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Munroe Brook Phase II Documentation and QA/QC Notes
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Introduction:

The following is a documentation of the key geomorphic processes and adjustments occurring in the Munroe Brook watershed at the reach scale. The intent of this documentation is to: 1) Concisely summarize Munroe Brook watershed zones and geomorphic processes; 2) 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 in the data. Within 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. Plots for each channel cross-section measured during the Phase II analysis are provided in Appendix 2. Reach summary statistics and mapping are found respectively in Appendices 3 and 4.

Munroe Brook Summary:

Munroe Brook is drained by a medium-sized, mixed land use watershed with a drainage area of 5.4 square miles. The Phase I and II analyses of the watershed focused on both the main stem, which drains the southern portion of the watershed, and the northern tributary, which drains the northern portion of the watershed. The main stem has an overall channel slope of 1.1%, however the channel slope varies widely across reaches. Three small tributaries originating to the north of Irish Hill Road form the headwaters of the main stem, and drain very flat terrain with heavy clay soils. The channel continues to the north across Bishop Road before taking a sharp turn to the west and meandering through the Kwiniaska Golf Course. To the west of the golf course, the main stem crosses Spear Street and tumbles down a high-gradient stretch before again reaching flat terrain in the vicinity of Webster Road. From Webster Road to the crossing at Route 7, Munroe brook meanders through a mix of residential and agricultural land uses. Below Route 7, the channel again becomes high gradient and flows west through a narrow valley before the outlet to the lake at Shelburne Bay.

The northern tributary heads in the northern arm of the watershed to the east of Spear Street. The low gradient channel meanders through abandoned agricultural fields with poorly-drained clay soils. Flowing south though a mixture of old agricultural land mixed with residences, the channel crosses Spear Street and flows west before becoming high-gradient and losing significant elevation through reach T1.02. Below the crossing at Pinehurst road the tributary turns south and maintains a lower gradient, riffle-pool channel form before entering an area with significant beaver activity just east of Route 7. Just upstream of Route 7 is the tributary's confluence with the main stem. This tributary has an overall channel slope of 1.4%, with great variation in channel slope and form along its length.

Below is a summary of reaches assessed during the Phase II field surveys in summer 2005. The main stem and northern tributary reaches are summarized separately, and some reaches with similar geologic settings and adjustment processes are grouped for concise discussion. Stream type departure and project identification information is found within each summary.

Reach M01

Description:
This reach is found from the Route 7 crossing down to the outlet at Shelburne Bay, and is a high-gradient channel with numerous impacts from surrounding urbanization. This reach has a length of 2500 feet, with a channel slope of approximately 2.0%. Observations of natural valley and slope characteristics suggest that reference conditions for this reach are riffle-pool bedform with a B-type channel. Due to apparent hydrologic impacts from upslope urban land use and stormwater outfalls, and the resulting changes in channel form, a stream type departure has been noted for bedform (see appendix 3). Six stormwater outfalls were noted along the reach, as well as one significant flood chute with a large mass failure within it (see figure 1). The grade control associated with the railroad crossing midway through the reach (see figure 2) is controlling some of the incision noted in the lower section of the reach near the mouth.


Figure 1. Mass failure on flood chute in reach M01


Figure 2. Railroad crossing grade control mid-reach

Project Identification:
The natural form of the channel in the vicinity of the Route 7 crossing has been completely altered by the two box culverts and road construction carried out in summer 2005. While there are no opportunities for channel and floodplain remediation near Route 7 and Bay Road, there are significant planform changes and bank erosion immediately below the crossing that deserve consideration for restoration. Approximately 150 feet below the Bay Road crossing, there is a large flood chute on the left side of the channel. This flood chute cuts off the large bend to then north, and is accessed during flows at or near bankfull. When accessed, a large, exposed mass failure found half-way down the chute contributes large amounts of sediment to the reach where the flood chute rejoins main stem channel flowing south at the end the large bend. Stabilization of this failure and other sections of the flood chute, which could likely be done without significant machinery (ie, VYCC and revegetation), would control sediment inputs to the downstream channel and Shelburne Bay. In addition, further monitoring of the main channel below Bay Road (downstream of the flood chute inlet) should continue in the future, as areas of significant bank failure and incision (see figure 3) threaten connectivity to the floodplain.

Figure 3. Channel narrowing and bank failure below Bay Road crossing in M01

Reaches M02 through M04-A

Description:

These low gradient reaches have been grouped together in this summary because of the similarity in their reference channel form and valley setting. Each of these reaches have channel slopes less than 0.5%, and under reference conditions E-type geometry with dune-ripple bedform would be found. However, due to historic impacts to the channel boundary conditions and current impacts from stormwater runoff, 3 of the 4 reaches do not maintain their reference bedform conditions, and are currently dominated by planebed features. Reach M02 has been divided into two segments due to the changes in buffer conditions at the segment break (see maps in appendix 4). Segment M02-A is a planebed, sand-bottomed reach that has been given an RGA score of poor due to the severe bank erosion and incision noted throughout. The habitat score (RHA) for this reach was assessed as fair, as the sinuosity and undercut banks continue to provide some habitat for fish which prefer low gradient channels. These adjustments appear to be resulting from historic straightening in the vicinity of culvert crossings (see figure 4), and from impacts from animal crossings in areas used as pasture. Segment M02-B is a short segment analyzed separately due to significantly altered channel geometry and stormwater inputs from upslope residential areas. A stream type departure has been noted due to entrenched channel (entrenchment ratio = 1.6) and G-type geometry. Reach M03 has relatively unimpacted buffer conditions, and the stream type remains unchanged from reference as E. However, note that entrenchment value is very low and channel may have gone through channel evolution through a G-type. Stage IV of channel evolution has thus been chosen due to the abundance of bar features.

Figure 4. Culvert crossing midway through reach M02-A

Figure 5. Cross-section in reach M04-A

The next upslope segment, M04-A, does not have significant human-induced alterations to channel, but historic beaver activity was observed. Incision observed in this segment may be resulting from the channel cutting down through aggraded sediment from historic beaver ponding (this was observed in many of the small Chittenden Co. streams throughout assessments). Some changes in planform are occurring as channel meanders through beaver meadow.

Project Identification:
All of the low gradient reaches described above have a very high sensitivity to further watershed land use changes, as noted in the summary table in appendix 3, due to the inherent sensitivity associated with these stream types and the impacts affecting them. Both segments in reach M02 are being impacted by different stressors from adjacent land use which should be considered in future restoration efforts. In segment A, direct impacts associated with the pasture and animal fords are causing instability in the banks. Due to the inherent erodibility of the bank parent material, impacts from nearby grazing animals is causing significant sediment loading within the reach and to downstream reach M01. Segment B is currently in an extreme state of disequilibrium due to historic straightening and current impacts from urban runoff from adjacent neighborhoods on Deer Run Road. Berming (see figure 6), straightening, and altered hydrology has left little floodplain connectivity in this segment, and sediment transported from above reaches and within-reach stormwater outfalls is moved through and deposited in downstream reaches. Efforts to control stormwater runoff from the Deer Run Road and Longmeadow Road neighborhoods, in combination with the restoration of equilibrium channel geometry, would greatly reduce sediment transport through this segment.

Figure 6. Berming and entrenchment in M02-B

Reaches M04-B and M05

Description:
Where the main stem of Munroe Brook bends to the east at the segment break of M04-A and M04-B, a drastic change in channel slope occurs. Segment M04-B and M05 are both high gradient reaches which tumble down gravel and cobble substrate within a narrowing valley. Segment M04-B has been assessed as a C-type channel with riffle-pool bedform within a broad valley which becomes more narrow in the upper portion of the segment. Although some incision and bank erosion was observed in this segment, overall reach scores reflect good habitat conditions with fair stability (see appendix 3). Reach M05 is a cobble-bottomed B-type channel with a slope of 3.5%. Some incision was noted in the lower section of the reach, but overall stability and habitat conditions were assessed as fair. The intact forested buffer

along M05 and minimal upslope urbanization are likely helping to keep this reach geomorphically stable. No preliminary project identification has been made for either of these two reaches.

Reaches M06 & M07

Description:
Upstream of the Spear Street crossing (where break in valley slope occurs), the channel slope lessens as reach M06 meanders through Kwiniaska Golf Course. This reach has been segmented due observed differences in channel geometry. Through the golf course, segment A maintains a lower width to depth ratio indicative of an E-type channel. The observed valley width was less than expected for this topographical setting (e.g., slope), and human caused changes in valley width due to historic encroachment from the golf course is likely the cause. Gravel substrate was noted throughout the segment and some scour was observed below each of the four bridge (golf cart paths) crossings through the course. The break for segment B is found approximately 350 feet below Beaver Creek Road, where the channel slope steepens considerably and C-type channel geometry was observed. Two large beaver ponds were noted in the upper section of the reach above Beaver Creek Road. Geomorphic stability within M06 has been assessed as good, with fair to good habitat conditions (see appendix 3).

Reach M07 has been segmented due to impacts from beaver activity in the lower section of the reach below Bishop Road, and changes in buffer vegetation. Due to the small channel size of these headwaters segments, neither RGA nor RHA scores have been calculated. Data for Phase II steps 1, 3, and 4 have been collected are entered in the database. These data include: valley characteristics, bank and buffer vegetation and condition, beaver impacts, and channel constrictions. Beaver ponding was noted above and below Bishop Road, and historic straightening through the farm fields south of the road crossing was obvious. The Phase II field assessment data does not include any observations for channel characteristics or land use impacts to the south of the second confluence on segment B, and therefore does not include impact summaries for the quarry located to the southeast.

Project Identification:
Although the floodplain encroachment and stream crossings associated with the golf course in segment M06-A are not having severe impacts on geomorphic stability, any further floodplain loss could reduce the potential for fine sediment deposition in this segment. Similarly, continued incision below each of the 4 stream crossings could further exacerbate floodplain loss, and therefore should be monitored in the future. In addition, reestablishment of a more extensive stream buffer in areas where the golf course fairways are found within the corridor would reduce sediment and nutrient loading to the channel.

Reach T1.01

Description:
The northern tributary of Munroe Brook confluences with the main stem just east of the Route 7 crossing. The first reach of this tributary, T1.01, is found from the confluence up to Hullcrest Park just south of Pinehurst Road. This reach has been broken into 2 segments because of differences in channel slope and geometry. Segment A, found in the beaver meadow in between Route 7 and Executive Drive, is a low gradient, E-type channel with a sand substrate. One large beaver dam was noted in the vicinity of the confluence that is affecting the reach for an approximate distance of 300 feet upstream. The buffer and corridor of this segment remains intact, however upslope discharges of stormwater runoff may threaten its stability in the future. Observations of current geomorphic stability resulted in a rating of good.

Upstream of this low gradient segment is segment B, found from Executive Drive up to the southernmost extent of Hullcrest Park. This segment is continuing through an evolution of adjustments that likely began with historic degradation, perhaps from agricultural straightening. The channel is

currently redeveloping sinuosity and aggrading with material transported from upstream high gradient reach T1.02. Reference channel conditions have been assessed as C-type with riffle-pool bedform, and a stream type departure has been noted due to the dominance of planebed features in the segment. This segment has been assessed at stage IV of channel evolution due to the aggradation and planform changes. One small beaver dam and one on-stream impoundment were noted (mid segment near the cul-de-sac on Executive Drive). The high degree of incision noted in the lower cross-section measurement (see figure 7 and maps in appendix 4) suggests that the aggradation and planform changes noted in the upper section of the segment may be ameliorated by these on-stream structures.

Figure 7. Lower cross-section on T1.01.B

Project Identification:
This segment of Munroe Brook, and reaches M01 and T1.02 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). In the T1.01.B corridor, there has recently been implementation of a stormwater control structure at Hullcrest Park. Since increases in stream power due to stormwater outfalls near the Pinehurst Road crossing are driving the current instability observed in this segment, this control structure should help reduce sediment production and transport in the segment and to downstream reaches. However, further monitoring of the ongoing adjustments and floodplain connectivity in this segment will be necessary as a basis for restoration efforts to reduce sediment loading in the watershed.

Reaches T1.02 & T1.03

Description:
These two high gradient reaches are found in steeper topography above Pinehurst Road. T1.02 is found in a semi-confined valley and under reference conditions is a B-type channel with step-pool bedform (slope greater than 3.5%). Impacts from surrounding urban land-use has led to incision and the channel is now beginning to widen, despite the hard bank armoring found extensively on both banks. Increased sediment production from the widening of this reach may be contributing to the aggradation and planform changes observed below Pinehurst Road in T1.01.B. Channel stability and habitat conditions have been rated as fair, and a departure from reference bedform has been noted (see appendix 3). No project identification discussion is included for this reach, however discussion of stormwater impacts and the hydrologic regime should be referenced in the discussion for reach T1.01.

T1.03 is a C-type, riffle-pool reach with gravel substrate found above the break in slope which marks the

upper boundary of reach T1.02. The adjustments observed in this reach suggest that the on-stream pond found mid-reach is affecting the sediment regime below. Incision was noted directly below the structure, and severe aggradation was noted further downstream. Aggradation and widening are evident in the cross-section data in the lower reach (see figure 8), however further detailed field assessments and/or segmentation of the reach is warranted; the specific location of adjustments was not well described during the Phase II assessments. The reach has been given preliminary RGA and RHA scores of fair. No preliminary project identification has been made for either of these two reaches.

Figure 8. Cross-section on T1.03

Reach T1.04

Description:

This reach begins just upstream of the Spear Street crossing and parallels Barstow Road for 500 feet before turning to the north. Much variation in channel form was observed along the length of the reach as it flowed through varying buffer conditions. In the lower and middle section of the reach where the cross-section data was collected, a C-type channel with a width of 10 feet and mixed substrate was noted. In this section, significant aggradation of fine material was noted in the pebble count, and a stream type departure from riffle-pool to plane bedform. The upper section of the reach has a narrower channel width as the stream winds through herbaceous bank and buffer vegetation. Multiple floodchutes and one headcut, located just downstream of the gravel driveway marking the upstream boundary of the reach, suggest that planform changes may be resulting from the low-density residential development in this upper section of the watershed. Due to the increased sedimentation and the planform changes observed in this reach, a sensitivity rating of "very high" has been assigned, indicating that future land use changes in the upslope watershed could lead to significant adjustments and sediment loading to downstream reaches. No preliminary project identification has been made for either of these two reaches.

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 to the Munroe Brook dataset, after the initial QA/QC 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.
  - 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 some 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 1 to 2 cross-sections per reach; 2 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.
      1. Reaches with more than one cross-section that have average incision ratios **lower** than the one reported incision ratio include: **M06-A**
      2. Reaches with more than one cross-section that have average incision ratios **higher** than the one reported incision ratio include: **M01, M02-B, M05, & T1.01.B**
  - Riffle Data (2.10 – 2.11)
    - Riffle data has not been collected for "dune-ripple" or "plane" 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 riffle-pool include: **M01, M03, T1.01.B**
      2. Plane bed reaches that were likely dune-ripple include: **M02-A, M02-B, T1.04**
    - 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.

o 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.

o 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:*

o 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.

o 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.

o Flow Regulating Impoundments (4.5 & 4.7)

- In the Munroe Brook watershed there are two in-stream impoundments that affect the hydrologic and sediment regimes for some distance downstream. For 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 these two impoundments include: **T1.01, T1.02, & T1.03**

o 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:*

o 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.

o Planform Changes (5.2 – 5.3)

- Alterations to the hydrologic and sediment regimes in the Munroe Bk. watershed are caused primarily by: 1) urban runoff, and 2) beaver modifications to channel and floodplain. It is often difficult to tease apart the relative impacts of each of these factors during Phase II assessments when both are present in a reach or segment. Noteworthy planform changes relative to each impact are listed below:

1. Reaches where significant alterations to planform can be associated with **beaver activity** include the following reaches: **M06-B & T1.01.A**
2. Reaches where significant alterations to planform are resulting from **urban runoff** and/or **floodplain encroachment** include the following reaches: **M01, M02-A, M02-B, & M03**

o Channel Alterations (5.5)

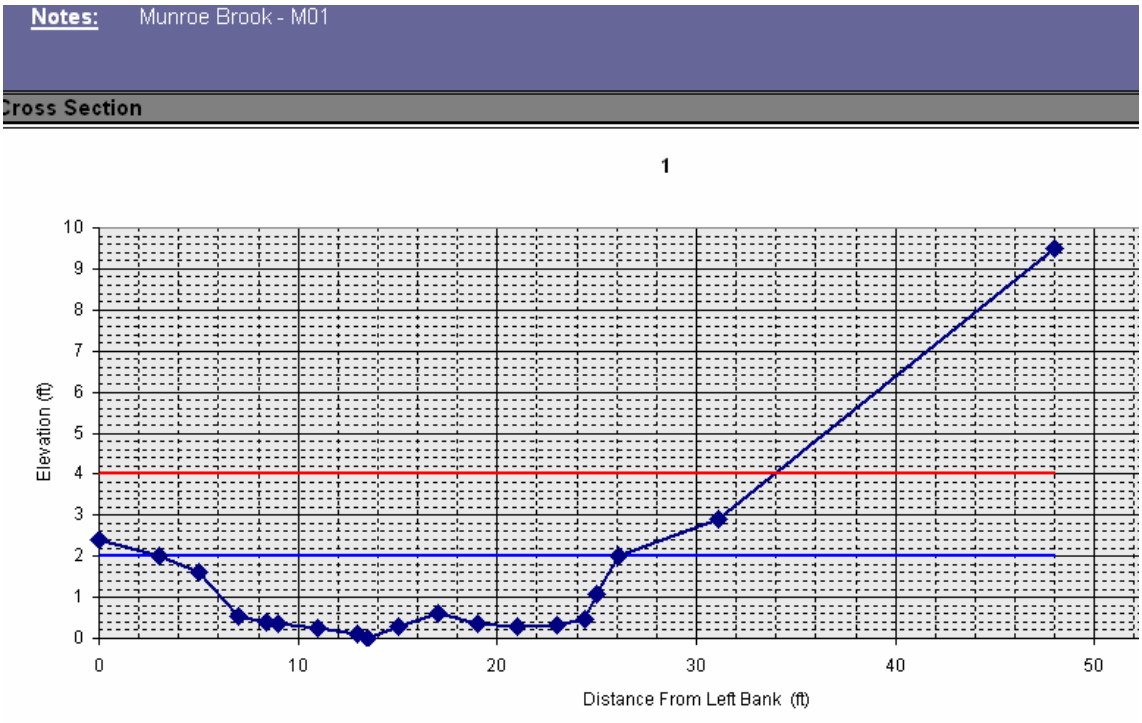
- Phase II channel alteration data have been reviewed but have **NOT** been updated in the Phase I database. Therefore, database user should refer to Phase II for correct data. Channel

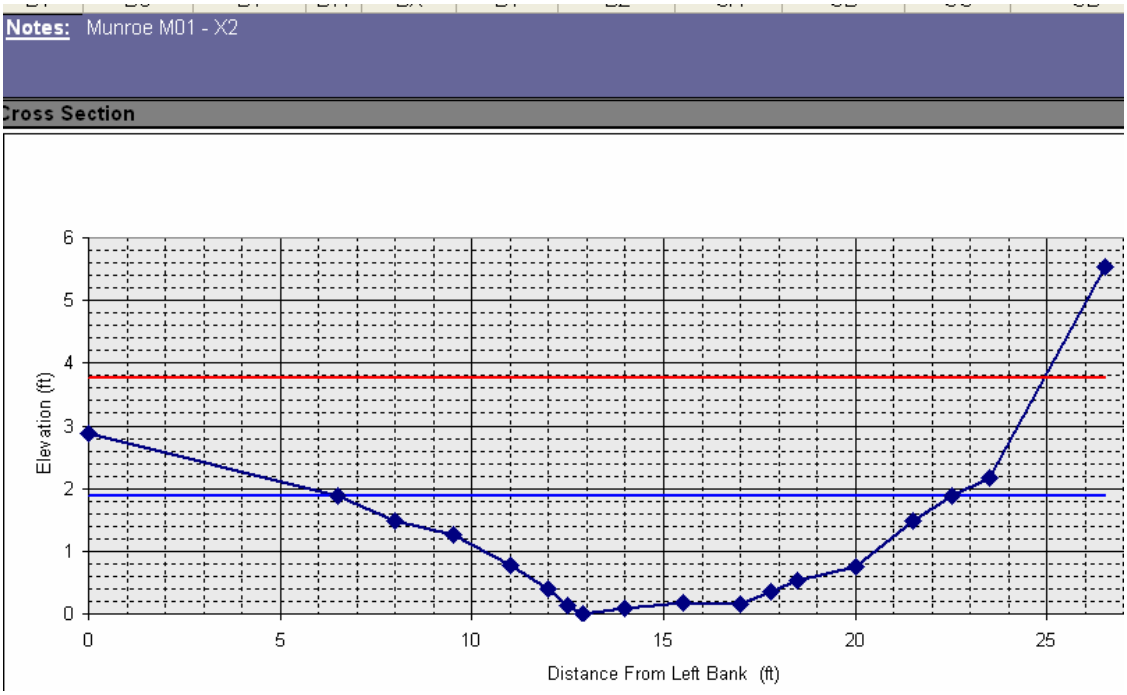
alterations are described in further detail in the commentary section at the end of step 5.

- *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 Munroe Brook.
    - Overall habitat assessment in E-type channels is difficult due to general lack of quality habitat associated with these sand-bottomed reaches. Another confounding variable which makes assessment of habitat in low-gradient E-type channels difficult is the influence of beaver activity. Reaches with lower RHA scores due to beaver influence included: **M04-A & T1.01.A**
- *Step 7 – RGA:*
  - Channel Degradation (7.1)
    - Degradation and widening are the predominant adjustment processes occurring in most reaches in Munroe 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 Munroe 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 Munroe Brook.
    - As discussed above in the RHA section, overall geomorphic stability is often difficult to assess in low-gradient, E-type channels affected by beaver activity. Historic beaver activity in many cases has led to aggradation of fine sediments behind the historic dam in many low gradient reaches. These reaches, when observed in current-day conditions in the absence of ponding, often appear to be actively incising back down through this aggraded material. Reaches where this phenomenon has been observed include: **M04-A**
    - Stream Type Departure (STD) information is found in a separate section in the text of this document.

Appendix 2

Cross-sectional plots for Munroe 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).



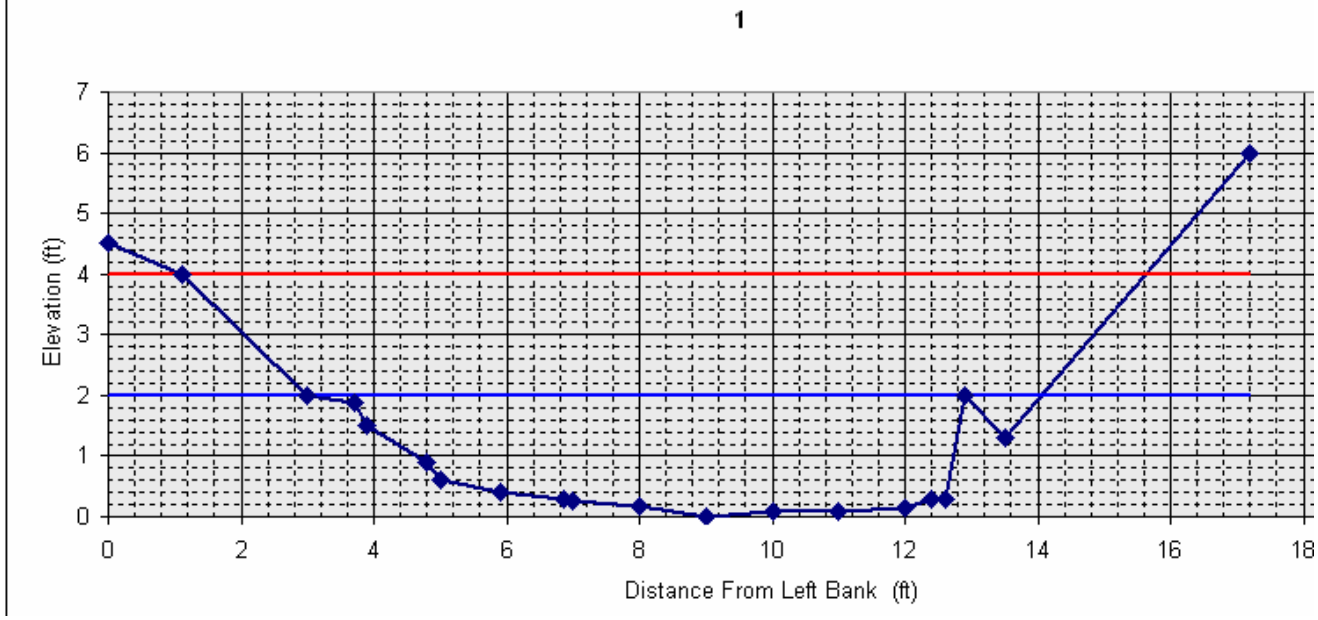


Notes: Munroe Brook - M02 - Segment A

Cross Section

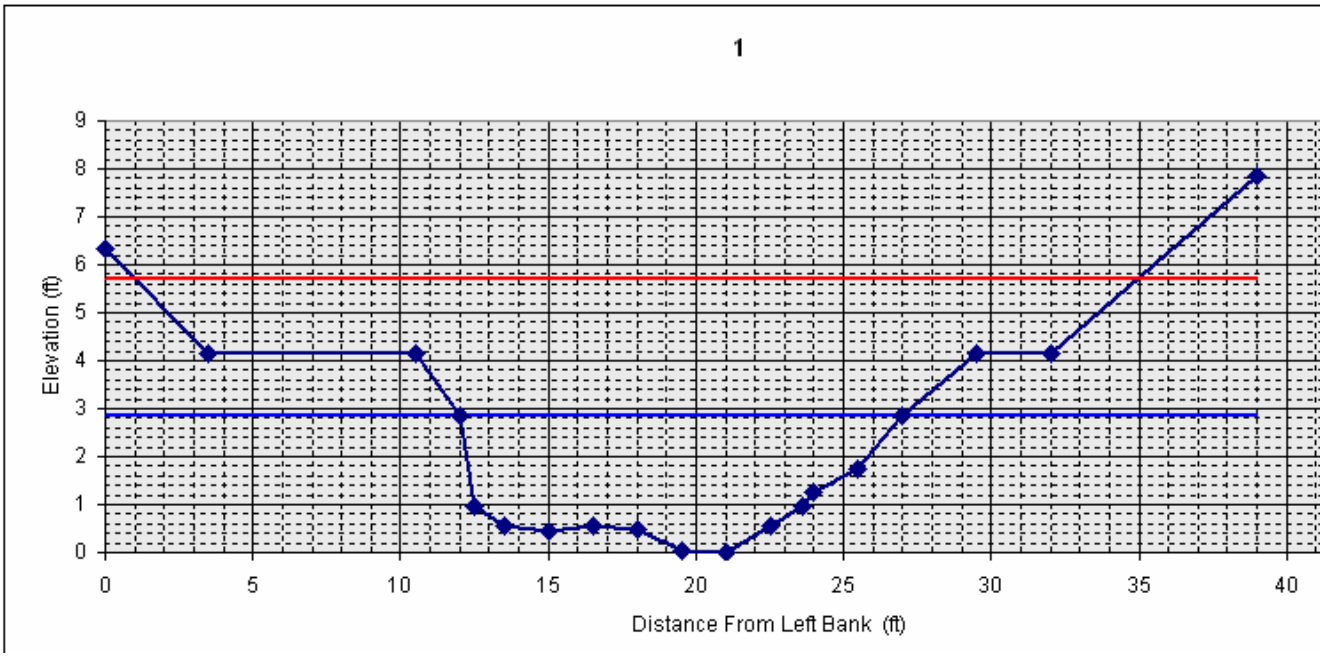
Notes: Munroe Brook - M02 - Segment B

Cross Section



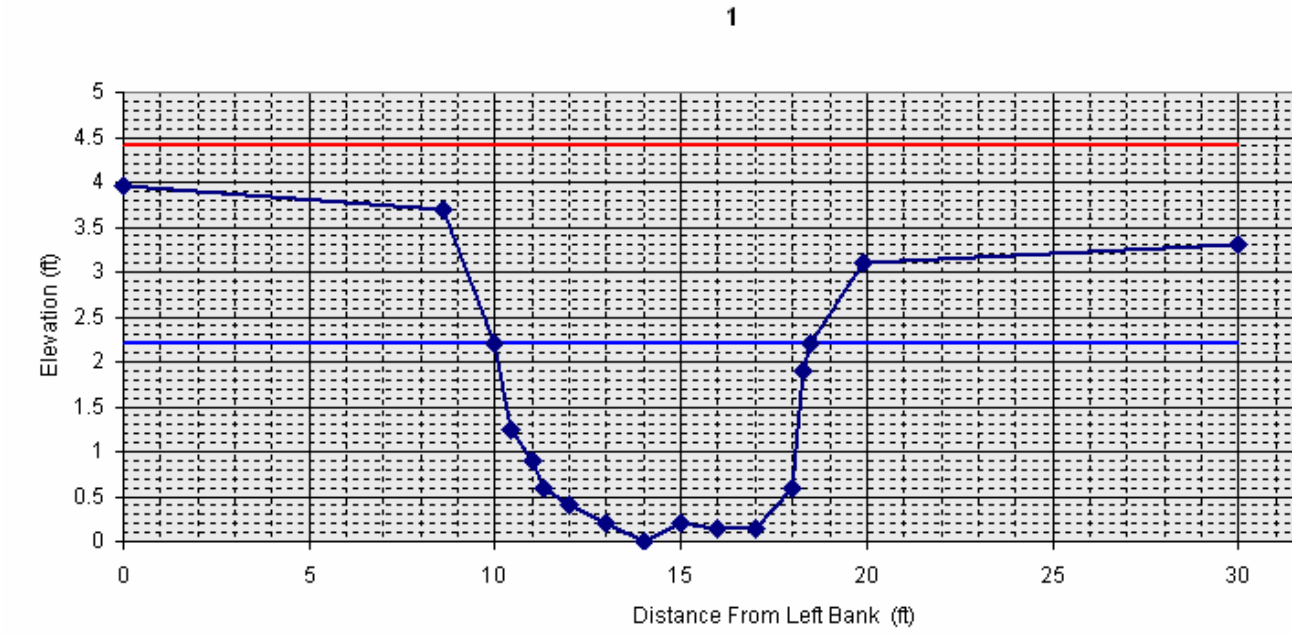
Notes: Munroe Brook - M03

Cross Section



Notes: Munroe Brook - M04 - Segment A

Cross Section



Notes: Munroe Brook - M04 - Segment B

ross Section

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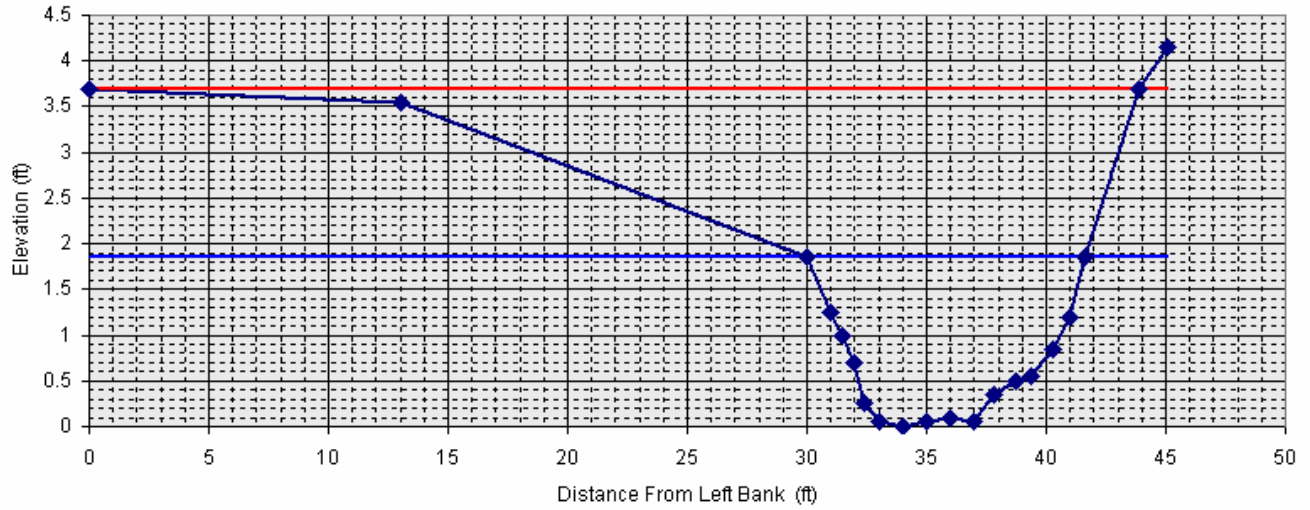

Notes: Munroe Brook - M05

ross Section

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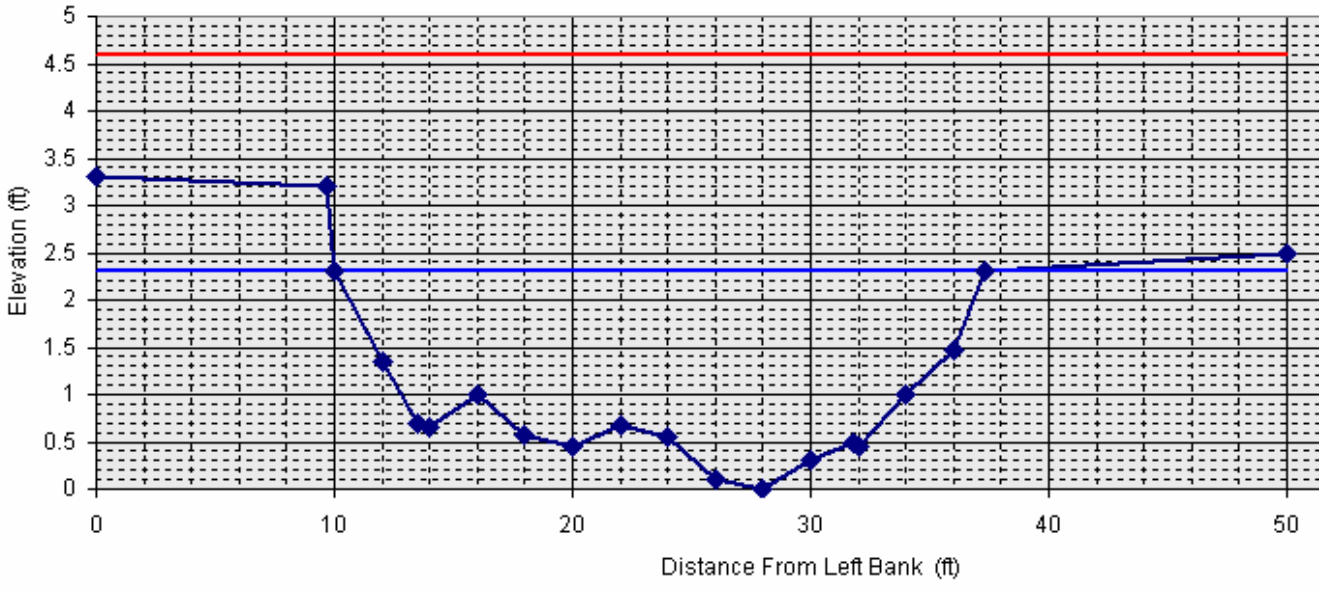
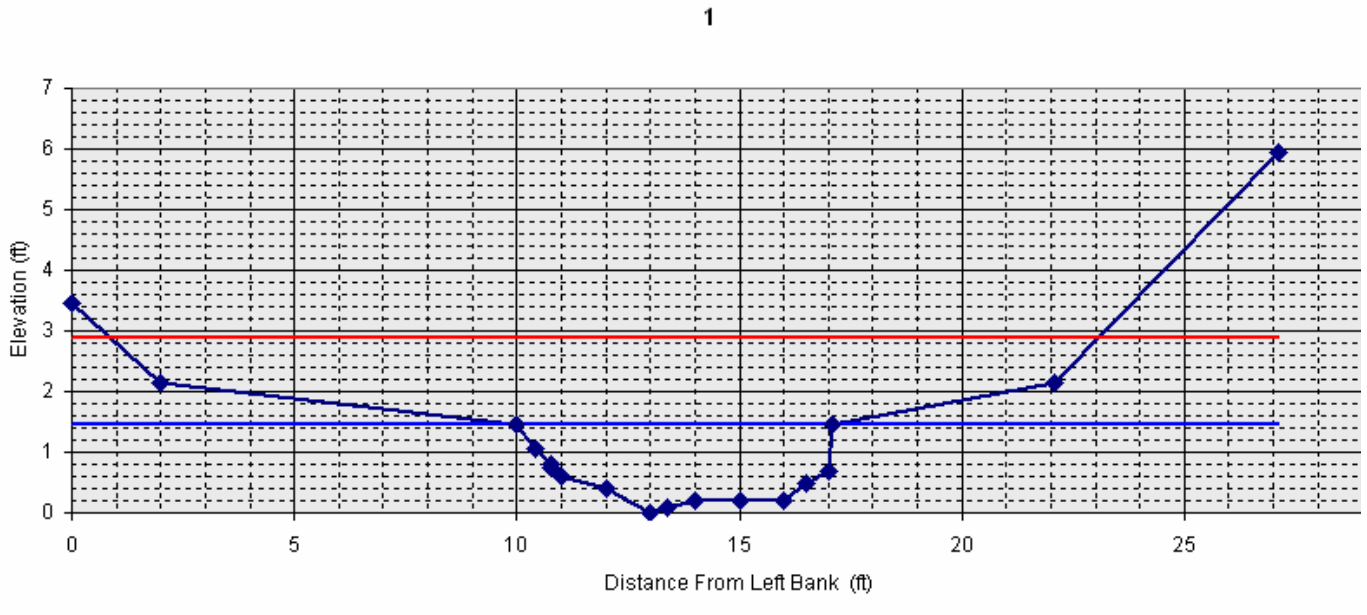


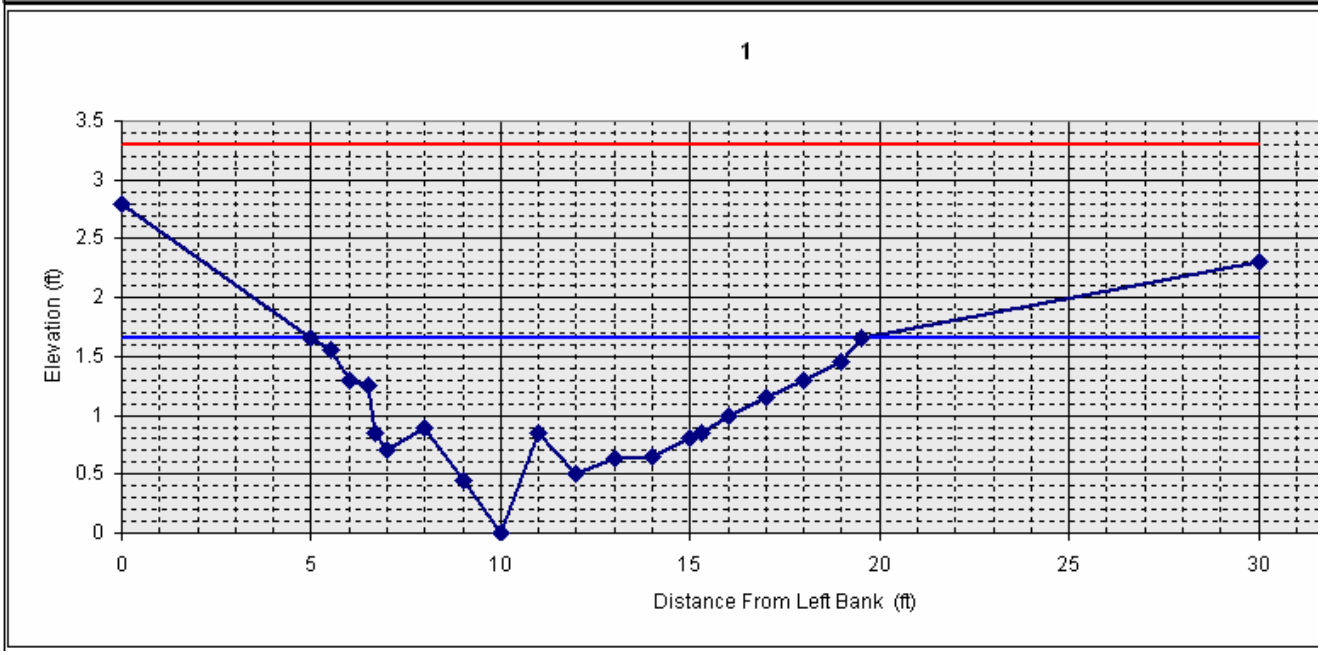
Notes: Munroe Brook - M06 - Segment A

ross Section



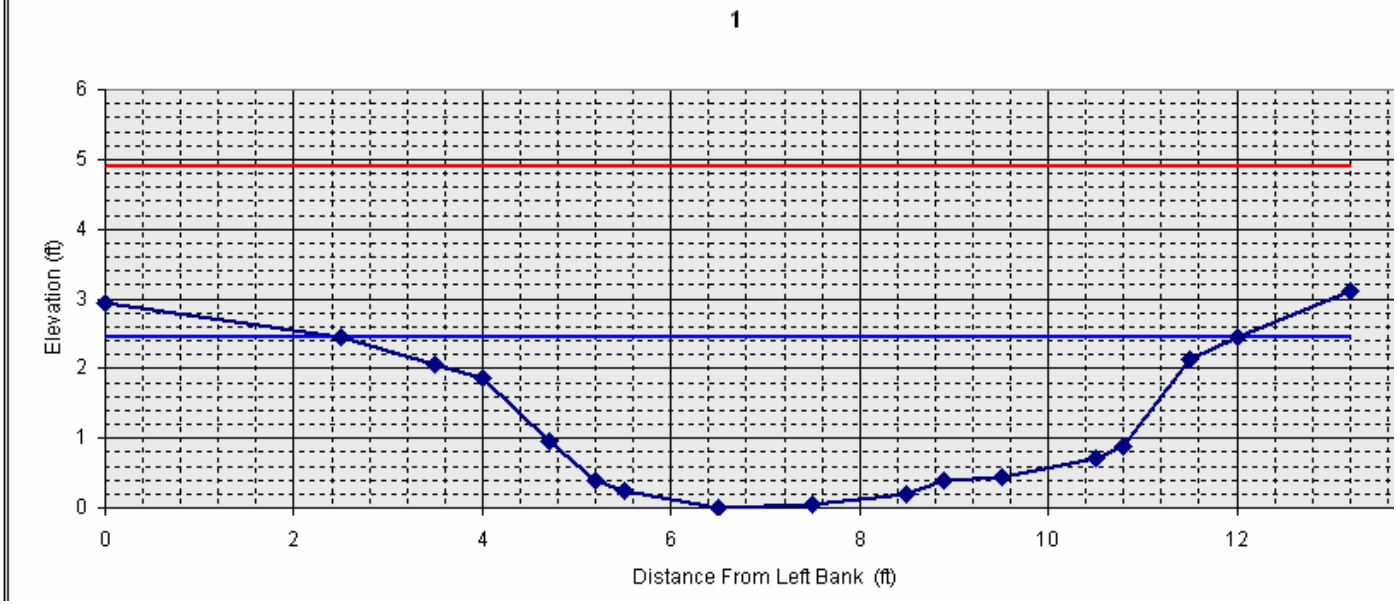
Notes: Munroe Brook - M06 - Segment B

Cross Section



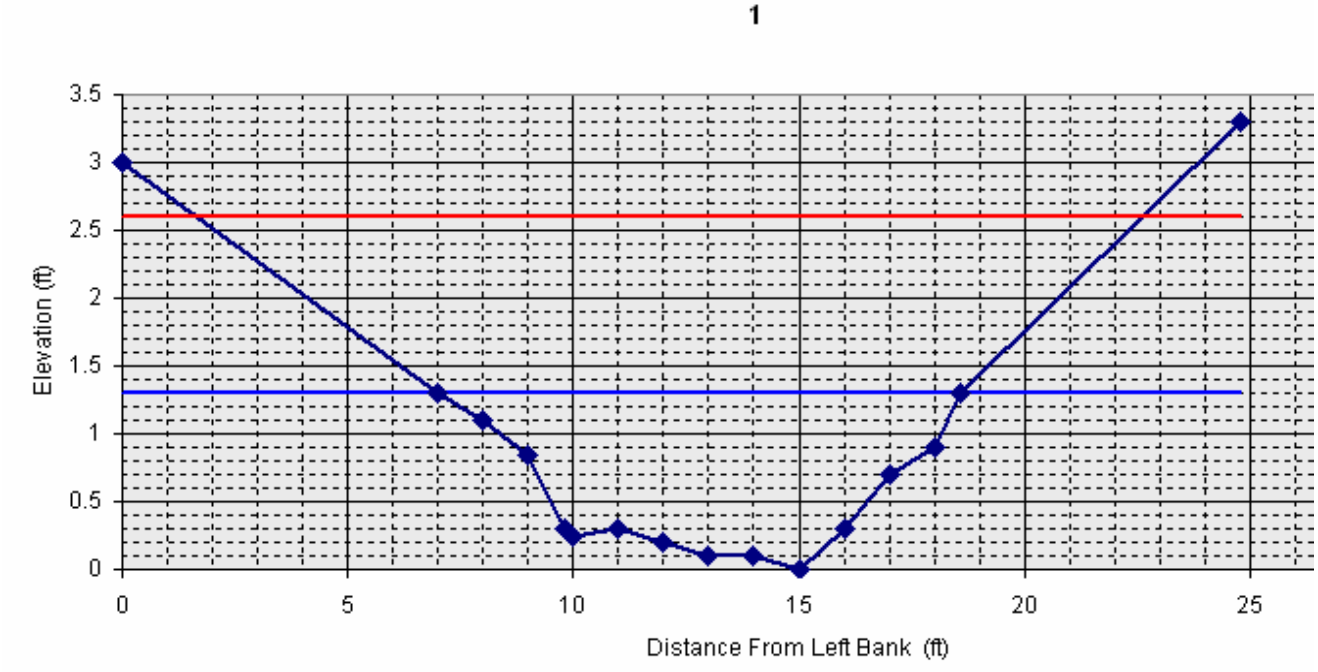
Notes: Munroe Brook - Tributary 1 - Reach 1 - Segment A

Cross Section



Notes: Munroe Brook - Tributary 1 - Reach 1 - Segment B

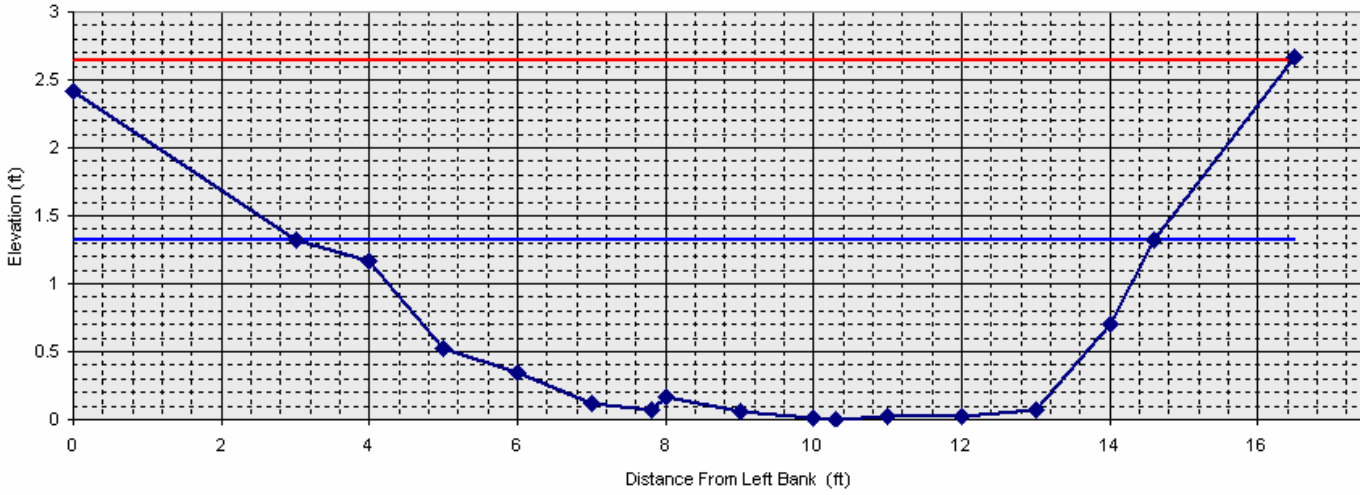
Cross Section



Notes: Munroe Brook - Tributary 1 - Reach 1 - Segment B

ross Section

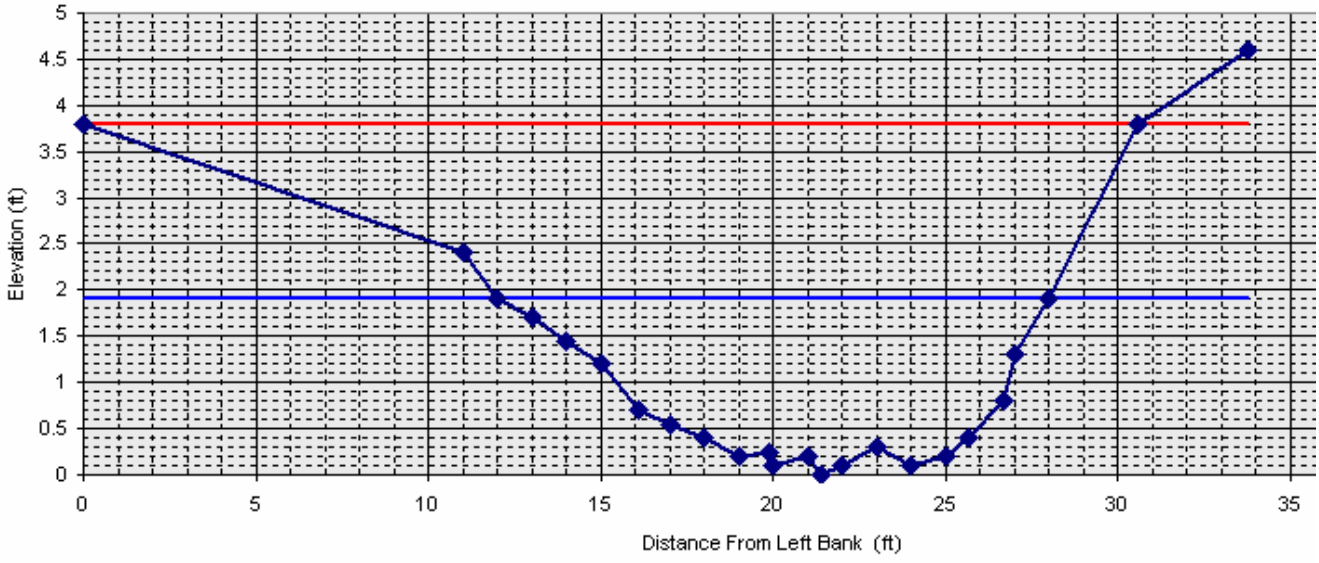
2



Notes: Munroe Brook - Tributary 1 - Reach 2

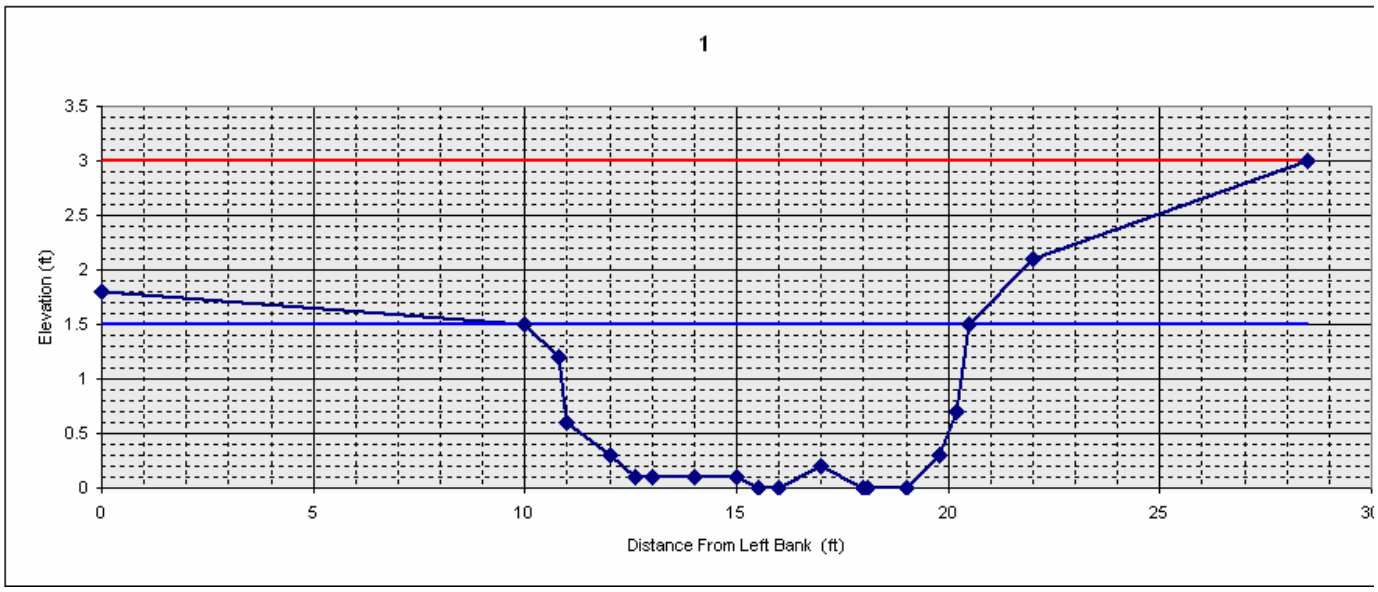
Cross Section

1



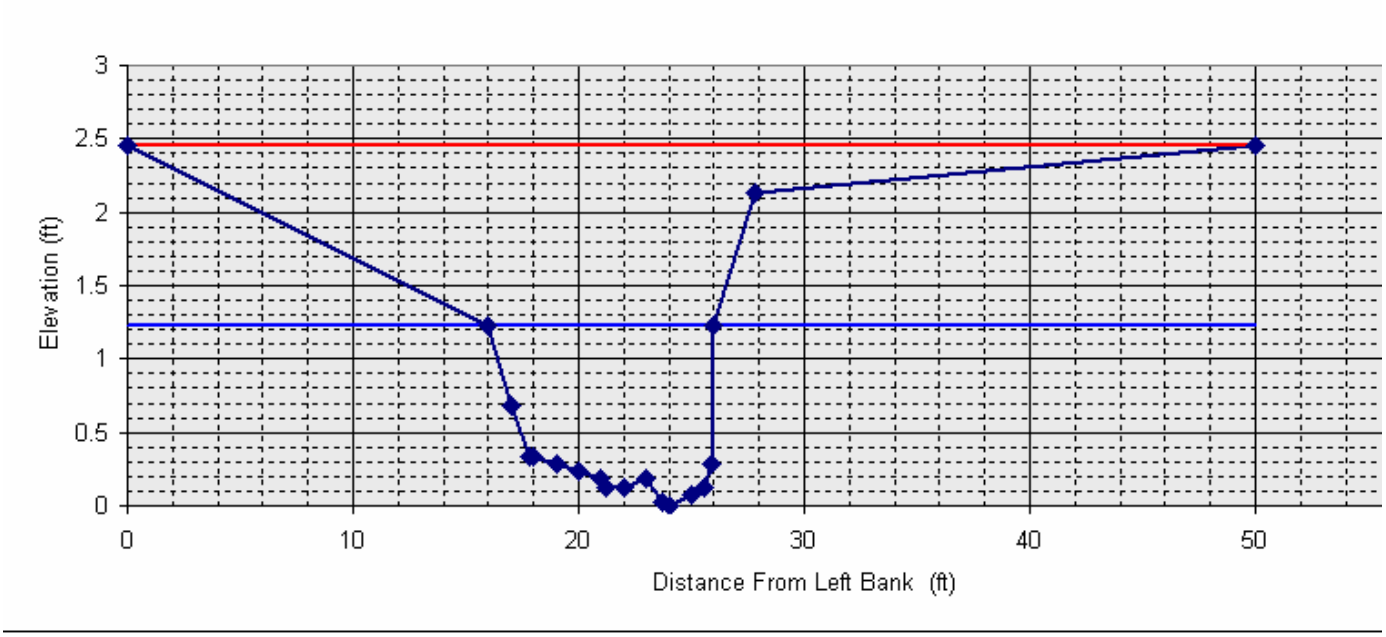
Notes: Munroe Brook - Tributary 1 - Reach 3

Cross Section



Notes: Munroe Brook - Tributary 1 - Reach 4

Cross Section



Munroe Brook Reach Summary Table

Evan P. Fitzgerald

10/19/06

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	Plane Bed	Yes	B	Gravel	Riffle-Pool	0.48	Fair	0.48	Fair	High
M02	A	E	Sand	Plane Bed	Yes	E	Sand	Dune-Ripple	0.43	Fair	0.28	Poor	Very High
M02	B	G	Sand	Plane Bed	Yes	E	Sand	Dune-Ripple	0.42	Fair	0.40	Fair	Very High
M03		E	Sand	Plane Bed	Yes	E	Sand	Dune-Ripple	0.45	Fair	0.38	Fair	Very High
M04	A	E	Sand	Dune-Ripple	No				0.67	Fair	0.54	Fair	Very High
M04	B	C	Gravel	Riffle-Pool	No				0.68	Good	0.59	Fair	Very High
M05		B	Cobble	Step-Pool	No				0.59	Fair	0.51	Fair	High
M06	A	E	Gravel	Riffle-Pool	No				0.55	Fair	0.65	Good	High
M06	B	C	Gravel	Riffle-Pool	No				0.66	Good	0.69	Good	High
M07	A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
M07	B	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
T1.01	A	E	Sand	Dune-Ripple	No				0.58	Fair	0.68	Good	High
T1.01	B	C	Gravel	Plane Bed	Yes	C	Gravel	Riffle-Pool	0.46	Fair	0.55	Fair	High
T1.02		B	Cobble	Plane Bed	Yes	B	Cobble	Step-Pool	0.36	Fair	0.39	Fair	High
T1.03		C	Gravel	Plane Bed	No				0.34	Poor	0.36	Fair	High
T1.04		C	Sand	Plane Bed	Yes	C	Gravel	Riffle-Pool	0.50	Fair	0.41	Fair	Very High
T1.05		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
T1.06	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

* STD = Stream Type Departure

† = Assessed Reference Condition Prior to Stream Type Departure

NE = Not Evaluated

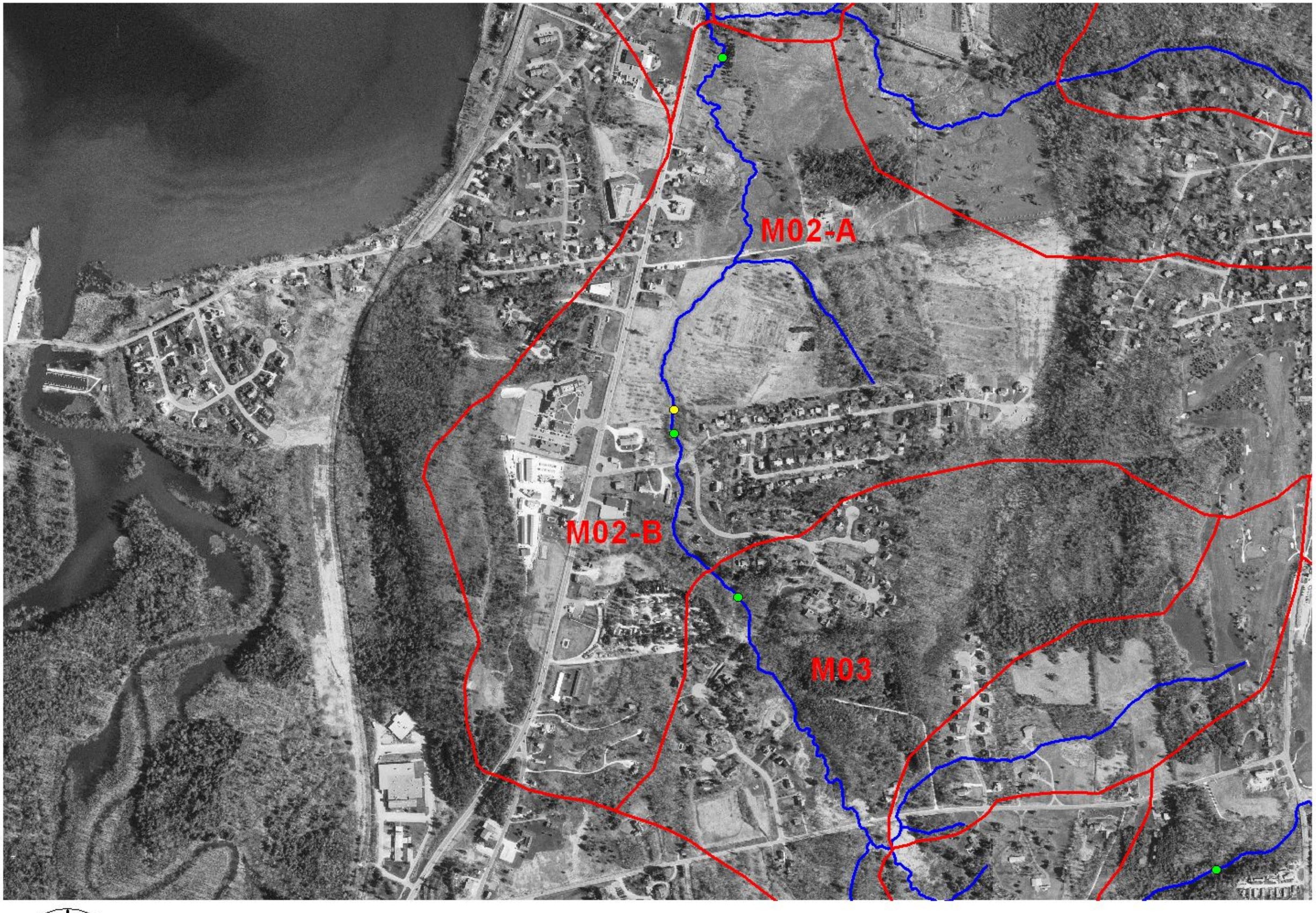
	RHA Score	RGA Score
Mean:	0.51	0.49
Max:	0.68	0.69
Min:	0.34	0.28

APPENDIX 4 – SGA WATERSHED MAPS

Munroe Brook SGA Watershed Map - M01 through T1.05

1000 0 1000 2000 Feet

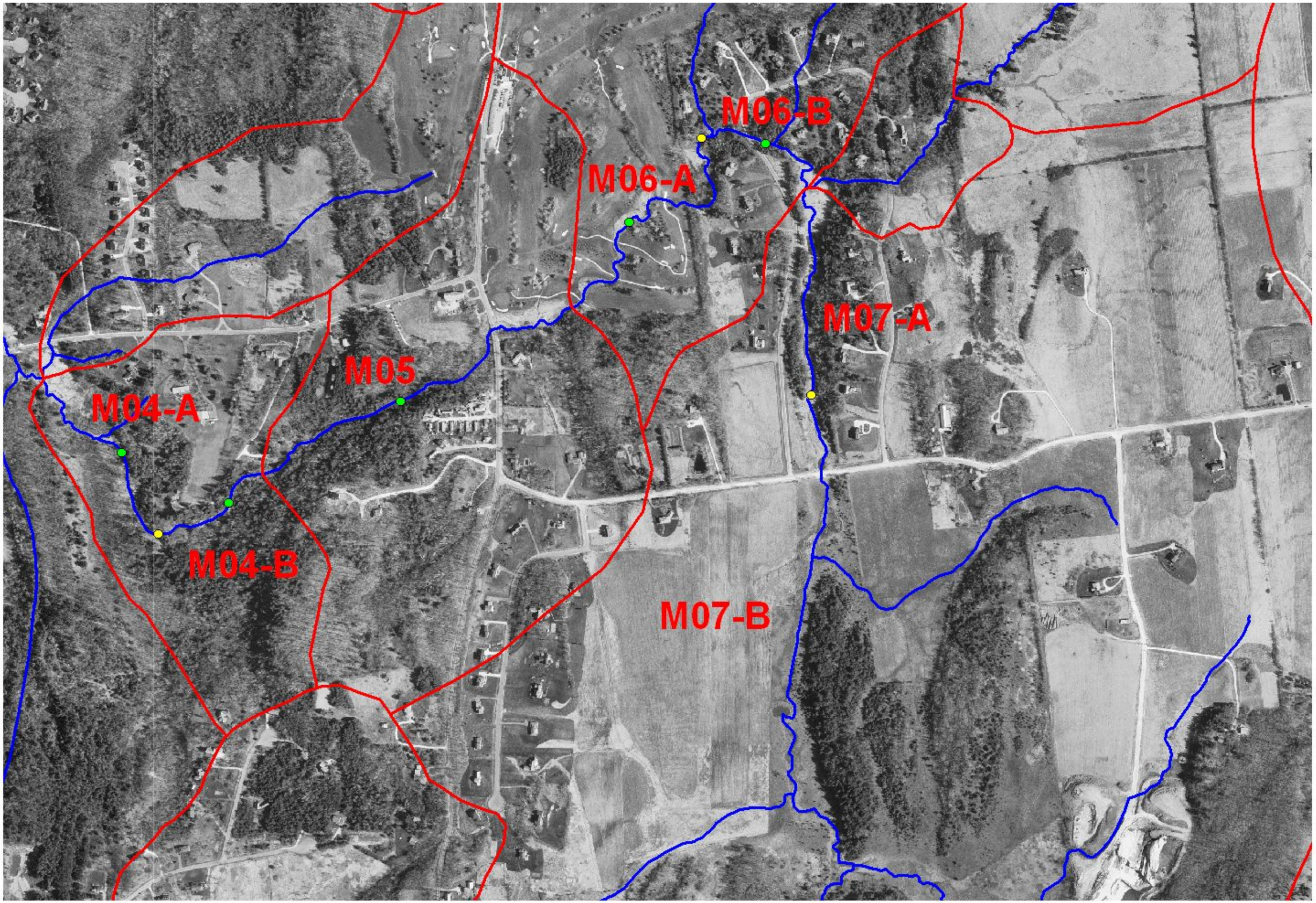
- Segment Breaks
- Cross Section Location
- Munroe Subwatershed Boundaries
- Munroe Surface Waters



Munroe Brook SGA Watershed Map - M02-A through M03

1000 0 1000 2000 Feet

- Segment Breaks
- Cross Section Location
- Munroe Subwatershed Boundaries
- Munroe Surface Waters



Munroe Brook SGA Watershed Map - M04-A through M07-B

1000 0 1000 2000 Feet

- Segment Breaks
- Cross Section Location
- Munroe Subwatershed Boundaries
- Munroe Surface Waters