Elmore Branch

River Corridor Plan

Wolcott and Elmore, Vermont

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1.0 EXECUTIVE SUMMARY

The River Corridor Planning effort is sponsored by the Lamoille County Planning Commission (LCPC) with funding provided through a grant from the Agency of Natural Resources Clean and Clear Program and the Federal Emergency Management Agency (FEMA). The Vermont Department of Environmental Conservation River Management Program provided technical expertise and shared quality control/quality assurance responsibilities with Bear Creek Environmental, LLC and the LCPC. The River Corridor Plan (RCP) followed the Vermont Agency of Natural Resources River Corridor Planning Guide (Vermont Agency of Natural Resources, 2007a) and Draft 9 of Chapter 5 of the plan dated October 2, 2007. Information for the RCP came from the DEC, the Vermont Center for Geographic Information (VCGI), as well as field data collected by Bear Creek Environmental and the LCPC.

The primary objective of the RCP is to use stream geomorphic assessment data to identify and prioritize river corridor protection and restoration projects within the Elmore Branch watershed in the Towns of Wolcott and Elmore. The stream geomorphic assessment data can be used by resource managers, community watershed groups, municipalities and others to identify how changes to land use alter the physical processes and habitat of rivers. The Vermont Stream Geomorphic Assessment Protocol includes three phases:

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

A Phase 1 Stream Geomorphic Assessment following Agency of Natural Resources Protocols was completed for Elmore Branch by LCPC in 2005, and a Phase 2 Stream Geomorphic Assessment following Agency of Natural Resources Protocols was completed for Elmore Branch by Bear Creek Environmental and LCPC during summer 2006.

The primary goal of the State of Vermont’s River Management Program’s is to “manage toward, protect, and restore the equilibrium conditions of Vermont’s rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner.” The RCP provides many opportunities for enhancing and restoring the Elmore Branch Watershed. A list of 13 potential restoration and conservation projects was developed during project identification. Types of projects include: potential projects river corridor protection, conservation, enhancing the riparian corridor and replacing undersized structures at stream crossings.

2.0 LOCAL PLANNING PROGRAM OVERVIEW

2.1 RIVER CORRIDOR PLANNING TEAM

The river corridor planning team for the Elmore Branch watershed is comprised of the Lamoille County Planning Commission, the Agency of Natural Resources, Bear Creek Environmental, local municipalities and landowners. This planning effort is sponsored by the Lamoille County Planning Commission. Funding for the project is provided through a grant from the Clean and Clear Program and FEMA. Staci Pomeroy from the Vermont River Management Section of the Vermont Agency of Natural Resources (VANR) provided technical guidance for this project.

2.2 GOALS AND OBJECTIVES OF THE PROJECT

The primary objective of the River Corridor Management Plan is to use the Phase 1 and 2 Stream Geomorphic Assessment data to identify and prioritize river corridor protection and restoration projects within the Elmore Branch Brook watershed. The State of Vermont's River Management Program has set out several goals and objectives that are supportive of the local initiative in the Elmore Branch 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, 2007a) The objectives of the Program are to include fluvial erosion hazard mitigation and sediment and nutrient load reduction as well as aquatic and riparian habitat protection and restoration. The Program seeks to conduct river corridor planning in an effort to remediate the geomorphic instability that is largely responsible for these problems in a majority of Vermont's rivers. Additionally, the Vermont River Management Program has set out to provide funding and technical assistance to facilitate an understanding of river instability and the establishment of well developed and appropriately scaled strategies to protect and restore river equilibrium.

A community-based river corridor management plan provides many opportunities for enhancing and restoring the Elmore Branch Watershed. These local goals support the objectives of the Vermont River Management Program and are listed below:

- Protect, manage, and restore stream corridors to accommodate river equilibrium conditions
- Promote sustainable community relationships with river systems
- Protect and restore the ecological potential and ecosystem services of rivers for future generations

3.0 BACKGROUND WATERSHED INFORMATION

3.1 Geographic Setting

3.1.1 Watershed Description

The Elmore Branch has a watershed size of 17.5 square miles just above the confluence of the Lamoille River in the Town of Wolcott, Vermont (Figure 1). The Phase 2 study focused on 10 stream reaches on the main stem of the Elmore Branch within the Towns of Elmore and Wolcott from the confluence with the Lamoille River upstream to above the Symonds Mill Road Bridge. The combined length of the stream reaches assessed is approximately 3.0 miles. The Elmore Branch flows north and joins the Lamoille River which drains westerly into Lake Champlain. The Elmore Branch drains from the west shoulder of the Woodbury Mountains and from Putnam State Forest in the east. It joins the Lamoille River at approximately 690 feet above sea level.

3.1.2 Political Jurisdictions

Project reaches for the Elmore Branch are located in Lamoille County Vermont within the Towns of Wolcott and Elmore. The Elmore Branch watershed falls under the jurisdiction of the Lamoille County Planning Commission.

3.1.3 Land Use

The headwaters of the Elmore Branch are forested (Figure 2). The land use within the entire watershed includes 84 percent forest, 3 percent residential, 3 percent crop, 1 percent field, and 9 percent water (approximately 0.1 percent wetland). Much of the Elmore Branch runs parallel or immediately adjacent to the East Elmore Branch Road, resulting in floodplain encroachment in many areas. According to Ryan (2001), agricultural fields have recently become idle and riparian vegetation is becoming reestablished in many sections.

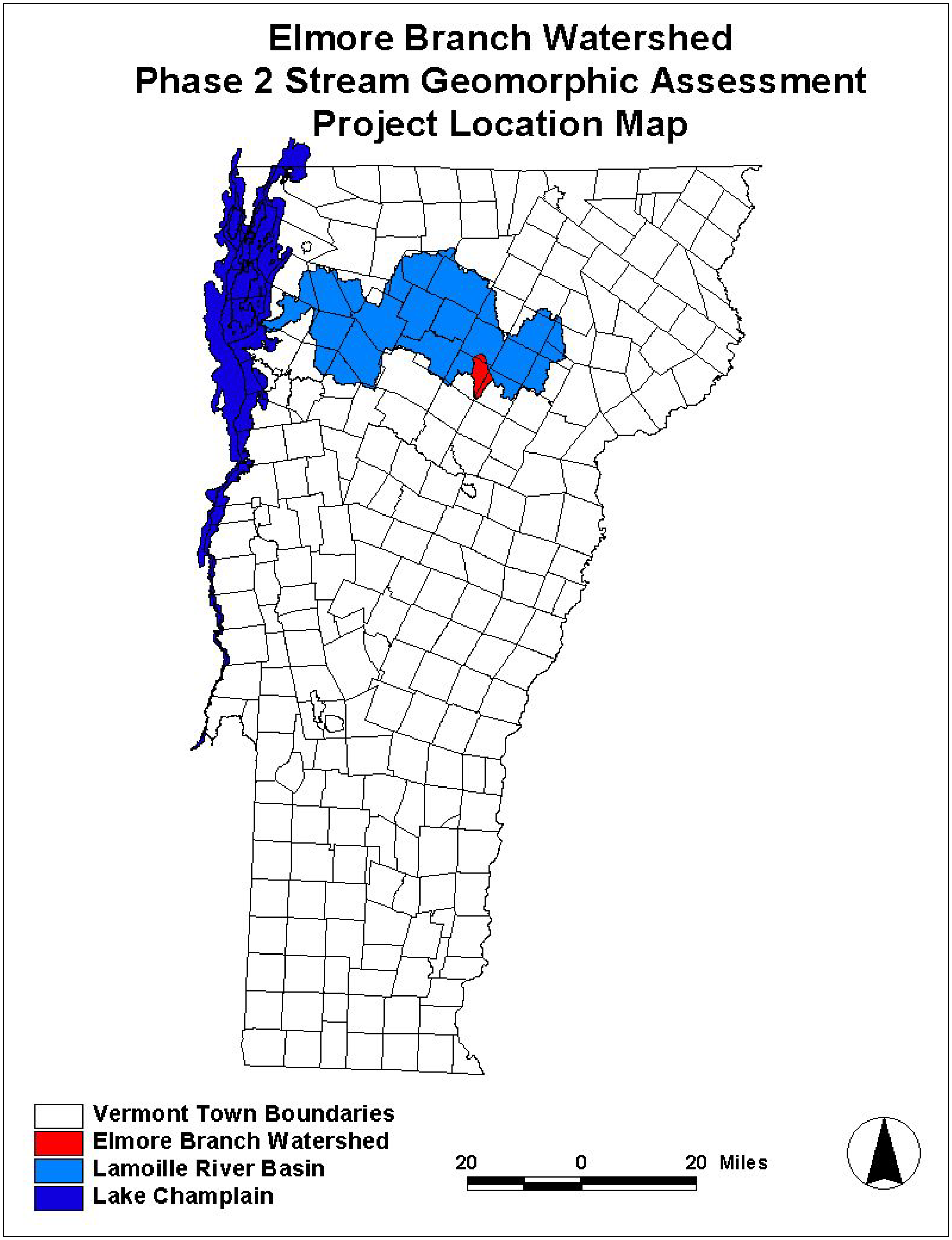

Figure 1: Project location map

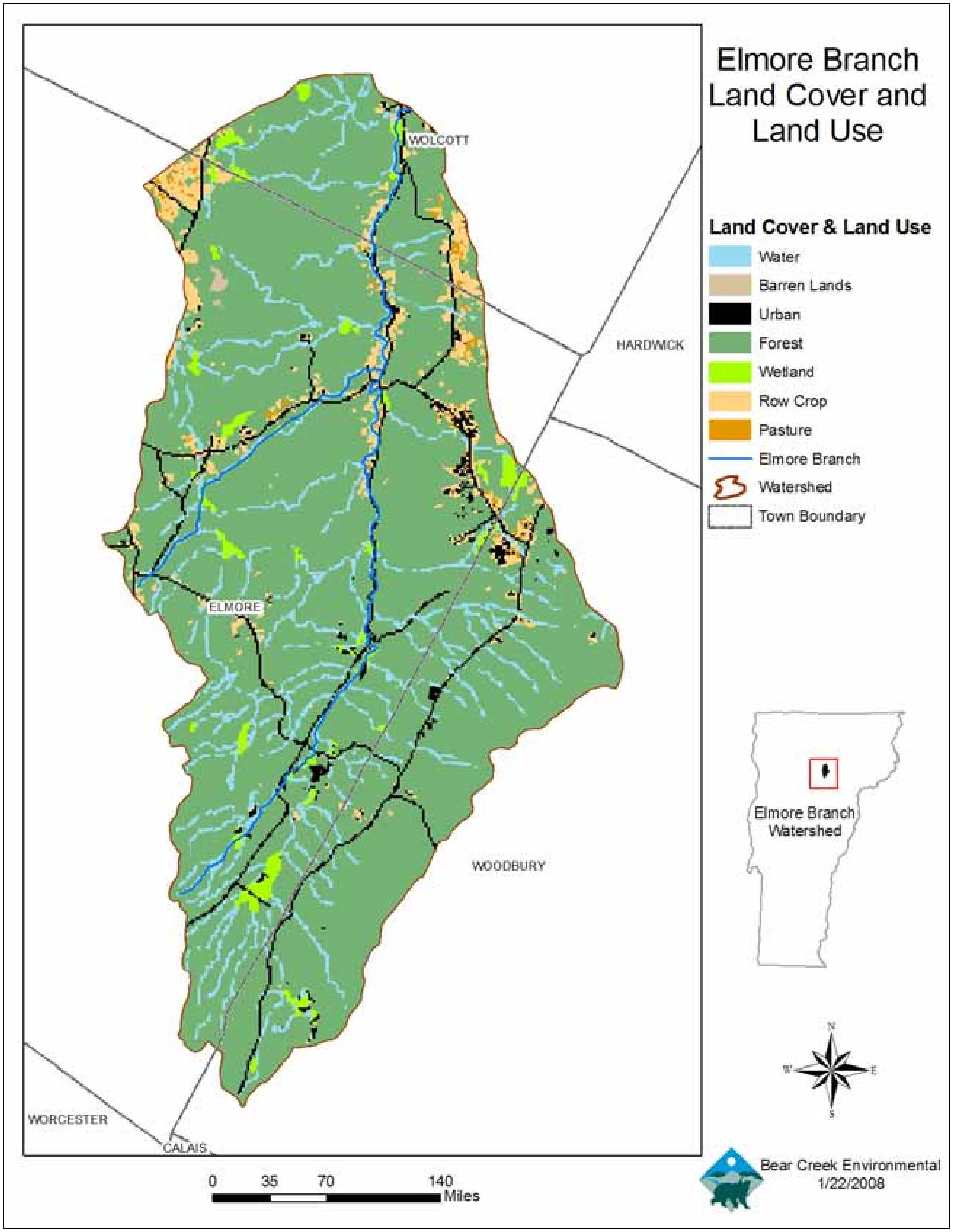

Figure 2. Land cover and land use for Elmore Branch waters

3.2 Geologic Setting

The Elmore Branch watershed is located on the eastern edge of the Green Mountain Geo-physiographic Province. The Green Mountains were uplifted during the Taconic orogeny about 455 million years ago (Doolan, 1996). The bedrock beneath the Elmore Branch watershed is that of the Moretown Member of the Missisquoi Formation. This unit is comprised of quartzite and quartz-plagioclase granulite, in layers with muscovite, chlorite, epidote, biotite and garnet (Doll, 1961). The Green Mountains and adjacent valleys 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 Lamoille River Valley. As the climate warmed, the glacier slowly retreated and glacial lakes were dammed in the Lamoille River valley. Following the retreat of the ice sheet, the Lamoille River and its tributaries began eroding the glacial and lake sediments that were left behind (Wright, 2003).

The dominant surficial geology of the Elmore Branch watershed consists of alluvium, glacial till, ice contact, and glacial lake deposits. The reaches studied in the Phase 2 geomorphic assessment have ice contact, alluvial, and glacial lake deposits as their dominant surficial geology (Doll, 1970). Alluvium soils are frequently flooded, however are only slightly to moderately erodible from overland flow; but may be more susceptible to stream bank erosion processes. Ice contact soils are infrequently flooded, however they have severe erodibility. Glacial lake deposits are rarely flooded and have very severe erodibility.

3.3 Geomorphic Setting

The Elmore Branch watershed was divided into 29 reaches for the Phase 1 Stream Geomorphic Assessment. The three upper-most reaches on the main stem of the Elmore Branch were not included in the Phase 1 assessment. Each reach represents a similar section of the stream based on physical attributes such as valley confinement, slope, sinuosity, bed material, dominant bedform, land use, and other hydrologic characteristics. The downstream end of the reach is indicated by a point (Figure 3).

The Phase 2 study focused on 10 stream reaches on the main stem of the Elmore Branch within the Towns of Elmore and Wolcott from the confluence with the Lamoille River upstream to above the Symonds Mill Road crossing. The combined length of the stream reaches assessed is approximately 3.0 miles (Figure 4).

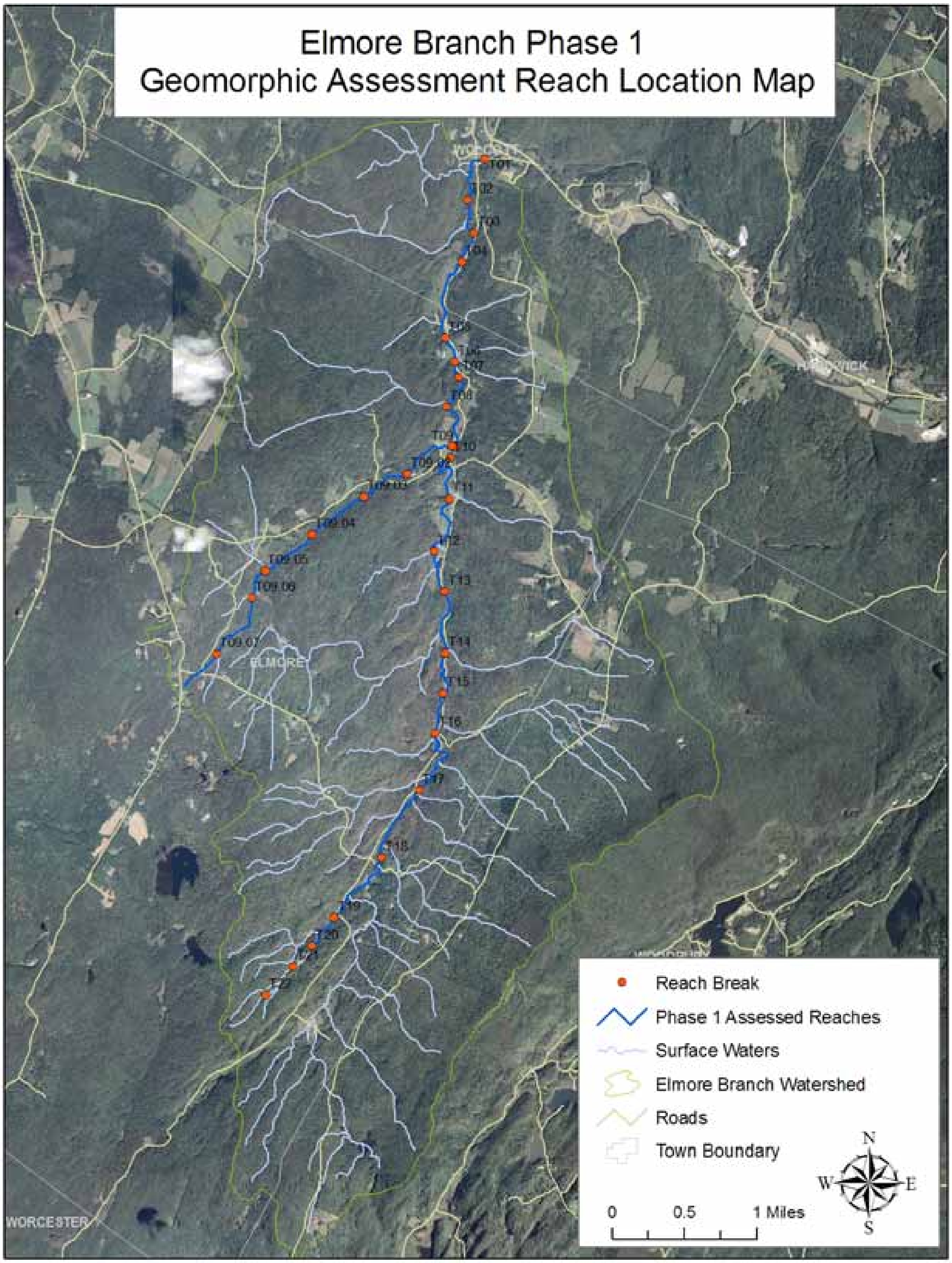

Figure 3. Phase 1 reach location map

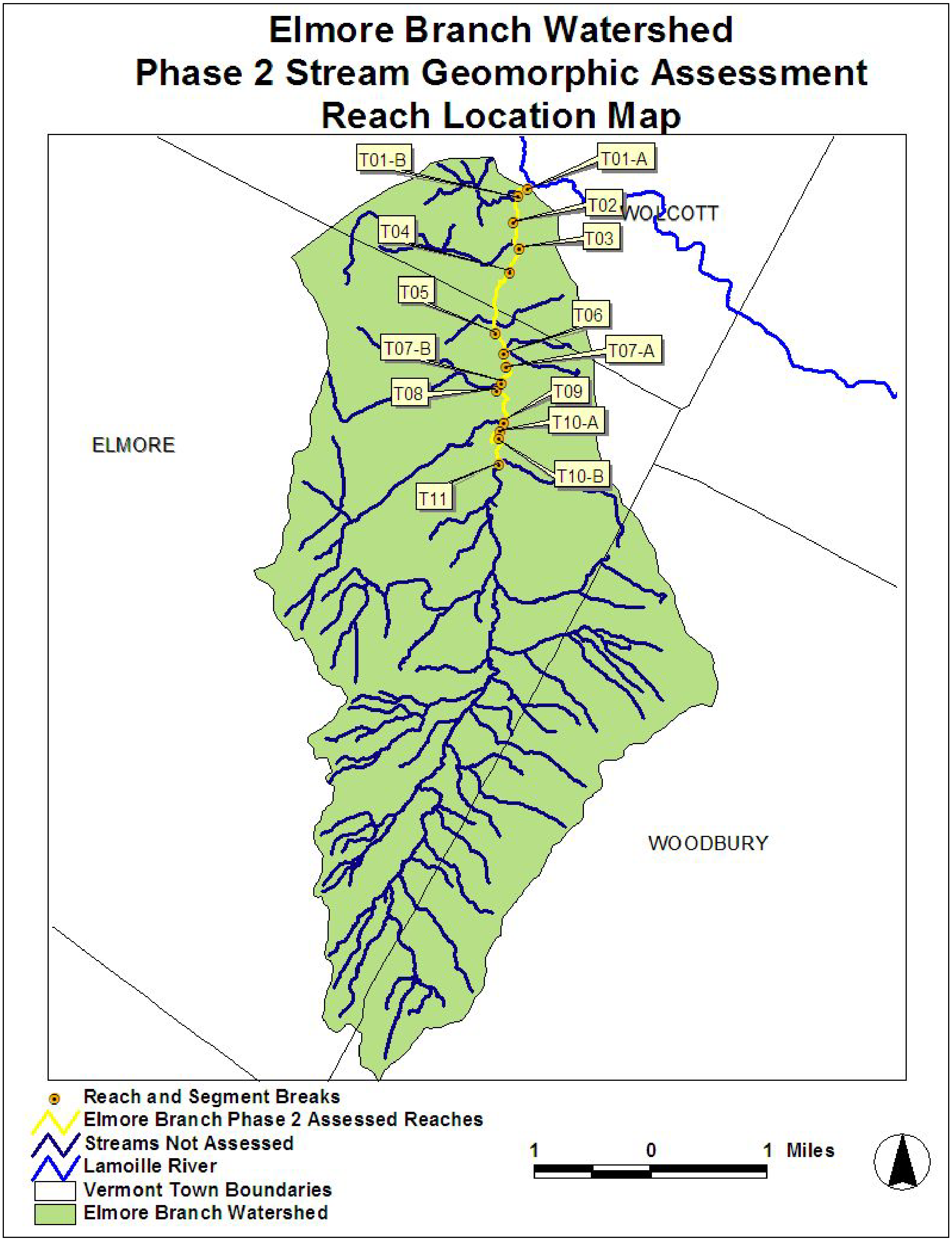

Figure 4. Reach location map for Phase 2 Stream Geomorphic Assessments.

Reference stream types are based on the valley type, geology and climate of a region and describe what the channel would look like in the absence of human-related changes to the channel, floodplain, and/or watershed. Stream and valley characteristics including valley confinement, and slope determined from digital USGS topographic maps. The reference reach characteristics were refined during the windshield survey and Phase 2 Assessment. Reference reach typing was based on both the Rosgen (1996) and the Montgomery and Buffington (1997) classification systems. Table 1 shows the typical characteristics used to determine reference stream types (VANR, 2007b). Reference stream types for the assessed reaches are listed in Table 2. With the exception of reaches T06 and T07 which are more confined, all reaches are classified as “C” channels by reference. These reaches have a moderate width to depth ratio and flow through unconfined valleys.

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	Bedform
T01	C	Very Broad	1.23	Riffle-Pool
T04	C	Very Broad	0.54	Riffle-Pool
T05	Cb	Narrow	2.41	Riffle-Pool
T06	Bc	Semi-confined	I.15	Plane Bed
T07	F	Narrowly confined	1.96	Bedrock

Table 2: Geomorphic Setting of Assessed Reaches				
Reach ID	**Reference Stream Type**	**Confinement**	**Valley Slope**	**Bedform**
T08	C	Very Broad	0.45	Riffle-Pool
T09	C	Very Broad	1.86	Riffle-Pool
T10	C	Broad	0.62	Riffle-Pool

Natural bedrock grade controls were noted in eight of the assessed reaches (T01, T02, T03, T05, T06, T07, T08 and T10). The steepness of the valley side slopes was determined using a combination of USGS 1:24000 topographic maps and the Natural Resource Conservation Services soils layer. No alluvial fans were identified in the study area.

3.4 Hydrology

In order to better understand the flood history of Elmore Branch, long term data from the U.S. Department of the Interior, U.S. Geological Survey (USGS) gauge on the Lamoille River in Johnson, VT and data from a smaller brook, Stony Brook in Eden, VT, were obtained (USGS, 2007). Eighty-two years of record (1912-1913 and 1929-2008) are available for the Lamoille River gauge at Johnson, VT. A total of twenty-one years of record (1964-1974 and 1999-2008) are currently available for Stony Brook.

The near term record for Lamoille River and Stony Brook both show that a 25 year flood event or greater occurred in 1973. The long term record on the Lamoille gauge shows major flood events also occurred in the years 1912, 1936, 1984, 1995 and 1997. A flood frequency analysis for the Lamoille River gauge and the Stony Brook gauge are provided in Figures 5 and 6, respectively.

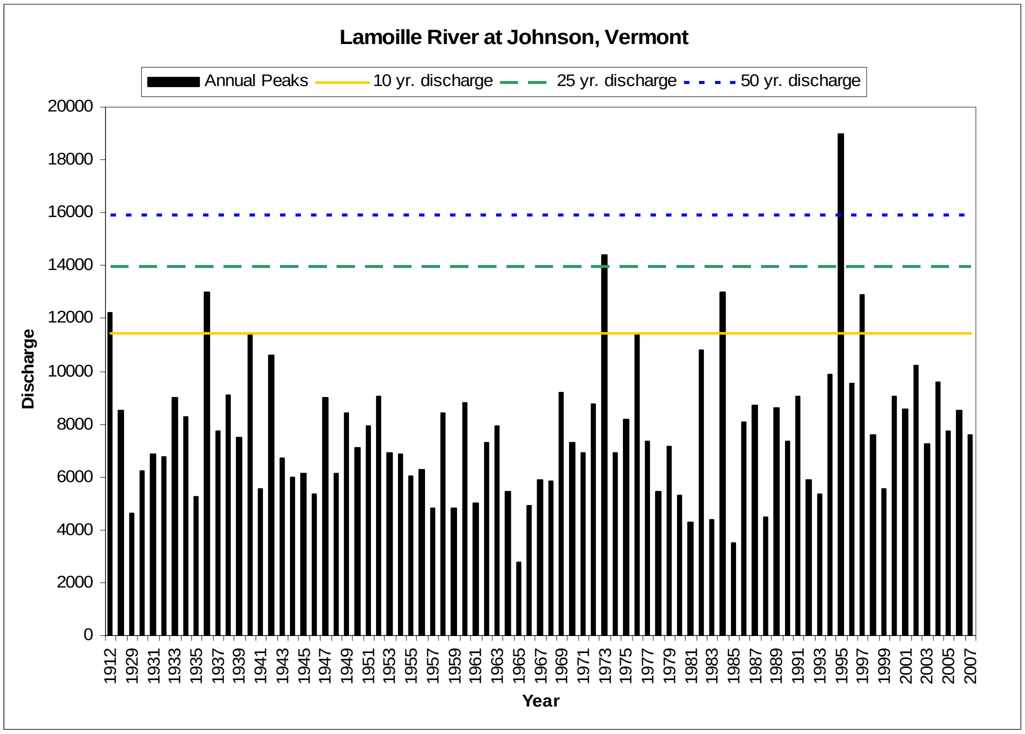

Figure 5. Flood frequency analysis for Lamoille River at Johnson, VT

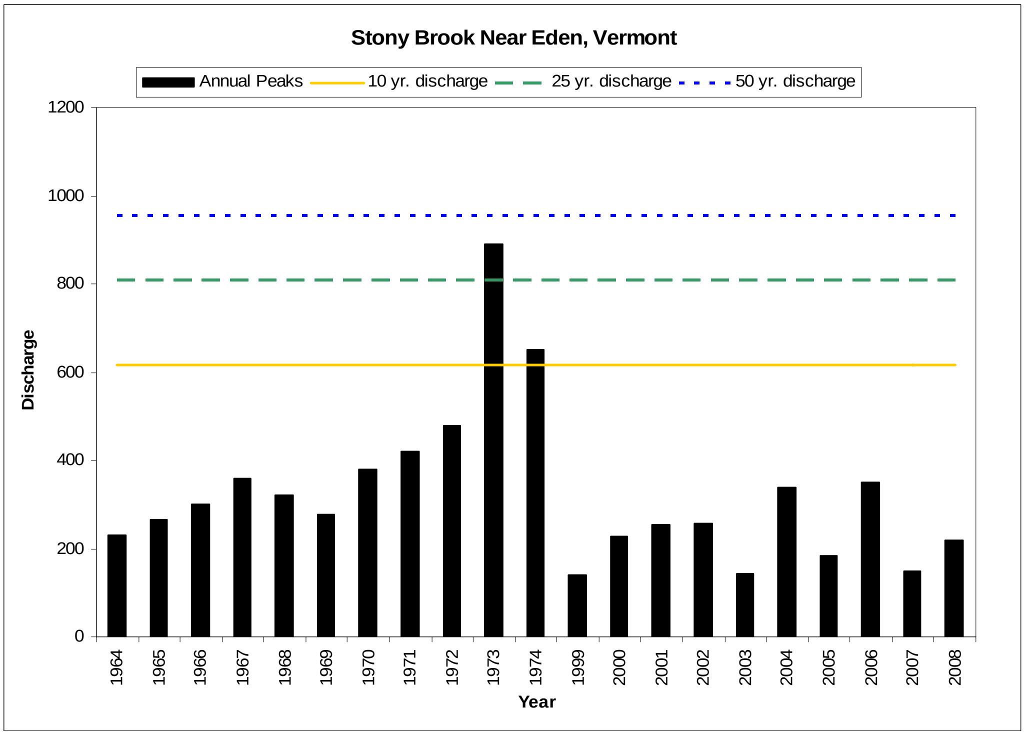

Figure 6. Flood frequency analysis for Stony Brook, Eden, VT

In recent history, roads and infrastructure within the Lamoille Valley have sustained damages during flood events. The majority of the twentieth century's largest floods have occurred during the summer months of June through August and are associated with intense cloudbursts, which stay in the mountains producing high rainfall amounts. The remainder is divided quite evenly between fall floods (September through November) which are often associated with hurricanes. Winter/spring floods (January through April) are associated with rain on snow events or snowmelt. Summer and fall floods are associated with greater flood damage than winter snowmelt floods. A flood in July 2004 in Stowe dropped as much as 4 inches of rain in one hour causing almost $500,000 in flood damage according to the Federal Emergency Management Agency (Barg, 2004).

Along the Elmore Branch itself, flooding has been a problem near the Symond Mill Road Bridge. According to the Elmore Town Clerk's office, this area has sustained damage on more than one occasion, though exact dates were not available. Severe storms and flooding from July 21 through August 12, 2008 resulted in a federal disaster (DR 1790) to be declared in Addison, Caledonia, Essex, Lamoille, Orange, Washington and Windsor counties on September 12, 2008 (FEMA 2008). According to Gary Schelley of the Vermont Agency of Transportation (VTrans), $74,226.47 of federal funds and $14,845.30 of state funds were allocated for public assistance within the Town of Wolcott following the summer 2008 flooding (personal communication between Schelley and Andrew Flagg of LCPC). Public assistance money can be used towards infrastructure for projects such as debris clean up and bridge and road repair/maintenance.

3.5 Ecological Setting

Several of the study reaches lacked a strong riffle-pool bedform and the diversity of habitat features that this brings. Many reaches within the study area had major intrusion into their river corridor from East Elmore Road and other major roads and many had inadequate riparian buffers due to historic and /or recent land clearing.

The Elmore Branch watershed lies within the Northern Green Mountains biophysical region. This region 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 Northern 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.

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. A Phase 1 Assessment of the Elmore Branch was completed by the Lamoille County Planning Commission in 2005.

4.2 Phase 2 Methodology

The Phase 2 assessment of the Elmore Branch was collaboratively conducted by BCE and LCPC following procedures specified in the Vermont Stream Geomorphic Assessment Handbook Phase 2 (Vermont Agency of Natural Resources, 2005). All assessment data were recorded on the Agency of Natural Resources Phase 2 data sheets, and were entered in to the ANR Stream Geomorphic Assessment data management system (DMS). The Phase 1 database was updated using the field data from the Phase 2 assessment in 2006.

The parameters and protocols used for undertaking each of the above steps are outlined in the Phase 2 Handbook (Vermont Agency of Natural Resources, 2005). The entire length of each Phase 2 reach was walked to determine segment breaks. Bank erosion, grade control structures, bank revetments, debris jams, depositional features, stormwater inputs, flood chutes and other important features were mapped. Bear Creek Environmental used SGAT version 4.53 to index features that were mapped during the Phase 2 assessment. BCE also indexed locations where riparian buffers are less than 25 feet on either side of the channel using SGAT version 4.56 based on National Agriculture Imagery Program (NAIP 2003) photos during winter 2008.

4.3 Bridge and Culvert

A watershed-wide bridge and culvert inventory and assessment was conducted by LCPC in 2004 to determine if stream crossings were contributing to localized streambank erosion, sedimentation, and impaired fish passage. Fourteen bridges and culverts were assessed within the Elmore Branch watershed. Three of these structures are located within the Phase 2 study area. The Agency of Natural Resources Bridge and Culvert Phase 1 protocols were used (VANR, 2003).

4.4 River Corridor Plan

The Vermont Agency of Natural Resources River Corridor Planning Guide (2007a) 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 e911 roads, e911 buildings and e911 driveways. The stressor maps were then used to identify potential river corridor restoration and protection projects.

4.5 Quality Control/Quality Assurance Procedures

To assure a high level of confidence in the Phase 1 and 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 December 2006, 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 Bear Creek Environmental based on the Phase 2 field assessment work. The DMS and the ArcView shapefiles for the Elmore Branch Phase 2 study were submitted to Staci Pomeroy of the ANR for a Quality Assurance review in January 2007. Bear Creek Environmental made some minor revisions to the DMS following this review and the ANR QA review was completed in February 2007.

5.0 RESULTS

5.1 Phase 1 Results

The Phase 1 results are summarized in this section by the LCPC. A phase I assessment of the Elmore Branch of the Lamoille River and one of its tributaries (unnamed) was conducted in August, 2005 by the Lamoille County Planning Commission (LCPC). The characteristic that stands out after the phase I assessment of the Elmore Branch is the amount of bedrock in the channel. There are multiple bedrock gorges, and channel spanning bedrock is also extensive. This stream has few encroachments other than a road that runs along a significant portion of it. A small section has some erosion and rip-rap, but not enough to significantly impact the rest of the stream. There were only three reaches on the entire stream (#1, 3, and 10) that have rip-rap for a total of 475 feet. However, implementation measures to curtail degradation now are a simple way to protect this healthy river.

There were very few significant instream modifications on the Elmore Branch. Of the instream modifications, channel straightening and bridges/culverts were the most noted modifications. Three reaches had high scores for bridges/culverts, and two had high scores for channel straightening. Most of the 19 reaches scored 0 (not significant) or 1 (low impact). Reaches T09, T09.02, T09.07, and T13 recorded high impact ratings (scored 2) for bridge and culvert data.

Reaches 1, 3, 4, 8, 9, 10, 13, and 18 on the main stem all had land use scores of 4-5, and all but one had floodplain modification scores of 5-6. Berms and road encroachments were the most significant floodplain modifications. These reaches all had total impact scores of 11-15 out of a possible score of 32.

There are only a few sections of the Elmore Branch, reaches 3, 8, 10, and 13, which are capable of storing a significant amount of sediment. However, there are also few areas (minor bank erosion on reach 3 and 6) that add sediment to the stream. Reaches 4 and 13 had condition ratings of ‘poor’, mostly due to plan form, degradation, and aggradation. Reaches 8 and 9 also had high scores for these characteristics with condition ratings of “fair”.

5.2 Phase 2 Results

<u>Rapid Geomorphic Assessment</u>

Summary reports of the Phase 2 data are provided in Appendix A. Figure 7 is a map presenting the existing stream types found in the Elmore Branch watershed. Most of the reaches are Rosgen (1996) “C” channels by reference. C channels have wide valleys and moderate to gentle gradients. B channels have moderate to steep slopes and have narrower valleys than E or C channels. The reach condition for the Rapid Phase 2 Stream Geomorphic Assessment (RGA) is depicted in Figure 8. The bedrock grade controls are playing an important role in the vertical stability and condition of the Elmore Branch. Ryan (2001) noted that. “Much of the Elmore Branch is unstable with several areas of bedrock control restricting a total system head cutting”. The lower reach is historically incised and received a reach condition of fair in both segments. Reaches T02, T03 and segments T07-A and T10-A are in reference condition and are stable, bedrock dominated sections. Between the bedrock dominated sections in the lower and mid portions of the study area, reaches T04 through T06 have not incised and are in good condition largely because of the bedrock grade controls on either end. The upper end of the study area (T07-B through T09) is in fair condition. It is not clear why this section has incised with the bedrock grade controls on each end. Segment T10-B is also in fair condition and appears to have been influenced by the former mill dams.

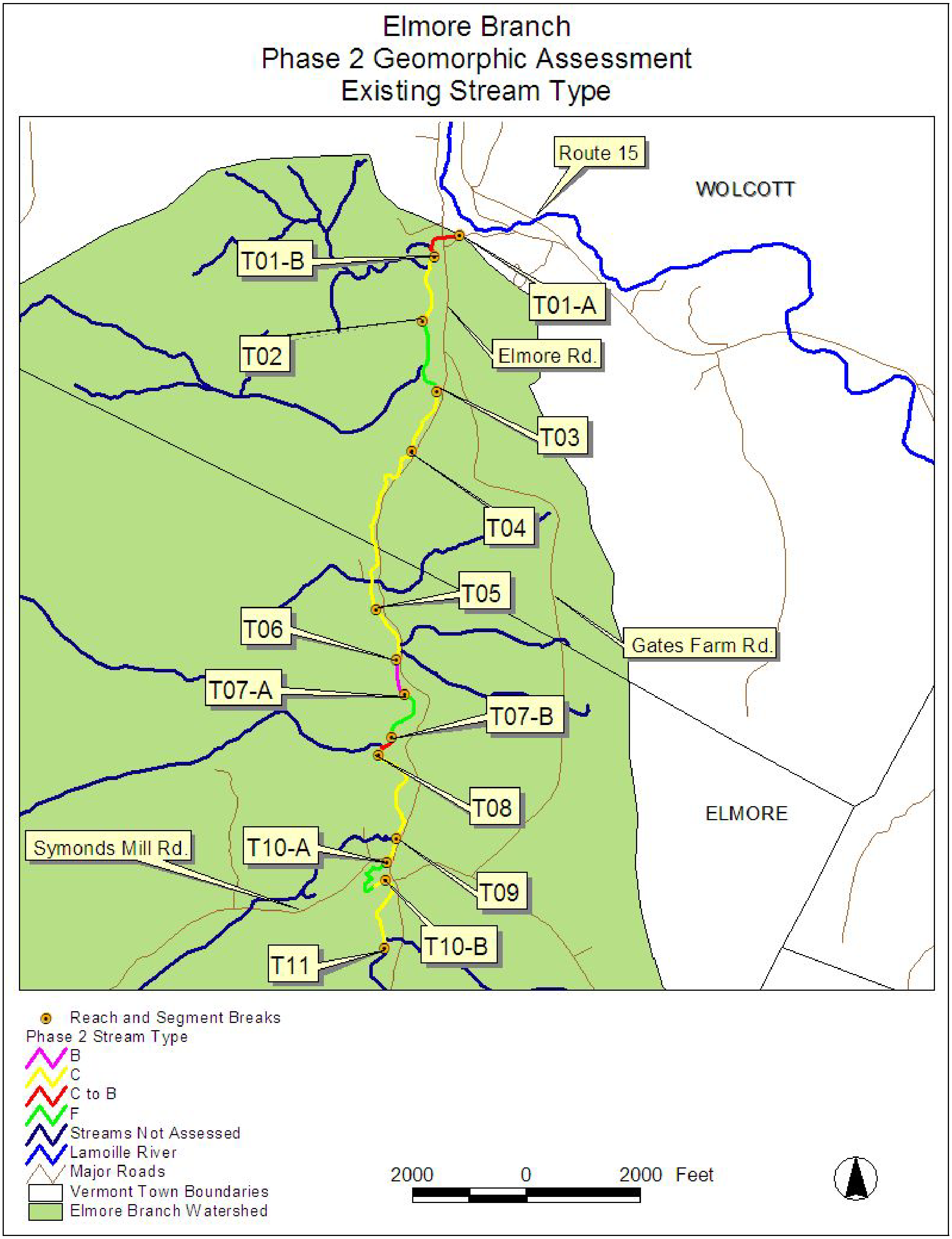

Figure 7. Existing Stream Type

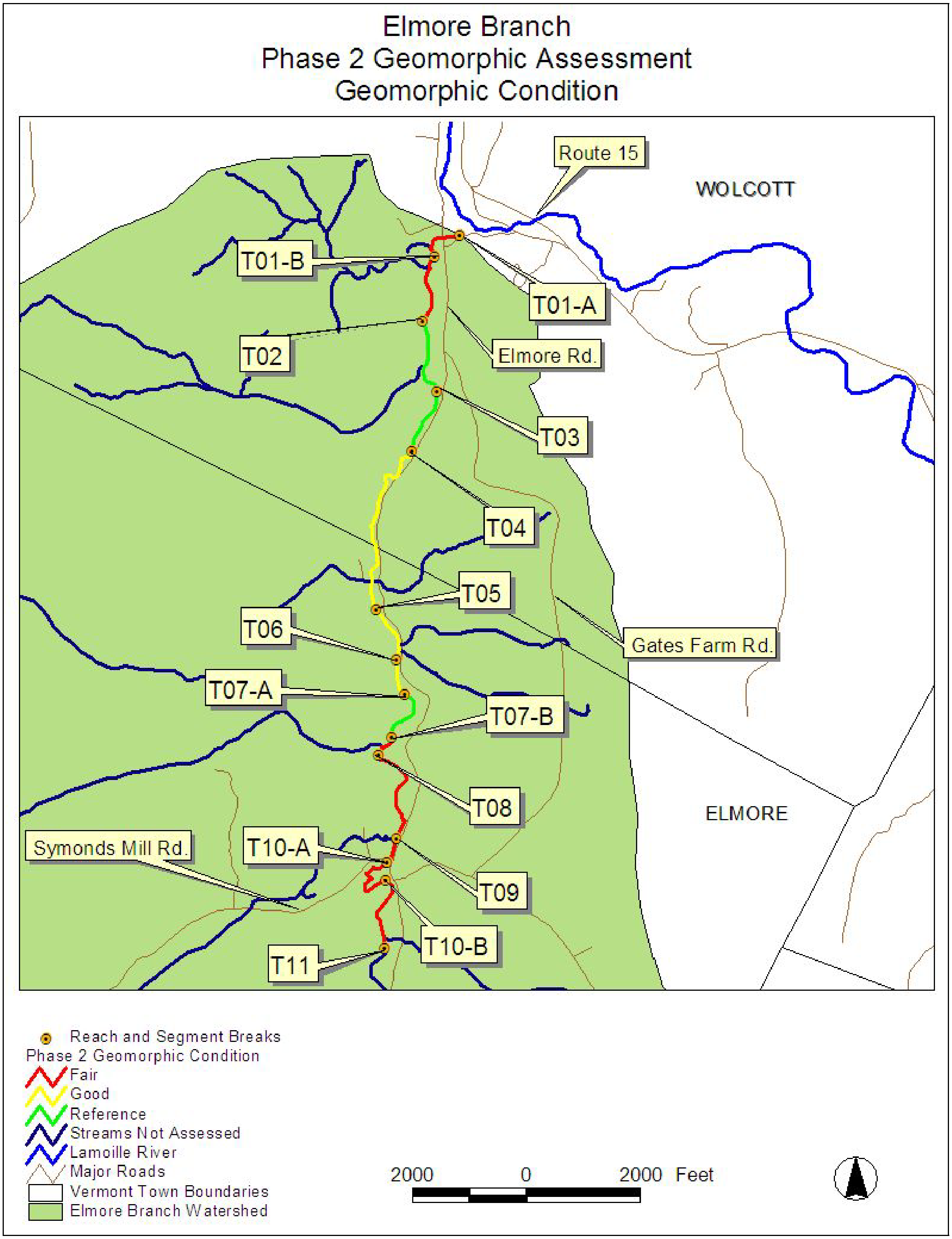

Figure 8: Phase 2 Geomorphic Condition of the Elmore Branch Watershed

The RGA for the Elmore Branch indicate that several of the reaches are actively, or have historically, undergone a process of minor or major geomorphic adjustment. In a 2001 study, (Ryan 2001) it was noted that, "The East Elmore Road is responsible for much of the Elmore Branch's instability. The road acts as a major flood plain encroachment reducing the river's flood prone width, therefore reducing the stream's entrenchment ratio. The East Elmore Road runs parallel, and in some areas immediately adjacent, to the Elmore Branch". According to research conducted by Jim Ryan (2001 and 2007), review of USDA aerial photos revealed what looked to be like an intentional channel straightening near a farmhouse on Eagle Ledge Road that likely took place somewhere between 1960 and 1990. Additionally, Ryan observed that the Elmore Branch was relocated and channelized immediately below Brown Hill Road along the East Elmore Road. The channel relocation has contributed to some channel incision but it still has access to its active flood plain.

Poor highway maintenance practices have also contributed to the stream's instability. In his 2001 report, Ryan noted that, "steep roadside ditches are not lined with grass or stone. Culverts are undersized and/or improperly installed." According to follow up communication with Ryan in 2007, "Many of the road-related conflicts have been addressed…in the form of culvert upgrades and stone-lining of ditches." High bedload contributions from feeder tributaries have deposited large delta bar deposits and are contributing to localized bank scour." In general it seems that the most common adjustment processes in the Elmore Branch are widening[1] and planform[2] migration as a result of historic degradation[3] within the channel. Several of the reaches studied in the Elmore Branch watershed are undergoing a channel evolution process. Table 3 below summarizes the channel evolution of each study reach and the primary adjustment processes that are occurring. Once a stream begins to incise, it will typically erode its way through an evolution process until it has created a new floodplain at a lower elevation in the landscape. The common stages of channel evolution, as shown below in Figure 9, 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

[1] Channel widening occurs when stream flows are contained in a channel as a result of degradation or floodplain encroachment or when sediments overwhelm the stream channel and the erosive energy is concentrated into both banks.
[2] Planform is the channel shape as seen from the air.
[3] Degradation describes the process whereby the stream lowers in elevation through erosion, or scour, of bed material.

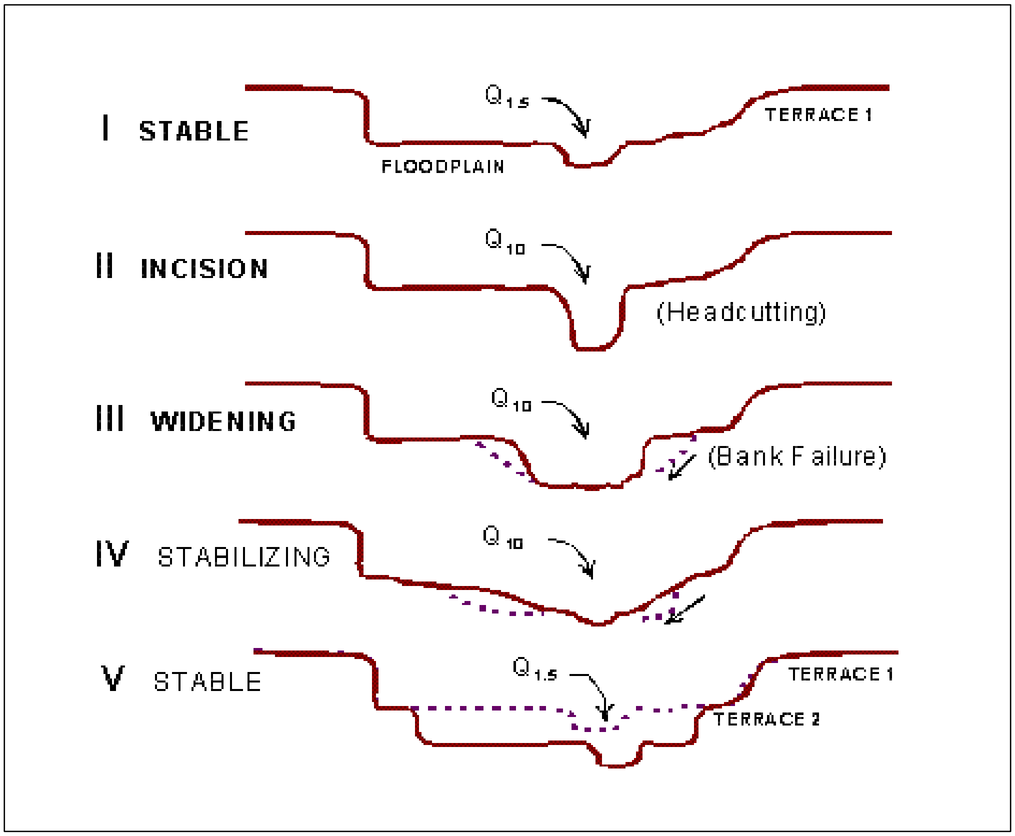

Figure 9. F-stage Channel Evolution Process (from Vermont Agency of Natural Resources, 2006)

Table 3. Stream Type and Channel Evolution Stage

Segment Number	Entrenchment Ratio	Width to Depth Ratio	Reference Stream Type	Existing Stream Type	Channel Evolution Stage	Active Adjustment Process
T01-A	1.5	18.4	C4	B4	III	Aggradation Widening
T01-B	4.9	38.5	C3	C3	IV	**Widening**
T02	Predominately bedrock controlled					
T03	Predominately bedrock controlled					
T04	7.8	10.5	C4	C4	IIc	**Planform** Widening
T05	3.2	10.5	C3b	C3b	IIc	Widening Planform
T06	1.4	18.5	B3	B3	I	Widening Aggradation
T07-A	Predominately bedrock controlled					

Table 3. Stream Type and Channel Evolution Stage

Segment Number	Entrenchment Ratio	Width to Depth Ratio	Reference Stream Type	Existing Stream Type	Channel Evolution Stage	Active Adjustment Process
T07-B	1.9	19.6	C4	B4	III	Widening Aggradation Planform
T08	7.0	18.3	C4	C4	IV	**Aggradation** Widening Planform
T09	2.6	14.4	C4	C4	III	Widening Planform
T10-A	Predominately bedrock controlled					
T10-B	11.7	13.5	C4	C4	III	**Degradation** Widening Planform

Bold Black lettering – denotes major adjustment process
Black lettering (no bold) – denotes minor adjustment process

In terms of the ANR channel evolution model, the Elmore Branch is predominately at stage III of the “F-stage” channel evolution model (see Figure 9). In many reaches the channel has undergone historic degradation as evidenced by abandoned terraces and rejuvenating tributaries. Many of the cross sections on study reaches were found to be incised. The incision ratio ranged form 1.0 to 2.4. Along many of the main stem reaches and near the mouths of the tributaries, the system is actively adjusting to this lower bed elevation by moving laterally and widening in order to create a new floodplain at a lower elevation. This widening and planform adjustment is leading to another adjustment process, aggradation. Aggradation in the Elmore Branch study area seems to be a combination of endogenous sediment that is created as the stream widens and erodes its banks to reestablish a new floodplain as well as from exogenous sources such as gravel roads and land clearing.

Several segments within the Elmore Branch study area fell into another channel evolution model. The “D-stage” channel evolution model applies to reaches where there may have been some minor historic incision; however, the more dominant active adjustment process is aggradation, which then in turn leads to channel widening and planform adjustment. This evolution is occurring in reaches T04 and T05 where, due to bedrock grade control (which is common in the watershed, see Figure 13), the stream channel has not incised. In the IIc stage, a steeper gradient may be imposed through activities such as channelization, but due to the resistance of the bed material, the stream has not incised or lost access to its floodplain (remaining a “C” Stream Type). The channel is widening and migrating laterally through bank erosion caused by the increased stream power. The balance between stream power and boundary materials is re-established when the slope flattens after a process of channel lengthening and increased sinuosity. The stream bed in these channels may be a combination of poorly defined riffle-pool features and plane bed features. Both segments T04 and T05 are in the IIc stage.

HABITAT EVALUATION

Table 4 below shows a comparison of the habitat condition based on the Rapid Habitat Assessment (RHA) and the geomorphic condition based on the RGA. Often times the habitat condition is related to the geomorphic condition within a reach. For four of the nine assessed segments, both the RHA and the RGA resulted a fair rating. Segments T07-B and T08 had a rating of good for habitat, but a rating of fair for geomorphic condition. Reaches T04 and T05, conversely, had only a fair rating for habitat condition, but a good rating for geomorphic condition. Only reach T06 resulted in a rating of good for both geomorphic and habitat condition. Instream cover within many of the reaches included large boulders, tree roots and depth cover in pools, most of which were well shaded by a healthy riparian corridor. In general several of the study reaches lacked a strong riffle-pool bedform and the diversity of habitat features that this brings. Many reaches involved in the study had major intrusion into their river corridor from the Elmore and other major roads and many had inadequate riparian buffers due to historic and /or recent land clearing. Overall, the RHA score was similar to the RGA score, implying that the ecological health of the Elmore Branch is closely related to the geomorphic condition of the stream.

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

Segment Number	Score RHA	Score RGA	Rating RHA	Rating RGA
T01-A	0.52	0.56	Fair	Fair
T01-B	0.64	0.56	Fair	Fair
T02	Not Evaluated – bedrock controlled			
T03	Not Evaluated – bedrock controlled			
T04	0.54	0.68	Fair	Good
T05	0.53	0.69	Fair	Good
T06	0.74	0.75	Good	Good
T07-A	Not Evaluated – bedrock controlled			
T07-B	0.70	0.54	Good	Fair
T08	0.68	0.54	Good	Fair
T09	0.60	0.64	Fair	Fair
T10-B	0.58	0.55	Fair	Fair
T10-A	Not Evaluated – bedrock controlled			

5.3 Bridge and Culvert Assessment

There are three bridges on the Elmore Branch in the Phase 2 study area. The bridge on Symonds Mill Road just before it meets East Elmore Road impacts sediment movement and is a bit undersized. According to LCPC, this bridge failed in a flood in 1995 and is in danger of failing again due to upstream sediment deposition and poor location and alignment. This reach also has some sediment storage in the form of point and side bars, and the most significant erosion on the entire river with erosion spanning fifty feet long by twenty feet high. This bank failure was located about 2000 feet upstream of the bridge on Symonds Road. During the Phase 2 Assessment conducted by BCE and LCPC, the undersized bridge with poor alignment at Symonds Mill Road was identified as creating sediment transport problems (see Table 5). This bridge has a span of 49 percent of the bankfull width is recommended for replacement. No significant sediment transport or alignment problems were noted at the other three stream crossings during the Phase 2 assessment.

Table 5: Elmore Branch Stream Crossing Structures

Reach/ Segment No.	Structure No.	Structure Type	Road Name/ Location	% Channel Width[1]	Blocks AOP[2]	Problems Noted		Priority for Replace-ment
						Sediment Transport	Alignment	
T.01-A	700003006108103	Bridge	School Street	73	NA			Low
T04	700036018808043	Bridge	Mitchell Lane	72	NA			Low
T05	NA	Bridge	Private Driveway	94	NA			Low
T09	990001000208041	Bridge	Symonds Mill Road	49	NA	√	√	High

[1] % bankfull width based on span and bankfull width measured in field by BCE during Phase 2 assessment
[2] Aquatic organism passage not applicable to bridges

According to an analysis by LCPC, twelve of the thirteen culverts within the Elmore Branch watershed have the potential to fail due to existing problems. These problems include upstream sediment deposition, scour or erosion, inlet obstruction, poor location or alignment, and beaver activity.

Undersized bridges and culverts are not designed to accommodate both flow and sediment. During flood events large point bars can consequently deposit upstream of undersized bridges and culverts. During catastrophic flood events crossings can become outflanked, taking out large sections of roads and driveways. Significant sediment discharges to waterways can result. Sedimentation of the river poses water quality and aquatic habitat concerns.

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 Elmore Branch stream network 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 alterations 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).

The dominant watershed land cover/land use within the Elmore Branch watershed is forest. Only two of the twenty-six reaches resulted in a watershed land cover/land use impact rating of high (10% or more is crop and/or urban). Analysis of hydric soils located where current land uses are agricultural or urban indicates some minor loss of wetland attenuation. Historical deforestation in the Elmore Branch watershed may also have contributed to historic incision.

The Elmore Branch watershed has a limited network of roads as shown in Figure 10. Only two stormwater inputs (one in reach T06 and one in reach T09) were mapped during the Phase 2 field work. Extensive road networks can contribute significantly to increased flows within a river resulting both from increased runoff and stormwater ditching. According to Foreman and Alexander (1998), increased peak flows in streams may be evident at road densities of 3.2 miles/ square mile. Subwatersheds with road densities of greater than 3.2 mile/ square mile account for approximately 4.4 percent of the Elmore Branch watershed. The road density for the subwatersheds of the Elmore Branch is only greater than 7 miles per square mile in one subwatershed near the intersection of Harwood Flats Road and Tallman Road in Elmore. Generally the subwatersheds of the Elmore Branch have low road densities.

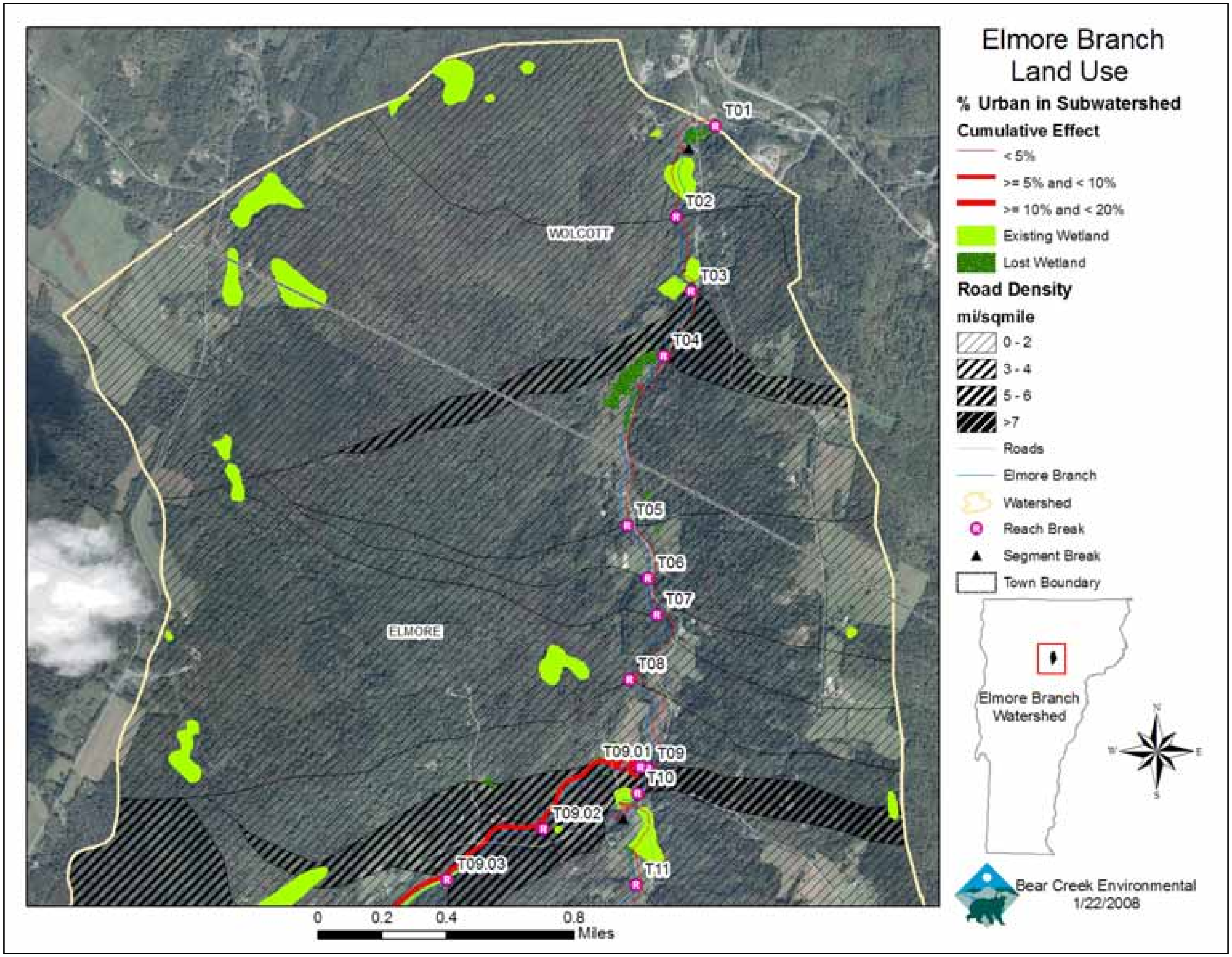

Figure 10. Land use map showing cumulative percent of urban land use, road density and lost wetlands.

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 11) shows the distribution of sediment load indicators in the Elmore Branch watershed at the watershed scale. Isolated mass wasting sites were identified during the Stream Geomorphic Assessments in reaches T08 and T10-B. Localized areas of bank erosion and depositional features (steep riffles, mid channel bars, delta bars, flood chutes, and/or avulsions) are prevalent in the watershed.

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. This 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. The primary stressors in each segment of the Elmore Branch watershed are identified in Table 6.

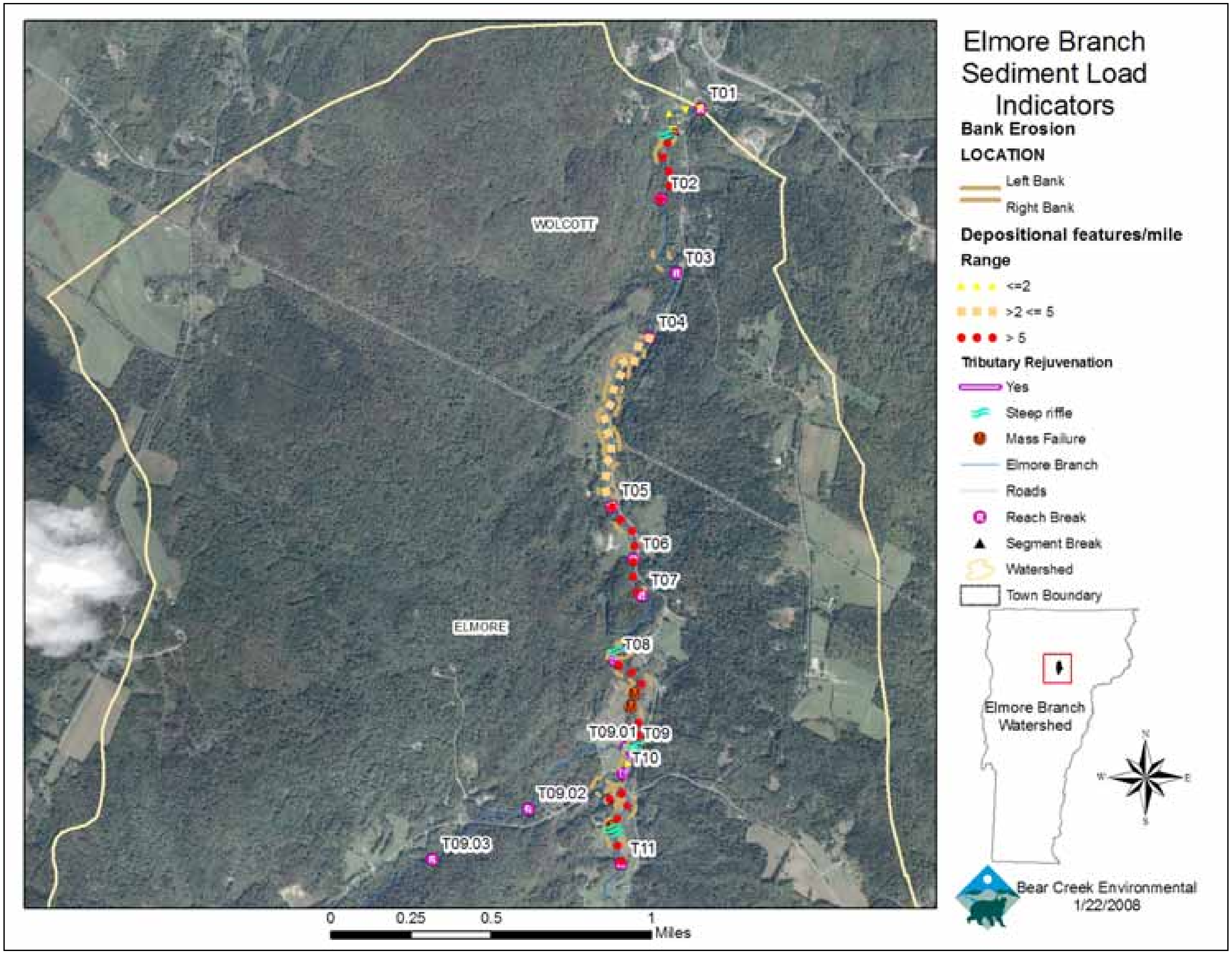

Figure 11. Sediment load indicators map showing depositional features per mile, bank erosion, steep riffles, mass failures and areas of tributary rejuvenation.

Table 6. Primary Stressors

River Segment		Watershed Input Stressors: Hydrologic	Watershed Input Stressors: Sediment load	Reach Modification Stressors: Stream Power (**Bold**=increase, Plain=decrease)	Reach Modification Stressors: Boundary Resistance (**Bold**=increase, Plain=decrease)
T01	A		Historic Degradation	**Straightening (H)** Constriction Grade Controls	Reduced riparian vegetation (E) **Armoring (M)**
T01	B		Bank Erosion (H) Historic Degradation Depositional Features (H)	Grade Controls	
T02				Grade Controls	
T03		Road Density (M)		Grade Controls	
T04			Bank Erosion (H)	**Straightening (H) Encroachment (H)** Constriction	Reduced riparian vegetation (H) **Armoring (M)**
T05			Bank Erosion (M) Depositional Features (M)	**Straightening (H) Encroachment (H)** Constriction Grade Controls	**Armoring (H)** Reduced riparian vegetation (H)
T06		Stormwater Input (H)	Bank Erosion (M) Depositional Features (H)	**Encroachment (H)** Grade Controls	Reduced riparian vegetation (M)
T07	A			Grade Controls	
T07	B		Bank Erosion (H) Historic Degradation Depositional Features (H)		
T08			Bank Erosion (M) Historic Degradation Depositional Features (H)	**Straightening (M) Encroachment (H)** Grade Controls	Reduced riparian vegetation (M)
T09		Stormwater Input (H) Road Density (H)	Bank Erosion (H) Historic Degradation	**Straightening (H) Encroachment (H)** Constriction	Reduced riparian vegetation (E) **Armoring (M)**
T10	A			Grade Controls	Reduced riparian vegetation (M)

Table 6. Primary Stressors						
	Watershed Input Stressors			Reach Modification Stressors	
River Segment		Hydrologic	Sediment load	Stream Power **Bold**=increase Plain=decrease	Boundary Resistance **Bold**=increase Plain=decrease
T10	B		Bank Erosion (H) Depositional Features (H)	**Straightening (M)** **Encroachment (H)** **Head Cuts**	Reduced Riparian vegetation (E) **Armoring (M)**

Moderate	Stormwater Inputs and Depositional Features 2-5 mile; Road Density 3-4 mi/sq. mi. Straightening, Bank Armoring, Erosion, and Encroachment 5-20% Urban 5-10%; Reduced Riparian Buffer 5-20%
High	Stormwater Inputs and Depositional Features >5 mile; Road Density 5-6 mi/sq. mi. Straightening, Bank Armoring, Erosion, and Encroachment >20% Urban 10-20%; Reduced Riparian Buffer 20-50%
Extreme	Reduced Riparian Buffer >50%; Urban >20%

6.1.4 Channel Slope and Depth Modifiers

Results from the Elmore Branch watershed indicate that primary stressors include extensive straightening of the channel along with road crossings and encroachments (see Figures 12 and 13). The majority of the channel straightening within the Elmore Branch watershed was associated with roads that run parallel to the stream and farm fields within the river corridor. In particular, straightening is evident in reaches T04, T05, T09, and T10 that runs parallel to East Elmore Road.

There are no records at the Vermont Agency of Natural Resources regarding dredging of the channel. Likewise, no existing data indicates that dredging has occurred within the stream network of concern in this study. However, where the channel has been straightened, it is likely that some dredging that may have occurred during the straightening process.

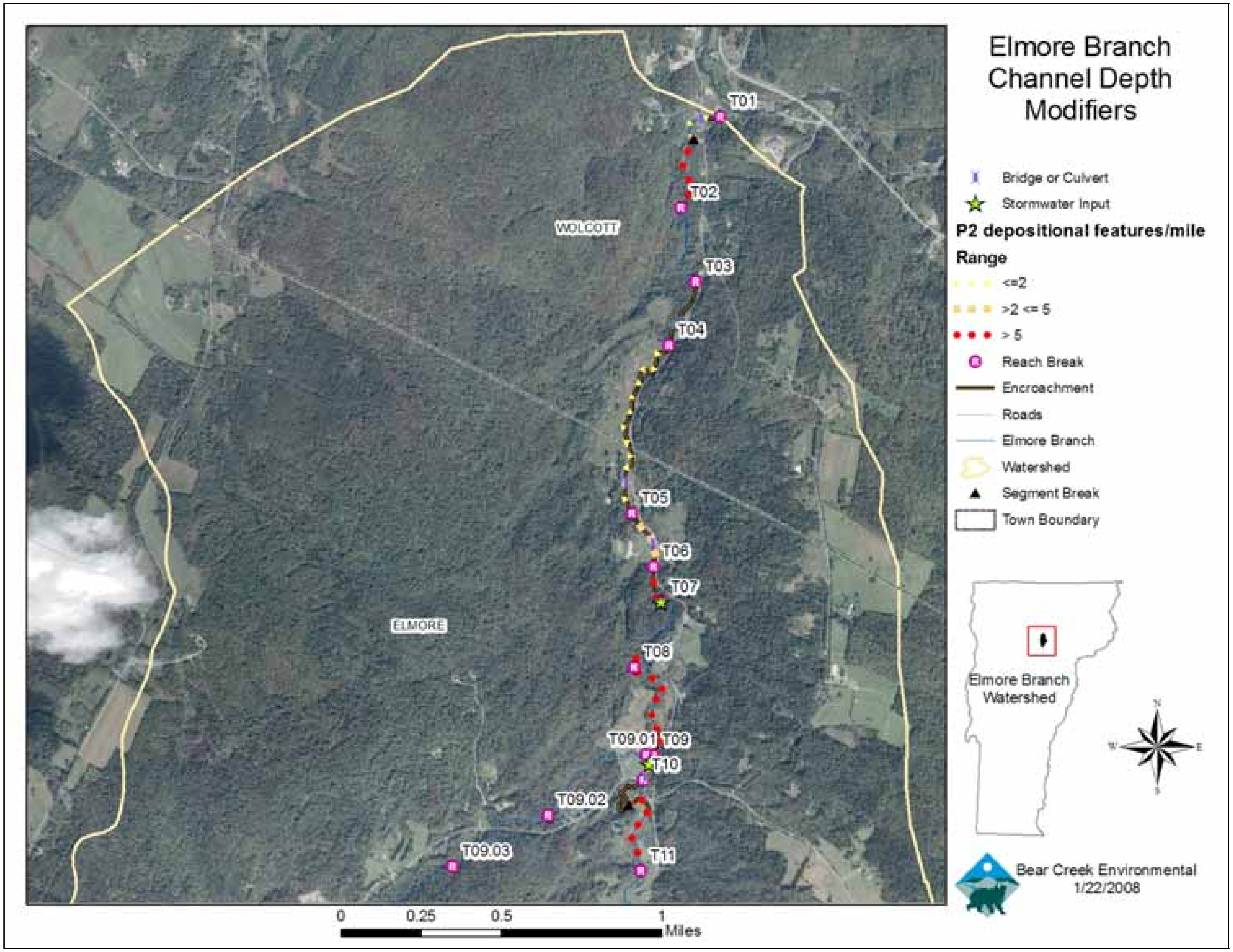

Figure 12. Channel depth modifiers showing encroachments, depositional features per mile, stormwater inputs and bridge locations.

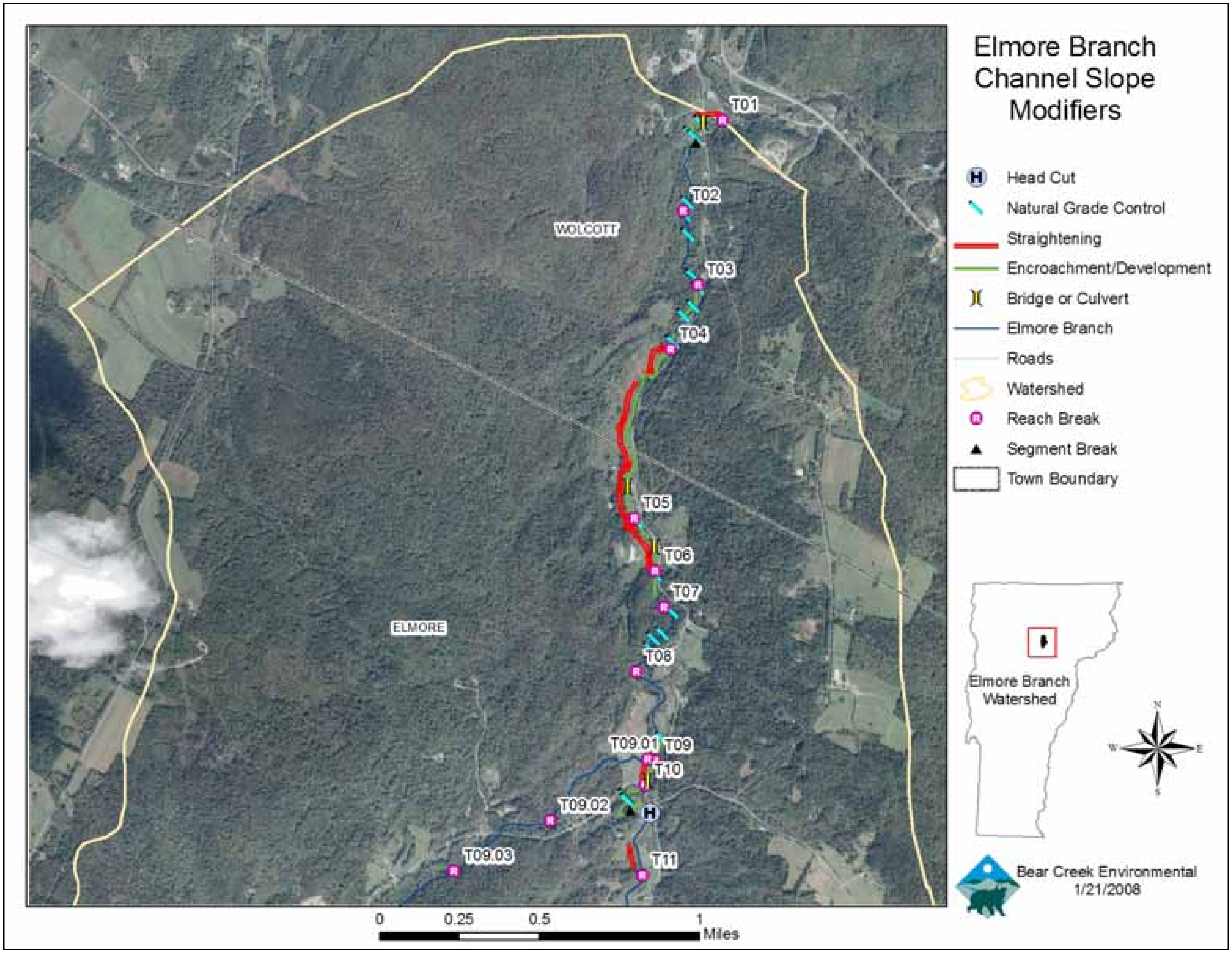

Figure 13. Channel slope modifiers map showing areas of development, straightening, grade controls and head cuts.

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. Two stream segments, T01-A and T09 had over 70 percent of the reach with little or no buffer on at least one bank. Six other segments had intermittent locations with riparian buffers less than 25 feet. The data for the locations indicated as having little to no buffer on the Boundary Conditions and Riparian Modifiers map (Figure 14) were indexed by Bear Creek Environmental based on NAIP photos. These stream reaches which lack a high quality riparian buffer are at a significantly higher risk of experiencing high rates of lateral erosion.

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, 2007a).

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 sediment regime departure map (Figure 15) shows the Phase 1 reference stream sediment conditions for each reach within the stream network. These reference type streams use available floodplain access as a means to store sediment within the watershed. The majority of the stream network has a reference sediment regime of a *Coarse Equilibrium (in=out) & Fine Deposition*. The bedrock dominated reaches have a *Transport* sediment regime.

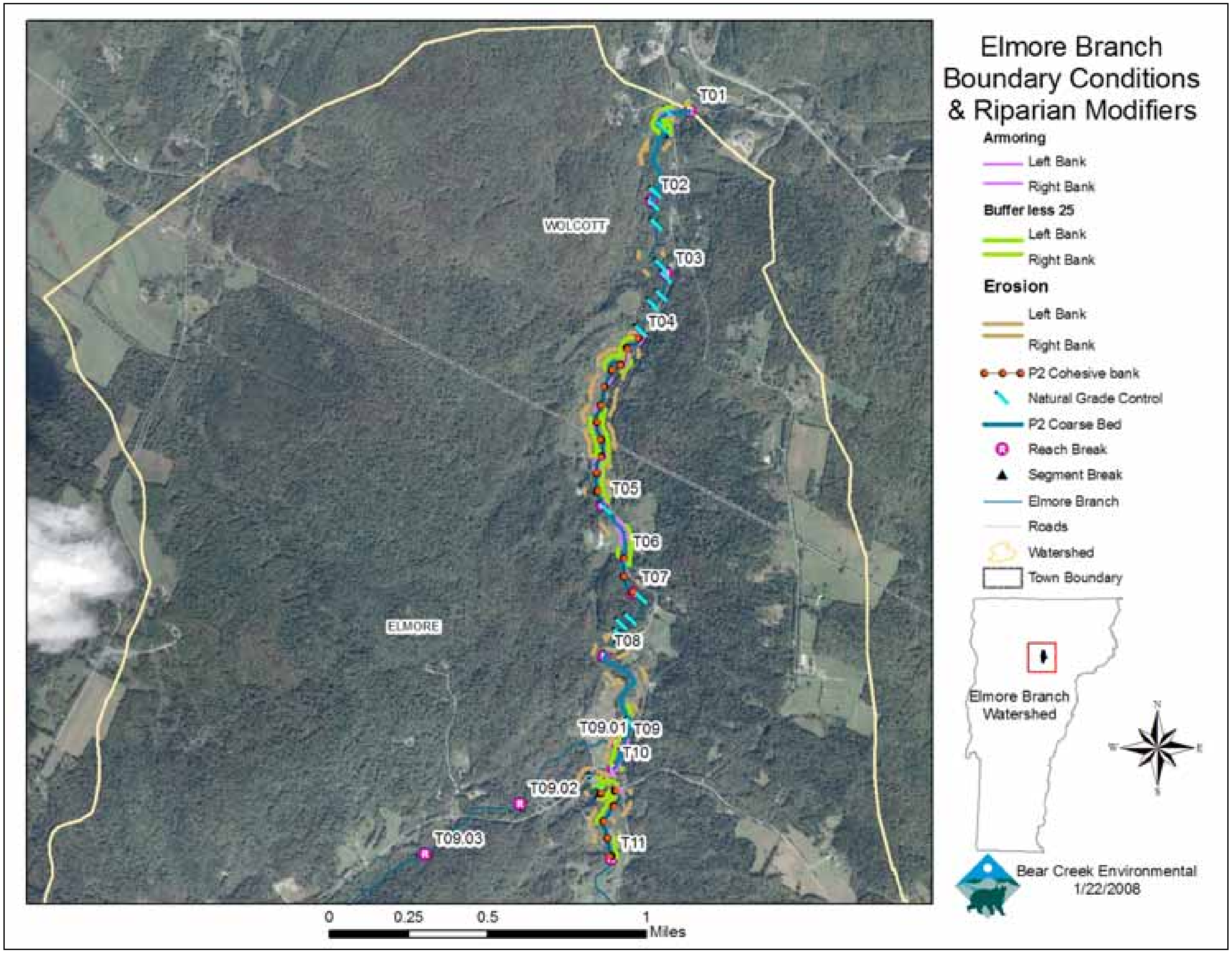

Figure 14. Boundary conditions and riparian modifications map showing areas of erosion, bank armoring, bank erosion, cohesive banks, grade controls, and coarse bed materials.

Changes in hydrology (such as development and agriculture within the riparian corridor) and sediment storage within the watershed have altered the reference sediment regime types for some reach segments. Reach T01 near the confluence with the Lamoille, and reaches T08, T09, and T10-B were *Coarse Equilibrium (in=out) & Fine Deposition* 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. Additionally coarse sediment storage is increased due to increased load, along with lower transport capacity. One segment (T07-B) that was *Coarse Equilibrium (in=out) & Fine Deposition* by reference has been converted to a *Confined Source and Transport* sediment regime due to increased transport capacity derived from the gradient and/or entrenchment of the channel.

All departures were derived from the DMS according to the sediment regime criteria established by the Vermont Agency of Natural Resources (2007a). For bedrock dominated segments that were not assessed during the Phase 2 investigation (T02, T03, T07-A, T10-A), Bear Creek Environmental used the protocols set forth in the VT ANR River Corridor Guide (2007a) to identify the proper existing sediment regime.

The existing sediment regime for the Elmore Branch watershed includes reduced floodplain access, increased stream power, reduced boundary resistance, and lateral constraints at various 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, 2007a). Segments and reaches of the Elmore Branch watershed 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:

T01-B
T04 (downstream end)
T08
T10-B

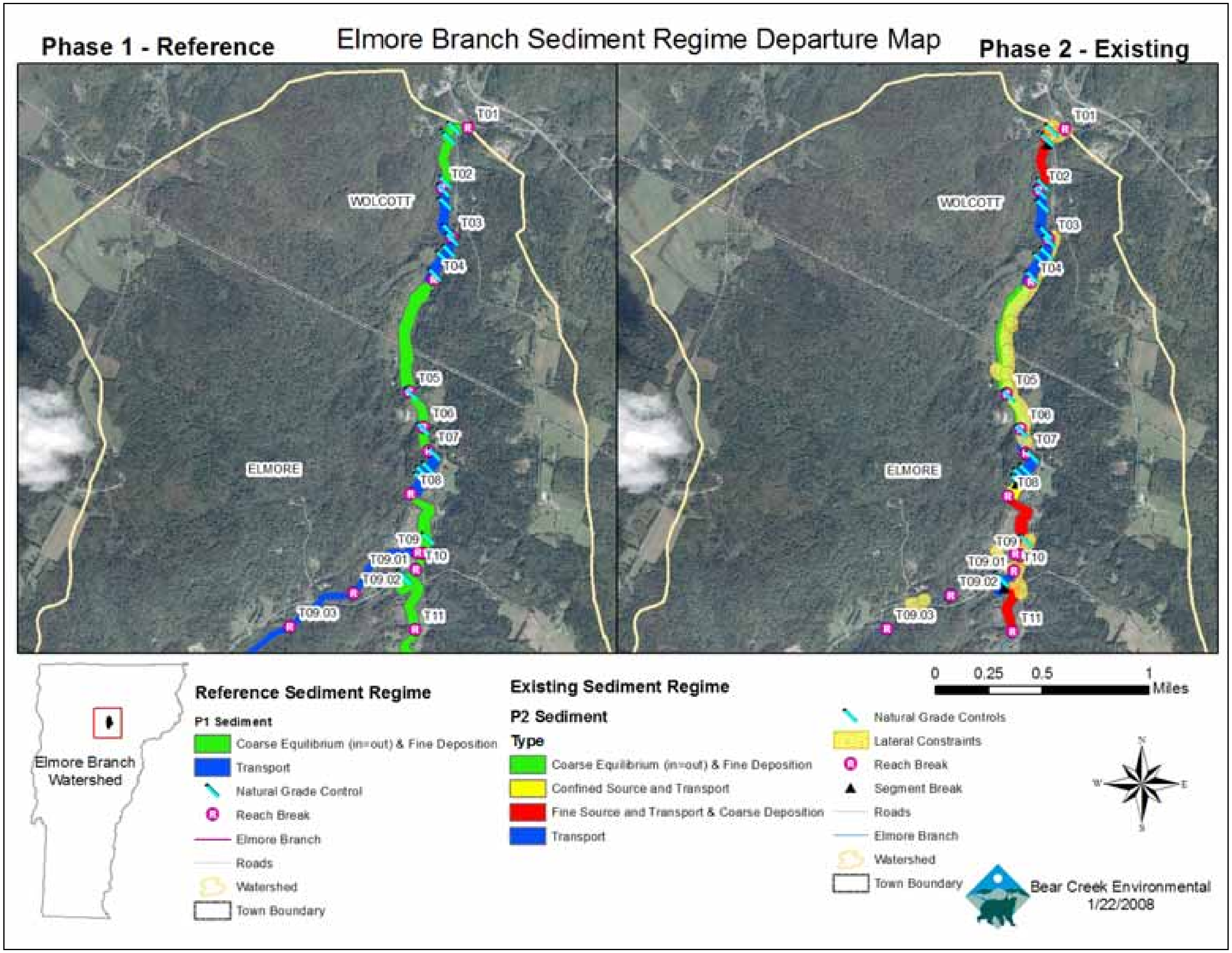

Figure 15. Sediment Regime Departure Map

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 streams in the Elmore Branch watershed. The existing geomorphic condition and stream sensitivity of the Phase 2 assessed reaches are presented in Table 7.

Table 7. Stream Sensitivity for Phase 2 Reaches

Segment Number	Reference Stream Type	Existing Stream Type	Stream Type Departure	Geomorphic Condition	Sensitivity
T01-A	C4	Bc4	Yes	Fair	High
T01-B	C3	C3	No	Fair	Very High
T02	Not Evaluated – bedrock controlled				
T03	Not Evaluated – bedrock controlled				
T04	C4	C4	No	Good	High
T05	C3b	C3b	No	Good	High
T06	Bc3	Bc3	No	Good	Moderate
T07-A	Not Evaluated – bedrock controlled				
T07-B	C4	Bc4	Yes	Fair	High
T08	C4	C4	No	Fair	Very High
T09	C4	C4	No	Fair	Very High
T10-A	Not Evaluated – bedrock controlled				
T10-B	C4	C4	No	Fair	Very High

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. Additionally, flow regime and floodplain constrictions may be affecting the sensitivity of the Elmore Branch. 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 16 is a map presenting the stream sensitivity, generalized according to stream type and condition as per the ANR protocol, and current adjustments for each reach segment in the Elmore Branch watershed. Sensitivity ratings have not been assigned for bedrock dominated segments that were not assessed.

The stream sensitivity map also documents vertical channel adjustments currently going on within a reach segment. Major degradation or aggradation adjustment processes are displayed on the sensitivity corridors where they were found to be actively occurring and they were 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. Vertical channel adjustments exist in the following segments:

Segment ID	Current Major Adjustment Process
T08	Aggradation
T10-B	Degradation (possible localized)

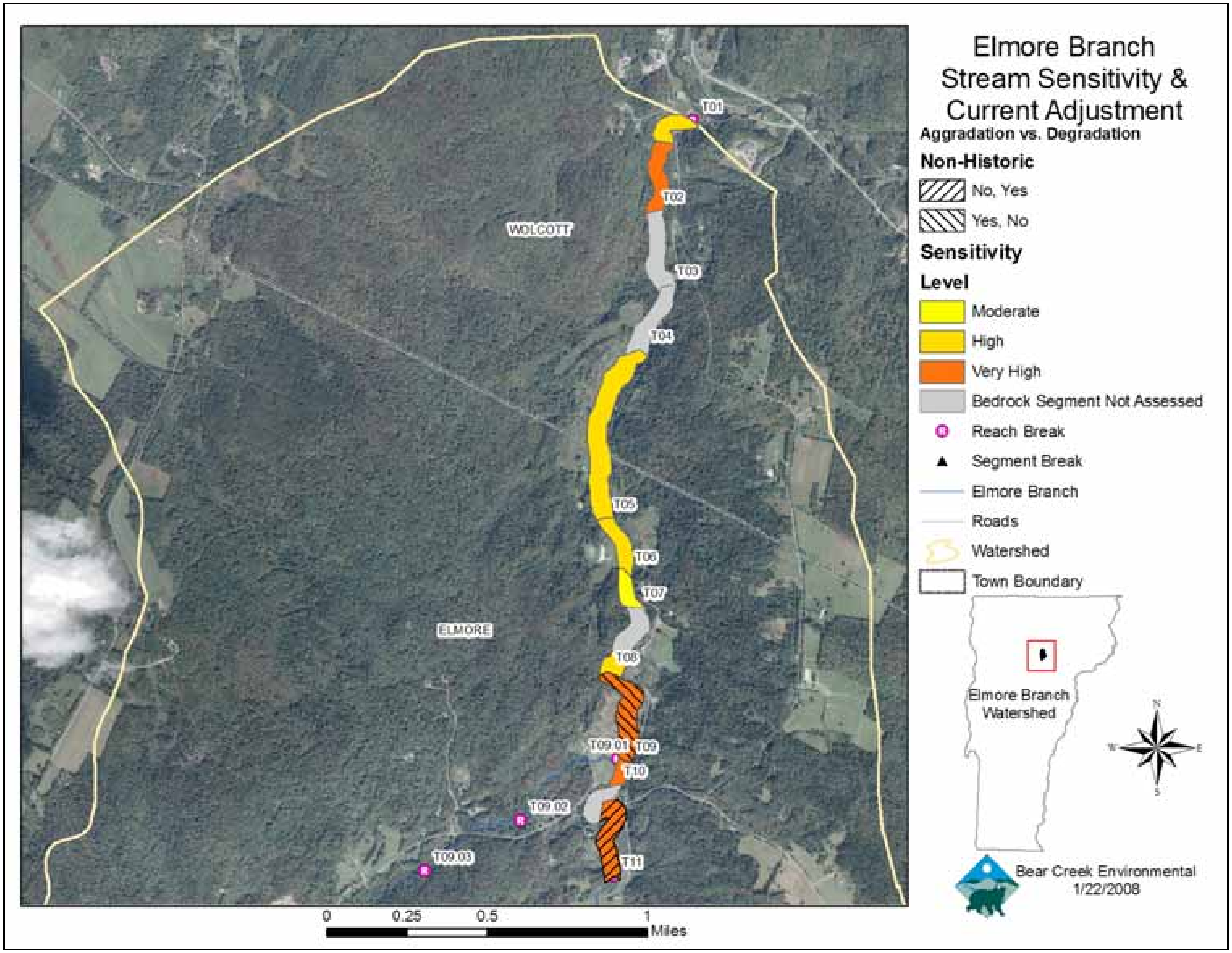

Figure 16. Elmore Branch Watershed Stream Sensitivity and Current Adjustment

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.

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

Passive Geomorphic Restoration allows rivers to return to a state of geomorphic equilibrium by removing factors adversely impacting the river and subsequently using the river's own energy and watershed inputs to re-establish its meanders, floodplains and equilibrium conditions. In many cases, passive restoration projects may require varying degrees of active measures to achieve 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. Similarly, corridor easement approaches to passive restoration provide protection for areas that are highly active in adjustment, allowing active processes to continue.

There are a number of voluntary programs available for river protection. Two of the primary programs are the Conservation Reserve Enhancement Program (CREP) and the River Corridor Easement (RCE). CREP is a program that helps protect environmentally sensitive land, decrease erosion, and restore wildlife habitat by taking land out of agricultural production. An overview of the Conservation Reserve Enhancement Program is found at http://www.fsa.usda.gov/FSA/webapp?area=home&subject=lown&topic=cep. The River Corridor Easement is designed to promote the long term physical stability of the river by allowing the river to achieve a state of equilibrium (where sediment and water loads are in balance). River corridor easements are vital for a passive geomorphic restoration approach and can also be used for conserving rivers that are in good condition (equilibrium). Rivers that are in equilibrium have access to their floodplains and therefore experience less erosion and negative impacts from flooding events. A description of each of the programs prepared by the Vermont River Management Program is provided below.

Conservation Reserve Enhancement Program

- CREP can be either a 15 or 30 year contract to plant trees.

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

River Corridor Easement (RCE)

- Easements are in perpetuity, meaning the agreement stays with the land forever.
- A one time payment is received by the landowner for transferal of channel management rights to a second party (a land trust).
- Transferal of channel management rights means that the landowner would not longer be able to rock line river banks or remove gravel for personal use.
- A management plan accompanies the easement outlining the management and land use practices expected to occur within the corridor and describe any accommodations that must be made for existing structures (e.g. outbuildings, stream crossing, etc.).
- A RCE requires a minimum 50 foot buffer that floats with the river. No active land use is allowed within the buffer. The buffer can be actively planted or allowed to revegetate passively.
- The easement does not take away the agricultural land use rights, so the landowner could continue to crop or pasture the farm land mapped within the corridor for as long as the river allows.

7.1 Watershed-Level Opportunities

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 acquisition 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 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. Information collected during the Phase 2 Assessment including reach sensitivity, reach condition, and stream type is used to develop these zones. Towns have the opportunity to work with the Vermont River Management Program to develop fluvial erosion hazard zones to reduce conflicts within the river corridor.

STORMWATER

Stormwater runoff rates are of particular concern in urbanized and agricultural watersheds because stormwater runs off from impervious surfaces rather than naturally infiltrating the soil. The cumulative effect of the increased frequency, volume, and rate of stormwater runoff results in increases in wash-off pollutant loading to streams and destabilization of stream channels. All potential restoration projects along the Elmore Branch stream network should be evaluated in terms of their effects on stormwater.

7.2 Reach-Level Opportunities

A description of each Phase 2 reach/segment is provided in this section along with general recommendations for restoration and protection strategies. The reaches are listed from downstream to upstream. Overview maps (Figures 17, 18, and 19) have been included to provide a reference for location as well as to display channel modifications such as straightening and streambank armoring, both of which have greatly affected the condition of the Elmore Branch.

Lower Section – T01 through T03

The lower section of the Elmore Branch begins at T03 and continues downstream to the confluence with the Lamoille River (Figure 17). This section is dominated by forested banks and bedrock grade controls until near the end of the river where residences of Wolcott Village, roads, and a town ball field all start to encroach on the stream corridor. Most of the final segment T01-A has been channelized.

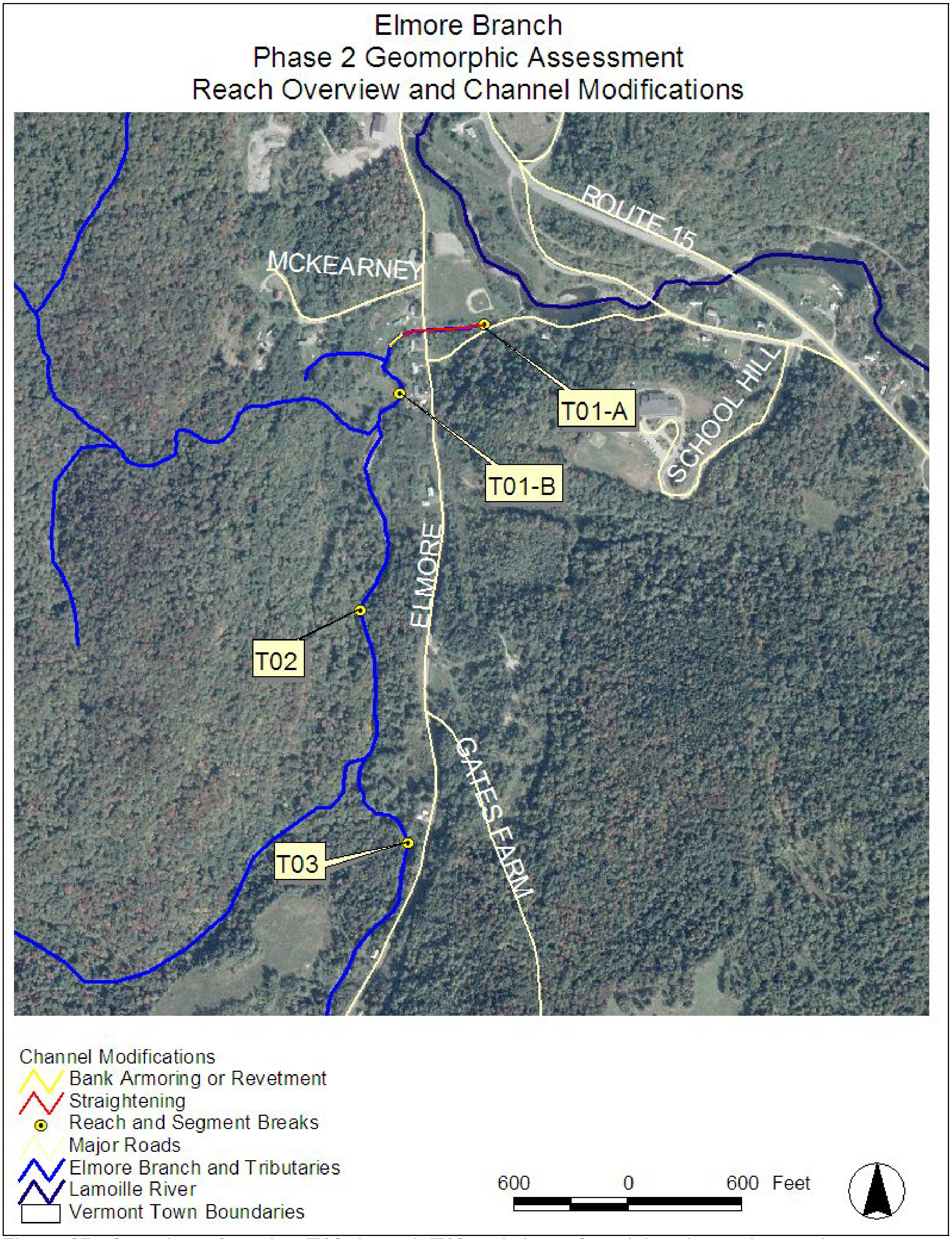

Figure 17. Overview of reaches T01 through T03 and channel straightening and armoring.

Reach T01

Elmore Branch reach T01 begins at the end of a large bedrock waterfall and flows downstream to eventually join the Lamoille River in Wolcott Village. The reach was segmented because of a change in the channel dimensions (the incision and entrenchment ratios).

Segment T01-A
Improve Riparian Buffer

Segment T01-A begins at the bedrock ledges near the junction of Flat Iron and Elmore Roads and continues downstream to the confluence with the Lamoille River. A hay field and residential development were noted to be the dominant land use within the riparian corridor of segment T01-A. The buffer is narrow on both sides (<5 feet in width). Shrubs and saplings are the dominant vegetation type.

Segment T01-A has undergone a stream type departure from a C channel to a B channel due to historic incision and floodplain encroachment. The measured incision ratio was calculated to be 2.0, suggesting a high degree of incision and loss of floodplain access along this reach. The incision along this segment may be related to extensive channel straightening that seems to have occurred throughout this segment and/or degradation that has occurred in the mainstem of the Lamoille River. Lateral adjustment of the channel in response to this straightening has likely been limited due to extensive armoring of the streambanks. Active adjustment has been limited to only minor widening in this section due to extensive riprap. Approximately 15 percent of the north bank and 35 percent of the south bank has been armored. Sediment storage included only two small bars. The lack of bars in a reference “C” channel is indicative of a segment that has been straightened. The bedform recorded for this section was a plane bed indicating that the incision has resulted in a loss of pool habitat.

Segment T01-B
Protect River Corridor

From a major waterfall at the end of reach T02, Elmore Branch segment T01-B continues downstream for 1277 feet to a series of bedrock ledges. This upper segment of reach T01 is a “C” type channel. There is evidence of historic incision through this segment; however, the reach has rebuilt a juvenile floodplain through major widening and minor planform and aggradation adjustments.

The bedform recorded for this section was a weak riffle-pool indicating that the incision has resulted in a loss of pool habitat. Forest and residential development were noted to be the dominant land use within the riparian corridor of segment T01-B. The buffer was over 100 feet wide on both sides. Shrubs and saplings were the dominant vegetation type.

<u>Reach T02</u>
Protect River Corridor

Elmore Branch reach T02 is a 1387 foot long reach that is a very stable bedrock controlled “F” channel. Due to the very stable nature of this stream type, this reach was not assessed for geomorphic condition or habitat quality. The surrounding land use of this reach is also predominately forest.

<u>Reach T03</u>
Protect River Corridor

Elmore Branch reach T03 is an 1193 foot long reach that is a very stable bedrock controlled “F” channel. This reach was not assessed for geomorphic condition or habitat quality. The riparian corridor of the surrounding landscape is predominately forest.

<u>Mid Section – T04 through T06</u>

The next section of the Elmore Branch begins at T06 and continues downstream to reach T04 (Figure 18). The westbank of this section is predominately old farm field and pasture. The east bank of the section has several residences and the East Elmore Road along almost its entire corridor. The bridge at Mitchell Lane is a channel constriction.

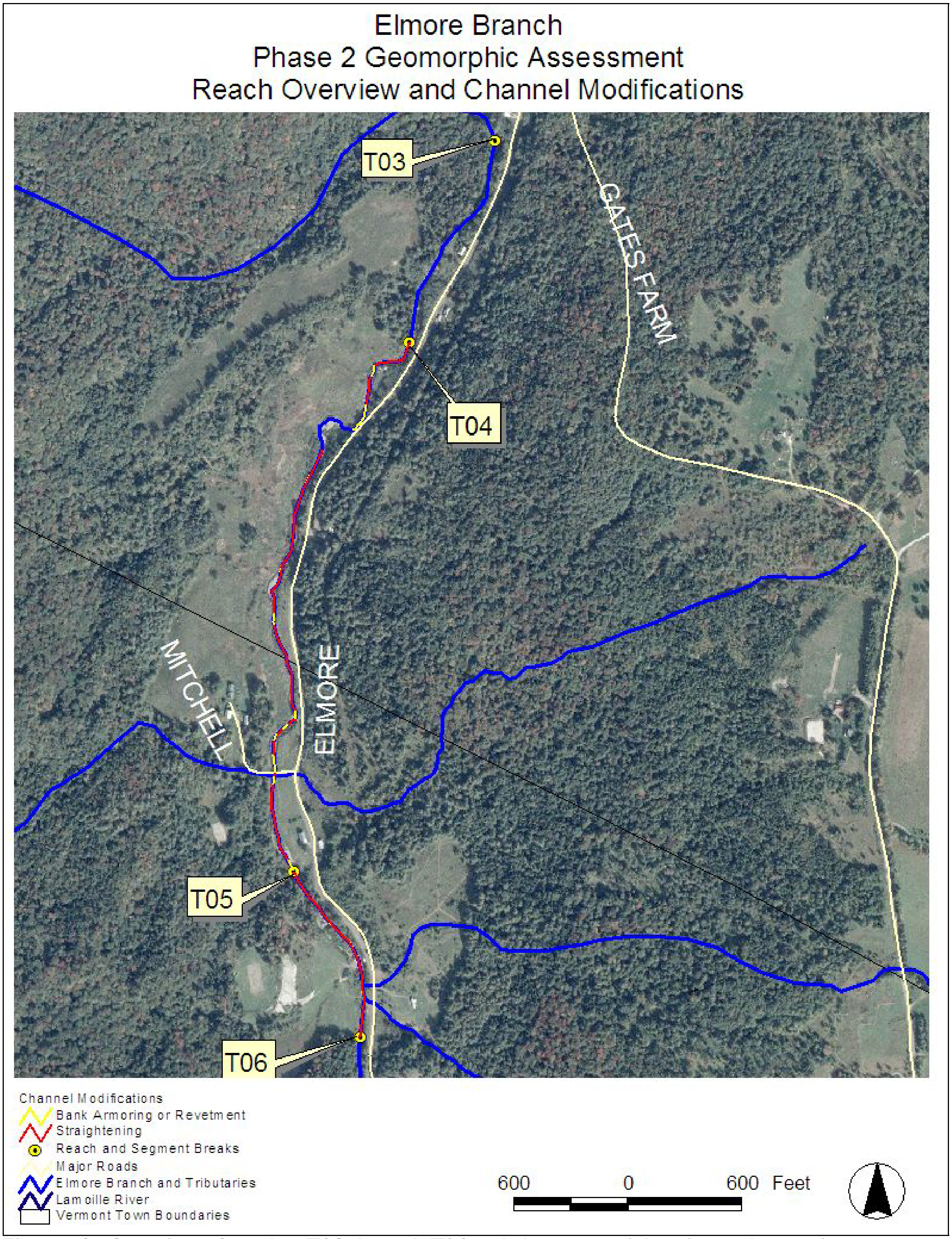

Figure 18. Overview of reaches T06 through T04 and channel straightening and armoring.

Reach T04

Improve Riparian Buffer

Elmore Branch reach T04 begins at a large waterfall and continues downstream for 3334 feet to where the valley confinement and stream type of the Elmore Branch change. Bank material in this reach was a cohesive mix of silt, clay, and sand. The channel was determined to be a "C" stream type with a riffle-pool bedform. Despite extensive channel straightening through this reach, the river does not appear to have incised. Grade controls at the bottom and top of the reach have likely prevented incision. The stream is, however, undergoing minor widening and major planform adjustment as a result of the increased slope of the channel. Moderate to high scour and erosion at the base of both banks was observed within riffle sections in locations that had not been armored and lacked a high quality buffer of trees and shrubs. It is likely that pasture land (or other agricultural activities) once dominated the surrounding river corridor. The riparian and near bank vegetation is still dominated by herbaceous species rather than woody species.

Reach T05

Elmore Branch reach T05 begins downstream of a bedrock dominated section of stream and ends at a large waterfall. This reach is a "C" riffle pool type stream channel by reference and flows through a narrow valley. The major impact affecting the river corridor in this reach is the encroachment of the Elmore Road on the right bank. There was evidence of riprap in the channel that had once been armoring the banks. Some channel straightening and bank armoring may have caused the loss of the riffle-pool bedform, as the reach was found to be a planebed system. Despite these impacts, the reach was found to be in good geomorphic condition exhibiting only minor widening and planform adjustment.

Reach T06

Elmore Branch reach T06 is a 645 foot long "B" type stream channel that is controlled by bedrock in the stream channel and on the west bank. It is a plane bed stream that transports sediment under reference condition. The reach showed only minor signs of channel aggradation and widening most likely associated with excess sediment from major bank erosion in upstream reaches. Some encroachment of the west corridor has occurred due to the location of Elmore Road. Overall the riparian condition of this reach is good with greater than 100 feet of forest buffering each side of the channel.

Upper Section – Reach T07 through T10

The last section of stream (illustrated in Figure 19) begins off Eagle Ledge Road in the town of Elmore near where the stream emerges from its heavily wooded upper watershed. From here down to reach T06, the Elmore Branch flows through predominately old pasture and agricultural fields. Major significant impacts in this section include historic removal of riparian vegetation, an old mill dam (no longer in operation), an undersized culvert under Symonds Mill Road, and channel straightening downstream of this culvert.

Reach T07

Elmore Branch reach T07 was segmented because of a change in reference stream type within the reach.

<u>Segment T07-A</u>
Conserve River Corridor

Elmore Branch segment T07-A is a 1031 foot long bedrock gorge with excellent geomorphic stability. Encroachment of the river corridor through this reach was minimal and in all cases has not affected the stability of the stream channel. Due to the very stable nature of this stream type, this reach was not assessed for geomorphic condition or habitat quality.

<u>Segment T07-B</u>

Elmore Branch segment T07-B is 422 feet in length. This short segment encompasses a transition zone between the reference "C" channel found in reach T08 and the bedrock gorge of segment T07-A that begins immediately downstream. The segment was found to be a "B" stream that had departed from a reference "C" channel. High terraces indicated that the stream has undergone some incision (the incision ratio was 2.4). This incision may be related to excessive aggradation that may occur at the entrance to the bedrock gorge where the stream may be cutting back through this deposition. The segment showed only minor signs of channel aggradation, widening, and planform adjustment likely associated with excess sediment from major bank erosion in upstream reaches as well as from channel adjustment associated with the historic incision. Buffer conditions on both sides of the stream channel were dominated by mixed trees and shrub saplings.

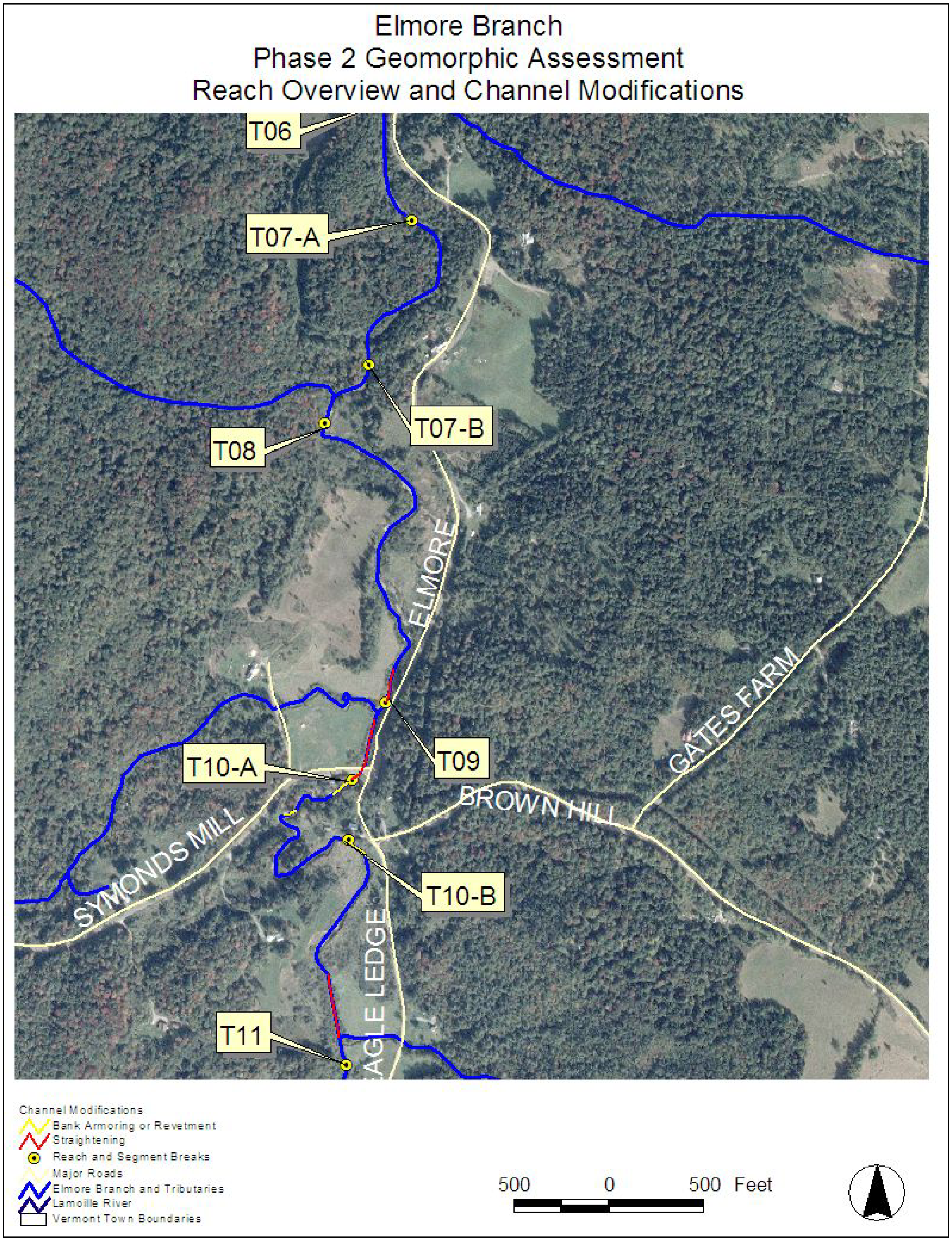

Figure 19: Overview of reaches T07 through T10

Reach T08
Protect River Corridor

Elmore Branch reach T08 is 1911 feet long and begins at the confluence of a tributary downstream of Symonds Mill Road. Land use within the stream corridor was found to be influenced by clearing for hay. Some channel straightening was also noted along this reach as was historic channel incision. The floodplain is mostly old field and wetland with no structures. A juvenile floodplain has developed along much of reach as the stream has been building bars and narrowing. The reach was found to be undergoing major aggradation and planform adjustment. The reference and existing stream type for this reach is “C”.

Reach T09
Replace Undersized Bridge
Improve Riparian Buffer

Elmore Branch reach T09 is 450 feet long. The reach begins at the confluence of an unnamed tributary, flows under the Symonds Mill Road and ends at the confluence of another unnamed tributary. The banks are mostly lined with alder; there is a road on the east bank and an old field on the west. The dominant buffer width on the west bank is less than 25 feet. The lowest tributary is undergoing major rejuvenation; however that is not affecting this reach. Reach T09 had evidence of historic channel straightening and incision. It was found to be undergoing minor widening and planform adjustment. The reference and existing stream type for this reach is “C”. The bridge at Symonds Mill Road is undersized and is poorly aligned and is recommended for replacement.

T10

Elmore Branch reach T10 begins upstream of the Symonds Mill Road bridge. The reach was divided into homogenous sections (segmented) due to a change in stream type associated with a natural change in channel confinement.

Segment T10-A
Improve Riparian Buffer

Elmore Branch segment T10-A flows through a narrow bedrock gorge. Two historic mill dam sites were found within this segment. Due to bedrock control that was found through most of this reach, only a partial assessment was conducted in accordance with ANR assessment protocols. Some erosion of the stream banks were noted in several locations, indicating the channel had undergone some localized widening in this reach. The reference stream type for this segment is a “B” channel dominated by bedrock. Due to the width and steep bank, the existing stream type appeared to be an “F” channel.

Segment T10-B

Protect River Corridor
Improve Riparian Buffer
Evaluate Localized Incision

Elmore Branch segment T10-B flows through a very broad valley that may have been partially flooded by historic mill dams in segment T10-A. These dams may have caused years of sediment build up (aggradation) to occur. It appears that the stream has eroded its channel (incised) and is possibly still cutting through this sediment buildup. The upper portion of the segment has been straightened historically, likely for agricultural purposes. The reference stream type for this segment is a “C4” channel that is a slightly entrenched, meandering, gravel dominated, riffle-pool channel with a well developed floodplain. Despite some areas of poor floodplain access, the stream was found to be a “C” channel through most of the reach. Continued minor adjustment within this reach will likely occur until the channel has reached an equilibrium slope, planform, dimension, and access to a seasonal floodplain.

7.3 Site Level Opportunities

Site specific projects were identified using the criteria outlined by the ANR in Chapter 6 – Preliminary Identification and Prioritization (Vermont Agency of Natural Resources 2007a). This planning guide is intended to aid in the development of projects that project and restore river equilibrium. The site level projects that were developed for the Elmore Branch are provided below in Table 8. The project strategy, technical feasibility, and priority for each project are listed by project number and reach.

Maps of the high priority sites are found in Appendix B. These high priority projects include river corridor protection projects to provide attenuation of sediment and floodwaters in targeted areas of the upper, mid and lower parts of the study area (T01-B, T04, and T10-B). Buffer restoration to provide bank stability, to improve water quality and to allow for other important riparian functions has been identified for five different sections of the Elmore Branch. Reach T04 is high priority for buffer plantings because this reach is not incised. Tree/shrub plantings in combination with bioengineering techniques could successfully be used in this reach to achieve bank stability. Passive buffer restoration by allowing the vegetation to come in on its own is recommended for sections (T01-A, T08, T09 and T10-B) where the Elmore Branch is currently undergoing widening and/or building new floodplain. Another option is to plant back away from the bank to allow the river to adjust and the trees space to grow.

Information from the Phase 2 stream geomorphic assessment and ANR bridge and culvert assessment could be used to inform the Town of Elmore of which stream crossings are contributing to localized instability. The bridge at Symonds Mill Road is undersized and has been identified as high priority for replacement.

7.4 Next Steps

There are many opportunities to restore the Elmore Branch to a stable condition. Addressing these issues can reduce flood hazards, avoid conflicts regarding land use, and save money spent on flood damage and river maintenance. The Town of Elmore can pursue the opportunity to work the Vermont River Management Program to develop fluvial erosion hazard zones for the land surrounding the Elmore Branch.

Table 8. Elmore Branch Site Level Opportunities for Restoration and Protection

Project # Segment	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 T01-A	Fair, FIII	Riparian banks influenced by hay field and residential development; historically straightened and armored	Improve stream buffer	Low priority	Prevent erosion and reduce water temperature	Cost of trees and shrubs	Hay to forested; yard to forested	CREP, ANR,USFWS, LCPC
#2 T01-B	Fair, FIV	Undergone historic degradation and is rebuilding floodplain at lower elevation, has healthy riparian corridor (100 feet both sides);	Protect River Corridor to provide attenuation area	High priority (important location in watershed, currently acting as sediment attenuation area, wetland offers some protection from development within corridor)	Flood and sediment attenuation asset	Cost of river corridor easement acquisition	Land use conversion may be minimal	ANR, land trust, VRC, LCPC
#3 T02 & T03	Bedrock controlled	These reaches are predominately forested and have stable, bedrock controlled channels	Conserve River Corridor	Low priority (forested but low priority due to stable, bedrock controlled channel	Recreation	Cost of river corridor easements	None	ANR, land trust, LCPC
#4 T04 (focus on lower end)	Good, DIIC	The lower end of the reach below the straightened section and above the bedrock controlled channels of T02 and T03 is providing some attenuation of sediment	Protect River Corridor	Moderate priority (very short section, a portion runs along Elmore Branch Road)	Flood and sediment attenuation asset	Cost of river corridor easements	Land use conversion may be minimal	ANR, land trust, VRC, LCPC
#5 T04	Good, DIIC	Reach M04 has moderate to high scour and erosion at the base of both banks; the lack of woody vegetation is likely contributing to this erosion	Improve riparian buffer and use bioengineering techniques as needed	High priority (reach is not incised)	Prevent erosion	Cost of trees and shrubs or allow buffer to grow in passively; cost of bioengineering design and implementation		LCPC, ANR

Table 8. Elmore Branch Site Level Opportunities for Restoration and Protection

Project # Segment	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
#6 T07-A	Bedrock controlled	Multiple ledge grade controls exist within this segment; there is a high quality buffer	Conserve River Corridor	Low priority in terms of geomorphic stability; provides aesthetics and recreation	Recreation	Cost of river corridor easements	None	ANR, land trust, LCPC
#7 T08	Fair, F- IV	Reach is becoming an attenuation asset by building a juvenile floodplain	Protect River Corridor	High priority, floodplain mostly old field and wetland with no structures	Flood and sediment attenuation	Cost of river corridor easements	No new structures in river corridor	ANR, land trust, LCPC
#8 T08	Fair, F- IV	Hay is the subdominant land use within the corridor	Improve riparian buffer (active plantings could occur back away from the channel or allow to revegetate passively)	Moderate priority	Prevent erosion and reduce water temperature	Minimal if allow to revegetate passively	Hay to forested	CREP, ANR,USFWS, LCPC
#9 T09	Fair, F-III	Bridge at Symonds Mill Road is 18 feet wide (49% bankfull width) and 9 feet high. Problems noted at this stream crossing during the Phase 2 Assessment included deposition above and below, scour above and below, and alignment	Replace undersized box culvert at Symonds Mill Road	High priority	Improve sediment transport, reduce debris jam potential	Likely to be a high cost to replace this structure	Depends upon the size of the structure and alignment	Town of Elmore, ANR
#10 T09	Fair, F-III	The dominant riparian buffer is less than 25 feet in width on the west side of the channel where there is a field that is hayed	Improve Riparian Buffer	Low priority (considering planting back away from the bank to allow stream to widen and rebuild floodplain)	Prevent erosion and reduce water temperature	Minimal if allow to revegetate passively	Hay to forested	CREP, ANR, USGWS, LCPC

Table 8. Elmore Branch Site Level Opportunities for Restoration and Protection

Project # Segment	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
#11 T10-B	Fair-FIII	The Elmore Branch flows through a very broad valley in this segment. The stream has eroded and is possibly cutting through aggradation caused by historic dams; upper portion has been straightened	Protect River Corridor	High priority (approximately 2/3 of the segment does not have lateral constraints such as roads and buildings)	Attenuation assets currently exist in areas that have started to meander; future attenuation assets	Cost of river corridor easements	No new structures in river corridor	ANR, land trust, LCPC., landowners
#12 T10-B	Fair-FIII	Dominant buffer width on west side is less than 25 feet	Improve Riparian Buffer	Low priority (consider planting back away from the bank to allow stream to widen and rebuild floodplain)	Prevent erosion and reduce water temperature	Minimal if allow to revegetate passively	Hay to forested	CREP, ANR, LCPC, landowners
#13 T10-B	Fair-FIII	Possible localized headcut identified during Phase 2 assessment	Evaluate localized headcut	Moderate	Prevent incision	Cost of evaluation, design and implementation for arresting headcut, if needed	None anticipated	ANR, LCPC, landowners

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Appendix A
Phase 2 Stream Geomorphic Assessment Data
Elmore Branch

Project: **Elmore Branch**

Phase 2 Segment Summary

May 12, 2008 SGAT Version: 3

Stream: **Elmore Branch** Reach # **T01** Segment: **A** Completion Date: **June 16, 2006**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon & Mike Blazewicz** Why Not assessed: Rain: **Yes**

Segment Length (ft): **825** Segment Location: **From confluence with Lamoille River to about 825 feet upstream.**

QC Status - Staff: Provisional Consultant: 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	207	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	360	169

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

1.5 Valley Features

Valley Width (ft) **500**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **yes**

Step 2. Stream Channel

2.1 Bankfull Width **41**

2.2 Max Depth (ft) **3.20**

2.3 Mean Depth (ft) **2.20**

2.4 Floodprone Width (ft) **61**

Notes:

Poor floodplain access. No Erosion indicated in DMS due to the SGAT stream line not extending the full length of the reach to the confluence with the Lamoille, so therefore unable to be mapped by the FIT. Erosion is

Step 2. (Contued)

2.5 Aband. Floodpln **6.50** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **18.41**

2.7 Entrenchment Ratio **1.51**

2.8 Incision Ratio **2.03**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Not Applicable**

2.11 Riffle/Step Spacing (ft) **N/A**

2.12 Substrate Composition

Bedrock	0 %
Boulder	5 %
Cobble	33 %
Coarse Gravel	36 %
Fine Gravel	13 %
Sand	13 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **1** %

Large Woody **1**

2.13 Average Largest Particle on

Bed	16.0	inches
Bar	0.5	inches

2.14 Stream Type

Stream Type: **B**

Bed Material: **Gravel**

Subclass Slope: **c**

Bed Form: **Plane Bed**

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	Gravel	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	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	110	104

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

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	0-25	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	Residential
Sub-dominant	Residential	Shrubs/Saplin
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 **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

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	1	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: **429**

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: **Elmore Branch** Reach # **T01** Segment: **A** Completion Date: **June 16, 2006**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon & Mike Blazewicz** Rain: **Yes**

Segment Length (ft): **825** Segment Location: **From confluence with Lamoille River to about 825 feet upstream.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Downstream	3.00	1.00		
Ledge	Mid-Segment	3.00	2.00		
Ledge	Upstream	0.00	0.00		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	29.5	Yes	No	Yes	Yes
Problem: Scour Below					
Bedrock	25.0	Yes	No	Yes	Yes
Problem: Scour Below,Alignment					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**4**	**C to B**	**Yes**
7.2 Channel Aggradation	**12**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**15**		**No**
Total Score	**45**		
Geomorphic Rating	**0.5625**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	6
6.2 Embeddedness	13
6.3 Velocity/Depth Patterns	8
6.4 Sediment Deposition	13
6.5 Channel Flow Status	11
6.6 Channel Alteration	6
6.7 Frequency of Riffles/Steps	13
6.8 Bank Stability	Left: 7 Right: 9
6.9 Bank Vegetation Protection	Left: 7 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 2 Right: 2
Total Score	104
Habitat Rating	0.52
Habitat Stream Condition	**Fair**

Narrative:

Historic degradation (associated with incison of Lamoille and/or channel straightening), current only minor widening due to rip-rap. Segment has been straightened.

Project: **Elmore Branch**

Phase 2 Segment Summary

May 12, 2008 SGAT Version: 3

Stream: **Elmore Branch** Reach # **T01** Segment: **B** Completion Date: **June 16, 2006**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon & Mike Blazewicz** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,277** Segment Location: **From segment break (825 feet upstream of confluence with the Lamoille River) to 1277 more**

QC Status - Staff: Passed **Consultant:** 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	54	0

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

1.5 Valley Features

Valley Width (ft) **500**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **62**

2.2 Max Depth (ft) **2.80**

2.3 Mean Depth (ft) **1.61**

2.4 Floodprone Width (ft) **301**

Notes:

juvenile floodplain

Step 2. (Contued)

2.5 Aband. Floodpln **5.30** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **38.51**

2.7 Entrenchment Ratio **4.85**

2.8 Incision Ratio **1.89**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **400**

2.12 Substrate Composition

Bedrock	2 %
Boulder	5 %
Cobble	43 %
Coarse Gravel	38 %
Fine Gravel	5 %
Sand	6 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **2** %

Large Woody **2**

2.13 Average Largest Particle on

Bed **18.0** inches

Bar **10.0** inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Cobble**

Subclass Slope: **None**

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	Sand
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	311	75
Erosion Height (ft)	3.00	5.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

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

Bank Canopy	Left	Right
Canopy %	26-50	1-25

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	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
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 **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

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
1	0	4
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.
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: **Elmore Branch** Reach # **T01** Segment: **B** Completion Date: **June 16, 2006**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon & Mike Blazewicz** Rain: **Yes**

Segment Length (ft): **1,277** Segment Location: **From segment break (825 feet upstream of confluence with the Lamoille River) to 1277 more**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Upstream	10.00	6.00		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	30.0	Yes	No	Yes	Yes

Problem Deposition Above,Deposition Below,Scour

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**9**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**9**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**45**		
Geomorphic Rating	**0.5625**		

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	8
6.2 Embeddedness	13
6.3 Velocity/Depth Patterns	10
6.4 Sediment Deposition	9
6.5 Channel Flow Status	8
6.6 Channel Alteration	18
6.7 Frequency of Riffles/Steps	14
6.8 Bank Stability	Left: 6 Right: 9
6.9 Bank Vegetation Protection	Left: 6 Right: 8
6.10 Riparian Vegetation Zone Width	Left: 9 Right: 9
Total Score	127
Habitat Rating	0.635
Habitat Stream Condition	**Fair**

Narrative:

Historic incision w/major widening. rebuilt juvenile floodplain. Bedrock grade control upstream and downstream. No structures in jeopardy, floodplain mostly forest.

Project: Elmore Branch

Phase 2 Segment Summary

May 12, 2008 SGAT Version: 3

Stream: Elmore Branch | Reach # T02 | Segment: 0 | Completion Date: **November 10, 2006**

Organization: **Bear Creek Environmental** | Observers: **Mary Nealon, Michael Blazewicz** | Why Not assessed: **bedrock gorge** | Rain: **No**

Segment Length (ft): **1,387** | Segment Location: **This segment continues until approximately 600 feet upstream of where Gates Farm Road**

QC Status - Staff: Provisional **Consultant:** 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	113	0

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

1.5 Valley Features

Valley Width (ft) **100**

Width Determination **Measured**

Confinement Type **Semi-confined**

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:

Over 75% of reach is a bedrock dominated gorge.

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

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

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: **F**

Bed Material: **Bedrock**

Subclass Slope: **None**

Bed Form: **Bedrock**

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	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	130	133
Erosion Height (ft)	4.00	5.87
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Bare	Bare

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

Mid-Channel Canopy **Closed**

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	Coniferous	Coniferous

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 **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

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 **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: **Elmore Branch** Reach # **T02** Segment: **0** Completion Date: **November 10,**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon, Michael Blazewicz** Rain: **No**

Segment Length (ft): **1,387** Segment Location: **This segment continues until approximately 600 feet upstream of where Gates Farm Road**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Downstream	8.00	6.00		
Waterfall	Upstream	8.00	6.00		
Ledge	Mid-Segment	0.00	0.00		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	20.0	Yes	Yes	Yes	Yes

Problem Deposition Above

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Reference**

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Project: Elmore Branch

Phase 2 Segment Summary

May 12, 2008 SGAT Version: 3

Stream: **Elmore Branch** Reach # **T03** Segment: **0** Completion Date: **June 16, 2006**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon, Mike Blazewicz** Why Not assessed: **bedrock gorge** Rain: **Yes**

Segment Length (ft): **1,193** Segment Location: **This segment continues about 1/4 mile upstream from the end of T02.**

QC Status - Staff: Provisional Consultant: 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	940	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	97	0

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

1.5 Valley Features

- Valley Width (ft) **50**
- 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:

Bedrock controlled channel .

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

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

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: **F**
- Bed Material: **Bedrock**
- Subclass Slope: **None**
- Bed Form: **Bedrock**
- 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	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	Coniferous	Coniferous
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	None
W less than 25	0	0

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

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 **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 **None**
- Impoundmt. Location
- 4.6 Up/Down strm flow reg
- (old) Upstrm Flow Reg **None**

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	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: **Elmore Branch** | **Phase 2 Segment Summary** | May 12, 2008

Stream: **Elmore Branch** | Reach # **T03** | Segment: **0** | Completion Date: **June 16, 2006**

Organization: **Bear Creek Environmental** | Observers: **Mary Nealon, Mike Blazewicz** | Rain: **Yes**

Segment Length (ft): **1,193** | Segment Location: **This segment continues about 1/4 mile upstream from the end of T02.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-Segment	0.00	0.00		
Ledge	Upstream	0.00	0.00		
Ledge	Downstream	0.00	0.00		
Ledge	Downstream	0.00	0.00		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	0.00	Yes	No	No	No

Problem None

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Reference**

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Confined bedrock controlled channel.

Project: Elmore Branch **Phase 2 Segment Summary** May 12, 2008 SGAT Version: 3

Stream: **Elmore Branch** Reach # **T04** Segment: **0** Completion Date: **November 3, 2006**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon, Mike Blazewicz** Why Not assessed: Rain: **No**

Segment Length (ft): **3,334** Segment Location: **Elmore Branch**

QC Status - Staff: Passed **Consultant: 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	3,167	159
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	178	35

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

1.5 Valley Features

Valley Width (ft) **385**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **yes**

Step 2. Stream Channel

2.1 Bankfull Width **36**

2.2 Max Depth (ft) **4.70**

2.3 Mean Depth (ft) **3.42**

2.4 Floodprone Width (ft) **280**

Notes:

Step 2. (Contued)

2.5 Aband. Floodpln **4.70** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **10.53**

2.7 Entrenchment Ratio **7.78**

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) **300**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	26 %
Coarse Gravel	54 %
Fine Gravel	12 %
Sand	8 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **1** %

Large Woody **8**

2.13 Average Largest Particle on

Bed	8.0	inches
Bar	4.0	inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

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	Clay	Clay
Consistency	Cohesive	Cohesive
Lower		
Material Type	Clay	Clay
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	1,287	1,135
Erosion Height (ft)	4.00	3.93
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	284	555

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

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

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

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

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
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 **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

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	5	3
Diagonal	**Delta**	**Island**
0	0	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.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **2,982**

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: **Elmore Branch** Reach # **T04** Segment: **0** Completion Date: **November 3, 2006**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon, Mike Blazewicz** Rain: **No**

Segment Length (ft): **3,334** Segment Location: **Elmore Branch**

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?
Bridge	26.0	Yes	Yes	Yes	Yes

Problem Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**10**		**No**
Total Score	**54**		
Geomorphic Rating	**0.675**		

Channel Evolution Model **D**

Channel Evolution Stage **IIc**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	10
6.2 Embeddedness	15
6.3 Velocity/Depth Patterns	14
6.4 Sediment Deposition	13
6.5 Channel Flow Status	15
6.6 Channel Alteration	4
6.7 Frequency of Riffles/Steps	14
6.8 Bank Stability	Left: 5 Right: 5
6.9 Bank Vegetation Protection	Left: 4 Right: 4
6.10 Riparian Vegetation Zone Width	Left: 3 Right: 2
Total Score	108
Habitat Rating	0.54
Habitat Stream Condition	**Fair**

Narrative:

Minor widening and major planform associated with channel straightening. No evidence of incision. Grade controls upstream and downstream of reach.

Project: **Elmore Branch** | **Phase 2 Segment Summary** | May 12, 2008 SGAT Version: 3

Stream: **Elmore Branch** | Reach # **T05** | Segment: **0** | Completion Date: **November 3, 2006**

Organization: **Bear Creek Environmental** | Observers: **Mary Nealon, Mike Blazewicz** | Why Not assessed: | Rain: **No**

Segment Length (ft): **999** | Segment Location: **Elmore Branch.**

QC Status - Staff: **Provisional** Consultant: **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	985	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	63	0

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

1.5 Valley Features

Valley Width (ft) **210**

Width Determination **Measured**

Confinement Type **Narrow**

Rock Gorge? **No**

Human-caused Change? **yes**

Step 2. Stream Channel

2.1 Bankfull Width **32**

2.2 Max Depth (ft) **4.50**

2.3 Mean Depth (ft) **3.05**

2.4 Floodprone Width (ft) **102**

Notes:

Historic straightening. Widening limited due to rip-rap. Rip-rap in channel. Loss of riffle-pool bedform.

Step 2. (Contued)

2.5 Aband. Floodpln **4.50** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **10.49**

2.7 Entrenchment Ratio **3.17**

2.8 Incision Ratio **1.00**

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	35 %
Cobble	38 %
Coarse Gravel	18 %
Fine Gravel	7 %
Sand	2 %
Silt and smaller	0 %

Silt/Clay Present? **No**

Detritus **1** %

Large Woody **2**

2.13 Average Largest Particle on

Bed	24.0	inches
Bar	N/A	inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Cobble**

Subclass Slope: **b**

Bed Form: **Plane Bed**

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	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	170	0
Erosion Height (ft)	3.00	0.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	246	384

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

Bank Canopy	Left	Right
Canopy %	1-25	26-50

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

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

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	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 **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

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
1	0	0
Diagonal	**Delta**	**Island**
0	0	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.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **987**

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: **Elmore Branch** Reach # **T05** Segment: **0** Completion Date: **November 3, 2006**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon, Mike Blazewicz** Rain: **No**

Segment Length (ft): **999** Segment Location: **Elmore Branch.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Downstream	15.00	12.00		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	30.0	Yes	Yes	No	Yes

Problem None

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**15**	**None**	**No**
7.2 Channel Aggradation	**14**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**55**		
Geomorphic Rating	**0.6875**		

Channel Evolution Model **D**

Channel Evolution Stage **IIc**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	12
6.2 Embeddedness	16
6.3 Velocity/Depth Patterns	7
6.4 Sediment Deposition	16
6.5 Channel Flow Status	17
6.6 Channel Alteration	2
6.7 Frequency of Riffles/Steps	7
6.8 Bank Stability	Left: 7 Right: 7
6.9 Bank Vegetation Protection	Left: 4 Right: 4
6.10 Riparian Vegetation Zone Width	Left: 5 Right: 2
Total Score	106
Habitat Rating	0.53
Habitat Stream Condition	**Fair**

Narrative:

Minor widening, riprap limiting adjustment, channelization created change in bedform. Score of 13, reflecting minor widening, was due to evidence of riprap in the channel.

Project: **Elmore Branch** — **Phase 2 Segment Summary** — May 12, 2008 — SGAT Version: 3

Stream: **Elmore Branch** — Reach # **T06** — Segment: **0** — Completion Date: **June 15, 2006**

Organization: **Bear Creek Environmental** — Observers: **Mike Blazewicz & Stacey** — Why Not assessed: — Rain: **Yes**

Segment Length (ft): **645** — Segment Location: **This segment continues 645 feet upstream from the end of T05.**

QC Status - Staff: Passed **Consultant:** 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	396	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	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Not Evalua

1.5 Valley Features

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

Step 2. Stream Channel

2.1 Bankfull Width	46
2.2 Max Depth (ft)	3.50
2.3 Mean Depth (ft)	2.46
2.4 Floodprone Width (ft)	64

Notes:

Channel is an F3 in places. Overall stable transport reach.

Step 2. (Contued)

2.5 Aband. Floodpln	3.50 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	18.50
2.7 Entrenchment Ratio	1.40
2.8 Incision Ratio	1.00
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Not Applicable
2.11 Riffle/Step Spacing (ft)	N/A

2.12 Substrate Composition

Bedrock	14 %
Boulder	21 %
Cobble	26 %
Coarse Gravel	20 %
Fine Gravel	12 %
Sand	7 %
Silt and smaller	0 %

Silt/Clay Present?	Yes
Detritus	3 %
# Large Woody	10

2.13 Average Largest Particle on

Bed	30.0	inches
Bar	16.0	inches

2.14 Stream Type

Stream Type:	B
Bed Material:	Cobble
Subclass Slope:	c
Bed Form:	Plane Bed

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	Bedrock	Sand
Consistency	Cohesive	Non-cohesive
Lower		
Material Type	Bedrock	Boulder/Cobbl
Consistency	Cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	105
Erosion Height (ft)	0.00	6.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

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

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	0

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

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	None
Impoundmt. Location	
4.6 Up/Down strm flow reg	
(old) Upstrm Flow Reg	None

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
1	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	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: **Elmore Branch** Reach # **T06** Segment: **0** Completion Date: **June 15, 2006**

Organization: **Bear Creek Environmental** Observers: **Mike Blazewicz & Stacey Ambler** Rain: **Yes**

Segment Length (ft): **645** Segment Location: **This segment continues 645 feet upstream from the end of T05.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Downstream	0.00	0.00		

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Plane Bed**

	Score	STD	Historic
7.1 Channel Degradation	**17**	**None**	**No**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**16**		**No**
Total Score	**60**		
Geomorphic Rating	**0.75**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	14
6.2 Embeddedness	11
6.3 Velocity/Depth Patterns	12
6.4 Sediment Deposition	13
6.5 Channel Flow Status	10
6.6 Channel Alteration	18
6.7 Frequency of Riffles/Steps	18
6.8 Bank Stability	Left: 10 Right: 7
6.9 Bank Vegetation Protection	Left: 9 Right: 9
6.10 Riparian Vegetation Zone Width	Left: 10 Right: 7
Total Score	148
Habitat Rating	0.74
Habitat Stream Condition	**Good**

Narrative:

Minor widening & aggradation (sediment likely from upstream bank erosion).Bedrock in channel upstream and mid-segment and some on left bank.

Project: Elmore Branch

Phase 2 Segment Summary

May 12, 2008 SGAT Version: 3

Stream: **Elmore Branch** Reach # **T07** Segment: **A** Completion Date: **June 15, 2006**

Organization: **Bear Creek Environmental** Observers: **Mike Blazewicz & Stacey** Why Not assessed: **bedrock gorge** Rain: **Yes**

Segment Length (ft): **1,031** Segment Location: **This segment continues 1031 feet upstream from the end of T06 until just upstream of**

QC Status - Staff: **Provisional** **Consultant:** **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/	Always	Always
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features

Valley Width (ft) **45**

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:

Bedrock gorge.

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

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

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: **F**

Bed Material: **Bedrock**

Subclass Slope: **None**

Bed Form: **Bedrock**

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	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	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous

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	None
W less than 25	0	0

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 **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 **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

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	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: **Elmore Branch** | **Phase 2 Segment Summary** | | May 12, 2008

Stream: **Elmore Branch** | Reach # **T07** | Segment: **A** | Completion Date: **June 15, 2006**

Organization: **Bear Creek Environmental** | Observers: **Mike Blazewicz & Stacey Ambler** | Rain: **Yes**

Segment Length (ft): **1,031** | Segment Location: **This segment continues 1031 feet upstream from the end of T06 until just upstream of**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Mid-Segment	5.00	5.00		
Ledge	Downstream	0.00	0.00		
Ledge	Upstream	0.00	0.00		
Ledge	Mid-Segment	0.00	0.00		

4.8 Channel Constrictions **None**

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 **Reference**

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

bedrock controlled channel

Project: **Elmore Branch** | **Phase 2 Segment Summary** | page 1 of 2 | May 12, 2008 | SGAT Version: 3

Stream: **Elmore Branch** | Reach # **T07** | Segment: **B** | Completion Date: **June 15, 2006**

Organization: **Bear Creek Environmental** | Observers: **Mike Blazewicz & Stacey** | Why Not assessed: | Rain: **Yes**

Segment Length (ft): **422** | Segment Location: **This segment begins just upstream from bedrock grade control in T07-A, and continues 422**

QC Status - Staff: Provisional Consultant: 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	Steep	Steep
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Always	Never
Texture	Sand	Not Evalua

1.5 Valley Features

- Valley Width (ft) **147**
- Width Determination **Estimated**
- Confinement Type **Semi-confined**
- Rock Gorge? **No**

Human-caused Change? **no**

Step 2. Stream Channel

- 2.1 Bankfull Width **37**
- 2.2 Max Depth (ft) **2.50**
- 2.3 Mean Depth (ft) **1.89**
- 2.4 Floodprone Width (ft) **70**

Notes:

Incised channel has become a B4 stream. Likely C by reference.

Step 2. (Contued)

- 2.5 Aband. Floodpln **6.00** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **19.58**
- 2.7 Entrenchment Ratio **1.89**
- 2.8 Incision Ratio **2.40**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Moderate**
- 2.10 Riffles Type **Complete**
- 2.11 Riffle/Step Spacing (ft) **200**

2.12 Substrate Composition

Bedrock	3 %
Boulder	12 %
Cobble	29 %
Coarse Gravel	35 %
Fine Gravel	14 %
Sand	7 %
Silt and smaller	0 %

- Silt/Clay Present? **Yes**
- Detritus **3** %
- # Large Woody **5**

2.13 Average Largest Particle on

- Bed **30.0** inches
- Bar **4.0** inches

2.14 Stream Type

- Stream Type: **B**
- Bed Material: **Gravel**
- Subclass Slope: **c**
- Bed Form: **Riffle-Pool**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

C 4 Non Riffle-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	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	253	82
Erosion Height (ft)	3.31	4.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

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

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	None	26-50
W less than 25	0	0

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

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	Shrubs/Saplin
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 **None**
- Impoundmt. Location
- 4.6 Up/Down strm flow reg
- (old) Upstrm Flow Reg **None**

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	1	2
Diagonal	**Delta**	**Island**
0	1	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.
1	0	Yes

- 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: **Elmore Branch** Reach # **T07** Segment: **B** Completion Date: **June 15, 2006**

Organization: **Bear Creek Environmental** Observers: **Mike Blazewicz & Stacey Ambler** Rain: **Yes**

Segment Length (ft): **422** Segment Location: **This segment begins just upstream from bedrock grade control in T07-A, and continues 422**

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	**4**	**C to B**	**Yes**
7.2 Channel Aggradation	**12**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**43**		
Geomorphic Rating	**0.5375**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	15
6.2 Embeddedness	12
6.3 Velocity/Depth Patterns	18
6.4 Sediment Deposition	11
6.5 Channel Flow Status	10
6.6 Channel Alteration	18
6.7 Frequency of Riffles/Steps	18
6.8 Bank Stability	Left: 1 Right: 7
6.9 Bank Vegetation Protection	Left: 7 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 7 Right: 9
Total Score	140
Habitat Rating	0.7
Habitat Stream Condition	**Good**

Narrative:

Historic incision, minor aggradation, widening, and planform adjustment. Grade control at start of downstream segment. River may be cutting back through historic aggradational deposit and therefore incised?

Project: Elmore Branch

Phase 2 Segment Summary

May 12, 2008 SGAT Version: 3

Stream: Elmore Branch | Reach # T08 | Segment: 0 | Completion Date: June 8, 2006

Organization: Bear Creek Environmental | Observers: Mary Nealon & Mike Blazewicz | Why Not assessed: | Rain: Yes

Segment Length (ft): 1,911 | Segment Location: Segment begins just downstream from sharp bend in stream at end of T08 and continues to

QC Status - Staff: Passed | Consultant: 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	433	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	Hilly	Extremely
Continuous w/	Never	Never
W/in 1 Bankfill	Sometimes	Never
Texture	Sand	Not Evalua

1.5 Valley Features

Valley Width (ft) **508**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **39**

2.2 Max Depth (ft) **3.80**

2.3 Mean Depth (ft) **2.10**

2.4 Floodprone Width (ft) **270**

Notes:

seems to be narrowing

Step 2. (Contued)

2.5 Aband. Floodpln **6.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **18.33**

2.7 Entrenchment Ratio **7.01**

2.8 Incision Ratio **1.58**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **300**

2.12 Substrate Composition

Bedrock	0 %
Boulder	5 %
Cobble	31 %
Coarse Gravel	33 %
Fine Gravel	17 %
Sand	14 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **5** %

Large Woody **8**

2.13 Average Largest Particle on

Bed	12.0	inches
Bar	8.0	inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	Multiple	45.00
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	Sand	Sand
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	362	308
Erosion Height (ft)	3.86	3.83
Revetmt. Type	None	Rip-Rap
Revetmt. Length (ft)	0	74

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

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	0-25	26-50
W less than 25	0	0

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

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Hay	Hay
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 **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

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	4
Diagonal	Delta	Island
0	1	0

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.
1	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **169**

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:	Elmore Branch		**Phase 2 Segment Summary**		May 12, 2008
Stream:	**Elmore Branch**	Reach #	**T08**	Segment: **0**	Completion Date: **June 8, 2006**
Organization:	**Bear Creek Environmental**	Observers:	**Mary Nealon & Mike Blazewicz**		Rain: **Yes**
Segment Length (ft):	**1,911**	Segment Location:	**Segment begins just downstream from sharp bend in stream at end of T08 and continues to**		

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Upstream	0.00	0.00		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	40.0	Yes	No	Yes	No

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	**10**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**12**		**No**
Total Score	**43**		
Geomorphic Rating	**0.5375**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	14
6.2 Embeddedness	12
6.3 Velocity/Depth Patterns	18
6.4 Sediment Deposition	12
6.5 Channel Flow Status	9
6.6 Channel Alteration	15
6.7 Frequency of Riffles/Steps	14
6.8 Bank Stability	Left: 7 Right: 7
6.9 Bank Vegetation Protection	Left: 7 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 5
Total Score	135
Habitat Rating	0.675
Habitat Stream Condition	**Good**

Narrative:

historic degradation, major aggradation. Floodplain is mostly old field and wetland with no structures. Juvenile floodplain along much of reach; building bars and narrowing

Project: Elmore Branch

Phase 2 Segment Summary

May 12, 2008 SGAT Version: 3

Stream: Elmore Branch | Reach # T09 | Segment: 0 | Completion Date: June 8, 2006

Organization: Bear Creek Environmental | Observers: Mary Nealon & Mike Blazewicz | Why Not assessed: | Rain: Yes

Segment Length (ft): 450 | Segment Location: Segment begins at the confluence of the Elmore Branch and unnamed tributary T09.01.

QC Status - Staff: Passed **Consultant:** 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	443	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	Steep	Extremely
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Bedrock

1.5 Valley Features

Valley Width (ft) **580**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **yes**

Step 2. Stream Channel

2.1 Bankfull Width **37**

2.2 Max Depth (ft) **4.10**

2.3 Mean Depth (ft) **2.53**

2.4 Floodprone Width (ft) **97**

Notes:

Trib T09.1 rejuvenating! Major adjustments.

Step 2. (Contued)

2.5 Aband. Floodpln **8.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **14.43**

2.7 Entrenchment Ratio **2.64**

2.8 Incision Ratio **1.95**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **350**

2.12 Substrate Composition

Bedrock	0%
Boulder	3%
Cobble	34%
Coarse Gravel	44%
Fine Gravel	10%
Sand	9%
Silt and smaller	0%

Silt/Clay Present? **Yes**

Detritus **3** %

\# Large Woody **0**

2.13 Average Largest Particle on

Bed **12.0** inches

Bar **N/A** inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

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	Sand
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	181	0
Erosion Height (ft)	5.00	0.00
Revetmt. Type	None	Rip-Rap
Revetmt. Length (ft)	0	94

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

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

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

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

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	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 **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

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	Yes

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **344**

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: **Elmore Branch** Reach # **T09** Segment: **0** Completion Date: **June 8, 2006**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon & Mike Blazewicz** Rain: **Yes**

Segment Length (ft): **450** Segment Location: **Segment begins at the confluence of the Elmore Branch and unnamed tributary T09.01.**

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?
Culvert	18.0	Yes	No	Yes	Yes

Problem Deposition Above,Deposition Below,Scour

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**6**	**None**	**Yes**
7.2 Channel Aggradation	**17**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**51**		
Geomorphic Rating	**0.6375**		

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	12
6.2 Embeddedness	11
6.3 Velocity/Depth Patterns	18
6.4 Sediment Deposition	14
6.5 Channel Flow Status	18
6.6 Channel Alteration	2
6.7 Frequency of Riffles/Steps	13
6.8 Bank Stability	Left: 5 Right: 9
6.9 Bank Vegetation Protection	Left: 8 Right: 6
6.10 Riparian Vegetation Zone Width	Left: 2 Right: 2
Total Score	120
Habitat Rating	0.6
Habitat Stream Condition	**Fair**

Narrative:

historic degradation, current minor widening and planform adjustment. Floodplain is mostly old field and alder lined banks. Road on right bank.

Phase 2 Segment Summary

May 12, 2008 SGAT Version: 3

Project: **Elmore Branch**
Stream: **Elmore Branch** Reach # **T10** Segment: **A** Completion Date: **November 10, 2006**
Organization: **Bear Creek Environmental** Observers: **Mary Nealon, Michael Blazewicz** Why Not assessed: **bedrock gorge** Rain: **No**
Segment Length (ft): **1,074** Segment Location: **This reach begins just upstream of Symonds Mill Road bridge and ends were valley widens**

QC Status - Staff: **Provisional** Consultant: **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	1,073	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	945	0

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

1.5 Valley Features

Valley Width (ft) **100**
Width Determination **Measured**
Confinement Type **Semi-confined**
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:

Most of segment is bedrock dominated gorge. Two historic mill dam sites were found in reach. The reference stream type for this segment is a B channel dominated by bedrock. There is some erosion of soil banks

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

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

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: **F**
Bed Material: **Cobble**
Subclass Slope: **None**
Bed Form: **Bedrock**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)
B **3** **Non Bedrock**

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)	82	271
Erosion Height (ft)	6.00	5.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	53	173

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Bare	Bare

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	51-100	0-25
W less than 25	0	0

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

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

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	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: **Elmore Branch** Reach # **T10** Segment: **A** Completion Date: **November 10,**

Organization: **Bear Creek Environmental** Observers: **Mary Nealon, Michael Blazewicz** Rain: **No**

Segment Length (ft): **1,074** Segment Location: **This reach begins just upstream of Symonds Mill Road bridge and ends were valley widens**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-Segment	0.00	0.00		
Ledge	Mid-Segment	0.00	0.00		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	23.0	Yes	Yes	Yes	Yes
Problem: Deposition Above,Scour Below					
Old	20.0	Yes	Yes	Yes	Yes
Problem: Deposition Above,Scour Above,Scour					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Phase 2 Segment Summary

May 12, 2008 SGAT Version: 3

Project: **Elmore Branch**
Stream: **Elmore Branch** Reach # **T10** Segment: **B** Completion Date: **November 10, 2006**
Organization: **Bear Creek Environmental** Observers: **Mary Nealon, Michael Blazewicz** Why Not assessed: Rain: **No**
Segment Length (ft): **1,600** Segment Location: **Elmore Branch above Symonds Mill Road Bridge.**

QC Status - Staff: Provisional Consultant: Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Planform and Scope**
1.2 Alluvial Fan **None**
1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	563	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	305	0

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

1.5 Valley Features
Valley Width (ft) **545**
Width Determination **Measured**
Confinement Type **Very Broad**
Rock Gorge? **No**
Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **35**
2.2 Max Depth (ft) **3.50**
2.3 Mean Depth (ft) **2.60**
2.4 Floodprone Width (ft) **409**

Notes:

Upper section of segment straightened. There may have been years of aggradation in lower portion of segment due to mill dams, the stream is now incised (and possibly still incising) through this sediment.

Step 2. (Contued)

2.5 Aband. Floodpln **5.70** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **13.46**
2.7 Entrenchment Ratio **11.69**
2.8 Incision Ratio **1.63**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Low**
2.10 Riffles Type **Complete**
2.11 Riffle/Step Spacing (ft) **275**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	8 %
Coarse Gravel	48 %
Fine Gravel	24 %
Sand	20 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**
Detritus **5** %
\# Large Woody **12**

2.13 Average Largest Particle on
Bed **9.0** inches
Bar **4.0** inches

2.14 Stream Type
Stream Type: **C**
Bed Material: **Gravel**
Subclass Slope: **None**
Bed Form: **Riffle-Pool**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	30.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

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

Bank Erosion	Left	Right
Erosion Length (ft)	646	505
Erosion Height (ft)	5.00	5.00
Revetmt. Type	None	Rip-Rap
Revetmt. Length (ft)	0	100

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

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

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

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

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	Shrubs/Saplin
Sub-dominant	Shrubs/Saplin	Hay
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 **Minimal**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **0**
4.5 Flow Regulation Type **None**
Flow Regulation Use
Impoundments **None**
Impoundmt. Location
4.6 Up/Down strm flow reg
(old) Upstrm Flow Reg **None**

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
4	1	1
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.
2	1	No

5.4 Stream Ford or Animal **No**
5.5 Straightening **Straightening**
Straightening Length: **333**
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:	Elmore Branch	Phase 2 Segment Summary	page 2 of 2		May 12, 2008
Stream:	Elmore Branch	Reach # T10	Segment: B	Completion Date:	November 10,
Organization:	Bear Creek Environmental	Observers: Mary Nealon, Michael Blazewicz		Rain:	No
Segment Length (ft):	1,600	Segment Location: Elmore Branch above Symonds Mill Road Bridge.			

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	**8**	**None**	**No**
7.2 Channel Aggradation	**12**	**None**	**Yes**
7.3 Widening Channel	**12**		**No**
7.4 Change in Planform	**12**		**No**
Total Score	**44**		
Geomorphic Rating	**0.55**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	10
6.2 Embeddedness	14
6.3 Velocity/Depth Patterns	16
6.4 Sediment Deposition	10
6.5 Channel Flow Status	11
6.6 Channel Alteration	11
6.7 Frequency of Riffles/Steps	15
6.8 Bank Stability	Left: 4 Right: 5
6.9 Bank Vegetation Protection	Left: 4 Right: 4
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 4
Total Score	116
Habitat Rating	0.58
Habitat Stream Condition	**Fair**

Narrative:

Historic aggradation may have been caused by mill dams downstream. Degredation is likely associated with the stream cutting back through these sediments. Current minor widening and minor planform adjustment. Also may continue to incise and aggrade

Stream Geometry Data

Elmore Branch

		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
T01	A	B	Gravel	Plane Bed	c	No	2.79	46.15	40.5	3.2	2.2	61.0	6.5	18.41	1.51	2.03	III	F	Fair	Fair	P	P
T01	B	C	Cobble	Riffle-Pool	None	No	1.80	46.15	62.0	2.8	1.61	301.0	5.3	38.51	4.85	1.89	IV	F	Fair	Fair	P	P
T02	0	F	Bedrock	Bedrock	None	No	1.51	45.55											Refere		P	F
T03	0	F	Bedrock	Bedrock	None	No	1.34	43.87											Refere		P	F
T04	0	C	Gravel	Riffle-Pool	None	No	0.45	43.68	36.0	4.7	3.42	280.0	4.7	10.53	7.78	1.00	IIc	D	Good	Fair	P	P
T05	0	C	Cobble	Plane Bed	b	No	2.30	42.83	32.0	4.5	3.05	101.5	4.5	10.49	3.17	1.00	IIc	D	Good	Fair	P	P
T06	0	B	Cobble	Plane Bed	c	No	1.09	42.37	45.5	3.5	2.46	63.5	3.5	18.50	1.40	1.00	I	F	Good	Good	P	P
T07	A	F	Bedrock	Bedrock	None	No	2.42	42.09											Refere		P	F
T07	B	B	Gravel	Riffle-Pool	c	Yes	5.92	42.09	37.0	2.5	1.89	70.0	6.0	19.58	1.89	2.40	III	F	Fair	Good	P	P
T08	0	C	Gravel	Riffle-Pool	None	No	0.31	40.65	38.5	3.8	2.1	270.0	6.0	18.33	7.01	1.58	IV	F	Fair	Good	P	P
T09	0	C	Gravel	Riffle-Pool	None	No	1.78	40.17	36.5	4.1	2.53	96.5	8.0	14.43	2.64	1.95	III	F	Fair	Fair	P	P
T10	A	F	Cobble	Bedrock	None	Yes	0.93	37.83											Fair		P	F
T10	B	C	Gravel	Riffle-Pool	None	No	0.63	37.83	35.0	3.5	2.6	409.0	5.7	13.46	11.69	1.63	III	F	Fair	Fair	P	P

Rapid Geomorphic Assessment

Elmore Branch

Reach	Seg-ment	Sub-Rch?	Degradation Score	Degradation STD	Degradation Historic	Aggradation Score	Aggradation STD	Aggradation Historic	Widening Score	Widening Historic	Planform Score	Planform Historic	Geo. Score	Geo. Condition	Evol. Stage	Confin-ement Type	Sens-itivity	QC Stf	QC Aut
T01	A	No	4	C to B	Yes	12	None	No	14	No	15	No	0.56	Fair	III	VB	High	P	P
T01	B	No	9	None	Yes	13	None	No	9	No	14	No	0.56	Fair	IV	VB	Very	P	P
T02	0	No											0.00	Reference		SC	Low	P	F
T03	0	No											0.00	Reference		NC	Low	P	F
T04	0	No	16	None	No	15	None	No	13	No	10	No	0.68	Good	IIc	BD	High	P	P
T05	0	No	15	None	No	14	None	No	13	No	13	No	0.69	Good	IIc	NW	High	P	P
T06	0	No	17	None	No	13	None	No	14	No	16	No	0.75	Good	I	SC	Moderat	P	P
T07	A	No											0.00	Reference		NC	Low	P	F
T07	B	Yes	4	C to B	Yes	12	None	No	13	No	14	No	0.54	Fair	III	SC	High	P	P
T08	0	No	8	None	Yes	10	None	No	13	No	12	No	0.54	Fair	IV	VB	Very	P	P
T09	0	No	6	None	Yes	17	None	No	14	No	14	No	0.64	Fair	III	VB	Very	P	P
T10	A	Yes											0.00	Fair		SC	Extreme	P	F
T10	B	No	8	None	No	12	None	Yes	12	No	12	No	0.55	Fair	III	VB	Very	P	P

Appendix B
Maps of High Priority Projects
Elmore Branch

0 250 500 1,000
Feet

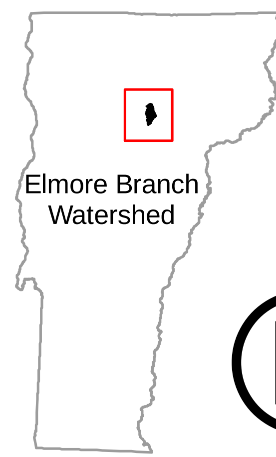
T01-B Elmore Branch Potential Project Location

Legend

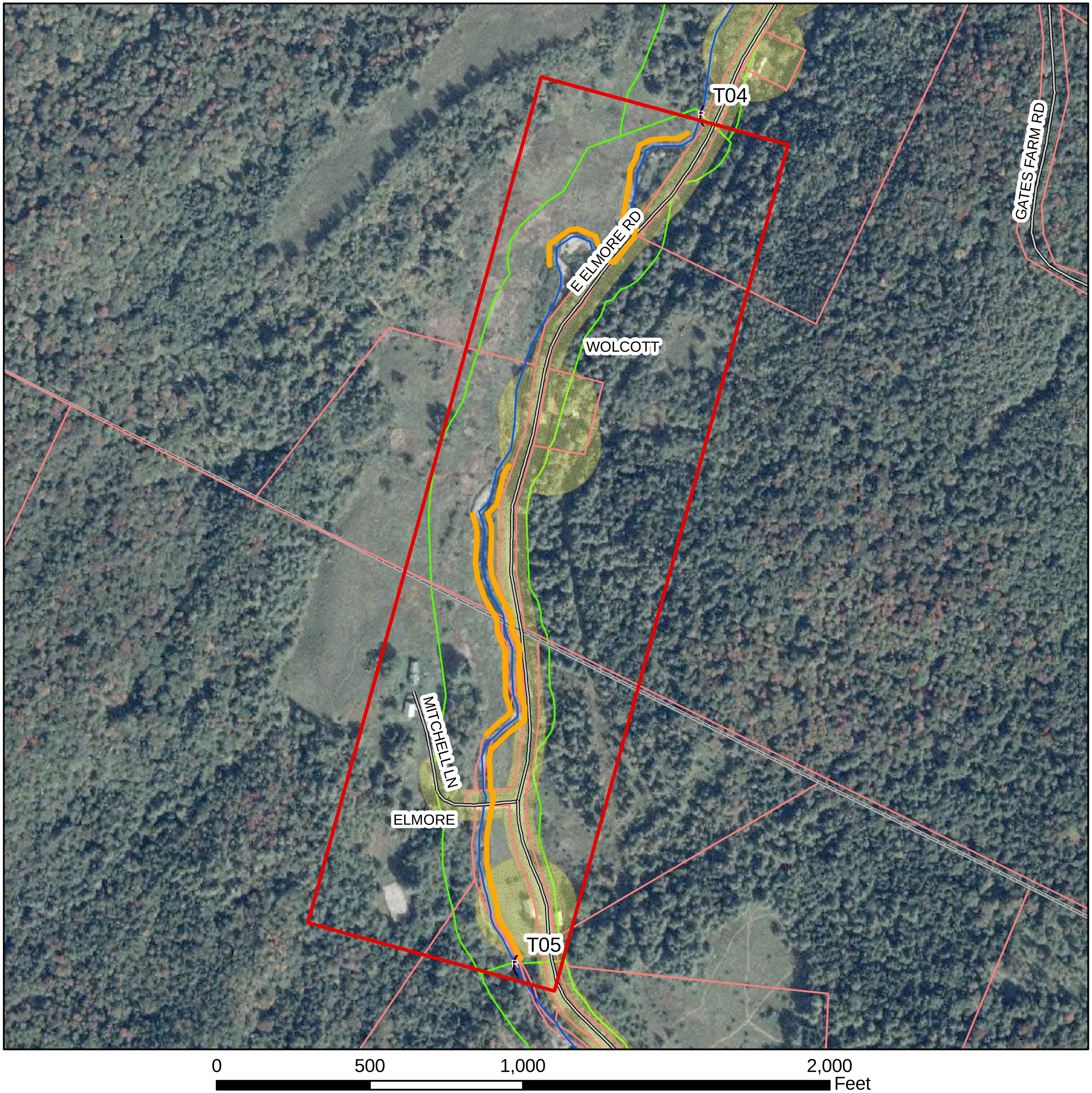
- Reach Break
- # Segment Break
- Road
- Elmore Branch
- Lateral Constraints
- Parcel Boundary
- River Corridor
- Potential Project Location

Project Description

Protect river corridor to provide attenuation area



T04
Elmore Branch Potential Project Location



Legend

- Reach Break
- # Segment Break
- Road
- Elmore Branch

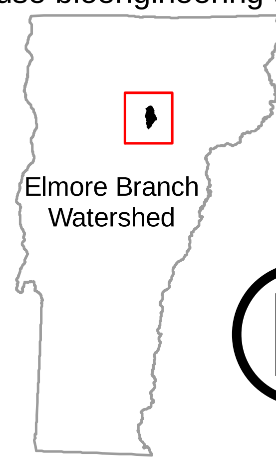
Buffers <25 feet

LOCATION

- Left Bank
- Right Bank
- Parcel Boundary
- Lateral Constraints
- Town Boundary
- River Corridor
- Potential Project Location

Project Descriptions

1) Improve riparian buffer & use bioengineering techniques



T09 Elmore Branch Potential Project Location

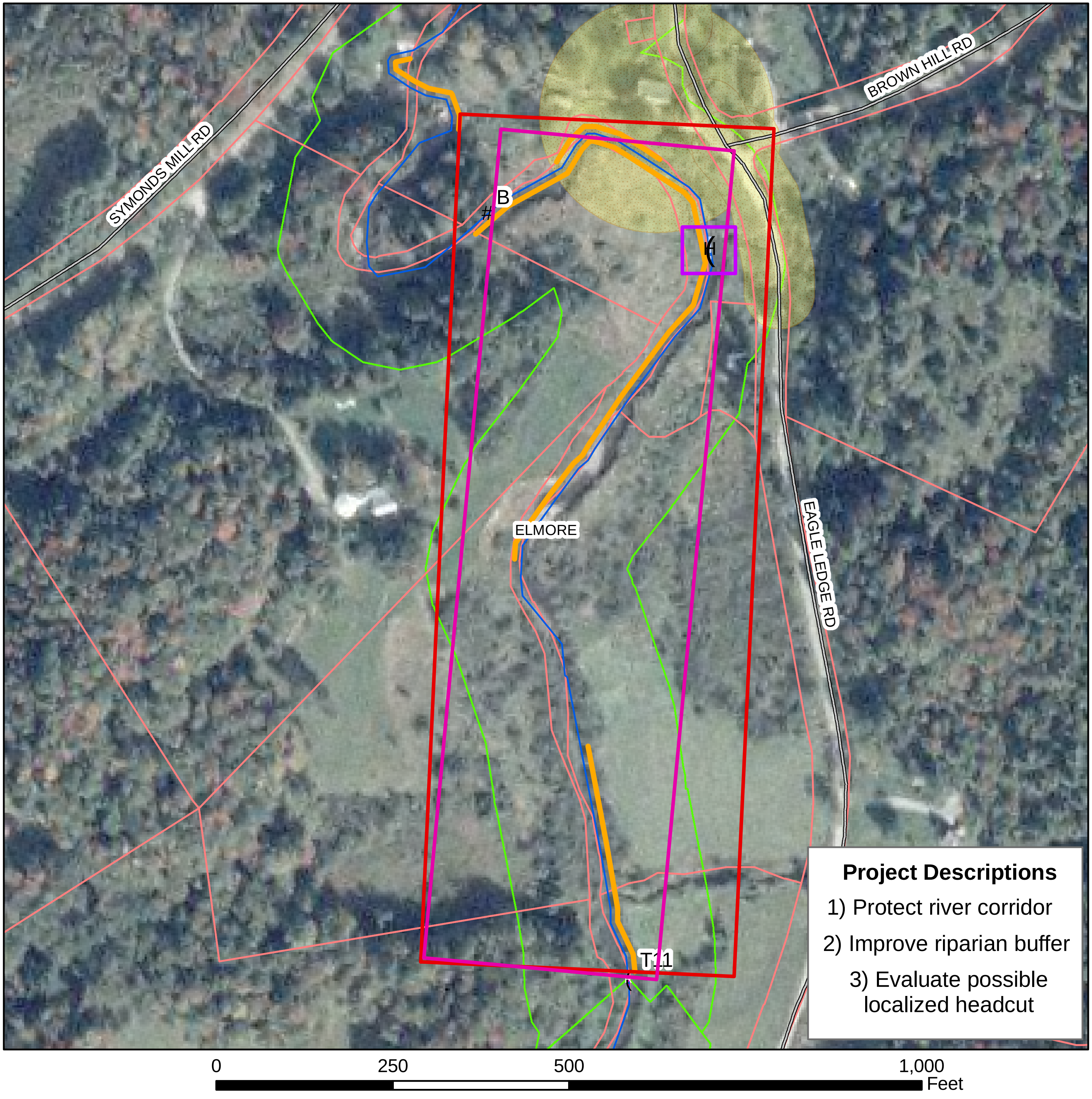
Legend

- Reach Break
- Segment Break
- Road
- Elmore Branch
- Parcel Boundary
- Lateral Constraints
- Town Boundary
- River Corridor
- Potential Project Location

Project Description

Replace undersized box culvert at Symonds Mill Road

T10-B
Elmore Branch Potential Project Location



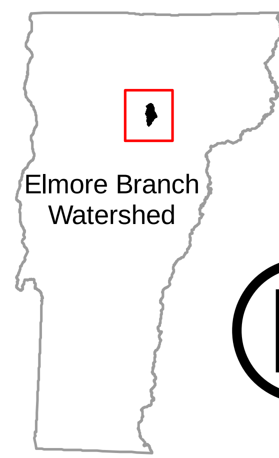
Legend

- Reach Break
- Segment Break
- Road
- Elmore Branch
- Headcut

Buffers <25 feet

LOCATION

- Left Bank
- Right Bank
- Parcel Boundary
- Lateral Constraints
- Town Boundary
- River Corridor
- Potential Project Location #1
- Potential Project Location #2
- Potential Project Location #3



Project Descriptions

1) Protect river corridor
2) Improve riparian buffer
3) Evaluate possible localized headcut