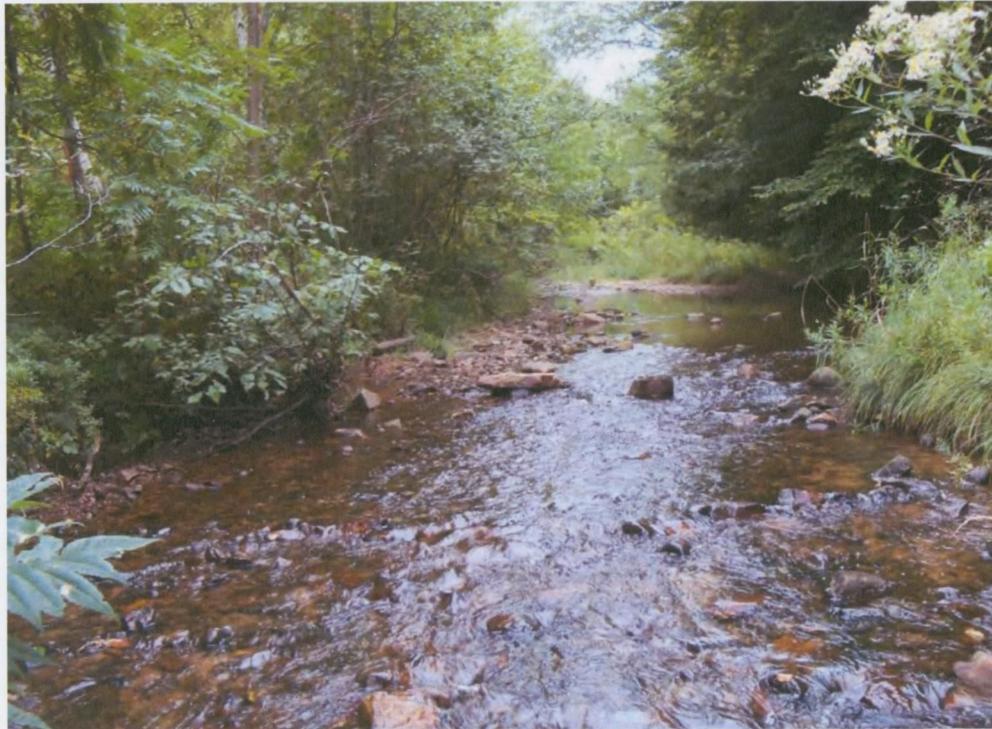




Gunstock Brook Watershed Stream Geomorphic Assessment Gilford, New Hampshire July 9, 2012



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Gunstock Brook Watershed Stream Geomorphic Assessment Gilford, New Hampshire

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1.0 EXECUTIVE SUMMARY

A stream geomorphic assessment of Gunstock Brook was conducted by Bear Creek Environmental, LLC (BCE) in August 2011. The study was funded by the Samuel P. Pardoe Foundation and the Belknap County Conservation District. A planning strategy based on fluvial geomorphic science (see glossary at end of report for associated definitions) was chosen because it provides a holistic, watershed-scale approach to identifying the stressors on river ecosystem health. The stream geomorphic assessment data can be used by resource managers, community watershed groups, municipalities and others to identify how changes to land use alter the physical processes and habitat of rivers. The stream geomorphic assessment data will be used to help focus stream restoration activities within the watershed and assist with town planning.

The stream geomorphic assessment followed the Vermont Agency of Natural Resources Protocols that has been adopted by the New Hampshire Department of Environmental Services (NHDES). The Gunstock Brook watershed was divided into six reaches for the Phase 2 assessment (five on the main stem and one on a major tributary to Gunstock Brook), encompassing approximately six miles of stream channel. The most downstream 550 feet of the main stem was impounded and did not receive a full Phase 2 assessment. Bridge and culvert data collected by BCE were used to identify structures that have the potential to fail because of channel adjustments, are having a geomorphic impact on the stream, or are impeding aquatic organism passage.

Some problems in the Gunstock Brook watershed include undersized stream crossings, corridor encroachments, increased stormwater runoff from impervious surfaces, channel straightening associated with the construction of roads and development, lack of riparian buffers, mass failures, and degraded water quality through sediment loading. Several reaches of Gunstock Brook and the major tributary have undersized culverts or bridges that are causing localized geomorphic instability and are reducing or impeding fish passage. Alteration of stream channels mostly in the downstream section of Gunstock Brook has caused major to extreme channel degradation resulting in a disconnection between the channel and adjacent floodplain. High quality streamside buffers are lacking along the many reaches where development is prevalent within the river corridor of Gunstock Brook. Despite all these impacts, there are areas within the watershed that still contain well forested river corridors as well as undeveloped wetland areas.

A list of 20 potential restoration and conservation projects was developed during project identification. Types of projects include: river corridor protection through conservation easements or adoption of fluvial erosion hazard zones, replacing undersized structures causing localized channel instability, improving riparian buffers, alternative analysis for dam removal and

berm removal, remediation of erosion from a well discharge to improve water quality, and improved stormwater treatment.

2.0 BACKGROUND

The Belknap County Conservation District retained Bear Creek Environmental, LLC to conduct a Phase 2 Geomorphic Assessment within the Gunstock Brook Watershed. The Gunstock Brook watershed has a drainage area of approximately 9 square miles at the mouth, where the brook enters Sanders Bay of Lake Winnepesaukee (Figure 2.1). A summary of the geomorphic condition of Gunstock Brook and one major tributary is described in this report along with the identification of preliminary projects to be further developed. Stream geomorphic assessment data can be used by resource managers, community watershed groups, municipalities and others to identify how changes to land use alter the physical processes of rivers.

A total of approximately six river miles were assessed using Phase 2 protocols, including five reaches on the main stem of Gunstock Brook and one reach on its major tributary. These six reaches (M01 through M05 and T2.01) were further divided into eighteen segments during the Phase 2 investigation based on changes in channel conditions identified during the field work. A segment is distinct in one or more of the following parameters: degree of floodplain encroachment or channel alteration, presence of grade controls, channel dimensions, channel sinuosity and slope, riparian vegetation and corridor conditions, and degree of flow regulation. Segments are assigned letters starting with "A" at the most downstream end of the reach. All segments were assessed except for the most downstream segment, which was impounded from Lake Winnepesaukee.

This study of the Gunstock Brook watershed utilized state-of-the-art Stream Geomorphic Assessment (SGA) protocols developed by the Vermont Department of Environmental Conservation (VTDEC). The SGA protocols are intended to be used by resource managers, community watershed groups, municipalities and others to identify how changes to land use affect hydro-geomorphic processes at the landscape and reach scale, and how these changes alter the physical structure and biological habitat of rivers. The Vermont protocol includes three phases:

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

BCE conducted a partial Phase 1 assessment of the Gunstock Brook watershed during spring 2011. This partial phase 1 assessment included breaking the watershed into reaches (sections of river that are similar), and characterizing the reaches in terms valley confinement (valley width) and valley slope. The fieldwork for the Phase 2 assessment was completed in August 2011 by BCE. Bridge and culvert assessments following the New Hampshire Stream Crossing Protocol were conducted on all assessed reaches. These field data were used to develop preliminary river restoration and protection projects presented in this report. Phase 3 surveys for active restoration projects, may be required at some point in the near future for project design and permitting. The Phase 1 and 2 stream geomorphic assessment data can be used by

resource managers to develop fluvial erosion hazard (FEH) zones. FEH zoning ordinances are intended to prevent increased river encroachment in areas prone to fluvial erosion hazards to reduce property loss and damage, and encourage long-term river stability. Although the delineation of FEH zones were not part of this study, the data collected in 2011 can be used in the future to develop these zones.

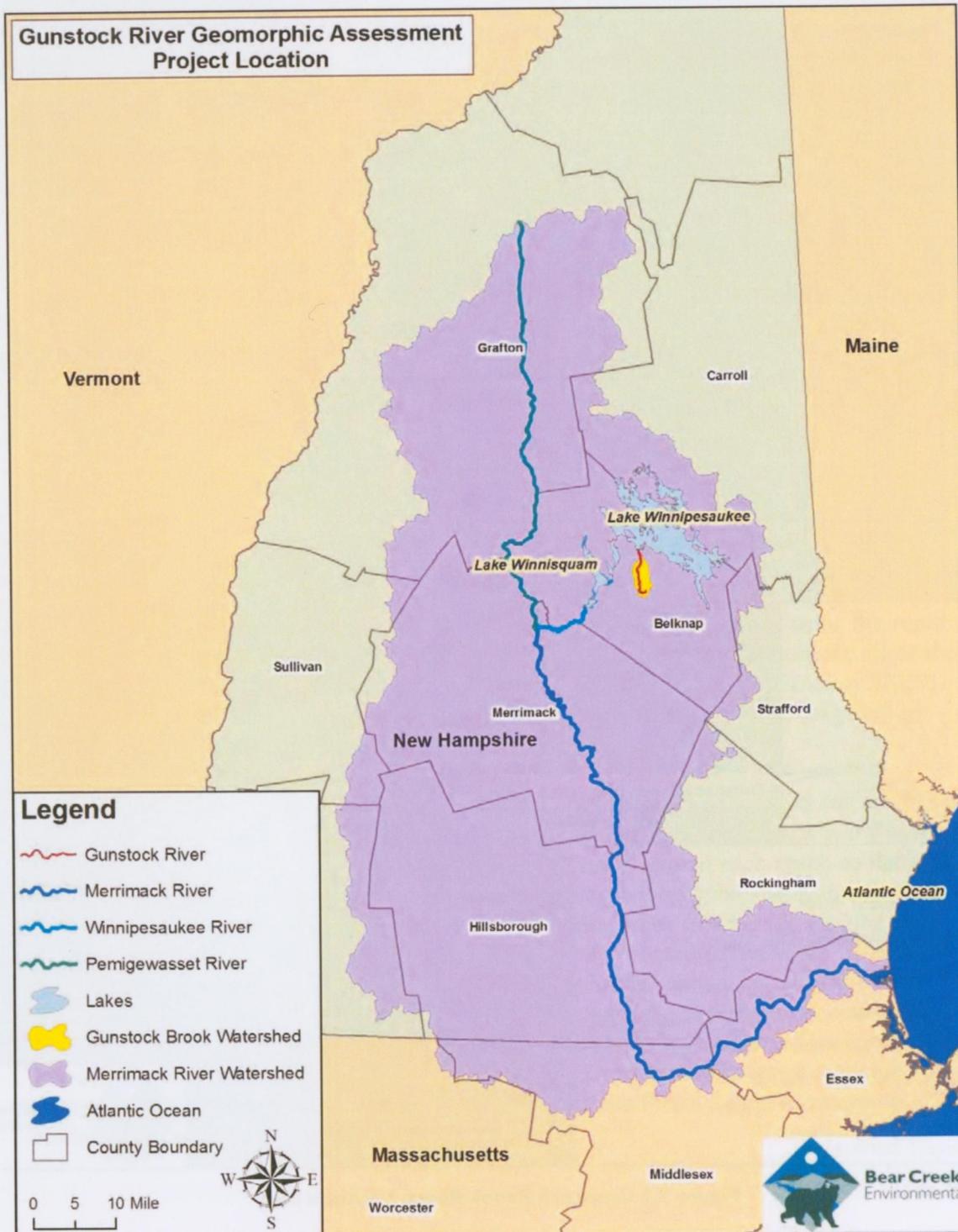


Figure 2.1 Project Location Map

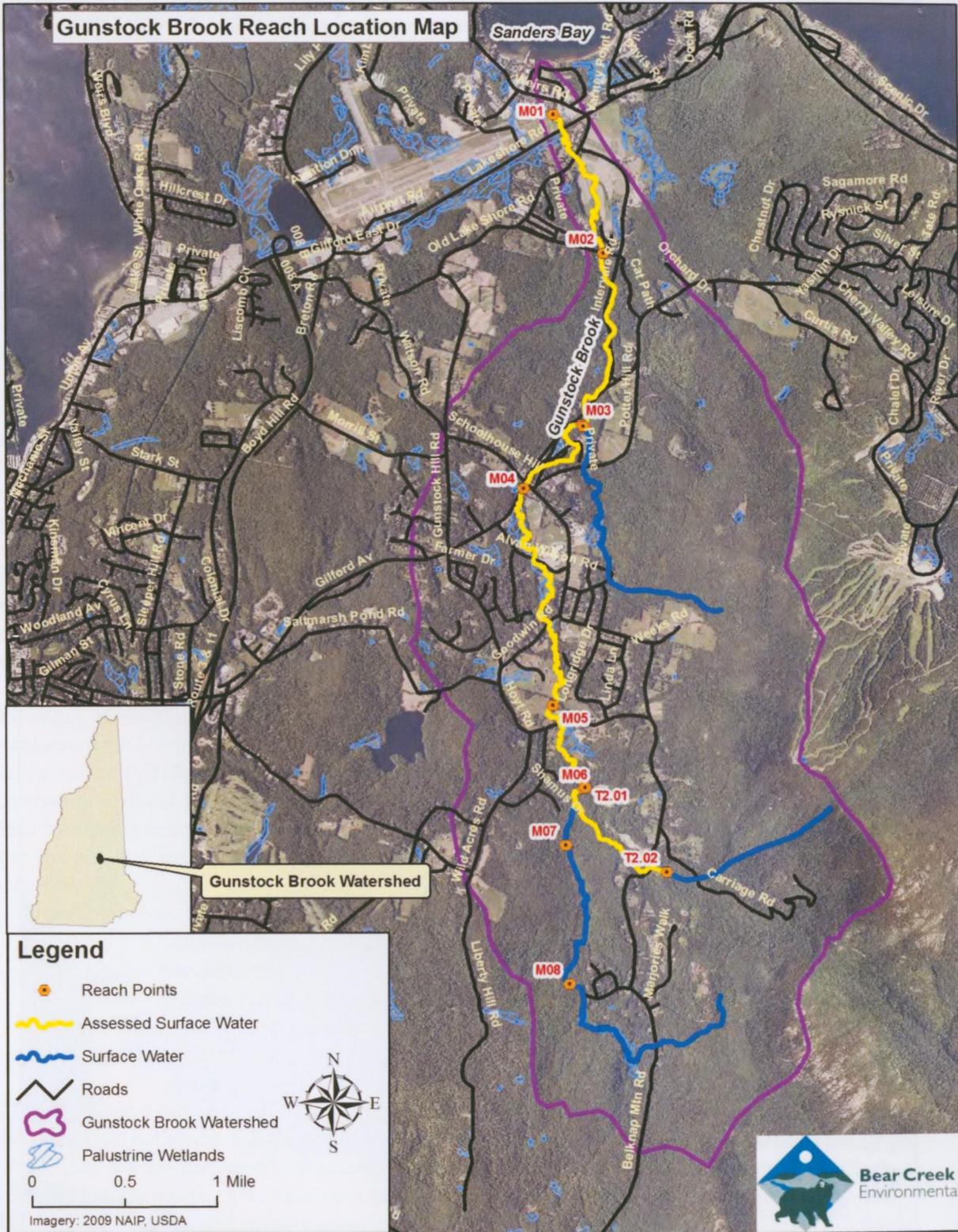


Figure 2.2 Gunstock Brook Reach Location Map

3.0 METHODS

A summary of the Phase 1, Phase 2, and Bridge and Culvert methodologies is provided in the following sections.

3.1 Phase 1 Methodology

The Phase 1 assessment followed procedures specified in the Vermont Stream Geomorphic Assessment Handbook Phase 1 (Vermont Agency of Natural Resources 2007), and used version 4.59 of the Stream Geomorphic Assessment Tool (SGAT). SGAT is an ArcView extension. Phase 1, the remote sensing phase, involves the collection of data from topographic maps and aerial photographs, from existing studies, and from very limited field studies, called "windshield surveys". The Phase 1 assessment provides an overview of the general physical nature of the watershed. As part of the Phase 1 study, stream reaches are determined based on geomorphic characteristics such as: valley confinement, valley slope, geologic materials, and tributary influence. The stream centerline of Gunstock Brook was delineated using 2010 orthoimagery. In addition, a short section of stream channel behind the Gilford Town Hall was mapped using a submeter GPS unit to better understand the location that could not easily be discerned from the 2010 imagery.

3.2 Phase 2 Methodology

The Phase 2 assessment of the Gunstock Brook watershed followed procedures specified in the Vermont Stream Geomorphic Assessment (SGA) Handbook Phase 2 (Vermont Agency of Natural Resources, 2009), and used version 4.59 of the Stream Geomorphic Assessment Tool (SGAT) Geographic Information System (GIS) extension to index impacts within each reach. The geomorphic condition for each Phase 2 reach is determined using the rapid geomorphic assessment (RGA) protocol, and is based on the degree of departure of the channel from its reference stream type (Vermont Agency of Natural Resources, 2009). The study also used a new rapid habitat assessment (RHA) protocol (Vermont Agency of Natural Resources, 2008a; Milone and MacBroom, Inc, 2008c).

Reaches determined during Phase 1 were broken up further into segments for the Phase 2 geomorphic assessment as necessary. Topographic maps and orthophotos were used as a first cut in delineating segment breaks. The project team walked each reach to confirm preliminary segment breaks determined from reviewing topographic maps and orthophotos. The reaches were walked to the extent that conditions were suitable for walking and landowners had granted permission. Attributes that were considered when determining segment breaks include: grade controls, changes in channel dimensions, changes in dominant bed material, slope, entrenchment or sinuosity, signs of planform changes, presence of beaver dams, and evidence of aggradation and degradation. The bankfull width and depth were measured occasionally along the reach to track changes in bankfull dimensions. Once segment breaks were determined, the Phase 2 field forms were completed accordingly.

Valley walls delineated during Phase 1 were field verified using a range finder and submeter GPS unit (Trimble Geoexplorer 2008 series). Human caused changes in valley width due to permanent high embankments that serve as artificial valley walls were also mapped on field sketches with reference to topographic maps and/or orthophotographs. The valley walls were used to evaluate Phase 2 confinement. Adjacent terraces and valley walls were evaluated in terms of their proximity to the channel as outlined in the most current version of the Vermont Phase 2 SGA Handbook. The location, total height and height above water surface were recorded for channel spanning grade controls, both natural and human constructed.

Channel dimensions and bed substrate composition were measured at one to three representative locations within each segment. The channel dimensions and substrate composition were recorded on the Cross-section Worksheet and summarized on the Rapid Stream Assessment Field Notes form under Step 2. Stream type was evaluated based on the channel dimension data, bed substrate composition results, and confirmed channel slope. Dominant bed forms were determined based on the criteria set forth in the most recent version of the Vermont Phase 2 SGA Handbook.

Stream banks were evaluated in terms of their typical slope and dominant texture as outlined in the Vermont Phase 2 SGA Handbook. Areas of bank erosion, mass failures, and gullies were mapped and pertinent information regarding the height and length of such features was recorded. Areas lacking adequate riparian buffers (<25 feet) were mapped and notes were made about the types of vegetation comprising existing riparian buffers. River corridor encroachments including roads, railroads, improved paths, and development were mapped according to their locations, and the height of these encroachments was recorded. Notes were also taken concerning river corridor land use activities.

The locations of springs, seeps, small tributaries, adjacent wetlands, debris jams, beaver dams and channel constrictions were recorded and evaluated in terms of how they may be affecting channel flows. Locations of stormwater inputs from urban runoff, agricultural drainage and road ditching were noted to determine the extent of increased flow status during a storm event. Similarly, locations of flow regulations and water withdrawals were mapped to evaluate potential decreases in channel flows.

Depositional features were mapped to assess the sediment transport regime and storage capacity of the segment. Channel migration features were also mapped in order to determine the amount of channel planform adjustment the segment was undergoing. Sections of the stream where the channel does not appear to be following the natural path of the river and may have been straightened were noted, along with locations where material has been removed from the channel in order to assess the extent to which stream power and morphology have been altered. Steep riffles and headcuts were mapped and used as indicators of active geomorphic processes.

RHA and RGA field forms were completed for the Phase 2 reaches. The appropriate RHA and RGA forms were selected based on segment characteristics and scored according to the data collected from the field assessment. A segment score and corresponding condition

were determined for both the RHA and the RGA. Additionally for the RGA, major geomorphic processes were identified, the stage of channel evolution was determined, and a stream sensitivity rating was assigned.

The RHA is used to evaluate the physical components of a stream (channel bed, banks, and riparian vegetation) and how the physical condition of the stream affects aquatic life. The RHA results can be used to compare physical habitat condition between sites, streams, or watersheds, and they can also serve as a management tool in watershed planning.

To assure a high level of confidence in the Phase 2 SGA data, strict quality assurance/quality control (QA/QC) procedures were followed by BCE. These procedures involved a thorough in-house review of all data, which took place during January 2012. The Project Team conducted the assessment according to the approved Quality Assurance procedures specified in the Phase 2 handbook.

A quality control review of the Gunstock Brook geomorphic assessment data by the New Hampshire Geological Survey was initiated by BCE to lay the ground work for the development of Fluvial Erosion Hazard (FEH) Zones, which are based on the Phase 1 and 2 stream geomorphic assessment data. Stream geomorphic assessment data and delineated FEH zones need to go through the standard QA review from the NHGS in order for the Department of Environmental Services (DES) to state the zones are consistent with the Department's protocols. Dave Jeffers, Regional Planner with the Lakes Regional Planning Commission has been working with the Gilford Hazard Mitigation Plan Update Committee. According to Mr. Jeffers, there may be local interest in using the stream geomorphic assessment data to develop FEH zones for Gunstock Brook.

Shane Csiki of the New Hampshire Geological Survey (NHGS) conducted a QA/QC review of the data collected by Bear Creek Environmental (BCE) for Gunstock Brook. At the end of January, 2012, the NHGS sent the first set of QA recommendations based on review of the GIS data. The NHGS recommended that changes be made to the stream centerline and the valley walls. Based on recommendations from NHGS, BCE updated the stream centerline using 2010 orthoimagery. The meander centerline and valley walls were also updated. NHGS reviewed the updated files for valley walls and stream centerline and then made further recommendations on February 6, 2012 referring to refining the valley walls and the stream centerline. Mr. Csiki accepted the revisions and provided a couple of additional comments. BCE conducted a field visit to verify valley wall locations on February 10, 2012. The valley walls and meander centerlines were updated once more and SGAT was rerun.

Following the review of GIS data, the NHGS reviewed the Phase 2 data excel spreadsheets. Mr. Csiki had questions/comments on four segments. These comments were addressed in a response document from BCE dated March 13, 2012. A second QA document was sent to BCE on 3/21/12 containing comments/questions on three segments on Gunstock Brook. BCE promptly responded (on March 28, 2012) to the comments and made necessary updates to the data. The Gunstock Brook stream geomorphic assessment data passed the

QA review by the NHGS, and these data are approved for use in developing FEH zones. The phase 2 QA comments and questions are provided at the end of Appendix A.

3.3 Bridge and Culvert Methodology

Bridge and culvert inventory and assessments were conducted by BCE during the Phase 2 assessment to determine if stream crossings were contributing to localized streambank erosion, sedimentation, and reduced fish passage. The New Hampshire Stream Crossing Protocol was followed. The Vermont Culvert Geomorphic Screening Tool (Milone and MacBroom, Inc., 2008a) and the Vermont Culvert Aquatic Organism Passage Screening Tool (Milone and MacBroom, Inc, 2008b) were used to identify culverts within the Gunstock Brook watershed that are highest priority for replacement/retrofit due to geomorphic incompatibility and/or for being potential barriers to movement and migration of aquatic organisms.

4.0 STREAM TYPES

Reference stream types are based on the valley type, geology and climate of a region and describe what the channel would look like in the absence of human-related changes to the channel, floodplain, and/or watershed. Table I shows the typical characteristics used to determine reference stream types (Vermont Agency of Natural Resources, 2009). Reference reach typing was based on both the Rosgen (1996) and the Montgomery and Buffington (1997) classification systems. Stream and valley characteristics including valley confinement, and slope were determined from digital United States Geological Survey (USGS) topographic maps (Table 2).

Stream Type	Confinement	Valley Slope	Bed Form
A	Narrowly Confined	Very steep > 6.5 %	Cascade
A	Confined	Very steep 4.0 - 6.5 %	Step-Pool
B	Confined or Semi-confined	Steep 3.0 - 4.0 %	Step-Pool
B	Confined, Semi-confined or Narrow	Moderate to Steep 2.0 - 3.0 %	Plane Bed
C or E	Unconfined (Narrow, Broad or Very Broad)	Moderate to Gentle <2.0 %	Riffle-Pool or Dune-Ripple
D	Unconfined (Narrow, Broad or Very Broad)	Moderate to Gentle <4.0 %	Braided Channel
F	Confined or Semi-confined	Moderate to Gentle <4.0 %	Variable

Table 2 lists the reference stream types for assessed reaches in the Gunstock Brook watershed. All reaches assessed for Phase 2 in the Gunstock Brook watershed are "C" channels by reference. Reference "C" channels have unconfined valleys with moderate to gentle valley slopes and moderate to high width to depth ratios and sinuosity. All the mainstem reaches, with the exception of M02 and M03, which are steeper, have an overall confinement type of very broad. Reaches M03 and T2.01 (on a tributary of Gunstock Brook) have slopes greater than 2.0 percent, and are therefore, assigned a subclass slope of "b". All reaches have a reference bedform of riffle-pool except for T2.01 which has a step-pool bedform. The reference reach characteristics were refined during the Phase 2 Assessment.

Stream	Reach ID	Reference Stream Type	Confinement	Valley Slope	Bedform
Gunstock Brook	M01	C	Very Broad	0.55	Riffle-Pool
	M02	C	Broad	1.99	Riffle-Pool
	M03	Cb	Broad	2.80	Riffle-Pool
	M04	C	Very Broad	0.66	Riffle-Pool
	M05	C	Very Broad	1.12	Riffle-Pool
Tributary to Gunstock Brook	T2.01	Cb	Very Broad	3.78	Step-pool

During the Phase 2 assessment, the six assessed reaches were broken into 18 segments based on detailed field observations. The existing stream type is based on channel dimensions measured during the Phase 2 assessment. The reference and existing stream type for each assessed reach/segment is included in Figures 4.1 and 4.2, respectively. Detailed segment summary data are provided in Appendix A. Table 3 summarizes the segment locations, and is included as reference for the reader.

Stream	Segment ID	Description
Gunstock Brook	M01-A	From mouth to Lakeshore Road
	M01-B	From Lakeshore Road to Old Lakeshore Road
	M01-C	Old Lakeshore Road to one-half mile upstream of Old Lakeshore Road
	M01-D	One-half mile upstream of Old Lakeshore Road to east of cul-de-sac on Hampshire Drive
	M01-E	East of cul-de-sac on Hampshire Drive to Henderson Road crossing
	M02 - A	Henderson Road crossing to where brook becomes close to Intervale Rd
	M02-B	Brook runs parallel and in close proximity to Intervale Road
	M02-C	From just downstream of Intervale Road Crossing to tributary

Stream	Segment ID	Description
		confluence south of Cherry Valley Road
	M03-A	Tributary confluence south of Cherry Valley Road to upstream of Tannery Hill Road Covered Bridge
	M03-B	Just upstream of Tannery Hill Road Covered Bridge to Belknap Mountain Road crossing
	M04-A	Belknap Mountain Road crossing to approximately 1000 feet upstream of Goodwin Road crossing
	M04-B	About 1000 feet upstream of Goodwin Road crossing to east of Given Drive cul-de-sac
	M04-C	East of Given Drive cul-de-sac to tributary confluence about 1000 feet upstream of Hoyt Road crossing
	M05-A	Tributary confluence about 1000 feet upstream of Hoyt Road crossing to Hoyt Road crossing
	M05-B	Hoyt Road crossing to northeast of Bridget Circle
	M05-C	Northeast of Bridge Circle to confluence with tributary 2 (T2)
Tributary 2	T2.01-A	Confluence with Gunstock Brook to below sand pit
	T2.01-B	Below sand pit to just east of Belknap Mountain Road Crossing

For most of the segments on the Gunstock Brook main stem, the existing stream type is "C". All but two segments have the same reference and existing stream type. For the two most downstream assessed segments located downstream and upstream of Old Lakeshore Road, M01-B and M01-C, the existing stream type differs from the reference stream type and a stream type departure has taken place. A stream type departure occurs when the channel dimensions deviate so far from the reference condition that the existing stream type is no longer the reference stream type. In both segments M01-B and M01-C a stream type departure from a reference "C" channel with slight entrenchment to a "B" channel with moderate entrenchment has occurred due to channel straightening and downcutting of the channel.

These stream type departures represent a significant change in floodplain access and stability. Watersheds which have lost attenuation or sediment storage areas due to human related constraints are generally more sensitive to erosion hazards, transport greater quantities of sediment and nutrients to receiving waters, and lack the sediment storage and distribution processes that create and maintain habitat (Vermont Agency of Natural Resources, 2009).

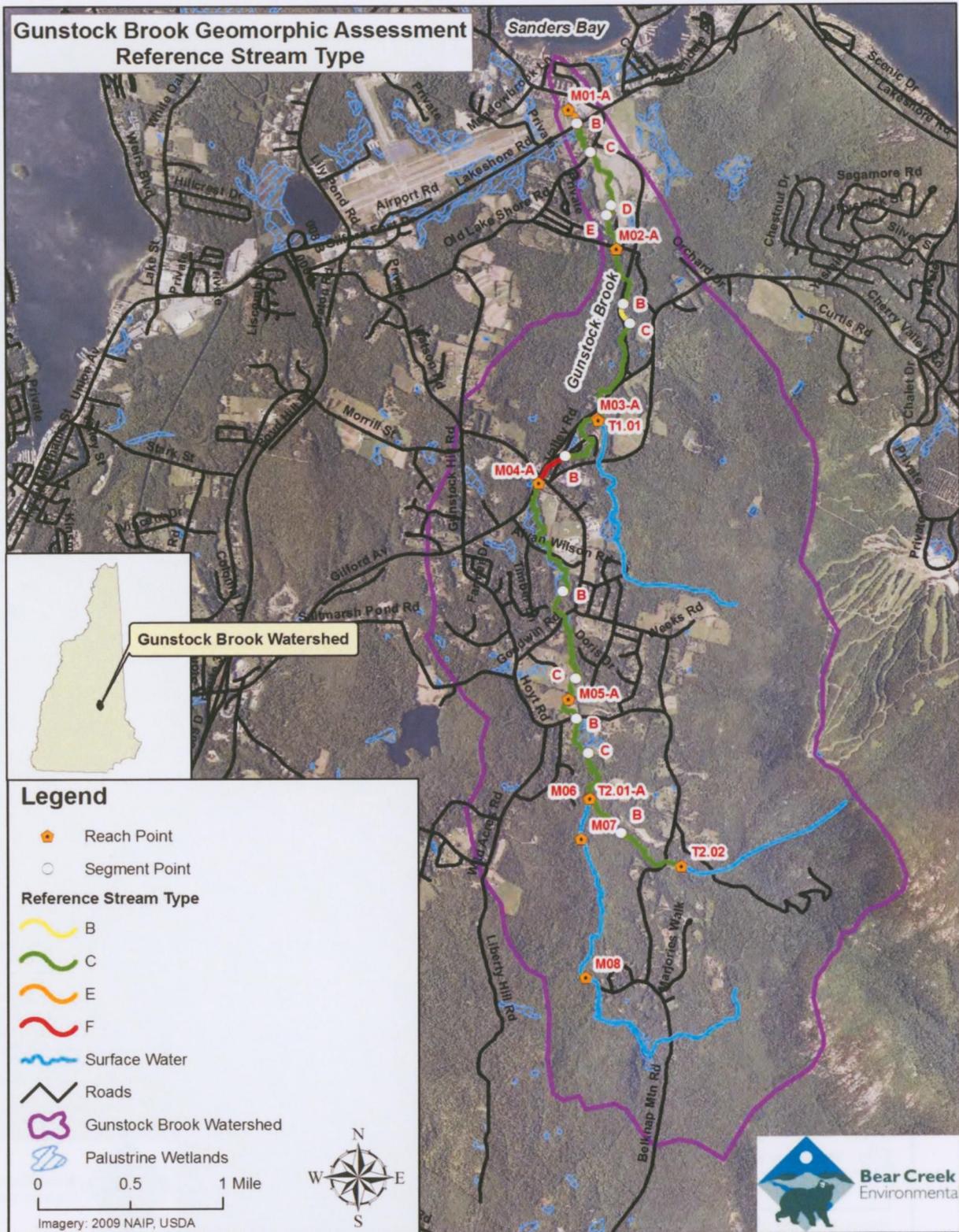


Figure 4.1 Gunstock Brook Reference Stream Types for Phase 2 Assessment

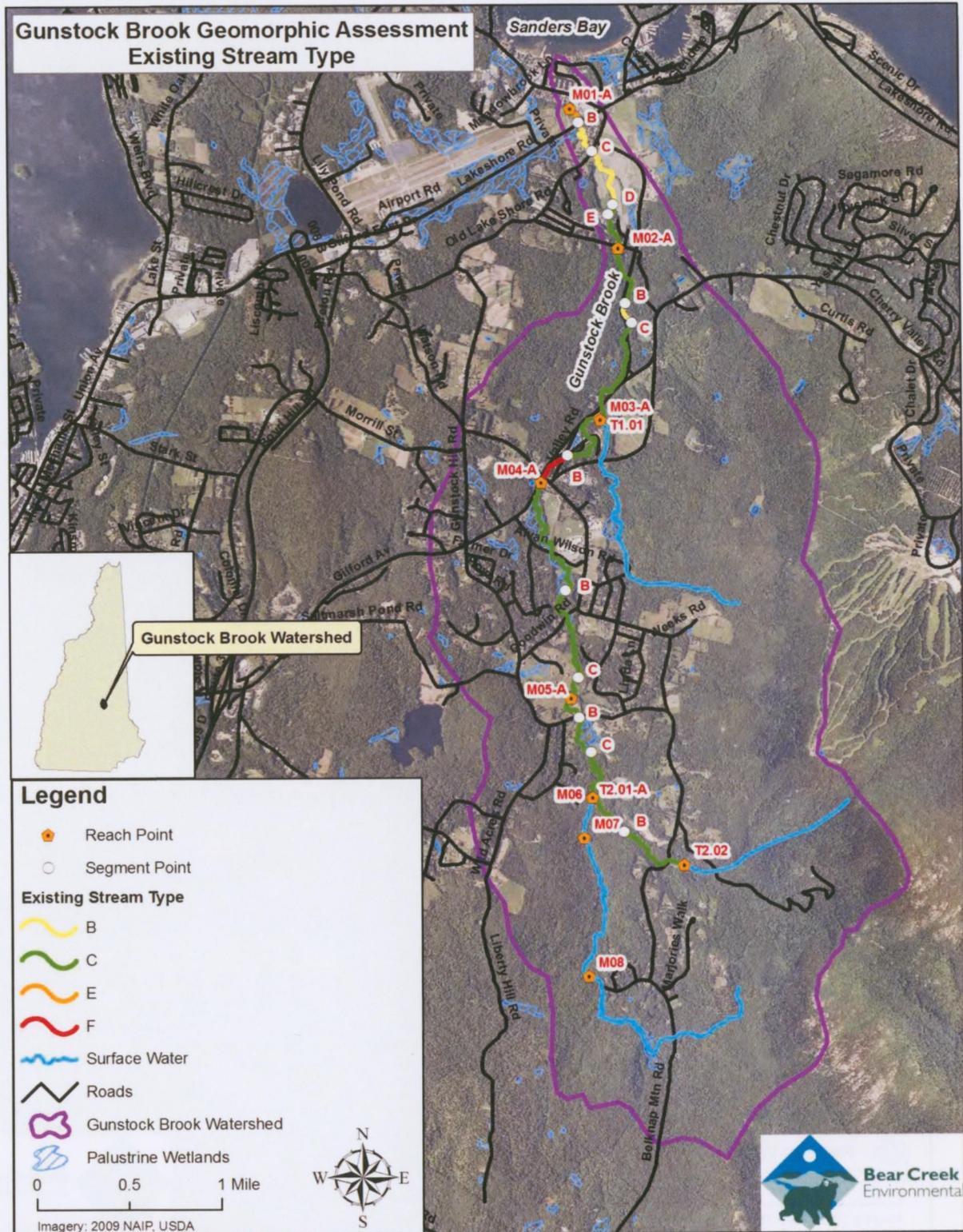


Figure 4.2 Existing Stream Type for Phase 2 Geomorphic Assessments

5.0 GEOMORPHIC CONDITION

The stream condition is determined using the scores on the rapid assessment field forms, and is defined in terms of departure from the reference condition. There are four categories to describe the condition (reference, good, fair and poor). These ratings are defined below.

- Reference – no departure
- Good – minor departure
- Fair – major departure
- Poor – severe departure

The existing geomorphic condition is depicted in Figure 5.1. Geomorphic condition is determined based on the degree (if any) of channel degradation, aggradation, widening and planform adjustment. Degradation is the term used to describe the process whereby the stream bed lowers in elevation through erosion, or scour, of bed material. Aggradation is a term used to describe the raising of the bed elevation through an accumulation of sediment. The planform of a channel is its shape as seen from the air. Planform change can be the result of a straightened course imposed on the river through different channel management activities, or a channel response to other adjustment processes such as aggradation and widening. Channel widening 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.

Four segments along the main stem of Gunstock Brook are in “good” geomorphic condition (M02-B, M03-B, M04-A, and M05-B). In addition, the most downstream reach on the major tributary to Gunstock Brook (T2.01) is in “good” geomorphic condition. Two of the Gunstock Brook segments in “good” condition are located in higher gradient, more confined sections with step-pool bedform and cobble dominated substrate. The other two segments in “good” condition are surrounded by wetland, have healthy buffers, and minimal encroachments. All of the remaining segments except two, which have a “poor” condition (M02-A and M03-A), are in “fair” geomorphic condition. Segment M02-A, located upstream of the Henderson Road crossing is impacted by floodplain encroachments from Intervale Road and a undersized and poorly aligned bridge crossing at Intervale Road. The poor geomorphic condition of segment M03-A is related to extensive straightening of the channel and floodplain encroachment from development near the Gilford Town offices. In the areas that are in “poor” or “fair” condition, significant instream modifications and floodplain encroachment is common leading to an increase in stream power in the channel and a loss of functioning floodplains.

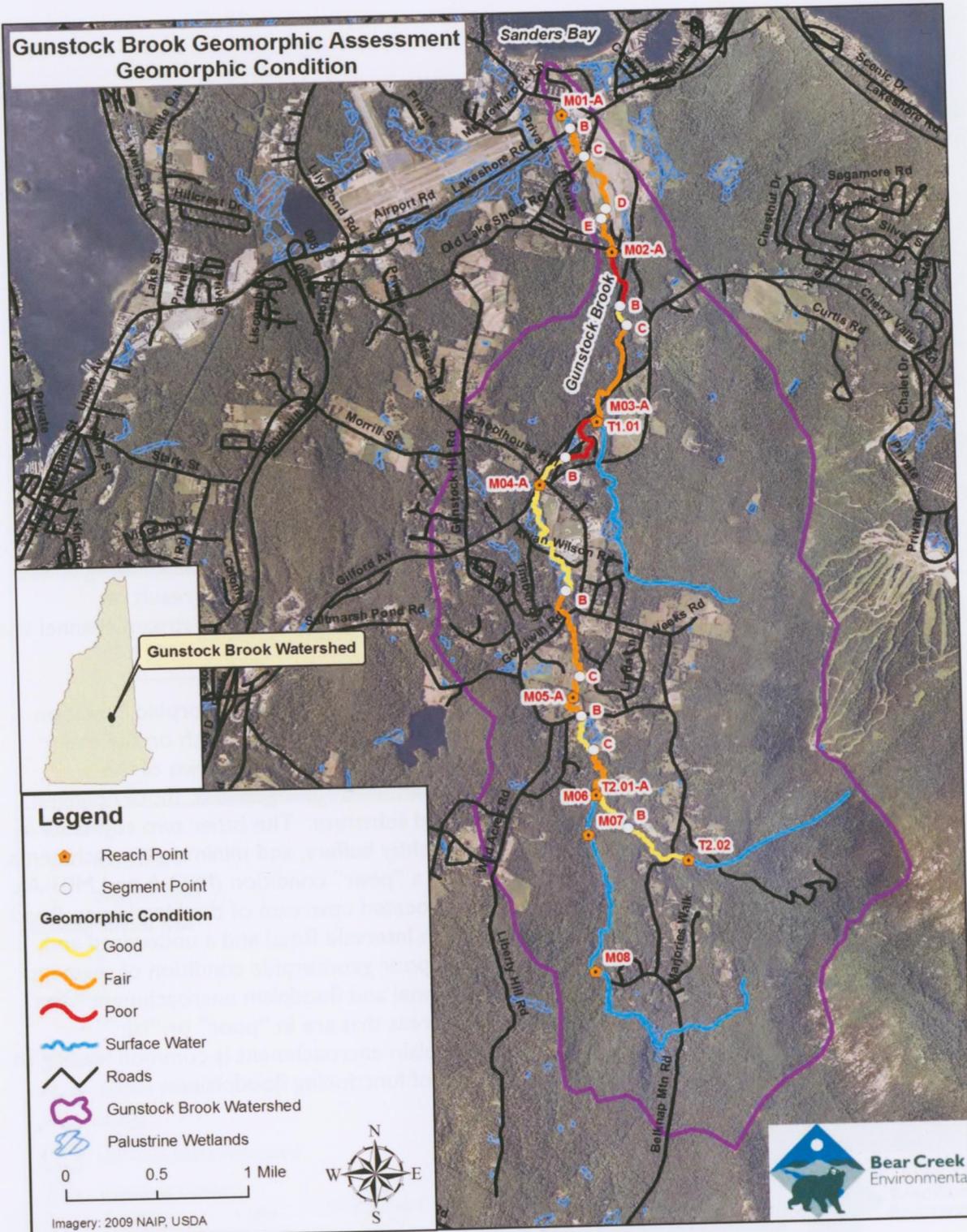


Figure 5.1. Phase 2 Geomorphic Condition of the Gunstock Brook Watershed

Functioning floodplains play a crucial role in providing long term stability to a river system. Natural and anthropogenic impacts may alter the equilibrium of sediment and discharge in natural stream systems and set in motion a series of morphological responses (aggradation, degradation, 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). Human-induced practices that have contributed to stream instability within the Gunstock Brook watershed include:

- Forest clearing
- Channelization and bank armoring
- Removal of woody riparian vegetation
- Floodplain encroachments
- Poor road maintenance and installation of infrastructure
- Loss of wetlands

These anthropogenic practices have altered the balance between water and sediment discharges within the Gunstock Brook watershed. Channel morphologic responses to these practices contribute to channel adjustment that may further create unstable channels. All three adjustment processes, aggradation, widening and planform migration as a result of historic degradation within the channel are present within the Gunstock Brook watershed.

The reach condition ratings of the Gunstock Brook watershed indicate that most of the reaches/segments are actively or have historically undergone a process of minor or major geomorphic adjustment. Many of the reaches studied in the Gunstock Brook watershed are undergoing a channel evolution process in response to large scale changes in its sediment, slope, and/or discharge associated with the human influences on the watershed. Table 4 below summarizes the channel evolution of each study reach and the primary adjustment processes that are occurring.

Both the "D" stage and "F" stage channel evolution models (Vermont Agency of Natural Resources, 2009; Vermont Agency of Natural Resources, 2004) are helpful for explaining the channel adjustment processes underway in the Gunstock Brook watershed. The "F" stage channel evolution model is used to understand the process that occurs when a stream degrades (incises). The common stages of the "F" channel evolution stage, as depicted in Figure 5.2 include:

- Stable (F-I) - a pre-disturbance period
- Incision (F-II) – channel degradation (head cutting)
- Widening (F-III) – bank failure
- Stabilizing (F-IV) – channel narrows through sediment build up and moves laterally building juvenile floodplain
- Stable (F-V) - gradual formation of a stable channel with access to its floodplain at a lower elevation

The "D-stage" channel evolution model applies to reaches where there may have been some minor historic incision; however, the more dominant active adjustment process is aggradation, which in turn leads to channel widening and planform adjustment. The D-stage adjustment process typically occurs in unconfined, low to moderate gradient valleys where the stream is not entrenched and has access to its floodplain or flood prone area at the 1-2 year flood stage.

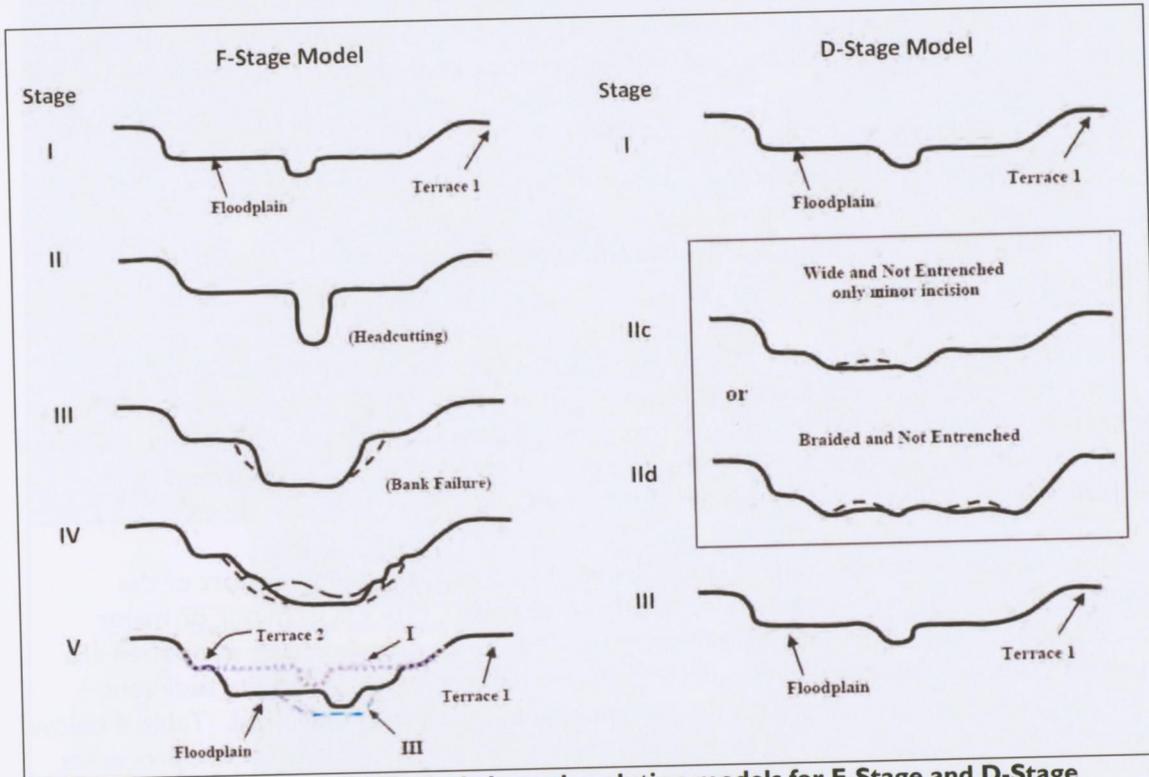


Figure 5.2 Typical channel evolution models for F-Stage and D-Stage (Vermont Agency of Natural Resources, 2009)

Table 4. Stream Type and Channel Evolution Stage							
Segment Number	Entr. Ratio	Width to Depth Ratio	Incision Ratio	Reference Stream Type	Existing Stream Type	Channel Evolution Stage	Active Adjustment Process
Gunstock Brook							
M01-A	Not Assessed - Impounded						
M01-B	1.9	9.2	2.2	C4	B4c	F-II	Aggradation Widening Planform
M01-C	1.7	8.8	2.3	C4	B4c	F-II	Aggradation Widening Planform
M01-D	34	17	1.3	C4	C4	F-III	Aggradation Widening Planform

Table 4. Stream Type and Channel Evolution Stage

Segment Number	Entr. Ratio	Width to Depth Ratio	Incision Ratio	Reference Stream Type	Existing Stream Type	Channel Evolution Stage	Active Adjustment Process
M01-E	2.4	34.1	1.8	C4	C4	F-III	Aggradation Widening Planform
M02-A	4.8	13.8	1.3	C3b	C3b	F-III	Aggradation Widening Planform
M02-B	1.4	13.8	1.0	B3	B3	F-I	Widening Planform
M02-C	2.5	19.3	1.0	C3	C3	F-III	Aggradation Widening Planform
M03-A	2.2	34.8	2.0	C3	C3	F-IV	Aggradation Widening Planform
M03-B	1.2	17.5	1.0	F3b	F3b	F-I	Aggradation Planform
M04-A	16.1	23.3	1.0	C4	C4	F-I	Aggradation Widening Planform
M04-B	5.2	10.4	1.3	C4	C4	F-II	Aggradation Widening Planform
M04-C	17.1	16.7	1.5	C4	C4	F-II	Aggradation Widening Planform
M05-A	10.1	10.8	1.5	C4	C4	F-II	Aggradation Planform
M05-B	19.4	18.7	1.0	C4	C4	D-IIc	Aggradation Planform
M05-C	11.3	22	1.0	C4	C4	D-IIc	Aggradation Widening Planform
Tributary to Gunstock Brook							
T2.01-A	13.2	14.2	1.1	C4b	C4b	D-IIc	Aggradation Widening Planform
T2.01-B	6.8	12.4	1.0	C4b	C4b	F-I	Planform
<p>Italics and Bold Black lettering – denotes extreme adjustment process Bold Black lettering – denotes major adjustment process Black lettering (no bold) – denotes minor adjustment process Red denotes severe incision ratio Blue denotes moderate incision ratio Green denotes a stream type departure</p>							

When stream channels are altered through straightening, it can set this evolution process into motion and cause adjustment processes to occur. The bed erosion that occurs when a meandering river is straightened in its valley is a problem that translates to other sections of the stream. Localized incision will travel upstream and into tributaries, thereby eroding sediments from otherwise stable streambeds. These bed sediments will move into and clog reaches downstream, leading to lateral scour and erosion of the 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.

In terms of the channel evolution model, two segments on Gunstock Brook in the vicinity of the Belknap Mountain Road crossing (M03-B and M04-A) are in stage I of the "F-stage" channel evolution model. This means these reaches have not undergone a channel incision process, and generally the sediment transport capacity is in equilibrium with the sediment load. The most upstream segment on the tributary to Gunstock Brook (T2.01-B), which has been relatively undisturbed is also in stage F-I. Segment M02-B, which flows close to Intervale Road, is a stream channel in stage F-I whose reference stream type has been modified due to the placement of the road.

In contrast, many segments on the main stem have undergone historic degradation. These channels are either in stage F-II or F-III of the "F-stage" channel evolution model. Segments that have been heavily armored and/or extensively straightened (M01-B, M01-C, M04-B, M04-C, and M05-A) have lost access to the floodplain as a result of channel incision or floodplain filling. These segments have remained in stage F-II because the armoring has prevented the channel from widening. Stream power is increased within the channel due to the increased slope and loss of floodplain access.

The next stage (stage F-III) occurs when an entrenched channel widens and migrates laterally through bank erosion caused by the increased stream power. The following segments located in the first two reaches of Gunstock Brook are in stage F-III (M01-D, M01-E, M02-A and M02-C). Stage F-IV of the "F-stage" channel evolution model involves the channel stabilizing itself by changes in its migration pattern and building a new floodplain at a lower elevation. Only one segment, M03-A, on Gunstock Brook was in stage F-IV. This segment had undergone severe channel incision with a historic incision ratio of 2.0.

Three segments within the Gunstock Brook study area (T2.01-A, M05-B and M05-C) fall into the "D-stage" evolution model, where the more dominant active adjustment process is aggradation. This build up of sediment leads to channel widening and planform adjustment. In the D-IIc stage, the channel becomes extremely depositional. The channel width narrows through aggradation as bar features develop. Transverse (diagonal bars) may be common. The segments in stage D-IIc are not incised. The high number of diagonal bars and steep riffles indicate the segments are aggradational and the large number of flood chutes reflects planform adjustment. Segments T2.01-A (Tributary 2 near confluence with Gunstock Brook), M05-B

and M05-C (Hoyt Road crossing to confluence with Tributary 2) are currently acting as important attenuation segments for sediment and flood flows.

6.0 HABITAT CONDITION

Table 5 below shows a comparison of the habitat condition based on the Rapid Habitat Assessment (RHA) and the geomorphic condition based on the Rapid Geomorphic Assessment (RGA). A summary of the rapid habitat assessment values for each reach/segment is included on page 2 of Appendix A. For seven of the 17 assessed segments, both the habitat score and the geomorphic score resulted in a "fair" rating. Four segments (M04-A, M05-B, T2.01-A and T2.01-B) had a rating of "good" for both habitat and geomorphic condition. Two of the segments (M02-A and M03-A) had a fair habitat condition, but a poor geomorphic condition. Segment M02-A is planebed by reference and therefore lacks key pool and riffle features that would provide good habitat. Many of the segments that had been straightened or had floodplain alterations lacked a strong riffle-pool bedform and the diversity of habitat features that this brings. Numerous segments had major intrusion into their river corridor from roads, and many segments had inadequate riparian buffers due to historic and/or recent land clearing. In most cases, the habitat score was similar to the geomorphic score, implying that the ecological health of Gunstock Brook is closely related to the geomorphic condition of the stream.

Segment Number	Habitat Score	Geomorphic Score	Habitat Condition	Geomorphic Condition
M01-B	0.43	0.49	Fair	Fair
M01-C	0.47	0.53	Fair	Fair
M01-D	0.53	0.55	Fair	Fair
M01-E	0.36	0.46	Fair	Fair
M02-A	0.61	0.33	Fair	Poor
M02-B	0.54	0.78	Fair	Good
M02-C	0.49	0.53	Fair	Fair
M03-A	0.56	0.26	Fair	Poor
M03-B	0.50	0.78	Fair	Good
M04-A	0.71	0.69	Good	Good
M04-B	0.73	0.53	Good	Fair
M04-C	0.54	0.56	Fair	Fair
M05-A	0.59	0.61	Fair	Fair
M05-B	0.73	0.66	Good	Good
M05-C	0.74	0.59	Good	Fair
T2.01-A	0.74	0.65	Good	Good
T2.01-B	0.78	0.83	Good	Good

7.0 BRIDGE AND CULVERT ASSESSMENT RESULTS

A total of 18 stream crossings (fourteen bridges and four culverts) within the Gunstock Brook watershed were evaluated using the New Hampshire Stream Crossing Protocol. The geomorphic compatibility and Aquatic organism passage (AOP) screening tools, photographs and Phase 2 constriction notes were used to prioritize structures for replacement/retrofit. The geomorphic compatibility ratings span the following range:

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

The VT AOP screening guide has the following four categories:

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

Table 6 summarizes the data collected for the assessed structures within the Phase 2 study area. The final column of Table 6 includes a prioritization of structures for replacement or retrofit based on three criteria: structure width in relation to bankfull channel width, aquatic organism passage (AOP) and geomorphic compatibility, and notes from the Phase 2 study. One of three priorities for replacement was assigned (low, moderate or high). The following criteria explain the priority level assigned to each structure:

High Priority: Structures with spans of approximately 50 percent of the bankfull width or less, which are significantly impeding natural sediment transport. In general, culverts that have a geomorphic compatibility rating of fully incompatible or mostly incompatible are given a high priority. Culverts that are impeding the passage of aquatic organisms are automatically placed in the high priority category (e.g. free fall outlet) unless the habitat value in the vicinity of the structure is lacking.

Moderate Priority: Structures with spans less than 50 percent that are not causing significant geomorphic instability and structures with spans greater than 50 percent that are causing instability. Culverts that are resulting in reduced aquatic organism passage (e.g. do not have material throughout the structure or have a cascade outfall) result in at least moderate priority.

Low Priority: Stream crossing structures that are not included in either of the two categories above.

A total of eight structures were identified as high priority for replacement. Two of the high priority structures are culverts (Lakeshore Road and Town Garage Access Road) with no aquatic organism passage including adult salmonids. The Lakeshore Road Culvert was partially compatible and the Town Garage Access Road Culvert was mostly compatible. One of the high priority culverts (Trail to Lyman's) is mostly incompatible with reduced AOP. The most downstream Intervale Road crossing did not meet the criteria of high priority above, but was placed in the high priority category because of the poor alignment of the structure and the resultant impacts. The bridge at Old Lakeshore Road also did not meet the criteria for high priority but was placed in this category due to its poor condition. A private trail bridge in segment M04-B was placed in the high priority category since it is failing and a debris jam is currently obstructing part of the bridge. It appears that the bridge is not being used so removal is recommended instead of replacement. Two bridges (Intervale Road, upstream and Cherry Valley Road) are significantly undersized and therefore placed in the high priority category. The Cherry Valley Road Bridge has deteriorating footers (Figure 7.1)



Figure 7.1. The Cherry Valley Road Bridge has deteriorating footers.

Table 6 Gunstock Brook Evaluation using Vermont Geomorphic Compatibility and AOP Screening Tools								
Stream Name	Reach/ Segment Number	Road Name	Structure Type	Percent Bankfull Channel Width ^{1,2}	Aquatic Organism Passage (AOP)	Geomorphic Compatibility	Phase 2 Notes	Priority for Replacement or Retrofit
Gunstock Brook	M01-B	Lakeshore Road	Culvert	54	No AOP including adult salmonids	Partially Compatible	Scour below. Culvert is perched 1 foot and is free fall. Water depth in culvert is shallow.	High
	M01-B	Snowmobile Trail	Bridge	97	NA	NA	Just upstream of Lakeshore Road Culvert. Any issues are probably more due to Lakeshore Road culvert.	Not recommended
	M01-B	Old Lakeshore Road	Bridge	78	NA	NA	Deposition above and below. Bridge in poor condition. Deteriorating decking and center pier.	High
	M01-E	Henderson Road	Culvert	50	Reduced AOP	Mostly Incompatible	Ten years old according to landowner. Deposition above and below. Scour below and in structure. Erosion below box culvert on both sides.	Moderate
	M02-A	Intervale Road	Bridge	63	NA	NA	Poor alignment; Large mid- channel bar upstream of structure diverting flow to bank with mass failure. Deposition and scour below. Bedrock grade control within structure.	High
	M02-C	Intervale Road	Bridge	43	NA	NA	Scour below and poor alignment. Deterioration of abutments.	High
	M02-C	Cherry Valley Road	Bridge	46	NA	NA	Footers deteriorating. Deposition above and poor alignment.	High
	M03-A	Town Garage Access Road	Culvert	80	No AOP including adult salmonids	Mostly Compatible	Shallow water depth in culvert. Culvert is perched 1 foot and is a free fall.	High

Table 6 Gunstock Brook Evaluation using Vermont Geomorphic Compatibility and AOP Screening Tools									
Stream Name	Reach/ Segment Number	Road Name	Structure Type	Percent Bankfull Channel Width ^{1,2}	Aquatic Organism Passage (AOP)	Geomorphic Compatibility	Phase 2 Notes	Priority for Replacement or Retrofit	
Unnamed Tributary to Gunstock Brook	M03-B	Tannery Hill Trail	Bridge	63	NA	NA	Deteriorating abutments. Scour below and deposition above.	Low	
	M03-B	Belknap Mountain Road	Bridge	63	NA	NA	Perched dam 9 feet high under bridge. Deposition and scour above.	Low	
	M04-A	Alvah Wilson Road	Bridge	83	NA	NA	Beaver dam close to structure. Guard rail and cement block on decking old. Rusted beams. Deposition below and poor alignment.	Low	
	M04-B	Goodwin Road	Bridge	61	NA	NA	Scour above. Abundant failed armoring in channel.	Low	
	M04-B	Private Trail	Bridge	79	NA	NA	Debris jam under bridge. Wooden bridge failing and does not seem to be used. Should be removed if not used.	High (Removal recommended)	
	M05-A	Farm Bridge	Bridge	96	NA	NA	Wooden bridge.	Not recommended	
	M05-A	Field Access Bridge	Bridge	83	NA	NA	Wooden bridge. Erosion and armoring failing on upstream end.	Low	
	M05-A	Hoyt Road	Arch	117	NA	NA	Structure new and sized appropriately. Deposition below.	Not recommended	
	T2.01-A	Trail to Lyman's	Culvert	31	Reduced AOP	Mostly Incompatible	Structure rusted on bottom and deformed. Deposition above and below. Scour pool below. Abundant right bank erosion on downstream end.	High	
	T2.01-B	Belknap Mountain Road	Bridge	100	NA	NA	Riprap within structure.	Not recommended	

¹Shaded for bankfull width percentage less than 50%, ²Percent bankfull width based on New Hampshire Hydraulic Geometry Curve; NA – not applicable for bridges and arches.

8.0 PRELIMINARY PROJECT IDENTIFICATION AND PRIORITIZATION

The stream reaches evaluated in this study present a variety of planning and management strategies which can be classified under one of the following categories: Active Geomorphic Restoration, Passive Geomorphic Restoration, and Conservation.

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

Passive Geomorphic Restoration allows rivers to return to a state of geomorphic equilibrium by removing factors adversely impacting the river and subsequently using the river's own energy and watershed inputs to re-establish its meanders, floodplains and equilibrium conditions. In many cases, passive restoration projects may require varying degrees of active measures to achieve the ideal results. Active riparian buffer revegetation and long-term protection of a river corridor is also essential to this alternative.

Conservation is an option to consider for protecting the riparian corridor from future development. Providing an easement on lands adjacent to surface waters reduces conflict and provides a long term solution to sediment storage and flood water attenuation needs.

There are a number of federal programs available for river restoration and protection. These programs are as follows:

- Conservation Reserve Enhance Program (CREP)
- Environmental Quality Incentives Program (EQUIP)
- Wildlife Habitat Incentives Program (WHIP)
- Wetland Reserve Program (WRP)

Conservation Reserve Enhancement Program

The USDA Farm Service administers a program called the Conservation Reserve Enhancement Program that helps agricultural producers to take farmland out of production in sensitive areas, such as river corridors. This helps to improve water quality and restore wildlife habitat.

- CREP can be either a 15 or 30 year contract to plant trees.
- 90% of the practice costs are covered with the remaining 10% either resting with the participants or could be paid by the US Partners for Fish and Wildlife. Examples of the practice costs include fencing, watering facilities, and trees. There are some costs that are capped, but generally all the practice costs can be paid through the program.
- To provide additional incentives to enroll in CREP, the program offers upfront and annual rental payments for the land where agricultural production is lost during the contract period.

Environmental Quality Incentives Program

EQUIP is a voluntary program available through the Natural Resources Conservation Service (NRCS) that provides financial and technical assistance to implement conservation practices to meet local environmental regulations. Owners of land in agricultural or forest production are eligible for the program. Contracts with landowners can be up to ten years in length.

Wildlife Habitat Incentives Program

WHIP is a voluntary program offered to landowners to improve wildlife habitat on their land. Owners of agricultural land, nonindustrial private forest land, and Native American land are eligible. Technical assistance and up to 75 percent cost-share is available to improve fish and wildlife habitat.

Wetland Reserve Program

WRP is a voluntary program offered by NRCS to landowners to protect, restore and enhance wetlands on their property. NRCS provides technical assistance and financial support for projects that establish long-term conservation and wildlife practices and protection.

8.1 Watershed-Level Opportunities

There are a number of watershed-level opportunities available to improve the geomorphic stability and water quality of the Gunstock Brook watershed. Watershed opportunities include the development and adoption of fluvial erosion hazard zones, improved stormwater treatment, and community stream clean-up activities.

FLUVIAL EROSION HAZARD ZONES

The purpose of defining Fluvial Erosion Hazard Zones is to prevent increases in man-made conflicts that can result from development in identified fluvial erosion hazard areas; minimize property loss and damage due to fluvial erosion; and prohibit land uses and development in fluvial erosion hazard areas that pose a danger to health and safety. The basis of a Fluvial Erosion Hazard Zone is a defined river corridor which includes the course of a river and its adjacent lands. The width of the corridor is defined by the lateral extent of the river meanders, called the meander belt width, which is governed by valley landforms, surficial geology, and the length and slope requirements of the river channel. The width of the corridor is also governed by the stream type and sensitivity of the stream. River corridors, as defined by the Vermont Agency of Natural Resources (2008b), are intended to provide landowners, land use planners, and river managers with a meander belt width which would accommodate the meanders and slope of a balanced or equilibrium channel, which when achieved, would serve to maximize channel stability and minimize fluvial erosion hazards. Information collected during the Phase 2 Assessment including reach sensitivity, reach condition, and stream type is used to develop these zones. Towns have the opportunity to work with the New Hampshire Department of Environmental Services

(NHDES) and regional planning commissions to develop fluvial erosion hazard zones to reduce conflicts within the river corridor. Additional information regarding Fluvial Erosion Hazard Zones is available on the NHDES website (<http://des.nh.gov/organization/commissioner/pip/factsheets/geo/documents/geo-10.pdf>) in the Environmental Fact Sheet (New Hampshire Department of Environmental Services, 2010a; and in Chapter 2.9 of the Innovative Land Use Planning and Techniques Handbook: New Hampshire Department of Environmental Services, 2010b).

STORMWATER

Stormwater runoff rates are of particular concern in urbanized and agricultural watersheds because stormwater runs off from impervious surfaces rather than naturally infiltrating the soil. The cumulative effect of the increased frequency, volume, and rate of stormwater runoff results in increases in wash-off pollutant loading to streams and destabilization of stream channels. Stormwater improvement projects to increase baseflow and decrease peak flow and sediment loading are recommended for the Gunstock Brook watershed. The details of project location are outlined in the reach level opportunities below.

8.2 Reach-Level Opportunities

A description of each reach/segment is provided in this section along with general recommendations for restoration and protection strategies. The reaches/segments are listed from downstream to upstream. The reaches are broken into sections based on the stream they are located in: Gunstock Brook main stem and Tributary to Gunstock Brook. Proposed project locations are provided on maps on pages 1 through 7 in Appendix B. Project locations where the Natural Resources Conservation District has recommended projects are also included on the maps. The Phase 2 stream geomorphic assessments provides a picture of the condition of the channel and the adjustment process, however, is not a comprehensive study for determining site specific actions. The Phase 2 study provides a foundation for project development, and additional work is recommended to further develop these projects.

Gunstock Brook Main Stem

Reach M01

The most downstream reach of Gunstock Brook (M01) starts about 600 feet downstream of Lakeshore Road (Route 11) and continues upstream approximately one mile to the Henderson Road crossing. Reach M01 has been broken up into five segments. The most downstream segment, M01-A, is about 600 feet long and is impounded by Lake Winnepesaukee (Figure 8.1). This segment was not fully assessed because of the lake influence. No potential projects were identified by BCE within this short segment.



Figure 8.1. Impounded segment M01-A

The Natural Resources Conservation Service (NRCS) has recommended a streambank stabilization project (SB6) along the banks of an impounded section of Gunstock Brook upstream of the Route 11B crossing (Winnepesaukee Gateway, 2012, <http://winnepesaukeegateway.org/monitoring-the-lake/potential-restoration-sites-map>). The NRCS has also evaluated two bank erosion areas that are located downstream of Lakeshore Road. These locations are shown on the map on page 1 of Appendix B. All three of these proposed bank stabilization areas are located downstream of the Gunstock Brook study area that received a full phase 2 assessment by BCE. For this reason, BCE does not have information to guide a decision about bank stabilization in this location.

Segment M01-B begins just upstream of the Lakeshore Road crossing and continues upstream for 1,200 feet until Old Lakeshore Road. Extreme degradation has occurred in this segment due to the extensive channel alteration, which has resulted in a stream type departure from a "C" stream to a "B" stream. Widening is being prevented by the abundant riprap (Figure 8.2). Riprap is graded rock that is used to stabilize banks. The bedform has been altered from riffle-pool to plane bed (i.e. lacks defined habitat features) due to the channel alterations. The geomorphic and habitat condition of Segment M01-B are both "fair". The lack of large woody debris, embedded channel, lack of riffle habitat, and the lack of vegetation on both banks and in buffers has led to the "fair" habitat condition.



Figure 8.2 Rock riprap in vicinity of measured cross section in M01-B.

Three potential projects have been identified by BCE in segment M01-B based on the Phase 2 study. The first project is the retrofit or replacement of a box culvert at the Lakeshore Road crossing, which is impeding fish passage (Project #1, Figure 8.3). Based on the Vermont AOP culvert screening tool, the AOP retrofit potential is medium for strong and moderate swimmers and low for weak swimmers. Additional studies are recommended to determine if the replacement or retrofit of the culvert makes more sense. Project #2 includes improving stormwater runoff to alleviate excess sediment into the stream (Figure 8.4). The third project involves a bridge at the Old Lakeshore Road crossing at the upstream end of M01-B. The Old Lakeshore Road crossing is in poor condition due to deteriorating decking and pier (Figure 8.5). This structure was placed in the high priority category for replacement. It is recommended that the bridge be replaced (Project #3) and special consideration be given to geomorphic compatibility including the span and alignment as part of the bridge design.

The Natural Resources Conservation Service (NRCS) has targeted two locations near the tennis courts and upstream of Lakeshore Road for possible bank stabilization work (Winnepesaukee Gateway, 2012, <http://winnepesaukeegateway.org/monitoring-the-lake/potential-restoration-sites-map/>). Site SB5-A is located on the western bank approximately 200 feet upstream of Lakeshore Road). The second location (Site SB5-B) is on the east bank about 400 feet upstream of Lakeshore Road. This section appears to have been historically riprapped and there are areas where erosion is occurring within the armored sections. This area has been straightened and the river is now finding a more sinuous course. There are trees and shrubs on the bank that would need to be removed to riprap the bank, and that action would reduce shading and possibly increase energy into the channel and banks below the stabilized section thereby causing bank erosion. It may be

possible to plant additional trees back away from the bank to give them time to grow and establish root structure. If infrastructure, such as homes or the tennis courts are threatened, bank stabilization using rock armoring may be the only recourse to protect these investments. If a decision is made to armor the banks, a biotechnical approach is recommended, where the upper bank is sloped and planted and live cuttings are incorporated into the rock riprap. Existing large trees along the bank should remain to the extent feasible.



Figure 8.3. Perched box culvert at Lakeshore Road.



Figure 8.4 Sediment laden stormwater culvert along segment M01-B.



Figure 8.5. Deteriorating decking and pier of Old Lakeshore Road Bridge in Segment M01-B.

The next segment upstream, Segment M01-C, begins at the Old Lakeshore Road crossing and continues for 2,195 feet until the dominant corridor land use changes from hay and cropland to shrub/sapling. The channel in segment M01-C flows through a farm where a Conservation Reserve Enhancement Program (CREP) is currently underway to protect water quality through the establishment of a 35 foot buffer. Like M01-B, M01-C has undergone severe incision (ratio of 2.3) due to channel alteration, which has resulted in a stream type departure from a "C" stream to a "B". Rip-rap along channel banks has prevented widening. Both the RGA and RHA were scored as "fair". The "fair" habitat condition was attributed to a lack of large woody debris, channel incision, and the compromised condition of banks and the riparian corridor due to incomplete vegetation layers and buffer widths less than 50 feet.

Extensive erosion is occurring in the next segment, M01-D, indicating that it is in the widening stage. There is also abundant aggradation in this segment as seen through the presence of diagonal bars and steep riffles. Segment M01-D begins where the corridor land use is predominantly shrub/sapling and where incision is minor. The segment continues upstream for 654 feet until the dominant river corridor land use becomes residential. The geomorphic and habitat condition were both scored as "fair". The channel aggradation and widening contributed to the "fair" geomorphic condition, while lack of woody debris and the bank and buffer condition contributed to the "fair" habitat condition. Through most of the segment, the buffer is naturally regenerating.

There is a proposed NRCS project (SB4) in segment M01-D project (SB4) that involves streambank stabilization of a bank that is experiencing significant erosion (Figure 8.6). The river is currently in an adjustment process that will move it towards a stable or equilibrium condition through erosion and deposition of sediment. If allowed to continue in the current course, the river will eventually create a bankfull bench or floodplain at a lower elevation. It is understandable that the farmer is concerned about losing land in this location. If the farmer is amenable, a wide buffer of land could be taken out of production and the farmer could be compensated for this additional land through the CREP program. Problems associated with riprapping this section include loss of aquatic habitat, increased energy and erosion downstream of the riprapped section and loss of floodplain access. If the landowner and NRCS decide to move forward with riprapping the bank, a biotechnical approach is recommended. A biotechnical approach may include grading the upper bank and planting with trees as well as incorporating live cuttings such as willow into the rock toe.



Figure 8.6. Bank erosion (looking upstream) along Segment M01-D at proposed NRCS project SB4

Development within the river corridor is pronounced in segment M01-E. Approximately 30 percent of segment M01-E has been straightened and armored, which has led to major degradation of the stream channel. The extensive armoring is seen just downstream of Henderson Road on the east bank (Figure 8.7). The incision process has resulted in a loss

of floodplain access and subsequent widening of the stream channel. Aggradation is a major adjustment process; there are numerous side bars and some diagonal bars and steep riffles. The habitat and geomorphic scores were both "fair". Japanese knotweed, an invasive plant, is present on both banks. Riffle embeddedness, limited vegetative cover on the eastern stream bank and altered riparian areas also contributed to the "fair" habitat condition.

In the center of M01-E, there is a stormwater retention pond in the western side of the river corridor (Figure 8.8). The retention pond is helping to alleviate the impact of stormwater drainage from the nearby development into Gunstock Brook. However, the buffer vegetation within the vicinity of the stormwater pond is predominantly herbaceous, which does not provide the best riparian condition. Approximately 180 feet downstream of the pond is another stormwater input that is causing localized erosion on the western stream bank, which is contributing sediment to the channel (Figure 8.9). It is recommended that the stormwater runoff in this location be improved to alleviate further sediment contribution to the channel (Project #4).

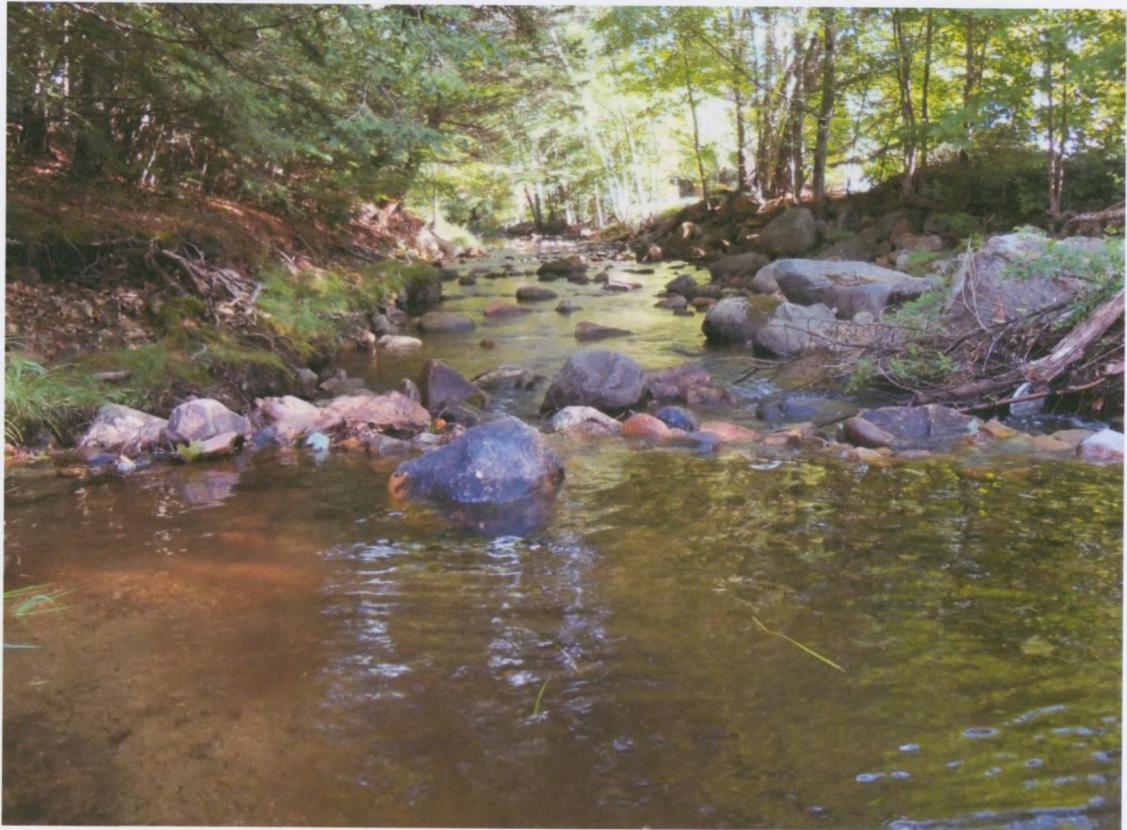


Figure 8.7. Segment M01-E just downstream of Henderson Road crossing with abundant riprap on east bank.



Figure 8.8. Stormwater Pond in the river corridor for M01-E.



Figure 8.9. Stormwater input causing localized erosion on streambank in M01-E.

Reach M02

Reach M02 begins just upstream of the Henderson Road crossing and continues for just over one mile until the confluence with a major tributary (T1). The majority of reach M02 is encroached upon by Intervale Road and Cherry Valley Road. The reach was broken up into three segments based on planform and slope and channel dimensions. Projects for reach M02 are shown on page 2 of Appendix B.

Segment M02-A is unique among all other segments in the Gunstock Brook study since its reference bedform is plane bed. Upstream of the Intervale Road crossing, there is a human caused change in confinement due to the encroachment of Intervale Road in the river corridor. Channel incision is minor in segment M02-A. However, abundant erosion indicates that the channel is widening. There are areas of channel braiding with islands and large depositional features causing major planform change. The geomorphic condition in M02-A is "poor" while the habitat condition is "fair", which was mostly a result of the river banks and riparian areas being impacted by erosion and road encroachment.

The Intervale Road Bridge is undersized and in poor alignment to the stream channel, which has resulted in a large mid-channel bar immediately upstream of the structure (Figure 8.10). The bar is diverting flow into the eastern bank into a mass failure (Figure 8.11). The replacement of the Intervale Road Bridge with a larger span and compatible alignment (Project #5) would improve the geomorphic stability of Gunstock Brook. The NRCS has recommended a streambank stabilization project (SB3) to arrest the mass failure and to reduce sediment loading into Gunstock Brook and Lake Winnepesaukee. The steep slope of the bank does not allow plants to grow in this location and trees are falling into the brook. If allowed to continue naturally, the bank would continue to erode and eventually reach a more stable slope that allows plant growth. Given the steep bank, this would take many years. BCE would recommend that a geotextile engineer be retained to evaluate if the mass failure should be remediated. As part of the evaluation of the site, engineers and river scientists should consider approaches to improve geomorphic compatibility through the design and installation of a bridge with a wider span and an improved alignment. Options may be available to reduce erosion at this site without hard armoring the steep bank.

Segment M02-B begins about 750 feet upstream of the most downstream Intervale Road crossing and continues until about 180 feet downstream of the second downstream Intervale Road crossing. The entire 653 foot length of the segment is encroached upon by Intervale Road, which has caused a change in confinement from very broad to semi-confined. The encroachment of the road has resulted in a modification of the reference stream type, which is now a cobble dominated "B" stream with a dominant bedform of step-pool (Figure 8.12). The road is now acting as the new valley wall and will prohibit the evolution of the channel back to the reference stream type of "C". The channel has not incised. A significant amount of riprap exists along the western bank, but much of it is failing. Geomorphic condition in the segment scored as "good" and the habitat condition was scored "fair". The lack of large woody debris cover in M02-B and the poor condition of the western banks and riparian areas led to the "fair" habitat condition for the segment.



Figure 8.10. Undersized and misaligned Intervale Road Bridge with mid-channel bar upstream in M02-A.



Figure 8.11. Mass failure along eastern bank just upstream of Intervale Road Bridge in M02-A.

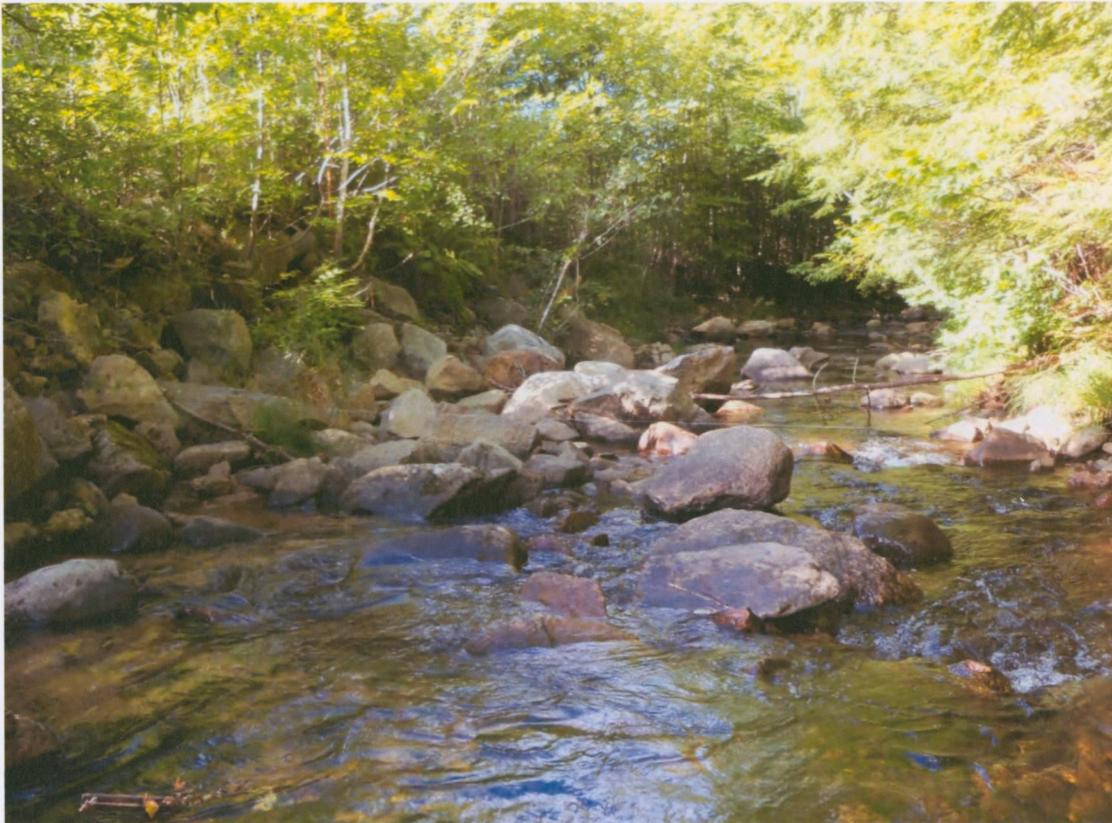


Figure 8.12. Cobble dominated “B” stream type and failing riprap in segment M02-B.

M02-C begins about 180 feet downstream of the most upstream Intervale Road crossing and continues for 3,470 feet until the confluence with the first major tributary to Gunstock Brook (T1). The RGA resulted in a geomorphic condition of “fair” for Segment M02-C. The floodplain has been encroached upon by Intervale Road and Cherry Valley Road throughout most of the segment and approximately half of the segment has been straightened. Floodplain access is variable in M02-C. For most of the segment the channel is not incised. However, there are areas where either the road encroachment or streamside berms have caused channel incision, which has resulted in a stream type departure (Figure 8.13). Widening is minor as is aggradation, although steep riffles and diagonal bars were observed (Figure 8.14). The overall habitat condition is “fair” predominantly due to the lack of woody debris cover, unsorted substrate, compromised riffle and pool features, and poor eastern bank and riparian area from the road encroachment. Japanese knotweed was observed along the bank by Intervale Road.

Projects that would benefit M02-C include berm removal, stormwater improvements, and replacing undersized structures. The berm located upstream of the Intervale Road crossing could be removed to provide for better floodplain access (Project #8). A study is recommended to determine if this berm removal project would make Intervale Road more vulnerable to flooding. Stormwater from Intervale Road (Figure 8.15) is also a concern

within Segment M02-C. Project #6 addresses improving stormwater runoff from Intervale Road into Gunstock Brook. The two bridges that cross Gunstock Brook in Segment M02-C (Intervale Road and Cherry Valley Road) are both noted as high priority for replacement due to being significantly undersized (Projects #7 and #9).

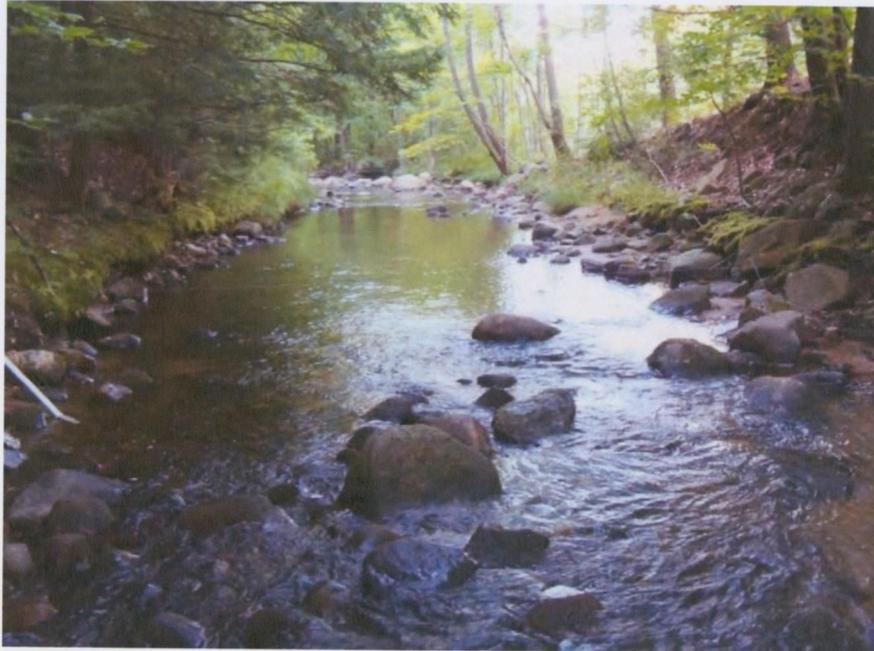


Figure 8.13. Straightening and road encroachment in Segment M02-C.



Figure 8.14. Diagonal bar in Segment M02-C.



Figure 8.15. Stormwater runoff from Intervale Road into M02-C.

M03

Reach M03 was divided into two segments to account for the presence of grade controls and variable channel dimensions in the upstream segment. The reach begins at the confluence with the first major tributary (T1) and continues until just upstream from the Belknap Mountain Road crossing. M03-A is 2,388 feet in length and the upper end of the segment ends just downstream of the covered bridge at Tannery Hill Trail. Segment M03-A flows through a broad valley and is a cobble dominated "C" stream with a riffle-pool bedform.

Road encroachment occurs along about half of the western bank in M03-A, which is armored along the most upstream section. There are three mass failures along the eastern bank totaling 113 feet in length. An incision ratio of 2.0 indicates that this segment has undergone extreme degradation, which has resulted in major widening and extreme aggradation and planform adjustment. The floodplain appears to have been filled in previous years along the town hall parking area. Downstream of the parking area, M03-A becomes extremely depositional with areas of braiding (Figure 8.16). A juvenile floodplain is forming.

Due to the geomorphic instability caused by channel degradation, the geomorphic condition of M03-A is "poor". The rapid habitat condition was "fair". The "fair" condition was due to riffle-pool habitat features, such as small pool size and cover, riffle spacing, and depositional features. Channel morphology (high width to depth and incision ratios) also contributed to the "fair" habitat condition.

The Town Garage Access Road crossing is the only road crossing within segment M03-A. The culvert at this crossing is mostly compatible in terms of geomorphic stability and was flagged as no aquatic organism passage including adult salmonids using the Vermont AOP screening tool. The structure is perched about one foot and is recommended for replacement or retrofit (Figure 8.17, Project # 10).

Stormwater runoff from the town garage parking lot is causing excess sediment into Gunstock Brook (Figure 8.18). Project # 11 would address the sediment loading by improving stormwater runoff from the parking area. Another project that would address sediment loading and runoff into Gunstock Brook (M03-A) is an investigation of an eroded swale (Figure 8.19) that is receiving discharge from a well (Project #12). Runoff from the swale is introducing significant sediment into Gunstock Brook (Figure 8.20).



Figure 8.16. Braided section of M03-A.



Figure 8.17. Perched culvert at Town Garage Access Road in Segment M03-A impeding aquatic organism passage.



Figure 8.18. Sediment laden stormwater runoff from Town Garage parking lot in M03-A.

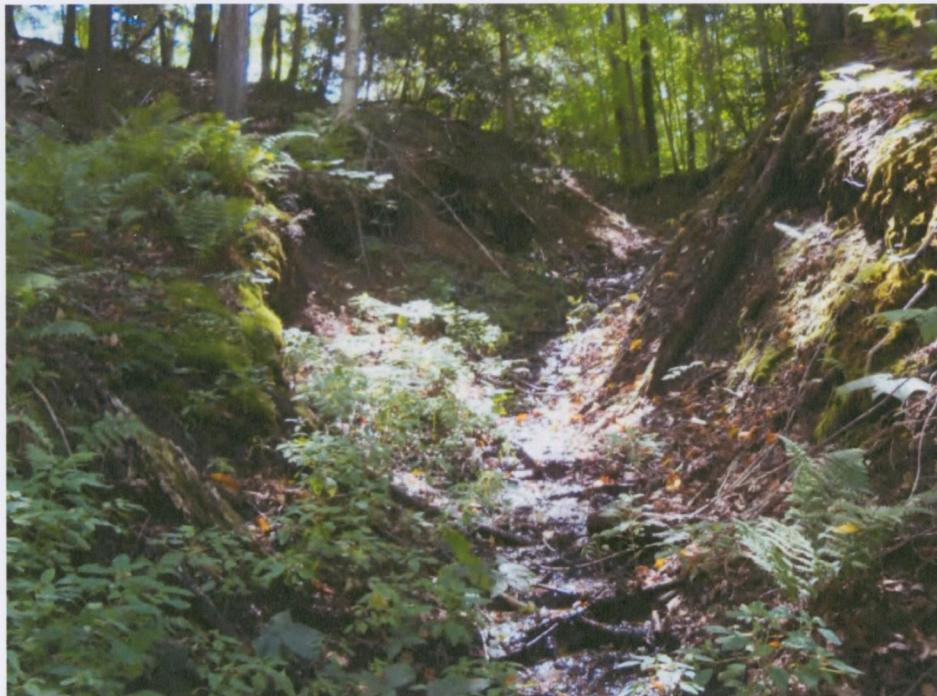


Figure 8.19. Eroded swale in Segment M03-A.



Figure 8.20. Sediment from eroded swale in Segment M03-A.

Segment M03-B begins approximately 150 feet downstream of the Tannery Hill Bridge crossing and continues to just upstream of the Belknap Mountain Road crossing. The segment is 1,098 feet in length and the western bank is encroached upon by Cherry Valley Road. Approximately half of M03-B has been straightened using rock riprap on one or both banks. Bedrock grade controls throughout M03-B have prevented the bed from degrading and the extensive armoring is keeping the channel from widening. Despite the channel alterations and the proximity to Cherry Valley Road, M03-B is a cobble dominated natural "F" channel, with a slope of a "B" channel and a step-pool bedform (Figure 8.21). Some locations along the segment have a stream type of "B", but "F" is the predominant stream type. At the downstream end, Japanese knotweed is present along the western bank near the Gilford town hall.

Thanks to the stability the bedrock grade controls provide, Segment M03-B scored "good" for geomorphic condition. The habitat condition was "fair" due mostly to the condition of the western banks and the lack of connectivity resulted from a dam under the Belknap Mountain Road crossing (Figure 8.22). The lack of woody debris cover in the segment also contributed to the "fair" habitat condition. Pool cover was good due to the boulders in the upper portion of the segment.

The dam under Belknap Mountain Road is impeding the passage of aquatic organisms. Downstream from the dam are rock walls lining the stream banks (Figure 8.23). The dam and rock walls are what is left of a sawmill that operated in the 1800s (Gilford Historic District Commission, 1990). During this time period, the dam impounded water up into Reach M04. The recreational area was called the Millpond and was used as a fishing and ice skating spot. Now the area contains tennis courts. An alternatives analysis is recommended to improve habitat connectivity at the former mill site and determine if it is feasible and beneficial to remove the dam and rock walls (Project #13). Historic preservation may be a consideration regarding removal of this dam.

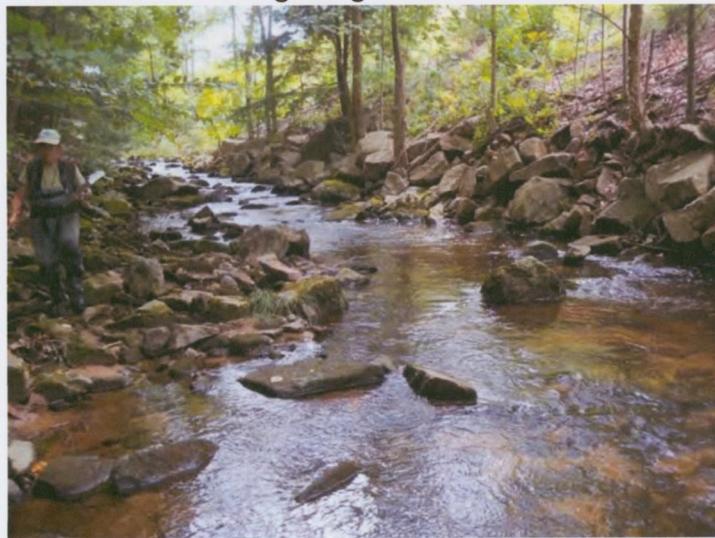


Figure 8.21. Natural cobble dominated "Fb" channel in M03-B.



Figure 8.22. Dam at Belknap Mountain Road crossing in M03-B.



Figure 8.23. Rock walls downstream of the Belknap Mountain Road crossing in M03-B.

M04

Upstream of Belknap Mountain Road, Gunstock Brook becomes lower gradient. Reach M04 was divided up into three segments based on variable banks and buffers. The most downstream segment, M04-A, begins approximately 100 feet upstream of Belknap Mountain Road Bridge and continues for approximately one mile to where the river corridor becomes more forested and less shrub/sapling. The first 800 feet of Segment M04-A is encroached upon by Gilford Avenue where approximately 460 feet of the channel has been straightened. Due to its historic alteration, this section of Segment M04-A has high banks and is lacking habitat features (Figure 8.24). The segment then transitions into a channel that flows through wetland habitat with good floodplain access, which comprises the majority of the rest of the segment (Figure 8.25).



Figure 8.24. Straightened section of M04-A.



Figure 8.25. Typical wetland channel in M04-A.

Based on the Phase 2 assessment, both the geomorphic and habitat conditions of segment M04-A are “good”. The stream type is a gravel dominated “C” stream which has not incised. Segment M0-4A is undergoing minor aggradation with some diagonal and point bars and limited planform change with the presence of an island. Abundant large woody debris, coarse particulate organic matter and deep pools that are providing suitable water depths for fish and amphibians has contributed to the “good” habitat condition. Alders are the dominant vegetation on the banks. Given the prime riparian condition and wetland habitat, a 1,890 foot length of Segment M04-A is recommended for conservation to protect it from future impacts and to maintain the function of the wetland it flows through (Project #14).

Approximately halfway through the segment heading upstream, Gunstock Brook flows past the Alvah Wilson Middle School and then continues under Alvah Wilson Road Bridge. There is currently a beaver dam within the structure that may cause some problems in the future for stream flow through the bridge (Figure 8.26). There are also two old abutments within M04-A which are constricting the stream channel. One abutment is in the downstream straightened section, but another one is located approximately 850 feet from the top of the segment (Figure 8.27).



Figure 8.26. Beaver dam within Alvah Wilson Road Bridge in M04-A.



Figure 8.27. Old abutment constricting the stream channel in M04-A.

Segment M04-B begins where the habitat changes from a shrub/sapling wetland channel to a 3,641 foot long channel flowing through a more forested area with some development. For much of the segment the banks are covered in moss and create some undercuts suitable for fish to obtain cover (Figure 8.28). The stream type is a gravel dominated "C" riffle-pool that has experienced minor incision. Aggradation is major throughout the reach with numerous depositional features including point, mid-channel, diagonal, and side bars as well as many steep riffles. As the sediment is working its way through the segment, planform change is major with one neck cut off and many flood chutes.

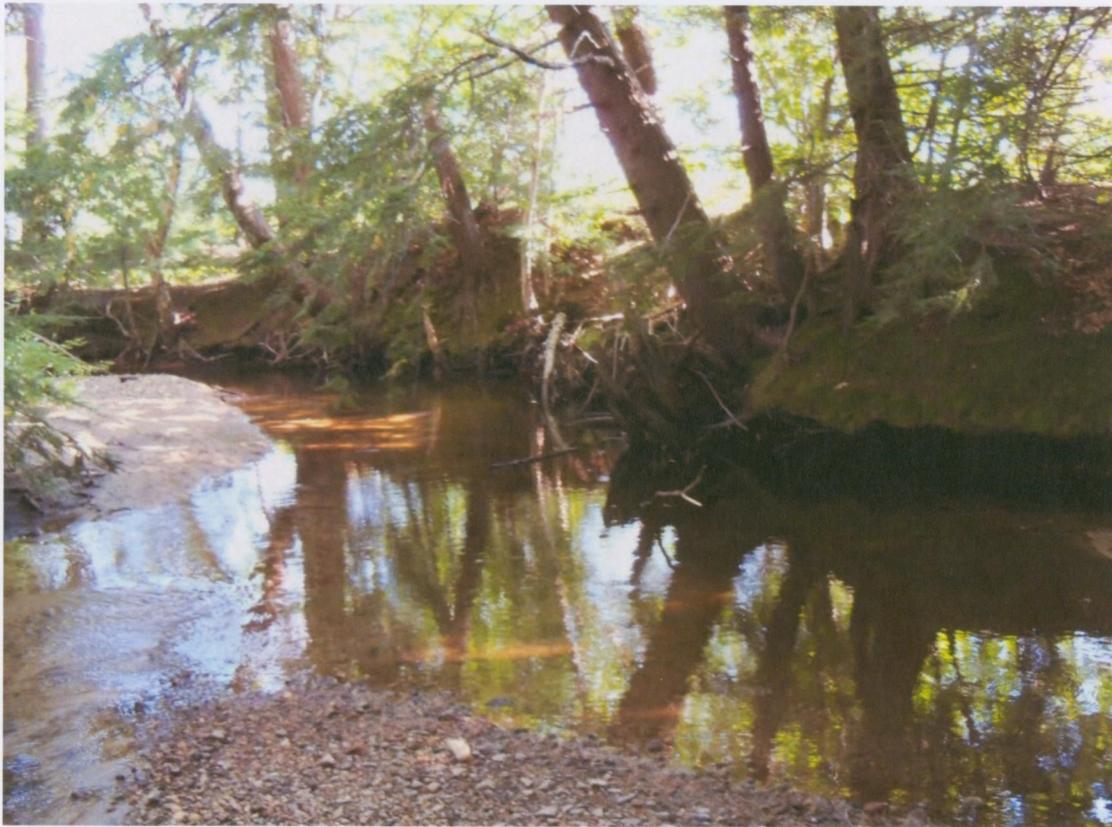


Figure 8.28. Moss covered undercut bank in M04-B.

One contributor to the sediment in this reach appears to be coming from tributaries (Figure 8.29) that are receiving stormwater runoff from Doris Drive residential development. During a rainstorm in August 2011, stormwater runoff was observed from Doris Drive and driveways (Figure 8.30) into tributaries of the mainstem (Figure 8.31). Improving the stormwater runoff from this area would be beneficial to reducing sediment loading into Gunstock Brook (Project #16).

A wooden bridge along Gunstock Brook is currently collapsing (Figure 8.32). Sediment and debris are blocking the bridge that does not appear to be in use. Removal of the bridge is recommended (Project #15).



Figure 8.29. Tributary contributing sediment to Gunstock Brook in Segment. M04-B.



Figure 8.30. Turbid stormwater runoff on Doris Drive on August 21, 2012.



Figure 8.31. Sediment loading from sandy tributary into M04-B.



Figure 8.32. Collapsing wooden bridge in M04-B.

The most upstream segment in Reach M04, M04-C, begins near the Given Drive development. The segment continues for 848 feet where there is a lack of buffer along about half the segment on the eastern side (Figure 8.33). The channel has also been straightened and armored in the downstream section (Figure 8.34). A channel avulsion (change in channel course) has occurred here leading to major planform adjustment. There is abundant erosion on the banks in places which lack riprap or a vegetated buffer. Planting of native trees and shrubs away from the bank in backyards of the Given Drive housing development would help to stabilize the bank as the channel migrates to reach its equilibrium state (Project #17).

M04-C is a gravel dominated "C" stream that has lost access to its floodplain through channel incision but has not yet widened. Armoring of the banks is increasing the stream power through the lower end of the segment. The loss of floodplain access has resulted in M04-C being a sediment transport reach as opposed to its natural condition as a depositional reach. The geomorphic condition of M04-C is "fair" due to the degree of channel alteration and resultant degradation. The habitat condition also scored as "fair" mostly as a result of poor buffers and riparian habitat on the eastern side, compromised bank condition and lack of vegetative cover, short riffles, and very little pool cover.



Figure 8.33. Lack of riparian buffer and streambank erosion in M04-C.



Figure 8.34. Channel alteration and streambank armoring in M04-C.

M05

Reach M05, the uppermost reach on Gunstock Brook, begins about 900 feet downstream of the Hoyt Road crossing and continues for 4,425 feet until the confluence with a major tributary of Gunstock Brook (T2). The reach was broken up into three segments due to variable channel dimensions and banks and buffers. Segment M05-A is 936 feet long and begins at a tributary confluence and continues until just upstream of the Hoyt Road crossing.

Dominant land use in the eastern corridor is hay but a small portion of lack of buffer on the western side is due to residential lawn. Two wooden bridges span the channel in Segment M05-A, but they are of low priority for replacement since they are close to the bankfull channel width and are causing little or no geomorphic instability. The Hoyt Road crossing is at the upstream end of the segment and is not recommended for replacement since it has an adequate width to accommodate channel flows and sediment. The Hoyt Road culvert was previously identified by NRCS as an undersized structure. According to Brian Denutte at the Gilford Dept. of public works, this undersized structure was replaced in 2007 by an arch.

The banks are well vegetated (Figure 8.35) along most of the segment except where there is no vegetated buffer by one of the bridges and the lawn on the western side. One major impact in M05-A is that it has been straightened at the downstream end for approximately one third of its length. The channel alteration most likely led to the major incision observed in M05-A. The channel has not yet widened. The stream type is a gravel dominated "C" stream with riffle-pool bedform. There is minor aggradation in the segment as observed through some steep riffles, diagonal bars, point bars, side bars, and mid-channel bars. Planform has changed somewhat due to the aggradation, but not as pronounced as in reaches upstream from here.

Both the geomorphic and habitat condition resulted in a "fair" score. The "fair" geomorphic condition was primarily due to the channel incision and channel alteration. Compromised riparian area on the eastern side due to the hay field, lack of abundant woody debris, and loss of floodplain access contributed to the "fair" habitat condition.



Figure 8.35. Well vegetated banks in M05-A.

The Natural Resource Conservation Service (NRCS) has investigated sediment loading upstream of Hoyt Road in the vicinity of Gunstock Brook segment M05-A (Winnepesaukee Gateway, 2012, <http://winnepesaukeegateway.org/monitoring-the-lake/potential-restoration-sites-map/>). The following actions have been recommended by the NRCS for this site (SB2):

1. Clean out existing sediment & erosion control structures.
2. Vegetate excavation sites not being used.
3. Re-establish woody vegetation within the brook's riparian buffer.

4. Replace undersized culvert at trail crossing.

Segment M05-B begins just upstream of the Hoyt Road crossing and continues for 1,433 feet until the riparian corridor becomes forested as opposed to shrub/sapling. The only area of channel straightening is at the downstream end of the segment near the Hoyt Road crossing. There are localized areas of rip-rap that is presently failing (Figure 8.36). Riparian buffers are in good shape in the segment with a width of greater than 200 feet in most locations.



Figure 8.36. Failing rip-rap in M05-B.

The stream type in segment M05-B is a gravel dominated “C” riffle-pool with good floodplain access. The habitat and geomorphic conditions are both good. The good geomorphic condition is due to the lack of incision and subsequent widening. The channel is in a state of aggradation that is causing planform change as seen through many flood chutes. The dominant active adjustment process is aggradation. Many steep riffles along with bar features were observed during the Phase 2 assessment. The good habitat condition is attributed to abundant pools, the well vegetated banks and buffers, and wide riparian area.

The most upstream Segment in M05, M05-C, begins where the riparian land use becomes forested and continues until the confluence with a major tributary of Gunstock Brook (T2). This segment has good floodplain access, well forested buffers and no channel alteration. However, sediment input to the segment has resulted in steep riffles and bar features (Figure 8.37) indicating major aggradation leading to abundant flood chutes (major planform change). Aggradation is the dominant adjustment process. A channel avulsion (Figure 8.38) and two debris jams are also present in Segment M05-C.

The RGA condition scored in the “fair” category due to the major aggradation and resultant planform adjustment. There was no incision in this Segment M05-C and the channel therefore has good access to its floodplain. The RHA scored in the “good” category mostly due to the nice undercut banks and pools (Figure 8.39) and well vegetated stream banks and riparian corridor. Given the high quality buffer and corridor conditions and habitat, it is recommended that Segments M05-B and M05-C be considered for conservation (Project #18). These two segments serve as key flood and sediment attenuation sections of Gunstock Brook and development within the corridor would jeopardize the ability for them to continue to provide flood and sediment retention.



Figure 8.37. Large diagonal bar showing major aggradation in M05-C.



Figure 8.38. Channel avulsion indicating major planform change in M05-C.



Figure 8.39. Deep pool and nice undercut bank in M05-C.

Major Tributary to Gunstock Brook

Reach T2.01

Reach T2.01 begins at the confluence with Gunstock Brook and was divided into two segments primarily based on variable confinement. The most downstream segment, T2.01-A, is a 1,482 foot long and extends to where valley width narrows. The stream type is a gravel dominated "C" channel with a slope of a "B" channel that has not experienced any channel alteration and is therefore not incised. Depositional features such as steep riffles, mid-channel bars, point bars, and side bars are common showing evidence of major aggradation. The aggradation (Figure 8.40) is primarily due to a drop in channel slope in this segment but may also be attributed to sediment input from the nearby gravel operation. Aggradation is the driving process in T2.01-A.

Major planform change has resulted from the aggradation in T2.01-A and can be seen as evidence from the many flood chutes and two neck cut-offs. Although there was significant deposition and planform adjustment in T2.01-A, the RGA scored in the low "good" category. High quality banks and buffers are present on both sides of the corridor in T2.01-A, which are wide and well vegetated. This contributed to the "good" score along with the lack of incision and widening. The RHA score of "good" in segment T2.01-A was primarily due to the abundant large woody debris and pools, and well vegetated and stable banks and buffers.

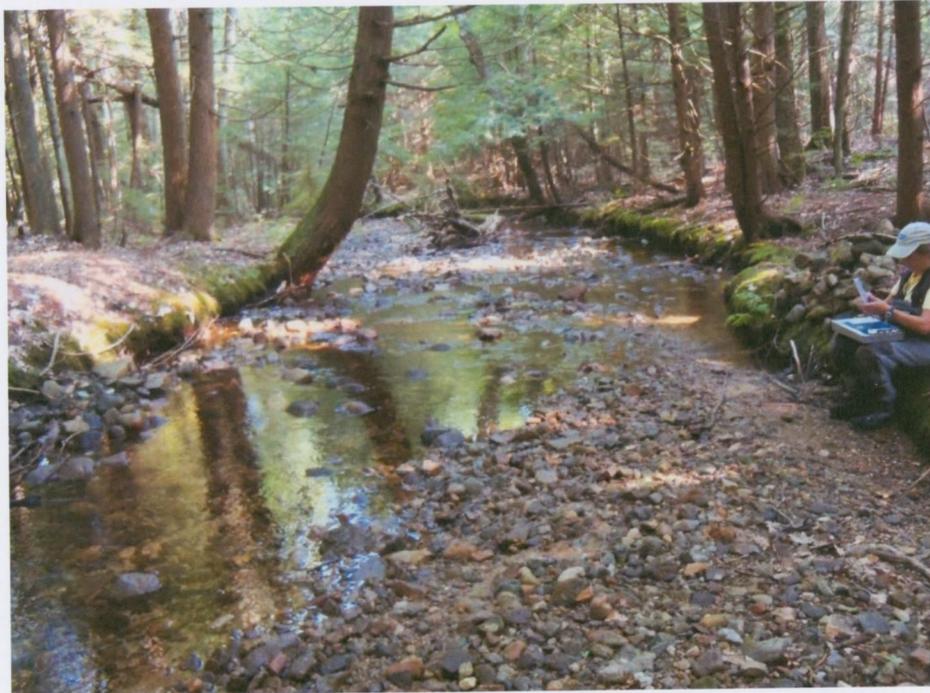


Figure 8.40. Depositional features in T2.01-A caused by drop in slope and perhaps upstream sediment source.

There is one stream crossing in T2.01-A that is significantly undersized and causing geomorphic instability. A culvert at a trail crossing (Figure 8.41) is in poor condition (rusty bottom and deformed) and has been given a high priority for replacement (Project #19) due to its reduced aquatic organism passage and geomorphic incompatibility. The replacement of this undersized structure is also a recommendation of NRCS (see page 51).



Figure 8.41. Undersized and rusted culvert in T2.01-A.

Segment T2.01-B begins where the valley becomes narrower and continues approximately ½ mile until 450 feet upstream of Belknap Mountain Road. Like T2.01-A, the banks and buffers are well forested in Segment T2.01-B. There has been no incision based on the cross section measured in this segment (Figure 8.42). Some banks are higher but this is more a function of natural floodplain variability than incision. There is very little erosion indicating that the segment is not widening. The stream type is a gravel dominated “C” channel with a slope of a “B” channel that has a dominant bedform of riffle-pool with a subdominant bedform of step-pool (upstream of Belknap Mountain Road). The channel is in the first stage of the channel evolution model, indicating it stable condition. All geomorphic processes were scored in the “good” or “reference” category. The lack of channel alteration, high quality banks and buffers, minor erosion and channel migration is indicative of the “good” geomorphic condition. The habitat condition also scored as “good” as a result of abundant pools, good hydrologic characteristics, nice undercut banks (Figure 8.43), and high quality banks and buffers.

Conservation of reach T2.01 is recommended to provide continued flood and sediment attenuation (Project #20). Flood and sediment attenuation is important to prevent further transport of sediment to Gunstock Brook.



Figure 8.42. Cross section in T2.01-B showing good floodplain access.



Figure 8.43. Nice undercut in T2.01-B providing cover for aquatic species.

8.3 Site Level Opportunities

Site specific projects were identified using the criteria outlined by the VANR in Chapter 6 – Preliminary Identification and Prioritization (Vermont Agency of Natural Resources 2010). This planning guide is intended to aid in the development of projects that protect and restore river equilibrium. Project maps (Appendix B) have been developed for the Gunstock Brook watershed. These maps were created using indexed data from the Phase 2 Stream Geomorphic Assessments along with existing data available from the New Hampshire Geographically Referenced Analysis and Information Transfer System (GRANIT). Locations of potential projects included on the Lake Winnepesaukee website <http://winnepesaukeegateway.org/monitoring-the-lake/potential-restoration-sites-map/> are also shown on the map.

A total of 20 projects were identified by BCE to promote the restoration or protection of channel stability and aquatic habitat in the Gunstock Brook watershed. The projects are broken down by category as follows: 3 conservation, 1 passive restoration (streamside plantings); 5 stormwater improvement projects; 11 active restoration (8 bridge or culvert replacement or retrofit projects, one alternative analysis for dam and rock wall removal, one berm removal/planform restoration project, and one investigation and alternatives analysis for well discharge into a swale that enters Gunstock Brook. Information from the Phase 2 stream geomorphic assessment and bridge and culvert assessments could be used to inform the Town of Gilford of which stream crossings are contributing to localized instability. The projects include:

Reach M01 – Gunstock Brook Mainstem (Refer to map on Page 1 of Appendix B)

- **Active Restoration** by replacing culvert impeding fish passage at Lakeshore Road (Project #1);
- **Stormwater Management** in the vicinity of Lakeshore Road (Project #2);
- **Active Restoration** by replacing bridge in poor condition at Old Lakeshore Road (Project #3);
- **Stormwater Management** of developed area west of Gunstock Brook off of Henderson Road (Project #4).

Reach M02 – Gunstock Brook Mainstem (Refer to map on page 2 of Appendix B)

- **Active Restoration** by replacing undersized and poorly aligned bridge at downstream Intervale Road crossing (Project #5);
- **Stormwater Management** of runoff from Intervale Road (Project #6);
- **Active Restoration** by replacing significantly undersized bridge at upstream Intervale Road crossing (Project #7);
- **Alternatives analysis** for berm removal to improve floodplain function just upstream of Intervale Road crossing (Project #8);
- **Active Restoration** by replacing significantly undersized bridge at Cherry Valley Road (Project #9).

Reach M03 – Gunstock Brook Mainstem (Refer to map on page 3 of Appendix B)

- **Active Restoration** by replacing perched culvert at the Town Garage Access Road (Project #10);
- **Stormwater Management** of runoff from Town Garage parking lot (Project #11);
- **Investigation** of eroded swale receiving well discharge (Project #12);
- **Active Restoration** by alternatives analysis of dam and rock wall removal (Project #13)

Reach M04 – Gunstock Brook Mainstem (Refer to maps on pages 4 and 5 of Appendix B)

- **Conservation** of the riparian corridor and wetland to maintain wetland function and to prevent further development that would reduce flood and sediment attenuation capacity (Project #14);
- **Active Restoration** by replacing undersized failing bridge along private trail where a debris jam is developing (Project #15 – Page 5 of Appendix B);
- **Stormwater Management** of Doris Drive residential development (Project #16);
- **Passive Restoration** by planting trees within the riparian corridor along the streambank at the Given Drive development to improve buffer conditions (Project #17).

Reach M05 – Gunstock Brook Mainstem (Refer to map on page 6 of Appendix B)

- **Conservation** of the riparian corridor to maintain stability and habitat (Project #18).

Major Tributary (T2) to Gunstock Brook (Refer to map on page 7 of Appendix B)

- **Active Restoration** by replacing significantly undersized and deteriorating culvert at trail crossing (Project #19);
- **Conservation** of the riparian corridor to provide shading of the brook and maintain sediment and flood attenuation areas (Project #20).

9.0 Next Steps

There are many opportunities to either restore Gunstock Brook and its major tributary to a stable condition. Preliminary reach level and site level projects have been identified and will form the bases for future project development. These preliminary projects include: conservation, streamside plantings, retrofit and/or replacement of stream crossings, berm removal, dam and/or rock wall removal, investigation of well discharge, and improving stormwater runoff. On the watershed level, the development and implementation of fluvial erosion hazard zones is recommended to avoid conflicts regarding land use and to save money spent on flood damage and river maintenance. The Town of Gilford could pursue the opportunity to work with the New Hampshire Department of Environmental Services and the Lakes Regional Planning Commission to develop fluvial erosion hazard zones for the land surrounding the Gunstock Brook mainstem and tributaries. The following are recommendations for next steps.

1. Complete a river corridor plan for the Gunstock Brook watershed to help guide project prioritization and development.
2. BCCD to meet with project partners including the Guildford Conservation Commission, Lake Regional Planning Commission, North County Resource Conservation & Development Area Council, Gilford Hazard Mitigation Update Committee, NRCS and the NHDES to discuss restoration and protection opportunities.
3. Provide outreach to private landowners and the public about the plan and potential projects.
4. Hire contractors (river scientists and engineers) to prepare project design and implementation strategies for selected high priority projects.
5. Work with regulatory agencies on project design and permitting.

For additional information about river restoration and protection opportunities within the Gunstock Brook watershed please contact:

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(603) 527-5880
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10.0 LIST OF ACRONYMS AND GLOSSARY OF TERMS

List of Acronyms

AOP – aquatic organism passage
BCE – Bear Creek Environmental, LLC
FEH – Fluvial Erosion Hazard Zone
GIS – Geographic Information System
GRANIT- New Hampshire Geographically Referenced Analysis and Information Transfer System
NHDES - New Hampshire Department of Environmental Services
NWI – National Wetlands Inventory
QA/QC – quality assurance/quality control
RHA- Rapid Habitat Assessment
RGA-Rapid Geomorphic Assessment
SGA – Stream Geomorphic Assessment
SGAT – Stream Geomorphic Assessment Tool
USGS – United States Geological Survey
VTDEC – Vermont Department of Environmental Conservation

Glossary of Terms

Adapted from:

Restoration Terms, by Craig Fischenich, February, 2000, USAE Research and Development Center, Environmental Laboratory, 3909 Halls Ferry Rd., Vicksburg, MS 39180

And

Vermont Stream Geomorphic Assessment Handbook, Appendix Q, 2009, VT Agency of Natural Resources, Waterbury, VT. http://www.vtwaterquality.org/rivers/docs/assessmenthandbooks/rv_apxqglossary.pdf

Adjustment process – type of change that is underway due to natural causes or human activity that has or will result in a change to the valley, floodplain, and/or channel condition (e.g., vertical, lateral, or channel plan form adjustment processes).

Aggradation - A progressive buildup or raising of the channel bed and floodplain due to sediment deposition. The geologic process by which streambeds are raised in elevation and floodplains are formed. Aggradation indicates that the stream discharge and/or bed load characteristics are changing. Opposite of degradation.

Alluvial fan – A fan-shaped accumulation of alluvium (alluvial soils) deposited at the mouth of a ravine or at the juncture of a tributary stream with the main stem where there is an abrupt change in slope.

Alluvial soils – Soil deposits from rivers.

Alluvium – A general term for detrital deposits made by streams on riverbeds, floodplains, and alluvial fans.

Avulsion – A change in channel course that occurs when a stream suddenly breaks through its banks, typically bisecting an overextended meander arc.

Bank Stability – The ability of a streambank to counteract erosion or gravity forces.

Bankfull channel depth - The maximum depth of a channel within a riffle segment when flowing at a bankfull discharge.

Bankfull channel width - The top surface width of a stream channel when flowing at a bankfull discharge.

Bankfull discharge - The stream discharge corresponding to the water stage that overtops the natural banks. This flow occurs, on average, about once every 1 to 2 years and given its frequency and magnitude is responsible for the shaping of most stream or river channels.

Bar – An accumulation of alluvium (usually gravel or sand) caused by a decrease in sediment transport capacity on the inside of meander bends or in the center of an over wide channel.

Berms – Mounds of dirt, earth, gravel or other fill built parallel to the stream banks designed to keep flood flows from entering the adjacent floodplain.

Cascade – River bed form where the channel is very steep with narrow confinement. There are often large boulders and bedrock with waterfalls.

Channelization – The process of changing (usually straightening) the natural path of a waterway.

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

Degradation – (1) A progressive lowering of the channel bed due to scour. Degradation is an indicator that the stream's discharge and/or sediment load is changing. The opposite of aggradation. (2) A decrease in value for a designated use.

Delta bar – A deposit of sediment where a tributary enters the mainstem of a river.

Depositional features – Types of sediment deposition and storage areas in a channel (e.g. mid-channel bars, point bars, side bars, diagonal bars, delta bars, and islands).

Diagonal Bar – Type of depositional feature perpendicular to the bank that is formed from excess sedimentation and within the channel and from the development of steep riffles.

Drainage Basin – The total area of land from which water drains into a specific river.

Dredging – Removing material (usually sediments) from wetlands or waterways, usually to make them deeper or wider.

Erosion – Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces.

Floodplain – Land built of sediment that is regularly covered with water as a result of the flooding of a nearby stream.

Gaging Station – A particular site in a stream, lake, reservoir, etc., where hydrologic data are obtained.

Grade control - A fixed feature on the streambed that controls the bed elevation at that point, effectively fixing the bed elevation from potential incision; typically bedrock, dams or culverts.

Gradient – Vertical drop per unit of horizontal distance.

Habitat – The local environment in which organisms normally grow and live.

Headwater – Referring to the source of a stream or river.

Head cut – Sudden change in elevation or knickpoint at the leading edge of a gully

Incised River – A river that erodes its channel by the process of degradation to a lower base level than existed previously or is consistent with the current hydrology.

Islands – Mid-channel bars that are above the average water level and have established woody vegetation.

Lacustrine soils- Soil deposits from lakes.

Meander - The winding of a stream channel, usually in an erodible alluvial valley. A series of sine-generated curves characterized by curved flow and alternating banks and shoals.

Meander migration – The change of course or movement of a channel. The movement of a channel over time is natural in most alluvial systems. The rate of movement may be increased if the stream is out of balance with its watershed inputs.

Meander belt width – The horizontal distance between the opposite outside banks of fully developed meanders determined by extending two lines (one on each side of the channel) parallel to the valley from the lateral extent of each meander bend along both sides of the channel.

Meander wavelength - The lineal distance downvalley between two corresponding points of successive meanders of the same phase.

Meander wavelength ratio – The meander wavelength divided by the bankfull channel width.

Meander width ratio – The meander belt width divided by the bankfull channel width.

Mid-channel bar – Sediment deposits (bar) located in the channel away from the banks, generally found in areas where the channel runs straight. Mid-channel bars caused by recent channel instability are unvegetated.

Planform - The channel shape as if observed from the air. Changes in planform often involve shifts in large amount of sediment, bank erosion, or the migration of the channel.

Plane bed – Channel lacks discrete bed features (such as pools, riffles, and point bars) and may have long stretches of featureless bed.

Point bar – The convex side of a meander bend that is built up due to sediment deposition.

Pool -- A habitat feature (section of stream) that is characterized by deep, low-velocity water and a smooth surface.

Reach - Section of river with similar characteristics such as slope, confinement (valley width), and tributary influence.

Restoration – The return of an ecosystem to a close approximation of its condition prior to disturbance.

Riffle - A habitat feature (section of stream) that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.

Riffle-pool - Channel has undulating bed that defines a sequence of riffles, runs, pools, and point bars. Occurs in moderate to low gradient and moderately sinuous channels, generally in unconfined valleys with well-established floodplains.

Riparian Buffer – The width of naturally vegetated land adjacent to the stream between the top of the bank and the edge of other land uses. A buffer is largely undisturbed and consists of the trees, shrubs, groundcover plants, duff layer, and naturally uneven ground surface.

Riparian Corridor – Lands defined by the lateral extent of a stream's meanders necessary to maintain a stable stream dimension, pattern, profile and sediment regime.

Segment – A relatively homogeneous section of stream contained within a reach that has the same reference stream characteristics but is distinct from other segments in the reach.

Sensitivity – The valley, floodplain and/or channel condition's likelihood to change due to natural causes and/or anticipated human activity.

Side bar – Unvegetated sediment deposits located along the margins or the channel in locations other than the inside of channel meander bends.

Step-pool – Characterized by longitudinal steps formed by large particles (boulder/cobbles) organized into discrete channel-spanning accumulations that separate pools, which contain smaller sized materials. Often associated with steep channels in confined valleys.

Steep riffle – Associated with aggradation where sediment has dropped out to form a steep face of sediment on the downstream side.

Surficial sediment/geology – Sediment that lies on top of bedrock.

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

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

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APPENDIX A

PHASE 2 GEOMORPHIC ASSESSMENT DATA

Phase 2 Reach Summary Statistics for Gunstock Brook

Reach/ Segment ID	Segment Length (ft)	Watershed Area (sq mi)	Reference Condition Stream Type, Substrate, Bedform	Phase 1 Valley Width (ft)	Phase 1 Confinement Ratio	Phase 1 Confinement Type	Reference Bankfull Width (ft)	Geo.Cross- sectional Area (sq ft)	Phase 2 Valley Width (ft)	Phase 2 Confinement Ratio	Phase 2 Confinement Type	Channel Dimensions			Channel & Floodplain Ratios			Existing Conditions		RGA* Condition	RHA* Condition	CEM† Stage	Stream Sensitivity		
												Width (ft)	Mean Depth (ft)	Area (ft²)	Width-to- Depth	Enrich- ment	Inclon	Stream Type	Substrate					Bedform	
M01-A	596	9.06	C, Gravel, Riffle-pool	1,320	57.4	Very Broad	37.0	84.6	1,065	46.3	Very Broad	23.0	2.51	57.7	9.2	1.9	2.2	Bc	Gravel	Plane-Bed	Fair	Fair	F	II	Very High
M01-B	1,293	9.06	C, Gravel, Riffle-pool	1,787	77.7	Very Broad	37.0	84.6	1,616	70.3	Very Broad	23.0	2.60	59.8	8.8	1.7	2.3	Bc	Gravel	Riffle-Pool	Fair	Fair	F	II	Very High
M01-C	2,195	9.06	C, Gravel, Riffle-pool	1,750	51.5	Very Broad	37.0	84.6	1,277	37.6	Very Broad	34.0	2.00	68.0	17.0	34.0	1.3	C	Gravel	Riffle-Pool	Fair	Fair	F	III	Very High
M01-E	1,110	9.06	C, Gravel, Riffle-pool	1,440	38.9	Very Broad	37.0	84.6	400	10.8	Very Broad	44.3	1.30	57.6	34.1	2.4	1.8	C	Gravel	Riffle-Pool	Fair	Fair	F	III	Very High
M02-A	1,807	8.22	C, Cobble, Plane Bed	303	8.7	Broad	35.0	78.6	225	6.4	Broad	36.0	2.61	94.0	13.8	4.8	1.3	Ch	Cobble	Plane-Bed	Poor	Fair	F	III	Very High
M02-B	639	8.22	B**, Cobble, Step Pool	266	10.1	Very Broad	35.0	78.6	80	3.0	Semi-confined	26.3	1.91	50.2	13.8	1.37	1.0	B	Cobble	Step-Pool	Good	Fair	F	I	High
M02-C	3,470	8.22	C, Cobble, Riffle-pool	428	12.2	Very Broad	35.0	78.6	227	6.5	Broad	38.5	2.0	77.0	19.3	2.49	1.0	C	Cobble	Riffle-Pool	Fair	Fair	F	III	Moderate
M03-A	2,388	5.86	C, Cobble, Riffle-pool	468	15.6	Semi-confined	30.0	60.9	225	7.5	Broad	40	1.15	46.0	34.8	2.15	2.0	C	Cobble	Riffle-Pool	Poor	Fair	F	III	High
M03-B	1,098	5.86	Fb, Cobble, Step-pool	112	3.7	Semi-confined	30.0	60.9	86	2.9	Semi-confined	30	1.71	51.3	17.5	1.2	1.0	Fb	Cobble	Step-Pool	Good	Fair	F	I	High
M04-A	5,200	5.61	C, Gravel, Riffle-pool	1,464	39.4	Very Broad	29.0	58.9	889	30.7	Very Broad	35	1.5	52.5	23.3	16.1	1.0	C	Gravel	Riffle-Pool	Good	Fair	F	I	High
M04-B	3,641	5.61	C, Gravel, Riffle-pool	918	45.5	Very Broad	29.0	58.9	576	24.7	Very Broad	23.3	2.24	52.2	20.4	5.2	1.3	C	Gravel	Riffle-Pool	Good	Fair	F	I	High
M04-C	848	5.61	C, Gravel, Riffle-pool	1,273	48.5	Very Broad	29.0	58.9	1,235	44.1	Very Broad	28.0	1.68	47.0	16.7	17.1	1.5	C	Gravel	Riffle-Pool	Fair	Fair	F	II	Very High
M05-A	936	3.91	C, Gravel, Riffle-pool	888	48.5	Very Broad	24.0	44.9	888	48.5	Very Broad	28.3	1.70	31.1	10.8	10.1	1.5	C	Gravel	Riffle-Pool	Fair	Fair	F	II	Very High
M05-B	1,433	3.91	C, Gravel, Riffle-pool	1,344	56.0	Very Broad	24.0	44.9	1,338	51.6	Very Broad	26.4	1.41	37.2	18.7	19.4	1.0	C	Gravel	Riffle-Pool	Good	Good	D	IIc	Very High
M05-C	2,056	3.91	C, Gravel, Riffle-pool	936	39.0	Very Broad	24.0	44.9	916	38.2	Very Broad	33.0	1.50	49.5	22.0	11.3	1.0	C	Gravel	Riffle-Pool	Fair	Good	D	IIc	Very High
TZ01-A	1,487	1.49	Ch, Gravel, Riffle-pool	407	27.1	Very Broad	15.0	21.6	407	27.1	Very Broad	20.0	1.41	28.2	24.2	13.2	1.1	Ch	Gravel	Riffle-Pool	Good	Good	D	IIc	Very High
TZ01-B	2,324	1.49	Ch, Gravel, Riffle-pool	190	12.7	Very Broad	15.0	21.6	179	11.9	Very Broad	17	1.37	23.3	12.4	6.8	1.0	Cb	Gravel	Riffle-Pool	Good	Good	F	I	High

*RGA = Rapid Geomorphic Assessment, RHA = Rapid Habitat Assessment, †CEM = Channel Evolution Model
 NA = Not Applicable

** Modified reference stream type
 last updated March 7, 2012

Summary of the Rapid Habitat Assessment (RHA) Values for Gunstock Brook

Segment/ Reach ID	Reference Stream Type	Woody Debris Cover	Bed Substrate Cover	Scour and Depositional Features	Channel Morphology	Hydrologic Characteristics	Connectivity		River Banks		Riparian Area		Total Score	Percentage	Habitat Condition				
							Left	Right	Left	Right	Left	Right							
M01-A																			
Impounded - Not Assessed																			
M01-B	Riffle-Pool	7	6	11	8	13	12	3	4	2	2	2	68	43%	Fair				
M01-C	Riffle-Pool	6	9	12	5	13	14	5	5	3	3	3	75	47%	Fair				
M01-D	Riffle-Pool	7	12	13	14	12	12	4	4	3	4	4	85	53%	Fair				
M01-E	Riffle-Pool	3	7	8	7	7	12	6	4	2	2	2	58	36%	Fair				
M02-A	Plane Bed	13	12	11	14	13	13	6	5	4	7	7	98	61%	Fair				
M02-B	Step-Pool	7	11	12	14	13	12	2	6	1	9	9	87	54%	Fair				
M02-C	Riffle-Pool	6	8	9	11	13	13	6	3	7	2	2	78	49%	Fair				
M03-A	Riffle-Pool	13	13	8	8	12	13	7	3	5	7	7	89	56%	Fair				
M03-B	Step-Pool	8	12	12	13	13	3	3	7	2	7	80	50%	Fair					
M04-A	Riffle-Pool	14	16	13	14	14	17	7	7	6	6	114	71%	Good					
M04-B	Riffle-Pool	16	14	14	16	11	15	9	9	3	10	117	73%	Good					
M04-C	Riffle-Pool	8	16	10	8	9	14	3	8	3	8	87	54%	Fair					
M05-A	Riffle-Pool	9	13	13	8	14	13	7	7	3	7	94	59%	Fair					
M05-B	Riffle-Pool	12	13	13	14	13	14	9	9	10	10	117	73%	Good					
M05-C	Riffle-Pool	16	11	11	16	12	17	9	9	9	9	119	74%	Good					
T2.01-A	Riffle-Pool	15	18	13	15	9	13	9	9	9	9	119	74%	Good					
T2.01-B	Riffle-Pool	11	14	17	18	13	18	8	9	8	8	124	78%	Good					
Total Possible Scores:													20	20	10	10	160	100%	Reference

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M01	Segment:	A	Completion Date:	24-Aug-11
Stream:	Gunstock Brook	Observers:	PD, MN	Why Not Assessed:	I	Rain:	Yes
Segment Length (ft):	596	Segment Location:	From mouth to Lakeshore Road				
Step 1. Valley and Floodplain							
1.1 Segmentation:	OT	2.6 Width/Depth Ratio	NE	Bank Texture	Left	Right	Right
1.2 Alluvial Fan:	None	2.7 Entrenchment Ratio	NE	Upper			
1.3 Corridor Encroachments:							
Length (ft)	One	2.8 Incision Ratio	NE	Material Type	Sand	Sand	Shrub/Sapling
Berm	0	*Human Elevated Incision	NA	Consistency	Non-cohesive	Non-cohesive	Commercial
height (ft)	0	2.9 Sinuosity	Not Evaluated	Lower			Forest
Roads	0	2.10 Riffle Type	NA	Material Type	Sand	Sand	Commercial
Railroads	0	2.11 Riffle Step Spacing (ft)		Consistency	Non-cohesive	Non-cohesive	Commercial
height (ft)	0	2.12 Substrate Composition					Forest
Improved Paths	0	Bedrock	NE	Bank Erosion	Left	Right	Forest
height (ft)	0	Boulder	NE	Erosion Length (ft)	0	48	Commercial
Development	417	Cobble	NE	Erosion Height (ft)	Multiple	Multiple	Commercial
Left	0	Coarse Gravel	NE	Revetment Type	36	73	Commercial
Right	0	Fine Gravel	NE	Near Bank Veg. Type	% Cover Invasive	Deciduous	Commercial
Hillside Slope	Never	Sand	NE	L Trees (%)	10	0	Commercial
Continuous	Never			R Trees (%)	70	0	Commercial
W/in 1 bankfull	Never	Silt/Clay Present	No	% Cover Invasive	70	0	Commercial
Texture	NE	Embedded (chan)	NE	% Cover Invasive	100	0	Commercial
	NE	Embedded (marg)	NE	% Cover Invasive	70	0	Commercial
	NE	LWD #	NE	% Cover Invasive	70	0	Commercial
1.4 Adjacent Features							
Valley Width (ft)	1100			% Cover Invasive	10	0	Commercial
Width Determination	Estimated	2.13 Average Largest Particle	Ne	% Cover Invasive	70	0	Commercial
Confinement Type	Very Broad	Bed	Ne	% Cover Invasive	70	0	Commercial
Rock Gorge?	No	Bar	Ne	% Cover Invasive	70	0	Commercial
Human Caused Change?	No	2.13a % Subs. Exp.	Ne	% Cover Invasive	70	0	Commercial
Step 2. Stream Channel							
2.1 Bankfull Width (ft)	NE	2.14 Stream Type	E	% Cover Invasive	70	0	Commercial
2.1a Wetted Width (ft)	NE	Stream Type:	Sand	% Cover Invasive	70	0	Commercial
2.1b Ratio (wetted/bkfl)	NE	Bed Material:	None	% Cover Invasive	70	0	Commercial
2.2 Max Depth (ft)	NE	Subclass Slope:	Dune-Ripple	% Cover Invasive	70	0	Commercial
2.3 Mean Depth (ft)	NE	Bed Form:	Field Measured Slope:	% Cover Invasive	70	0	Commercial
2.4 Floodprone Width (ft)	NE	Field Measured Slope:	2.15 Reference Stream Type	% Cover Invasive	70	0	Commercial
2.5 RAF	NE	E, Sand, Dune-Ripple	3.1 Stream Banks	% Cover Invasive	70	0	Commercial
*Human Elevated FP	NA	Typical Bank Slope	Steep	% Cover Invasive	70	0	Commercial
Step 3. Riparian Features							
3.1 Stream Banks							
3.2 Riparian Buffer							
3.3 Riparian Corridor							
3.4 Flow & Flow Modifiers							
3.5 Channel Bed & Planform Changes							
3.6 Other Features							
3.7 Steep Riffles & Headcuts							
3.8 Stream Ford or Animal Crossing							
3.9 Straightening							
3.10 Dredging							
3.11 Bridge and Culvert Survey							

Note: General comments, Step 1.6 Grade Controls and Step 4.8

Channel Constrictions on Sheet 2 of this workbook.

Legend: RAF=Recently Abandoned Floodplain, FP=Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Step Riffle, HC=Head Cut

NE= Not evaluated, NA=Not applicable

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 596
 1.6 Grade Controls: None
 Reach #: M01
 Observers: PD, MN
 Segment Location: From mouth to Lakeshore Road
 Segment: A
 Why Not Assessed: I
 Completion Date: 24-Aug-11
 Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Score	STD	Historic
Unconfined	NE	NE	NE
7.1 Channel Degradation	NE	NE	NE
7.2 Channel Aggradation	NE	NE	NE
7.3 Widening Channel	NE	NE	NE
7.4 Change in Planform	NE	NE	NE
Total Score: NE			
Geomorphic Rating: NE			
Channel Evolution Model NE			
Channel Evolution Stage NE			
Geomorphic Condition NE			
Stream Sensitivity NE			
Channel Adjustment Processes Narrative			

4.8 Channel Constrictions

Type	Width (ft)	Photo	Channel Constr.	Floodprone Constr.
None	GPS	Photo	Channel Constr.	Floodprone Constr.

Problems:

Notes:
Did not walk entire segment.

Legend: Ht.=Height, Constr.=Constriction, Old abutrm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment, NE= Not evaluatec

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M01	Segment:	B	Completion Date:	24-Aug-11
Stream:	Gunstock Brook	Observers:	PD, MN	Why Not Assessed:	NA	Rain:	Yes
Organization:	BCE	Segment Location:	From Lakeshore Road upstream to Old Lakeshore Road	Material Type	Sand	Left	Residential
Segment Length (ft):	1203	Step 2. (Cont'd)	2.6 Width/Depth Ratio	Consistency	Non-cohesive	Right	Residential
		2.7 Entrenchment Ratio	1.9	Upper	Sand	None	None
		2.8 Incision Ratio	2.2	NA	Non-cohesive	0	0
		*Human Elevated Incision	NA	Consistency	Non-cohesive	0	0
		2.9 Sinuosity	Mod (1.2-1.5)	Lower	Sand	0	0
		2.10 Riffle Type	Not Applicable	Material Type	Non-cohesive	0	0
		2.11 Riffle Step Spacing (ft)	95	Consistency	Sand	0	0
		2.12 Substrate Composition		Bank Erosion	Non-cohesive	0	0
		Bedrock	0	Erosion Length (ft)	Right	153	None
		Boulder	1	Erosion Height (ft)	Right	3	None
		Cobble	6	Revetment Type	Multiple	4.3 Flow Status	Base
		Coarse Gravel	5	Revetment Length (ft)	Multiple	4.4 # of Debris Jams	0
		Fine Gravel	66	Near Bank Veg. Type	Confifer	Deciduous	None
		Sand	22	L Trees (%)	0	0	None
				R Trees (%)	0	0	None
		Silt/Clay Present	No	L Shrub/Sapling (%)	0	0	Road Ditch
		Embedded (chan)	56	R Shrub/Sapling (%)	0	0	Tile Drain
		Embedded (margin)	40	L Herbs (%)	0	0	Other
		LWD #	6	R Herbs (%)	0	0	0
		Valley Width (ft)	1065	Canopy %	1-25	1-25	
		Width Determination	Estimated	Mid-channel canopy	Open		
		Confinement Type	Very Broad	3.2 Riparian Buffer			
		Rock Gorge?	No	Buffer Width	Left	26-50	
		Human Caused Change?	Yes	Dominant	Right	26-50	
				Sub-dominant	Left	0-25	
				Length <25 ft	Right	51-100	
				Buffer Veg. Type	Confifer	Deciduous	
				L Trees (%)	10	0	
				R Trees (%)	30	0	
				L Shrub/Sapling (%)	20	0	
				R Shrub/Sapling (%)	10	0	
				L Herbs (%)	90	0	
				R Herbs (%)	90	0	
				Typical Bank Slope	Steep		
				Stream Type:	B		
				Bed Material:	Gravel		
				Subclass Slope:	c		
				Bed Form:	Plane Bed		
				Field Measured Slope:			
				2.15 Reference Stream Type	C, Gravel, Riffle-Pool		
				3.1 Stream Banks			
				Typical Bank Slope	Steep		
				2.1 Bankfull Width (ft)	23		
				2.1a Wetted Width (ft)	13.4		
				2.1b Ratio (wetted/bkfl)	0.58		
				2.2 Max Depth (ft)	3.95		
				2.3 Mean Depth (ft)	2.51		
				2.4 Floodprone Width (ft)	44		
				2.5 RAF	8.7		
				*Human Elevated FP	NA		
				3.3 Riparian Corridor			
				Corridor Land Use			
				Dominant	Residential		
				Sub-dominant	None		
				Mass Failures (ft)	0		
				Height (ft)	0		
				Gullies (number)	0		
				Height (ft)	0		
				Step 4. Flow & Flow Modifiers			
				4.1 Springs/Seeps	None		
				4.2 Adjacent Wetlands	None		
				4.3 Flow Status	Base		
				4.4 # of Debris Jams	0		
				4.5 Flow Reg Type	None		
				4.6 Up/Downstream Flow Reg	None		
				4.7 Stormwater Inputs	None		
				Field Ditch	0		
				Urban Storm Pipe	1		
				Overland Flow	0		
				# of Beaver Dams	0		
				Affected Length (ft)	0		
				Step 5. Channel Bed & Planform Changes			
				5.1 Bar Types	Mid	Point	Side
				Diagonal	1	2	2
				Flood	1	0	0
				5.2 Other Features	Delta	NCO	Avulsion
				Braiding	0	0	0
				# SRs	1	0	0
				# HCs	0	0	0
				5.4 Stream Ford or Animal Crossing	5.4 Stream Ford	0	Trib Rejuv.
				5.5 Straightening	5.5 Straightening	0	No
				Length (ft)	822		
				5.5 Dredging	None		
				Bridge and Culvert Survey	Yes		

Note: General comments, Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook.
Legend: RAP=Recently Abandoned Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut
 NE= Not evaluated, NA=Not applicable

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 1203
 1.6 Grade Controls: None
 Reach #: M01
 Observers: PD, MN
 Segment Location: From Lakeshore Road upstream to Old Lakeshore Road
 Segment: B
 Why Not Assessed: NA
 Completion Date: 24-Aug-11
 Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Unconfined Score	STD	C to B	Historic
7.1 Channel Degradation	3		None	Yes
7.2 Channel Aggradation	10		None	No
7.3 Widening Channel	14		None	No
7.4 Change in Planform	12		None	No

Total Score: 39
 Geomorphic Rating: 0.49

Channel Evolution Model F
 Channel Evolution Stage II
 Geomorphic Condition Fair (0.35-0.64)
 Stream Sensitivity Very High

Channel Adjustment Processes Narrative

Segment has experienced extreme incision. Aggradation is minor but bed has considerable fine deposition. Widening is being prevented by extensive rip rap. Planform has been altered by straightening, but it is not a major process.

Notes:

Sandy substrate. Not much exposed substrate. Generally fair pool cover.

4.8 Channel Constrictions Present

Type	Width (ft)	Photo	GPS	Channel Constr.	Floodprone Constr.
Bridge	36	Yes	Yes	Yes	No
Culvert	20	Yes	Yes	Yes	Yes
Bridge	29	Yes	Yes	Yes	Yes

Problems: DA, DB

Legend: Ht.=Height, Constr.=Constriction, Old abutm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M01	Segment:	C	Completion Date:	24-Aug-11
Organization:	Gunstock Brook BCE	Observers:	PD, MN	Why Not Assessed:	NA	Rain:	Yes
Segment Length (ft):	2195	Segment Location:	Begins at Old Lakeshore Road and continues upstream for about 1/2 mile to where banks and buffers contain more trees:				
Step 1. Valley and Floodplain							
1.1 Segmentation:	BB	2.6 Width/Depth Ratio	8.8	Bank Texture	Left	Right	Right
1.2 Alluvial Fan:	None	2.7 Entrenchment Ratio	1.7	Upper	Sand	Sand	Hay Shrub/Sapling
1.3 Corridor Encroachments:	Both	2.8 Incision Ratio	2.3	Material Type	Sub-dominant	Sub-dominant	Crop
Length (ft)	0	*Human Elevated Incision	NA	Consistency	Non-cohesive	Non-cohesive	Shrub/Sapling
Berms	0	2.9 Sinuosity	Low (<1.2)	Consistency	Non-cohesive	Non-cohesive	Shrub/Sapling
height (ft)	0	2.10 Riffle Type	Complete	Material Type	Sand	Sand	0
Roads	0	2.11 Riffle Step Spacing (ft)	74	Consistency	Non-cohesive	Non-cohesive	0
Railroads	0	2.12 Substrate Composition		Bank Erosion	Left	Right	0
height (ft)	0	Bedrock	0	Erosion Length (ft)	475	517	Minimum
Improved Paths	0	Boulder	0	Erosion Height (ft)	3	3	Extensive
height (ft)	0	Cobble	2	Revetment Type	Multiple	Multiple	Base
Development	103	Coarse Gravel	30	Revetment Length (ft)	306	609	0
Hillside Slope	Left	Fine Gravel	44	Near Bank Veg. Type	%Cover Invasive	Deciduous	Irrigation
Continuous	Never	Sand	24	L Trees (%)	10	0	None
W/in 1 bankfull	Never	Silt/Clay Present	No	R Trees (%)	0	0	None
Texture	NE	Embedded (chan)	32	L Shrub/Sapling (%)	90	0	Road Ditch
1.4 Adjacent Side	NE	Embedded (marg)	32	R Shrub/Sapling (%)	90	0	Tile Drain
Hillside Slope	Flat	LWD #	9	L Herbs (%)	90	0	Other
Continuous	Never	2.13 Average Largest Particle	2.9	R Herbs (%)	90	0	0
W/in 1 bankfull	Never	Bed	2.9	Bank Canopy	Left	Right	0
Texture	NE	Bar	2	Canopy %	51-75	51-75	0
1.5 Valley Features	NE	2.13a % Subs. Exp.	20	Mid-channel canopy	Open	Open	0
Valley Width (ft)	1616	2.14 Stream Type		3.2 Riparian Buffer			
Width Determination	Estimated	Stream Type:	B	Buffer Width	Left	Right	
Confinement Type	Very Broad	Bed Material:	Gravel	Dominant	26-50	26-50	
Rock Gorge?	No	Subclass Slope:	c	Sub-dominant	51-100	51-100	
Human Caused Change?	Yes	Bed Form:	Riffle-Pool	Length <25 ft	178	274	
2.1 Bankfull Width (ft)	23	Field Measured Slope:		Buffer Veg. Type	%Cover Invasive	Comifer	
2.1a Wetted Width (ft)	12.8	C, Gravel, Riffle-Pool		L Trees (%)	10	0	
2.1b Ratio (wetted/bkfl)	0.56	2.15 Reference Stream Type	Step	R Trees (%)	10	0	
2.2 Max Depth (ft)	3.3	Step 3. Riparian Features		L Shrub/Sapling (%)	30	0	
2.3 Mean Depth (ft)	2.6	3.1 Stream Banks		R Shrub/Sapling (%)	30	0	
2.4 Floodprone Width (ft)	38	Typical Bank Slope	Step	L Herbs (%)	100	0	
2.5 RAF	7.6			R Herbs (%)	100	0	
*Human Elevated FP	NA						

Note: General comments, Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook.
 Legend: RAF=Recently Abandoned Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut
 NE= Not evaluated, NA=Not applicable

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 2195
 1.6 Grade Controls: None

Segment: M01
 Why Not Assessed: PD, MN
 Reach #: Begins at Old Lakeshore Road and continues upstream for about 1/2 mile to where banks and buffers contain more trees.
 Observers: NA
 Completion Date: 24-Aug-11
 Rain: Yes

Type	Location	Total Ht (ft)	Ht Above (ft)	Photo	GPS	Confinement Type		Historic
						Unconfined	Score	
4.8 Channel Constrictions						3	42	Yes
						13	0.53	No
						15		No
						11		No

Total Score: 42
 Geomorphic Rating: 0.53
 Channel Evolution Model F
 Channel Evolution Stage II
 Geomorphic Condition Fair (0.35-0.64)
 Stream Sensitivity Very High
 Channel Adjustment Processes Narrative

Extreme historic incision. Widening is minor due to extensive rip rap in segment. However, erosion on outside bends. Planform was altered by channel straightening. Diagonal bars are small and just starting to form. Elevation stage is late stage II or early stage III.

Notes:
 High banks with outflanked riprap. Poor cover in pools. Very long featureless pools. Bank erosion occurred during Mother's Day flood in 2006.

Legend: Ht.=Height, Constr.=Constriction, Old abutrm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M01	Segment:	D	Completion Date:	24-Aug-11
Stream:	Gunstock Brook	Observers:	PD, MN	Why Not Assessed:	NA	Rain:	Yes
Organization:	BCE	Segment Location:	Begins where banks and buffers contain more trees and continues 682 feet until developed sector				
Segment Length (ft):	654	Step 2. (Cont'd)					
Step 1. Valley and Floodplain	Step 3. (Cont'd)						
1.1 Alluvial Fan:	BB	2.6 Width/Depth Ratio	17.0	Left	Right	Left	Right
1.2 Segmentation:	None	2.7 Entrenchment Ratio	34.0	Upper			
1.3 Corridor Encroachments:		2.8 Incision Ratio	1.3	Material Type	Sand	Sand <td>Sand</td>	Sand
Length (ft)	One	*Human Elevated Incision	NA	Consistency	Non-cohesive	Non-cohesive <td>Non-cohesive</td>	Non-cohesive
Berm	0	2.9 Sinuosity	Mod (1.2-1.5)	Complete	Complete	Complete	Complete
height (ft)	0	2.10 Riffle Type	0	Bank Erosion	93	Bank Erosion	93
Roads	0	2.11 Riffle Type	0	Erosion Length (ft)	133	Erosion Length (ft)	111
height (ft)	0	2.12 Substrate Composition	0	Erosion Height (ft)	5	Erosion Height (ft)	5
Railroads	0	Bedrock	0	Revetment Type	None	Revetment Type	None
height (ft)	0	Cobble	28	Revetment Length (ft)	0	Revetment Length (ft)	0
Improved Paths	0	Coarse Gravel	65	Near Bank Veg. Type	L Trees	Near Bank Veg. Type	L Trees
height (ft)	0	Fine Gravel	2	L Trees (%)	10	L Trees (%)	10
Development	39	Sand	5	R Trees (%)	0	R Trees (%)	0
1.4 Adjacent Side	Left	Silt/Clay Present	No	L Shrub/Sapling (%)	100	L Shrub/Sapling (%)	100
Hillside Slope	Flat	Embedded (chan)	22	R Shrub/Sapling (%)	0	R Shrub/Sapling (%)	0
Continuous	Never	Embedded (marg)	26	L Herbs (%)	100	L Herbs (%)	100
W/in 1 bankfull	Never	LWD #	4	R Herbs (%)	100	R Herbs (%)	100
Texture	NE	2.13 Average Largest Particle	4.4	Bank Canopy	1-25	Bank Canopy	1-25
1.5 Valley Features		Bed	2.8	Mid-channel canopy	Open	Mid-channel canopy	Open
Valley Width (ft)	1277	Bar	30	3.2 Riparian Buffer		3.2 Riparian Buffer	
Width Determination	Estimated	2.13a % Subs. Exp.	30	Buffer Width	Left	Buffer Width	Right
Confinement Type	Very Broad	2.14 Stream Type	C	Dominant	51-100	Dominant	51-100
Rock Gorge?	No	Bed Material:	Gravel	Sub-dominant	26-50	Sub-dominant	101-150
Human Caused Change?	Yes	Bed Form:	Riffle-Pool	Length <25 ft	124	Length <25 ft	0
2.1 Stream Channel		Field Measured Slope:	2	Buffer Veg. Type	% Cover Invasive	Buffer Veg. Type	% Cover Invasive
2.1a Bankfull Width (ft)	34	2.15 Reference Stream Type	C, Gravel, Riffle-Pool	L Trees (%)	5	L Trees (%)	5
2.1a Wetted Width (ft)	13	3.1 Stream Banks	Step	R Trees (%)	0	R Trees (%)	0
2.1b Ratio (wetted/bkfl)	0.38	Typical Bank Slope	Step	L Shrub/Sapling (%)	100	L Shrub/Sapling (%)	100
2.2 Max Depth (ft)	2.9	3.1.1 Stream Banks		R Shrub/Sapling (%)	100	R Shrub/Sapling (%)	100
2.3 Mean Depth (ft)	2	Typical Bank Slope	Step	L Herbs (%)	100	L Herbs (%)	100
2.4 Floodprone Width (ft)	1155	3.1.2 Stream Banks		R Herbs (%)	100	R Herbs (%)	100
2.5 RAF	3.7	Typical Bank Slope	Step	L Herbs (%)	100	L Herbs (%)	100
*Human Elevated FP	NA	3.1.3 Stream Banks		R Herbs (%)	100	R Herbs (%)	100
<p>Note: General comments. Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook.</p> <p>Legend: RAF=Recently Abandoned Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut</p> <p>NE= Not evaluated, NA=Not applicable</p>							

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 654
 1.6 Grade Controls: None

Reach #: M01
 Observers: PD, MN
 Segment Location: Begins where banks and buffers contain more trees and continues 682 feet until developed sector

Why Not Assessed: NA
 Completion Date: 24-Aug-11
 Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Unconfined	Score	STD	Historic
7.1 Channel Degradation	13	None	None	Yes
7.2 Channel Aggradation	8	None	None	No
7.3 Widening Channel	9	None	None	No
7.4 Change in Planform	14	None	None	No

Total Score: 44
 Geomorphic Rating: 0.55

Channel Evolution Model F
 Channel Evolution Stage III
 Geomorphic Condition Fair (0.35-0.64)
 Stream Sensitivity Very High

Channel Adjustment Processes Narrative

Minor historic degradation, abundant aggradation - large point bars, some steep riffles and diagonal bars. Banks are eroding but low width to depth ratio. Channel is widening based on extensive erosion. Minor planform adjustment as indicated by flood chutes.

Notes:

High sinuosity with sandy banks. Good vegetation on undercuts.

Total Ht (ft): None
 Location: Ht Above
 Photo: GPS

4.8 Channel Constrictions Present

Type	Width (ft)	Photo	GPS
Channel Constr.	GPS	Channel Constr.	Floodprone Constr.

Problems:

Legend: Ht.=Height, Constr.=Constriction, Old abuttm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
Stream: Gunstock Brook
Organization: BCE
Segment Length (ft): 1110
1.6 Grade Controls: None

Reach #: M01
Observers: PD, MN
Segment Location: Begins in developed section

Why Not Assessed: NA
Completion Date: 24-Aug-11
Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)
Confinement Type: Unconfined

Confinement Type	Score	STD	Historic
7.1 Channel Degradation	7	None	Yes
7.2 Channel Aggradation	9	None	No
7.3 Widening Channel	9	None	No
7.4 Change in Planform	12	None	No
Total Score:	37		
Geomorphic Rating:	0.46		

Channel Evolution Model F
Channel Evolution Stage III
Geomorphic Condition Fair (0.35-0.64)
Stream Sensitivity Very High

Channel Adjustment Processes Narrative
 Channel has experienced major incision which has led to major widening. Planform is minor and aggradation is major as seen through steep riffles and diagonal bars.

Notes:
 Bank heights higher below Henderson Road. High bank erosion. Poor pool coverage and embedded cobbles. Knotweed on both sides. Many small pools are run-like.

4.8 Channel Constrictions Present

Type	Width (ft)	Photo	GPS	Channel Constr.	Floodprone Constr.
Culvert	18.5	Yes	Yes	Yes	Yes
Problems:	DA, DB, SB				

Legend: Ht.=Height, Constr.=Construction, Old abuttm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M02	Segment:	A	Completion Date:	23-Aug-11
Stream:	Gunstock Brook	Observers:	PD, MN	Why Not Assessed:	NA	Rain:	Yes
Organization:	BCE	Segment Location:	Begins just upstream of Henderson Road and continues for 1,770 feet until Intervale Road is very close to stream channel.	Corridor Land Use	Dominant	Residential Forest	0
Segment Length (ft):	1807	Step 2. (Cont'd)		Left		Right	
Step 1. Valley and Floodplain		Step 2. (Cont'd)		Left	Right	Left	Right
1.1 Segmentation:	PS	2.6 Width/Depth Ratio	13.8	Sand	Sand	Residential Forest	Forest
1.2 Alluvial Fan:	None	2.7 Entrenchment Ratio	4.8	Non-cohesive	Non-cohesive	Forest	Residential
1.3 Corridor Encroachments:	Both	2.8 Incision Ratio	1.3	Gravel	Gravel	0	94
Length (ft)	0	*Human Elevated Incision	NA	Non-cohesive	Non-cohesive	0	30
Berms	32	2.9 Sinuosity	Low (<1.2)	Gravel	Gullies (number)	0	0
Roads	718	2.10 Riffle Type	Not Applicable	Non-cohesive	Height (ft)		
height	0	2.11 Riffle Step Spacing	59	Gravel	Step 4. Flow & Flow Modifiers		
Railroads	0	2.12 Substrate Composition		Non-cohesive	4.1 Springs/ Seeps	Extensive	
height	0	Boulder	0	Multiple	4.2 Adjacent Wetlands	None	
height	0	Cobble	45	Multiple	4.3 Flow Status	Base	
height	0	Coarse Gravel	24	Multiple	4.4 # of Debris Jams	0	
Development	379	Fine Gravel	13	Multiple	4.5 Flow Reg Type	Unknown	
1.4 Adjacent Side	Left	Sand	11	% Cover Invasive	4.6 Up/Downstream Flow Reg	None	
Hillside Slope	Extremely Steep			80	4.7 Stormwater Inputs	0	
Continuous	Sometimes			0	Field Ditch	Road Ditch	1
W/in 1 bnkfl	Sometimes			30	Urban Storm Pipe	Tile Drain	0
Texture	Sometimes			30	Overland Flow	Other	0
1.5 Valley Features	NE			70	4.9 # of Beaver Dams	0	
Valley Width (ft)	225			70	Affected Length (ft)		
Width Determination	Measured			70	Step 5. Channel Bed & Planform Changes		
Confinement Type	Broad			76-100	5.1 Bar Types	Mid	Point
Rock Gorge?	No			Closed	Diagonal	2	Delta
Human Caused Change?	Yes			3.2 Riparian Buffer	Flood	2	NCO
2.1 Stream Channel				Buffer Width	5.2 Other Features	1	0
2.1 Bankfull Width (ft)	36			Dominant	Braiding	1	
2.1a Wetted Width (ft)	24.2			Sub-dominant			
2.1b Ratio (wetted/bkfl)	0.67			Length <25 ft			
2.2 Max Depth (ft)	3.4			Buffer Veg. Type			
2.3 Mean Depth (ft)	2.61			L Trees (%)			
2.4 Floodprone Width (ft)	173			R Trees (%)			
2.5 RAF	4.5			L Shrub/Sapling (%)			
*Human Elevated FP	NA			R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			
				3.2 Riparian Buffer			
				Buffer Width			
				Dominant			
				Sub-dominant			
				Length <25 ft			
				Buffer Veg. Type			
				L Trees (%)			
				R Trees (%)			
				L Shrub/Sapling (%)			
				R Shrub/Sapling (%)			
				L Herbs (%)			
				R Herbs (%)			
				Canopy %			
				Mid-channel canopy			

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 1807
 1.6 Grade Controls: Present

Reach #: M02
 Observers: PD, MN
 Segment Location: Begins just upstream of Henderson Road and continues for 1,770 feet until Intervale Road is very close to stream channel.
 Why Not Assessed: NA
 Completion Date: 23-Aug-2011
 Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Plane bed	Score	STD	Historic
7.1 Channel Degradation		13	None	Yes
7.2 Channel Aggradation		3	None	No
7.3 Widening Channel		7		No
7.4 Change in Planform		3		No

Total Score: 26
 Geomorphic Rating: 0.325

Channel Evolution Model F
 Channel Evolution Stage III
 Geomorphic Condition Poor (0.0-0.34)
 Stream Sensitivity High

Channel Adjustment Processes Narrative

Channel has incised and is widening as shown by eroding banks. Large mass failure upstream from bridge crossing. Undersized structure has caused major deposition upstream and directed flow toward failing bank. Areas of braiding with islands and large depositional features causing major planform change.

Notes:

Bankfull cross-sectional area was high relative to other cross sections, but cross section photos support bankfull elevation measured in the field. If bankfull elevation were lowered (ie, higher incision ratio), this would not change the geomorphic condition, which was poor.

4.8 Channel Constrictions

Present
 Type: Bridge
 Width: 22
 Location: Mid
 Photo: 22 Yes
 GPS: Yes
 Channel Constr.: Yes
 Floodprone Constr.: Yes
 Problems: DA, DB, SB, A

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M02	Segment:	B	Completion Date:	23-Aug-11
Stream:	Gunstock Brook	Observers:	MN, PD	Why Not Assessed:	NA	Rain:	Yes
Organization:	BCE	Segment Location:	Segment begins where bedform changes to step-pool and continues for 668 feet.				
Segment Length (ft):	653	Step 2. (Cont'd)	Left	Right	Left	Right	
Step 1. Valley and Floodplain		Step 3. (Cont'd)					
1.1 Segmentation:	CD	13.8 Bank Texture					
1.2 Alluvial Fan:	None	1.37 Upper					
1.3 Corridor Encroachments:		2.0 Material Type					
Berm height (ft)	Both	NA Consistency					
Roads height (ft)	0	Low (<1.2) Lower					
Railroads height (ft)	0	Complete					
Improved Paths height (ft)	0	75 Consistency					
Development height (ft)	0	Bank Erosion					
1.4 Adjacent Side		Erosion Length (ft)					
Hillslope	Extremely Steep	Erosion Height (ft)					
Continuous	Sometimes	Revetment Type					
W/in 1 bankfull	Always	Revetment Length (ft)					
Texture	Sometimes	Near Bank Veg. Type					
1.5 Valley Features		L Trees (%)					
Valley Width (ft)	80	R Trees (%)					
Width Determination	Measured	L Shrub/Sapling (%)					
Confinement Type	Semi-Confined	R Shrub/Sapling (%)					
Rock Gorge?	No	% Cover Invasive					
Human Caused Change?	Yes	% Cover Invasive					
2. Stream Channel		% Cover Invasive					
2.1 Bankfull Width (ft)	26.3	WADs					
2.1a Wetted Width (ft)	17.2	Grasses Forbs					
2.1b Ratio (wetted/bkfl)	0.65	% Cover Invasive					
2.2 Max Depth (ft)	3.1	WADs					
2.3 Mean Depth (ft)	1.9	% Cover Invasive					
2.4 Floodprone Width (ft)	36.1	Grasses Forbs					
2.5 RAF	3.1	% Cover Invasive					
* Human Elevated FP	NA	Grasses Forbs					
<p>Note: Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook. Legend: RAF=Recently Abandoned Floodplain, FP=Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Floods=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut NE= Not evaluated, NA=Not applicable</p>							

Revised March 13, 2012

Phase 2 Segment Summary (page 2)

Project: Stream: Organization: Segment Length (ft):	Gunstock Brook Gunstock Brook BCE 653	Reach #: Observers: Segment Location:	M02 MN, PD	Segment: Why Not Assessed: Segment begins where bedform changes to step-pool and continues for 668 feet.	B NA	Completion Date: Rain:	23-Aug-11 Yes																												
1.6 Grade Controls	None	Ht. Above (ft)		Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)																															
Type	Location	Total Ht (ft)	Photo	GPS	<table border="1"> <thead> <tr> <th>Confinement Type</th> <th>Score</th> <th>STD</th> <th>Historic</th> </tr> </thead> <tbody> <tr> <td>7.1 Channel Degradation</td> <td>18</td> <td>None</td> <td>No</td> </tr> <tr> <td>7.2 Channel Aggradation</td> <td>17</td> <td>None</td> <td>No</td> </tr> <tr> <td>7.3 Widening Channel</td> <td>13</td> <td></td> <td>No</td> </tr> <tr> <td>7.4 Change in Planform</td> <td>14</td> <td></td> <td>No</td> </tr> <tr> <td>Total Score:</td> <td>62</td> <td></td> <td></td> </tr> <tr> <td>Geomorphic Rating:</td> <td>0.78</td> <td></td> <td></td> </tr> </tbody> </table>			Confinement Type	Score	STD	Historic	7.1 Channel Degradation	18	None	No	7.2 Channel Aggradation	17	None	No	7.3 Widening Channel	13		No	7.4 Change in Planform	14		No	Total Score:	62			Geomorphic Rating:	0.78		
Confinement Type	Score	STD	Historic																																
7.1 Channel Degradation	18	None	No																																
7.2 Channel Aggradation	17	None	No																																
7.3 Widening Channel	13		No																																
7.4 Change in Planform	14		No																																
Total Score:	62																																		
Geomorphic Rating:	0.78																																		
4.8 Channel Constrictions	None	<p>Channel Evolution Model F Channel Evolution Stage I Geomorphic Condition Good (0.65-0.84) Stream Sensitivity Moderate</p> <p>Channel Adjustment Processes Narrative The segment has a modified reference stream type of "B" due to change in valley width from Intervale Road. The floodplain encroachment from Intervale Road is acting as a "new valley wall" and will prohibit the evolution of the channel back to the natural reference stream type of "C". Segment is not incised and is in good condition.</p>																																	
Type	Width	Photo	GPS	Channel Constr.	Floodprone Constr.	<p>Notes: Considerable erosion on west bank where riprap along road has failed.</p>																													

Legend: Ht.=Height, Constr.=Constriction, Old abuttm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M02	Segment:	C	Completion Date:	23-Aug-11
Stream:	Gunstock Brook	Observers:	PD, MN	Why Not Assessed:	NA	Rain:	Yes
Segment Length (ft):	3470	Segment Location:	Segment begins about 200 feet downstream of the Intervale Road Bridge and continues until tributary confluence				
Step 1. Valley and Floodplain							
1.1 Segmentation:	CD	2.6 Width/Depth Ratio	19.3	9.7	Bank Texture	Left	Right
1.2 Alluvial Fan:	None	2.7 Entrenchment Ratio	2.5	1.5	Upper	Sand	Sub-dominant
1.3 Corridor Encroachments:	Both	2.8 Incision Ratio	NA	3.1	Material Type	Non-cohesive	Non-cohesive
Berm	242	2.9 Sinuosity	0	Complete	Material Type	Mix	Mix
Road	4	2.10 Riffle Type	0	68	Consistency	Non-cohesive	Non-cohesive
Railroad	0	2.11 Riffle Step Spacing (ft)	0	0	Bank Erosion	814	4.1 Springs/ Seeps
Improved Paths	0	2.12 Substrate Composition	5	4	Erosion Length (ft)	4	4.2 Adjacent Wetlands
Development	912	Bedrock	49	Multiple	Revetment Type	Multiple	4.3 Flow Status
Hillside Slope	Left	Boulder	20	682	Revetment Length (ft)	979	4.4 # of Debris Jams
Continuous	Right	Cobble	17	% Cover	Near Bank Veg. Type	4.5 Flow Reg Type	4.5 Flow Reg Type
Silt/Clay Present	Never	Coarse Gravel	9	% Cover	L Trees (%)	80	4.6 Up/Downstream Flow Reg
W/in 1 bankfull	Sometimes	Fine Gravel	Yes	% Cover	R Trees (%)	50	4.7 Stormwater Inputs
Texture	NE	Sand	40	% Cover	L Shrub/Sapling (%)	60	Field Ditch
LWD #	227	Extremely Steep	44	% Cover	R Shrub/Sapling (%)	50	Urban Storm Pipe
Valley Width (ft)	Measured	Wet	11	% Cover	L Herbs (%)	80	Overland Flow
Width Determination	Broad	Very Wet	Yes	% Cover	R Herbs (%)	70	Other
Confinement Type	No	Extremely Wet	Yes	% Cover	Bank Canopy	76-100	Other
Rock Gorge?	Yes	Very Wet	Yes	% Cover	Canopy %	Open	Other
Human Caused Change?	Yes	Wet	Yes	% Cover	Mid-channel canopy	26-50	Other
2.1 Bankfull Width (ft)	38.5	Wet	Yes	% Cover	3.2 Riparian Buffer	Open	Other
2.1a Wetted Width (ft)	24	Wet	Yes	% Cover	Buffer Width	Left	Other
2.1b Ratio (wetted/bkfl)	2.8	Wet	Yes	% Cover	Dominant	>200	Other
2.2 Max Depth (ft)	2.8	Wet	Yes	% Cover	Sub-dominant	26-50	Other
2.3 Mean Depth (ft)	2.00	Wet	Yes	% Cover	Length <25 ft	253	Other
2.4 Floodprone Width (ft)	96	Wet	Yes	% Cover	Buffer Veg. Type	90	Other
2.5 RAF	2.8	Wet	Yes	% Cover	L Trees (%)	20	Other
*Human Elevated FP	NA	Wet	Yes	% Cover	R Trees (%)	20	Other
Step 2. Stream Channel							
2.1 Bankfull Width (ft)	38.5	Stream Type:	Cobble	26-50	51-100	946	Other
2.1a Wetted Width (ft)	24	Bed Material:	None	253	946	Other	Other
2.1b Ratio (wetted/bkfl)	2.8	Subclass Slope:	Riffle-Pool	90	10	90	Other
2.2 Max Depth (ft)	2.8	Field Measured Slope:	Step	60	0	10	Other
2.3 Mean Depth (ft)	2.00	2.15 Reference Stream Type	Step	20	0	100	Other
2.4 Floodprone Width (ft)	96	Cobble, Riffle-pool	Step	60	0	100	Other
2.5 RAF	2.8	Step 3. Riparian Features	Step	60	0	100	Other
*Human Elevated FP	NA	3.1 Stream Banks	Step	60	0	100	Other
Step 3. Riparian Features							
3.1 Stream Banks	Typical Bank Slope	3.2 Riparian Features	Step	60	0	100	Other
3.2 Riparian Features	Typical Bank Slope	3.3 Riparian Corridor	Step	60	0	100	Other
3.3 Riparian Corridor	Corridor Land Use	3.4 Riparian Features	Step	60	0	100	Other
3.4 Riparian Features	Corridor Land Use	3.5 Riparian Features	Step	60	0	100	Other
3.5 Riparian Features	Corridor Land Use	3.6 Riparian Features	Step	60	0	100	Other
3.6 Riparian Features	Corridor Land Use	3.7 Riparian Features	Step	60	0	100	Other
3.7 Riparian Features	Corridor Land Use	3.8 Riparian Features	Step	60	0	100	Other
3.8 Riparian Features	Corridor Land Use	3.9 Riparian Features	Step	60	0	100	Other
3.9 Riparian Features	Corridor Land Use	3.10 Riparian Features	Step	60	0	100	Other
3.10 Riparian Features	Corridor Land Use	3.11 Riparian Features	Step	60	0	100	Other
3.11 Riparian Features	Corridor Land Use	3.12 Riparian Features	Step	60	0	100	Other
3.12 Riparian Features	Corridor Land Use	3.13 Riparian Features	Step	60	0	100	Other
3.13 Riparian Features	Corridor Land Use	3.14 Riparian Features	Step	60	0	100	Other
3.14 Riparian Features	Corridor Land Use	3.15 Riparian Features	Step	60	0	100	Other
3.15 Riparian Features	Corridor Land Use	3.16 Riparian Features	Step	60	0	100	Other
3.16 Riparian Features	Corridor Land Use	3.17 Riparian Features	Step	60	0	100	Other
3.17 Riparian Features	Corridor Land Use	3.18 Riparian Features	Step	60	0	100	Other
3.18 Riparian Features	Corridor Land Use	3.19 Riparian Features	Step	60	0	100	Other
3.19 Riparian Features	Corridor Land Use	3.20 Riparian Features	Step	60	0	100	Other
3.20 Riparian Features	Corridor Land Use	3.21 Riparian Features	Step	60	0	100	Other
3.21 Riparian Features	Corridor Land Use	3.22 Riparian Features	Step	60	0	100	Other
3.22 Riparian Features	Corridor Land Use	3.23 Riparian Features	Step	60	0	100	Other
3.23 Riparian Features	Corridor Land Use	3.24 Riparian Features	Step	60	0	100	Other
3.24 Riparian Features	Corridor Land Use	3.25 Riparian Features	Step	60	0	100	Other
3.25 Riparian Features	Corridor Land Use	3.26 Riparian Features	Step	60	0	100	Other
3.26 Riparian Features	Corridor Land Use	3.27 Riparian Features	Step	60	0	100	Other
3.27 Riparian Features	Corridor Land Use	3.28 Riparian Features	Step	60	0	100	Other
3.28 Riparian Features	Corridor Land Use	3.29 Riparian Features	Step	60	0	100	Other
3.29 Riparian Features	Corridor Land Use	3.30 Riparian Features	Step	60	0	100	Other
3.30 Riparian Features	Corridor Land Use	3.31 Riparian Features	Step	60	0	100	Other
3.31 Riparian Features	Corridor Land Use	3.32 Riparian Features	Step	60	0	100	Other
3.32 Riparian Features	Corridor Land Use	3.33 Riparian Features	Step	60	0	100	Other
3.33 Riparian Features	Corridor Land Use	3.34 Riparian Features	Step	60	0	100	Other
3.34 Riparian Features	Corridor Land Use	3.35 Riparian Features	Step	60	0	100	Other
3.35 Riparian Features	Corridor Land Use	3.36 Riparian Features	Step	60	0	100	Other
3.36 Riparian Features	Corridor Land Use	3.37 Riparian Features	Step	60	0	100	Other
3.37 Riparian Features	Corridor Land Use	3.38 Riparian Features	Step	60	0	100	Other
3.38 Riparian Features	Corridor Land Use	3.39 Riparian Features	Step	60	0	100	Other
3.39 Riparian Features	Corridor Land Use	3.40 Riparian Features	Step	60	0	100	Other
3.40 Riparian Features	Corridor Land Use	3.41 Riparian Features	Step	60	0	100	Other
3.41 Riparian Features	Corridor Land Use	3.42 Riparian Features	Step	60	0	100	Other
3.42 Riparian Features	Corridor Land Use	3.43 Riparian Features	Step	60	0	100	Other
3.43 Riparian Features	Corridor Land Use	3.44 Riparian Features	Step	60	0	100	Other
3.44 Riparian Features	Corridor Land Use	3.45 Riparian Features	Step	60	0	100	Other
3.45 Riparian Features	Corridor Land Use	3.46 Riparian Features	Step	60	0	100	Other
3.46 Riparian Features	Corridor Land Use	3.47 Riparian Features	Step	60	0	100	Other
3.47 Riparian Features	Corridor Land Use	3.48 Riparian Features	Step	60	0	100	Other
3.48 Riparian Features	Corridor Land Use	3.49 Riparian Features	Step	60	0	100	Other
3.49 Riparian Features	Corridor Land Use	3.50 Riparian Features	Step	60	0	100	Other
3.50 Riparian Features	Corridor Land Use	3.51 Riparian Features	Step	60	0	100	Other
3.51 Riparian Features	Corridor Land Use	3.52 Riparian Features	Step	60	0	100	Other
3.52 Riparian Features	Corridor Land Use	3.53 Riparian Features	Step	60	0	100	Other
3.53 Riparian Features	Corridor Land Use	3.54 Riparian Features	Step	60	0	100	Other
3.54 Riparian Features	Corridor Land Use	3.55 Riparian Features	Step	60	0	100	Other
3.55 Riparian Features	Corridor Land Use	3.56 Riparian Features	Step	60	0	100	Other
3.56 Riparian Features	Corridor Land Use	3.57 Riparian Features	Step	60	0	100	Other
3.57 Riparian Features	Corridor Land Use	3.58 Riparian Features	Step	60	0	100	Other
3.58 Riparian Features	Corridor Land Use	3.59 Riparian Features	Step	60	0	100	Other
3.59 Riparian Features	Corridor Land Use	3.60 Riparian Features	Step	60	0	100	Other
3.60 Riparian Features	Corridor Land Use	3.61 Riparian Features	Step	60	0	100	Other
3.61 Riparian Features	Corridor Land Use	3.62 Riparian Features	Step	60	0	100	Other
3.62 Riparian Features	Corridor Land Use	3.63 Riparian Features	Step	60	0	100	Other
3.63 Riparian Features	Corridor Land Use	3.64 Riparian Features	Step	60	0	100	Other
3.64 Riparian Features	Corridor Land Use	3.65 Riparian Features	Step	60	0	100	Other
3.65 Riparian Features	Corridor Land Use	3.66 Riparian Features	Step	60	0	100	Other
3.66 Riparian Features	Corridor Land Use	3.67 Riparian Features	Step	60	0	100	Other
3.67 Riparian Features	Corridor Land Use	3.68 Riparian Features	Step	60	0	100	Other
3.68 Riparian Features	Corridor Land Use	3.69 Riparian Features	Step	60	0	100	Other
3.69 Riparian Features	Corridor Land Use	3.70 Riparian Features	Step	60	0	100	Other
3.70 Riparian Features	Corridor Land Use	3.71 Riparian Features	Step	60	0	100	Other
3.71 Riparian Features	Corridor Land Use	3.72 Riparian Features	Step	60	0	100	Other
3.72 Riparian Features	Corridor Land Use	3.73 Riparian Features	Step	60	0	100	Other
3.73 Riparian Features	Corridor Land Use	3.74 Riparian Features	Step	60	0	100	Other
3.74 Riparian Features	Corridor Land Use	3.75 Riparian Features	Step	60	0	100	Other
3.75 Riparian Features	Corridor Land Use	3.76 Riparian Features	Step	60	0	100	Other
3.76 Riparian Features	Corridor Land Use	3.77 Riparian Features	Step	60	0	100	Other
3.77 Riparian Features	Corridor Land Use	3.78 Riparian Features	Step	60	0	100	Other
3.78 Riparian Features	Corridor Land Use	3.79 Riparian Features	Step	60	0	100	Other
3.79 Riparian Features	Corridor Land Use	3.80 Riparian Features	Step	60	0	100	Other
3.80 Riparian Features	Corridor Land Use	3.81 Riparian Features	Step	60	0	100	Other
3.81 Riparian Features	Corridor Land Use	3.82 Riparian Features	Step	60	0	100	Other
3.82 Riparian Features	Corridor Land Use	3.83 Riparian Features	Step	60	0	100	Other
3.83 Riparian Features	Corridor Land Use	3.84 Riparian Features	Step	60	0	100	Other
3.84 Riparian Features	Corridor Land Use	3.85 Riparian Features	Step	60	0	100	Other
3.85 Riparian Features	Corridor Land Use	3.86 Riparian Features	Step	60	0	100	Other
3.86 Riparian Features	Corridor Land Use	3.87 Riparian Features	Step	60	0	100	Other
3.87 Riparian Features	Corridor Land Use	3.88 Riparian Features	Step	60	0	100	Other
3.88 Riparian Features	Corridor Land Use	3.89 Riparian Features	Step	60	0	100	Other
3.89 Riparian Features	Corridor Land Use	3.90 Riparian Features	Step	60	0	100	Other
3.90 Riparian Features	Corridor Land Use	3.91 Riparian Features	Step	60	0	100	Other
3.91 Riparian Features	Corridor Land Use	3.92 Riparian Features	Step	60	0	100	Other
3.92 Riparian Features	Corridor Land Use	3.93 Riparian Features	Step	60	0	100	Other
3.93 Riparian Features	Corridor Land Use	3.94 Riparian Features	Step	60	0	100	Other
3.94 Riparian Features	Corridor Land Use	3.95 Riparian Features	Step	60	0	100	Other
3.95 Riparian Features	Corridor Land Use	3.96 Riparian Features	Step	60	0	100	Other
3.96 Riparian Features	Corridor Land Use	3.97 Riparian Features	Step	60	0	100	Other
3.97 Riparian Features	Corridor Land Use	3.98 Riparian Features	Step	60	0	100	Other
3.98 Riparian Features	Corridor Land Use	3.99 Riparian Features	Step	60	0	100	Other
3.99 Riparian Features	Corridor Land Use	4.00 Riparian Features	Step	60	0	100	Other
4.00 Riparian Features	Corridor Land Use	4.01 Riparian Features	Step	60	0	100	Other
4.01 Riparian Features	Corridor Land Use	4.02 Riparian Features	Step	60	0	100	Other
4.02 Riparian Features	Corridor Land Use	4.03 Riparian Features	Step	60	0	100	Other
4.03 Riparian Features	Corridor Land Use	4.04 Riparian Features	Step	60	0	100	Other
4.04 Riparian Features	Corridor Land Use	4.05 Riparian Features	Step	60	0	100	Other
4.05 Riparian Features	Corridor Land Use	4.06 Riparian Features	Step	60	0	100	Other
4.06 Riparian Features	Corridor Land Use	4.07 Riparian Features	Step	60	0	100	Other
4.07 Riparian Features	Corridor Land Use	4.08 Riparian Features	Step	60	0	100	Other
4.08 Riparian Features	Corridor Land Use	4.09 Riparian Features	Step	60	0	100	Other
4.09 Riparian Features	Corridor Land Use	4.10 Riparian Features	Step	60	0	100	Other
4.10 Riparian Features	Corridor Land Use	4.11 Riparian Features	Step	60	0	100	Other
4.11 Riparian Features	Corridor Land Use	4.12 Riparian Features	Step	60	0	100	Other
4.12 Riparian Features	Corridor Land Use	4.13 Riparian Features	Step	60	0	100	Other
4.13 Riparian Features	Corridor Land Use	4.14 Riparian Features	Step	60	0	100	Other
4.14 Riparian Features	Corridor Land Use	4.15 Riparian Features	Step	60	0	100	Other
4.15 Riparian Features	Corridor Land Use	4.16 Riparian Features	Step	60	0	100	Other</

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 3470
 1.6 Grade Controls: None
 Reach #: M02
 Observers: PD, MN
 Segment Location: Segment begins about 200 feet downstream of the Intervale Road Bridge and continues until tributary confluence
 Why Not Assessed: NA
 Completion Date: 23-Aug-11
 Rain: Yes
 Segment: C
 Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Unconfined	Score	STD	Historic
7.1 Channel Degradation	10	None	Yes	Yes
7.2 Channel Aggradation	12	None	No	No
7.3 Widening Channel	12	None	No	No
7.4 Change in Planform	8	None	No	No

Total Score: 42
 Geomorphic Rating: 0.53
 Channel Evolution Model F
 Channel Evolution Stage III
 Geomorphic Condition Fair (0.35-0.64)
 Stream Sensitivity High

4.8 Channel Constrictions Present

Type	Width (ft)	Photo	GPS	Channel Constr.	Floodprone Constr.
Bridge	16	Yes	Yes	Yes	Yes
Problems:	DA, A				
Bridge	15	Yes	Yes	Yes	Yes
Problems:	SB, A				

Channel Adjustment Processes Narrative
 Segment has been extensively straightened. Aggradation is minor, but there is a lot of fine gravel and sand working its way through segment. The road in places and berms are creating a human elevated floodplain, which is resulting in incision and a stream type departure. Along the majority of the segment, floodplain access is good on both sides.
Notes:
 Japanese knotweed (invasive) along Intervale Road. Dense algae in areas where canopy is open. Two cross sections have been included to provide information about variable floodplain access within this segment. The two cross sections are within close proximity to each other. Cross section #1 reflects the good floodplain access (incision ratio or 1.0) throughout much of the segment. Cross section #2 reflects the influence of floodplain filling from the road and berms.

Legend: Ht.=Height, Constr.=Constriction, Old abutm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M03	Segment:	A	Completion Date:	22-Aug-11
Stream:	Gunstock Brook	Observers:	PD, MN	Why Not Assessed:	NA	Rain:	Yes
Segment Length (ft):	2388	Segment Location:	Segment begins at tributary confluence and continues upstream until grade control, where confinement becomes much narrower.				
Step 1. Valley and Floodplain							
1.1 Segmentation:	GC	2.6 Width/Depth Ratio	34.8	Bank Texture	Left	Right	Left
1.2 Alluvial Fan:	None	2.7 Entrenchment Ratio	2.2	Upper	Sand	Sand	Forest
1.3 Corridor Encroachments:	Both	2.8 Incision Ratio	2.0	Material Type	Non-cohesive	Non-cohesive	Commercial
Berm Length (ft)	0	*Human Elevated Incision	NA	Consistency	Sand	Sand	0
Berm height (ft)	1073	2.9 Sinuosity	Mod (1.2-1.5)	Lower	Mix	Mix	14
Roads height (ft)	0	2.10 Riffle Type	Sedimented	Material Type	Non-cohesive	Non-cohesive	0
Railroads height (ft)	0	2.11 Riffle Step Spacing (ft)	74	Consistency	Left	Right	0
Improved Paths height (ft)	0	2.12 Substrate Composition		Bank Erosion	Left	Right	Extensive
Development height (ft)	912	Bedrock	%	Erosion Length (ft)	75	528	Minimum
Hillslope	Left	Boulder	%	Erosion Height (ft)	2	9	Base
Continuous	Right	Cobble	%	Revetment Type	Rip-rap	Rip-rap	0
Sometimes	Right	Coarse Gravel	%	Revetment Length (ft)	563	23	0
Sometimes	Right	Fine Gravel	%	Near Bank Veg. Type	Invasive	Conifer	None
Sometimes	Right	Sand	%	L Trees (%)	0	20	None
NE	Right		%	R Trees (%)	70	0	None
NE	Right		%	L Shrub/Sapling (%)	60	10	Road Ditch
NE	Right		%	R Shrub/Sapling (%)	40	0	Tile Drain
NE	Right		%	L Herbs (%)	80	0	Other
NE	Right		%	R Herbs (%)	40	0	0
NE	Right		%	Bank Canopy	76-100	76-100	0
NE	Right		%	Canopy %	Closed	Closed	0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE	Right		%	Dominant			0
NE	Right		%	Sub-dominant			0
NE	Right		%	Length <25 ft			0
NE	Right		%	Buffer Veg. Type			0
NE	Right		%	L Trees (%)			0
NE	Right		%	R Trees (%)			0
NE	Right		%	L Shrub/Sapling (%)			0
NE	Right		%	R Shrub/Sapling (%)			0
NE	Right		%	L Herbs (%)			0
NE	Right		%	R Herbs (%)			0
NE	Right		%	Bank Canopy			0
NE	Right		%	Canopy %			0
NE	Right		%	Mid-channel canopy			0
NE	Right		%	Buffer Width			0
NE	Right		%	3.2 Riparian Buffer			0
NE	Right		%	Buffer Width			0
NE							

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 2388
 1.6 Grade Controls: None

Reach #: M03
 Observers: PD, MN
 Segment Location: Segment begins at tributary confluence and continues upstream until grade control, where confinement becomes much narrower

Segment: A
 Why Not Assessed: NA
 Rain: Yes
 Completion Date: 22-Aug-11

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Unconfined Score	STD	Historic
7.1 Channel Degradation	5	None	Yes
7.2 Channel Aggradation	3	None	No
7.3 Widening Channel	8	No	No
7.4 Change in Planform	5	No	No

Total Score: 21
 Geomorphic Rating: 0.26

Channel Evolution Model F
 Channel Evolution Stage IV
 Geomorphic Condition Poor (0.0-0.34)
 Stream Sensitivity High

Channel Adjustment Processes Narrative

Major degradation, extreme planform adjustment including braiding. Substrate not well sorted. Major channel widening and extreme planform adjustment. Channel has built a juvenile floodplain.

Notes:

Japanese knotweed at top of segment near Gilford town hall. Floodplain appears to have been filled in at one time along parking area. Planform adjustment below town hall where there is the first opportunity for floodplain access (depositional). Groundwater seeps below town hall. Multiple mass failures on east bank.

Type: None
 Total Ht (ft): None
 Location: Ht Above (ft)
 Photo: GPS

4.8 Channel Constrictions Present

Type: None
 Width (ft): 24
 Photo: Yes
 Culvert: Yes
 Problems: None

Channel Constr.: Yes
 Floodprone Constr.: Yes

Legend: Ht=Height, Constr.=Constriction, Old abutrm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M03	Segment:	B	Completion Date:	22-Aug-11
Stream:	Gunstock Brook	Observers:	PD, MN	Why Not Assessed:	NA	Rain:	Yes
Organization:	BCE	Segment Location:	1098	Segment begins where confinement becomes much narrower and continues until just upstream of Belknap Mountain Road crossing		3.3 Riparian Corridor	
Segment Length (ft):		Step 2. (Cont'd)		Step 3. (Cont'd)		Left	Right
Step 1. Valley and Floodplain		17.5	Bank Texture	Upper			
1.1 Segmentation:	GC	2.6	Width/Depth Ratio	1.2			
1.2 Alluvial Fan:	None	2.7	Entrenchment Ratio	1.0			
1.3 Corridor Encroachments:		2.8	Incision Ratio	NA			
Length (ft)		2.9	Human Elevated Incision	Low (<1.2)			
Berm	One	2.9	Sinuosity	Complete			
height (ft)	0	2.10	Riffle Type	NE			
Roads	277	2.11	Riffle Step Spacing (ft)				
Railroads	0	2.12	Substrate Composition				
Improved Paths	0		Bedrock	4			
height (ft)	0		Boulder	8			
Development	149		Cobble	44			
Left			Coarse Gravel	11			
Right			Fine Gravel	15			
Extremely Steep			Sand	18			
Continuously			Silt/Clay Present	No			
W/in 1 bankfull			Embedded (chan)	30			
Texture			Embedded (marg)	51			
1.5 Valley Features							
Valley Width (ft)	86		# LWD	2			
Width Determination	Measured		2.13 Average Largest Particle	11.6			
Confinement Type	Semi-Confined		Bed	NA			
Rock Gorge?	No		2.13a % Subs. Exp.	20			
Human Caused Change?	No		2.14 Stream Type				
Stream Type:	F		Stream Type:	Cobble			
2.1 Bankfull Width (ft)	30		Bed Material:	b			
2.1a Wetted Width (ft)	19		Subclass Slope:	Step Pool			
2.1b Ratio (wetted/bkfl)	0.63		Field Measured Slope:				
2.2 Max Depth (ft)	2.45		2.15 Reference Stream Type				
2.3 Mean Depth (ft)	1.7		F, Cobble, Step-pool				
2.4 Floodprone Width (ft)	36		Step 3. Riparian Features				
2.5 RAF	2.45		3.1 Stream Banks	Step			
* Human Elevated FP	NA		Typical Bank Slope				
Note: Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook.							
Legend: RAF=Recently Abandoned Floodplain, FP=Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut							
NE= Not evaluated, NA=Not applicable							

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 1098
 Segment Location: M03 PD, MN
 Reach #: 7
 Observers: PD, MN
 Segment Location: gment begins where confinement becomes much narrower and continues until just upstream of Belknap Mountain Road crossi
 Why Not Assessed: NA
 Completion Date: 22-Aug-2011
 Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Score	STD	Historic
7.1 Channel Degradation	18	None	No
7.2 Channel Aggradation	15	None	No
7.3 Widening Channel	19	None	No
7.4 Change in Planform	10	None	No
Total Score:	62		
Geomorphic Rating:	0.78		

Channel Evolution Model F
 Channel Evolution Stage I
 Geomorphic Condition Good (0.65-0.84)
 Stream Sensitivity High
Channel Adjustment Processes Narrative
 Channel is a natural "F" despite being so close to Cherry Valley Road. Riprap is present adjacent to Cherry Valley Road and hard bank armoring is near covered bridge and Belknap Mt. Road Bridge. Armoring is keeping channel from widening and bedrock grade controls have prevented incision. Planform change is minor due to straightening.

Notes:
 Some locations are "B" stream type. No appropriate bars for largest particle measurement. Japanese knotweed below covered bridge near Gilford town hall. Good pool cover below dam (large boulders and cobble).

1.6 Grade Controls

Type	Location	Total Ht (ft)	Ht. Above (ft)	Photo	GPS
Dam	at Belknap Rd	9	7	Yes	Yes
Ledge		6	4	Yes	No
Ledge		3	2.5	Yes	No
Ledge		3	2.5	Yes	No
Waterfall		5.5	5	Yes	No
Ledge		5	3.5	Yes	No
Ledge		8	6.5	Yes	No

4.8 Channel Constrictions

Type	Width	Photo	GPS	Channel Constr.	Floodprone Constr.
Bridge	19	Yes	Yes	Yes	Yes
Problems:	DA, SA	4	No	Yes	No
Bedrock outcrop	SB	19	No	Yes	No
Bridge	DA, SB	19	No	Yes	No
Problems:					

Legend: Ht.=Height, Constr.=Constriction, Old abutm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M04	Segment:	A	Completion Date:	20-Aug-11
Stream:	Gunstock Brook	Observers:	PD, MN	Why Not Assessed:	NA	Rain:	Yes
Organization:	BCE	Segment Location:	5200	Segment begins just upstream of Belknap Mountain Road crossing and continues until vegetation changes from wetland vegetation		3.3 Riparian Corridor	
Segment Length (ft):		Step 2. (Cont'd)		Step 3. (Cont'd)		Left	Right
1.1 Segmentation:	BB	2.6 Width/Depth Ratio	23.3	Bank Texture	Left	Right	Shrub/Sapling
1.2 Alluvial Fan:	None	2.7 Entrenchment Ratio	16.1	Upper	Sand	Sand	Residential
1.3 Corridor Encroachments:		2.8 Incision Ratio	1.0	Material Type	Non-cohesive	Non-cohesive	Residential
		*Human Elevated Incision	NA	Consistency	Sand	Sand	0
		2.9 Sinuosity	High (>1.5)	Lower	Non-cohesive	Non-cohesive	0
		2.10 Riffle Type	Sedimented	Material Type	Sand	Sand	0
		2.11 Riffle Step Spacing (ft)	83	Consistency	Non-cohesive	Non-cohesive	0
		2.12 Substrate Composition		Bank Erosion	Left	Right	Present
		Bedrock	0	Erosion Length (ft)	194	218	Extensive
		Boulder	0	Erosion Height (ft)	4	4	Base
		Cobble	2	Revetment Type	Rip-rap	Rip-rap	0
		Coarse Gravel	49	Revetment Length (ft)	213	173	None
		Fine Gravel	21	Near Bank Veg. Type	% Cover Invasive	Conifer	None
		Sand	19	L Trees (%)	5	0	None
		Extremely Steep	9	R Trees (%)	80	0	None
		Silt	Yes	L Shrub/Sapling (%)	% Cover Invasive	WADs	Road Ditch
		Silt/Clay Present	20	R Shrub/Sapling (%)	80	0	Tile Drain
		Embedded (chan)	32	L Herbs (%)	100	0	Other
		Embedded (marg)	35	R Herbs (%)	100	0	3
		LWD #	889	Bank Canopy	Left	Right	1230
1.5 Valley Features		Valley Width (ft)	Estimated	Canopy %	26-50	26-50	Step 5. Channel Bed & Platform Changes
		Width Determination	Very Broad	Mid-channel canopy	Open	Open	5.1 Bar Types
		Confinement Type	No	3.2 Riparian Buffer			Mid
		Rock Gorge?	Yes	Buffer Width			Diagonal
		Human Caused Change?	Yes	Dominant	Left	Right	4
				Sub-dominant	>200	101-150	Flood
				Length <25 ft	26-50	0-25	6
				Buffer Veg. Type	0	139	Braiding
				L Trees (%)	% Cover Invasive	Conifer	1
				R Trees (%)	40	0	5.3 Steep Riffles & Headcuts
				L Shrub/Sapling (%)	40	0	# SRs
				R Shrub/Sapling (%)	80	0	# HCs
				Typical Bank Slope	Shallow	Shallow	4
							Trib Rejuv.
							No
							None

Note: General comments, Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook.
 Legend: RAF=Recently Abandoned Floodplain, FP=Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut
 NE= Not evaluated, NA=Not applicable

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
Stream: Gunstock Brook
Organization: BCE
Segment Length (ft): 5200
1.6 Grade Controls: None
Reach #: M04
Observers: PD, MN
Segment Location: Segment begins just upstream of Belknap Mountain Road crossing and continues until vegetation changes from wetland veget (fill out RGA sheet first, then enter narrative)
Segment: Why Not Assessed: NA
Completion Date: 20-Aug-11
Rain: Yes

Type	Location	Total Ht (ft)	Ht Above (ft)	Photo	GPS	Unconfined		Historic
						Score	STD	
7.1 Channel Degradation						16	None	No
7.2 Channel Aggradation						12	None	No
7.3 Widening Channel						14		No
7.4 Change in Planform						13		No

Total Score: 55
Geomorphic Rating: 0.69
 Channel Evolution Model F
 Channel Evolution Stage I
 Geomorphic Condition Good (0.65-0.84)
 Stream Sensitivity High

Channel Adjustment Processes Narrative
 Has not incised in wetland. Some erosion in spots but is not widening. Some aggradation associated with diagonal bars and point bars. Limited planform adjustment noted in wetland with the exception of an island.

Notes:
 A very short section (<200 feet) upstream of the intersection of RT11 (Gifford Ave) and Belknap Mt. Road is channelized and entrenched due to floodplain encroachment from parking lot and Gifford Ave. Nice pools with vegetation. Abundant CPOM. Alders dominant vegetation.

4.8 Channel Constrictions		Present	
Type	Width (ft)	Photo	Channel Constr.
Old abutment	9.2	Yes	Floodprone Constr. Yes
Problems: Bridge	DB, SA, SB, A 24	Yes	Yes
Problems: Old abutment	DB, A 21	Yes	Yes
Problems:	None		

Legend: Ht=Height, Constr.=Constriction, Old abuttm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
Stream: Gunstock Brook
Organization: BCE
Segment Length (ft): 3641
1.6 Grade Controls: None
Reach #: M04
Observers: PD, MN
Segment Location: Segment begins where vegetation changes from wetland to forest and continues until Given Drive development
Segment: B
Why Not Assessed: NA
Completion Date: 20-Aug-11
Rain: Yes
Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Unconfined Score	STD	Historic
7.1 Channel Degradation	11	None	Yes
7.2 Channel Aggradation	8	None	No
7.3 Widening Channel	14	None	No
7.4 Change in Planform	9	None	No

Total Score: 42
Geomorphic Rating: 0.53
 Channel Evolution Model F
 Channel Evolution Stage II
 Geomorphic Condition: Fair (0.35-0.64)
 Stream Sensitivity: Very High
Channel Adjustment Processes Narrative
 Minor incision. Major planform change as sediment works its way through reach.

4.8 Channel Constrictions		Present	
Type	Width (ft)	Photo	Channel Constr.
Bridge	23	Yes	No
Problems:	DA, DB, SB	Yes	Yes
Bridge	17.6	Yes	Yes
Problems:	SA		

Notes:
 Good diversity of pool sizes. Relatively stable banks and great undercut bank cover.

Legend: Ht.=Height, Constr.=Constriction, Old abutm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	M04	Segment:	C	Completion Date:	20-Aug-11
Stream:	Gunstock Brook	Observers:	PD, MN	Why Not Assessed:	NA	Rain:	Yes
Organization:	BCE	Segment Location:	Segment begins where there is a lack of buffer near the Given Drive development and continues for 736 feet at tributary confluence.	Corridor Land Use:	Residential Shrub/Sapling Forest	Left:	0
Segment Length (ft):	848	Step 2. (Cont'd)		Right:	0	Right:	0
Step 1. Valley and Floodplain							
1.1 Segmentation:	BB	16.7	Bank Texture	Left	Right	Left	Right
1.2 Alluvial Fan:	None	17.1	Upper	Sand	Sand	Sub-dominant	Shrub/Sapling
1.3 Corridor Encroachments:	Both	1.5	Material Type	Non-cohesive	Non-cohesive	Mass Failures (ft)	Forest
Berm	0	NA	Consistency	Mix	Mix	Height (ft)	0
height (ft)	0	Low (<1.2)	Lower	Non-cohesive	Non-cohesive	Gullies (number)	0
Roads	0	Eroded	Material Type	Left	Right	Step 4. Flow & Flow Modifiers	Present
Railroads	0	49	Consistency	93	39	4.1 Springs/ Seeps	Present
Improved Paths	0	%	Bank Erosion	4	2	4.2 Adjacent Wetlands	Base
Development	0	%	Erosion Length (ft)	Rip-rap	0	4.3 Flow Status	0
Hillside Slope	0	%	Erosion Height (ft)	141	0	4.4 # of Debris Jams	None
Continuous	0	%	Revetment Length (ft)	%Cover Invasive	Confir	4.5 Flow Reg Type	None
W/in 1 bankfull	0	%	Revetment Length (ft)	10	0	4.6 Up/Downstream Flow Reg	None
Texture	0	%	Near Bank Veg. Type	10	0	4.7 Stormwater Inputs	0
NE	0	%	L Trees (%)	10	0	Field Ditch	Road Ditch
NE	0	%	R Trees (%)	20	10	Urban Storm Pipe	Tile Drain
NE	0	%	L Shrub/Sapling (%)	50	10	Overland Flow	Other
NE	0	%	R Shrub/Sapling (%)	%Cover Invasive	Grasses Forbs	4.9 # of Beaver Dams	0
NE	0	%	L Herbs (%)	100	0	Affected Length (ft)	0
NE	0	%	R Herbs (%)	40	0	Step 5. Channel Bed & Planform Changes	Point
NE	0	%	Bank Canopy	26-50	Right	5.1 Bar Types	2
NE	0	%	Canopy %	Open	51-75	Mid	Delta
NE	0	%	Mid-channel canopy	Open	51-75	Diagonal	0
NE	0	%	Buffer Width	Left	Right	Flood	0
NE	0	%	Buffer Width	0-25	Right	5.2 Other Features	1
NE	0	%	Stream Type:	51-100	Right	5.3 Steep Riffles & Headcuts	0
NE	0	%	Bed Material:	441	Right	# SRs	0
NE	0	%	Subclass Slope:	%Cover Invasive	Confir	Deciduous	0
NE	0	%	Bed Form:	10	0	5.4 Stream Ford or Animal Crossing:	0
NE	0	%	Field Measured Slope:	%Cover Invasive	WADs	Saplings	0
NE	0	%	C, Gravel, Riffle-pool	10	10	5.5 Straightening	509
NE	0	%	Step 3. Riparian Features	50	10	Length (ft)	None
NE	0	%	3.1 Stream Banks	%Cover Invasive	Grasses Forbs	5.5 Dredging	None
NE	0	%	Typical Bank Slope	100	0	Bridge and Culvert Survey	No
NE	0	%	Step	50	0	NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut	No

Note: General comments, Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook.
 Legend: RAF=Recently Abandoned Floodplain, FP=Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut
 NE= Not evaluated, NA=Not applicable

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 848
 1.6 Grade Controls: None

Reach #: M04
 Observers: PD, MN
 Segment Location: Segment begins where there is a lack of buffer near the Given Drive development and continues for 736 feet at tributary confluence

Segment: C
 Why Not Assessed: NA
 Rain: Yes

Completion Date: 20-Aug-11

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Score	STD	Historic
7.1 Channel Degradation	9	None	Yes
7.2 Channel Aggradation	12	None	No
7.3 Widening Channel	16	None	No
7.4 Change in Platform	8	None	No

Total Score: 45
 Geomorphic Rating: 0.56

Channel Evolution Model F
 Channel Evolution Stage II
 Geomorphic Condition Fair (0.35-0.64)
 Stream Sensitivity Very High

Channel Adjustment Processes Narrative

Channel has incised. Was straightened within vicinity of development and riprapped. Channel seems to have avulsed here as well leading to major planform change. Some aggradation in upstream part of segment. Short riffles.

Notes:

Lacks buffers in backyards (left bank). Appears to be incised. Possible planting locale for alders. Very little pool cover. Becomes less incised at downstream end of segment (right bank height seems to be at bankfull elevation). Sediment transport reach.

4.8 Channel Constrictions: None

Type	Location	Total Ht (ft)	Ht Above (ft)	Photo	GPS

Type	Width (ft)	Photo	GPS	Channel Constr.	Floodprone Constr.

Legend: Ht.=Height, Constr.=Constriction, Old abutmn.=Old abutment, DA=Deposition above, DB=Scour above, SA=Scour below, A=Alignment

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 936
 1.6 Grade Controls: None

Reach #: M05
 Observers: PD, MN
 Segment Location: Segment begins at tributary confluence and continues until Hoyt Road.

Segment: A
 Why Not Assessed: NA
 Completion Date: 20-Aug-11
 Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Type	Location	Total Ht (ft)	HT.Above (ft)	Photo	GPS	Confinement Type		Historic
						Unconfined	Score	
7.1 Channel Degradation						9	None	Yes
7.2 Channel Aggradation						12	None	No
7.3 Widening Channel						18		No
7.4 Change in Planform						10		No

Total Score: 49
 Geomorphic Rating: 0.61

Channel Evolution Model F
 Channel Evolution Stage II
 Geomorphic Condition Fair (0.35-0.64)
 Stream Sensitivity Very High

Channel Adjustment Processes Narrative

Major incision, not at widening stage yet. Planform change due to minor aggradation as seen through steep riffles and diagonal bars, but not as pronounced as upstream reaches. Some straightening.

Notes:
 Looks like it may have been historically straightened adjacent to ag fields. Very little riprap, yet appears straightened.

4.8 Channel Constrictions		Present	
Type	Width (ft)	Photo	GPS
Bridge	20	Yes	Yes
Problems:	None		
Bridge	23	Yes	Yes
Problems:	None		
Bridge	28	Yes	Yes
Problems:	DB		

Legend: Ht.=Height, Constr.=Constriction, Old abuttm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 1433
 1.6 Grade Controls: None
 Reach #: M05
 Observers: PD, MN
 Segment Location: Segment begins at Hoyt Road and continues for 1300 feet until corridor is forested again.
 Why Not Assessed: NA
 Completion Date: 19-Aug-11
 Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Score	STD	Historic
7.1 Channel Degradation	19	None	No
7.2 Channel Aggradation	10	None	No
7.3 Widening Channel	16		No
7.4 Change in Planform	8		No

Total Score: 53
 Geomorphic Rating: 0.66

Channel Evolution Model D
 Channel Evolution Stage II c
 Geomorphic Condition Good (0.65-0.84)
 Stream Sensitivity High

Channel Adjustment Processes Narrative

Major planform adjustment and aggradation. Not incised or widening.

Notes:

More sinuous than NHD. Moderate sinuosity. Minor straightening upstream of Hoyt Road Bridge. Good floodplain access. Large trout observed.

4.8 Channel Constrictions	Type	Width (ft)	Photo	Ht. Above (ft)	None	Photo	GPS

Legend: Ht.=Height, Constr.=Constriction, Old abutm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Stream:	Gunstock Brook	Segment:	C	Completion Date:	19-Aug-11
Organization:	BCE	Observers:	M05	Why Not Assessed:	NA	Rain:	Yes
Segment Length (ft):	2056	Segment Location:	Segment begins where corridor is forested again and continues until tributary confluence				
Step 1. Valley and Floodplain							
1.1 Segmentation:	BB	2.6 Width/Depth Ratio	22.0	Left	Right	Left	Right
1.2 Alluvial Fan:	None	2.7 Entrenchment Ratio	11.3	Upper			
1.3 Corridor Encroachments:		2.8 Incision Ratio	1.0	Material Type	Sand	Sub-dominant	Forest
Length (ft)	Both	*Human Elevated Incision	NA	Consistency	Non-cohesive	Mass Failures (ft)	Shrub/Sapling
Berm	0	2.9 Sinuosity	Mod (1.2-1.5)	Lower	Boulder/Cobble	Gullies (number)	Forest
Roads	0	2.10 Riffle Type	Sedimented	54	Non-cohesive	Height (ft)	0
Railroads	0	2.11 Riffle Step Spacing (ft)	%		Boulder/Cobble	Height (ft)	0
Improved Paths	0	2.12 Substrate Composition			Non-cohesive	Height (ft)	0
Development	0	Bedrock	0		Non-cohesive	Height (ft)	0
Hillslope	Left	Boulder	0		Non-cohesive	Height (ft)	0
Continuous	Hilly	Cobble	16		Non-cohesive	Height (ft)	0
W/in 1 bankfull	Never	Coarse Gravel	52		Non-cohesive	Height (ft)	0
Texture	NE	Fine Gravel	16		Non-cohesive	Height (ft)	0
1.4 Adjacent Side	Left	Sand	16		Non-cohesive	Height (ft)	0
Valley Width (ft)	916	Silt/Clay Present	No		Non-cohesive	Height (ft)	0
Width Determination	Estimated	Embedded (chan)	28		Non-cohesive	Height (ft)	0
Confinement Type	Very Broad	Embedded (marg)	39		Non-cohesive	Height (ft)	0
Rock Gorge?	No	LWD #	30		Non-cohesive	Height (ft)	0
Human Caused Change?	No	2.13 Average Largest Particle	4.5		Non-cohesive	Height (ft)	0
Stream Type:	C	2.14 Stream Type	3.1		Non-cohesive	Height (ft)	0
2.1 Bankfull Width (ft)	33	Bed	Gravel		Non-cohesive	Height (ft)	0
2.1a Wetted Width (ft)	16.4	Subclass Slope:	None		Non-cohesive	Height (ft)	0
2.1b Ratio (wetted/bkfl)	0.50	Bed Form:	Riffle-Pool		Non-cohesive	Height (ft)	0
2.2 Max Depth (ft)	2.9	Field Measured Slope:			Non-cohesive	Height (ft)	0
2.3 Mean Depth (ft)	1.5	2.15 Reference Stream Type			Non-cohesive	Height (ft)	0
2.4 Floodprone Width (ft)	373	C, Gravel, Riffle-pool			Non-cohesive	Height (ft)	0
2.5 RAF	2.9	Step 3. Riparian Features			Non-cohesive	Height (ft)	0
*Human Elevated FP	NA	Typical Bank Slope	Moderate		Non-cohesive	Height (ft)	0
Step 2. Stream Channel							
2.1 Bankfull Width (ft)	33	Stream Type:	C		Non-cohesive	Height (ft)	0
2.1a Wetted Width (ft)	16.4	Bed Material:	Gravel		Non-cohesive	Height (ft)	0
2.1b Ratio (wetted/bkfl)	0.50	Subclass Slope:	None		Non-cohesive	Height (ft)	0
2.2 Max Depth (ft)	2.9	Bed Form:	Riffle-Pool		Non-cohesive	Height (ft)	0
2.3 Mean Depth (ft)	1.5	Field Measured Slope:			Non-cohesive	Height (ft)	0
2.4 Floodprone Width (ft)	373	2.15 Reference Stream Type			Non-cohesive	Height (ft)	0
2.5 RAF	2.9	C, Gravel, Riffle-pool			Non-cohesive	Height (ft)	0
*Human Elevated FP	NA	Step 3. Riparian Features			Non-cohesive	Height (ft)	0
Step 3. Riparian Features							
Typical Bank Slope	Moderate	2.1 Stream Banks			Non-cohesive	Height (ft)	0
Step 4. Flow & Flow Modifiers							
4.1 Springs/Seeps	Present	4.2 Adjacent Wetlands	Base		Non-cohesive	Height (ft)	0
4.2 Adjacent Wetlands	Present	4.3 Flow Status	2		Non-cohesive	Height (ft)	0
4.3 Flow Status	Base	4.4 # of Debris Jams	None		Non-cohesive	Height (ft)	0
4.4 # of Debris Jams	2	4.5 Flow Reg Type	None		Non-cohesive	Height (ft)	0
4.5 Flow Reg Type	None	4.6 Up/Downstream Flow Reg	None		Non-cohesive	Height (ft)	0
4.6 Up/Downstream Flow Reg	None	4.7 Stormwater Inputs	None		Non-cohesive	Height (ft)	0
4.7 Stormwater Inputs	None	Field Ditch	0		Non-cohesive	Height (ft)	0
4.8 Road Ditch	0	Urban Storm Pipe	0		Non-cohesive	Height (ft)	0
4.9 # of Beaver Dams	0	Overland Flow	0		Non-cohesive	Height (ft)	0
Affected Length (ft)	0	Grasses Forbs	0		Non-cohesive	Height (ft)	0
5.1 Bar Types	2	5.2 Other Features	Diagonal		Non-cohesive	Height (ft)	0
5.2 Other Features	7	Flood	NCO		Non-cohesive	Height (ft)	0
5.3 Steep Riffles & Headcuts	13	Braiding	0		Non-cohesive	Height (ft)	0
5.4 Stream Ford or Animal Crossing:	None	5.5 Straightening	0		Non-cohesive	Height (ft)	0
5.5 Straightening	None	5.5 Dredging	None		Non-cohesive	Height (ft)	0
5.5 Dredging	None	Bridge and Culvert Survey	No		Non-cohesive	Height (ft)	0
Bridge and Culvert Survey	No				Non-cohesive	Height (ft)	0

Note: General comments, Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook.
 Legend: RAF=Recently Abandoned Floodplain, FP=Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut
 NE= Not evaluated, NA=Not applicable

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Gunstock Brook
 Organization: BCE
 Segment Length (ft): 2056
 1.6 Grade Controls: None
 Reach #: M05
 Observers: PD, MN
 Segment Location: Segment begins where corridor is forested again and continues until tributary confluence
 Segment: Why Not Assessed: NA
 Completion Date: 19-Aug-11
 Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Unconfined Score	STD	Historic
7.1 Channel Degradation	18	None	No
7.2 Channel Aggradation	7	None	No
7.3 Widening Channel	15		No
7.4 Change in Planform	7		No

Total Score: 47
 Geomorphic Rating: 0.59
 Channel Evolution Model D
 Channel Evolution Stage II c
 Geomorphic Condition Fair (0.35-0.64)
 Stream Sensitivity Very High
 Channel Adjustment Processes Narrative

No incision, but major aggradation and planform adjustment. Deposition of sand on banks. Good floodplain access. Numerous flood chutes and steep riffles.

Notes:

Nice undercut banks with stable roots. Steep riffles flow directly into pools on bends.

Legend: Ht.=Height, Constr.=Constriction, Old abuttm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

4.8 Channel Constrictions
 Type Width (ft) Photo GPS Channel Constr. Floodprone Constr.

None

GPS

Channel Constr.

Floodprone Constr.

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	T2.01	Segment:	A	Completion Date:	19-Aug-11
Stream:	Trib to Gunstock Brook	Observed:	PD, MIN	Why Not Assessed:	NA	Rain:	Yes
Organization:	BCE	Segment Location:	Segment begins at confluence with the main stem and continues until valley width decreases				
Step 1. Valley and Floodplain							
1.1 Segmentation:	VW	2.6 Width/Depth Ratio	14.2	Bank Texture	Left	Right	Corridor Land Use
1.2 Alluvial Fan:	None	2.7 Entrenchment Ratio	13.2	Upper			Dominant
1.3 Corridor Encroachments:	Both	2.8 Incision Ratio	1.1	Material Type	Sand	Sand	Sub-dominant
Berms height (ft)	0	*Human Elevated Incision	Mod (1.2-1.5)	Consistency	Non-cohesive	Non-cohesive	Mass Failures (ft)
Roads height (ft)	0	2.9 Sinuosity	Sedimented	Material Type	Boulder/Cobble	Boulder/Cobble	Gullies (number)
Railroads height (ft)	0	2.10 Riffle Type	44	Bank Erosion	Non-cohesive	Non-cohesive	Height (ft)
Improved Paths height (ft)	0	2.11 Riffle Step Spacing (ft)	%	Erosion Length (ft)	122	76	Step 4. Flow & Flow Modifiers
Development height (ft)	0	2.12 Substrate Composition	%	Erosion Height (ft)	3	3	4.1 Springs/Seeps
1.4 Adjacent Side	Left		%	Revetment Type	Rip-rap	Rip-rap	4.2 Adjacent Wetlands
Hillside Slope	Flat		%	Revetment Length (ft)	22	29	4.3 Flow Status
Continuous	Never		%	Near Bank Veg. Type	% Cover	Invasive	4.4 # of Debris Jams
W/in 1 bankfull	Never		%	L Trees (%)	70	0	4.5 Flow Reg Type
Texture	NE		%	R Trees (%)	70	0	4.6 Up/Downstream Flow Reg
1.5 Valley Features	407		%	L Herbs (%)	80	0	4.7 Stormwater Inputs
Valley Width (ft)	Measured	2.13 Average Largest Particle	9.3	R Herbs (%)	80	0	Field Ditch
Width Determination	Very Broad	Bed	3.5	Canopy %	76-100	76-100	Urban Storm Pipe
Confinement Type	No	Bar	3.0	Mid-channel canopy	Closed		Overland Flow
Rock Gorge?	No	2.13a % Subs. Exp.	3.5	3.2 Riparian Buffer			0
Human Caused Change?	No	2.14 Stream Type	C	Buffer Width	Left	Right	Road Ditch
2.1 Stream Channel	20	Stream Type:	C	Dominant	>200	>200	0
2.1a Bankfull Width (ft)	8.9	Bed Material:	Gravel	Sub-dominant	None	>150	0
2.1b Ratio (wetted/bkfl)	0.45	Subclass Slope:	b	Length <25 ft	0	0	0
2.2 Max Depth (ft)	2.05	Bed Form:	Riffle-Pool	L Trees (%)	80	0	0
2.3 Mean Depth (ft)	1.41	Field Measured Slope:	C, Gravel, Riffle-pool	R Trees (%)	80	0	0
2.4 Floodprone Width (ft)	264	2.15 Reference Stream Type	Step 3. Riparian Features	L Shrub/Sapling (%)	50	0	100
2.5 RAF	2.25	3.1 Stream Banks	Typical Bank Slope	R Shrub/Sapling (%)	50	0	100
*Human Elevated FP	NA	3.2 Stream Slope	Steep	L Herbs (%)	50	0	100
Note: General comments, Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook.							
Legend: RAF=Recently Abandoned Floodplain, FP=Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut							
NE= Not evaluated, NA=Not applicable							

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Trib to Gunstock Brook
 Organization: BCE
 Segment Length (ft): 1482
 Reach #: 1482
 Observers: BCE
 Segment Location: Segment begins at confluence with the main stem and continues until valley width decreases
 Why Not Assessed: NA
 Completion Date: 19-Aug-11
 Rain: Yes

1.6 Grade Controls

Type	Location	Total Ht (ft)	Ht Above (ft)	Photo	GPS	Historic
7.1 Channel Degradation		19	None	No	No	No
7.2 Channel Aggradation		9	None	No	No	No
7.3 Widening Channel		14	None	No	No	No
7.4 Change in Planform		10	None	No	No	No

Total Score: 52
 Geomorphic Rating: 0.65
 Channel Evolution Model D
 Channel Evolution Stage II c
 Geomorphic Condition Good (0.65-0.84)
 Stream Sensitivity High

Channel Adjustment Processes Narrative
 Aggradation is attributed to drop in channel slope in this segment. Possible contribution of sediment from gravel operation (per P. Tarpey).

Notes:

4.8 Channel Constrictions

Type	Width (ft)	Photo	GPS	Channel Constr.	Floodprone Constr.
Culvert	4.7	Yes	Yes	Yes	Yes

Problems: DA, DB, SB

Legend: Ht.=Height, Constr.=Constriction, Old abuttm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

Phase 2 Segment Summary (page 1)

Project:	Gunstock Brook	Reach #:	T2.01 <th>Segment:</th> <td>B <th>Completion Date:</th> <td>18-Aug-11 </td></td>	Segment:	B <th>Completion Date:</th> <td>18-Aug-11 </td>	Completion Date:	18-Aug-11
Stream:	Trib to Gunstock Brook	Observers:	PD, MN <th>Why Not Assessed:</th> <td>NA <th>Rain:</th> <td>Yes </td></td>	Why Not Assessed:	NA <th>Rain:</th> <td>Yes </td>	Rain:	Yes
Organization:	BCE	Segment Location:	Segment begins where valley width decreases and continues to about 470 feet upstream of Belknap Mountain Road crossing				
Segment Length (ft):	2324	Step 2 (Cont'd)					
Step 1. Valley and Floodplain		Step 3 (Cont'd)					
1.1 Segmentation:	VW	Bank Texture	12.4	Left		Right	
1.2 Alluvial Fan:	None	Upper	6.8	Mix		Mix	
1.3 Corridor Encroachments:		Material Type	1.0	Non-cohesive		Non-cohesive	
Length (ft)		Consistency	NA	Boulder/Cobble		Boulder/Cobble	
Berm	0	Lower	Low (<1.2)	Non-cohesive		Non-cohesive	
Roads	0	Complete	65	Boulder/Cobble		Boulder/Cobble	
Railroads	0	Material Type		Non-cohesive		Non-cohesive	
height (ft)	0	Consistency		Boulder/Cobble		Boulder/Cobble	
height (ft)	0	Bank Erosion		Non-cohesive		Non-cohesive	
Improved Paths	0	Erosion Length (ft)	321	Right		Right	
height (ft)	0	Erosion Height (ft)	4	125 <td></td> <th>125 <td></td> </th>		125 <td></td>	
Development	0	Revetment Type	Rip-rap	4.1 Springs/ Seeps		4.1 Springs/ Seeps	
1.4 Adjacent Side		Revetment Length (ft)	57	4.2 Adjacent Wetlands		4.2 Adjacent Wetlands	
Hillside Slope	Extremely Steep	Near Bank Veg. Type		4.3 Flow Status		4.3 Flow Status	
Continuous	Never	L Trees (%)	60	4.4 # of Debris Jams		4.4 # of Debris Jams	
W/in 1 bankfull	Never	R Trees (%)	60	4.5 Flow Reg Type		4.5 Flow Reg Type	
Texture	NE	% Cover	70	4.6 Up/Downstream Flow Reg		4.6 Up/Downstream Flow Reg	
1.5 Valley Features		% Cover	70	4.7 Stormwater Inputs		4.7 Stormwater Inputs	
Valley Width (ft)	179	L Herbs (%)	70	Field Ditch		Field Ditch	
Width Determination	Measured	R Herbs (%)	70	Urban Storm Pipe		Urban Storm Pipe	
Confinement Type	Very Broad	Canopy %	76-100	Overland Flow		Overland Flow	
Rock Gorge?	No	Mid-channel canopy	Closed	4.9 # of Beaver Dams		4.9 # of Beaver Dams	
Human Caused Change?	No	Buffer Width		Affected Length (ft)		Affected Length (ft)	
2.1 Bankfull Width (ft)	17	Dominant	>200	5.1 Bar Types		5.1 Bar Types	
2.1a Wetted Width (ft)	10.5	Sub-dominant	51-100	Diagonal		Diagonal	
2.1b Ratio (wetted/bkfl)	0.62	Length <25 ft	0	Flood		Flood	
2.2 Max Depth (ft)	2	Buffer Veg. Type		Braiding		Braiding	
2.3 Mean Depth (ft)	1.37	L Trees (%)	70	5.2 Other Features		5.2 Other Features	
2.4 Floodprone Width (ft)	116	R Trees (%)	70	5.3 Steep Riffles & Headcuts		5.3 Steep Riffles & Headcuts	
2.5 RAF	2	L Shrub/Sapling (%)	50	5.4 Stream Ford or Animal Crossing		5.4 Stream Ford or Animal Crossing	
* Human Elevated FP	NA	R Shrub/Sapling (%)	50	5.5 Straightening		5.5 Straightening	
		Typical Bank Slope	Steep	5.5 Dredging		5.5 Dredging	

Note: General comments: Step 1.6 Grade Controls and Step 4.8 Channel Constrictions on Sheet 2 of this workbook.
 Legend: RAF=Recently Abandoned Floodplain, LWD=Large Woody Debris, % Subs. Exp.=Exposed Substrate, Flood=Flood Chute, NCO=Neck Cutoff, SR=Steep Riffle, HC=Head Cut
 NE= Not evaluated, NA=Not applicable

Phase 2 Segment Summary (page 2)

Project: Gunstock Brook
 Stream: Trib to Gunstock Brook
 Organization: BCE
 Segment Length (ft): 2324
 1.6 Grade Controls: None
 Total Ht (ft): None
 Location: Ht. Above (ft)
 Photo: Present
 Reach #: T2.01
 Observers: PD, MN
 Segment Location: Segment begins where valley width decreases and continues to about 470 feet upstream of Belknap Mountain Road crossing
 Why Not Assessed: NA
 Completion Date: 18-Aug-11
 Rain: Yes

Step 7. Rapid Geomorphic Assessment Summary (fill out RGA sheet first, then enter narrative)

Confinement Type	Unconfined	
	Score	STD
7.1 Channel Degradation	17	None
7.2 Channel Aggradation	18	None
7.3 Widening Channel	17	No
7.4 Change in Planform	14	No

Total Score: 66
 Geomorphic Rating: 0.83

Channel Evolution Model F
 Channel Evolution Stage I
 Geomorphic Condition Good (0.65-0.84)
 Stream Sensitivity High

Channel Adjustment Processes Narrative
 Some areas of channel have a higher bank, while other areas have a lower bank. Cross section was measured where banks are lower. No evidence of widening. Very little erosion. Banks may be naturally higher in places and therefore floodplain may be higher also. Channel does not appear incised.

Notes:
 Step-pool above Belknap Mountain Road.

Legend: Ht.=Height, Constr.=Constriction, Old abutrm.=Old abutment, DA=Deposition above, DB=Deposition below, SA=Scour above, SB=Scour below, A=Alignment

New Hampshire Geological Survey
New Hampshire Department of Environmental Services
QA/QC Comments
Gunstock Brook Phase 2 Data
March 12, 2012

Bear Creek Environmental, LLC
QA/QC responses
Gunstock Brook Phase 2 Data
March 13, 2012
Responses in red

Reach 1, Segment A

- You indicate the reason for segmentation as "Other Reason." What is the reason?
The other reason is that this lower segment is influenced by Lake Winnepesaukee and was impounded at the time of the assessment.
- In Step 5.5., you indicate that there is a 49 foot length of straightening. Yet, I don't see it in your FIT line shapefile that you sent.
The straightening was marked in the vicinity of the bridge. There is a record in the FIT length shapefile (Fit01Inimpactseg.shp) for 49 feet.
- The stream type is visually estimated as isn't the bed material. As there is no cross-section data, FEH zones will not be able to be delineated for this segment.
That is correct; since this segment was not assessed there is no cross section data available. The steam type is based on administrative judgment in the field.

Reach 1, Segment B

- Step 7.1, Row 5 – Your data indicates that the segment has experienced 822 feet of straightening, and you have several straightening lines digitized as part of your FIT data. In this row, then, do you have the "Good" checkbox selected. Is 822 feet of straightening not significant, such as defined in the "Fair" checkbox? What was your rationale for selecting "Good" instead of "Fair?"
**"Fair" should have been checked due to the straightening in this segment.
Checkbox was changed to "Fair" for step 7.1, row 5.**

Reach 1, Segment C

- Your data shows this typed out as a "B" stream type. The cross-section data shows that the entrenchment ratio places the stream in the "B" range, but the width/depth ratio does not squarely fit a "B" (w/d ratio = 8.85, while strictly speaking, the w/d ratio for a "B" type stream is greater than 12). Thus, this reach is a case where it doesn't fit the stream typing method fully. Looking at the photos from this reach and the surrounding topography, its hard for this stream to fit the B4 description of a river channel. It seems that this really more fits a "C" type stream, and thus would type out as a C4, based upon your pebble count. The shape of the cross-section plot also verifies this interpretation. Any comments on this point?

We agree that the width to depth ratio does not fit a "B" stream type, but the channel has not widened yet and is still in stage F-II of the channel evolution model. Therefore, it would not have a higher width to depth ratio at this stage. We indicated that by reference the stream type is a "C". Since the channel has incised considerably (incision ratio = 2.3), the stream has become more entrenched and is therefore now a "B". Entrenchment is the first thing to look at in Rosgen's stream classification and in this case, the channel is a "B" with a stream type departure from a reference "C" based on the entrenchment of 1.65. No changes were made.

Reach 2, Segment B

- The entrenchment ratio comes out to be 1.37. Typically, I don't round. So, 1.37 is 1.37 . . . not 1.4, as you rounded to on your spreadsheet. That said, however, as it is close on the threshold of the 1.4 cutoff, after examining your photos from that segment and the shape of the plotted cross-section, I agree with your assessment that this types out as a "B" rather than an "F."

The rounding was a function of the spreadsheet that we used to generate our reports. This has been corrected in the spreadsheet.

New Hampshire Geological Survey, Shane Csiki
QA Comments on Gunstock Brook
Reaches 3 through 5
3/21/2012

**Response from Bear Creek Environmental, LLC
March 28, 2012**

Reach 4A

In looking at the photos as well as what this reach looks like on the aerial photography, this strikes me as an area that was once inundated, possibly by additional impounding structures near the downstream reach break at some point in the past. This strikes me as if this was some sort of formerly inundated pond in the past (particularly downstream of Alvah Wilson Road).

It is very possible that this area was previously inundated and that there was a dam at the historic mill near the Belknap Mountain Road crossing. We asked Lisa Morin about this, and she has offered to call Pat Tarpey and the Gilford Historical Society to get some information.

Reach 4B

As you chose Cross-Section #1, rather than Cross-Section #2, the results from that cross-section type out as an "E" rather than a "C," given the width/depth ratio value of 10.39 for the cross-section you selected. Based on your geomorphic condition rating of Fair based on the RGA, the difference in stream type between "E" and "C" marks the difference between a "Very High" and "Extreme" sensitivity rating. Now, if you chose Cross-Section #2, then the type would be "C" automatically. Can you provide your rationale here as to how you ultimately chose "C" for the stream type given the above?

You raise a good point here, and it's important to justify this is a "C" stream type rather than an "E" stream type due to the differences in stream sensitivity and width of the FEH zones (6 channel widths versus 8 channel widths). There are a number of things that we look for to make an "E" stream type determination. Typically "E" channels occur in lacustrine soils (have cohesive clay soils) and high sinuosity. An "E" channel in reference condition would have a low width to depth ratio and should be able to efficiently transport sediment resulting in a lack of bars features.

Although the width to depth ratio in this cross section represents more of an "E" stream type, there are numerous bars in this segment including mid-channel and diagonal bars. These bars could certainly be a result of aggradation due to channel adjustment (as you point out, the geomorphic rating is fair"). The width to depth ratio is a guideline and allows for flexibility from the 12 value cutoff. Both of our cross sections indicate the channel was incised within segment M04-B. We thought segment M04-B was generally in stage F-II of the channel evolution model. Therefore, this low width to depth ratio would make sense. Cross section #2 provides some additional evidence that the channel is a "C" rather than an "E" due to the width to depth ratio of 13.6.

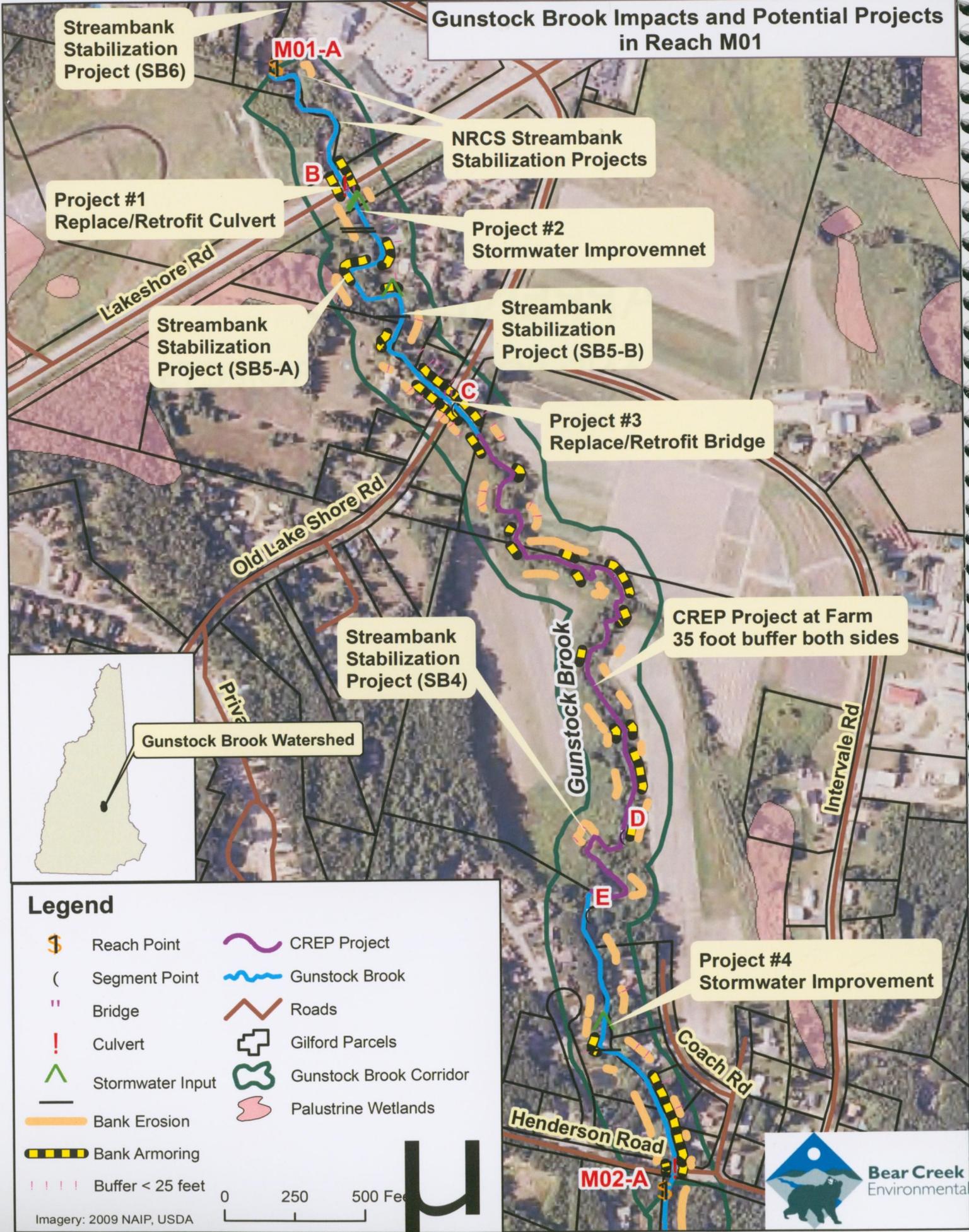
Based on the photos, you can see that the much of the segment is more "C" like. The sinuosity was moderate, where in an "E" stream, it would typically be high. We noted that the both the upper and lower banks in this segment are made up of sandy, non-cohesive material. Soils data from GRANIT shows much of the river corridor to be made up of very fine sandy loam or loamy fine sand rather than lacustrine soils. In conclusion, our best professional judgment is this segment is a "C" channel.

Reach 5A

Given the parameters inherent with the cross-section you collected here, what is your rationale for the "C" versus "E" stream typing?

Please see our response to segment M04b. The low sinuosity, presence of diagonal bars and mid-channel bars is more indicative of a "C" channel. Soils were sandy, and there was a lack of cohesive material. Once again, this segment was incised and was in stage F-II of the channel evolution model, resulting in a low width to depth ratio.

Gunstock Brook Impacts and Potential Projects in Reach M01



Streambank Stabilization Project (SB6)

NRCS Streambank Stabilization Projects

Project #1 Replace/Retrofit Culvert

Project #2 Stormwater Improvement

Streambank Stabilization Project (SB5-A)

Streambank Stabilization Project (SB5-B)

Project #3 Replace/Retrofit Bridge

Streambank Stabilization Project (SB4)

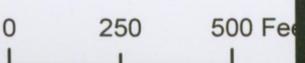
CREP Project at Farm 35 foot buffer both sides

Gunstock Brook Watershed

Project #4 Stormwater Improvement

Legend

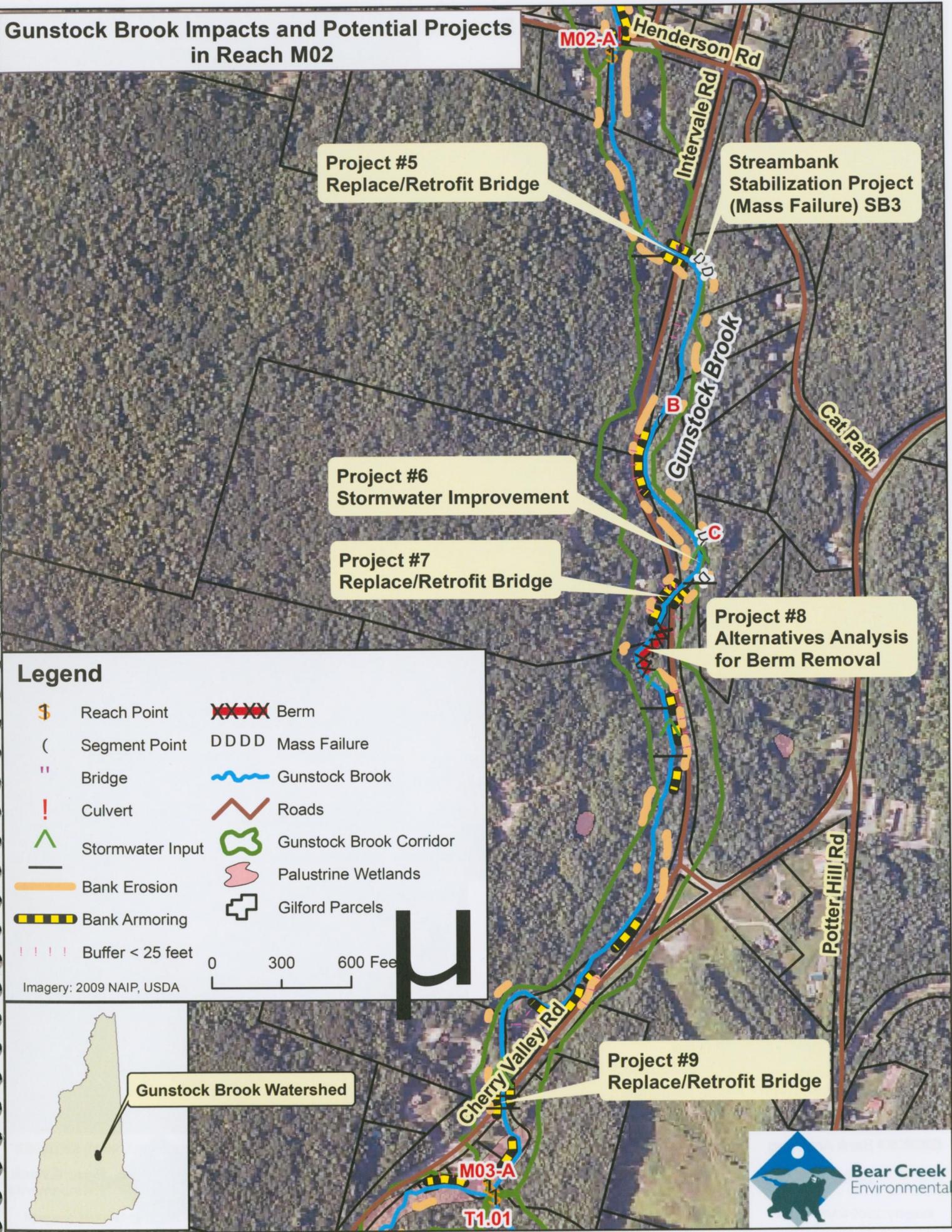
- Reach Point
- Segment Point
- Bridge
- Culvert
- Stormwater Input
- Bank Erosion
- Bank Armoring
- Buffer < 25 feet
- CREP Project
- Gunstock Brook
- Roads
- Gilford Parcels
- Gunstock Brook Corridor
- Palustrine Wetlands



Imagery: 2009 NAIP, USDA



Gunstock Brook Impacts and Potential Projects in Reach M02



Project #5
Replace/Retrofit Bridge

Streambank
Stabilization Project
(Mass Failure) SB3

Project #6
Stormwater Improvement

Project #7
Replace/Retrofit Bridge

Project #8
Alternatives Analysis
for Berm Removal

Project #9
Replace/Retrofit Bridge

Legend

- | | | | |
|------|------------------|------|-------------------------|
| \$ | Reach Point | XXXX | Berm |
| (| Segment Point | DDDD | Mass Failure |
| " | Bridge | ~~~~ | Gunstock Brook |
| ! | Culvert | ~~~~ | Roads |
| ^ | Stormwater Input | ~~~~ | Gunstock Brook Corridor |
| — | Bank Erosion | ~~~~ | Palustrine Wetlands |
| — | Bank Armoring | + | Gilford Parcels |
| ---- | Buffer < 25 feet | | |

0 300 600 Feet

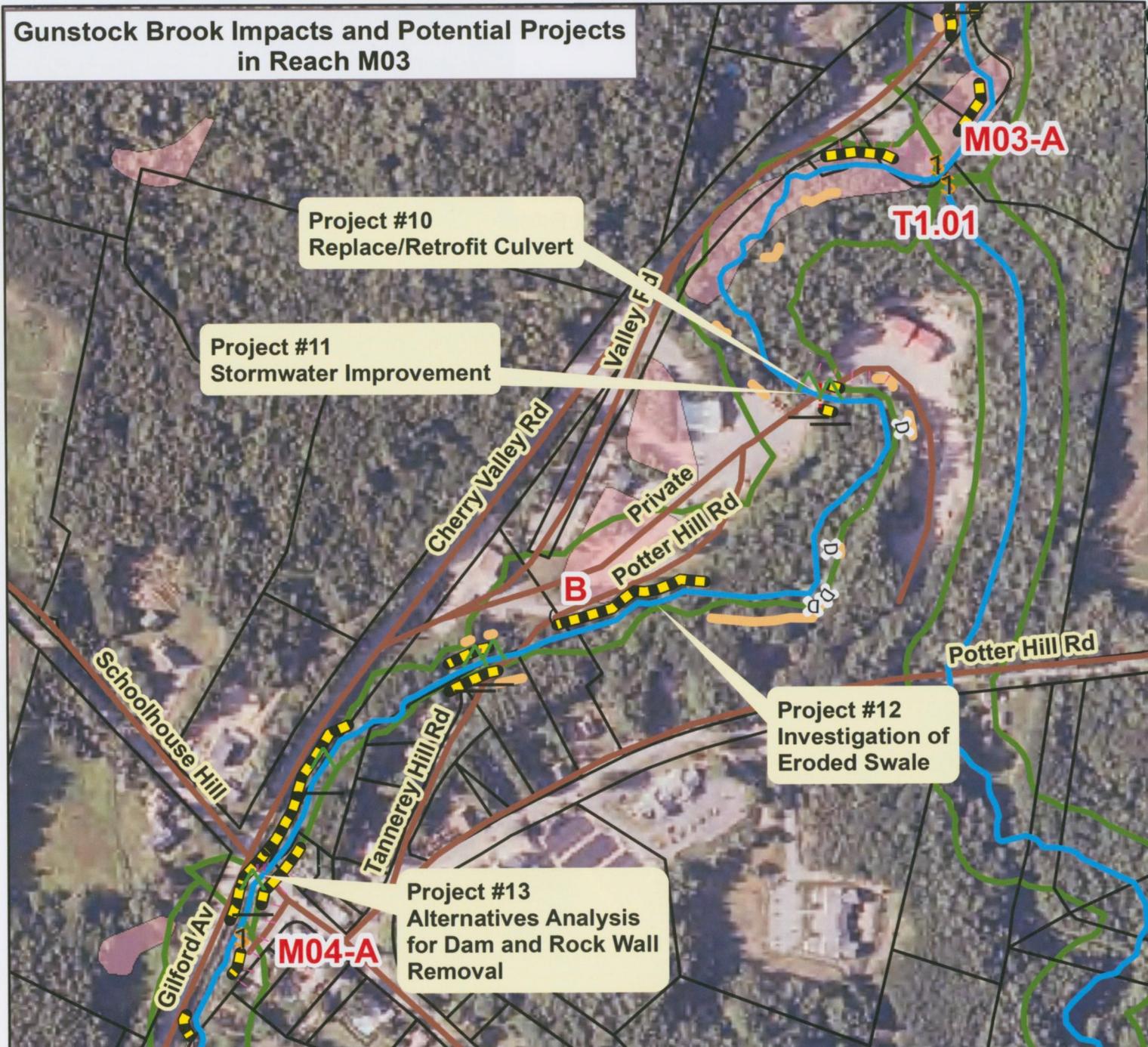
Imagery: 2009 NAIP, USDA



Gunstock Brook Watershed



Gunstock Brook Impacts and Potential Projects in Reach M03



Project #10
Replace/Retrofit Culvert

Project #11
Stormwater Improvement

Project #12
Investigation of
Eroded Swale

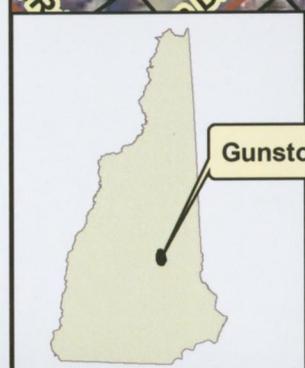
Project #13
Alternatives Analysis
for Dam and Rock Wall
Removal

Legend

- | | | | |
|------|------------------|------|-------------------------|
| § | Reach Point | DDDD | Mass Failure |
| (| Segment Point | | Gunstock Brook |
| " | Bridge | | Roads |
| ! | Culvert | | Gifford Parcels |
| | Stormwater Input | | Gunstock Brook Corridor |
| | Bank Erosion | | Palustrine Wetlands |
| | Bank Armoring | | |
| ---- | Buffer < 25 feet | | |

0 200 400 Feet

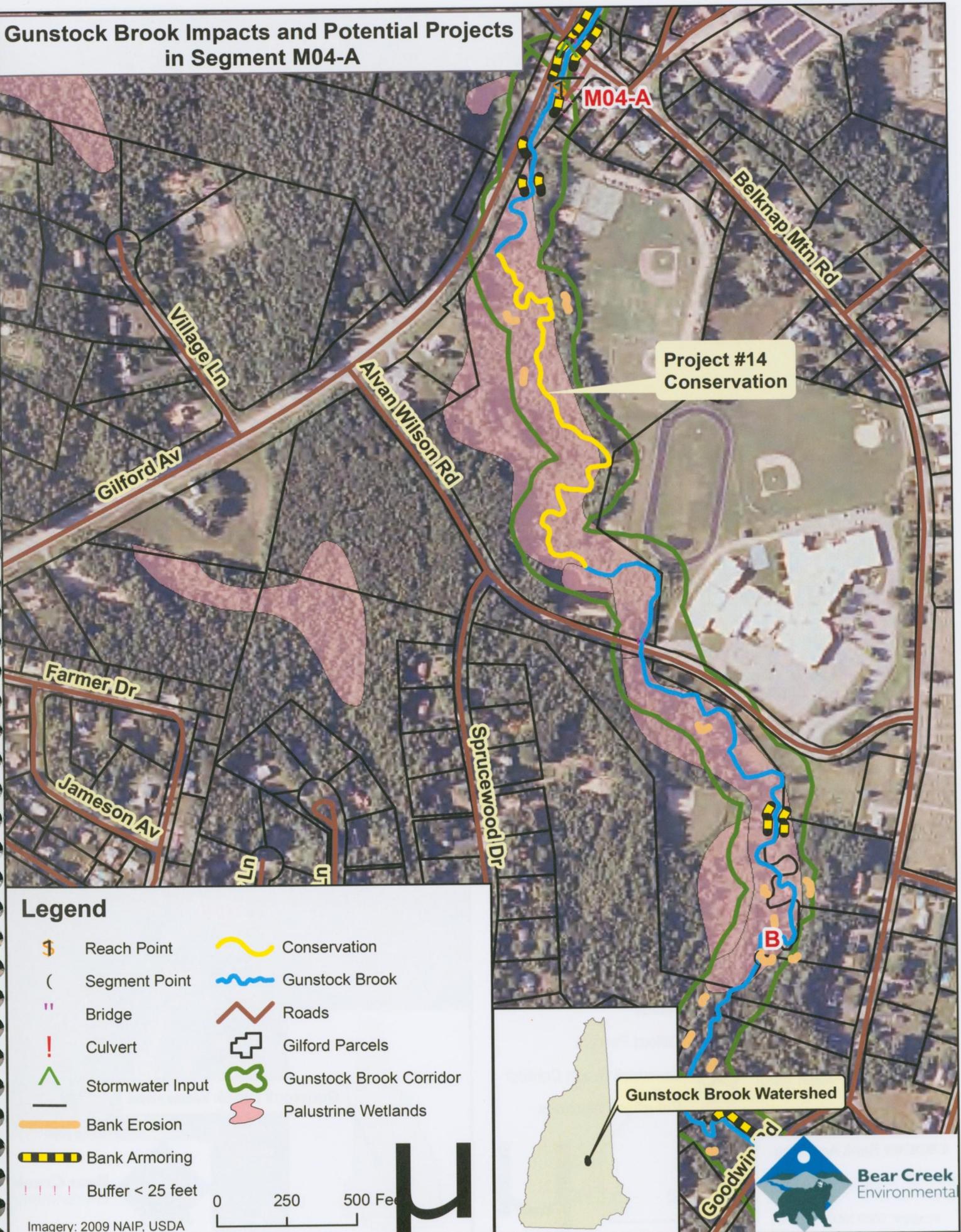
Imagery: 2009 NAIP, USDA



Gunstock Brook Watershed



Gunstock Brook Impacts and Potential Projects in Segment M04-A



M04-A

Project #14
Conservation

Belknap Mtn Rd

Village Ln

Gilford Av

Alvan Wilson Rd

Farmer Dr

Jameson Av

Sprucewood Dr

B

Gunstock Brook Watershed

Goodwin Rd

Legend

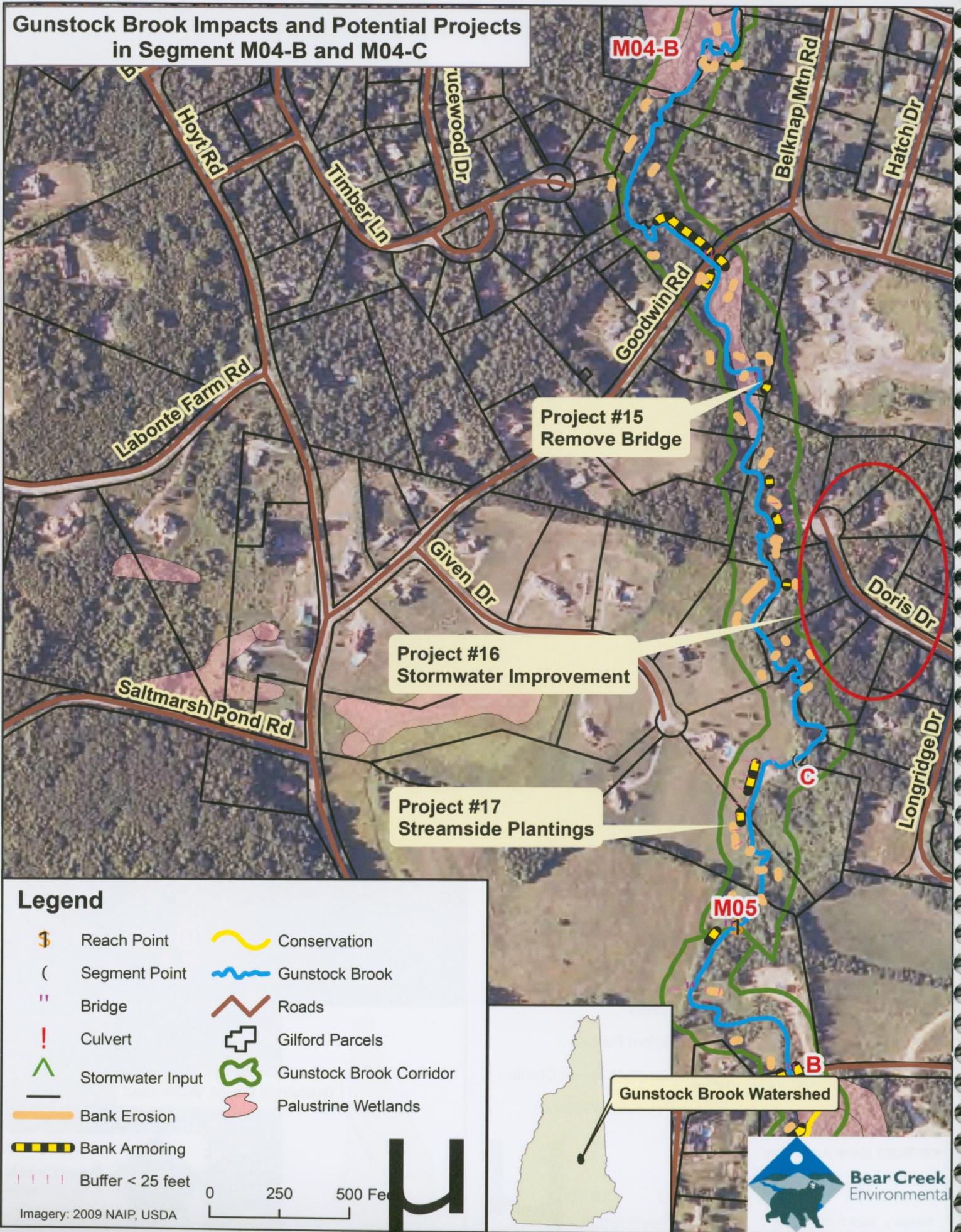
- | | | | |
|---|------------------|---|-------------------------|
| § | Reach Point | ~ | Conservation |
| (| Segment Point | ~ | Gunstock Brook |
| " | Bridge | — | Roads |
| ! | Culvert | + | Gilford Parcels |
| ^ | Stormwater Input | ~ | Gunstock Brook Corridor |
| — | Bank Erosion | ~ | Palustrine Wetlands |
| ▬ | Bank Armoring | | |
| | Buffer < 25 feet | | |

0 250 500 Feet

Imagery: 2009 NAIP, USDA



Gunstock Brook Impacts and Potential Projects in Segment M04-B and M04-C



Legend

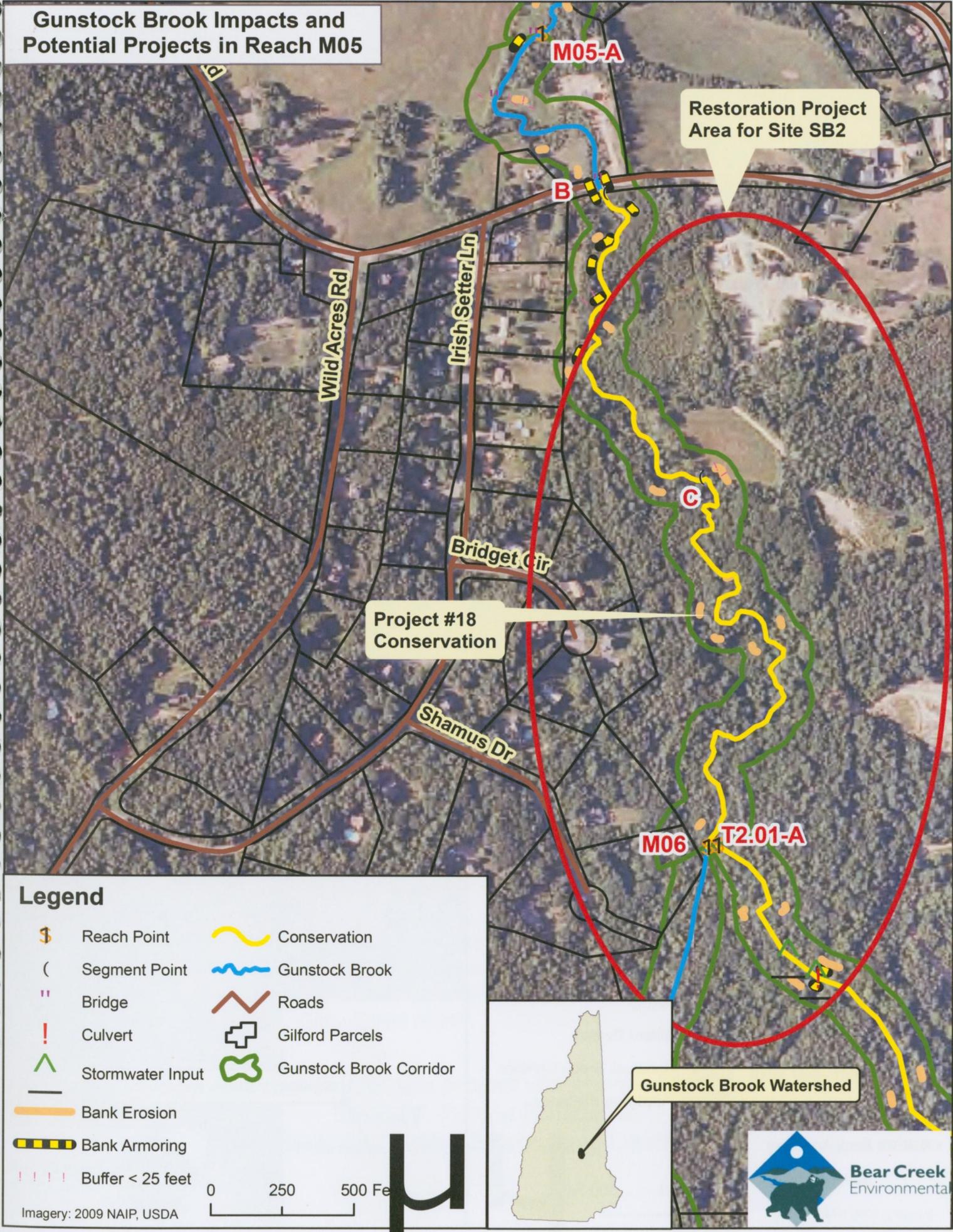
- | | |
|------------------|-------------------------|
| Reach Point | Conservation |
| Segment Point | Gunstock Brook |
| Bridge | Roads |
| Culvert | Gilford Parcels |
| Stormwater Input | Gunstock Brook Corridor |
| Bank Erosion | Palustrine Wetlands |
| Bank Armoring | |
| Buffer < 25 feet | |

0 250 500 Feet

Imagery: 2009 NAIP, USDA



Gunstock Brook Impacts and Potential Projects in Reach M05

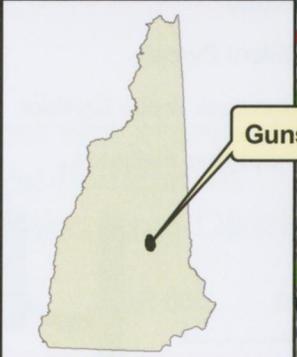


Legend

- | | | | |
|--|------------------|--|-------------------------|
| | Reach Point | | Conservation |
| | Segment Point | | Gunstock Brook |
| | Bridge | | Roads |
| | Culvert | | Gilford Parcels |
| | Stormwater Input | | Gunstock Brook Corridor |
| | Bank Erosion | | |
| | Bank Armoring | | |
| | Buffer < 25 feet | | |



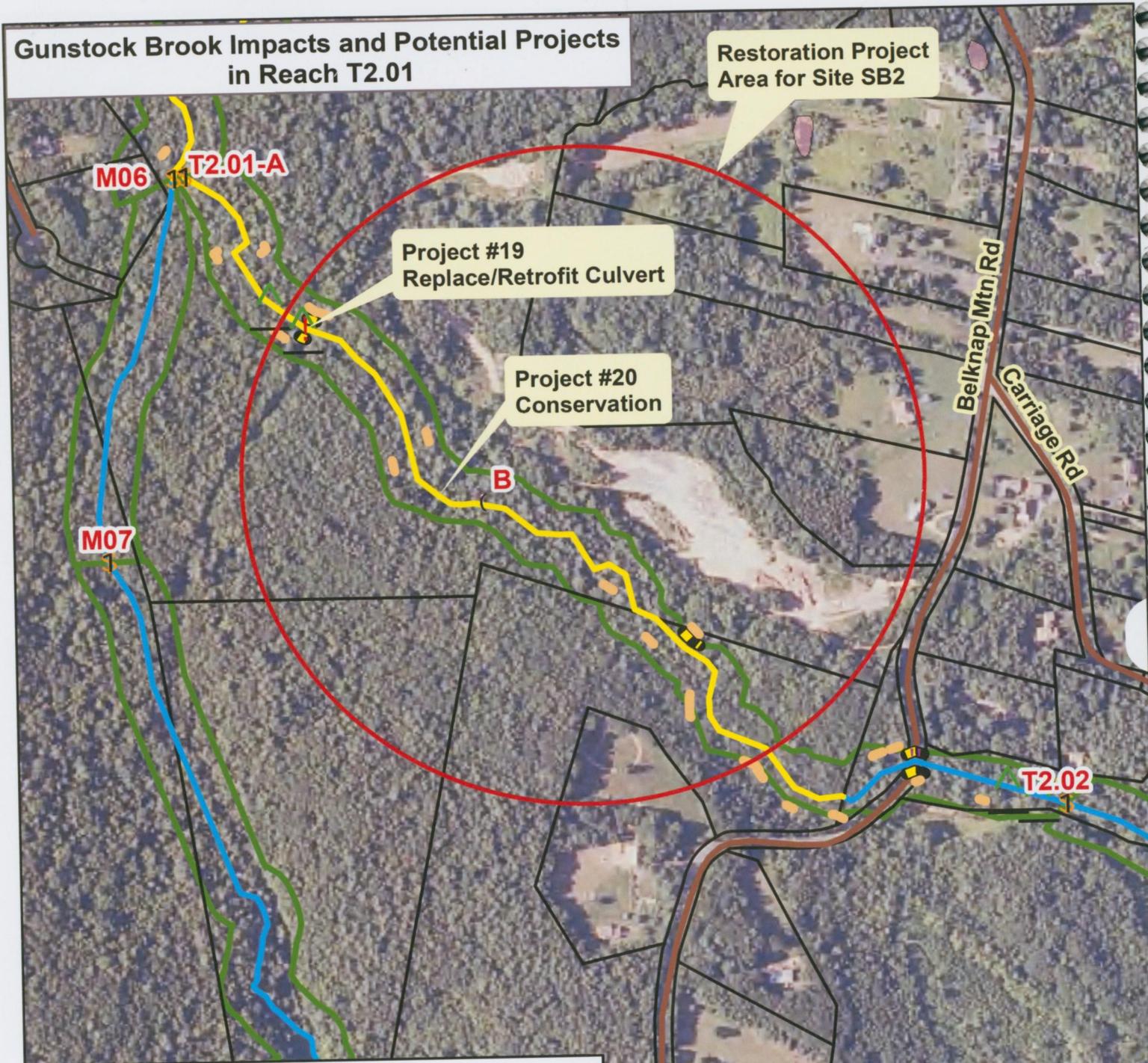
Imagery: 2009 NAIP, USDA



Gunstock Brook Watershed



Gunstock Brook Impacts and Potential Projects in Reach T2.01

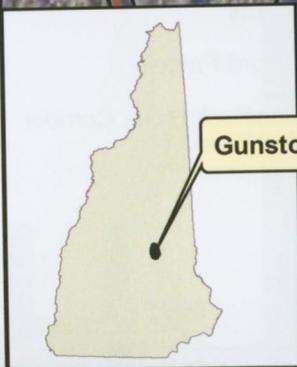


Legend

- | | | | |
|--|------------------|--|-------------------------|
| | Reach Point | | Conservation |
| | Segment Point | | Gunstock Brook |
| | Bridge | | Roads |
| | Culvert | | Gilford Parcels |
| | Stormwater Input | | Gunstock Brook Corridor |
| | Bank Erosion | | Palustrine Wetlands |
| | Bank Armoring | | |
| | Buffer < 25 feet | | |

0 250 500 Feet

Imagery: 2009 NAIP, USDA



Gunstock Brook Watershed

