Cold River
Phase 2 Stream Geomorphic Assessment
Rutland County, Vermont

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Executive Summary

- The Rutland Regional Planning Commission retained Round River Design to perform a Phase 2 Stream Geomorphic Assessment of the main stem of the Cold River Watershed in the Towns of Clarendon and Shrewsbury during the autumn of 2007. This assessment is meant to provide information about the physical condition of the Cold River watershed and the factors that are influencing the stability of this system in order to predict future channel adjustments and inform restoration and management decisions.

- The studies followed the assessment protocol (version 2007) developed by the Vermont River Management Program, Department of Environmental Conservation.

- The main stem of the Cold River varies between highly stable bedrock controlled channels and highly sensitive gravel and cobble dominated channels that are highly influenced by the presence and condition of the riparian vegetation as well as their ability to access a floodplain during high water events.

- The mid section of the Cold River in Shrewsbury has seen high amounts of historic channel straightening, floodplain encroachment, berming, and removal of riparian vegetation. There has been a collective loss of floodplain access for water and sediment storage due to berming, incision of the streambed, and floodplain encroachment. The result has been an increase in river power during high water events which has led to further instability and exacerbated fluvial erosion hazards in these reaches. Below a bedrock gorge in Clarendon to the confluence with the Otter Creek the Cold River is a highly dynamic stream in an alluvial fan area that is has a history of channel management in response to natural movements.

- The Cold River is working toward a more stable equilibrium through streambank erosion, widening, and lateral migration. The Clarendon and Shrewsbury communities have the opportunity to provide long-term protection to the river corridor and encourage the reestablishment of functioning floodplain and healthy in-stream habitat through river corridor management and protection.

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1.0 PROJECT OVERVIEW

Stream geomorphic assessments provide information about the physical condition of streams and the factors that influence their stability. The Vermont Agency of Natural Resources (VTANR) River Management Program has developed a series of protocols (Phase 1, Phase 2, and Phase 3) for the statewide assessment of rivers and streams. A Phase 1 Stream Geomorphic Assessment looks at broad scale landscape data, historical data, and limited field reconnaissance to begin to understand watershed characteristics and potential stressors. A Phase 1 Geomorphic Assessment of the Cold River was completed in 2007 by the Rutland Regional Planning Commission (RRPC). The Phase 1 project report summarized the results of this work (Rutland Regional Planning Commission, 2007). A Phase 2 Geomorphic Assessment of select reaches of the Cold River was recommended by the RRPC to gather more detailed information about the stream channel and riparian corridor in order to inform current and future planning and restoration efforts. The RRPC retained Round River Design to perform a Phase 2 Stream Geomorphic Assessments of the main stem of the Cold River in the Towns of Clarendon and Shrewsbury during the autumn of 2007.

The Cold River has a watershed area of 37 square miles just above the confluence of the Otter Creek in the Town of Clarendon, Vermont (Figure 1). The Phase 2 study focused on stream reaches on the main stem of the Cold River within the Towns of Clarendon and Shrewsbury (Figure 2). The combined length of the stream reaches assessed was approximately 12.7 miles.

2.0 BACKGROUND WATERSHED INFORMATION

2.1 Geographic Setting

Located entirely in Rutland County, Vermont, the Cold River watershed has an area of approximately 37 square miles. The Cold River flows westerly and joins the Otter Creek which then drains northerly into Lake Champlain. It is one of the major watersheds comprising the Upper Otter Creek Watershed. The Cold River watershed drains from its forested headwaters in the Green Mountains covering portions of five towns: Clarendon, Mendon, Shrewsbury, Killington and Rutland Town. The watershed includes Johnsons Pond, and several other smaller ponds and wetlands. It joins the Otter Creek at approximately 520 feet above sea level near the town boundary of Clarendon and Rutland Town.

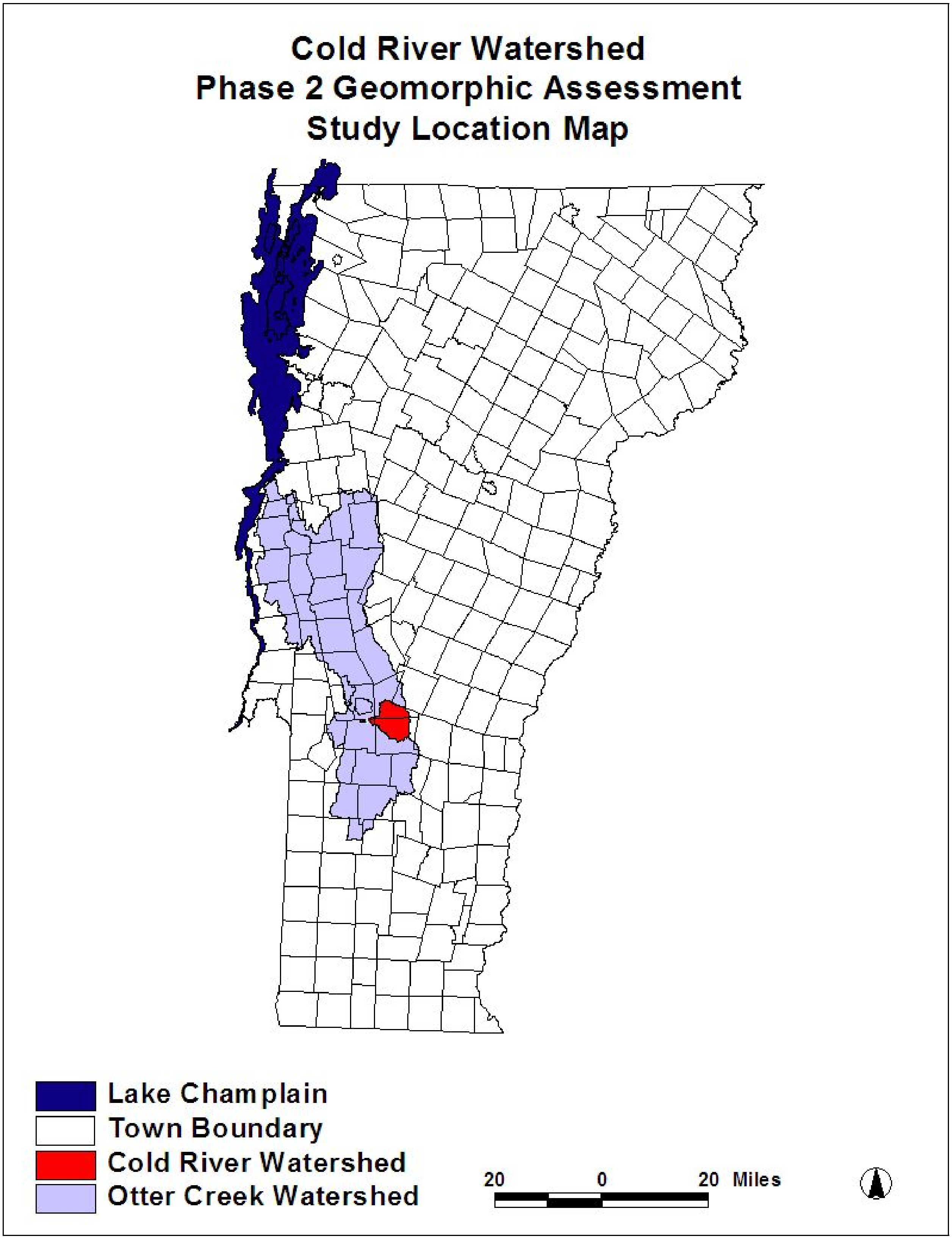

Figure 1: Project Location Map

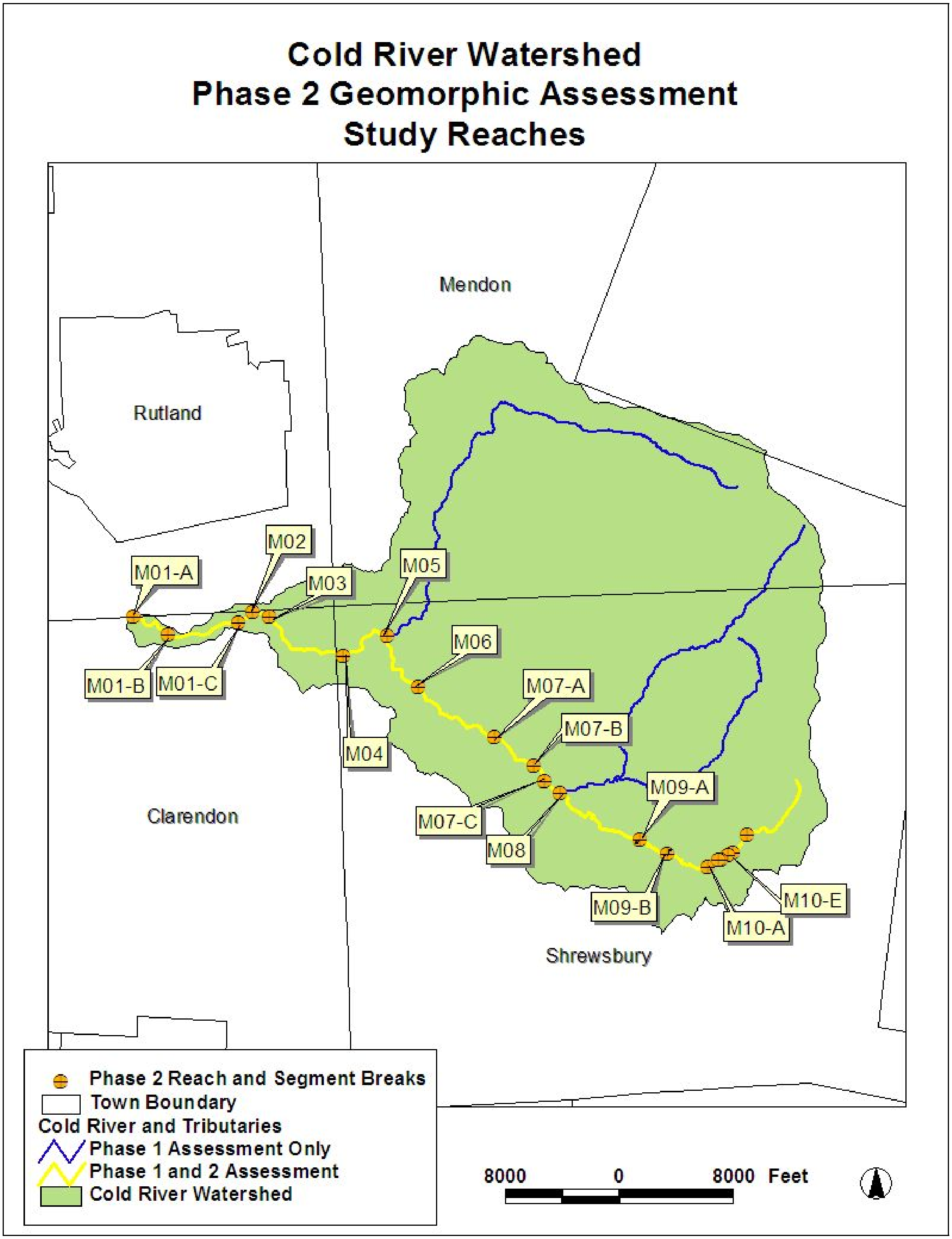

Figure 2: Reach location map for the Cold River Phase 2 Stream Geomorphic Assessment

2.2 Geologic Setting

Streams are transport systems that carry not only water but also sediment from highlands to lowlands. The geology of a watershed determines the source material that a river will carry; the way the material is carried; and the rate of channel adjustments. In a broad geologic context the Cold River spans two larger physioregions. The lower reaches are within the "Vermont Valley" – a continuation of the Champlain Valley that lies to the west of the Green Mountains and north of the Taconic Mountains where hills thrust up from bedrock dominate the topography. In the upper reaches the Cold River is considered part of the "Green Mountain" physioregion a huge anticlinorium comprised of three anticlines that have been compressed and uplifted and trend in a north-south direction (Stewart 1972).

2.2.1 Bedrock Geology

The headwaters and upper reaches of the Cold River flow over bedrock of the Green Mountain Physioregion. According to Stewart (1972), Precambrian basement rock (Mount Holly Complex) forms the core of the Green Mountains. The Mount Holly Complex is the most highly metamorphosed rock of the whole region having been subjected to two or more mountain building periods. The rock is a complex mixture of schists and gneisses with large areas of quartzite and small concentrations of calcite and dolomite marble. Flowing down from Shrewsbury, the Cold River also passes through the Wilcox Formation (a Precambrian formation of gneiss and schist).

Roughly near reach M03 the Cold River enters the Vermont Valley physioregion; a series of mostly Cambrian carbonate rock composed both of dolomitic and limestone marbles with occasional quartzite members (Stewart 1972). As indicated on a map titled, "Areal Geology of the Rutland Area" (Vermont Geological Survey 1952), the Mendon Formation (a Lower Cambrian quartzite formation found within M03) and Danby Quartzite (Upper Cambrian) are two such formations that the Cold River passes through. Winooski Dolomite and Monkton Quartzite form the gorge in reach M02. From here the Cold River spills out to the valley floor of the Otter Creek and into an area dominated by glacial drift and surficial deposits.

The underlying bedrock of the watershed influences the topography and energy gradients of the streams while the rock characteristics can influence the erodibility (and therefore stability of the channel) as well as the chemical water quality properties of a stream and subsequently influence its biology. Frequent bedrock exposures in the Cold River corridor influence the channel position and longitudinal profile of the river locking the channel in place in areas highly resistant to erosion. Bedrock exposed along the valley walls may control the lateral position of the river channel. Channel spanning bedrock (Found in reaches M10-F, M10-C, M10-A, M03 and M02) creates a vertical grade control that prevents possible downcutting of the river channel (at least in the near geologic time of which this study is concerned).

2.2.2 Surficial Geology

The surficial materials in the Cold River region are composed of sediments transported by glaciers or by melt water from streams or in small lakes associated with glaciation. The exception is the recent alluvium from floodwaters that forms a thin veneer on the floor of most broad river valleys. Till, unsorted glacial debris deposited directly from melting ice, contains a wide variety of particles sizes. According to Stewart (1972), till covers the uplands of the Rutland region as a thin veneer generally less than 10 feet thick and much thicker in the valleys. At the base of the Green Mountains near the Vermont Valley kame terraces, kames, and valley train deposits (outwash from glacial streams) can be found.

The Phase 1 Stream Geomorphic Assessment (Rutland Regional Planning Commission 2007) used soils maps delineated by the Natural Resource Conservation Service to identify that ice-contact, glacial till, and alluvial deposits are the dominant surficial geologic materials in the Cold River watershed (based on soils maps of the watershed). Alluvium soils are frequently flooded and have high erodibility potential. Ice contact soils are infrequently flooded, however have high to severe erodibility. Glacial till deposits are infrequently flooded and have high erodibility.

2.3 Geomorphic Setting

The Phase 1 Assessment of the Cold River Watershed (Rutland Regional Planning Commission, 2007) delineated geomorphic reaches using remote sensing and windshield surveys. Reaches were defined according to VTANR Phase 1 protocol based on variations in valley confinement, slope, sinuosity, and soils.

Based on the channel and watershed stressors identified during the Phase 1 Assessment, the ten main stem reaches of the Cold River were prioritized for Phase 2 Stream Geomorphic Assessments in 2007 (Table 1). These targeted reaches were expected to demonstrate higher degrees of channel adjustment and sensitivity.

Table 1: Location of Reaches Selected for Phase 2 Assessment

Reach Number	Length (feet)	Phase 1 Impact Score* (0 = low, 32 = high)	Location
M01	10771	29	Clarendon
M02	1351	9	Clarendon
M03	6870	19	Clarendon/Shrewsbury
M04	4340	5	Shrewsbury
M05	5188	9	Shrewsbury
M06	7152	23	Shrewsbury
M07	6494	24	Shrewsbury
M08	7826	16	Shrewsbury
M09	6216	10	Shrewsbury
M10	10537	16	Shrewsbury

*Original Phase 1 Impact score as reported prior to Phase 2 revisions.

2.4 Flood History

According to the Vermont Agency of Natural Resources document "Municipal Guide to Fluvial Erosion Hazard Mitigation" (2006), "Of all the natural hazards experienced in Vermont, flooding is the most frequent, damaging, and costly." The guide documents that over the last 50 years, flood recovery has cost the state an average of $14 Million a year and that during the period of 1995-1998 alone, flood losses in Vermont totaled almost $57 Million. Of particular concern for towns and properties near streams, it notes that, "While some flood losses are caused by inundation (i.e. waters rise, fill, and damage low-lying structures), most flood losses in Vermont are caused by "fluvial erosion". Fluvial erosion is caused by rivers and streams, and can range from gradual bank erosion to catastrophic changes in river channel location and dimension during flood events (Figure 3)."

Figure 3: These images of the nearby Mill River show damage from the 1927 flood. Left image is looking towards the intersection of Route 104 and Route 155 in East Wallingford. Right image is of route 103 washout in Cuttingsville. (Similar damage was likely inflicted on land around the Cold River).

The Municipal Guide further documents that, "Closer study of our rivers and streams reveals that Vermont's erosion hazard problems are largely due to pervasive, human-caused alteration during the past 150 to 200 years of our waterways and landscapes they drain. By end of the 19th century, forests had been cleared from many watersheds, resulting in major changes in watershed hydrology and sediment production. Towns and villages, the centers of commerce, grew on the banks of rivers, whose role in power generation and transportation at first outweighed flood risks. In addition, many watersheds were changed by development, agriculture, log drives, roads and railways." The legacy of this landscape manipulation is rivers and streams, such as the Cold River, which are unstable and prone to sudden and significant fluvial erosion (Vermont Agency of Natural Resources 2006).

To further complicate and concern riparian landowners, precipitation trend analysis suggests that intense, localized storms, which can cause flash flooding, are occurring with greater frequency (Vermont Department of Public Safety, 2006). In order to better understand the flood history of the Cold River, long term data from the U.S. Department of the Interior, U.S. Geological Survey (USGS) gauge on the Otter Creek in Rutland, VT (Figure 4) and data from a smaller stream, the Ottauquechee River near West Bridgewater, VT (Figure 5), were obtained (United States Geological Survey 2007). Seventy-eight years of record are available for the Otter Creek gauge at Rutland, VT which provides a continuous record of flow from 1929 through the present. Only the last twenty-two years (1985-2007) of record are available on the Ottauquechee River.

The long term record at the Otter Creek gauge shows major events near 10,000 cfs occurred in the years 1947, 1949, 1973 and 1987. In 1938, during the New England Hurricane, the Otter Creek reached a peak of 13,700 cfs. In the near term record of the Ottauquechee River gauge (from 1985 to 2006) major events occurred in 1996, 1998, 2000, and 2002 perhaps supporting data that suggests an increasing trend in intense storms.

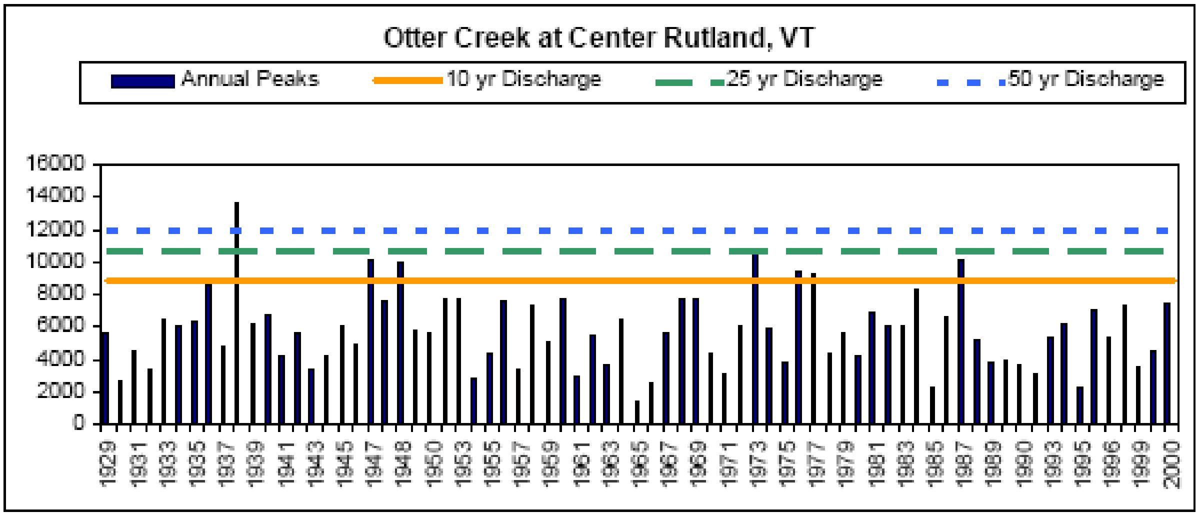

Figure 4: Flood frequency analysis for Otter Creek, Rutland, VT.

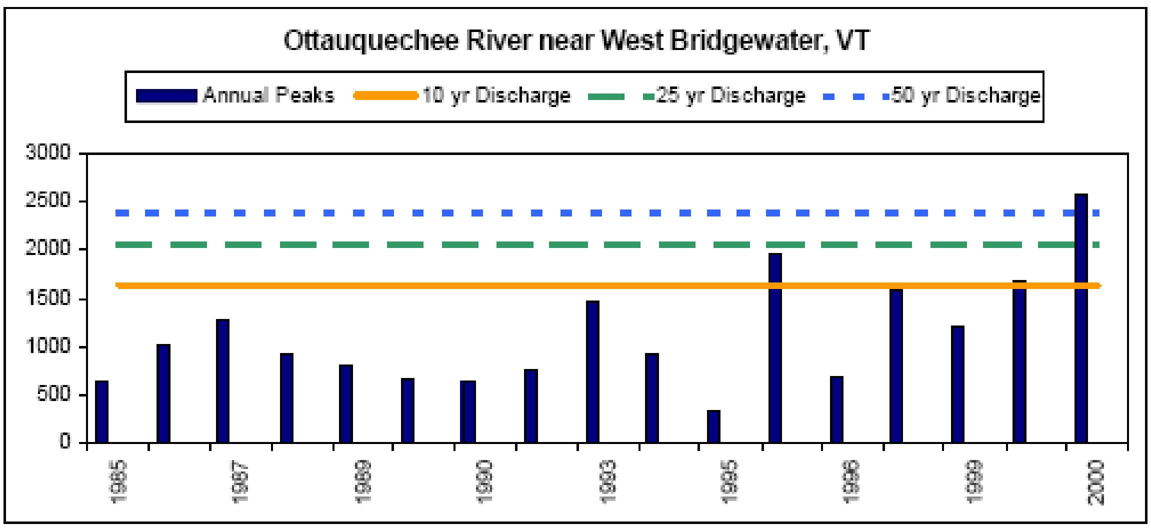

Figure 5: Flood frequency analysis for Ottauquechee River at West Bridgewater, VT.

2.5 Land Use and Hydrology

As reported in the Phase 1 Assessment Report (Rutland Regional Planning Commission 2007) most of the land in the Cold River watershed is forested. Some subwatersheds were reported to have as much as 12% in urban land use with as much as 25% urban land use in the corridor of one reach based data obtained from the Vermont Center for Geographic Information.

These numbers are important because development in the watershed, both current and historic, may play a large impact on fluvial erosion, water quality, and habitat quality. For instance, according to a study conducted at the University of Maryland, (Barnes et al, 2007) declines in biological integrity and habitat quality are observable in watersheds with impervious cover ranging between 10 percent to 20 percent. The alteration of first-order, and in some cases, second-order channels (the small feeder streams that join to become the major tributaries to the Cold River) is problematic since runoff and sediments formerly distributed among many small channels are now delivered to fewer channels. The outcomes of this are more rapid flow velocities and flood peaks downstream.

Channel and bank instability, which leads to the physical degradation of streams, stems from the increased flooding that follows development. The signs of instability, however, may not become evident for several years following urbanization. Signs of instability include channel widening by bank erosion or a deepening of the channel through down cutting. With the former, channel beds may become covered in sediment; with the latter, beds are subject to frequent scours.

The study continues to describe that, “When development occurs on floodplains not previously developed, natural flooding will inevitably threaten the people and property inhabiting those floodplains, which can lead to environmental harm. What’s more, areas that did not commonly flood before urbanization may suffer more frequent inundations due to the greater volumes of runoff and increased flood heights associated with imperviousness. Properties and structures may be threatened by bank erosion from streams’ whose channels have been destabilized by upstream development” (Barnes et al, 2001).”

3.0 ASSESSMENT METHODOLOGY

The Phase 2 assessment followed procedures specified in the Vermont Stream Geomorphic Assessment Phase 2 Handbook (Vermont Agency of Natural Resources 2007b). All assessment data were recorded on the Agency of Natural Resources Phase 2 data sheets, and were entered in to the VTANR Stream Geomorphic Assessment data management system (DMS). The Phase 1 database was updated when necessary based on the field data collected during the Phase 2 assessment.

3.1 Phase 2 Geomorphic Assessment Protocol

The VTANR Phase 2 stream geomorphic assessment protocol outlines a scientific methodology for gathering information about the stream channel and habitat conditions of a stream. The information can be used in watershed planning and detailed evaluations of aquatic habitat and erosion hazards. The Phase 2 Assessment is composed of field observations and measurements that help verify Phase 1 stream geomorphic data and provide more specific information about stream reaches of interest. Phase 2 assessments can be used to compare stream reaches within the same watershed to each other and/or to regional reference conditions.

The VTANR Phase 2 Assessment includes seven categories of investigation. These categories are as follows:

1. Valley and River Corridor
2. Stream Channel
3. Riparian Banks, Buffers and Corridor
4. Flow Modifiers
5. Channel, Bed and Planform Changes
6. Rapid Habitat Assessment (RHA)

7. Rapid Geomorphic Assessment (RGA)

The parameters and protocols used for undertaking each of the above steps are outlined in the Phase 2 Handbook (Vermont Agency of Natural Resources, 2007b). The entire length of each Phase 2 reach was walked during the low flow months of August, September, and October 2007. Where necessary, reaches were further reduced to segments in order to capture important variations in the river channel and/or corridor that may impact assessment calculations and future management decisions.

Bank erosion, grade control structures, bank revetments, debris jams, depositional features, stormwater inputs, flood chutes and other important features were mapped and photographed in the field. In accordance with protocols, specific features were then digitized in ArcView 3.x shapefiles, referenced to the Vermont Hydrography Dataset (VHD), using the Feature Indexing Tool (FIT), a component of the Stream Geomorphic Assessment Tool (SGAT).

All assessment data were recorded on the Agency of Natural Resources Phase 2 data sheets, and were entered in to the VTANR Stream Geomorphic Assessment data management system (DMS). The Phase 1 database was updated using the field data from the Phase 2 assessment.

3.2 Bridge and Culvert Assessment

Fourteen bridge and culvert assessments were conducted on the Cold River mainstem following protocols listed in Appendix G of the Phase 2 Assessment Handbook (Vermont Agency of Natural Resources, 2007b). Only one permanent structure (a private footbridge on reach M10-F) was not assessed as permission from the landowner could not be confirmed.

3.3 Quality Assurance (QA) Review

Assessments were carried out in compliance with the VTANR Programmatic QAPP (VTANR, 2003). Round River Design performed a thorough in-house QA review of the Phase 2 data in November of 2007 following Phase 2 quality control checks developed by VTANR. The DMS and the ArcView Shapefiles for the Cold River Phase 2 study were submitted to Shannon Pytlik of the ANR for a QA review in November of 2007. Shannon Pytlik completed the QA review during December, 2007.

The following considerations and limitations apply to the Phase 2 data for the Cold River watershed:

- All Phase 2 features (including grade controls, bank erosion, stormwater inputs, bank armoring, berms, and more) were geo-located using the Feature Indexing Tool (FIT). These features are indexed to the centerline of the Vermont Hydrography Dataset (VHD) for the Cold River watershed (source date of 1995). In some instances, particularly where the stream has undergone recent planform adjustment such as near the confluence of the Otter Creek, and in areas of heavy forest, the actual channel position may be different than what was mapped in 1995. Therefore, locations and lengths of features indexed with the FIT should be considered approximate.

4.0 PHASE 2 RESULTS

Phase 2 Reach Summary Reports from the DMS are included on pages 1 through 42 of Appendix A. The Stream Geometry Data Report is found on page 43 of Appendix A, while page 44 of Appendix A provides the Rapid Geomorphic Summary Report. The results of the Phase 2 study are discussed below by reach number. In addition, four overview maps (Figures 6, 5, 20, and 26) have been included to provide a reference for location as well as to display channel modifications such as straightening and berming, both of which have greatly affected the condition of the Cold River.

The most common adjustment processes in the Cold River are widening and planform migration as a result of historic degradation within the channel. Degradation is the term used to describe the process whereby the stream bed lowers in elevation through erosion, or scour, of bed material. Aggradation is a term used to describe the raising of the bed elevation through an accumulation of sediment. The planform is the channel shape as seen from the air. Planform change can be the result of a straightened course imposed on the river through different channel management activities, or a channel response to other adjustment processes such as aggradation and widening. Channel widening occurs when stream flows are contained in a channel as a result of degradation or floodplain encroachment or when sediments overwhelm the stream channel and the erosive energy is concentrated into both banks.

RIVER SECTION 1: UPPER SHREWSBURY VILLAGE TO MAJOR WETLAND SYSTEM

The first section of river (illustrated in Figure 6) begins in the mountain headwaters of Shrewsbury and flows south and westerly through Upper Shrewsbury Village. The valley alternates between very broad and narrow and land use changes from predominately forested to residential and then back to forested land. A significant wetland exists at reach M09-A. Major significant impacts in this section include removal of riparian vegetation, channel straightening, streambank armoring, and several undersized bridges and culverts.

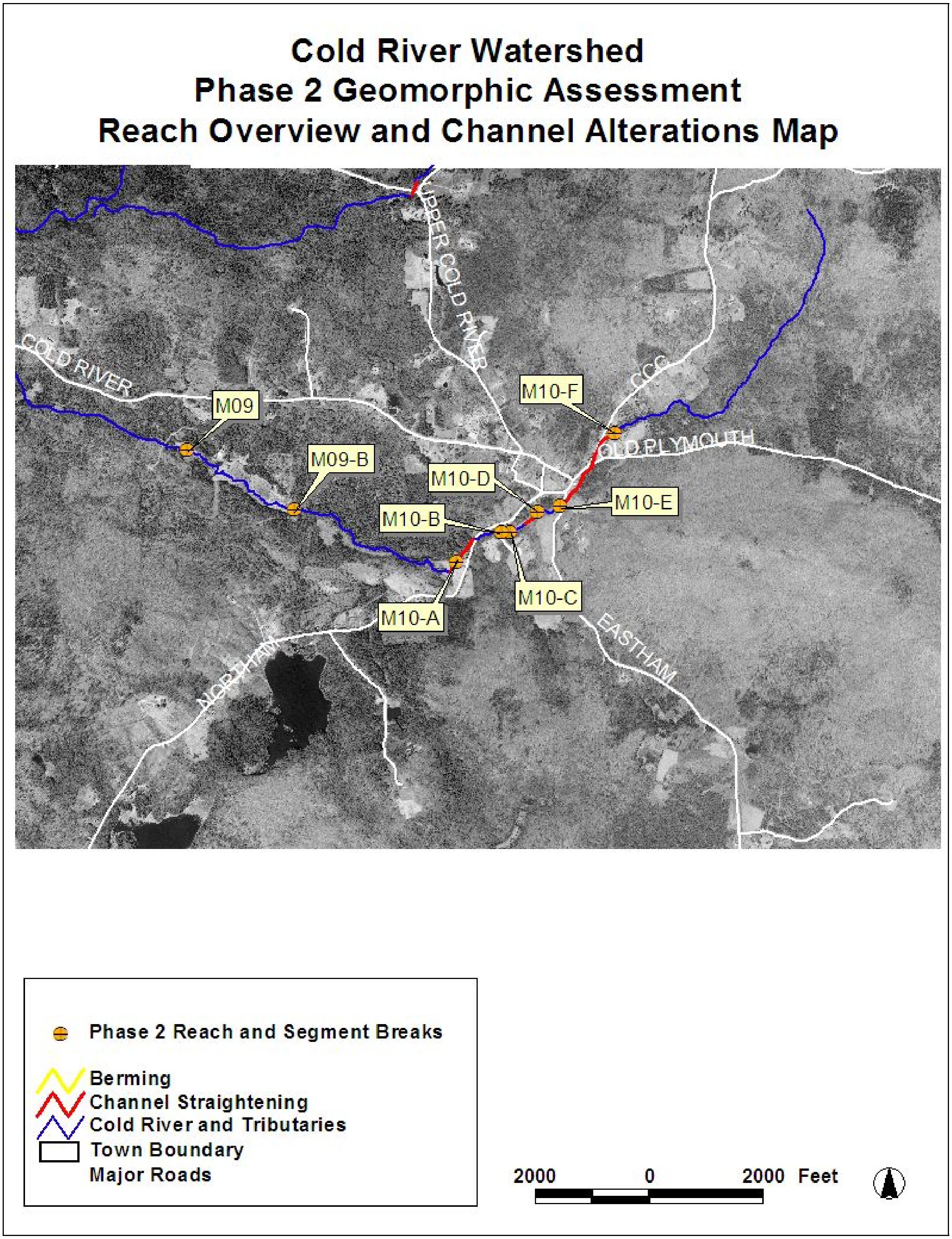

Figure 6: Overview of reaches M10-F through M09 and channel straightening and berming.

4.1 Reach M10

Cold River reach M10 is a long variable reach that begins in the forested headwaters above Upper Shrewsbury Village on the flanks of the Green Mountains. It flows down from a large forested area passing through a residential zone, a short bedrock gorge, and an on-stream pond before returning to a wooded section. The reach was divided into six segments to account for these diverse conditions.

Segment F:

Cold River segment M10-F begins above Upper Shrewsbury Village in the forests that lead up to the Coolidge Range of the Green Mountains. With the exception of a few ATV fords and an old garbage dump there was very little recent anthropogenic disturbance evident within this mile long reach. This reach is currently in its reference condition as a C-channel dominated by gravel substrates with a riffle-pool bedform (Figure 7). Long-term protection of headwaters areas are important for ensuring cool, clean water consistently through the year.

Figure 7. Segment M10-F is a stable channel in a well forested watershed.

Segment E:

Exiting from forested headwaters, the Cold River becomes very highly impacted by human land use within the river corridor as it flows through the residential area of Upper Shrewsbury Village. The stream was segmented in this area due to the high degree of channel straightening and bank armoring which have caused a departure from a C channel to a B channel and have eliminated much of the habitat value of the segment. A significant amount of riparian vegetation has been removed making this the first area of the river where thermal pollution may have an impact on water temperatures for aquatic species downstream. Despite a high degree of channel incision, widening and planform adjustments have been limited due to channel armoring (Figure 8). These adjustments, however, may quickly happen during a flash flood type event where stream energy will certainly now be concentrated in the channel. Continued maintenance of this armoring should be expected so long as there is no floodplain access in the stream channel.

Figure 8. Cold River segment M10-E has been highly altered by human disturbance of the stream corridor.

Segment D:

Passing through an undersized culvert (Eastham Road) the Cold River plunges over a large cascading waterfall of approximately 20 feet in total height. For another 450 feet, the Cold River drops through a bedrock controlled channel in a confined "gorge" (Figure 9), an area of obvious difference in characteristic than what exists upstream and downstream. Due to the bedrock, which lends to long term stability, only a partial Phase 2 Assessment was conducted for this segment. Long-term stability can be expected in this segment and habitat value can be maintained through preservation of the forested buffer.

Figure 9. Cold River segment M10-D is a bedrock controlled gorge. Bedrock dominates both the streambed and banks.

Segment C:

Cold River segment M10-C is a short segment located between a bedrock gorge and an on-stream pond in Upper Shrewsbury Village. There is some evidence of channel management in the vicinity of a residence where it appears that the channel abuts against a rock wall. However, for the most part the stream is in its natural condition with adequate floodplain access and a well forested riparian corridor (Figure 10) (some enhancement on the right bank near existing houses would help). No major channel adjustments were observed in this segment. Dismantling of the aforementioned rock wall near the bank of the stream may allow for critical flood flows to access the floodplain during a major event and help preserve the stable nature of this segment.

Figure 10. Cold River segment M10-C is in stable condition with adequate floodplain access and a forested buffer.

Segment B:

Cold River segment M10-B is impounded by a private on-stream pond (Figure 11). Due to the disruption of flow, only a partial Phase 2 Assessment was conducted. Shading of the pond to limit thermal pollution to the Cold River (a long-term pollution issue that should be considered with maintenance of this pond) would be improved with plantings around the pond edge. The landowner of the right bank of the pond reported that she had observed that the road below the pond had only been overtopped once in 25 years of her residency. This anecdotal information indicates that the culvert under the Mountain School Road is large enough to convey most flows, however, may still be vulnerable during the largest (25-100 year) runoff events. In addition to these observations, it should be noted that on-stream ponds trap sediment and risk starving downstream reaches which may lead to channel incision and widening in reach M10-A and M09-B, this may be especially true if sediment is continuously dredged from the pond and removed from the stream system entirely.

Figure 11. Segment M10-B is an on-stream pond controlled by a small concrete dam.

Segment A:

Cold River segment M10-A is a short segment of 900 feet length that begins at the dam of the on-stream pond and flows downstream to the beginning of reach M09. The Cold River is highly incised through this segment. The small pond upstream may have altered the sediment supply and caused some channel incision. There have also been human caused changes in valley width and channel confinement due to encroachment by Northam Road which looks to have been built up into the floodplain of the stream. Loss of floodplain access has led to a stream type departure from a C channel to a B stream type (although the very upper end (~100 feet) of the segment where there is a grade control may be B by reference due to the slope and valley walls). Despite the incision, only minor widening was recorded. Planform adjustment has likely been limited by the cobble and boulder material of the banks, armoring, and fill.

The segment also has two floodplain constricting culverts. The culvert under Eastham Road seems to be a major channel and floodplain constriction with a sharp upstream bend and a failing retaining wall due to road stormwater runoff (Figure 12). The culvert under the Mountain Road is perched very high above the downstream bed and causing a significant amount of scour and is a fish passage impediment.

As a final observation, there is an old road crossing near the powerline that crosses the stream at the most downstream end of this segment. If this road is no longer in use, it may be a simple restoration project to cut back the bank and remove this channel constriction.

Figure 12. Segment M10-A has incised and has several floodplain constrictions such as this culvert under Northam road.

4.2 Reach M09

Below Upper Shrewsbury Village the Cold River enters an area dominated by a forested landscape. Reach M09 was divided into two segments to account for a large wetland complex controlled by beaver dams at the lower end of the reach.

Segment B:

Segment B flows through a predominately forested corridor (some recent logging in left corridor and some past clearing evident in the upstream end). Unlike most other reaches in the system, this portion of the river has not incised. There was an abundance of sand and fine gravel (source unknown) in the channel (Figure 13). Minor channel widening and planform adjustments were observed to be occurring, mostly in response to the major aggradation and the numerous debris jams. Overall the segment seems like an asset to the watershed for its sediment and water attenuation capacity.

Figure 13. M09-B flows through a predominately forested corridor and has minor channel widening and planform adjustments as a result of major aggradation.

Segment A:

Cold River segment M09-A comprises a significant wetland system (Figure 14). Due to the impounded nature of much of the reach and the difficult access through the wetland muck only a partial Phase 2 Assessment was conducted on this segment. Despite the lack of Phase 2 data, it is easy to see that this area is significant to the Cold River watershed. The owners of much of the wetland property described an event that occurred within the last year. The beaver dams at Johnson's Pond (upstream and to the south) failed causing a huge volume of water into a small tributary that enters near the most upstream end of the wetland. Evidence of a major flood exists in the woods where huge fans of sediment have buried the forest floor several feet thick. The landowner observed flows exiting the M09-A wetland complex during the duration of this event and described that the river downstream did not rise significantly. This anecdotal story suggests that the wetland of this segment acted as a huge sponge to absorb the runoff from the upstream pond. Continued protection of this wetland for its habitat and floodwater storage functions will be an important benefit for the Cold River.

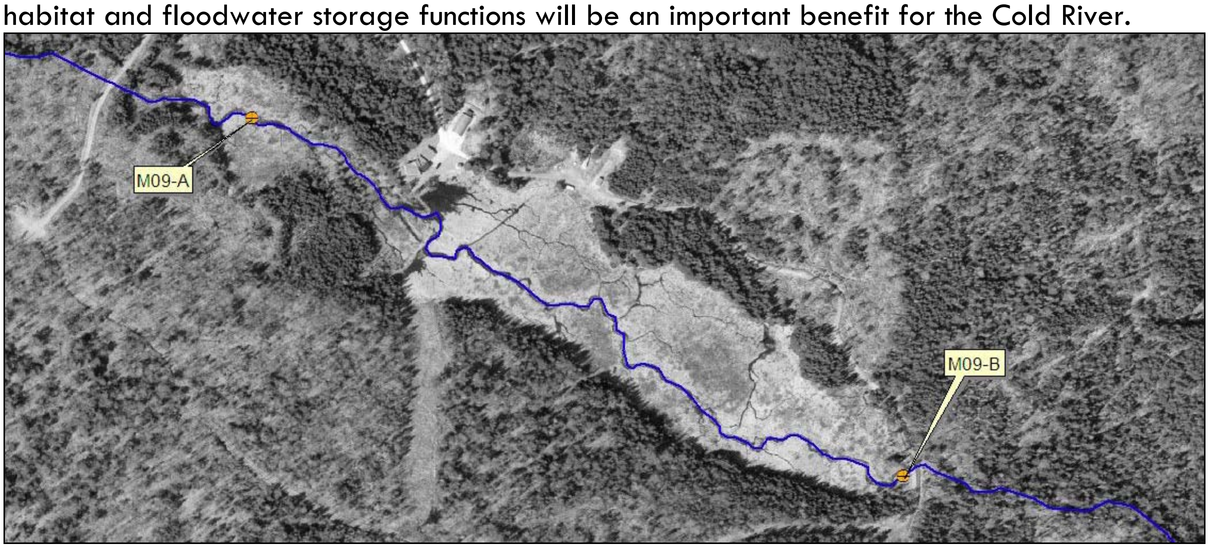

Figure 14. M09-A consists of a large wetland complex as seen in this aerial photograph.

RIVER SECTION 2: WETLAND TO COLD RIVER ROAD MID-SHREWSBURY

The second section of the Cold River (illustrated in Figure 15) begins below a large wetland complex and continues downstream following the Cold River Road closely. The valley is broad to very broad and land use is residential, agricultural, and forest. Major significant impacts in this section include removal of riparian vegetation, channel straightening, dredging, berming, channel armoring, and floodplain encroachment.

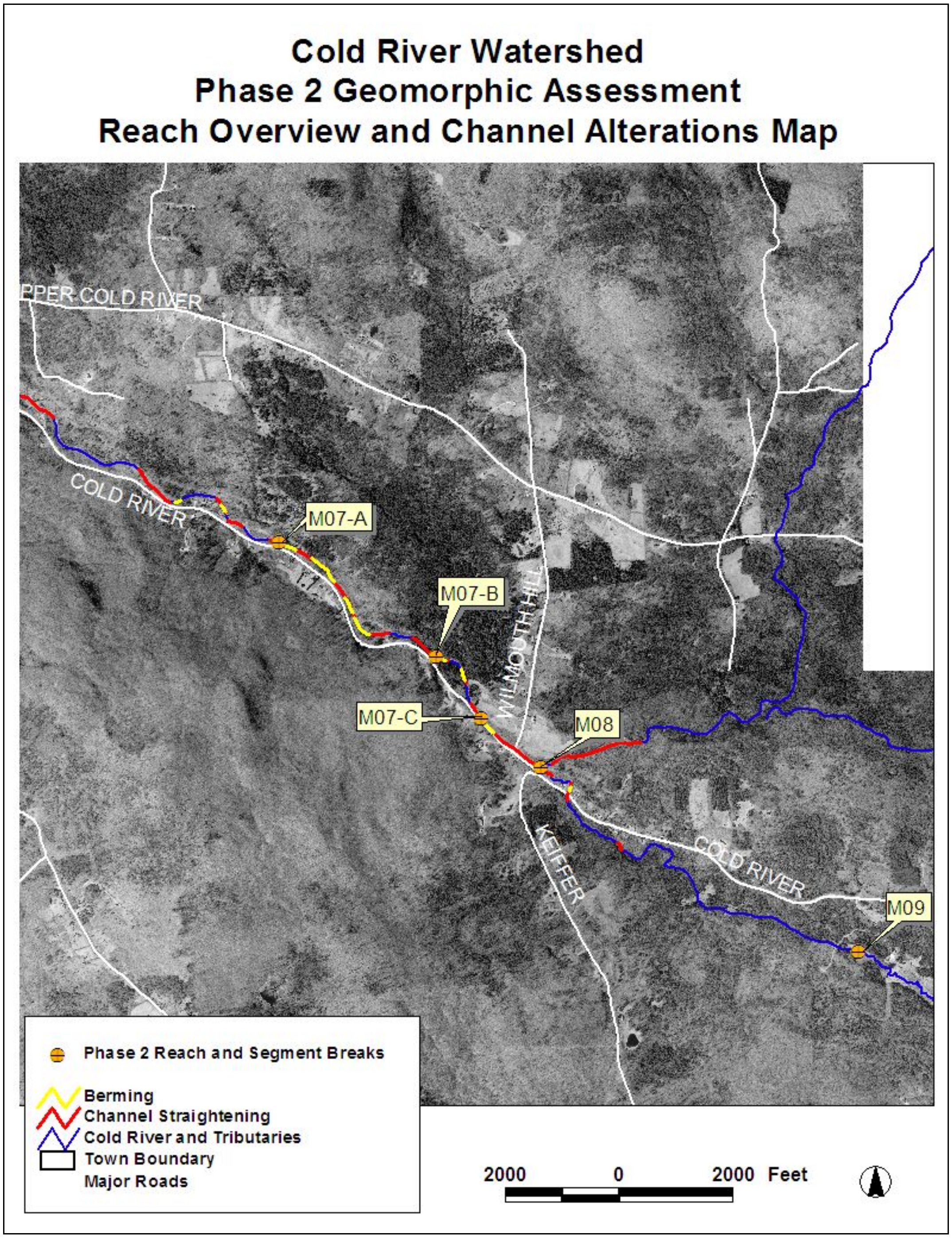

Figure 15: Overview of reaches M06 (partial), M07 and M08 and channel straightening and berming.

4.3 Reach M08

Cold River reach M08 begins downstream of a large wetland complex and flows through a watershed dominated by a wooded corridor. At the lower end of the reach a short section of residential development encroaches the corridor; however, it did not appear significant enough for the reach to be segmented. Some straightening and dredging has occurred in this area, however, for the most part this reach has not been disturbed by human channel management projects. The channel dimensions of this reach, as with reaches M09 and M10 upstream, are significantly smaller than the next reach downstream due to several large tributaries that enter the main stem at the top of reach M07.

The channel of reach M08 appears to have undergone some historic incision; however a new juvenile bankfull bench was observed in many locations. The narrow valley widths measured in the field along with the channel slope (2.6%) indicate that this reach is a C3 plane bed channel by reference (Figure 16). No major channel adjustments were observed to be currently occurring in this reach, although several channel constrictions exist at the downstream end.

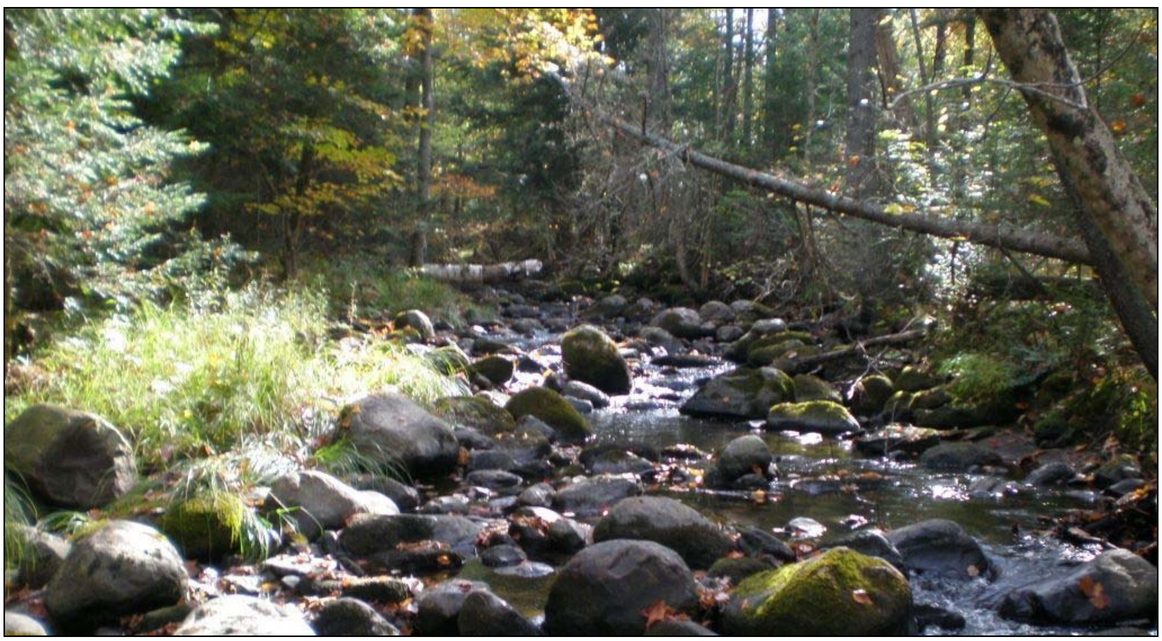

Figure 16. Cold River reach M08 is a relatively stable reach considered to be a C3 planebed system by reference. No major channel adjustments were observed to be occurring.

4.4 Reach M07

Cold River reach M07 begins were the Gould and Sargent Brook tributaries join with the Cold River mainstem just upstream from the Wilmouth Hill Bridge in Shrewsbury. The reach was divided into three segments to account for a change in stream type that occurs in the middle of the reach.

Segment C:

Cold River segment M07-C has been highly altered due to channel straightening and streambank armoring. The channel floodplain has been partially filled by the Cold River Road which runs along the left bank. This, along with bed degradation and widening has caused a departure from a reference C-type riffle-pool to a F-type plane bed stream. Channel armoring, the location of Cold River Road, and nearby residences have all but eliminated any opportunity for floodplain development on the left bank of the river in the present location of the channel (Figure 17). Restoration of floodplain access in this potentially dynamic confluence of tributaries may be feasible on the right bank (which has no existing structures) and may alleviate flood pressures on the Wilmouth Hill Road Bridge.

Figure 17. M07-C has been historically straightened and is now has a plane bed form.

Segment B:

Cold River segment M07-B is a short segment that veers away from Cold River Road thus escaping some of the encroachment that has occurred in the upstream and downstream segments. This section was analyzed as a separate segment because there is floodplain access along the left bank. This area seems like an important localized resource given the high degree of floodplain loss that has occurred upstream and downstream. The river is somewhat incised in this segment, however, thereby limiting the effectiveness of the floodplain at just above bankfull flows (in addition there is a small amount of dredged material on the left bank that may act as a small berm). No major channel adjustment is occurring currently. Channel incision and the effects of alterations upstream and downstream have caused a change from a riffle-pool system to a planebed stream (Figure 18).

Figure 18. M07-B is a plane bed channel with a forested buffer and some floodplain access.

Segment A:

Cold River segment M07-A runs through an area of residential encroachment along Cold River Road (Figure 19). Incision has led to entrenchment and a stream type departure from a C-type riffle-pool to an F-type plane bed system. Berming, dredging, and bank armoring have been implemented in an attempt to lock the channel in its present location and prevent further channel migration. Floodplain access in this reach has been greatly reduced due to these management activities. The right bank is forested and removal of dredged material on this bank may be a feasible and beneficial project that would open up some floodplain access and thereby reduce the pressures on the structures and road.

Figure 19. M07-A has a significant degree of floodplain encroachment as well as channel management evidence such as berming, straightening, and bank armoring.

RIVER SECTION 3: MID-SHREWSBURY TO CLARENDON TOWN LINE

The third section of the Cold River (illustrated in Figure 20) begins upstream from the Browns Covered Bridge and continues in a westerly direction downstream to a gorge at reach M02. The valley alternates between very broad and confined through this section and land use is predominately forested with minor sections of residential and commercial development. Only some channel straightening (reach M03) has impacted this section.

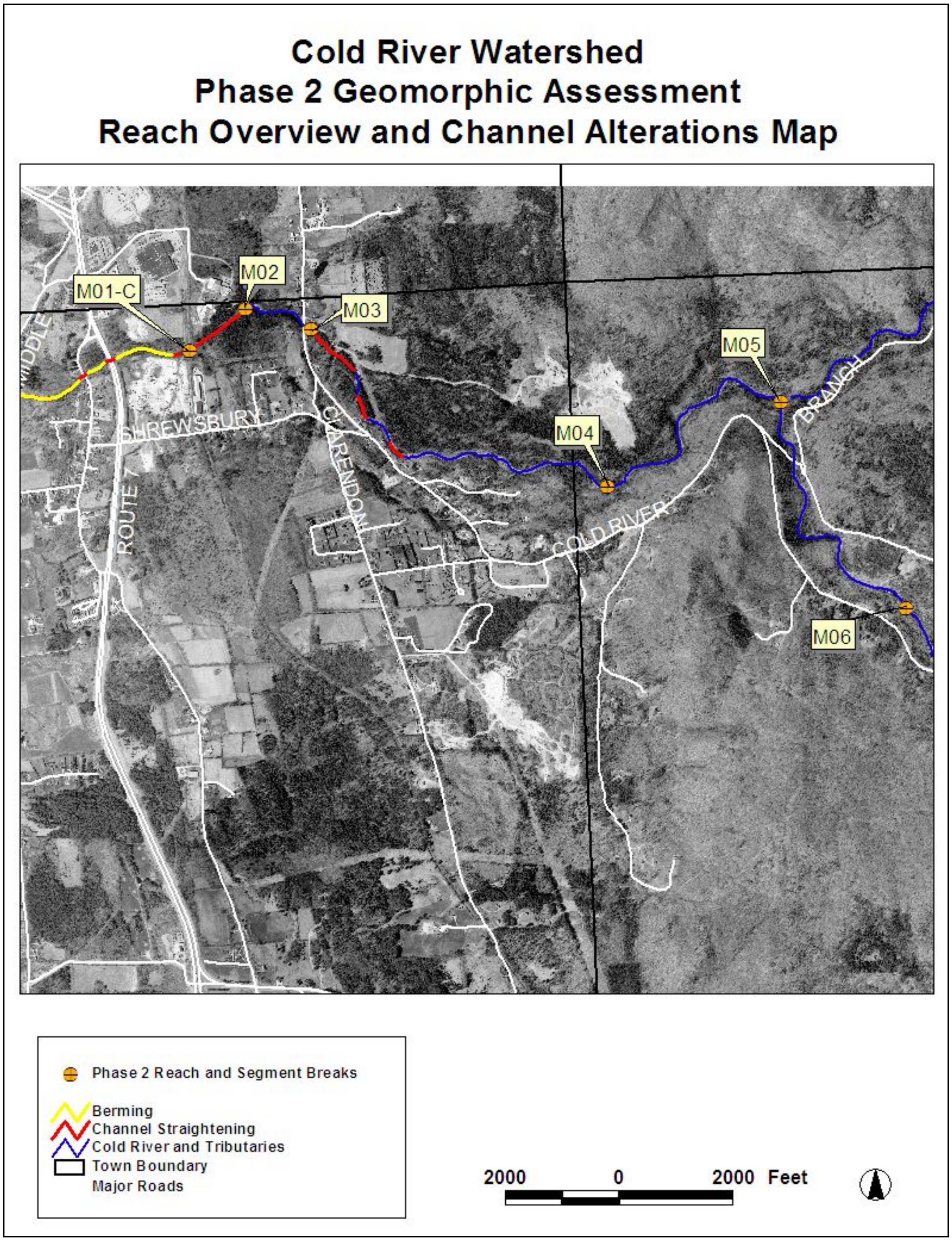

Figure 20: Overview of reaches M02 through M05 and channel straightening and berming.

4.5 Reach M06

Cold River reach M06 has a high degree of corridor encroachment on the left bank due to residential development along Cold River Road (Figure 21). The floodplain fill and encroachment have led to channel management activities such as dredging, armoring, and berming in an attempt to protect infrastructure and prevent natural channel migration. The channel is incised from its floodplain; however, it is still a C-type channel retaining some floodplain access during the largest events. The channel incision and management have led to the loss of the riffle-pool bedform and much of the habitat value of the reach. The right corridor of the reach is forested and removal of at least one berm on the right side may be a beneficial restoration project. Future channel management activities should weigh the possibility of floodplain creation as a long-term strategy versus the short term strategies of bank armoring and dredging.

Figure 21. M06 flows along Cold River Road and has been impacted by channel management activities meant to protect public and private property that was built in the river corridor.

4.6 Reach M05

Cold River reach M05 is a B3 stream by reference that flows through a forested corridor, passing underneath Browns Covered Bridge to the confluence with the North Branch of the Cold River. This reach has incised historically. At one point it may have been a G-type channel, however, due to channel widening it is now an F-type stream. Development of a new floodplain through planform adjustment, flood chutes, and bar formation is occurring as the stream attempts to recreate B3 channel dimensions. This reach has a very healthy forested corridor (Figure 22). This reach has the potential for only limited water and sediment attenuation due to the semi-confined valley through which it flows and its steep slope. With a well forested corridor and a diversity or channel materials including unembedded gravels and cobbles and many boulders this reach has good aquatic habitat. Floodplain and corridor encroachments should be prohibited in this reach as it is likely to continue to adjust in response to the historic incision.

Figure 22. Cold River reach M05 is an incised B3 (F3 existing) channel with a healthy forested buffer.

4.7 Reach M04

Cold River reach M04 is a cobble dominated B-type plane bed system that begins at the confluence of the North Branch of the Cold River and continues downstream for 4340 feet. There was evidence of historic incision found throughout this reach. M04 is a high energy reach with limited capacity for floodwater and sediment storage. The forested corridor on both sides of the channel adds to the habitat and long term stability of this reach.

Figure 23. M04 is a B3 channel dominated by plane bed features and a healthy forested corridor.

4.8 Reach M03

Cold River reach M03 is a C3b riffle pool system by reference. Historic channel bed degradation (despite bedrock grade control at both the upper and lower end) has occurred causing a disconnection between the river and its floodplain. This incision has created a B3 plane bed stream with major widening and planform adjustments occurring as the stream works to redevelop a floodplain bench (Figure 24). The river corridor is mostly forested with residential encroachment on the left bank near the lower end. Continued channel adjustments should be expected and therefore floodplain and corridor encroachments prohibited in order to allow for the river to reestablish equilibrium conditions.

Figure 24. M03 is a C3 system by reference, however, has incised and is currently exhibiting major widening and planform adjustment as a B3 plane bed channel.

4.9 Reach M02

Cold River reach M02 is a bedrock gorge (Figure 25) consisting of excellent habitat and beauty and is a great resource for the Cold River community. Due to the bedrock control of the streambed and banks, this reach only received a partial Phase 2 assessment.

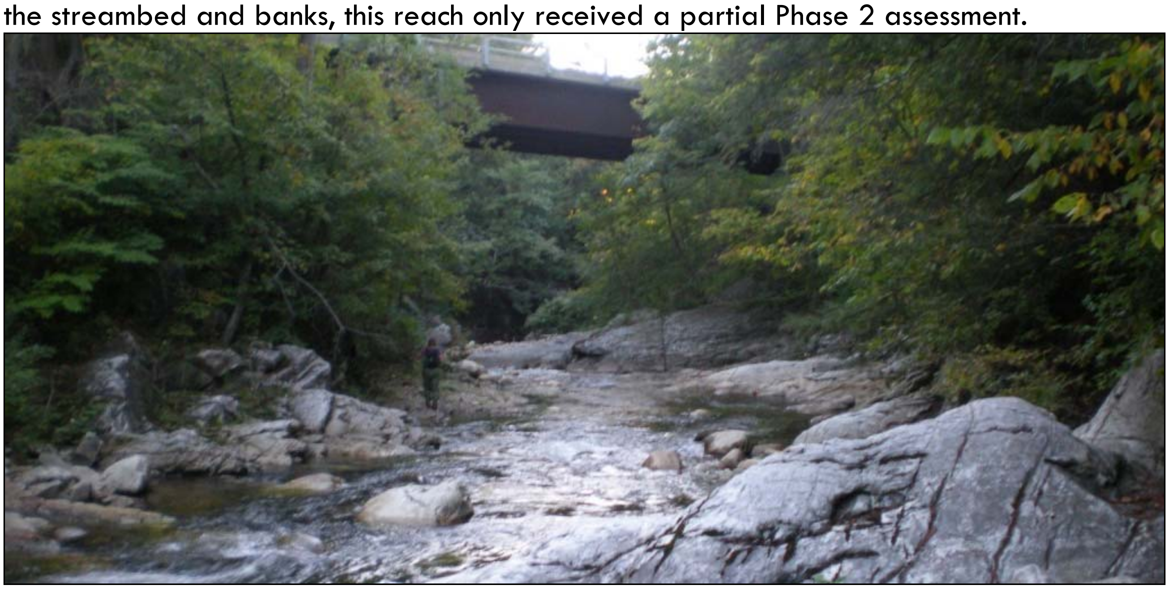

Figure 25. M02 is a bedrock dominated channel with a high degree of geomorphic stability.

RIVER SECTION 4: CLARENDON TOWN LINE TO CONFLUENCE WITH OTTER CREEK

The final section of the Cold River (illustrated in Figure 26) begins below a gorge in the town of Clarendon and continues downstream to the confluence with the Otter Creek. The valley widens as the Cold River spills down from the Green Mountains and onto the large valley bottom of the Otter Creek. Land use is dominated by commercial and agriculture. Major significant impacts in this section include removal of riparian vegetation, channel straightening, dredging, berming, channel armoring, floodplain encroachment and undersized structures.

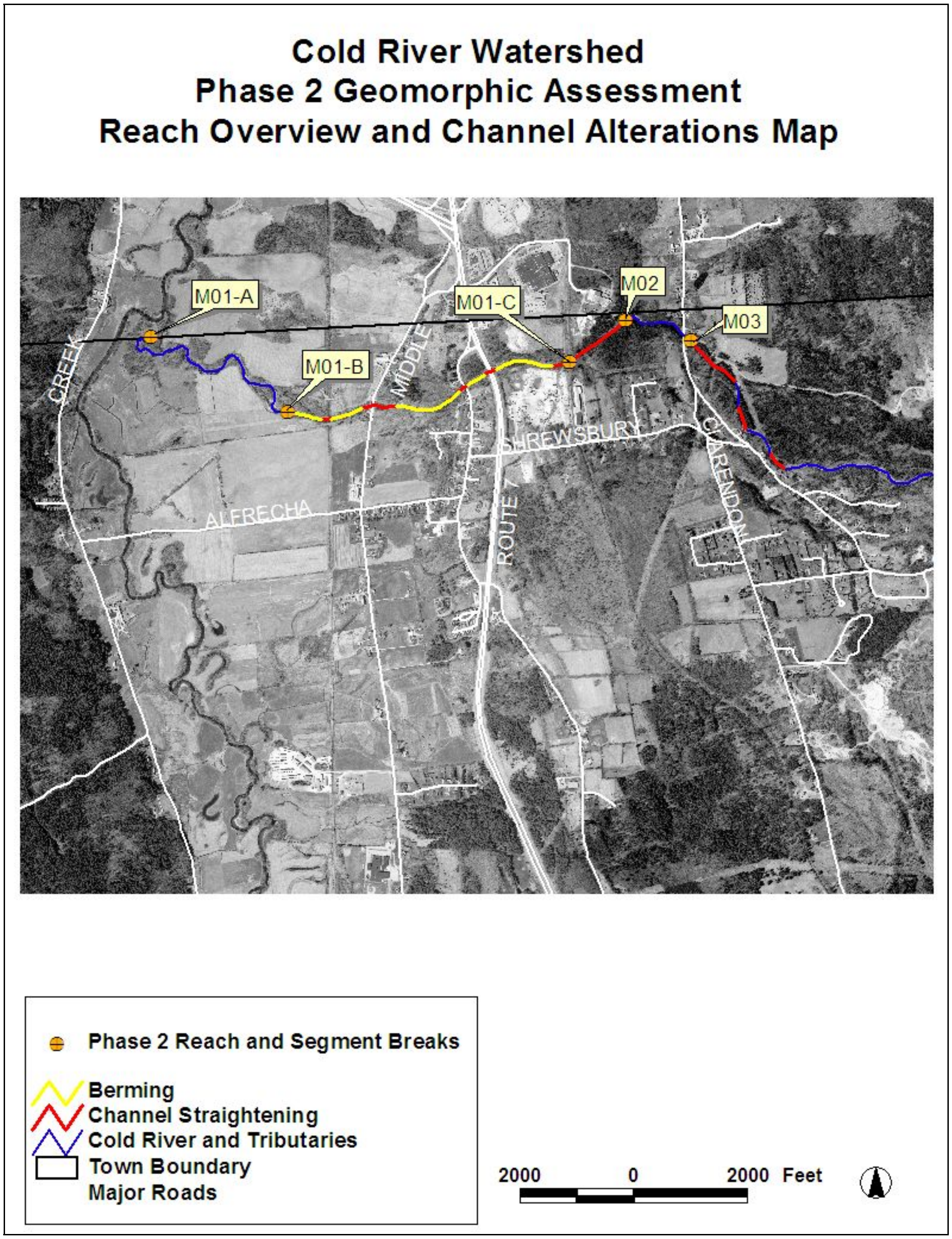

Figure 26: Overview map of the mouth of the Cold River (reach M01) and channel straightening and berming.

4.10 Reach M01

Cold River reach M01 flows from a bedrock gorge at the edge of the Green Mountain physioregion down onto the flat valley bottom of the Otter Creek. This is a transitional and dynamic reach with a high degree of corridor encroachment by commercial, residential, and agricultural interests. Due to the changing slopes, sinuosity, and channel dimensions of the river, the reach was divided into three segments.

Segment C:

Cold River segment M01-C is a high energy reach that connects a bedrock gorge to the alluvial valley bottom of the Otter Creek, this short segment has a naturally high slope and is a B-type plane bed segment by reference. Some historic incision was noted for the segment, however planform adjustments and widening have been limited by the boundary conditions of the banks (large cobbles, boulders, and vegetation) and the stable nature of reference plane bed channels (Figure 27). Two industrial water diversions exist at the top of this segment, however, they do not appear to be having a significant impact on the geomorphic condition of the segment or those downstream.

Figure 27. M01-C is a B3 plane bed segment. It connects a gorge with the alluvial valley bottom of the Otter Creek.

Segment B:

Cold River segment M01-B has seen extensive channel straightening, dredging, and windrowing in response a high degree of channel movement. It is a predictable tendency for a river system to have a high level of natural adjustment where there is a significant break in slope (here the Cold River transitions from a high sloped mountain stream, to the low slope of the Otter Creek valley). These alterations, which have been an attempt to control this natural channel migration, have caused the stream to loose its riffle-pool features and most of its natural sinuosity (significantly impacting the habitat and sediment and floodwater storage capacity of this segment). The channel in this reach is a C-type plane bed (Figure 28) with a high incision ratio due to berming. Several channel constricting structures that cross the Cold River in this segment are further creating high degrees of instability. Located at a major break in slope and near the end of the river system, the loss of floodplain attenuation in this segment is likely exacerbating the instability found in the downstream segment M01-A. Although there are limitations to improving floodplain access and returning a more natural degree of sinuosity in this segment due to the structures and residences in the river corridor, a berm removal or relocation (back further away from the top of bank) project may be feasible in some areas of this reach in order to reestablish some flood and sediment storage.

Figure 28. M01-B has been historically straightened and dredged and is now has a plane bed system with limited floodplain access.

Segment A:

M01-A is the lowest reach of the Cold River. This segment is also located within a highly dynamic zone where floodwaters and sediment coming down from the relatively steep Green Mountain hillsides are released in the flat valley bottom of the Otter Creek. Scientists from RRD and VTANR observed a high degree of bank erosion and channel adjustment (Figure 29) within this segment. The steam banks are composed of silts and clay near the confluence with the Otter Creek and the bank height increases significantly (likely due to the influence of the Otter Creek). There is plenty of large woody debris recruitment in this reach due to the river undercutting trees as it migrates laterally. Although some areas are in need of a wider riparian buffer, habitat in this segment overall provides adequate depth cover and structure (although sediments are fairly well imbedded). It is certain that continued investment in channel management will be necessary in order to keep the channel in its relative location, however this area is highly dynamic and should be expected to always be undergoing extreme adjustment, especially during flood events as the river reacts to changes in sediment transport and hydrology in the watershed upstream. Due to this predictable change, it may be advisable to set land-use and channel location expectations so that a shifting stream is expected rather than resisted.

Figure 29. M01-A connects the Cold River with the Otter Creek and is an area of high natural adjustment.

5.0 BRIDGE AND CULVERT ASSESSMENT RESULTS

Bridge and culvert assessments were completed for all but one permanent structure located on the Phase 2 reaches (see Appendix C for complete results). The bridge not assessed was a small private footbridge on reach M10-F and was not assessed because permission from the landowner could not be confirmed. In total, fourteen structures were assessed according to VTANR protocols for characteristics such as specific height and width, geomorphic and fish passage data, nearby vegetation, and evidence of wildlife.

During the Phase 2 Assessment a number of channel and floodplain constricting bridge and culverts were observed to be considerably narrower than the existing bankfull width, subsequently causing instability in the river (Table 2). In particular need of replacement based on the problems observed and their percent bankfull width are the Old Plymouth Road Bridge (which has a failing retaining wall) and the Eastham and Northam Road culverts in Shrewsbury.

TABLE 2: COLD RIVER BRIDGES: PROBLEMS AND POTENTIAL FAILURE MODES

Reach	Road	Type	F1	F2	F3	F4	F5	F6	P1	P2	P3	P4	P5	P6	P7	Width
M10-E	OLD PLYMOUTH RD	Bridge	-	X	X	X	X	X	-	X	X	X	-	-	X	43 %
M10-E	EASTHAM RD	Culvert	-	X	X	X	X	X	X	-	X	-	-	-	X	36 %
M10-A	MT SCHOOL RD	Culvert	-	-	X	X	-	X	-	-	X	-	-	-	X	79 %
M10-A	NORTHAM RD	Culvert	-	X	X	X	X	X	X	-	-	X	X	-	X	43 %
M09-B	Private	Bridge	-	X	-	X	X	X	X	X	-	X	X	X	X	86 %
M09-A	Private-logging	Bridge	-	X	-	X	X	X	-	-	-	-	X	X	X	58 %
M08	COLD RIVER RD	Bridge	-	-	-	-	-	X	X	-	-	-	X	-	X	116 %
M07-C	WILMOUTH HILL RD	Bridge	-	-	-	-	-	-	-	-	-	-	-	-	X	122 %
M05	UPPER COLD RIVER RD	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	172 %
M02	COLD RIVER RD	Bridge	-	-	-	-	-	-	-	-	-	-	-	-	X	102 %
M01-C	Railroad	Bridge	-	-	X	-	-	-	X	X	X	-	X	-	X	196 %
M01-B	ROUTE 7	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	156 %
M01-B	MIDDLE RD	Bridge	X	-	-	-	-	X	X	-	-	-	-	-	X	131 %
M01-B	Railroad	Bridge	-	-	X	X	-	X	X	X	X	X	X	-	X	110 %

Failure Modes	
F1	Concern for structure due to fluvial condition or process
F2	Potential failure due to out-flanking
F3	Potential failure due to scour
F4	Potential failure due to ice or debris jam
F5	Structure related damage due to flooding of adjacent property
F6	Structure related damage due to erosion of adjacent property
Existing Problems	
P1	Upstream sediment deposit
P2	Upstream Scour and/or erosion present
P3	Downstream Scour and/or erosion present
P4	Inlet obstruction present
P5	Poor location or alignment
P6	Beaver activity
P7	Floodplain filled entirely or partially by roadway approaches
Width	Structure width divided by channel width as a percent (% bankfull width)

6.0 SUMMARY AND DISCUSSION

Understanding the response to changes in the sediment regime, hydrology, and channel of the Cold River is highly useful for informing restoration and planning efforts.

6.1 Watershed, Floodplain, and Channel Stressors

Natural and anthropogenic impacts may alter the equilibrium of sediment and flow in natural stream systems and set in motion a series of morphological responses (aggradation, degradation, and widening and/or planform adjustment) as the channel tries to reestablish a dynamic equilibrium. Small to moderate changes in slope, discharge, and/or sediment supply can alter the size of transported sediment as well as the geometry of the channel; while large changes can transform reach level channel types (Ryan 2001).

Between the 1700's and the 1800's, the building of roads and railroads within river floodplains, deforestation, and straightening and moving streams to accommodate agricultural fields and villages resulted in unstable river channels all across Vermont. Even in recent decades, large-scale channelization practices have been employed to reclaim damaged lands after large flood events. The 1970's and 1980's were also a period of extensive gravel mining in many Vermont streams. Other human-induced practices that have contributed to stream instability within the Cold River watershed include (also see Table 3):

- Forest clearing
- Channelization, dredging, berming and bank armoring
- Removal of woody riparian vegetation
- Floodplain encroachments
- Undersized bridges and culverts
- Loss of wetlands and floodwater storage

These anthropogenic practices have altered the balance between water and sediment discharges within the Cold River watershed. Channel morphologic responses to these practices contribute to channel adjustment that may further create unstable channels (Figure 30).

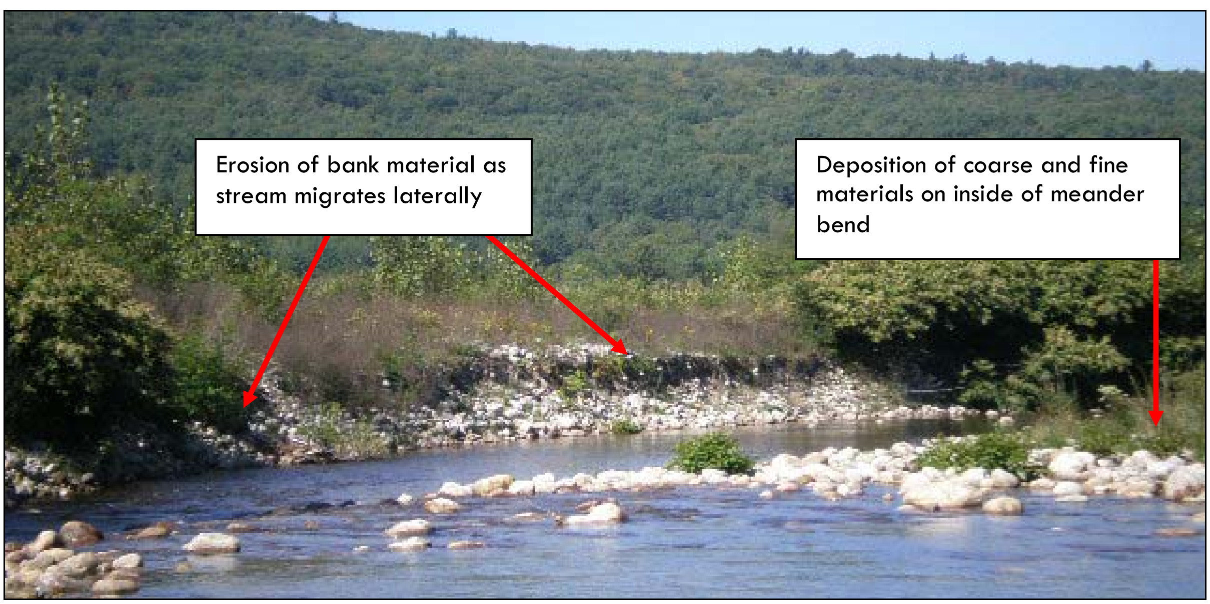

Figure 30: Planform migration associated with floodplain development in the Cold River.

Segment Number	Table 3: Watershed, Floodplain and Channel Stressors												
	Watershed Stressors			Floodplain and Channel Stressors									
	Deforestation in the 1800's	Increased Road Networks (1800-1900's)	Historic Flood Events	Channelization/Straightening	Dredging	Berming	Bank Armoring	Floodplain Development	Loss of Buffers	Impoundment (Historic)	Gravel Extraction	Undersized Bridge/Culvert	Stormwater Inputs
M10-F	↓	↓	↓										
M10-E	↓	↓	↓	√			√	√	√			√	√
M10-D	↓	↓	↓										
M10-C	↓	↓	↓				√						
M10-B	↓	↓	↓	√					√				
M10-A	↓	↓	↓	√			√	√				√	
M09-B	↓	↓	↓	√								√	
M09-A	↓	↓	↓									√	
M08	↓	↓	↓	√	√	√	√	√					√
M07-C	↓	↓	↓	√	√	√	√	√	√				
M07-B	↓	↓	↓	√	√	√	√	√					√
M07-A	↓	↓	↓	√	√	√	√	√	√				
M06	↓	↓	↓	√	√	√	√	√	√				√
M05	↓	↓	↓										
M04	↓	↓	↓										
M03	↓	↓	↓	√			√	√					√
M02	↓	↓	↓										
M01-C	↓	↓	↓	√									
M01-B	↓	↓	↓	√	√	√	√	√	√		√		
M01-A	↓	↓	↓	√	√	√			√		√		√

6.2 Channel Adjustment and Evolution

The stability of a stream channel is based on maintaining a certain flow of water, shape and slope of the channel, and sediment load. When any of these change significantly, the river channel must change, typically resulting in erosion of the stream bed or banks. A steep channel in a relatively flat valley may initiate a process of bed degradation or incision. Postflood channel straightening, gravel mining of point bars, and similar watershed and reach stressors have the effect of increasing stream channel gradients. Once a stream begins to incise, it will typically erode its way through an evolution process until it has created a new floodplain at a lower elevation in the landscape. The common stages of channel evolution, as shown below in Figure 31, include:

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

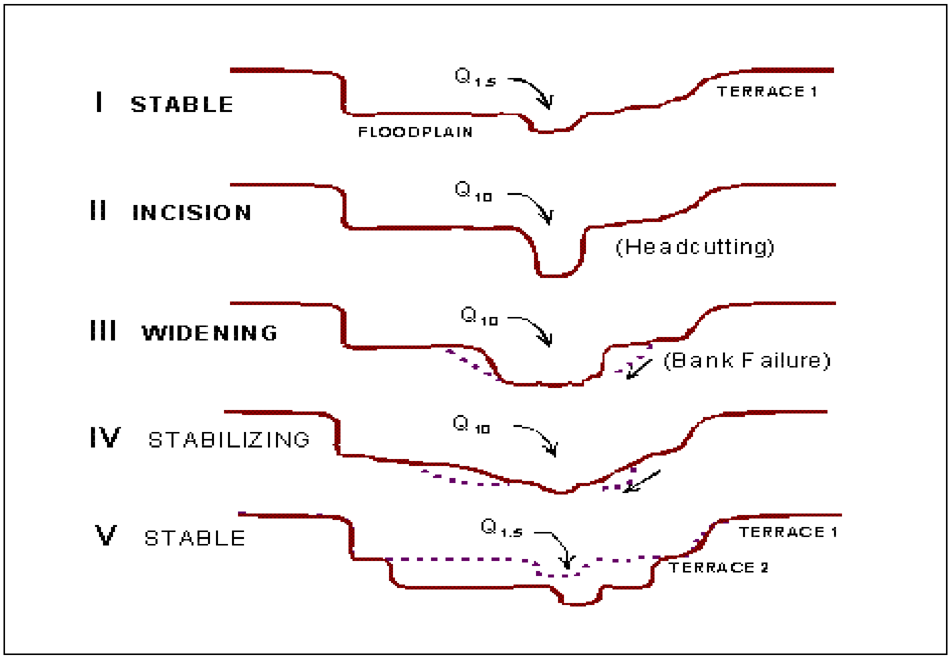

Figure 31. F-stage Channel Evolution Process (from Vermont Agency of Natural Resources, 2007b)

The bed erosion that occurs when a meandering river is straightened in its valley is a problem that extends to other sections of the stream. Incision points will travel upstream and into tributaries eroding sediments from otherwise stable streambeds. These bed sediments will move into and clog reaches downstream leading to lateral scour, widening and erosion of the streambanks. Channel evolution processes may take decades to play out. Even landowners that have maintained wooded areas along their stream and riverbanks may have experienced eroding banks as stream channel slopes adjust to match the valley slopes.

It is difficult for streams to attain a new equilibrium where the placement of roads and other infrastructure has resulted in little or no valley space for the stream to access or to create a floodplain as is the case with many of the Cold River's reaches. Landowners and government agencies have repeatedly armored and bermed reaches of Vermont's rivers to contain floodwaters in channels. These efforts have proven to be temporary fixes at best, and in some cases have lead to disastrous property losses and natural resource degradation.

A more effective solution for long term channel management is to limit encroachments within the riparian corridor and maintain a buffer of woody vegetation between the stream and adjacent land uses. Maintaining vegetated riparian corridors and offsetting development limits the conflict between property investments and the natural processes of flooding and channel migration that occurs gradually over time. Given room, a channel will adjust its shape and slope to changes in flow and sediment load. In general, the space provided by an established riparian corridor allows the river or stream system to be more resilient to watershed changes thereby protecting human interests, while at the same time having a beneficial impact on water quality and fisheries (Vermont Agency of Natural Resources 2007b).

The reach condition ratings of Cold River indicate that several of the reaches are actively, or have historically, undergone a process of minor or major geomorphic adjustment. The most common adjustment processes in the Cold River are widening and planform migration as a result of historic degradation within the channel. Several of the reaches studied in the Cold River watershed are undergoing a channel evolution process in response to large scale changes in its sediment, slope, and/or discharge associated with the human influences on the watershed. Table 4 below summarizes the channel evolution of each study reach and the primary adjustment processes that are occurring.

In terms of the ANR channel evolution model, the Cold River is predominately at stage III of the “F-stage” channel evolution model (Appendix B). In many reaches the channel has undergone historic degradation as evidenced by abandoned terraces, juvenile floodplain benches, and rejuvenating tributaries. Many of the cross sections on study reaches were found to be incised. The incision ratio ranged form 1.0 to 2.75. Along many of the main stem reaches and near the mouths of the tributaries, the system is actively adjusting to this lower bed elevation by moving laterally and widening in order to create a new floodplain at a lower elevation. This widening and planform adjustment is leading to another adjustment process, aggradation. Aggradation in the Cold River study area is likely a combination of endogenous sediment that is created as the stream widens and erodes its banks to in response to channel adjustments well as from exogenous sources such as gravel roads and land clearing.

Table 4. Stream Type, Active Adjustment Processes*, and Channel Evolution Stage							
Segment Number	**Incision Ratio**	**Entrench-ment Ratio**	**Width to Depth Ratio**	**Reference Stream Type**	**Existing Stream Type**	**Channel Evolution Stage**	**Major Adjustment Process**
M10-F	1.00	4.5	9.4	C4	C4	I	None
M10-E	2.56	1.8	9.3	C4	B4	II	None
M10-D	Not Assessed: Bedrock controlled gorge.						
M10-C	1.00	4.5	9.4	C4	C4	I	None
M10-B	Not Assessed: On-stream Pond (Impounded)						
M10-A	2.75	1.8	10.5	C4	B4	III	None
M09-B	1.00	36.0	13.2	C4	C4	I	**Aggradation**
M09-A	Not Assessed: Wetland System						
M08	1.62	3.7	20.0	C3b	C3b	III	None
M07-C	2.58	1.3	22.5	C4	F3	II	None
M07-B	1.36	3.5	29.6	C4	C4	III	None
M07-A	1.68	1.2	23.1	C4	F4	II	**Widening**
M06	1.59	32.8	31.1	C3	C3	III	**Widening Planform**
M05	2.55	1.2	29.3	B3	F3b	III	**Widening**
M04	1.72	1.7	31.3	B3	B3	III	**Widening**
M03	2.06	9.2	38.9	C3b	B3	III	**Widening Planform**
M02	Not Assessed: Bedrock Controlled Gorge						
M01-C	2.06	1.4	29.0	B3	B3	II	None
M01-B	1.15	12.0	32.7	C4	C3	II	**Aggradation Widening Planform**
M01-A	1.38	21.8	19.4	C4	C4	IV	**Planform**

Bold Black lettering – denotes major adjustment process

*NOTE: All assessed reaches except M10-F, M10-C, M09-B, M08, M07-B, and M01-A had major or extreme historic degradation

6.3 Constraints to Sediment Transport and Attenuation

Successful river corridor restoration and protection projects require an understanding of where in the channel evolution process a stream reach is and how rapidly one might expect the channel to evolve back to equilibrium conditions. Since channel conditions both upstream and downstream (degradation downstream can progress upstream at a "nickpoint") may affect a given reach, it is important to keep in mind that this analysis should not be isolated to the project reach. An analysis of stream type departure and sensitivity must be conducted over larger reach and watershed scales. Whether a project works with or against the physical processes at play in a watershed is primarily determined by examining the source, volumes, and attenuation of flood flows and sediment loads from one reach to the next within the stream network. If increasing loads are transported through the network to the sensitive reach, where conflicts with human investments are creating a management expectation, little success can be expected unless the restoration design accommodates the increased load or finds a way to attenuate the loads upstream (Vermont Agency of Natural Resources 2007a).

Within a reach, the principals of stream equilibrium dictate that stream power and sediment will tend to distribute evenly over time. Changes or modifications to watershed inputs and the stream channel may create disequilibrium and lead to an uneven distribution of power and sediment. Large channel adjustments observed as dramatic erosion and deposition may be the result of this uneven distribution and may continue until equilibrium is achieved. Figures 32 and 33 have been provided to assist in understanding where sediment transport areas have been increased and attenuation areas have been lost in the Cold River watershed. These maps may be useful in preliminary project identification because specific strategies may be devised to deal with stressors which have been targeted as contributing to the departure. Figure 32 indicates that nearly the entire main stem of the Cold River had the capacity to store fine sediments in the floodplain and to transport the normal balance of gravels, cobbles, and the occasional boulder downstream at a rate that was in balance with the inputs coming from the highest sources in the watershed thus leading to long term stability. Analysis of Figure 33, the current sediment regime map, indicates that numerous reaches in the upper Cold River watershed have become sources of both fine and course materials. In areas where course deposition is occurring in the upper watershed this deposition may be at occurring at a high rate (leading to numerous mid channel bars and channel migration and conversely the human response which has been the dredging of this accumulating material) such as in reach M06.

The excessive degree of departure in the upper watershed presents two situations downstream. First, the downstream reaches may be moving towards excessive aggradation of material (such as in reach M01-B) and therefore a high degree of lateral channel adjustment and bar building. Second, the storage capacity of these downstream reaches would be a key asset to the receiving watershed, the Otter Creek (and eventually Lake Champlain) if they were functioning to attenuate sediment. Finally, analysis of these maps reveals that restoration of attenuation capacity in the upper reaches of the watershed, especially in areas where development is not confining the channel, may help reduce fluvial erosion hazard pressure in areas where houses and roads encroach on the stream corridor.

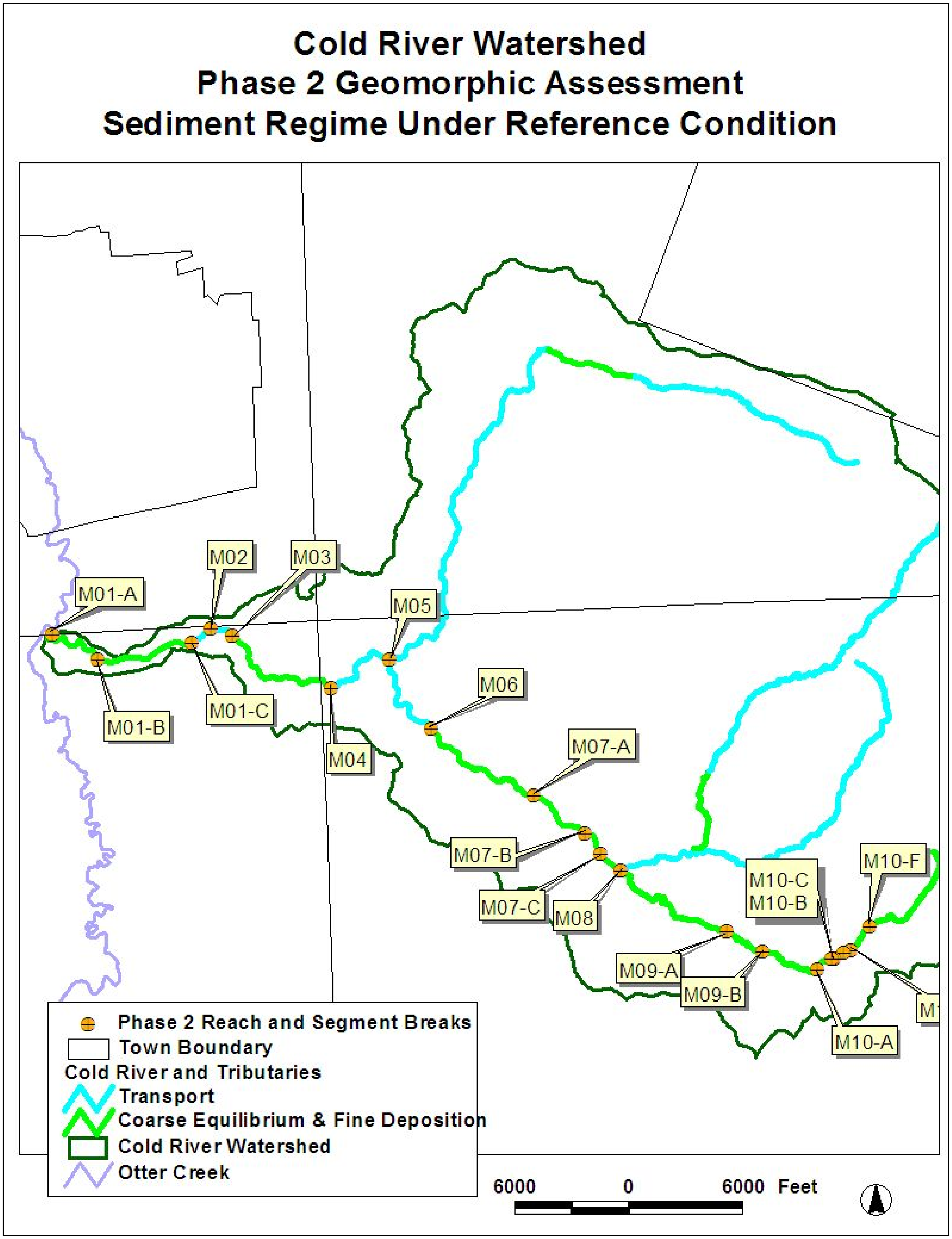

Figure 32. Sediment Transport and Attenuation under reference conditions.

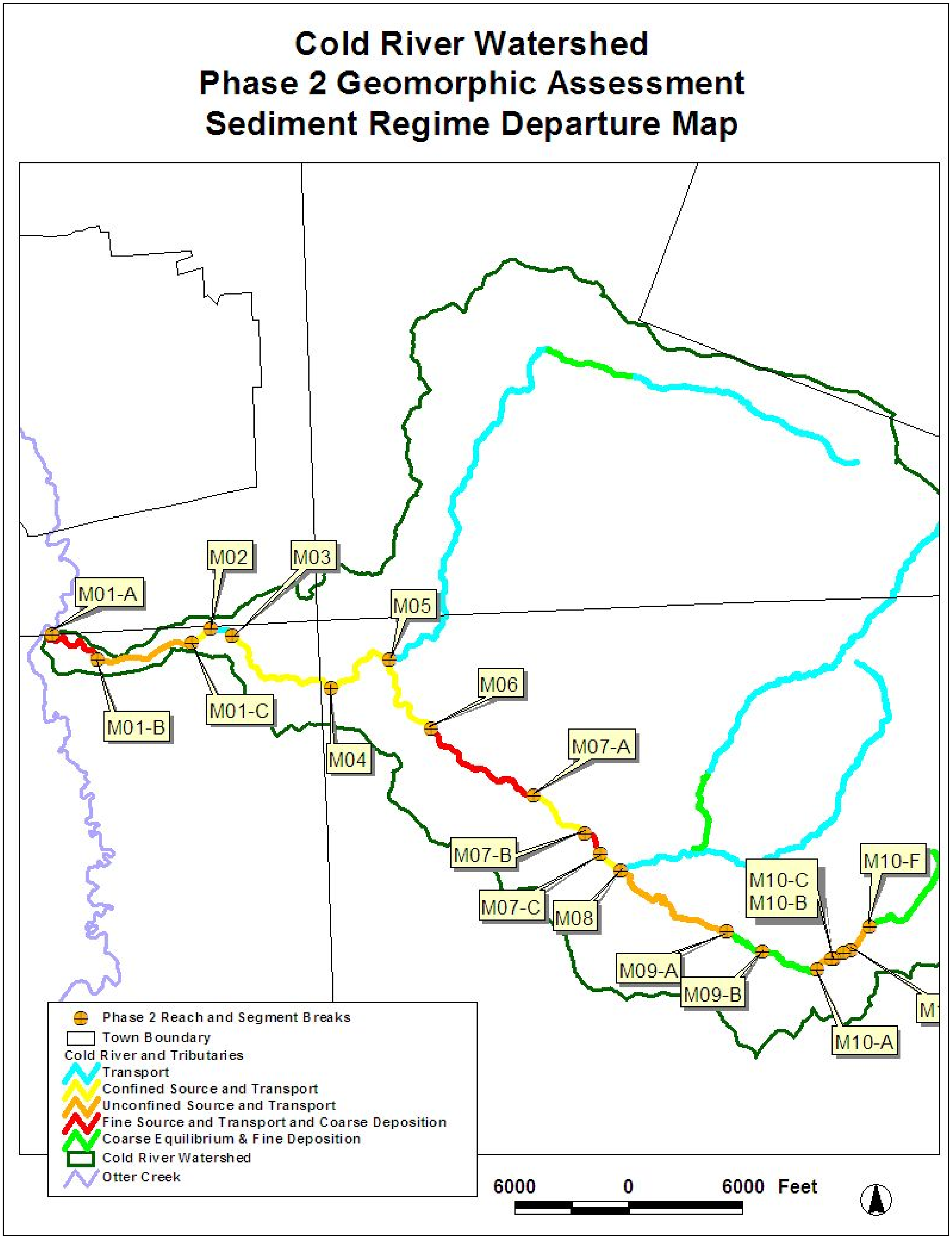

Figure 33. Sediment Transport and Attenuation, Existing Cold River conditions.

6.4 Stream Sensitivity

Sensitivity refers to the likelihood that a stream will respond to a watershed level or reach level stress, such as; floodplain encroachment, channel straightening, berming, armoring, changes in sediment or flow inputs, and/or disturbance of riparian vegetation. A stream's inherent sensitivity is based on a host of factors including the relative magnitude of channel adjustments occurring together with the topographic, geologic, and vegetative context that the surrounds the reach. The sensitivity of a given reach may be heightened when human activities alter the setting characteristics that influence a stream's natural adjustment rate including: boundary conditions; sediment and flow regimes; and the degree of confinement within the valley. Streams that are currently in adjustment, especially those undergoing degradation or aggradation, may become acutely sensitive (Vermont Agency of Natural Resources 2007b).

Generally speaking, channels with steeper gradients in confined valleys with coarse sediments (boulders, cobbles) and ample vertical grade controls (e.g., channel spanning bedrock) are considered less likely to undergo large scale vertical and lateral shifts in response to watershed and corridor stressors (such as reach M10-D and M02). In contrast, more sensitive reaches (high, very high, and extreme), are considered susceptible to future adjustment and are typically channels with a low to moderate gradient (less than 2% slope) dominated by gravel and sand substrates lacking in vertical grade controls (as with many of the Cold River reaches).

Figure 34 is a map presenting the existing stream types found in the Cold River watershed. Most of the reaches are Rosgen (1996) "C" channels by reference. C channels have wide valleys and moderate to gentle gradients. B channels have moderate to steep slopes and have narrower valleys than C channels. The stream sensitivity of these reaches, generalized according to ANR protocol, is depicted in Table 5 and in Figure 35. For the most part the Phase 2 purposefully studied reaches that would be expected to exhibit a higher sensitivity and be undergoing active adjustments. It is not surprising therefore that all of the study area reaches were defined as having high, very high, or extreme sensitivity. The exception being the bedrock controlled reaches M10-D and M02 which have a greater resistance to rapid adjustment due to the underlying bedrock and lateral constraints.

Table 5. Stream Sensitivity for Phase 2 Reaches					
Segment Number	**Reference Stream Type**	**Existing Stream Type**	**Stream Type Departure**	**Geomorphic Condition**	**Sensitivity**
M10-F	C4	C4	None	Good	High
M10-E	C4	B4	C to B	Fair	High
M10-D*	B1	B1	None	Good	Low*
M10-C	C4	C4	None	Good	High
M10-B*	C4	C4	None	Good	High*
M10-A	C4	B4	C to B	Fair	High
M09-B	C4	C4	None	Fair	**Very High**
M09-A*	E4	E4	None	Good	High*
M08	C3b	C3b	None	Fair	High
M07-C	C4	F3	C to F	Fair	**Extreme**
M07-B	C4	C4	None	Fair	**Very High**
M07-A	C4	F4	C to F	Fair	**Extreme**
M06	C3	C3	None	Fair	High
M05	B3	F3b	B to F	Fair	**Extreme**
M04	B3	B3	None	Fair	High
M03	C3b	B3	C to B	Fair	High
M02*	B1	B1	None	Good	Low*
M01-C	B3	B3	None	Fair	High
M01-B	C4	C3	None	Fair	**Very High**
M01-A	C4	C4	None	Fair	**Very High**
*Partial Assessment – Administrative judgment made regarding geomorphic condition and sensitivity					

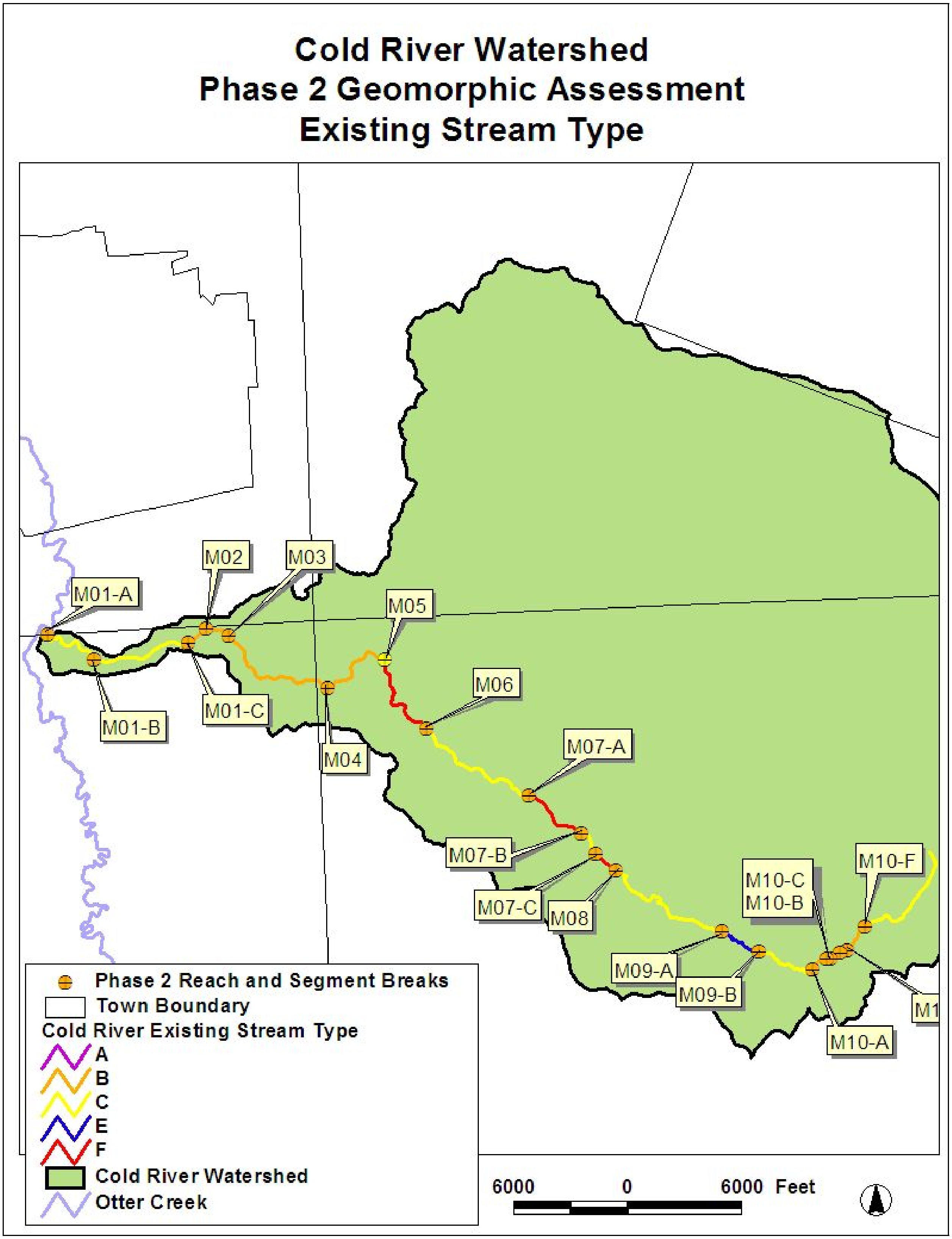

Figure 34. Phase 2 Existing Stream Types

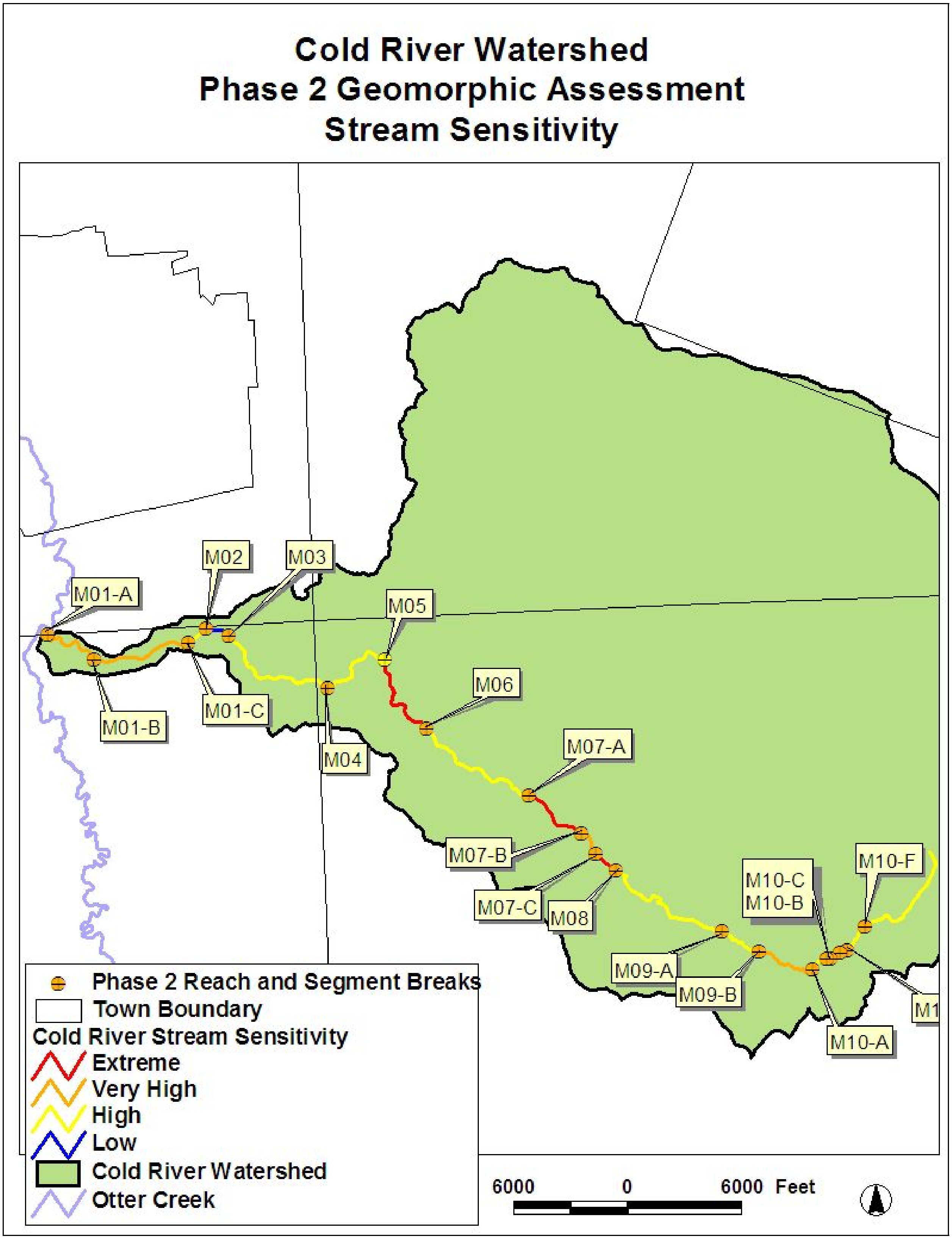

Figure 35: Phase 2 Stream Sensitivity Map

7.0 HABITAT EVALUATION

A comparison of the habitat condition based on the RHA and the geomorphic condition based on the RGA can be found in Appendix A. For nine of the sixteen assessed segments, both the RHA and the RGA resulted in a fair rating. Five segments had a rating of good for habitat, but a rating of fair for geomorphic condition. Only reaches M10-F and M10-C resulted in a rating of good for both geomorphic and habitat condition. In-stream cover within many of the upstream reaches included large boulders, tree roots and depth cover in pools, many of which were well shaded by a healthy riparian corridor. Many of the reaches that had been straightened or had floodplain alterations lacked a strong riffle-pool bedform and the diversity of habitat features that this brings. Many reaches had major intrusion into their river corridor from roads and many had inadequate riparian buffers due to historic and /or recent land clearing. Overall, the RHA score was similar to the RGA score, implying that the ecological health of the Cold River is closely related to the geomorphic condition of the stream.

8.0 PRELIMINARY PROJECT IDENTIFICATION

Future management strategies should take into account geomorphic data for the Cold River. For a given reach or segment, identifying the active channel stressors, adjustment processes, degree of departure from reference stream type, and sensitivity will inform the short-term compatibility and long-term sustainability of various restoration or conservation options and future land use or channel management activities.

The preliminary identification and prioritization of corridor restoration and protection projects and practices outlined below has been informed by:

- Field observations (summarized for each reach in Sections 4.1 through 4.10)
- Field and remotely sensed (Phase 1) observations of channel and floodplain stressors (Section 6.1)
- Analysis of stream type, adjustment processes, departure, and channel evolution sequence (Section 6.2)
- Stream sensitivity data (Section 6.3)

This provisional listing of potential projects in the Cold River watershed follows the outline of management actions identified in the "*River Corridor Planning Guide to Identify and Develop River Corridor Protection and Restoration Projects*" (Vermont Agency of Natural Resources 2007a). According to the VTANR document all projects may be classified under one of three broad management approaches that are meant to best expend community resources based on the current conditions, limitations, and opportunities of a given project area:

Active Geomorphic: This approach seeks to restore or manage rivers to a geomorphic state of dynamic equilibrium through an active approach that may include the removal or reduction of human-placed constraints or the construction of meanders, floodplains, and bank stabilization techniques. Active riparian buffer revegetation and long-term protection of a river corridor is essential to this alternative. This approach typically costs the most and has the highest potential for failure.

Passive Geomorphic: This approach allow rivers to return to a state of dynamic equilibrium through a passive approach that typically involves the removal of constraints from a river corridor thereby allowing the river, utilizing its own energy and watershed inputs to re-establish its meanders, floodplains, and self maintaining equilibrium condition over an extended time period. Active riparian buffer revegetation and long-term protection of a river corridor is essential to this alternative. This approach typically costs the least, however may take the longest to see realized results.

Active-Passive Combination: This approach uses a sequenced combination of active and passive approaches to accommodate the varying constraints that typically occur along a project reach.

Sections 8.1 through 8.6 of this document are intended to form the basis for future project development and implementation efforts in the context of watershed, community, and corridor planning projects. This information has not included public outreach or technical, financial, and social feasibility studies. Nor has this information taken into account the community priorities and landowner commitment for restoration work which may also be an important factor in determining priorities and project identification.

A few of these projects (e.g., buffer plantings) can be considered for immediate implementation, independent of other watershed projects, and will require only minimal feasibility analysis and project development activities. Other identified projects may require further evaluation (e.g., Phase 3 Geomorphic study) and efforts to conduct alternatives analyses, conduct landowner outreach and negotiations, and identify potential stakeholders and funding sources.

8.1 Protecting River Corridors

Protection of river corridors is an essential element to all passive and active geomorphic restoration and conservation projects. An overriding objective of river corridor protection is to reduce the need for maintenance of traditional channel management applications (i.e. berming, straightening, riprapping, etc.) and shift the focus of management projects from short term control to long term equilibrium and stability. River corridor protection is a very worthwhile initiative because it can support multiple objectives for the Cold River community including:

- *Returning the Cold River to a state of "Dynamic Equilibrium"* – Corridor protection would help preserve (or support a return to) reference sinuosity, slope, and channel dimensions. It would also help the community refrain from future detrimental channel management activities, such as channelization, dredging, berming, armoring.
- *Reestablishing Floodplain Access* – Corridor protection would help preserve or restore the river's access to its surrounding floodplain in bankfull and higher flow events in order to improve sediment attenuation (the storage of sediments within the channel margins, floodplain, and channel-contiguous wetlands) and flood water attenuation (detainment of flood flows through overbank flooding, increased channel length (sinuosity), increased channel roughness (e.g., buffers), and inundation of channel-contiguous wetlands).
- *Preventing Future Conflict* – Corridor protection would help the community refrain from placing further developments and infrastructure in the Cold River corridor to minimize

future restrictions and fluvial erosion losses including the possibility of major property loss and at worst the loss of life.

River corridor protection is generally thought of as a passive geomorphic approach. The river channel is allowed to freely meander within an area determined through the scientific guidelines of fluvial geomorphology. For a reach that is already close to reference condition or exhibiting only minor adjustments, preserving a river corridor will ensure the river's ability to continue to meander through the valley unconstrained by human infrastructure. In turn, human investments in the landscape will be protected from future channel adjustments. For a reach that has seen significant channel management in the past, and has lost some floodplain connection and some measure of its sinuosity (as with many of the Cold River's reaches), the channel is allowed to adjust unimpeded to a more sinuous, meandering planform determined by the nature of the river. Through minor and major adjustments, the river will eventually reestablish greater floodplain access (where access has been lost) and readjust channel dimensions for optimum transport and storage of its water and sediment loads.
Where active geomorphic restoration approaches are deemed necessary, river corridor protection will help to prevent future channel management that might unravel constructed features of a recently restored reach.

Lower priority reaches for river corridor protection include "wooded corridors experiencing very little threat from encroachment and less sensitive reaches not playing a significant flow or sediment load attenuation role in the watershed (Vermont Agency of Natural Resources 2007a)". Of the Cold River reaches assessed, this would include the three bedrock gorge reaches (M04, M03-B, and M02) which were assigned a "very low" sensitivity due to the stable nature of their channels.

In determining where to start, the highest priority reaches for river corridor protection are "highly sensitive reaches critical for flow and sediment attenuation from upstream sources or sensitive reaches where there is a major departure from equilibrium conditions and threats from encroachment (Vermont Agency of Natural Resources 2007a)". River corridor protection may be accomplished through informal landowner agreements, limited or long term easements, and/or fluvial erosion hazard zoning which takes into account geomorphic channel adjustments and seeks to assist the community in preventing future conflicts. Table 6 provides direction on where to start for prioritizing river corridor protection projects.

Table 6: High Priority River Corridor Protection Reaches		
Description	Reach	Town
Protection Upstream of Constrained / Altered Reaches Reduction of streambank erosion, improved floodplain access and enhanced sediment and flow attenuation in these reaches upstream will reduce sediment production and delivery in the long-term to downstream segments which are constrained by the topographic setting and floodplain encroachments and are unable to adjust their dimensions, planform, and profile in response to excess sediment and water loads delivered from upstream. At present, land uses contiguous to many of these locations do not appear to be in conflict with channel adjustment processes. These sites are high-priority candidates for outreach and eventual conservation with the willingness of landowners.	M10-F M09-B M09-A M08 M05 M04	Shrewsbury Shrewsbury Shrewsbury Shrewsbury Shrewsbury Shrewsbury
Reduction of Fluvial Erosion Hazards Corridor protection in all reaches, enabled by FEH mapping and zoning, can:		
(a) Inform residents of FEH hazards in already densely populated areas	M10-E M07-C M07-A M06 M03 M01-B	Shrewsbury Shrewsbury Shrewsbury Shrewsbury Shrewsbury Clarendon
(b) reduce future fluvial erosion hazards along highly "sensitive **reaches where there is a major departure from equilibrium** conditions and threats from encroachment" (VTANR, 2007a)	M07 (all) M06	Shrewsbury Shrewsbury
(c) reduce future fluvial erosion hazards along reaches at **alluvial fans or points of marked valley slope reduction** that contributes to increased sediment aggradation and planform adjustment. Carefully manage land use changes in the upstream watershed to reduce the potential for increases in sediment or flows that may induce channel adjustments in the subject reach/segment.	M01-B M01-A	Clarendon Clarendon

8.2 Planting Stream Buffers

The reference stream type for much of the main stem of the Cold River is "C". These slightly entrenched, meandering channels are highly dependent upon vegetation for stability. For this reason, the establishment and protection of vegetated buffers should be high priority in restoration planning and design work. Riparian buffers provide many benefits. Some of these benefits are protecting and enhancing water quality, providing fish and wildlife habitat, providing streamside shading, and providing root structure to prevent bank erosion. In fact, from a water quality and habitat standpoint it is important to establish a buffer of vegetation on all river borders.

The column heading "Loss of Forested Buffers" in Table 3 (Section 6.1) is a good first pass at identifying the Cold River reaches which would benefit most from buffer plantings. As a stand alone restoration option highest priority should be given to highly sensitivity reaches that are vertically stable (see Table 5). Due to the extreme lateral adjustments that may be occurring in unstable reaches, tree plantings may be quickly washed out if they are planted along the top of an eroding bank. For these reaches long-term restoration would be better served by planting trees away from the top of the streambank focusing more on reestablishment of a belt-width forest so that long-term channel adjustment is met by trees that have had at least several years to establish. Table 7 below provides a good first focus of where to prioritize buffer restoration projects.

Table 7: High Priority Buffer Restoration Reaches		
Description	Reach	Town
Reestablishment of Riparian Buffers. Restore and maintain dynamic equilibrium of the channel by increasing resistance to boundary shear stresses along the channel margins where wooded buffers have been removed.	M10-E M07-C M07-A M06 M01-B M01-A	Shrewsbury Shrewsbury Shrewsbury Shrewsbury Clarendon Clarendon

8.3 Stabilizing Stream Banks

Physical efforts to stabilize streambanks may be considered in "laterally-unstable, [but vertically stable] reaches where human-placed structures are at high risk and not taking action may result in increased risk of erosion, to not only the structure, but lands that would provide the opportunity to establish a buffer (Vermont Agency of Natural Resources 2007a)". Also in reaches upstream of sensitive reaches where bank stabilization efforts may allow for the reestablishment of riparian vegetation. As with most techniques, bank stabilization projects should be considered in the broader context (both in time and space) for the channel adjustment processes such management will set in motion and for the consequences to upstream and downstream reaches.

As described in Table 8, at the writing of this report no eroding banks were determined to be detrimental to sensitive reaches downstream where excess sediment would destabilize a channel. Several reaches had erosion near structures (listed in the table below). Public meetings may yield observations/concerns that would identify priority projects.

Table 8: Potential Streambank Stabilization Sites		
Description	Reach	Town
Stabilization of streambanks in these reaches may be appropriate to protect structures, although such stabilization may lead to further instability in the system and is subject to failure due to the high instability of the reaches. Public meetings may yield observations/concerns from landowners that were not observed in the field for one reason or another.	M07-A M06	Shrewsbury Shrewsbury

8.4 Removing Berms / Other Constraints to Flood & Sediment Load Attenuation

Removing berms or other constraints (such as roads) to the lateral migration of streams and floodplain connection of a river channel may accelerate a return to dynamic stability in the channel, and reduce impacts to downstream segments, by creating more opportunities for sediment and flow attenuation. Priority for berm removal, listed in Table 9, should go to reaches where a significant (>50%) portion of the river (belt width) corridor would become accessible to the stream if the berm were to be removed or where the berm is the predominate reason why the reach is incised and therefore not accessing its floodplain regularly.

Table 9: High Priority Potential Berm Removal Sites		
Description	Reach	Town
Restore Floodplain Access and Remove Constraints for Increased Flow and Sediment Load Attenuation		
Evaluate the feasibility of lowering elevation of near-bank areas where berms/roads constrain the channel and limit floodplain access. These activities should be accompanied by corridor protection (see Section 8.1)	M07-C M07-B M07-A M06 M01-B M01-A	Shrewsbury Shrewsbury Shrewsbury Shrewsbury Clarendon Clarendon

8.5 Removing / Replacing Structures

Buildings, road crossings, and dams are examples of structures that may limit the vertical and lateral movement of the channel and/or result in a significant constriction of the floodplain causing localized and systemic instability. Removing such structures may be an important and highly effective way to restore dynamic equilibrium to a reach or section of river. Several problem bridge and culvert crossings were encountered during the Bridge and Culvert Assessment. Their status as either a bankfull or flood-prone-width constrictor is addressed in section 5.0. This data may be utilized by the town road crews and regional planning commissions when establishing schedules and budgets for crossing rehabilitation and replacement.

In general, the geomorphic context of the streams that are being crossed should be considered when replacing or installing new structures. New or replacement bridges and culverts should ideally have openings which pass at least the bankfull width and better the floodprone-width without constriction. They should be perpendicular to the channel and should take into account the historic and predicted lateral movement of the stream. Efforts to keep a natural channel bottom and minimize hard armoring of streambanks may help to reduce scour downstream and benefit aquatic and terrestrial organism passage.

8.6 Restoring Incised Reaches

As noted in previous sections, the majority of the reaches assessed in the Cold River are incised. Further study could evaluate the feasibility of various active geomorphic and engineering techniques to restore some of these incised reaches. Restoration would attempt to accelerate a return to dynamic equilibrium of the channel, and reduce impacts to downstream segments, by creating more opportunities for sediment and flow attenuation within floodplain.

For any of the potential project reaches, listed in Table 10 below, a more detailed geomorphic assessment (Phase 3) and an alternatives analysis would be required to evaluate the long-term feasibility of controlling the stressors that resulted in the incision. The study would also want to examine the feasibility or restoring full channel equilibrium including slope and profile, removing corridor constraints, and long-term landowner commitment.

Table 10: Potential Restoration of Incised Reaches

Description	Reach	Town
Restore Floodplain Access to Improve Flow and Sediment Load Attenuation and *take pressure off downstream reaches* (with the intention to reduce fluvial erosion hazard and restore dynamic equilibrium).		
Evaluate the feasibility of lowering elevation of near-bank areas that constrain the channel and limit floodplain access. These activities should be accompanied by corridor protection (see Section 8.1)	M10-E M10-A M07-C M07-A M06 M03 M01-B	Shrewsbury Shrewsbury Shrewsbury Shrewsbury Shrewsbury Shrewsbury Clarendon

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APPENDIX A
STANDARD PHASE 2 DMS REPORTS

Phase 2 Segment Summary

January 16, 2008 SGAT Version: 4.56

Project: **Otter Creek - Cold River**
Stream: **Cold River** Reach # **M01** Segment: **A** Completion Date: **September 17, 2007**
Organization: **Rutland RPC** Observers: **Michael Blazewicz, Shannon** Why Not assessed: Rain: **No**
Segment Length (ft): **4,171** Segment Location: **Begins downstream of the railroad bridge downstream of Middle Road and runs to the**

QC Status - Staff: **Provisional Cons**

Step 1. Valley and Floodplain

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

Length (ft)	One	Both
Berms	**357**	**0**
height	**9**	**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**	**Flat**
Continuous w/	**Never**	**Sometimes**
W/in 1 Bankfill	**Never**	**Sometimes**
Texture	**Sand**	**Sand**

1.5 Valley Features
Valley Width (ft) **1,098**
Width Determination **Estimated**
Confinement Type **Very Broad**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **64**
2.2 Max Depth (ft) **5.00**
2.3 Mean Depth (ft) **3.30**
2.4 Floodprone Width (ft) **1,400**

Notes:
Segment runs through agricultural land currently farmed by Jesse Billings. Banks turn into silt/clay near confluence with Otter Creek and bank height as well is may be influenced by bankfull height of Otter Creek at downstream end. High degree of bank

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln **6.90** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **19.39**
2.7 Entrenchment Ratio **21.88**
2.8 Incision Ratio **1.38**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Moderate**
2.10 Riffles Type **Complete**
2.11 Riffle/Step Spacing (ft) **300**
2.12 Substrate Composition

Bedrock	**0**%
Boulder	**0**%
Cobble	**4**%
Coarse Gravel	**37**%
Fine Gravel	**31**%
Sand	**23**%
Silt and smaller	**5**%

Silt/Clay Present? **Yes**
Detritus **2** %
Large Woody **50**

2.13 Average Largest Particle on
Bed **100.0** **mm**
Bar **40.0** **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)

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	**Cohesive**	**Cohesive**
Lower		
Material Type	**Silt**	**Silt**
Consistency	**Cohesive**	**Cohesive**
Bank Erosion	Left	Right
Erosion Length (ft)	**2,501**	**1,668**
Erosion Height (ft)	**7.00**	**7.25**
Revetmt. Type	**None**	**None**
Revetmt. Length (ft)	**0**	**0**
Near Bank Veg. Type	Left	Right
Dominant	**Deciduous**	**Deciduous**
Sub-dominant	**Pasture**	**Pasture**
Bank Canopy	Left	Right
Canopy %	**26-50**	**26-50**
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	**1,950**	**1,018**
Buffer Veg. Type	Left	Right
Dominant	**Deciduous**	**Deciduous**
Sub-dominant	**Herbaceous**	**Herbaceous**

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **Minimal**
4.3 Flow Status **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 **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	**0**	**0**	**3**

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 **With Windrowing**
Straightening Length: **39**
5.5 Dredging **Dredging**

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

Project: **Otter Creek - Cold River** **Phase 2 Reach Summary** January 16, 2008

Stream: **Cold River** Reach # **M01** Segment: **A** Completion Date: **September 17,**

Organization: **Rutland RPC** Observers: **Michael Blazewicz, Shannon Pytlik** Rain: **No**

Segment Length (ft): **4,171** Segment Location: **Begins downstream of the railroad bridge downstream of Middle Road and runs to the**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**6**		**No**
Total Score	**44**		
Geomorphic Rating	**0.55**		

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**6**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**8**
6.6 Channel Alteration	**8**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 4 Right: 4**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 4 Right: 5**
Total Score	**95**
Habitat Rating	**0.475**

Habitat Stream Condition **Fair**

Narrative:

Major planform adjustment as a result of historic channel management and incision likely in both the Cold River and Otter Creek. Aggradation is also a result of instability as a result of its location at the end of a long stretch of transport reach

Phase 2 Segment Summary

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M01**
Segment: **B**
Completion Date: **September 18, 2007**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz, Shannon**
Why Not assessed:
Rain: **No**
Segment Length (ft): **5,400**
Segment Location: **Runs from the railroad bridge upstream of the Route 7 bridge, downstream past route 7 and**

QC Status - Staff: **Provisional Cons**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**
1.2 Alluvial Fan **Yes**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	**2,550**	**1,476**
height	**9**	**8**
Roads	**1,001**	**0**
height	**9**	**0**
Railroads	**0**	**0**
height	**0**	**0**
Improved Paths	**0**	**0**
height	**0**	**0**
Development	**868**	**1,931**

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

1.5 Valley Features
Valley Width (ft) **1,098**
Width Determination **Estimated**
Confinement Type **Very Broad**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **84**
2.2 Max Depth (ft) **3.30**
2.3 Mean Depth (ft) **2.55**
2.4 Floodprone Width (ft) **1,005**

Notes:
Segment has seen extensive channel straightening, dredging and windrowing. Several channel constricting structures will likley need ongoing maintenance, or see high degrees of instability upstream and downstream. Located at a major break in

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln **3.80** ft.
Human Elev Floodpln **5.30** ft.
2.6 Width/Depth Ratio **32.75**
2.7 Entrenchment Ratio **12.04**
2.8 Incision Ratio **1.15**
Human Elevated Inc Rat **1.61**
2.9 Sinuosity **Low**
2.10 Riffles Type **Eroded**
2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	**0**%
Boulder	**7**%
Cobble	**42**%
Coarse Gravel	**35**%
Fine Gravel	**15**%
Sand	**0**%
Silt and smaller	**1**%

Silt/Clay Present? **No**
Detritus **1** %
Large Woody **3**

2.13 Average Largest Particle on

Bed	**22.0**	**inches**
Bar	**12.0**	**inches**

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	**None**	**0.00**

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

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

Bank Erosion	Left	Right
Erosion Length (ft)	**177**	**387**
Erosion Height (ft)	**6.00**	**5.33**
Revetmt. Type	**Multiple**	**Rip-Rap**
Revetmt. Length (ft)	**1,012**	**448**

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

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	**0-25**	**0-25**
W less than 25	**1,259**	**749**

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

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

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

4.7 StormwaterInputs

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
4	**0**	**5**
Diagonal	Delta	Island
1	**0**	**1**

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	**0**	**0**	**0**

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	**0**	**No**

5.4 Stream Ford or Animal **No**
5.5 Straightening **With Windrowing**
Straightening Length: **5,098**
5.5 Dredging **Commercial Mining, Dredging**

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

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M01**
Segment: **B**
Completion Date: **September 18,**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz, Shannon Pytik**
Rain: **No**
Segment Length (ft): **5,400**
Segment Location: **Runs from the railroad bridge upstream of the Route 7 bridge, downstream past route**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**70.0**	**Yes**	**Yes**	**No**	**Yes**
Problem	**Deposition Above,Deposition Below**				
Bridge	**84.0**	**Yes**	**Yes**	**No**	**Yes**
Problem	**Deposition Above,Deposition Below**				
Bridge	**100.**	**Yes**	**Yes**	**No**	**Yes**
Problem	**Deposition Above,Deposition Below**				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**9**	**None**	**Yes**
7.2 Channel Aggradation	**7**	**None**	**No**
7.3 Widening Channel	**8**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**32**		
Geomorphic Rating	**0.4**		

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	**8**
6.2 Embeddedness	**11**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**8**
6.6 Channel Alteration	**3**
6.7 Frequency of Riffles/Steps	**8**
6.8 Bank Stability	**Left: 9 Right: 8**
6.9 Bank Vegetation Protection	**Left: 2 Right: 2**
6.10 Riparian Vegetation Zone Width	**Left: 3 Right: 3**
Total Score	**81**
Habitat Rating	**0.405**

Habitat Stream Condition **Fair**

Narrative:

Extensive channel straightening and berming has led to high incision. Degradation may be being offset due to aggradation. Widening and planform are major adjustment processes although limited by windrowing that has hardened the banks.

Project: **Otter Creek - Cold River** | # Phase 2 Segment Summary | page 1 of 2 | January 16, 2008 SGAT Version: 4.56

Stream: **Cold River** | Reach # **M01** | Segment: **C** | Completion Date: **September 18, 2007**

Organization: **Rutland RPC** | Observers: **Michael Blazewicz, Sarah Lade** | Why Not assessed: | Rain: **No**

Segment Length (ft): **1,200** | Segment Location: **Begins at the end of a gorge near where industrial activities occur along the banks of 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	748	36

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

1.5 Valley Features

Valley Width (ft) **200**

Width Determination **Measured**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **76**

2.2 Max Depth (ft) **3.50**

2.3 Mean Depth (ft) **2.62**

2.4 Floodprone Width (ft) **106**

Notes:

Connecting a gorge to the valley bottom of the Otter Creek, this short segment has a naturally high slope and would be a B type plane bed segment by reference. An industrial water diversion exists at the top of this segment.

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln **7.20** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **29.01**

2.7 Entrenchment Ratio **1.40**

2.8 Incision Ratio **2.06**

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	30%
Cobble	32%
Coarse Gravel	20%
Fine Gravel	15%
Sand	3%
Silt and smaller	0%

Silt/Clay Present? **No**

Detritus **1** %

Large Woody **3**

2.13 Average Largest Particle on

Bed	36.0	inches
Bar	N/A	inches

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)

B **3** **Non Plane Bed**

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	189	214
Erosion Height (ft)	10.00	7.00
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	51-75
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	None	>100
W less than 25	0	81
Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Coniferous	Coniferous

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **Small Bypass**

Flow Regulation Use **Other**

Impoundments **Small**

Impoundmt. Location **In Reach**

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

(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

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

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **1,082**

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.

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M01**
Segment: **C**
Completion Date: **September 18,**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz, Sarah Lade**
Rain: **No**
Segment Length (ft): **1,200**
Segment Location: **Begins at the end of a gorge near where industrial activities occur along the banks of**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**125.**	**Yes**	**Yes**	**No**	**Yes**

Problem **Scour Above**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Plane Bed**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**None**	**Yes**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**12**		**No**
7.4 Change in Planform	**15**		**No**
Total Score	**47**		
Geomorphic Rating	**0.5875**		

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	**11**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**15**
6.6 Channel Alteration	**13**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 7 Right: 7**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 7**
Total Score	**130**
Habitat Rating	**0.65**

Habitat Stream Condition **Good**

Narrative:
Historic incision active minor widening limited by bank resistance (material and vegetation). Stability increased by stream type (B).

Phase 2 Segment Summary

January 16, 2008 SGAT Version: 4.56

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M02**
Segment: **0**
Completion Date: **September 13, 2007**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz**
Why Not assessed: **bedrock gorge**
Rain: **No**
Segment Length (ft): **1,351**
Segment Location: **A gorge that extends mostly downstream from the Cold River Road bridge in Clarendon.**

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	36	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	473	0

1.4 Adjacent Side

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

1.5 Valley Features

Valley Width (ft) **118**
Width Determination **Estimated**
Confinement Type **Narrowly**
Rock Gorge? **Yes**
Human-caused Change? **No**

Step 2. Stream Channel

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

Notes:

This segment is a bedrock gorge consisting of excellent habitat and beauty. A property owner has expressed interest in its conservation and has been referred to the Vermont River Conservancy.

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:
Bed Material:
Subclass Slope:
Bed Form:
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

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

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

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

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

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

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

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

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	None
4.3 Flow Status	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

4.7 StormwaterInputs

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

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

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

Project: **Otter Creek - Cold River** **Phase 2 Reach Summary** January 16, 2008

Stream: **Cold River** Reach # **M02** Segment: **0** Completion Date: **September 13,**

Organization: **Rutland RPC** Observers: **Michael Blazewicz** Rain: **No**

Segment Length (ft): **1,351** Segment Location: **A gorge that extends mostly downstream from the Cold River Road bridge in**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Ledge	**Mid-segment**	**0.00**	**0.00**	**Yes**	
Ledge	**Mid-segment**	**0.00**	**0.00**	**Yes**	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**65.0**	**Yes**	**Yes**	**No**	**Yes**
	Problem	**None**			

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model
Channel Evolution Stage
Geomorphic Condition
Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

Habitat Stream Condition

Narrative:

Phase 2 Segment Summary

January 16, 2008 SGAT Version: 4.56

Project: **Otter Creek - Cold River**
Stream: **Cold River** Reach # **M03** Segment: **0** Completion Date: **September 18, 2007**
Organization: **Rutland RPC** Observers: **Michael Blazewicz, Sarah Lade** Why Not assessed: Rain: **No**
Segment Length (ft): **6,870** Segment Location: **From north of the Cold River road in a remote location to downstream where a gorge begins**

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	1,052	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	1,592	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 **Measured**
Confinement Type **Narrow**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **77**
2.2 Max Depth (ft) **3.40**
2.3 Mean Depth (ft) **1.98**
2.4 Floodprone Width (ft) **707**

Notes:

A C3b system by reference. It is likely that in reference condition the channel would have more defined pools and riffle heads. Historic channel incision has created a planebed stream. There is no indication of why the channel may have incised as there is bedrock

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln **7.00** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **38.94**
2.7 Entrenchment Ratio **9.17**
2.8 Incision Ratio **2.06**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Low**
2.10 Riffles Type **Eroded**
2.11 Riffle/Step Spacing (ft) **2,000**

2.12 Substrate Composition

Bedrock	0%
Boulder	28%
Cobble	36%
Coarse Gravel	28%
Fine Gravel	6%
Sand	2%
Silt and smaller	0%

Silt/Clay Present? **No**
Detritus **2** %
Large Woody **33**

2.13 Average Largest Particle on

Bed	30.0	inches
Bar	6.0	inches

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	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	1,654	2,173
Erosion Height (ft)	4.43	5.31
Revetmt. Type	Multiple	None
Revetmt. Length (ft)	206	0
Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Deciduous
Sub-dominant	Deciduous	Shrubs/Saplin
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	None
W less than 25	810	0
Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Shrubs/Saplin	Coniferous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Residential	None
Mass Failures	0	83
Height	0	50
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

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

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	6
Diagonal	**Delta**	**Island**
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
10	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: **1,770**
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.

January 16, 2008

Phase 2 Reach Summary

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M03**
Segment: **0**
Completion Date: **September 18,**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz, Sarah Lade**
Rain: **No**
Segment Length (ft): **6,870**
Segment Location: **From north of the Cold River road in a remote location to downstream where a gorge**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Ledge	**Mid-segment**	**0.00**	**0.00**	**Yes**	
Ledge	**Mid-segment**	**0.00**	**0.00**	**Yes**	

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**C to B**	**Yes**
7.2 Channel Aggradation	**12**	**None**	**No**
7.3 Widening Channel	**8**		**No**
7.4 Change in Planform	**9**		**No**
Total Score	**34**		
Geomorphic Rating	**0.425**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**13**
6.2 Embeddedness	**11**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**11**
6.5 Channel Flow Status	**8**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**6**
6.8 Bank Stability	**Left: 6 Right: 5**
6.9 Bank Vegetation Protection	**Left: 6 Right: 6**
6.10 Riparian Vegetation Zone Width	**Left: 8 Right: 9**
Total Score	**115**
Habitat Rating	**0.575**

Habitat Stream Condition **Fair**

Narrative:

Stream has incised. Active widening and planform adjustment as well as aggradation are occuring. Stream is borderline "C" type channel, however is still a planebed B. Continued widening, rebuilding of bankfull bars, planform adjustmen

January 16, 2008 SGAT Version: 4.56

Phase 2 Segment Summary

Project:	Otter Creek - Cold River		
Stream:	**Cold River**	Reach #	**M04**
Segment:	**0**	Completion Date:	**September 10, 2007**
Organization:	**Rutland RPC**	Observers:	**Michael Blazewicz, Sarah Lade**
Why Not assessed:		Rain:	**No**
Segment Length (ft):	**4,340**	Segment Location:	**From where the North Branch joins the Cold River downstream to the start of the next**

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**	**Steep**
Continuous w/	**Sometimes**	**Sometimes**
W/in 1 Bankfill	**Sometimes**	**Sometimes**
Texture	**Boulder**	**Boulder**

1.5 Valley Features

Valley Width (ft)	**262**
Width Determination	**Estimated**
Confinement Type	**Narrow**
Rock Gorge?	**No**
Human-caused Change?	**No**

Step 2. Stream Channel

2.1 Bankfull Width	**76**
2.2 Max Depth (ft)	**3.60**
2.3 Mean Depth (ft)	**2.43**
2.4 Floodprone Width (ft)	**130**

Notes:

Phase 1 data said straightening, however, no evidence of straightening observed in the field. A B3 step-pool system that has evidence of historic incision. This incision has led to a predominately plane bed system with step-pool being subdominant through

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln	**6.20** ft.
Human Elev Floodpln	**0.00** ft.
2.6 Width/Depth Ratio	**31.28**
2.7 Entrenchment Ratio	**1.71**
2.8 Incision Ratio	**1.72**
Human Elevated Inc Rat	**0.00**
2.9 Sinuosity	**Low**
2.10 Riffles Type	**Complete**
2.11 Riffle/Step Spacing (ft)	**400**

2.12 Substrate Composition

Bedrock	**0**%
Boulder	**40**%
Cobble	**35**%
Coarse Gravel	**17**%
Fine Gravel	**5**%
Sand	**3**%
Silt and smaller	**0**%

Silt/Clay Present?	**No**
Detritus	**2** %
# Large Woody	**27**

2.13 Average Largest Particle on

Bed	**24.0**	**inches**
Bar	**8.0**	**inches**

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

Bank Erosion	Left	Right
Erosion Length (ft)	**762**	**325**
Erosion Height (ft)	**4.00**	**4.00**
Revetmt. Type	**None**	**None**
Revetmt. Length (ft)	**0**	**0**

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

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	**Mixed Trees**	**Mixed Trees**
Sub-dominant	**Shrubs/Saplin**	**Shrubs/Saplin**

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	**Minimal**
4.2 Adjacent Wetlands	**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	**None**

4.7 StormwaterInputs

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	**1**	**6**
Diagonal	Delta	Island
0	**0**	**1**

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
4	**0**	**0**	**0**

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	**0**	**No**

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

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

Project: **Otter Creek - Cold River**
Stream: **Cold River** Reach # **M04** Segment: **0** Completion Date: **September 10,**
Organization: **Rutland RPC** Observers: **Michael Blazewicz, Sarah Lade** Rain: **No**
Segment Length (ft): **4,340** Segment Location: **From where the North Branch joins the Cold River downstream to the start of the next**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

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	**10**	**None**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**8**		**No**
7.4 Change in Planform	**11**		**No**
Total Score	**40**		
Geomorphic Rating	**0.5**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**15**
6.2 Embeddedness	**18**
6.3 Velocity/Depth Patterns	**11**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**10**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**16**
6.8 Bank Stability	**Left: 7 Right: 8**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 10 Right: 10**
Total Score	**150**
Habitat Rating	**0.75**

Habitat Stream Condition **Good**

Narrative:
B channel has incised. steps have turned to planebed. widening and aggradation are occurring and leading to some planform adjustments such as floodchutes. Expect continued active adjustment as a new floodplain is developed.

Phase 2 Segment Summary

January 16, 2008 SGAT Version: 4.56

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M05**
Segment: **0**
Completion Date: **September 11, 2007**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz**
Why Not assessed:
Rain: **No**
Segment Length (ft): **5,188**
Segment Location: **From northeast of the Cold River road, downstream under the Covered Bridge on the Upper**

QC Status - Staff: Provisional Cons

Provisional

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	94

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

1.5 Valley Features

Valley Width (ft) **138**
Width Determination **Estimated**
Confinement Type **Semi-confined**
Rock Gorge? **No**
Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **60**
2.2 Max Depth (ft) **3.10**
2.3 Mean Depth (ft) **2.05**
2.4 Floodprone Width (ft) **74**

Notes:

Another B3 stream by reference. This reach has incised historically. At one point it may have been a G type channel, however, due to channel widening is now an F type stream. Development of a new floodplain through planform adjustment, flood chutes, bar

Step 2. (Contued)

2.5 Aband. Floodpln **7.90** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **29.27**
2.7 Entrenchment Ratio **1.23**
2.8 Incision Ratio **2.55**
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	25%
Cobble	31%
Coarse Gravel	27%
Fine Gravel	13%
Sand	4%
Silt and smaller	0%

Silt/Clay Present? **No**
Detritus **3** %
Large Woody **21**

2.13 Average Largest Particle on

Bed	36.0	inches
Bar	12.0	inches

2.14 Stream Type

Stream Type: **F**
Bed Material: **Cobble**
Subclass Slope: **b**
Bed Form: **Plane Bed**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

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

Bank Erosion	Left	Right
Erosion Length (ft)	1,215	1,113
Erosion Height (ft)	4.00	4.88
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

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

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>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	50
Height	0	70
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

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

4.7 StormwaterInputs

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	2	6
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
4	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
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.

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M05**
Segment: **0**
Completion Date: **September 11,**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz**
Rain: **No**
Segment Length (ft): **5,188**
Segment Location: **From northeast of the Cold River road, downstream under the Covered Bridge on the**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**90.0**	**Yes**	**Yes**	**No**	**Yes**

Problem **Deposition Above,Deposition Below,Scour**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Plane Bed**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**B to F**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**10**		**No**
7.4 Change in Planform	**11**		**No**
Total Score	**37**		
Geomorphic Rating	**0.4625**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**15**
6.2 Embeddedness	**16**
6.3 Velocity/Depth Patterns	**15**
6.4 Sediment Deposition	**14**
6.5 Channel Flow Status	**9**
6.6 Channel Alteration	**16**
6.7 Frequency of Riffles/Steps	**16**
6.8 Bank Stability	**Left: 7 Right: 7**
6.9 Bank Vegetation Protection	**Left: 6 Right: 6**
6.10 Riparian Vegetation Zone Width	**Left: 8 Right: 8**
Total Score	**143**
Habitat Rating	**0.715**

Habitat Stream Condition **Good**

Narrative:
Historic channel incision. Major widening, minor aggradation and planform. Buffers are healthy, no major floodplain encroachment. STD from B to F due to incision.

January 16, 2008 SGAT Version: 4.56

Phase 2 Segment Summary

Project: **Otter Creek - Cold River**
Stream: **Cold River** Reach # **M06** Segment: **0** Completion Date: **September 13, 2007**
Organization: **Rutland RPC** Observers: **Michael Blazewicz, Andrew** Why Not assessed: Rain: **No**
Segment Length (ft): **7,152** Segment Location: **East of the Cold River Road in Shrewsbury.**

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	**294**	**0**
height	**6**	**0**
Roads	**4,876**	**0**
height	**0**	**0**
Railroads	**0**	**0**
height	**0**	**0**
Improved Paths	**0**	**0**
height	**0**	**0**
Development	**2,214**	**0**

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

1.5 Valley Features

Valley Width (ft) **377**
Width Determination **Estimated**
Confinement Type **Broad**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **61**
2.2 Max Depth (ft) **3.40**
2.3 Mean Depth (ft) **1.96**
2.4 Floodprone Width (ft) **200**

Notes:

This reach has a high degree of corridor encroachment on the left bank due to residential development along Cold River Road. The stream encroachment has led to channel management activiites such as dredging, armoring, and berming. The

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln **5.40** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **31.12**
2.7 Entrenchment Ratio **3.28**
2.8 Incision Ratio **1.59**
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	**14**%
Cobble	**39**%
Coarse Gravel	**32**%
Fine Gravel	**12**%
Sand	**2**%
Silt and smaller	**1**%

Silt/Clay Present? **No**
Detritus **3** %
Large Woody **29**

2.13 Average Largest Particle on

Bed **14.0** **inches**
Bar **8.0** **inches**

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	**None**	**0.00**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

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

Bank Erosion	Left	Right
Erosion Length (ft)	**1,714**	**2,039**
Erosion Height (ft)	**3.93**	**5.00**
Revetmt. Type	**Rip-Rap**	**None**
Revetmt. Length (ft)	**762**	**0**

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

Bank Canopy	Left	Right
Canopy %	**26-50**	**51-75**

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**26-50**	**>100**
Sub-dominant	**0-25**	**None**
W less than 25	**2,471**	**0**

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

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **Minimal**
4.3 Flow Status **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**

4.7 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
2	**2**	**6**
Diagonal	Delta	Island
0	**0**	**1**

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 **With Windrowing**
Straightening Length: **2,281**
5.5 Dredging **Dredging**

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

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M06**
Segment: **0**
Completion Date: **September 13,**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz, Andrew Notte**
Rain: **No**
Segment Length (ft): **7,152**
Segment Location: **East of the Cold River Road in Shrewsbury.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**8**	**None**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**8**		**No**
7.4 Change in Planform	**10**		**No**
Total Score	**37**		
Geomorphic Rating	**0.4625**		

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	**10**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**11**
6.4 Sediment Deposition	**10**
6.5 Channel Flow Status	**10**
6.6 Channel Alteration	**10**
6.7 Frequency of Riffles/Steps	**12**
6.8 Bank Stability	**Left: 7 Right: 6**
6.9 Bank Vegetation Protection	**Left: 5 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 5 Right: 8**
Total Score	**114**
Habitat Rating	**0.57**

Habitat Stream Condition **Fair**

Narrative:

Stream has lost riffle-pool form, now planebed. Some F3b exists in lower end. Incised and widening with major planform limited by road and house encroachment and some berming and dredging of channel. Continued floodplain development expected.

Phase 2 Segment Summary

Project: **Otter Creek - Cold River**
Stream: **Cold River** Reach # **M07** Segment: **A** Completion Date: **September 14, 2007**
Organization: **Rutland RPC** Observers: **Michael Blazewicz, Andrew** Why Not assessed: Rain: **No**
Segment Length (ft): **3,459** Segment Location: **On the east side of Cold River Road in Shrewsbury.**

QC Status - Staff: Provisional Cons Provisional

Step 1. Valley and Floodplain

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

Length (ft)	One	Both
Berms	1,239	375
height	7	7
Roads	3,346	0
height	11	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	2,804	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	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 **Narrow**
Rock Gorge? **No**
Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **48**
2.2 Max Depth (ft) **2.80**
2.3 Mean Depth (ft) **2.08**
2.4 Floodprone Width (ft) **59**

Notes:
Residential and encroachment from Cold River Road continue in this reach. Incision has led to entrenchment and a stream type departure from a C riffle-pool to an F plane bed system. Berming, dredging, and bank armoring are present in an attempt to lock the

Step 2. (Contued)

2.5 Aband. Floodpln **4.70** ft.
Human Elev Floodpln **6.70** ft.
2.6 Width/Depth Ratio **23.08**
2.7 Entrenchment Ratio **1.23**
2.8 Incision Ratio **1.68**
Human Elevated Inc Rat **2.39**
2.9 Sinuosity **Low**
2.10 Riffles Type **Eroded**
2.11 Riffle/Step Spacing (ft) **0**
2.12 Substrate Composition

Bedrock	0%
Boulder	20%
Cobble	28%
Coarse Gravel	32%
Fine Gravel	15%
Sand	5%
Silt and smaller	0%

Silt/Clay Present? **No**
Detritus **1** %
Large Woody **5**

2.13 Average Largest Particle on
Bed **24.0** **inches**
Bar **8.0** **inches**

2.14 Stream Type
Stream Type: **F**
Bed Material: **Gravel**
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	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	613	659
Erosion Height (ft)	4.60	5.60
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	929	238

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

Bank Canopy	Left	Right
Canopy %	26-50	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	>100
Sub-dominant	26-50	None
W less than 25	319	0

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

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **None**
4.3 Flow Status **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**

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**
5.5 Straightening **With Windrowing**
Straightening Length: **3,207**
5.5 Dredging **Dredging**

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

Phase 2 Reach Summary

January 16, 2008

Project:	**Otter Creek - Cold River**		
Stream:	**Cold River**	Reach #	**M07**
Segment:	**A**	Completion Date:	**September 14,**
Organization:	**Rutland RPC**	Observers:	**Michael Blazewicz, Andrew Notte**
Rain:	**No**		
Segment Length (ft):	**3,459**	Segment Location:	**On the east side of Cold River Road in Shrewsbury.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**70.0**	**Yes**	**Yes**	**No**	**Yes**
Problem		**None**			

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**6**	**C to F**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**10**		**No**
7.4 Change in Planform	**11**		**No**
Total Score	**40**		
Geomorphic Rating	**0.5**		

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	**8**
6.2 Embeddedness	**11**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**14**
6.6 Channel Alteration	**3**
6.7 Frequency of Riffles/Steps	**8**
6.8 Bank Stability	**Left: 7 Right: 7**
6.9 Bank Vegetation Protection	**Left: 4 Right: 4**
6.10 Riparian Vegetation Zone Width	**Left: 1 Right: 8**
Total Score	**96**
Habitat Rating	**0.48**

Habitat Stream Condition **Fair**

Narrative:

Channel stuck in stage II (F channel) due to extensive berming dredging and road encroachment. Major widening observed. Planform and aggradation limited due to channel mangement and alteration to transport type system.

Phase 2 Segment Summary

January 16, 2008 SGAT Version: 4.56

Project: Otter Creek - Cold River
Stream: **Cold River** Reach # **M07** Segment: **B** Completion Date: **September 14, 2007**
Organization: **Rutland RPC** Observers: **Michael Blazewicz, Andrew** Why Not assessed: Rain: **No**
Segment Length (ft): **1,475** Segment Location: **East of the cold river road on a bend in the river.**

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	319	0
height	6	0
Roads	1,463	0
height	13	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	15	0

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

1.5 Valley Features
- Valley Width (ft) **621**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width	56
2.2 Max Depth (ft)	2.80
2.3 Mean Depth (ft)	1.89
2.4 Floodprone Width (ft)	198

Notes:

This short segment veers away from Cold River Road and so is not as encroached as the upstream and downstream segments. There is floodplain access in this reach although some windrowing of dredged materials has reduced the degree to which

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln	3.80 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	29.63
2.7 Entrenchment Ratio	3.54
2.8 Incision Ratio	1.36
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Moderate
2.10 Riffles Type	Eroded
2.11 Riffle/Step Spacing (ft)	0

2.12 Substrate Composition

Bedrock	0%
Boulder	9%
Cobble	34%
Coarse Gravel	36%
Fine Gravel	16%
Sand	2%
Silt and smaller	3%

Silt/Clay Present? **No**
Detritus **3** %
Large Woody **15**

2.13 Average Largest Particle on

Bed	24.0	inches
Bar	6.0	inches

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)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

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

Bank Erosion	Left	Right
Erosion Length (ft)	0	89
Erosion Height (ft)	0.00	4.00
Revetmt. Type	Rip-Rap	None
Revetmt. Length (ft)	399	0

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

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	501	0

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

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	40
Height	0	40
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	Minimal
4.3 Flow Status	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

4.7 StormwaterInputs

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	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 **With Windrowing**
Straightening Length: **789**
5.5 Dredging **Dredging**

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

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M07**
Segment: **B**
Completion Date: **September 14,**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz, Andrew Notte**
Rain: **No**
Segment Length (ft): **1,475**
Segment Location: **East of the cold river road on a bend in the river.**

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	**13**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**11**		**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 **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**13**
6.2 Embeddedness	**11**
6.3 Velocity/Depth Patterns	**11**
6.4 Sediment Deposition	**14**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**8**
6.7 Frequency of Riffles/Steps	**8**
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	**123**
Habitat Rating	**0.615**

Habitat Stream Condition **Fair**

Narrative:
Historic degradation associated with channel management. Current minor widening and minor planform adjustment. Some floodplain access.

January 16, 2008 SGAT Version: 4.56

Phase 2 Segment Summary

Project:	**Otter Creek - Cold River**		
Stream:	**Cold River**	Reach #	**M07**
Segment:	**C**	Completion Date:	**September 14, 2007**
Organization:	**Rutland RPC**	Observers:	**Michael Blazewicz, Andrew**
Why Not assessed:		Rain:	**No**
Segment Length (ft):	**1,560**	Segment Location:	**From upstream of the Wilmouth Hill Road bridge downstream along a straightened section**

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

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	**308**	**0**
height	**6**	**0**
Roads	**1,378**	**0**
height	**13**	**0**
Railroads	**0**	**0**
height	**0**	**0**
Improved Paths	**0**	**0**
height	**0**	**0**
Development	**755**	**0**

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

1.5 Valley Features

- Valley Width (ft) **621**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

- 2.1 Bankfull Width **45**
- 2.2 Max Depth (ft) **3.10**
- 2.3 Mean Depth (ft) **2.00**
- 2.4 Floodprone Width (ft) **59**

Notes:

This segment has been highly altered due to channel straightening. The channel has incised significantly and widened into an F type plane bed stream. Channel armoring, the location of Cold River Road and nearby residences has all but eliminated any

Step 2. (Contued)

- 2.5 Aband. Floodpln **8.00** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **22.50**
- 2.7 Entrenchment Ratio **1.31**
- 2.8 Incision Ratio **2.58**
- 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	**23**%
Cobble	**31**%
Coarse Gravel	**22**%
Fine Gravel	**16**%
Sand	**7**%
Silt and smaller	**1**%

- Silt/Clay Present? **No**
- Detritus **1** %
- # Large Woody **7**

2.13 Average Largest Particle on

Bed	**26.0**	**inches**
Bar	**8.0**	**inches**

2.14 Stream Type

- Stream Type: **F**
- 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	**Boulder/Cobbl**	**Boulder/Cobbl**
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**	**159**
Erosion Height (ft)	**0.00**	**10.00**
Revetmt. Type	**Rip-Rap**	**Rip-Rap**
Revetmt. Length (ft)	**1,202**	**319**

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

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**0-25**
Sub-dominant	**None**	**26-50**
W less than 25	**1,228**	**0**

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

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **None**
- 4.2 Adjacent Wetlands **None**
- 4.3 Flow Status **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**

4.7 StormwaterInputs

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	**0**	**0**
Diagonal	**Delta**	**Island**
0	**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: **1,378**
- 5.5 Dredging **Dredging**

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

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach #: **M07**
Segment: **C**
Completion Date: **September 14,**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz, Andrew Notte**
Rain: **No**
Segment Length (ft): **1,560**
Segment Location: **From upstream of the Wilmouth Hill Road bridge downstream along a straightened**

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	**60.0**	**Yes**	**Yes**	**No**	**Yes**

Problem **Scour Above,Scour Below**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**3**	**C to F**	**Yes**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**44**		
Geomorphic Rating	**0.55**		

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	**7**
6.2 Embeddedness	**14**
6.3 Velocity/Depth Patterns	**5**
6.4 Sediment Deposition	**15**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**2**
6.7 Frequency of Riffles/Steps	**5**
6.8 Bank Stability	**Left: 8 Right: 7**
6.9 Bank Vegetation Protection	**Left: 1 Right: 4**
6.10 Riparian Vegetation Zone Width	**Left: 2 Right: 1**
Total Score	**84**
Habitat Rating	**0.42**

Habitat Stream Condition **Fair**

Narrative:

Channel straightening and berming has led to extreme incision. Rip-rap and windrowing has limited widening and planform adjustment keeping the channel evolution stage from progressing to stage III.

Phase 2 Segment Summary

Project: Otter Creek - Cold River
Stream: Cold River | Reach # M08 | Segment: 0 | Completion Date: October 3, 2007
Organization: Rutland RPC | Observers: Michael Blazewicz, Andrew | Why Not assessed: | Rain: No
Segment Length (ft): 7,826 | Segment Location: From below a large wetland system downstream under the Cold River Road to where there

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	79	0
height	6	0
Roads	1,445	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	433	0

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

1.5 Valley Features
Valley Width (ft) **112**
Width Determination **Measured**
Confinement Type **Narrow**
Rock Gorge? **No**
Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **30**
2.2 Max Depth (ft) **2.40**
2.3 Mean Depth (ft) **1.50**
2.4 Floodprone Width (ft) **112**

Notes:
Bridge at lower end of reach is the first observance of Japanese Knotweed in the stream system during the Phase 2 assessment. Some straightening and dredging by lower Cold River Road bridge was observed. This reach is significantly

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln **3.90** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **20.00**
2.7 Entrenchment Ratio **3.73**
2.8 Incision Ratio **1.62**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Moderate**
2.10 Riffles Type **Eroded**
2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	20%
Cobble	32%
Coarse Gravel	15%
Fine Gravel	20%
Sand	12%
Silt and smaller	1%

Silt/Clay Present? **No**
Detritus **3** %
Large Woody **40**

2.13 Average Largest Particle on
Bed **12.0** inches
Bar **N/A** inches

2.14 Stream Type
Stream Type: **C**
Bed Material: **Cobble**
Subclass Slope: **b**
Bed Form: **Plane Bed**
Field Measured Slope:
2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	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)	1,136	1,046
Erosion Height (ft)	3.92	3.90
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	84	173
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	350	0
Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

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

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 **1**
Affected Length (ft) **100**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
7	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 **With Windrowing**
Straightening Length: **910**
5.5 Dredging **Dredging**

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

Project: **Otter Creek - Cold River**
Stream: **Cold River** Reach # **M08** Segment: **0** Completion Date: **October 3, 2007**
Organization: **Rutland RPC** Observers: **Michael Blazewicz, Andrew Notte** Rain: **No**
Segment Length (ft): **7,826** Segment Location: **From below a large wetland system downstream under the Cold River Road to where**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**15.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Scour Below**				
Bridge	**30.0**	**Yes**	**Yes**	**No**	**No**
Problem	**None**				
Bridge	**30.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Deposition Above,Deposition Below,Scour**				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Plane Bed**

	Score	STD	Historic
7.1 Channel Degradation	**11**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**13**		**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	**13**
6.2 Embeddedness	**10**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**10**
6.5 Channel Flow Status	**11**
6.6 Channel Alteration	**13**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 7 Right: 7**
6.9 Bank Vegetation Protection	**Left: 8 Right: 8**
6.10 Riparian Vegetation Zone Width	**Left: 8 Right: 8**
Total Score	**129**
Habitat Rating	**0.645**

Habitat Stream Condition **Good**

Narrative:
Stream had incised. There is evidence of channel widening. In some areas floodplain access has been maintained or established with the formation of small benches. Overall there does not seem to be enough planform adjst or aggradation for stage IV.

January 16, 2008 SGAT Version: 4.56

Phase 2 Segment Summary

Project: Otter Creek - Cold River
Stream: **Cold River** Reach # **M09** Segment: **A** Completion Date: **October 4, 2007**
Organization: **Rutland RPC** Observers: **Michael Blazewicz, Andrew** Why Not assessed: **wetland** Rain: **No**
Segment Length (ft): **2,500** Segment Location: **From below a logging road bridge where the stream enters a large wetland complex to**

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	**Steep**	**Hilly**
Continuous w/	**Never**	**Never**
W/in 1 Bankfill	**Never**	**Never**
Texture	**Not Evalua**	**Not Evalua**

1.5 Valley Features
Valley Width (ft) **620**
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:

This segment comprises a significant wetland system. The owners of the wetland property described an event that occurred within the last year. The beaver dams at Johnsons Pond (upstream and south) broke draining a huge volume of water into a small tributary

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: **Gravel**
Subclass Slope: **None**
Bed Form: **Riffle-Pool**
Field Measured Slope:
2.15 Reference Stream Type
(if different from Phase 1)
E 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	**Gravel**	**Gravel**
Consistency	**Cohesive**	**Cohesive**
Lower		
Material Type	**Silt**	**Silt**
Consistency	**Cohesive**	**Cohesive**
Bank Erosion	Left	Right
Erosion Length (ft)	**0**	**0**
Erosion Height (ft)	**0.00**	**0.00**
Revetmt. Type	**None**	**None**
Revetmt. Length (ft)	**0**	**0**
Near Bank Veg. Type	Left	Right
Dominant	**Shrubs/Saplin**	**Shrubs/Saplin**
Sub-dominant	**Herbaceous**	**Herbaceous**
Bank Canopy	Left	Right
Canopy %	**26-50**	**26-50**
Mid-Channel Canopy	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-dominant	**None**	**None**
W less than 25	**0**	**126**
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	**Forest**	**Forest**
Mass Failures	**0**	**0**
Height	**0**	**0**
Gullies	**0**	**0**
Height	**0**	**0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**
4.2 Adjacent Wetlands **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 **None**
4.7 StormwaterInputs
Field Ditch **0** Road Ditch **0**
Other **0** Tile Drain **0**
Overland Flow **0** Urb Strm Wtr Pipe **0**
4.9 # of Beaver Dams **3**
Affected Length (ft) **400**

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.

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M09**
Segment: **A**
Completion Date: **October 4, 2007**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz, Andrew Notte**
Rain: **No**
Segment Length (ft): **2,500**
Segment Location: **From below a logging road bridge where the stream enters a large wetland complex to**

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
Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

Habitat Stream Condition

Phase 2 Segment Summary

January 16, 2008 SGAT Version: 4.56

Project: Otter Creek - Cold River
Stream: Cold River | Reach # M09 | Segment: B | Completion Date: October 4, 2007
Organization: Rutland RPC | Observers: Michael Blazewicz, Andrew | Why Not assessed: | Rain: No
Segment Length (ft): 3,716 | Segment Location: From where the reach begins below a culvert on Northam Road downstream to where 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	59	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	Never
W/in 1 Bankfill	Sometimes	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features
- Valley Width (ft): **620**
- Width Determination: **Estimated**
- 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): **1.60**
- 2.3 Mean Depth (ft): **1.29**
- 2.4 Floodprone Width (ft): **612**

Notes:

Segment B flows through a forested corridor (some logging in left corridor). The channel has not incised. There is a good amount of aggradation in the channel (source unknown) of sand and fine gravel. Minor channel widening and planform adjustment observed.

Provisional *Step 2. (Contued)*

- 2.5 Aband. Floodpln: **1.60** ft.
- Human Elev Floodpln: **0.00** ft.
- 2.6 Width/Depth Ratio: **13.18**
- 2.7 Entrenchment Ratio: **36.00**
- 2.8 Incision Ratio: **1.00**
- Human Elevated Inc Rat: **0.00**
- 2.9 Sinuosity: **Moderate**
- 2.10 Riffles Type: **Sedimented**
- 2.11 Riffle/Step Spacing (ft): **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	2%
Cobble	1%
Coarse Gravel	32%
Fine Gravel	32%
Sand	29%
Silt and smaller	4%

- Silt/Clay Present?: **No**
- Detritus: **7** %
- # Large Woody: **102**

2.13 Average Largest Particle on

Bed	4.0	inches
Bar	1.0	inches

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

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

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

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	369	207
Erosion Height (ft)	2.75	3.67
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	26-50	None
W less than 25	383	376
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	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps: **Minimal**
- 4.2 Adjacent Wetlands: **Abundant**
- 4.3 Flow Status: **Low**
- 4.4 # of Debris Jams: **6**
- 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**

4.7 StormwaterInputs

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
5	4	2
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
3	0	1	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: **226**
- 5.5 Dredging: **None**

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

Project: **Otter Creek - Cold River**	**Phase 2 Reach Summary**		January 16, 2008
Stream: **Cold River**	Reach # **M09**	Segment: **B**	Completion Date: **October 4, 2007**
Organization: **Rutland RPC**	Observers: **Michael Blazewicz, Andrew Notte**		Rain: **No**
Segment Length (ft): **3,716**	Segment Location: **From where the reach begins below a culvert on Northam Road downstream to where**		

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

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

Problem **Deposition Above,Deposition Below,Scour**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**10**	**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 **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**13**
6.2 Embeddedness	**10**
6.3 Velocity/Depth Patterns	**16**
6.4 Sediment Deposition	**7**
6.5 Channel Flow Status	**10**
6.6 Channel Alteration	**14**
6.7 Frequency of Riffles/Steps	**8**
6.8 Bank Stability	**Left: 8 Right: 8**
6.9 Bank Vegetation Protection	**Left: 9 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 8 Right: 9**
Total Score	**129**
Habitat Rating	**0.645**

Habitat Stream Condition **Good**

Narrative:

Major aggradation is affecting channel leading to many debris jams, mcb, traverse bars, etc. Unsure of sediment source. Planform and Widening are still only minor at this time.

January 16, 2008 SGAT Version: 4.56

Phase 2 Segment Summary

Project:	Otter Creek - Cold River				
Stream:	**Cold River**	Reach #	**M10**	Segment: **A**	Completion Date: **October 4, 2007**
Organization:	**Rutland RPC**	Observers:	**Michael Blazewicz, Andrew**	Why Not assessed:	Rain: **No**
Segment Length (ft):	**900**	Segment Location:	**From an onstream pond upstream of the Mountain School Road culvert downstream to just**		

QC Status - Staff: Provisional Cons

Step 1. Valley and Floodplain

1.1 Segmentation **Grade Controls**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	**0**	**0**
height	**0**	**0**
Roads	**661**	**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	**Sometimes**	**Sometimes**
Texture	**Not Evalua**	**Not Evalua**

1.5 Valley Features

Valley Width (ft) **70**

Width Determination **Measured**

Confinement Type **Narrow**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **13**

2.2 Max Depth (ft) **1.60**

2.3 Mean Depth (ft) **1.24**

2.4 Floodprone Width (ft) **24**

Notes:

This short segment of 900 feet is highly incised. It is directly downstream of a small impoundment (date impounded? - at least 25 years old) which may have altered the sediment supply and caused the incision. There have also been human caused

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln **4.40** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **10.48**

2.7 Entrenchment Ratio **1.85**

2.8 Incision Ratio **2.75**

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	**9**%
Cobble	**35**%
Coarse Gravel	**32**%
Fine Gravel	**16**%
Sand	**8**%
Silt and smaller	**0**%

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **12**

2.13 Average Largest Particle on

Bed	**12.0**	**inches**
Bar	**N/A**	**inches**

2.14 Stream Type

Stream Type: **B**

Bed Material: **Gravel**

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	**Gravel**	**Gravel**
Consistency	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type	**Boulder/Cobbl**	**Boulder/Cobbl**
Consistency	**Non-cohesive**	**Non-cohesive**
Bank Erosion	Left	Right
Erosion Length (ft)	**100**	**44**
Erosion Height (ft)	**3.50**	**2.00**
Revetmt. Type	**Rip-Rap**	**Rip-Rap**
Revetmt. Length (ft)	**90**	**138**
Near Bank Veg. Type	Left	Right
Dominant	**Deciduous**	**Deciduous**
Sub-dominant	**Shrubs/Saplin**	**Shrubs/Saplin**
Bank Canopy	Left	Right
Canopy %	**76-100**	**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	**0**	**50**
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	**Residential**	**Forest**
Sub-dominant	**Commercial**	**Residential**
Mass Failures	**0**	**0**
Height	**0**	**0**
Gullies	**0**	**0**
Height	**0**	**0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **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**

4.7 StormwaterInputs

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

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	**0**	**0**	**0**

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	**0**	**No**

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **604**

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.

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M10**
Segment: **A**
Completion Date: **October 4, 2007**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz, Andrew Notte**
Rain: **No**
Segment Length (ft): **900**
Segment Location: **From an onstream pond upstream of the Mountain School Road culvert downstream to**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Mid-segment**	**0.00**	**0.00**	**Yes**	
Dam	**Mid-segment**	**3.00**	**3.00**	**Yes**	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Old	**10.0**	**Yes**	**Yes**	**Yes**	**Yes**
	Problem	**Scour Below**			
Culvert	**12.0**	**Yes**	**Yes**	**Yes**	**Yes**
	Problem	**Scour Below**			
Culvert	**6.50**	**Yes**	**Yes**	**Yes**	**Yes**
	Problem	**Deposition Above,Scour Below**			

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Plane Bed**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**C to B**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**16**		**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	**11**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**15**
6.6 Channel Alteration	**11**
6.7 Frequency of Riffles/Steps	**10**
6.8 Bank Stability	**Left: 8 Right: 8**
6.9 Bank Vegetation Protection	**Left: 5 Right: 5**
6.10 Riparian Vegetation Zone Width	**Left: 6 Right: 6**
Total Score	**124**
Habitat Rating	**0.62**

Habitat Stream Condition **Fair**

Narrative:

Historic incision (some sediment starvation from upstream pond?) . Minor widening. Planform and aggradation limited by bed and bank materials. Transport reach. Likely to remain fairly stable unless major flood destabilizes culvert or road.

January 16, 2008 SGAT Version: 4.56

Phase 2 Segment Summary

Project:	Otter Creek - Cold River		
Stream:	**Cold River**	Reach #	**M10**
Segment:	**B**	Completion Date:	**October 4, 2007**
Organization:	**Rutland RPC**	Observers:	**Michael Blazewicz**
Why Not assessed:	**impounded**	Rain:	**No**
Segment Length (ft):	**180**	Segment Location:	**An onstream pond just upstream of the Mt School Road.**

QC Status - Staff: Provisional Cons

Step 1. Valley and Floodplain

1.1 Segmentation **Planform and Scope**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	**0**	**0**
height	**0**	**0**
Roads	**97**	**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/	**Never**	**Never**
W/in 1 Bankfill	**Sometimes**	**Never**
Texture	**Not Evalua**	**Not Evalua**

1.5 Valley Features

Valley Width (ft) **220**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

This segment is impounded by a private in-stream pond. The landowner observed that the road below the pond had only been overtopped once in 25 years of her residency there.

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:

Bed Material:

Subclass Slope:

Bed Form:

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	**Silt**	**Silt**
Consistency	**Non-cohesive**	**Non-cohesive**

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

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

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

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**0-25**
Sub-dominant	**None**	**None**
W less than 25	**0**	**148**

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

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **None**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **Small Run of**

Flow Regulation Use **Recreation**

Impoundments **Small**

Impoundmt. Location **In Reach**

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

(old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

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

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	**0**	**0**	**0**

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	**0**	

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **148**

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.

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Organization: **Rutland RPC**
Segment Length (ft): **180**
Reach # **M10**
Observers: **Michael Blazewicz**
Segment Location: **An onstream pond just upstream of the Mt School Road.**
Segment: **B**
Completion Date: **October 4, 2007**
Rain: **No**

1.6 Grade Controls

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
Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

Habitat Stream Condition

January 16, 2008 SGAT Version: 4.56

Phase 2 Segment Summary

Project: Otter Creek - Cold River
Stream: **Cold River** | Reach # **M10** | Segment: **C** | Completion Date: **October 4, 2007**
Organization: **Rutland RPC** | Observers: **Michael Blazewicz** | Why Not assessed: | Rain: **No**
Segment Length (ft): **550** | Segment Location: **From below a gorge downstream of the Eastham Road culvert to downstream where the**

QC Status - Staff: **Provisional Cons**

Step 1. Valley and Floodplain

1.1 Segmentation **Planform and Scope**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	267	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/	Never	Never
W/in 1 Bankfill	Sometimes	Never
Texture	Bedrock	Not Evalua

1.5 Valley Features
- Valley Width (ft) **250**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width	10
2.2 Max Depth (ft)	1.50
2.3 Mean Depth (ft)	1.06
2.4 Floodprone Width (ft)	45

Notes:

This is a short segment between an on-stream pond and a bedrock gorge. There is some evidence of channel management in the vicinity of a residence; however, for the most part the stream is in its natural condition with good floodplain access.

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln	1.50 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	9.43
2.7 Entrenchment Ratio	4.50
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)	200

2.12 Substrate Composition

Bedrock	0%
Boulder	14%
Cobble	32%
Coarse Gravel	23%
Fine Gravel	18%
Sand	10%
Silt and smaller	3%

Silt/Clay Present? **No**
Detritus **2** %
Large Woody **7**

2.13 Average Largest Particle on
- Bed **10.0** inches
- Bar **3.0** inches

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

Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	37	44
Erosion Height (ft)	3.00	3.00
Revetmt. Type	None	Rip-Rap
Revetmt. Length (ft)	0	161
Near Bank Veg. Type	**Left**	**Right**
Dominant	Deciduous	Deciduous
Sub-dominant	Coniferous	Lawn
Bank Canopy	**Left**	**Right**
Canopy %	51-75	26-50

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	0-25
Sub-dominant	None	51-100
W less than 25	0	42
Buffer Veg. Type	**Left**	**Right**
Dominant	Mixed Trees	Deciduous
Sub-dominant	Deciduous	Herbaceous

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	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	Run-of-river

4.7 StormwaterInputs

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal	No
5.5 Straightening	Straightening
Straightening Length:	341
5.5 Dredging	None

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

Project: **Otter Creek - Cold River** | **Phase 2 Reach Summary** | | January 16, 2008

Stream: **Cold River** | Reach # **M10** | Segment: **C** | Completion Date: **October 4, 2007**

Organization: **Rutland RPC** | Observers: **Michael Blazewicz** | Rain: **No**

Segment Length (ft): **550** | Segment Location: **From below a gorge downstream of the Eastham Road culvert to downstream where**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take~	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**15**		**No**
7.4 Change in Planform	**15**		**No**
Total Score	**61**		
Geomorphic Rating	**0.7625**		

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	**13**
6.2 Embeddedness	**11**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**15**
6.5 Channel Flow Status	**15**
6.6 Channel Alteration	**11**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 9 Right: 7**
6.9 Bank Vegetation Protection	**Left: 9 Right: 5**
6.10 Riparian Vegetation Zone Width	**Left: 7 Right: 3**
Total Score	**131**
Habitat Rating	**0.655**

Habitat Stream Condition **Good**

Narrative:
No significant incision detected. Stream appears relatively stable due to bed and bank boundaries.

January 16, 2008 SGAT Version: 4.56

Phase 2 Segment Summary

Project: Otter Creek - Cold River
Stream: **Cold River** Reach # **M10** Segment: **D** Completion Date: **October 4, 2007**
Organization: **Rutland RPC** Observers: **Michael Blazewicz** Why Not assessed: **bedrock gorge** Rain: **No**
Segment Length (ft): **450** Segment Location: **From below the culvert on Eastham Road where the channel is in a bedrock gorge.**

QC Status - Staff: Provisional Cons

Step 1. Valley and Floodplain

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

1.3 Corridor Encroachments

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

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

1.5 Valley Features
Valley Width (ft) **15**
Width Determination **Estimated**
Confinement Type **Narrowly**
Rock Gorge? **Yes**
Human-caused Change? **No**

Step 2. Stream Channel

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

Notes:
A short bedrock gorge section topped by a large cascading waterfall of approximately 20 feet in height. Bedrock grade control on bed and banks throughout.

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: **A**
Bed Material: **Bedrock**
Subclass Slope: **None**
Bed Form: **Cascade**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)
A 1 Non Cascade

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

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

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

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

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

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

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

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

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **None**
4.3 Flow Status **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**

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

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

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

Project: **Otter Creek - Cold River** **Phase 2 Reach Summary** January 16, 2008

Stream: **Cold River** Reach # **M10** Segment: **D** Completion Date: **October 4, 2007**

Organization: **Rutland RPC** Observers: **Michael Blazewicz** Rain: **No**

Segment Length (ft): **450** Segment Location: **From below the culvert on Eastham Road where the channel is in a bedrock gorge.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Ledge	**Mid-segment**	**0.00**	**0.00**	**Yes**	
Ledge	**Mid-segment**	**0.00**	**0.00**	**Yes**	
Waterfall	**Mid-segment**	**19.00**	**18.00**	**Yes**	

4.8 Channel Constrictions

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

Problem **Deposition Above**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**0**
6.2 Embeddedness	**0**
6.3 Velocity/Depth Patterns	**0**
6.4 Sediment Deposition	**0**
6.5 Channel Flow Status	**0**
6.6 Channel Alteration	**0**
6.7 Frequency of Riffles/Steps	**0**
6.8 Bank Stability	**Left: 0 Right: 0**
6.9 Bank Vegetation Protection	**Left: 0 Right: 0**
6.10 Riparian Vegetation Zone Width	**Left: 0 Right: 0**
Total Score	**0**
Habitat Rating	**0**

Habitat Stream Condition

Narrative:

Project:	Otter Creek - Cold River				
Stream:	**Cold River**	Reach #	**M10**	Segment: **E**	Completion Date: **October 4, 2007**
Organization:	**Rutland RPC**	Observers:	**Michael Blazewicz**	Why Not assessed:	Rain: **No**
Segment Length (ft):	**1,810**	Segment Location:	**From just upstream of the Old Plymouth Road bridge to downstream of the Eastham 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	**1,664**	**0**
height	**4**	**0**
Railroads	**0**	**0**
height	**0**	**0**
Improved Paths	**0**	**0**
height	**0**	**0**
Development	**679**	**694**

1.4 Adjacent Side

	Left	Right
Hillside Slope	**Steep**	**Hilly**
Continuous w/	**Sometimes**	**Never**
W/in 1 Bankfill	**Sometimes**	**Never**
Texture	**Bedrock**	**Not Evalua**

1.5 Valley Features

Valley Width (ft) **76**

Width Determination **Measured**

Confinement Type **Narrow**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **11**

2.2 Max Depth (ft) **1.60**

2.3 Mean Depth (ft) **1.18**

2.4 Floodprone Width (ft) **20**

Notes:

A highly managed channel that flows through a residential area of Shrewsbury. Heavy channel straightening and bank armoring have causes a departure from a C channel to a B channel and have eliminated much of the habitat value of the segment. Much riparian

Provisional *Step 2. (Contued)*

2.5 Aband. Floodpln **4.10** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **9.32**

2.7 Entrenchment Ratio **1.82**

2.8 Incision Ratio **2.56**

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	**13**%
Cobble	**34**%
Coarse Gravel	**22**%
Fine Gravel	**19**%
Sand	**12**%
Silt and smaller	**0**%

Silt/Clay Present? **No**

Detritus **1** %

Large Woody **0**

2.13 Average Largest Particle on

Bed	**8.0**	**inches**
Bar	**N/A**	**inches**

2.14 Stream Type

Stream Type: **B**

Bed Material: **Gravel**

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	**Gravel**	**Gravel**
Consistency	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type	**Boulder/Cobbl**	**Boulder/Cobbl**
Consistency	**Non-cohesive**	**Non-cohesive**
Bank Erosion	Left	Right
Erosion Length (ft)	**0**	**0**
Erosion Height (ft)	**0.00**	**0.00**
Revetmt. Type	**Rip-Rap**	**Rip-Rap**
Revetmt. Length (ft)	**320**	**724**
Near Bank Veg. Type	Left	Right
Dominant	**Lawn**	**Lawn**
Sub-dominant	**Shrubs/Saplin**	**Shrubs/Saplin**
Bank Canopy	Left	Right
Canopy %	**1-25**	**1-25**
Mid-Channel Canopy	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**0-25**
Sub-dominant	**>100**	**None**
W less than 25	**604**	**1,639**
Buffer Veg. Type	Left	Right
Dominant	**Mixed Trees**	**Herbaceous**
Sub-dominant	**Herbaceous**	**Shrubs/Saplin**

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **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**

4.7 StormwaterInputs

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

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	**0**	**0**	**0**

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	**0**	**No**

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **1,806**

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.

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River** Reach # **M10** Segment: **E** Completion Date: **October 4, 2007**
Organization: **Rutland RPC** Observers: **Michael Blazewicz** Rain: **No**
Segment Length (ft): **1,810** Segment Location: **From just upstream of the Old Plymouth Road bridge to downstream of the Eastham**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	**5.50**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Deposition Below,Scour Above,Scour**				
Bridge	**10.0**	**No**	**Yes**	**No**	**No**
Problem	**None**				
Bridge	**6.50**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Deposition Below,Scour Above,Alignment**				
Bridge	**6.50**	**No**	**Yes**	**No**	**No**
Problem	**None**				

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	**16**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**13**		**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	**10**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**5**
6.7 Frequency of Riffles/Steps	**10**
6.8 Bank Stability	**Left: 8 Right: 8**
6.9 Bank Vegetation Protection	**Left: 2 Right: 2**
6.10 Riparian Vegetation Zone Width	**Left: 2 Right: 2**
Total Score	**96**
Habitat Rating	**0.48**

Habitat Stream Condition **Fair**

Narrative:

Major channel straightening and armoring has occurred. Stream is very incised and locked into stage II. Planform adjustment and widening limited by boundary materials.

Phase 2 Segment Summary

January 16, 2008 SGAT Version: 4.56

Project: Otter Creek - Cold River
Stream: Cold River — Reach # M10 — Segment: F — Completion Date: October 4, 2007
Organization: Rutland RPC — Observers: Michael Blazewicz — Why Not assessed: — Rain: No
Segment Length (ft): 6,647 — Segment Location: The headwaters of the Cold River to downstream where residential properties begin in the

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

Step 1. Valley and Floodplain

1.1 Segmentation **Planform and Scope**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	100	0
height	4	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	Never
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features
Valley Width (ft) **45**
Width Determination **Measured**
Confinement Type **Narrow**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **10**
2.2 Max Depth (ft) **1.50**
2.3 Mean Depth (ft) **1.06**
2.4 Floodprone Width (ft) **45**

Notes:
The final long segment of wilderness river that runs from Shrewsbury Village up to the headwaters of the Cold River. With the exception of a few ATV fords and an old garbage dump there was very little anthropogenic disturbance evident within this

Step 2. (Contued)

2.5 Aband. Floodpln **1.50** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **9.43**
2.7 Entrenchment Ratio **4.50**
2.8 Incision Ratio **1.00**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Moderate**
2.10 Riffles Type **Complete**
2.11 Riffle/Step Spacing (ft) **100**

2.12 Substrate Composition

Bedrock	0%
Boulder	14%
Cobble	32%
Coarse Gravel	23%
Fine Gravel	18%
Sand	10%
Silt and smaller	3%

Silt/Clay Present? **No**
Detritus **4** %
Large Woody **36**

2.13 Average Largest Particle on
Bed **8.0** **inches**
Bar **3.0** **inches**

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

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Moderate**

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)	74	85
Erosion Height (ft)	3.00	3.00
Revetmt. Type	None	Rip-Rap
Revetmt. Length (ft)	0	55
Near Bank Veg. Type	**Left**	**Right**
Dominant	Deciduous	Deciduous
Sub-dominant	Coniferous	Coniferous
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	25
Buffer Veg. Type	**Left**	**Right**
Dominant	Deciduous	Deciduous
Sub-dominant	Mixed Trees	Mixed Trees

3.3 Riparian Corridor

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

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **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 **None**

4.7 StormwaterInputs

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

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

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
5	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

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.

Phase 2 Reach Summary

January 16, 2008

Project: **Otter Creek - Cold River**
Stream: **Cold River**
Reach # **M10**
Segment: **F**
Completion Date: **October 4, 2007**
Organization: **Rutland RPC**
Observers: **Michael Blazewicz**
Rain: **No**
Segment Length (ft): **6,647**
Segment Location: **The headwaters of the Cold River to downstream where residential properties begin in**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Mid-segment**	**0.00**	**0.00**	**Yes**	

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**16**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**62**		
Geomorphic Rating	**0.775**		

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	**15**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**15**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**15**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**18**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 9 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 10 Right: 10**
Total Score	**163**
Habitat Rating	**0.815**

Habitat Stream Condition **Good**

Narrative:
Channel not incised. Appears stable. Fines and sand count more than expected and may be a result of geology as no other sediment sources were detected during stream walk.

Stream Geometry Data

Otter Creek - Cold

Reach	Seg-ment	Phase 2 Stream Type: Stream Type	Bed Material	Bedform	Subcl. Slope	Sub Rch?	Phase 1 Data: Channel Slope	Channel width	Phase 2 Channel Data: Bankfull width	Max. depth	Mean depth	Floodpr. width	Abandn FldPln	W/D Ratio	Entrench-ment	Incision Ratio	Stage Evol.	Evol. Model	RGA Cond.	RHA Cond.	QC Stf	QC Aut
M01	A	C	Gravel	Riffle-Pool	None	No	2.64	63.93	64.0	5.0	3.3	1400.0	6.9	19.39	21.88	1.38	IV	F	Fair	Fair	F	P
M01	B	C	Cobble	Plane Bed	None	No	2.04	63.93	83.5	3.3	2.55	1005.0	3.8	32.75	12.04	1.15	II	F	Fair	Fair	F	P
M01	C	B	Cobble	Plane Bed	None	Yes	9.17	63.93	76.0	3.5	2.62	106.1	7.2	29.01	1.40	2.06	II	F	Fair	Good	F	P
M02	0					No	2.96	63.54													F	F
M03	0	B	Cobble	Plane Bed	None	No	2.33	63.48	77.1	3.4	1.98	707.0	7.0	38.94	9.17	2.06	III	F	Fair	Fair	F	P
M04	0	B	Cobble	Plane Bed	None	No	2.76	62.35	76.0	3.6	2.43	130.0	6.2	31.28	1.71	1.72	III	F	Fair	Good	F	P
M05	0	F	Cobble	Plane Bed	b	No	2.89	52.15	60.0	3.1	2.05	74.0	7.9	29.27	1.23	2.55	III	F	Fair	Good	F	P
M06	0	C	Cobble	Plane Bed	None	No	1.96	51.47	61.0	3.4	1.96	200.0	5.4	31.12	3.28	1.59	III	F	Fair	Fair	F	P
M07	A	F	Gravel	Plane Bed	None	No	3.18	49.24	48.0	2.8	2.08	59.0	4.7	23.08	1.23	1.68	II	F	Fair	Fair	F	P
M07	B	C	Gravel	Plane Bed	None	No	7.46	49.24	56.0	2.8	1.89	198.0	3.8	29.63	3.54	1.36	III	F	Fair	Fair	F	P
M07	C	F	Cobble	Plane Bed	None	No	7.05	49.24	45.0	3.1	2.0	59.0	8.0	22.50	1.31	2.58	II	F	Fair	Fair	F	P
M08	0	C	Cobble	Plane Bed	b	No	2.68	25.85	30.0	2.4	1.5	112.0	3.9	20.00	3.73	1.62	III	F	Fair	Good	F	P
M09	A	E	Gravel	Riffle-Pool	None	Yes	1.20	21.03													F	F
M09	B	C	Gravel	Riffle-Pool	None	No	0.81	21.03	17.0	1.6	1.29	612.0	1.6	13.18	36.00	1.00	I	F	Fair	Good	F	P
M10	A	B	Gravel	Plane Bed	None	No	60.00	15.06	13.0	1.6	1.24	24.0	4.4	10.48	1.85	2.75	III	F	Fair	Fair	F	P
M10	B					No	300.00	15.06													F	F
M10	C	C	Gravel	Riffle-Pool	None	No	98.18	15.06	10.0	1.5	1.06	45.0	1.5	9.43	4.50	1.00	I	F	Good	Good	F	P
M10	D	A	Bedrock	Cascade	None	Yes	120.00	15.06													F	F
M10	E	B	Gravel	Plane Bed	None	No	29.83	15.06	11.0	1.6	1.18	20.0	4.1	9.32	1.82	2.56	II	F	Fair	Fair	F	P
M10	F	C	Gravel	Riffle-Pool	None	No	8.12	15.06	10.0	1.5	1.06	45.0	1.5	9.43	4.50	1.00	I	F	Good	Good	F	P

Rapid Geomorphic Assessment

Otter Creek - Cold

			Degradation			Aggradation			Widening		Planform								
Reach	Seg-ment	Sub-Rch?	Score	STD	Historic	Score	STD	Historic	Score	Historic	Score	Historic	Geo. Score	Geo. Condition	Evol. Stage	Confin-ement Type	Sens-itivity	QC Stf	QC Aut
M01	A	No	14	None	Yes	11	None	No	13	No	6	No	0.55	Fair	IV	VB	Very	F	P
M01	B	No	9	None	Yes	7	None	No	8	No	8	No	0.40	Fair	II	VB	Very	F	P
M01	C	Yes	5	None	Yes	15	None	No	12	No	15	No	0.59	Fair	II	SC	High	F	P
M02	0	No											0.00			NC		F	F
M03	0	No	5	C to B	Yes	12	None	No	8	No	9	No	0.43	Fair	III	NW	High	F	P
M04	0	No	10	None	Yes	11	None	No	8	No	11	No	0.50	Fair	III	NW	High	F	P
M05	0	No	5	B to F	Yes	11	None	No	10	No	11	No	0.46	Fair	III	SC	Extreme	F	P
M06	0	No	8	None	Yes	11	None	No	8	No	10	No	0.46	Fair	III	BD	High	F	P
M07	A	No	6	C to F	Yes	13	None	No	10	No	11	No	0.50	Fair	II	NW	Extreme	F	P
M07	B	No	13	None	Yes	13	None	No	11	No	13	No	0.63	Fair	III	VB	Very	F	P
M07	C	No	3	C to F	Yes	16	None	No	11	No	14	No	0.55	Fair	II	VB	Extreme	F	P
M08	0	No	11	None	Yes	13	None	No	11	No	13	No	0.60	Fair	III	NW	High	F	P
M09	A	Yes											0.00			VB		F	F
M09	B	No	16	None	No	10	None	No	13	No	11	No	0.63	Fair	I	VB	Very	F	P
M10	A	No	5	C to B	No	16	None	No	13	No	16	No	0.63	Fair	III	NW	High	F	P
M10	B	No											0.00			VB		F	F
M10	C	No	16	None	No	15	None	No	15	No	15	No	0.76	Good	I	VB	High	F	P
M10	D	Yes											0.00			NC		F	F
M10	E	No	3	C to B	Yes	16	None	No	13	No	13	No	0.56	Fair	II	NW	High	F	P
M10	F	No	18	None	No	15	None	No	16	No	13	No	0.78	Good	I	NW	High	F	P

APPENDIX B

Channel Evolution Models

(Vermont Agency of Natural Resources, Appendix C, May 2007)

Channel Evolution Models

F-stage Channel Evolution Process

The capital letters used throughout the following discussions refer to the stream types (Rosgen, 1996) typically encountered as the channel form passes through the different stages of channel evolution. The F-stage adjustment process begins where the streams are not entrenched and have access to a floodplain at the 1-2 year flood stage. Moderately entrenched, semi-confined "B" streams may also go through an F-stage channel evolution. This channel evolution model (CEM) is based on the assumption that the stream has a bed and banks that are sufficiently erodible so that they can be shaped by the stream over the course of years or decades. Streams beginning this process are typically flowing in alluvium or other materials that may be eroded by an increase in stream power. As the incision process continues, they may degrade to bedrock or glacial till materials. When a stream with a low width to depth ratio ("E" stream types) goes through this process, the sequence of stream types may be **E-C-F-C-E** (other forms may include **E-C-G-F-C-E** or **C-G-F-C** or **C-F-C** or **C-B-F-B-C** or **B-G-F-B** or **B-G-F** or **C-B-C**).

Stage I - Channel in regime with access to floodplain or flood prone area at discharges at and above the average annual high flow. Planform is moderate to highly sinuous; supportive of energy dissipating bed features (steps, riffles, runs, pools) essential to channel stability (B, C and E Stream Types). Channel slope (vertical drop in relation to length) generates flow velocities and stream power in balance with the resistance of stream bed and bank materials. Sediment transport capacity in equilibrium with sediment load.

Stage II - Channel has lost access to its floodplain or flood prone area, at its historic bankfull discharge, through a bed degradation process or floodplain build up. Stream has become more entrenched as discharges in excess of the annual high flow are now contained in the channel (B or G or F Stream Type). Channel slope is increased with commensurate increase in velocity and power to erode the stream bed and banks (boundary materials). The result of preventing access to the floodplain and containing greater flows in the channel is to increase the stream's power that must be resisted by the channel boundary materials; i.e., the rocks, soil, vegetation or man-made structures that make up the bed and banks of the river. Plane bed may begin to form as head cuts move upstream and step/riffle materials are eroded.

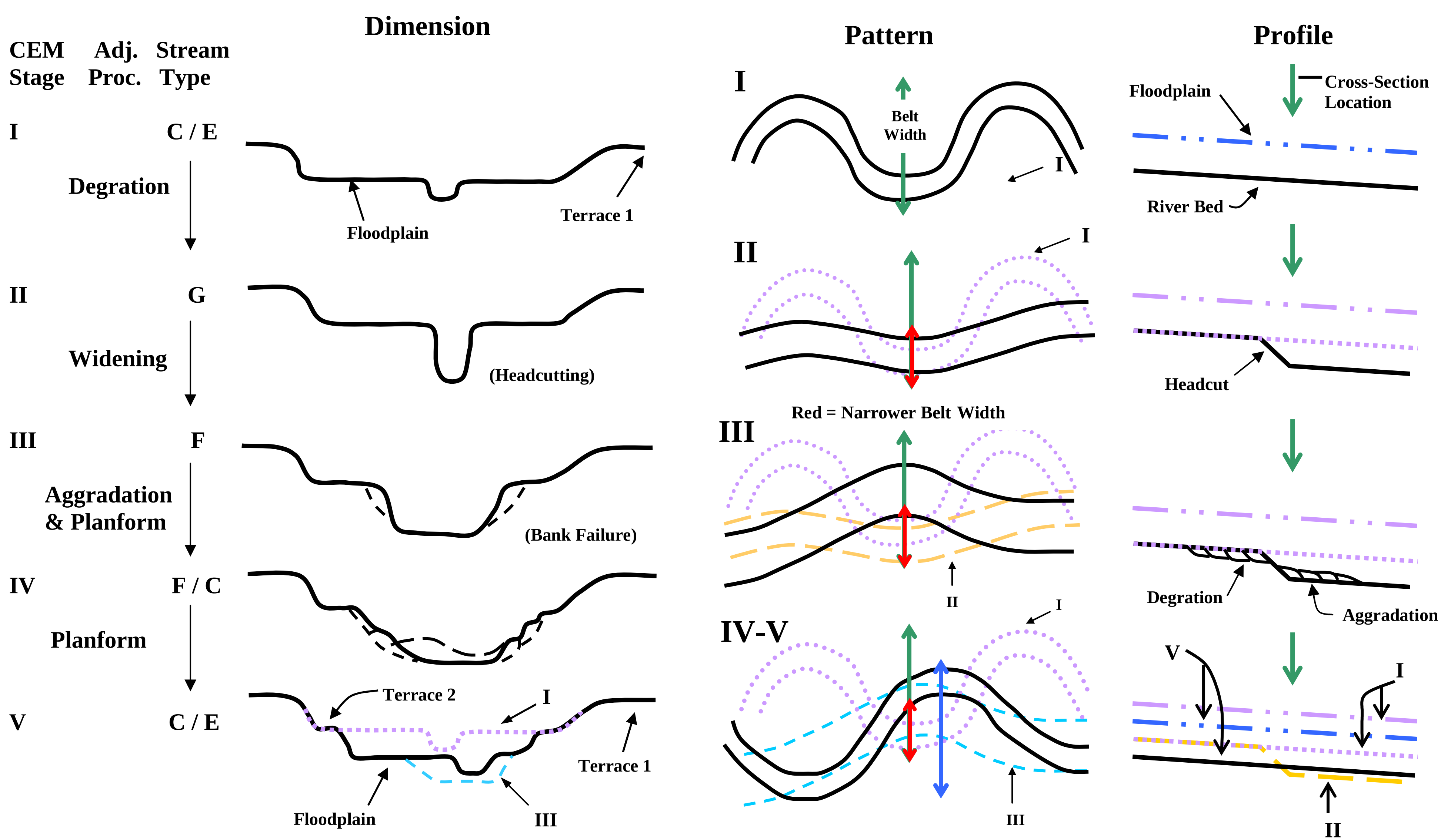
Stage III - Channel is still entrenched, widening and migrating laterally through bank erosion caused by the increased stream power (B or G or F Stream Type). The system regains balance between the power produced and the boundary materials as sinuosity increases and slope decreases. There are profound physical adjustments that occur upstream and downstream from the site of alteration as bed degradation (head cuts) migrates up through the system and aggradation in the form of sedimentation occurs downstream. Stream bed largely becomes a featureless plane bed.

Stage IV - Channel dimension and plan form adjustment process continues. Channel width begins to narrow through aggradation and the development of bar features. The main channel may shift back and forth through different flood chutes, continuing to erode terrace side slopes as a juvenile floodplain widens and forms. Weak step/riffle-pool bed features forming. Transverse bars may be common as planform continues to adjust. At Stage IV, erosion may be severe. Historically, channels have been dredged, bermed, and/or armored at this Stage pushing the process back to Stage II or III.

Stage V - Channel adjustment process is complete. Channel dimension, pattern, and profile are similar to the pre-adjustment form but at a lower elevation in the landscape (B, C and E Stream Types). Planform geometry, longitudinal profile, channel depth, and bed features produce an energy grade that is in balance with the sediment regime produced by the stream's watershed.

Higher gradient, more entrenched streams ("A" or "B" stream types) with erodible beds also go through channel evolution processes that involves bed degradation. In these cases, the floodplain forming stages may be comparatively minor. A lowering of the bed elevation is more quickly followed by a re-sloping of the banks until the appropriate energy grade is achieved.

F-stage Channel Evolution Process (VTDEC-Modified from Schumm, 1977 & 1984 and Thorne et al, 1997)



D-stage Channel Evolution Process

Only use the D stage CEM where the stream has no opportunity to incise. If the stream has incised and has now hit bedrock or clay and is currently widening, you would still use the F stage CEM.

The capital letters used throughout the following discussions refer to the stream types (Rosgen, 1996) typically encountered as the channel form in the different stages of channel evolution. The difference between F and D-stage channel evolution processes is the degree of channel incision. In D-stage channel evolution, the dominant, active adjustment processes is **aggradation**, widening, and plan form change. In some situations, the stream may not experience any degradation because its bed is significantly more resistant to erosion than its banks. The process may start with limited vertical adjustment and goes right into aggradation and a lateral adjustment processes. Stream with low width to depth ratios ("E" Stream Types) may also go through this process.

Stage I - Channel in regime with access to floodplain or flood prone area at discharges at and above the average annual high flow (B, C and E Stream Types). Plan form is moderate to highly sinuous; supportive of energy dissipating bed features (steps, riffles, runs, pools) essential to channel stability. Channel slope (vertical drop in relation to length) generates flow velocities and stream power in balance with the resistance of stream bed and bank materials. **Then either of the following Stage II scenarios may occur:**

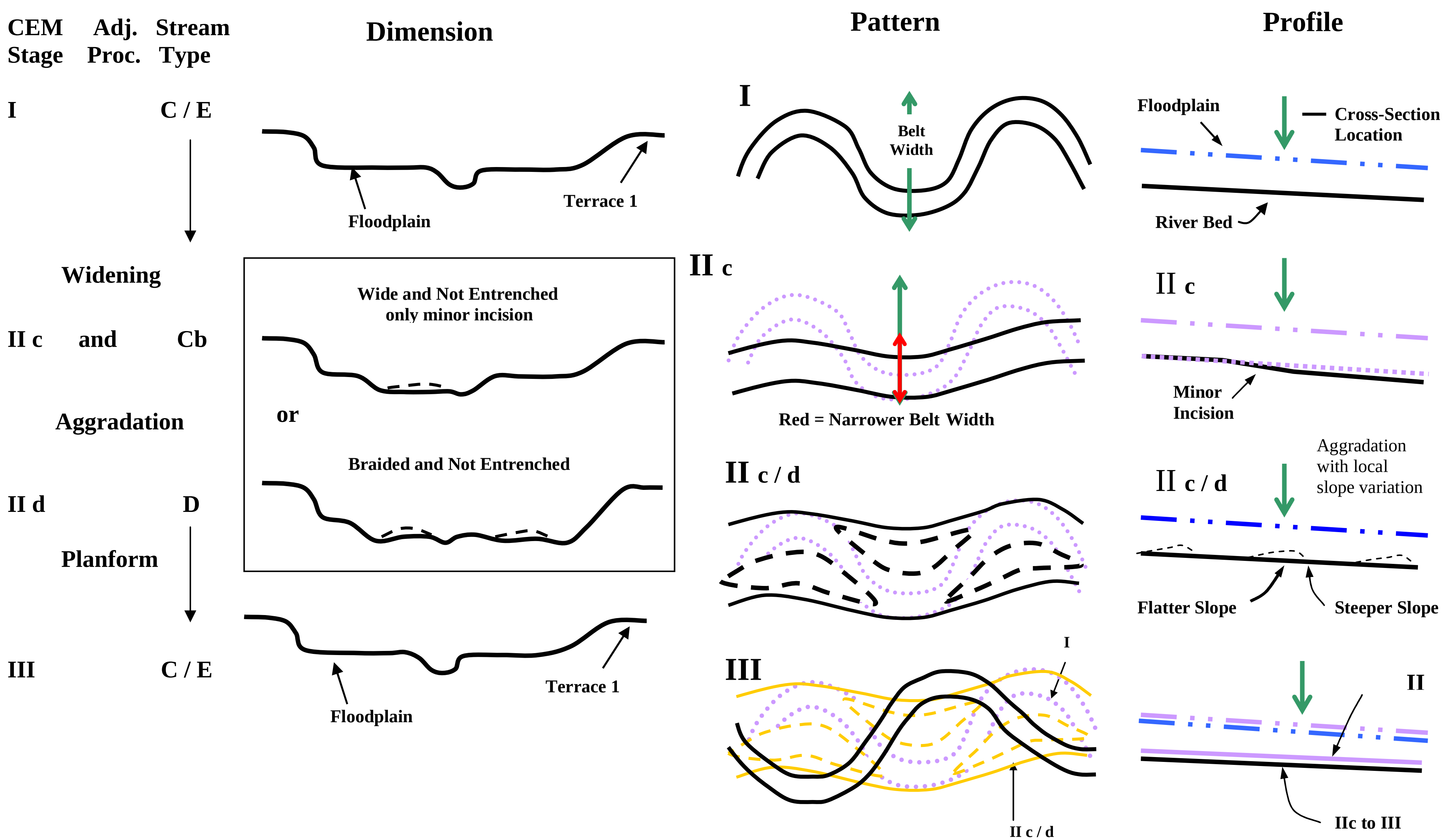
Stage IIc Steeper gradient may be imposed through activities such as channelization, but due to the resistance of the bed material, the stream has not incised significantly or lost access to its floodplain (remaining a "C" Stream Type). Channel is widening and migrating laterally through bank erosion caused by the increased stream power. The balance between stream power and boundary materials is re-established when the slope flattens after a process of channel lengthening and increased sinuosity. Stream bed may be a combination of poorly defined riffle-pool and plane bed features.

Stage IId Channel becomes extremely depositional and becomes braided with water flowing in multiple channels at low flow stage ("D" stream type). Dimension and plan form adjustment processes continue. Channel width begins to narrows through aggradation and the development of bar features. The main channel may shift back and forth through different channels and chute cut-offs, continuing to erode banks or terrace side slopes. Riffle-pool bed features develop as single thread channel begins forming. Transverse bars may be common as planform continues to adjust.

Stage III Channel adjustment process is complete (back to a B, C or E stream type). Channel dimension, pattern, and profile are similar to the pre-adjustment form. May or may not be at a lower elevation in the landscape. Planform geometry, longitudinal profile, channel depth, and bed features produce an energy grade (sediment transport capacity) that is in balance with the sediment regime produced by the stream watershed.

Important Notes: 1) The imposition of new constraints or changes at watershed, reach, or local scales, especially those related to large floods that energize the stream system with high flows of water, sediment, and debris, will affect the time scales associated with each stage of channel evolution. They may also have dramatic effects on the direction of a channel evolution process. The overlapping pulses of channel adjustment moving upstream and downstream in a watershed often makes the pinpointing of a specific channel evolution stage complicated. 2) Bedrock-controlled reaches in Vermont are presumed to be relatively fixed for the purposes of these protocols as little bed or back erosion can be expected even over a century. Such reaches may, however, dramatically change or evolve due to rapid or catastrophic avulsions of the flow onto more erodible sediments nearby, leaving the bedrock channel wholly or partially abandoned.

C-D-C Channel Evolution Process (VTDEC-Modified from Schumm, 1977 & 1984 and Thorne et al, 1997)



APPENDIX C

STANDARD DMS
BRIDGE AND CULVERT REPORTS

Stream Geomorphic Assessment VT DEC

Failure Modes Report - Geomorphic Incompatibility

Explanation of codes used in table header

Failure Modes		Existing Problems	
F1	Concern for structure due to fluvial condition or process	P1	Upstream sediment deposit
F2	Potential failure due to out-flanking	P2	Upstream Scour and/or erosion present
F3	Potential failure due to scour	P3	Downstream Scour and/or erosion present
F4	Potential failure due to ice or debris jam	P4	Inlet obstruction present
F5	Structure related damage due to flooding of adjacent property	P5	Poor location or alignment
F6	Structure related damage due to erosion of adjacent property	P6	Beaver activity
		P7	Floodplain filled entirely or partially by roadway approaches
Width	Structure width divided by channel width as a percent (% bankfull width)		

					X = meets criteria MD = missing data													
Town	Road	Stream Name	Structure: SGA / VOBCIT	Type	F1	F2	F3	F4	F5	F6	P1	P2	P3	P4	P5	P6	P7	Width
Clarendon	Railroad	Cold River	700000000111053 990004000611051	Bridge	-	-	X	-	-	-	X	X	X	-	X	-	X	196 %
Clarendon	Railroad	Cold River	700000000211053 990014000711051	Bridge	-	-	X	X	-	X	X	X	X	X	X	-	X	110 %
Clarendon	COLD RIVER RD	Cold River	101105001311051	Bridge	-	-	-	-	-	-	-	-	-	-	-	-	X	102 %
Clarendon	MIDDLE RD	Cold River	200127001411052 990001000211051	Bridge	X	-	-	-	-	X	X	-	-	-	-	-	X	131 %
Clarendon	ROUTE 7	Cold River	200019009611052	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	156 %
Shrewsbury	Private	Cold River	700000000111223 400002020011221	Bridge	-	X	-	X	X	X	X	X	-	X	X	X	X	86 %
Shrewsbury	Private-logging	Cold River	700000000211223 400003020211221	Bridge	-	X	-	X	X	X	-	-	-	-	X	X	X	58 %
Shrewsbury	COLD RIVER RD	Cold River	101122000711221 990030020311221	Bridge	-	-	-	-	-	X	X	-	-	-	X	-	X	116 %
Shrewsbury	EASTHAM RD	Cold River	401122002811221 600003044111221	Culvert	-	X	X	X	X	X	X	-	X	-	-	-	X	36 %
Shrewsbury	MT SCHOOL RD	Cold River	100000000011221 600002050411221	Culvert	-	-	X	X	-	X	-	-	X	-	-	-	X	79 %
Shrewsbury	NORTHAM RD	Cold River	401122000211221 600002051311221	Culvert	-	X	X	X	X	X	X	-	-	X	X	-	X	43 %
Shrewsbury	OLD PLYMOUTH RD	Cold River	401122001411221 990020060411221	Bridge	-	X	X	X	X	X	-	X	X	X	-	-	X	43 %
Shrewsbury	UPPER COLD RIVER RD	cold river	101122003411221 990006061011221	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	172 %
Shrewsbury	WILMOUTH HILL RD	cold river	101122003311221 990013061511221	Bridge	-	-	-	-	-	-	-	-	-	-	-	-	X	122 %

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Failure Modes Report - Geomorphic Incompatibility

Explanation of codes used in table header

Failure Modes		Existing Problems	
F1	Concern for structure due to fluvial condition or process	**P1**	Upstream sediment deposit
F2	Potential failure due to out-flanking	**P2**	Upstream Scour and/or erosion present
F3	Potential failure due to scour	**P3**	Downstream Scour and/or erosion present
F4	Potential failure due to ice or debris jam	**P4**	Inlet obstruction present
F5	Structure related damage due to flooding of adjacent property	**P5**	Poor location or alignment
F6	Structure related damage due to erosion of adjacent property	**P6**	Beaver activity
		P7	Floodplain filled entirely or partially by roadway approaches
Width	Structure width divided by channel width as a percent (% bankfull width)		

X = meets criteria MD = missing data

Town	Road	Stream Name	Structure: SGA / VOBCIT	Type	F1	F2	F3	F4	F5	F6	P1	P2	P3	P4	P5	P6	P7	Width
Clarendon	Railroad	Cold River	700000000111053 990004000611051	Bridge	-	-	X	-	-	-	X	X	X	-	X	-	X	196 %
Clarendon	Railroad	Cold River	700000000211053 990014000711051	Bridge	-	-	X	X	-	X	X	X	X	X	X	-	X	110 %
Clarendon	COLD RIVER RD	Cold River	101105001311051	Bridge	-	-	-	-	-	-	-	-	-	-	-	-	X	102 %
Clarendon	MIDDLE RD	Cold River	200127001411052 990001000211051	Bridge	X	-	-	-	-	X	X	-	-	-	-	-	X	131 %
Clarendon	ROUTE 7	Cold River	200019009611052	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	156 %
Shrewsbury	Private	Cold River	700000000111223 400002020011221	Bridge	-	X	-	X	X	X	X	X	-	X	X	X	X	86 %
Shrewsbury	Private-logging	Cold River	700000000211223 400003020211221	Bridge	-	X	-	X	X	X	-	-	-	-	X	X	X	58 %
Shrewsbury	COLD RIVER RD	Cold River	101122000711221 990030020311221	Bridge	-	-	-	-	-	X	X	-	-	-	X	-	X	116 %
Shrewsbury	EASTHAM RD	Cold River	401122002811221 600003044111221	Culvert	-	X	X	X	X	X	X	-	X	-	-	-	X	36 %
Shrewsbury	MT SCHOOL RD	Cold River	100000000011221 600002050411221	Culvert	-	-	X	X	-	X	-	-	X	-	-	-	X	79 %
Shrewsbury	NORTHAM RD	Cold River	401122000211221 600002051311221	Culvert	-	X	X	X	X	X	X	-	-	X	X	-	X	43 %
Shrewsbury	OLD PLYMOUTH RD	Cold River	401122001411221 990020060411221	Bridge	-	X	X	X	X	X	-	X	X	X	-	-	X	43 %
Shrewsbury	UPPER COLD RIVER RD	cold river	101122003411221 990006061011221	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	172 %
Shrewsbury	WILMOUTH HILL RD	cold river	101122003311221 990013061511221	Bridge	-	-	-	-	-	-	-	-	-	-	-	-	X	122 %

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Culvert Aquatic Organism Passage Report - Potential Barriers to Movement and Migration

				X = meets criteria MD = missing data				
				all fish and stream salamanders				
AOP = Aquatic Organism Passage				except adult salmonids	including adult salmonids			
Town	Road	Stream Name	Structure: SGA - VOBCIT	[RED] Blocks AOP	[RED] Blocks AOP	[GRAY] Potentially blocks AOP	[GREEN] Does not block AOP	Percent Bankfull Width
Shrewsbury	EASTHAM RD	Cold River	401122002811221 - 600003044111221	-	-	X	-	36 %
Shrewsbury	MT SCHOOL RD	Cold River	100000000011221 - 600002050411221	-	X	-	-	79 %
Shrewsbury	NORTHAM RD	Cold River	401122000211221 - 600002051311221	-	-	X	-	43 %

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Culvert Aquatic Organism Passage Report - Potential Barriers to Movement and Migration

				X = meets criteria MD = missing data				
				all fish and stream salamanders				
AOP = Aquatic Organism Passage				**except adult salmonids**	**including adult salmonids**			
Town	**Road**	**Stream Name**	**Structure: SGA - VOBCIT**	[RED] **Blocks AOP**	[RED] **Blocks AOP**	**[GRAY] Potentially blocks AOP**	[GREEN] **Does not block AOP**	**Percent Bankfull Width**
Shrewsbury	EASTHAM RD	Cold River	401122002811221 - 600003044111221	-	-	X	-	36 %
Shrewsbury	MT SCHOOL RD	Cold River	100000000011221 - 600002050411221	-	X	-	-	79 %
Shrewsbury	NORTHAM RD	Cold River	401122000211221 - 600002051311221	-	-	X	-	43 %

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