# Browns River Phase 2 Stream Geomorphic Assessment Summary
# Underhill, Jericho, and Westford Reaches

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## Executive Summary

The Browns River drains a 92 square mile watershed spanning 8 towns in Chittenden, Lamoille, and Franklin Counties. Tributary to the Lamoille River, the Browns River is one of the dominant landscape features in northern Chittenden County. The fertile floodplain soils along the river in Essex and Westford have been used for many generations for agriculture, and numerous town centers were historically developed alongside the river where cascades were once used for milling and hydropower. The river and its tributaries provide many recreational opportunities in the form of fishing and boating, natural beauty and aesthetics, and significant historical and cultural value.

Previous geomorphic assessment and river corridor planning efforts in the Browns River watershed have resulted in Phase 1 and 2 Stream Geomorphic Assessment (SGA) data and a river corridor plan for the watershed. In 2009 the Chittenden County Regional Planning Commission (CCRPC), in conjunction with the Vermont Department of Environmental Conservation (VTDEC), sought to collect additional Phase 2 data on 13 reaches in the Towns of Jericho, Underhill and Westford. The study is part of a broader CCRPC effort to work with the towns and identify areas where development pressures could conflict with erosion hazards over the long term. Fitzgerald Environmental Associates, LLC. (FEA) was retained by CCRPC to carry out Phase 2 assessments following the SGA Protocols developed by VTDEC (VTDEC, 2007). The following is a summary of Phase 2 SGA findings and the stressor and project identification effort:

- A total of 13 river reaches (15.8 river miles) were assessed using the VTDEC Phase 2 SGA Protocols. Due to the varied topographic terrain and valley setting, especially in the tributaries, the reaches were further subdivided into 29 segments for field data collection. Three (3) segments were not assessed due to lack of property access, 3 others were only partially assessed due to beaver activity, and 1 segment was not assessed fully because of a bedrock gorge setting.

- Browns River main stem reaches are found in varied settings across the study area. In the upper reaches in Jericho and Underhill, B and C-type channel morphologies (Rosgen, 1994) are found in confined and unconfined valley settings. Most segments in Jericho and Underhill received “Fair” scores for geomorphic stability and habitat conditions. One segment, M16-A, has been severely altered by corridor land use and channel manipulation and has “Poor” conditions. In Westford, the valley setting oscillates between confined and unconfined due to natural changes in topography along the river corridor. Generally, the river can be characterized by B and C-type channel morphologies with “Fair” to “Good” conditions. Human impacts to the channel and floodplain are most severe in three unconfined segments: M03-B, M05, and M06. In these areas, adjacent agricultural land use in combination with channel straightening and armoring has resulted in incised, simplified channel morphologies with degraded aquatic habitat and reduced floodplain function.

- The tributary reaches in Jericho and Underhill were found to have E, C, and B-type channel morphologies. Geomorphic stability and habitat conditions were “Fair” to “Good”, and channel

incision was limited to areas directly impacted by channel straightening and/or armoring. The tributary reaches along Morgan and Rogers Brooks, in Westford, are dominated by E-type channel morphology. The assessed segments in Westford were found to be in “Fair” to “Good” condition, with only one segment receiving an administrative judgment score of “Poor” (Morgan Brook Segment T1.02-E).

- A total of 20 structures were assessed using the VTDEC methods during the Phase 2 field effort, including 9 culverts and 11 bridges. The results of a structure analysis indicate that only 15 percent of the assessed bridges and culverts are adequately sized to accommodate stream equilibrium conditions (i.e., bankfull channel width). None of the 9 assessed culverts have widths equal to or greater than bankfull channel width. The VTDEC Geomorphic Compatibility and Aquatic Organism Passage Screening Tools were used to prioritize structures for replacement or retrofit. Three (3) culverts have been identified as high priority to address compatibility problems with channel stability and aquatic organism passage.

- Site level approaches to restoration of dynamic equilibrium conditions were evaluated in detail at the reach scale using a step-wise procedure developed by VTANR. This resulted in the identification of 33 unique projects for the Browns River study area, including 24 projects that do not require significant further study (i.e., passive approaches such as buffer plantings and corridor protection), and 9 projects requiring further feasibility study or engineering design (i.e., active restoration approaches such as culvert replacements).

## 1.0 Introduction

The fluvial geomorphic conditions of the Browns River watershed have been studied as part of numerous assessment efforts over the last 5 years. In 2004 the Winooski Natural Resources Conservation District (WNRCD) and the Vermont Department of Environmental Conservation (VTDEC) completed Phase 1 Stream Geomorphic Assessments (SGA) for the entire watershed and conducted Phase 2 assessments on 8 reaches (WNRCD, 2004). Fifteen additional reaches were assessed by Arrowwood Environmental in 2007 and summarized in a Phase 2 report (Arrowwood, 2008). Following the Phase 2 work, Arrowwood worked with VTDEC to develop a River Corridor Plan for the main stem of the Browns River and other selected tributaries (Arrowwood, 2009).

In 2009 the Chittenden County Regional Planning Commission (CCRPC), in conjunction with VTDEC, sought to collect additional Phase 2 data on 13 reaches in the Towns of Jericho, Underhill and Westford. The study is part of a broader CCRPC effort to work with the towns and identify areas where development pressures could conflict with erosion hazards over the long term. Phase 2 SGA field surveys are required to characterize the fluvial geomorphic conditions of each reach in order to develop Fluvial Erosion Hazard mapping used for planning at local and regional levels. Fitzgerald Environmental Associates, LLC. (FEA) was retained by CCRPC to carry out Phase 2 assessments following the SGA Protocols developed by the Vermont Department of Environmental Conservation (VTDEC, 2007). This report provides the data, mapping and narrative summaries for 13 reaches located in Jericho, Underhill and Westford.

## 2.0 Watershed Background

The Browns River watershed spans the Towns of Underhill, Bolton, Jericho, Essex, Westford and Fairfax. The Browns River headwaters are found in the eastern portion of Chittenden County and drain the western slopes of Mount Mansfield and Bolton Mountain. The upper reaches flow westerly through a mix of rural and residential lands in Underhill and Jericho before the main stem bends to the north near the village of Essex. The main stem then flows northerly through a wide alluvial valley occupied by predominately agricultural lands in the towns of Essex and Westford. The Browns River then descends into the Lamoille River valley where it meets the river in the town of Fairfax. The current CCRPC/VTDEC assessment project focuses on 13 main stem and tributary reaches in the upper and lower watershed (Figure 2.1).

The Browns River Corridor Plan (RCP) contains an extensive review of the geologic, geomorphic and ecological settings of the watershed. In addition, it contains a review of water quality data collected within the watershed, and a discussion of flood history and road crossings damaged or replaced by past flood events. The following Phase 2 documentation is intended to be used in conjunction with the RCP. Where appropriate, the watershed settings, background information, and watershed stressor mapping found in the RCP have been reference in this document as it applies to the current study reaches.

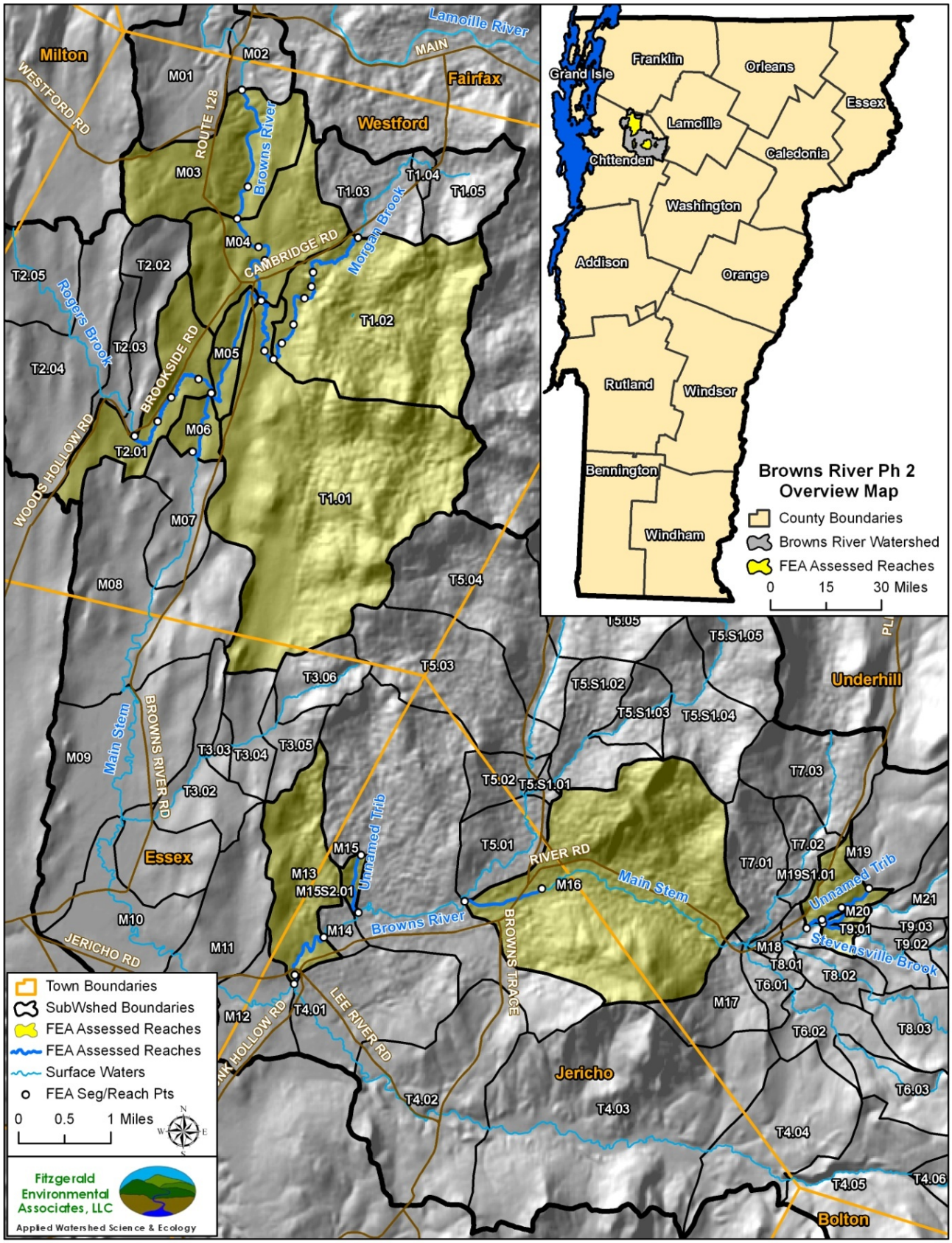



**Figure 2.1** Map of assessed reaches and surface waters in the Browns River Watershed

## 3.0 Methods

The Vermont River Management Program (RMP) has invested many years of effort into developing a state-of-the-art system of Stream Geomorphic Assessment (SGA) protocols. The SGA protocols are intended to be used by resource managers, community watershed groups, municipalities and others to identify how changes to land use affect hydro-geomorphic processes at the watershed and reach scale, and how these changes alter the physical structure and biotic habitat of streams in Vermont. The SGA protocols have become a key tool in the prioritization of restoration projects that will 1) reduce sediment and nutrient loading to downstream receiving waters such as the Lamoille River and Lake Champlain, 2) reduce the risk of property damage from flooding and erosion, and 3) enhance the quality of in-stream biotic habitat. The protocols are based on defensible scientific principles and have been tested widely in many watersheds throughout the state. Data collected for the Browns River watershed using the protocols forms the basis for the site-level project identification carried out as part of this Phase 2 effort.

### *3.1 Phase 1 and 2 SGA Methods*

Phase 1 assessments employ remote sensing techniques, along with limited field verification, to identify background conditions in the watershed. The Phase 1 approach results in watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), providing a basis for understanding the natural and human-impacted conditions within the watershed. The Phase 2 approach builds upon Phase 1 data through the collection of reach-specific data about the current physical conditions. Characterization of reach conditions utilizes a suite of quantitative (e.g., channel geometry, pebble counts) and qualitative (e.g., pool-riffle habitat) measurements to calculate two indices: Rapid Geomorphic Assessment (RGA) Score; Rapid Habitat Assessment (RHA) score. Using the RGA scores in conjunction with knowledge about the background or “reference” conditions, a sensitivity rating is developed to describe the degree to which the channel will adjust to human impacts in the future.

Phase 1 data were previously collected by VTDEC the Winooski Natural Resources Conservation District (WNRCD). For this Phase 2 project, a total of 13 reaches (15.8 miles) were selected for further assessment in summer and fall of 2009, including 7 reaches on the main stem and 6 tributary reaches (See Figure 1). This report summarizes SGA data for 7 main stem and 6 tributary reaches in the watershed. Due to the variation in channel form and topography, we divided these reaches into a total of 29 segments. To the extent possible, each segment was assessed for Phase 2 data and the data were entered into the Data Management System (DMS). A total of 7 segments were not fully assessed because of property access (3), beaver dam impoundments (3), and bedrock gorge settings (1). All major human impacts and natural features noted during the Phase 2 surveys were indexed in a GIS using the Feature Indexing Tool (FIT; VTDEC, 2007).

### *3.2 Bridge and Culvert Assessments*

FEA conducted bridge and culvert surveys on all private and public bridges and culverts within the selected Phase 2 reaches. The Bridge and Culvert Assessment and Survey Protocols specified in

Appendix G of the Vermont Stream Geomorphic Assessment Handbook (VTANR, 2007) were followed. Latitude and Longitude at each of the structures was determined using a GPS unit. The assessment included various photos documenting the conditions of each structure.

The Vermont Culvert Geomorphic Screening tool (MMI, 2008a) and the Vermont Culvert Aquatic Organism Passage Screening Tool (MMI, 2008b) developed by Milone and MacBroom, Inc. for VTDEC were used to identify culverts within the Browns River watershed that have a higher priority for replacement/retrofit due to geomorphic incompatibility and/or for being potential barriers to movement and migration of aquatic organisms.

### *3.3 Quality Assurance*

The RMP Quality Assurance (QA) protocols outlined in the SGA protocols (VTANR, 2007) were followed in order to ensure a complete and accurate dataset. FEA and RMP shared responsibility for QA of the finalized Phase 2 dataset. All metadata describing the data sources were entered in the Data Management System (DMS), with extraordinary sources noted in the comments section in Step 7 of Phase 1 or Step 5 of Phase 2. Staci Pomeroy of VTDEC provided a QA review following the completion of Steps 1 through 7 of Phase 2. A written record of the QA issues raised by RMP, and responses from FEA is included in Appendix E. The DMS database for the Browns River reaches was finalized on March 5, 2010.

### *3.4 River Corridor Planning*

A River Corridor Plan for a majority of the main stem reaches and a number of significant tributaries was prepared by Arrowwood Environmental for VTANR and WNRCD in 2009. The Plan included an extensive summary of the background geomorphic, ecological, and land use conditions of the watershed. Where appropriate, FEA has referenced Arrowwood's summaries as well as the stressor maps developed as part of the Plan. In identifying additional restoration project opportunities for the reaches in this study, FEA also followed the VTDEC methods for developing river corridor plans outlined in the Vermont River Corridor Planning Guide (VTANR, 2007). This technical guide is directed towards river scientists, planners, and engineers engaged in finding economically and ecologically sustainable solutions to the conflicts between human investments and river dynamics. The guide provides explanations for the following:

- River science and societal benefits of managing streams in a sustainable manner toward equilibrium conditions
- Methods for assessing and mapping stream geomorphic conditions, and identifying and prioritizing river corridor protection and restoration projects
- Methods for examining project feasibility and negotiating management alternatives with stakeholders
- Information on current programs available to Vermont landowners, towns, and other interested parties to implement river corridor protection and restoration projects

Included in this approach is a mapping exercise to lay the foundation for understanding stressors on stream channel stability at the watershed and reach scales. FEA compiled these maps at the reach scale for the assessed reaches as part of the stressor and departure analysis to illustrate a gradient of human impacts and stream response across the study area. The maps provide a basis for identifying projects through a step-wise procedure to screen potential projects for compatibility with equilibrium conditions.

## 4.0 Results

The following section includes a description of the reference stream setting, narratives describing the Phase 2 results, a summary of the watershed and reach-scale stressors on channel stability, an overview of all stream crossings assessed in the study area and reach-specific recommendations for restoration projects. The preliminary restoration projects were identified using the following objectives: (a) to improve the long-term stability of the Browns River and its tributaries; (b) to reduce sediment and nutrient pollution loading of the Browns River and therefore Lake Champlain; (c) to, over time, reduce landowner vulnerability and infrastructure damage from flood and fluvial erosion hazards.

### *4.1 Reference Stream Setting*

The river reaches assessed in this study are found in varied topographic terrain. Variation in topography and valley slope influences the channel morphologies that would be expected under reference (i.e., undisturbed) conditions. A Phase 1 SGA study was previously carried out by the Winooski Natural Resource Conservation District (WNRCD) in 2004. This study included summary data of the topographic characteristics that influence valley and channel morphology, including watershed area, channel/valley slopes, predicted channel widths, and sinuosity. Following the Phase 2 SGA work done in this study, reference reach characteristics for some of the reaches were refined based on improved knowledge of the reach and valley setting. Table 4.1 provides a summary of the reference reach data for the 13 reaches assessed on the Browns River.

**Table 4.1** Reference reach characteristics for assessed reaches of the Browns River

| Surface Water | Reach ID | Drainage Area (sq mi) | Channel Dimensions | | | Sinuo-sity | Valley Type* | Reference Stream Type† | Bedform‡ |
|---|---|---|---|---|---|---|---|---|---|
| | | | Length (ft) | Width (ft) | Slope (%) | | | | |
| Browns River | M03 | 90.3 | 8,954 | 95.0 | 0.2 | 1.2 | NW | C | Plane Bed |
| | M04 | 88.5 | 7,523 | 94.2 | 0.7 | 1.3 | SC | B | Riffle-Pool |
| | M05 | 75.2 | 8,372 | 83.0 | 0.1 | 1.2 | SC | C | Plane Bed |
| | M06 | 68.5 | 4,747 | 84.2 | 0.1 | 1.5 | BD | C | Riffle-Pool |
| | M13 | 53.9 | 5,149 | 64.0 | 1.9 | 1.4 | NC | B | Step-Pool |
| | M16 | 32.2 | 18,578 | 60.4 | 0.7 | 1.1 | VB | C | Riffle-Pool |
| | M20 | 6.8 | 3,037 | 30.4 | 2.8 | 1.1 | VB | C | Riffle-Pool |
| Morgan Brook | T1.01 | 11.6 | 5,515 | 24.3 | 0.5 | 1.5 | BD | E | Dune-Ripple |
| | T1.02 | 5.3 | 12,694 | 27.3 | 0.3 | 1.3 | BD | E | Dune-Ripple |
| Rogers Brook | T2.01 | 6.3 | 10,381 | 29.4 | 0.6 | 1.3 | VB | E | Riffle-Pool |
| Stevensville Brook | T9.01 | 3.1 | 2,147 | 28.0 | 1.9 | 1.1 | SC | B | Plane Bed |
| Unnamed Tributary | M15S 2.01 | 1.9 | 3,908 | 17.4 | 0.7 | 1.1 | VB | E | Dune-Ripple |
| Unnamed Tributary | M19S 1.01 | 1.6 | 4,917 | 16.1 | 2.7 | 1.1 | VB | C | Riffle-Pool |

* NC= Narrowly Confined; SC= Semi-Confined; NW= Narrow; BD=Broad; VB=Very Broad

† per Rosgen, 1994; ‡ per Montgomery and Buffington, 1997

The Browns River main stem reaches in Westford and Jericho are largely influenced by the valley setting. When the valley is unconfined the reference stream conditions should result in long, winding reaches; however, much of the main stem reaches have been historically straightened so the actual reference sinuosity is unknown. In a reference state the unconfined reaches would have C or E-type channel morphology with well-formed riffle-pool or dune-ripple bedform. Where the valley setting is confined or on the cusp of being confined the channel morphology is unusual because of the low slope. These reaches tend to be C or B-type channels with riffle-pool or plane bedform and have less sinuosity. Anomalous reaches like M13 occurred in settings where surficial materials were mostly scoured away and bedrock prevailed.

Morgan and Rogers Brook have very broad or broad valleys and low slopes. Given the smaller drainage areas of these segments, under reference conditions beaver activity would have greatly impeded the flow and influenced the watershed hydrology and site-scale hydraulics, making these reaches more sluggish and E-type by reference. The upper reaches of Stevensville Brook and the Browns River in Underhill mark a transition area between the high sloped mountainous reaches and the valley reaches downstream. With greater slope and larger substrate size these would be C or B type by reference.

## *4.2 Reach Narratives*

The following section summarizes the reach observations made during the Phase 2 field surveys. The DMS data summaries and RHA data summaries are found in Appendices A and B, respectively. Bridge and culvert summary data and a structure locator map are included in Appendix C. The reach stressor and project identification maps are included in Appendix D Additional project summary information is available in the Site-Level Project Opportunities section below. Finally, a summary of the QA notes between FEA and VTDEC staff are included in Appendix E.

***Westford Reaches***
***Browns River Main Stem (M03-M06)***

**M03-A**

Reach M03 is the most downstream reach included in the study area. It was divided into two segments because of the change in channel slope and morphology in the upper reach where the valley becomes wider. Segment M03-A is 1.3 miles long and has an average slope of approximately 0.5%. The segment begins at the downstream reach break with M02 and extends upstream to a change in valley confinement west of Bouffard Lane. The segment is set in a narrow valley (no human-caused change in confinement) and has C-type channel morphology (Rosgen, 1994) with plane bedform by reference (Montgomery and Buffington, 1997; Figure 4.1). Due to the valley confinement, the segment has low sinuosity with limited development of riffle and pool features; however some larger pools were found downstream of a bedrock grade control in the lower segment. The width-to-depth (WDR) and entrenchment ratios (ER) are 33.7 and 4.0, respectively. Minor incision was observed in the field and the incision ratio (IR) is 1.2. Substrate is predominately cobble (54%) with slightly elevated levels of sand (15%); the median substrate size is 170 mm (cobble).

**Figure 4.1** Plane bed morphology in lower segment

**Figure 4.2** Area of cattle grazing along right bank mid-segment

With the exception of some minor impacts to the buffer conditions mid-segment, M03-A was relatively stable. Only one small section of the segment had ongoing impacts from cattle grazing in the buffer (Figure 4.2). The valley confinement naturally limits the development of meanders, and may explain the stable condition despite the high WDR. As plane bed rivers with greater sediment

transport capacity tend to have a higher WDR. The minor incision is within the range expected for stable channels (RGA score = "Good"). There was no evidence of terraces indicating significant historical channel adjustments (CEM stage I). The habitat condition is "Fair" due to limited features. Large woody debris (LWD) in this segment was somewhat limited and pools were found primarily around grade controls or large boulders in the channel creating localized scour (LWD/Mile = 40; Pools/Mile = 29).

**M03-B**

Segment M03-B is 0.4 miles long and has a very low channel slope (less than 0.1%; not estimated due to limited resolution of elevation data). The segment begins at a change in valley confinement west of Bouffard Lane and extends upstream to the confluence with a small tributary entering from the west. At the segment break the buffer and bank vegetation changes from good conditions (Segment A) to fair to poor conditions in Segment B. Land use in the riparian corridor is mostly agricultural, and has been for many decades based on a review of aerial photography from the 1970's to the present. The segment is set in a broad valley and has C-type channel morphology with plane bedform (Figure 4.3). The width-to-depth and entrenchment ratios are 17.6 and 7.0, respectively. Significant incision was noted throughout the segment (IR = 1.9), and bank erosion was common, especially in the upper segment. Substrate is predominately sand (42%; Figure 4.4), with lesser amounts of gravel (29%) and cobble (22%); the median substrate size is 5 mm (sand).

**Figure 4.3** Plane bed morphology and degraded buffer

**Figure 4.4.** Sand-dominated bed substrate

Historical channel straightening has impacted nearly 90% of this segment. It appears that the channel, with a lack of natural grade controls, has responded to this straightening by incising its bed. Channel incision was severe and consistent throughout the segment. The high degree of sand in the bed substrate has likely been sourced from the ongoing bank erosion. Due to the incision with lack of significant widening (RGA = "Fair"), the CEM has been classified as stage II. The segment has a "very high" sensitivity to future impacts, and will likely undergo significant lateral adjustments in the future. The habitat condition is "Poor" due to the lack of bed features, limited woody debris (LWD/Mile = 36) and pools (Pools/Mile = 29), and the high degree of bed fining which smothers any coarse substrate for benthic macroinvertebrates.

**M04-A**

Reach M04 is found upstream and downstream of the Westford Village. This reach was divided into three segments during Phase 2 field work because of changes in channel and valley slope and morphology. Segment M04-A is 0.4 miles long and has a channel slope of approximately 0.8%. The segment begins at the reach break and extends upstream to a change in valley confinement. The segment is set in a semi-confined valley (no human-caused change in confinement; Figure 4.5) and has B-type channel morphology with riffle-pool bedform. The segment has naturally low sinuosity, but good development of riffle and pool features around bedrock outcrops and large boulders that create localized scour (Figure 4.6). The width-to-depth and entrenchment ratios are 21.8 and 2.1, respectively. Substrate is predominately boulder (29%), with lesser amounts of cobble (25%) and gravel (19%); the median substrate size is within the cobble class range (64 – 256 mm).

**Figure 4.5** Confined channel setting mid-segment

**Figure 4.6** Bedrock grade control and large pool downstream

The M04-A channel is stable (RGA score = “Good”) mainly due to the high number of grade controls present (6 total). There was no evidence of terraces indicating significant historical channel adjustments (CEM stage I). The habitat condition is “Good” due to the presence of expected features for this setting. Woody debris and pools were common (LWD/Mile = 108; Pools/Mile = 63), and there was limited embeddedness in the substrate.

**M04-B**

Segment M04-B is 0.3 miles long and has a very low channel slope (not estimated due to low resolution of elevation data). The segment is found along Huntley Road where the channel confinement changes to a broad setting with human-caused change to the valley width. Land use in the riparian corridor is agricultural on the left (west) bank, while Huntley Road and other residential development occupies the right (east) corridor. The segment has C-type channel morphology with plane bedform (Figure 4.7); this represents a departure from riffle-pool bedform expected under reference conditions. The width-to-depth and entrenchment ratios are 16.3 and 5.8, respectively. Moderate incision was noted in the segment at the cross-section location (IR = 1.5). Substrate is

predominately sand (50%; Figure 4.8), with lesser amounts of gravel (25%) and cobble (10%); the median substrate size is within the sand class range (0.06 - 2 mm).

**Figure 4.7** Plane bed morphology; Huntley Road on the left

**Figure 4.8** Sand-dominated bed substrate

Historical channel straightening has impacted the entire segment. As in M03-B, the channel has responded by incising its bed. Due to the moderate incision and aggradation, the CEM has been classified as stage II since there is no evidence of channel widening (RGA = "Fair"). The segment has a "very high" sensitivity to future human impacts, and is predicted to undergo lateral adjustments in the future. The habitat condition is "Fair" due to limited bed features, pools (Pools/Mile = 19), and the high degree of bed fining. Woody debris was common (LWD/Mile = 59), but dominated by smaller pieces found along the channel margins.

**M04-C**

Segment M04-C is 0.7 miles long and has a channel slope of approximately 0.5%. The segment begins along Huntley Road and extends upstream to the reach break at the confluence with Morgan Brook entering from the south. Some agricultural land use is found within the corridor in the upper and lower segments, and residential development is common along the left (west) bank mid-segment. Remnants of a dam and hydro-electric facility are located downstream of the Cambridge Road covered bridge in the Westford Village (Figure 4.9). A large scour pool is present downstream of this structure with significant widening observed in this section. The segment is set in a semi-confined valley (no human-caused change in confinement) and has B-type channel morphology with plane bed (dominant) and riffle-pool (subdominant) bedforms (Figure 4.10). The width-to-depth and entrenchment ratios are 21.0 and 2.1, respectively. Substrate is predominately cobble (47%), with lesser amounts of gravel (20%) and boulder (18%); the median substrate size is 100 mm (cobble).

**Figure 4.9** Remnants of dam/hydro-electric facility

**Figure 4.10** Riffle at cross-section location in upper segment

A high degree of channel incision was noted in the cross-section in the upper segment (IR = 1.8).The lack of grade controls in the upper segment have allowed the channel to become disconnected from a small adjacent floodplain; however, channel incision was less severe in the lower segment. The scour pool below the defunct dam is very wide (over 150 feet) because of the increased stream power through this section of the segment. Due to the incision and early stages of widening (RGA = "Fair"), the channel has been classified as CEM stage III. Despite the good conditions for woody debris and pools noted in the habitat surveys (LWD/Mile = 133; Pools/Mile = 29), the habitat condition is "Fair" due to the frequency of riffles, channel alterations associated with the dam, and bank/buffer impacts from residential development.

**M05**

Reach M05 is 1.6 miles long and has a channel slope of approximately 0.1%. The reach begins at the confluence with Morgan Brook and extends upstream to the confluence with Rogers Brook. Some residential land use is found within the corridor in the lower reach near Westford Village and agricultural land use is found within the corridor in the upper reach. However, a large portion of this reach is well buffered with healthy forest along both banks. The reach is set in a semi-confined valley (no human-caused change in confinement), yet it has and has C-type channel morphology with plane bed (dominant) and dune-ripple (subdominant) bedform (Figure 4.11). The width-to-depth and entrenchment ratios are 16.3 and 2.9, respectively. The entrenchment ratio appeared relatively consistent throughout the reach, but was slightly higher in portions of the upper and lower reach. This supports the stream type classification of C-type; an otherwise unusual classification for a semi-confined valley setting. Substrate is predominately sand (47%), with only small amounts of gravel (15%) and cobble (7%); the median substrate size is within the sand class range (0.06 - 2 mm).

**Figure 4.11** Cross-section location in upper M05

**Figure 4.12.** Severe erosion along left (west) bank in upper M05

A moderate degree of channel incision was noted in the cross-section in the upper reach (IR = 1.5). The absence of natural grade controls in the upper reach has allowed the channel to become disconnected from the adjacent floodplain on the west bank - incision increases in severity as you move upstream. In the upper reach, where the channel lacks buffers greater than 25 feet in many places, bank erosion is severe (Figure 4.12). Channel incision and bank erosion has likely been exacerbated by historical channel straightening where corn fields are found adjacent the channel. The bed substrate is assumed to be gravel by reference, and was noted beneath an aggraded sand layer above. The bank erosion in the upper reach, as well as in upstream Reach M06 and M07 are likely the sources of fine sediment in this reach. Due to the moderate channel incision (RGA = "Fair") and lack of widening, the channel has been classified as CEM stage II. The habitat condition is "Fair" due to limited bed features, pools (Pools/Mile = 11), woody debris (LWD/Mile = 42), and the high degree of bed fining.

**M06**

Reach M06 is 0.9 miles long and has a channel slope of approximately 0.1%. The reach begins at the confluence with Rogers Brook and extends upstream to the reach break at a sharp bend in the channel to the west. The river corridor is completely forested to the west, but agricultural land use is found within the eastern corridor in the lower reach. The segment is set in a broad valley and has E-type channel morphology with plane bedform (Figure 4.13), representing a departure from reference bedform of riffle-pool. The width-to-depth and entrenchment ratios are 10.7 and 7.1, respectively. Substrate is predominately sand (77%), with only small amounts of gravel (12%) and very little cobble; the median substrate size is within the sand class range (0.06 - 2 mm).

**Figure 4.13** Cross-section location in upper M06

**Figure 4.14** Severe erosion along left (west) bank in upper M06

A moderate to high degree of channel incision was noted in the cross-section in the upper reach (IR = 1.6). Historical channel straightening (86% of reach), in combination with lack of natural grade controls, have caused the channel to become disconnected from the adjacent floodplain throughout the entire reach. Bank erosion is severe throughout, especially along the left bank (47% of entire reach). Buffers along the right bank have been impacted by historical agricultural uses in the corridor, with 48% of the right bank lacking a healthy buffer greater than 25 feet in width. The bed substrate is assumed to be gravel by reference, and was noted beneath an aggraded sand layer above. The bank erosion in the upper reach (Figure 4.14) is probably one of the sources of fine sediment in this reach. Accounting for the channel incision (RGA = "Fair") and lack of widening, the channel has been classified as CEM stage II. The habitat condition was assessed at the very low end of "Fair" due to lack of well formed bed features and high degree of bed fining. Pools (Pools/Mile = 29) and woody debris (LWD/Mile = 133) were very common; however the woody debris was often found along the channel margins, and the pools were homogeneous and lacked good cover.

**Morgan Brook Reaches (T1.01-T1.02)**

**T1.01-A**

Morgan Brook is the first significant tributary to the Browns River, entering the Main Stem in downtown Westford. Reach T1.01 was segmented because of flow status and because of a series of beaver dams in the upper reach. Segment T1.01-A is 0.8 miles in length and has an average slope of approximately 0.4%. The segment begins at the confluence with the main stem and ends about 200 feet to the west of the first house on Osgood Hill Road. The valley setting is broad with no significant human-caused change in the valley width. The segment is moderately sinuous with dune-ripple bedform. The channel exhibits E-type geometry with width-to-depth (WDR) and entrenchment ratios (ER) of 6.1 and 9.5, respectively (Figure 4.15). Some minor incision was observed in the field and the incision ratio (IR) is 1.2. Substrate is predominately silt (30%) and sand (41%) with a median substrate size between 0.06 and 2 mm (sand). In the lower segment T1.01-A had a bedrock outcrop and grade control that acts as a channel constriction (Figure 4.16). Water upstream was slightly impounded because of the low slope.

**Figure 4.15** E-type geometry X-S looking upstream

**Figure 4.16 Grade** control located upstream of the main stem

This segment has experienced some straightening and channel alterations associated with agricultural land use in the corridor. Much of the left and right riparian areas have been reduced because of hay fields and pastures for horses and cattle. Some erosion was observed on both the left and right banks mostly downstream of the Osgood Hill Road culvert and some armoring was noted where the channel was encroached upon by the road. The habitat condition is "Fair" as a result of bank and buffer impacts and channel alterations. Woody debris in this segment was common and pools were found primarily in areas where bedform had riffle-pool morphology (LWD/Mile = 58; Pools/Mile = 16). Geomorphically, this segment is stable (RGA score = "Good"). Only minor planform changes and some historical straightening in lower segment. No evidence of terraces in straightened section to indicated channel evolution, so the segment was classified as stage I of the CEM.

**T1.01-B**

Segment T1.01-B was not assessed fully because of ponding associated with beaver activity. A total of 3 beaver dams were observed in this segment impounding approximately 1,175 feet (Figure 4.17). The segment begins at the first beaver dam west of the first house between Osgood Hill Road and Route 128 coming from downtown Westford and ends at the reach break at the second Osgood Hill Road crossing. The segment is 0.2 miles in length with a slope too low to measure using the available spatial data. Professional judgment was used to identify the stream type, bedform, and substrate (E-type; Dune-Ripple; Sand). Administrative judgment was also used to determine the RGA condition (RGA score = "Good"). Interestingly, the beavers used corn stalks from nearby cornfield to aid in their dam construction. These structures may not be as durable as dams constructed from alder or other woody plants, but appeared to be stable (Figure 4.18).

**Figure 4.17** Impounded channel downstream of the reach break

**Figure 4.18.** Beaver dam constructed largely of corn stalks

### T1.02-A

Reach T1.02 is a long reach that was segmented multiple times to best characterize the differences in channel morphology. Two segments were not fully assessed due to impoundment and lack of property access. Segment T1.02-A begins at the reach break downstream of Osgood Hill Road where a significantly-sized tributary enters from the south and extends upstream 0.3 miles, ending near the southeastern side of a large hay field. T1.02-A is set in a very broad valley with no human caused change in the valley width. The stream channel exhibits E-type morphology with dune-ripple bedform (Figure 4.19). The channel geometry is consistent with the stream type designation and the width-to-depth and entrenchment ratios are 5.4 and 20.9, respectfully. Sinuosity is only moderate, and much of the lower segment has been historically straightened. Substrate in this segment is predominately sand (41%) and gravel (33%) with a median substrate size between 0.06 - 2 mm (Sand). Like T1.01-B, this segment has some beaver activity, but the dams that were observed were very small and only impounding about 14% of the segment, so no further segmentation was done. In the lower segment, approximately 85 feet upstream of the Osgood Hill Road Crossing, the field on the left side of the channel has been ditched to drain off water (Figure 4.20). The area is not considered a wetland, but the soil there is probably saturated for much of the year. Over time this drainage ditch, if not maintained properly, could contribute sediment to the system.

**Figure 4.19** Cross-section location looking upstream

**Figure 4.20** Floodplain in lower reach that has been ditched

Several impacts to this segment have been associated with poor buffer conditions on the right side. Active hay production in the right corridor has reduced the buffer width to less than 25 feet over 65% of the segment's length. Despite the reduction in buffer width, the banks of the channel remained in good condition. Woody debris density was surprisingly high, considering the lack of woody vegetation on the near bank (LWD/Mile = 73) and pools were frequent (Pools/Mile = 40). The overall habitat condition was improved by the pool substrate and variability (RHA score = "Good"). Incision triggered by historical channel straightening has led to a decrease in geomorphic stability (IR = 1.3). This segment is on the cusp between fair and good condition, but some changes in planform following the incision lowered the overall score (RGA score = "Fair"). T1.02-A is in stage II of the CEM because of the incision and lack of widening.

**T1.02-B**

Segment T1.02-B begins at the southeast corner of the hay field and extends upstream 0.3 miles, ending at an old channel crossing. The channel is in a broad valley setting with no human caused change to the valley width. The C-type channel has a riffle-pool bedform with complete riffles. Channel geometry is consistent with the C-type designation (WDR = 13.3; ER = 5.7) and no incision was observed on this segment. Substrate is predominately cobble (53%) and silt (18%) with a median substrate size of 85.0 mm. The coarser substrate of this segment can be attributed to the greater slope and transport capacity compared with the segment downstream. Two grade controls were observed in this segment with approximately 6 feet of height above water. The old channel crossing located at the upstream segment break is a severe channel constriction. The width of this structure is only 11% of the bankfull channel width (Figure 4.21). In addition to the narrow span of the structure, the upstream end is blocked with debris, making it even more problematic to the dynamics of the channel (Figure 4.22). This structure should be removed to help reduce ponding upstream.

**Figure 4.21** Looking upstream at the channel constriction

**Figure 4.22** Looking downstream debris jam above the constriction

The habitat and geomorphic condition of this segment have been heavily impacted by the structure located at the segment break with T1.02-C, but impacts to the channel form and function have also been influenced by a very large beaver dam located mid-reach. The beaver dam was about 6 feet in height and caused water to pond up to the channel constriction. The structure was breached

between the summer of 2008 and 2009. Since then, much of the sediment that formerly aggraded behind the impoundment has washed downstream leading to several point bars and mid-channel deposition. Habitat in this segment is impacted by the riparian buffer zone in the downstream, right (west) side of the segment and by the channel alteration from the constriction (RHA score = "Fair"). Woody debris density is slightly higher than expected, largely because of the high woody debris count in the debris jam upstream of the constriction (LWD/Mile = 82). Pools were also quite frequent (Pools/Mile = 31). The impacts from the constriction and from the large, breached beaver dam make it difficult to determine the stage of channel evolution. Considering the aggradation prior to dam breach and subsequent degradation canceling each other out, this segment is considered to be in stage I of the CEM.

**T1.02-C**

Segment T1.02-C was not fully assessed because of impoundment associated with several beaver dams (Figure 4.23). Aerial imagery also indicates that this segment was recently completely inundated with water (Figure 4.24). This probably was the result of a larger debris jam on the downstream channel constriction. T1.02-C begins upstream of the channel constriction and ends 0.4 miles upstream at the change in flow status about 600 feet downstream of Old Number 11 Road. The majority of this segment is currently being used to graze cattle, which are free to come in contact with the stream. This has led to an increased sediment load. This area has potential for restoration and could qualify for CREP (Conservation Reserve Enhancement Program) funding. Professional judgment was used to identify the stream type, bedform, and substrate (E-type; Dune-Ripple; Sand). Administrative judgment was also used to determine the RGA condition (RGA score = "Fair").

**Figure 4.23** One of the 3 beaver dams observed in the segment

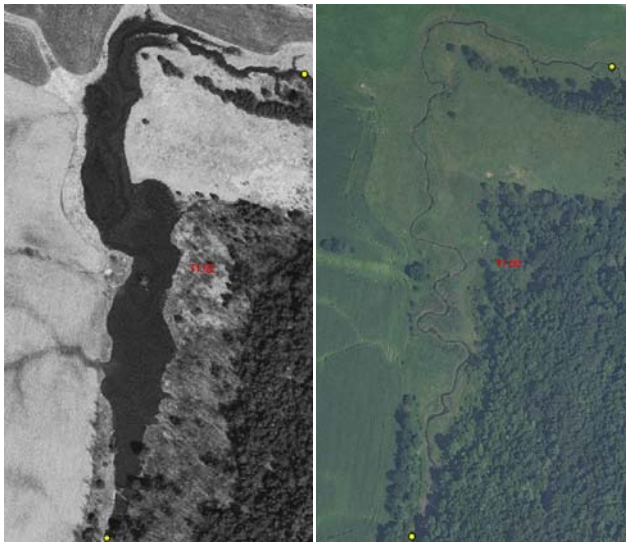


**Figure 4.24** T1.02-C inundated by water in 1999 and clear in 2008

**T1.02-D**

Segment T1.02-D begins at the change in flow status downstream of Old Number 11 Road and ends about 120 feet upstream of a driveway crossing that extends to the north off Old # 11 Rd. The segment is 0.2 miles in length and the channel is set in a very broad valley. The width-to-depth and entrenchment ratios are indicative of the E-type channel morphology (WDR = 6.5; ER = 12.9; Figure 4.25). Minor incision was observed on this segment and the channel is responding to historical straightening (IR = 1.2). The dominant bedform is riffle-pool although some areas of dune-ripple bedform were observed. The median substrate size class observed was sand (36%), but gravel (30%) and silt were also common (33%). The culvert crossing of the driveway in the upper segment is considerably undersized and causing a large plunge-pool to form along with significant right bank erosion (Figure 4.26). This structure has a width which is 24% of the bankfull channel width making it a high priority for replacement.

**Figure 4.25** Looking upstream at the cross-section

**Figure 4.26** Culvert causing a large plunge pool downstream

The habitat condition of this segment has been impacted negatively by the available cover, sinuosity and buffer widths (RHA score = “Fair”). Below the Old Number 11 Road crossing the stream is open to cattle grazing in the channel, reducing the epifaunal substrate cover. Woody debris and pool densities were both low because of the decreased riparian zone and fining (LWD/Mile = 24; Pools/Mile = 20). The geomorphic condition of this reach has been reduced because of the minor incision and historical changes in planform from straightening (RGA score = “Fair”). The channel is in stage II of the CEM because of the incision and limited channel widening.

**T1.02-E**

Segment E was not fully assessed because of lack of property access. T1.02-E begins just upstream of the driveway crossing off Old Number 11 Road and extends upstream 0.2 miles, ending 2,000 feet due east of the Old Number 11 and Cambridge Rd intersection where the fence line is found. Cattle and horses were observed grazing throughout the segment impacting the stability of the banks. The entire segment has been straightened and no buffer exists on either side of the channel (Figure 4.27). Professional judgment was used to identify the stream type, bedform, and substrate (C-type; Plane bed; Sand). Administrative judgment was also used to determine the RGA condition (RGA score = “Poor”).

**Figure 4.27** Looking downstream into the segment; no buffers and some bank erosion

**T1.02-F**

The last segment in reach T1.02, segment F begins at the fence line where property access was granted and extends upstream to the reach break just upstream of a significant tributary which enters from the east. The segment is 0.9 miles in length in a broad valley setting with no human-caused change in valley width. The channel exhibits E-type morphology with dune-ripple bedform. The width-to-depth and entrenchment ratios are 6.3 and 9.1, respectively. A moderate degree of incision observed in this segment; the degradation resulting from historical channel straightening and areas of limited buffer width (IR = 1.4). The bed substrate is predominately sand (58%) and sinuosity is moderate. Several areas in the middle and upper segment that have reduced buffer width and straightening are experiencing shifts in planform and bank erosion (Figure 4.28).

**Figure 4.28** Bank slumping and buffer width < 25 feet on the left bank

Habitat in this segment has been impacted by the corridor agricultural land use and limited buffer widths (RHA score = “Fair”). Woody debris and pool density were 63 (LWD/Mile) and 27 (Pools/Mile), respectively. One crossing was observed in this segment at Covey Road North. This structure appears to be sized adequately with minor scour below (Figure 4.29). The geomorphic condition, much like the habitat, has been impacted by the land use and channel alterations (RGA score = “Fair”). Changes in planform and minor widening have occurred following the incision and the channel is in stage III of the CEM.

**Figure 4.29** Covey Road North culvert looking upstream, some bank erosion downstream

**Rogers Brook Reach (T2.01)**

**T2.01-A**

Rogers Brook is the second significant tributary which branches off the main stem at the reach break between M05 and M06. The tributary extends eastward toward Brookside Road and then follows the road to the south. Segment T2.01 begins at the confluence with the main stem and ends at the start of the slightly impounded area located about 1,000 feet east of the intersection of Brookside Road with the driveway that crosses Rogers Brook. The segment is 0.2 miles in length and has an average slope of 2.7%. Much of the slope change in this segment occurs at one of two large grade controls (Figure 4.30). Valley setting is semi-confined in T2.01-A, with no human-caused change in the valley width. The channel exhibits C-type morphology with a subclass slope of b (Figure 4.31). The width-to-depth and entrenchment ratios are consistent with the stream typing and no incision was observed (WDR = 14.7; ER = 3.1; IR = 1.0). The dominant bedform is step-pool and the subdominant is riffle-pool. Substrate distribution is predominately cobble (50%) and gravel (23%) with a median particle size of 90.0 mm (Cobble).

**Figure 4.30** Grade control located just downstream of segment break

**Figure 4.31** Cross-section with C-type morphology

Woody debris and pools were both abundant in this segment (LWD/Mile = 105; Pools/Mile = 45). The high gradient setting had excellent bank and buffers, cover, and velocity/depth patterns (RHA score = "Good"). Most banks had either dense willow (*Salix sp.*), alder (*Alnus sp.*), or dogwood (*Cornus sp.*) species (WADs) or mature hemlocks or hardwoods in the upper segment. The only negative impact to the habitat condition was the frequency of riffles and steps which were influenced by the slope changes from the grade controls. Geomorphically, T2.01-A was very stable (CEM stage = I; RGA score = "Good"). Some bank erosion on the left bank in the lower segment was observed, but the erosion is most likely from the backwaters of the Browns River when the stage gets high during spring and summer runoff events.

**T2.01-B**

T2.01-B was segmented because of slope, valley dimensions, and channel dimensions. The segment begins at the slope break just upstream of the large grade control and extends upstream ending just downstream of a farm trail culvert crossing. T2.01-B is 0.6 miles in length and the slope is approximately 0.2%. The valley setting is very broad with no human-caused change in the valley width. Channel geometry is indicative of E-type channels and the dominant bedform is riffle-pool (Figure 4.32). The width-to-depth and entrenchment ratios are 8.5 and 18.9, respectfully. The substrate in this segment is predominately sand (42%) and gravel (29%) with a median particle size between 0.06 and 2 mm (Sand). At the segment break the culvert crossing very problematic. The structure is undersized with a width only large enough to support 15% of a bankfull flow event. The constriction has led to a scour pool to form downstream (Figure 4.33).

**Figure 4.32** Cross-section looking upstream

**Figure 4.33** Scour-pool downstream of constricted culvert

The habitat condition in this segment has been reduced by channel alteration caused by some historical straightening. Also, the flow status and sediment regime has been altered by the culvert crossing in the upper segment (RHA score = "Fair"). Woody debris and pools were abundant (LWD/Mile =82; Pools/Mile = 66). The geomorphic condition of the segment has been affected by the culvert as well (RGA score = "Fair"). The structure has starved the channel of sediment in the upper reach, and some erosion has occurred to meet the sediment need of the channel. The constriction has also led to the formation of a headcut in the right floodplain (not on the tributary channel). This feature is about 50 feet southeast of the current crossing at a low point where water crosses the farm trail during storm events. This feature was not FITed because it is occurring in the floodplain, not in the channel. The segment is in stage IV of the CEM, a newly formed floodplain was observed throughout much of the segment. Shifts in planform and other adjustments are ongoing and the channel will remain in stage IV of the CEM until the culvert is replaced and it can re-establish an equilibrium condition.

**T2.01-C**

T2.01-C begins at the constricted culvert crossing and ends 0.5 miles upstream at the farm pasture where property access is restricted. The segmentation was made because of depositional features associated with the culvert constriction (Figure 4.34). Lots of fine sediment has backed up upstream of the culvert changing the channel dynamics. The slope in this segment is similar to that downstream, approximately 0.2%, and the valley is also very broad with no human-caused change in valley width. The channel exhibits E-type morphology and the dominant bedform is riffle-pool. The width-to-depth and entrenchment ratios are 12.0 and 7.6, respectfully. The substrate in this segment is predominately sand (54%) and silt (30%) with a median particle size between 0.06 and 2 mm (Sand). Aggradation upstream of the crossing has led to the formation of several mid-channel, point, and side bars. The channel may become bifurcated in the future if aggradation continues. Approximately 500 feet downstream of the segment break with T2.01-C a large beaver dam was observed (Figure 4.35). The dam is 5 feet in height and impounds water well into the next segment. No further segmentation was done on the beaver dam area because of its short length.

**Figure 4.34** Culvert inlet looking downstream

**Figure 4.35** Large beaver dam in upper segment

Habitat in this segment was impacted by the aggradation of sediment and some bank stability issues (RHA score = "Fair"). The total woody debris density was very similar to the downstream segment (87 LWD/ Mile), but the pool density was much lower because of deposition of fines filling the pools (Pools/Mile = 42). Aggradation and planform shifts were the most significant impacts that decreased the geomorphic stability in this segment (RGA score = "Fair"). The channel is in stage IV of channel evolution like the downstream segment. If the culvert were to be replaced at the segment break, the segments would equilibrate and be very similar in stage IV of the CEM and start approaching dynamic equilibrium in stage V.

**T2.01-D**

Segment T2.01-D was not assessed due to lack of property access. The segment begins about 500 feet upstream of the large beaver dam end extends upstream 0.6 miles, ending 260 feet downstream of the Brookside Road crossing at the reach break. Much of this segment has been straightened and is used for grazing livestock. The buffer widths on the left and right bank are both reduced with 58% and 30% of the buffers less than 25 feet, respectively. Professional judgment was used to identify the stream type, bedform, and substrate (E-type; Riffle-Pool; Sand). Administrative judgment was also used to determine the RGA condition (RGA score = "Fair").

***Jericho and Underhill Reaches***

**Browns River Main Stem (M13, M16-A, and M20)**

**M13-A**

Reach M13 begins approximately 900 feet downstream of the Route 15 crossing in downtown Jericho and extends to just upstream of the Old Pump Crossing. Segment A is 0.1 miles in length. The segment begins at the confluence with the Lee River (T4.01) at the reach break and ends 345 feet downstream of the Route 15 crossing. This reach was segmented because it is set in a broad alluvial valley, while the upstream segment is in a bedrock gorge (Figure 4.36). The channel exhibits C-type geometry with consistent entrenchment (ER = 5.2) and width-to-depth ratios (WDR=15.5). The bedform is riffle-pool with substrate that is predominately coarse gravel (39%), with a median

particle size of 30mm (Gravel). The stream power generated by the upslope gorge has caused the segment to be slightly incised (IR=1.6), but the floodplain is not completely disconnected.

The sharp change in slope between the upstream segment and segment A has caused a large mid-channel bar to form at the top of this segment (Figure 4.37). The minor impacts to the degradation adjustments have lowered the geomorphic stability and put this segment in stage II of the CEM (RGA score = "Fair"). The change in slope responsible for the mid-channel bar also aided in the attenuation of large woody debris pieces (LWD/Mile = 156). The overall habitat condition of this reach was impacted by the limited depth-velocity patterns, and the number of pools (Pools/Mile = 28; RHA score = "Fair").

**Figure 4.36** Right valley wall and floodprone area

**Figure 4.37** Large MCB downstream of segment break

**M13-B**

Beginning at the start of the bedrock gorge downstream of the Route 15 crossing, M13-B extends 0.9 miles to the reach break just upstream of the Old Pump Road crossing. This segment is considered to be a "gorge" and isn't responding or adjusting to the stressors identified in the assessment protocol. This reach was assessed as normal, but professional judgment was used to estimate the substrate distribution and stream type. Channel dimensions of this reach were dependent on the positioning of the bedrock side walls, as opposed to the slope (2.6%) and substrate size, and therefore no cross-section was taken. Substrate was predominately bedrock (50%) and boulder (20%). The channel had geometry similar to a B-type channel with step-pool bedform. Downstream of Route 15 an old dam remains partially intact. Water is currently flowing under the structure and the old mill and the rusty penstock on the right bank (Figure 4.38).

**Figure 4.38** Dam and penstock downstream of Rt. 15 crossing

Upstream of Route 15 is the Red Mill, an iconic structure in downtown Jericho. There, another dam was located at the upstream end and water was drawn in to power a variety of milling machines (JHS, 2009; Figure 4.39). The dam that was once located on the upstream end of this structure has since been removed and water and sediment is free to flow downstream (Figure 3.40).

**Figure 4.39** The dam at the Old Red Mill c. 1964 (UVM, 2009)

**Figure 4.40** The Jericho Mill with the dam removed

This segment has a few areas where bedrock does not control the channel's banks. These areas were less than 300 feet in length and were not segmented out, because the channel resumed a bedrock gorge setting upstream. Upstream of Old Pump Road the valley becomes unconfined in a wide alluvial setting; this area was not further divided because it was only 250 feet from the reach break. The good variety of velocity-depth patterns, healthy buffer and vegetation and decent woody debris counts (LWD/Mile = 57) provided adequate habitat (RHA score = "Fair").

**M16-A**

M16-A is 0.9 miles in length with a slope of 0.4%. The segment begins at the confluence with T5.01 and ends 400 feet upstream of the covered bridge at the Mill Riverside Park. This segment's natural geomorphic state and habitat have been severely impacted by anthropogenic activities both past and present. The channel geometry is indicative of a B-type channel with a subclass slope of c. Entrenchment (ER = 2.0) and incision (IR = 2.0) ratios suggest departure from its reference condition of a C-type to a B-type channel. Some widening has occurred (WDR =17.8), but it has been limited by the extensive rip-rap armoring. Virtually all sinuosity has been removed by straightening and the channelizing effects of rip-rap. This has led to a system dominated by sediment transport processes and the bed morphology is plane bed (Figure 4.41). The substrate is gravel, with 39% and 16% coarse and fine gravel, respectively.

**Figure 4.41** Plane bed channel with gravel substrate

Upstream of the Route 15 crossing the channel's high incision ratio can be attributed to a human elevated floodplain in the form of a berm (Figure 4.42). From the covered bridge crossing downstream to Route 15 the left bank is bermed in the Mills Riverside Park area. This berm is typically 2.0 feet in height and greatly reduces floodplain connectivity. This feature was likely made to protect the hay fields downstream, and could be an opportunity for restoration. The bank and buffer conditions were substantially worse in the lower segment. Several hundred feet of the bank were almost entirely covered with Japanese knotweed that was growing on top of rip-rap (Figure 4.43). Geomorphically, this segment is fairly stable, because the channel has been severely manipulated. The armoring on the banks inhibits any future changes in planform and the segment will continue to carry sediment downstream. The aggradation and degradation adjustment processes reflect the historic incision and complete loss of any riffle-pool sequences from the filling of pools (RGA score "Poor"). The channel is in stage II of the CEM and will likely remain there because of the armoring. There is little to no habitat in this segment because of its human manipulated state. The limited woody debris and pools decreased the habitat further (RHA score "Poor").

**Figure 4.42** Berm on the left bank in the Mills Riverside Park Area

**Figure 4.43** Buffer less than 25 feet, rip-rap, and invasive spp.

This segment and the downstream reach M15 have experienced significant channel migration and avulsions within the last 70 years. All of M16-A was straightened and is unable to regain any sinuosity because of the extensive bank armoring. Figure 4.44 shows the extent of channel migration at four unique time intervals in the last century. The channel centerline was derived from georeferenced historical aerial imagery.

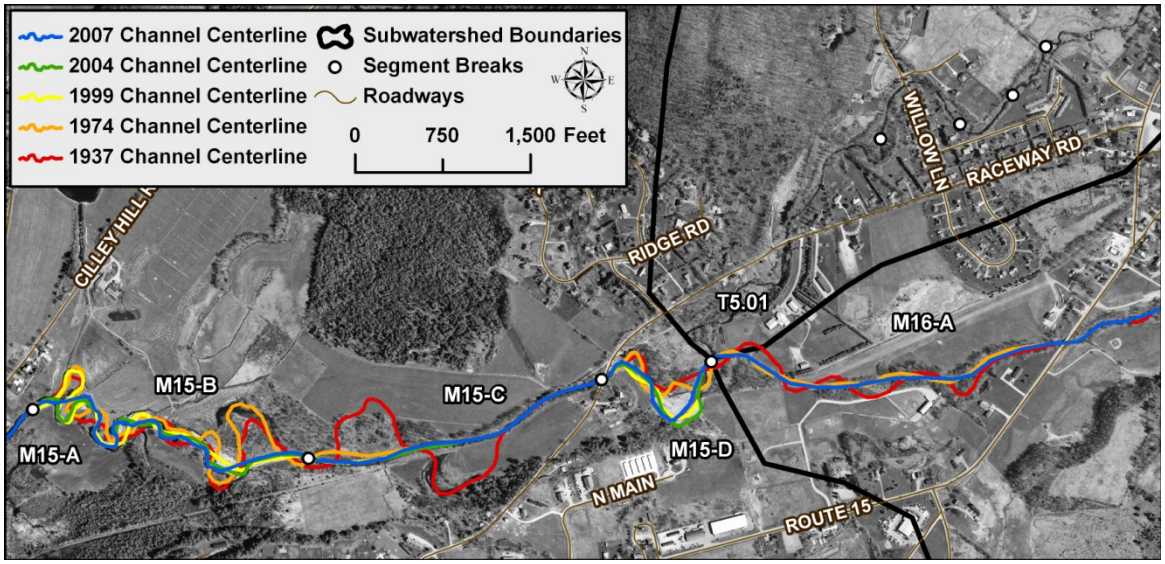



**Figure 4.44** The extent of channel migration in segment M16-A and reach M15 at four different time periods

### M20

M20 is a short reach, 0.6 miles in length, that acts as a transition area between the steep headwater reach M21 and the downstream reaches. The slope of M20 is 2.8%. The dominant bedform is riffle-pool and the sub-dominant bedform is plane-bed. The channel morphology represents C-type geometry: the entrenchment ratio is 6.2 and the width-to-depth ratio is 14.4. The reach is moderately incised (IR = 1.5), but the floodplain remains accessible throughout most of the reach. Substrate in M20 is predominately cobble (51%) and gravel (31%) with no fine silts or clays present. The median substrate size is 114 mm (Cobble).

The lower portion of this reach has extensive aggradation. Steep riffles and large, well developed bars were common. Wood was prevalent in the channel and led to the formation of deep pools downstream of partial and full debris jams (LWD/Mile = 68). One full debris jam in the lower reach caused extensive aggradation above and a deep pool to form below (Figure 4.45). The downstream pool was in excess of four-feet deep and provided excellent habitat (Pools/Mile = 24). The upper section of this reach near the Maple Leaf Road Crossing has encroachments on both sides from a farm road on the east and from Mountain Road on the west (Figure 4.46). Development was also noted in the left corridor of the upper reach. This section is more confined and has a steeper slope, but it was not segmented because the extent of encroachment leading up to M21 is only about 400 feet. The high slope (8.7%) and confined setting of M21 facilitates sediment transport downstream and the lower part of this reach seems to be a prime area for aggradation. The habitat score in this reach was negatively impacted by the low buffer widths mid-reach and the lack of any woody debris and pools in the upper plane bed section (RHA score = "Fair"). Significant sediment deposition and many bar features caused aggradation and planform changes to be the most prominent adjustment processes in the reach (RGA score = "Fair"). Minor widening also suggests stage III of the CEM.

**Figure 4.45** Deep pool downstream of a debris jam

**Figure 4.46** Low buffer width and encroachment mid-reach

**Stevensville Brook (T9.01)**

**T9.01-A**

Reach T9.01 was segmented because a small section in the upper reach was not accessible because of an electric fence. Segment A is 1812 feet in length and has an average slope of 1.9%. This segment is set in a semi-confined valley. The geometry is indicative of a B-type channel (ER = 1.9; WDR = 15.9) with c-type subclass slope. The channel is only slightly incised (IR =1.2), and the floodplain on the left bank is well connected. Substrate is predominately gravel (39%) and cobble (36%) with a median particle size of 70 mm.

The downstream third of this segment has nicely vegetated banks and buffers of adequate width, but the banks and buffers in the remaining two-thirds of the segment have been largely degraded by human activity. The right bank in particular has been completely denuded of trees and large shrubs

within the last 5 years. The 2003 NAIP imagery shows a buffer between 26 and 50 feet wide with large deciduous species (Figure 4.47). Now the area is planted for hay within 10 to 20 feet of the channel and only tree trunks and vegetation stubble remain (Figure 4.48). The left bank also had some buffer impacts upstream by the house. There, the buffer is mowed all the way up to the channel's edge. The habitat score was greatly reduced by the lack of buffer and subsequent reduction in LWD and pools (LWD/Mile = 114; Pools/Mile = 26; RHA score = "Fair"). The geomorphic condition of this segment was fair (RGA score = "Fair"). Degradation being the most prominent adjustment process lowering the overall score.

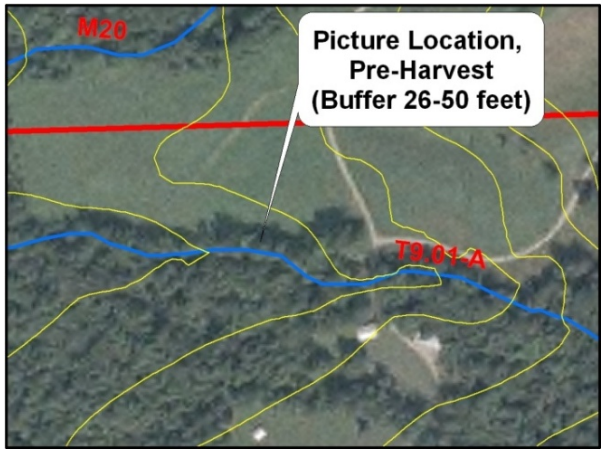



**Figure 4.47** Location of Figure 4.48 pre-harvest

**Figure 4.48** Post-harvest looking upstream from picture location

**T9.01-B**

Segment T9.01-B was segmented out because an electric fence prohibiting access. The segment is less than 0.1 miles in length. Phase 2 assessment was done for steps 1, 3, and 4 using aerial imagery and topographic maps. Professional judgment was used to determine the stream type (B3, Plane Bed). A stream crossing for the livestock grazing in the abutting field was observed in the lower segment (Figure 4.49).

**Figure 4.49** Stream crossing in T9.01-B

**Unnamed Tributaries (M15.S2.01 and M19.S1.01)**

**M15.S2.01**

Reach M15.S2.01 is 0.7 miles long and has an average slope of 0.7%. The reach begins at the confluence with the main stem 620 feet upstream of the Cilley Hill Dam. This reach is largely impounded by beaver activity, but areas with channelized flow were assessed for geometry (Figure 4.50). The entrenchment and width-to-depth ratios are 11 and 6.4, respectfully. The channel morphology is indicative of an E-type channel and the dominant bedform was dune-ripple. The substrate in this reach was almost entirely fines, with 45% silt and 40% sand.

A waterfall, 15 feet in height is located just upstream of the Cilley Hill Road crossing (Figure 4.51). The culvert downstream of the waterfall poses an alignment issue and a large wing wall was constructed to divert water into the culvert. The top edge of the grade control is constricted by an old dam that has been blown out. Considering the height of the grade control the slope of the channel upstream is about 0.3%; less than the average Phase 1 channel slope. The habitat score was "Fair," which reflects the limited large woody debris (LWD/Mile = 26) and pools (Pools/Mile = 27). The upper 1,200 feet of this reach was straightened like much of the upslope farm drainage ditches. The historic straightening reduced the geomorphic stability making the major adjustment processes in this reach to be degradation and shifts in planform. However, beaver activity in the segment has reduced the extent of the degradation adding localized stability upstream of the dams (RGA score "Fair"; CEM stage I).

**Figure 4.50** Ponding upstream of the first beaver dam

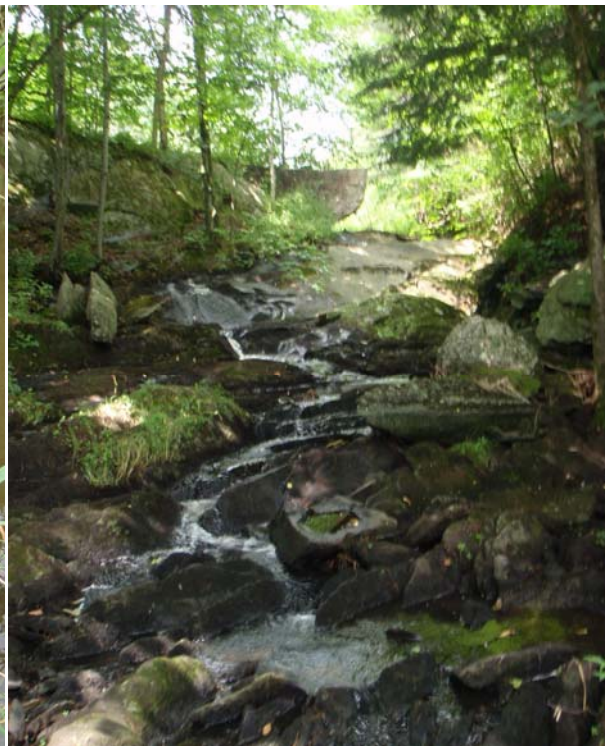


**Figure 4.51** Large waterfall upstream of the culvert crossing

**M19.S1.01-A**

M19.S1.01-A is 0.2 miles in length. This segment was only assessed for bank, buffer and corridor conditions (Steps 1, 3, and 4), because of beaver dams that impounded the area (Figure 4.52). A total of 8 significant beaver dams were observed in the field and using aerial imagery (Figure 4.53).

**Figure 4.52** Ponding behind one of the beaver dams

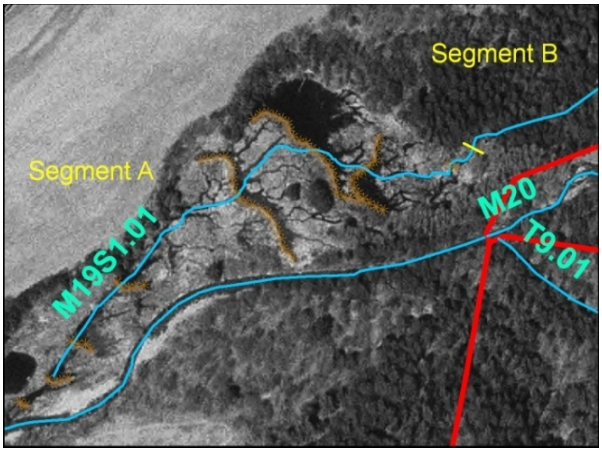



**Figure 4.53** Aerial image showing locations of the 8 dams

**M19.S1.01B**

Segment B, begins just upstream of the area impounded by beaver activity and extends up 0.3 miles to just above the Mountain Road crossing. This segment has a slope of 2.8% and a riffle-pool bedform. The channel geometry is indicative of a $C_b$-type channel with entrenchment and width-to-depth ratios of 12.9 and 10.8, respectfully. Minor incision (IR = 1.3) was noted, but the floodplain remains largely accessible. Bed substrate in this segment is predominately gravel (F. gravel = 17%; C. gravel = 33%) and cobble (35%). The sediment seems to be well sorted and riffles are complete with a spacing of 70 feet on average.

The segment was well buffered on the left side with a dense hemlock stand in the lower segment and a mixed hardwood forest in the upper. The right corridor was similarly buffered in the lower segment, but the adjacent side slope was logged in places limiting the buffer width from 26 to 50 feet. At the Mountain Road crossing near the segment break with M19.S1.01-C the bridge acted as a bankfull and floodprone channel constriction. This structure had some deterioration of the footer and the wing-walls on the up and downstream ends (Figure 4.54). Large woody debris (LWD = 200 LWD/Mile) was abundant and positively impacted the habitat score (Figure 4.55). Other habitat features such as debris jams, pools and undercuts were common, but not as abundant. The healthy bank and buffer condition along with LWD led to “Good” habitat rating for the RHA. The RGA condition was also “Good,” with similar scores with all of the adjustment processes and a CEM stage of I.

**Figure 4.54** Mountain Rd crossing, with scour to the wing-walls

**Figure 4.55** Great woody debris density in the lower segment

**M19.S1.01-C**

M19.S1.01-C was segmented to distinguish between the healthy bank and riparian conditions in segment B. The segment extends from the break point above Mountain Road to the reach break 0.4 miles upstream. The lower two-thirds of this segment are missing any natural buffer on the left bank, and the right bank only has some areas with buffers (Figure 4.56). The wide unconfined valley is mowed and used for hay production. The channel geometry reflects E-type morphology and with a subclass slope of b (Slope =3.6%). The entrenchment and width-to-depth ratios are 20.1 and 6.3, respectfully. The highly managed state of the channel and lack of woody debris has changed the bedform to plane bed. The substrate was predominately cobble (47%), but the median substrate was gravel (42%).

Two man-made ponds were observed to the left of the channel. Both of these features divert water from the channel upstream and have an outlet pipe that allows it to re-enter downstream. The ponds are raised slightly above the floodplain making an avulsion, if the pond blows out, unlikely. The outlet of the upstream pond (Figure 4.57) has caused a small channel to form. This channel resembles a rejuvenating tributary and is contributing sediment downstream. Degradation and planform changes are the two most notable adjustment processes. Straightening was observed for over 55% of the reach length. Changes in planform and incision (IR = 1.9) in the straightened areas suggests departure from a C-type to an E-type channel. Although the incision was not observed throughout the segment, the majority of the channel was impacted by land use changes. The poor scoring for degradation and planform in those areas lowered the geomorphic condition of this segment (RGA score “Fair”; CEM stage II). The lack of habitat features such as pools (Pools/Mile =2) and woody debris (LWD/Mile = 45) along with the poor riparian and bank condition was reflective of the “Poor” habitat rating. This is a prime site for riparian plantings and other restoration efforts described in greater detail in table 4.5.

**Figure 4.56** Plane bed channel mowed up to the edge

**Figure 4.57** Man-made pond located in the left floodplain.

### *4.3 Watershed and Reach-Scale Stressor Summary*

The data collected through the Phase 1 and 2 SGA studies provides the basis for assessing the impacts to the hydrologic and sediment regimes, and the channel riparian and boundary conditions. These data, when combined with other watershed-scale data developed in the RCP, also allows for the assessment of physical departure from reference conditions, and serves to validate watershed-scale patterns and stream conditions observed in the field.

The stream reaches studied as part of this project have a diversity of natural forms and sensitivities. Some segments have undergone severe channel adjustments, resulting in a departure from reference conditions. The average score from the segments that had full Rapid Geomorphic Assessment (RGA) stability assessment was 60.3%, or within the range of “Fair” conditions; indicating that the impacts of land use change and historic channel straightening have resulted in many segments that are not in regime and have channels experiencing some degree of floodplain disconnection. Similarly, the Rapid Habitat Assessment (RHA) results indicate “Fair” conditions overall, with degraded conditions typically reflective of increased substrate embeddedness (due to excess fine substrate), limited presence of pools, low variability of velocity and depth patterns, limited presence of coarse particulate organic matter and large woody debris, and poor bank vegetation. Fourteen (14) of the 22 fully assessed study segments are in a state of channel incision (stage II of channel evolution; VTANR, 2006b), or channel widening (stage III) due primarily to vertical adjustments brought on by historical land use changes and channel management. Two (2) of the segments are in a state of planform shifts and aggradation (stage IV of the CEM). The remaining 8 segments are stable and in stage I of the CEM.

Table 4.2 summarizes the Phase 2 data collected for the 29 study segments. Pertinent Phase 1 data, such as watershed area and reference stream type, are also summarized. Table 4.3 summarizes the watershed and reach-scale stressors impacting equilibrium conditions. Included in this summary are observations from the recent Phase 2 surveys, as well as watershed-scale observations (e.g., stressor maps) previously compiled in the RCP. More specific discussions of stressors in relation to restoration projects are included in the final section for site-level project opportunities.

**Table 4.2** Phase 2 summary statistics for assessed reaches in Westford, Jericho, and Underhill, Vermont

| Surface Water | Reach/ Segment ID | Watershed Area ($Mi^{2)}$ | Length (Miles) | Confine-ment | Channel Width (ft) | Incision Ratio | Sinuosity | Reference Conditions | | Existing Conditions | | | RHA* Condition | RGA* Condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Type | Bedform | Type | Bedform | Substrate | | |
| Browns River Main Stem | M03-A | 90.3 | 1.3 | NW | 96.0 | 1.2 | Low | C | Plane Bed | C | Plane Bed | Cobble | Fair | Good |
| | M03-B | 90.3 | 0.4 | BD | 82.5 | 1.9 | Low | C | Riffle-Pool | C | Plane Bed | Gravel | Poor | Fair |
| | M04-A | 88.5 | 0.4 | SC | 85.0 | 1.0 | Low | Bc | Riffle-Pool | Bc | Riffle-Pool | Cobble | Good | Good |
| | M04-B | 88.5 | 0.3 | BD | 80.0 | 1.5 | Low | C | Riffle-Pool | C | Plane Bed | Sand | Fair | Fair |
| | M04-C | 88.5 | 0.7 | SC | 82.0 | 1.8 | Mod. | Bc | Riffle-Pool | Bc | Plane Bed | Cobble | Fair | Fair |
| | M05 | 75.2 | 1.6 | SC | 83.0 | 1.5 | Low | C | Plane Bed | C | Plane Bed | Sand | Fair | Good |
| | M06 | 68.5 | 0.9 | BD | 57.5 | 1.6 | Low | C | Riffle-Pool | E | Plane Bed | Sand | Fair | Fair |
| | M13-A | 53.9 | 0.1 | BD | 64.0 | 1.6 | Low | C | Riffle-Pool | C | Riffle-Pool | Gravel | Fair | Fair |
| | M13-B† | 53.9 | 0.9 | SC | NA | NA | Mod. | B | Step-Pool | B | Step-Pool | Bedrock | Good | NA |
| | M16-A | 32.2 | 0.9 | VB | 54.0 | 1.5 | Low | C | Riffle-Pool | Bc | Plane Bed | Gravel | Poor | Poor |
| | M20 | 6.8 | 0.6 | VB | 32.5 | 1.5 | Low | C | Riffle-Pool | Cb | Riffle-Pool | Cobble | Fair | Fair |
| Morgan Brook | T1.01-A | 11.6 | 0.8 | BD | 24.3 | 1.2 | Mod. | E | Dune-Ripple | E | Dune-Ripple | Sand | Fair | Good |
| | T1.01-B‡ | 11.6 | 0.2 | BD | NA | NA | Mod. | E | Dune-Ripple | E | Dune-Ripple | Sand | NA | Good |
| | T1.02-A | 5.3 | 0.3 | VB | 16.0 | 1.3 | Mod. | E | Dune-Ripple | E | Dune-Ripple | Sand | Good | Fair |
| | T1.02-B | 5.3 | 0.3 | BD | 28.3 | 1.0 | Low | C | Riffle-Pool | C | Riffle-Pool | Cobble | Fair | Fair |
| | T1.02-C‡ | 5.3 | 0.4 | BD | NA | NA | Mod. | E | Dune-Ripple | E | Dune-Ripple | Sand | NA | Fair |
| | T1.02-D | 5.3 | 0.2 | VB | 21.0 | 1.0 | Mod. | E | Riffle-Pool | E | Riffle-Pool | Sand | Fair | Fair |
| | T1.02-E‡ | 5.3 | 0.2 | VB | NA | NA | Low | E | Dune-Ripple | C | Plane Bed | Sand | NA | Poor |
| | T1.02-F | 5.3 | 0.9 | BD | 15.0 | 1.0 | Mod. | E | Dune-Ripple | E | Dune-Ripple | Sand | Fair | Fair |
| Rogers Brook | T2.01-A | 6.3 | 0.2 | SC | 33.8 | 1.0 | Low | Cb | Step-Pool | Cb | Step-Pool | Cobble | Good | Good |
| | T2.01-B | 6.3 | 0.6 | VB | 22.0 | 1.4 | High | E | Riffle-Pool | E | Riffle-Pool | Sand | Fair | Fair |
| | T2.01-C | 6.3 | 0.5 | VB | 23.0 | 1.0 | High | E | Riffle-Pool | E | Riffle-Pool | Sand | Fair | Fair |
| | T2.01-D‡ | 6.3 | 0.6 | VB | 0.0 | 0.0 | Low | E | Riffle-Pool | E | Riffle-Pool | Sand | NA | Fair |
| Stevensville Brook | T9.01-A | 3.1 | 0.3 | SC | 28.0 | 1.2 | Low | B | Plane Bed | B | Plane Bed | Cobble | Fair | Fair |
| | T9.01-B‡ | 3.1 | 0.1 | NW | NA | NA | Low | B | Plane Bed | B | Plane Bed | Cobble | NA | Good |
| Unnamed Tributary | M15S2.01 | 1.9 | 0.7 | VB | 14.5 | 1.0 | Mod. | E | Dune-Ripple | E | Dune-Ripple | Sand | Fair | Fair |
| | M19S1.01-A‡ | 1.6 | 0.2 | VB | NA | NA | NA | C | Riffle-Pool | C | Riffle-Pool | Gravel | NA | Fair |
| | M19S1.01-B | 1.6 | 0.3 | VB | 17.0 | 1.3 | Mod. | Cb | Riffle-Pool | Cb | Riffle-Pool | Gravel | Good | Good |
| | M19S1.01-C | 1.6 | 0.4 | VB | 11.0 | 2.0 | Low | Cb | Riffle-Pool | Eb | Plane Bed | Cobble | Poor | Fair |

‡Segments not fully assessed because of property access (T1.02-E, T2.01-D, & T9.01-B) and beaver activity (T1.01-B, T1.02-C, &M19.S1.01-A)

* RGA = Rapid Geomorphic Assessment, *RHA = Rapid Habitat Assessment

† M13-B: Segment is set in a bedrock gorge--RGA data not applicable

**Table 4.3** Watershed and Reach-Scale Stressors Impacting Equilibrium Conditions in the Browns River Watershed, VT

| Stream Segment (CEM;RGA†) | Watershed Regime Stressors | | Reach-Scale Stressors | |
|---|---|---|---|---|
| | **Hydrologic** | **Sediment** | **Stream Power** | **Boundary Resistance** |
| Browns River Main Stem M03-A (I, Good) | *Increased Flows*<br>• Moderate local road density (2 - 5 Miles/Mile$^2$)<br>• Moderate local wetland loss (5 - 10%) | *Increased Load*<br>• Moderate local corridor cropland and bare land (5 - 10%)<br>• One gully in segment<br>• Moderate depositional features (2 -5 /Mile) | *Decrease*<br>• Moderate depositional features (2 -5 /Mile)<br>• High degree of widening | *Increase*<br>• Grade controls (2)<br>*Decrease*<br>• One gully in segment |
| Browns River Main Stem M03-B (II, Fair) | *Increased Flows*<br>• Moderate local road density (2 - 5 Miles/Mile$^2$)<br>• Moderate local wetland loss (5 - 10%) | *Increased Load*<br>• Moderate local corridor cropland and bare land (5 - 10%)<br>• High average bank erosion in segment (20 - 50%)<br>• Moderate depositional features (2 -5 /Mile) | *Increase*<br>• Extreme channel straightening (> 50%)<br>*Decrease*<br>• Moderate depositional features (2 -5 /Mile) | *Decrease*<br>• High average bank erosion in segment (20 - 50%)<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |
| Browns River Main Stem M04-A (I, Good) | *Increased Flows*<br>• Moderate local corridor development (5 - 10%)<br>• High local wetland loss (10 - 20%) | *Increased Load*<br>• High local corridor cropland and bare land (10 - 20%)<br>• Moderate local reach cropland and bare land (5 - 10%)<br>• Extreme depositional features (>10 /Mile) | *Increase*<br>• High channel straightening (20 - 50%)<br>*Decrease*<br>• Extreme depositional features (>10 /Mile)<br>• Moderate degree of widening | *Increase*<br>• Grade controls (6)<br>*Decrease*<br>• Moderate reduction in riparian vegetation; buffer < 25ft (5 - 20%) |
| Browns River Main Stem M04-B (II, Fair) | *Increased Flows*<br>• Moderate local corridor development (5 - 10%)<br>• High local wetland loss (10 - 20%) | *Increased Load*<br>• High local corridor cropland and bare land (10 - 20%)<br>• Moderate local reach cropland and bare land (5 - 10%)<br>• Moderate depositional features (2 -5 /Mile) | *Increase*<br>• Extreme channel straightening (> 50%)<br>• High corridor encroachment (20 - 50%)<br>• Moderate corridor development (5 - 20%)<br>*Decrease*<br>• Moderate depositional features (2 -5 /Mile) | *Increase*<br>• Grade controls (1)<br>• Moderate average bank armoring (5 - 20%)<br>*Decrease*<br>• Extreme reduction in riparian vegetation; buffer < 25ft (> 50%) |
| Browns River Main Stem M04-C (III, Fair) | *Increased Flows*<br>• Moderate local corridor development (5 - 10%)<br>• High local wetland loss (10 - 20%) | *Increased Load*<br>• High local corridor cropland and bare land (10 - 20%)<br>• Moderate local reach cropland and bare land (5 - 10%)<br>• Moderate depositional features (2 -5 /Mile) | *Increase*<br>• High channel straightening (20 - 50%)<br>• Moderate corridor development (5 - 20%)<br>*Decrease*<br>• 2 Bridges (1 Constricting)<br>• Moderate depositional features (2 -5 /Mile)<br>• Moderate degree of widening | *Increase*<br>• Grade controls (5)<br>*Decrease*<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |

**Table 4.3** Watershed and Reach-Scale Stressors Impacting Equilibrium Conditions in the Browns River Watershed, VT

| Stream Segment (CEM;RGA†) | Watershed Regime Stressors | | Reach-Scale Stressors | |
|---|---|---|---|---|
| | **Hydrologic** | **Sediment** | **Stream Power** | **Boundary Resistance** |
| Browns River Main Stem M05 (II, Good) | *Increased Flows*<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• High local corridor cropland and bare land (10 - 20%)<br>• High local reach cropland and bare land upstream (10 - 20%)<br>• Moderate average bank erosion in reach (5 - 20%) | *Increase*<br>• Moderate channel straightening (5-20%)<br>• Moderate corridor encroachment (5 - 20%)<br>• Moderate corridor development (5 - 20%)<br>*Decrease*<br>• 1 Bridge (Constricting) | *Increase*<br>• Grade controls (3)<br>*Decrease*<br>• Moderate average bank erosion in reach (5 - 20%)<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |
| Browns River Main Stem M06 (II, Fair) | *Increased Flows*<br>• Moderate local wetland loss (5 - 10%) | *Increased Load*<br>• High local corridor cropland and bare land (10 - 20%)<br>• Moderate local reach cropland and bare land (5 - 10%)<br>• One mass failure in reach<br>• High average bank erosion in reach (20 - 50%)<br>• Moderate depositional features (2 -5 /Mile) | *Increased*<br>• Extreme channel straightening (> 50%)<br>*Decreased*<br>• Moderate depositional features (2 -5 /Mile) | *Increased*<br>• Moderate average bank armoring (5 - 20%)<br>*Decreased*<br>• High average bank erosion in reach (20 - 50%)<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |
| Browns River Main Stem M13-A (II, Fair) | *Increased Flows*<br>• High local corridor development (10 - 20%)<br>• Moderate local road density (2 - 5 Miles/Mile$^2$) | *Increased Load*<br>• Moderate average bank erosion in segment (5 - 20%)<br>• Extreme depositional features (>10 /Mile) | *Increase*<br>• Development and moderately high impervious area in the Village of Jericho<br>*Decrease*<br>• Extreme depositional features (>10 /Mile) | *Decrease*<br>• Moderate average bank erosion in reach (5 - 20%) |
| Browns River Main Stem M13-B (I; Good) | *Increased Flows*<br>• Moderate local road density (2 - 5 Miles/Mile$^2$) | *No Significant Increase or Decrease in Sediment Load* | *Increase*<br>• High slope in gorge setting<br>• Moderate corridor encroachment (5 - 20%)<br>• Moderate corridor development (5 - 20%)<br>*Decrease*<br>• Several bedrock constrictions and one bridge | *Increase*<br>• Grade controls (13) |
| Browns River Main Stem M16-A (II; Poor) | *Increased Flows*<br>• Moderate local road density (2 - 5 Miles/Mile$^2$)<br>• Moderate local wetland loss (5 - 10%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• Abundant depositional and channel migration features upstream<br>• Moderate depositional features (2 -5 /Mile)<br>*Decreased Load*<br>• Recent gravel mining noted | *Increased*<br>• Extreme channel straightening (> 50%)<br>• Moderate corridor encroachment (5 - 20%)<br>• Moderate corridor development (5 - 20%)<br>*Decrease*<br>• 2 Bridges (1 constricting)<br>• Moderate depositional features (2 -5 /Mile) | *Increase*<br>• High average bank armoring (20 - 50%)<br>*Decrease*<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%)<br>• Homogenous particle size (gravel) |

**Table 4.3** Watershed and Reach-Scale Stressors Impacting Equilibrium Conditions in the Browns River Watershed, VT

| Stream Segment (CEM;RGA†) | Watershed Regime Stressors | | Reach-Scale Stressors | |
|---|---|---|---|---|
| | **Hydrologic** | **Sediment** | **Stream Power** | **Boundary Resistance** |
| Browns River Main Stem M20 (III, Fair) | *Increased Flows*<br>• Moderate local road density (2 - 5 Miles/Mile$^2$) | *Increased Load*<br>• Extreme depositional features (>10 /Mile) | *Increase*<br>• High channel straightening (20 - 50%)<br>• Moderate corridor encroachment and development (5 - 20%)<br>*Decrease*<br>• 1 Bridge (Constricting)<br>• Extreme depositional features (>10 /Mile) | *Increase*<br>• Grade controls (2)<br>• Debris jams present<br>*Decrease*<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |
| Morgan Brook T1.01-A (I, Good) | *Increased Flows*<br>• Moderate local corridor development (5 - 10%)<br>• High local wetland loss (10 - 20%) | *Increased Load*<br>• High local corridor cropland and bare land (10 - 20%)<br>• Moderate average bank erosion in segment (5 - 20%)<br>• Moderate depositional features (2 -5 /Mile) | *Increase*<br>• High channel straightening (20 - 50%)<br>• Moderate corridor encroachment (5 - 20%)<br>*Decrease*<br>• 1 Culvert (Constricting)<br>• Moderate depositional features (2 -5 /Mile) | *Increase*<br>• Grade controls (1)<br>*Decrease*<br>• Moderate average bank erosion in reach (5 - 20%)<br>• Extreme reduction in riparian vegetation; buffer < 25ft (> 50%) |
| Morgan Brook T1.01-B (NA, Good) | *Increased Flows*<br>• Moderate local corridor development (5 - 10%)<br>• High local wetland loss (10 - 20%) | *Increased Load*<br>• High local corridor cropland and bare land (10 - 20%)<br>• Moderate average bank erosion in segment (5 - 20%) | *Increase*<br>• High channel straightening (20 - 50%)<br>• Moderate corridor development (5 - 20%)<br>*Decrease*<br>• Beaver activity (3 Dams) | *Increase*<br>• Grade controls (2)<br>*Decrease*<br>• Moderate average bank erosion in reach (5 - 20%) |
| Morgan Brook T1.02-A (II, Fair) | *Increased Flows*<br>• Moderate local stormwater inputs (2 - 2 SI/Mile)<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• Moderate local reach cropland and bare land (5 - 10%)<br>• Moderate average bank erosion in segment (5 - 20%) | *Increase*<br>• Extreme channel straightening (> 50%)<br>*Decrease*<br>• 1 Culvert (Constricting)<br>• Beaver activity (4 Dams) | *Increase*<br>• Moderate average bank armoring (5 - 20%)<br>*Decrease*<br>• Moderate average bank erosion in reach (5 - 20%)<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |
| Morgan Brook T1.02-B (I, Fair) | *Increased Flows*<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• Moderate local reach cropland and bare land (5 - 10%)<br>• High depositional features (5 -10 /Mile) | *Decrease*<br>• 1 Old abutment (Constricting)<br>• High depositional features (5 -10 /Mile)<br>• Beaver activity (1 Dam) | *Decrease*<br>• Moderate reduction in riparian vegetation; buffer < 25ft (5 - 20%) |
| Morgan Brook T1.02-C (NA, Fair) | *Increased Flows*<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• Moderate local reach cropland and bare land (5 - 10%) | *Increase*<br>• Moderate channel straightening (5-20%)<br>*Decrease*<br>• Beaver activity (3 Dams) | *Decrease*<br>• Extreme reduction in riparian vegetation; buffer < 25ft (> 50%) |

**Table 4.3** Watershed and Reach-Scale Stressors Impacting Equilibrium Conditions in the Browns River Watershed, VT

| Stream Segment (CEM;RGA†) | Watershed Regime Stressors | | Reach-Scale Stressors | |
|---|---|---|---|---|
| | **Hydrologic** | **Sediment** | **Stream Power** | **Boundary Resistance** |
| Morgan Brook T1.02-D (II, Fair) | *Increased Flows*<br>• Moderate local stormwater inputs (2 - 2 SI/Mile)<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• Moderate local reach cropland and bare land (5 - 10%)<br>• Moderate average bank erosion in segment (5 - 20%)<br>• Moderate depositional features (2 -5 /Mile) | *Increase*<br>• Extreme channel straightening (> 50%)<br>*Decrease*<br>• 2 Culverts (Both Constricting)<br>• Moderate depositional features (2 -5 /Mile) | *Decrease*<br>• Moderate average bank erosion in reach (5 - 20%)<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |
| Morgan Brook T1.02-E (NA, Poor) | *Increased Flows*<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• Moderate local reach cropland and bare land (5 - 10%) | *Increase*<br>• Extreme channel straightening (> 50%) | *Decrease*<br>• Extreme reduction in riparian vegetation; buffer < 25ft (> 50%) |
| Morgan Brook T1.02-F (III, Fair) | *Increased Flows*<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• Moderate local reach cropland and bare land (5 - 10%)<br>• Moderate average bank erosion in segment (5 - 20%)<br>• High depositional features (5 -10 /Mile) | *Increase*<br>• High channel straightening (20 - 50%)<br>*Decrease*<br>• 1 Culvert (Constricting)<br>• High depositional features (5 -10 /Mile)<br>• Beaver activity (1 Dam) | *Decrease*<br>• Moderate average bank erosion in reach (5 - 20%)<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |
| Rogers Brook T2.01-A (I, Good) | *Increased Flows*<br>• Moderate local road density (2 - 5 Miles/Mile$^2$)<br>• Extreme local wetland loss upstream (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land upstream (> 20%)<br>• High local reach cropland and bare land upstream (10 - 20%)<br>• Moderate average bank erosion in segment (5 - 20%)<br>• High depositional features (5 -10/mi) | *Decrease*<br>• High depositional features (5 -10 /Mile)<br>• Beaver activity (1 Dam) | *Increase*<br>• Grade controls (3)<br>*Decrease*<br>• Moderate average bank erosion in reach (5 - 20%) |
| Rogers Brook T2.01-B (IV, Fair) | *Increased Flows*<br>• Moderate local road density (2 - 5 Miles/Mile$^2$)<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• High local reach cropland and bare land upstream (10 - 20%)<br>• Moderate average bank erosion in segment (5 - 20%)<br>• Moderate depositional features (2 -5 /Mile) | *Increase*<br>• High channel straightening (20 - 50%)<br>*Decrease*<br>• 1 Bridge (Constricting)<br>• Moderate depositional features (2 -5 /Mile)<br>• Beaver activity (1 Dam) | *Decrease*<br>• Moderate average bank erosion in reach (5 - 20%) |

**Table 4.3** Watershed and Reach-Scale Stressors Impacting Equilibrium Conditions in the Browns River Watershed, VT

| Stream Segment (CEM;RGA†) | Watershed Regime Stressors | | Reach-Scale Stressors | |
|---|---|---|---|---|
| | **Hydrologic** | **Sediment** | **Stream Power** | **Boundary Resistance** |
| Rogers Brook T2.01-C (IV, Fair) | *Increased Flows*<br>• Moderate local road density (2 - 5 Miles/Mile$^2$)<br>• Moderate local stormwater inputs (2 - 2 SI/Mile)<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• High local reach cropland and bare land upstream (10 - 20%)<br>• One mass failure in segment<br>• Extreme depositional features (>10 /Mile) | *Increase*<br>• Moderate channel straightening (5-20%)<br>• Moderate corridor encroachment (5 - 20%)<br>*Decrease*<br>• 1 Culvert (Constricting)<br>• Extreme depositional features (>10 /Mile)<br>• Beaver activity (1 Dam) | *Decrease*<br>• One mass failure in segment |
| Rogers Brook T2.01-D (NA, Fair) | *Increased Flows*<br>• Moderate local road density (2 - 5 Miles/Mile$^2$)<br>• Extreme local wetland loss (>20%) | *Increased Load*<br>• Extreme local corridor cropland and bare land (> 20%)<br>• High local reach cropland and bare land upstream (10 - 20%) | *Increase*<br>• Extreme channel straightening (> 50%) | *Decrease*<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |
| Stevensville Brook T9.01-A (I; Fair) | *No Significant Increase or Decrease in flows* | *Increased Load*<br>• High depositional features (5 -10 /Mile)<br>• Animal stream crossings present upslope | *Increase*<br>• Moderate corridor development (5 - 20%)<br>*Decrease*<br>• Moderate migration features<br>• Beaver activity (historic) | *Increase*<br>• Debris jams present<br>*Decrease*<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |
| Stevensville Brook T9.01-B (NA; Good) | *No Significant Increase or Decrease in flows* | *Increased Load*<br>• Animal stream crossings present within segment | *Not Assessed (No Access)* | *Not Assessed (No Access)* |
| Unnamed Tributary M15.S2.01 (I; Fair) | *Increased Flows*<br>• Moderate local reach development (5 - 10%)<br>• High local road density (5 - 10 Miles/Mile$^2$)<br>• Moderate local wetland loss (5 - 10%) | *Increased Load*<br>• Moderate local and upslope agricultural land uses<br>*Decreased Load*<br>• Possible dredging upstream | *Increase*<br>• High channel straightening (20 - 50%)<br>• High corridor development (20 - 50%)<br>*Decrease*<br>• Very low channel/valley slope<br>• 2 Culverts (Constricting)<br>• Beaver activity (4 Dams) | *Increase*<br>• Debris jams present<br>• Beaver activity<br>• Grade controls (1)<br>• Dam remains<br>*Decrease*<br>• Moderate reduction in riparian vegetation; buffer < 25ft (5 - 20%) |
| Unnamed Tributary M19.S1.01-A (NA, Fair) | *Increased Flows*<br>• Moderate local reach development (5 - 10%)<br>• High local road density (5 - 10 Miles/Mile$^2$)<br>• Moderate local wetland loss (5 - 10%) | *Increased Load*<br>• High local corridor cropland and bare land upstream (10 - 20%)<br>*Decreased Load*<br>• Beaver activity reducing downstream load | *Decrease*<br>• Extreme beaver activity (8 Dams) | *Increase*<br>• Extreme beaver activity |

**Table 4.3** Watershed and Reach-Scale Stressors Impacting Equilibrium Conditions in the Browns River Watershed, VT

| Stream Segment (CEM;RGA†) | Watershed Regime Stressors | | Reach-Scale Stressors | |
|---|---|---|---|---|
| | **Hydrologic** | **Sediment** | **Stream Power** | **Boundary Resistance** |
| Unnamed Tributary M19.S1.01-B (I; Good) | *Increased Flows*<br>• Moderate local reach development (5 - 10%)<br>• High local road density (5 - 10 Miles/Mile$^2$)<br>• Moderate local wetland loss (5 - 10%) | *Increased Load*<br>• High local corridor cropland and bare land (10 - 20%)<br>• Moderate local and upslope agricultural land uses<br>• Abundant depositional features<br>• High depositional features (5 -10 /Mile) | *Decrease*<br>• 1 Bridge (Constricting)<br>• High depositional features (5 -10 /Mile) | *No Significant Increase or Decrease in Boundary Resistance* |
| Unnamed Tributary M19.S1.01-C (II; Fair) | *Increased Flows*<br>• Moderate local reach development (5 - 10%)<br>• High local road density (5 - 10 Miles/Mile$^2$)<br>• Moderate local wetland loss (5 - 10%)<br>*Decreased Flows*<br>• Two water withdrawals for recreational ponds | *Increased Load*<br>• High local corridor cropland and bare land (10 - 20%)<br>• One mass failure in segment | *Increase*<br>• Extreme channel straightening (> 50%)<br>• Moderate corridor development | *Decrease*<br>• One mass failure in segment<br>• High reduction in riparian vegetation; buffer < 25ft (20 - 50%) |

† Channel evolution stage (F model for all reaches) and Rapid Geomorphic Assessment categorical score

### *4.4 Stream Crossings*

Throughout Vermont, undersized bridges and poorly aligned culverts limit critical sediment and woody debris transport processes, and prevent fish and wildlife movement. These conditions result in 1) channel instability and/or damage to infrastructure and personal property, 2) increased flooding, and 3) decreased fish and wildlife population health. Some bridges and culverts in the study reaches are currently undersized and causing various problems such as upstream deposition, excessive erosion, downstream bed degradation, and aquatic organism passage problems. As such structures come up for replacement at the municipal level, it is important to resize them to accommodate the expected discharge and sediment loads and to place them in proper alignment with stream channel.

Summary data for all structures in the study reaches was entered into the DMS. In order to make use of the VTANR culvert screening tools for structure prioritization, Table 4.4 summarizes data collected for 20 crossings in the study reaches. The final column of the table includes a prioritization of structures for replacement or retrofit based on a review of the following three criteria: structure width in relation to bankfull channel width; aquatic organism passage (culverts only); geomorphic compatibility (culverts only). A structure location map and additional data is available in Appendix C. One (1) culvert and one bridge have been assigned a moderate priority for replacement or retrofit. Three (3) additional culverts received a high priority for replacement or retrofit. Additional information about the recommended actions to address the high priority culverts and moderate priority bridge, 4 structures total, is provided in the site-level project opportunities Table 4.5 in the following section.

**Table 4.4** Structures assessed during Phase 2 RGA of portions of the Browns River and Tributaries and priority for replacement or retrofit

| Town | Map ID* | Stream Name | Reach/ Segment ID | Structure Type | Road Name | Route # | Percent Bankfull Width[1] | Aquatic Organism Passage[2] (AOP) | Geomorphic Compatibility[3] | AOP Priority[4] | Overall Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Westford | 1 | Brown River | M04-C | Bridge | Old Cambridge Rd | NA | 89% | -- | -- | -- | Low |
| | 2 | Brown River | M04-C | Bridge | Cambridge Rd | 3 | 106% | -- | -- | -- | Low |
| | 3 | Brown River | M05 | Bridge | Route 128 | 128 | 84% | -- | -- | -- | Low |
| | 4 | Morgan Brook | T1.01-A | Culvert | Osgood Hill Rd | 19 | 37% | Reduced AOP | Mostly Compatible | MLL | Low |
| | 5 | Morgan Brook | T1.02-A | Culvert | Osgood Hill Rd | 19 | 88% | Reduced AOP | Partially Compatible | HHM | Low |
| | 6 | Morgan Brook | T1.02-D | Culvert | Old # 11 Rd | 15 | 64% | Reduced AOP | Partially Compatible | MML | Low |
| | 7 | Morgan Brook | T1.02-D | Culvert | Private Driveway | NA | 24% | Reduced AOP | Mostly Incompatible | LLL | High |
| | 8 | Morgan Brook | T1.02-F | Culvert | Covey Rd North | 14 | 53% | Reduced AOP | Mostly Compatible | MML | Low |
| | 9 | Rogers Brook | T2.01-B | Bridge | Private Driveway | NA | 91% | -- | -- | -- | Low |
| | 10 | Rogers Brook | T2.01-C | Culvert | Farm Rd | NA | 15% | Reduced AOP | Mostly Incompatible | LLL | High |
| Jericho | 11 | Brown River | M13-B | Bridge | Route 15 | 15 | 141% | -- | -- | -- | Low |
| | 12 | Brown River | M13-B | Bridge | Old Pump Rd | 17 | 94% | -- | -- | -- | Low |
| | 13 | Unnamed Trib | M15S2.01 | Culvert | Cilley Hill Rd | 9 | 47% | No AOP | Partially Compatible | MLL | High |
| | 14 | Unnamed Trib | M15S2.01 | Culvert | Unknown Driveway | NA | 55% | Reduced AOP | Mostly Compatible | LLL | Low |
| | 15 | Unnamed Trib | M15S2.01 | Culvert | Hanley Ln | 11 | 38% | Reduced AOP | Partially Compatible | MLL | Moderate |
| | 16 | Brown River | M16-A | Bridge | Route 15 | 15 | 167% | -- | -- | -- | Low |
| | 17 | Brown River | M16-A | Bridge | Covered Bridge at Riverside Park | NA | 67% | -- | -- | -- | Low |
| Underhill | 18 | Unnamed Trib | M19S1.01-B | Bridge | Mountain Rd | 2 | 47% | -- | -- | -- | Moderate |
| | 19 | Brown River | M20 | Bridge | Maple Leaf Rd | 36 | 56% | -- | -- | -- | Low |
| | 20 | Stevensville Bk | T9.01-A | Bridge | Driveway off Maple Leaf Rd | NA | 89% | -- | -- | -- | Low |

*Map ID Corresponds to labels on bridge and culvert map in Appendix C; [1]Shaded for bankfull width percentage less than 50%; [2]AOP ratings developed with the VTANR methodology (not applicable for bridges); [3]Scores and ratings developed with the VTANR Geomorphic Compatibility Screening Tool; [4] Culvert Retrofit Potential: H = high, M = Medium, L = Low; Position 1 (Left) For strong swimmers, Position 2 (Center) for moderate swimmers Position 3 (Right) For weak swimmers.

### *4.5 Site-Level Project Opportunities*

The site-level projects developed for the Browns River watershed in the study area are provided below in Table 4.5. The project strategy, technical feasibility, and priority for each project are listed by project number and reach/segment. A total of 33 projects were identified to promote the restoration or protection of channel stability and aquatic habitat. The table summarizes key information for each project, including the site stressors and constraints, project strategy, priority, relative costs, and potential partners.

The project locations identified for the study area are included on maps in Appendix D. The 33 projects are further broken down by category as follows: 9 active geomorphic restoration projects; 24 passive geomorphic restoration projects.

**Table 4.5** Browns River site-specific opportunities for restoration and protection in Westford, Jericho, and Underhill, Vermont

| Stream Name, Reach/Segment, ID #, Location, & Town | Type of Project | Site Description Including Stressors and Constraints | Project or Strategy Description | Hazard Mitigation Priority | Ecological Benefits Priority | Project Benefits | Costs | Potential Partners |
|---|---|---|---|---|---|---|---|---|
| **Browns River M03-A # 1**<br><br>2,500 feet due east of the intersection of Westford-Milton Rd and Route 128<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings* | The left bank of the channel along the hay field has limited buffer width and the corridor is in hay production. | Plant a wider riparian buffer with native woody vegetation in areas lacking canopy cover. Take portions of the hayfield out of production where the buffer width is less than 50 feet. | Low | Low | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Increase floodplain roughness | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VTDEC; Landowner |
| **Browns River M03-B & M04-A # 1**<br><br>2,200 feet due east of the intersection of Woods Hollow Rd and Route 128<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | The left and right banks of the channel along the hay field have limited buffer width. The channel in this area has been historical straightened. The straightening in combination with the loss of buffer vegetation has led to a decrease in boundary resistance and incision has ensued. | A wider riparian buffer should be planted with native woody species in 2,000 foot stretch of channel where buffer width is limited. Easements of some of the land in hay production should also be considered to promote greater riparian area and allow the channel to regain a natural planform. | High | High | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Potentially reduced property and infrastructure loss | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VTDEC; Landowner |
| **Browns River M05 # 1**<br><br>Upstream of Route 128 crossing<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings* | The right bank of the channel starting from 500 feet upstream of the crossing to 900 feet upstream of the crossing has limited buffer width from agricultural land use and some development in the corridor. | Plant a wider riparian buffer with native woody vegetation in areas lacking canopy cover. Reduce lawn management practices and allow vegetation to grow. | Low | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Increase floodplain roughness | Low to moderate costs for buffer restoration | WNRCD; VTDEC; Landowner |
| **Browns River M05 # 2**<br><br>At reach break downstream of the confluence with Rogers Brook (T2.01)<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | The right bank of the channel from the confluence with Rogers Brook to 2,500 feet downstream is in corn or hay production or being used as pasture. Bank erosion and channel migration is occurring at the sharp channel bend. This area is quite incised and the meander has potential to be a neck-cutoff. | Plant a wider riparian buffer with native woody vegetation in areas lacking canopy cover. Corridor conservation to take some of the pasture and crop land out of production and allow the channel to migrate. The corridor should be conserved to help mitigate property loss as the channel migrates. | High | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Reduce loss of property | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VTDEC; Town of Westford; Landowner |

**Table 4.5** Browns River site-specific opportunities for restoration and protection in Westford, Jericho, and Underhill, Vermont

| Stream Name, Reach/Segment, ID #, Location, & Town | Type of Project | Site Description Including Stressors and Constraints | Project or Strategy Description | Hazard Mitigation Priority | Ecological Benefits Priority | Project Benefits | Costs | Potential Partners |
|---|---|---|---|---|---|---|---|---|
| **Browns River M06 # 1**<br><br>At reach break upstream of the confluence with Rogers Brook (T2.01)<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | The right bank of the channel from the confluence with Rogers Brook to 2,300 feet upstream is in corn production. Erosion, migration, and a large neck cutoff are occurring at the one meander bend upstream. The stretch of channel is straightened, incised and largely transport based. | A wider riparian buffer should be created by planting native woody species where buffer width is limited. The corridor should be conserved to help mitigate property loss as the channel migrates. | High | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Allow for natural planform to develop | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VTDEC; Town of Westford; Landowner |
| **Browns River M06 # 2**<br><br>Upstream of the confluence with Rogers Brook (T2.01)<br><br>***Westford*** | Active Restoration<br><br>*Channel and Floodplain Restoration* | A large meander that was present in the 1970's was lost along the right bank. Significant sediment attenuation was lost, and bank erosion is currently high at bend. | Use a naturalized channel restoration approach to redirect channel into lost meander using LWD additions at upstream end. | Moderate | Moderate | Increased attenuation of fine sediment and floodwaters in floodplain; reduced erosion risks; improved habitat in riparian corridor | Likely high costs for easements and design for channel re-capture. | VTDEC; Landowner |
| **Browns River M07 # 1**<br><br>Entire reach<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | The entire reach has been straightened - incision seems prevalent where the riparian buffer is limited. Erosion is abundant and the low boundary resistance is causing excessive sedimentation. | A wider riparian buffer should be created by planting native woody species where buffer width is limited. The corridor should be conserved to help mitigate property loss as the channel migrates. | High | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Allow for natural planform to develop; Reduced bank erosion | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VTDEC; Town of Westford; Landowner |
| **Browns River Reach M12 # 1**<br><br>Downstream of confluence with T4.01<br><br>***Essex, Jericho*** | Passive Restoration<br><br>*Corridor Conservation* | Upper reach is a natural attenuation site with good sinuosity. The large volume of sediment passing through upstream segment M13-B, which is bedrock controlled and transport based could attenuate in this reach. | Corridor protection will enable sediment that is transported from segment M13-B above to settle out in developing meanders. | High | Moderate | Improved natural planform and reduced net sediment flux to downstream reaches | Potentially moderate to high costs for easements | WNRCD; VRC; VTDEC; Town of Jericho |

**Table 4.5** Browns River site-specific opportunities for restoration and protection in Westford, Jericho, and Underhill, Vermont

| Stream Name, Reach/Segment, ID #, Location, & Town | Type of Project | Site Description Including Stressors and Constraints | Project or Strategy Description | Hazard Mitigation Priority | Ecological Benefits Priority | Project Benefits | Costs | Potential Partners |
|---|---|---|---|---|---|---|---|---|
| **Browns River M13-A # 1**<br><br>Approximately 500 feet downstream of Route 15 to the confluence with T4.01<br><br>***Jericho*** | Passive Restoration<br><br>*Corridor Conservation* | Lower segment is a natural attenuation site and an easement would help to mitigate the large volume of sediment passing through upstream segment M13-B, which is bedrock controlled and transport based. | Corridor protection will enable sediment that is transported from segment M13-B above will settle out in developing meanders. | Moderate | Moderate | Improve natural planform and reduced net sediment flux to downstream reaches | Potentially moderate to high costs for easements | WNRCD; VRC; VTDEC; Town of Jericho |
| **Browns River M13-B # 1**<br><br>Northwest of Joe's Snack Bar Downtown<br><br>***Jericho*** | Passive Restoration<br><br>*Buffer Plantings* | The left bank of the channel is eroding and buffer vegetation is limited. The buffer is managed as lawn and mowed up to the edge of the channel. | Mowing of the grass up to the bank of the channel should be stopped. Planting woody species in 300 foot stretch of bank would improve the bank stability. | Low | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach | Low to moderate costs for buffer restoration | WNRCD; LCBP; WVPD; Landowner |
| **Browns River M13-B # 2**<br><br>Approximately 200 feet east of the Old Pump Rd Crossing<br><br>***Jericho*** | Passive Restoration<br><br>*Buffer Plantings* | The left bank of the channel is eroding and buffer vegetation is limited. The buffer is managed as a hay field; woody species are limited. | A wider buffer should be created. Planting woody species in 350 foot stretch of bank would improve the bank stability and provide more floodplain roughness. | Low | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach | Low to moderate costs for buffer restoration | WNRCD; LCBP; Landowner |
| **Browns River M15 # 1**<br><br>Downstream of confluence with T5.01<br><br>***Jericho*** | Passive Restoration<br><br>*Corridor Conservation* | The upper reach is extremely active; channel migration has greatly changed the channel over the last 70 years. Reach is a natural attenuation site. The upstream segment, M16-A, has been completely straightened and rip-rapped and transports fine-to-gravel sized particles downstream. | Corridor protection will enable sediment that is transported from segment M16-A above to settle out in developing meanders. The area is also extremely active and easements would prevent and infrastructure from being placed in a dangerous area. | High | High | Improve natural planform and reduced net sediment flux to downstream reaches | Potentially moderate to high costs for easements | WNRCD; VRC; VTDEC; Town of Jericho |

**Table 4.5** Browns River site-specific opportunities for restoration and protection in Westford, Jericho, and Underhill, Vermont

| Stream Name, Reach/Segment, ID #, Location, & Town | Type of Project | Site Description Including Stressors and Constraints | Project or Strategy Description | Hazard Mitigation Priority | Ecological Benefits Priority | Project Benefits | Costs | Potential Partners |
|---|---|---|---|---|---|---|---|---|
| **Browns River M16-A # 1**<br><br>Approximately 2,000 feet downstream of the Route 15 crossing near the Browns River Middle School in the right corridor<br><br>***Jericho*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | The segment has been completely straightened and heavily rip-rapped. The segment has plane bedform and the system is largely depositional. The right bank in this area lacks extensive armoring and infrastructure is not present in this portion of the corridor making it a prime site for conservation. | Considering the extent of human impacts in this segment, restoration opportunities are limited. This site should be conserved: buffers planted with native woody vegetation and the corridor protected, to give the channel room to move where armoring isn't present. | Moderate | Low | Allow an area where floodplain can redevelop with no human infrastructure. | Potentially moderate to high costs for easements | WNRCD; VRC; VTDEC; Town of Jericho |
| **Browns River M16-A # 2**<br><br>Upstream of the Route 15 crossing on the left bank up to the covered bridge at Mills Riverside Park<br><br>***Jericho*** | Active Restoration<br><br>*Berm Removal* | Left floodplain has been disconnected because of a berm that extends from the Route 15 crossing up to the covered bridge at Mills Riverside Park. | Excavation of the berm and buffer plantings would help restore this site to a natural state. However, the removal of the berm may create a flooding hazard and the channel could potentially cross over Route 15 downstream. | Low | Low | Regain floodplain connectivity and allow for natural channel dynamics | High costs associated with berm removal and floodplain management | VTDEC; Town of Jericho |
| **Browns River M16-B # 1**<br><br>Approximately 500 feet upstream of the covered bridge crossing at Mills Riverside Park<br><br>***Jericho, Underhill*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | There is no infrastructure in place in the corridor of this segment. Changes in planform and deposition are the dominant processes; it is a sediment attenuation site. Historical aerial imagery shows a very large neck-cutoff and bank erosion, possibly contributing sediment downstream. | Corridor protection will enable sediment that is transported from above reaches to settle out in developing meanders before it reaches the straightened transport reach. The area is also extremely active; easements and buffer plantings could stabilize banks and allow for more sediment attenuation. | High | High | Allow an area where floodplain can redevelop with no human infrastructure | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VRC; VTDEC; LCBP; Town of Jericho; Town of Underhill |

**Table 4.5** Browns River site-specific opportunities for restoration and protection in Westford, Jericho, and Underhill, Vermont

| Stream Name, Reach/Segment, ID #, Location, & Town | Type of Project | Site Description Including Stressors and Constraints | Project or Strategy Description | Hazard Mitigation Priority | Ecological Benefits Priority | Project Benefits | Costs | Potential Partners |
|---|---|---|---|---|---|---|---|---|
| **Browns River M20 # 1**<br><br>Approximately 1,700 feet downstream of the Maple Leaf Rd Crossing<br><br>***Underhill*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | The left bank of the channel is eroding and buffer vegetation is limited. Site extent is from approximately 1,900 feet downstream of the crossing to about 1,500 feet downstream of the crossing. The buffer in this area is currently being used for hay production. Lower end of reach has several steep riffles and largely depositional. | A wider buffer should be created by planting native woody species in 400 foot stretch of the left bank. Easement of some of the land in hay production should also be considered to help protect property losses. Conservation of downstream end of segment would also help mitigate sediment flux downstream | Moderate | Low | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VRC; VTDEC; LCBP; Town of Underhill |
| **Browns River M20 # 2**<br><br>Approximately 300 feet downstream of the Maple Leaf Rd Crossing<br><br>***Underhill*** | Passive Restoration<br><br>*Buffer Plantings* | The left bank of the channel has limited buffer vegetation. Site extent is from approximately 500 feet downstream of the crossing to about 200 feet downstream of the crossing. The buffer in this area is currently being used as a yard and the area is encroached and developed. | Native woody species should be planted in 300 foot stretch of left bank. | Low | Low | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach | Low to moderate costs for buffer restoration | WNRCD; VRC; VTDEC; LCBP; Town of Underhill |
| **Browns River T1.01-A # 1**<br><br>Approximately 430 feet due east of the intersection of Osgood Hill Rd and Route 128<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings* | The left bank for about 500 feet downstream of the channel east of the intersection has reduced buffer width and horses grazing along the channel. | Plant a wider riparian buffer with native woody vegetation in areas lacking canopy cover. Increase the buffer width between the pasture and the channel. | Low | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach | Low costs for buffer restoration | WNRCD; VTDEC; Town of Westford; Landowner |
| **Browns River T1.02-A # 1**<br><br>Entire segment upstream of Osgood Hill Rd Crossing<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | The right riparian buffer is in hay production for much of this segment. Segment is actively migrating and recovering from historical channel straightening. | Plant a wider riparian buffer with native woody vegetation in areas lacking canopy cover on the right corridor. Conserve corridor and take land out of hay production to allow for channel movement with limited loss to property. | Moderate | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Allow for natural planform to develop | Low costs for buffer restoration; moderate to high cost for easements | WNRCD; VTDEC; Town of Westford; Landowner |

**Table 4.5** Browns River site-specific opportunities for restoration and protection in Westford, Jericho, and Underhill, Vermont

| Stream Name, Reach/Segment, ID #, Location, & Town | Type of Project | Site Description Including Stressors and Constraints | Project or Strategy Description | Hazard Mitigation Priority | Ecological Benefits Priority | Project Benefits | Costs | Potential Partners |
|---|---|---|---|---|---|---|---|---|
| **Browns River T1.02-B # 1**<br><br>Upper segment approximately 2,200 feet due east of the intersection of Osgood Hill Road and Route 128<br><br>***Westford*** | Active Restoration<br><br>*Structure Removal* | At the segment break with T1.02-C, a historic bridge crossing or mill structure exists where the valley is narrowly confined. This structure is a severe channel constriction, only 3 feet of the structure is open to allow water to pass and the upstream end of the structure has a large debris jam present. | Remove the stone structure and the debris upstream. Need to investigate historical significance of structure. | High | Moderate | Reduce ponding potential in upstream segment; Restore natural hydrologic conditions in the segment; Reduce ponding frequency upstream. | Moderate to high costs for machinery access and debris removal. | VTDEC; Town of Westford; Landowner |
| **Browns River T1.02-C # 1**<br><br>Entire segment<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | Both right and left riparian areas are used to graze cows for much of this segment. Much of the segment has been recently ponded by beaver activity and large constriction downstream. | Land easements would help with property loss as channel migrates. Plant stream buffer with native woody vegetation in areas lacking canopy cover; Potential CREP project. | Moderate | High | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Allow for natural planform to develop | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VTDEC; Town of Westford; Landowner |
| **Browns River T1.02-D # 1**<br><br>Driveway crossing upstream of Old Number 11 Rd<br><br>Westford | Active Restoration<br><br>*Culvert Retrofit/ Replacement* | Culvert is under a driveway off Old Number 11 Road. The structure is undersized and its width is only 24% of the bankfull channel width. The constriction has caused a large plunge-pool to form downstream with right bank erosion. | Replace the structure with a new culvert that is adequately sized. | High | Moderate | Reduce erosion and sediment loading downstream caused by the structures plunge-pool; Restore natural hydraulic state of the stream | Moderate to high costs for design and installation of new structure | VTDEC; Landowner |
| **Browns River T1.02-E # 1**<br><br>Entire segment<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | Both right and left riparian areas are used to graze cows for the entire segment. The segment was not accessible, but several areas of bank erosion and stream crossings were observed from up and downstream. | Land easements would help with property loss as channel migrates. Plant stream buffer with native woody vegetation in areas lacking canopy cover; Potential CREP project. | High | High | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Allow for natural planform to develop | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VTDEC; Landowner |

**Table 4.5** Browns River site-specific opportunities for restoration and protection in Westford, Jericho, and Underhill, Vermont

| Stream Name, Reach/Segment, ID #, Location, & Town | Type of Project | Site Description Including Stressors and Constraints | Project or Strategy Description | Hazard Mitigation Priority | Ecological Benefits Priority | Project Benefits | Costs | Potential Partners |
|---|---|---|---|---|---|---|---|---|
| **Browns River T1.02-F # 1**<br><br>Mid-segment approximately 1,400 feet downstream of Covey Rd North<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings* | Right riparian area is used for hay production for about 700 feet of the segment. This area has had some historic channel straightening, beaver activity, and incision. | Plant a wider riparian buffer with native woody vegetation in areas lacking canopy cover. Increase the buffer width between the hay field and the channel. | Moderate | Low | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Allow for natural planform to develop | Low costs for buffer restoration | WNRCD; VTDEC; Landowner |
| **Browns River T1.02-F # 2**<br><br>Upstream of Covey Rd North<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | Both right and left riparian areas are used for hay production for about 650 feet upstream of road crossing. Bank slumping along the banks was frequent and buffer width was often less than 10 feet. | Plant a wider riparian buffer with native woody vegetation in areas lacking canopy cover. Increase the buffer width between the hay field and the channel. Land easements would help with property loss as channel migrates. | Moderate | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Allow for natural planform to develop | Low to moderate costs for buffer restoration; moderate to high cost for easements | WNRCD; VTDEC; Landowner |
| **Browns River T2.01-B # 1**<br><br>Driveway crossing upstream of Old Number 11 Rd<br><br>***Westford*** | Active Restoration<br><br>*Culvert Retrofit/ Replacement* | Culvert is under farm trail off Brookside Road. The structure is undersized - width is only 17% of the bankfull channel width. The constriction has caused a large plunge-pool to form downstream and significant aggradation upstream. A headcut has also formed in the right floodplain where high flows cross the road. | Replace the structure with a new culvert or bridge that is adequately sized. | High | Moderate | Reduce erosion and sediment loading downstream caused by the structures plunge-pool; Restore natural hydrologic state of the stream | Moderate costs for design and installation of new structure | VTDEC; Landowner |
| **Browns River T2.01-D # 1**<br><br>Lower and upper segment<br><br>***Westford*** | Passive Restoration<br><br>*Buffer Plantings; Corridor Conservation* | Both right and left riparian areas are used to graze cows for the much of the segment. The segment was not accessible, but impacts from straightening and low buffer width were observed from downstream and from aerial imagery. | Plant stream buffer with native woody vegetation in areas lacking canopy cover; Potential CREP project. | High | Moderate | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach; Allow for natural planform to develop | Low costs for buffer restoration | WNRCD; VTDEC; Landowner |

**Table 4.5** Browns River site-specific opportunities for restoration and protection in Westford, Jericho, and Underhill, Vermont

| Stream Name, Reach/Segment, ID #, Location, & Town | Type of Project | Site Description Including Stressors and Constraints | Project or Strategy Description | Hazard Mitigation Priority | Ecological Benefits Priority | Project Benefits | Costs | Potential Partners |
|---|---|---|---|---|---|---|---|---|
| **Stevensville Brook T9.01-A # 1**<br><br>Approximately 500 feet downstream of the driveway off Maple Leaf Rd<br><br>***Underhill*** | Passive Restoration<br><br>*Buffer Plantings* | All of the woody vegetation on the right bank of the channel has been recently clear-cut. The site extent is approximately 750 feet downstream of the crossing to about 300 feet downstream of the crossing. The buffer width before the trees were felled was between 26 and 50 feet. | A wider buffer should be planted with native woody species in 450 foot stretch of the right bank. Some of the hay field in the corridor should be taken out of production. | Moderate | High | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach | Low to moderate costs for buffer restoration | WNRCD; VRC; VTDEC; Town of Underhill |
| **Unnamed Tributary M15.S2.01 # 1**<br><br>Culvert beneath Cilley Hill Rd<br><br>***Jericho*** | Active Restoration<br><br>*Culvert Retrofit/ Replacement* | The corrugated steel culvert is located approximately 250 feet upstream of the Browns River main stem reach M15. The culvert is perched and has some alignment issues and a large cascade upstream. The culvert width is 47% of the bankfull channel width. | Retrofit culvert outlet with weir or large boulders to keep water level at grade during low flows. Upstream alignment issues could be addressed if culvert is replaced. | High | Moderate | Improved AOP in tributary reach; Reduced risks of erosion around road. | Low to moderate for retrofit downstream. Replacement would be more costly | Town of Jericho; VFWD; CCRPC |
| **Unnamed Tributary M19.S1.01-B # 1**<br><br>Bridge beneath Mountain Rd<br><br>***Jericho*** | Active Restoration<br><br>*Bridge Retrofit/ Replacement* | The concrete bridge is located approximately 1,110 feet west of the Mountain Rd and Maple Leaf Rd intersection. The bridge span is 47% of the bankfull width and the structure is deteriorating. | Replacement of the structure or retrofit would stabilize the deteriorating wing-walls and footers on both the up and downstream sides of the bridge and, if replaced, increase the capacity to handle bankfull flow events. | Moderate | Low | Improve ability to handle large flow events and reduce the risk of infrastructure damage | Moderate to high costs for design and installation of new structure; Retrofit would be less costly | CCRPC; Town of Underhill |
| **Unnamed Tributary M19.S1.01-C # 1**<br><br>Upstream of the Mountain Road Crossing<br><br>***Underhill*** | Passive Restoration<br><br>*Buffer Plantings* | All of the woody vegetation on the right and left banks have been removed and the area is managed as lawn. The site extent is approximately 900 feet. From 500 feet upstream of the Mountain Road crossing to the tree line upstream. The channel has been straightened and some erosion is occurring as a result of the vegetation loss. | A buffer of native woody vegetation should be planted in the 900 foot stretch of corridor. | Moderate | High | Reduced thermal loading; Reduced fine sediment loading; Improved biotic habitat within reach | Low to moderate costs for buffer restoration | WNRCD; VTDEC; Town of Underhill; Landowner |

**Table 4.5** Browns River site-specific opportunities for restoration and protection in Westford, Jericho, and Underhill, Vermont

| Stream Name, Reach/Segment, ID #, Location, & Town | Type of Project | Site Description Including Stressors and Constraints | Project or Strategy Description | Hazard Mitigation Priority | Ecological Benefits Priority | Project Benefits | Costs | Potential Partners |
|---|---|---|---|---|---|---|---|---|
| **Unnamed Tributary M19.S1.01-C # 2**<br><br>From 1,000 feet upstream of the Mountain Road crossing<br><br>***Underhill*** | Active Restoration<br><br>*Withdrawal Removal* | A recreational pond 800 feet upstream of the crossing in the left corridor is filled by a water withdrawal pipe located 200 feet upstream. This bypass is altering the natural hydrologic regime of the channel and reducing the flow downstream. | Removal of this bypass would allow the channel to regain natural hydrologic conditions. | Low | Low | Lowered risk of withdrawal impacting high quality trout habitat. | Moderate to high depending on whether the pond would be removed and the floodplain would be restored | Landowner; VTDEC |
| **Unnamed Tributary M19.S1.01-C # 3**<br><br>From 1,750 feet upstream of the Mountain Road crossing<br><br>***Underhill*** | Active Restoration<br><br>*Withdrawal Removal* | A recreational pond 1,750 feet upstream of the crossing in the left corridor is filled by a water withdrawal pipe located 100 feet upstream. This bypass is altering the natural hydrologic regime of the channel. The outlet of this structure is causing erosion in a small tributary/gully that has formed and enters into the channel downstream. | Removal of this bypass would allow the channel to regain natural hydrologic. | Moderate | Moderate | Mitigation of further erosion and sediment in the gully/tributary outlet | Moderate to high depending on whether the pond would be removed and the floodplain would be restored | Landowner; VTDEC |

## 5.0 Conclusions and Recommendations

The Browns River and its tributaries exhibit diversity in form, function, and condition. Historical floods, defunct dams, undersized culverts, and various other types of human land use in the river corridor have all left a lasting imprint on the morphology and stability of the Browns River and tributary channels.

Browns River main stem reaches vary significantly from the headwaters to outlet at the Lamoille River in Fairfax. In the upper reaches in Jericho and Underhill, B and C-type channel morphologies are found in confined and unconfined valley settings with generally "Fair" conditions. Segments with the greatest departures, such as M16-A, have been altered primarily by corridor land use and channel manipulation (e.g., straightening and armoring). In Westford, the valley setting varies between confined and unconfined due to natural topographic changes along the river corridor. Here, the river can be characterized by B and C-type channel morphologies with "Fair" to "Good" conditions. Human impacts to the channel and floodplain are most severe in three unconfined segments: M03-B, M05, and M06. In these areas, adjacent agricultural land use in combination with channel straightening and armoring has resulted in incised, simplified channel morphologies with degraded aquatic habitat and reduced floodplain function. Given the current state of the main stem channel and predicted future adjustments, the following watershed-scale and site-specific management actions are recommended:

- Implementation of FEH zones for the entire Town of Westford (main stem and tributaries), and selected areas of Underhill and Jericho where Phase 2 data exists
- Protection of specific areas of river corridor (see "high priority" projects in Table 4.5; maps in Appendix D) along the main stem that are more prone to future lateral adjustments
- Multiple areas of buffer plantings along the main stem to improve stream bank shading and cover for fishes, and long-term bank stability

The tributary reaches in Jericho and Underhill were found to have E, C, and B-type channel morphologies. Geomorphic stability and habitat conditions were "Fair" to "Good". Significant channel adjustments were limited to areas directly impacted by channel straightening and/or armoring, such as an unnamed tributary to Stevensville Brook (M19.S1.01-C). The tributary reaches along Morgan and Rogers Brooks in Westford are dominated by E-type channel morphology. These segments were found to be in "Fair" to "Good" conditions, with only one segment receiving an administrative judgment score of "Poor" (Morgan Brook Segment T1.02-E). Given the current state of the tributary channels and predicted future adjustments, the following site-specific management actions are recommended:

- Replacement or retrofit of three (3) high-priority culverts that are incompatible with geomorphic stability and/or aquatic organism passage (see Table 4.4)
- Removal of a channel constricting structure on Morgan Brook segment T1.02-B
- Multiple areas of buffer plantings to improve stream bank shading and cover for fishes, and long-term bank stability (see Table 4.5)

## 6.0 References

Arrowwood Environmental, 2008, Phase 2 Stream Geomorphic Assessment – Browns River Watershed, Prepared for Vermont Agency of Natural Resources River Management Program, April 17, 2008

Arrowwood Environmental, 2009, Browns River Corridor Plan – Browns River Watershed, Prepared for Winooski Natural Resources Conservation District and Vermont Agency of Natural Resources River Management Program, March 19, 2009

JHS (Jericho Historical Society), 2009, The Jericho Historical Society Website. Accessed in September, 2009 at: http://www.jerichohistoricalsociety.org/mill.htm

MMI (Milone & MacBroom, Inc.), 2008a, The Vermont Culvert Geomorphic Capability Screening Tool. South Burlington, Vermont.

MMI (Milone & MacBroom, Inc.), 2008b, The Vermont Culvert Aquatic Organism Passage Screening Tool, South Burlington, Vermont.

Montgomery, D. R., & Buffington, J. M., 1997, Channel-reach morphology in mountain drainage basins, *Geological Society of America Bulletin*, 109(5), 596-611.

Rosgen, D. L., 1994, A classification of natural rivers, *Catena*, 22(3), 169 - 199.

UVM Landscape Change, 2009, Photograph LS09049_000 Accessed in September, 2009 at: http://www.uvm.edu/landscape

VTANR, 2007, Vermont Agency of Natural Resources River Corridor Planning Guide, Draft dated July 11, 2007. Accessed in August, 2007 at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_restoration.htm

VTDEC (Vermont Department of Environmental Conservation), 2007, Stream Geomorphic Assessment Handbook - Phase 1 & 2 Protocols. Vermont Agency of Natural Resources Publication. Available at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm.

Winooski Natural Resources Conservation District (WNRCD), 2004, Browns River Watershed Phase 1 SGA Summary

# Appendix A

# DMS Reach Summary Data

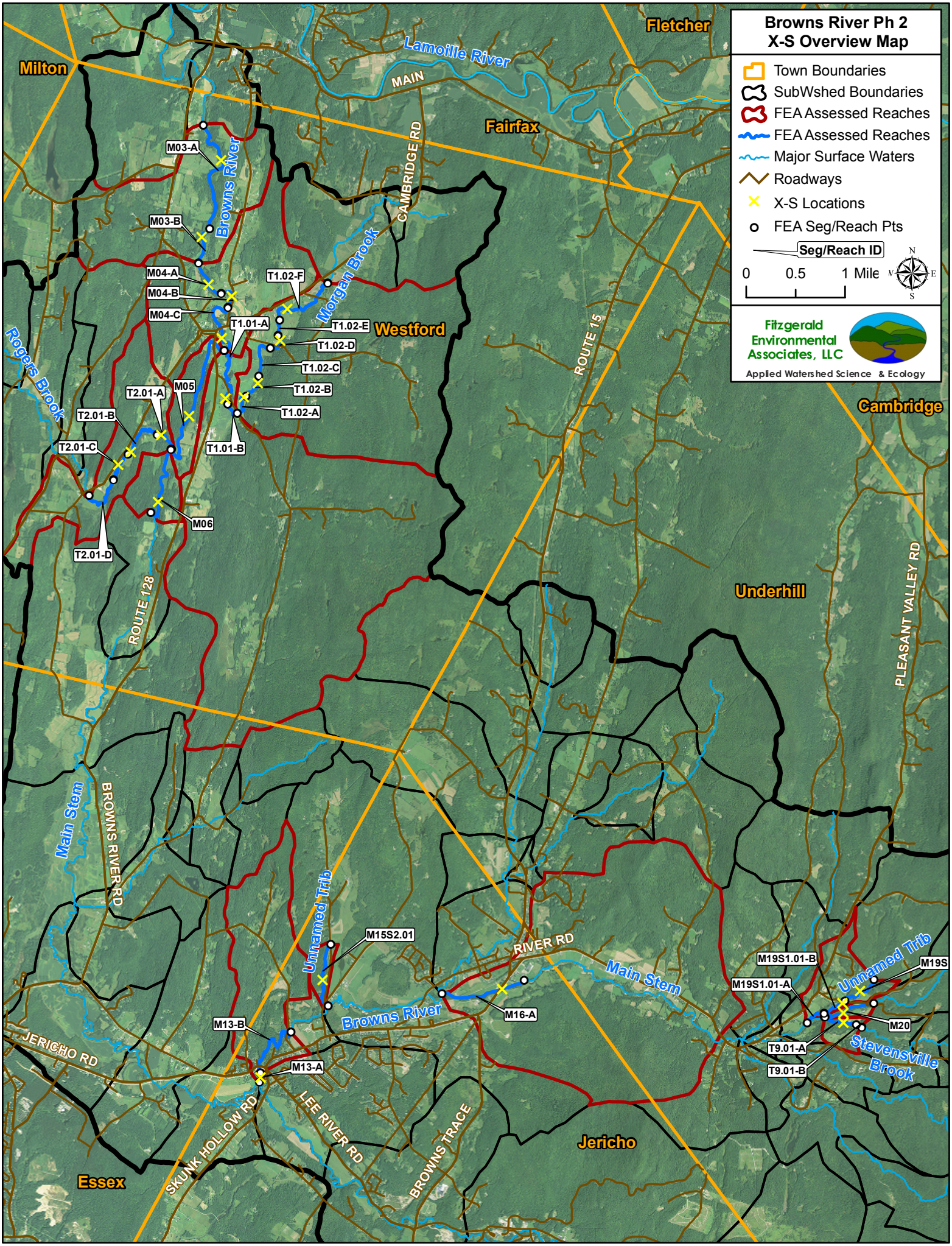

Browns River Ph 2
X-S Overview Map
Town Boundaries
SubWshed Boundaries
FEA Assessed Reaches
FEA Assessed Reaches
Major Surface Waters
Roadways
X-S Locations
FEA Seg/Reach Pts
Seg/Reach ID
0
0.5
1 Mile
N
E
S
W
Fitzgerald Environmental Associates, LLC
Applied Watershed Science & Ecology
Milton
Fletcher
Fairfax
Westford
Cambridge
Underhill
Jericho
Essex
Lamoille River
MAIN
Browns River
Morgan Brook
CAMBRIDGE RD
ROUTE 15
Rogers Brook
ROUTE 128
PLEASANT VALLEY RD
BROWNS RIVER RD
Main Stem
Unnamed Trib
RIVER RD
JERICHO RD
SKUNK HOLLOW RD
LEE RIVER RD
BROWNS TRACE
Stevensville Brook
M03-A
M03-B
M04-A
M04-B
M04-C
T1.02-F
T1.02-E
T1.02-D
T1.02-C
T1.02-B
T1.02-A
T1.01-A
T1.01-B
M05
T2.01-A
T2.01-B
T2.01-C
T2.01-D
M06
M15S2.01
M13-B
M13-A
M16-A
M19S1.01-B
M19S1.01-A
M19S
M20
T9.01-A
T9.01-B

**Table 1 (Appendix A)** Phase 2 Reach Summary Statistics for the Assessed Reaches in the Browns River and its Tributaries

| Surface Water | Town | Reach/ Segment ID | Length (ft) | Confine-ment Type | Watershed Area ($Mi^{2)}$ | Reference Bankfull Width (ft) | Ph 2 Channel Dimensions | | | Channel & Floodplain Ratios | | | Reference Conditions | | Existing Conditions | | | RHA* Condition | RGA* Condition | CEM* | CEM* Stage | Stream Sensitivity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Channel Width (ft) | Mean Depth (ft) | Area ($ft^2$) | Width-to-Depth | Entrench ment | Incision | Type | Bedform | Type | Bedform | Substrate | | | | | |
| Browns River Main Stem | Westford | M03-A | 6,783 | NW | 90.3 | 95.0 | 96.0 | 2.9 | 273.6 | 33.7 | 4.0 | 1.2 | C | Plane Bed | C | Plane Bed | Cobble | Fair | Good | F | I | Moderate |
| | | M03-B | 2,171 | BD | | | 82.5 | 4.7 | 386.9 | 17.6 | 7.0 | 1.9 | C | Riffle-Pool | C | Plane Bed | Gravel | Poor | Fair | F | II | Very High |
| | | M04-A | 2,255 | SC | 88.5 | 94.2 | 85.0 | 3.9 | 331.5 | 21.8 | 2.1 | 1.0 | Bc | Riffle-Pool | Bc | Riffle-Pool | Cobble | Good | Good | F | I | Moderate |
| | | M04-B | 1,425 | BD | | | 80.0 | 4.9 | 392.0 | 16.3 | 5.8 | 1.5 | C | Riffle-Pool | C | Plane Bed | Sand | Fair | Fair | F | II | Very High |
| | | M04-C | 3,842 | SC | | | 82.0 | 3.9 | 319.8 | 21.0 | 2.1 | 1.8 | Bc | Riffle-Pool | Bc | Plane Bed | Cobble | Fair | Fair | F | III | High |
| | | M05 | 8,372 | SC | 75.2 | 83.0 | 83.0 | 5.1 | 421.6 | 16.3 | 2.9 | 1.5 | C | Plane Bed | C | Plane Bed | Sand | Fair | Good | F | II | High |
| | | M06 | 4,747 | BD | 68.5 | 84.2 | 57.5 | 5.4 | 309.4 | 10.7 | 7.1 | 1.6 | C | Riffle-Pool | E | Plane Bed | Sand | Fair | Fair | F | II | Extreme |
| | Jericho | M13-A | 555 | BD | 53.9 | 64.0 | 64.0 | 4.1 | 265.0 | 15.5 | 5.2 | 1.6 | C | Riffle-Pool | C | Riffle-Pool | Gravel | Fair | Fair | F | II | Very High |
| | | M13-B† | 4,594 | SC | | | -- | -- | -- | -- | -- | -- | B | Step-Pool | B | Step-Pool | Bedrock | Good | NA | -- | -- | Very Low |
| | | M16-A | 4,738 | VB | 32.2 | 60.4 | 54.0 | 3.0 | 164.2 | 17.8 | 2.0 | 1.5 | C | Riffle-Pool | Bc | Plane Bed | Gravel | Poor | Poor | F | II | Extreme |
| | Underhill | M20 | 3,037 | VB | 6.8 | 30.4 | 32.5 | 2.3 | 73.1 | 14.4 | 6.2 | 1.5 | C | Riffle-Pool | Cb | Riffle-Pool | Cobble | Fair | Fair | F | III | High |
| Morgan Brook | Westford | T1.01-A | 4,305 | BD | 11.6 | 24.3 | 24.3 | 4.0 | 96.5 | 6.1 | 9.5 | 1.2 | E | Dune-Ripple | E | Dune-Ripple | Sand | Fair | Good | F | I | High |
| | | T1.01-B‡ | 1,210 | BD | | | -- | -- | -- | -- | -- | -- | E | Dune-Ripple | E | Dune-Ripple | Sand | NA | Good | -- | -- | High |
| | | T1.02-A | 1,728 | VB | 5.3 | 27.3 | 16.0 | 3.0 | 47.2 | 5.4 | 20.9 | 1.3 | E | Dune-Ripple | E | Dune-Ripple | Sand | Good | Fair | F | II | Extreme |
| | | T1.02-B | 1,551 | BD | | | 28.3 | 2.1 | 60.0 | 13.3 | 5.7 | 1.0 | C | Riffle-Pool | C | Riffle-Pool | Cobble | Fair | Fair | F | I | High |
| | | T1.02-C‡ | 2,291 | BD | | | -- | -- | -- | -- | -- | -- | E | Dune-Ripple | E | Dune-Ripple | Sand | NA | Fair | -- | -- | Extreme |
| | | T1.02-D | 1,297 | VB | | | 21.0 | 3.2 | 68.0 | 6.5 | 12.9 | 1.0 | E | Riffle-Pool | E | Riffle-Pool | Sand | Fair | Fair | F | II | Extreme |
| | | T1.02-E‡ | 909 | VB | | | -- | -- | -- | -- | -- | -- | E | Dune-Ripple | C | Plane Bed | Sand | NA | Poor | -- | -- | Very High |
| | | T1.02-F | 4,762 | BD | | | 15.0 | 2.4 | 35.7 | 6.3 | 9.1 | 1.0 | E | Dune-Ripple | E | Dune-Ripple | Sand | Fair | Fair | F | III | Extreme |
| Rogers Brook | Westford | T2.01-A | 1,303 | SC | 6.3 | 29.4 | 33.8 | 2.3 | 77.7 | 14.7 | 3.0 | 1.0 | Cb | Step-Pool | Cb | Step-Pool | Cobble | Good | Good | F | I | Moderate |
| | | T2.01-B | 3,281 | VB | | | 22.0 | 2.6 | 56.8 | 8.5 | 18.9 | 1.4 | E | Riffle-Pool | E | Riffle-Pool | Sand | Fair | Fair | F | IV | Extreme |
| | | T2.01-C | 2,613 | VB | | | 23.0 | 1.9 | 43.9 | 12.0 | 7.6 | 1.0 | E | Riffle-Pool | E | Riffle-Pool | Sand | Fair | Fair | F | IV | Extreme |
| | | T2.01-D‡ | 3,184 | VB | | | -- | -- | -- | -- | -- | -- | E | Riffle-Pool | E | Riffle-Pool | Sand | NA | Fair | -- | -- | Extreme |
| Stevensville Brook | Underhill | T9.01-A | 1,812 | SC | 3.1 | 28.0 | 28.0 | 1.8 | 49.3 | 15.9 | 1.9 | 1.2 | B | Plane Bed | B | Plane Bed | Cobble | Fair | Fair | F | I | High |
| | | T9.01-B‡ | 335 | NW | 3.1 | | -- | -- | -- | -- | -- | -- | B | Plane Bed | B | Plane Bed | Cobble | NA | Good | -- | -- | Moderate |
| Unnamed Tributary | Jericho | M15S2.01 | 3,908 | VB | 1.9 | 17.4 | 14.5 | 2.2 | 32.3 | 6.5 | 15.0 | 1.0 | E | Dune-Ripple | E | Dune-Ripple | Sand | Fair | Fair | F | I | Extreme |
| | Underhill | M19S1.01-A‡ | 1,202 | VB | 1.6 | 16.1 | -- | -- | -- | -- | -- | -- | C | Riffle-Pool | C | Riffle-Pool | Gravel | NA | Fair | -- | -- | Very High |
| | | M19S1.01-B | 1,458 | VB | | | 17.0 | 1.6 | 26.7 | 10.8 | 7.1 | 1.3 | Cb | Riffle-Pool | Cb | Riffle-Pool | Gravel | Good | Good | F | I | High |
| | | M19S1.01-C | 2,257 | VB | | | 11.0 | 1.8 | 19.3 | 6.3 | 20.1 | 2.0 | Cb | Riffle-Pool | Eb | Plane Bed | Cobble | Poor | Fair | F | II | High |

‡Segments not fully assessed because of property access (T1.02-E, T2.01-D, & T9.01-B) and beaver activity (T1.01-B, T1.02-C, &M19.S1.01-A)

* RGA = Rapid Geomorphic Assessment, *RHA = Rapid Habitat Assessment; *CEM = Channel Evolution Model

† M13-B: Segment is set in a bedrock gorge--RGA data not applicable

Stream: **Browns River** Reach # **M03** Segment: **A** Completion Date: **September 3, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Why Not assessed: Rain: **No**

Segment Length (ft): **6,783** Segment Location: **From the reach break with M02 up to the change in confinement and slope in upper reach.**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Substrate Size**

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 | Very Steep |
| Continuous w/ | Sometimes | Sometimes |
| W/in 1 Bankfill | Sometimes | Sometimes |
| Texture | Bedrock | Bedrock |

1.5 Valley Features

Valley Width (ft) **520**

Width Determination **Measured**

Confinement Type **Narrow**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **96**

2.2 Max Depth (ft) **4.10**

2.3 Mean Depth (ft) **2.85**

2.4 Floodprone Width (ft) **380**

Notes:

Valley confinement varies between narrow and broad, with resulting bedform being dominated by plane bed; some riffle/pool sequences where meanders exists. Habitat limited. No erosion, but width to depth ratio suggest some widening, or scour out of past

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **5.10** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **33.68**

2.7 Entrenchment Ratio **3.96**

2.8 Incision Ratio **1.24**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **750**

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 17% |
| Cobble | 54% |
| Coarse Gravel | 8% |
| Fine Gravel | 4% |
| Sand | 15% |
| Silt and smaller | 2% |

Silt/Clay Present? **No**

Detritus **10** %

# Large Woody **51**

2.13 Average Largest Particle on

Bed **900.0** **mm**

Bar **N/A** **mm**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Cobble**

Subclass Slope: **None**

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 | One | 3.00 |

## Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

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

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 0 | 0 |
| Erosion Height (ft) | 0.00 | 0.00 |
| Revetmt. Type | None | Rip-Rap |
| Revetmt. Length (ft) | 0 | 147 |

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

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | >100 | >100 |
| Sub-dominant | 26-50 | None |
| W less than 25 | 563 | 0 |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | Forest | Forest |
| Sub-dominant | Hay | Pasture |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 1 | |
| Length | 150 | |
| Height | 3.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Low**

4.4 # of Debris Jams **3**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

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 | 2 | 1 |
| **Diagonal** | **Delta** | **Island** |
| 0 | 0 | 1 |

5.2 Other Features

| Flood | Neck Cutoff | Avulsion | Braiding |
|---|---|---|---|
| 0 | 0 | 0 | 1 |

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: **Browns River** Reach # **M03** Segment: **A** Completion Date: **September 3,**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Rain: **No**

Segment Length (ft): **6,783** Segment Location: **From the reach break with M02 up to the change in confinement and slope in upper**

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Ledge | Mid-segment | 6.00 | 4.00 | Yes | |
| Ledge | Mid-segment | 1.00 | 0.00 | No | |

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 | **16** | **None** | **No** |
| 7.2 Channel Aggradation | **14** | **None** | **No** |
| 7.3 Widening Channel | **12** | | **No** |
| 7.4 Change in Planform | **15** | | **No** |
| Total Score | **57** | | |
| Geomorphic Rating | **0.7125** | | |

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 10 |
| 6.2 Embeddedness | 11 |
| 6.3 Velocity/Depth Patterns | 11 |
| 6.4 Sediment Deposition | 11 |
| 6.5 Channel Flow Status | 11 |
| 6.6 Channel Alteration | 15 |
| 6.7 Frequency of Riffles/Steps | 7 |
| 6.8 Bank Stability | Left: 8 Right: 8 |
| 6.9 Bank Vegetation Protection | Left: 7 Right: 7 |
| 6.10 Riparian Vegetation Zone Width | Left: 6 Right: 9 |
| Total Score | 121 |
| Habitat Rating | 0.605 |

Habitat Stream Condition **Fair**

Narrative:

Minor Widening and aggradation but no evidence of historical incision or terraces.

Project: **Browns River** — **Phase 2 Segment Summary** — February 24, 2010 SGAT Version: 4.56

Stream: **Browns River** Reach # **M03** Segment: **B** Completion Date: **September 3, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **No**

Segment Length (ft): **2,171** Segment Location: **From change in slope and substrate size up to reach break.**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Substrate Size**

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 | Very Steep |
| Continuous w/ | Sometimes | Sometimes |
| W/in 1 Bankfill | Sometimes | Sometimes |
| Texture | Sand | Sand |

1.5 Valley Features

Valley Width (ft) **696**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **83**

2.2 Max Depth (ft) **5.40**

2.3 Mean Depth (ft) **4.69**

2.4 Floodprone Width (ft) **575**

Notes:

Segment has historically had extensive straightening and subsequent degradation and incision. IR is 1.9 and most areas have limited access to the floodplain. Now, lots of aggradation of fine sediment is causing almost all of the habitat to be smothered.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **10.20** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **17.59**

2.7 Entrenchment Ratio **6.97**

2.8 Incision Ratio **1.89**

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 | 3% |
| Cobble | 22% |
| Coarse Gravel | 13% |
| Fine Gravel | 16% |
| Sand | 42% |
| Silt and smaller | 4% |

Silt/Clay Present? **No**

Detritus **30** %

# Large Woody **15**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Plane Bed**

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 | Silt | Silt |
| Consistency | Non-cohesive | Non-cohesive |
| Lower | | |
| Material Type | Sand | Sand |
| Consistency | Non-cohesive | Non-cohesive |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 651 | 345 |
| Erosion Height (ft) | 1.43 | 8.42 |
| Revetmt. Type | None | Rip-Rap |
| Revetmt. Length (ft) | 0 | 85 |

| 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 | 26-50 | 0-25 |
| Sub-dominant | >100 | 26-50 |
| W less than 25 | 393 | 1,386 |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | Hay | Hay |
| Sub-dominant | Forest | Shrubs/Saplin |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

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

| | |
|---|---|
| 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 | 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. |
|---|---|---|
| 0 | 0 | Yes |

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **1,925**

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: **Browns River** Reach # **M03** Segment: **B** Completion Date: **September 3,**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **No**

Segment Length (ft): **2,171** Segment Location: **From change in slope and substrate size up to reach break.**

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 | **6** | **None** | **No** |
| 7.2 Channel Aggradation | **8** | **None** | **No** |
| 7.3 Widening Channel | **9** | | **No** |
| 7.4 Change in Planform | **10** | | **Yes** |
| Total Score | **33** | | |
| Geomorphic Rating | **0.4125** | | |

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 5 |
| 6.2 Pool Substrate | 6 |
| 6.3 Pool Variability | 6 |
| 6.4 Sediment Deposition | 6 |
| 6.5 Channel Flow Status | 8 |
| 6.6 Channel Alteration | 7 |
| 6.7 Channel Sinuosity | 3 |
| 6.8 Bank Stability | Left: 3 Right: 5 |
| 6.9 Bank Vegetation Protection | Left: 5 Right: 3 |
| 6.10 Riparian Vegetation Zone Width | Left: 5 Right: 2 |
| Total Score | 64 |
| Habitat Rating | 0.32 |

Habitat Stream Condition **Poor**

Narrative:

Incision and minor widening, following historical straightening.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Browns River** Reach # **M04** Segment: **A** Completion Date: **September 4, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **No**

Segment Length (ft): **2,255** Segment Location: **From reach break up to change in slope at bend to the east.**

**QC Status - Staff: Provisional Cons**

## 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 | 80 | 0 |

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

1.5 Valley Features

Valley Width (ft) **255**

Width Determination **Measured**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **85**

2.2 Max Depth (ft) **4.70**

2.3 Mean Depth (ft) **3.90**

2.4 Floodprone Width (ft) **177**

Notes:

Vegetated islands natural and occurring on bedrock outcrops with exception of one mid-channel deposition near reach break with M03. Bedrock grade controls throughout with good near bank vegetation and pool features around the bedrock controls. Slope is very

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **4.70** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **21.79**

2.7 Entrenchment Ratio **2.08**

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) **670**

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 18% |
| Boulder | 29% |
| Cobble | 25% |
| Coarse Gravel | 11% |
| Fine Gravel | 8% |
| Sand | 8% |
| Silt and smaller | 1% |

Silt/Clay Present? **No**

Detritus **15** %

# Large Woody **46**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **B**

Bed Material: **Cobble**

Subclass Slope: **c**

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 **Moderate**

| Bank Texture | Left | Right |
|---|---|---|
| Upper | | |
| Material Type | Mix | Mix |
| Consistency | Non-cohesive | Non-cohesive |
| Lower | | |
| Material Type | Bedrock | Bedrock |
| Consistency | Cohesive | Cohesive |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 216 | 0 |
| Erosion Height (ft) | 3.58 | 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 **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | >100 | 51-100 |
| Sub-dominant | 51-100 | 26-50 |
| W less than 25 | 76 | 419 |

| 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 | Hay |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Low**

4.4 # of Debris Jams **1**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

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 | 1 | 4 |

5.2 Other Features

| Flood | Neck Cutoff | Avulsion | Braiding |
|---|---|---|---|
| 0 | 0 | 0 | 1 |

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: **458**

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: **Browns River** Reach # **M04** Segment: **A** Completion Date: **September 4,**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **No**

Segment Length (ft): **2,255** Segment Location: **From reach break up to change in slope at bend to the east.**

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Ledge | Mid-segment | 3.00 | 1.00 | Yes | |
| Waterfall | Mid-segment | 8.00 | 5.00 | Yes | |
| Ledge | Mid-segment | 3.00 | 2.00 | Yes | |
| Ledge | Mid-segment | 4.00 | 3.00 | Yes | |
| Ledge | Mid-segment | 1.00 | 0.00 | No | |
| Waterfall | Mid-segment | 10.00 | 6.00 | No | |

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **15** | **None** | **No** |
| 7.2 Channel Aggradation | **13** | **None** | **No** |
| 7.3 Widening Channel | **13** | | **No** |
| 7.4 Change in Planform | **16** | | **No** |
| Total Score | **57** | | |
| Geomorphic Rating | **0.7125** | | |

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 17 |
| 6.2 Embeddedness | 15 |
| 6.3 Velocity/Depth Patterns | 18 |
| 6.4 Sediment Deposition | 15 |
| 6.5 Channel Flow Status | 15 |
| 6.6 Channel Alteration | 18 |
| 6.7 Frequency of Riffles/Steps | 15 |
| 6.8 Bank Stability | Left: 7 Right: 9 |
| 6.9 Bank Vegetation Protection | Left: 9 Right: 9 |
| 6.10 Riparian Vegetation Zone Width | Left: 8 Right: 8 |
| Total Score | 163 |
| Habitat Rating | 0.815 |

Habitat Stream Condition **Good**

Narrative:

Bedrock makes the channel stable vertically. Only minor aggradation and widening around bedrock outcrops. See step 5 for further narrative.

Project: **Browns River** — **Phase 2 Segment Summary** — February 24, 2010 SGAT Version: 4.56

Stream: **Browns River** Reach # **M04** Segment: **B** Completion Date: **September 4, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **No**

Segment Length (ft): **1,425** Segment Location: **From break in slope up to grade control approximately 2000' downstream of Cambridge**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Substrate Size**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

| Length (ft) | One | Both |
|---|---|---|
| Berms | 0 | 0 |
| height | 0 | 0 |
| Roads | 993 | 0 |
| height | 8 | 0 |
| Railroads | 0 | 0 |
| height | 0 | 0 |
| Improved Paths | 0 | 0 |
| height | 0 | 0 |
| Development | 203 | 0 |

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

1.5 Valley Features

Valley Width (ft) **486**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

## Step 2. Stream Channel

2.1 Bankfull Width **80**

2.2 Max Depth (ft) **6.30**

2.3 Mean Depth (ft) **4.90**

2.4 Floodprone Width (ft) **461**

Notes:

Depositional section of river between grade controls similar to segment M03-B. Channel incised--perhaps due to historical straightening/gravel mining and road encroachments. Substrate dominated by sands with poor habitat features. By

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **9.30** ft.

Human Elev Floodpln **10.30** ft.

2.6 Width/Depth Ratio **16.33**

2.7 Entrenchment Ratio **5.76**

2.8 Incision Ratio **1.48**

Human Elevated Inc Rat **1.63**

2.9 Sinuosity **Low**

2.10 Riffles Type **Eroded**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 5% |
| Cobble | 10% |
| Coarse Gravel | 10% |
| Fine Gravel | 15% |
| Sand | 50% |
| Silt and smaller | 10% |

Silt/Clay Present? **Yes**

Detritus **10** %

# Large Woody **16**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Plane Bed**

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 **Undercut**

| Bank Texture | Left | Right |
|---|---|---|
| Upper | | |
| Material Type | Sand | Sand |
| Consistency | Non-cohesive | Non-cohesive |
| Lower | | |
| Material Type | Mix | Mix |
| Consistency | Non-cohesive | Non-cohesive |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 0 | 0 |
| Erosion Height (ft) | 0.00 | 0.00 |
| Revetmt. Type | None | Rip-Rap |
| Revetmt. Length (ft) | 0 | 310 |

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | 0 | 1-25 |

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | 0-25 | 0-25 |
| Sub-dominant | 26-50 | 26-50 |
| W less than 25 | 999 | 610 |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | Crop | Residential |
| Sub-dominant | Shrubs/Saplin | Shrubs/Saplin |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |

Gullies **0**

Length **0**

Height **0.00**

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **Unknown**

Impoundmt. Location

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

(old) Upstrm Flow Reg

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 | 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. |
|---|---|---|
| 0 | 0 | Yes |

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **1,425**

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: **Browns River** Reach # **M04** Segment: **B** Completion Date: **September 4,**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **No**

Segment Length (ft): **1,425** Segment Location: **From break in slope up to grade control approximately 2000' downstream of**

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Ledge | Mid-segment | 4.00 | 1.00 | No | |

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 | **9** | **None** | **No** |
| 7.2 Channel Aggradation | **7** | **None** | **No** |
| 7.3 Widening Channel | **12** | | **No** |
| 7.4 Change in Planform | **13** | | **Yes** |
| Total Score | **41** | | |
| Geomorphic Rating | **0.5125** | | |

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 8 |
| 6.2 Pool Substrate | 7 |
| 6.3 Pool Variability | 10 |
| 6.4 Sediment Deposition | 6 |
| 6.5 Channel Flow Status | 11 |
| 6.6 Channel Alteration | 2 |
| 6.7 Channel Sinuosity | 12 |
| 6.8 Bank Stability | Left: 7 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 7 Right: 5 |
| 6.10 Riparian Vegetation Zone Width | Left: 4 Right: 3 |
| Total Score | 88 |
| Habitat Rating | 0.44 |

Habitat Stream Condition **Fair**

Narrative:

Historical straightening has caused ongoing degradation and now fine sediment is beginning to aggrade.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Browns River** Reach # **M04** Segment: **C** Completion Date: **September 4, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **No**

Segment Length (ft): **3,842** Segment Location: **From large bend where the channel follows Huntley Road up to the reach break at the**

**QC Status - Staff: Provisional Cons**

## 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 | **325** | **0** |
| height | **8** | **0** |
| Railroads | **0** | **0** |
| height | **0** | **0** |
| Improved Paths | **0** | **0** |
| height | **0** | **0** |
| Development | **653** | **364** |

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

1.5 Valley Features

Valley Width (ft) **310**

Width Determination **Measured**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **82**

2.2 Max Depth (ft) **4.70**

2.3 Mean Depth (ft) **3.90**

2.4 Floodprone Width (ft) **171**

Notes:

Segment confinement is variable. Valley walls narrow mid-segment, but are wider in upper and lower segment. Overall, valley width is on average 310 feet wide - semi-confined valley setting agrees with dominant stream type observed - B-type.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **8.50** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **21.03**

2.7 Entrenchment Ratio **2.09**

2.8 Incision Ratio **1.81**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Not Applicable**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | **2** % |
| Boulder | **18** % |
| Cobble | **47** % |
| Coarse Gravel | **10** % |
| Fine Gravel | **10** % |
| Sand | **10** % |
| Silt and smaller | **3** % |

Silt/Clay Present? **No**

Detritus **25** %

# Large Woody **29**

2.13 Average Largest Particle on

Bed **460.0** mm

Bar **N/A** mm

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 | **Mix** | **Mix** |
| Consistency | **Non-cohesive** | **Non-cohesive** |
| Lower | | |
| Material Type | **Boulder/Cobbl** | **Boulder/Cobbl** |
| Consistency | **Non-cohesive** | **Non-cohesive** |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | **0** | **188** |
| Erosion Height (ft) | **0.00** | **3.94** |
| Revetmt. Type | **Rip-Rap** | **Rip-Rap** |
| Revetmt. Length (ft) | **87** | **79** |

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | **76-100** | **51-75** |
| Mid-Channel Canopy | | **Open** |

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | **51-100** | **51-100** |
| Sub-dominant | **0-25** | **0-25** |
| W less than 25 | **939** | **1,028** |

| Buffer Veg. Type | Left | Right |
|---|---|---|
| Dominant | **Deciduous** | **Deciduous** |
| Sub-dominant | **Shrubs/Saplin** | **Shrubs/Saplin** |

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | **Forest** | **Forest** |
| Sub-dominant | **Residential** | **Residential** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | | **0** |
| Length | | **0** |
| Height | | **0.00** |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

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** | **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. |
|---|---|---|
| **0** | **0** | **No** |

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **837**

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: **Browns River** Reach # **M04** Segment: **C** Completion Date: **September 4,**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **No**

Segment Length (ft): **3,842** Segment Location: **From large bend where the channel follows Huntley Road up to the reach break at the**

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Ledge | Mid-segment | 2.00 | 1.00 | No | |
| Ledge | Mid-segment | 6.00 | 4.00 | No | |
| Waterfall | Mid-segment | 6.00 | 2.00 | Yes | |
| Waterfall | Mid-segment | 8.00 | 3.00 | Yes | |
| Ledge | Mid-segment | 0.00 | 0.00 | No | |

4.8 Channel Constrictions

| Type | Width | Photo Taken? | GPS Taken? | Channel Constriction? | Floodprone Constriction? |
|---|---|---|---|---|---|
| Other | 50.0 | Yes | Yes | Yes | Yes |
| Problem | Scour Below | | | | |
| Bridge | 73.0 | Yes | Yes | Yes | Yes |
| Problem | None | | | | |
| Bridge | 87.0 | Yes | Yes | No | Yes |
| Problem | None | | | | |

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **12** | **None** | **Yes** |
| 7.2 Channel Aggradation | **13** | **None** | **No** |
| 7.3 Widening Channel | **12** | | **No** |
| 7.4 Change in Planform | **13** | | **No** |
| Total Score | **50** | | |
| Geomorphic Rating | **0.625** | | |

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 | 13 |
| 6.2 Embeddedness | 12 |
| 6.3 Velocity/Depth Patterns | 16 |
| 6.4 Sediment Deposition | 11 |
| 6.5 Channel Flow Status | 12 |
| 6.6 Channel Alteration | 11 |
| 6.7 Frequency of Riffles/Steps | 8 |
| 6.8 Bank Stability | Left: 7 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 7 Right: 7 |
| 6.10 Riparian Vegetation Zone Width | Left: 8 Right: 6 |
| Total Score | 124 |
| Habitat Rating | 0.62 |

Habitat Stream Condition **Fair**

Narrative:

Some historic degradation and now aggradation process is beginning. Widening will likely occur in near future if aggradation continues.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Browns River** Reach # **M05** Segment: **0** Completion Date: **October 15, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **No**

Segment Length (ft): **8,372** Segment Location: **From confluence with Morgan Brook up to the confluence with Rogers Brook.**

**QC Status - Staff: Provisional Cons**

## 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 | **880** | **0** |
| height | **15** | **0** |
| Railroads | **0** | **0** |
| height | **0** | **0** |
| Improved Paths | **0** | **0** |
| height | **0** | **0** |
| Development | **662** | **333** |

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

1.5 Valley Features

Valley Width (ft) **242**

Width Determination **Measured**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **83**

2.2 Max Depth (ft) **6.00**

2.3 Mean Depth (ft) **5.08**

2.4 Floodprone Width (ft) **242**

Notes:

Reach is set in a semi-confined valley with C-type morphology and plane bed bedform. The dominant substrate type observed is sand and riffles only seemed to be present in areas where bedrock extended into the channel.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **8.70** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **16.34**

2.7 Entrenchment Ratio **2.92**

2.8 Incision Ratio **1.45**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Eroded**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | **0** % |
| Boulder | **3** % |
| Cobble | **7** % |
| Coarse Gravel | **6** % |
| Fine Gravel | **9** % |
| Sand | **67** % |
| Silt and smaller | **8** % |

Silt/Clay Present? **Yes**

Detritus **35** %

# Large Woody **66**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Sand**

Subclass Slope: **None**

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 | **Mix** | **Mix** |
| Consistency | **Non-cohesive** | **Non-cohesive** |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | **1,261** | **1,021** |
| Erosion Height (ft) | **6.38** | **7.69** |
| Revetmt. Type | **Rip-Rap** | **None** |
| Revetmt. Length (ft) | **121** | **0** |

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

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

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 | **1,070** | **3,744** |

| 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 | **Shrubs/Saplin** | **Hay** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | **0** | |
| Length | **0** | |
| Height | **0.00** | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

4.7 StormwaterInputs

| | | | |
|---|---|---|---|
| Field Ditch | **0** | Road Ditch | **1** |
| Other | **0** | Tile Drain | **0** |
| Overland Flow | **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** | **4** | **3** |

| 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: **1,072**

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: **Browns River** Reach # **M05** Segment: **0** Completion Date: **October 15, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **No**

Segment Length (ft): **8,372** Segment Location: **From confluence with Morgan Brook up to the confluence with Rogers Brook.**

### 1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Ledge | Mid-segment | 1.00 | 0.00 | Yes | |
| Ledge | Mid-segment | 5.00 | 2.00 | Yes | |
| Ledge | Mid-segment | 2.00 | 1.00 | Yes | |
| Ledge | Mid-segment | 1.00 | 0.00 | No | |

### 4.8 Channel Constrictions

| Type | Width | Photo Taken? | GPS Taken? | Channel Constriction? | Floodprone Constriction? |
|---|---|---|---|---|---|
| Bridge | 70.0 | Yes | Yes | Yes | Yes |
| Problem | Scour Below | | | | |
| Bedrock | 90.0 | No | No | No | Yes |
| Problem | None | | | | |

### Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Plane Bed**

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

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Good**

Stream Sensitivity **High**

### Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 6 |
| 6.2 Embeddedness | 7 |
| 6.3 Velocity/Depth Patterns | 11 |
| 6.4 Sediment Deposition | 9 |
| 6.5 Channel Flow Status | 15 |
| 6.6 Channel Alteration | 13 |
| 6.7 Frequency of Riffles/Steps | 4 |
| 6.8 Bank Stability | Left: 7 Right: 7 |
| 6.9 Bank Vegetation Protection | Left: 6 Right: 5 |
| 6.10 Riparian Vegetation Zone Width | Left: 7 Right: 6 |
| Total Score | 103 |
| Habitat Rating | 0.515 |

Habitat Stream Condition **Fair**

Narrative:

Minor incision/degradation, but channel is set in a semi-confined valley so planform changes unlikely. MInor to moderate Incision may be natural for this setting due to limited natural floodplain development.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Browns River** Reach # **M06** Segment: **0** Completion Date: **October 15, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **No**

Segment Length (ft): **4,747** Segment Location: **From the reach break at the confluence with Rogers Brook, up to the large sharp meander**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

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

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

1.5 Valley Features

Valley Width (ft) **475**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **58**

2.2 Max Depth (ft) **7.20**

2.3 Mean Depth (ft) **5.38**

2.4 Floodprone Width (ft) **411**

Notes:

This reach has been extensively, historically straightened. Old rip-rap that has been grown over was observed over much of the right bank. Only areas where the rip-rap was exposed and recent was it FITed. This incised E-type channel was most likely a

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **11.40** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **10.69**

2.7 Entrenchment Ratio **7.14**

2.8 Incision Ratio **1.58**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Eroded**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 2% |
| Cobble | 1% |
| Coarse Gravel | 1% |
| Fine Gravel | 11% |
| Sand | 77% |
| Silt and smaller | 8% |

Silt/Clay Present? **No**

Detritus **35** %

# Large Woody **104**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Plane Bed**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

| 3.3 old | Amount | Mean Height |
|---|---|---|
| Failures | One | 18.00 |
| 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) | 2,224 | 920 |
| Erosion Height (ft) | 7.11 | 8.00 |
| Revetmt. Type | None | Rip-Rap |
| Revetmt. Length (ft) | 0 | 658 |

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | 76-100 | 26-50 |
| Mid-Channel Canopy | Open | |

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | >100 | 0-25 |
| Sub-dominant | None | >100 |
| W less than 25 | 0 | 2,255 |

| 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 | Crop |
| Sub-dominant | Shrubs/Saplin | Forest |
| Mass Failures | 55 | 0 |
| Height | 18 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Low**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

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 | 4 | 2 |
| **Diagonal** | **Delta** | **Island** |
| 0 | 0 | 0 |

5.2 Other Features

| Flood | Neck Cutoff | Avulsion | Braiding |
|---|---|---|---|
| 1 | 2 | 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: **4,073**

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: **Browns River** Reach # **M06** Segment: **0** Completion Date: **October 15, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **No**

Segment Length (ft): **4,747** Segment Location: **From the reach break at the confluence with Rogers Brook, up to the large sharp**

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 | **9** | **Other** | **No** |
| 7.2 Channel Aggradation | **12** | **None** | **No** |
| 7.3 Widening Channel | **11** | | **No** |
| 7.4 Change in Planform | **7** | | **No** |
| Total Score | **39** | | |
| Geomorphic Rating | **0.4875** | | |

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 3 |
| 6.2 Embeddedness | 3 |
| 6.3 Velocity/Depth Patterns | 7 |
| 6.4 Sediment Deposition | 5 |
| 6.5 Channel Flow Status | 13 |
| 6.6 Channel Alteration | 6 |
| 6.7 Frequency of Riffles/Steps | 3 |
| 6.8 Bank Stability | Left: 3 Right: 2 |
| 6.9 Bank Vegetation Protection | Left: 7 Right: 5 |
| 6.10 Riparian Vegetation Zone Width | Left: 9 Right: 4 |
| Total Score | 70 |
| Habitat Rating | 0.35 |

Habitat Stream Condition **Fair**

Narrative:

Both current and historical planform changes are present. Current: the observed neck cutoff mid-reach; Historic: the extensive channel straightening which led to severe incision and a stream type departure from C to E.

Project: **Browns River** — **Phase 2 Segment Summary** — February 24, 2010 — SGAT Version: 4.56

Stream: **Browns River** Reach # **M13** Segment: **A** Completion Date: **August 7, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP; FEA, CCRCP** Why Not assessed: Rain: **No**

Segment Length (ft): **555** Segment Location: **From the reach break with M12 at the confluence with T4.01 up to the segment break just**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

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

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

1.5 Valley Features

Valley Width (ft) **555**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **64**

2.2 Max Depth (ft) **5.40**

2.3 Mean Depth (ft) **4.14**

2.4 Floodprone Width (ft) **331**

Notes:

Very short segment below Route 15 to characterize the unconfined stretch. Riffle sequence not evaluated due to short length. Channel incised and disconnected from historical floodplain on the right bank.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **8.70** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **15.46**

2.7 Entrenchment Ratio **5.17**

2.8 Incision Ratio **1.61**

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 | 6% |
| Cobble | 12% |
| Coarse Gravel | 39% |
| Fine Gravel | 17% |
| Sand | 10% |
| Silt and smaller | 16% |

Silt/Clay Present? **No**

Detritus **10** %

# Large Woody **14**

2.13 Average Largest Particle on

Bed **400.0** **mm**

Bar **N/A** **mm**

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)

**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 | Boulder/Cobbl | Boulder/Cobbl |
| Consistency | Non-cohesive | Non-cohesive |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 0 | 105 |
| Erosion Height (ft) | 0.00 | 5.00 |
| Revetmt. Type | None | None |
| Revetmt. Length (ft) | 0 | 0 |

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | 51-75 | 51-75 |
| Mid-Channel Canopy | | Open |

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | 51-100 | 26-50 |
| Sub-dominant | 26-50 | 51-100 |
| W less than 25 | 0 | 0 |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | Forest | Forest |
| Sub-dominant | Residential | Hay |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## 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 **None**

(old) Upstrm Flow Reg **None**

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 | 1 |

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: **Browns River** Reach # **M13** Segment: **A** Completion Date: **August 7, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP; FEA, CCRCP** Rain: **No**

Segment Length (ft): **555** Segment Location: **From the reach break with M12 at the confluence with T4.01 up to the segment break**

1.6 Grade Controls **None**

| Type | Location | Total | Total Height Above Water | Photo Taken | GPS Taken |
|---|---|---|---|---|---|

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 | **11** | **None** | **No** |
| 7.2 Channel Aggradation | **12** | **None** | **No** |
| 7.3 Widening Channel | **12** | | **No** |
| 7.4 Change in Planform | **12** | | **No** |
| Total Score | **47** | | |
| Geomorphic Rating | **0.5875** | | |

Channel Evolution Model **F**

Channel Evolution Stage **II**

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 | 11 |
| 6.3 Velocity/Depth Patterns | 8 |
| 6.4 Sediment Deposition | 10 |
| 6.5 Channel Flow Status | 9 |
| 6.6 Channel Alteration | 14 |
| 6.7 Frequency of Riffles/Steps | 11 |
| 6.8 Bank Stability | Left: 8 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 6 Right: 6 |
| 6.10 Riparian Vegetation Zone Width | Left: 8 Right: 7 |
| Total Score | 114 |
| Habitat Rating | 0.57 |

Habitat Stream Condition **Fair**

Narrative:

All adjustments are present in some form, with no process more notable than the others.

Project: **Browns River** **Phase 2 Segment Summary** February 24, 2010 SGAT Version: 4.56

Stream: **Browns River** Reach # **M13** Segment: **B** Completion Date: **August 7, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP; FEA, CCRCP** Why Not assessed: Rain: **No**

Segment Length (ft): **4,594** Segment Location: **Bedrock gorge that extends from just below the Route 15 crossing to the reach break with**

**QC Status - Staff: Provisional Cons**

## 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 | **853** | **0** |
| height | **0** | **0** |
| Railroads | **0** | **0** |
| height | **0** | **0** |
| Improved Paths | **0** | **0** |
| height | **0** | **0** |
| Development | **284** | **421** |

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

1.5 Valley Features

Valley Width (ft) **126**

Width Determination **Estimated**

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:

Channel is set in a bedrock gorge. Several areas of the channel don't have complete bedrock side slopes and have more of a plane bed bedform. No cross-section was taken, but the banks and buffers were assessed and substrate was estimated.

**Provisional** *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 **Moderate**

2.10 Riffles Type **Not Applicable**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | **50** % |
| Boulder | **20** % |
| Cobble | **8** % |
| Coarse Gravel | **10** % |
| Fine Gravel | **5** % |
| Sand | **5** % |
| Silt and smaller | **2** % |

Silt/Clay Present? **No**

Detritus **10** %

# Large Woody **36**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **B**

Bed Material: **Bedrock**

Subclass Slope: **None**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

| 3.3 old | Amount | Mean Height |
|---|---|---|
| Failures | **None** | **0.00** |
| Gullies | **None** | **0.00** |

## Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

| Bank Texture | Left | Right |
|---|---|---|
| Upper | | |
| Material Type | **Bedrock** | **Bedrock** |
| Consistency | **Cohesive** | **Cohesive** |
| Lower | | |
| Material Type | **Bedrock** | **Bedrock** |
| Consistency | **Cohesive** | **Cohesive** |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | **188** | **0** |
| Erosion Height (ft) | **7.21** | **0.00** |
| Revetmt. Type | **Rip-Rap** | **Rip-Rap** |
| Revetmt. Length (ft) | **226** | **173** |

| Near Bank Veg. Type | Left | Right |
|---|---|---|
| Dominant | **Coniferous** | **Coniferous** |
| 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 | **582** | **183** |

| 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 | **Residential** | **Residential** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | **0** | |
| Length | **0** | |
| Height | **0.00** | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg **None**

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** | **1** |

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: **Browns River** Reach # **M13** Segment: **B** Completion Date: **August 7, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP; FEA, CCRCP** Rain: **No**

Segment Length (ft): **4,594** Segment Location: **Bedrock gorge that extends from just below the Route 15 crossing to the reach break**

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Ledge | Mid-segment | 3.00 | 2.00 | Yes | |
| Waterfall | Mid-segment | 30.00 | 28.00 | Yes | |
| Waterfall | Mid-segment | 2.00 | 1.00 | Yes | |
| Ledge | Mid-segment | 10.00 | 5.00 | Yes | |
| Waterfall | Mid-segment | 4.00 | 1.00 | Yes | |
| Ledge | Mid-segment | 3.00 | 1.00 | Yes | |
| Waterfall | Mid-segment | 13.00 | 10.00 | Yes | |
| Ledge | Mid-segment | 5.00 | 2.00 | Yes | |
| Waterfall | Mid-segment | 6.00 | 4.00 | Yes | |
| Ledge | Mid-segment | 4.00 | 2.00 | Yes | |
| Ledge | Mid-segment | 10.00 | 8.00 | Yes | |
| Waterfall | Mid-segment | 7.00 | 4.00 | Yes | |
| Waterfall | Mid-segment | 20.00 | 15.00 | Yes | |
| Problem | None | | | | |
| Bridge | 90.0 | Yes | Yes | No | Yes |
| Problem | None | | | | |
| Other | 18.0 | Yes | No | Yes | Yes |
| Problem | Deposition Above | | | | |
| Bedrock | 30.0 | Yes | No | Yes | Yes |
| Problem | None | | | | |
| Bedrock | 19.0 | Yes | No | Yes | Yes |
| Problem | None | | | | |
| Bedrock | 20.0 | No | No | Yes | Yes |
| Problem | None | | | | |
| Bridge | 60.0 | Yes | Yes | Yes | Yes |
| Problem | Deposition Above | | | | |

Narrative:

No RGA filled out because segment is in a bedrock gorge setting.

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity Very Low

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 11 |
| 6.2 Embeddedness | 13 |
| 6.3 Velocity/Depth Patterns | 15 |
| 6.4 Sediment Deposition | 12 |
| 6.5 Channel Flow Status | 11 |
| 6.6 Channel Alteration | 13 |
| 6.7 Frequency of Riffles/Steps | 12 |
| 6.8 Bank Stability | Left: 8 Right: 10 |
| 6.9 Bank Vegetation Protection | Left: 7 Right: 7 |
| 6.10 Riparian Vegetation Zone Width | Left: 6 Right: 7 |
| Total Score | 132 |
| Habitat Rating | 0.66 |

Habitat Stream Condition **Good**

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Browns River** Reach # **M16** Segment: **A** Completion Date: **August 7, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP; FEA, CCRCP** Why Not assessed: Rain: **No**

Segment Length (ft): **4,738** Segment Location: ***NOTE: Segment Length has been changed to 4738 from 1115 so the length measurements**

**QC Status - Staff: Provisional Cons Passed**

## Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

| Length (ft) | One | Both |
|---|---|---|
| Berms | **814** | **0** |
| height | **2** | **0** |
| Roads | **577** | **0** |
| height | **8** | **0** |
| Railroads | **0** | **0** |
| height | **0** | **0** |
| Improved Paths | **0** | **0** |
| height | **0** | **0** |
| Development | **1,187** | **0** |

| 1.4 Adjacent Side | Left | Right |
|---|---|---|
| Hillside Slope | **Hilly** | **Flat** |
| Continuous w/ | **Never** | **Never** |
| W/in 1 Bankfill | **Never** | **Never** |
| Texture | **Not Evalua** | **Not Evalua** |

1.5 Valley Features

Valley Width (ft) **670**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

## Step 2. Stream Channel

2.1 Bankfull Width **54**

2.2 Max Depth (ft) **4.00**

2.3 Mean Depth (ft) **3.04**

2.4 Floodprone Width (ft) **108**

Notes:

Entire reach was likely straightened and mined for gravel historically. Banks extensively armored and with limited buffer width. Downstream end of the segment is less incised as it approaches a depositional area in reach M15. Upper reach is very

*Step 2. (Contued)*

2.5 Aband. Floodpln **6.00** ft.

Human Elev Floodpln **8.00** ft.

2.6 Width/Depth Ratio **17.76**

2.7 Entrenchment Ratio **2.00**

2.8 Incision Ratio **1.50**

Human Elevated Inc Rat **2.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Eroded**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | **0** % |
| Boulder | **3** % |
| Cobble | **30** % |
| Coarse Gravel | **39** % |
| Fine Gravel | **16** % |
| Sand | **12** % |
| Silt and smaller | **0** % |

Silt/Clay Present? **No**

Detritus **20** %

# Large Woody **8**

2.13 Average Largest Particle on

Bed **250.0** mm

Bar **110.0** mm

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** | **Gravel** |
| Consistency | **Non-cohesive** | **Non-cohesive** |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | **53** | **264** |
| Erosion Height (ft) | **6.00** | **4.35** |
| Revetmt. Type | **Rip-Rap** | **Rip-Rap** |
| Revetmt. Length (ft) | **2,542** | **1,642** |

| Near Bank Veg. Type | Left | Right |
|---|---|---|
| Dominant | **Invasives** | **Invasives** |
| Sub-dominant | **Shrubs/Saplin** | **Shrubs/Saplin** |

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | **26-50** | **51-100** |
| Sub-dominant | **0-25** | **0-25** |
| W less than 25 | **656** | **1,650** |

| Buffer Veg. Type | Left | Right |
|---|---|---|
| Dominant | **Deciduous** | **Deciduous** |
| Sub-dominant | **Herbaceous** | **Herbaceous** |

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | **Hay** | **Hay** |
| Sub-dominant | **Residential** | **Residential** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | **0** | |
| Length | **0** | |
| Height | **0.00** | |

## 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 **None**

(old) Upstrm Flow Reg **None**

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** | **7** | **5** |

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

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **Straightening**

Straightening Length: **4,642**

5.5 Dredging **Gravel Mining**

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: **Browns River** Reach # **M16** Segment: **A** Completion Date: **August 7, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP; FEA, CCRCP** Rain: **No**

Segment Length (ft): **4,738** Segment Location: ***NOTE: Segment Length has been changed to 4738 from 1115 so the length**

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 | 90.0 | Yes | Yes | No | Yes |
| Problem | Deposition Above,Deposition Below | | | | |
| Bridge | 36.0 | Yes | Yes | Yes | Yes |
| Problem | Deposition Above | | | | |

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **3** | **C to B** | **Yes** |
| 7.2 Channel Aggradation | **5** | **None** | **No** |
| 7.3 Widening Channel | **9** | | **No** |
| 7.4 Change in Planform | **11** | | **Yes** |
| Total Score | **28** | | |
| Geomorphic Rating | **0.35** | | |

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Poor**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 1 |
| 6.2 Embeddedness | 6 |
| 6.3 Velocity/Depth Patterns | 2 |
| 6.4 Sediment Deposition | 1 |
| 6.5 Channel Flow Status | 5 |
| 6.6 Channel Alteration | 1 |
| 6.7 Frequency of Riffles/Steps | 2 |
| 6.8 Bank Stability | Left: 5 Right: 5 |
| 6.9 Bank Vegetation Protection | Left: 3 Right: 2 |
| 6.10 Riparian Vegetation Zone Width | Left: 3 Right: 2 |
| Total Score | 38 |
| Habitat Rating | 0.19 |

Habitat Stream Condition **Poor**

Narrative:

RGA scores added by FEA 9-8-09, but stream sensitivity was kept as "Extreme" to be consistent with the FEH corridor work done by Staci P (1-16-09). Actual sensitivity is "Very high" for B4-type with Poor RGA. All adjustments very active. See step 5.

Stream: **Browns River** Reach # **M20** Segment: **0** Completion Date: **August 26, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **3,037** Segment Location: **From the reach break at the confluence with T9.01 to the reach break with M21 where the**

**QC Status - Staff: Provisional Cons**

## 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 | **426** | **0** |
| height | **15** | **0** |
| Railroads | **0** | **0** |
| height | **0** | **0** |
| Improved Paths | **0** | **0** |
| height | **0** | **0** |
| Development | **584** | **0** |

| 1.4 Adjacent Side | Left | Right |
|---|---|---|
| Hillside Slope | **Steep** | **Hilly** |
| Continuous w/ | **Sometimes** | **Sometimes** |
| W/in 1 Bankfill | **Sometimes** | **Sometimes** |
| Texture | **Not Evalua** | **Not Evalua** |

1.5 Valley Features

Valley Width (ft) **515**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **33**

2.2 Max Depth (ft) **3.20**

2.3 Mean Depth (ft) **2.25**

2.4 Floodprone Width (ft) **202**

Notes:

Lower reach had significant aggradation and many steep riffles. Several floodchutes were observed on this reach, 1 even connected to T9.01. Buffer width is low in mid-reach along both banks. As slope increased and bedform became plane bed, the available habitat

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **4.70** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **14.44**

2.7 Entrenchment Ratio **6.20**

2.8 Incision Ratio **1.47**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **85**

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | **0** % |
| Boulder | **7** % |
| Cobble | **51** % |
| Coarse Gravel | **13** % |
| Fine Gravel | **18** % |
| Sand | **11** % |
| Silt and smaller | **0** % |

Silt/Clay Present? **No**

Detritus **20** %

# Large Woody **39**

2.13 Average Largest Particle on

Bed **11.5** **inches**

Bar **4.5** **inches**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Cobble**

Subclass Slope: **b**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

| 3.3 old | Amount | Mean Height |
|---|---|---|
| Failures | **None** | **0.00** |
| Gullies | **None** | **0.00** |

## Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

| Bank Texture | Left | Right |
|---|---|---|
| Upper | | |
| Material Type | **Mix** | **Mix** |
| Consistency | **Non-cohesive** | **Non-cohesive** |
| Lower | | |
| Material Type | **Boulder/Cobbl** | **Boulder/Cobbl** |
| Consistency | **Non-cohesive** | **Non-cohesive** |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | **46** | **0** |
| Erosion Height (ft) | **4.00** | **0.00** |
| Revetmt. Type | **None** | **None** |
| Revetmt. Length (ft) | **0** | **0** |

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

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

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | **26-50** | **>100** |
| Sub-dominant | **0-25** | **0-25** |
| W less than 25 | **734** | **871** |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | **Hay** | **Forest** |
| Sub-dominant | **Residential** | **Residential** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | **0** | |
| Length | **0** | |
| Height | **0.00** | |

## Step 4. Flow & Flow Modifiers

| | |
|---|---|
| 4.1 Springs / Seeps | **Minimal** |
| 4.2 Adjacent Wetlands | **None** |
| 4.3 Flow Status | **Low** |
| 4.4 # of Debris Jams | **3** |
| 4.5 Flow Regulation Type | **None** |
| Flow Regulation Use | |
| Impoundments | **None** |
| Impoundmt. Location | |
| 4.6 Up/Down strm flow reg | **None** |
| (old) Upstrm Flow Reg | **None** |

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** | **9** | **2** |
| **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. |
|---|---|---|
| **4** | **0** | **No** |

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **699**

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: **Browns River** Reach # **M20** Segment: **0** Completion Date: **August 26, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **3,037** Segment Location: **From the reach break at the confluence with T9.01 to the reach break with M21 where**

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Ledge | Mid-segment | 1.00 | 0.00 | No | |
| Ledge | Mid-segment | 4.00 | 2.00 | No | |

4.8 Channel Constrictions

| Type | Width | Photo Taken? | GPS Taken? | Channel Constriction? | Floodprone Constriction? |
|---|---|---|---|---|---|
| Bridge | 18.0 | Yes | Yes | Yes | 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 | **11** | **None** | **No** |
| 7.3 Widening Channel | **12** | | **No** |
| 7.4 Change in Planform | **10** | | **No** |

Total Score **48**

Geomorphic Rating **0.6**

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 | 9 |
| 6.2 Embeddedness | 12 |
| 6.3 Velocity/Depth Patterns | 10 |
| 6.4 Sediment Deposition | 6 |
| 6.5 Channel Flow Status | 8 |
| 6.6 Channel Alteration | 12 |
| 6.7 Frequency of Riffles/Steps | 11 |
| 6.8 Bank Stability | Left: 6 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 3 Right: 4 |
| 6.10 Riparian Vegetation Zone Width | Left: 3 Right: 3 |

Total Score 93

Habitat Rating 0.465

Habitat Stream Condition **Fair**

Narrative:

Aggradation, shifting planform, and widening in lower reach.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Morgan Brook** Reach # **T1.01** Segment: **A** Completion Date: **October 21, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **Yes**

Segment Length (ft): **4,305** Segment Location: **From the confluence with the main stem of the browns river to approximately 1,200 feet**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Flow Status**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

| Length (ft) | One | Both |
|---|---|---|
| Berms | **0** | **0** |
| height | **0** | **0** |
| Roads | **885** | **0** |
| height | **15** | **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** | **Sometimes** |
| W/in 1 Bankfill | **Sometimes** | **Sometimes** |
| Texture | **Not Evalua** | **Not Evalua** |

1.5 Valley Features

Valley Width (ft) **231**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **24**

2.2 Max Depth (ft) **5.70**

2.3 Mean Depth (ft) **3.97**

2.4 Floodprone Width (ft) **231**

Notes:

Segment E-type with some ponding associated with large waterfall/grade control in downstream end. Outside of meander bends have moderate erosion and relic rip-rap is present throughout segment.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **6.60** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **6.12**

2.7 Entrenchment Ratio **9.51**

2.8 Incision Ratio **1.16**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Not Applicable**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | **0** % |
| Boulder | **6** % |
| Cobble | **12** % |
| Coarse Gravel | **6** % |
| Fine Gravel | **5** % |
| Sand | **41** % |
| Silt and smaller | **30** % |

Silt/Clay Present? **Yes**

Detritus **12** %

# Large Woody **47**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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 | **Sand** | **Sand** |
| Consistency | **Non-cohesive** | **Non-cohesive** |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | **284** | **454** |
| Erosion Height (ft) | **4.20** | **4.24** |
| Revetmt. Type | **Rip-Rap** | **None** |
| Revetmt. Length (ft) | **113** | **0** |

| Near Bank Veg. Type | Left | Right |
|---|---|---|
| Dominant | **Shrubs/Saplin** | **Shrubs/Saplin** |
| Sub-dominant | **Pasture** | **Pasture** |

| 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 | **26-50** | **26-50** |
| W less than 25 | **1,756** | **2,712** |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | **Hay** | **Hay** |
| Sub-dominant | **Pasture** | **Pasture** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | **0** | |
| Length | **0** | |
| Height | **0.00** | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Low**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

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** | **4** | **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 **Yes**

5.5 Straightening **Straightening**

Straightening Length: **1,888**

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.

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Waterfall | Mid-segment | 11.00 | 9.00 | Yes | |

4.8 Channel Constrictions

| Type | Width | Photo Taken? | GPS Taken? | Channel Constriction? | Floodprone Constriction? |
|---|---|---|---|---|---|
| Bedrock | 12.0 | Yes | Yes | Yes | Yes |
| Problem | None | | | | |
| Culvert | 16.0 | Yes | Yes | Yes | Yes |
| Problem | Scour Below | | | | |

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **14** | **None** | **No** |
| 7.2 Channel Aggradation | **14** | **None** | **No** |
| 7.3 Widening Channel | **15** | | **No** |
| 7.4 Change in Planform | **13** | | **Yes** |
| Total Score | **56** | | |
| Geomorphic Rating | **0.7** | | |

Channel Evolution Model **F**
Channel Evolution Stage **I**
Geomorphic Condition **Good**
Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 12 |
| 6.2 Pool Substrate | 15 |
| 6.3 Pool Variability | 15 |
| 6.4 Sediment Deposition | 15 |
| 6.5 Channel Flow Status | 10 |
| 6.6 Channel Alteration | 7 |
| 6.7 Channel Sinuosity | 10 |
| 6.8 Bank Stability | Left: 7 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 4 Right: 4 |
| 6.10 Riparian Vegetation Zone Width | Left: 4 Right: 3 |
| Total Score | 112 |
| Habitat Rating | 0.56 |

Habitat Stream Condition **Fair**

Narrative:
Minor planform changes and some historical straightening in lower segment. No evidence of terraces in straightened section, so segment classified in stage I of CEM.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Morgan Brook** Reach # **T1.01** Segment: **B** Completion Date: **October 21, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: **beaver dam** Rain: **Yes**

Segment Length (ft): **1,210** Segment Location: **From the segment break approximately 1,200 feet downstream of the reach break to the**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Flow Status**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

| Length (ft) | One | Both |
|---|---|---|
| Berms | **86** | **0** |
| height | **2** | **0** |
| Roads | **0** | **0** |
| height | **0** | **0** |
| Railroads | **0** | **0** |
| height | **0** | **0** |
| Improved Paths | **0** | **0** |
| height | **0** | **0** |
| Development | **147** | **0** |

| 1.4 Adjacent Side | Left | Right |
|---|---|---|
| Hillside Slope | **Steep** | **Steep** |
| Continuous w/ | **Sometimes** | **Sometimes** |
| W/in 1 Bankfill | **Sometimes** | **Sometimes** |
| Texture | **Bedrock** | **Not Evalua** |

1.5 Valley Features

Valley Width (ft) **170**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

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:

Segment entirely impounded by beaver activity, professional judgment was used to identify a stream type (E-type) and RGA condition. Interestingly, the beaver dams in this reach were made using the corn from the adjacent corn field.

**Provisional** *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 **Moderate**

2.10 Riffles Type

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

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

# Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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 | **Sand** | **Sand** |
| Consistency | **Non-cohesive** | **Non-cohesive** |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | **123** | **0** |
| Erosion Height (ft) | **4.00** | **0.00** |
| Revetmt. Type | **None** | **Rip-Rap** |
| Revetmt. Length (ft) | **0** | **13** |

| 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 | **26-50** | **26-50** |
| Sub-dominant | **51-100** | **0-25** |
| W less than 25 | **0** | **226** |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | **Crop** | **Shrubs/Saplin** |
| Sub-dominant | **Pasture** | **Residential** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | | **0** |
| Length | | **0** |
| Height | | **0.00** |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Low**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **3**

Affected Length (ft) **1,175**

## Step 5. Channel Bed and Planform Changes

5.1 Bar Types

| Mid | Point | Side |
|---|---|---|
| **0** | **1** | **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 **Straightening**

Straightening Length: **561**

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.

1.6 Grade Controls **None**

| Type | Location | Total | Total Height Above Water | Photo Taken | GPS Taken |
|---|---|---|---|---|---|

4.8 Channel Constrictions **None**

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition: **Good**

Stream Sensitivity: High

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: **Browns River** | **Phase 2 Segment Summary** | February 24, 2010 SGAT Version: 4.56

Stream: **Morgan Brook** Reach # **T1.02** Segment: **A** Completion Date: **October 21, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,728** Segment Location: **From the reach break at the Osgood Hill Road crossing up to the segment break at the**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

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

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

1.5 Valley Features

Valley Width (ft) **335**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **16**

2.2 Max Depth (ft) **4.50**

2.3 Mean Depth (ft) **2.95**

2.4 Floodprone Width (ft) **335**

Notes:

Segment has experienced significant historic channel straightening. Much of the reach has also been ponded by beaver activity recently. Currently only three small beaver dams were observed, that have a limited effect on the flow dynamics of the channel.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **6.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **5.42**

2.7 Entrenchment Ratio **20.94**

2.8 Incision Ratio **1.33**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Not Applicable**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 0% |
| Cobble | 0% |
| Coarse Gravel | 11% |
| Fine Gravel | 22% |
| Sand | 41% |
| Silt and smaller | 26% |

Silt/Clay Present? **Yes**

Detritus **15** %

# Large Woody **24**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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 | Gravel |
| Consistency | Non-cohesive | Non-cohesive |
| Bank Erosion | Left | Right |
| Erosion Length (ft) | 159 | 124 |
| Erosion Height (ft) | 3.54 | 3.85 |
| Revetmt. Type | Rip-Rap | Rip-Rap |
| Revetmt. Length (ft) | 148 | 102 |
| 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 | >100 | 0-25 |
| Sub-dominant | 26-50 | 26-50 |
| W less than 25 | 0 | 1,114 |
| 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 | Hay |
| Sub-dominant | Forest | Shrubs/Saplin |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Low**

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 **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

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

4.9 # of Beaver Dams **4**

Affected Length (ft) **250**

## Step 5. Channel Bed and Planform Changes

5.1 Bar Types

| Mid | Point | Side |
|---|---|---|
| 0 | 4 | 0 |
| Diagonal | Delta | Island |
| 0 | 0 | 0 |

5.2 Other Features

| Flood | Neck Cutoff | Avulsion | Braiding |
|---|---|---|---|
| 0 | 2 | 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: **1,015**

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: **Morgan Brook** Reach # **T1.02** Segment: **A** Completion Date: **October 21, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **Yes**

Segment Length (ft): **1,728** Segment Location: **From the reach break at the Osgood Hill Road crossing up to the segment break at the**

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 | 14.0 | Yes | Yes | Yes | Yes |

Problem: Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **11** | **None** | **No** |
| 7.2 Channel Aggradation | **14** | **None** | **No** |
| 7.3 Widening Channel | **14** | | **No** |
| 7.4 Change in Planform | **11** | | **No** |
| Total Score | **50** | | |
| Geomorphic Rating | **0.625** | | |

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 16 |
| 6.2 Pool Substrate | 16 |
| 6.3 Pool Variability | 16 |
| 6.4 Sediment Deposition | 16 |
| 6.5 Channel Flow Status | 14 |
| 6.6 Channel Alteration | 10 |
| 6.7 Channel Sinuosity | 10 |
| 6.8 Bank Stability | Left: 7 Right: 7 |
| 6.9 Bank Vegetation Protection | Left: 7 Right: 6 |
| 6.10 Riparian Vegetation Zone Width | Left: 9 Right: 3 |
| Total Score | 137 |
| Habitat Rating | 0.685 |

Habitat Stream Condition **Good**

Narrative:

Incision triggered by historical channel straightening. Channel has regained some sinuosity and ongoing minor planform changes were noted in upper segment, but are also naturally found in this setting when beavers are present.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Morgan Brook** Reach # **T1.02** Segment: **B** Completion Date: **October 21, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,551** Segment Location: **From the segment break at the southeast edge of the Hay field up to the next segment break**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

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

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

1.5 Valley Features

Valley Width (ft) **217**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **28**

2.2 Max Depth (ft) **2.80**

2.3 Mean Depth (ft) **2.12**

2.4 Floodprone Width (ft) **162**

Notes:

Segment recently has been impounded by a large beaver dam located mid-reach. Since it has been breached, almost all sediment that was deposited behind it has been flushed through the system.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **2.80** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **13.35**

2.7 Entrenchment Ratio **5.72**

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) **145**

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 7% |
| Cobble | 53% |
| Coarse Gravel | 10% |
| Fine Gravel | 4% |
| Sand | 8% |
| Silt and smaller | 18% |

Silt/Clay Present? **Yes**

Detritus **10** %

# Large Woody **24**

2.13 Average Largest Particle on

Bed **500.0** **mm**

Bar **N/A** **mm**

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)

**C 3 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 | **Mix** | **Mix** |
| Consistency | **Non-cohesive** | **Non-cohesive** |
| Lower | | |
| Material Type | **Boulder/Cobbl** | **Boulder/Cobbl** |
| Consistency | **Non-cohesive** | **Non-cohesive** |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 0 | 51 |
| Erosion Height (ft) | 0.00 | 3.00 |
| Revetmt. Type | **Rip-Rap** | **Rip-Rap** |
| Revetmt. Length (ft) | 72 | 63 |

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | **51-75** | **1-25** |

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 | 368 |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | **Forest** | **Forest** |
| Sub-dominant | **Shrubs/Saplin** | **Hay** |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Low**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **1**

Affected Length (ft) **5**

## Step 5. Channel Bed and Planform Changes

5.1 Bar Types

| Mid | Point | Side |
|---|---|---|
| 1 | 3 | 0 |

| Diagonal | Delta | Island |
|---|---|---|
| 0 | 0 | 0 |

5.2 Other Features

| Flood | Neck Cutoff | Avulsion | Braiding |
|---|---|---|---|
| 0 | 1 | 1 | 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: **Morgan Brook** Reach # **T1.02** Segment: **B** Completion Date: **October 21, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **Yes**

Segment Length (ft): **1,551** Segment Location: **From the segment break at the southeast edge of the Hay field up to the next segment**

### 1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Ledge | Mid-segment | 1.00 | 0.00 | No | |
| Waterfall | Mid-segment | 8.00 | 6.00 | No | |

### 4.8 Channel Constrictions

| Type | Width | Photo Taken? | GPS Taken? | Channel Constriction? | Floodprone Constriction? |
|---|---|---|---|---|---|
| Old | 3.00 | Yes | Yes | Yes | Yes |

Problem Deposition Above

### Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **14** | **None** | **No** |
| 7.2 Channel Aggradation | **12** | **None** | **No** |
| 7.3 Widening Channel | **13** | | **No** |
| 7.4 Change in Planform | **11** | | **No** |

Total Score **50**

Geomorphic Rating **0.625**

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

### Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 13 |
| 6.2 Embeddedness | 14 |
| 6.3 Velocity/Depth Patterns | 11 |
| 6.4 Sediment Deposition | 11 |
| 6.5 Channel Flow Status | 12 |
| 6.6 Channel Alteration | 10 |
| 6.7 Frequency of Riffles/Steps | 16 |
| 6.8 Bank Stability | Left: 7 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 8 Right: 6 |
| 6.10 Riparian Vegetation Zone Width | Left: 9 Right: 4 |
| Total Score | 127 |
| Habitat Rating | 0.635 |

Habitat Stream Condition **Fair**

Narrative:

Stream has aggraded sediment behind a large beaver dam that has been breached. Now it is back to coarse substrate, and the channel evolution stage remains I.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Morgan Brook** Reach # **T1.02** Segment: **C** Completion Date: **October 29, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: **beaver dam** Rain: **Yes**

Segment Length (ft): **2,291** Segment Location: **From the segment break at the old bridge crossing, up to the next segment break about 600**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

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

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

1.5 Valley Features

Valley Width (ft) **180**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

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:

At the time of survey the channel was impounded by 3 beaver dams. The majority of the channel is within a fenced in pasture that is used to graze cattle. much of the saturated banks and buffers were trampled in by hooves and providing an ample source of

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

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

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

# Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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 **Undercut**

| 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) | **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 | **Pasture** | **Pasture** |
| Sub-dominant | **Herbaceous** | **Herbaceous** |

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | **0** | **0** |

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | **0-25** | **0-25** |
| Sub-dominant | **26-50** | **26-50** |
| W less than 25 | **1,455** | **1,448** |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | **Pasture** | **Pasture** |
| Sub-dominant | **Shrubs/Saplin** | **Crop** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |

Gullies **0**

Length **0**

Height **0.00**

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Low**

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 **None**

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **3**

Affected Length (ft) **2,100**

## 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 **Yes**

5.5 Straightening **Straightening**

Straightening Length: **442**

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.

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? |
|---|---|---|---|---|---|

Narrative:

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

Stream: **Morgan Brook** Reach # **T1.02** Segment: **D** Completion Date: **October 29, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,297** Segment Location: **From the segment break downstream of Old Number 11 Road, to the segment break at the**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Flow Status**

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** | **Hilly** |
| Continuous w/ | **Sometimes** | **Sometimes** |
| W/in 1 Bankfill | **Sometimes** | **Sometimes** |
| Texture | **Sand** | **Not Evalua** |

1.5 Valley Features

Valley Width (ft) **270**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **21**

2.2 Max Depth (ft) **4.60**

2.3 Mean Depth (ft) **3.24**

2.4 Floodprone Width (ft) **270**

Notes:

Part of the segment is in pasture along the south side of Old Number 11 Road. The rest of the segment is on the north side of the road. The channel is an E-type by reference, but beaver activity and human activity have caused minor incision in the lower segment.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **5.60** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **6.48**

2.7 Entrenchment Ratio **12.86**

2.8 Incision Ratio **1.22**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Eroded**

2.11 Riffle/Step Spacing (ft) **165**

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 0% |
| Cobble | 1% |
| Coarse Gravel | 5% |
| Fine Gravel | 25% |
| Sand | 36% |
| Silt and smaller | 33% |

Silt/Clay Present? **Yes**

Detritus **15** %

# Large Woody **6**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

**E 5 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 | **Gravel** | **Gravel** |
| Consistency | **Non-cohesive** | **Non-cohesive** |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | **117** | **59** |
| Erosion Height (ft) | **5.00** | **3.00** |
| Revetmt. Type | **Rip-Rap** | **None** |
| Revetmt. Length (ft) | **73** | **0** |

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

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | **26-50** | **0-25** |
| Sub-dominant | **0-25** | **26-50** |
| W less than 25 | **254** | **679** |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | **Shrubs/Saplin** | **Hay** |
| Sub-dominant | **Pasture** | **Pasture** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | **0** | |
| Length | **0** | |
| Height | **0.00** | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Low**

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 **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

| | | | |
|---|---|---|---|
| Field Ditch | **0** | Road Ditch | **1** |
| 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 | 3 | 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 **Yes**

5.5 Straightening **Straightening**

Straightening Length: **729**

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: **Morgan Brook** Reach # **T1.02** Segment: **D** Completion Date: **October 29, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **Yes**

Segment Length (ft): **1,297** Segment Location: **From the segment break downstream of Old Number 11 Road, to the segment break at**

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 | 13.5 | Yes | Yes | Yes | Yes |
| Problem | Scour Below | | | | |
| Culvert | 5.50 | Yes | Yes | Yes | Yes |
| Problem | Deposition Above,Scour Below,Alignment | | | | |

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **11** | **None** | **No** |
| 7.2 Channel Aggradation | **13** | **None** | **No** |
| 7.3 Widening Channel | **14** | | **No** |
| 7.4 Change in Planform | **10** | | **No** |
| Total Score | **48** | | |
| Geomorphic Rating | **0.6** | | |

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 8 |
| 6.2 Pool Substrate | 14 |
| 6.3 Pool Variability | 12 |
| 6.4 Sediment Deposition | 11 |
| 6.5 Channel Flow Status | 14 |
| 6.6 Channel Alteration | 10 |
| 6.7 Channel Sinuosity | 8 |
| 6.8 Bank Stability | Left: 6 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 7 Right: 6 |
| 6.10 Riparian Vegetation Zone Width | Left: 5 Right: 2 |
| Total Score | 109 |
| Habitat Rating | 0.545 |

Habitat Stream Condition **Fair**

Narrative:

Channel evolution model stage II was chosen to represent the incision observed in the lower segment that was not captured in the cross-section.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Morgan Brook** Reach # **T1.02** Segment: **E** Completion Date: **October 29, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: **no property access** Rain: **Yes**

Segment Length (ft): **909** Segment Location: **Segment in Santaw Property and access was denied.**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Property Access**

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 | Hilly | Hilly |
| Continuous w/ | Sometimes | Sometimes |
| W/in 1 Bankfill | Sometimes | Sometimes |
| Texture | Not Evalua | Sand |

1.5 Valley Features

Valley Width (ft) **300**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

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:

Segment was not assessed, because of property access issues; only the banks and buffers were done based on observations made from up and downstream access points and the 2008 color 0.3m Canadian border imagery. It is most likely that this segment is

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

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

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

# Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Sand**

Subclass Slope: **None**

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 **Moderate**

| 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) | 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 | Pasture | Pasture |
| Sub-dominant | None | None |

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | 0 | 0 |

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | 0-25 | 0-25 |
| Sub-dominant | None | None |
| W less than 25 | 908 | 908 |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | Pasture | Pasture |
| Sub-dominant | None | None |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

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 **Yes**

5.5 Straightening **Straightening**

Straightening Length: **909**

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.

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? |
|---|---|---|---|---|---|

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model
Channel Evolution Stage
Geomorphic Condition **Poor**
Stream Sensitivity Very High

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Morgan Brook** Reach # **T1.02** Segment: **F** Completion Date: **October 29, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **Yes**

Segment Length (ft): **4,762** Segment Location: **From the end of the Santaw Property up to the reach break.**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

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

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

1.5 Valley Features

| | |
|---|---|
| Valley Width (ft) | 137 |
| Width Determination | Measured |
| Confinement Type | Broad |
| Rock Gorge? | No |
| Human-caused Change? | No |

## Step 2. Stream Channel

| | |
|---|---|
| 2.1 Bankfull Width | 15 |
| 2.2 Max Depth (ft) | 3.40 |
| 2.3 Mean Depth (ft) | 2.38 |
| 2.4 Floodprone Width (ft) | 137 |

Notes:

Segment had well formed dune-ripple and sometimes riffle-pool bed features. Some beaver activity mid-reach is impounding about 550' of the channel, but the area was not segmented out. In the upper segment, poor buffer widths are greatly reducing

**Provisional** *Step 2. (Contued)*

| | |
|---|---|
| 2.5 Aband. Floodpln | 4.60 ft. |
| Human Elev Floodpln | 0.00 ft. |
| 2.6 Width/Depth Ratio | 6.30 |
| 2.7 Entrenchment Ratio | 9.13 |
| 2.8 Incision Ratio | 1.35 |
| Human Elevated Inc Rat | 0.00 |
| 2.9 Sinuosity | Moderate |
| 2.10 Riffles Type | Not Applicable |
| 2.11 Riffle/Step Spacing (ft) | 0 |

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 0% |
| Cobble | 0% |
| Coarse Gravel | 8% |
| Fine Gravel | 14% |
| Sand | 58% |
| Silt and smaller | 20% |

| | |
|---|---|
| Silt/Clay Present? | Yes |
| Detritus | 20 % |
| # Large Woody | 57 |

2.13 Average Largest Particle on

| | |
|---|---|
| Bed | N/A |
| Bar | N/A |

2.14 Stream Type

| | |
|---|---|
| Stream Type: | E |
| Bed Material: | Sand |
| Subclass Slope: | None |
| Bed Form: | Dune-Ripple |
| 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 **Undercut**

| Bank Texture | Left | Right |
|---|---|---|
| Upper | | |
| Material Type | Sand | Sand |
| Consistency | Non-cohesive | Non-cohesive |
| Lower | | |
| Material Type | Gravel | Gravel |
| Consistency | Non-cohesive | Non-cohesive |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 643 | 555 |
| Erosion Height (ft) | 4.01 | 3.18 |
| Revetmt. Type | Rip-Rap | Rip-Rap |
| Revetmt. Length (ft) | 19 | 54 |

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | 26-50 | 26-50 |
| Mid-Channel Canopy | Open | |

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | 51-100 | 0-25 |
| Sub-dominant | 0-25 | 51-100 |
| W less than 25 | 1,056 | 2,943 |
| 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 | Hay |
| Sub-dominant | Hay | Shrubs/Saplin |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

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

| | |
|---|---|
| 4.9 # of Beaver Dams | 1 |
| Affected Length (ft) | 550 |

## Step 5. Channel Bed and Planform Changes

5.1 Bar Types

| Mid | Point | Side |
|---|---|---|
| 3 | 3 | 2 |
| **Diagonal** | **Delta** | **Island** |
| 0 | 0 | 0 |

5.2 Other Features

| Flood | Neck Cutoff | Avulsion | Braiding |
|---|---|---|---|
| 2 | 1 | 0 | 0 |

5.3 Steep Riffles and Head Cuts

| Steep Riffles | Head Cuts | Trib Rejuv. |
|---|---|---|
| 0 | 0 | No |

| | |
|---|---|
| 5.4 Stream Ford or Animal | Yes |
| 5.5 Straightening | Straightening |
| Straightening Length: | 2,207 |
| 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: **Morgan Brook** Reach # **T1.02** Segment: **F** Completion Date: **October 29, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **Yes**

Segment Length (ft): **4,762** Segment Location: **From the end of the Santaw Property up to the reach break.**

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 | 13.0 | Yes | Yes | Yes | Yes |
| Problem | Deposition Above,Scour Below | | | | |
| Old | 6.50 | Yes | Yes | Yes | Yes |
| Problem | Deposition Above,Scour Below | | | | |

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **11** | **None** | **No** |
| 7.2 Channel Aggradation | **13** | **None** | **No** |
| 7.3 Widening Channel | **12** | | **No** |
| 7.4 Change in Planform | **9** | | **No** |
| Total Score | **45** | | |
| Geomorphic Rating | **0.5625** | | |

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 14 |
| 6.2 Pool Substrate | 13 |
| 6.3 Pool Variability | 15 |
| 6.4 Sediment Deposition | 15 |
| 6.5 Channel Flow Status | 14 |
| 6.6 Channel Alteration | 8 |
| 6.7 Channel Sinuosity | 9 |
| 6.8 Bank Stability | Left: 6 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 6 Right: 6 |
| 6.10 Riparian Vegetation Zone Width | Left: 5 Right: 2 |
| Total Score | 119 |
| Habitat Rating | 0.595 |

Habitat Stream Condition **Fair**

Narrative:

Channel responding to historical channel straightening though planform shifts and some widening. Widening not evidenced in cross-section, but was observed in upper and lower sections of segment where bank erosion is extensive.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Rogers Brook** Reach # **T2.01** Segment: **A** Completion Date: **October 15, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,303** Segment Location: **From the confluence with the main stem of the Browns River, up to the segment break at the**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Subreach**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

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

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

1.5 Valley Features

Valley Width (ft) **100**

Width Determination **Measured**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **34**

2.2 Max Depth (ft) **3.00**

2.3 Mean Depth (ft) **2.30**

2.4 Floodprone Width (ft) **100**

Notes:

Interesting high gradient segment with two large grade controls and step-pool features. Over 100 LWD/mile and 40 pools/miles indicate good natural habitat. Valley width and actual confinement is consistent with Ph2 measurement.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **3.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **14.70**

2.7 Entrenchment Ratio **2.96**

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) **310**

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 1% |
| Boulder | 6% |
| Cobble | 50% |
| Coarse Gravel | 11% |
| Fine Gravel | 12% |
| Sand | 20% |
| Silt and smaller | 0% |

Silt/Clay Present? **No**

Detritus **25** %

# Large Woody **26**

2.13 Average Largest Particle on

Bed **300.0** **mm**

Bar **N/A** **mm**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Cobble**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

**C** **3** **b** **Step-Pool**

| 3.3 old | Amount | Mean Height |
|---|---|---|
| Failures | None | 0.00 |
| Gullies | None | 0.00 |

## Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

| Bank Texture | Left | Right |
|---|---|---|
| Upper | | |
| Material Type | Mix | Mix |
| Consistency | Non-cohesive | Non-cohesive |
| Lower | | |
| Material Type | Boulder/Cobbl | Boulder/Cobbl |
| Consistency | Cohesive | Cohesive |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 145 | 0 |
| Erosion Height (ft) | 6.00 | 0.00 |
| Revetmt. Type | None | None |
| Revetmt. Length (ft) | 0 | 0 |

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | 51-75 | 51-75 |
| 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 | Coniferous | Mixed Trees |
| Sub-dominant | Shrubs/Saplin | Shrubs/Saplin |

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | Forest | Forest |
| Sub-dominant | Shrubs/Saplin | Shrubs/Saplin |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Low**

4.4 # of Debris Jams **1**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **1**

Affected Length (ft) **200**

## Step 5. Channel Bed and Planform Changes

5.1 Bar Types

| Mid | Point | Side |
|---|---|---|
| 1 | 0 | 0 |

| Diagonal | Delta | Island |
|---|---|---|
| 0 | 0 | 1 |

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: **Rogers Brook** Reach # **T2.01** Segment: **A** Completion Date: **October 15, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **Yes**

Segment Length (ft): **1,303** Segment Location: **From the confluence with the main stem of the Browns River, up to the segment break**

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Waterfall | Mid-segment | 6.00 | 4.00 | Yes | |
| Waterfall | Mid-segment | 29.00 | 27.00 | Yes | |
| Ledge | Mid-segment | 3.00 | 2.00 | Yes | |

4.8 Channel Constrictions

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

Problem None

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **16** | **None** | **No** |
| 7.2 Channel Aggradation | **16** | **None** | **No** |
| 7.3 Widening Channel | **15** | | **No** |
| 7.4 Change in Planform | **15** | | **No** |
| Total Score | **62** | | |
| Geomorphic Rating | **0.775** | | |

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 | 15 |
| 6.2 Embeddedness | 18 |
| 6.3 Velocity/Depth Patterns | 16 |
| 6.4 Sediment Deposition | 15 |
| 6.5 Channel Flow Status | 15 |
| 6.6 Channel Alteration | 16 |
| 6.7 Frequency of Riffles/Steps | 12 |
| 6.8 Bank Stability | Left: 8 Right: 9 |
| 6.9 Bank Vegetation Protection | Left: 8 Right: 8 |
| 6.10 Riparian Vegetation Zone Width | Left: 9 Right: 9 |
| Total Score | 158 |
| Habitat Rating | 0.79 |

Habitat Stream Condition **Good**

Narrative:

Stable reach with good riparian and near bank vegetation.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Rogers Brook** Reach # **T2.01** Segment: **B** Completion Date: **November 11, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **No**

Segment Length (ft): **3,281** Segment Location: **From the segment break at the clearing upstream of the large grade control, up to the next**

**QC Status - Staff: Provisional Cons**

## 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 | **166** | **0** |
| height | **8** | **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/ | **Never** | **Sometimes** |
| W/in 1 Bankfill | **Sometimes** | **Sometimes** |
| Texture | **Not Evalua** | **Not Evalua** |

1.5 Valley Features

Valley Width (ft) **460**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **22**

2.2 Max Depth (ft) **3.80**

2.3 Mean Depth (ft) **2.58**

2.4 Floodprone Width (ft) **415**

Notes:

Segment is in stage IV of the CEM and is recovering from land use changes and historic manipulation (straightening) to sections of the channel. The largest impact to the segment observed was an extremely undersized culvert located in the upstream

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **5.30** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **8.53**

2.7 Entrenchment Ratio **18.86**

2.8 Incision Ratio **1.39**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **High**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **145**

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | **0** % |
| Boulder | **0** % |
| Cobble | **1** % |
| Coarse Gravel | **9** % |
| Fine Gravel | **20** % |
| Sand | **42** % |
| Silt and smaller | **28** % |

Silt/Clay Present? **Yes**

Detritus **20** %

# Large Woody **51**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

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 **Undercut**

| Bank Texture | Left | Right |
|---|---|---|
| Upper | | |
| Material Type | **Sand** | **Sand** |
| Consistency | **Non-cohesive** | **Non-cohesive** |
| Lower | | |
| Material Type | **Clay** | **Clay** |
| Consistency | **Cohesive** | **Cohesive** |
| Bank Erosion | Left | Right |
| Erosion Length (ft) | **465** | **207** |
| Erosion Height (ft) | **3.00** | **3.49** |
| Revetmt. Type | **None** | **None** |
| Revetmt. Length (ft) | **0** | **0** |
| Near Bank Veg. Type | Left | Right |
| Dominant | **Herbaceous** | **Herbaceous** |
| Sub-dominant | **Shrubs/Saplin** | **Shrubs/Saplin** |
| Bank Canopy | Left | Right |
| Canopy % | **26-50** | **26-50** |
| Mid-Channel Canopy | | **Open** |

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | **51-100** | **>100** |
| Sub-dominant | **26-50** | **26-50** |
| W less than 25 | **0** | **112** |
| 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** | **Forest** |
| Sub-dominant | **Residential** | **Hay** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | **0** | |
| Length | **0** | |
| Height | **0.00** | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Low**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **1**

Affected Length (ft) **100**

## Step 5. Channel Bed and Planform Changes

5.1 Bar Types

| Mid | Point | Side |
|---|---|---|
| **3** | **6** | **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: **791**

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: **Rogers Brook** Reach # **T2.01** Segment: **B** Completion Date: **November 11,**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **No**

Segment Length (ft): **3,281** Segment Location: **From the segment break at the clearing upstream of the large grade control, up to the**

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 | 20.0 | Yes | Yes | Yes | Yes |

Problem None

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **10** | **None** | **No** |
| 7.2 Channel Aggradation | **12** | **None** | **No** |
| 7.3 Widening Channel | **12** | | **No** |
| 7.4 Change in Planform | **10** | | **No** |
| Total Score | **44** | | |
| Geomorphic Rating | **0.55** | | |

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 14 |
| 6.2 Pool Substrate | 11 |
| 6.3 Pool Variability | 16 |
| 6.4 Sediment Deposition | 11 |
| 6.5 Channel Flow Status | 11 |
| 6.6 Channel Alteration | 10 |
| 6.7 Channel Sinuosity | 11 |
| 6.8 Bank Stability | Left: 6 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 7 Right: 5 |
| 6.10 Riparian Vegetation Zone Width | Left: 8 Right: 6 |
| Total Score | 122 |
| Habitat Rating | 0.61 |

Habitat Stream Condition **Fair**

Narrative:

Segment downstream of an undersized culvert is slightly incised and starved of sediment. The channel adjustments have been caused by the undersized culvert and is in stage IV of the CEM with evidence of recently formed floodplain close to the channel

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Rogers Brook** Reach # **T2.01** Segment: **C** Completion Date: **November 11, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: Rain: **No**

Segment Length (ft): **2,613** Segment Location: **From the segment break at the culvert, up to the Bancroft property where access was**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Depositional Features**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

| Length (ft) | One | Both |
|---|---|---|
| Berms | 0 | 0 |
| height | 0 | 0 |
| Roads | 645 | 0 |
| height | 8 | 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 | Very Steep |
| Continuous w/ | Never | Sometimes |
| W/in 1 Bankfill | Sometimes | Sometimes |
| Texture | Not Evalua | Silt/Clay |

1.5 Valley Features

Valley Width (ft) **285**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **23**

2.2 Max Depth (ft) **3.80**

2.3 Mean Depth (ft) **1.91**

2.4 Floodprone Width (ft) **175**

Notes:

Segment is in stage IIc of the CEM (D model) because the culvert at the segment break with T2.01-B is causing sediment to aggrade. Riffles are mostly sedimented and spacing is shorter than in downstream segment. Planform changes (ie, flood chutes) occurring

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **3.80** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **12.04**

2.7 Entrenchment Ratio **7.61**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **High**

2.10 Riffles Type **Sedimented**

2.11 Riffle/Step Spacing (ft) **70**

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 0% |
| Cobble | 0% |
| Coarse Gravel | 2% |
| Fine Gravel | 14% |
| Sand | 54% |
| Silt and smaller | 30% |

Silt/Clay Present? **Yes**

Detritus **15** %

# Large Woody **43**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

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 | 10.00 |
| 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 | Silt | Silt |
| Consistency | Non-cohesive | Non-cohesive |
| Bank Erosion | Left | Right |
| Erosion Length (ft) | 194 | 51 |
| Erosion Height (ft) | 2.70 | 3.00 |
| Revetmt. Type | Rip-Rap | Rip-Rap |
| Revetmt. Length (ft) | 31 | 28 |
| 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 | >100 | >100 |
| Sub-dominant | 51-100 | 26-50 |
| W less than 25 | 69 | 350 |
| 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 | Forest |
| Sub-dominant | Residential | Hay |
| Mass Failures | 0 | 75 |
| Height | 0 | 10 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Low**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg

4.7 StormwaterInputs

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

4.9 # of Beaver Dams **1**

Affected Length (ft) **515**

## Step 5. Channel Bed and Planform Changes

5.1 Bar Types

| Mid | Point | Side |
|---|---|---|
| 2 | 3 | 6 |
| **Diagonal** | **Delta** | **Island** |
| 0 | 0 | 0 |

5.2 Other Features

| Flood | Neck Cutoff | Avulsion | Braiding |
|---|---|---|---|
| 3 | 0 | 0 | 0 |

5.3 Steep Riffles and Head Cuts

| Steep Riffles | Head Cuts | Trib Rejuv. |
|---|---|---|
| 0 | 0 | No |

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **506**

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: **Rogers Brook** Reach # **T2.01** Segment: **C** Completion Date: **November 11,**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Rain: **No**

Segment Length (ft): **2,613** Segment Location: **From the segment break at the culvert, up to the Bancroft property where access was**

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 | 3.50 | Yes | Yes | Yes | Yes |
| Problem | Deposition Above,Scour Below,Alignment | | | | |

Narrative:

Segment impacted by culvert constriction at downstream end.

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **15** | **None** | **No** |
| 7.2 Channel Aggradation | **9** | **None** | **No** |
| 7.3 Widening Channel | **12** | | **No** |
| 7.4 Change in Planform | **9** | | **No** |

Total Score **45**

Geomorphic Rating **0.5625**

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 11 |
| 6.2 Pool Substrate | 11 |
| 6.3 Pool Variability | 10 |
| 6.4 Sediment Deposition | 6 |
| 6.5 Channel Flow Status | 13 |
| 6.6 Channel Alteration | 11 |
| 6.7 Channel Sinuosity | 11 |
| 6.8 Bank Stability | Left: 6 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 7 Right: 5 |
| 6.10 Riparian Vegetation Zone Width | Left: 7 Right: 6 |
| Total Score | 110 |
| Habitat Rating | 0.55 |

Habitat Stream Condition **Fair**

Stream: **Rogers Brook** Reach # **T2.01** Segment: **D** Completion Date: **November 11, 2009**

Organization: **Chittenden County Regional** Observers: **EPF (FEA), SPP (FEA)** Why Not assessed: **no property access** Rain: **No**

Segment Length (ft): **3,184** Segment Location: **From the segment break, where property access was denied up to the reach break.**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Property Access**

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** | **Hilly** |
| 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 **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

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:

No property access in this segment, so only bank and buffer assessment done, and any observations that could be made from the road and the downstream segment break from the property boundary.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

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

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

# Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

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 | **Sand** | **Sand** |
| Consistency | **Non-cohesive** | **Non-cohesive** |

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

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | **1-25** | **51-75** |

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | **0-25** | **>100** |
| Sub-dominant | **26-50** | **0-25** |
| W less than 25 | **1,862** | **970** |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | **Pasture** | **Forest** |
| Sub-dominant | **Hay** | **Pasture** |
| Mass Failures | **0** | **0** |
| Height | **0** | **0** |
| Gullies | | **0** |
| Length | | **0** |
| Height | | **0.00** |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Low**

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 **None**

(old) Upstrm Flow Reg

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 | 1 | 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 **Straightening**

Straightening Length: **1,863**

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.

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model
Channel Evolution Stage
Geomorphic Condition **Fair**
Stream Sensitivity Extreme

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Stream: **Stevensville Brook** Reach # **T9.01** Segment: **A** Completion Date: **August 26, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,812** Segment Location: **From the confluence with the mainstem reach M20 up to the segment break at the edge of**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Property Access**

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 | 208 | 0 |

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

1.5 Valley Features

Valley Width (ft) **110**

Width Determination **Measured**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **28**

2.2 Max Depth (ft) **2.40**

2.3 Mean Depth (ft) **1.76**

2.4 Floodprone Width (ft) **53**

Notes:

Right riparian buffer has been cut down on the right side of the channel for a length of 1,100 feet for no apparent reason. This stretch of the segment has compromised what was a good, stable channel. Habitat has been reduced significantly and most pools

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **2.90** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **15.91**

2.7 Entrenchment Ratio **1.89**

2.8 Incision Ratio **1.21**

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 | 15% |
| Cobble | 36% |
| Coarse Gravel | 26% |
| Fine Gravel | 13% |
| Sand | 10% |
| Silt and smaller | 0% |

Silt/Clay Present? **No**

Detritus **10** %

# Large Woody **39**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **B**

Bed Material: **Cobble**

Subclass Slope: **None**

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 | Mix | Mix |
| Consistency | Non-cohesive | Non-cohesive |
| Lower | | |
| Material Type | Boulder/Cobbl | Boulder/Cobbl |
| Consistency | Non-cohesive | Non-cohesive |

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 0 | 0 |
| Erosion Height (ft) | 0.00 | 0.00 |
| Revetmt. Type | Rip-Rap | None |
| Revetmt. Length (ft) | 60 | 0 |

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | 76-100 | 26-50 |

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | >100 | 0-25 |
| Sub-dominant | 0-25 | >100 |
| W less than 25 | 154 | 1,060 |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | Forest | Hay |
| Sub-dominant | Residential | Forest |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **4**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg **None**

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 | 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 **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: **Stevensville Brook** Reach # **T9.01** Segment: **A** Completion Date: **August 26, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **1,812** Segment Location: **From the confluence with the mainstem reach M20 up to the segment break at the**

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 | 25.0 | Yes | Yes | Yes | Yes |

Problem None

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **11** | **None** | **No** |
| 7.2 Channel Aggradation | **13** | **None** | **No** |
| 7.3 Widening Channel | **12** | | **No** |
| 7.4 Change in Planform | **12** | | **No** |
| Total Score | **48** | | |
| Geomorphic Rating | **0.6** | | |

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 7 |
| 6.2 Embeddedness | 13 |
| 6.3 Velocity/Depth Patterns | 7 |
| 6.4 Sediment Deposition | 9 |
| 6.5 Channel Flow Status | 8 |
| 6.6 Channel Alteration | 10 |
| 6.7 Frequency of Riffles/Steps | 8 |
| 6.8 Bank Stability | Left: 8 Right: 6 |
| 6.9 Bank Vegetation Protection | Left: 8 Right: 1 |
| 6.10 Riparian Vegetation Zone Width | Left: 8 Right: 1 |
| Total Score | 94 |
| Habitat Rating | 0.47 |

Habitat Stream Condition **Fair**

Narrative:

Some bank and buffer issues associated with the tree removal on the right bank.

Project: **Browns River**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Stevensville Brook** Reach # **T9.01** Segment: **B** Completion Date: **August 26, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Why Not assessed: **no property access** Rain: **Yes**

Segment Length (ft): **355** Segment Location: **Electric fence with animals grazing. Segment partially evaluated for banks and buffers from**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Property Access**

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 | Hilly | Very Steep |
| Continuous w/ | Never | Sometimes |
| W/in 1 Bankfill | Sometimes | Sometimes |
| Texture | Not Evalua | Not Evalua |

1.5 Valley Features

Valley Width (ft) **150**

Width Determination **Estimated**

Confinement Type **Narrow**

Rock Gorge? **No**

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:

Reach was not accessed in Ph 2 survey because of property access issues (an electric fence crossed the channel). Field observations looking up into the reach from the segmentation point suggests that the reach shares channel dimensions with the

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

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

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

# Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **B**

Bed Material: **Cobble**

Subclass Slope: **None**

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 | | |
| Consistency | | |
| Lower | | |
| Material Type | | |
| Consistency | | |

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

| Near Bank Veg. Type | Left | Right |
|---|---|---|
| Dominant | 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 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg **None**

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 **Yes**

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: **Stevensville Brook** Reach # **T9.01** Segment: **B** Completion Date: **August 26, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **355** Segment Location: **Electric fence with animals grazing. Segment partially evaluated for banks and buffers**

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Good**

Stream Sensitivity Moderate

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: **Browns River Tribs**

# Phase 2 Segment Summary

February 24, 2010 SGAT Version: 4.56

Stream: **Trib to Browns** Reach # **M15S2.01** Segment: **0** Completion Date: **August 10, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP; FEA, CCRCP** Why Not assessed: Rain: **No**

Segment Length (ft): **3,908** Segment Location: **From the confluence with M15 just upstream of the Cilley Hill Crib dam to the reach break**

**QC Status - Staff: Provisional Cons**

## 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 | 1,010 | 292 |

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

1.5 Valley Features

Valley Width (ft) **235**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **15**

2.2 Max Depth (ft) **3.10**

2.3 Mean Depth (ft) **2.23**

2.4 Floodprone Width (ft) **217**

Notes:

Large waterfall grade control in lower reach--channel dimensions above and below are similar E-type. Beaver activity intermittent and affects a large portion of the reach. Assessment done on sections not affected by ponding - segmentation not necessary.

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **3.10** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **6.50**

2.7 Entrenchment Ratio **14.97**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Not Applicable**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 0% |
| Cobble | 0% |
| Coarse Gravel | 5% |
| Fine Gravel | 10% |
| Sand | 40% |
| Silt and smaller | 45% |

Silt/Clay Present? **Yes**

Detritus **50** %

# Large Woody **15**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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 | Silt | Silt |
| Consistency | Non-cohesive | Non-cohesive |
| Lower | | |
| Material Type | Clay | Clay |
| Consistency | Cohesive | Cohesive |
| Bank Erosion | Left | Right |
| Erosion Length (ft) | 0 | 0 |
| Erosion Height (ft) | 0.00 | 0.00 |
| Revetmt. Type | Rip-Rap | Hard Bank |
| Revetmt. Length (ft) | 109 | 23 |
| 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 | 51-100 | >100 |
| Sub-dominant | 26-50 | 26-50 |
| W less than 25 | 882 | 0 |
| Buffer Veg. Type | Left | Right |
| Dominant | Herbaceous | Herbaceous |
| Sub-dominant | Deciduous | Mixed Trees |

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | Forest | Forest |
| Sub-dominant | Residential | Shrubs/Saplin |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

| | |
|---|---|
| 4.1 Springs / Seeps | Minimal |
| 4.2 Adjacent Wetlands | Abundant |
| 4.3 Flow Status | Low |
| 4.4 # of Debris Jams | 2 |
| 4.5 Flow Regulation Type | None |
| Flow Regulation Use | |
| Impoundments | Unknown |
| Impoundmt. Location | |
| 4.6 Up/Down strm flow reg | None |
| (old) Upstrm Flow Reg | None |

| | |
|---|---|
| 4.9 # of Beaver Dams | 4 |
| Affected Length (ft) | 3,100 |

## 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 **Straightening**

Straightening Length: **1,189**

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.

1.6 Grade Controls

| Type | Location | Total | Total Height Above Water | Photo Taken | GPSTaken |
|---|---|---|---|---|---|
| Waterfall | Mid-segment | 15.00 | 15.00 | Yes | |

4.8 Channel Constrictions

| Type | Width | Photo Taken? | GPS Taken? | Channel Constriction? | Floodprone Constriction? |
|---|---|---|---|---|---|
| Culvert | 6.80 | Yes | Yes | Yes | Yes |
| Problem | Alignment | | | | |
| Culvert | 5.50 | Yes | Yes | Yes | Yes |
| Problem | Scour Below | | | | |
| Old | 13.1 | Yes | Yes | Yes | Yes |
| Problem | Scour Above | | | | |

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **11** | **None** | **No** |
| 7.2 Channel Aggradation | **12** | **None** | **No** |
| 7.3 Widening Channel | **16** | | **No** |
| 7.4 Change in Planform | **11** | | **No** |
| Total Score | **50** | | |
| Geomorphic Rating | **0.625** | | |

Channel Evolution Model **F**
Channel Evolution Stage **I**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 6 |
| 6.2 Pool Substrate | 8 |
| 6.3 Pool Variability | 7 |
| 6.4 Sediment Deposition | 15 |
| 6.5 Channel Flow Status | 12 |
| 6.6 Channel Alteration | 8 |
| 6.7 Channel Sinuosity | 7 |
| 6.8 Bank Stability | Left: 8 Right: 8 |
| 6.9 Bank Vegetation Protection | Left: 5 Right: 7 |
| 6.10 Riparian Vegetation Zone Width | Left: 4 Right: 8 |
| Total Score | 103 |
| Habitat Rating | 0.515 |

Habitat Stream Condition **Fair**

Narrative:
No evidence of terraces to indicate stage V of CEM. Likely historical aggradation above old dam in lower reac, and incision in upper reach where it was straightened. In upper reach the CEM would be stage II, but no incision noted in cross-section.

Project: **Browns River Tribs** — **Phase 2 Segment Summary** — February 24, 2010 SGAT Version: 4.56

Stream: **Trib to Browns** Reach # **M19S1.01** Segment: **A** Completion Date: **August 10, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Why Not assessed: **beaver dam** Rain: **Yes**

Segment Length (ft): **1,202** Segment Location: **From the confluence with the mainstem reach M19 up to the end of the area affected by**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Other Reason**

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 | Flat | Steep |
| Continuous w/ | Never | Sometimes |
| W/in 1 Bankfill | Never | Sometimes |
| Texture | Not Evalua | Not Evalua |

1.5 Valley Features

Valley Width (ft) **200**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

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:

Segment impounded by beaver activity, 8 beaver dams in total. NOTE: Segment assessment is limited to due beaver activity; data entered for steps 1, 3, 4 and where applicable. Aerial photographs and topographic maps were used to aid in data

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

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

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

# Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

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 **Moderate**

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

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

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

| Bank Canopy | Left | Right |
|---|---|---|
| Canopy % | 1-25 | 1-25 |
| Mid-Channel Canopy | | Open |

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | >100 | 51-100 |
| Sub-dominant | None | 51-100 |
| 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 | Other | Hay |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **Small**

Impoundmt. Location **In Reach**

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

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **8**

Affected Length (ft) **815**

## 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: **Trib to Browns** Reach # **M19S1.01** Segment: **A** Completion Date: **August 10, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **1,202** Segment Location: **From the confluence with the mainstem reach M19 up to the end of the area affected**

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? |
|---|---|---|---|---|---|

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity Very High

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Stream: **Trib to Browns** Reach # **M19S1.01** Segment: **B** Completion Date: **August 10, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,458** Segment Location: **From end of area impounded by beaver activity to just upstream of the Mountain Road**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

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

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

1.5 Valley Features

Valley Width (ft) **280**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **17**

2.2 Max Depth (ft) **2.00**

2.3 Mean Depth (ft) **1.57**

2.4 Floodprone Width (ft) **120**

Notes:

Lower end of segment has great riffle-pool bedform with lots of wood in the channel. There is a slight slope increase mid-segment with plane bed bed features. Overall, good floodplain connectivity and lots of wood, habitat score is "good".

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **2.50** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **10.83**

2.7 Entrenchment Ratio **7.06**

2.8 Incision Ratio **1.25**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **70**

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 0% |
| Cobble | 35% |
| Coarse Gravel | 33% |
| Fine Gravel | 17% |
| Sand | 9% |
| Silt and smaller | 6% |

Silt/Clay Present? **No**

Detritus **10** %

# Large Woody **60**

2.13 Average Largest Particle on

Bed **10.6** **inches**

Bar **3.5** **inches**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **b**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

| 3.3 old | Amount | Mean Height |
|---|---|---|
| Failures | None | 0.00 |
| Gullies | None | 0.00 |

## Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

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

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 73 | 0 |
| Erosion Height (ft) | 3.00 | 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 | 26-50 |
| W less than 25 | 3 | 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 | Shrubs/Saplin | Shrubs/Saplin |
| Mass Failures | 0 | 0 |
| Height | 0 | 0 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **5**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

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

(old) Upstrm Flow Reg **Diversion**

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 | 9 | 2 |
| **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: **Trib to Browns** Reach # **M19S1.01** Segment: **B** Completion Date: **August 10, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **1,458** Segment Location: **From end of area impounded by beaver activity to just upstream of the Mountain Road**

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 | 8.00 | Yes | Yes | Yes | Yes |

Problem Deposition Above

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

| | Score | STD | Historic |
|---|---|---|---|
| 7.1 Channel Degradation | **15** | **None** | **No** |
| 7.2 Channel Aggradation | **15** | **None** | **No** |
| 7.3 Widening Channel | **15** | | **No** |
| 7.4 Change in Planform | **14** | | **No** |

| | |
|---|---|
| Total Score | **59** |
| Geomorphic Rating | **0.7375** |
| Channel Evolution Model | **F** |
| Channel Evolution Stage | **I** |
| Geomorphic Condition | **Good** |
| Stream Sensitivity | **High** |

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 14 |
| 6.2 Embeddedness | 15 |
| 6.3 Velocity/Depth Patterns | 14 |
| 6.4 Sediment Deposition | 13 |
| 6.5 Channel Flow Status | 12 |
| 6.6 Channel Alteration | 16 |
| 6.7 Frequency of Riffles/Steps | 15 |
| 6.8 Bank Stability | Left: 8 Right: 8 |
| 6.9 Bank Vegetation Protection | Left: 8 Right: 8 |
| 6.10 Riparian Vegetation Zone Width | Left: 9 Right: 8 |
| Total Score | 148 |
| Habitat Rating | 0.74 |

Habitat Stream Condition **Good**

Narrative:

Limited adjustments, only minor planform changes in lower reach.

Project: **Browns River Tribs** | **Phase 2 Segment Summary** | February 24, 2010 SGAT Version: 4.56

Stream: **Trib to Browns** Reach # **M19S1.01** Segment: **C** Completion Date: **August 10, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **2,257** Segment Location: **From just upstream of the Mountain Road crossing, up to the reach break about 830 feet**

**QC Status - Staff: Provisional Cons**

## Step 1. Valley and Floodplain

1.1 Segmentation **Banks and Buffers**

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 | Hilly | Steep |
| Continuous w/ | Never | Sometimes |
| W/in 1 Bankfill | Never | Sometimes |
| Texture | Not Evalua | Mixed |

1.5 Valley Features

Valley Width (ft) **380**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

## Step 2. Stream Channel

2.1 Bankfull Width **11**

2.2 Max Depth (ft) **2.30**

2.3 Mean Depth (ft) **1.75**

2.4 Floodprone Width (ft) **221**

Notes:

High degree of manipulation along entire segment--channel pushed up against valley wall in upper segment. Lawn/hay fields extend to channel bank on left bank. Two withdrawals for ponds in upper segment. These withdrawals divert water into a pipe

**Provisional** *Step 2. (Contued)*

2.5 Aband. Floodpln **4.50** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **6.29**

2.7 Entrenchment Ratio **20.09**

2.8 Incision Ratio **1.96**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Eroded**

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

2.12 Substrate Composition

| | |
|---|---|
| Bedrock | 0% |
| Boulder | 0% |
| Cobble | 47% |
| Coarse Gravel | 22% |
| Fine Gravel | 20% |
| Sand | 11% |
| Silt and smaller | 0% |

Silt/Clay Present? **No**

Detritus **5** %

# Large Woody **20**

2.13 Average Largest Particle on

Bed **9.4** **inches**

Bar **3.5** **inches**

2.14 Stream Type

Stream Type: **E**

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 | One | 10.00 |
| Gullies | None | 0.00 |

## Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

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

| Bank Erosion | Left | Right |
|---|---|---|
| Erosion Length (ft) | 109 | 0 |
| Erosion Height (ft) | 3.00 | 0.00 |
| Revetmt. Type | None | None |
| Revetmt. Length (ft) | 0 | 0 |

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

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

| Buffer Width | Left | Right |
|---|---|---|
| Dominant | 0-25 | 26-50 |
| Sub-dominant | >100 | 0-25 |
| W less than 25 | 1,412 | 261 |

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

3.3 Riparian Corridor

| Corridor Land | Left | Right |
|---|---|---|
| Dominant | Hay | Shrubs/Saplin |
| Sub-dominant | Forest | Forest |
| Mass Failures | 0 | 45 |
| Height | 0 | 10 |
| Gullies | 0 | |
| Length | 0 | |
| Height | 0.00 | |

## Step 4. Flow & Flow Modifiers

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

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 | 2 | 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: **1,263**

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: **Trib to Browns** Reach # **M19S1.01** Segment: **C** Completion Date: **August 10, 2009**

Organization: **Chittenden County Regional** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **2,257** Segment Location: **From just upstream of the Mountain Road crossing, up to the reach break about 830**

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 | **7** | **Other** | **Yes** |
| 7.2 Channel Aggradation | **14** | **None** | **No** |
| 7.3 Widening Channel | **13** | | **No** |
| 7.4 Change in Planform | **11** | | **No** |
| Total Score | **45** | | |
| Geomorphic Rating | **0.5625** | | |

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

| | Score |
|---|---|
| 6.1 Epifaunal Substrate - Available Cover | 7 |
| 6.2 Embeddedness | 10 |
| 6.3 Velocity/Depth Patterns | 6 |
| 6.4 Sediment Deposition | 11 |
| 6.5 Channel Flow Status | 11 |
| 6.6 Channel Alteration | 5 |
| 6.7 Frequency of Riffles/Steps | 3 |
| 6.8 Bank Stability | Left: 3 Right: 5 |
| 6.9 Bank Vegetation Protection | Left: 1 Right: 2 |
| 6.10 Riparian Vegetation Zone Width | Left: 1 Right: 3 |
| Total Score | 68 |
| Habitat Rating | 0.34 |

Habitat Stream Condition **Poor**

Narrative:

Degradation resulting from historic channel straightening. Bed and banks have natural armoring--severe incision and widening have not occurred, but STD still a Cb to an Eb.

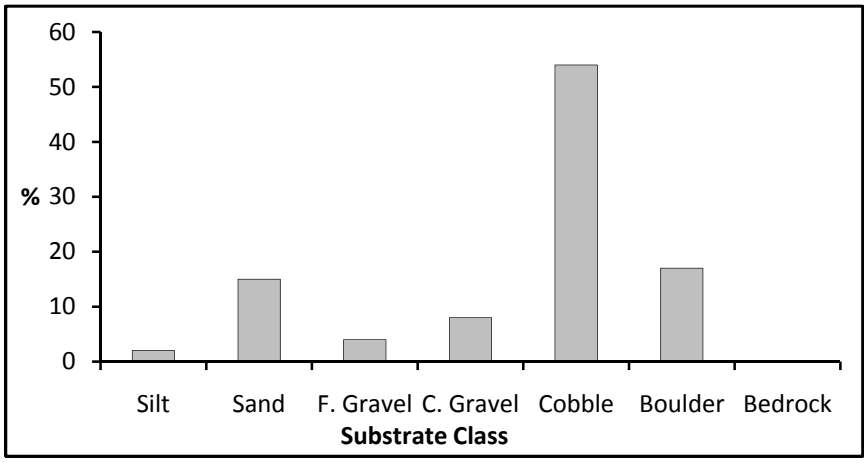
# Appendix B

# RHA Data Summaries

## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M03-A |
| **Length:** | 6,783 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 121 |
| **RHA Percentage:** | 61% |
| **Overall Habitat Condition:** | Fair |

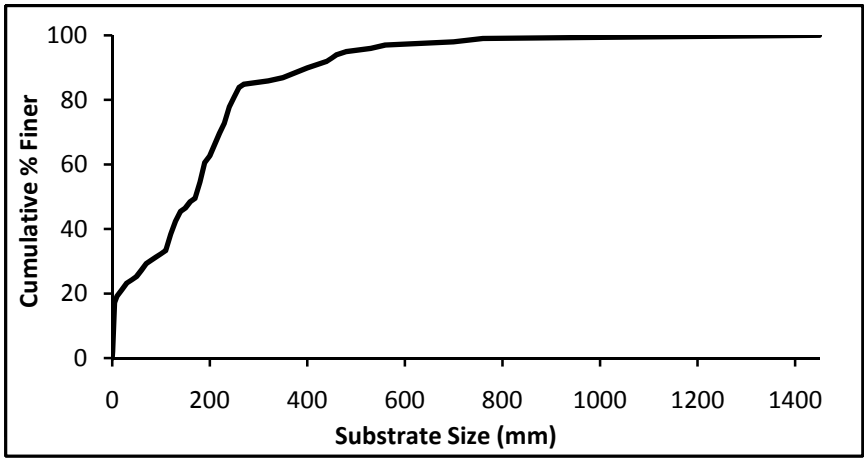
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 2 |
| **Sand** | 0.06 - 2 | 15 |
| **F. Gravel** | 2 - 16 | 4 |
| **C. Gravel** | 16 - 64 | 8 |
| **Cobble** | 64 - 256 | 54 |
| **Boulder** | 256 - 4096 | 17 |
| **Bedrock** | > 4096 | 0 |

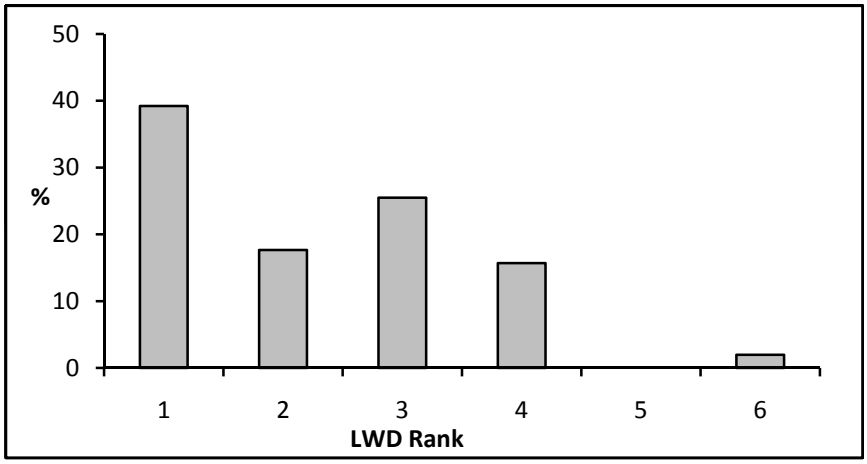
| | | |
|---|---|---|
| **Median Substrate Size:** | 170 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 20 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 9 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 13 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 8 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 1 |

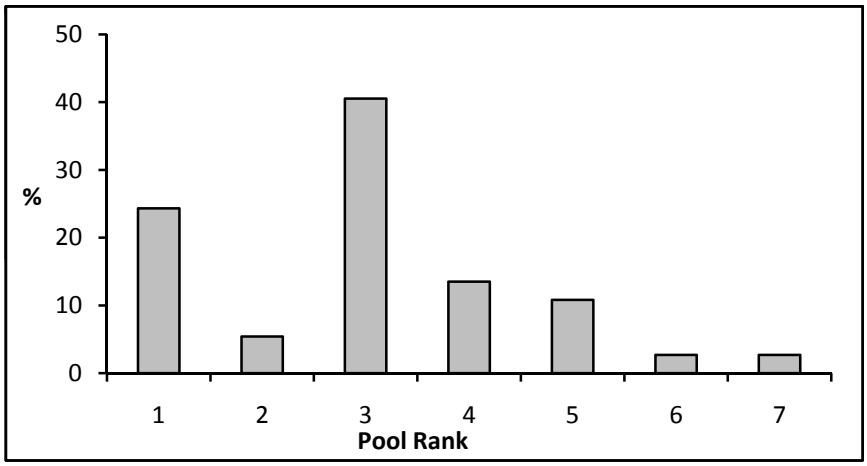
**# LWDs/mile:** 40




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 9 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 2 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 15 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 5 |
| **5** | D ≥ 3.0 | < 0.5 | 4 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 1 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 1 |

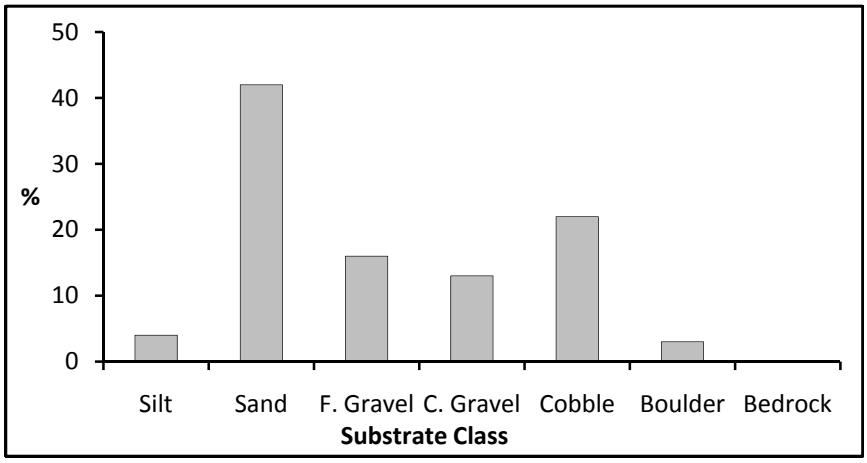
**# Pools/mile:** 29



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M03-B |
| **Length:** | 2,171 ft |
| **Field Form:** | Low Gradient |
| **Total RHA Score:** | 64 |
| **RHA Percentage:** | 32% |
| **Overall Habitat Condition:** | Poor |

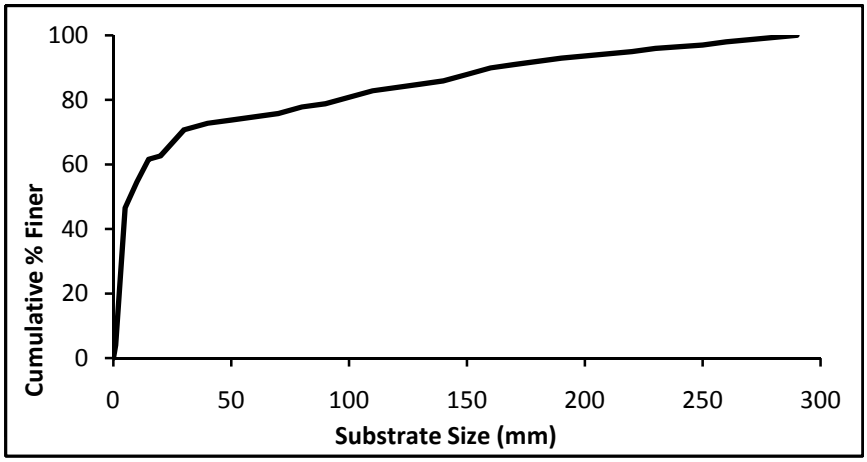
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 4 |
| **Sand** | 0.06 - 2 | 42 |
| **F. Gravel** | 2 - 16 | 16 |
| **C. Gravel** | 16 - 64 | 13 |
| **Cobble** | 64 - 256 | 22 |
| **Boulder** | 256 - 4096 | 3 |
| **Bedrock** | > 4096 | 0 |

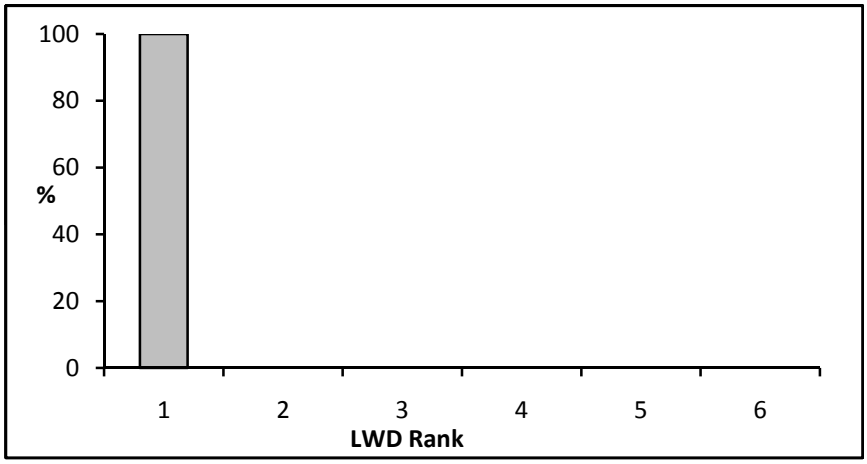
| | | |
|---|---|---|
| **Median Substrate Size:** | 5 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 15 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 0 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 0 |

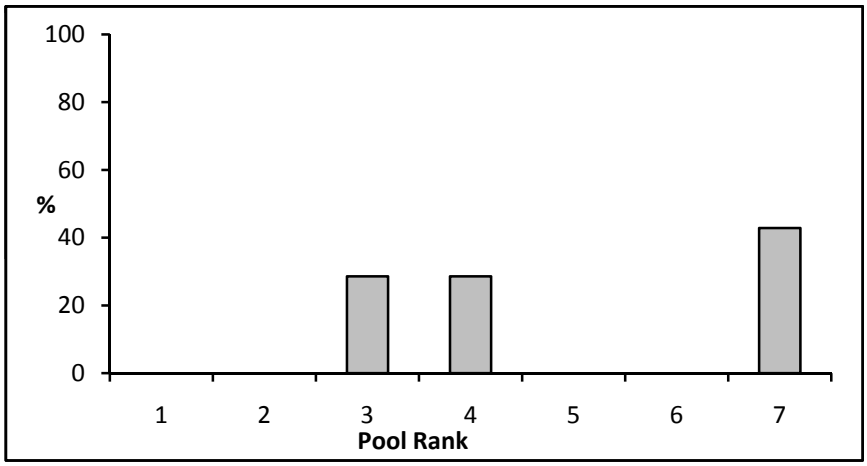
**# LWDs/mile:** 36




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 2 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 2 |
| **5** | D ≥ 3.0 | < 0.5 | 0 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 0 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 3 |

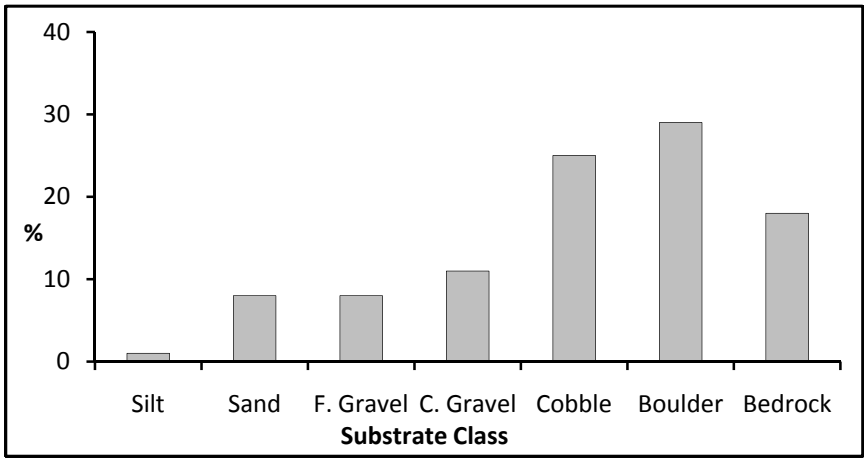
**# Pools/mile:** 17



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M04-A |
| **Length:** | 2,255 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 163 |
| **RHA Percentage:** | 82% |
| **Overall Habitat Condition:** | Good |

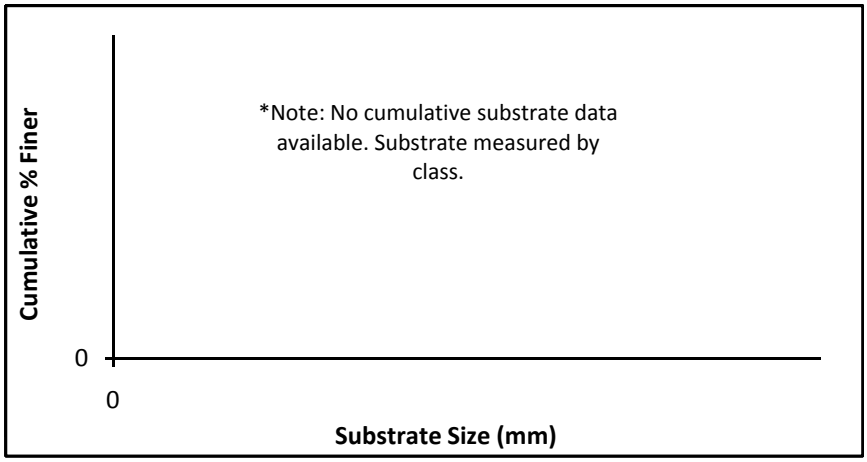
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 1 |
| **Sand** | 0.06 - 2 | 8 |
| **F. Gravel** | 2 - 16 | 8 |
| **C. Gravel** | 16 - 64 | 11 |
| **Cobble** | 64 - 256 | 25 |
| **Boulder** | 256 - 4096 | 29 |
| **Bedrock** | > 4096 | 18 |

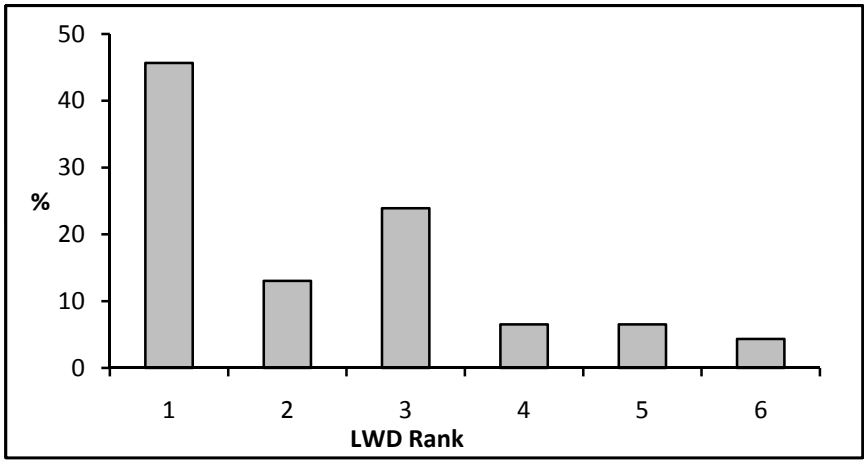
| | | |
|---|---|---|
| **Median Substrate Size:** | 64 - 256 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 21 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 6 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 11 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 3 |
| **5** | D ≥ 2.0 | < 0.5 | 3 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 2 |

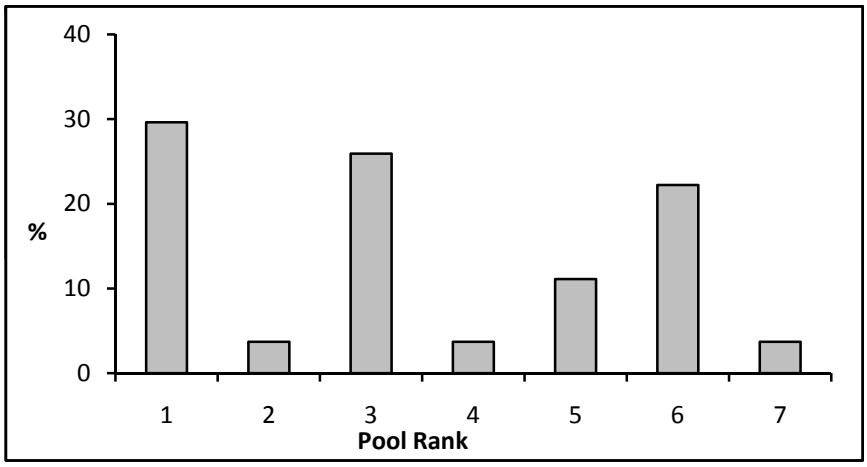
**# LWDs/mile:** 108




## Pools

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 8 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 1 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 7 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 1 |
| **5** | D ≥ 3.0 | < 0.5 | 3 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 6 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 1 |

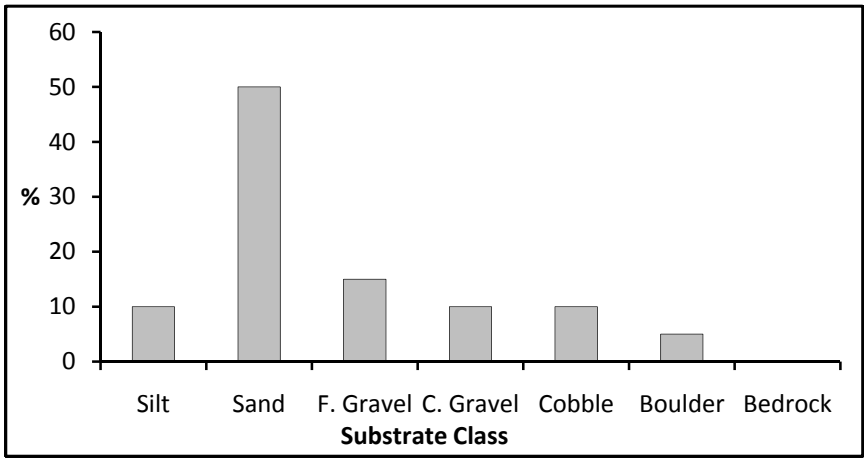
**# Pools/mile:** 63



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M04-B |
| **Length:** | 1,425 ft |
| **Field Form:** | Low Gradient |
| **Total RHA Score:** | 88 |
| **RHA Percentage:** | 44% |
| **Overall Habitat Condition:** | Fair |

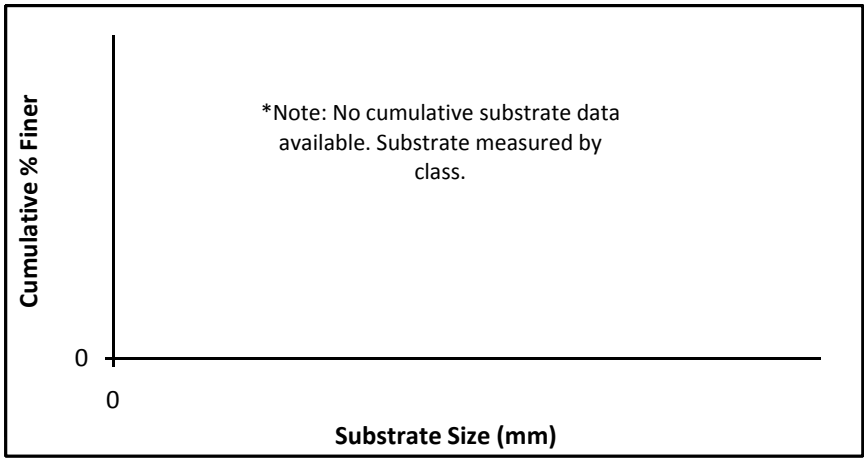
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 10 |
| **Sand** | 0.06 - 2 | 50 |
| **F. Gravel** | 2 - 16 | 15 |
| **C. Gravel** | 16 - 64 | 10 |
| **Cobble** | 64 - 256 | 10 |
| **Boulder** | 256 - 4096 | 5 |
| **Bedrock** | > 4096 | 0 |

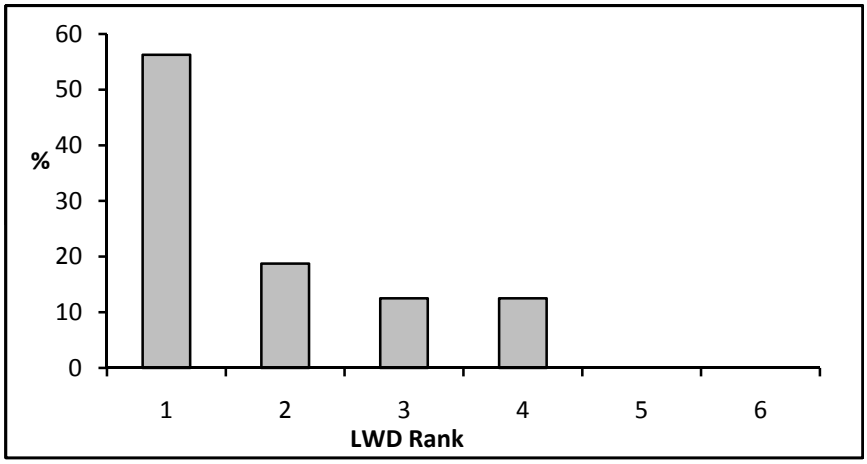
| | | |
|---|---|---|
| **Median Substrate Size:** | 0.06 - 2 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 9 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 3 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 2 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 2 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 0 |

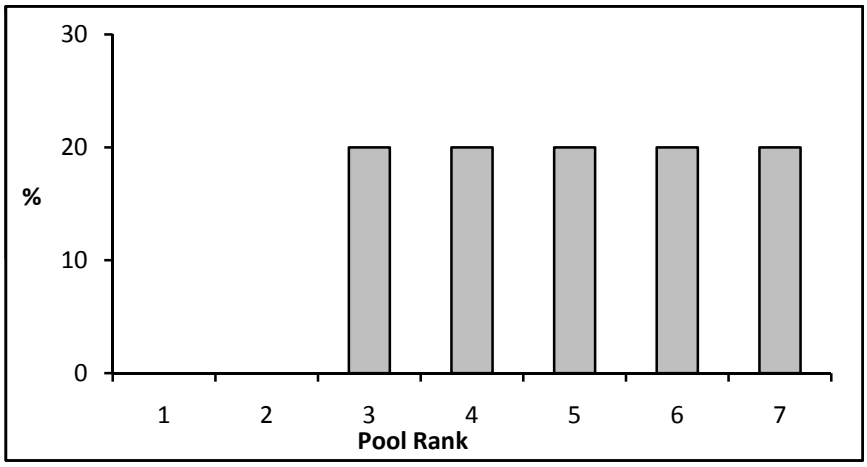
**# LWDs/mile:** 59




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 1 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 1 |
| **5** | D ≥ 3.0 | < 0.5 | 1 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 1 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 1 |

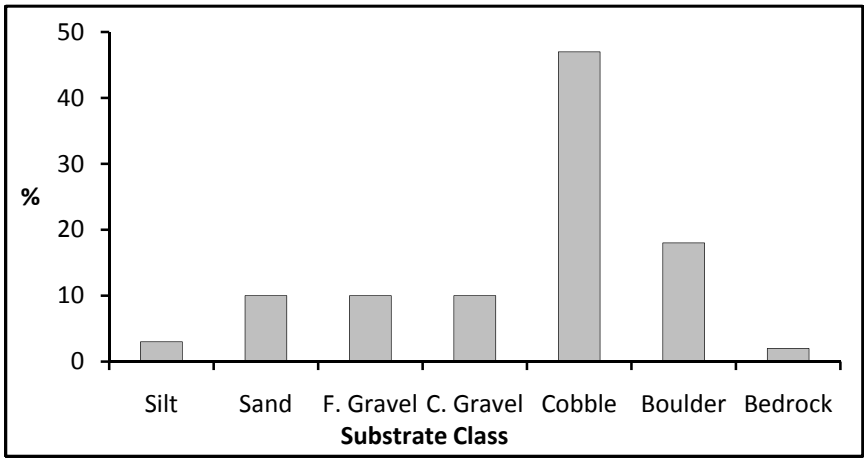
**# Pools/mile:** 19



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M04-C |
| **Length:** | 3,842 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 124 |
| **RHA Percentage:** | 62% |
| **Overall Habitat Condition:** | Fair |

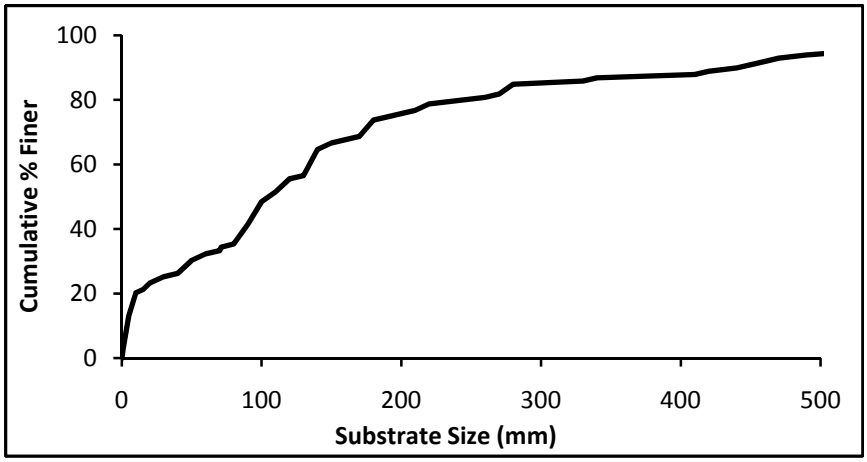
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 3 |
| **Sand** | 0.06 - 2 | 10 |
| **F. Gravel** | 2 - 16 | 10 |
| **C. Gravel** | 16 - 64 | 10 |
| **Cobble** | 64 - 256 | 47 |
| **Boulder** | 256 - 4096 | 18 |
| **Bedrock** | > 4096 | 2 |

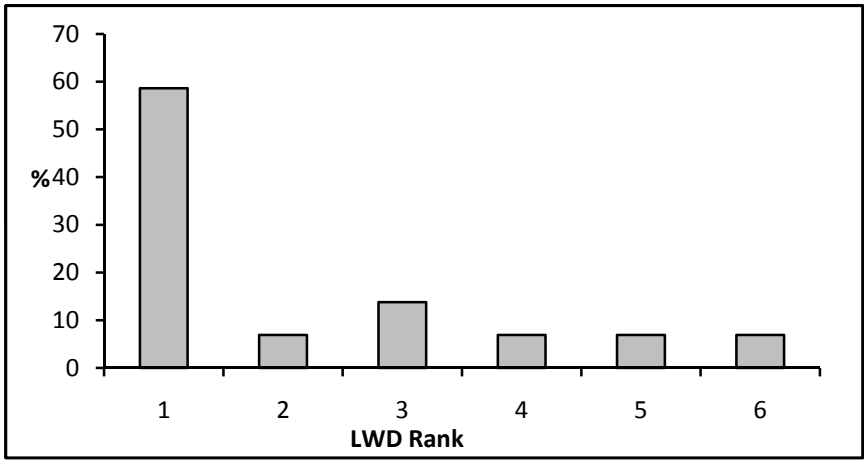
| | | |
|---|---|---|
| **Median Substrate Size:** | 100 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 17 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 2 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 4 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 2 |
| **5** | D ≥ 2.0 | < 0.5 | 2 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 2 |

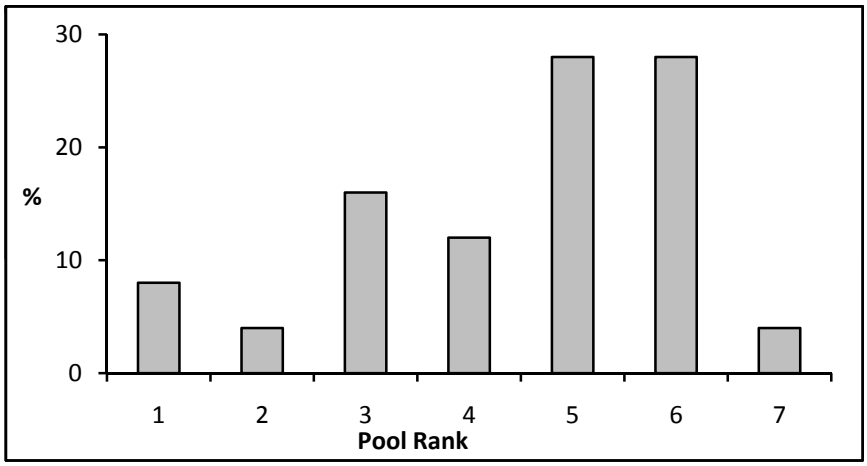
**# LWDs/mile:** 133




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 2 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 1 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 4 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 3 |
| **5** | D ≥ 3.0 | < 0.5 | 7 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 7 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 1 |

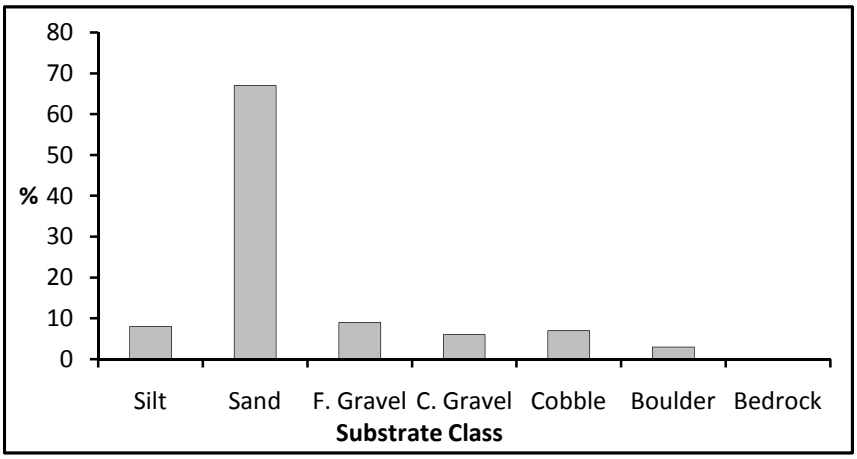
**# Pools/mile:** 29



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M05 |
| **Length:** | 8,372 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 103 |
| **RHA Percentage:** | 52% |
| **Overall Habitat Condition:** | Fair |

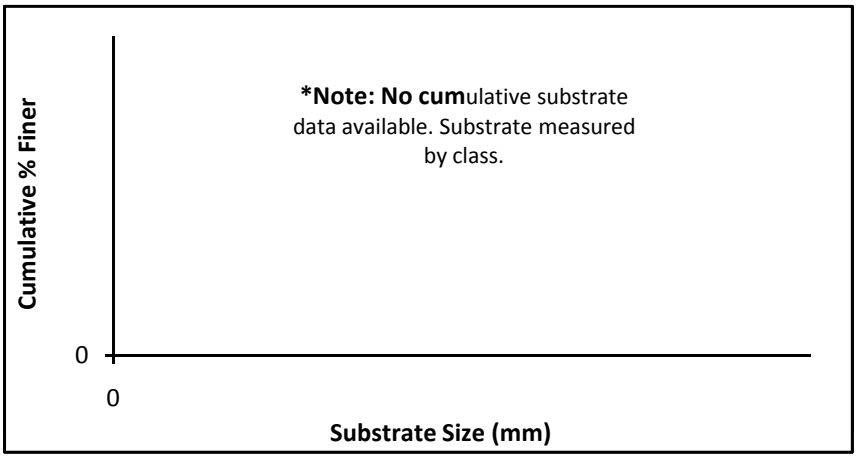
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 8 |
| **Sand** | 0.06 - 2 | 67 |
| **F. Gravel** | 2 - 16 | 9 |
| **C. Gravel** | 16 - 64 | 6 |
| **Cobble** | 64 - 256 | 7 |
| **Boulder** | 256 - 4096 | 3 |
| **Bedrock** | > 4096 | 0 |

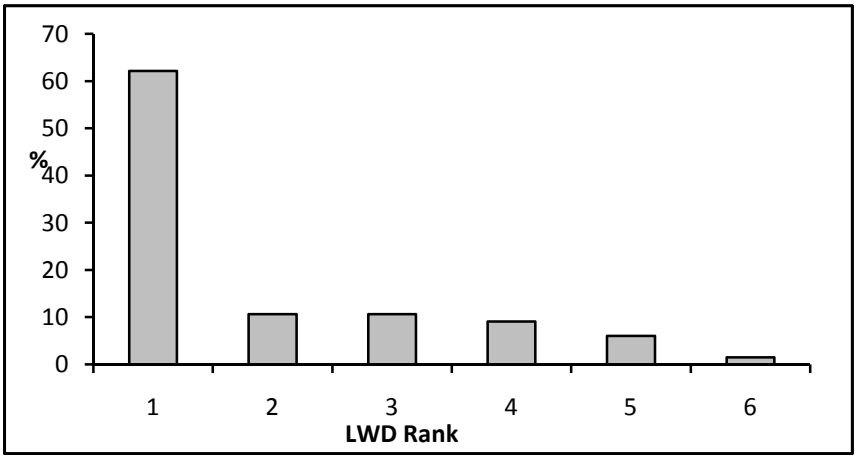
| | | |
|---|---|---|
| **Median Substrate Size:** | 0.06 - 2 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 41 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 7 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 7 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 6 |
| **5** | D ≥ 2.0 | < 0.5 | 4 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 1 |

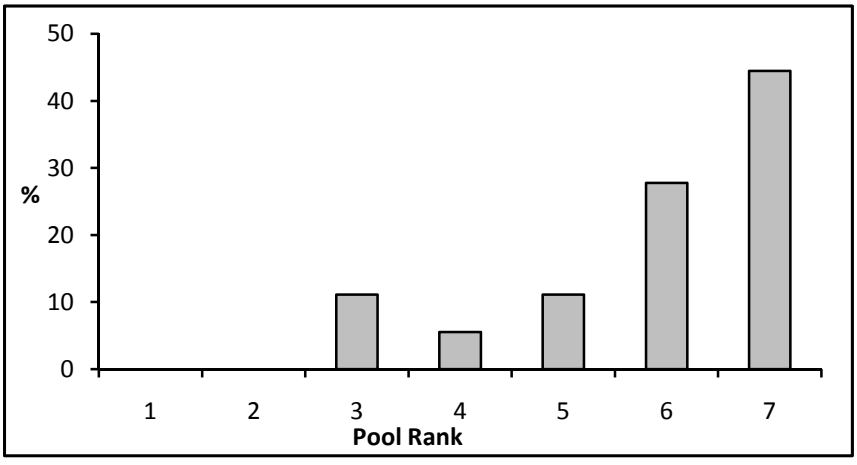
**# LWDs/mile:** 42




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 2 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 1 |
| **5** | D ≥ 3.0 | < 0.5 | 2 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 5 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 8 |

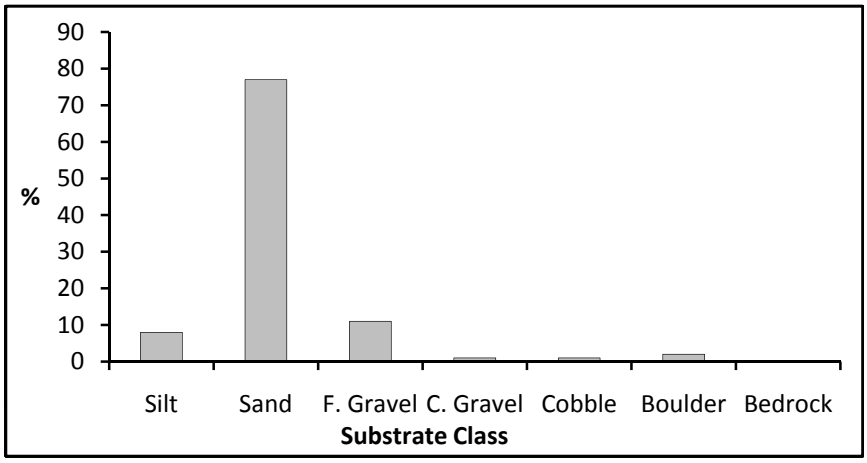
**# Pools/mile:** 11



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M06 |
| **Length:** | 4,747 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 70 |
| **RHA Percentage:** | 35% |
| **Overall Habitat Condition:** | Fair |

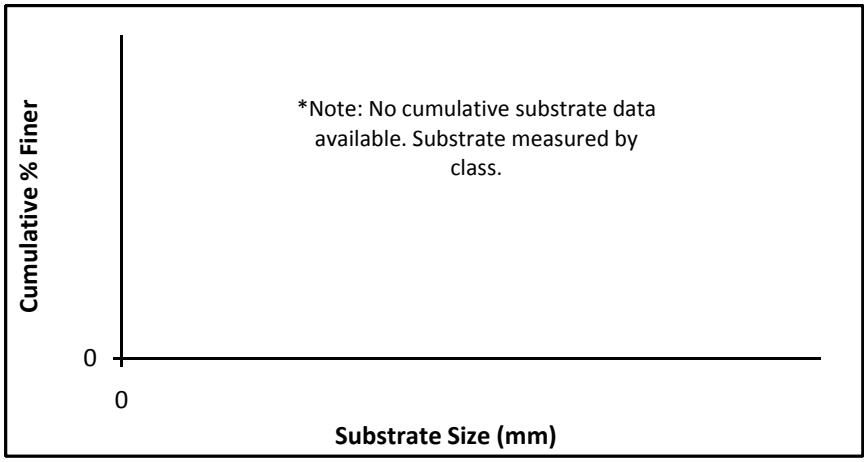
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 8 |
| **Sand** | 0.06 - 2 | 77 |
| **F. Gravel** | 2 - 16 | 11 |
| **C. Gravel** | 16 - 64 | 1 |
| **Cobble** | 64 - 256 | 1 |
| **Boulder** | 256 - 4096 | 2 |
| **Bedrock** | > 4096 | 0 |

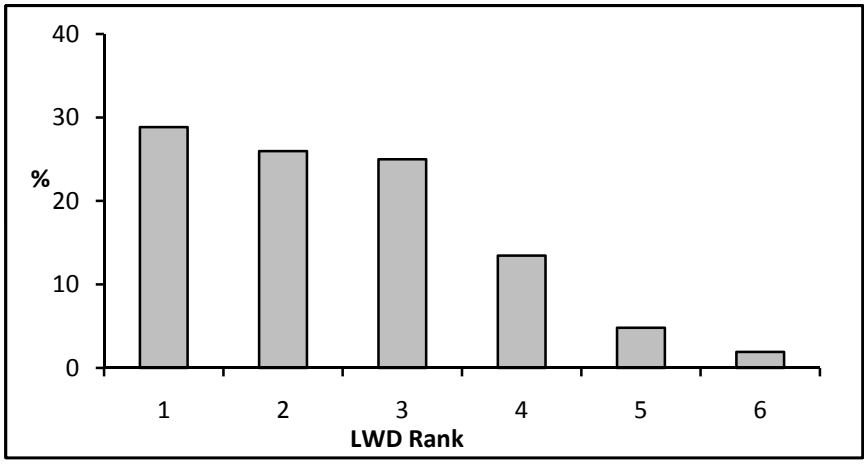
| | | |
|---|---|---|
| **Median Substrate Size:** | 0.06 - 2 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 30 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 27 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 26 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 14 |
| **5** | D ≥ 2.0 | < 0.5 | 5 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 2 |

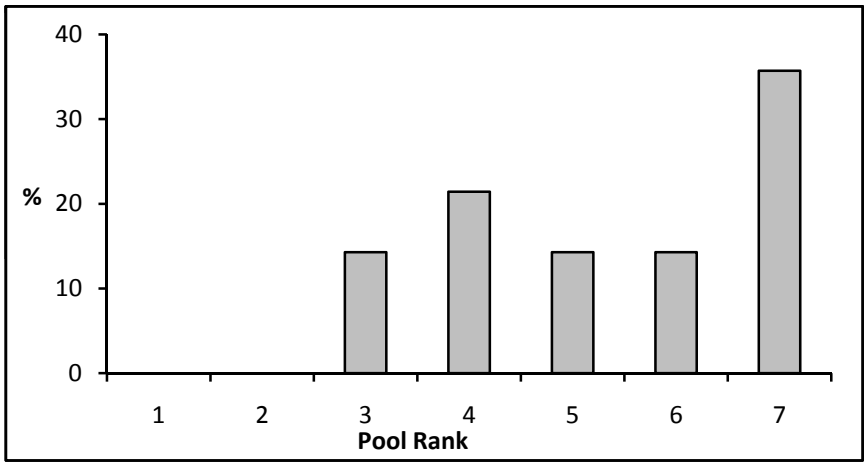
**# LWDs/mile:** 133




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 2 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 3 |
| **5** | D ≥ 3.0 | < 0.5 | 2 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 2 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 5 |

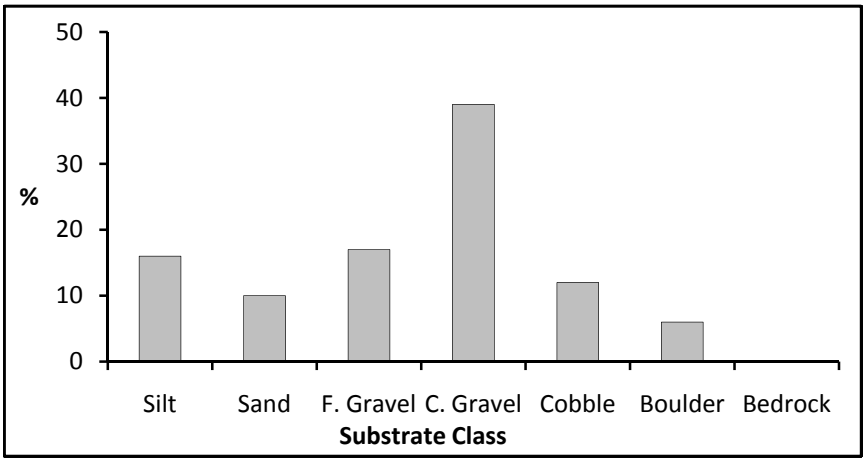
**# Pools/mile:** 29



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M13A |
| **Length:** | 555 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 114 |
| **RHA Percentage:** | 57% |
| **Overall Habitat Condition:** | Fair |

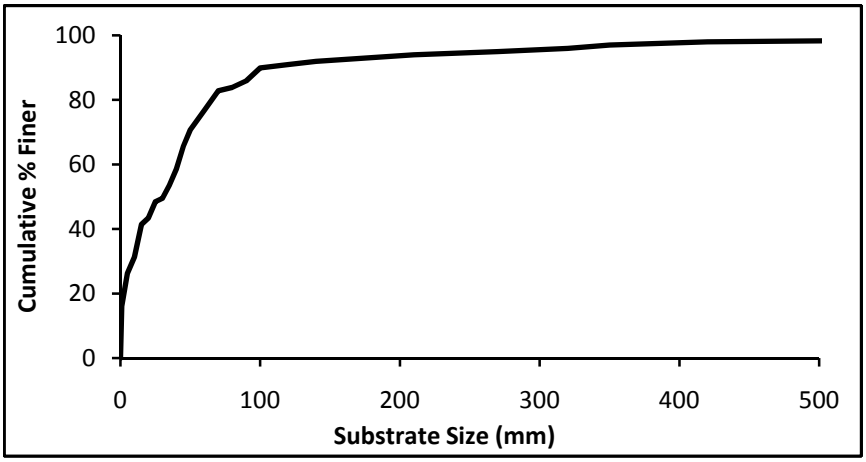
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 16 |
| **Sand** | 0.06 - 2 | 10 |
| **F. Gravel** | 2 - 16 | 17 |
| **C. Gravel** | 16 - 64 | 39 |
| **Cobble** | 64 - 256 | 12 |
| **Boulder** | 256 - 4096 | 6 |
| **Bedrock** | > 4096 | 0 |

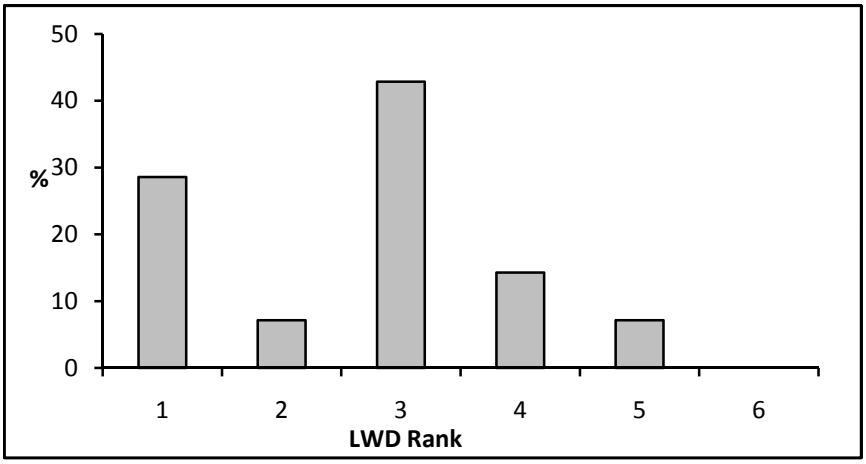
| | | |
|---|---|---|
| **Median Substrate Size:** | 30 | mm |
| **Avg. Largest Particle (Bar):** | N/A | mm |
| **Riffle Stability Index (RSI):** | N/A | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 4 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 1 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 6 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 2 |
| **5** | D ≥ 2.0 | < 0.5 | 1 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 0 |

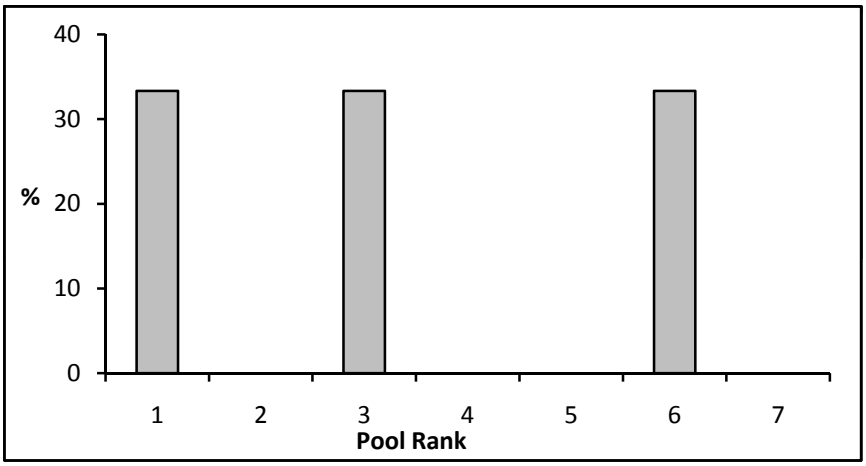
**# LWDs/mile:** 133




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 1 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 1 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 3.0 | < 0.5 | 0 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 1 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 0 |

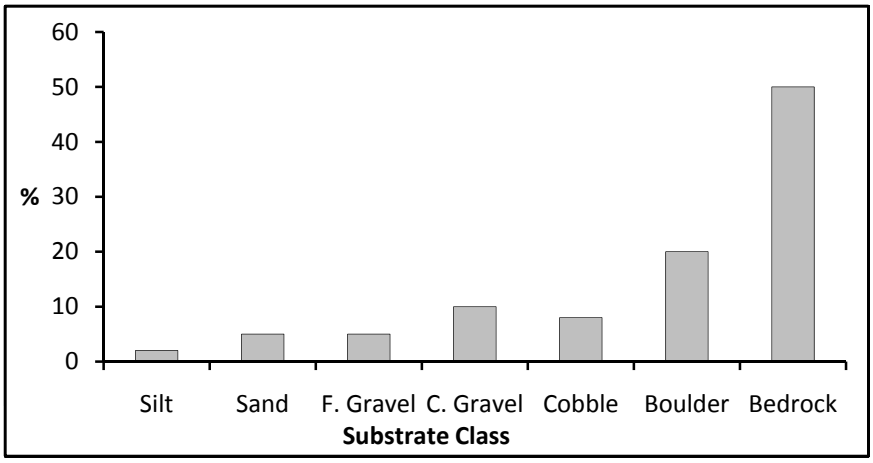
**# Pools/mile:** 29



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M13B |
| **Length:** | 4,594 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 132 |
| **RHA Percentage:** | 66% |
| **Overall Habitat Condition:** | Good |

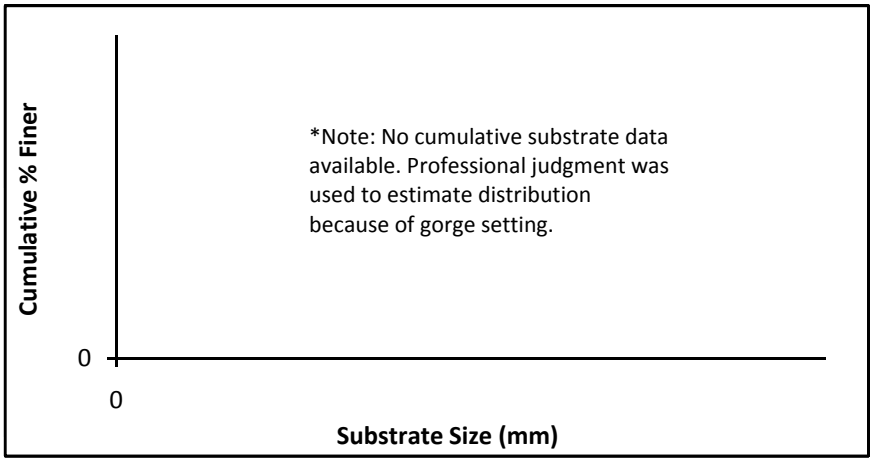
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 2 |
| **Sand** | 0.06 - 2 | 5 |
| **F. Gravel** | 2 - 16 | 5 |
| **C. Gravel** | 16 - 64 | 10 |
| **Cobble** | 64 - 256 | 8 |
| **Boulder** | 256 - 4096 | 20 |
| **Bedrock** | > 4096 | 50 |

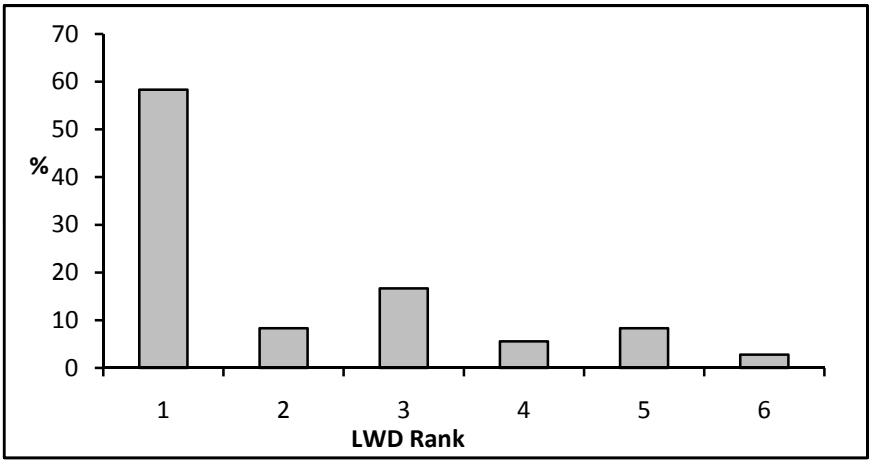
| | | |
|---|---|---|
| **Median Substrate Size:** | N/A | mm |
| **Avg. Largest Particle (Bar):** | N/A | mm |
| **Riffle Stability Index (RSI):** | N/A | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 21 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 3 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 6 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 2 |
| **5** | D ≥ 2.0 | < 0.5 | 3 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 1 |

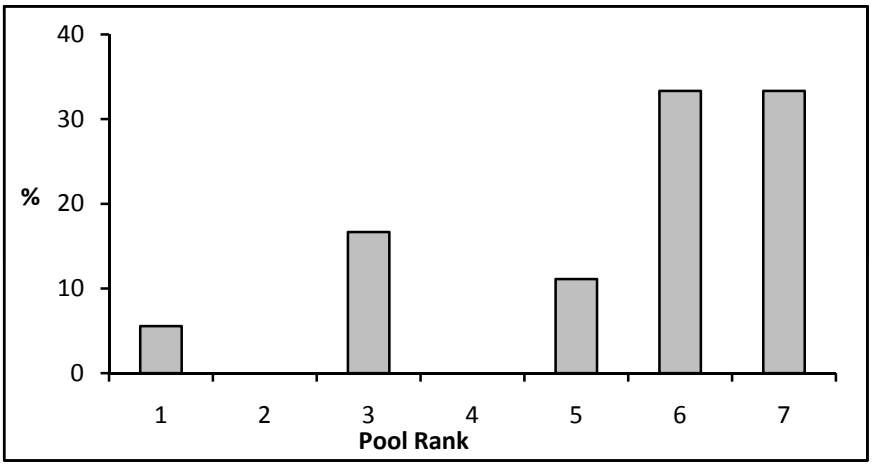
**# LWDs/mile:** 41




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 1 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 3 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 3.0 | < 0.5 | 2 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 6 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 6 |

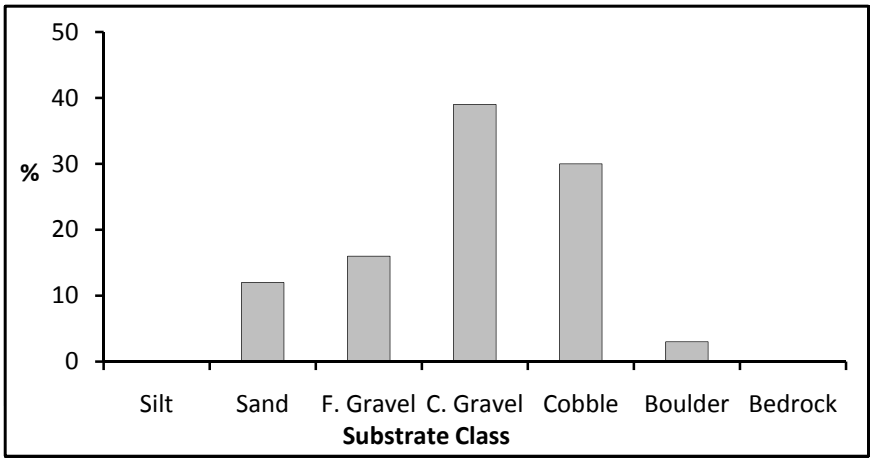
**# Pools/mile:** 21



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M16A |
| **Length:** | 4,738 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 38 |
| **RHA Percentage:** | 19% |
| **Overall Habitat Condition:** | Poor |

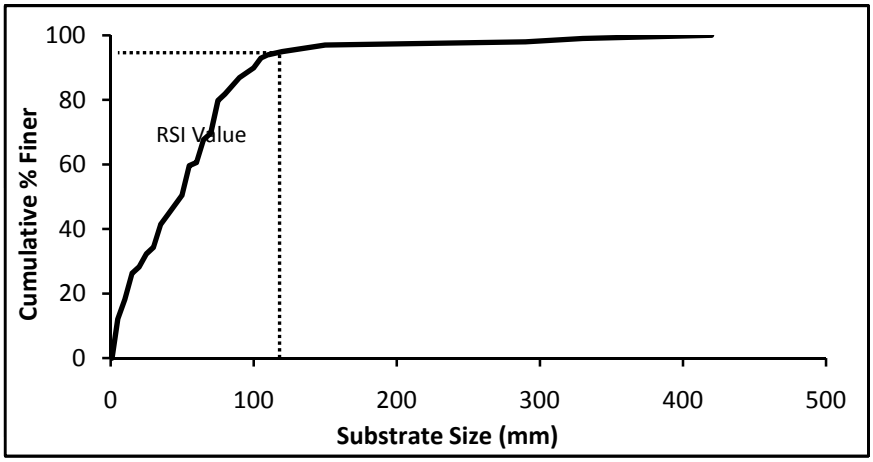
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 0 |
| **Sand** | 0.06 - 2 | 12 |
| **F. Gravel** | 2 - 16 | 16 |
| **C. Gravel** | 16 - 64 | 39 |
| **Cobble** | 64 - 256 | 30 |
| **Boulder** | 256 - 4096 | 3 |
| **Bedrock** | > 4096 | 0 |

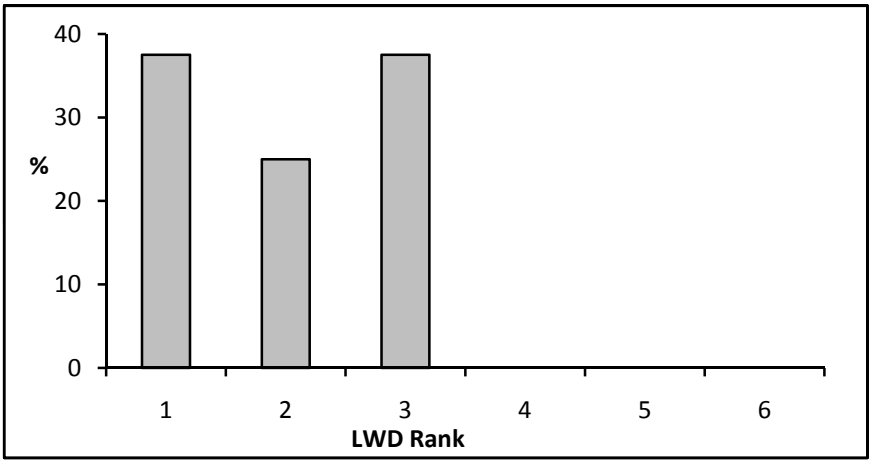
| | | |
|---|---|---|
| **Median Substrate Size:** | 45 | mm |
| **Avg. Largest Particle (Bar):** | 110 | mm |
| **Riffle Stability Index (RSI):** | 95 | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 3 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 2 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 3 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 0 |

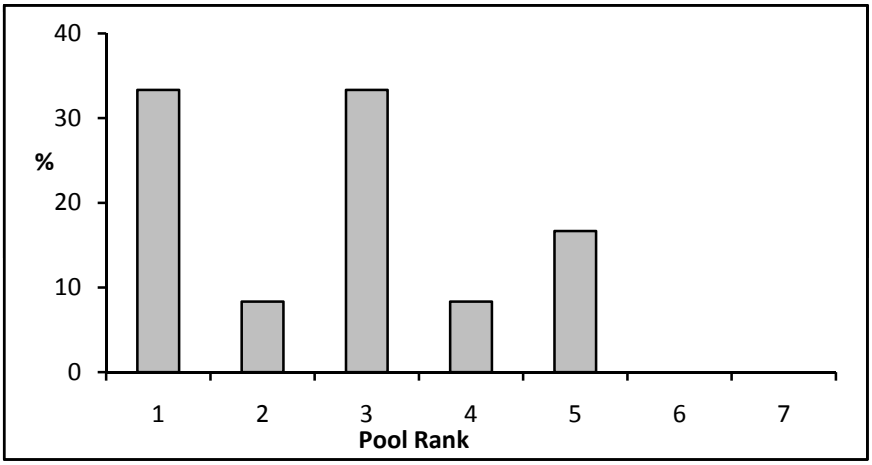
**# LWDs/mile:** 9




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 4 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 1 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 4 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 1 |
| **5** | D ≥ 3.0 | < 0.5 | 2 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 0 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 0 |

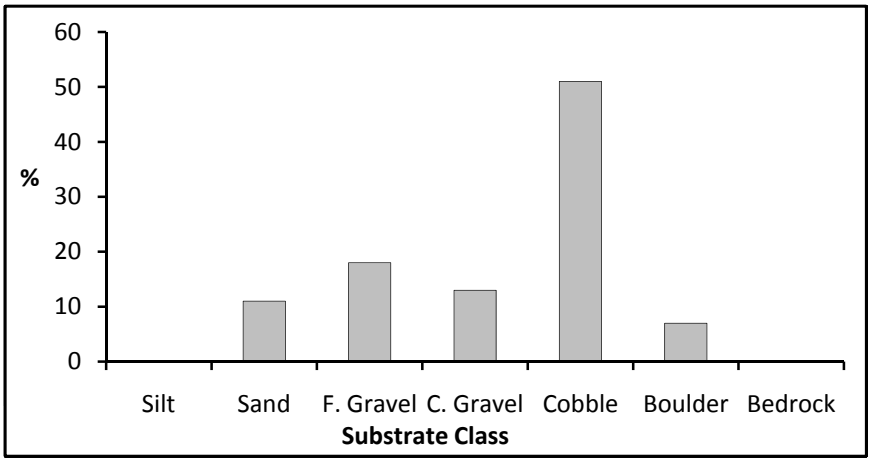
**# Pools/mile:** 13



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M20 |
| **Length:** | 3,037 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 93 |
| **RHA Percentage:** | 47% |
| **Overall Habitat Condition:** | Fair |

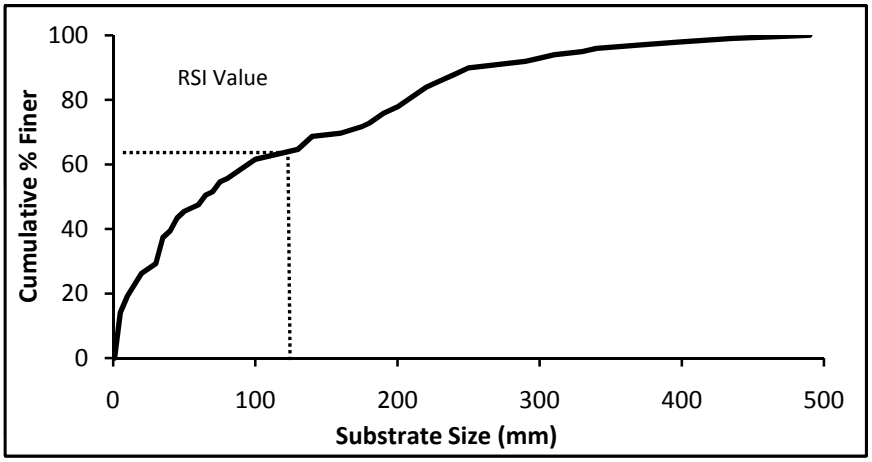
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 0 |
| **Sand** | 0.06 - 2 | 11 |
| **F. Gravel** | 2 - 16 | 18 |
| **C. Gravel** | 16 - 64 | 13 |
| **Cobble** | 64 - 256 | 51 |
| **Boulder** | 256 - 4096 | 7 |
| **Bedrock** | > 4096 | 0 |

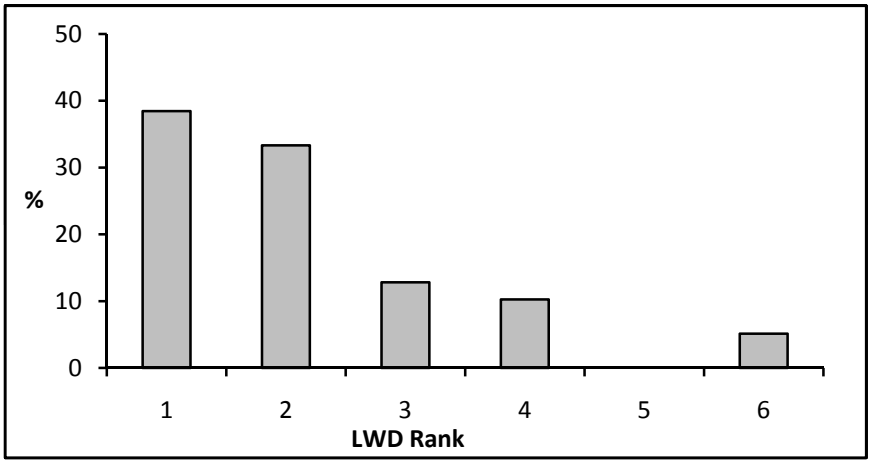
| | | |
|---|---|---|
| **Median Substrate Size:** | 75 | mm |
| **Avg. Largest Particle (Bar):** | 114 | mm |
| **Riffle Stability Index (RSI):** | 62 | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 15 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 13 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 5 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 4 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 2 |

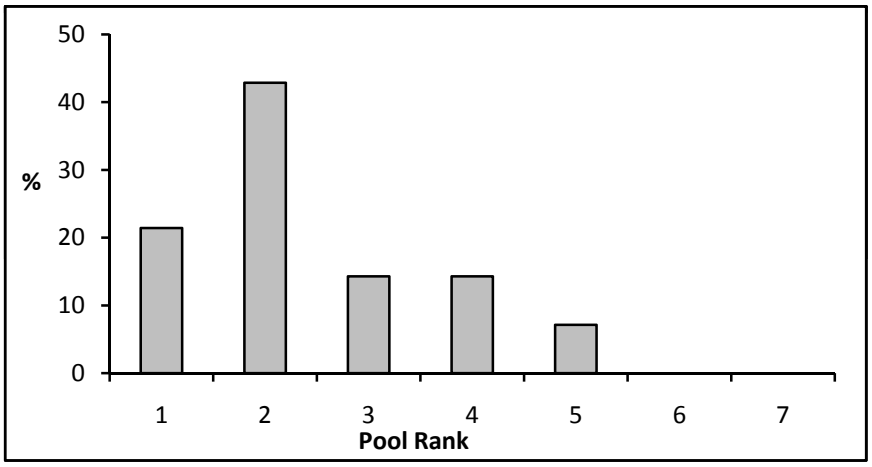
**# LWDs/mile:** 68




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 3 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 6 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 2 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 2 |
| **5** | D ≥ 3.0 | < 0.5 | 1 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 0 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 0 |

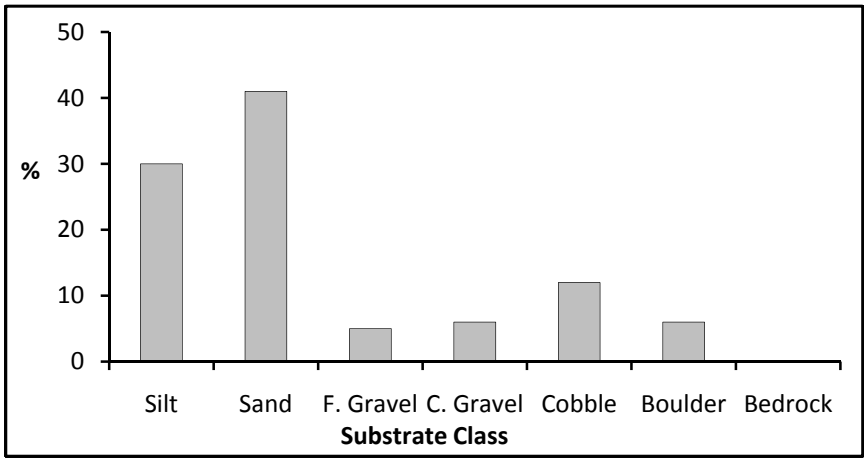
**# Pools/mile:** 24



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | T1.01-A |
| **Length:** | 4,305 ft |
| **Field Form:** | Low Gradient |
| **Total RHA Score:** | 112 |
| **RHA Percentage:** | 56% |
| **Overall Habitat Condition:** | Fair |

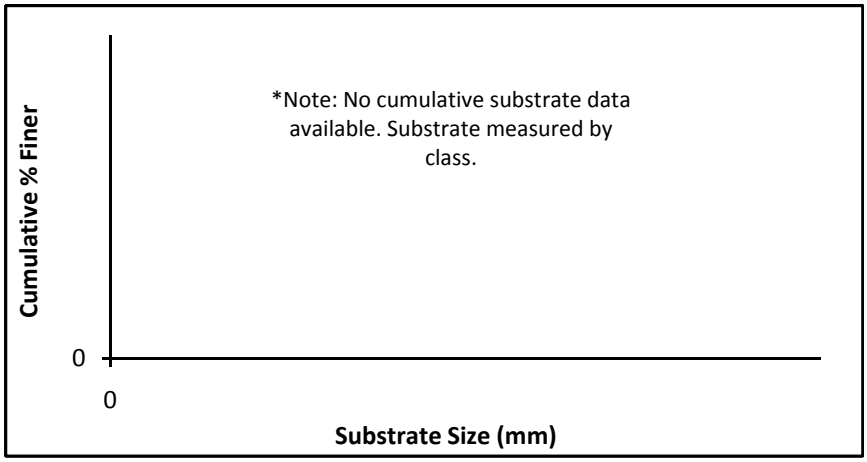
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 30 |
| **Sand** | 0.06 - 2 | 41 |
| **F. Gravel** | 2 - 16 | 5 |
| **C. Gravel** | 16 - 64 | 6 |
| **Cobble** | 64 - 256 | 12 |
| **Boulder** | 256 - 4096 | 6 |
| **Bedrock** | > 4096 | 0 |

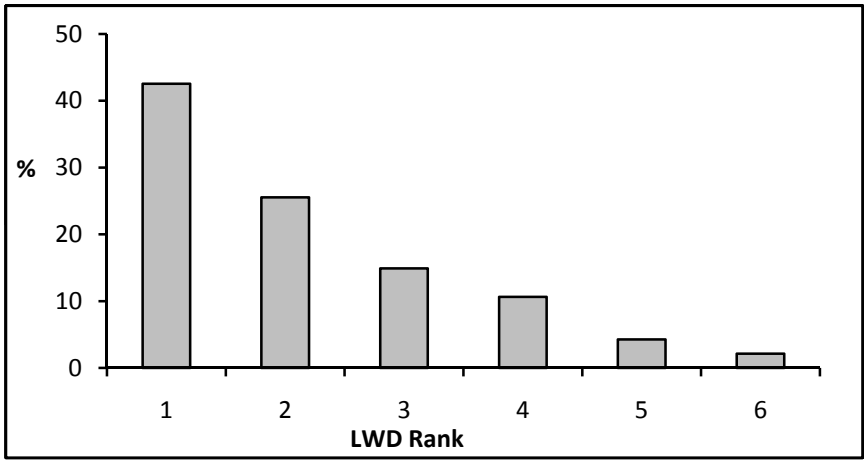
| | | |
|---|---|---|
| **Median Substrate Size:** | 0.06 - 2 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 20 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 12 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 7 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 5 |
| **5** | D ≥ 2.0 | < 0.5 | 2 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 1 |

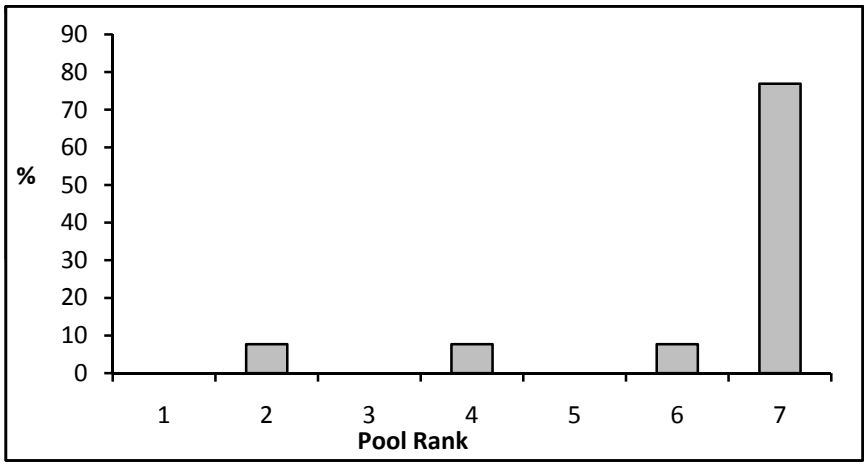
**# LWDs/mile:** 58




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 1 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 0 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 1 |
| **5** | D ≥ 3.0 | < 0.5 | 0 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 1 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 10 |

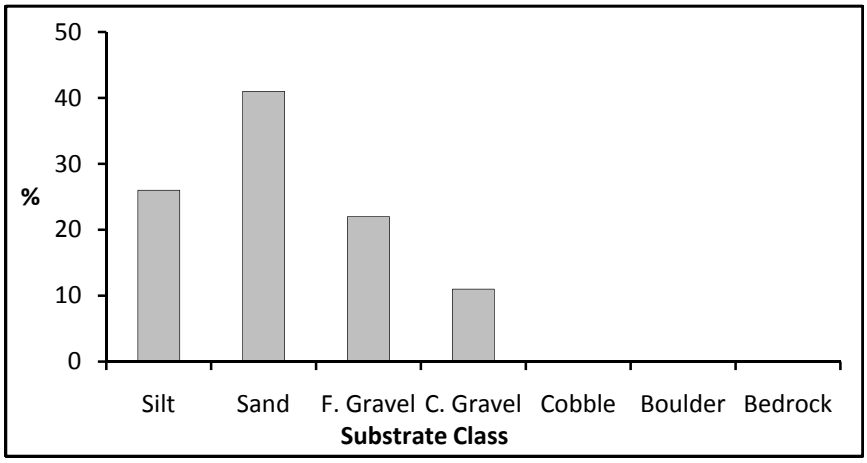
**# Pools/mile:** 16



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | T1.02-A |
| **Length:** | 1,728 ft |
| **Field Form:** | Low Gradient |
| **Total RHA Score:** | 137 |
| **RHA Percentage:** | 69% |
| **Overall Habitat Condition:** | Good |

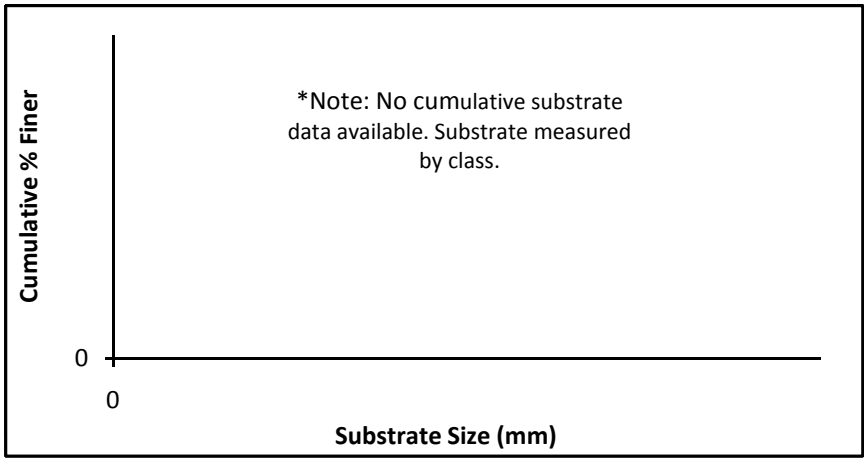
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 26 |
| **Sand** | 0.06 - 2 | 41 |
| **F. Gravel** | 2 - 16 | 22 |
| **C. Gravel** | 16 - 64 | 11 |
| **Cobble** | 64 - 256 | 0 |
| **Boulder** | 256 - 4096 | 0 |
| **Bedrock** | > 4096 | 0 |

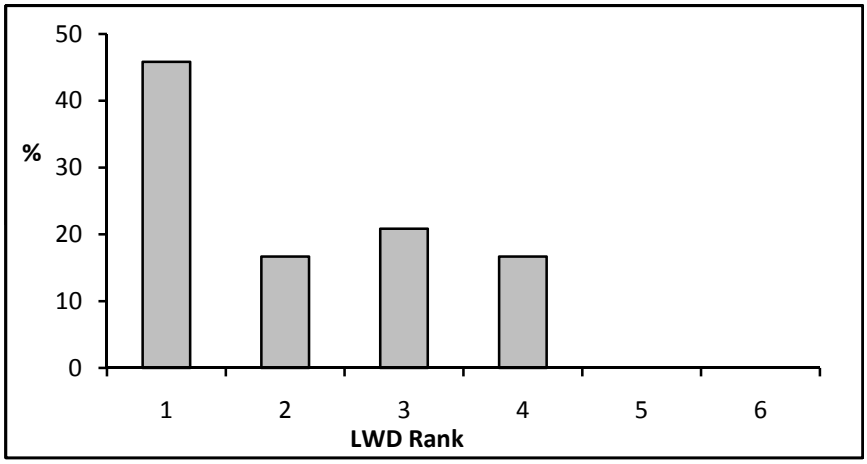
| | | |
|---|---|---|
| **Median Substrate Size:** | 0.06 - 2 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 11 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 4 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 5 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 4 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 0 |

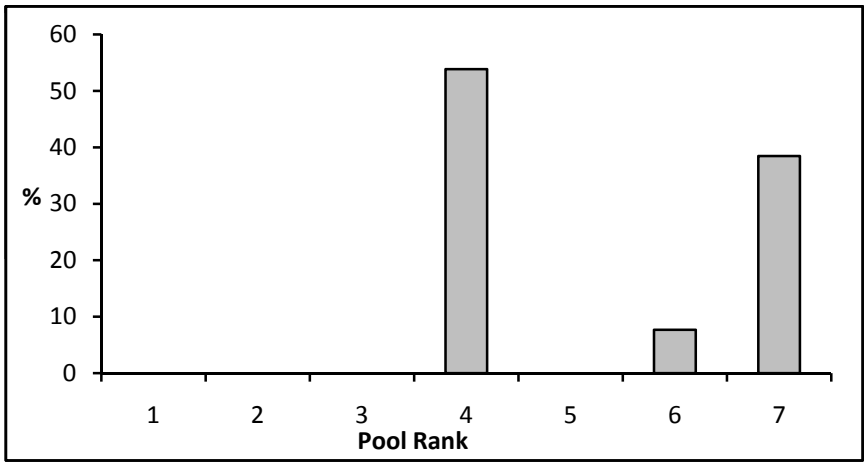
**# LWDs/mile:** 73




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 0 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 7 |
| **5** | D ≥ 3.0 | < 0.5 | 0 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 1 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 5 |

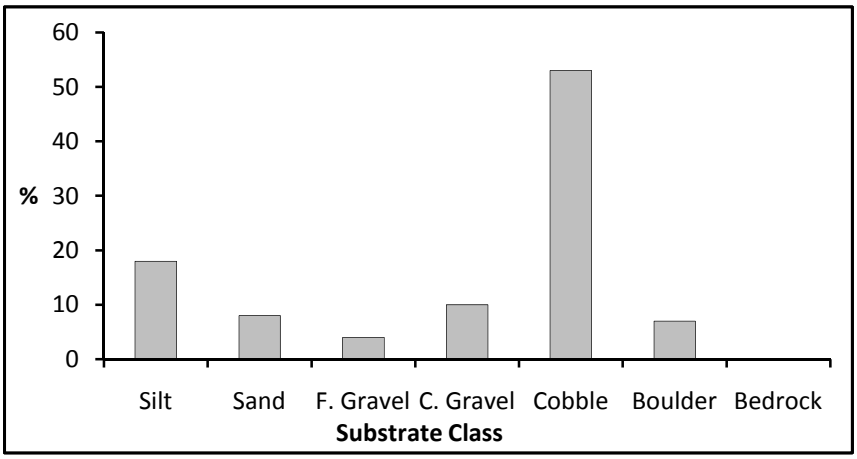
**# Pools/mile:** 40



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | T1.02-B |
| **Length:** | 1,551 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 127 |
| **RHA Percentage:** | 64% |
| **Overall Habitat Condition:** | Fair |

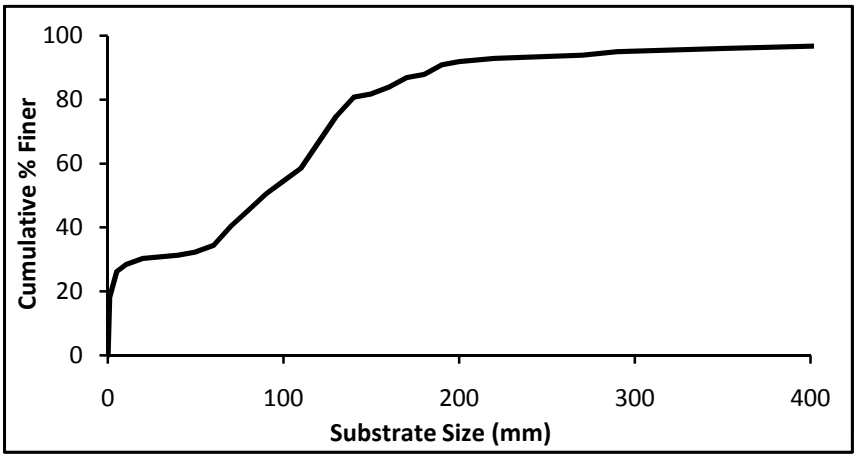
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 18 |
| **Sand** | 0.06 - 2 | 8 |
| **F. Gravel** | 2 - 16 | 4 |
| **C. Gravel** | 16 - 64 | 10 |
| **Cobble** | 64 - 256 | 53 |
| **Boulder** | 256 - 4096 | 7 |
| **Bedrock** | > 4096 | 0 |

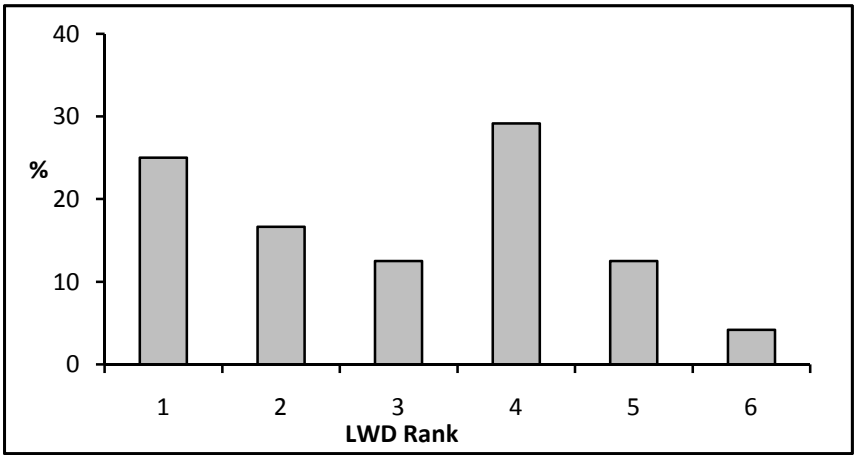
| | | |
|---|---|---|
| **Median Substrate Size:** | 85 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 6 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 4 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 3 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 7 |
| **5** | D ≥ 2.0 | < 0.5 | 3 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 1 |

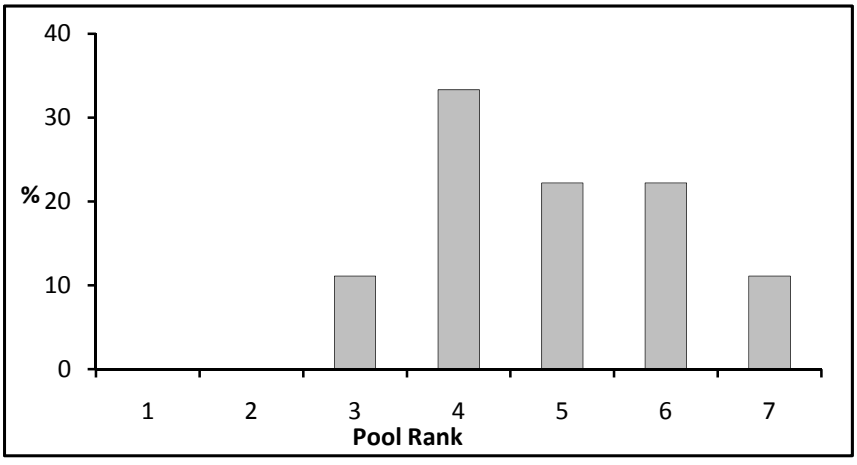
**# LWDs/mile:** 82




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 1 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 3 |
| **5** | D ≥ 3.0 | < 0.5 | 2 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 2 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 1 |

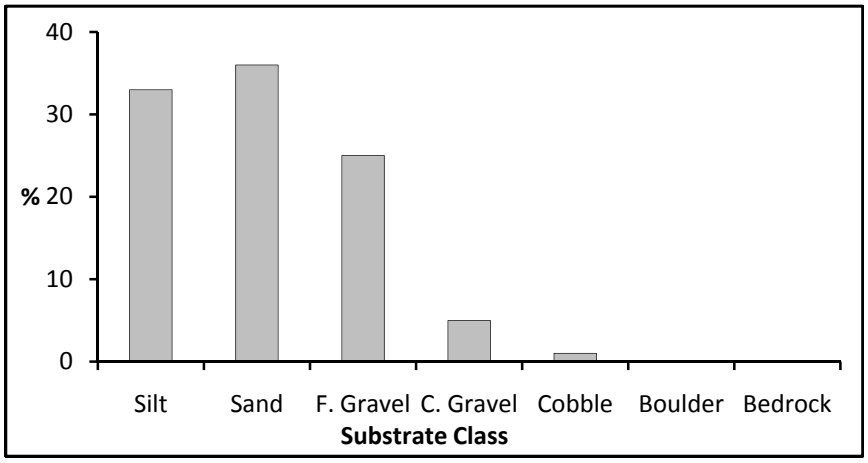
**# Pools/mile:** 31



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | T1.02-D |
| **Length:** | 1,297 ft |
| **Field Form:** | Low Gradient |
| **Total RHA Score:** | 109 |
| **RHA Percentage:** | 55% |
| **Overall Habitat Condition:** | Fair |

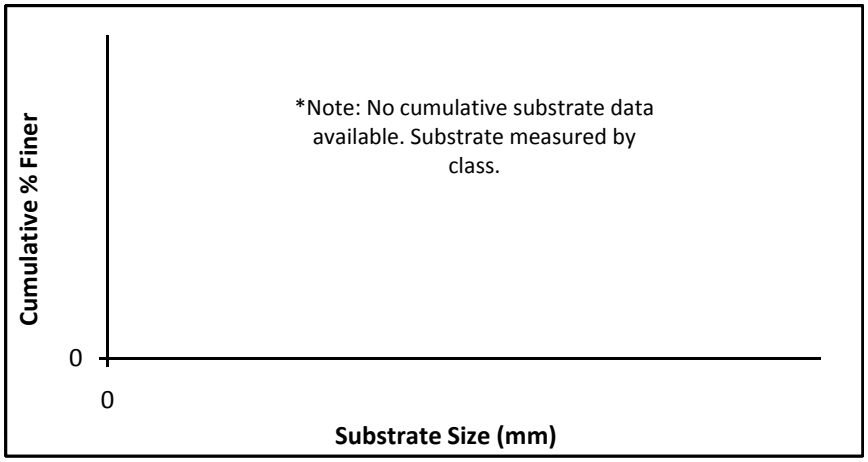
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 33 |
| **Sand** | 0.06 - 2 | 36 |
| **F. Gravel** | 2 - 16 | 25 |
| **C. Gravel** | 16 - 64 | 5 |
| **Cobble** | 64 - 256 | 1 |
| **Boulder** | 256 - 4096 | 0 |
| **Bedrock** | > 4096 | 0 |

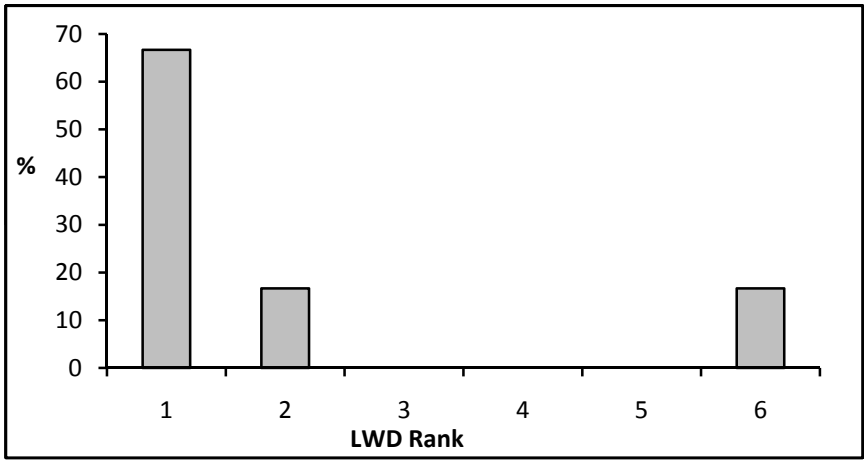
| | | |
|---|---|---|
| **Median Substrate Size:** | 0.06 - 2 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 4 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 1 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 1 |

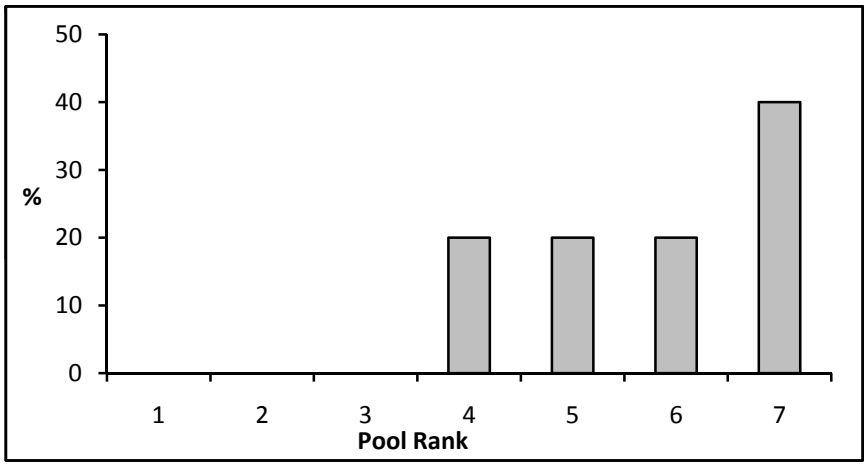
**# LWDs/mile:** 24




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 0 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 1 |
| **5** | D ≥ 3.0 | < 0.5 | 1 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 1 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 2 |

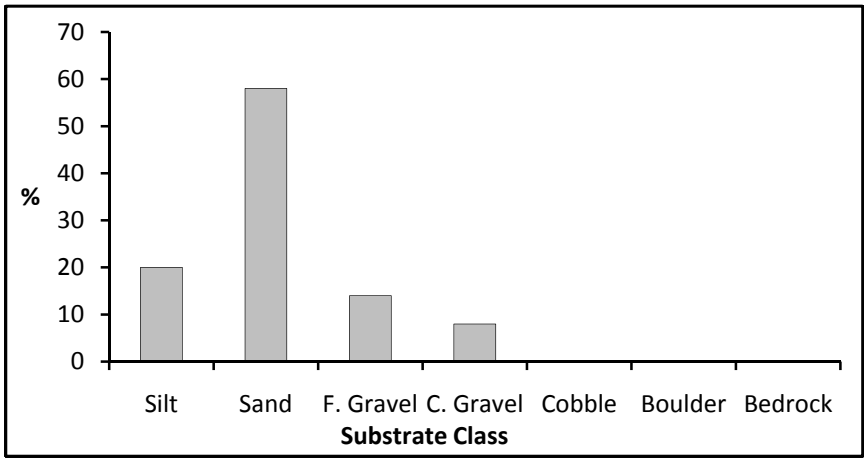
**# Pools/mile:** 20



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | T1.02-F |
| **Length:** | 4,762 ft |
| **Field Form:** | Low Gradient |
| **Total RHA Score:** | 119 |
| **RHA Percentage:** | 60% |
| **Overall Habitat Condition:** | Fair |

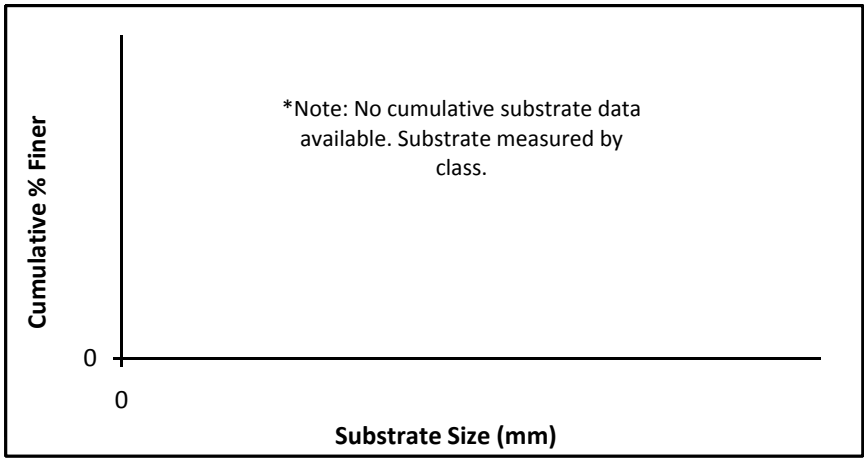
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 20 |
| **Sand** | 0.06 - 2 | 58 |
| **F. Gravel** | 2 - 16 | 14 |
| **C. Gravel** | 16 - 64 | 8 |
| **Cobble** | 64 - 256 | 0 |
| **Boulder** | 256 - 4096 | 0 |
| **Bedrock** | > 4096 | 0 |

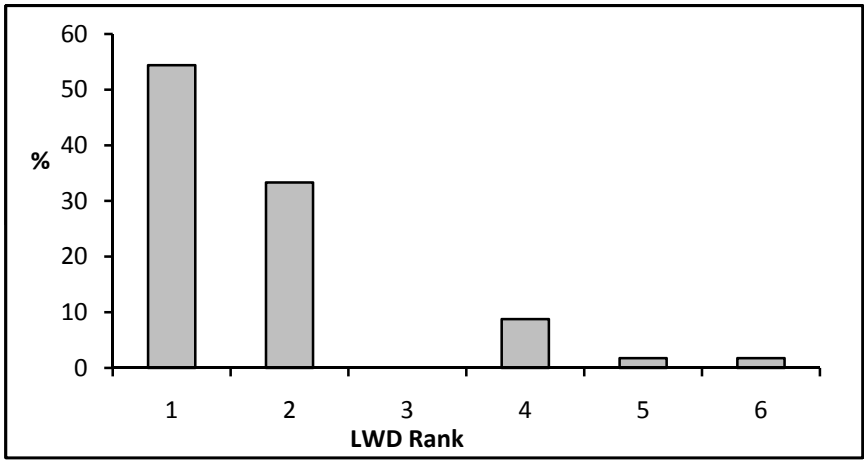
| | | |
|---|---|---|
| **Median Substrate Size:** | 0.06 - 2 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 31 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 19 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 5 |
| **5** | D ≥ 2.0 | < 0.5 | 1 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 1 |

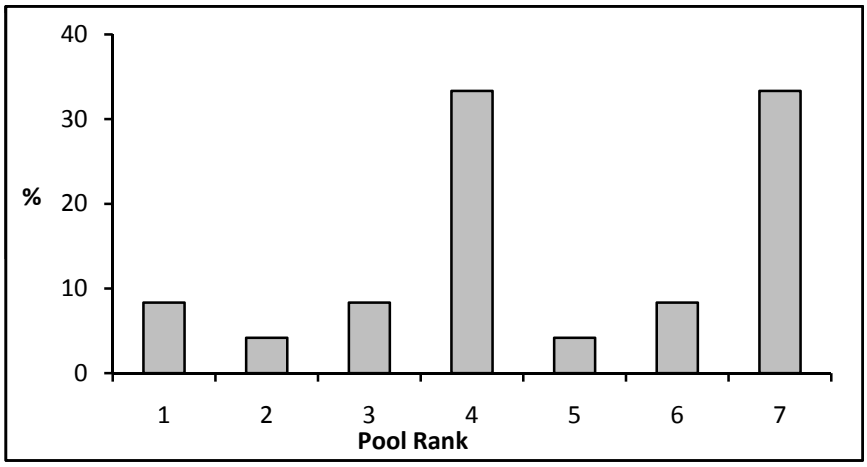
**# LWDs/mile:** 63




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 2 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 1 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 2 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 8 |
| **5** | D ≥ 3.0 | < 0.5 | 1 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 2 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 8 |

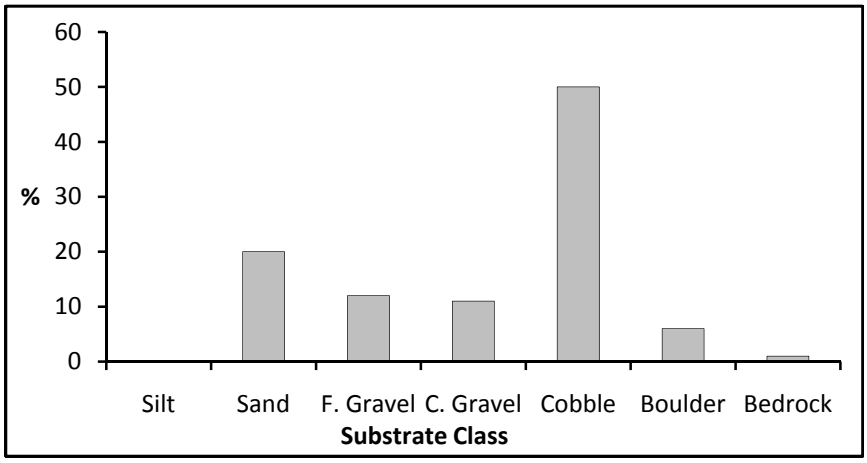
**# Pools/mile:** 27



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | T2.01-A |
| **Length:** | 1,303 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 158 |
| **RHA Percentage:** | 79% |
| **Overall Habitat Condition:** | Good |

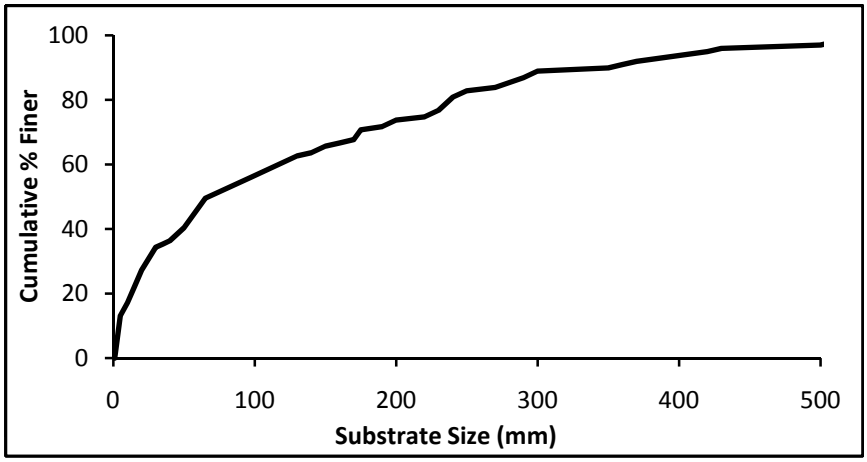
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 0 |
| **Sand** | 0.06 - 2 | 20 |
| **F. Gravel** | 2 - 16 | 12 |
| **C. Gravel** | 16 - 64 | 11 |
| **Cobble** | 64 - 256 | 50 |
| **Boulder** | 256 - 4096 | 6 |
| **Bedrock** | > 4096 | 1 |

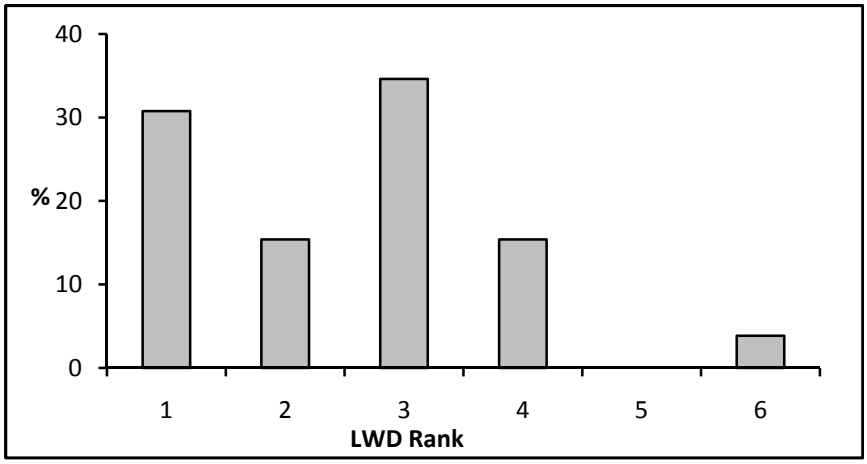
| | | |
|---|---|---|
| **Median Substrate Size:** | 90 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 8 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 4 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 9 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 4 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 1 |

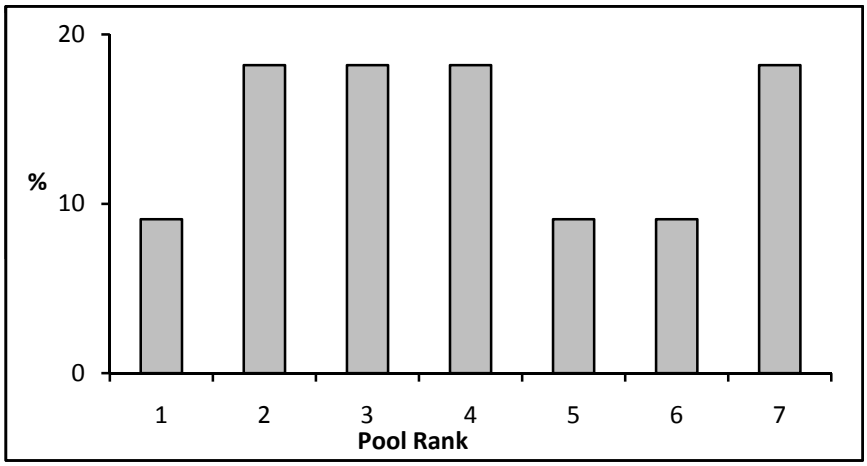
**# LWDs/mile:** 105




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 1 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 2 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 2 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 2 |
| **5** | D ≥ 3.0 | < 0.5 | 1 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 1 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 2 |

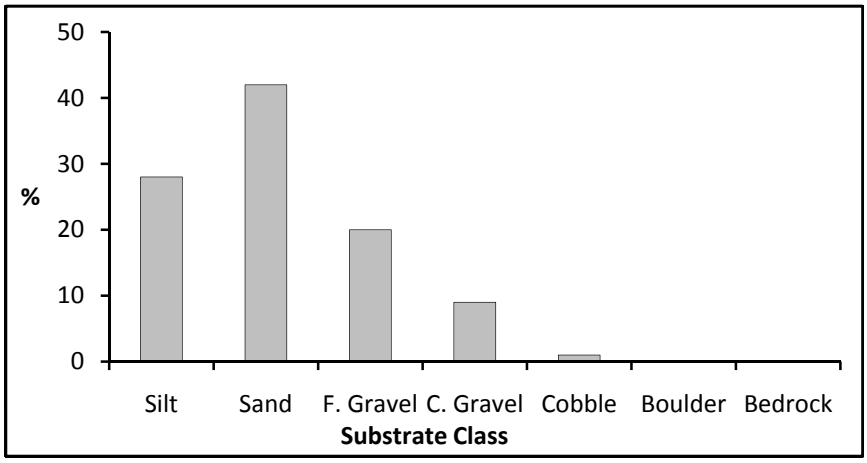
**# Pools/mile:** 45



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | T2.01-B |
| **Length:** | 3,281 ft |
| **Field Form:** | Low Gradient |
| **Total RHA Score:** | 122 |
| **RHA Percentage:** | 61% |
| **Overall Habitat Condition:** | Fair |

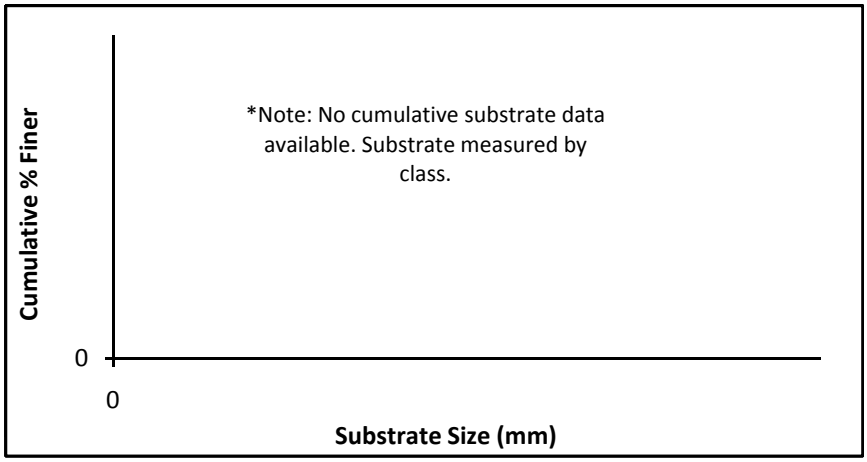
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 28 |
| **Sand** | 0.06 - 2 | 42 |
| **F. Gravel** | 2 - 16 | 20 |
| **C. Gravel** | 16 - 64 | 9 |
| **Cobble** | 64 - 256 | 1 |
| **Boulder** | 256 - 4096 | 0 |
| **Bedrock** | > 4096 | 0 |

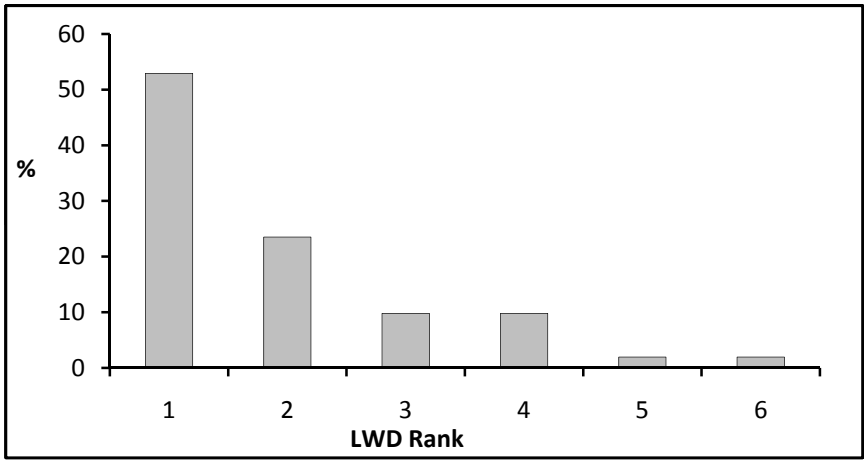
| | | |
|---|---|---|
| **Median Substrate Size:** | 0.06 - 2 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 27 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 12 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 5 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 5 |
| **5** | D ≥ 2.0 | < 0.5 | 1 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 1 |

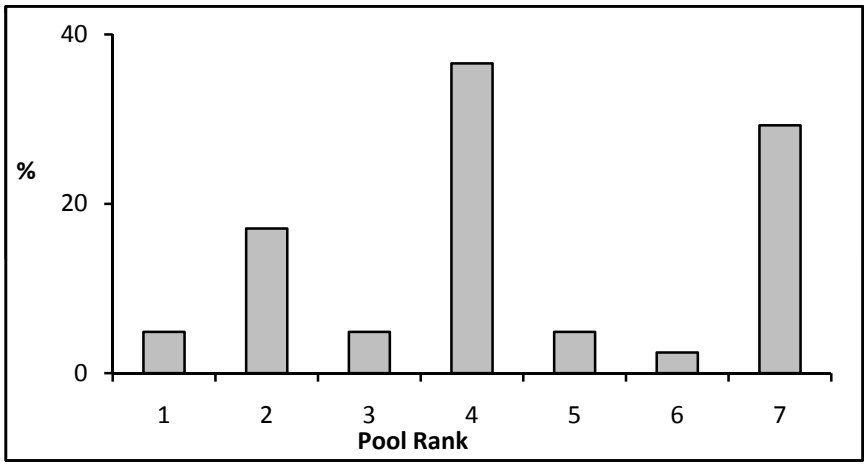
**# LWDs/mile:** 82




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 2 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 7 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 2 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 15 |
| **5** | D ≥ 3.0 | < 0.5 | 2 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 1 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 12 |

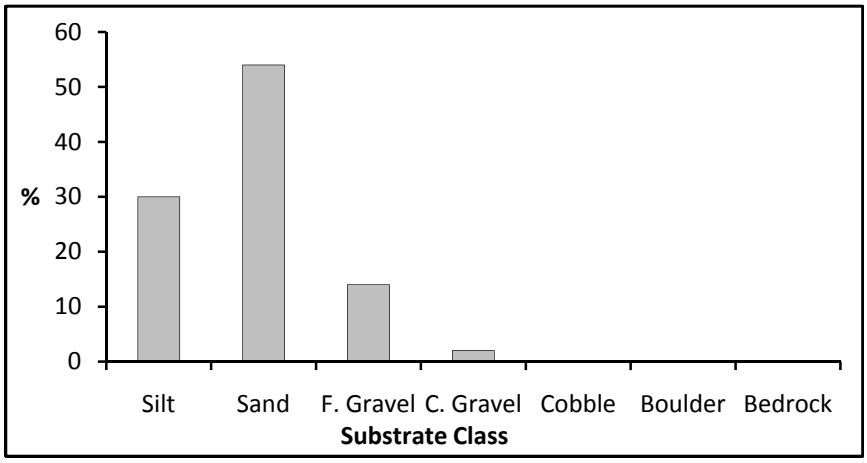
**# Pools/mile:** 66



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | T2.01-C |
| **Length:** | 2,613 ft |
| **Field Form:** | Low Gradient |
| **Total RHA Score:** | 110 |
| **RHA Percentage:** | 55% |
| **Overall Habitat Condition:** | Fair |

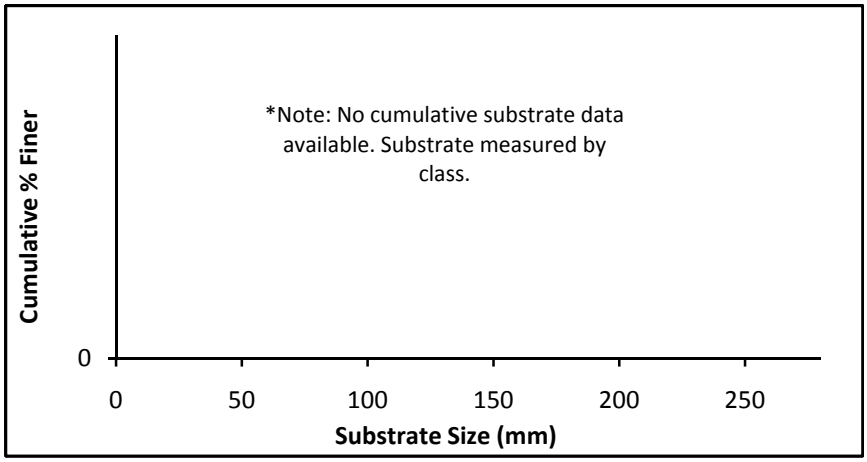
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 30 |
| **Sand** | 0.06 - 2 | 54 |
| **F. Gravel** | 2 - 16 | 14 |
| **C. Gravel** | 16 - 64 | 2 |
| **Cobble** | 64 - 256 | 0 |
| **Boulder** | 256 - 4096 | 0 |
| **Bedrock** | > 4096 | 0 |

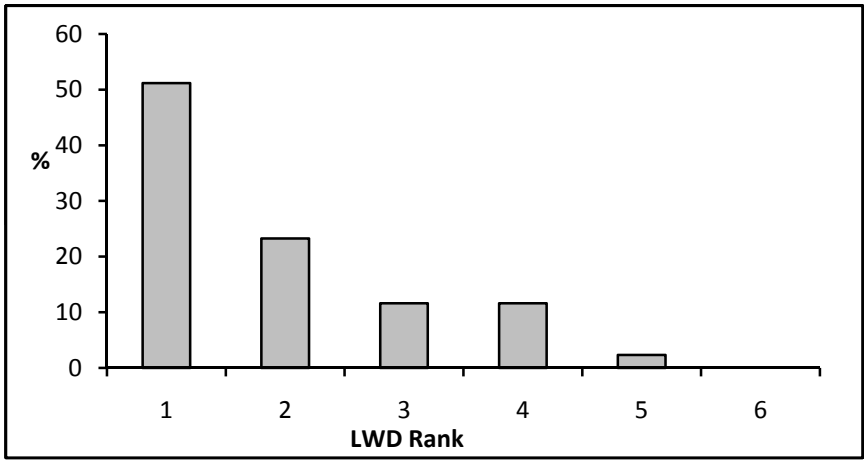
| | | |
|---|---|---|
| **Median Substrate Size:** | 0.06 - 2 | mm |
| **Avg. Largest Particle (Bar):** | NA | mm |
| **Riffle Stability Index (RSI):** | NA | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 22 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 10 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 5 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 5 |
| **5** | D ≥ 2.0 | < 0.5 | 1 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 0 |

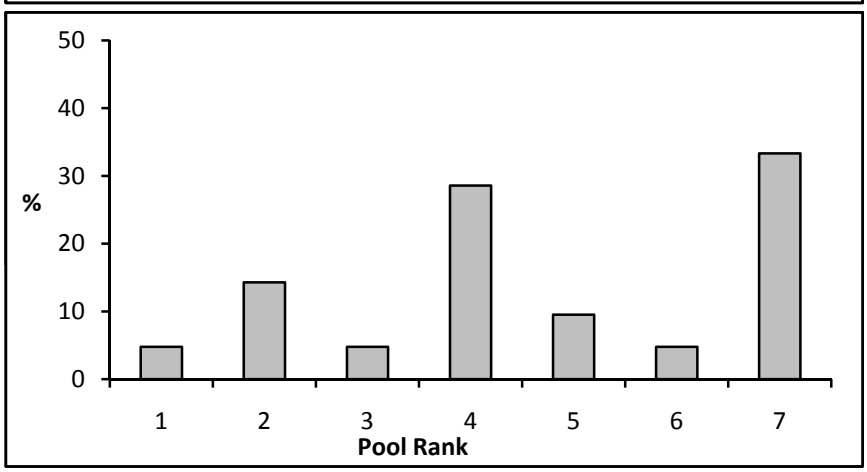
**# LWDs/mile:** 87




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 1 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 3 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 1 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 6 |
| **5** | D ≥ 3.0 | < 0.5 | 2 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 1 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 7 |

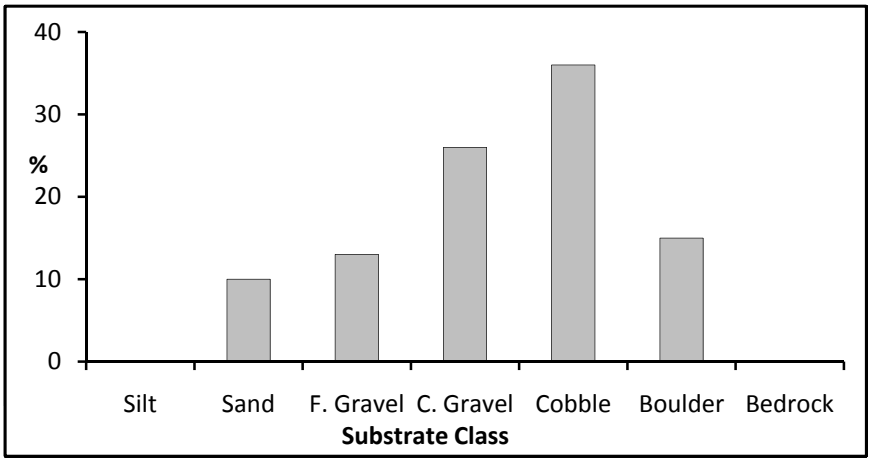
**# Pools/mile:** 42



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | T9.01-A |
| **Length:** | 1,812 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 94 |
| **RHA Percentage:** | 47% |
| **Overall Habitat Condition:** | Fair |

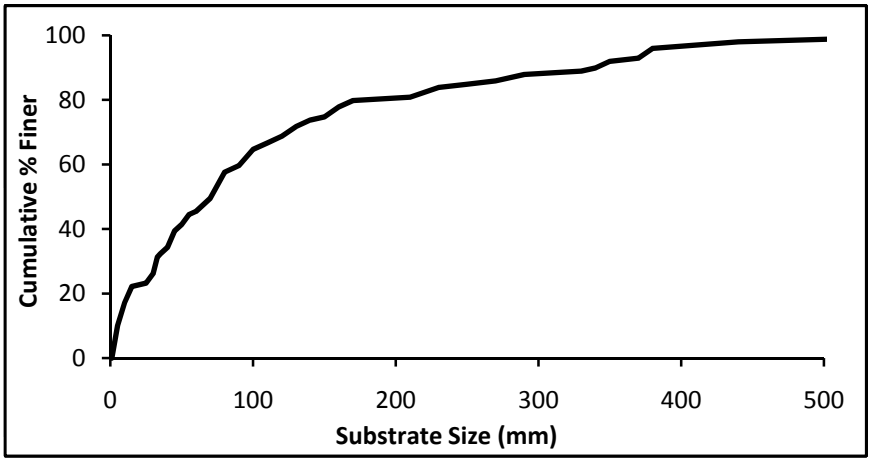
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 0 |
| **Sand** | 0.06 - 2 | 10 |
| **F. Gravel** | 2 - 16 | 13 |
| **C. Gravel** | 16 - 64 | 26 |
| **Cobble** | 64 - 256 | 36 |
| **Boulder** | 256 - 4096 | 15 |
| **Bedrock** | > 4096 | 0 |

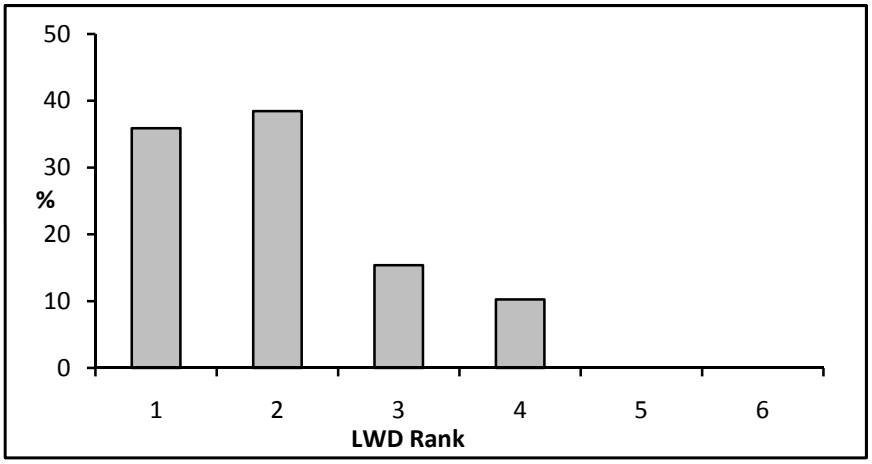
| | | |
|---|---|---|
| **Median Substrate Size:** | 70 | mm |
| **Avg. Largest Particle (Bar):** | N/A | mm |
| **Riffle Stability Index (RSI):** | N/A | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 14 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 15 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 6 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 4 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 0 |

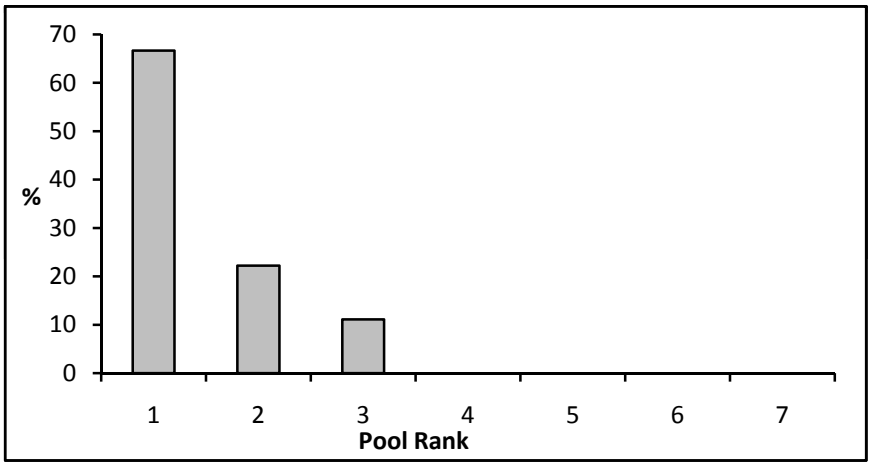
**# LWDs/mile:** 114




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 6 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 2 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 1 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 3.0 | < 0.5 | 0 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 0 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 0 |

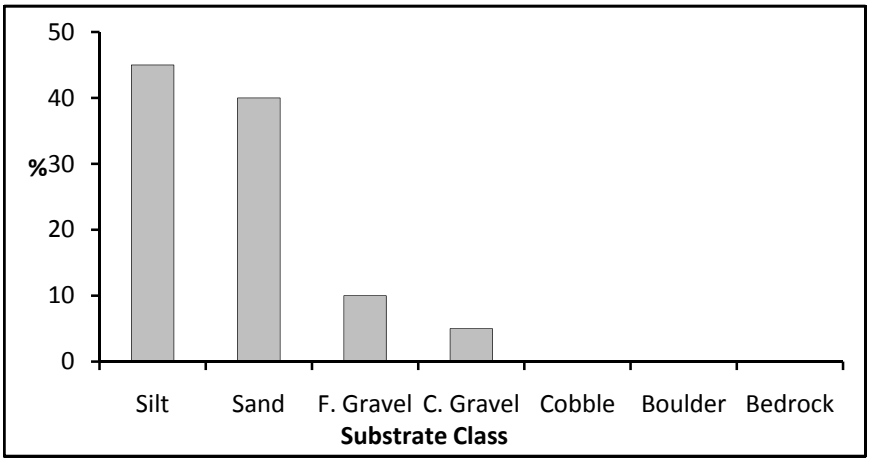
**# Pools/mile:** 26



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M15.S2.01 |
| **Length:** | 3,908 ft |
| **Field Form:** | Low Gradient |
| **Total RHA Score:** | 103 |
| **RHA Percentage:** | 52% |
| **Overall Habitat Condition:** | Fair |

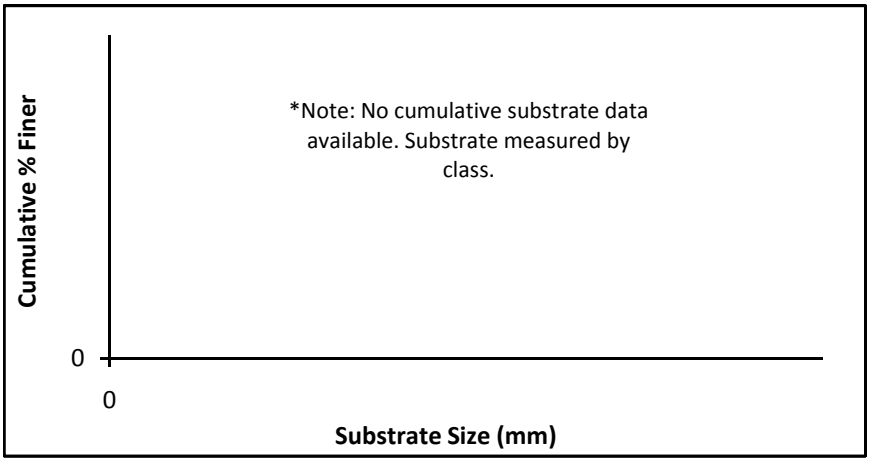
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 45 |
| **Sand** | 0.06 - 2 | 40 |
| **F. Gravel** | 2 - 16 | 10 |
| **C. Gravel** | 16 - 64 | 5 |
| **Cobble** | 64 - 256 | 0 |
| **Boulder** | 256 - 4096 | 0 |
| **Bedrock** | > 4096 | 0 |

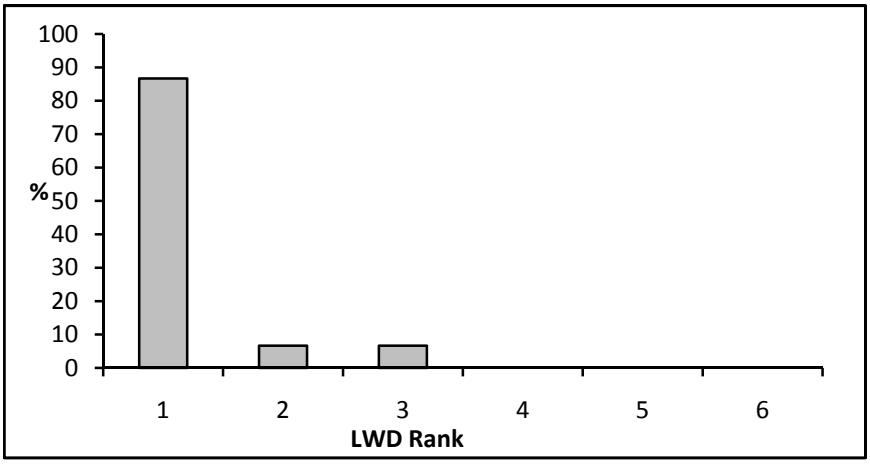
| | | |
|---|---|---|
| **Median Substrate Size:** | N/A | mm |
| **Avg. Largest Particle (Bar):** | N/A | mm |
| **Riffle Stability Index (RSI):** | N/A | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 13 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 1 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 1 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 0 |

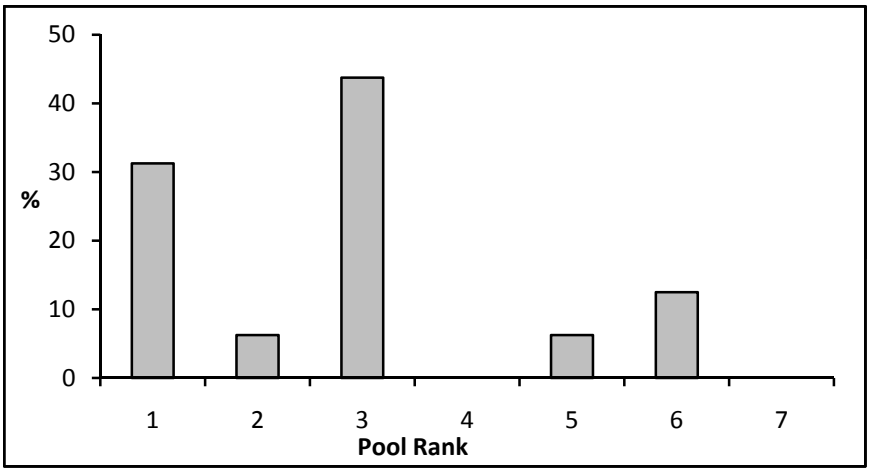
**# LWDs/mile:** 20




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 5 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 1 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 7 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 3.0 | < 0.5 | 1 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 2 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 0 |

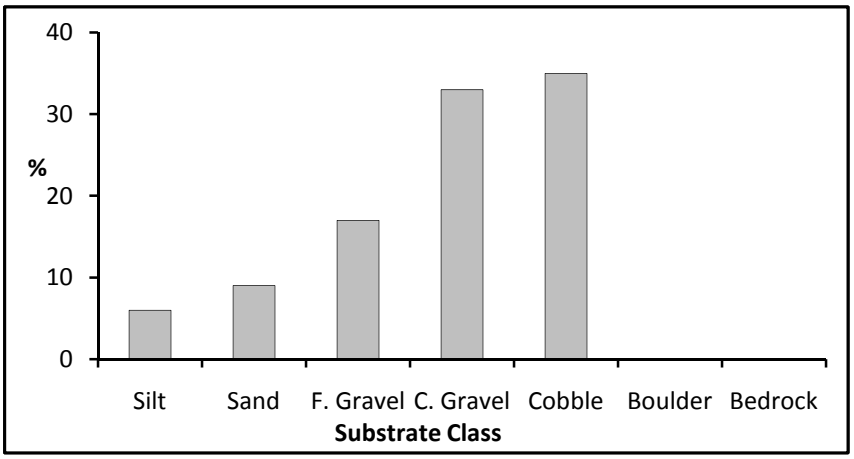
**# Pools/mile:** 22



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M19.S1.01-B |
| **Length:** | 1,458 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 148 |
| **RHA Percentage:** | 74% |
| **Overall Habitat Condition:** | Good |

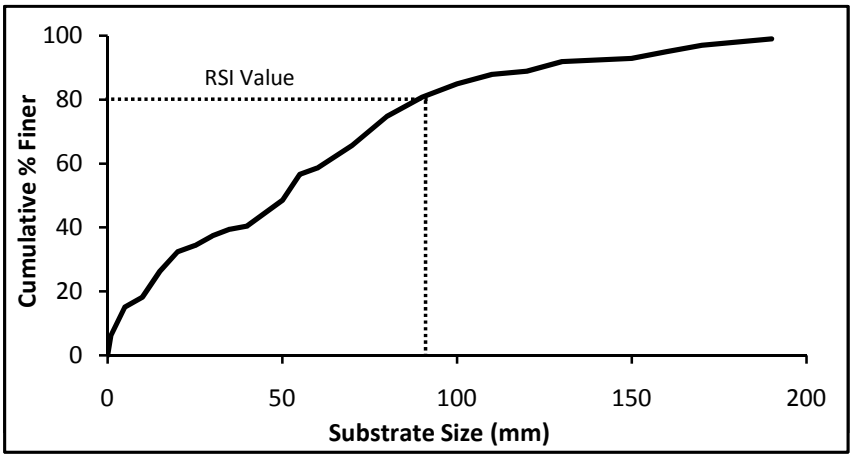
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 6 |
| **Sand** | 0.06 - 2 | 9 |
| **F. Gravel** | 2 - 16 | 17 |
| **C. Gravel** | 16 - 64 | 33 |
| **Cobble** | 64 - 256 | 35 |
| **Boulder** | 256 - 4096 | 0 |
| **Bedrock** | > 4096 | 0 |

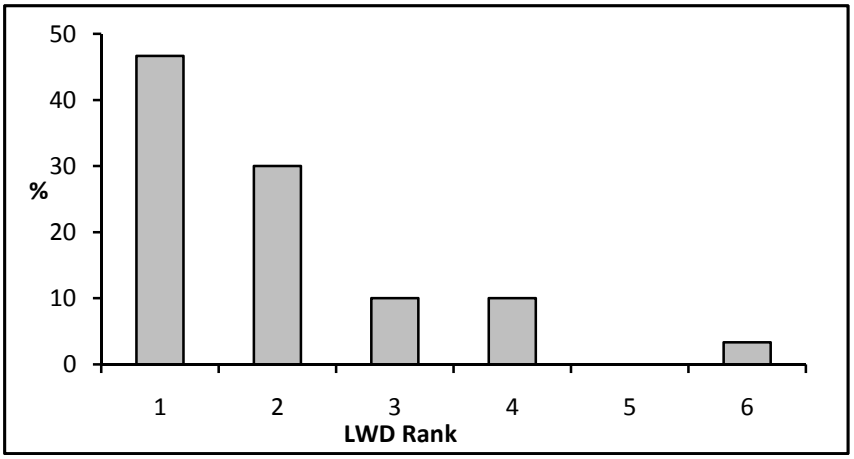
| | | |
|---|---|---|
| **Median Substrate Size:** | 50 | mm |
| **Avg. Largest Particle (Bar):** | 90 | mm |
| **Riffle Stability Index (RSI):** | **80** | **%** |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 28 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 18 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 6 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 6 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 2 |

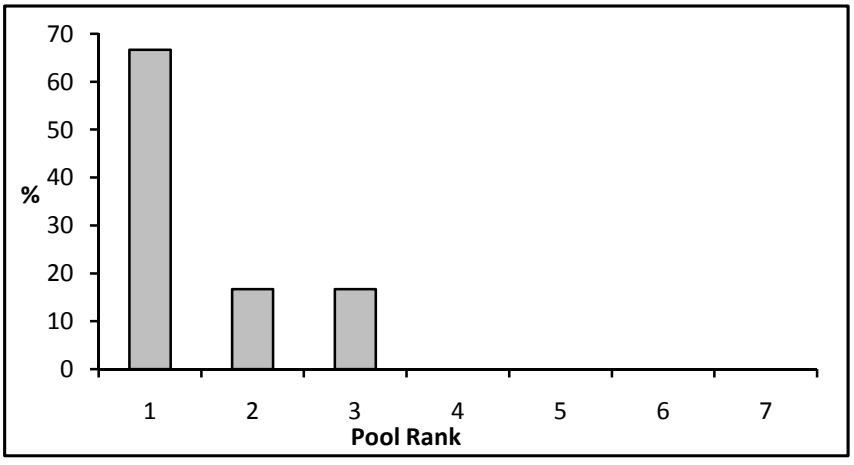
**# LWDs/mile:** 217




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 4 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 1 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 1 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 3.0 | < 0.5 | 0 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 0 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 0 |

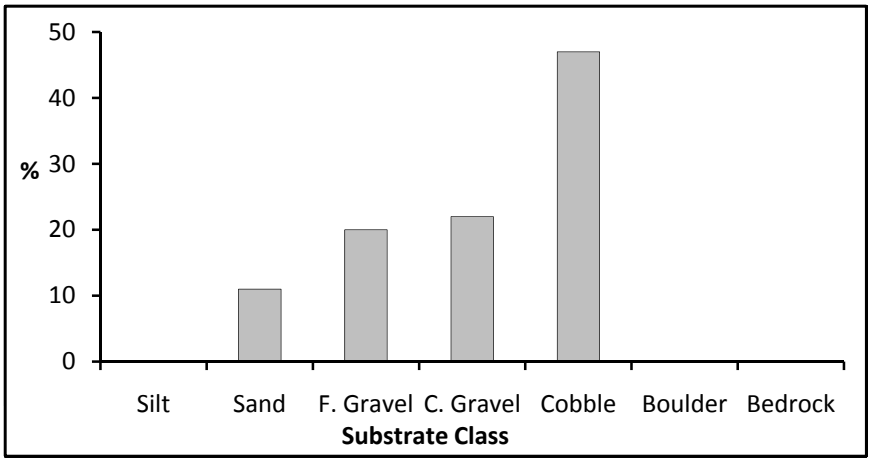
**# Pools/mile:** 22



## Reach/Segment Information

| | |
|---|---|
| **SGA ID:** | M19.S1.01-C |
| **Length:** | 2,257 ft |
| **Field Form:** | High Gradient |
| **Total RHA Score:** | 68 |
| **RHA Percentage:** | 34% |
| **Overall Habitat Condition:** | Poor |

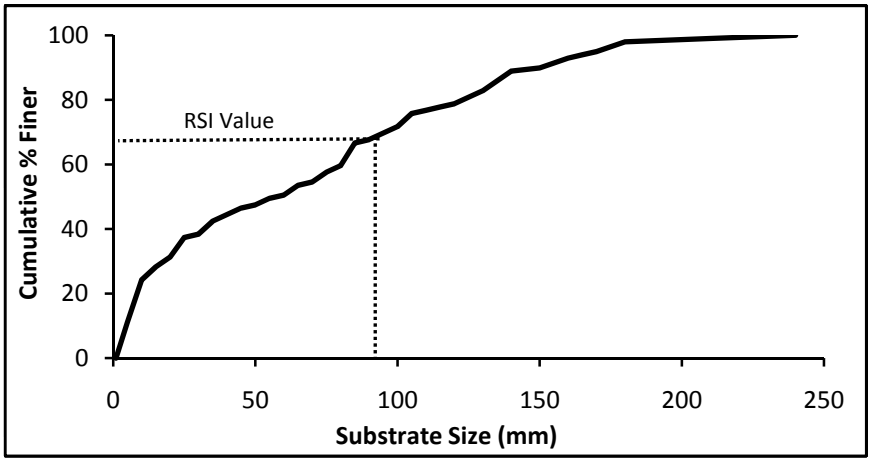
*Note: Scores based on old RHA protocol; LWD and pool distribution data was also recorded in the field




## Sediment Composition and Mobility

| Class | Range (mm) | Percent |
|---|---|---|
| **Silt** | < 0.06 | 0 |
| **Sand** | 0.06 - 2 | 11 |
| **F. Gravel** | 2 - 16 | 20 |
| **C. Gravel** | 16 - 64 | 22 |
| **Cobble** | 64 - 256 | 47 |
| **Boulder** | 256 - 4096 | 0 |
| **Bedrock** | > 4096 | 0 |

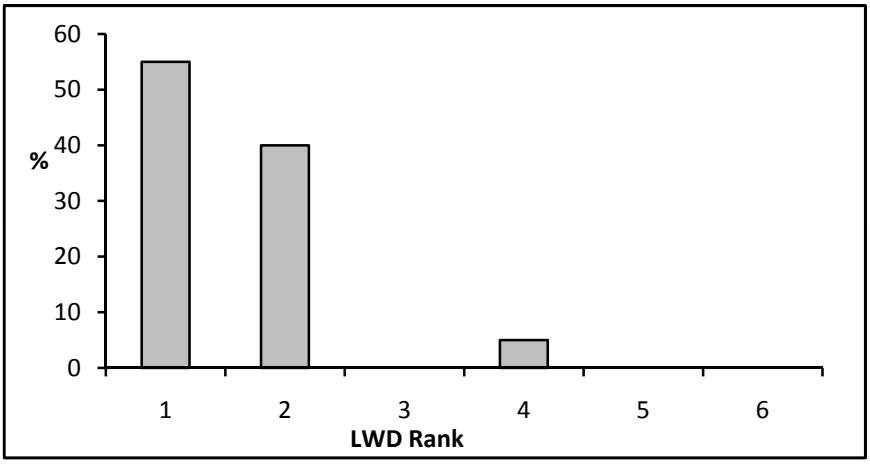
| | | |
|---|---|---|
| **Median Substrate Size:** | 57.5 | mm |
| **Avg. Largest Particle (Bar):** | 90 | mm |
| **Riffle Stability Index (RSI):** | 68 | % |




## Large Woody Debris (LWD)

| Rank | Diameter (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 0.5 ≤ D < 1.0 | < 0.5 | 11 |
| **2** | 0.5 ≤ D < 1.0 | ≥ 0.5 | 8 |
| **3** | 1.0 ≤ D < 2.0 | < 0.5 | 0 |
| **4** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 1 |
| **5** | D ≥ 2.0 | < 0.5 | 0 |
| **6** | D ≥ 2.0 | ≥ 0.5 | 0 |

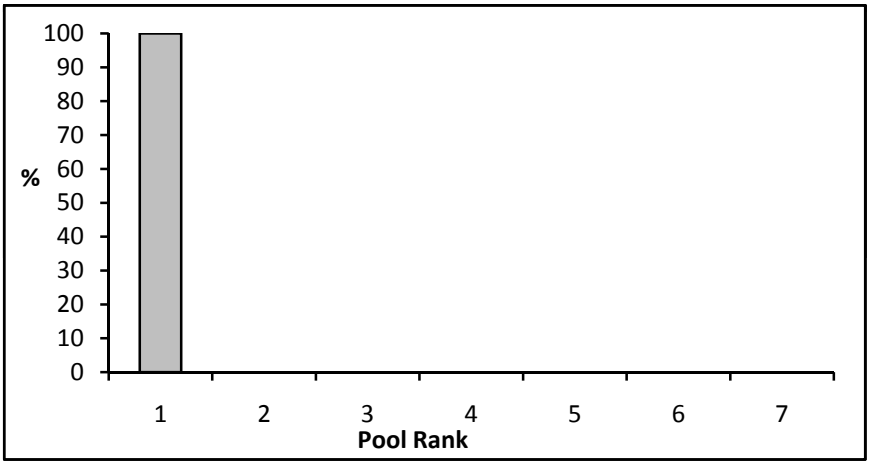
**# LWDs/mile:** 47




## Pools

| Rank | Depth (ft) | L ($W_{bkf}$) | # |
|---|---|---|---|
| **1** | 1.0 ≤ D < 2.0 | < 0.5 | 1 |
| **2** | 1.0 ≤ D < 2.0 | ≥ 0.5 | 0 |
| **3** | 2.0 ≤ D < 3.0 | < 0.5 | 0 |
| **4** | 2.0 ≤ D < 3.0 | ≥ 0.5 | 0 |
| **5** | D ≥ 3.0 | < 0.5 | 0 |
| 6 | D ≥ 3.0 | ≥ 0.5 | 0 |
| **7** | D ≥ 3.0 | ≥ 1.0 | 0 |

**# Pools/mile:** 2



# Appendix C

# Bridge & Culvert Assessment Data

# & Structure Locator Maps

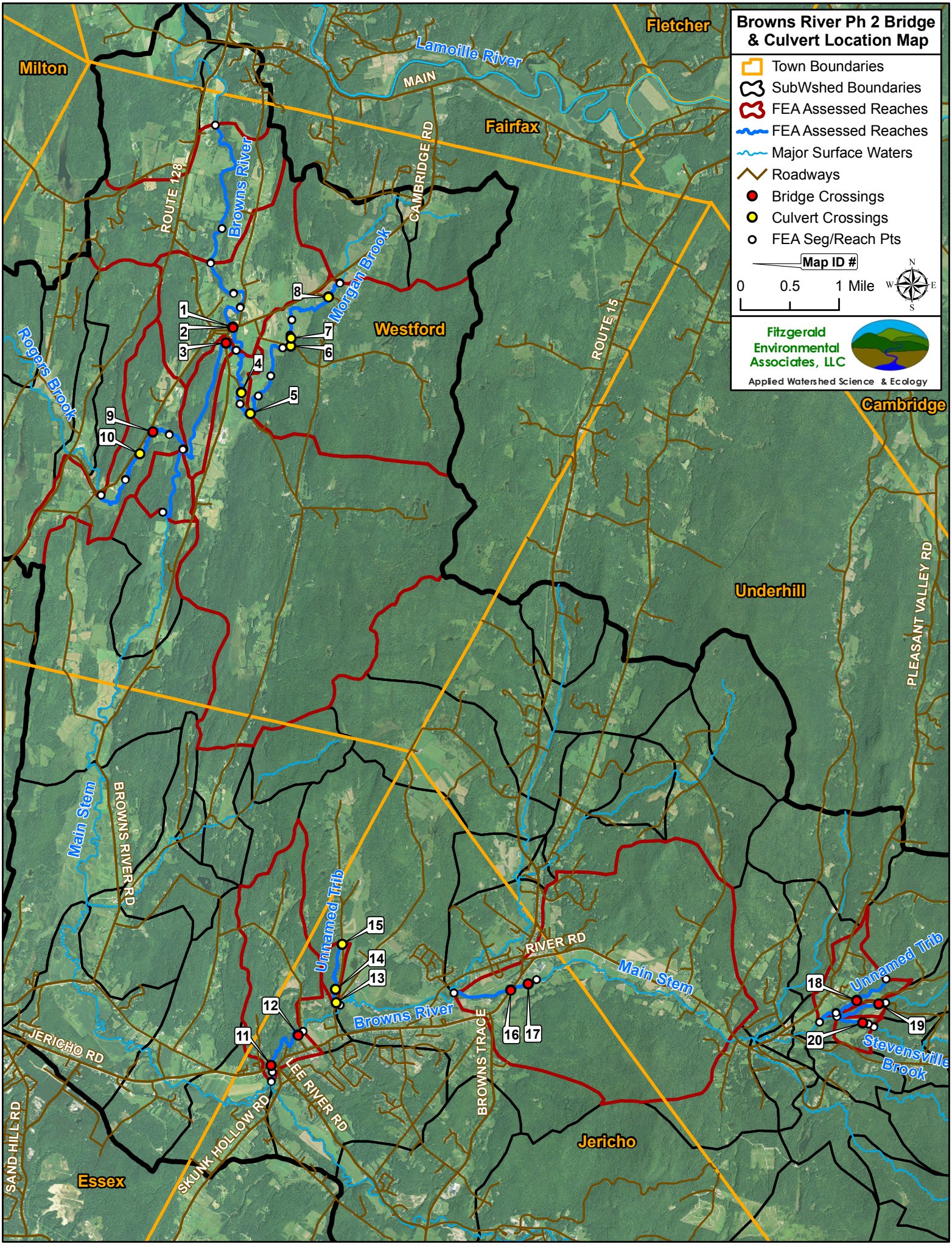

Browns River Ph 2 Bridge & Culvert Location Map
Town Boundaries
SubWshed Boundaries
FEA Assessed Reaches
FEA Assessed Reaches
Major Surface Waters
Roadways
Bridge Crossings
Culvert Crossings
FEA Seg/Reach Pts
Map ID #
0 0.5 1 Mile
N
W
E
S
Fitzgerald Environmental Associates, LLC
Applied Watershed Science & Ecology
Milton
Fletcher
Fairfax
Westford
Cambridge
Underhill
Jericho
Essex
Lamoille River
MAIN
Browns River
ROUTE 128
CAMBRIDGE RD
Morgan Brook
ROUTE 15
Rogers Brook
PLEASANT VALLEY RD
Main Stem
BROWNS RIVER RD
Unnamed Trib
RIVER RD
Main Stem
Browns River
Unnamed Trib
JERICHO RD
LEE RIVER RD
BROWNS TRACE
SKUNK HOLLOW RD
SAND HILL RD
Stevensville Brook
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

**Table 1 (Appendix C)** Structures assessed by FEA during Phase 2 Surveys of Select Reaches of the Browns River and Tributaries

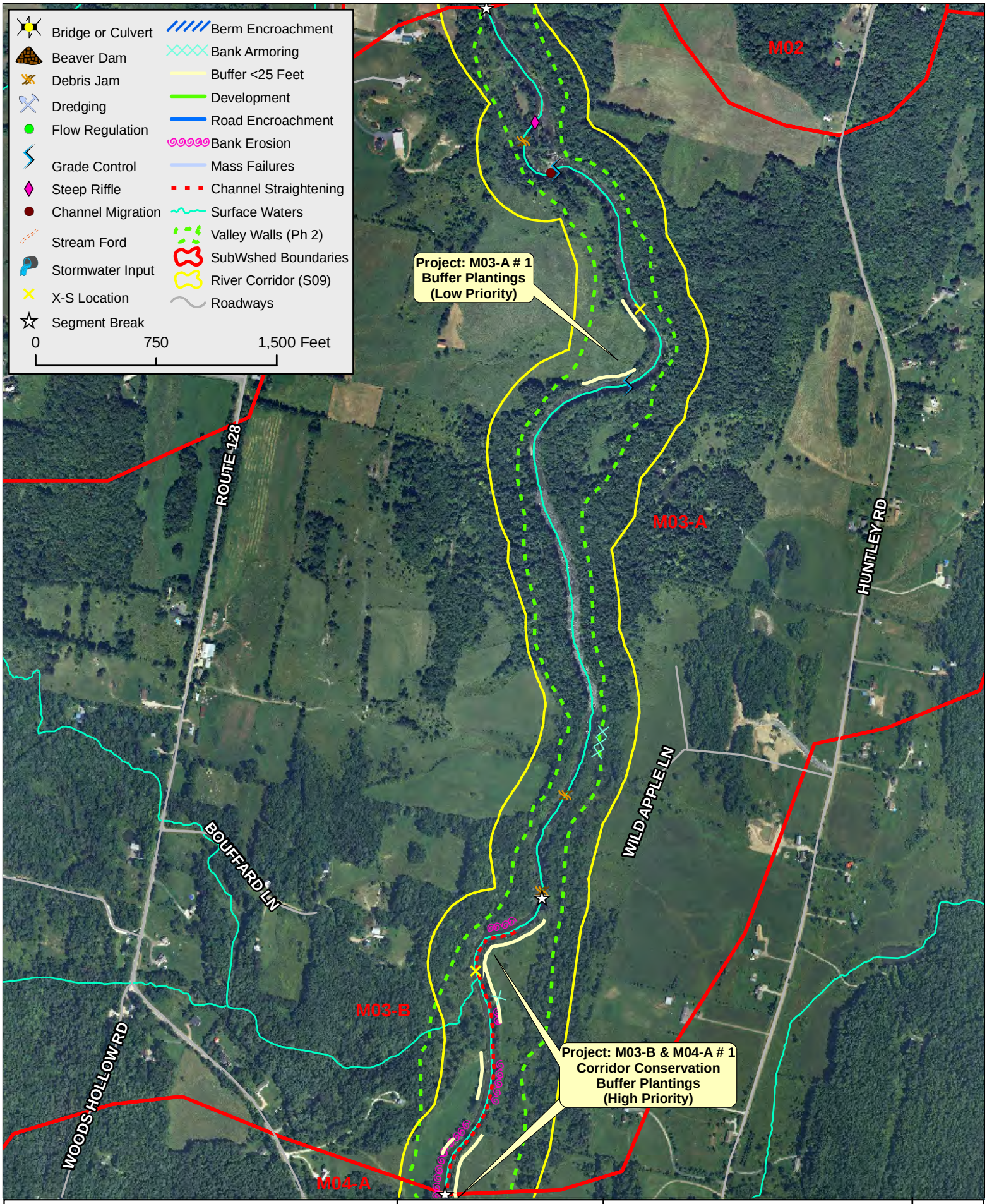
| Town | Map ID* | Stream Name | Reach/ Seg ID | SGA ID | Struture Type | Road Name | Route Number | Latitude | Longitude | Road Type | Structure Material | Bankfull Channel Width (ft) | Structure Dimensions | | | | % Bankfull Width |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | Count** | Length (ft) | Height (ft) | Width (ft) | |
| Westford | 1 | Brown River | M04-C | 100000000004161 | Bridge | Old Cambridge Rd | NA | 44.61246 | -73.00821 | Trail | Timber | 82.0 | 0 | 22.0 | 25.0 | 73.0 | 89.0% |
| | 2 | Brown River | M04-C | 100003000004161 | Bridge | Cambridge Rd | 3 | 44.61236 | -73.00815 | Paved | Steel | 82.0 | 0 | 30.0 | 20.0 | 87.0 | 106.1% |
| | 3 | Brown River | M05 | 200128000004162 | Bridge | Route 128 | 128 | 44.61005 | -73.00934 | Paved | Steel | 83.0 | 0 | 35.0 | 18.0 | 70.0 | 84.3% |
| | 4 | Morgan Brook | T1.01-A | 100019000104161 | Culvert | Osgood Hill Rd | 19 | 44.60290 | -73.00617 | Gravel | Steel Corrugated | 24.3 | 1 | 65.0 | 16.0 | 9.0 | 37.0% |
| | 5 | Morgan Brook | T1.02-A | 100019000204161 | Culvert | Osgood Hill Rd | 19 | 44.59982 | -73.00440 | Gravel | Concrete | 16.0 | 1 | 48.0 | 7.0 | 14.0 | 87.5% |
| | 6 | Morgan Brook | T1.02-D | 100015000004161 | Culvert | Old # 11 Rd | 15 | 44.60988 | -72.99613 | Gravel | Steel Corrugated | 21.0 | 1 | 65.0 | 8.8 | 13.5 | 64.3% |
| | 7 | Morgan Brook | T1.02-D | 700000000604163 | Culvert | Private Driveway | NA | 44.61093 | -72.99612 | Gravel | Concrete | 21.0 | 1 | 30.0 | 5.0 | 5.0 | 23.8% |
| | 8 | Morgan Brook | T1.02-F | 100014000004161 | Culvert | Covey Rd North | 14 | 44.61685 | -72.98850 | Gravel | Steel Corrugated | 15.0 | 1 | 66.0 | 13.1 | 8.0 | 53.3% |
| | 9 | Rogers Brook | T2.01-B | 700000000704163 | Bridge | Private Driveway | NA | 44.59708 | -73.02441 | Gravel | Steel | 22.0 | 0 | 20.0 | 8.5 | 20.0 | 90.9% |
| | 10 | Rogers Brook | T2.01-C | 700000000804163 | Culvert | Farm Rd | NA | 44.59379 | -73.02702 | Trail | Concrete | 23.0 | 1 | 16.0 | 3.5 | 3.5 | 15.2% |
| Jericho | 11 | Brown River | M13-B | 200015000004091 | Bridge | Route 15 | 15 | 44.50420 | -72.99930 | Paved | Steel | 64.0 | 0 | 35.0 | 31.0 | 90.0 | 140.6% |
| | 12 | Brown River | M13-B | 100017000404091 | Bridge | Old Pump Rd | 17 | 44.50859 | -72.99366 | Gravel | Concrete | 64.0 | 0 | 25.0 | 15.0 | 60.0 | 93.8% |
| | 13 | Unnamed Trib | M15S2.01 | 100009000004091 | Culvert | Cilley Hill Rd | 9 | 44.51342 | -72.98595 | Gravel | Steel Corrugated | 14.5 | 1 | 55.0 | 6.8 | 6.8 | 46.9% |
| | 14 | Unnamed Trib | M15S2.01 | 700000000804093 | Culvert | Unknown Driveway | NA | 44.51555 | -72.98618 | Gravel | Steel Corrugated | 14.5 | 2 | 36.0 | 4.0 | 4.0 | 55.2% |
| | 15 | Unnamed Trib | M15S2.01 | 100011000004091 | Culvert | Hanley Ln | 11 | 44.52211 | -72.98471 | Gravel | Steel Corrugated | 14.5 | 1 | 32.0 | 4.5 | 5.5 | 37.9% |
| | 16 | Brown River | M16-A | 200015000104091 | Bridge | Route 15 | 15 | 44.51547 | -72.95036 | Paved | Steel | 54.0 | 0 | 45.0 | 11.3 | 90.0 | 166.7% |
| | 17 | Brown River | M16-A | 100000000204091 | Bridge | Covered Bridge | NA | 44.51650 | -72.94652 | Trail | Timber | 54.0 | 0 | 20.0 | 10.5 | 36.0 | 66.7% |
| Underhill | 18 | Unnamed Trib | M19S1.01-B | 400002000004151 | Bridge | Mountain Rd | 2 | 44.51414 | -72.87934 | Gravel | Concrete | 17.0 | 0 | 40.0 | 6.7 | 8.0 | 47.1% |
| | 19 | Brown River | M20 | 400036000004151 | Bridge | Maple Leaf Rd | 36 | 44.51372 | -72.87485 | Gravel | Concrete | 32.0 | 0 | 18.0 | 13.1 | 18.0 | 56.3% |
| | 20 | Stevensville Bk | T9.01-A | 700000000704153 | Bridge | Driveway off Maple Leaf Rd | NA | 44.51090 | -72.87813 | Gravel | Concrete | 28.0 | 0 | 12.0 | 7.2 | 25.0 | 89.3% |

***Map ID** Corresponds to labels on bridge and culvert map; ****Count** refers to the number of piers for bridge crossings and the number of culverts for culvert crossings

# Appendix D

# Stressor/Departure and Project Identification Maps

# Westford Reaches

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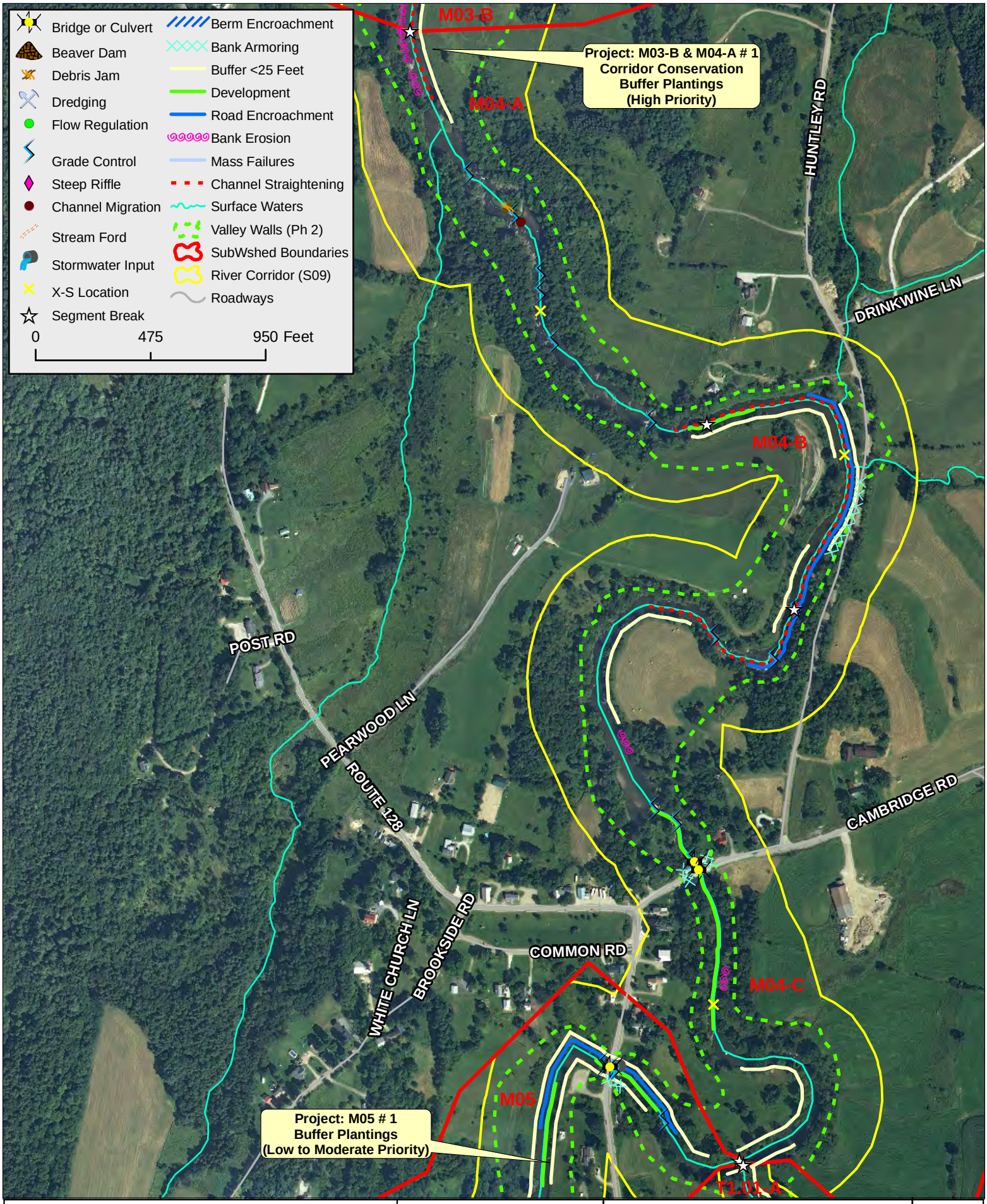
**Browns River Phase 2**

*Stressor & Project ID Map*
*Reach: M03-A & M03-B*
***Westford, VT***

Notes:
- Data exported from SGAT following the completion of the phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 0.3m Canadian Border obtained from VCGI

N
W
E
S

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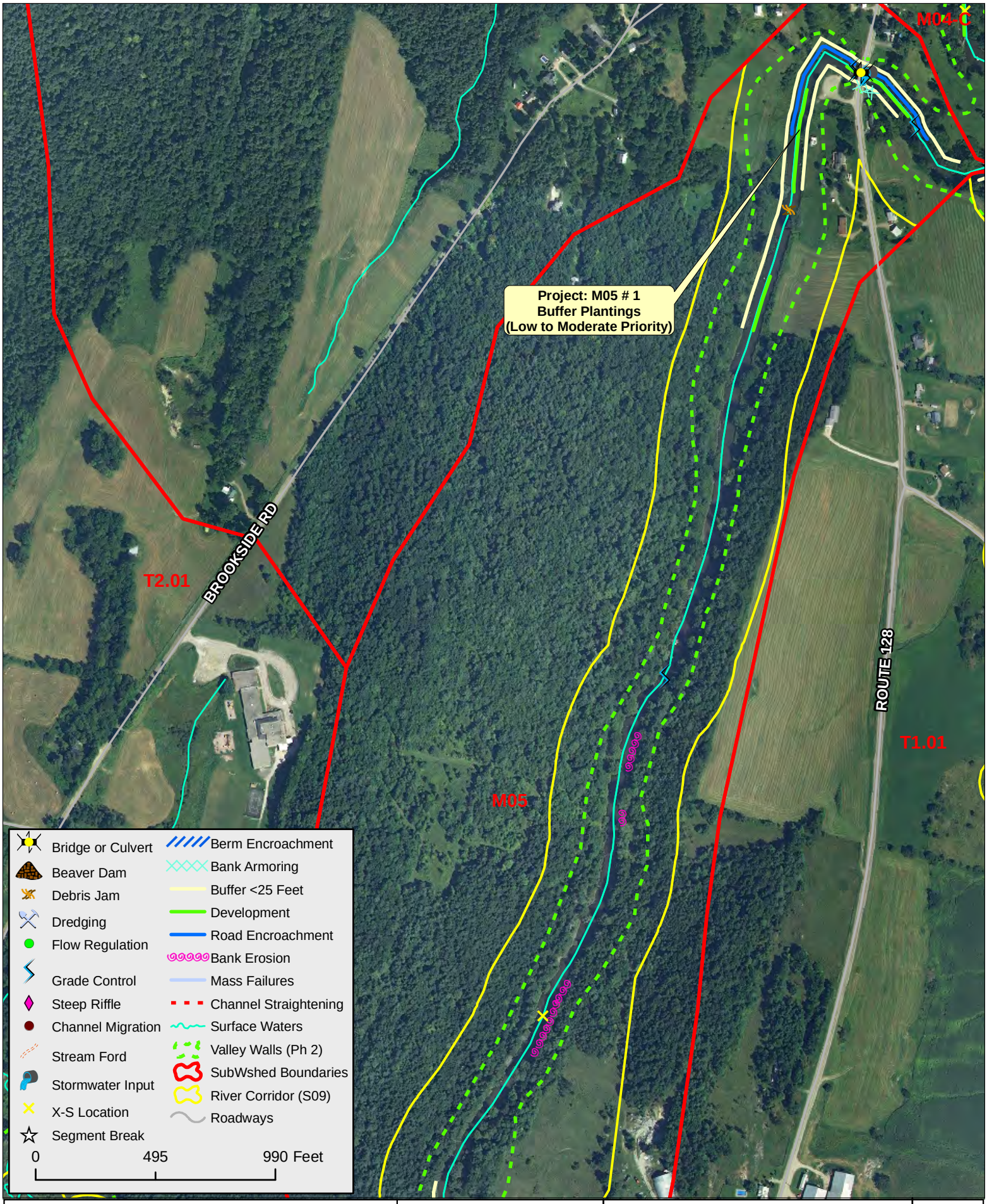
**Browns River Phase 2**

*Stressor & Project ID Map*
*Reach: M04 & M05*
***Westford, VT***

Notes:
- Data exported from SGAT following the completion of the phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 0.3m Canadian Border obtained from VCGI

N
W
E
S

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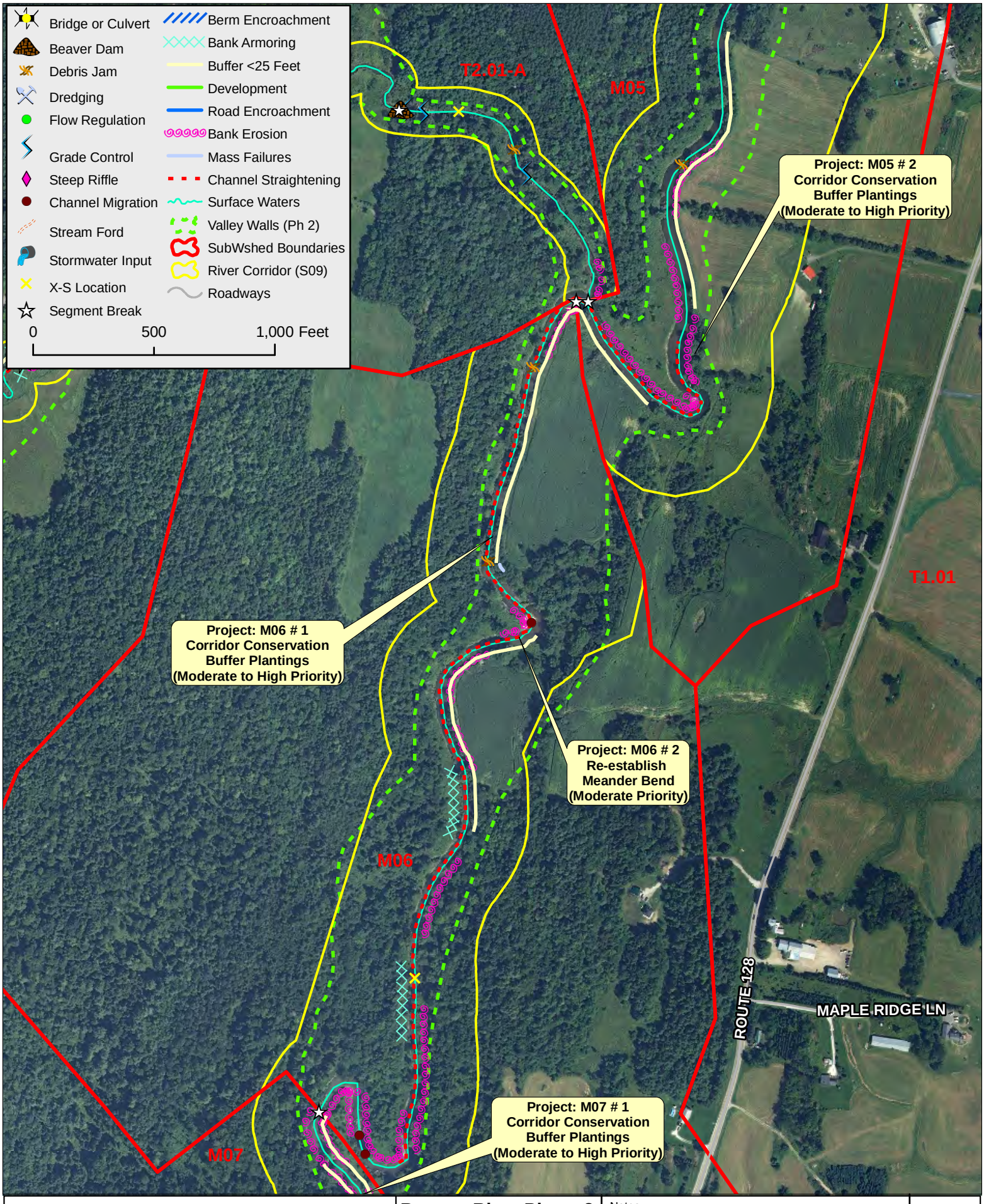
**Browns River Phase 2**
*Stressor & Project ID Map*
*Reach: M05*
***Westford, VT***

Notes:
- Data exported from SGAT following the completion of the phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 0.3m Canadian Border obtained from VCGI

N
W
E
S

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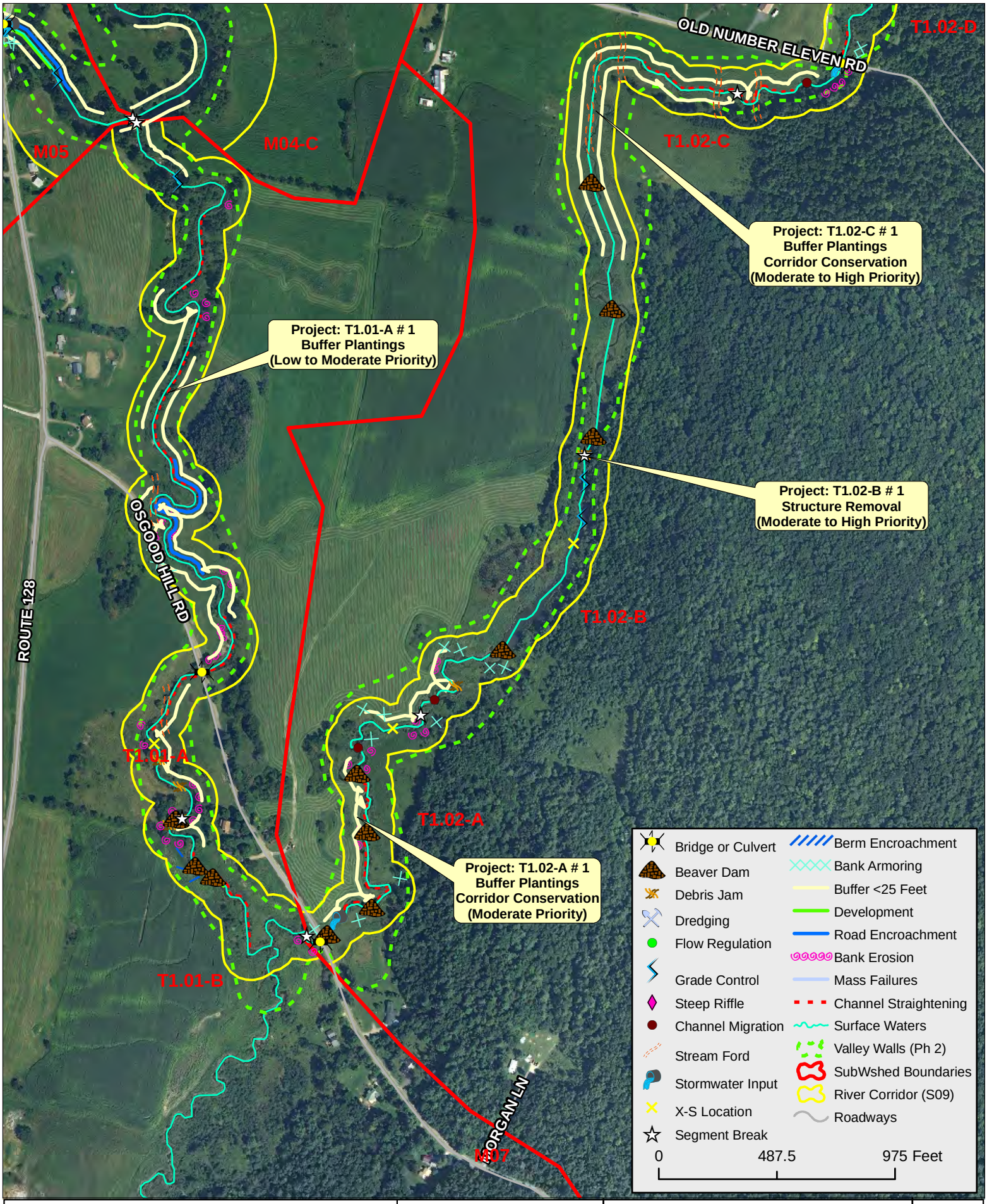
**Browns River Phase 2**
*Stressor & Project ID Map*
*Reach: M05, M06 & T2.01-A*
***Westford, VT***

Notes:
- Data exported from SGAT following the completion of the phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 0.3m Canadian Border obtained from VCGI

N
W E
S

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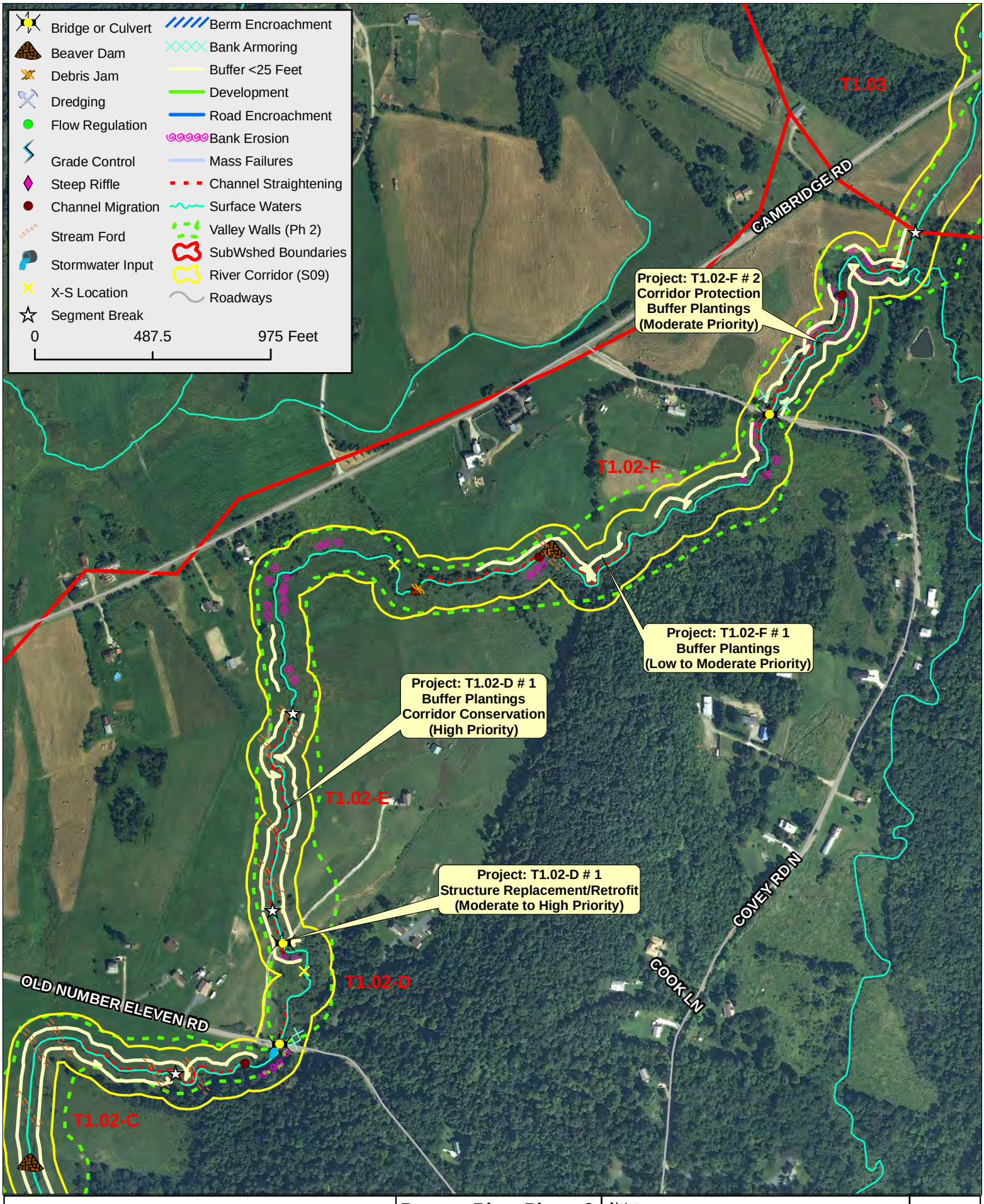
**Browns River Phase 2**

*Stressor & Project ID Map*
*Reach: T1.01 & Lower T1.02*
***Westford, VT***

Notes:
- Data exported from SGAT following the completion of the phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 0.3m Canadian Border obtained from VCGI

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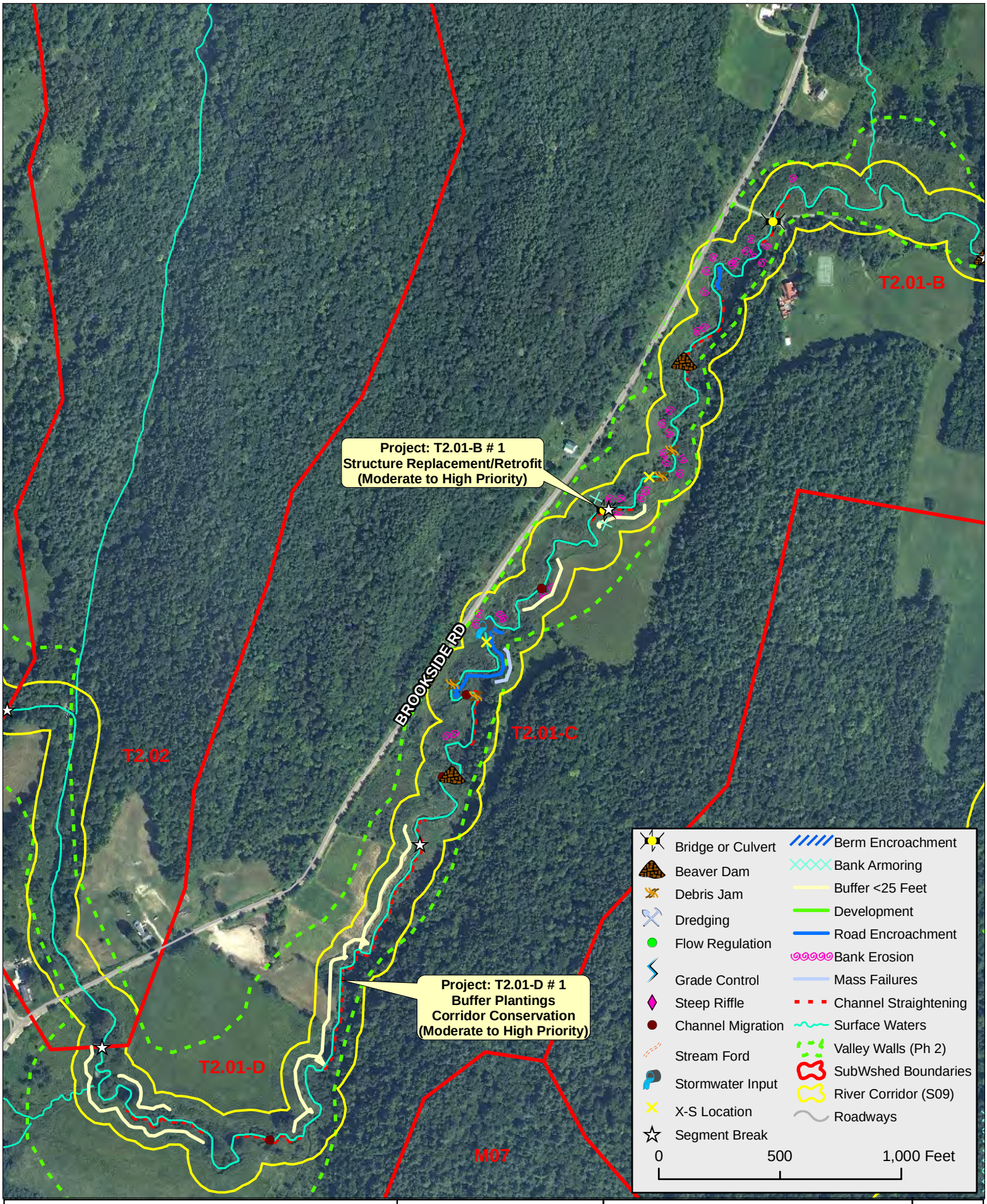
**Browns River Phase 2**

*Stressor & Project ID Map*
*Reach: Upper T1.02*
***Westford, VT***

Notes:
- Data exported from SGAT following the completion of the phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 0.3m Canadian Border obtained from VCGI

N
W
E
S

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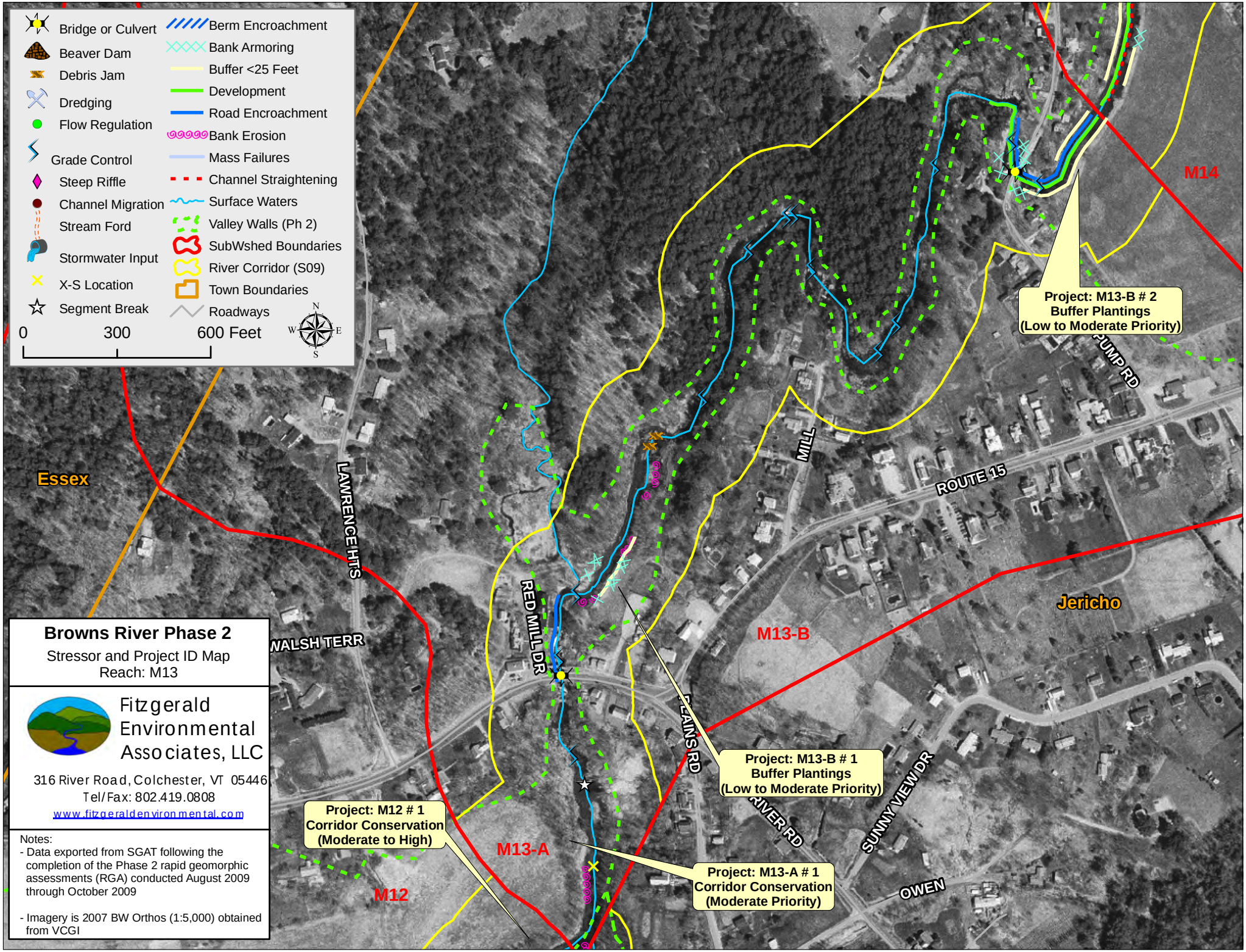
**Browns River Phase 2**
*Stressor & Project ID Map*
*Reach: Upper T2.01*
***Westford, VT***

Notes:
- Data exported from SGAT following the completion of the phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 0.3m Canadian Border obtained from VCGI

N
W E
S

# Jericho & Underhill Reaches




**Browns River Phase 2**

Stressor and Project ID Map
Reach: M13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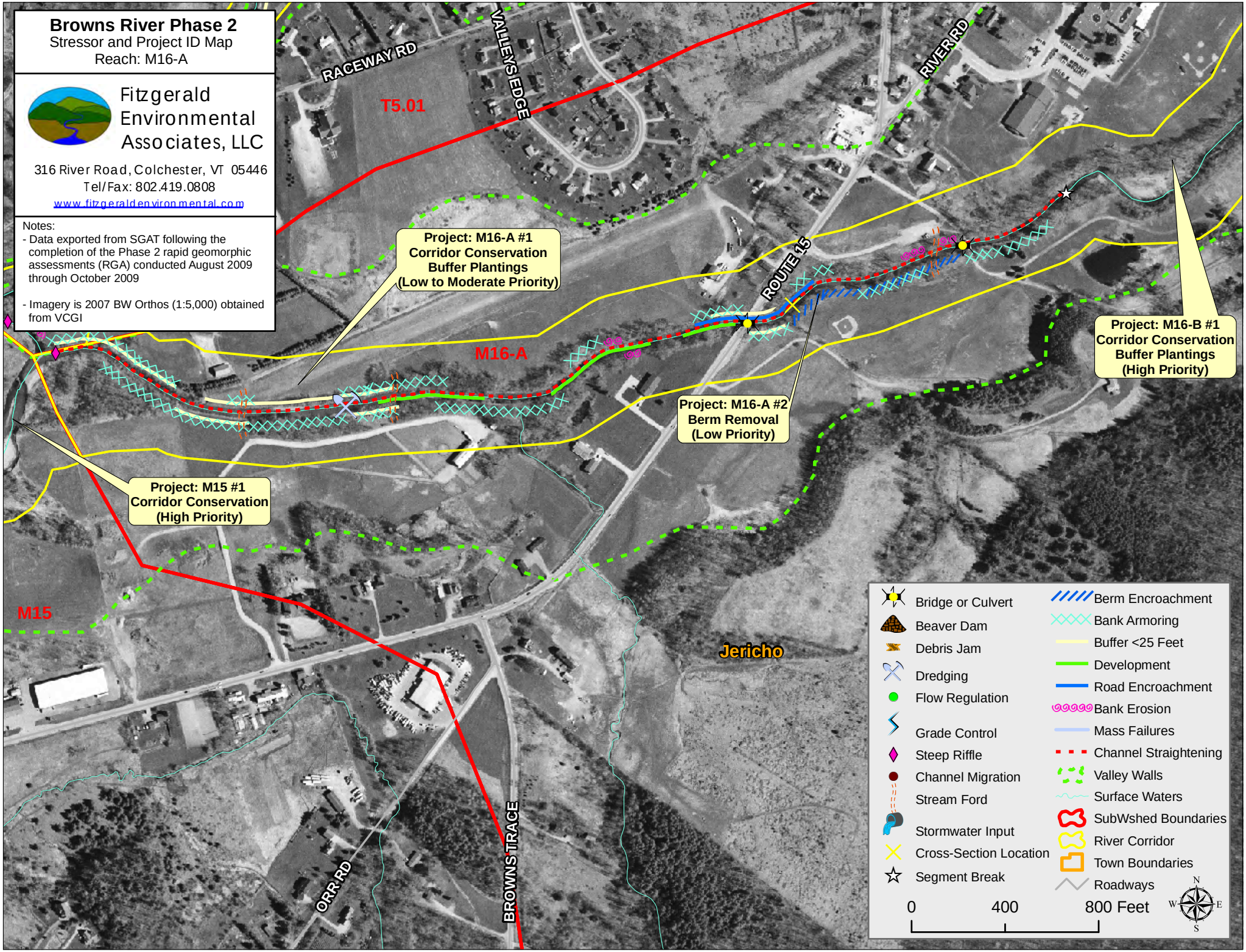
Notes:
- Data exported from SGAT following the completion of the Phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 2007 BW Orthos (1:5,000) obtained from VCGI


Browns River Phase 2
Stressor and Project ID Map
Reach: M16-A
Fitzgerald Environmental Associates, LLC
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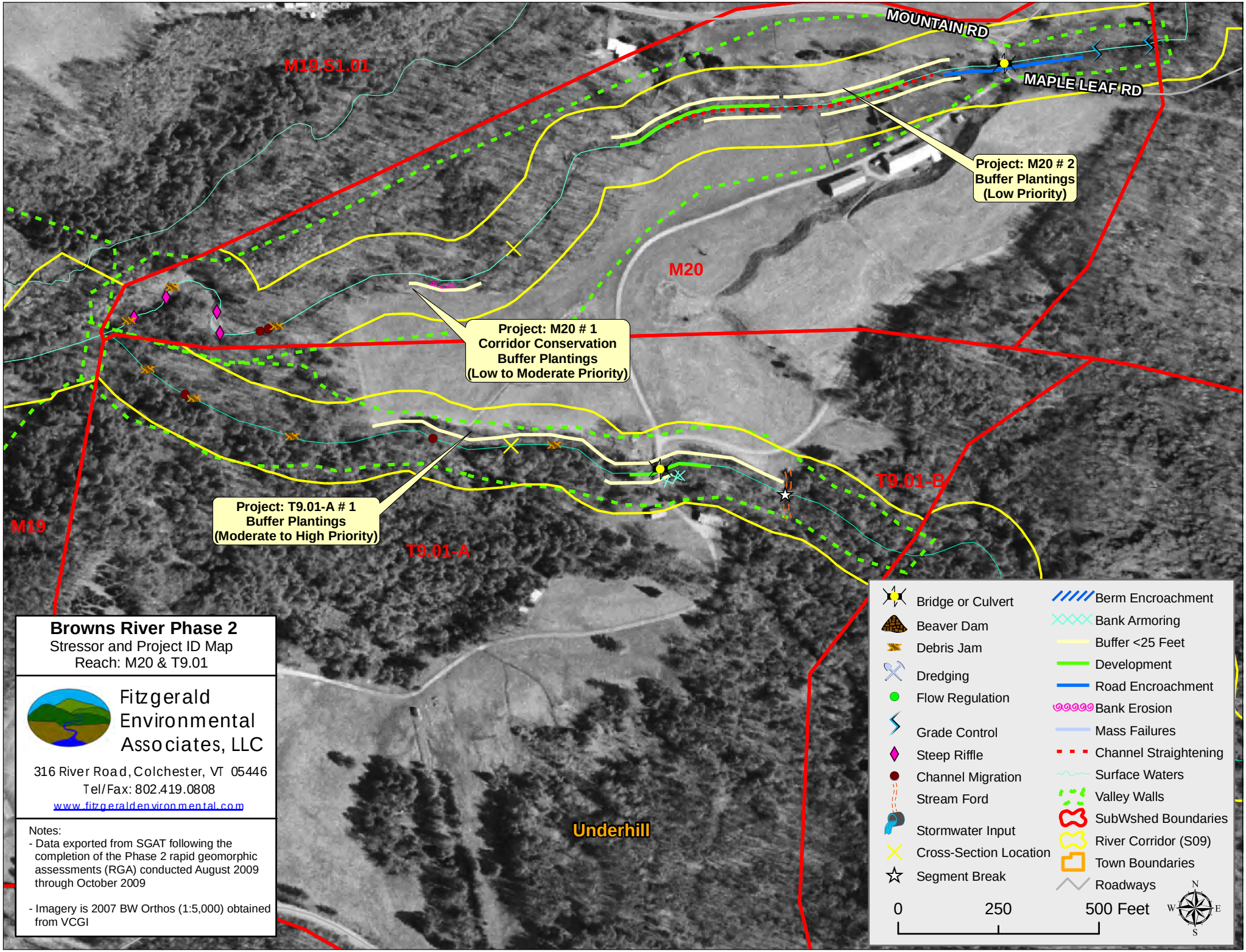
Notes:
- Data exported from SGAT following the completion of the Phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009
- Imagery is 2007 BW Orthos (1:5,000) obtained from VCGI
RACEWAY RD
VALLEY'S EDGE
RIVER RD
T5.01
ROUTE 15
M16-A
M15
Jericho
ORR RD
BROWNS TRACE
Project: M16-A #1 Corridor Conservation Buffer Plantings (Low to Moderate Priority)
Project: M16-A #2 Berm Removal (Low Priority)
Project: M16-B #1 Corridor Conservation Buffer Plantings (High Priority)
Project: M15 #1 Corridor Conservation (High Priority)
Bridge or Culvert
Beaver Dam
Debris Jam
Dredging
Flow Regulation
Grade Control
Steep Riffle
Channel Migration
Stream Ford
Stormwater Input
Cross-Section Location
Segment Break
Berm Encroachment
Bank Armoring
Buffer <25 Feet
Development
Road Encroachment
Bank Erosion
Mass Failures
Channel Straightening
Valley Walls
Surface Waters
SubWshed Boundaries
River Corridor
Town Boundaries
Roadways
0
400
800 Feet
N
W
E
S




**Browns River Phase 2**
Stressor and Project ID Map
Reach: M20 & T9.01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Notes:
- Data exported from SGAT following the completion of the Phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 2007 BW Orthos (1:5,000) obtained from VCGI

# Browns River Phase 2

Stressor and Project ID Map
Reach: M15.S2.01

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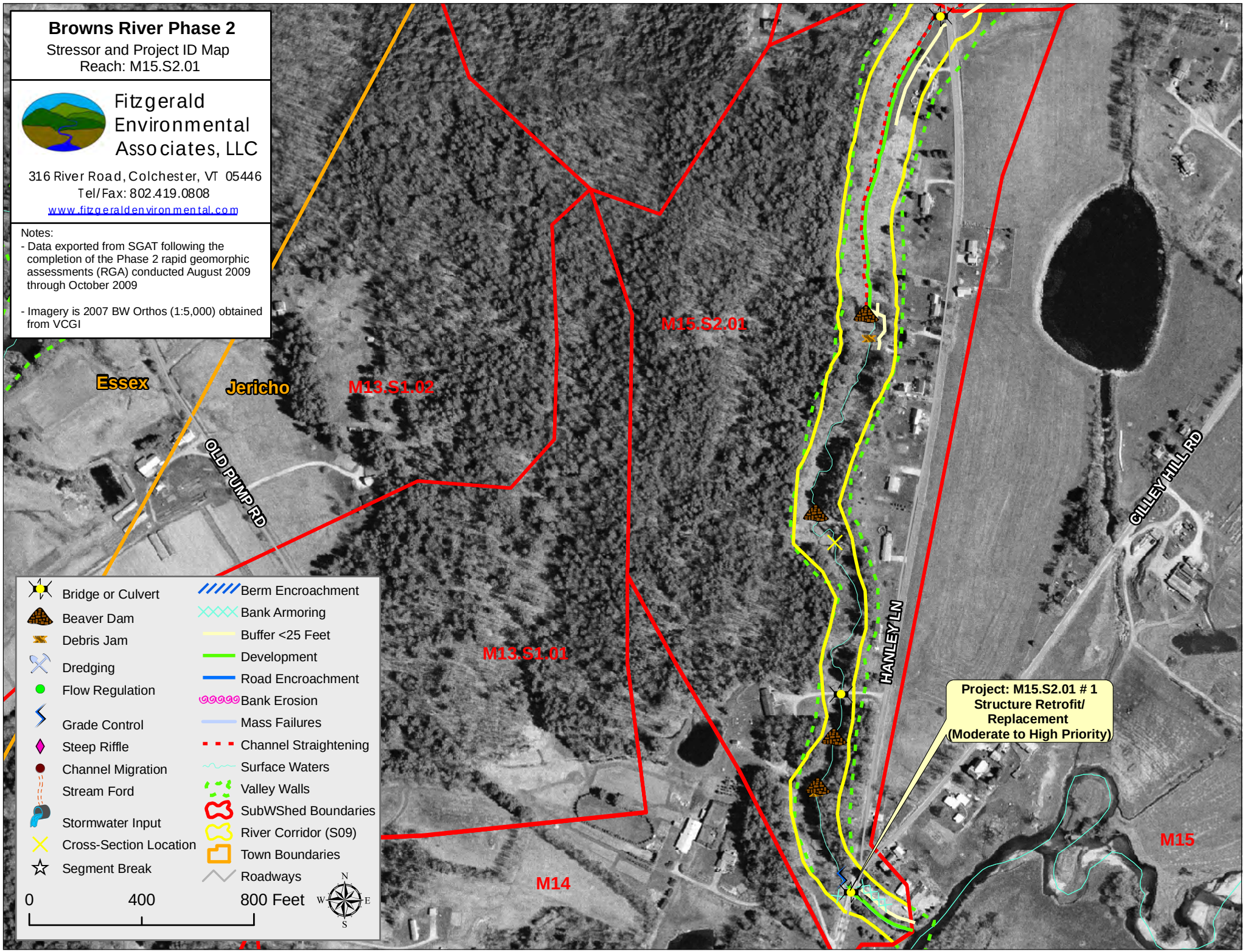
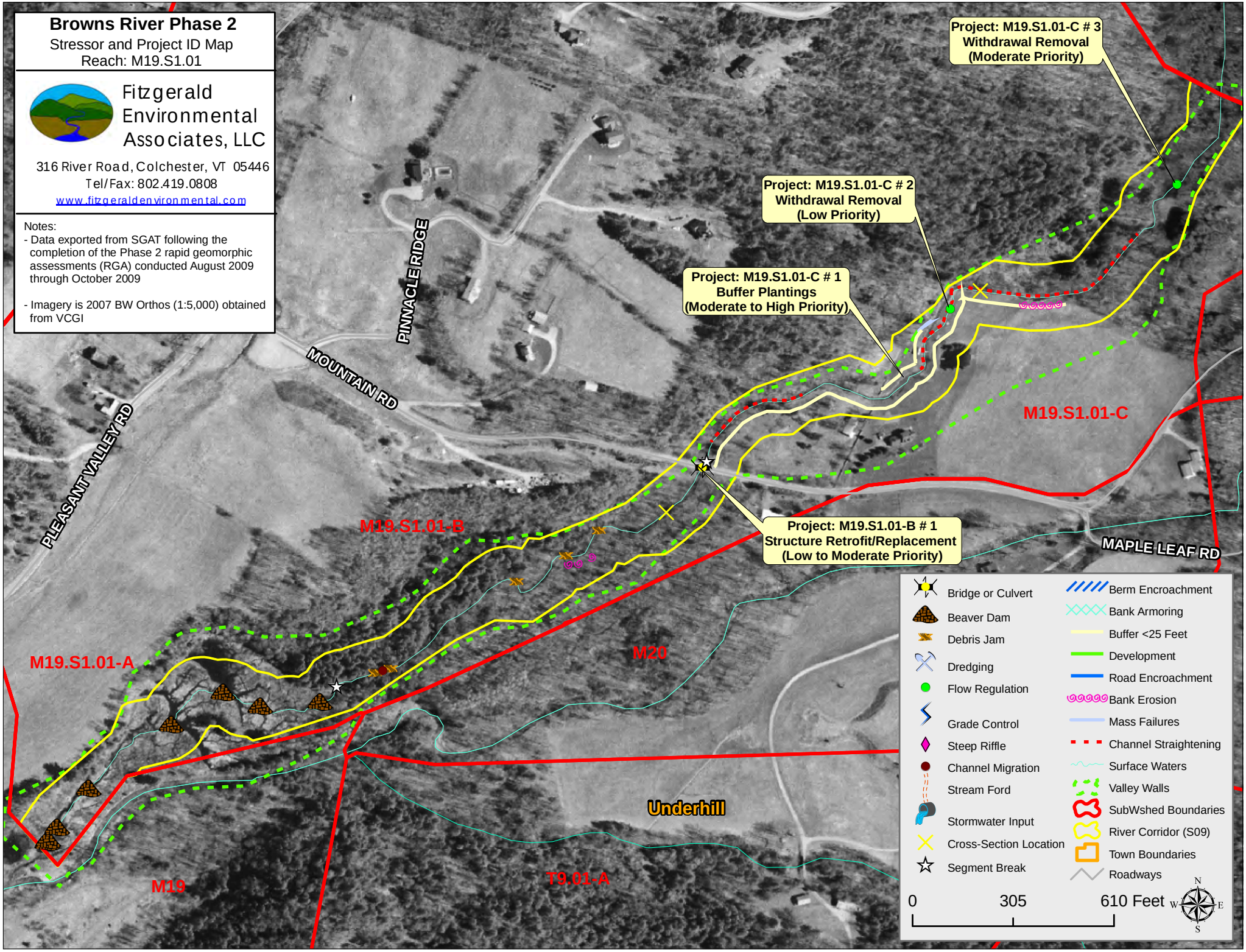
Notes:
- Data exported from SGAT following the completion of the Phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009

- Imagery is 2007 BW Orthos (1:5,000) obtained from VCGI




Browns River Phase 2
Stressor and Project ID Map
Reach: M19.S1.01
Fitzgerald Environmental Associates, LLC
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Notes:
- Data exported from SGAT following the completion of the Phase 2 rapid geomorphic assessments (RGA) conducted August 2009 through October 2009
- Imagery is 2007 BW Orthos (1:5,000) obtained from VCGI
Project: M19.S1.01-C # 3
Withdrawal Removal
(Moderate Priority)
Project: M19.S1.01-C # 2
Withdrawal Removal
(Low Priority)
Project: M19.S1.01-C # 1
Buffer Plantings
(Moderate to High Priority)
Project: M19.S1.01-B # 1
Structure Retrofit/Replacement
(Low to Moderate Priority)
PINNACLE RIDGE
MOUNTAIN RD
PLEASANT VALLEY RD
MAPLE LEAF RD
M19.S1.01-C
M19.S1.01-B
M19.S1.01-A
M20
Underhill
T9.01-A
M19
Bridge or Culvert
Beaver Dam
Debris Jam
Dredging
Flow Regulation
Grade Control
Steep Riffle
Channel Migration
Stream Ford
Stormwater Input
Cross-Section Location
Segment Break
Berm Encroachment
Bank Armoring
Buffer <25 Feet
Development
Road Encroachment
Bank Erosion
Mass Failures
Channel Straightening
Surface Waters
Valley Walls
SubWshed Boundaries
River Corridor (S09)
Town Boundaries
Roadways
0
305
610 Feet
N
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# Appendix E

# QA Summary

October 8, 2009

QA Notes For: **Browns River**
Ph2 Assessment by Fitzgerald Environmental
Data checked by Staci Pomeroy
October 9 & 12, 2009 QA Response by Samuel Parker (FEA)
October 13, 2009Comments reviewed by Staci, no additional changes/comments added

The questions raised in this Quality Assurance assessment are meant to address potential discrepancies within the data set, uncover data entry errors, or otherwise clarify and confirm those observations that might not have been expected. It is important to take into consideration how data might be viewed or interpreted by the myriad of users who are familiar with the science and protocols but may be unfamiliar with the assessed reaches. While providing notes and comments, try to anticipate the types of questions that may arise due to outliers and exceptions observed within the reach or segment. While attempting to clarify the data for those users wishing to utilize it years after collected, it's better to err on the side of making excessive comments than it is for them to be insufficient.

After reviewing the information noted, the consultant should update this document (preferably in a second color) with what steps, if any, were taken to address the comments/questions.

**General Comments:**

The notes and narratives for all reaches were well done and provide additional data to help with interpretation of the data and understanding of why certain segments/reaches were done the way they were. It is greatly appreciated that this level of effort was taken to help provide this data.

To assist in using the data when it is reviewed in Phase 1, it is requested where reaches are segmented, that comments are added in Phase 1 to that affect. This will help insure that users of the data recognize that the data in Phase 1 may not represent all sections of the reach at this time and/or that there may be sub-reaches within a larger reach. An example of what is requested : Reach M13: " 2 segments on reach – Seg. A = 555 ft, C4 riffle-pool; Seg. B = 4,594 ft, Ab1 cascade".

**Reach Notes:**
**M13:**

- **Phase 1:**
  - Step 2.8 Channel Width: The channel width is noted as 76 ft. Does this make sense given the bedrock gorge is the dominant condition? Is the channel width narrower in the gorge?
  - When assessing Segment M13-B several measurements of bankfull width were taken. On average these came out to be very similar to the width measured in M13-A. The Ph 1 channel width has been updated with the M13-A bankfull width of 64 feet to highlight the gorge setting.
  - Step 2.10 Valley type: Noted as "narrow"; Phase 2 dominant condition is "narrowly confined". Please review and update as appropriate.
  - Changes have been made, valley width averaged from several field measurements and GIS measurements estimated to be 126 feet; M13 is narrowly confined.
  - Step 2.11 Reference stream type: Is noted as B step-pool. Dominant condition in Phase 2 is the gorge, and is noted as Ab cascade. Review and determine if the Phase 2 condition is accurate description of stream type and/or if the Phase 1 should be updated to show the dominant Phase 2 reference condition.
  - Phase 1 stream type has been updated to B-type step-pool with bedrock substrate.

- Step 4.3 Buffers: Differences in what Phase 1 & 2 show for conditions; P1 left bank 0-25/51-100 // P2 >100 / 0-25; Right bank subdominant P1 0-25 // P2 26-50. Please review and update as appropriate.
- Buffers have been updated appropriately
- Step 5.2 bridge/culverts: Phase 1 has 0 shown; There are 2 shown in Phase 2 segment B. Please review and update as appropriate.
- The Route 15 and Old Pump Road bridges have been added. Sorry I missed them when FITing
- Step 7 Ice/debris: Phase 1 has "no data"; Phase 2 has 2. Please review and update as appropriate.
- Changed to "Debris" and "Low"
- Step 7 comments: Please add comments for segmentation as noted above.
- Comments added

- **Segment A:**
  - Step 1.5 valley width: It just caught my eye that the valley width and segment length are the same 555 ft. Just confirming that this is correct.
  - Valley Wall is correct, just coincidence that both the VW and the reach length are equal values (Reach length is actually 555.2, but it was rounded down)
- **Segment B:** No additional comments.

**M16:**

- **Phase 1:**
  - Step 2.11 sub-class slope: No data entered. Please review and update as appropriate.
  - Subclass slope of "None" added
  - Step 5.2 Bridge/culvert: Two bridge are noted, with no impact shown. Looking to see if there should be any length of impact associated with those structures?
  - A total impact length of 68 feet shows up on Ph1, I am not sure why it didn't show up for you.
  - Step 7 comments: Please add comments for segmentation as noted above.
  - Added in a comment
- **Phase 2:**
  - Narrative: Good note, I will confirm with Kari Dolan as to the "extreme" sensitivity rating for FEH.
  - Thanks

**M20:**

- **Phase 1:**
  - Step 2.9 Valley width: No data entered. A valley width was measured in Phase 2, is it correct for the reach? Please review and update as appropriate.
  - Phase 1 Valley width was updated to match that of Ph 2.
  - Human caused change in valley width was only applicable in upper section where confinement changes a note was made in step 5 (of Ph2) to acknowledge this.
  - Step 2.10 valley type: Currently noted as "narrowly confined"; Phase 2 is noted as "very broad". Please review and update as appropriate.
  - Valley confinement type and width have been changed
  - Step 4.3 Riparian Buffer: Left bank P1 noted as 0-25 & > 100, P2 noted as 26-50 & 0-25; Right bank subdominant P1 51-100, P2 0-25. Please review and update as appropriate.
  - Buffers have been matched up and updated between Ph1 and Ph2

- Step 7.3 Ice/Debris: Noted as “no data”; Phase 2 has 3 debris jams. Please review and update as appropriate.
- “Debris” Selected as impact with an impact of “low”

- **Phase 2**:
  - Step 1.5 Human caused change. Is noted as “yes” There is only 426 ft of road noted in a 3,037 ft reach; did the road change the valley type in that section of the reach? This is trying to look at where the human encroachments changed the valley type, not just if there is encroachments. Please review and update as appropriate.
  - Human caused change in valley width check box unchecked, it did not change the valley type of the reach.

**T9.01:**

- **Phase 1:**
  - Step 2.9 Valley Width: No width is entered. A valley width was measured in Phase 2 for the dominant length of reach. Please review and update as appropriate.
  - Valley Width updated; width the same for Ph 2
  - Step 4.3 Buffer: Right bank dominant is shown as 26-50. Phase 2 is 0-25 for dominant length of reach. Please review and update as appropriate.
  - Buffers have been updated to be consistent between Ph1 and Ph 2
  - Step 5.1 Flow Regs: Please update “old data” field with “none”
  - Field updated
  - Step 7.3 Ice/Debris jam: No Data shown; 4 are shown in P2. Please review and update as appropriate.
  - Fields updated
  - Step 7 comments: Please add comments for segmentation as noted above.
  - Segmentation comment added
- **Seg. A:** No additional comments.
- **Seg. B:** While this was not fully assessed it is requested that some data be updated per review of ortho/topo where feasible: Steps 1.2, 1.3, 1.4, 1.5, 4.1-4.6, 5.5. A comment can be added for any data collected via ortho/topo as needed to note difference in data collection method. If the ortho does not allow for data to be collected because unable to see the reach on the ortho, please make a note to this affect.
  - Comments added along with administrative judgment data
  - Step 5.4 stream ford/animal crossing – appears the reach is accessed by animals grazing – would be appropriate to mark a spot mid-segment to note animal crossing.
  - Stream crossing point added

**M15S2.01:**

- **Phase 1:**
  - Step 4.3 Riparian Buffer: Left bank subdominant: P1 0-25, P2 26-50; right bank subdominant P1 51-100, P2 26-50 ft. Please review and update as appropriate.
  - Buffers have been changed accordingly
  - Step 6.3 Channel Bars: Noted as “mid-channel”. No bars are noted in Phase 2. Please review and update as appropriate.
  - Changed to “none”
- **Phase 2:**
  - Step 4.5 Flow Regs.: Remove “unknown” from the “old” data entry field.
  - Changed to “none”

**M19S1.01:**

- **Phase 1:**
  - Step 4.3 Riparian Buffer: No data is provided for dominant or subdominant. Please review and update as appropriate.
  - Buffers have been updated to the condition of the whole reach
  - Step 5.1 Flow Reg.: Please provide a comment as to what the small withdrawal is and its potential impacts it is having in this reach. I see in segment B, that it is withdrawal for ponds. Are these pipes drawing water from the river and pumping it into a pond? I was not sure what these withdrawals were and/or how they were working.
  - Comment added in Ph 1 step 7 and Ph 2 step 5
  - Step 5.2 Bridge/culvert. None are noted. There is 1 noted in Phase 2 in segment B. Please review and update as appropriate.
  - Changed accordingly, sorry about that.
  - Step 5.4 channel Straightening: None is noted. In Segment C Phase 2 notes it notes that there is a high degree of straightening along the entire segment. Please review and update as appropriate.
  - Channel straightening added to two areas within the segment. Comment edited to be consistent.
  - Step 6.3 Channel bars: No data is provided. Multiple bars are noted in Phase 2. Please review and update as appropriate.
  - Depositional features changed to "Point" with a "Not significant" impact; Meander migration changed to "Flood Chute" with a "Low" Impact
  - Step 7.3 Ice/Debris: No data provided. Several debris jams noted in segment B. Please review and update as appropriate.
  - Ice and debris jam potential changed to "Debris" and "Low"
  - Step 7 comments: Please add comments for segmentation as noted above.
  - Comment added

- **Phase 2:** In the DMS the Excel worksheets have been swapped between M19S1.01 and M15S2.01. Please check and re-upload as needed.
  - Excel data switch on the DMS accordingly

- **Segment A:** While not assessed due to beaver dams, protocols do request that information for steps 1, 3, and 4 be competed to the extent possible. There was a good count of beaver dams, so perhaps some of the reach was walked and/or reviewed remotely, and may provide additional data for these steps. Please review orthos/topos for this segment; also confirm that there are no encroachments that should be FIT'd.
  - Information for steps 1, 3, and 4 has been completed and comments added. No encroachments observed.

- **Segment B:** no additional comments
- **Segment C:** In the notes there is says " a high degree of straightening along entire segment…..". Step 5.4 – channel straightening has none noted. Please review and update as needed.
  - Channel straightening added in areas where the channel appears to be pushed against the valley wall.
  - Comments added to explain the withdrawals

January 29, 2010

QA Notes For: **Browns River**
Ph2 Assessment by Fitzgerald Environmental
Data checked by Staci Pomeroy

February 22, 2010 Response to QA by Fitzgerald Environmental
March 5, 2010 Staci review of updates.

The questions raised in this Quality Assurance assessment are meant to address potential discrepancies within the data set, uncover data entry errors, or otherwise clarify and confirm those observations that might not have been expected. It is important to take into consideration how data might be viewed or interpreted by the myriad of users who are familiar with the science and protocols but may be unfamiliar with the assessed reaches. While providing notes and comments, try to anticipate the types of questions that may arise due to outliers and exceptions observed within the reach or segment. While attempting to clarify the data for those users wishing to utilize it years after collected, it's better to err on the side of making excessive comments than it is for them to be insufficient.

After reviewing the information noted, the consultant should update this document (preferably in a second color) with what steps, if any, were taken to address the comments/questions.

**General Comments:**

The notes and narratives for all reaches were very well done and provide additional data to help with interpretation of the data and understanding of why certain segments/reaches were done the way they were. It is greatly appreciated that this level of effort was taken to help provide this data.

Thank you! We were very pleased with this dataset and put a lot of effort into making it as clean as possible. You're welcome. These notes are very valuable for use of the data.

Thank you for adding notes in Phase 1 for the reaches that had segmentation/sub-reaches. Notes and data were easy to review for Phase 1 data interpretation on reach stream types for sub-reach/segments contained in the overall reach.

You're welcome. We liked your idea about adding in the additional data in Ph1 very much. It seems to really help with data interpretation between Ph 1 and Ph2, so we are going to add in comments in Ph 1 for all future Ph2 projects. Thanks this will be really helpful.

I was struck by how much LWD was in the system. Every reach had at least a few pieces and in most, had a significant amount of wood. It is not clear from just the reach forms how much of a role this wood is playing in helping with bed-form (was wood mostly along the side of the channel, or within the channel) or in retaining sediments (ie: aggradation upstream of debris jams). This may be something to capture in reporting, giving an idea of what may be contributing LWD recruitment, how much of a role it plays in the channel characteristics and/or habitat seen, etc. Many streams are limited in LWD, so in reviewing the data this caught my eye as a stream that is holding LWD and/or has good recruitment of wood.

Yes, there is a lot of large woody debris in most of the reaches. The attenuation potential of these lower reaches might be higher than normal because of the channel slope and the bed substrate. Most of the

main stem reaches have low slopes, and a sandy or gravely bottom. Much of the woody debris that was observed was near the banks of the channel where fallen trees more or less just remained where they fell. We will make sure to highlight the recruitment potential in the reach narratives of the report and explain how the wood is influencing the channel dynamics and how the physical condition of the channel might be helping wood to accrue. Thanks

**Reach Notes:**

**M03A/B:**

- Step 2.9 Sinuosity: For segment B, was noted as moderate. With the amount of straightening ~ 1,925 ft out of 2,171 ft; this seemed high for level of sinuosity. For Seg. A, it was noted as "low". Is the 6,783 ft of Seg. A less sinuous as compared to Seg. B?
- Both segments have a low level of sinuosity (~1.12). The sinuosity selected in step 2.9 for segment B has been changed to "Low."

**M04:**

- Phase 1:
  - Step 2.8 Channel width: Currently noted as 94 ft. Should this be updated with information from Phase 2, given that this is a B-type stream by reference. Segment A, is ~ 85 ft and in good condition. Would you expect the stream to continue to widen to the width noted in Phase 1, or stay within the range noted in the Phase 2 segments: 80-85 ft?
  - Reference channel width for Ph1 step 2.8 was not updated because segment B and C are both in "Fair" Condition. Segment C is the longest, 3,842 feet, and updating the reference channel width doesn't seem appropriate given the disturbances in the segments, and the possibility of this segment continuing to adjust/widen towards the reference width of 94ft. Okay, appropriate.

  - Step 2.10 Valley width: Is noted as "narrow". Phase 2 segments A & C appear to be the dominant stream type and valley setting (given lengths of segments), these are noted as "semi-confined". Please review and determine if the overall reach valley type should be updated to semi-confined; if remains as "narrow" please provide a brief explanation, as none of the segments have this valley type.
  - Yes, the valley width should be "semi-confined." The update calculated fields button was not pressed in the DMS so it valley confinement type didn't change from its previous setting. Appears to have been updated in DMS, thanks.

- **Seg. A:** No comments

- **Seg. B:** Step 4.5 Flow Regs: There is an "unknown" marked for "impoundments". Is this suppose to be there? It is noted as "none" for flow reg. type, so this did not seem to be correct. Please review and update as needed.
- That is a mistake, it has been changed to "None" okay

- **Seg. C:** Step 4.8 Constrictions: One of them is noted as "other". Was this the old dam?
- Yes, this was the old dam, a comment was added in step 5 of the DMS to clarify. Thank you

**M05:** No comments

**M06:**

- Step 2 Cross-section data: In looking at the cross section, I was curious why the small bench on the left bank at ~ 11 ft was not chosen as bankfull. The elevation that bankfull was chosen at does not seem to have any obvious feature. Please review and provide information as to the bankfull indictor that was chosen and why the small bench on the left bank was not considered bankfull.
- There were few bankfull indicators in this reach, because the banks were steep from historic channel straightening and ongoing incision. The bankfull height was determined by the scour marks on the bank located at an inflection point, which were noted along the entire reach. We used Manning's calculation to check discharge on this segment (see excel cross-section workbooks) as compared to downstream reaches and feel confident with the height we chose. Okay, just good to confirm what folks are looking at.

- Impressive how much wood was in this channel! Wow 104 LWD!!
- Yes, this channel had a lot of wood. Throughout the reach there was a good amount of wood near the channel banks, but what really increased the total count was a huge debris jam, with a lot of small pieces of wood and some larger pieces as well (See below). Wow that is a big jam.

**T1.01:**

- Phase 1: Step. 5.1 and Step 6.4, please update data from "no data" to appropriate data type.
- Step 5.1 has been changed to "None" & step 6.4 has been changed to "Low" Thanks

- **Seg. A:** no comments

- **Seg. B**: Thank you for collecting as much data as possible for beaver impacted reach. Interesting about the corn stock use for beaver dams.
- See photo below – these beavers were quite crafty… I saw this on the Lewis Creek some years ago too. The famer indicated the corn field didn't look disturbed until he started to cut the corn and then came across a circle in the middle of the field where the beaver had come in through a small path and taken out of the center.. really sneaky ☺ no sign of activity from the edge of the field, but a big bare patch in the middle!

**T1.02:**

- Phase 1: Step 5.1, please update "no data" to appropriate data type.
- Step 5.1 has been changed to "None" & step 6.4 has been changed to "Low" Thanks

- **Seg. A:**
  - Step 2.15 Ref. stream type: This is filled in as "E5 –dune ripple"; this is the same as the Phase 1 stream type. This field should only be filled in if the reference stream type for the segment is not the same as that for the Phase 1 reach. Please review and see if the data needs to be updated or removed.
  - The subreach reference stream type was removed. Sorry about that. Thanks

  - Step 7.1 – degradation: The "historic" check is noted as "no", is degradation still happening? See in the narrative that incision triggered by historic straightening, so was sure if the channel is now moving from incision to widening, or likely to still incise?
  - The channel is experiencing some degradation in area downstream of where the large beaver dam in T1.02-B was recently breached, that is why the CEM stage is II and full-fledged widening/stage III has not yet occurred. Good note, be sure to capture this in the narrative for the reach.

- **Seg. B:**
  - Step 2 cross-section: No incision was noted (bankfull and RAF noted as the same). In reviewing the cross-section there appears to be a floodplain on the right bank that is now accessed at the 2x bankfull. Should this floodplain be considered the RAF (at elevation 5.6 on the xs worksheet)? Or could this be a possible bankfull indicator? Please review.

- This segment/cross-section is a bit tricky because of the changes that have occurred in the last 10 years. The lower portion of the segment had a very large and robust beaver dam that has breached between the time of survey and the summer of 2008. The water was completely filing the current bankfull channel. At the time of survey, the best bankfull bench was the one used on the left bank (see photo below). There was a small, well-formed floodplain along the left bank that was well accessible. Since the bankfull width we chose was right on the HGC predicted for C-type streams, and we felt the channel was relatively stable, we feel we had decent indicators. Okay, good note, be sure to capture this in the narrative for the reach.

- Step 2.9 sinuosity: Is noted as "low". In reading the comments, as "deposition area w/ high sinuosity" ? Should this have a higher sinuosity?
- No, the sinuosity is "low" for this segment. The comment in step 5 has been refined to say "higher sinuosity" and in the "lower segment" to clarify the issue. Okay

- Step 2.15 Stream type: The Reference stream type is noted as a C3-riffle pool. Looking at the cross-section data, the width/depth ratio is on the cusp of a E/C. Do you think the beaver activity may have played a role in the stream having a slightly wider width/depth ratio (13 versus 12 for an E)? From the note appears that the segment has been affected by a large beaver dam, with aggradation and planform change being caused by that dam. Would you expect that this stream would remain a "C" stream in the mix of E stream types upstream/downstream of the segment?
- Yes, the slope of this segment is slightly higher than that of the upstream and downstream segments. Two grade controls were observed downstream of the large constriction

struction/old abutments upstream. Although the width/depth ratio is on the cusp between C and E-type channels it seems more fitting to be a C-type. Okay, good to understand as thinking about management strategies and FEH.

- Step 4.8 constrictions: Wow, a 3 ft old abutment(?) on a 28 ft wide stream. Is this something that might be a good project for removal? Please be sure to mark the location of this on the reach map, as it is not something that was FIT'd and would be good to know where it is in reviewing possible project and/or hazards.

- Yes, it would be a great project area. Sometimes it would be helpful to have a constriction point feature on FIT. I know that these things can't just be added in, but in terms of features that influence the channel it would be nice to have the spatial locations of constrictions on record. Perhaps it could be captured under the bridge/culvert point in FIT for helping track this "structure". Agree some additional FIT options would be helpful, something I will review with folks. Thanks for the picture.

- **Seg. C:** Thank you for the information collected on a segment not fully accessible.

- **Seg. D:**
  - Step 2 cross-section: No incision was noted (bankfull and RAF noted as the same). In reviewing the cross-section there appears to be a floodplain on the left and right bank that is now accessed at the 2x bankfull. Should this floodplain be considered the RAF (at elevation 6.1 on the xs worksheet)? Or could this be a possible bankfull indicator? Please review.
  - After reviewing the cross-section, it seems appropriate to raise the RAF to 5.6 (6.6 on the X-S). The RGA score for step 7.1 dropped to 11 and the excel cross-section sheet has been changed and re-uploaded. Thank you.

  - Step 2.10 –riffle type: I see the riffles are considered eroded, yet there is no incision, was there historic incision that may have eroded the riffles? =
  - The riffles are considered "eroded" because of the slight incision observed in the downstream segment. More comments were added to step 5 to clarify this. IR ratio is now 1.2, which makes sense. Thank you.

- Step 2.14 / 2.15, the bed-form is noted as “riffle-pool”. With the amount of fine sediments, would you expect a strong riffle-pool series to set up? For size material would a dune-ripple be possible?
- Where the cross-section was taken there was more sand and silt. Downstream there is more fine gravel, so it seems that riffle-pool is the dominant bedform. Dune-ripple was chosen as the sub-dominant bedform. Okay, helpful information.

- **Seg. E:** Thank you for the information collected on a segment not fully accessible.

- **Seg. F:**
  - Step 2 cross-section: No incision was noted (bankfull and RAF noted as the same). In reviewing the cross-section there appears to be a floodplain on the left bank that is now accessed at the 2x bankfull. Should this floodplain be considered the RAF (at elevation 5.6 on the xs worksheet)? Or could this be a possible bankfull indicator? Please review.
  - Given the straightening observed on this segment, it seems appropriate to have the RAF at 4.6 (5.6 on XS sheet). The DMS steps 2, 7.1 and 7.3 have been modified to show this change. Thank you.

  - Narrative: The last note in the narrative is that “bank erosion is extensive”. Out of 4,762ft, the amount of erosion 643 ft – L / 555 ft – R, does not seem extensive. Does this not fully capture the type of erosion seen?
  - Comment refers to the degree of bank erosion “In the upper segment,” where the left and right erosion exceeds 20%. Comment has been changed from “extensive” to “significant.” Thank you.

**T2.01:**

- Phase 1: Step 5.2 – bridge/culvert: There is no amount of impact shown (percent impact 0%) for the 2 structures noted. The structure in Seg. C appears to be having a large impact, given the description of the aggradation that is happening. How much of the segment is that culvert impacting? Please review and update as appropriate.
- FIT updated to show 2,000 feet of impact to the segment because of the aggradation upstream. Thank you.

- **Seg. A:** No comments

- **Seg B:**
  - Step 3.1 – bank canopy: The left bank is noted as “0”. This seemed low considering the same type of vegetation was found on the right bank and that had 26-50% canopy. Is 0% still an appropriate value for this bank.
  - Changed to 26-50% Thank you.

  - In the comments, the note is that the “undersized culvert is in the upper segment at downstream end of T2.01B. Should this be “T2.01C” as that is where the culvert is noted?
  - Comment clarified Thank you.

  - Narrative: Notes that the CEM is in stage 5 with evidence of “recently formed terraces close to the channel”. These were not really seen in the cross-section; and appeared more

obvious in Seg. C? Do the terraces seen in Seg. C reflect what is also seen in Seg. B, just not caught in the cross-section?

- Yes, after looking at both cross-sections it seems most appropriate for both segments to be in stage IV of the CEM. The lower segment is slightly starved of sediment and the upper segment is more aggradational. The cross-section of T2.01-B didn't do the best job at capturing the terrace features, but it did appear to be re-establishing sinuosity and forming a juvenile floodplain. The comment in step 7 has been revised to clarify the processes by say "with evidence of recently formed floodplain" instead of "recently formed terraces. Thank you.
  - Where do you suppose the sediment is coming from for the new floodplain, given the limited erosion and the trapping of sediment from the culvert upstream? Is this segment really getting established to a new equilibrium with the changes in sediment load given the upstream culvert issue? If the culvert were to be taken out, would this segment start to adjust again or be able to accommodate the increase in flow and sediment that would then be available to it? Just things to consider as we look at strategies in this reach. If the segment is almost in equilibrium, and then there is a change in the sediment/flow regime with a better structure upstream, how does that affect the segment.
  - The current sediment observed in this reach is probably sourced from the large scour pool downstream of the culvert, or the bank erosion noted in the upper portion of the segment. By removing the upstream culvert this segment would probably continue to redevelop its floodplain and continue into stage V of the CEM. The increase in sediment would most likely balance the two segments that are at the cusp of being stable. We will discuss this in the reach and project ID narratives in the report. Thank you., helpful information to know as we look at projects.

- **Seg. C:**
  - Step 2 cross-section: No incision was noted (bankfull and RAF noted as the same). In reviewing the cross-section there appears to be a floodplain on the right bank that is now accessed at the 2x bankfull. Should this floodplain be considered the RAF (at elevation 6.8 on the xs worksheet)? Please review.
  - The current RAF location on left bank seems most appropriate we are not confident that the raised floodplain on the right side could be the RAF, because easily accessible floodplains on both sides of the channel was most common, with only minor areas of incision. Okay, good information.

  - In the comments: It is noted that the segment is used with a CEM (D model) due to the amount of aggradation from the culvert. How much of the segment is impacted by this aggradation, the entire 2,000 + ft or some portion by the culvert? Are the bed conditions such that the reach would not incise if the culvert were to be replaced, or is the reach still susceptible to incision process…. So a F-model would be considered if the culvert were gone. I'm not sure that the use of the D-model is a good fit here unless there are other conditions in the reach that would indicate that it would also be prone to an aggradational process versus an incision process. Please provide some additional information as to the length of segment affected by the culverts aggradation, and consider what type of channel adjustments the channel would be more prone to if the culvert issue were not there.

    - Good point, the segment seems more likely to be in stage IV of the CEM (F-Model). See comments above about potential changes associated with the replacement of the culvert. Thank you.

- **Seg. D:** Thank you for the information collected on a segment not fully accessible.