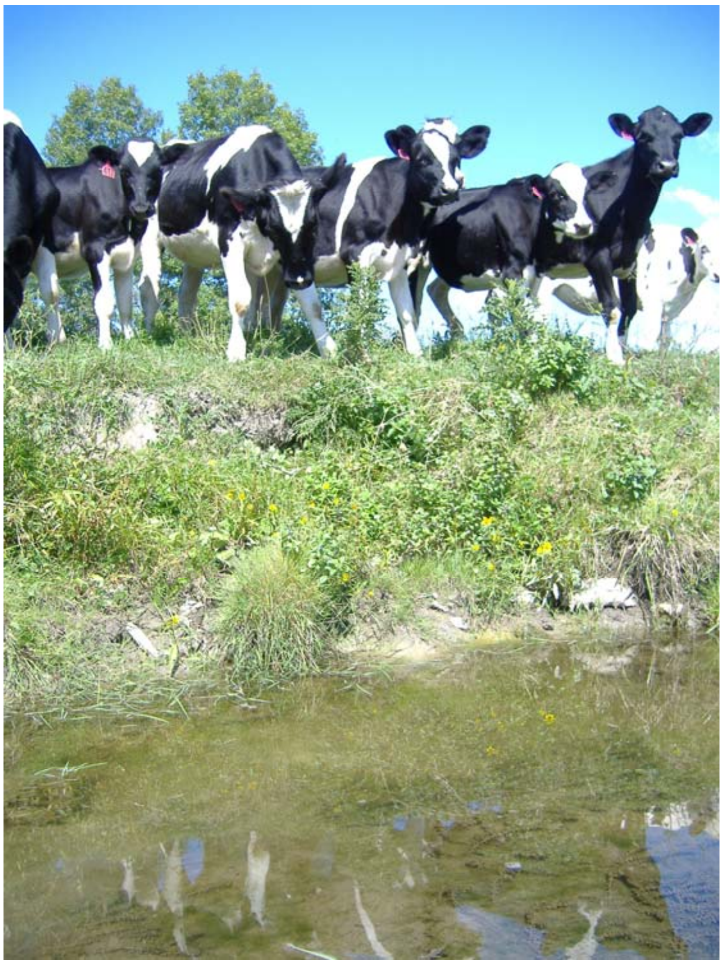
Phase 2 Assessment of the Hungerford Brook Watershed, Franklin County, Vermont 2006



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1.0 Summary

In 2006 a Phase 2 Geomorphic Assessment was completed in the Hungerford Brook Watershed, tributary to the Missisquoi River, in the towns of St. Albans, Sheldon, and Swanton, Vermont. The study of the Hungerford Brook was possible because of a grant from the Vermont Agency of Natural Resources (VTANR) Water Quality Division. The grant was administered by the town of Swanton with support from Bethany Remmers of the Northwest Regional Planning Commission (NRPC). Brendan O'Shea of Carmi Consulting was the project lead and worked closely with Brian Jerose of Waste Not Resource Solutions and Kristen Underwood of South Mountain Research and Consulting to complete the assessment.

The goal of this study was to assess the Hungerford Brook watershed and identify stream conditions including sediment and nutrient inputs, channel constrictions and other features. Other objectives of the study included the determination of the geomorphic condition of targeted reaches, identification of adjustment processes, identification of current and historic watershed stressors, evaluation of the sensitivity of the reaches, and to support selection, prioritization and design of riparian projects that are compatible and sustainable. Projects meeting those criteria are intended to improve water quality, wildlife habitat and reduce flood and erosion hazard risks to infrastructure, property and the public.

The Hungerford Brook watershed is located within the Champlain Valley physiographic province (Thompson & Sorenson, 2000; Dennis, 1964), the broad north-south trending valley that surrounds Lake Champlain and extends into portions of Vermont, New York and Quebec. The Hungerford Brook watershed is located in the higher-elevation area of the Champlain Valley in the foothills near the boundary with the Green Mountain physiographic province to the east (Stewart, 1974).

Geomorphic and habitat assessments were completed for twelve reaches in the Hungerford Watershed. A geomorphic assessment looks at four major processes, aggradation, widening, degradation, and change in plan form. A habitat assessment has more criteria such as bank canopy and vegetative buffer. The assessment of the Hungerford Brook Watershed followed protocols specified by the Vermont Agency of Natural Resources (ANR) Stream Geomorphic Assessment Phase 2 Handbook

Common stressors found in the watershed were lack of woody buffer, accelerated erosion due to increased hydrologic pressure, undersized culverts, straightened channels and drainage of wetlands.

The phase 2 assessment of the Hungerford Brook and its tributaries will help the town, state and the landowners identify areas of erosion hazard risks, sediment production and nutrient inputs in the brooks corridor. The study also will help identify potential

floodplain and channel projects that will increase the capacity for stream corridor capture and storage of sediment and nutrients. Agency, technical and funding partners will be able to use this information to help prioritize and justify future development and implementation projects.

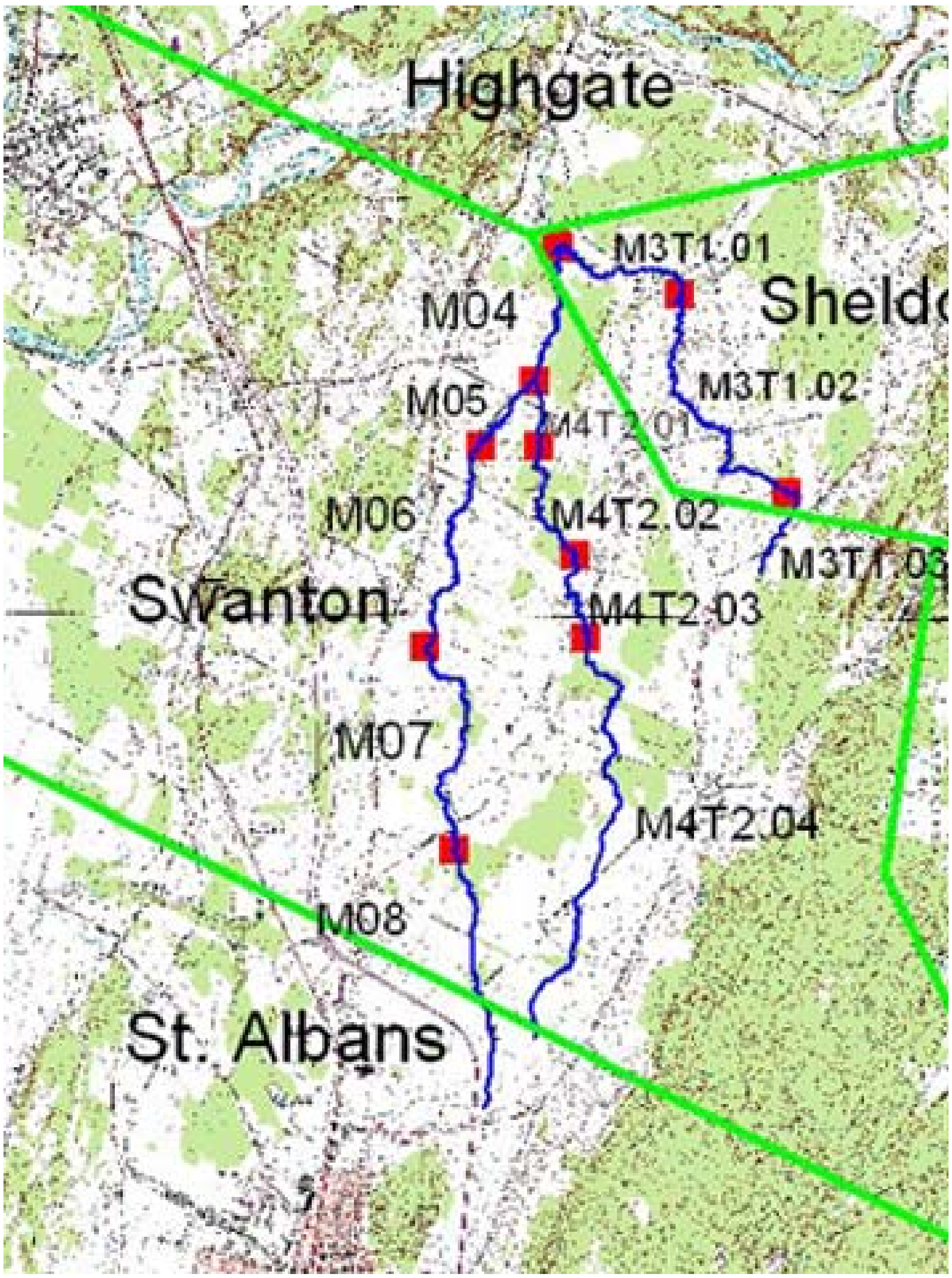

Figure 1. Location of Studied Reaches

2.0 Background

The Phase 2 Geomorphic Assessment of The Hungerford Brook was undertaken to identify sources of nutrients and sediments from sources such as stream bank erosion and areas with little to no buffer. Over the past few decades, water quality in and around the Missisquoi Bay of Lake Champlain has been diminishing. Water quality and aesthetic impairments consisting of large blooms of Blue-Green Algae have caused the bay to be virtually unapproachable in the later months of summer and early months of fall. The watershed including the Hungerford Brook is targeted for major reductions in phosphorus (P) loads through a Total Maximum Daily Load (TMDL) plan for Lake Champlain and agreement between the state of Vermont and the US Environmental Protection Agency (EPA). This project was funded through the Clean and Clear Action Plan of Governor Douglas.

Land use in this watershed is agricultural, forested, developed and wetland. Recent increases of housing and commercial development are occurring in several of the upper reaches of the watershed. The Hungerford Brook is located in some of the most highly concentrated agricultural land in the state. Watershed impacts such as direct cattle access, close cropping with mall or absent buffers, channel alteration and run off were observed in this small but significant brook.

Stream bank erosion is a contributing non point source of phosphorus in rivers and streams.

Figure 2 Nutrient Input. M08

Eroded banks combined with agricultural run off, and a wash load dominated stream make for a brook very high in sediments and nutrients. Fine soil particles consisting of clays and silts are locally common and easily suspended and carried by runoff water and stream flows. In reaches of streams where the channel has lost access to the historic floodplain, there are reduced opportunities to settle soil particles and attached nutrients such as phosphorus.

2.1 Geographic Setting

The Hungerford Brook drains a 19.5 square mile area in the towns of Swanton, St. Albans, Sheldon, Highgate, and Fairfield townships in Franklin County, Vermont. The majority of the Watershed is in the Town of Swanton. The Hungerford Brook flows into the Missisquoi just downstream of Highgate Falls. The headwaters of the Hungerford are located near French Hill in St. Albans. Most of the land use in the Hungerford watershed is agricultural with a small amount of residential.

2.2 Regional Geologic Setting

The Hungerford Brook watershed is located within the Champlain Valley physiographic province (Thompson & Sorenson, 2000; Dennis, 1964), the broad north-south trending valley which surrounds Lake Champlain and extends into portions of Vermont, New York and Quebec. The Hungerford Brook watershed is located in the higher-elevation area of the Champlain Valley in the foothills near the boundary with the Green Mountain physiographic province to the east (Stewart, 1974).

In recent geologic time (from 20,000 to 13,200 years before present) this landscape was occupied by advancing and retreating glaciers, with ice up to a mile or more in thickness above the present land surface in the Champlain Valley (Stewart & MacClintock, 1969). Glacial tills now blanket much of the bedrock-controlled slopes and headwaters of the watershed (Doll, 1970).

As the global climate warmed and the glaciers receded, a large fresh-water lake inundated the Champlain Valley. At its highest stage, Lake Vermont's shoreline extended into the Hungerford Brook watershed and beyond (Stewart & MacClintock, 1969; Doll, 1970).

Lake Vermont waters receded in stages as natural ice dams in southern Vermont and New York gave way. From approximately 12,800 to 10,200 years before present, marine waters filled the valley from the St. Lawrence Seaway as the rate of rise in ocean water levels far exceeded the rate of rise, or isostatic rebound, of the land surface now relieved of its glacial burden (Stewart and MacClintock, 1969; Cronin, 1977; Wagner, 1972). The maximum elevation of these brackish waters is believed to have extended into the Hungerford Brook watershed to areas north and west of Route 105 (Wagner, 1972).

Champlain Sea waters had receded from the Champlain Valley by approximately 10,000 years before present, as the rate of land rise began to outpace the rate of sea-level rise. River systems, including the Hungerford Brook and the Missisquoi River, then went to

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work moving sediments left in the wake of the glaciers. The surrounding landscape continues in this erosion/deposition phase today.

2.2.1 Bedrock Geology

In general, the bedrock geology of the Hungerford Brook watershed consists of fractured shales and slates with lesser occurrences of limestones, dolomites, and quartzites (Stewart, 1974; Dennis, 1964; Mehrtens & Dorsey, 1987). The shales and slates originated as sedimentary mudstones deposited in an ancient sea (450 to 550 million years old). They were later compressed and altered under elevated temperature and pressure conditions during mountain building events and subsequent regional deformations to form metamorphic slates. In the process of mountain-building, older Cambrian and Ordovician rocks were folded and thrust over younger Ordovician limestones and marbles. Later, regional stresses caused further folding and faulting of the rocks.

The topography of the Hungerford Brook watershed is, in part, a direct result of the characteristics of the underlying bedrock. The Hungerford Brook main stem and major tributaries drain generally to the north, nearly parallel with the alignment of the underlying bedrock. Quartzite and dolomite members that are more resistant to weathering, and comprise thrust sheets, form the uplands along the eastern and western margins of the watershed. The eastern extent of the watershed is bounded by higher-relief, erosion-resistant quartzites and dolomites of the northeast-trending Hinesburg-Oak Hill Thrust at the foothills of the Green Mountain province. The western edge of the watershed is bounded by dolomites along the north-northeast-trending Champlain Thrust fault (Stewart, 1974).

Figure 3 Channel Spanning Bedrock M4T2.03

Frequent bedrock exposures influence the channel position and profile in the watershed. Bedrock exposures along the valley walls control the lateral position of the river channel. Locations of channel-spanning bedrock offer vertical grade control, preventing possible downward erosion of the channel in response to regional or local stressors (at least over the 10- to 100-year time spans on which this study is focused). Within the study area there are several exposures of bedrock (grade controls) along the main stem and tributary channels.

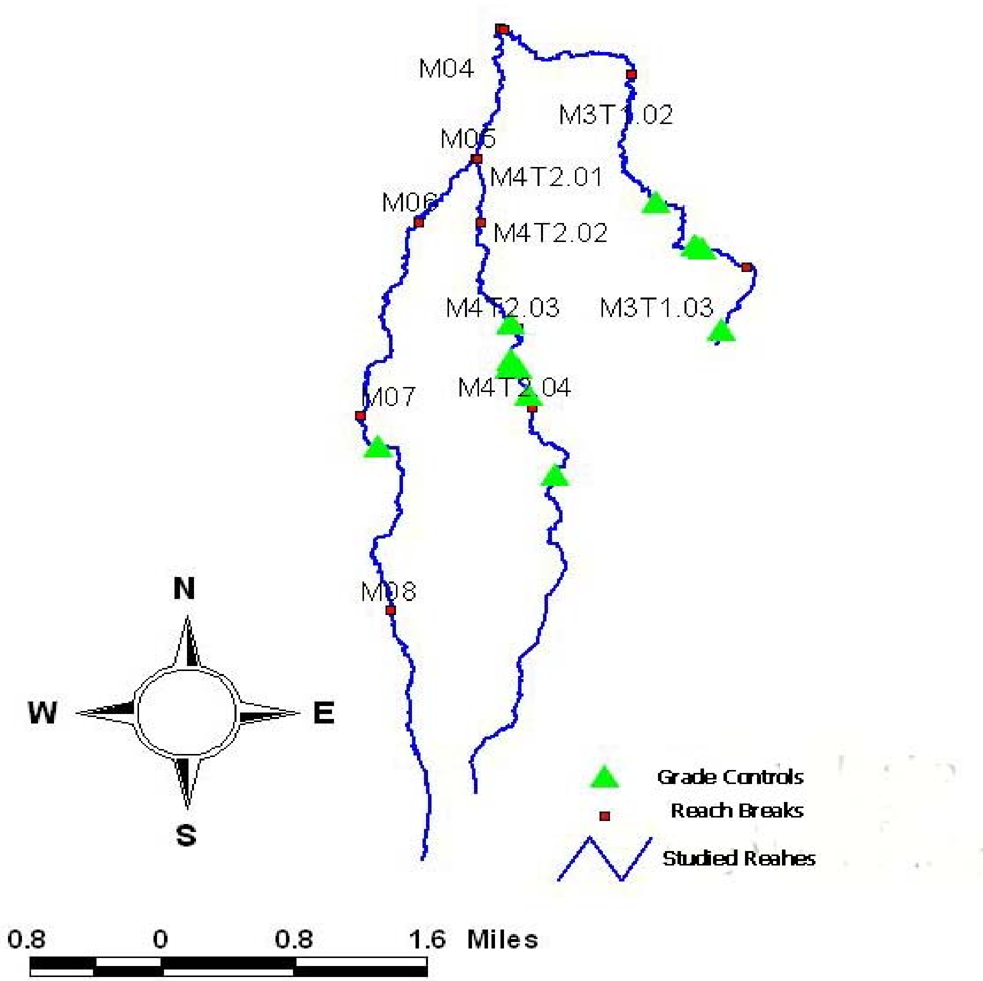

Figure 5 Location of Grade Controls

2.2.2 Surficial Geology

Figure 4 Clay on Bedrock M3T1.03

Glacial and post-glacial events have influenced the surficial sediments and soil types which are present in the Hungerford Brook watershed today. Upland slopes along the eastern and western margins of the watershed are dominated by shallow- to moderate-thickness glacial till deposits overlying bedrock. The mid-portion of the watershed is underlain by silts and clays deposited first in fresh-water Lake Vermont and later in the Champlain Sea. Marine beach gravels from the Champlain Sea have been mapped in the southern portion of the watershed; these sand and gravel deposits form some of the higher-relief terraces in the watershed visible along Route 105, for example. At the downstream end of the watershed, near the confluence with Missisquoi River, the Hungerford Brook cuts through sands and pebbly sands of the Champlain Sea delta deposited by the Missisquoi River over 10,000 years ago (Stewart and MacClintock, 1969; Stewart, 1974; Doll, 1970).

2.3 Geomorphic Setting

In the phase 1 geomorphic assessment the Hungerford Brook watershed (NRPC) was delineated into geomorphic reaches based on remote sensing techniques. Reaches were defined by slope, sinuosity and valley confinement.

The Hungerford Brook Watershed was made into 66 separate reaches ranging in length from 13,635 ft. to 937 ft. Based on Phase 1 impact scores and factors such as stressors and encroachments, twelve reaches of the Hungerford and its tributaries were selected to have phase 2 assessments completed in the fall of 2006.

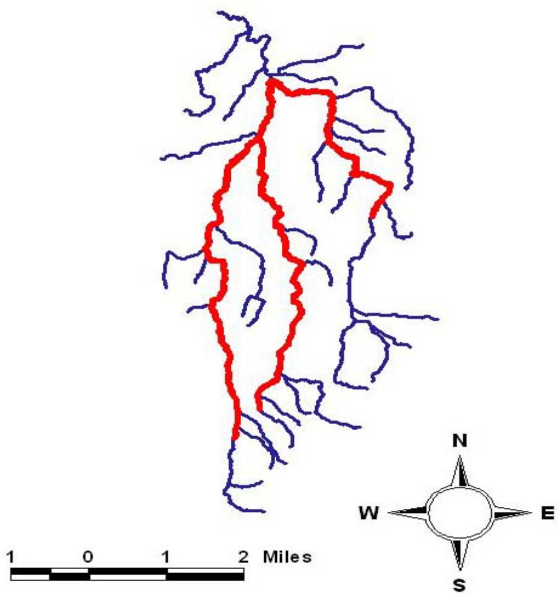

Figure 6 Studied reaches in red.

The elevations of the studied reaches ranged from 482 ft. (M08) to 281 ft. (M04). 41,141 feet of the main stem of the Hungerford and 53,942 feet on two of the larger tributaries was assessed. A total of 95,083 feet of the Hungerford and its tributaries now have geomorphic data in the states Data Management System. The assessed reaches of the Hungerford and its tributaries have an extremely low gradient dropping just 200 ft in over 10 miles.

The size of the drainage areas of the assessed reaches ranged from 10.48 square miles (M04) to 1.92 square miles (M08.)

3.0 Assessment Methodology

Phase 2 Geomorphic data were collected for 12 reaches of the Hungerford Brook and its tributaries. Landowner records were researched at the Swanton, St. Albans and Sheldon town offices. Landowners identified with property along reaches to be assessed were contacted by mail to inform them of the study, provide contact information for questions or concerns, and invite them to a project kick-off meeting. The assessment of the Hungerford Brook Watershed followed protocols specified by the Vermont Agency of Natural Resources (ANR) Stream Geomorphic Assessment Phase 2 Handbook.

Phase 2 data are used to document natural and human disturbances to the watershed and the response and adjustment of the channel to these disturbances. The information gathered during this Phase 2 Assessment will also aid in the understanding of the geomorphic condition of each reach assessed.

Segmentation of some stream reaches occurred based on the protocols. Field data was collected using a Garmin© eTrex VISTA GPS, digital camera, and various survey equipment and techniques. Certain features such as grade controls, cross sections, bridges and culverts were then digitized using *ArcView 3x*. All of this data was then uploaded into the states Data Management System.

A land owner database was compiled of all the landowners whose land might be crossed or accessed during the assessment. The project team, assisted by the Steering Committee prepared a letter to landowners stating the approximate schedule, purpose of the study and dates of the two public outreach meetings. Copies of this letter were mailed out as well as brought into the field when access might be granted verbally. A second letter was also sent out to land owners thanking them for their cooperation and participation in the assessment. See attachment A and B.

4.0 Phase 2 Assessment Results

The following is a brief summary of each reach, highlighting good aspects, bad aspects and problems which may be addressed. Phase 2 Assessment results from the states DMS can be found in Appendix A.

4.1 Hungerford Main Stem

Phase 2 assessments were completed for five reaches along the main stem of the Hungerford Brook. A total of 41,141 feet of the Hungerford Brook was assessed from Rte. 105 to the Highgate town line. Some common problems (stressors) observed on the main stem were lack of buffer, bank erosion, channel straightening, loss of floodplain/ wetlands, and undersized culverts.

Near reference conditions can be found in a few locations along the main stem. These areas offer woody buffer and an infrastructure free corridor. These areas must be conserved and protected to return the Hungerford Brook to a more natural state. These areas also offer habitat for wildlife and an opportunity for the brook to deposit nutrients in its corridor.

The following table (Table 1) is a brief overview of the information collected for each reach. A more detailed description follows for each reach discussing stressors, impacts, and possible projects.

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Hungerford Brook Main Stem

Table 1 Results of Phase 2 Assessment, Hungerford Brook Main Stem

Reach	Segmnt	Channel Length	Stream Type	RHA Score	RGA Score	Adjust.	Stream Type Departure	Sensitivity	CEM
M08	B	8,103	E4	.30	.51	Incision	None	Very High	F II
	A	2,200	E4	.73	.63	Stable	None	High	F I
M07	B	5,423	C5	.82	.64	Incision	None	High	F II
	A	4,400	C3	.45	.70	Stable	None	Moderate	F I
M06	--	10,152	E5	.34	.46	Incision	None	Very High	F II
M05	--	4,260	E5	.56	.48	Incision	None	Very High	F II
M04	--	6,503	C5	.55	.71	Stable	None	High	F I

Abbreviations RHA=Rapid Habitat Assessment; RGA=Rapid Geomorphic Assessment, CEM=Channel Evolution Model (VT DEC)

Table 2 RGA and RHA Score Ranges

0.85 – 1.0	Reference Condition
0.65 – 0.84	Good Condition
0.35 – 0.64	Fair Condition
0.00 – 0.34	Poor Condition

The following information will read from upstream to downstream.

M08B- M08B is an E type channel with a gravel bottom. The channel is currently incising most likely due to increased hydrologic pressure from straightened/ channelized tributaries. It has not yet undergone a Stream Type Departure however without a more adequate buffer, it is inevitable.

Figure 5 M08B Cross section looking upstream

M08B is located in a very broad valley in an agricultural setting. There are corn and hay fields on both the right and left banks for most of the segment. The downstream quarter of the reach flows through pasture with cows accessing the brook. This reach and its tributaries have little to no woody buffer and suffer from extensive historical straightening and ditching.

Increased hydrological pressure was also observed due to increased run off from residential areas and highway surfaces. Loss of wetlands was also apparent.

Due to these processes the reach is incised and has lost much of its access to its floodplain.

M08A- M08A is an E type channel with a gravel bottom. This segment is currently in stable condition.

This fairly short segment of M08 has an excellent corridor. This segment is located in forested land cover. Excellent epifaunal substrate (cobbles) and the lack of channel alteration indicate good habitat conditions for M08A.

Processes caused by upstream channel alteration and stressors were noted in M08A. Large areas of accelerated erosion were observed on both banks. Given the more natural sinuous planform and relatively minor encroachments a greater degree of flood plain connection was expected (Incision ratio of 1.0 or 1.2.) Instead an incision ratio of 1.35 was observed.

Exemplary corridor can be found on the banks of this reach. However due to upstream stressors and increased hydrologic pressure this reach is incising and losing access to its floodplain.

Figure 6 M08A Cross Section looking upstream

M07B- M07B is a C type channel with a sandy bottom. It is currently incising, with a headcut present.M07 flows from just upstream of Bushey Road to Hazard Road. The reach was segmented due to a change in banks and buffers. In segment M07A 100' of buffers can be observed and the banks are not slumping into the brook. This is not the case however for segment B of M07. There is a lack of woody buffer and large areas of erosion can be observed, possibly due to the direct access by cattle.

M07B flows under a small pedestrian bridge, through some rip-rap and then through a box culvert under the Bushey Road. The Brook flows by a short residential area (where the brook has been straightened) and then into a pasture in a very broad valley. The

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pasture has cows accessing the brook and has little to no woody buffer making it a production zone for sediment and nutrients.

Downstream of the pasture, the brook flows through a farm road culvert and along a corn field on the left bank. Slumping banks are common along this segment as are storm water inputs (tile drains) from agricultural lands.

A headcut was observed in this segment making this reach especially vulnerable to loss of floodplain and a possible stream type departure.

Figure 7 Slumping banks on M07B

M07A- M07A is a C type stream with a cobble bottom. It is currently in stable condition.

M07A has stream banks and riparian buffers in near reference condition for geomorphic and habitat features. A deciduous old growth forest can be found on the left and right banks of this segment. The first debris jam we found was located in this segment and it was the first area we saw large woody debris walking downstream from M08.

A large braided area halfway through the segment clued us in to the sediment load coming from upstream. This reach is working as a sediment attenuation area trapping bed load upstream of its debris jams and bedrock outcrop. This outcrop is channel spanning and offers grade control for the brook.

Figure 8 Reference conditions of M07A

This was the first grade control observed walking downstream from M09.The last 200 feet of the segment has little to no woody buffer and there are corn fields on the right and left banks.

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M06- M06 is an E type channel with a sandy bottom. This reach is currently incising.

M06 starts just upstream of Hazard Road. It flows through pastures for the next 10,000 feet, some with direct access by cattle and some with cattle exclusion. This reach has numerous stressors and is one of the larger production reaches for sediments and nutrients. Due to the lack of woody buffer and direct access by cattle accelerated erosion is quite common.

Erosion is also related to an incision ratio of 1.6. Flood waters are now trapped within the banks rather than overflowing to the floodplain. This causes banks to erode and the bed to lower. This incision ratio could be directly related to the increased magnitudes and peak of flows due to increased tile drainage and/or storm water runoff to upstream reaches and tributaries.

There are three bridges and two culverts on this reach all channel constrictions. Most are old in and desperate need of repair or removal. One bridge in particular had broken in to numerous pieces and now lies across the channel.

Buffers, stream crossings, cattle exclusion and meanders must be reestablished if there is an expectation to reduce on-going sediment and nutrient production and channel adjustment leading to stream bank failure and other damage.

A headcut was observed in this reach that threatens to cut off even more of M06's floodplain if not addressed.

Figure 9 M06 from the air.

M05- M05 is an E type channel with a sandy bottom. This reach is currently incising.

M05 flows from south of the Woods Hill Road to where the main stem meets up with M4T2. This section of the brook flows through a very broad valley and is fairly incised. At the cross section site a 1.82 incision ratio was observed. Abandoned pasture surrounds the corridor and woody buffer is slowly re establishing itself. Some shrubs and deciduous trees can be found inside the corridor.

Midway down the reach the brook flows under a bridge located at the Woods Hill Road. This area acts as a constriction and the depth of the brook upstream ranged from four to

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six feet. This was almost three times the average depth recorded upstream. The alignment of the bridge is off and it seems as if though the channel would like to re establish itself to the west. However because the road grade has been built up the brook is confined to its present channel.

The town of Swanton has done extensive channel alteration to this area due to the floods that would flow over the Woods Hill Road. Down stream of the road the channel has been dredged and straightened in hopes the high water would dissipate faster. This has caused headcuts to migrate upstream causing very high incision ratios upstream of Woods Hill Road. This has also caused loss of floodplain resulting in more water, with more pressure flowing towards the Woods Hill Road.

Figure 10 Incised M05

M04- M04 is an E type channel with a sandy bottom. This reach is currently in stable condition.

M04 almost doubles in size from M05 with the addition of M4T2. This reach is very sinuous and when looked at by digital orthographic photo one can easily see where the channel has evolved its planform over time. Occasionally, the meanders will become so torturous that they are truncated by a neck cut off. There are some pastures on the left and right banks however they are not in the river corridor and the cattle do not have access to the stream.

Erosion was present on some meander bends possibly due to the sinuous nature of this reach. Erosion could also be a result of the changes in hydrology and sediment load found in upstream reaches. Flows that are higher in magnitude and velocity will cause erosion of banks. The bank texture consisted of sand, silt and clay, all easily eroded during high flows.

Figure 11 Erosion on a meander bend M04

The prevalence of wetlands adjacent to the channel, bars on the inside meander bends and very low slope help attenuate some of the sediment from the channel.

The upstream elevation of this reach is 281 feet. The downstream elevation is 280 feet. That is a one foot change in elevation over 6500 feet of channel.

4.2 Hungerford Brook Tributaries

Phase 2 Assessments were completed on two major tributaries of the Hungerford Brook, M4T2 and M3T1. 53, 942 feet of channel was assessed on the two tributaries. Some common problems (stressors) observed on the main stem were lack of buffer, bank erosion, channel straightening, loss of floodplain/ wetlands, and undersized culverts.

Near reference conditions can be found in a few locations along the two studied tributaries. These areas offer woody buffer and an infrastructure free corridor. These areas must be conserved and protected to return the Hungerford Brook and its tributaries to a more natural state. These areas also offer habitat for wildlife and an opportunity for the brook to deposit nutrients in its corridor.

The following table (Table 3) is a brief overview of the information collected for each reach. A more detailed description follows for each reach discussing stressors, impacts, and possible projects.

Table 3 Results of Phase 2 Assessment, Hungerford Brook Tributaries

Hungerford Brook Tributaries

Reach	Segment	Channel Length	Stream Type	RHA Score	RGA Score	Adjustment	Stream Type Departure	Sensitivity	CEM
M4T2.04	D	2,000	G5	.23	.46	Incision	Yes	Very High	F II
	C	1,000	B4	.55	.50	Widening	Yes	Very High	F III
	B	6,509	B5	.40	.53	Incision	Yes	Very High	F II
	A	8,000	E4	.58	.54	Stable	None	High	F I
M4T2.03	--	4,491	E5	.53	.83	Stable	None	Moderate	F I
M4T2.02	--	5,520	E5	.73	.86	Stable	None	Moderate	F I
M4T2.01	--	2,480	E5	.39	.49	Incision	None	Very High	F II
M3T1.03	--	3,697	E4	.54	.68	Stable	None	High	F I
M3T1.02	--	13,208	E4	.82	.70	Stable	None	High	F I
M3T1.01	C	2,037	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	B	4,000	E5	.69	.68	Stable	None	High	F I
	A	1,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Abbreviations RHA=Rapid Habitat Assessment; RGA=Rapid Geomorphic Assessment (see Table 2 RGA score ranges), CEM= Channel Evolution Model (VT DEC) N/A= Not Assessed

M4T2.04D- M04T2.04D is a G type channel with a sandy bottom. It is currently incising and has already undergone a stream type departure (E to G.)

This upstream segment of M4T2.04 flows through both corn and hay fields. Extensive channel alteration including dredging and straightening have left this part of the reach with virtually none of its original characteristics. It is a sediment production zone and transport zone moving agricultural runoff and sediments from the corn and hay fields. There is no more than ten feet of herbaceous buffer on either bank. Due to incision during high water most of the flood plain access is lost.

Figure 12 M4T2.04D

M4T2.04C- M4T2.04C is a B type channel with a gravel bottom. This reach is currently widening and has already undergone a stream type departure (E to B).

Segment C has excellent woody buffer on both banks, excellent meanders, and good bed strata, however because of increased hydrologic pressure and channelization of the upper watershed, this very short segment is in fair state. Much erosion has already undergone to create room to handle the increased cfs.

Figure 13 Cross section M4T2.04C

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M4T2.04B- M4T2.04B is a B type channel with a sandy bottom. This reach is actively incising and has already undergone a stream type departure (E to B.)

M4T2.04B flows from Sholan Road to upstream of Viens Road. This segment has little to no woody buffer. It also suffers from channel alterations such as straightening and dredging. Just downstream from Sholan Road the channel flows under the old rail road grade (now known as the "rail trail".) The channel flows along side the berm for about 800'before it heads north at a farm road culvert. Downstream of the berm the channel is straightened and incised.

There is crop land on both the right and left banks with only minimal herbaceous buffer. The channel is very straight with no meander bends.

Figure 14 M4T2.04B Downstream of Rail Trail

M4T2.04A- M4T2.04A is an E type channel with a gravel bottom. It is in stable condition.

Figure 15 M4T2.04A

Segment A flows from upstream of the Viens Road to just upstream of the Bushey Road. This segment has excellent buffer with woody vegetation. It has adjacent wetlands and two bedrock outcrops on the bottom portion providing grade control.

Debris jams were observed inside of the stream corridor. There are numerous crossings made for an ATV that have accelerated erosion of some banks. Overall however this reach is in excellent condition and needs only to be conserved and preserved through land use management. Not one of the bigger sediment production areas in the Hungerford Watershed.

M4T2.03- M4T2.03 is an E type channel with a sandy bottom. It is currently in stable condition.

This reach flows from upstream of Bushey Road to behind the Vosberg Farm. This reach has the most bedrock of all the reaches assessed in the Hungerford Watershed. A total of five outcrops were observed, almost as many as all of the other reaches combined.

Figure 16 M4T2.03

M4T2.03 flows through pasture with access to the channel by cattle and horses. Rip-Rap was observed downstream of Bushey Road next to a residence in the corridor

Due to stressors such as lack of woody buffer, vehicle crossings and animal accessibility, this reach has much erosion on its banks. It does however offer grade control for upstream reaches and will reduce the potential for the reach to lose connection with its flood plain.

M4T2.02- M4T2.02 is an E type channel with a sandy bottom. It is currently in stable condition.

Figure 17 M4T2.02 Beaver activities

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This reach flows from behind the north of Route 105 to just upstream of the Woods Hill Road. The first 1000' of this reach flow through a pasture where cattle have direct access to the brook. Due to a small number of cattle in the pasture the channel is in good shape but does show some signs of accelerated erosion.

M4T2.02 has excellent canopy cover and for most of the reach has 100' or more of woody buffer. Midway down the reach the buffer changes from deciduous/ conifer to alders. Not long after that change was observed the reach became impounded by beavers.

This in stream wetland offers water purification, flood plain, and wildlife habitat.

M4T2.01- M4T2.01 is an E type channel with a sandy bottom. This reach is currently incising and only remains an E type channel due to the transient grade control (culvert) located underneath the Woods Hill Road (see figure 22.) If this grade control is lost however, headcuts will migrate upstream causing loss of floodplain and incision.

This reach joins the main stem of the Hungerford Brook just downstream of the Woods Hill Road. Upstream of Woods Hill Road the reach has 50' of woody buffer on both banks and has not undergone channel alterations. Before M4T2 reaches the road however it has been straightened and dredged. It flows through a culvert underneath the Woods Hill Road and into crop land before joining the main stem (see *figure 10*.) Less than ten feet of herbaceous buffer surrounds the channel with corn being cultivated on both banks.

Figure 18 M4T2.01 Downstream of Woods Hill Rd.

M3T1.03- M3T1.03 is an E type channel with a sandy bottom. This reach is currently in stable condition.

This reach begins just upstream of Rte 105 in Swanton. It ends just downstream of the Swanton/Sheldon town line. Upstream of Rte 105 excellent woody buffer was observed as well as a small bedrock outcrop. On the roadside, within the corridor, Japanese knotweed was spotted, surprisingly the only plant of its kind seen during the whole assessment. Downstream of Rte 105 the brook flows through a pasture where cattle have direct access to the brook. There is no woody buffer in the pasture and most of the banks are undercut.

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Downstream of the pasture the reach regains woody buffer and flows by corn and hay fields on its right and left banks. This section was historically straightened to maximize crop production but in recent years has regained some of its sinuosity.

Possibly due to upstream grade control or the cohesive banks this reach has surprisingly good access to its floodplain.

Figure 19 Vehicle crossing M3T1.03

M3T1.02- M3T1.02 is an E type channel with a gravel bottom. It is currently in stable condition.

This reach starts just north of the Swanton/Sheldon town line and flows to just upstream of the Heald Road. Upstream of Woods Hill Road this tributary of the Hungerford Brook has more than 100’ of woody buffer on both banks. A bedrock outcrop offers grade control midway between the start of the reach and the Woods Hill road.

Close to Woods Hill Road cattle have access to the brook and much erosion was observed. Before the brook crosses the road it enters a barnyard and loses all buffer and is extremely eroded.

Old feed is dumped into the corridor leaching nutrients directly into the brook. Woody buffer is lost in this short area along Woods Hill Road.

Figure 20 M3T1.02 Cross Section

The channel flows through a culvert underneath Woods Hill Road and into a pasture where cattle can access the brook. Downstream of the pasture the channel regains woody buffer of about 50' on each bank. Beyond the buffer lie large areas of cropland.

The large areas of woody buffer on both banks throughout this reach have helped it stay in a stable condition. Though numerous stressors lie close to or within the streams corridor the brook has maintained excellent access to its floodplain. A good example of what woody buffer can do for stream equilibrium.

Figure 21 Nutrient source just upstream of Woods Hill Road M3T1.02

M3T1.01- M3T1.01 is an E type channel with a sandy bottom. It is currently in stable condition.

Figure 22 Heald Road culvert M3T1.01

This reach was segmented into three parts. Segments A and C were not assessable due to beaver activity. Segment B flows from just downstream of Heald Road to 1,800' upstream of the confluence with the main stem. Between Bushey Road and Heald Road the has excellent buffer and no encroachments in the corridor. Downstream of Bushey Road however cattle were in the brook and woody buffer was lacking although there were some alders in the corridor

This reach is in stable condition and offers good sediment attenuation zones due to all of the beaver activity. Much of the reach is impounded and gives sediment a chance to settle out before it reaches the main stem.

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4.3 Bridge and Culvert Assessment

Seven bridge and culvert assessments were completed for the Hungerford Brook Watershed. Of these seven assessments, six were culverts and one was a bridge. Common problems observed at these structures included scour pools above and below, deposition above and below and floodplain and channel constriction.

Printouts of these assessments are included on the project CD. This information can be used to prioritize upgrades and address problems as they may arise.

The following table shows location of studied bridge/ culvert by reach.

Table 4 Bridge and Culvert Assessment

Structure	Type	Reach	Floodplain Constriction
vtrans-990005006706143	Culvert	M3T1.01	Yes
vtrans-700051033906053	Culvert	M07B	Yes
vtrans-700052034406053	Culvert	M06	Yes
vtrans-700052034506053	Culvert	M4T2.04A	Yes
dms-100615000406151	Bridge	M05	Yes
vtrans-990003001006151	Culvert	M4T2.01	Yes
vtrans-990003000206151	Culvert	M3T1.01	Yes

Figure 22 Perched Output M4T2.01

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5.0 Summary and Discussion

The geomorphic condition of the Hungerford Watershed has been characterized by Phase 1 and 2 assessments. Using these assessments we can help identify sediment and nutrient production zones, transfer zones and attenuation zones. This information can also be used for future management of the Hungerford Brook and the land surrounding it. The main goal of these assessments is to improve water quality and habitat, to reduce risks to infrastructure and minimize production of sediments and nutrients.

5.1 Sediment Production Zones

If the Hungerford Brook is in equilibrium, the rate of erosion will equal the rate of deposition. This does not exist in nature, although some streams come close.

Sediment production zones are numerous in the Hungerford Watershed. Due to the broad valley setting and the low gradient of the watershed, the channel has been closely encroached by agriculture and residential uses. Tilled land can be found adjacent to every study reach except for one. Bank erosion and mid channel bars were observed on every study reach. Flood chutes and gullies were also common point source contributors to sediment in the channel.

The following table (Table 4) is a quick summary of some of the issues involving sediment production, storage and transfer and how they relate to the Hungerford by reach. In an equilibrium state a stream should be able to store as much sediment as it produces. This almost never occurs in nature although some streams come closer than others. At the present time the Hungerford Brook watershed appears to be producing and transferring much more sediment than it can store.

Much of the sediment that is being produced and transferred by the Hungerford Brook is deposited into the Missisquoi River downstream of the Highgate Dam. The sediment then overwhelms the Missisquoi and causes it to lose its equilibrium. This problem is then passed on to Missisquoi Bay causing it to become overwhelmed with sediments and nutrients causing water quality problems for flora and fauna alike.

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Table 5 Summary of Sediment Production and Transfer in Study Reaches

	Tilled land in corridor	Gullies	Bank Erosion	Mid Channel Bars, steep riffles, deltas	Flood Chutes, avulsions and braiding	IR > 1.4	Channel Straightening
M08	✕	✕	✕	✕	✕	✕	✕
M07	✕	✕	✕	✕	✕		✕
M06	✕	✕	✕	✕		✕	
M05	✕		✕	✕		✕	
M04	✕		✕	✕			
M4T2.04	✕	✕	✕	✕	✕	✕	✕
M4T2.03	✕		✕	✕	✕		
M4T2.02	✕	✕	✕	✕	✕		
M4T2.01	✕		✕	✕		✕	✕
M3T1.03	✕		✕	✕			
M3T1.02	✕		✕	✕	✕		
M3T1.01			✕	✕			

Abbreviations: IR =Incision Ratio

The following figure (Figure 24) highlights the problem of erosion observed in the Hungerford Brook watershed. Lots of red (erosion) can be seen in the figure. This erosion can be caused by increased hydrologic pressure, direct access by cattle, lack of woody buffer, ATV's, vehicle crossings, undersized crossing structures, and numerous other causes. Erosion is a problem that must be addressed if the Hungerford Brook is to be returned to a state closer to its equilibrium.

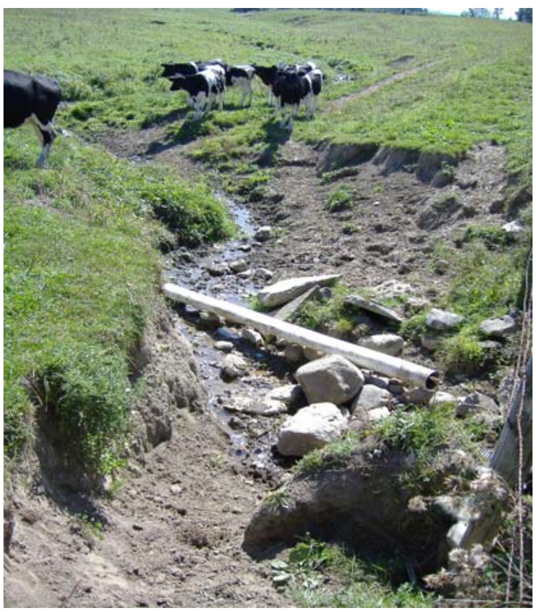

Figure 23 Erosion from Multiple Stressors M06

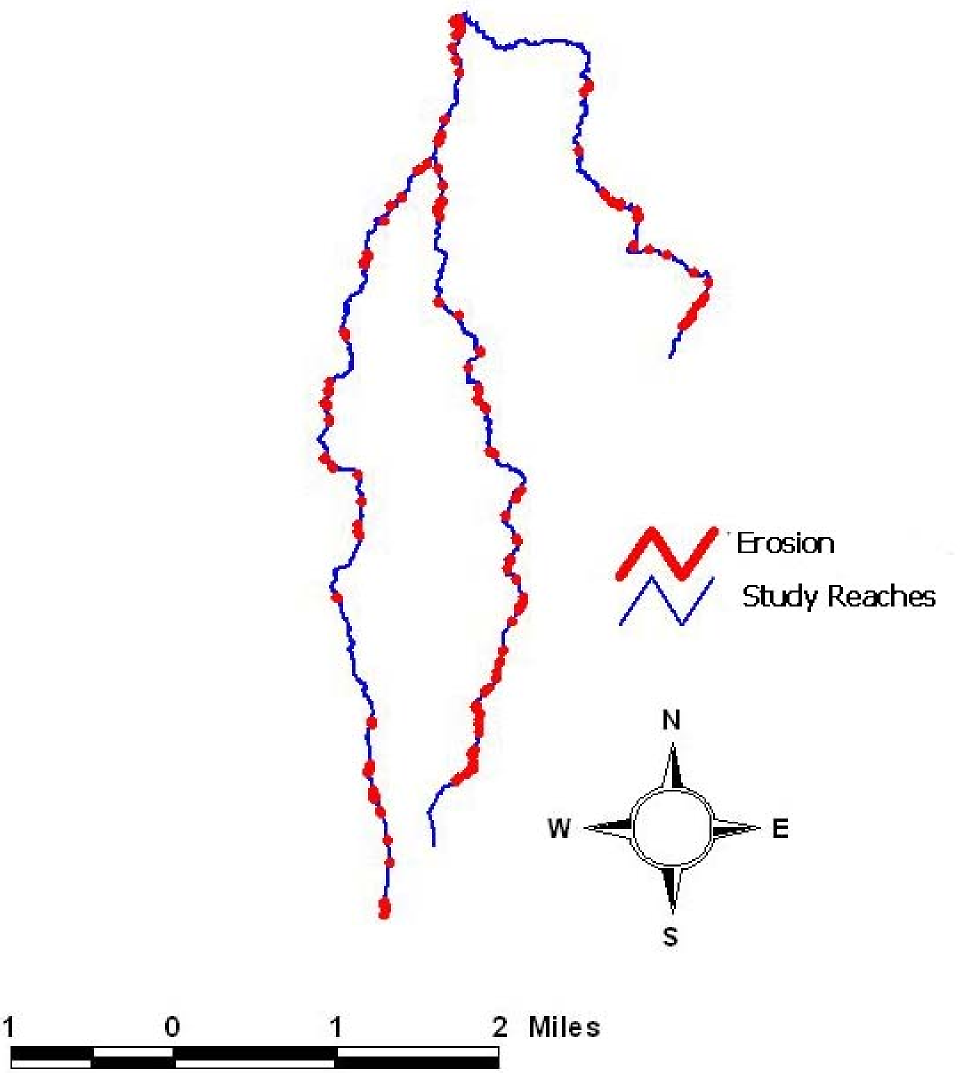

Figure 24 Erosion Map

5.2 Sediment Transfer Zones

After a stream erodes its channel, it can carry sediment three ways: bed load, suspended load and dissolved load. Sediment is transferred via these methods when there is a change in planform, a modification to channel slope, channel depth or riparian buffer zone. One of the most common increased sediment transfer zones observed in the Hungerford Brook Watershed was where the channel has been straightened. Straightening affects the channel slope and can cause incision. Incision will cause the increased transfer of sediments.

Five of the eleven reaches studied in The Hungerford Brook Watershed had an incision ratio of greater than 1.4 (See table 4.) Out of the five incised reaches three have been straightened. The following figure, Figure 25, shows reaches that have been bermed, straightened, and/or have storm water inputs. These factors can aid in sediment transfer causing the stream to lose its equilibrium.

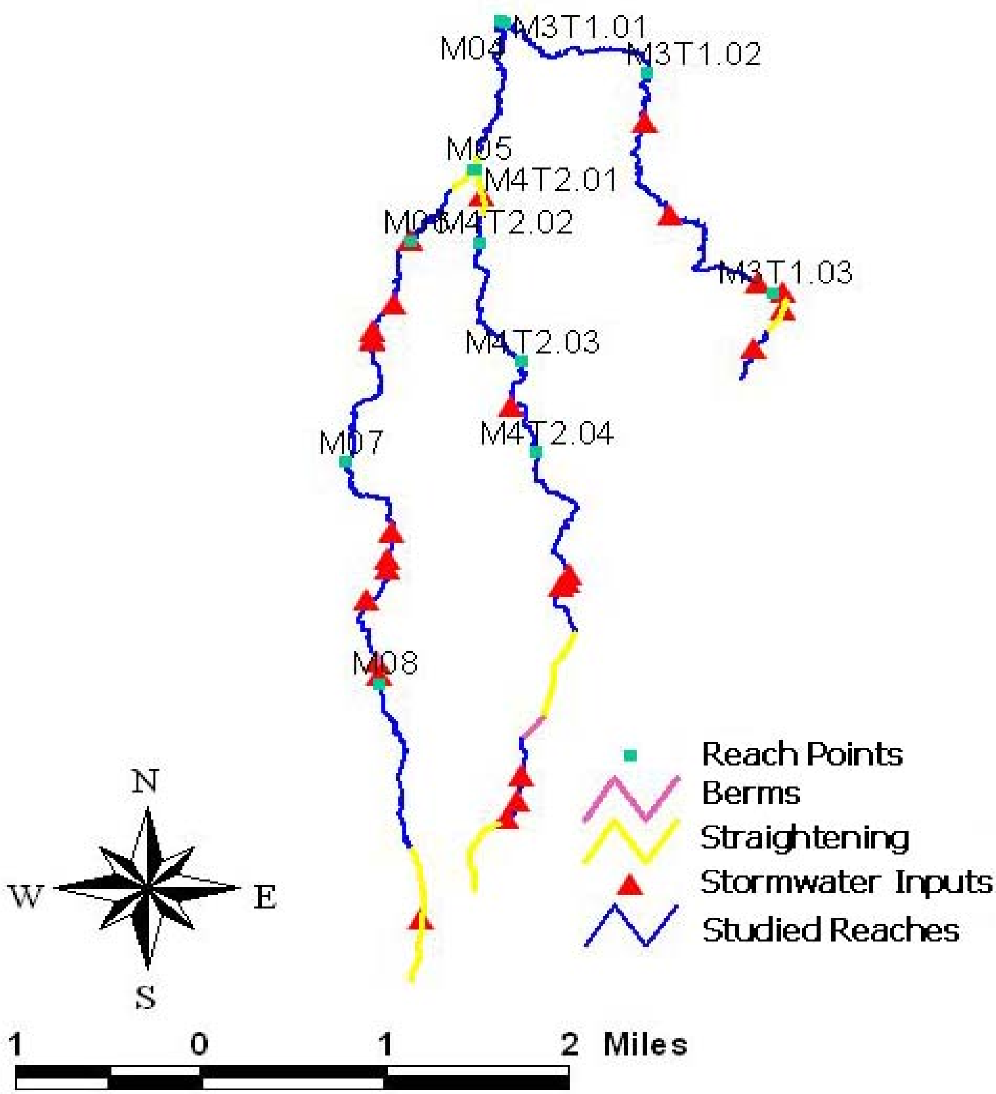

Figure 25 Sediment Transfer Zones

5.3 Sediment Attenuation Zones

Sediment can be stored one of three ways in a stream system: channel deposits, alluvial fans and deltas, and floodplain deposits. When a stream is straightened, for example, it is harder to form stream deposits and lots of time will also lose connection with its floodplain. This leaves one option for sediment attenuation, a delta (Missisquoi River). For a stream to be in an equilibrium state all three must be available for sediments.

Bars are transient features that often move in every high water event. In specific locations, where the channel has been straightened (see table 5), no in channel bars were observed This means that sediment is moving further downstream than it would if the stream was in an equilibrium state.

Incision greater than 1.4 was observed in five different reaches. These reaches have lost access to their floodplain and the ability to leave behind floodplain deposits. Incision also causes greater hydrologic pressure moving bars further downstream in high water events.

Beavers can be found on both tributaries studied. These some times pesky animals, offer sediment attenuation via floodplain deposits and remain a crucial part to any river systems equilibrium. These areas where beavers already exist should be conserved and protected.

5.4 Sensitivity Analysis

In the mid 1800's the federal government passed legislation known as the Swamp Land Acts, which established an official policy to fill and drain wetlands to convert them to agricultural uses wherever possible. Since then, farmers and ranchers, supported by both the federal and state programs, have worked industriously to transform swamplands into fields and pasture. Residential and commercial development has also contributed to the lost. (Thompson and Turk, 1993)

Only in the last three decades have the importance of wetlands in and around the stream corridor been realized. State and Federal governments have now changed the focus of laws from destruction of wetlands to protection and preservation. By doing so, they wish to prevent loss of natures water treatment and attenuation systems.

In addition to the ongoing vertical and lateral adjustments occurring to the channel, the stream sensitivity analysis examines susceptibility of the reach to start adjusting if there are changes in the corridor and/or watershed. Most channel adjustments occur during and after a high flow events when the power to overcome the resistance of the boundary material is achieved. This process can be a concern when looking at an incised reach. It can also be a positive mitigating factor on another reach. Streams with more resistant boundaries (such as the clays found on the banks of the Hungerford) do not adjust very quickly.

When designing stream corridor projects and management practices, it also important to know the sensitivity so one may prioritize. The Hungerford Brook and its tributaries had three reaches that were in the moderate category for stream sensitivity: M07A, M4T2.02 and M4T2.03. All other reaches and segments were either in the high or very high categories. Passive rather active restoration techniques work best for sensitive streams due to the multiple stressors.

Figure 26 M06 Very High Sensitivity Rating with Multiple Channel Stressors

Passive restoration techniques include establishment of corridor areas with improved woody buffers, adoption of agronomic and soil conservation practices or easements to prevent future development of infrastructure in the erosion hazard risk zone. Active restoration techniques include repair and resizing of culverts, stabilization of eroding stream banks, restoration of floodplain access and in-stream wetland creation/restoration. Active restoration techniques are often costlier with unsure certainty for long-term success without an integrated “watershed” approach.

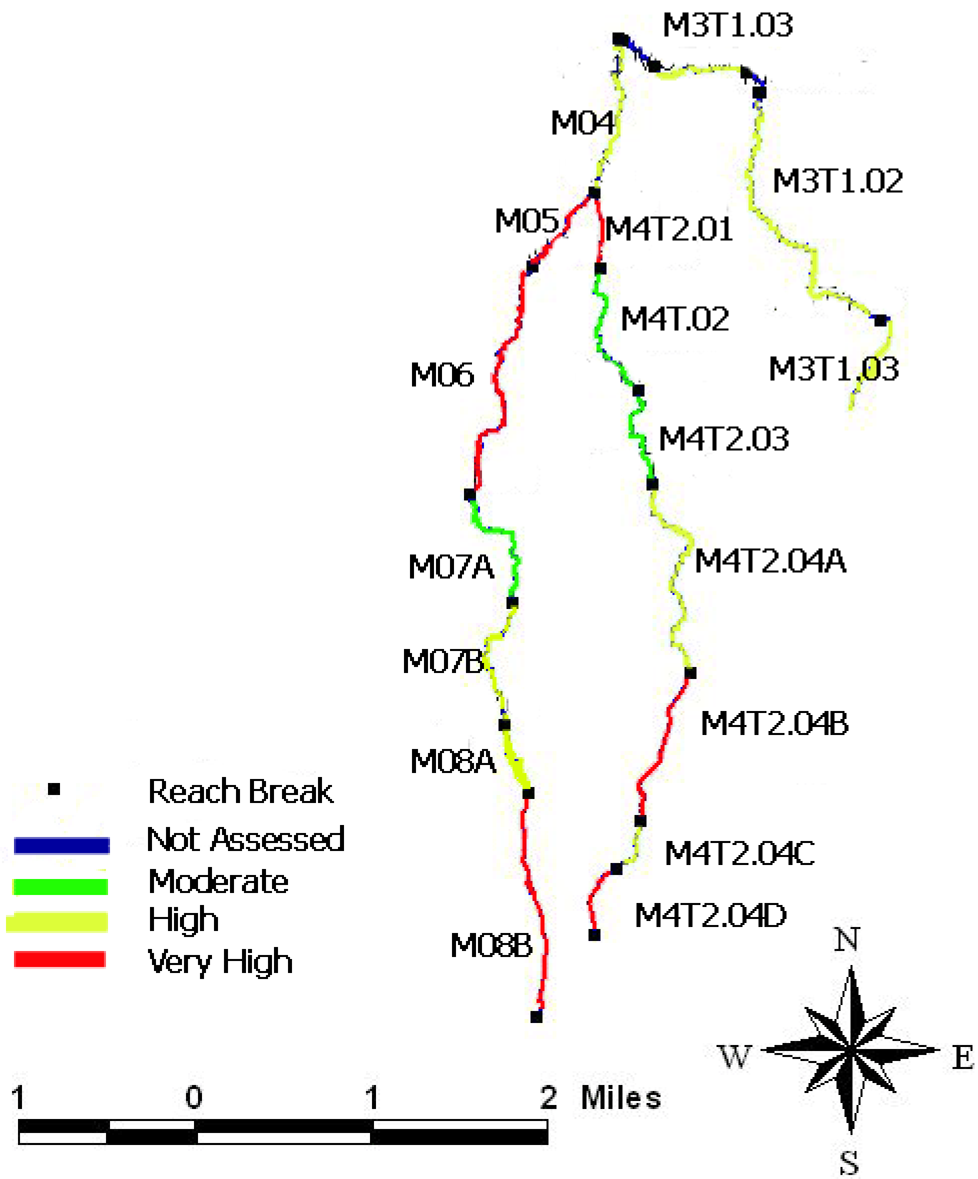

Figure 26 Stream Sensitivity

6.0 Preliminary Project Identification

Landowners, community members, schools, and resource agencies can use this Phase 2 Assessment data for the Hungerford Watershed to implement projects and manage the watershed. For each reach or segment the sensitivity, degree of departure, and active adjustment processes will define the restoration options, management strategies, and conservation options. VTDEC River Management Section has developed guidelines for classifying reaches / segments into potential management approaches based on geomorphic characteristics (VTDEC, 2005):

- **Equilibrium –** Stable Reference
- **Equilibrium –** Minor Adjustment
- **Unstable –** Moderate Departure
- **Unstable –** Downcutting
- **Unstable –** Severe Departure

Active approaches such as stream bank stabilization and tree plantings are appropriate for reaches with a severe departure from reference condition. Active geomorphic approaches are costly and can sometimes fail, however when the stakeholder wants to return the river to more natural state at an accelerated rate this is the only option. Active approaches are also affective when the stakeholder is losing infrastructure or property.

Passive approaches are nature’s way of returning the river to a more natural state. Passive approaches to geomorphic restoration involve management strategies and insurance that the corridor will not be encroached by development. Information from this assessment will be important in developing corridor management strategies.

If the rivers corridor is protected and managed, the river will return to a reference state. Often times a passive approach to geomorphic restoration is the best approach. Once you start active approaches to restoring reference geomorphic conditions you run the risk of failure and further damage to the channel and corridor. By refraining from altering the channel (straightening, dredging, etc.) the channel will remain connected with its floodplain. Generally, passive approaches to channel and floodplain restoration and conservation are most appropriate for reaches / segments in the following stream condition categories (VTDEC RMS, 2005):

-Equilibrium – Stable Reference - where conservation of the corridor can serve to protect stream equilibrium conditions and ecological processes within the riparian corridor.

- Equilibrium – Eroding Banks – High Recovery Reach where restoring channel boundary conditions (vegetation, to increase roughness elements

- Unstable – Moderate Departure.

Preserving the few sediment attenuation areas along the Hungerford Brook and its tributaries is crucial for storage of sediment. Areas where land use does not conflict the conservation of the corridor are prime candidates.

Buffers are an important part of corridor management. Buffers provide filters for sediments and nutrients and help dissipate energy from erosive high water flows. They also provide material for detritus, large woody debris and debris jams. Without buffers there is no continuous corridor for wildlife and loss of habitat.

6.1 Equilibrium- Minor Adjustment

The following table (table 4) shows reaches that are believed to be in minor adjustment. These reaches are all in stable condition and are reference stream types for this type of stream.

Table 6 Minor Adjustment Reaches

Reach	Segment	Stream Type	RGA Score	CEM	Sensitivity
M08	A	E4	.63	F I Stable	High
M07	A	C3	.70	F I Stable	Moderate
M04		C5	.61	F I Stable	High
M4T2.04	A	E4	.54	F I Stable	High
M4T2.03		E5	.83	F I Stable	Moderate
M4T2.02		E5	.88	F I Stable	Moderate
M3T1.03		E4	.69	F I Stable	High
M3T1.02		C4	.70	F I Stable	High
M3T1.01		E5	.68	F I Stable	High

Abbreviations: RGA= Rapid Geomorphic Assessment, CEM= Channel Evolution Model

Reaches that may have undergone minor adjustments to planform, and widening but still are in equilibrium are in this category. These reaches typically have stable banks and few stressors. Minor erosion, storm water inputs, channel constrictions and direct access by cattle can be found in a few locations but do not affect the equilibrium of the channel. Reaches in Minor Adjustment are very important to conserve and manage. With added stressors any one of these reaches could become unstable and lose its equilibrium.

Reaches in Minor Adjustment can be restored to reference state using various methods of passive restoration. The following are passive restoration techniques that may be appropriate:

- Protect River Corridors
- Plant Stream Buffers
- Stabilize Stream Banks (exclusion of cattle)
- Management Strategies to help keep infrastructure out of corridor
- Remove/ Replace undersized culverts and bridges
- Removal of Infrastructure in the corridor

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6.2 Unstable- Moderate Departure

The following table (table 5) shows reaches believed to unstable with a moderate departure. None of these reaches are in stable condition. M4T2.04 reaches have undergone a stream type departure but it may be reversed using simple passive techniques such as removal of berms from the corridor.

Table 6 Moderate Departure

Reach	Segment	Stream Type	RGA Score	CEM	Sensitivity
M08	B	E4	.51	F II Incision	Very High
M06		E5	.46	F II Incision	Very High
M4T2.04	B	B5	.53	F II Incision	Very High
M4T2.04	C	B4	.50	F III Widening	High
M4T2.04	D	G5	.46	F II Incision	Very High
M07	B	C5	.64	F II Incision	High

Abbreviations: RGA= Rapid Geomorphic Assessment, CEM= Channel Evolution Model

The reaches in table 5 indicate a moderate degree of channel adjustment. This is due to past and present stressors and channel management. M4T2.04 and M08 have been straightened and now are incised. Channel straightening may result in bed and bank erosion stemming from increased incision. The transport capacity is increased and the straightened channel now also works as a sediment transfer zone conveying its increased sediment load downstream.

These reaches are not rated as severely departed thanks to the cohesive banks, occasional riparian buffers, and bedrock grade controls. However, if these stressors continue and multiply these reaches could become severely unstable. The following are passive and active restoration techniques that may be appropriate:

<u>Passive</u>

- Protect River Corridors
- Plant Stream Buffers
- Stabilize Stream Banks (exclusion of cattle)
- Management Strategies to help keep infrastructure out of corridor
- Remove/ Replace undersized culverts and bridges
- Removal of Infrastructure in the corridor

<u>Active</u>

- Restore floodplain connection to historically straightened or bermed reaches

6.3 Unstable Severe Departure

The following table (Table 5) highlights two different reaches that are severely departed from their original state.

Table 8 Unstable Severe Departure

Reach	Segment	Stream Type	RGA Score	CEM	Sensitivity
M05		E	.48	F II Incision	Very High
M4T2.01		G	.49	F II Incision	Very High

Although M05 has not yet undergone a Stream Type Departure it is inevitable. Possibly due to the cohesive soils it has remained a reference stream type. Headcuts migrating from this site have caused it to be placed in the severely departed category even though it has not yet undergone a stream type departure.

The downstream portions of both reaches M4T2.01 and M05 have undergone major channel alterations. The brooks corridor is encroached by crop land and there is little to no woody buffer. The culvert under the Woods Hill Road on M4T2.01 serves as a transient grade control that could wash out in a high water event. M05 however flows under a bridge constricted by boulders. Upstream of these boulders, depths of water in the channel ranged from 4.0' to 6.0'. Data shows access to flood plain is lost upstream of Woods Hill Road due to increased degradation caused by increased hydrologic pressure.

Figure 27 Woods Hill Road M05 and M4T2.01

Active restoration techniques may be needed in these two reaches provided the restoration is sustainable. Active restoration designs may include; (1) lowering the stream bank to reconnect the channel with its floodplain; (2) possible replacement of undersized crossings; (3) enhancement of flow and sediment attenuation areas upstream; (4) create meander bends that mimic those found upstream and downstream

Passive restoration techniques may also be used on these two reaches to restore woody buffer, and stabilize stream banks.

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7.0 References

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Appendix A

August 21, 2006

Dear Landowners,

The Town of Swanton has received a grant from the Vermont Department of Environmental Conservation (DEC) to conduct geomorphic assessments and identify corridor projects within the Hungerford Brook watershed. The main purpose of this project is to identify areas of active river channel adjustment and stream bank erosion, and work with willing landowners to address priority areas. Assessment data can be used to improve water quality by reducing stream bank erosion, sedimentation and phosphorus loading to the Hungerford Brook and Missisquoi Bay. This data can also be used to reduce future flood erosion losses.

Brendan O'Shea of Carmi Consulting in Franklin, VT will lead the assessment team which will measure and record many aspects of the stream such as slope, width, depth, geologic material, erosion, culvert condition and access to the flood plain. Most measurements will be collected within the stream channel and stream banks, but the assessment team will at times need to briefly and discreetly cross local properties to access the streams. Please contract Dick Thompson, Swanton Town Administrator, 868-7418, swanadm@adelphia.net or Brendan O'Shea, Environmental Consultant, brendanboshea@yahoo.com, if you have any questions about the project or object to the assessment team crossing your property. Volunteers are welcome to participate where appropriate.

Field work will begin on September 1st and will continue throughout the fall. A kick off meeting for landowners and other interested parties will be held on September 19th at 7:30 pm in the Swanton Town Office after the Select Board meeting. The Public is welcome to attend and voice any concerns and or suggestions. Another meeting will be held in early winder to present the results of the assessment. The Town of Swanton and its partners anticipate that this effort will lead to applications for funds to develop and implement projects within the Hungerford Brook watershed.

Thank you,

Harold Garrett
Select Board Chair

December 18, 2006

Dear Landowners,

In the fall of 2006, the Town of Swanton received a grant from the Vermont Department of Environmental Conservation (DEC) to conduct geomorphic assessments and identify corridor projects within the Hungerford Brook watershed. The main purpose of this project was to identify areas of active river channel adjustment and stream bank erosion, and work with willing landowners to address priority areas.

Assessment data can be used to improve water quality by reducing stream bank erosion, sedimentation and phosphorus loading to the Hungerford Brook and Missisquoi Bay. This data can also be used to reduce future flood erosion losses.

The assessment of the Hungerford was a complete success thanks to the cooperation of the landowners and community members. If you would like to know more about the results of this study or get more information on the Hungerford Watershed stop by your local town office and check out a copy of “The Phase 2 Assessment of the Hungerford Watershed.”

Thank you,

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Appendix B

Hungerford RMP – QA 1-26-07

The review of the Hungerford data was done by Staci. Data from both Phase 1 and Phase 2 was reviewed. The DMS and ArcView projects were also used to help support review of data. Information from both phases was used to help look at what may be occurring on the reach/segment as noted in the Phase 2 information.

The first QA review of the Hungerford project was done in December 2006. As the consultant, Carmi Consulting, is new to this process, the first set of QA comments and needs were reviewed in a meeting between RMP and Carmi Consulting. Some of the things that were addressed were: cross-sectional information, an error caught in how segments had been assigned in SGAT – which caused errors in the way the DMS was uploaded, and reevaluating some of the RGA scores given the types of adjustments seen in the field form. The original copy of the DMS reports and notes will be retained by RMP as documentation for QA prior to current DMS reporting.

Carmi Consulting has reviewed and updated information given the QA needs identified in the first review. A written list of what changes were made on a reach was provided to RMP with the original DMS reports to assist with a second QA review. The second QA review showed that overall the Hungerford Brook Phase 2 data is well done. Many of the reaches had very good comments and narratives that explained nuances or specific considerations with the data. These comments and narratives should be referred to when using the data to insure that those nuances or considerations are incorporated in the use of the data.

Listed below are comments and the general types of errors/questions for particular steps and then those specific to a reach. These comments and questions are intended to: help insure that the data is as accurate as possible, allow for further explanation by the consultant who collected the data, point out areas where there may be issues that need to be addressed and/or recognized in using the data, and help document things that came up as data was reviewed. After review of the information noted, the consultant should update the document with what steps, if any, were taken to address the comments/questions.

Step 1.3 (Corridor Encroachment) and Step 3 (Erosion and Revetment lengths):

The original upload of the data table into the DMS was not correct. Due to incorrect segmentation in the SGAT some lengths of encroachments and erosion/revetment were wrong. The segmentation was corrected and now the data is both cleaner and more accurate.

Step 2, 4- Step 6: No general comments, specific reach related questions noted below.

Specific Reach Questions and/or Comments:

- **M07B –** In step 3.1 the lower bed material type is noted as "boulder/cobble". There is a low percentage of boulders and cobbles, 4% & 6 %, respectively. Is boulder / cobble still appropriate for the dominant bank texture for the lower banks?

This is what was observed for the whole segment. At the cross section there might have been a smaller amount of boulders and cobbles.

- **M08 A –** With a incision ratio of 1.3, a channel evolution stage of "I" may be right on the cusp of the stable stage. Potentially consider a "II" if there are other cross-section and/or notes that suggest that stream has incised.

This reach is definitely on the cusp of becoming incised. However, due to good corridor and transient grade control downstream (Bushey Road Culvert) I placed it in the stable category. This reach in particular could easily lose access to its floodplain with added stressors, a good conservation area.

- **M3T1.01A -** In step 4.4, there is one debris jam noted; there is no LWD noted in step 2.12. Is this jam made up of smaller materials?

The LWD count was not uploaded for this "not assessed reach." I will upload that information.

- **M3T1.01C -** For step 4.9, length of stream affected by beaver dam, the length in the original DMS report was 200ft; the current value is 720 ft. Please confirm which value is correct.

The second value is the correct one. Segmentation in the first upload was incorrect but was corrected for the second upload.

- **M3T1.02 -** There are 2 beaver dams noted in step 4.9, with almost 1,200 ft of stream affected; in the original DMS report this was 2,100ft. Please confirm which value is correct. Also, this is a significant length of stream, could this have been a separate segment or are these two beaver dams scattered in the reach?

The second value is correct. The beaver dams were located in the lower area of the reach. The reach however is 13,208' in length. The beaver dams affected areas similar to those without beaver dams and it was felt that more information would be gathered if the dams were not segmented out.

- **M4T2.01 -** The stream type is listed as an "B". Cross-sectional measurements (entrenchment 1.89 and width/depth 6.5), do not support this stream type. There is the allowance of a +/- 0.2 for entrenchment and +/- 2 for width depth, that may shift a stream type. These values do not appear to fit easily within any of the choices available. Is there additional cross-sectional data that supports the choice of stream type? While it is more than a +/- 0.2 for entrenchment, the stream type that may fit this would be a "G" (entrenchment <1.4 and width/depth <12). If Carmi Consulting does not feel confident either way, RMP staff will work with you to determine what may be the best fit, and how to address the apparent discrepancy with cross-section values in assigning a stream type.

If management decision will be made along this reach, it is strongly suggested that additional cross-sections be collected to confirm stream type and stream type departure. Stream type chosen for this reach does not fit the typical values indicated in the stream type table. A "Gc" was chosen to best fit the entrenchment and width/depth values that were obtained at this cross-section location and the slope of the overall reach. A "Bc" would also fit for this reach.

- **M4T2.03 -** A Phase 1 reference stream type is listed as "C". The Phase 2 stream type is "E". The reach appears to be in "good" condition, no incision is noted, and low erosion is noted over the 4,491 ft of the reach. Would an "E" for a reference type be appropriate; or is there a stream type departure from the C to E?

Reference stream type has been changed to E.

- **M4T2.04C -** The original DMS report for pebble count showed no cobble materials, and it was noted that in Step 2.13 there had been a cobble size noted for average largest particle, did this still seem appropriate. The updated form now different % for all fields, and has 30% cobble, please confirm that this is true values and not data created to satisfy original question.
  - The incision ratio is 1.56, and in the RGA under degradation, the "historic" is noted as "no". Is there still evidence of degradation happening? It is noted in the narrative, that there is a little bit of aggradation and incision from upstream straightening, ditching". Are there some clues that the incision is still happening? Should the reach be looked at for addressing this incision before it travel upstream?

  The expected Q2 is 41.2 cfs. If I use my new visual estimate for the pebble count (mannings .044) and change the BF to 2.2 in the xs I get a cfs of 60. This changes the stream type to a B and greatly increases the ER to 1.4 . The IR is also changed to 1.7. This seems more accurate to me given the data. This would also mean however an STD has occured and the CEM would probably be a F III (widening, w/d of 20). This all makes sense though given the surrounding straightened and ditched channels. Increased hydrologic pressure from numerous straightened channels in its basin has caused the stream to lose its equilibrium even though the corridor is in good shape.
- **M4T2.04D -** In the narrative there is a comment that the reach is "actively incising". For step 7.1 Degradation the "historic" is checked as "yes", there does not appear to be any head cuts or other clues that this is still active. What other clues were looked at for considering this actively incising? Does this statement still seem appropriate?

Changed the narrative to “historically cut off from flood plain using excavator.”