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Bartlett Brook Phase II Documentation and QA/QC Notes
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Bartlett Brook Summary:

The following is a documentation of the key geomorphic processes and adjustments occurring in the Bartlett Brook watershed at the reach scale. The intent of this documentation is to highlight for those using the data the key steps containing important or extraordinary information. When used in conjunction with the Phase I and II data in the DMS, and the SGA Watershed Map, this documentation also provides explanation for questions that may arise concerning discrepancies or disagreement in the data. At the end of this summary is a discussion of reaches in the context of potential projects that could protect, sustain, or restore fluvial geomorphic equilibrium conditions, through the implementation of either passive or active stream corridor management strategies. Following the discussion text is Appendix 1, which summarizes QA/QC notes and other relevant information for the Phase I and II databases. Also included in Appendix 2 are the plots for each channel cross-section measured in the field during the Phase II analysis.

The Bartlett Brook watershed is one of the few watersheds assessed during the summer 2005 field season that has no beaver activity, due to its high-gradient channel network (average 2.6% slope). In the absence of beaver impacts, current-day stressors (e.g., urbanization) dominate and make the determination of predominant fluvial processes in the watershed more easily done. However, in addition to the dominant current-day stressors, historic impacts from floodplain encroachment around highly urbanized areas and road crossings make assessment of the current stage of channel evolution difficult in some segments of the channel network. Specific zones of the watershed and the dominant fluvial processes observed within each are discussed below.

Lower Watershed Zone:

The lowest reach of Bartlett Brook, M01, is highly impacted by the effects of watershed-wide and local-scale urbanization. This reach is located below the redesigned channel and stormwater facility on the Shearer Chevrolet property. Significant degradation is visible throughout this reach and appears to have been occurring for a long time period (at least 20 years), as a large delta of fine sediment is found at the outlet to Shelburne Bay. The natural slope of this reach (3.2%) would suggest a bedform of step-pool features, however, bank erosion and its contribution of fine sediment to the bed has resulted in plane bed features dominating part the reach, leading to degraded biotic habitat in an important stream reach connected to the lake. However, the natural step-pool features persist through most of the reach and no stream type departure has been noted.

It can be clearly observed that the changes in watershed hydrology have affected the stability and habitat of reach M01. Bank erosion was observed in approximately 30% of the stream channel, and one large mass failure was noted (see photo to left). Local encroachments on the channel are also contributing to increased stream power and sediment transport capacity. Armoring appears to be holding a large area of the bank stable within the reach. Significant entrenchment and incision noted in channel geometry measurements will likely maintain transport regime (with degraded bed features) in perpetuity.

Reach M02, located above and below Rt. 7, is a diverse reach with many different types of stream features. This diversity of stream geometry within M02 has been noted in Step 5 of the DMS, and should include further segmentation for any future geomorphic assessment work. In the lower part of M02, the channel has been completely redesigned and modified as part of a channel restoration effort by Pioneer Environmental Associates and the City of South Burlington. A cross-section plot of this redesigned channel is included in Appendix 2, and the entire length of this segment of the channel was observed to be stable with no significant signs of aggradation or degradation.

In reach M02 just above Rt. 7, there is an historic road crossing (old Rt. 7 location) that is a very large grade control and continues to affect the equilibrium condition of the channel network directly above it (see photo to left). In future assessment work, this segment should be typed as a “sub-reach” of M02, as its channel geometry resembles an E-type more than the B type referenced in the DMS. This grade control (approx. 10 ft) has caused significant aggradation in the channel directly upstream, and has likely caused a change in stream type since the crossing was established. Further discussion of this reach is also found in the STD section below.

Above this zone of aggradation in M02, the channel slope increases and valley becomes more confined. Multiple, large mass failures are found in this small section of M02, and widening is occurring as a result (see photo to right). Dominant bed substrate was likely cobble under natural conditions, but aggradation of fine clay and sand material from the reach-wide mass failures has led to planebed features with a median substrate size of gravel. Although local encroachment is absent throughout this section, further incision and widening associated with upslope stormwater outfalls will likely continue to occur in this section of the reach, and habitat features associated with the natural step-pool system will continue to be lost.

Upper Watershed Zone:

An historic road crossing separates the upper section of reach M02 from reach M03/4. This road crossing (old logging road) causes a tightening in the valley width in the lower section of reach M03/4, further contributing to the channel adjustments occurring in this area. This reach has undergone significant incision (incision ratio = 2.0), most likely resulting from upstream stormwater inputs, and has changed confinement from a B-type channel to a G-type channel. This change in channel geometry is further discussed in the STD section below. Bed substrate has become dominated by fine (sand) substrate as a result of high bank erosion (>50%), and has degraded habitat conditions.

Above M03/4, segments M05-A and M05-B are both found within the flatter land areas associated with the UVM Horticultural Farm. Both reaches have been classified as C-type channels, however the upper segment (M05-B) represents the headwaters channel and, in addition to being greatly impacted by channel alterations, becomes an ephemeral channel not far above the channel segment break. Significant aggradation was noted in the lower segment of this reach, and could be attributable to historic agricultural impacts, as urbanization is not significant in the upslope catchment.

Stream Type Departure (STD) has been noted for the following reaches:

1. **M02 –** The upper section of this reach has channel geometry measurements which suggest that a channel evolution process of incision to widening is already occurring. The width to depth ratio has become lower than typically observed in B-type channels, suggesting that deepening and widening are concurrent, and that the channel evolution may result in a G stream type as observed in M03/4. Mass failures throughout this reach appear to be aggravated by a complex interaction of groundwater-surface water alterations due to the channel adjustment process. As incision occurs, the connection to the groundwater table is no longer at the typical surface water elevation, but higher on the banks. The banks, composed of highly erodible clay-silt material, begin to sheer into the channel, increasing fine sediment to the system and causing widening above and below the failures, and localized changes in planform. This sediment production is overwhelming the transport capacity of the reach despite the increased stream power from upstream stormwater inputs. A stream type departure has been noted in the data for change in planform from step-pool to plane bed.
2. **M03/4 –** A stream type departure has been noted from a B-type to a G-type for a majority of this reach. Mid-section of segment where cross-section was taken shows high incision and entrenchment, although this appears to be more natural in the upper and mid sections of segment. Similar interaction of groundwater-surface water is occurring in this reach as described above for M02. Although channel geometry may suggest a B-type more than G-type, reach has been assessed as a G-type due to the ongoing incision and likelihood that channel will continue to become more entrenched over time. Reference bed material has been noted as fine gravel, although high bank erosion in lower section of the reach has caused the bed to be dominated by sand.

Project Identification:

- Corridor Protection:
    1. In **M01** in particular, historic and current encroachment has increased stream power and is resulting in incision throughout the reach. Although further encroachment is unlikely in this reach because most of the property found in the stream corridor is already developed as residential, land-use management in this area should consider the activities of the adjacent property owners. It was observed along this reach that homeowners have dumped yard waste and other materials (fill) directly into the channel. Protecting this corridor from further encroachment in the way of dumping by homeowners should be a key, cost-effective measure taken (by the city or a homeowners association) to reduce further incision, mass wasting, and sediment conveyance to Shelburne Bay located a short distance downstream.
    2. In upstream reaches **M02** and **M03/4,** further encroachment near the stream corridor is also not likely due to the steep terrain (valley side slopes). However, upslope residential land-use and associated stormwater conveyances to the stream network remain a threat to the adjustment of the channel in these reaches. Due to the sensitive nature of the channel in these reaches above Rt. 7, attributable to the erodible bank substrate, collection and conveyance of stormwater runoff from the residential areas directly upslope (to the east) appears to be the main driver of channel adjustment. Because these residential areas (Pheasant Way, Deerfield Dr.) alter the hydrology of the entire watershed, in addition to directly causing extreme adjustments in the local channel network, they should be considered with high priority for arresting channel adjustments (e.g., bank erosion) which

result in increased sedimentation to Shelburne Bay and the greater lake.

- Disequilibrium Remediation:

  1. M01, M02, & M03/4 – As discussed in the stream type departure section of this document, these reaches of Bartlett Brook are experiencing extreme incision, widening, and bedform departure. Active restoration of stream channel geometry is likely not be feasible until the mitigation of the hydrologic regime of the entire watershed is addressed. This strategy, adopted by ANR, is consistent with research from other parts of the U.S. (Booth et al, 2002; Booth, 2005). Although restoration of channel geometry may not be desirable in each of these reaches, the instability in reaches M01 and M02 where significant widening is occurring could be addressed with other means. Mass failures along the banks of these reaches contribute significant amounts of sediment to the channel and downstream receiving waters. Stabilization of these failures, either through re-vegetation or other non-mechanical means, could also slow the widening process in these sections and could reduce fine sediment conveyance to Shelburne Bay and Lake Champlain.

References:

Booth, D. B. (2005). Challenges and prospects for restoring urban streams: A perspective from the Pacific Northwest of North America. *Journal of the North American Benthological Society, 24*(3), 724-737.

Booth, D. B., Hartley, D., & Jackson, R. (2002). Forest cover, impervious-surface area, and the mitigation of stormwater impacts. *Journal of the American Water Resources Association, 38*(3), 835-845.

Appendix 1

Phase II Notes and Updates to Phase I Data:
General updates are reviewed below for each DMS Phase II step to which noteworthy revisions were made, after the initial QA from DEC staff. Common parameter themes across reaches are summarized with **reach names in bold text**. References to Phase I data are summarized and discussed in red text.

- *Step 1 - Valley and Floodplain Corridor:*
  - Adjacent Terrace or Hillside (1.4)
    - Phase II side-slopes have been reviewed but have **NOT** been updated in the Phase I database. Therefore, database user should refer to Phase II for correct valley side-slope data.
  - Valley Features (1.5)
    - Where better estimated or measured values were taken for valley width in Phase II surveys, Phase I data has been updated. Otherwise, Phase I valley width has been used and entered in Phase II database.
    - All human caused changes in valley width reflect significantly altered valleys due to berming, adjacent roadways, etc. Structures that are in the floodplain that might significantly alter the floodplain hydraulics are also considered as human caused changes. Reaches with human-caused changes to valley width include: **M01 & M03**
  - Grade Controls (1.6)
    - Phase II grade controls have been reviewed but have **NOT** been updated in the Phase I database. Therefore, database user should refer to Phase II for correct grade control data.
    - Despite the abundance of beaver dams in many reaches and their ability to control stream grade on a short-term basis, these features have been removed as grade controls in the database.
- *Step 2 - Stream Channel:*
  - Stream Channel (2.1 – 2.9)
    - Efforts were made to get a minimum of 2 cross-sections per reach, especially for the longer reaches. Sometimes representative cross-sections selected for DMS data entry disagrees with stream type or adjustment type, or suggests a higher/lower degradation adjustment than that observed. No reaches have been noted for Bartlett Brook with major geometry-adjustment discrepancies, but all cross-sections should be referenced for details of channel geometry.
  - Riffle Data (2.10 – 2.11)
    - Riffle data has not been collected for "dune-ripple" bedforms. All observed riffle/pool spacings have been included for "riffle-pool" and "step-pool" bedforms.
  - Substrate Data (2.12 – 2.13)
    - Percent Detritus has been estimated and tends to be higher on lower gradient reaches (E-types). Note that this data is more qualitative than quantitative.
    - For "Dune-Ripple" bedforms, average largest particles on both the bed and bar are sand, which often appear as "0" values in the DMS.
  - Stream Type (2.14)
    - In heterogeneous reaches, dominant bedform has been selected even though reach may contain multiple bedforms throughout (e.g., B3 step-pool may also have significant portions of plane bedform). Those reaches with altered bedform from reference conditions are listed below:
      1. Plane bed reaches that were likely step-pool include: **M02**
    - Determination of stream type may be based on data from more than one cross-section measurement. Please refer to all cross section data to confirm chosen stream type.
    - Reference condition stream types have been updated in the Phase I database where a type different from Phase I estimate was observed in the field.
- *Step 3 - Riparian Banks, Buffers, and Corridors:*
  - Stream Banks (3.1)
    - Bank textures observations during Phase II assessments focused more on material type more than cohesiveness. Therefore, "cohesive" versus "non-cohesive" values have been updated

during the QA process and are now considered accurate.

Observed bank erosion values in many cases represent best possible estimations of length for each bank. For reaches with higher percentages in particular, estimated values are likely more qualitative than quantitative.

Phase II bank erosion data have **NOT** been updated in the Phase I database. Therefore, database user should refer to Phase II for correct data.

- Stream Buffer (3.2)
  - Phase II buffer width and vegetation data have been reviewed but have **NOT** been updated in the Phase I database. Therefore, database user should refer to Phase II for correct data.
- Stream Corridor (3.3)
  - Phase II corridor land use data have been reviewed but have **NOT** been updated in the Phase I database. Therefore, database user should refer to Phase II for correct data.

• *Step 4 – Flow and Flow Modifiers:*

- Springs, Seeps, & Tributaries (4.1)
  - In addition to seeps and springs, tributaries of any size were considered to provide water storage capacity at the reach scale during the Phase II assessments. GIS mapping using orthophotography and VHD layers were also used to determine the abundance of tributaries for each reach.
- Adjacent Wetlands/GW Inputs; Impoundments/Flow Regs; Constrictions (4.2, 4.5, 4.7, 4.8)
  - Phase II inputs for above-described data have been reviewed but have **NOT** been updated in the Phase I database. Therefore, database user should refer to Phase II for correct data.
- Flow Regulating Impoundments (4.5 & 4.7)
  - In the Bartlett Brook watershed there is one in-stream impoundment that affects the hydrologic and sediment regimes for some distance downstream. For each of these structures, the gradient of the channel network downstream of the impoundment has been analyzed to determine how far down the structure is likely to be impacting the watershed. Reaches affected by this impoundment include: **M04, M05-A & M05-B**
- Stormwater Inputs (4.6)
  - Stormwater inputs include those outfalls discharging directly to the channel, as well as those ditches and other features conveying concentrated runoff directly to channel. Man-made drainage mapping was used in field during Phase II assessments to locate potential stormwater inputs not found directly on the channel.
  - User of data should also consult with Pioneer's mapping and documentation of stormwater inputs directly to the channel for confirmation of this dataset.

• *Step 5 – Channel Bed and Planform Changes:*

- Bar Types (5.1)
  - Phase II bar type and abundance data have been reviewed but have **NOT** been updated in the Phase I database. Therefore, database user should refer to Phase II for correct data.
- Planform Changes (5.2 – 5.3)
  - Alterations to the hydrologic and sediment regimes the in Bartlett Bk. watershed are caused primarily by urban runoff Noteworthy planform changes relative to each impact are listed below:
    1. Reaches where significant alterations to planform resulting from **urban runoff** include the following reaches: **M01, M02, M03/4**
- Channel Alterations (5.5)
  - Phase II channel alteration data have been reviewed but have **NOT** been updated in the Phase I database. Therefore, database user should refer to Phase II for correct data. Channel alterations are described in further detail in the commentary section at the end of step 5.

• *Step 6 – RHA:*

- Bank Stability (6.8)
  - Bank stability measurements reflect estimated bank erosion values entered in step 3.1. In some cases RHA scores for bank stability may appear slightly higher or lower than the expected ranges/values entered in step 3.1. Best judgment was used in these cases when evaluating

bank stability from a habitat perspective.

- Overall Rating (6.11)

  Confidence in integrity of overall RHA scores is high for Bartlett Brook.

• *Step 7 – RGA:*

- Channel Degradation (7.1)

  Degradation and widening are the predominant adjustment processes occurring in most reaches in Bartlett Brook. This can be explained by the alterations to the hydrologic regime that result in higher stream power. Incision values and entrenchment ratios were reviewed for ALL reach cross-section measurements in order to determine scores in 7.1 (row 2) and 7.3 (row 3). Certain reaches may appear to have RGA scores for these rows which do not agree with reported DMS cross section geometry, in which case database user should refer to additional cross-sections.

- Channel Widening (7.3)

  As the channel evolution stage that follows incision, channel widening is also an adjustment process occurring in some of the impacted high-gradient (B & C type channels) reaches in Bartlett Brook. In the future, channel widths will be compared with hydraulic geometry curves developed for Chittenden County in order to make adjustments to scores in 7.3 (row 1). For this parameter, width to depth ratio is not always adequate at capturing the degree of widening. Also, certain reaches may appear to have RGA scores for these rows which do not agree with reported DMS cross section geometry, in which case the database user should refer to additional cross sections.

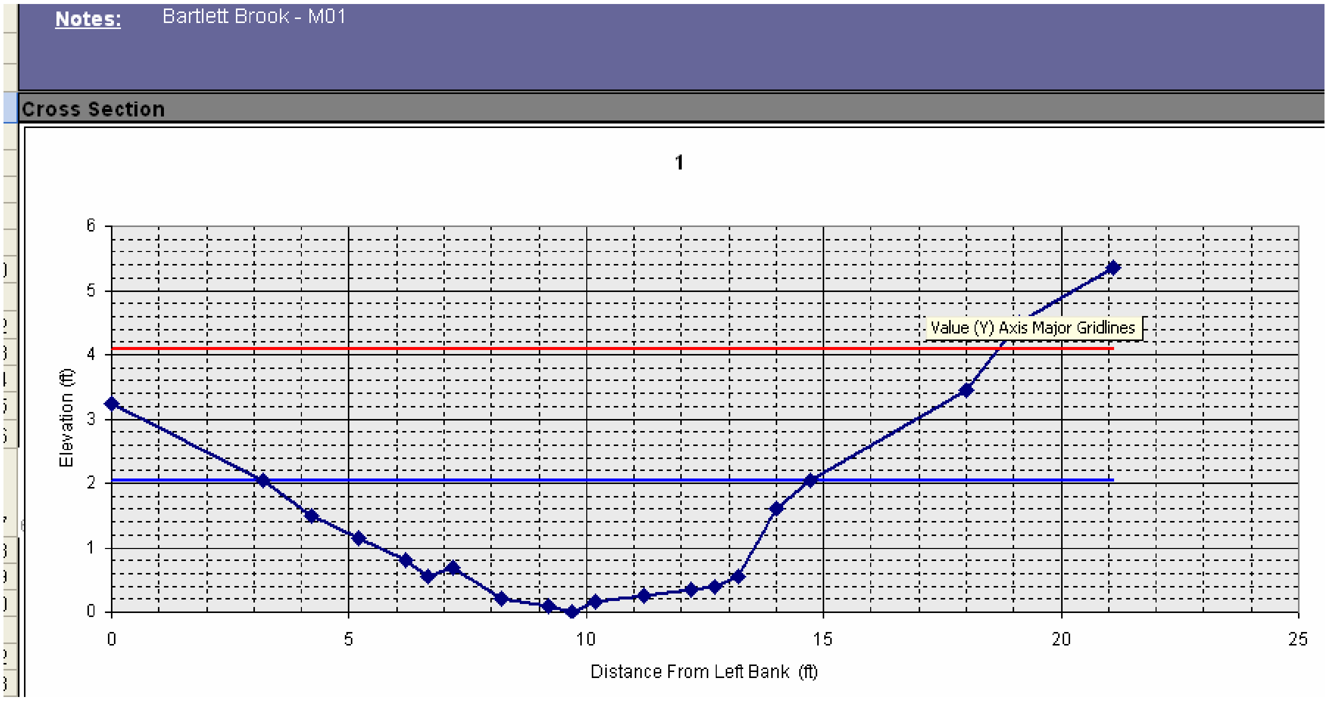
- Overall Rating (7.6)

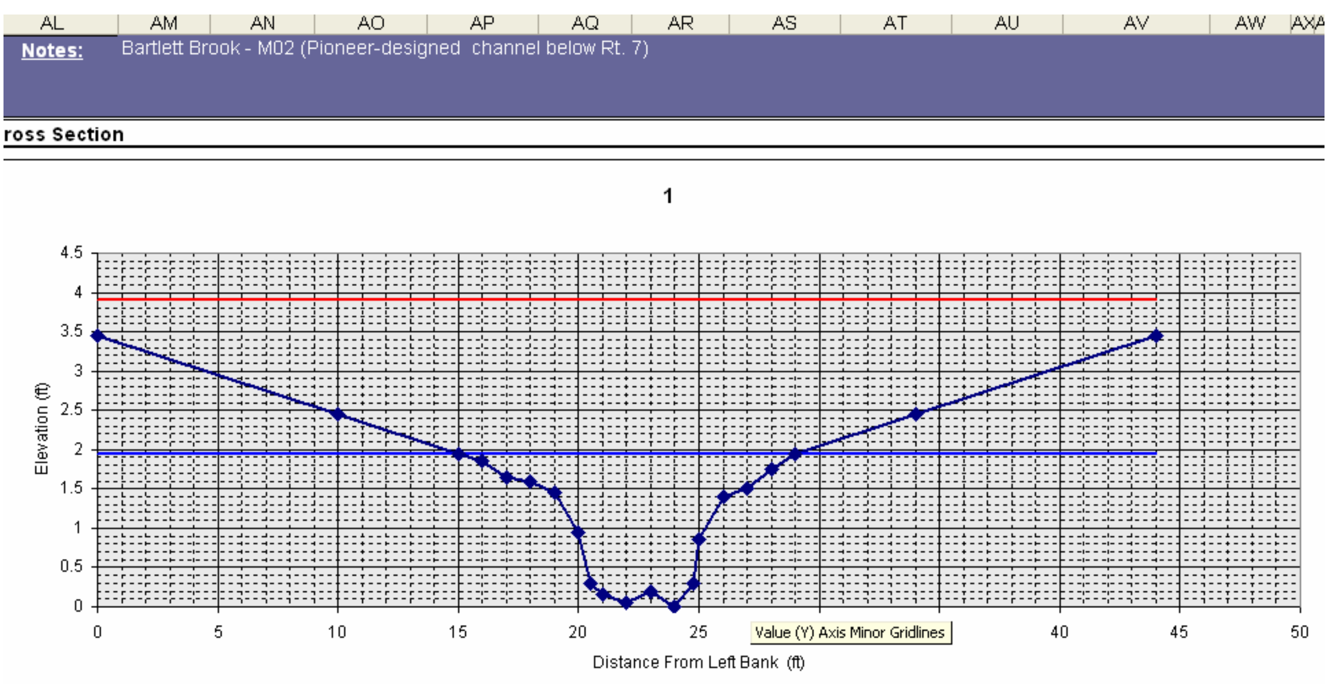
  Confidence in integrity of overall RGA scores is high for Bartlett Brook.

  Stream Type Departure (STD) information is found in a separate section in the text of this document.

Appendix 2

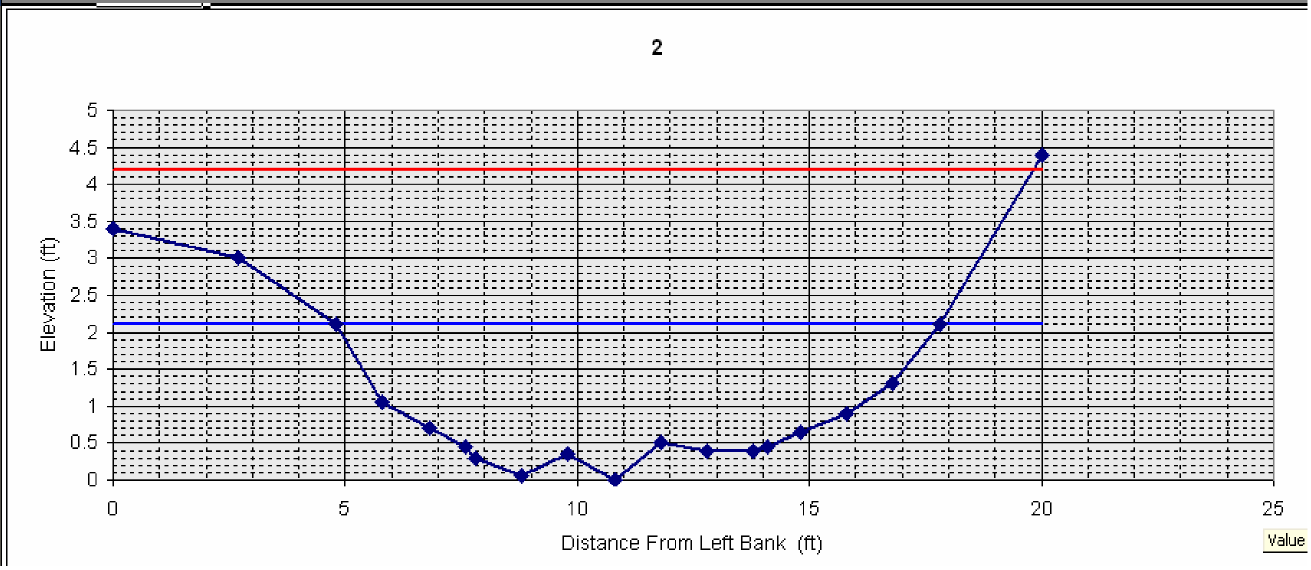
Cross-sectional plots for Bartlett Brook reaches are found below. The horizontal **blue line** represents the bankfull width and depth, and the **red line** represents the field-estimated floodprone depth and width (if plotted).





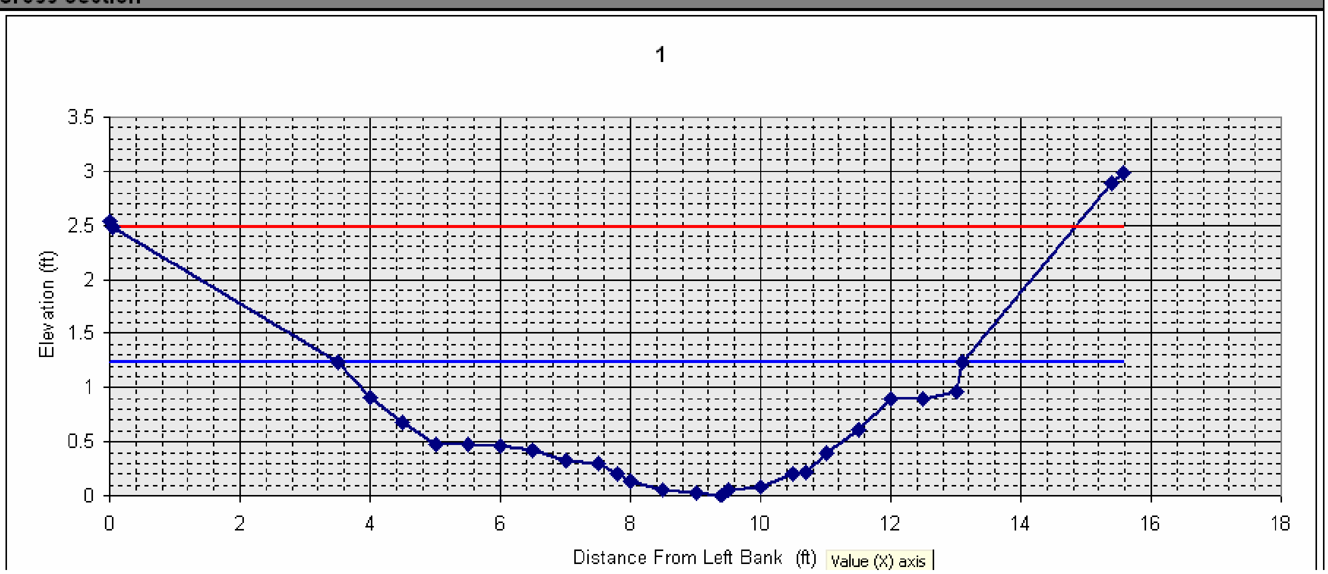
Notes: Bartlett Brook - M02 (cross section above Rt. 7 in upper reach)

Cross Section



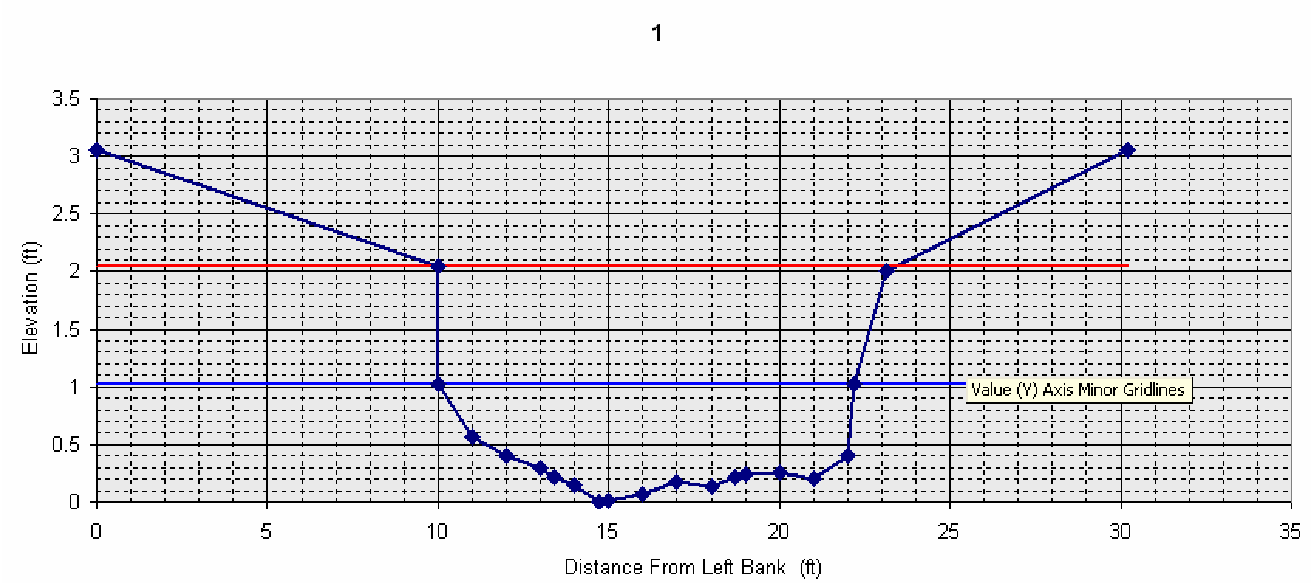
Notes: Bartlett Brook - M03 and M04

Cross Section



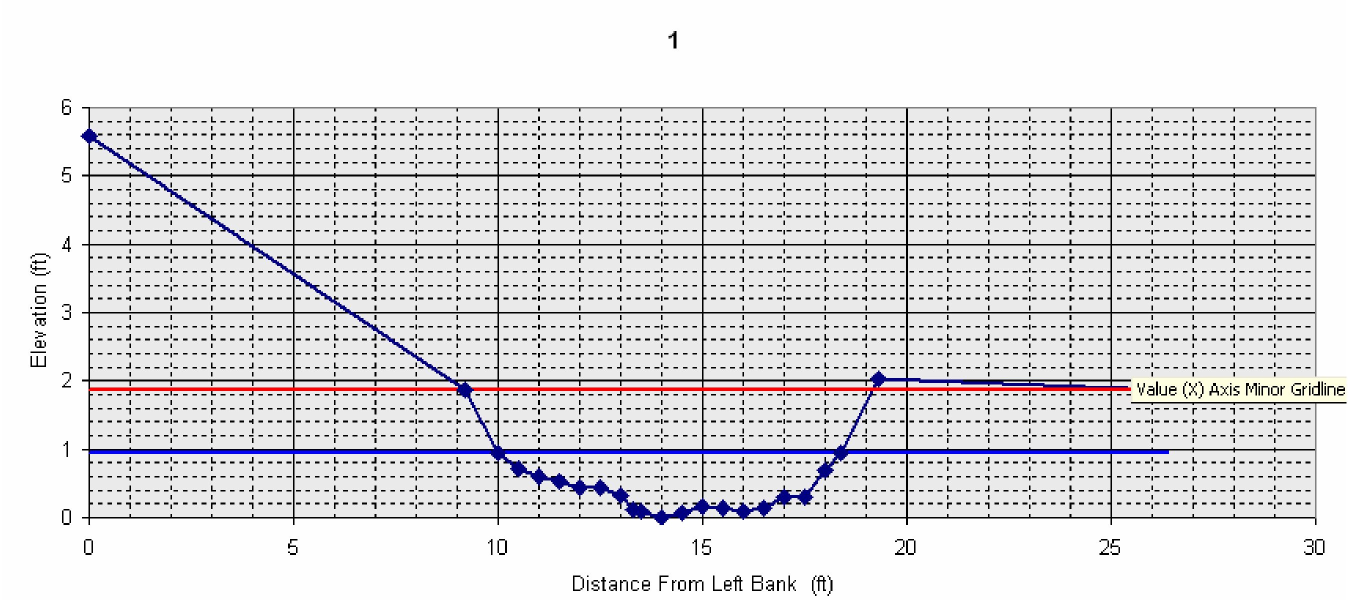
Notes: Bartlett Brook - M05 - Segment A

ross Section



Notes: Bartlett Brook - M05 - Segment B

ross Section

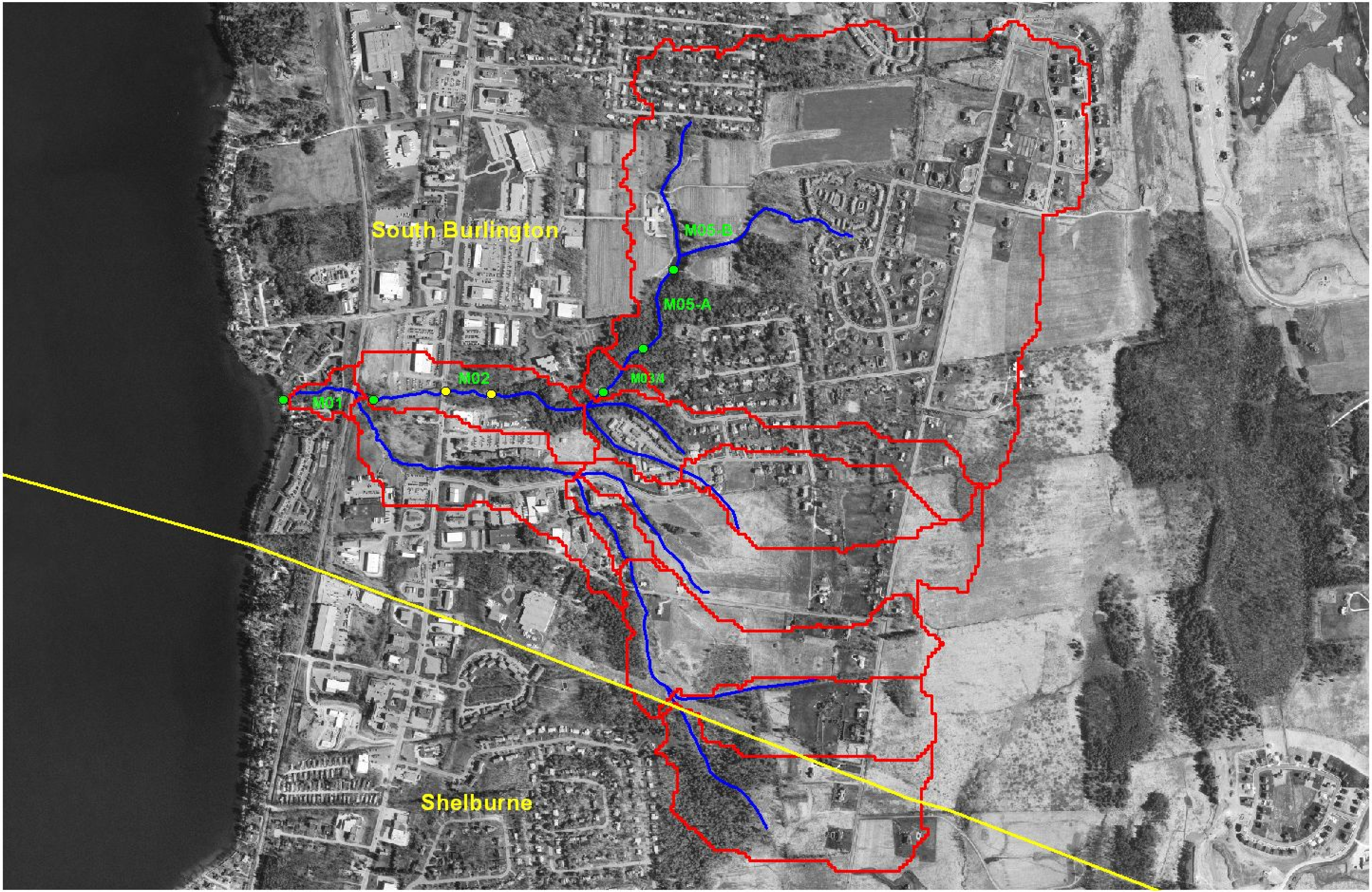


Bartlett Brook Reach Summary Table
Evan P. Fitzgerald
07/12/06

Reach	Segment	Stream Type	Dominant Bed Material	Bedform	STD*	Reference Stream Type†	Reference Bed Material†	Reference Bedform†	RHA Score	RHA Condition	RGA Score	RGA Condition	Reach Sensitivity
M01		B	Gravel	Step-Pool					0.53	Fair	0.48	Fair	High
M02		B	Gravel	Plane Bed	Yes	B	Cobble	Step-Pool	0.51	Fair	0.44	Fair	High
M03/04		G	Sand	Riffle-Pool	Yes	B	Gravel	Riffle-Pool	0.46	Fair	0.45	Fair	Very High
M05	A	C	Sand	Riffle-Pool					0.44	Fair	0.53	Fair	Very High
M05	B	C	Sand	Plane Bed					0.44	Fair	0.53	Fair	Very High

	RHA Score	RGA Score
Mean:	0.47	0.48
Max:	0.53	0.53
Min:	0.44	0.44

* STD = Stream Type Departure
† = Assessed Reference Condition Prior to Stream Type Departure
NE = Not Evaluated



Bartlett Brook SGA Watershed Map

1250 0 1250 2500 3750 Feet

Town Boundaries
Bartlett Bk Phase II Reach Revisions
Reach M02 Segmentation
Bartlett Bk Phase I Subwatersheds
Bartlett Bk Surface Waters