

Bed Material: **Cobble**

Subclass Slope: **a**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

B 3 a Step-Pool

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	1	3
Diagonal	**Delta**	**Island**
0	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
4	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project:	**Winooski Mid, Alder to Montp**		**Phase 2 Reach Summary**	page 2 of 2		January 27, 2009
Stream:	**Joiner Brook**	Reach #	**R10.S3.03**	Segment: **B**	Completion Date:	**October 7, 2008**
Organization:	**Bear Creek Environmental**	Observers:	**MN, CS**		Rain:	**No**
Segment Length (ft):	**1,325**	Segment Location:	**Upper end of reach is almost 2 miles up the Bolton Access Road. The top of the reach**			

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Mid-segment	8.00	3.00	Yes	
Waterfall	Mid-segment	9.00	5.00	Yes	
Waterfall	Mid-segment	15.00	10.00	Yes	
Waterfall	Mid-segment	12.00	8.00	Yes	
Waterfall	Mid-segment	25.00	15.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	10.0	Yes	No	Yes	Yes

Problem Deposition Below,Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**15**	**None**	**Yes**
7.2 Channel Aggradation	**9**	**None**	**No**
7.3 Widening Channel	**4**		**Yes**
7.4 Change in Planform	**10**		**No**
Total Score	**38**		
Geomorphic Rating	**0.475**		

Channel Evolution Model **D**

Channel Evolution Stage **IId**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Possible very minor historic incision (IR of 1.2); major aggradation and planform adjustment; extreme historic widening in areas where the valley opens up. Multiple flood chutes, one neck cutoff, some mid-channel bars.

Phase 2 Segment Summary

Project: Winooski Mid, Alder to Montp — January 27, 2009 — SGAT Version: 4.56

Stream: **Joiner Brook** — Reach # **R10.S3.04** — Segment: **A** — Completion Date: **October 10, 2008**

Organization: **Bear Creek Environmental** — Observers: **MN, CS** — Why Not assessed: — Rain: **No**

Segment Length (ft): **1,890** — Segment Location: **Lower end of segment is approximately 2 miles up the Bolton Valley Resort Access Road.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Valley Width**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

- Valley Width (ft) **615**
- Width Determination **Measured**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width	83
2.2 Max Depth (ft)	4.10
2.3 Mean Depth (ft)	1.67
2.4 Floodprone Width (ft)	537

Notes:

The field measured slope was 3.5%, putting this segment in the range of what could be considered planebed. This segment has a historic incision ratio of 1.76, which may be contributing to the planebed features. We have assigned the reference bedform to be

Step 2. (Contued)

2.5 Aband. Floodpln	7.20 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	49.40
2.7 Entrenchment Ratio	6.50
2.8 Incision Ratio	1.76
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Not Applicable
2.11 Riffle/Step Spacing (ft)	0

2.12 Substrate Composition

Bedrock	0%
Boulder	24%
Cobble	40%
Coarse Gravel	16%
Fine Gravel	12%
Sand	8%
Silt and smaller	0%

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **22**

2.13 Average Largest Particle on

Bed	15.6	inches
Bar	10.0	inches

2.14 Stream Type

- Stream Type: **C**
- Bed Material: **Cobble**
- Subclass Slope: **b**
- Bed Form: **Plane Bed**

Field Measured Slope: **3.5**

2.15 Reference Stream Type (if different from Phase 1)

C 3 b Plane Bed

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	259	409
Erosion Height (ft)	5.20	6.02
Revetmt. Type	Rip-Rap	Multiple
Revetmt. Length (ft)	57	36

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	26-50	26-50

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	0-25
W less than 25	44	131

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	None
4.3 Flow Status	Moderate
4.4 # of Debris Jams	0
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	1	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	2	15
Diagonal	**Delta**	**Island**
0	1	2

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
4	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.04** Segment: **A** Completion Date: **October 10, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, CS** Rain: **No**

Segment Length (ft): **1,890** Segment Location: **Lower end of segment is approximately 2 miles up the Bolton Valley Resort Access**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	36.0	Yes	Yes	Yes	Yes

Problem Deposition Below,Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Plane Bed**

	Score	STD	Historic
7.1 Channel Degradation	**8**	**None**	**Yes**
7.2 Channel Aggradation	**8**	**None**	**No**
7.3 Widening Channel	**5**		**No**
7.4 Change in Planform	**9**		**No**
Total Score	**30**		
Geomorphic Rating	**0.375**		

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Major historic degradation, major aggradation, widening and planform adjustment. Active flood chutes, islands, and a couple of mid-channel bars. Used planebed form (assigned planebed by reference due to field measured slope of 3.5%).

Stream: **Joiner Brook** Reach # **R10.S3.04** Segment: **B** Completion Date: **October 10, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, CS** Why Not assessed: Rain: **No**

Segment Length (ft): **860** Segment Location: **Lower end of segment starts about 2.3 miles from base of Bolton Valley Resort Access**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Valley Width**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft)	180
Width Determination	Measured
Confinement Type	Narrow
Rock Gorge?	No
Human-caused Change?	No

Step 2. Stream Channel

2.1 Bankfull Width	58
2.2 Max Depth (ft)	5.10
2.3 Mean Depth (ft)	3.00
2.4 Floodprone Width (ft)	139

Notes:

Cascade with large boulders at the very top of Segment B appears to be holding the elevation of the bed. Segment B is not incised.

The confinement type using the reference

Step 2. (Contued)

2.5 Aband. Floodpln	5.10 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	19.33
2.7 Entrenchment Ratio	2.40
2.8 Incision Ratio	1.00
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Complete
2.11 Riffle/Step Spacing (ft)	66

2.12 Substrate Composition

Bedrock	0%
Boulder	18%
Cobble	43%
Coarse Gravel	22%
Fine Gravel	12%
Sand	5%
Silt and smaller	0%

Silt/Clay Present?	No
Detritus	2 %
# Large Woody	6

2.13 Average Largest Particle on

Bed	15.4	inches
Bar	8.6	inches

2.14 Stream Type

Stream Type:	C
Bed Material:	Cobble
Subclass Slope:	b
Bed Form:	Step-Pool
Field Measured Slope:	5

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	141	0
Erosion Height (ft)	5.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Invasives	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	None
4.3 Flow Status	Moderate
4.4 # of Debris Jams	0
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	5
Diagonal	**Delta**	**Island**
1	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
3	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal	No
5.5 Straightening	None
Straightening Length:	0
5.5 Dredging	None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.04** Segment: **B** Completion Date: **October 10, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, CS** Rain: **No**

Segment Length (ft): **860** Segment Location: **Lower end of segment starts about 2.3 miles from base of Bolton Valley Resort Access**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**17**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**9**		**No**
Total Score	**58**		
Geomorphic Rating	**0.725**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Minor widening and major planform adjustment. Active flood chutes.

Project: Winooski Mid, Alder to Montp

Phase 2 Segment Summary

January 27, 2009 SGAT Version: 4.56

Stream: **Joiner Brook** Reach # **R10.S3.04** Segment: **C** Completion Date: **October 10, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, CS** Why Not assessed: Rain: **No**

Segment Length (ft): **450** Segment Location: **The lower end of the segment is located approximately 2.4 miles from the base of the Bolton**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Never	Never
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft)	325
Width Determination	Measured
Confinement Type	Broad
Rock Gorge?	No
Human-caused Change?	No

Step 2. Stream Channel

2.1 Bankfull Width	52
2.2 Max Depth (ft)	4.30
2.3 Mean Depth (ft)	3.28
2.4 Floodprone Width (ft)	58

Notes:

Channel constriction is a weir for the snowmaking waterwithdrawal. There are two-4 foot openings on the weir. One of the openings is filled with sediment. Segment C had one very large mid-channel bar which was created by the channel constriction

Step 2. (Contued)

2.5 Aband. Floodpln	11.30 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	15.85
2.7 Entrenchment Ratio	1.12
2.8 Incision Ratio	2.63
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Eroded
2.11 Riffle/Step Spacing (ft)	73

2.12 Substrate Composition

Bedrock	0 %
Boulder	20 %
Cobble	38 %
Coarse Gravel	26 %
Fine Gravel	11 %
Sand	5 %
Silt and smaller	0 %

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **5**

2.13 Average Largest Particle on

Bed	15.0	inches
Bar	9.0	inches

2.14 Stream Type

Stream Type:	F
Bed Material:	Cobble
Subclass Slope:	b
Bed Form:	Step-Pool
Field Measured Slope:	

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	139	201
Erosion Height (ft)	9.31	8.07
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	89

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	Commercial
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Abundant
4.2 Adjacent Wetlands	None
4.3 Flow Status	Moderate
4.4 # of Debris Jams	0
4.5 Flow Regulation Type	Small
Flow Regulation Use	Recreation
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	0	1
Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **89**

5.5 Dredging **Dredging**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.04** Segment: **C** Completion Date: **October 10, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, CS** Rain: **No**

Segment Length (ft): **450** Segment Location: **The lower end of the segment is located approximately 2.4 miles from the base of the**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Weir	Mid-segment	5.00	4.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Other	4.00	Yes	No	Yes	No

Problem Deposition Above,Deposition Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**3**	**C to F**	**Yes**
7.2 Channel Aggradation	**6**	**None**	**No**
7.3 Widening Channel	**10**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**32**		
Geomorphic Rating	**0.4**		

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Channel appears to be in early stage III of F channel evolution model. Extreme historic degradation due to snowmaking weir (sediment starved below); major aggradation; major widening (moderate bank erosion) and minor planform adjustment (MCB).

Project: Winooski Mid, Alder to Montp
Stream: Joiner Brook Reach # R10.S3.04 Segment: D Completion Date: October 10, 2008
Organization: Bear Creek Environmental Observers: MN, CS Why Not assessed: Rain: No
Segment Length (ft): 869 Segment Location: Located immediately upstream of Bolton Valley Resort's snowmaking water withdrawal and

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Never	Sometimes
W/in 1 Bankfill	Never	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features
- Valley Width (ft): **280**
- Width Determination: **Measured**
- Confinement Type: **Narrow**
- Rock Gorge?: **No**
- Human-caused Change?: **No**

Step 2. Stream Channel

- 2.1 Bankfull Width: **60**
- 2.2 Max Depth (ft): **5.00**
- 2.3 Mean Depth (ft): **2.70**
- 2.4 Floodprone Width (ft): **164**

Notes:

The lower end of this segment is just upstream of the weir for Bolton Valley Resort's snowmaking water withdrawal. This segment has some localized impact from the operation of the snowmaking water withdrawal at the lower end. The right bank

Step 2. (Contued)

- 2.5 Aband. Floodpln: **5.00** ft.
- Human Elev Floodpln: **0.00** ft.
- 2.6 Width/Depth Ratio: **22.04**
- 2.7 Entrenchment Ratio: **2.75**
- 2.8 Incision Ratio: **1.00**
- Human Elevated Inc Rat: **0.00**
- 2.9 Sinuosity: **Low**
- 2.10 Riffles Type: **Complete**
- 2.11 Riffle/Step Spacing (ft): **60**

2.12 Substrate Composition

Bedrock	0 %
Boulder	23 %
Cobble	33 %
Coarse Gravel	29 %
Fine Gravel	10 %
Sand	5 %
Silt and smaller	0 %

- Silt/Clay Present?: **No**
- Detritus: **2** %
- # Large Woody: **6**

2.13 Average Largest Particle on

Bed	15.0	inches
Bar	10.7	inches

2.14 Stream Type
- Stream Type: **C**
- Bed Material: **Cobble**
- Subclass Slope: **b**
- Bed Form: **Step-Pool**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	58	146
Erosion Height (ft)	5.00	5.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy: **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	0-25	None
W less than 25	0	85

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps: **Minimal**
- 4.2 Adjacent Wetlands: **None**
- 4.3 Flow Status: **Moderate**
- 4.4 # of Debris Jams: **0**
- 4.5 Flow Regulation Type: **None**
  - Flow Regulation Use
  - Impoundments
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg: **None**
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams: **0**
- Affected Length (ft): **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	0	7
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
3	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

- 5.4 Stream Ford or Animal: **No**
- 5.5 Straightening: **Straightening**
  - Straightening Length: **84**
- 5.5 Dredging: **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Winooski Mid, Alder to Montp** | **Phase 2 Reach Summary** | January 27, 2009

Stream: **Joiner Brook** | Reach # **R10.S3.04** | Segment: **D** | Completion Date: **October 10, 2008**

Organization: **Bear Creek Environmental** | Observers: **MN, CS** | Rain: **No**

Segment Length (ft): **869** | Segment Location: **Located immediately upstream of Bolton Valley Resort's snowmaking water**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**14**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**57**		
Geomorphic Rating	**0.7125**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Minor aggradation, widening and planform adjusment which is localized due to impact of snowmaking waterwithdrawal. Deposition and minor channel alteration immediately upstream of weir. This segment has some minor flood chutes.

Phase 2 Segment Summary

January 27, 2009 SGAT Version: 4.56

Project: Winooski Mid, Alder to Montp
Stream: Joiner Brook Reach # R10.S3.05 Segment: 0 Completion Date: **September 10, 2008**
Organization: **Bear Creek Environmental** Observers: **MN, PD, SP** Why Not assessed: Rain: **No**
Segment Length (ft): **2,744** Segment Location: **Joiner Brook crosses the "S" curve of the Bolton Valley Resort Access Road within this**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	93

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **100**
Width Determination **Measured**
Confinement Type **Semi-confined**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **74**
2.2 Max Depth (ft) **4.60**
2.3 Mean Depth (ft) **2.90**
2.4 Floodprone Width (ft) **165**

Notes:

Cross section in flood chute area. All other parts of segment were unsuitable or in a grade control bedrock section. Bankfull width included in flood chute resulting in a less entrenched stream (entrenchment ratio of 2.21). Stream type came out as Cb at cross

Step 2. (Contued)

2.5 Aband. Floodpln **8.20** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **25.41**
2.7 Entrenchment Ratio **2.23**
2.8 Incision Ratio **1.78**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Low**
2.10 Riffles Type **Complete**
2.11 Riffle/Step Spacing (ft) **73**

2.12 Substrate Composition

Bedrock	2%
Boulder	29%
Cobble	18%
Coarse Gravel	25%
Fine Gravel	15%
Sand	11%
Silt and smaller	0%

Silt/Clay Present? **No**
Detritus **2** %
Large Woody **30**

2.13 Average Largest Particle on

Bed	13.4	inches
Bar	23.0	inches

2.14 Stream Type

Stream Type: **B**
Bed Material: **Gravel**
Subclass Slope: **a**
Bed Form: **Step-Pool**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	Multiple	40.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	432	244
Erosion Height (ft)	24.86	7.96
Revetmt. Type	Rip-Rap	Multiple
Revetmt. Length (ft)	30	65
Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None
Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	0-25	0-25
W less than 25	83	80
Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Residential	Residential
Mass Failures	289	0
Height	40	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **None**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **0**
4.5 Flow Regulation Type **None**
Flow Regulation Use
Impoundments
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	4
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
7	0	27
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
5	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **No**
5.5 Straightening **Straightening**
Straightening Length: **174**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project:	Winooski Mid, Alder to Montp		**Phase 2 Reach Summary**	page 2 of 2	January 27, 2009
Stream:	**Joiner Brook**	Reach #	**R10.S3.05**	Segment: **0**	Completion Date: **September 10,**
Organization:	**Bear Creek Environmental**	Observers:	**MN, PD, SP**		Rain: **No**
Segment Length (ft):	**2,744**	Segment Location:	**Joiner Brook crosses the "S" curve of the Bolton Valley Resort Access Road within this**		

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Mid-segment	25.00	22.00	Yes	
Ledge	Mid-segment	0.00	0.00	No	
Waterfall	Mid-segment	15.00	14.00	Yes	
Waterfall	Mid-segment	40.00	38.00	Yes	
Waterfall	Mid-segment	18.00	15.00	Yes	
Waterfall	Mid-segment	0.00	0.00	No	
Waterfall	Mid-segment	0.00	0.00	No	
Waterfall	Mid-segment	0.00	0.00	No	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	16.0	Yes	Yes	Yes	Yes
	Problem	Deposition Above,Scour Below			
Bedrock	9.00	Yes	No	Yes	Yes
	Problem	Deposition Below,Scour Below			
Bedrock	6.00	Yes	No	No	No
	Problem	Deposition Below,Scour Above			
Bedrock	7.00	Yes	No	Yes	Yes
	Problem	Deposition Above,Scour Below			
Bedrock	7.00	Yes	No	Yes	No
	Problem	Deposition Above,Deposition Below,Scour			

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**10**	**None**	**Yes**
7.2 Channel Aggradation	**7**	**None**	**No**
7.3 Widening Channel	**4**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**34**		
Geomorphic Rating	**0.425**		

Channel Evolution Model **F**
Channel Evolution Stage **III**
Geomorphic Condition **Fair**
Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Historic incision, current aggradation is major process. Presence of flood chutes leading to higher width to depth ratio where valley opens up. Stream has widened in these places compared to bedrock grade controlled sections.

Project: Winooski Mid, Alder to Montp | **Phase 2 Segment Summary** | | January 27, 2009 SGAT Version: 4.56

Stream: **Joiner Brook** Reach # **R10.S3.06** Segment: **A** Completion Date: **September 17, 2008**

Organization: **Bear Creek Environmental** Observers: **PD, SP** Why Not assessed: Rain: **No**

Segment Length (ft): **2,540** Segment Location: **Lower end of segment is located north of "S" curve in Bolton Valley Access Road and at**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Valley Width**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Sand	Sand

1.5 Valley Features

- Valley Width (ft) **120**
- Width Determination **Measured**
- Confinement Type **Semi-confined**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width	47
2.2 Max Depth (ft)	4.40
2.3 Mean Depth (ft)	2.90
2.4 Floodprone Width (ft)	79

Notes:

Phase 1 confinement came out to be "narrow", but confined geomorphic assessment form was used because the unconfined form was not conducive to the stream type, bedform, and measurements encountered in the cross section, ie. incision

Step 2. (Contued)

2.5 Aband. Floodpln	4.40 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	16.03
2.7 Entrenchment Ratio	1.69
2.8 Incision Ratio	1.00
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Complete
2.11 Riffle/Step Spacing (ft)	64

2.12 Substrate Composition

Bedrock	1%
Boulder	32%
Cobble	28%
Coarse Gravel	20%
Fine Gravel	13%
Sand	6%
Silt and smaller	0%

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **116**

2.13 Average Largest Particle on

- Bed **38.4** inches
- Bar **11.0** inches

2.14 Stream Type

- Stream Type: **B**
- Bed Material: **Cobble**
- Subclass Slope: **a**
- Bed Form: **Step-Pool**
- Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

B 3 a Step-Pool

3.3 old	Amount	Mean Height
Failures	Multiple	25.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	437	99
Erosion Height (ft)	14.63	5.35
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	51-75	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	51-100	51-100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	361	0
Height	27	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	None
4.3 Flow Status	Moderate
4.4 # of Debris Jams	1
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	1	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	0	31
Diagonal	**Delta**	**Island**
0	1	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
9	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** | Reach # **R10.S3.06** | Segment: **A** | Completion Date: **September 17,**

Organization: **Bear Creek Environmental** | Observers: **PD, SP** | Rain: **No**

Segment Length (ft): **2,540** | Segment Location: **Lower end of segment is located north of "S" curve in Bolton Valley Access Road and at**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Ledge	Mid-segment	5.00	3.00	Yes	
Ledge	Mid-segment	6.00	3.00	Yes	
Ledge	Mid-segment	18.00	5.00	No	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	10.0	Yes	No	Yes	Yes

Problem Deposition Above,Scour Above,Scour

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**9**	**None**	**No**
7.3 Widening Channel	**9**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**48**		
Geomorphic Rating	**0.6**		

Channel Evolution Model **D**
Channel Evolution Stage **IId**
Geomorphic Condition **Fair**
Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Major current aggradation and major historic and current? widening.

Phase 2 Segment Summary

Project: Winooski Mid, Alder to Montp
Stream: Joiner Brook Reach # R10.S3.06 Segment: B Completion Date: October 13, 2008
Organization: Bear Creek Environmental Observers: MN, CS Why Not assessed: bedrock gorge Rain: No
Segment Length (ft): 450 Segment Location: Short bedrock controlled section located between Bolton Valley Resort Village and "S"

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Valley Width**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Always	Always
W/in 1 Bankfill	Always	Always
Texture	Not Evalua	Not Evalua

1.5 Valley Features
Valley Width (ft) **50**
Width Determination **Measured**
Confinement Type **Narrowly**
Rock Gorge? **Yes**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width 0
2.2 Max Depth (ft) 0.00
2.3 Mean Depth (ft) 0.00
2.4 Floodprone Width (ft) 0

Notes:
Reference geomorphic condition; major fish passage obstruction

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **0.00**
2.7 Entrenchment Ratio **0.00**
2.8 Incision Ratio **0.00**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity
2.10 Riffles Type
2.11 Riffle/Step Spacing (ft) **0**
2.12 Substrate Composition

Silt/Clay Present?
Detritus **0** %
Large Woody **0**

2.13 Average Largest Particle on
Bed **0.0**
Bar **0.0**

2.14 Stream Type
Stream Type: **A**
Bed Material: **Bedrock**
Subclass Slope: **None**
Bed Form: **Cascade**
Field Measured Slope:
2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant		
Sub-dominant		

Bank Canopy	Left	Right
Canopy %		
Mid-Channel Canopy		

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant		
Sub-dominant		
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant		
Sub-dominant		

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant		
Sub-dominant		
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **None**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **0**
4.5 Flow Regulation Type **None**
Flow Regulation Use
Impoundments
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal **No**
5.5 Straightening **None**
Straightening Length: **0**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.06** Segment: **B** Completion Date: **October 13, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, CS** Rain: **No**

Segment Length (ft): **450** Segment Location: **Short bedrock controlled section located between Bolton Valley Resort Village and "S"**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Mid-segment	35.00	30.00	Yes	

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Referenc**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: Winooski Mid, Alder to Montp | **Phase 2 Segment Summary** | January 27, 2009 SGAT Version: 4.56

Stream: **Joiner Brook** | Reach # **R10.S3.06** | Segment: **C** | Completion Date: **October 13, 2008**

Organization: **Bear Creek Environmental** | Observers: **MN, CS** | Why Not assessed: | Rain: **No**

Segment Length (ft): **3,273** | Segment Location: **Just downstream of Bolton Valley Resort Village.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Grade Controls**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **145**

Width Determination **Measured**

Confinement Type **Narrow**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **69**

2.2 Max Depth (ft) **3.80**

2.3 Mean Depth (ft) **1.80**

2.4 Floodprone Width (ft) **206**

Notes:

Went with narrow confinement due to difference in Phase 1 and 2 channel widths. The Phase 2 channel width results in semi-confined, while the Phase 1 channel width results in broad. Lots of planform adjustment especially in downstream end of segment.

Step 2. (Contued)

2.5 Aband. Floodpln **3.80** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **38.33**

2.7 Entrenchment Ratio **2.99**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **50**

2.12 Substrate Composition

Bedrock	0 %
Boulder	30 %
Cobble	40 %
Coarse Gravel	12 %
Fine Gravel	5 %
Sand	13 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **2** %

\# Large Woody **44**

2.13 Average Largest Particle on

Bed **17.2** inches

Bar **17.6** inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Cobble**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	Multiple	36.25
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	438	88
Erosion Height (ft)	8.24	5.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	218	0
Height	41	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
12	0	33
Diagonal	Delta	Island
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
14	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.06** Segment: **C** Completion Date: **October 13, 2008**

Organization: **Bear Creek Environmental** Observers: **MN, CS** Rain: **No**

Segment Length (ft): **3,273** Segment Location: **Just downstream of Bolton Valley Resort Village.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	18.0	Yes	No	Yes	No

Problem Deposition Above,Deposition Below,Scour

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**7**	**None**	**No**
7.3 Widening Channel	**8**		**Yes**
7.4 Change in Planform	**6**		**No**
Total Score	**37**		
Geomorphic Rating	**0.4625**		

Channel Evolution Model **D**

Channel Evolution Stage **IId**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Major aggradation and planform adjustment; Historic major widening. Multiple mid-channel bars and flood chutes. Some braiding of flows.

Stream: **Joiner Brook** Reach # **R10.S3.07** Segment: **0** Completion Date:

Organization: **Bear Creek Environmental** Observers: Why Not assessed: **Other (to be explained in** Rain:

Segment Length (ft): **0** Segment Location: **This reach is included in the DMS only for FEH purposes. The reach has only received a**

QC Status - Staff: Provisional Cons Provisional

Step 1. Valley and Floodplain

1.1 Segmentation

1.2 Alluvial Fan

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

This reach was not assessed. However, it was added to the DMS 1/14/09 for purposes of creating a prelimnary FEH zone based on administrative judgement using field observations.

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Cobble**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures		0.00
Gullies		0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type		
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant		
Sub-dominant		

Bank Canopy	Left	Right
Canopy %		
Mid-Channel Canopy		

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant		
Sub-dominant		
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant		
Sub-dominant		

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant		
Sub-dominant		
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal

5.5 Straightening

Straightening Length: **0**

5.5 Dredging

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Joiner Brook** Reach # **R10.S3.07** Segment: **0** Completion Date:

Organization: **Bear Creek Environmental** Observers: Rain:

Segment Length (ft): **0** Segment Location: **This reach is included in the DMS only for FEH purposes. The reach has only received a**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Referenc**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

This is a preliminary estimate of stream condition and sensitivity based only on field observations. Entire reach has not been walked.

Stream Geometry Data

Winooski Mid, Alder to

		Phase 2 Stream Type					Phase 1 Data		Phase 2 Channel Data													
Reach	Seg-ment	Stream Type	Bed Material	Bedform	Subcl. Slope	Sub Rch?	Channel Slope	Channel width	Bankfull width	Max. depth	Mean depth	Floodpr. width	Abandn FldPln	W/D Ratio	Entrench-ment	Incision Ratio	Stage Evol.	Evol. Model	RGA Cond.	RHA Cond.	QC Stf	QC Aut
R10.S3.01	0	C	Gravel	Riffle-Pool	b	No	3.01	34.91	67.0	5.5	3.97	157.3	8.3	16.88	2.35	1.51	II	F	Fair		P	P
R10.S3.02	A	C	Cobble	Step-Pool	b	No	6.27	34.71	78.6	5.0	3.04	253.0	6.25	25.86	3.22	1.25	III	F	Good		P	P
R10.S3.02	B	G	Bedrock	Cascade	None	No	6.27	34.71											Good		P	F
R10.S3.02	C	C	Cobble	Step-Pool	b	No	6.27	34.71	54.2	6.45	3.9	121.5	7.65	13.90	2.24	1.19	III	F	Good		P	P
R10.S3.02	D	G	Bedrock	Cascade	None	No	6.27	34.71											Good		P	F
R10.S3.02	E	B	Gravel	Step-Pool	a	Yes	6.27	34.71	74.7	4.65	2.87	116.7	4.65	26.03	1.56	1.00	IId	D	Fair		P	P
R10.S3.03	A	C	Cobble	Step-Pool	b	No	4.76	31.84	62.0	4.6	3.34	144.0	5.5	18.56	2.32	1.20	IIc	D	Fair		P	P
R10.S3.03	B	B	Cobble	Step-Pool	a	Yes	4.76	31.84	96.0	4.0	2.2	149.5	4.8	43.64	1.56	1.20	IId	D	Fair		P	P
R10.S3.04	A	C	Cobble	Plane Bed	b	Yes	4.42	29.27	82.5	4.1	1.67	536.5	7.2	49.40	6.50	1.76	III	F	Fair		P	P
R10.S3.04	B	C	Cobble	Step-Pool	b	No	4.42	29.27	58.0	5.1	3.0	139.0	5.1	19.33	2.40	1.00	I	F	Good		P	P
R10.S3.04	C	F	Cobble	Step-Pool	b	No	4.42	29.27	52.0	4.3	3.28	58.4	11.3	15.85	1.12	2.63	III	F	Fair		P	P
R10.S3.04	D	C	Cobble	Step-Pool	b	No	4.42	29.27	59.5	5.0	2.7	163.8	5.0	22.04	2.75	1.00	I	F	Good		P	P
R10.S3.05	0	B	Gravel	Step-Pool	a	No	8.75	25.72	73.7	4.6	2.9	164.5	8.2	25.41	2.23	1.78	III	F	Fair		P	P
R10.S3.06	A	B	Cobble	Step-Pool	a	Yes	8.86	21.83	46.5	4.4	2.9	78.5	4.4	16.03	1.69	1.00	IId	D	Fair		P	P
R10.S3.06	B	A	Bedrock	Cascade	None	No	8.86	21.83											Refere		P	F
R10.S3.06	C	C	Cobble	Step-Pool	b	No	8.86	21.83	69.0	3.8	1.8	206.0	3.8	38.33	2.99	1.00	IId	D	Fair		P	P
R10.S3.07	0	C	Cobble	Step-Pool	b	No	13.13	16.63											Refere		F	F

Rapid Geomorphic Assessment

Winooski Mid, Alder to

Reach	Seg-ment	Sub-Rch?	Degradation			Aggradation			Widening		Planform		Geo. Score	Geo. Condition	Evol. Stage	Confin-ement Type	Sens-itivity	QC Stf	QC Aut
			Score	STD	Historic	Score	STD	Historic	Score	Historic	Score	Historic							
R10.S3.01	0	No	8	None	Yes	7	None	No	13	No	13	Yes	0.51	Fair	II	BD	Very	P	P
R10.S3.02	A	No	14	None	Yes	13	None	No	13	No	12	No	0.65	Good	III	NW	Moderat	P	P
R10.S3.02	B	No											0.00	Good		NC		P	F
R10.S3.02	C	No	14	None	Yes	14	None	No	17	No	12	No	0.71	Good	III	NW	Moderat	P	P
R10.S3.02	D	No											0.00	Good		NC		P	F
R10.S3.02	E	Yes	18	None	No	7	None	No	14	No	8	No	0.59	Fair	IId	SC	High	P	P
R10.S3.03	A	No	16	None	No	7	None	No	14	No	8	No	0.56	Fair	IIc	NW	High	P	P
R10.S3.03	B	Yes	15	None	Yes	9	None	No	4	Yes	10	No	0.48	Fair	IId	SC	High	P	P
R10.S3.04	A	Yes	8	None	Yes	8	None	No	5	No	9	No	0.38	Fair	III	VB	High	P	P
R10.S3.04	B	No	18	None	No	17	None	No	14	No	9	No	0.73	Good	I	NW	Moderat	P	P
R10.S3.04	C	No	3	C to F	Yes	6	None	No	10	No	13	No	0.40	Fair	III	BD	Extreme	P	P
R10.S3.04	D	No	16	None	No	14	None	No	14	No	13	No	0.71	Good	I	NW	Moderat	P	P
R10.S3.05	0	No	10	None	Yes	7	None	No	4	No	13	No	0.43	Fair	III	SC	High	P	P
R10.S3.06	A	Yes	16	None	No	9	None	No	9	No	14	No	0.60	Fair	IId	SC	High	P	P
R10.S3.06	B	No											0.00	Reference		NC		P	F
R10.S3.06	C	No	16	None	No	7	None	No	8	Yes	6	No	0.46	Fair	IId	NW	High	P	P
R10.S3.07	0	No											0.00	Reference			Moderat	F	F

Project: Joiner Brook
Stream: Joiner Brook
Organization: BCE
Observers: MN, CS, PD, SP, GA
Date(s) Assessed: 8/29/2008-10/13/2008

Summary of the Reach Habitat Assessment (RHA) Values for Joiner Brook, Bolton, VT														
Reach Point ID	Bedform	Woody Debris Cover	Bed Substrate Cover	Scour and Depositional Features	Channel Morphology	Hydrologic Characteristics	Connectivity	River Banks		Riparian Area		Total Score	Percentage**	Habitat Condition
								Left Bank	Right Bank	Left Corridor	Right Corridor			
R10.S3.01	Riffle-Pool	3	8	12	9	5	4	4	4	2	1	52	33%	Poor
R10.S3.02-A	Step-Pool	10	16	15	8	11	8	7	8	9	9	101	63%	Fair
R10.S3.02-C	Step-Pool	8	18	13	14	9	10	8	4	6	2	92	58%	Fair
R10.S3.02-E	Step-Pool	9	9	13	15	7	5	7	7	10	9	91	57%	Fair
R10.S3.03-A	Step-Pool	7	15	14	13	9	12	8	9	10	9	106	66%	Good
R10.S3.03-B	Step-Pool	6	15	13	10	7	3	7	7	9	8	85	53%	Fair
R10.S3.04-A	Plane Bed	13	13	11	7	5	8	6	5	7	6	81	51%	Fair
R10.S3.04-B	Step-Pool	7	15	15	13	8	7	7	8	10	10	100	63%	Fair
R10.S3.04-C	Step-Pool	7	13	8	4	7	6	6	4	9	7	71	44%	Fair
R10.S3.04-D	Step-Pool	7	16	13	13	7	8	7	6	10	10	97	61%	Fair
R10.S3.05	Step-Pool	6	14	12	10	5	3	7	8	8	8	81	51%	Fair
R10.S3.06-A	Step-Pool	13	12	14	15	8	8	4	9	7	10	100	63%	Fair
R10.S3.06-C	Step-Pool	8	15	13	10	5	9	7	8	10	10	95	59%	Fair
Total Possible Score		**20**	**20**	**20**	**20**	**20**	**20**	**10**	**10**	**10**	**10**	**160**	**100%**	**Reference**