Hungerford Brook
Corridor Plan

Franklin County
April 2008

Prepared for:
Northwest Regional Planning Commission
155 Lake Street
St. Albans, VT 05478

Prepared by:
The Johnson Company, Inc.
100 State Street
Montpelier, VT 05602

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The Johnson Company
ENVIRONMENTAL SCIENCE AND ENGINEERING SOLUTIONS

ph (802) 229-4600
fax (802) 229-5876
100 State Street, Suite 600
Montpelier, VT 05602
www.johnsonco.com

April 25, 2008

Ms. Bethany Haase Remmers
Northwest Regional Planning Commission
155 Lake Street
St. Albans, Vermont 05478

Re: Hungerford Brook Corridor Plan
Franklin County, Vermont
JCO Project No. 1-1470-9

Dear Ms. Remmers:

The Johnson Company is pleased to present the following Hungerford Brook Corridor Plan to the Northwest Regional Planning Commission.

Should you have any questions or require additional assistance, please do not hesitate to contact The Johnson Company at (802) 229-4600. Thank you for the opportunity to be of assistance to the NRPC on this project.

Sincerely,
THE JOHNSON COMPANY, INC.

By: _____
Adam Robtoy
Project Scientist

cc: Staci Pomeroy, VT RMP

Reviewed by: SAS

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EXECUTIVE SUMMARY

Hungerford Brook is a moderately sized tributary to the Missisquoi River and drains approximately 19.5 square miles. The stream corridor extends from its confluence with the Missisquoi just downstream of Highgate Falls south to just east of St. Albans City and is roughly bordered to the east and west by Route 105 and Interstate 89. Hungerford brook flows through the towns of Highgate, Swanton, Sheldon, Fairfield, and St. Albans. This River Corridor Plan focuses on the mainstem upstream of Reach M04, as well as the two main tributaries M3T1 and M4T2. The project study area is shown on Figure 1.

Development of this Plan was a collaborative effort between The Johnson Company, Northwest Regional Planning Commission (NRPC), Vermont Rivers Management Program (RMP), and members of the steering committee which included representatives from Vermont Agency of Agriculture, United States Fish and Wildlife Department, Vermont Agency of Natural Resources Center for Clean and Clear (VT ANR CCC), and Missisquoi River Basin Association (MRBA). Funding for the project was provided through a grant from RMP to NRPC. The Corridor Planning Process involves the integration of fluvial geomorphic assessment data, and the goals and objectives of the local community to formulate scientifically sound and ecologically beneficial river restoration and conservation projects that will not only improve water quality, but also improve the community's relationship with the river.

The main goal of the Vermont River Management Program is to manage toward, protect, and restore the fluvial geomorphic equilibrium condition of Vermont rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner (VT ANR 2007). The objectives are fluvial erosion hazard mitigation, sediment and nutrient load reduction and attenuation, and aquatic and riparian habitat protection and restoration. Improving water quality in Hungerford Brook is also part of the larger effort to restore and sustain water quality in Lake Champlain. VT ANR CCC has developed a Draft Work Plan (2007) to serve as a model for improving water quality in the Lake and around the entire state. In order to implement a systematic approach in both developing and implementing water quality improvement projects, the Center will initially focus efforts on northern Lake Champlain, including the Hungerford Brook Watershed (VT ANR CCC 2007). This Corridor Plan is designed to fit within the framework described in the Work Plan, and is an initial step in beginning to develop river conservation and restoration projects with the watershed.

Phase 1 and 2 fluvial geomorphic assessments were conducted on sixteen reaches within the watershed in 2005, 2006 and 2007. Fluvial geomorphology is the study of physical river processes that occur in different landforms and geologic settings. It utilizes the collection of physical data such as channel width and depth, floodplain characteristics, and bed and bank conditions to evaluate how streams are adjusting from their expected norms (or equilibrium condition) and predict what sorts of adjustments are likely to occur in the future. The Phase 1

assessments were performed by the Northwest Regional Planning Commission and South Mountain Research and Consulting. The Phase 2 assessments were performed by Carmi Consulting and The Johnson Company. All of the assessments were performed in accordance with the most recent version of the Vermont Agency of Natural Resources (VT ANR) Stream Geomorphic Assessment Protocols (VT ANR 2007). The Phase 2 assessment results indicated a great deal of stream channel adjustment occurring in the watershed. A significant amount of historic channel alterations including straightening, dredging, and ditching were noted. These channel alterations, in conjunction with the intensive agricultural land use and growing residential development, have caused most of the assessed reaches to undergo some degree of channel incision, or downcutting, where the stream erodes into its bed and the stream no longer has complete access to it floodplain during high flow events. The incision, coupled with a lack of adequate woody riparian vegetation has led to a reduction in sediment and nutrient storage capacity, and an increase in nutrient inputs. The goals of the River Corridor Planning process are to identify restoration and conservation projects which can help restore balance to the river system, and reduce the impact of these stressors.

Watershed and reach scale stressors were evaluated for each reach including hydrologic alterations, land use and land cover changes, sediment regime stressors, channel slope and depth modifiers, boundary conditions and riparian modifiers. Changes to sediment regime and reach sensitivity to future adjustments were also evaluated. Figures and Tables were created to allow for in-depth evaluation of how each of these stressors has contributed to the current condition of the study reaches, and how that differs from the expected reference (or equilibrium) condition. Appropriate restoration and conservation techniques were developed for each reach, and a comprehensive Project and Practices Summary Table was created to prioritize the identified restoration and conservation strategies.

In summary, the findings of this Corridor Plan are as follows:

- Historically, most of the Hungerford watershed acted as a sediment and nutrient attenuation zone, where incoming fine sediments from upstream were stored on the floodplain, and inputs of coarse sediment were essentially in balance and equal to outputs of coarse sediment.
- Due to the historic and ongoing adjustment processes and stressors documented in the watershed, it has largely been transformed into a sediment and nutrient source and transport zone where floodplain access is limited and sediment and nutrients are funneled through the system to downstream receiving waters.
- The highest priority projects for the watershed are those that attempt to restore the sediment and nutrient attenuation assets which once dominated the system.
- Other recommended project types include riparian buffer enhancement to filter out excess nutrients, help stabilize streambanks, and provide shade and cover to improve aquatic habitat, and replacement of undersized bridges and culverts to reduce channel constrictions, restore normal flow patterns, and improve aquatic habitat.

Overall, the Hungerford Brook watershed is still largely undeveloped and provides significant opportunities for river corridor restoration. Obviously, there is a large amount of human investment within the river corridor, primarily in agricultural land, but also in homes, businesses, and infrastructure, but the goals of this and other river corridor plans is to find areas within the watershed where a balance can be reached between these human investments and the health and wellbeing of river systems. Some of the larger scale active restoration projects may require conversion of considerable acres of agricultural land to floodplain and buffer; however, considerable strides may also be made through implementation of relatively narrow buffer strips and other agricultural best management practices. A complete list of recommended projects for the study area is included in Table 21 at the end of this report along with maps showing the various project areas which are included as Figures 16 through 32.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION AND PROJECT OVERVIEW

Hungerford Brook is a moderately sized tributary of the Missisquoi River and drains approximately 19.5 square miles. The watershed extends from its confluence with the Missisquoi just downstream of Highgate Falls south to just east of St. Albans City and is roughly bordered to the east and west by Route 105 and Interstate 89. Hungerford brook flows through the towns of Highgate, Swanton, Sheldon, Fairfield, and St. Albans. This River Corridor Plan focuses on the mainstem, upstream of Reach M04, as well as the two main tributaries M3T1 and M4T2. The project study area is shown on Figure 1.

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The main goal of the Vermont River Management Program is to manage toward, protect, and restore the fluvial geomorphic equilibrium condition of Vermont rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner (VT ANR 2007). The objectives are fluvial erosion hazard mitigation, sediment and nutrient load reduction and attenuation, and aquatic and riparian habitat protection and restoration. Improving water quality in Hungerford Brook is also part of the larger effort to restore and sustain water quality in Lake Champlain. VT ANR CCC has

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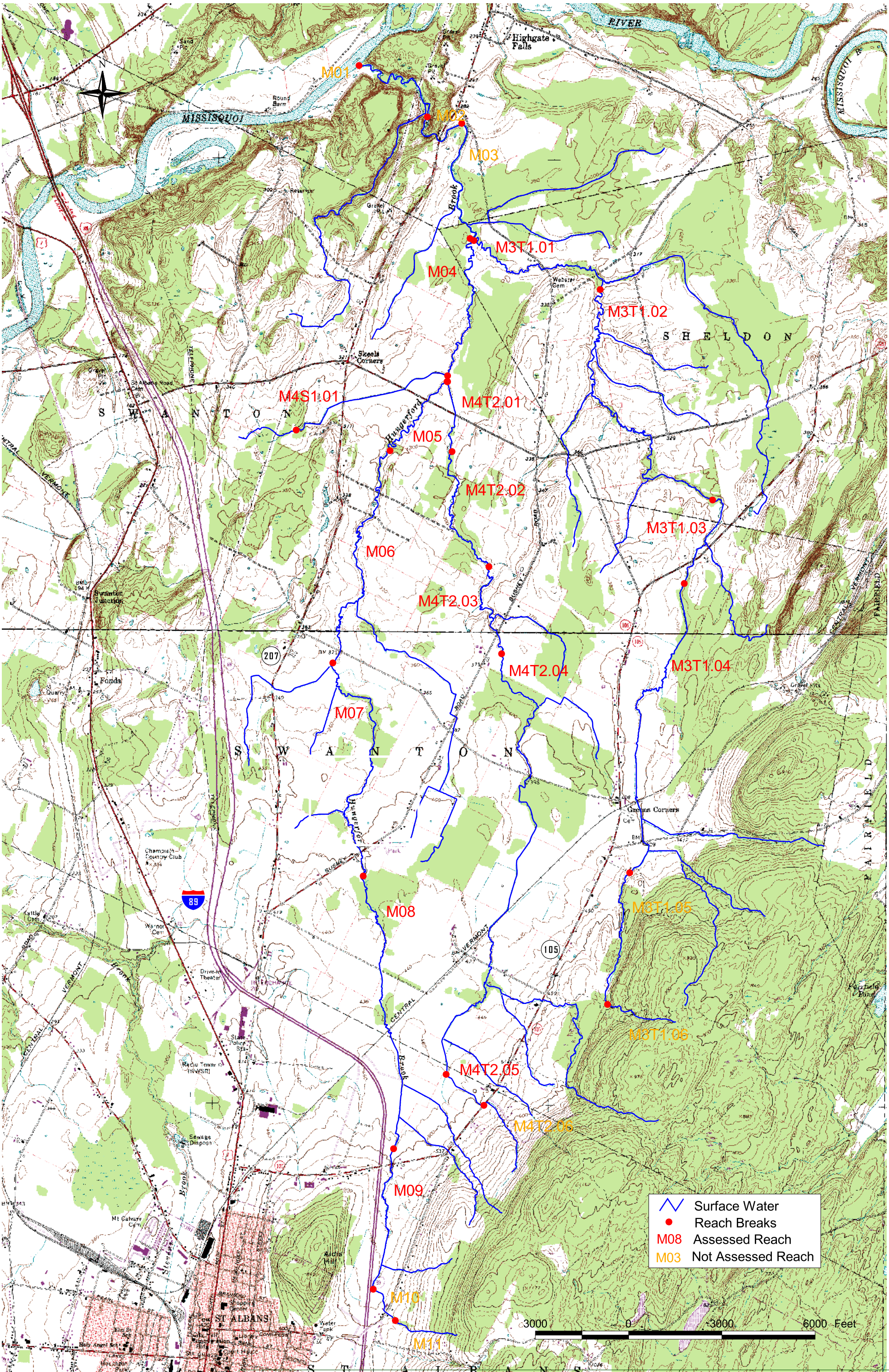


FIGURE 1 SITE LOCATION MAP
HUNGERFORD BROOK WATERSHED
STUDY AREA

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 3/4/2008 PROJECT: 1-1470-9
DRAWN BY: NBR SCALE: As shown above

2.0 BACKGROUND INFORMATION

2.1 GEOGRAPHIC SETTING

2.1.1 Watershed Description

The Hungerford Brook watershed lies within the towns of Swanton, St. Albans, Sheldon, Highgate, and Fairfield and encompasses approximately 19.5 square miles. The watershed elevation ranges from approximately 200 feet above mean sea level at the confluence of Hungerford Brook and the Missisquoi River to 570 feet above mean sea level at the southern end of the stream near St. Albans. Hungerford Brook is part of the larger Missisquoi River basin and empties into the Missisquoi below Highgate Falls, near Lake Champlain. Locations of the sixteen stream reaches included in this Corridor Plan (approximately 22 linear miles) are shown on Figure 1 above.

2.1.2 Political Jurisdictions

The entire study area lies within Franklin County, Vermont in the towns of Swanton, St. Albans, Sheldon, Highgate, and Fairfield. Nearly all lands within the watershed are privately owned with the exception of Town and State owned roads, bridges, and culverts.

2.1.3 Land Use History and Current General Characteristics

Hungerford Brook watershed lies within Franklin County, one of the most intense agricultural areas of Vermont. The first inhabitants of the area were likely Native Americans who were utilizing the Missisquoi River and surrounding lands for hundreds of years before the first European settlers arrived in the late 1700s. Archealogical evidence suggests that Native Americans had an established settlement in what is now the Town of Swanton as early as 800 B.C. (Swanton Chamber of Commerce, 2005). From the time the first European settlers moved into the region, agricultural activities began to dominate the region. Like many other areas of the State much of the forested land had been cleared by the late nineteenth century to accommodate the wool industry and other agricultural activities. Beginning in the early twentieth century, much of the forestland began to return and dairy farming expanded to become the dominant agricultural activity. Currently, a large portion of the Hungerford Brook watershed is occupied

by dairy related agricultural fields and farms. Sparse residential development is also present with an increasing number of homes and subdivisions built in the last few decades. This land use evolution has been documented as an ongoing source of the hydrological changes which have taken place in many Vermont watersheds and will be discussed in more detail in Section 4.

2.2 GEOLOGIC SETTING

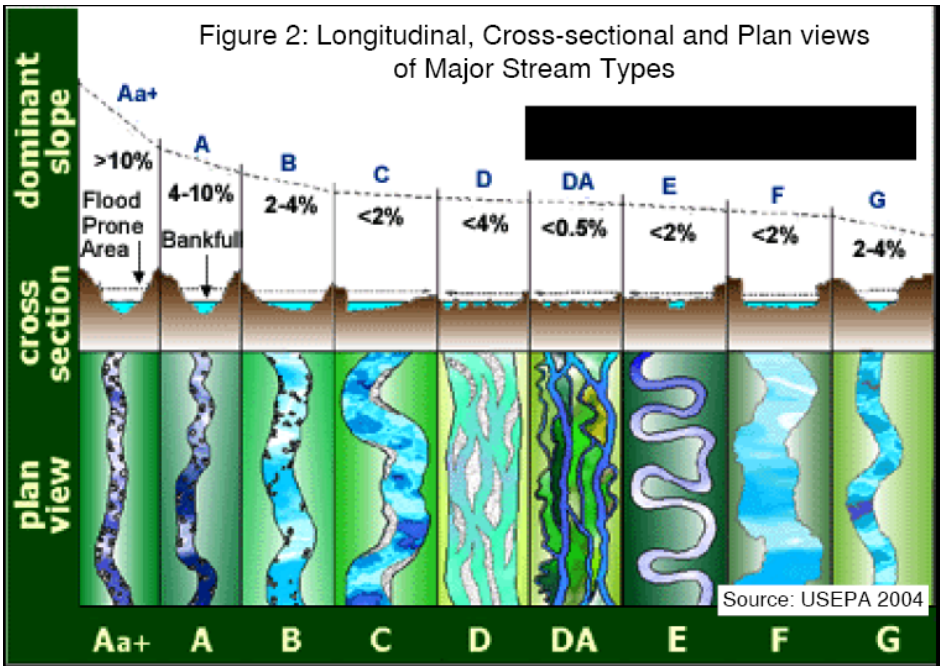
Hungerford Brook watershed is located to the west of the Green Mountain province in higher elevation areas of the Champlain Valley province that surrounds Lake Champlain. The study area, like all of Vermont, was covered by glaciers as recently as 10,000 years ago. These glaciers left exposed bedrock along the ridge tops and deposited glacial till at lower elevations. This bedrock and till comprise a majority of the valley walls within the watershed while a majority of the river corridor is comprised of less cohesive, silts, clays and sands. Bedrock in the study area is dominated by shales and slates that were deposited as sedimentary mudstones in an ancient sea 450 to 550 million years old. Smaller occurrences of limestones, dolomites, and quartzites are present. The topography of the Hungerford watershed reflects the alignment of the underlying bedrock, draining generally to the north and bounded by erosion-resistant quartzite at the foothills of the Green Mountain Province to the east and dolomites along the north-northeast trending Champlain Thrust fault to the west (Doll, 1961 and Carmi Consulting, 2006).

The surficial geology reflects glacial and post-glacial depositional events in the Hungerford watershed area. Marine beach gravel and wave washed till comprise the southern portions of the study area, lake bottom sediments and marine clay deposits of silt, silty clay and clay comprise the middle portion of the study area, and marine clay and alluvial deposited sand, gravels and silt near the confluence of Hungerford Brook with the Missisquoi River comprise the northern portion of the study area (Stewart and MacClintock 1970 and Carmi Consulting, 2006). Soils in the study area are dominated by deep, moderately to poorly drained silt and clay loams predominantly associated with the following series: Massena, Lyons, Munson, Buxton, Windsor, and Missisquoi (USDA SCS 1976).

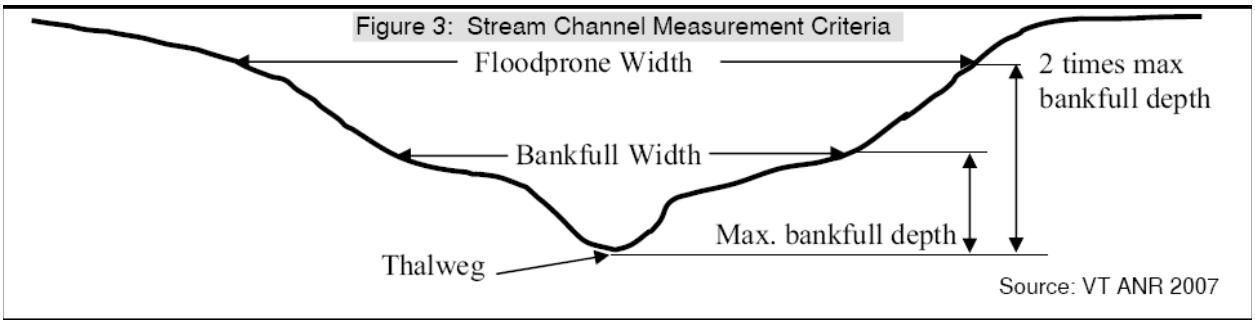
2.3 GEOMORPHIC SETTING

The watershed was divided into 66 reaches during Phase 1 assessment; 12 reaches had Phase Two assessments completed in the summer of 2006, and four additional reaches had Phase Two assessments completed in the summer of 2007. Each reach was delineated based on physical characteristics such as slope, sinuosity, valley confinement, and hydrologic characteristics, determined by remote sensing techniques in the Phase One geomorphic assessment. The locations of the assessed reaches are shown on Figure 1. Below is a summary of the Phase 1 Geomorphic results which describe the expected, or reference, condition for the study area. These data describe what one would expect the river system to look like in its natural state with no anthropogenic influences.

Channel slopes for the study area reported in the Phase 1 assessment ranged from 0.02% (M04) to 2.90% (M4T2.05) with most reaches having slopes less than 1%. Relatively large valley widths were reported for all studied reaches ranging from just over 200 to nearly 700 feet. Reference bankfull widths ranged from 7 to 37 feet. Based on the Phase 1 data, 14 of the 16 studied reaches have an E reference stream types characterized by slopes of less than 2%, moderate to high sinuosity, and substrate ranging from sand to boulder. The remaining 2 reaches were characterized as C-type streams. Figure 2 below shows the characteristics of various stream types (A through G) and how they appear in plan and cross section views (US EPA 2004).



Stream typing involves classifying reaches based on combinations of physical parameters such as valley landform, channel dimensions, slope, sediment supply, and bed forms, which indicate the fluvial processes at work in a river reach. Streams are placed into different stream types based on their entrenchment, width to depth ratio, sinuosity, channel slope, substrate size, and bed features (VT ANR 2007). The first stream type descriptor is a capital letter (A through G) that describes the entrenchment ratio (equal to floodprone width divided by bankfull width) and width to depth ratio (equal to bankfull width divided by average depth). Figure 3 below shows how each of these ratios is measured (VT ANR 2007).



The second descriptor is a number (1 through 6) used to describe the dominant bed substrate in decreasing order: 1 – bedrock; 2 – boulder; 3 – cobble; 4 – gravel; 5 – sand; and 6 -

silt. The third descriptor is a lower case letter which describes the channel slope: a = slope >4%; b = slope 2-4%; and C = slope <2%, though this descriptor is only used if the channel slope falls outside the normal range typically found for that stream type (shown in the Figure 2 above). The fourth and final descriptor describes the bedform of the reach. The most common of these is riffle-pool, but other bedforms include step-pool, plane bed, dune-ripple, and braided. When combined these four descriptors convey a great deal of information about what the stream reach looks like. A common stream type often found in Vermont is C4 riffle-pool. Table 1 below summarizes the Phase 1 data for the sixteen studied reaches. All of the study area reaches were classified as E or C stream types, which are common in Vermont. It is important to note that these stream types are the reference, or expected, ones for the study area, and may not reflect the current conditions. The objective of the Phase 2 and corridor planning processes is to identify what types of stressors are impacting each reach; how these stressors change the existing stream type and other parameters; and use this information to identify restoration and conservation projects that can aid in returning the river system to its equilibrium state. More detailed descriptions and maps of the study area are located in Section 5 of this report.

Table 1: Hungerford Brook Phase 1 Reference Stream Data								
Reach ID	Reach Length (miles)	Valley Type	Valley Width (ft)	Channel Width (ft)	Channel Slope (%)	Sinuosity	Reference Stream Type	Bedform
M04	1.2	Very-Broad	459	36.8	0.02	1.4	E	Dune-Ripple
M05	0.8	Very-Broad	373	26.6	0.14	1.47	E	Riffle-Pool
M06	1.9	Very-Broad	297	26.2	0.33	1.3	E	Riffle-Pool
M07	1.9	Very-Broad	265	21.8	0.80	1.2	E	Riffle-Pool
M08	2.0	Very-Broad	278	17.4	0.80	1.15	E	Riffle-Pool
M09	1.0	Very-Broad	1,000	12.3	1.7	1.7	E	Riffle-Pool
M3T1.01	1.3	Broad	300	30.3	0.14	1.4	E	Dune-Ripple
M3T1.02	2.5	Broad	265	27.4	0.4	1.4	E	Riffle-Pool
M3T1.03	0.7	Very-Broad	354	21.8	0.54	1.2	E	Riffle-Pool
M3T1.04	2.2	Very-Broad	453	20.2	0.54	1.2	E	Riffle-Pool
M4S1.01	1.1	Very-Broad		12.1	0.4	1.0	C	Riffle-Pool
M4T2.01	0.5	Very-Broad	261	24.1	0.52	1.1	E	Dune-Ripple
M4T2.02	1.0	Very-Broad	314	24.0	0.33	1.3	E	Riffle-Pool
M4T2.03	0.9	Broad	207	22.4	1.14	1.5	E	Riffle-Pool
M4T2.04	2.6	Very-Broad	683	21.0	0.57	1.1	C	Riffle-Pool
M4T2.05	0.3	Narrow		6.8	2.9	1.0	E	Riffle-Pool

2.4 HYDROLOGY

The United States Geological Survey (USGS) maintains a Vermont Streamstats website, which computes flow and basin characteristics for Sites without permanent gauges (http://water.usgs.gov/osw/streamstats/Vermont.html). A copy of the USGS Streamstats printout for Hungerford Brook is presented in Figure 4 below as an example.

Figure 4:
Streamflow Statistics Report

Date: Wed Mar 5 2008 11:58:35
Site Location: Vermont
Latitude: 44.9241
Longitude: -73.0629
Drainage Area: 19.5 mi2

Peak Flow Basin Characteristics

100% Statewide Peak Flow (19.5 mi2)

Parameter	Value	Min	Max
Drainage Area (square miles)	19.5	0.211	850
Percent Lakes and Ponds (percent)	0.0879	0	6.86
Percentage of Basin Above 1200 ft (percent)	0	0	100
Geographic Factor (dimensionless)	263766.5	-87	296194

Streamflow Statistics

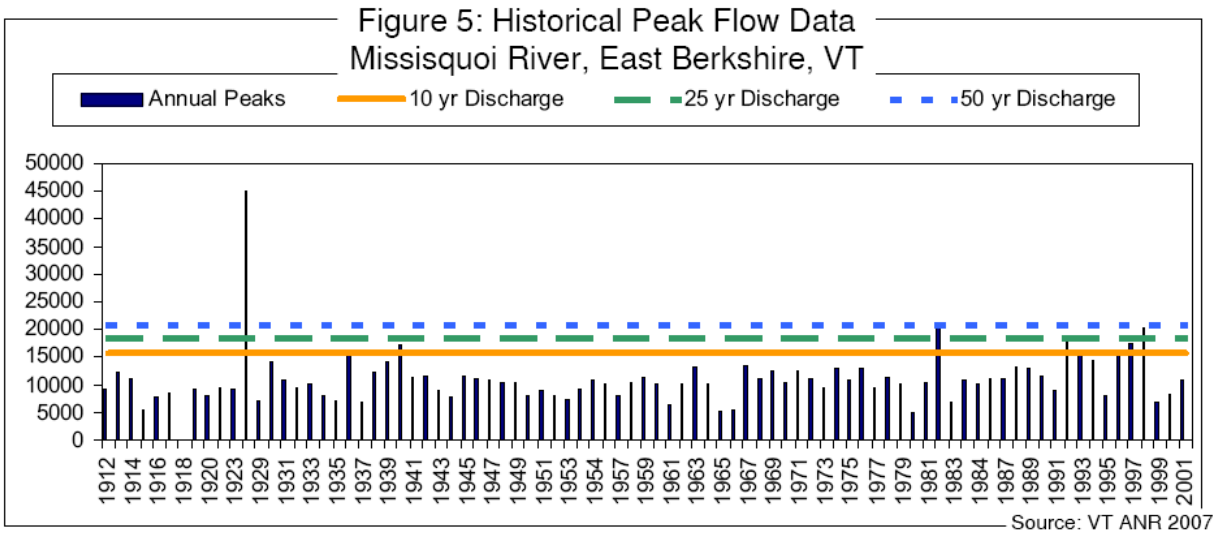
Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
Q2	445	42	1.4	227	875
Q5	634	40	2.3	326	1230
Q10	760	41	3.2	388	1490
Q25	910	42	4.6	460	1800
Q50	1020	43	5.5	508	2040
Q100	1130	44	6.3	548	2310
Q500	1370	49	7.6	619	3030

Source: USGS, 2008

The Basin Characteristics Table shows the drainage area (19.5 square miles) as well as other hydrologic data. The Streamflow Statistics Table shows the water flow in cubic feet per second (one cubic foot is equal to 7.5 gallons) for different streamflow events. Q2 refers to a 2-year flow event while Q100 refers to a 100-year flood event. The flood event numbers equal the statistical likelihood that the event will happen in any given year. For example on average there is a 1 in 2 chance that a Q2 flow event will occur in any year, while there is a 1 in 100 chance of a Q100 flow event occurring. While not directly used at this stage in the corridor planning

process, this USGS flow information can be useful in a variety of ways from delineating floodplains to designing proper bridge widths.

The nearest USGS gages for the study area are on the Missisquoi in Swanton, VT and East Berkshire, VT and on Stevens Brook at Lemnah Drive in St. Albans, VT. Annual peak recordings began at the Swanton gage in 1990 and show annual highs above the 10 year discharge in 1996 and 2006. Data for the East Berkshire gage goes back to 1912, and recorded the highest water levels in 1927, when many locations across Vermont were flooded, and lesser high flow events in excess of 25 year discharge in 1982, 1992, 1997, and 1998. A summary of peak annual flows for the East Berkshire gage is shown in Figure 5 below. The flow values along the Y-axis are shown in cubic feet per second (the same units as the Streamstats Table above). While this data represents a much larger watershed than that for Hungerford Brook, it shows that several large flow events have occurred in the region over the last 20 years.



2.5 ECOLOGICAL SETTING

The study area includes a variety of aquatic and upland habitat types which are dominated by agricultural crop and pasture land, but also includes forest, riparian wetland complexes, and beaver ponds. The primary aquatic habitat consists of a plane-bed sandy to silty

substrate community which is largely a result of active river management and corresponding geomorphic changes. Human land use, primarily conversion of forest and wetlands to agricultural land, have diminished the habitat diversity of the watershed and reduced the amount of riparian forest and wetland communities which, under natural conditions, would be the dominant ecological communities. The downstream reaches of Hungerford Brook (primarily M01-M03) are less intensely managed for agriculture and support deer wintering habitat and one or more rare, threatened, or endangered species (Vermont Fish and Wildlife, 1997). A majority of the studied reaches had habitat assessment ratings of fair to poor based on the Vermont Agency of Natural Resources Stream Geomorphic Assessment Protocols.

3.0 METHODOLOGY

3.1 FLUVIAL GEOMORPHIC ASSESSMENT PROTOCOLS

All of the Phase 2 Geomorphic Assessments conducted in 2006 and 2007 were performed in accordance with the most recent available Vermont Agency of Natural Resources (VT ANR) Stream Geomorphic Assessment Protocols. A copy of these protocols is available on the VT ANR Rivers Management Website at http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassess.htm. These protocols were designed to provide a sound, consistent, scientifically based data gathering and analysis system to obtain information about the physical processes ongoing within river systems. The protocols are divided into three phases. A Phase 1 assessment is completed primarily using remote sensing tools such as topographic maps, aerial photographs, GIS technology, and windshield surveys to predict the physical condition of streams in their natural, or equilibrium, state without human influences, and also document what human related impacts are ongoing within the watershed. Phase 2 assessments are field based and provide more detailed information, including physical measurements such as channel width and depth, and floodplain and substrate characteristics, to detail what levels of adjustment are occurring within the stream system and predict what future adjustments may occur. The Phase 2 assessment results form the basis for development of river corridor plans. A more detailed Phase 3 assessment involves detailed survey work and is used prior to implementation of larger scale active restoration projects.

A Phase 1 assessment of the entire Hungerford Brook watershed was completed by Northwest Regional Planning Commission and South Mountain Research and Consulting in 2005. A subset of 12 reaches were selected for Phase 2 assessment during 2006, and completed by Carmi Consulting. An additional 4 reaches were assessed using the Phase 2 Assessment Protocols in 2007 by The Johnson Company. All of the Phase 2 assessed reaches are shown on Figure 1.

The Phase 2 assessment results indicated a large degree of stream adjustment occurring within the Hungerford Brook watershed. Significant historic channel alterations including straightening, dredging, and ditching were noted. These channel alterations have caused most of the assessed reaches to undergo some degree of channel incision, or downcutting, where the stream erodes into its bed and no longer has complete access to it floodplain during high flow events. The incision, coupled with a lack of adequate woody riparian vegetation has led to a reduction in sediment and nutrient storage capacity, and an increase in nutrient inputs. The causes and consequences of these adjustment processes are discussed in more detail in Sections 4 and 5 of this Corridor Plan.

3.2 QUALITY ASSURANCE AND QUALITY CONTROL

Thorough QA reviews were performed by both Carmi Consulting and The Johnson Company in 2006 and 2007 and all of the data were reviewed by VT ANR following collection. All of the collected data are stored in the DMS and available to the public through RMP's Data Management System (DMS) located at https://anrnode.anr.state.vt.us/ssl/sga/security/frmLogin.cfm, username: public, password: public.

4.0 DEPARTURE ANALYSIS AND STRESSOR IDENTIFICATION

Section 4 describes the results of the Phase 1 and 2 assessments for the Hungerford Brook watershed. A variety of maps and tables including Stressor, Departure and Sensitivity

Maps are included to show watershed and reach scale stressors and how they interact and affect the watershed as a whole. The data, tables, and maps described in Section 4 will be used to identify restoration and conservation techniques on a reach scale basis (described in Section 5) that meet the goals and objectives of reducing fluvial erosion hazards, increasing sediment and nutrient attenuation sites, and improving aquatic and riparian habitat.

4.1 DEPARTURE ANALYSIS

4.1.1 Hydrologic Regime Stressors

The hydrologic regime may be defined as the timing, volume, and duration of flow events throughout the year, and over time it may be influenced by many factors including climate, soils, geology, groundwater inputs, watershed land cover and use, connectivity of the stream to riparian and floodplain networks, and valley and stream morphology (VT ANR 2007). Hydrologic regime is characterized by the input and manipulation of water at the watershed scale (i.e. dams, large land use changes, ect.) and should not be confused with channel hydraulics which deals with the energy and flows on a smaller, reach-wide scale (i.e. bridges, culverts). When the hydrologic regime of a watershed is impacted the stream will often undergo a series of predictable adjustments which can result in significant changes in sediment loading and flow patterns downstream (VT ANR 2007). An example of this is a large dam which impounds water and periodically releases it into the river system. The large pulses of water released from the dam will affect the stream channel and surrounding riparian lands differently than the more constant flow changes which occur in a natural system. Because dams are typically managed in a way that results in high flows occurring more frequently than they would naturally, the stream bed and banks are subjected to highly erosive energy more frequently than they would otherwise be. The River Stressor ID Table, Table 2, summarizes the stressors that were identified in the Hungerford Brook Watershed. These stressors and conditions are contributing to increased or decreased flow, sediment load, channel slope, power, and boundary resistance at both the watershed and reach scales. The red descriptor in each cell describes the overall stressor while the parameters listed below show which factors are contributing to or indicative of that stressor. For example, buffer widths less than 25 feet contribute to decreased boundary resistance while

widths greater that 25 feet help resist erosion and contribute to increased boundary resistance. More detailed descriptions of these stressors and contributing factors are provided in each appropriate Section below. Figure 6 depicts the major hydrologic stressors identified within the study area.

One of the most significant hydrologic stressors for the Hungerford Brook watershed, and the majority of Vermont, is the large scale deforestation that occurred in the 19th century. As the state was settled much of the forest was cut for timber and the land cleared for agriculture. Where today Vermont is approximately 80% forestland and 20% open, in the late 19th and early 20th century it was only 20% forested and 80% open. The effect of those land use changes are still being seen today. With much of the land cleared higher intensity flash floods were more common and carried with them a tremendous amount of sediment down into the valleys. This sediment built up in the river systems and raised the bed elevation of many streams. Hungerford Brook is now eroding down through the built-up sediment and losing access to its floodplain. This process is increased through channel management techniques such as channelization, dredging, and ditching (VT ANR 2007).

Table 2: River Stressor ID Table - Hungerford Brook

River Segment ID	Watershed Scale Stressors		Reach Scale Stressors	
	Hydrologic (Figures 6, 7, 8, and 9)	Sediment Load (Figures 7, 8, 9, and 10)	Stream Power (Figures 11 and 12)	Boundary Resistance (Figure 13)
M04	**Increased Flows** Urban land use = Watershed = >5 <=10% (moderate) Urban Land use = subwatershed = <5% (low) Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >10<=20% (Mod) Deposition Features/Mile = <=2 (low) Erosion Features = L = >5<20%, R = >5<20% (Moderate)	**Increased Stream Power - Slope** No Significant Impacts **Increased Stream Power - Depth** No Significant Impacts **Decreased Stream Power - Slope** No Significant Impacts **Decreased Stream Power - Depth** No Significant Impacts	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Bank Cohesive = Yes **Decreased Boundary Resistance** Bed = Smaller than Coarse Gravel Bank erosion = L = >5<20%, R = >5<20% Grade Controls = None
M05	**Increased Flows** Urban land use = watershed = >=5<10% (moderate) Urban land use = subwatershed = <5 % (low) Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >20% (extreme) Deposition Features/Mile = >2<=5 (moderate) Erosion Features = L = <5% (low), R = >5<20% (Moderate)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Stormwater Inputs = <=2 (Low) **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** Deposition Features/Mile = >2<=5 (moderate)	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Bank Cohesive = Yes **Decreased Boundary Resistance** Bed = Smaller than Coarse Gravel Bank erosion = L = >5<20%, R = >5<20% Grade Controls = None
M06	**Increased Flows** Urban land use = watershed = >=5<10% (moderate) Urban land use = subwatershed = 6.2 % (moderate) P2 coridor dominant = pasture Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >10<20% (High) P2 coridor dominant = pasture Deposition Features/Mile = <=2 (Low) Erosion Features = L = <5% (low), R = >5<20% (Moderate) Mass wasting = Low (1 Gully)	**Increased Stream Power - Slope** Head Cut = 1 **Increased Stream Power - Depth** Stormwater Inputs = <=2 (Low) **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** No Significant Impacts	**Increased Boundary Resistance** Bank Cohesive = Yes **Decreased Boundary Resistance** Bed = Smaller than Coarse Gravel L Buffer dominant= <25ft R Buffer dominant= <25ft Grade Controls = None
M07A	**Increased Flows** Stormwater Inputs = >2<=5 (Moderate) Urban land use = Watershed = >=5<10% (moderate) Urban Land use = subwatershed = <5% (Low) Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >10<20% (High) Deposition Features/Mile = >2<=5 (moderate) Erosion Features = R = <5% (low), L = >5<20% (Moderate) Mass wasting = Low (1 gully, 1 Mass Failure)	**Increased Stream Power - Slope** No Significant Impacts **Increased Stream Power - Depth** Stormwater Inputs = >2<=5 (moderate) **Decreased Stream Power - Slope** Bedrock Grade Control = 1 **Decreased Stream Power - Depth** Deposition Features/Mile = >2<=5 (moderate)	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Bed = coarse gravel Bedrock Grade Control **Decreased Boundary Resistance** Bank erosion = L = >5<=20%, R = <5% Bank Cohesive = No

The River Stressor ID Table shows the various stressors and conditions which are contributing to increased or decreased flow, sediment load, channel slope, power, and boundary resistance at both the watershed and reach scales.
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L and R refers to left and right side of channel when looking downstream

Table 2: River Stressor ID Table - Hungerford Brook

River Segment ID	Watershed Scale Stressors		Reach Scale Stressors	
	Hydrologic (Figures 6, 7, 8, and 9)	Sediment Load (Figures 7, 8, 9, and 10)	Stream Power (Figures 11 and 12)	Boundary Resistance (Figure 13)
M07B	**Increased Flows** Stormwater Inputs = >2<=5 (moderate) Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = <5% (Low) P2 corridor dominant = pasture Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >10<20% (High) P2 coridor dominant = pasture Deposition Features/Mile = >5 (High) Erosion Features = L = >5<20%, R = >5<20% (Moderate) Steep Riffle (1)	**Increased Stream Power - Slope** Straightening = >=5<20% (moderate) Head Cut = 1 **Increased Stream Power - Depth** Berms/roads = >5%<=20% (moderate) Stormwater Inputs = >2<=5 (moderate) **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** Deposition Features/Mile = >5 (High)	**Decreased Boundary Resistance** L Buffer dominant= <25ft R Buffer dominant= <25ft Bank Cohesive = No Grade Controls = None Bed = Smaller than Coarse Gravel Bank erosion = L = >5<=20%, R = >5<=20%
M08A	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = 7.4% (moderate) Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >20% (Extreme) Deposition Features/Mile = <=2 (Low) Erosion Features = R = <5% (low), L = <5% (low)	**Increased Stream Power - Slope** No Significant Impacts **Increased Stream Power - Depth** No Significant Impacts **Decreased Stream Power - Slope** No Significant Impacts **Decreased Stream Power - Depth** No Significant Impacts	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Bed = larger than coarse gravel **Decreased Boundary Resistance** Bank Cohesive = No Grade Controls = none
M08B	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = 7.4% (moderate) P2 corridor dominant = Hay/Crop Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >20% (Extreme) P2 coridor dominant =Hay/Crop Deposition Features/Mile = <=2 (Low) Erosion Features = L = >5<20%, R = >5<20% (Moderate)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Stormwater Inputs = <=2 (Low) **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** No Significant Impacts	**Increased Boundary Resistance** Bed = larger than coarse gravel **Decreased Boundary Resistance** L Buffer dominant= <25ft R Buffer dominant= <25ft Bank Cohesive = No Bank erosion = L = >5<20%, R = >5<20% Grade Controls = none
M09A	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = >10<20% (High) P2 corridor dominant = Pasture Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (Extreme) Crop land use = subwatershed = >20% (Extreme) P2 corridor dominant = L = Pasture, R = Pasture Deposition Features/Mile = >5 (High) Erosion Features = L = >5<20%, R = >5<20% (Moderate)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Berms/roads = >10<20% (Mod) Stormwater Inputs = <=2 (Low) **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** Deposition Features/Mile = >5 (High) Gravel mining = Low	**Decreased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= <25ft R Buffer dominant= <25ft Bank Cohesive = No Grade Controls = none Bed = smaller than coarse gravel Bank armoring = L = moderate R = moderate Bank erosion = L = >10<20%, R = >10<20% Gravel Mining/Dredging = historic

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Table 2: River Stressor ID Table - Hungerford Brook

River Segment ID	Watershed Scale Stressors		Reach Scale Stressors	
	Hydrologic (Figures 6, 7, 8, and 9)	Sediment Load (Figures 7, 8, 9, and 10)	Stream Power (Figures 11 and 12)	Boundary Resistance (Figure 13)
M09B	**Increased Flows** Stormwater Inputs = >2<=5 (moderate) Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = >10<20% (High) P2 corridor dominant = Hay Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (Extreme) Crop land use = subwatershed = >20% (Extreme) P2 coridor dominant = Hay Deposition Features/Mile = <=2 (Low) Erosion Features = R = <5% (low), L = <5% (low) Steep Riffle (1)	**Increased Stream Power - Slope** Straightening = >20% (high) Head Cut = 1 **Increased Stream Power - Depth** Berms/roads = >10<20% (mod) Stormwater Inputs = >2<=5 (mod) **Decreased Stream Power - Slope** Bridges and Culverts Beaver Dam **Decreased Stream Power - Depth** Beaver Dam	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Bed = larger than coarse gravel **Decreased Boundary Resistance** Bank Cohesive = No Grade Controls = none
M3T1.01A	Impounded water from Beaver Dam - Not Assessed			
M3T1.01B	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = 5.4% (Moderate) P2 corridor dominant = pasture Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >10<20 (High) Crop land use = subwatershed = >10<205% (High) P2 coridor dominant = L= pasture, R = pasture Deposition Features/Mile = >2<=5 (moderate) Erosion Features = R = <5% (low), L = <5% (low) Steep Riffles (2)	**Increased Stream Power - Slope** No Significant Impacts **Increased Stream Power - Depth** Bridges and Culverts **Decreased Stream Power - Slope** Bridges and Culverts Beaver Dam **Decreased Stream Power - Depth** Deposition Features/Mile = >2<=5 (moderate) Beaver Dam	**Increased Boundary Resistance** Bank Cohesive = Yes **Decreased Boundary Resistance** L Buffer dominant= <25ft R Buffer dominant= <25ft Bed = smaller than coarse gravel Grade Controls = none
M3T1.01C	Impounded water from Beaver Dam - Not Assessed			
M3T1.02	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = <5% (low) Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >10<20 (High) Crop land use = subwatershed = >20% (Extreme) Deposition Features/Mile = <=2 (Low) Erosion Features = R = <5% (low), L = <5% (low) Mass wasting = Low (1 Gully)	**Increased Stream Power - Slope** No Significant Impacts **Increased Stream Power - Depth** Bridges and Culverts Stormwater Inputs = <=2 (low) **Decreased Stream Power - Slope** Bridges and Culverts Beaver Dam, Bedrock Grade Control **Decreased Stream Power - Depth** Beaver Dam	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Bank Cohesive = Yes Grade Controls = multiple bedrock Bed = Larger than coarse gravel
M3T1.03	**Increased Flows** Stormwater Inputs = >2<=5 (Moderate) Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = >10<20% (High) P2 corridor dominant = Crop Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >10<20 (High) Crop land use = subwatershed = >10<20% (High) P2 corridor dominant = Crop Deposition Features/Mile = <=2 (Low) Erosion Features = L = <5% (low), R = >5<20% (Moderate)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Stormwater Inputs = >2<=5 (Moderate) Bridges and Culverts **Decreased Stream Power - Slope** Bridges and Culverts Bedrock Grade Control **Decreased Stream Power - Depth** No Significant Impacts	**Increased Boundary Resistance** Bank Cohesive = Yes Grade Controls = one bedrock Bed = larger than coarse gravel **Decreased Boundary Resistance** Bank erosion = L = >5<20%, R = >5<20% L Buffer dominant= <25ft R Buffer dominant= <25ft

The River Stressor ID Table shows the various stressors and conditions which are contributing to increased or decreased flow, sediment load, channel slope, power, and boundary resistance at both the watershed and reach scales.
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Table 2: River Stressor ID Table - Hungerford Brook

River Segment ID	Watershed Scale Stressors		Reach Scale Stressors	
	Hydrologic (Figures 6, 7, 8, and 9)	Sediment Load (Figures 7, 8, 9, and 10)	Stream Power (Figures 11 and 12)	Boundary Resistance (Figure 13)
M3T1.04A	**Increased Flows** Stormwater Inputs = >2<=5 (Moderate) Urban land use = Watershed = <5% (Low) Urban Land use = subwatershed = >5<10% (Moderate) P2 corridor dominant = L = crop, R = forest Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >10<20% (High) Crop land use = subwatershed = >10<20% (High) P2 corridor dominant = L = crop, R = forest Deposition Features/Mile = >5 (High) Erosion Features = R = <5% (low), L = <5% (low) Steep Riffle (1)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Berms/roads = >10<20% (moderate) Stormwater inputs = >2<=5 (moderate) **Decreased Stream Power - Slope** Beaver Dams **Decreased Stream Power - Depth** Deposition Features/Mile = >5 (High) Beaver Dams	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Grade Controls = multiple **Decreased Boundary Resistance** Bed = smaller than coarse gravel
M3T1.04B	**Increased Flows** Stormwater Inputs = >2<=5 (Moderate) Urban land use = Watershed = <5% (low) Urban Land use = subwatershed = >5<10% (Moderate) P2 corridor dominant = L = Hay, R = Pasture Devlopment, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >10<20 (High) Crop land use = subwatershed = >10<20% (High) P2 corridor dominant = L = Hay, R = Pasture Deposition Features/Mile = >2<=5 (moderate) Erosion Features = R = <5% (low), L = <5% (low)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Berms/roads = >10<20% (mod) Stormwater inputs = >2<=5 (moderate) Bridges and Culverts **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** Deposition Features/Mile = >2<=5 (moderate)	**Decreased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= <25ft R Buffer dominant= <25ft Bank Cohesive = No Grade Controls = None Bed = smaller than coarse gravel
M4S1.01A	**Increased Flows** Stormwater Inputs = >2<=5 (Moderate) Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = >10<20% (High) P2 corridor dominant = Crop Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (Extreme) Crop land use = subwatershed = >20% (Extreme) P2 corridor dominant = Crop Deposition Features/Mile = <=2 (Low) Erosion Features = R = <5% (low), L = <5% (low)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Berms/roads = >20% (high) Stormwater Inputs = >2<=5 (moderate) Bridges and Culverts **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** No Significant Impacts	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Bank Cohesive = Yes **Decreased Boundary Resistance** Grade Controls = None Bed = smaller than coarse gravel
M4S1.01B	**Increased Flows** Stormwater Inputs = >2<=5 (Moderate) Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = >10<20% (High) P2 corridor dominant = Hay Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (Extreme) Crop land use = subwatershed = >20% (Extreme) P2 corridor dominant = Hay Deposition Features/Mile = >2<=5 (moderate) Erosion Features = R = <5% (low), L = <5% (low)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Stormwater Inputs = >2<=5 (Moderate) Bridges and Culverts **Decreased Stream Power - Slope** Bridges and Culverts Remnants of old dam **Decreased Stream Power - Depth** Deposition Features/Mile = >2<=5 (moderate)	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Bank Cohesive = Yes Grade Controls = One **Decreased Boundary Resistance** Bed = smaller than coarse gravel

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River Segment ID	Watershed Scale Stressors		Reach Scale Stressors	
	Hydrologic (Figures 6, 7, 8, and 9)	Sediment Load (Figures 7, 8, 9, and 10)	Stream Power (Figures 11 and 12)	Boundary Resistance (Figure 13)
M4T2.01	**Increased Flows** Urban land use = Watershed = <5% (low) Urban Land use = subwatershed = 4.4% (low) P2 corridor dominant = Crop Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (Extreme) Crop land use = subwatershed = >20% (Extreme) P2 corridor dominant = Crop Deposition Features/Mile = <=2 (Low) Erosion Features = L = >5<20%, R = >5<20% (Moderate)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Bridges and Culverts Stormwater Inputs = <=2 (low) **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** No Significant Impacts	**Increased Boundary Resistance** Bank Cohesive = Yes **Decreased Boundary Resistance** Bed = smaller than coarse gravel Grade Controls = None Bank erosion = L = >5<20%, R = >5<20% L Buffer dominant= <25ft R Buffer dominant= <25ft
M4T2.02	**Increased Flows** Urban land use = Watershed = <5% (low) Urban Land use = subwatershed = 4.5% (low) P2 corridor dominant = Pasture/Crop Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (Extreme) Crop land use = subwatershed = >10<20% (High) P2 corridor dominant = Pasture/Crop Deposition Features/Mile = >5 (High) Erosion Features = R = <5% (low), L = <5% (low) Mass wasting = Low (1 Gully) Steep Riffle (1)	**Increased Stream Power - Slope** No Significant Impacts **Increased Stream Power - Depth** No Significant Impacts **Decreased Stream Power - Slope** Beaver Dam Bedrock Grade Control **Decreased Stream Power - Depth** Beaver Dam Deposition Features/Mile = >5 (High)	**Increased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= >25ft R Buffer dominant= >25ft Bank Cohesive = Yes Grade Controls = one bedrock **Decreased Boundary Resistance** Bed = smaller than coarse gravel
M4T2.03	**Increased Flows** Urban land use = Watershed = <5% (low) Urban Land use = subwatershed = >5<10% (Moderate) P2 corridor dominant = Pasture Development, Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >20% (Extreme) P2 coridor dominant = Pasture Deposition Features/Mile = >5 (High) Erosion Features = L = <5% (low), R = >5<20% (Moderate)	**Increased Stream Power - Slope** No Significant Impacts **Increased Stream Power - Depth** Bridges and Culverts Stormwater Inputs = <=2 (low) **Decreased Stream Power - Slope** Bedrock Grade Control (2) **Decreased Stream Power - Depth** Deposition Features/Mile = >5 (High)	**Increased Boundary Resistance** Grade Controls = multiple Bank Cohesive = Yes **Decreased Boundary Resistance** Bed = smaller than coarse gravel L Buffer dominant= <25ft R Buffer dominant= <25ft Bank erosion = L = <5%, R = >5%<=20%
M4T2.04A	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = 5.0% (Moderate) Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >20% (Extreme) Deposition Features/Mile = >2<=5 (moderate) Erosion Features = R = <5% (low), L = <5% (low)	**Increased Stream Power - Slope** No Significant Impacts **Increased Stream Power - Depth** Bridges and Culverts Stormwater Inputs = <=2 (low) **Decreased Stream Power - Slope** Bridges and Culverts Bedrock Grade Control **Decreased Stream Power - Depth** Deposition Features/Mile = >2<=5 (moderate)	**Increased Boundary Resistance** L Buffer dominant= >25ft R Buffer dominant= >25ft Grade Controls = multiple Bed = larger than coarse gravel **Decreased Boundary Resistance** Bank Cohesive = No
M4T2.04B	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = 5.0% (Moderate) P2 corridor dominant = Hay/Crop Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >20% (Extreme) P2 corridor dominant = Hay/Crop Deposition Features/Mile = <=2 (Low) Erosion Features = L = >5<20%, R = >5<20% (Moderate) rejuvinating tribs = Yes	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** Bridges and Culverts Berms/roads = >10<20% (Moderate) **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** No Significant Impacts	**Increased Boundary Resistance** Bank Cohesive = Yes **Decreased Boundary Resistance** Bed = smaller than coarse gravel Bank erosion = L = >5<=20%, R = >5<=20% L Buffer dominant= <25ft R Buffer dominant= <25ft Grade Controls = None

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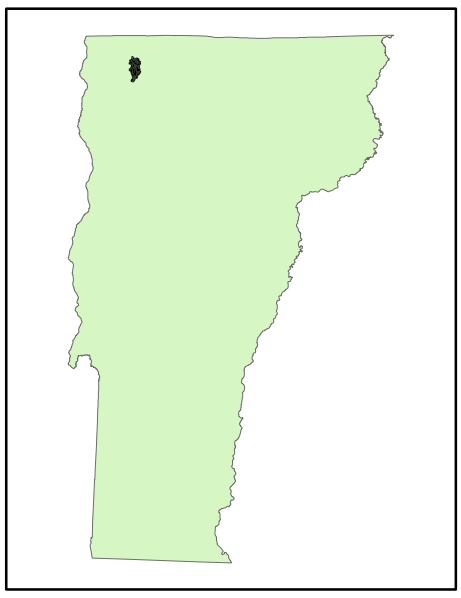
River Segment ID	Watershed Scale Stressors		Reach Scale Stressors	
	Hydrologic (Figures 6, 7, 8, and 9)	Sediment Load (Figures 7, 8, 9, and 10)	Stream Power (Figures 11 and 12)	Boundary Resistance (Figure 13)
M4T2.04C	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = 5.0% (Moderate) Stormwater Inputs = >5 (High) Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >20% (Extreme) Deposition Features/Mile = >5 (High) Erosion Features = L = >20% (High), R = >5<20% (Mod)	**Increased Stream Power - Slope** No Significant Impacts **Increased Stream Power - Depth** Stormwater Inputs = >5 (High) Bridges and Culverts **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** Deposition Features/Mile = >5 (High)	**Increased Boundary Resistance** L Buffer dominant= >25ft R Buffer dominant= >25ft Bed = larger than coarse gravel **Decreased Boundary Resistance** Bank Cohesive = No Bank armoring = Low Bank erosion = L = >20%, R = >5<20% Gravel Mining/Dredging = none Grade Controls = None
M4T2.04D	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = 5.0% (Moderate) P2 corridor dominant = Crop Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >20% (Extreme) P2 coridor dominant = Crop Deposition Features/Mile = <=2 (Low) Erosion Features = R = <5% (low), L = <5% (low)	**Increased Stream Power - Slope** Straightening = >20% (high) **Increased Stream Power - Depth** No Significant Impacts **Decreased Stream Power - Slope** No Significant Impacts **Decreased Stream Power - Depth** No Significant Impacts	**Increased Boundary Resistance** Bank Cohesive = Yes **Decreased Boundary Resistance** L Buffer dominant= <25ft R Buffer dominant= <25ft Bed = smaller than coarse gravel Grade controls = None
M4T2.05	**Increased Flows** Urban land use = Watershed = >=5 <10% (moderate) Urban Land use = subwatershed = <5% (low) P2 corridor dominant = L = Hay, R = Crop Roads, ditching, and ag drainage/tile	**Increased Load** Crop land use = watershed = >20% (extreme) Crop land use = subwatershed = >20% (Extreme) P2 corridor dominant = L = Hay, R = Crop Deposition Features/Mile = >2<=5 (moderate) Erosion Features = R = <5% (low), L = <5% (low) Mass wasting = Low (1 Gully)	**Increased Stream Power - Slope** Head Cut = 1 Straightening = >20% (high) **Increased Stream Power - Depth** Bridges and Culverts **Decreased Stream Power - Slope** Bridges and Culverts **Decreased Stream Power - Depth** Deposition Features/Mile = >2<=5 (moderate)	**Decreased Boundary Resistance** Riparian Veg./bank cohesiveness L Buffer dominant= <25ft R Buffer dominant= <25ft Bank Cohesive = No Grade Controls = None Bed = smaller than coarse gravel Bank armoring = L = high R = high

The River Stressor ID Table shows the various stressors and conditions which are contributing to increased or decreased flow, sediment load, channel slope, power, and boundary resistance at both the watershed and reach scales.
The red descriptor in each cell describes the overall stressor, while the parameters listed below describe what factors are contributing to or indicative of that stressor (i.e. reduced buffer widths cause decreased boundary resistance, while increased buffer widths increase boundary resistance and help resist bank erosion). More detailed desriptions of these stressors are provided in the appropriate text section of the report.
L and R refers to left and right side of channel when looking downstream

K:\1-1470-9\River Corridor Planning Maps\Maps 030708\Hydrologic Alterations (11x17) 030708.mxd



N

M3T1.01A
M3T1.01B
M3T1.01C
M3T1.02
M3T1.03
M3T1.04A
M3T1.04B
M04
M4S1.01A
M4S1.01B
M4T2.01
M4T2.02
M4T2.03
M4T2.04A
M4T2.04B
M4T2.04C
M4T2.04D
M4T2.05
M05
M06
M07A
M07B
M08A
M08B
M09A
M09B
DARLENE DR
SAMSON DR
HEALD RD
MOREY RD
GLEN RIDGE LN
207
DONALDSON RD
HIGHGATE RD
WOODS TRAIL RD
COOK RD
TOWN HWY 45
RUSSELL RD
ROUTE 105 SHELDON
TH 26
HAZARD RD
COUNTRY LN
INTERSTATE 89 N
BUSHEY RD
105
SWEETHOLLOW RD
POND RD
HOLAN RD
SHELDON RD
MARCEL DR
LEBEL DR
HEAVEN AV
BUSHEY DR
FISHER POND RD
ALDIS HILL
89

Legend

- Stormwater Input
- Dam
- Reach Break
- Segment Break
- Hungerford Brook

Stormwater Input/Mile

- <=2
- >2 <= 5
- > 5
- Sub-watershed
- Roads

2,500 1,250 0 2,500 Feet

Figure 6
Hydrologic Alterations Map
Hungerford Brook

Stormwater inputs affect the hydrologic regime by increasing the peak flow during high flow events. In addition, impervious surfaces such as roads and buildings reduce the attenuation of rainfall through infiltration and increase the rate and volume of precipitation that reaches the stream channel. The stormwater symbols depicted on Figure 6 include agricultural ditches and drainage tile inlets, as well as storm drains and other "end of pipe" inputs into the stream channel. The River Stressor ID Table breaks stormwater impacts down into three categories based on the number of stormwater inputs identified per mile of assessed stream (<=2 (low), >2<=5 (moderate), and >5 (high)). Hungerford Brook is dominated by agricultural and forest land except for sparse residential development along the roadways. As such, stormwater impacts in the area are generally moderate and primarily include ditches and tile drains.

Dams change the hydrologic regime of a watershed by altering the timing, duration, and volume of large flow events. While many river systems throughout Vermont are influenced by dams, Hungerford Brook is not one of them. No human constructed dams were identified within the study area with the exception of M4S1.01B, where the remnants of a former stone dam were noted. Several beaver dams were identified in the watershed. While they can influence the flow patterns of small portions of a reach, these features are generally transient and not large enough to have a significant impact on the overall hydrologic regime.

As described above, land use and land cover have a significant impact on the hydrologic regime of a watershed, particularly small intensely agricultural ones such as Hungerford Brook. Figures 7, 8, and 9 show the current land use and cover for the study area. As is evident on Figure 7 and 8, agriculture is by far the dominant land use in the watershed, however urbanization is also a contributing factor to changes in hydrology. Table 2 shows the percent urbanization for each reach. Altered hydrology may be a significant stressor once urban land use reaches greater then 5% of the watershed (VT ANR 2007). While the Hungerford watershed is a rather rural community, the urban land use within the study area is still slightly greater than 5%, and alters the hydrologic regime of the region. This urban and agricultural land use has caused

an increase in the magnitude and duration of large flow events through increased runoff and decreased infiltration capacity. This is particularly true in agricultural lands that were converted from wetlands. As is shown in Figure 8, a majority of the historic wetlands (i.e. hydric soils) have been converted through subsurface drainage and other means into agricultural lands. The conversion of these wetlands not only increases the magnitude and rate of runoff into the stream channel, it also increases the sediment and nutrient inputs into the system as fertilizers and topsoil are washed from the land surface. These and other sediment load stressors are discussed below.

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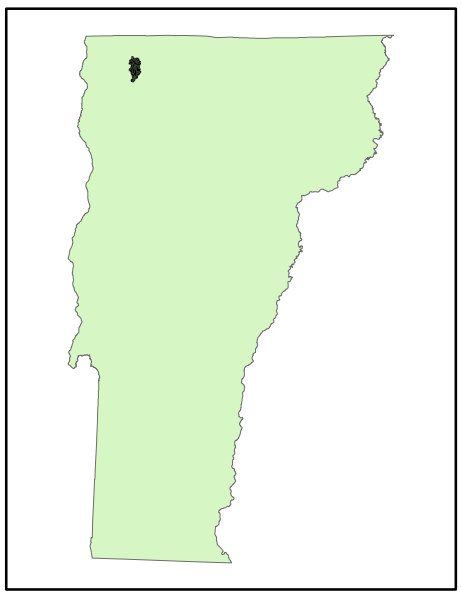


N

M3T1.01A
M3T1.01B
M3T1.01C
M3T1.02
M3T1.03
M3T1.04A
M3T1.04B
M04
M4S1.01A
M4S1.01B
M4T2.01
M05
M4T2.02
M06
M4T2.03
M07A
M07B
M4T2.04A
M4T2.04B
M4T2.04C
M4T2.04D
M08A
M08B
M09A
M09B
M4T2.05

DARLENE DR
GLEN RIDGE LN
207
SAMSON DR
HEALD RD
MOREY RD
DONALDSON RD
HIGHGATE RD
WOODS HILL RD
COOK RD
RUSSELL RD
ROUTE 105 SHELDON
TOWN HWY 45
TH 26
COUNTRY LN
HAZARD RD
INTERSTATE 89 N
BUSHEY RD
105
VIENS RD
SWEETTOOTH LOW RD
POND RD
SHOLAN RD
SHELDON RD
HEAVEN AV
FISHER POND RD
89
ALDIS HILL

Legend

Cumulative Upstream Crop Land

- < 5%
- >= 5% and < 10%
- >= 10% and < 20%
- >= 20%

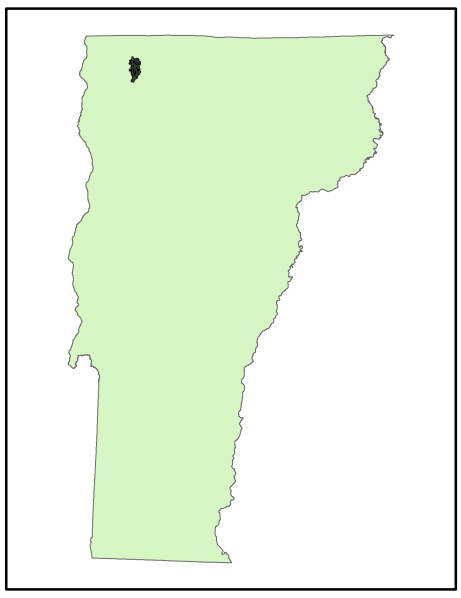
Crop Land Use Within Sub-watershed

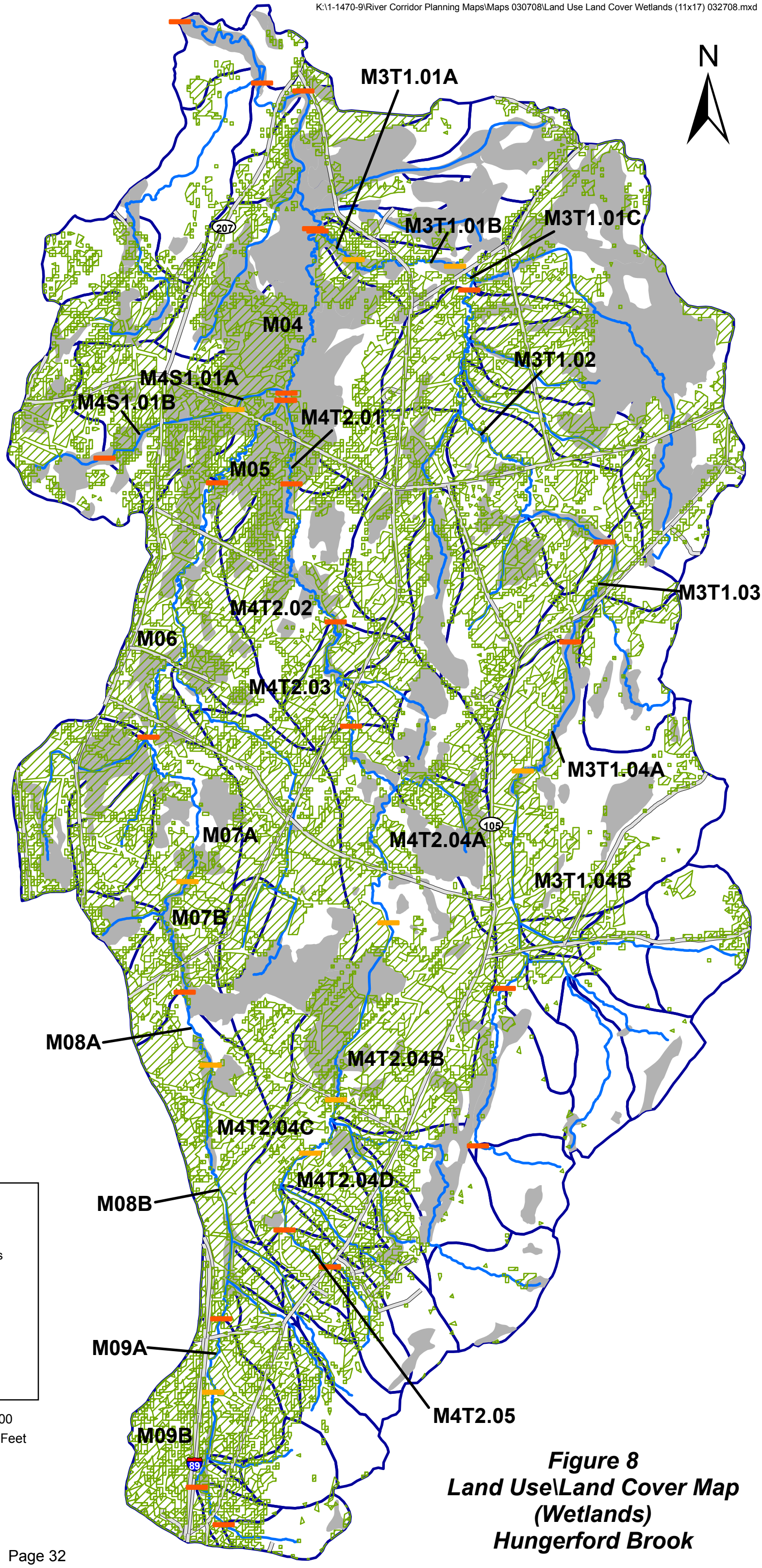
- < 5%
- >= 5% and < 10%
- >= 10% and < 20%
- >= 20%
- Reach Break
- Segment Break
- Roads
- Hungerford Brook
- Sub-Watershed

2,500 1,250 0 2,500
Feet

Figure 7
Land Use\Land Cover Map
(Agriculture)
Hungerford Brook

K:\1-1470-9\River Corridor Planning Maps\Maps 030708\Land Use Land Cover Wetlands (11x17) 032708.mxd





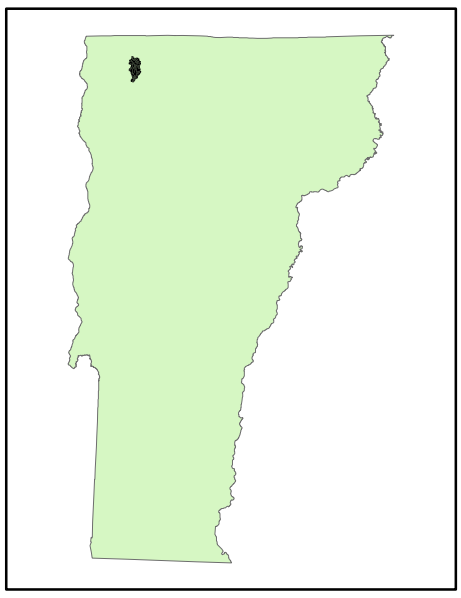
Legend

- Agricultural Landuse
- Vermont Significant Wetlands Inventory and/or Hydric Soils
- Reach Break
- Segment Break
- Roads
- Hungerford Brook
- Sub-Watershed

2,500 1,250 0 2,500 Feet

Figure 8
Land Use\Land Cover Map
(Wetlands)
Hungerford Brook

K:\1-1470-9\River Corridor Planning Maps\Maps 030708\Land Use Land Cover Urbanization (11x17) 030708.mxd



N

M3T1.01A
M3T1.01B
M3T1.01C
M3T1.02
M3T1.03
M3T1.04A
M3T1.04B
M04
M4S1.01A
M4S1.01B
M4T2.01
M05
M4T2.02
M06
M4T2.03
M07A
M07B
M4T2.04A
M4T2.04B
M4T2.04C
M4T2.04D
M4T2.05
M08A
M08B
M09A
M09B
DARLENE DR
SAMSON DR
GLEN RIDGE LN
207
HEALD RD
MOREY RD
DONALDSON RD
HIGHGATE RD
WOODS HILL RD
COOK RD
TOWN HWY 45
RUSSELL RD
ROUTE 105 SHELDON
TH 26
HAZARD RD
COUNTRY LN
INTERSTATE 89 N
BUSHEY RD
105
VIENS RD
SWEETHOLLOW RD
POND RD
SHOLAN RD
SHELDON RD
MARCEL DR
LEBEL DR
HEAVEN AV
BUSHEY DR
INTERSTATE 89 S
FISHER POND RD
89
ALDIS HILL

Legend

Cumulative Upstream Urbanization

- < 5%
- >= 5% and < 10%

Urban Land Use Within Sub-watershed

- < 5%
- >= 5% and < 10%
- >= 10% and < 20%
- Reach Break
- Segment Break
- Roads
- Hungerford Brook
- Sub-Watershed

2,500 1,250 0 2,500
Feet

Figure 9
Land Use\Land Cover Map
(Urbanization)
Hungerford Brook

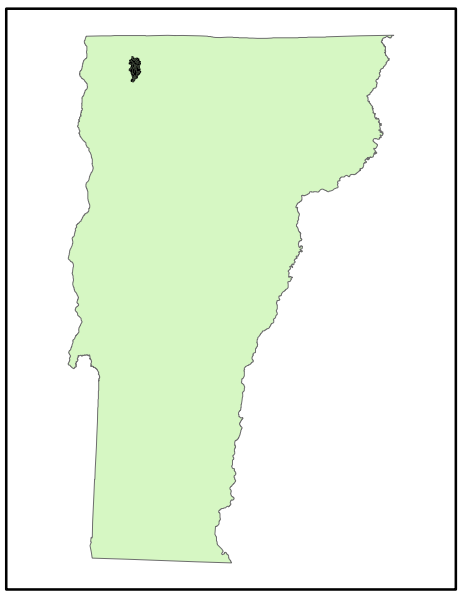
4.1.2 Sediment Regime Stressors

The sediment regime is defined as the quantity, size, transport, sorting, and distribution of sediments which are influenced by the proximity of sediment sources, the hydrologic regime, as well as the valley, stream, and floodplain characteristics (VT ANR 2007). The sediment regime may be split into two types of sediment: wash load and bed load. Wash load refers to finer grained materials which become suspended in the water column at higher flows and eventually settle out under lower flows and velocity, typically on floodplains and the inside of meander bends as flood waters recede. When these features are absent from a watershed, wash load sediments may remain suspended in the water column until they reach a larger receiving body of water. Bed load sediments are comprised of coarser materials that move during high flow events by rolling along the stream bed until they encounter areas of lesser energy. A watershed in equilibrium has a consistent pattern and movement of wash and bed loads. When this pattern is disrupted, aquatic habitat, water quality, and stream morphology are affected. (VT ANR 2007).

4.1.2.1 Watershed Scale Sediment Regime Stressors

Because the sediment regime is closely linked to a stream's hydrologic characteristics, many of the same stressors discussed above will have an impact on the watershed-wide sediment regime. Many of the existing hydrologic stressors such as stormwater inputs, increased runoff from agricultural fields, and urbanization not only cause increased flows, but also increased bed and wash loads due to lack of sediment attenuation sites and increased surface runoff. In addition, the increased flows can cause production of in-stream sediment from erosion of the stream banks and bed. As shown in Table 2 above, all of the assessed reaches have increased sediment load caused by one or more of these hydrologic stressors. Figure 10 shows the sediment load indicators for the study area. The increased sediment load is evident in the number of deposition features present (particularly in Reaches M07B, M09A, M4T2.02, M4T2.03, M4T2.04C, and M3T1.04A), as well as the extensive erosion noted in several reaches M4T2.04C, M4T2.01, M07B, M08B, and M09A.

K:\1-470-9\River Corridor Planning Maps\Maps 030708\Sediment Load (11x17) 031008.mxd



N

M3T1.01A
M3T1.01B
M3T1.01C
M3T1.02
M3T1.03
M3T1.04A
M3T1.04B
M04
M4S1.01A
M4S1.01B
M4T2.01
M4T2.02
M4T2.03
M4T2.04A
M4T2.04B
M4T2.04C
M4T2.04D
M4T2.05
M05
M06
M07A
M07B
M08A
M08B
M09A
M09B
DARLENE DR
SAMSON DR
HEATH RD
GLEN RIDGE LN
207
DONALDSON RD
HIGHGATE RD
WOODS HILL RD
COOK RD
MOREY RD
RUSSELL RD
ROUTE 105 SHELDON
TOWN HWY 45
TH 26
HAZARD RD
COUNTRY LN
INTERSTATE 89 N
BUSHEY RD
VIENS RD
105
SWEETHOLLOW RD
POND RD
SHOLAN RD
SHELDON RD
MARCEL DR
LEBEL DR
BUSHEY DR
HEAVEN AV
FISHER POND RD
ALDIS HILL
89

Legend

- Steep Riffle
- Gully
- Mass Failure

Bank Erosion

- Left Bank
- Right Bank

Deposition Features/Mile

- <=2
- >2 <= 5
- > 5
- Tributary Rejuvination
- Reach Break
- Segment Break
- Roads
- Hungerford Brook
- Sub-watershed

2,500 1,250 0 2,500
Feet

Figure 10
Sediment Load Indicators Map
Hungerford Brook

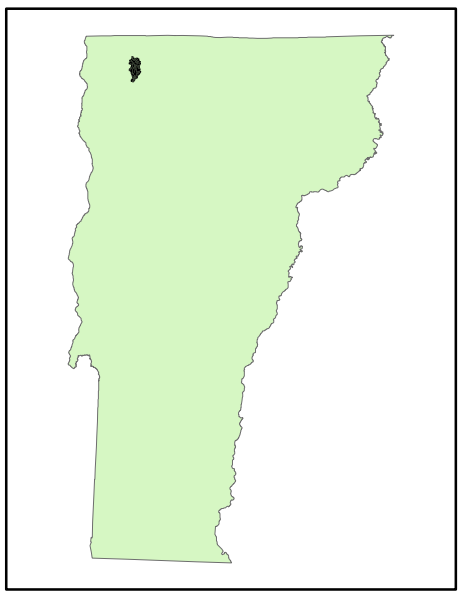
4.1.2.2 Reach Scale Sediment Regime Stressors

Just as hydrologic alterations can affect the watershed wide sediment regime, modifications to the valley, channel, floodplain, and boundary conditions at the reach scale can change the hydrology and sediment transport capacity. Reach scale stressors can affect either stream power (increase or decrease in stream channel slope or depth) or the resistance to stream power known as boundary conditions (VT ANR 2007). Examples of human related activities which can increase stream power through slope and depth changes are channel straightening, dredging, berming, and undersized bridges and culverts. Structures such as dams and weirs can lead to a decrease in stream power. Boundary resistance is increased through armoring and placement of grade controls or decreased by removal of riparian vegetation and dredging. A summary of these reach scale stressors is shown on Table 2 above.

Reach scale channel slope modifiers are summarized on Figure 11. Many of the assessed reaches within Hungerford watershed exhibit stressors related to channel slope increases including extensive straightening, and human related encroachments within the river corridor including roads and development including M4S1.01B, M4T2.01, M3T1.03, M3T1.04B, M08B, M4T2.04B, and M4T2.04D. Stressors related to decreased channel slope are also common in the watershed including multiple undersized bridges and culverts, beaver dams, and bedrock grade controls. Reaches M3T1.01, M3T1.02, M3T1.03, M3T1.04, M4T2.03, M4T2.04, M06, and M07 all contain multiple decreased channel slope stressors. Reach scale channel depth modifiers are shown on Figure 12. The main stressors associated with increased channel depth are roads, corridor encroachments from residential development, stormwater inputs, and bridges and culverts, all of which are common throughout the watershed. Channel depth decreases are caused by dredging, beaver dams, and an overabundance of deposition features. Those reaches with significant channel depth decreases include M3T1.01, M06, M08, and M09. Many of the reaches within the watershed contain multiple stressors which are

affecting both the stream slope and depth. The cumulative effect of these stressors in most reaches has led to widespread channel incision (or downcutting), and ultimately a decreased sediment and nutrient attenuation capacity as the stream has lost access to its historic floodplain.

K:\1-1470-9\River Corridor Planning Maps\Maps 031008\Channel Slope Modifiers (11x17) 031008.mxd



N

M3T1.01A
M3T1.01B
M3T1.01C
M04
M3T1.02
M4S1.01A
M4S1.01B
M4T2.01
M05
M3T1.03
M4T2.02
M06
M4T2.03
M3T1.04A
M07A
M4T2.04A
M3T1.04B
M07B
M08A
M4T2.04B
M4T2.04C
M4T2.04D
M08B
M09A
M4T2.05
M09B

DARLENE DR
GLEN RIDGE LN
207
SAMSON DR
HEALD RD
DONALDSON RD
HIGHGATE RD
WOODS HWY RD
COOK RD
MOREY RD
TOWN HWY 45
RUSSELL RD
ROUTE 105
SHELDON
TH 26
HAZARD RD
COUNTRY LN
INTERSTATE 89 N
HIGHGATE RD
BUSHEY RD
105
VIENS RD
SWEETHALLOW RD
POND RD
SHOLAN RD
SHELDON RD
MARCEL DR
LEBEL DR
HEAVEN AV
BUSHEY DR
INTERSTATE 89 S
FISHER POND RD
89
ALDIS HILL

Legend

- Reach Break
- Segment Break
- Roads
- Hungerford Brook
- Sub-watershed

Slope Increases

- Head Cut
- Straightening

P2 % Straightening

- <5%
- >5% <=20%
- >20%

Slope Decreases

- Beaver Dam
- Bridge or Culvert

P2 encroachment %

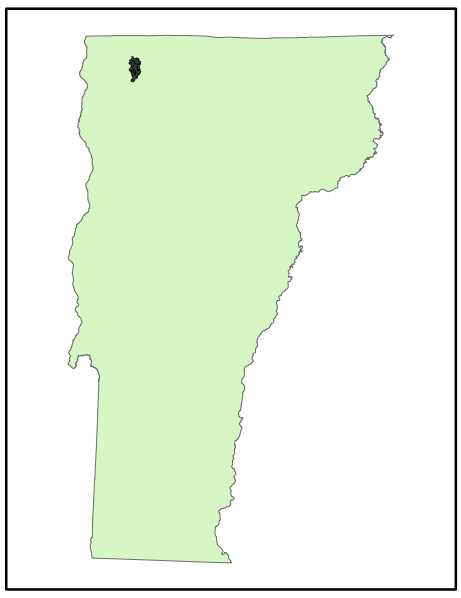
- <5%
- >5% <=20%
- >20%

Grade Control

- Human Constructed
- Natural

2,500 1,250 0 2,500
Feet

Figure 11
Channel Slope Modifiers Map
Hungerford Brook



N

M3T1.01A
M3T1.01B
M3T1.01C
M04
M4S1.01A
M4S1.01B
M4T2.01
M3T1.02
M05
M4T2.02
M3T1.03
M06
M4T2.03
M3T1.04A
M07A
M4T2.04A
M3T1.04B
M07B
M08A
M4T2.04B
M4T2.04C
M4T2.04D
M08B
M09A
M4T2.05
M09B

DARLENE DR
SAMSON DR
GLEN RIDGE LN
207
HEALD RD
MOREY RD
DONALDSON RD
HIGHLAND RD
WOODS HILL RD
COOK RD
TOWN HWY 45
RUSSELL RD
ROUTE 105 SHELDON
TH 26
COUNTRY LN
HAZARD RD
INTERSTATE 89 N
HIGHGATE RD
BUSHEY RD
105
SWEETHOLLOW RD
POND RD
HOLAN RD
SHELDON RD
MARCEL DR
LEBEL DR
BUSHEY DR
HEAVEN AV
INTERSTATE 89 S
FISHER POND RD
89
ALDIS HILL

Legend

- Reach Break
- Segment Break
- Roads
- Hungerford Brook
- Sub-watershed

Depth Increases

- Stormwater Input
- Bridge or Culvert

P2 encroachment %

- <5%
- >5% <=20%
- >20%

Depth Decreases

- Dredging
- Beaver Dam

Deposition Features/Mile

- <=2
- >2 <= 5
- > 5

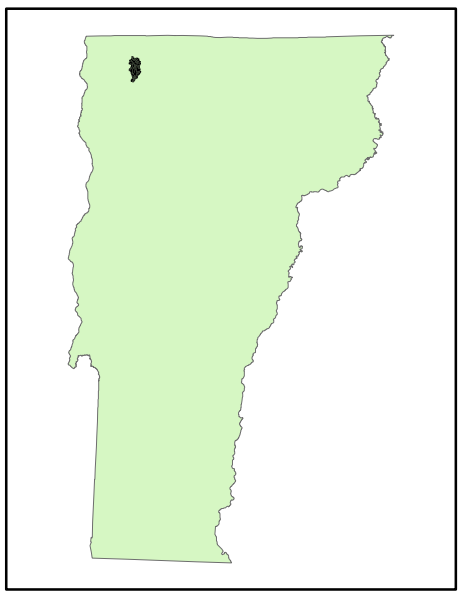
2,500 1,250 0 2,500
Feet

Figure 12
Channel Depth Modifier Map
Hungerford Brook

In addition to the increased channel slope and depth, a significant reduction in the channel boundary resistance has occurred through a reduction in bank vegetation and buffers. Normally woody vegetation located along the stream channel will withstand some of the stream energy produced during flood events and help prevent excessive erosion and channel migration. Also woody buffer vegetation is beneficial for filtering out sediment and nutrients before they reach the channel, and enhances aquatic habitat by moderating water temperatures and providing food and habitat structure for aquatic organisms. A Boundary Conditions and Riparian Modifiers Map is shown as Figure 13. The decreased boundary resistance in Hungerford Brook is caused by the lack of woody buffer along most reaches including M06, M07B, M08, M09A, M3T1.01B, M3T1.03, M3T1.04B, M4T2.01, M4T2.03, M4T2.04B, and M4T2.05. The naturally cohesive soils present within many reaches act to increase boundary resistance and may explain why more widespread erosion is not present in the watershed.

It is also important to note that most of the watershed, with the exception of M4T2.03, and M3T1.02/M3T1.03, lacks any permanent grade controls. This lack of bed resistance means that any vertical channel adjustments, such as the incision processes described above, will move upstream without any permanent structures to arrest it. The Phase 2 data indicates that historic incision has occurred in nearly every reach and has reduced the amount of floodplain connection still available during high flow events.

K:\1-1470-9\River Corridor Planning Maps\Maps 030708\BCs and Riparian (11x17) 031008.mxd



N

M3T1.01A
M3T1.01B
M3T1.01C
M04
M4S1.01A
M4S1.01B
M4T2.01
M05
M3T1.02
M4T2.02
M06
M4T2.03
M3T1.03
M3T1.04A
M07A
M4T2.04A
M3T1.04B
M07B
M4T2.04B
M08A
M4T2.04C
M4T2.04D
M08B
M09A
M4T2.05
M09B

DARLENE DR
SAMSON DR
GLEN RIDGE LN
207
HEALD RD
MOREY RD
DONALDSON RD
HIGHGATE RD
WOODS HILL RD
COOK RD
TOWN HWY 45
RUSSELL RD
ROUTE 105 SHELDON
COUNTRY LN
TH 26
HAZARD RD
INTERSTATE 89 N
BUSHEY RD
105
VIENS RD
SWEETHOLLOW RD
POND RD
SHOLAN RD
SHELDON RD
MARCEL DR
BUSHEY DR
LEBEL DR
HEAVEN AV
INTERSTATE 89 S
FISHER POND RD
89
ALDIS HILL

Legend

- Reach Break
- Segment Break
- Hungerford Brook
- Roads
- Sub-watershed

Increased Boundary Resistance

- P2 Coarse Bed
- P2 Cohesive bank

Grade Control

- Human Constructed
- Natural

Decreased Boundary Resistance

- Dredging

Armoring

- Bank Armoring
  (armoring on right and/or left bank 0-200 feet in length)

Erosion

- Left Bank
- Right Bank

Buffer <25'

- Left Buffer
- Right Buffer

2,500 1,250 0 2,500
Feet

Figure 13
Boundary Conditions and Riparian Modifiers Map
Hungerford Brook

4.1.3 Constraints to Sediment Transport and Attenuation

Streams in equilibrium are continuously moving sediment through the watershed from upstream to downstream. The type and amount of sediment are dictated by the size and overall slope of the watershed, and the type of geologic material the stream flows through. Understanding the transport and storage of sediment within a watershed is one of the most important aspects of river corridor restoration. Changes or modifications to watershed inputs and hydraulic geometry create disequilibrium and lead to an uneven distribution of stream power and sediment. This disequilibrium is manifested through large and small scale channel adjustments such as excessive erosion and deposition. These adjustments will continue until the stream returns itself to an equilibrium state where a balance between flow and sediment transport and attenuation are achieved (VT ANR 2007).

Table 3, Departure Analysis Table, presents data on sediment transport and Table 4, Sediment Regime Table, shows the sediment regime for the study area and how it has changed from its reference regime. This information is presented graphically in Figure 14. Historically, nearly the entire watershed, except for M03 (which is located in a gorge), M3T1.05, M4T2.06, and M10, had a coarse equilibrium and fine deposition sediment regime. This means that the stream was in balance, and the sediment inputs essentially equaled the sediment outputs. Fine sediments and nutrients were stored on the floodplain during high flow events, and generally the system was in equilibrium. Currently, much of the study area has been converted to a fine source and transport regime where little sediment and nutrient attenuation is occurring because the channel has lost much of its historic floodplain access. The consequence of this conversion is that sediment and nutrients are no longer retained in the watershed, but carried downstream to other reaches and receiving bodies of water, namely the Missisquoi River and ultimately Lake Champlain. In addition, the incision which has limited floodplain access also will also lead to excessive erosion which has converted many reaches from historic sediment and nutrient sinks to sediment and nutrient sources. The exception to this are reaches M04, M4S1.01A, M07, M09, M4T2.02, M4T2.03, M3T1.02, and M3T1.03, which still have limited floodplain access and

retain some of their fine sediment storage capacity. As shown in Table 3, all of the fine source and transport reaches have opportunities for increased sediment storage through floodplain restoration given the limited number of constraints from roads, bridges, homes and other development (Figure 14). More information about how these altered sediment regimes play into river corridor restoration and conservation projects for the area are described in Section 5.

Table 3: Departure Analysis Table - Hungerford Brook

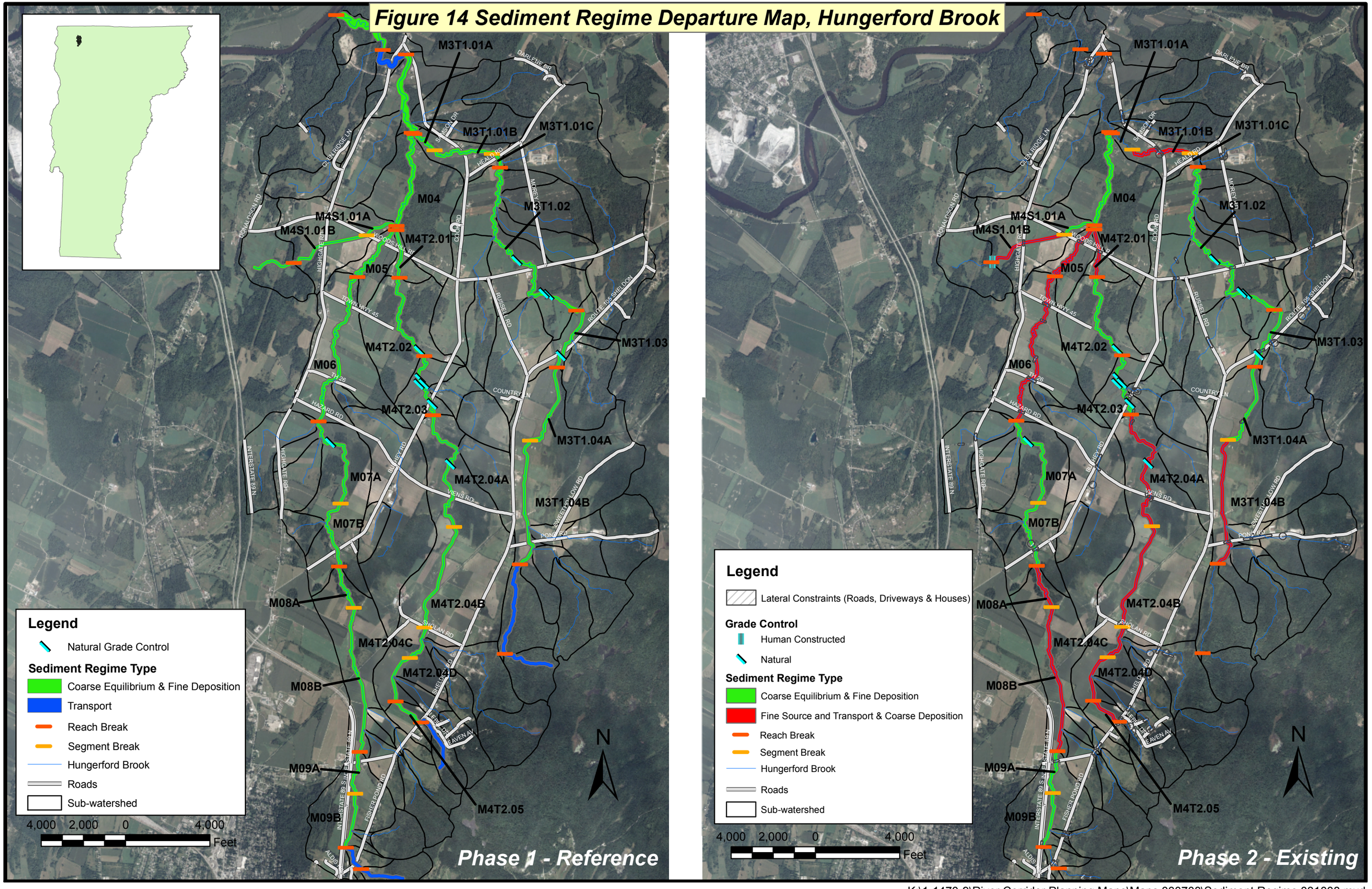
	Existing Constraints Which May Limit Restoration Opportunities		Transport[1]		Attenuation (sediment/nutrient storage)[2]		
River Segment	Vertical	Lateral	Natural	Converted	Natural	Increased	Asset
M04		Human - Agriculture			X		X
M05		Human - Agriculture, Culverts/Bridges		X	X		X
M06		Human - Agriculture, Culverts/Bridges		X	X		X
M07A	Natural - Bedrock Grade Control	Human - Agriculture Natural - Bedrock			X		X
M07B		Human - Agriculture, Culverts			X	X	X
M08A				X	X		X
M08B		Human - Agriculture, Culverts		X	X		X
M09A		Human - Agriculture, Culverts			X	X	X
M09B	Human - Dam	Human - Agriculture, Culverts			X		X
M3T1.01A	Impounded water from Beaver Dam - Not Assessed						
M3T1.01B		Human - Agriculture, Culverts		X	X		X
M3T1.01C	Impounded water from Beaver Dam - Not Assessed						
M3T1.02	Natural - Bedrock Grade Controls	Human - Culvert/Bridge			X		X
M3T1.03	Natural - Bedrock Grade Control	Human - Agriculture, Bridges			X		X
M3T1.04A		Human - Culvert			X	X	X
M3T1.04B		Human - Agriculture, Culverts		X	X		X
M4S1.01A		Human - Agriculture, Culverts			X	X	X
M4S1.01B	Human - Dam	Human - Agriculture, Culverts		X	X		X
M4T2.01		Human - Agriculture, Culvert		X	X		X
M4T2.02	Natural - Bedrock Grade Control	Natural - Bedrock			X	X	X
M4T2.03	Natural - Bedrock Grade Controls	Natural - Bedrock Human - Culvert			X	X	X
M4T2.04A	Natural - Bedrock Grade Control	Human - Culvert		X	X		X
M4T2.04B		Human - Agriculture, Culverts		X	X		X
M4T2.04C				X	X	X	X
M2T2.04D		Human - Agriculture		X	X		X
M4T2.05		Human - Agriculture, Culverts		X	X		X

Notes:
1 This column shows if each segment was naturally a transport reach, or has been converted from a storage to a transport reach (blank cells indicate the reach is not a transport reach)
[2] These columns indicate which segments were naturally high sediment deposition areas, are currently experiencing an increase in sediment depositional features, and/or could be an asset to allow future deposition to occur

Table 4: Sediment Regime Table - Hungerford Brook

Reach ID	Reference Sediment Regime	Reference Stream Type	Stage of Channel Evolution/Geomorphic Condition	Criteria related to Sediment Supply, Transport and Storage	Existing Stream Type	Existing Sediment Regime
M04	Coarse Equilibrium & Fine Deposition	E-Dune-Ripple	I / Good	Incision Ratio = 1.1 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 13.6	C5-Dune-Ripple	Coarse Equilibrium & Fine Deposition
M05	Coarse Equilibrium & Fine Deposition	E	II / Fair	Incision Ratio = 1.8 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 7.1	E5 Riffle-Pool	Fine Source & Transport and Coarse Deposition
M06	Coarse Equilibrium & Fine Deposition	E5-Riffle Pool	II / Fair	Incision Ratio = 1.8 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 6.3	E5 Riffle-Pool	Fine Source & Transport and Coarse Deposition
M07A	Coarse Equilibrium & Fine Deposition	E-Riffle-Pool	I / Good	Incision Ratio = 1.1 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 12.3	C3 Riffle-Pool	Coarse Equilibrium & Fine Deposition
M07B	Coarse Equilibrium & Fine Deposition	E4-Riffle Pool	I / Good	Incision Ratio = 1.2 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 3.9	E5 Riffle-Pool	Coarse Equilibrium & Fine Deposition
M08A	Coarse Equilibrium & Fine Deposition	E4-Riffle Pool	I / Good	Incision Ratio = 1.4 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 6.6	E4 Riffle-Pool	Fine Source & Transport and Coarse Deposition
M08B	Coarse Equilibrium & Fine Deposition	E4-Riffle Pool	II / Fair	Incision Ratio = 1.6 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 4	E4 Riffle-Pool	Fine Source & Transport and Coarse Deposition
M09A	Coarse Equilibrium & Fine Deposition	E-Riffle Pool	III / Poor	Incision Ratio = 1.2 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 13	C5-Riffle-Pool	Coarse Equilibrium & Fine Deposition
M09B	Coarse Equilibrium & Fine Deposition	E-Riffle-Pool	II / Fair	Incision Ratio = 1.2 Bank Armoring = <50% Valley Type = VB Straightening = >50% W/D Ratio = 5.4	E4-Riffle-Pool	Coarse Equilibrium & Fine Deposition
M3T1.01A				Incision Ratio = Bank Armoring = Valley Type = Straightening =		Segment not Assessed - impounded behind Beaver Dam
M3T1.01B	Coarse Equilibrium & Fine Deposition	E4-Dune-Ripple	II / Good	Incision Ratio = 1.4 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 6.3	E5 Dune-Ripple	Fine Source & Transport and Coarse Deposition
M3T1.01C				Incision Ratio = Bank Armoring = Valley Type = Straightening =		Segment not Assessed - impounded behind Beaver Dam
M3T1.02	Coarse Equilibrium & Fine Deposition	E4-Riffle-Pool	I / Good	Incision Ratio = 1.0 Bank Armoring = <50% Valley Type = B Straightening = <50% W/D Ratio = 8.5	E4 Riffle-Pool	Coarse Equilibrium & Fine Deposition
M3T1.03	Coarse Equilibrium & Fine Deposition	E4-Riffle-Pool	I / Good	Incision Ratio = 1.2 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 5.7	E4 Riffle-Pool	Coarse Equilibrium & Fine Deposition
M3T1.04A	Coarse Equilibrium & Fine Deposition	E5-Riffle-Pool	III/Fair	Incision Ratio = 1.1 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 6.9	E5-Riffle-Pool	Coarse Equilibrium & Fine Deposition
M3T1.04B	Coarse Equilibrium & Fine Deposition	E5-Riffle-Pool	II/Fair	Incision Ratio = 1.4 Bank Armoring = <50% Valley Type = VB Straightening = >50% W/D Ratio = 5.3	E5-Riffle-Pool	Fine Source & Transport and Coarse Deposition
M4S1.01A	Coarse Equilibrium & Fine Deposition	C	III/Fair	Incision Ratio = 1.2 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 19.3	B6-Plane-Bed	Coarse Equilibrium & Fine Deposition
M4S1.01B	Coarse Equilibrium & Fine Deposition	C	II/Fair	Incision Ratio = 1.9 Bank Armoring = <50% Valley Type = VB Straightening = >50% W/D Ratio = 13	C6-Riffle-Pool	Fine Source & Transport and Coarse Deposition
M4T2.01	Coarse Equilibrium & Fine Deposition	E4-Dune Ripple	II / Fair	Incision Ratio = 2.3 Bank Armoring = <50% Valley Type = VB Straightening = >50% W/D Ratio = 6.5	G5 Dune-Ripple	Fine Source & Transport and Coarse Deposition
M4T2.02	Coarse Equilibrium & Fine Deposition	E5-Riffle-Pool	I / Reference	Incision Ratio = 1.0 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 9	E5 - Riffle-Pool	Coarse Equilibrium & Fine Deposition
M4T2.03	Coarse Equilibrium & Fine Deposition	E5-Riffle-Pool	I / Good	Incision Ratio = 1.0 Bank Armoring = <50% Valley Type = B Straightening = <50% W/D Ratio = 8.4	E5 Riffle-Pool	Coarse Equilibrium & Fine Deposition
M4T2.04A	Coarse Equilibrium & Fine Deposition	C-Riffle-Pool	I / Fair	Incision Ratio = 1.4 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 6.3	E4 Riffle-Pool	Fine Source & Transport and Coarse Deposition
M4T2.04B	Coarse Equilibrium & Fine Deposition	C3 Riffle-Pool	II / Fair	Incision Ratio = 1.7 Bank Armoring = <50% Valley Type = VB Straightening = >50% W/D Ratio = 9	G5 Dune-Ripple	Fine Source & Transport and Coarse Deposition
M4T2.04C	Coarse Equilibrium & Fine Deposition	C-Riffle-Pool	III / Fair	Incision Ratio = 2.3 Bank Armoring = <50% Valley Type = VB Straightening = <50% W/D Ratio = 20.4	B4 Riffle-Pool	Fine Source & Transport and Coarse Deposition
M4T2.04D	Coarse Equilibrium & Fine Deposition	C Riffle-Pool	II / Fair	Incision Ratio = 3.6 Bank Armoring = <50% Valley Type = VB Straightening = >50% W/D Ratio = 9.2	G5 Dune-Ripple	Fine Source & Transport and Coarse Deposition
M4T2.05	Coarse Equilibrium & Fine Deposition	E-Riffle-Pool	II/Good	Incision Ratio = 1.4 Bank Armoring = <50% Valley Type = VB Straightening = >50% W/D Ratio = 11.2	E5-Plane-Bed	Fine Source & Transport and Coarse Deposition

Figure 14 Sediment Regime Departure Map, Hungerford Brook



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4.2 SENSITIVITY ANALYSIS

Figure 15 shows the predicted stream sensitivity for each reach in the study area. Stream sensitivity is defined as the likelihood that future vertical and lateral adjustments will occur including channel migration, widening, degradation, and aggradation. This sensitivity rating is based on the documented current and historic adjustment processes combined with known reference information for each reach. As is shown on Figure 15, fifteen of the sixteen reaches have a high or very high sensitivity, meaning it is very likely that further vertical and lateral adjustments will occur.

5.0 PRELIMINARY PROJECT IDENTIFICATION

The preceding Section 4 described the underlying stressors and described how each reach within the study area has departed from its reference conditions. Utilizing the Tables, Figures and data above along with the step-wise procedure for identification of river corridor restoration and conservation projects developed by VT ANR (2007) the following Section will identify appropriate types of projects for each reach in the study area. Appropriate projects were broken down into the following eight project types:

1. Protect River Corridors
2. Plant Stream Buffers
3. Stabilize Stream Banks
4. Arrest Head Cuts
5. Remove Berms
6. Remove or Replace Structures
7. Restore Incised Reach
8. Restore Aggraded Reach

For each of the sixteen assessed reaches, a Project and Practices Summary Table was created describing the types of projects which would best aid in restoring sediment and nutrient attenuation and restoring the reach to equilibrium conditions. Section 6.2 takes all of the identified project techniques identified at the Reach scale and prioritizes them at the watershed scale to identify which projects may be technically feasible and achieve the greatest possible benefit.

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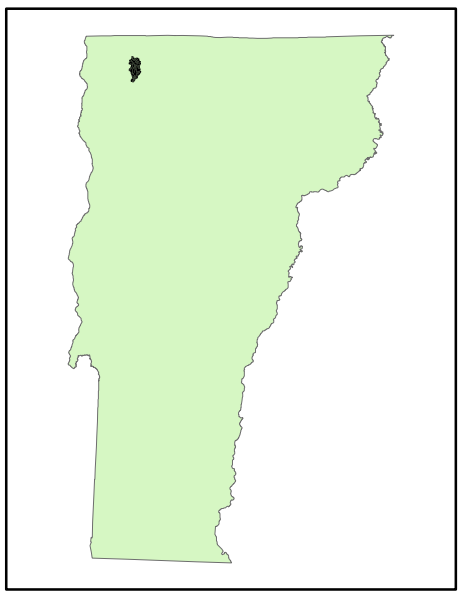


N

M3T1.01A
M3T1.01B
M3T1.01C
M04
M3T1.02
M4S1.01A
M4S1.01B
M4T2.01
M05
M4T2.02
M06
M4T2.03
M3T1.03
M3T1.04A
M07A
M4T2.04A
M3T1.04B
M07B
M08A
M4T2.04B
M4T2.04C
M4T2.04D
M08B
M09A
M4T2.05
M09B

DARLENE DR
GLEN RIDGE LN
207
SAMSON DR
HEALD RD
MOREY RD
DONALDSON RD
HIGHGATE RD
WOODS HILL RD
COOK RD
TOWN HWY 45
RUSSELL RD
ROUTE 105 SHELDON
TH 26
HAZARD RD
COUNTRY LN
INTERSTATE 89 N
BUSHEY RD
105
VIENS RD
SWEETHOLLOW RD
POND RD
SHOLAN RD
SHELDON RD
MARCEL DR
BUSHEY DR
LEBEL DR
HEAVEN AV
INTERSTATE 89 S
FISHER POND RD
89
ALDIS HILL

Legend

Current Adjustments

- Lateral
- Vertical
- Vertical & Lateral

Stream Sensitivity Level

- Moderate
- High
- Very High
- Reach Break
- Segment Break
- Roads
- Hungerford Brook
- Sub-watershed

2,500 1,250 0 2,500
Feet

Figure 15
Stream Sensitivity Map
Hungerford Brook

5.1 REACH BASED PROJECT IDENTIFICATION

5.1.1 Reach M04 Description and Project Identification

Reach M04 is the furthest downstream reach in the study area and extends from the end of M03 south to just north of Woods Hill Road in Swanton. This reach was found to be only slightly incised (incision ratio of 1.1) and still has access to its floodplain during most high flow events. The existing stream type of E5 Dune-Ripple was consistent with its reference stream type. Minor bank erosion was noted along small portions of the reach, though most of the banks were found to be relatively stable. The reach was found to be in Evolution Stage I, or Reference, with little active adjustments occurring. The riparian corridor was dominated by forest and shrub/saplings, with buffer widths of 50-100 feet except along the right bank in the downstream portion and the left bank in the upstream portion, where narrower buffers of 0 to 50 feet were noted. The habitat assessment showed fair aquatic habitat primarily due to embeddedness, lack of woody cover, and very few favorable sediment types and flow patterns.

Given the current, relatively stable condition of M04, the recommended remedial strategies are to protect the existing undeveloped river corridor to retain the reach's nutrient attenuation assets, and enhance the current buffer. The river corridor is defined as the area adjacent to the stream through which the stream would naturally meander over its lifetime to maintain equilibrium conditions. In most cases this is measured as three times the bankfull channel width on either side of the stream. Keeping the river corridor undeveloped allows the stream to undergo natural evolutionary processes without impacting human investments. Being one of the furthest downstream reaches, M04 receives all the inputs from upstream and provides some attenuation of those inputs. While the reach currently has adequate woody buffer along most banks, woody tree planting could be undertaken along the right bank in the downstream half and along the left bank in the upstream half. An aerial view of the reach is shown on Figure 16, and descriptions of the recommended projects are shown in Table 5. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 5: Projects and Practices Table - Hungerford Brook
Reach M04

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M04	Protect River Corridor - Retain floodplain connection and sediment attenuation zones. Corridor currently undeveloped and not in production with incision ratio of 1.1.	High	High	11	Yes	Landowner cooperation
M04	Plant Stream Buffer - majority of reach has adequate riparian buffer, buffer enhancement along right bank near downstream end of reach and along left bank near upstream end of reach	Low	Low	64	Yes	Need landowner permission and planting plan

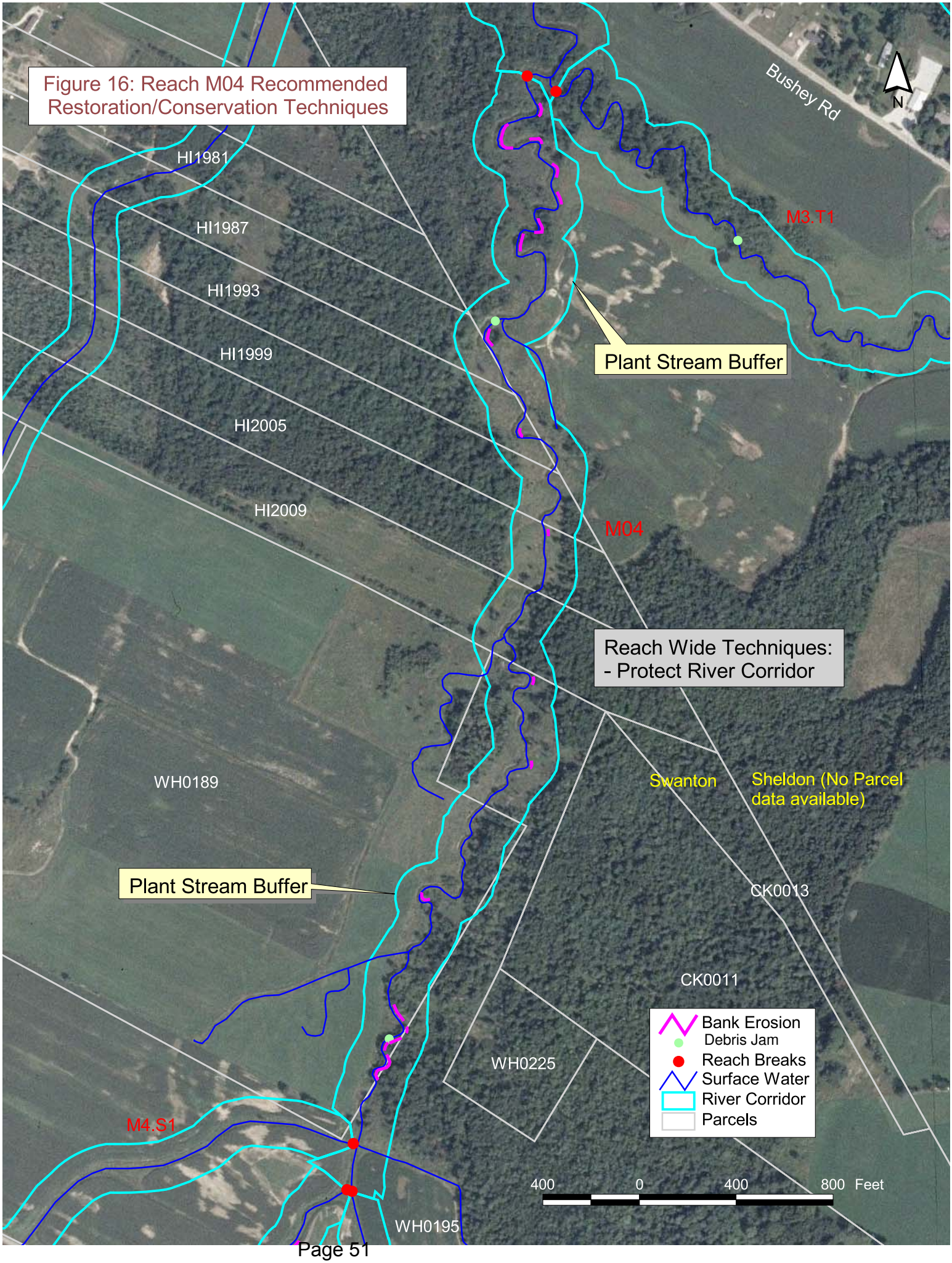


Figure 16: Reach M04 Recommended Restoration/Conservation Techniques
Bushey Rd
N
HI1981
HI1987
HI1993
HI1999
HI2005
HI2009
M3.T1
Plant Stream Buffer
M04
Reach Wide Techniques:
- Protect River Corridor
WH0189
Swanton
Sheldon (No Parcel data available)
Plant Stream Buffer
CK0013
CK0011
WH0225
M4.S1
WH0195
Bank Erosion
Debris Jam
Reach Breaks
Surface Water
River Corridor
Parcels
400
0
400
800 Feet

5.1.2 Reach M05 Description and Project Identification

Reach M05 extends from 500 feet north of Woods Hill Road south for approximately ¾ of a mile to the start of M06. This reach was found to be highly incised (has historically cut down into its bed) with an incision ratio of 1.8 due to historic straightening, extensive agricultural activities, and other channel management techniques, and only has access to the floodplain during extreme high flow events. No head cuts were noted indicating that the incision process is not currently active. The reach was classified as an E5 Riffle-Pool stream, consistent with its reference type. Despite the high incision only minor bank erosion was noted. The reach was found to be in Evolution Stage II (Incised) and due to cohesive soils and narrow riparian buffers, has not yet begun to erode its banks and widen (Evolution Stage III). The riparian corridor was dominated by shrubs and saplings upstream of Woods Hill Road and corn fields downstream of the road. Buffer widths were 50-100 feet upstream of the road, and less than 25 downstream of it. The habitat assessment showed relatively poor aquatic habitat due to lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Given the current condition of M05, the highest priority recommended remedial strategy is to re-establish floodplain connection to restore the sediment and nutrient storage potential of the Reach, and improve aquatic habitat. There are both passive and active remedial techniques which could be utilized. The passive approach involves protecting the river corridor and limiting channel management to allow the current channel evolution process to continue. Over time the stream will re-establish a more stable meander pattern, widen and create greater floodplain connection and return to a more stable equilibrium state. Given the cohesive bank texture, low gradient, and other geologic and geomorphic features of the reach, the passive approach would be very slow to develop, and the reach could remain in its current incised state for years or decades before floodplain connection is re-established. Therefore, the most appropriate technique for this reach would be active floodplain restoration. This approach would involve physical manipulation of the channel and adjacent corridor to construct a more stable meander pattern and accessible floodplain. Heavy equipment would be used to excavate and lower the

current streambanks to a level where the stream could access them during flood events. In conjunction with either technique, or as a stand alone project if active restoration is not feasible, woody buffer vegetation planting should be conducted to improve aquatic habitat, particularly downstream of Woods Hill Road, where little to no buffer currently exists. Other instream aquatic habitat improvement techniques, such as introduction of woody debris for cover, could also be considered once greater channel stability has been reached. Two stream crossing structures are also located in the reach, a Town owned bridge on Woods Hill Road, and a privately owned culvert. Both of these structures are undersized and act as channel and floodplain constrictions. Replacing or retrofitting these structures would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. Table 6 and Figure 17 below describe and show the locations of the recommended projects. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 6: Projects and Practices Table - Hungerford Brook
Reach M05

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M05	Protect River Corridor - River corridor currently undeveloped dominated by agriculture downstream of Woods Hill Road and abandoned pasture upstream. Stream incised and straightened downstream of Woods Hill Road so channel adjustments expected.	Low as a Stand Alone Project	Low as a Stand Alone Project	68	Yes	Landowner permission, also communication with town regarding bridge located mid-reach. Reach highly incised with cohesive soils so passive floodplain restoration probably not feasible in the short term. Should be combined with active restoration.
M05	Plant Stream Buffer - Upstream of Woods Hill Road has herbaceous buffer but few trees, downstream of Road little to no buffer present	Medium	Low	39	Yes	Landowner cooperation, expected channel adjustments downstream of road so plantings should account for expected changes
M05	Replace Undersized Structures - Woods Hill Road currently undersized and poorly aligned (width = 24'). Town had done extensive channel alterations (dredging/straightening) to protect bridge. Private culvert also present in reach (structure is only 33% of channel width).	Medium	Low	43	Yes	Town of Swanton cooperation, more detailed survey of existing conditions/Phase III Assessment
M05	Restore Incised Reach - Reach no longer has access to floodplain (incision of 1.8), corridor protection project could be combined with active restoration (create new floodplain) to enhance sediment attenuation and reduce erosion	High	High	3	Yes	Should be combined with corridor protection and stream buffer planting projects, Landowner cooperation and more detailed assessment needed

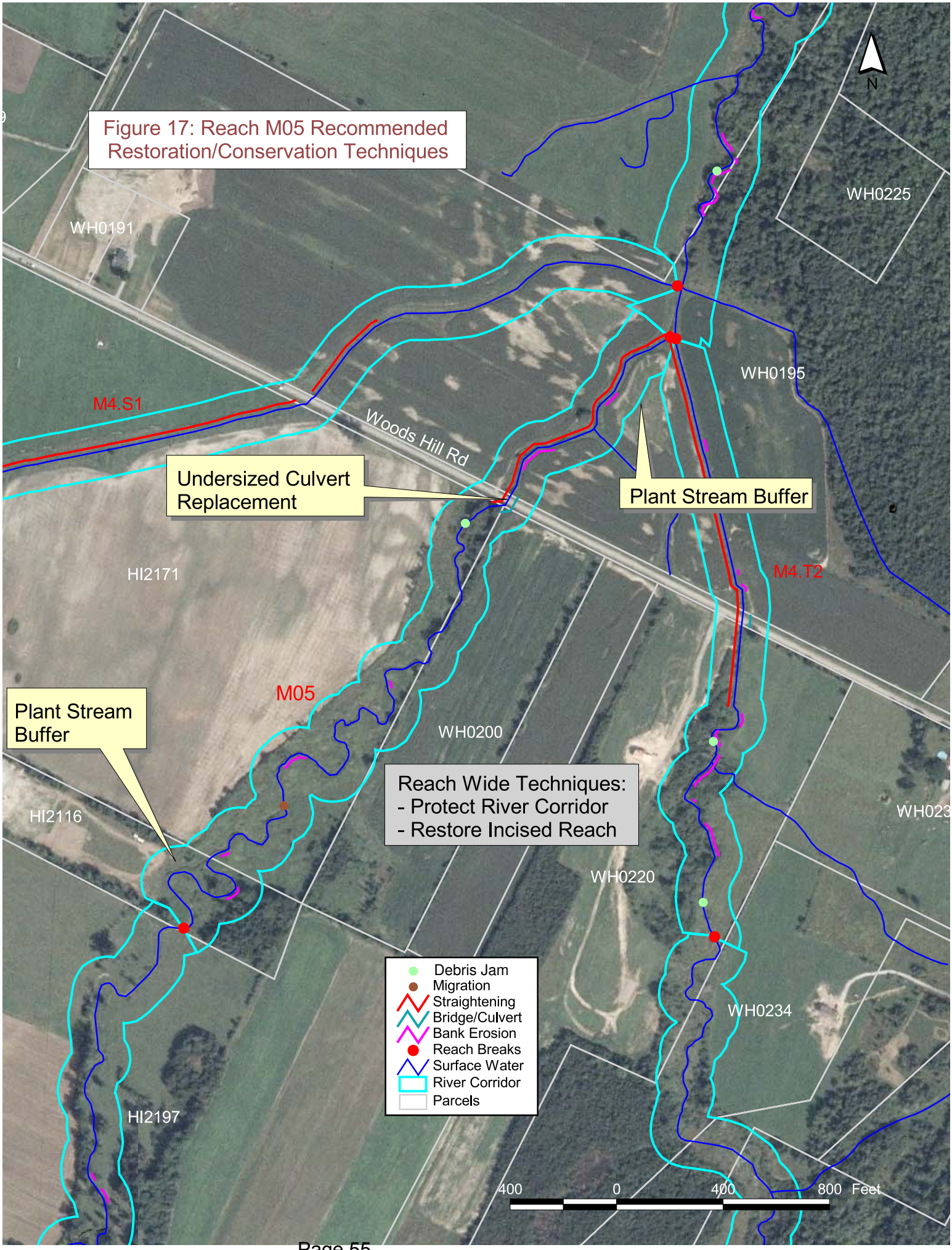


Figure 17: Reach M05 Recommended Restoration/Conservation Techniques
N
WH0191
WH0225
WH0195
M4.S1
Woods Hill Rd
Undersized Culvert Replacement
Plant Stream Buffer
HI2171
M4.T2
M05
Plant Stream Buffer
WH0200
Reach Wide Techniques:
- Protect River Corridor
- Restore Incised Reach
HI2116
WH0220
WH0234
HI2197
Debris Jam
Migration
Straightening
Bridge/Culvert
Bank Erosion
Reach Breaks
Surface Water
River Corridor
Parcels
400
0
400
800 Feet

5.1.3 Reach M06 Description and Project Identification

Reach M06 extends from the upstream end of M05 south for approximately 2 miles to Hazard Road. This reach was found to be highly incised with an incision ratio of 1.8 due to historic straightening, extensive agricultural activities, and other channel management techniques, and only has access to the adjacent floodplain during extreme high flow events. One head cut was noted indicating that the incision process is still occurring. The reach was classified as an E5 Riffle-Pool stream, consistent with its reference type. Despite the high incision only minor bank erosion was noted, likely due to the cohesive texture of the streambanks. The reach was found to be in Evolution Stage II (incised) and due to cohesive soils and narrow but intact riparian buffers, has not yet begun to erode its banks and widen (Evolution Stage III). The riparian corridor was dominated by pasture with narrow buffers and no fencing to prevent cattle access to the stream channel. The habitat assessment showed poor aquatic habitat due to lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Given the current condition of M06, the highest priority recommended remedial strategy is to re-establish floodplain connection to restore the sediment and nutrient storage potential of the Reach, and improve aquatic habitat. There are both passive and active remedial techniques which could be utilized, though like M05, the active approach would be most effective here. This approach would involve physical manipulation of the channel and adjacent corridor to construct a more stable meander pattern and accessible floodplain. Heavy equipment would be used to excavate and lower the current streambanks to a level where the stream could access them during flood events. In conjunction with either technique, or as a stand alone project if active restoration is not feasible, woody buffer vegetation planting should be conducted to improve aquatic habitat. Part of the buffer establishment project should include cattle fencing measures to limit the cows' access to the stream channel. Dedicated crossing structures and/or watering devices may also be needed. Other instream aquatic habitat improvement techniques, such as introduction of woody debris for cover, could also be considered once greater channel

stability has been reached. A permanent grade control structure should be installed above the active head cut to prevent it from migrating further upstream and increasing channel incision. Five stream crossing structures (three bridges and two culverts) are also located in the reach and all were noted as channel and floodplain constrictions. Three of the structures are located on Swanton Town roads, the other two are privately owned. Replacing or retrofitting these structures would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. Table 7 and Figure 18 below describe and show the locations of the recommended projects. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 7: Projects and Practices Table - Hungerford Brook
Reach M06

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M06	Protect River Corridor - Entire river corridor dominated by pasture with little to no buffer. Reach incised (ratio of 1.8) with loss of floodplain access.	Low as Stand Alone Project	Low as Stand Alone Project	67	Yes	Landowner cooperation, cattle within corridor - fencing also required to limit cow access to stream. Reach highly incised with cohesive soils so passive floodplain restoration probably not feasible in the short term. Should be combined with active restoration
M06	Plant Stream Buffer/Cattle Exclusion - Entire river corridor dominated by pasture with little to no buffer. Buffer planting should be combined with cattle fencing measures	High	Medium	13	Yes	Landowner cooperation, cattle within corridor - fencing also required to limit cow access to stream.
M06	Restore Incised Reach - Stream currently incised (ratio of1.8) with active head cut documented. Active floodplain restoration and ideally grade control placement to prevent future incision and restore sediment attenuation funtion	High	High	2	Yes	Should be combined with corridor protection and buffer planting efforts. Landowner cooperation needed along with more detailed Phase III assessment prior to implementation
M06	Replace undersized bridges and culverts - Reach contains 3 bridges and two culverts, all noted as constrictions with structure width/channel width ratios of 46%, 25%, 133%, 25%, and 44%.	Medium	Low	42	Yes	Only 1 Phase 2 culvert assessment completed in reach, additional data on other structures needed. Three of the structures located on town (Swanton) Roads, others privately owned.
M06	Arrest Head Cut - Active head cut observed in Reach, reach currently highly incised (ratio of 1.8) so head cut shoud be stopped to prevent further loss of floodplain access	High	High	8	Yes	Further Site evaluation needed to determine best technique for stopping head cut. Landowner permission and possible stream alteration permit required.

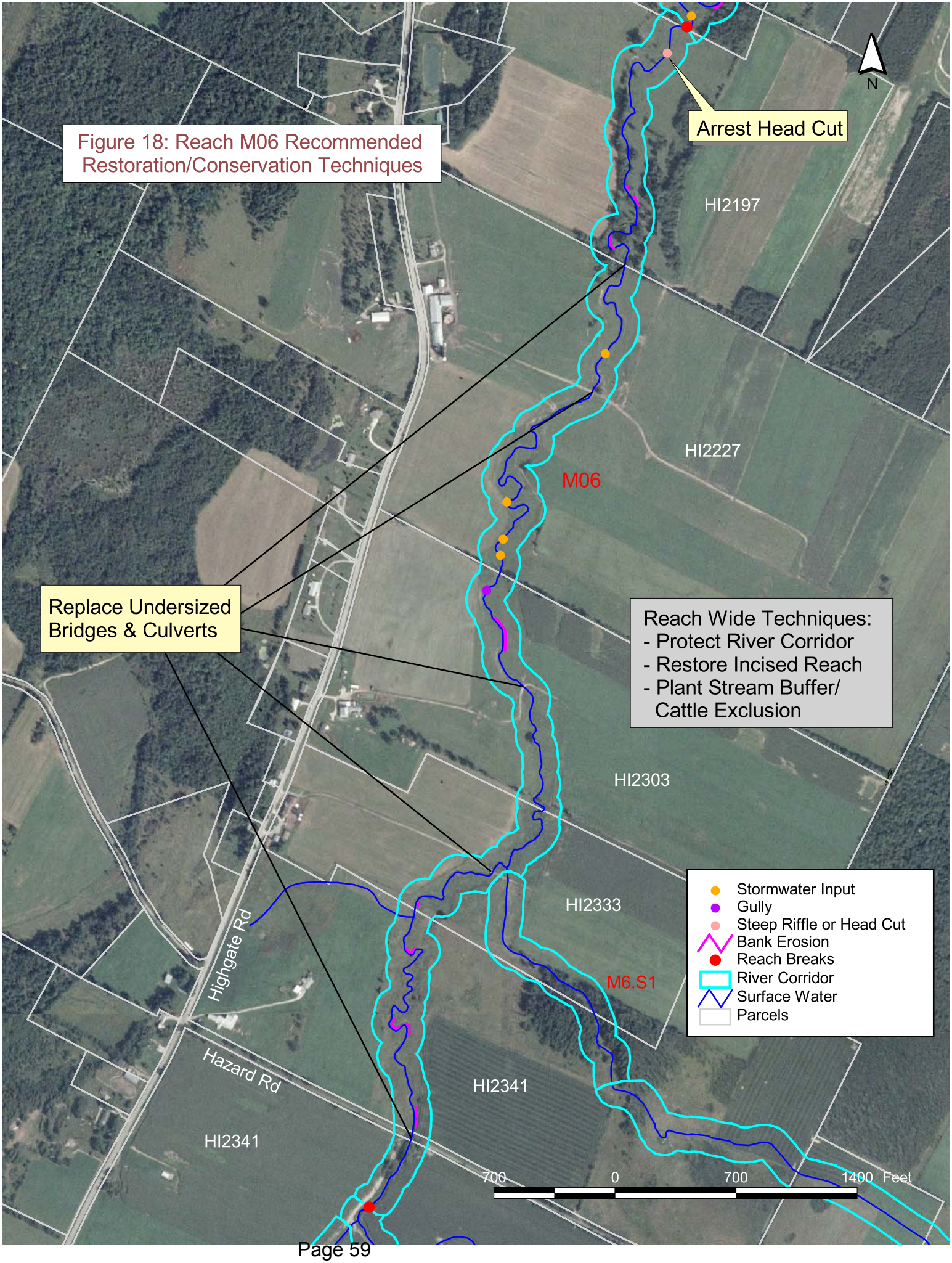


Figure 18: Reach M06 Recommended Restoration/Conservation Techniques
Arrest Head Cut
N
HI2197
HI2227
M06
Replace Undersized Bridges & Culverts
Reach Wide Techniques:
- Protect River Corridor
- Restore Incised Reach
- Plant Stream Buffer/ Cattle Exclusion
HI2303
HI2333
M6.S1
Highgate Rd
Hazard Rd
HI2341
HI2341
Stormwater Input
Gully
Steep Riffle or Head Cut
Bank Erosion
Reach Breaks
River Corridor
Surface Water
Parcels
700
0
700
1400 Feet

5.1.4 Reach M07 Description and Project Identification

Reach M07 extends from the just south of Hazard Road, upstream to just south of Bushey Road in Swanton. The reach was segmented into two parts, M07A and M07B, due to differences in the streambank and boundary conditions. M07A is the downstream half of the reach and was found to be relatively stable with only minor incision (ratio of 1.1). The reach was classified as a C3 Riffle-Pool, consistent with its reference type and in Evolution Stage I (Reference). The riparian corridor was dominated by forestland with buffer widths of 50-100 feet. The habitat assessment showed good aquatic habitat conditions. M07B is the upstream half of the reach and was found to be slightly incised with an incision ratio of 1.2 due to historic straightening, extensive agricultural activities, and other channel management techniques. One head cut was noted indicating that the incision process is still occurring. The reach was classified as an E5 Riffle-Pool stream, consistent with its reference type. Despite the incision, only minor bank erosion was noted. The reach was found to be in Evolution Stage I (Reference), though if the active head cut continues to migrate upstream the reach will likely move into Stage II (Incising). The riparian corridor was dominated by pasture with no buffers or fencing to prevent cattle access to the stream channel. The habitat assessment showed relatively poor aquatic habitat due to lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Given the current stable condition of M07A, the recommended remedial strategy is to protect the existing undeveloped river corridor to retain the sediment and nutrient attenuation assets of the reach. A majority of the reach has adequate woody buffer except for approximately 200’ at the downstream end, so establishing a woody buffer in this area would also be a priority. As with M07A, the recommended remedial strategies for M07B are to protect the river corridor to retain its attenuation assets, and establish and adequate woody buffer. M07B currently has little to no buffer and cows have access to the stream channel, so in addition to planting trees and shrubs, cattle fencing measures should also be implemented. Dedicated crossing structures and/or watering devices may also be needed. Other instream aquatic habitat improvement

techniques, such as introduction of woody debris for cover, could also be considered once greater channel stability has been reached. A permanent grade control structure should be installed above the active head cut to prevent it from migrating further upstream and increasing channel incision. Three stream crossing structures (one bridge and two culverts) are also located in the reach and were noted as channel and floodplain constrictions. One of the structures is located on a Swanton Town road, the other two are privately owned. Replacing or retrofitting these structures would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. Table 8 and Figure 19 below describe and show the locations of the recommended projects. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 8: Projects and Practices Table - Hungerford Brook
Reach M07

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M07A	Protect River Corridor - Most of Segment is forested with little impact within corridor. Incision ratio of 1.2. Downstream ~200' has corn andhay with little to no buffer so this area is higher priority of any corridor protection efforts.	High	High	51	Yes	Landowner cooperation
M07A	Plant Stream Buffer - majority of reach has excellent woody buffer except for downstream ~200'. This is where planting efforts should be focused	Medium	Low	46	Yes	Landowner cooperation, planting plan
M07B	Protect River Corridor - Most of Segment is undeveloped with agricultural pasture and crop land. Stream is currently incising (head cut present, but currently has incision ratio of 1.2) so channel adjustments are expected. Corridor should be protected to allow for these adjustments to occur and retain floodplain access.	High	High	24	Yes	Landowner cooperation, cattle have access to stream, fencing also needed
M07B	Plant Stream Buffer/Cattle Exclusion - Majority of reach has little to no buffer. Cows have access to stream, fencing also needed	High	Medium	15	Yes	Landowner cooperation, stream is actively incising so planting plan should take anticipated channel adjustments into account. Fencing also needed to limit cows access to stream.
M07B	Arrest Head Cut - Active head cut observed in Reach, reach currently only slightly incised (ratio of 1.2) so head cut shoud be stopped to prevent loss of floodplain access	High	High	7	Yes	Further Site evaluation needed to determine best technique for stopping head cut. Landowner permission and possible stream alteration permit required.
M07B	Replace/remove undersized bridges/culverts - 2 culverts and 1 bridge noted in segment, all noted as channel and floodplain constrictions with structure width/channel width ratios of 88%, 50%, and 44%.	Medium	Low	48	Yes	Only the Bushey Road culvert was completely assessed during the Phase 2. No major problems noted. Other culvert and bridge need to be further assessed to determine if replacement needed and/or warranted. Bushey Road culvert Town (Swanton) owned, other structures are private.

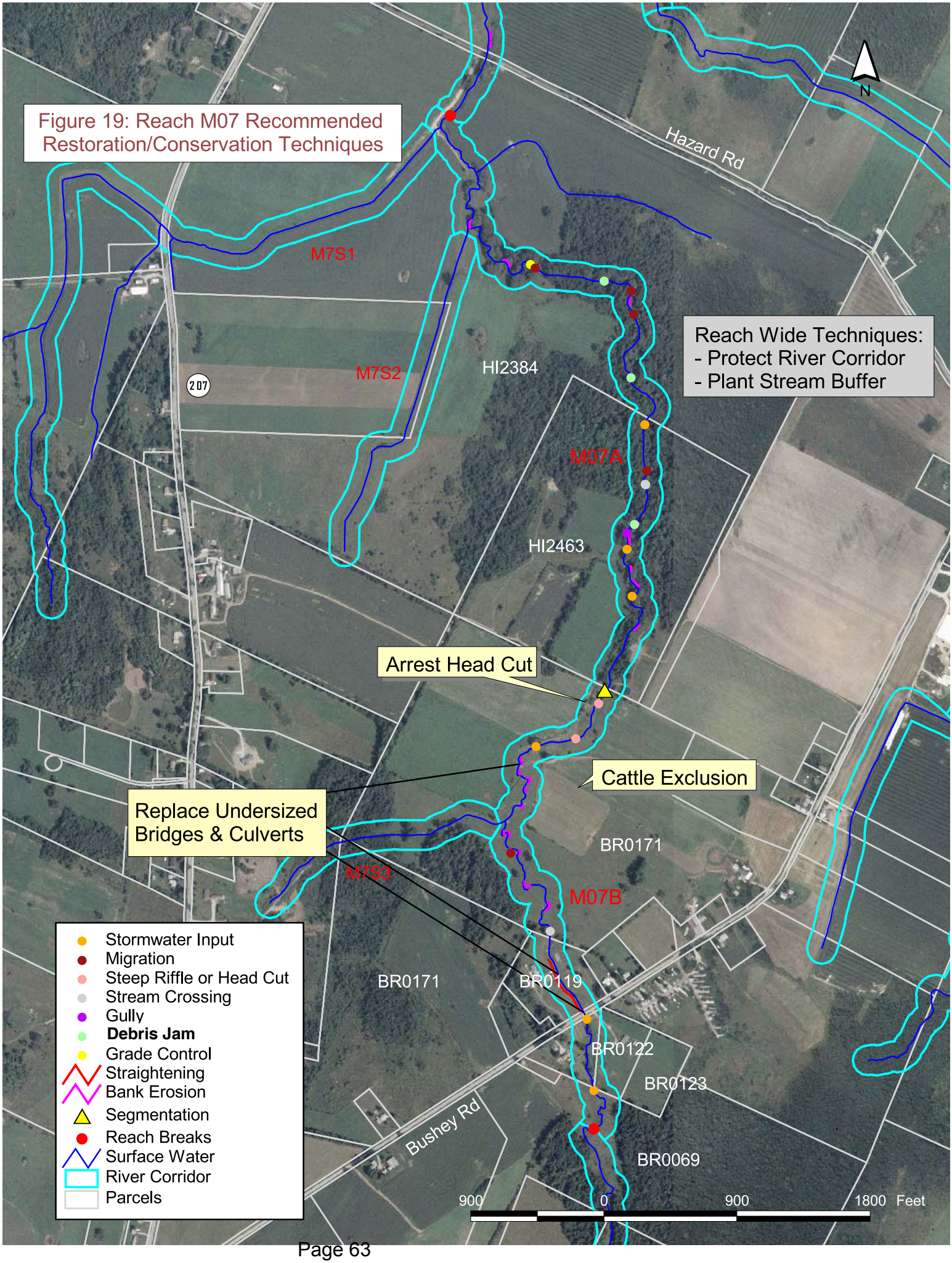


Figure 19: Reach M07 Recommended Restoration/Conservation Techniques
N
Hazard Rd
M7S1
M7S2
HI2384
207
Reach Wide Techniques:
- Protect River Corridor
- Plant Stream Buffer
M07A
HI2463
Arrest Head Cut
Cattle Exclusion
Replace Undersized Bridges & Culverts
BR0171
M7S3
M07B
BR0171
BR0119
BR0122
BR0123
Bushey Rd
BR0069
Stormwater Input
Migration
Steep Riffle or Head Cut
Stream Crossing
Gully
Debris Jam
Grade Control
Straightening
Bank Erosion
Segmentation
Reach Breaks
Surface Water
River Corridor
Parcels
900
0
900
1800 Feet

5.1.5 Reach M08 Description and Project Identification

Reach M08 extends from just south of Bushey Road to just north of Route 105 in Swanton and St. Albans. The reach was segmented into two parts, M08A and M08B, due to differences in the streambank and boundary conditions. M08A is the downstream end of the reach (approximately ½ mile long) and was found to be relatively stable despite moderate incision (ratio of 1.4). The reach was classified as an E4 Riffle-Pool, consistent with its reference type and in Evolution Stage II (Incised). Despite the moderate incision, no active head cuts or areas of bank erosion were observed. The riparian corridor was dominated by forestland with buffer widths of greater than 100 feet. The habitat assessment showed good aquatic habitat conditions. M08B is made up of the upstream end of the reach, and is approximately 1.3 miles long. This segment was found to be highly incised with an incision ratio of 1.6 due to historic straightening, extensive agricultural activities, and other channel management techniques, and only has access to the floodplain during very high flow events. The reach was classified as an E4 Riffle-Pool stream, consistent with its reference type. Despite the high incision only minor bank erosion was noted and no active head cuts were observed. The reach was found to be in Evolution Stage II (incised) and due to cohesive soils and narrow riparian buffers, has not yet begun to erode its banks and widen (Evolution Stage III). The riparian corridor was dominated by hay and corn fields with no buffers. The habitat assessment showed poor aquatic habitat due to lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Given the current stable condition of M08A, the recommended remedial strategy is to protect the existing undeveloped river corridor to retain the sediment and nutrient attenuation assets of the reach. M08B is much more unstable. The highest priority strategy is to re-establish floodplain connection to restore the sediment and nutrient storage potential of the reach. Like the other highly incised reaches, there are both passive and active remedial techniques which could be utilized though the active approach would be most effective. This approach would involve physical manipulation of the channel and adjacent corridor to construct a more stable

meander pattern and accessible floodplain. In conjunction with either technique, or as a stand alone project if active restoration is not feasible, woody buffer vegetation planting should be conducted to improve aquatic habitat. Three privately owned culverts are also located in the reach and all were noted as channel and floodplain constrictions. Replacing or retrofitting these structures would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. Table 9 and Figure 20 below describe and show the locations of the recommended projects. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 9: Projects and Practices Table - Hungerford Brook
Reach M08

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M08A	Protect River Corridor - Segment currently undeveloped with mostly forested buffer. Upstream alterations have caused moderate incision (1.4) and corridor protection needed to allow for passive restoration and floodplain connection	Medium	Low	40	Yes	Landowner Cooperation
M08B	Protect River Corridor - Segment currently undeveloped dominated by hay and pasture with little to no buffer. Highly incised (ratio of 1.6) and historically straightened, corridor should be protected to allow for floodplain re-connection and meander development.	Low as stand alone project	Low as stand alone project	69	Yes	Landowner Cooperation, Due to cohesive soils and other geomorphic features passive floodplain restoration would not occur in short term, should be completed in conjunction with active floodplain restoration and buffer planting and cattle exclusion measures
M08B	Plant Stream Buffer/Cattle Exclusion - Segment currently has little to no buffer, also cattle have access to stream channel in the downstream end.	High	Medium	16	Yes	Landowner Cooperation, should be completed in conjunction with cattle exclusion measures. Relatively high incision and historic straightening so plantings should be placed to account for expected channel adjustments (widening and planform).
M08B	Restore Incised Reach - Segment highly incised (ratio of 1.6) so active floodplain creation may be needed to reduce future erosion and re-establish sediment and nutrient attenuation zone	High	High	4	Yes	Should be conducted in conjunction with corridor protection and buffer planting, cattle fencing needs as well, landowner cooperation needed, further survey and Phase III needed prior to design
M08B	Replace undersized culverts - Three private culverts noted as channel/floodplain constriction with structure width/channel width ratios of 30%, 60%, and 30%.	Medium	Low	41	Yes	Complete assessments done during Phase 2 work, each should be further evaluated to determine need for and benefit of replacement.

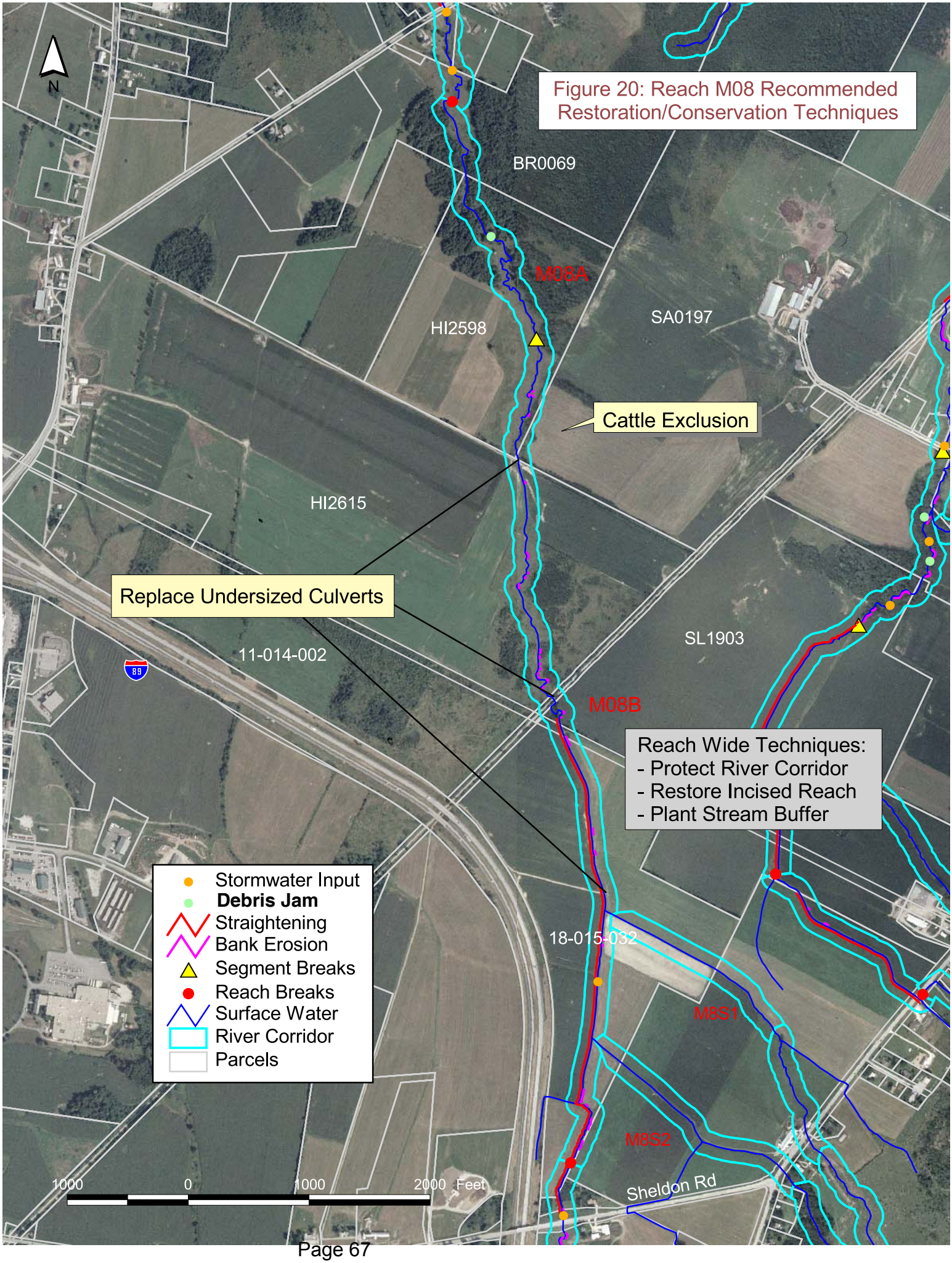


Figure 20: Reach M08 Recommended Restoration/Conservation Techniques
N
BR0069
M08A
HI2598
SA0197
Cattle Exclusion
HI2615
Replace Undersized Culverts
11-014-002
SL1903
M08B
Reach Wide Techniques:
- Protect River Corridor
- Restore Incised Reach
- Plant Stream Buffer
Stormwater Input
Debris Jam
Straightening
Bank Erosion
Segment Breaks
Reach Breaks
Surface Water
River Corridor
Parcels
18-015-032
M8S1
M8S2
Sheldon Rd
1000
0
1000
2000 Feet

5.1.6 Reach M09 Description and Project Identification

Reach M09 extends from just north of Route 105 in St. Albans upstream for approximately 1 mile. The reach was segmented into two parts, M09A and M09B, due to differences in the channel dimensions and streambank and boundary conditions. M09A is the downstream end of the reach and is approximately 0.5 miles long. The reach was classified as a C5 Riffle-Pool, a departure from its reference E4 stream type, mainly due to historic and active channel widening which has caused it to move into Evolution Stage III (Widening). Only minor incision was noted (ratio of 1.2), and no active head cuts were observed. Despite the ongoing widening, only moderate bank erosion was noted. The riparian corridor was dominated by pasture and cropland with buffer widths of 0-25 feet. The habitat assessment showed poor aquatic habitat conditions. M09B is the upstream end of the reach, and is approximately 0.5 miles long. This segment was found to be only slightly incised with an incision ratio of 1.2 due to historic straightening, agricultural activities, and other channel management techniques. The reach was classified as an E4 Riffle-Pool stream, consistent with its reference type. Only minor bank erosion was noted and one active head cut was observed. The reach was found to be in Evolution Stage II (incised) and due to cohesive soils and narrow riparian buffers, has not yet begun to erode its banks and widen (Evolution Stage III). The riparian corridor was dominated by hay fields with 26-50 foot buffers. The habitat assessment showed relatively poor aquatic habitat due to lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Given the current condition of M09A, the recommended remedial strategy is to protect the existing undeveloped river corridor to retain the sediment and nutrient attenuation assets of the reach. Buffer establishment and cattle fencing measures are needed in this segment to reduce sediment and nutrient inputs and improve aquatic habitat. Dedicated crossing structures and/or watering devices may also be needed. Other instream aquatic habitat improvement techniques, such as introduction of woody debris for cover, could also be considered once greater channel

stability has been reached. In addition, the current culvert crossing Route 105 is undersized, creating a channel and floodplain constriction. Replacing this structure would improve habitat and reduce future erosion hazards. The techniques for M09B are similar to those for M09A except for the installation of a permanent grade control in Segment B which is needed to arrest the head cut identified there and prevent further incision. The other recommended remedial strategies are to protect the existing river corridor to retain the sediment and nutrient storage potential of the reach, and establish adequate woody buffers between the agricultural lands and the stream channel. Minimal buffers currently exist along most of the reach, but these could be widened and enhanced through the introduction of trees and saplings. One privately owned culvert is also located in the reach and was noted as a channel and floodplain constriction. Replacing this structure would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. Table 10 and Figure 21 below describe and show the locations of the recommended projects. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 10: Projects and Practices Table - Hungerford Brook
Reach M09

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M09A	Protect River Corridor - Segment currently undeveloped dominated by hay and pasture with little to no buffer. Moderately incised (ratio of 1.2) and historically straightened, corridor should be protected to allow for floodplain re-connection and meander development.	Medium	Medium	29	Yes	Landowner Cooperation, should be completed in conjunction with buffer planting and cattle exclusion measures
M09A	Plant Stream Buffer/Cattle Exclusion - Segment currently has little to no buffer with cows in stream.	High	Medium	19	Yes	Landowner Cooperation, planting plans and fencing/watering plans
M09A	Replace undersized Culvert on Route 105 - Current culvert undersized acts as channel/floodplain constriction	Medium	Low	53	Yes	Cooperation/planning with St. Albans/State, may need further Phase III Assessment prior to replacement, current structure only ~35% of channel width
M09B	Protect River Corridor - Segment currently undeveloped dominated by hay and pasture with little to no buffer. Moderately incised (ratio of 1.2) and historically straightened, corridor should be protected to allow for floodplain re-connection and meander development.	Medium	Medium	30	Yes	Landowner Cooperation, should be completed in conjunction with buffer planting and cattle exclusion measures
M09B	Plant Stream Buffer - Segment currently has inadequate woody buffer.	High	Medium	21	Yes	Landowner Cooperation, planting plans and fencing/watering plans
M09B	Replace undersized Culvert on Private Farm Road - Current culvert undersized acts as channel/floodplain constriction	Medium	Low	54	Yes	Cooperation/planning with landowner, may need further Phase III Assessment prior to replacement, current structure only ~40% of channel width
M09B	Arrest Head Cut - Active head cut observed in Reach, reach currently only slightly incised (ratio of 1.2) so head cut shoud be stopped to prevent further loss of floodplain access	High	Medium	20	Yes	Further Site evaluation needed to determine best technique for stopping head cut. Landowner permission and possible stream alteration permit required.

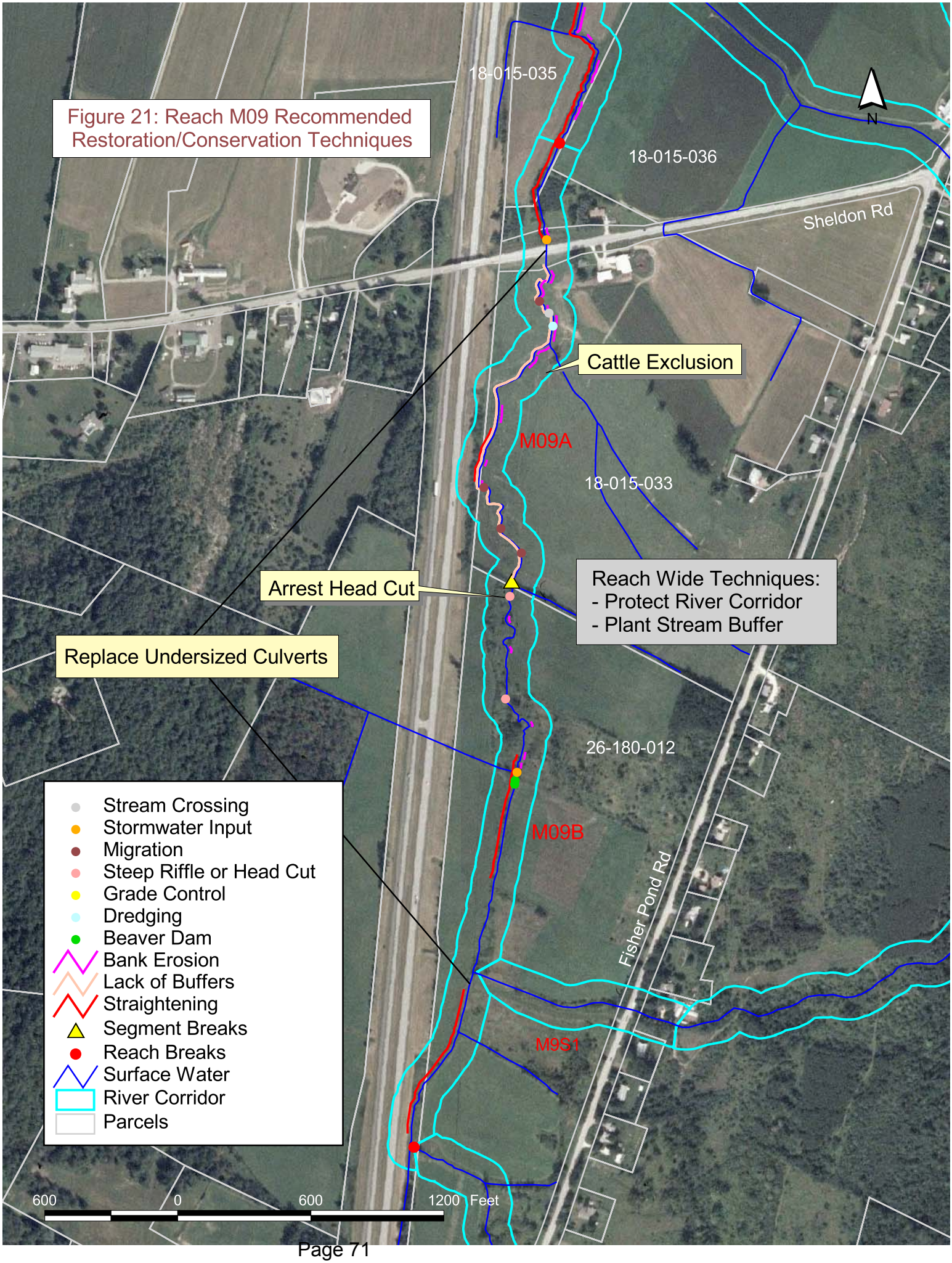


Figure 21: Reach M09 Recommended Restoration/Conservation Techniques
18-015-035
18-015-036
Sheldon Rd
N
Cattle Exclusion
M09A
18-015-033
Arrest Head Cut
Reach Wide Techniques:
- Protect River Corridor
- Plant Stream Buffer
Replace Undersized Culverts
26-180-012
M09B
Fisher Pond Rd
M9S1
Stream Crossing
Stormwater Input
Migration
Steep Riffle or Head Cut
Grade Control
Dredging
Beaver Dam
Bank Erosion
Lack of Buffers
Straightening
Segment Breaks
Reach Breaks
Surface Water
River Corridor
Parcels
600
0
600
1200 Feet

5.1.7 Reach M3T1.01 Description and Project Identification

Reach M3T1.01 is the first major tributary to Hungerford Brook and extends from the downstream end of M04 upstream for approximately 1.5 miles in the town of Sheldon. The reach was segmented into three part, A, B, and C due to numerous beaver dams. Segments A and C, the upstream and downstream ends of the reach were not assessed as they consisted primarily of ponded water behind the dams. Segment B is the middle ½ of the reach and was found to be moderately incised (incision ratio of 1.4), though it still has access to its floodplain during most high flow events. The existing stream type of E5 Dune-Ripple was consistent with its reference stream type. No major areas of bank erosion were noted, and the reach was found to be in Evolution Stage II (incised). The riparian corridor was dominated by pasture, with buffer widths of 0-25 feet. The habitat assessment showed overall good aquatic habitat, though the reach lacks adequate woody cover, and contains few favorable sediment types and flow patterns.

The recommended remedial strategies for M3T1.03 are to protect the existing river corridor and enhance its riparian buffers. Corridor protection is needed to retain the reach's limited nutrient attenuation assets, and allow for future passive floodplain restoration to enhance these assets. Active floodplain restoration could also be an option for this reach, however, since the area is only moderately incised, it would be more appropriate and cost effective to use active measures on those reaches with higher incision ratios. By keeping the river corridor undeveloped it allows the stream to undergo natural evolutionary processes without impacting human investments. Another important technique would be to establish a woody buffer between the agricultural lands and the stream channel. While some of the reach currently has adequate woody buffer, the area downstream of Cook Road has no buffer with cows accessing the stream channel. Fencing measures should also be employed to limit the cows' access to the stream. The culvert on Cook Road was identified as a channel and floodplain constriction so replacement of this structure is also a need for this reach. An aerial view of the reach is shown on Figure 22, and descriptions of the recommended projects are shown in Table 11.

Table 11: Projects and Practices Table - Hungerford Brook
Reach M3T1.01

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M3T1.01B	Protect River Corridor - Corridor undeveloped with mix of pasture and forest. Reach is moderately incised (ratio of 1.4) so channel migration and widening anticipated. Primary area of concern is just downstream of Bushey Road where active pasture is present.	Medium	Medium	36	Yes	Landowner cooperation needed, should be conducted in conjunction with fencing and buffer planting
M3T1.01B	Plant Stream Buffer/Cattle Exclusion - Area just downstream of Bushey Road has little buffer with cattle in stream. Fencing and buffer establishment needed here. Remainder of reach has no cattle and adequate buffers.	High	Medium	17	Yes	Landowner cooperation needed, Ideally planting project conducted as part of larger corridor protection project
M3T1.01B	Replace Culvert - Cook Road culvert undersized with scour above and below	Medium	Low	58	Yes	More detailed assessment of culvert my be needed to determine if replacement is warranted. Structure width is only 67% of channel width. Cooperation with Town of Sheldon required.

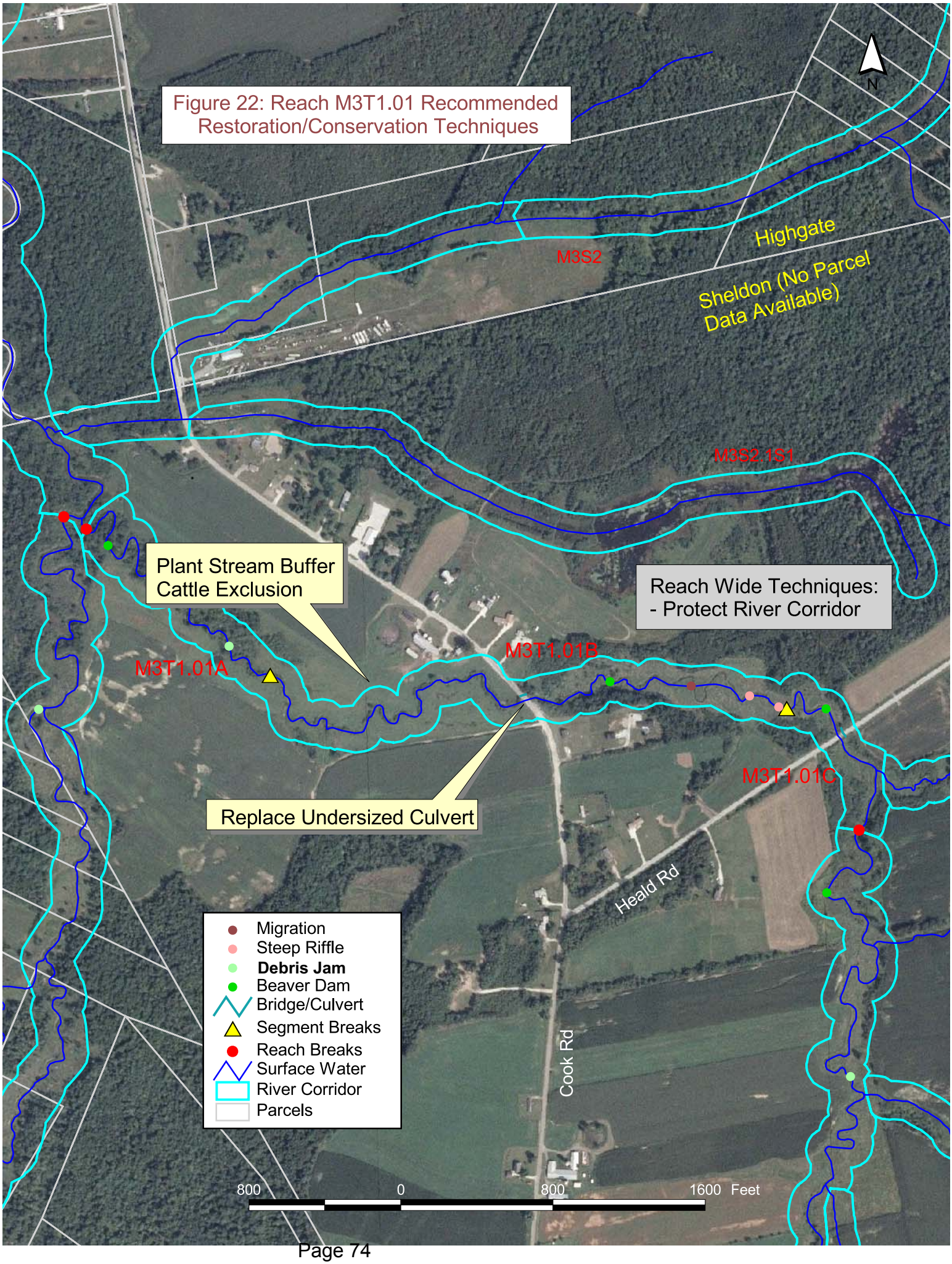


Figure 22: Reach M3T1.01 Recommended Restoration/Conservation Techniques
N
Highgate
Sheldon (No Parcel Data Available)
M3S2
M3S2.1S1
Plant Stream Buffer Cattle Exclusion
Reach Wide Techniques:
- Protect River Corridor
M3T1.01A
M3T1.01B
M3T1.01C
Replace Undersized Culvert
Heald Rd
Cook Rd
Migration
Steep Riffle
Debris Jam
Beaver Dam
Bridge/Culvert
Segment Breaks
Reach Breaks
Surface Water
River Corridor
Parcels
800
0
800
1600 Feet

5.1.8 Reach M3T1.02 Description and Project Identification

Reach M3T1.02 extends from just south of Heald Road in Sheldon to approximately ½ mile south of Woods Hill Road. Overall, the reach was relatively stable with no documented incision. The existing stream type of E4 Dune-Ripple was consistent with its reference stream type. Only a few minor areas of bank erosion were noted, and the reach was found to be in Evolution Stage I, or Reference, with little active adjustments occurring. This reach was one of the few within the watershed with naturally occurring bedrock grade controls. The riparian corridor was dominated by forest land upstream of Woods Hill Road and pasture downstream of it, with buffer widths ranging from 25 to 100 feet. One major area of concern was near the Woods Hill Road crossing, where little buffer was present and cows were observed in the stream channel. The habitat assessment showed overall good aquatic habitat.

Given the current stable condition of M3T1.02, the recommended remedial strategies are to protect the existing undeveloped river corridor to retain the reach's nutrient attenuation assets, and enhance the riparian buffer to increase those assets. Most of the reach has adequate woody buffer, however some areas, particularly near Woods Hill Road are in need of buffer enhancement and cattle fencing/exclusion measures. Two culverts and one bridge were noted as channel and floodplain constrictions during the Phase 2 Assessment, so replacing these structures with adequately sized ones would also be a valid restoration technique. An aerial view of the reach is shown on Figure 23, and descriptions of the recommended projects are shown in Table 12. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 12: Projects and Practices Table - Hungerford Brook
Reach M3T1.02

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M3T1.02	Protect River Corridor - Corridor largely undeveloped with mix of forest and pasture. Reach currently has good floodplain access (incision ratio of 1.0) and provides sediment and nutrient attenuation. Corridor protection needed to retain this asset	Medium	Medium	31	Yes	Landowner negotiations
M3T1.02	Plant Stream Buffer/Cattle Exclusion - Area near Woods Hill Road has little buffer and cattle in stream. Remainder of reach has overall adequate buffer.	High	Medium	18	Yes	Landowner cooperation, fencing scheme and planting plans - other BMPs may also be needed - feed dumped into brook noted during Phase 2
M3T1.02	Replace undersized structure(s) - Two culverts and one bridge noted as channel and floodplain constrictions in phase 2 with structure width/channel width ratios of 95%, 22%, and 22%.	Medium	Low	44	Yes	Further assessment needed to determine if replacement warranted. One structure located on Town (Sheldon) road, remaining two are privately owned.

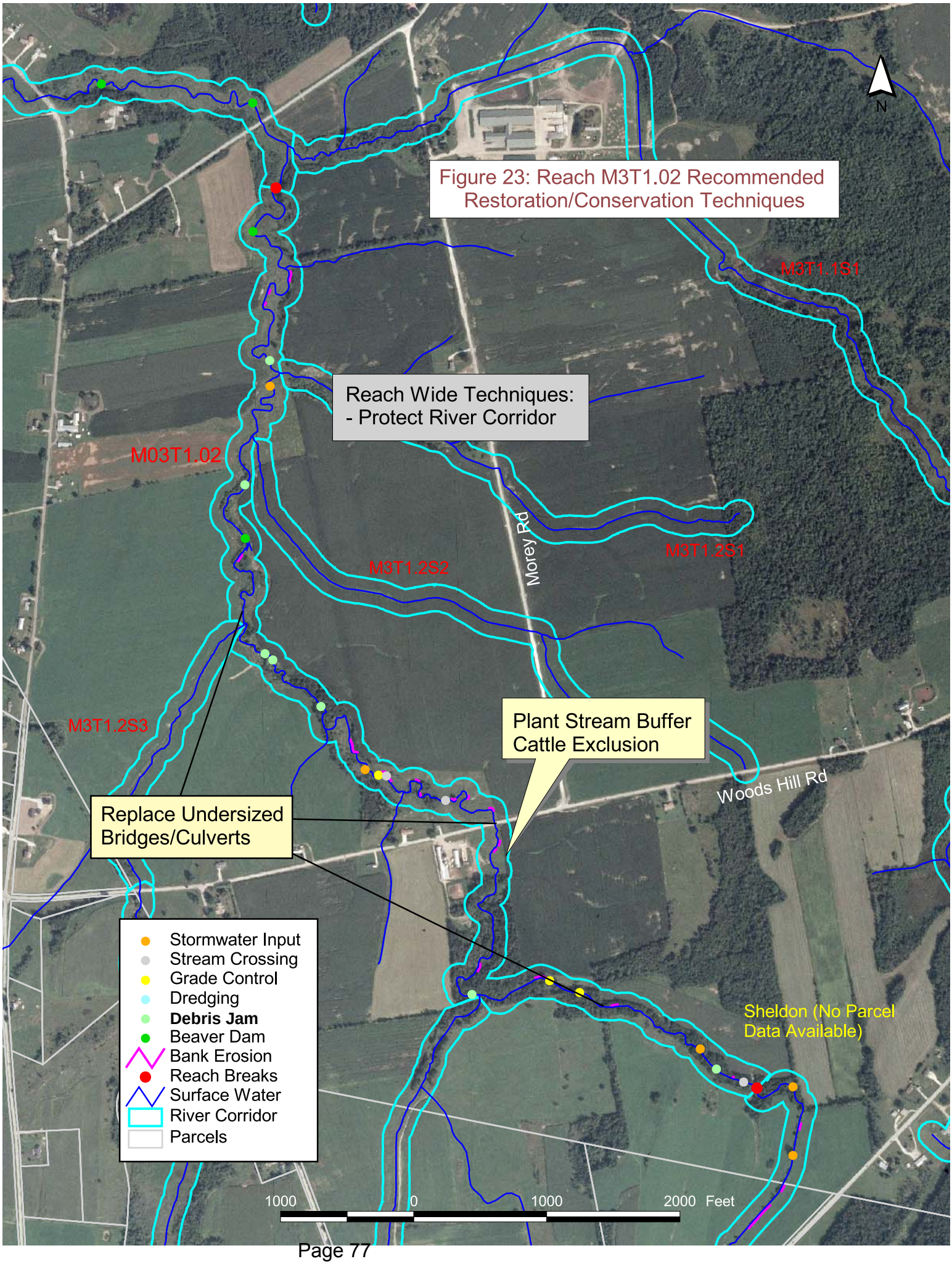


Figure 23: Reach M3T1.02 Recommended Restoration/Conservation Techniques
N
M3T1.1S1
Reach Wide Techniques:
- Protect River Corridor
M03T1.02
Morey Rd
M3T1.2S1
M3T1.2S2
M3T1.2S3
Plant Stream Buffer
Cattle Exclusion
Woods Hill Rd
Replace Undersized
Bridges/Culverts
Stormwater Input
Stream Crossing
Grade Control
Dredging
Debris Jam
Beaver Dam
Bank Erosion
Reach Breaks
Surface Water
River Corridor
Parcels
Sheldon (No Parcel
Data Available)
1000
0
1000
2000 Feet

5.1.9 Reach M3T1.03 Description and Project Identification

Reach M3T1.03 extends from the upstream end of M3T1.02 to approximately 500 feet south of Route 105 in Swanton. Overall, the reach was relatively stable with only slight incision noted (ratio of 1.2). The existing stream type of E4 Riffle-Pool was consistent with its reference stream type. Only a few minor areas of bank erosion were noted, and the reach was found to be in Evolution Stage I, or Reference, with little active adjustments occurring. This reach was one of the few within the watershed with naturally occurring bedrock grade controls. The riparian corridor was dominated by a mix of crop and pasture with buffer widths ranging from 0 to 25 feet and no fencing to prevent cattle access to the stream channel. The habitat assessment showed relatively poor aquatic habitat due primarily to a lack of adequate woody cover, and few favorable sediment types and flow patterns.

Given the relative stable condition of M3T1.02, the recommended remedial strategies are to protect the existing undeveloped river corridor to retain the reach's nutrient attenuation assets, and enhance the riparian buffer to increase those assets. Most of the reach lacks adequate woody buffer and proper cattle fencing, and re-establishing these features is a top priority for this reach. In addition, two bridges were noted as channel and floodplain constrictions during the Phase 2 Assessment, so replacing these structures with adequately sized ones would also be a valid restoration technique. An aerial view of the reach is shown on Figure 24, and descriptions of the recommended projects are shown in Table 13. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 13: Projects and Practices Table - Hungerford Brook
Reach M3T1.03

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M3T1.03	Protect River Corridor - Corridor largely undeveloped with mix of forest (upstream of Rt. 105) crop and pasture (downstream of 105). Reach currently only slightly incised (ratio of 1.2) and provides some sediment and nutrient attenuation. Corridor protection needed to retain these assets. Large portion of reach historically straightened so future channel adjustments anticipated.	High	Medium	23	Yes	Landowner negotiations, corridor protection should be conducted in conjunction with buffer planting and cattle exclusion practices.
M3T1.03	Plant Stream Buffer/Cattle Exclusion - Area downstream of Route 105 has little buffer and cattle in stream. Below straightened section of stream flows through cropland with no buffer. Upstream of 105 has adequate buffer.	High	Medium	12	Yes	Landowner cooperation, fencing scheme and planting plans
M3T1.03	Replace undersized structure(s) - Two bridges noted as channel and floodplain constrictions in phase 2 with structure/channel width ratios of 77% and 93%.	Medium	Low	60	Yes	Bridge and culvert assessments needed to determine if replacement warranted. One structure located on Route 105, cooperation with State needed.

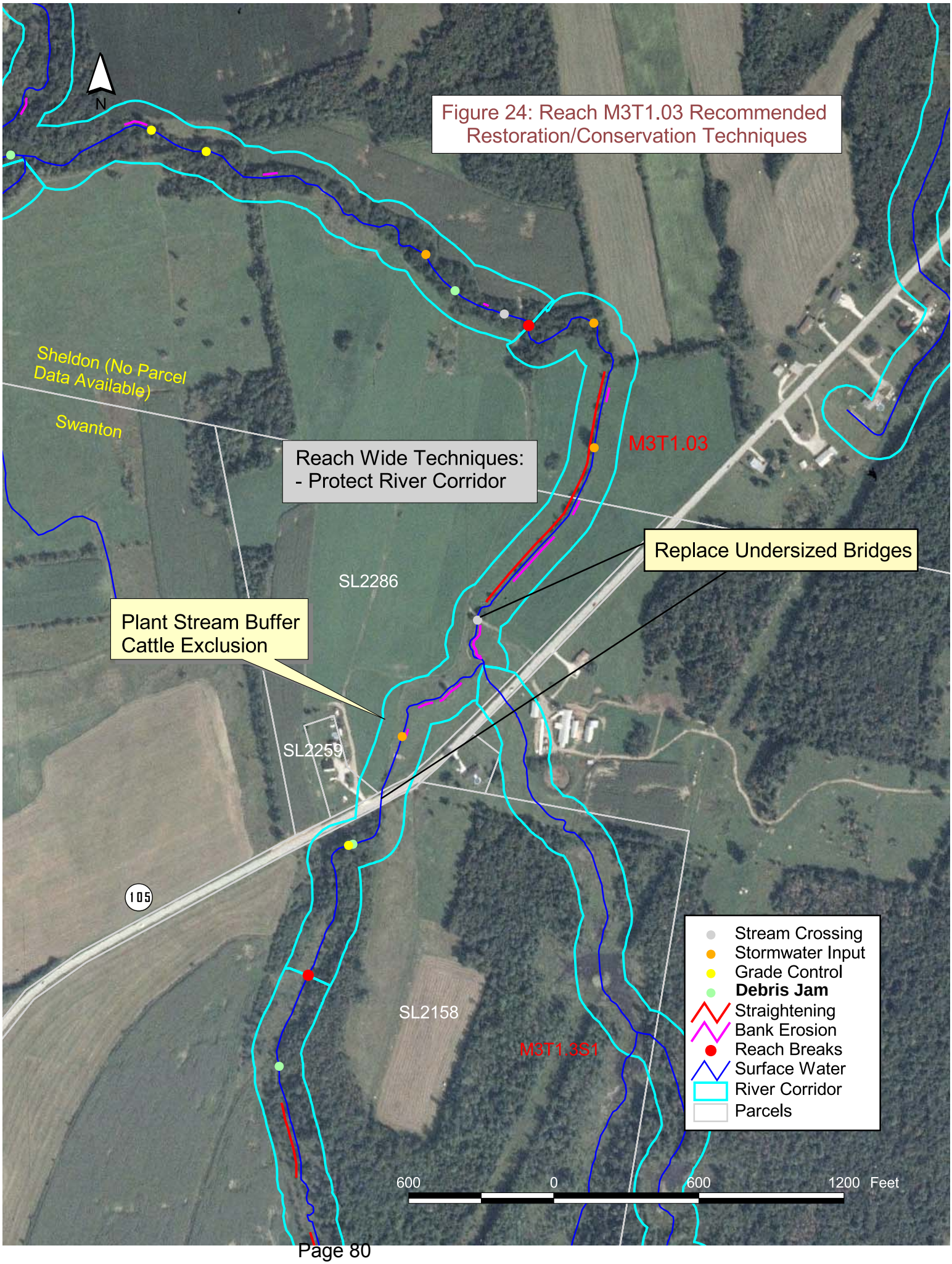


Figure 24: Reach M3T1.03 Recommended Restoration/Conservation Techniques
N
Sheldon (No Parcel Data Available)
Swanton
M3T1.03
Reach Wide Techniques:
- Protect River Corridor
Replace Undersized Bridges
SL2286
Plant Stream Buffer
Cattle Exclusion
SL2259
105
SL2158
M3T1.3S1
Stream Crossing
Stormwater Input
Grade Control
Debris Jam
Straightening
Bank Erosion
Reach Breaks
Surface Water
River Corridor
Parcels
600
0
600
1200 Feet

5.1.10 Reach M3T1.04 Description and Project Identification

Reach M3T1.04 extends from approximately 500 feet south of Route 105 in Swanton to approximately 500 feet south of Pond Road. The reach was segmented into two parts, Segment A and B, due to differences in the channel dimensions and streambank and boundary conditions. Segment A is the downstream end of the reach and is approximately 0.75 miles long. The reach was classified as an E5 Riffle-Pool, consistent with its reference stream type, though due to minor historic channel degradation and widening it is in Evolution Stage III (Widening). Only minor incision was noted (ratio of 1.1), and no active head cuts were observed. Only minor bank erosion was noted along a small portion of the Segment. The riparian corridor was dominated by a mix of crop and hay on the left and forest on the right with buffer widths of 26-100 feet. The habitat assessment showed poor aquatic habitat conditions. M3T1.04B is the upstream end of the reach, and is approximately 1.5 miles long. This segment was found to be moderately incised with an incision ratio of 1.4 due to historic straightening, extensive agricultural activities, and other channel management techniques. The reach was classified as an E5 Riffle-Pool stream, consistent with its reference type. Relatively minor bank erosion was noted and no active head cuts were observed. The reach was found to be in Evolution Stage II (incised) and has not yet begun to erode its banks and widen (Evolution Stage III). The riparian corridor was dominated by a mix of hay, crop, and pasture with 0-25 foot wide buffers. The habitat assessment showed relatively poor aquatic habitat due to a lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Given the current condition of Segment A, the recommended remedial strategies are to protect the existing undeveloped river corridor to retain the sediment and nutrient attenuation assets of the reach and enhance the riparian buffer. Buffer establishment is needed in the downstream portion of the segment to reduce sediment and nutrient inputs and improve aquatic habitat. Other instream aquatic habitat improvement techniques, such as introduction of woody debris for cover could also be considered. In addition, the current private culvert crossing mid-segment is undersized, creating a channel and floodplain constriction. Replacing this structure

would improve habitat and reduce future erosion hazards. The techniques for Segment B are similar to those for Segment A and include protection of the existing river corridor to retain the sediment and nutrient storage potential of the Reach, and establishment of adequate woody buffers between the agricultural lands and the stream channel. Active floodplain restoration could also be an option for this reach, however, since the area is only moderately incised, it would be more appropriate and cost effective to use active measures on those reaches with higher incision ratios. By keeping the river corridor undeveloped it allows the stream to undergo natural evolutionary processes without impacting human investments. In addition to establishing adequate woody buffers, cattle fencing is also needed to limit the cows' access to the stream channel. Dedicated crossing structures and/or watering mechanisms may also be required as part of the fencing plans. Three culverts were also identified as channel and floodplain constrictions. Replacing these structures would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. Table 14 and Figure 25 below describe and show the locations of the recommended projects. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 14: Projects and Practices Table - Hungerford Brook
Reach M3T1.04

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M3T1.04A	Protect River Corridor - Segment currently undeveloped dominated by mix of forest and crop. Slightly incised (ratio of 1.1) and historically straightened, corridor should be protected to allow for floodplain re-connection and meander development.	Medium	Medium	35	Yes	Landowner Cooperation, should be completed in conjunction with buffer planting and cattle exclusion measures
M3T1.04A	Plant Stream Buffer - Segment currently has inadequate buffer in downstream half.	Medium	Low	47	Yes	Landowner Cooperation, planting plans
M3T1.04A	Replace undersized Culvert - Private culvert on farm road undersized; acts as channel/floodplain constriction	Medium	Low	45	Yes	Cooperation/planning with Landowner, may need further Phase III Assessment prior to replacement, current structure only ~25% of channel width
M3T1.04B	Protect River Corridor - Segment currently undeveloped dominated by crop, hay and pasture with little to no buffer. Moderately incised (ratio of 1.4) and historically straightened, corridor should be protected to allow for floodplain re-connection and meander development.	High	Medium	28	Yes	Landowner Cooperation, should be completed in conjunction with buffer planting and cattle exclusion measures
M3T1.04B	Plant Stream Buffer/Cattle Exclusion - Segment currently has little buffer with cows in stream. Negotiations currently underway between NRCS and landowner to implement buffer/fencing plans	High	Medium	14	Yes	Landowner Cooperation already initiated by NRCS, planting plans and fencing/watering plans underway.
M3T1.04B	Replace undersized Culverts - Three culverts noted as channel constrictions, should be replaced with wider structure	Medium	Low	55	Yes	Cooperation/planning with landowner, may need further Phase III Assessment prior to replacement, current structures only ~25-50% of channel width. One structure located on Town of Swanton Road, remaining 2 are privately owned.

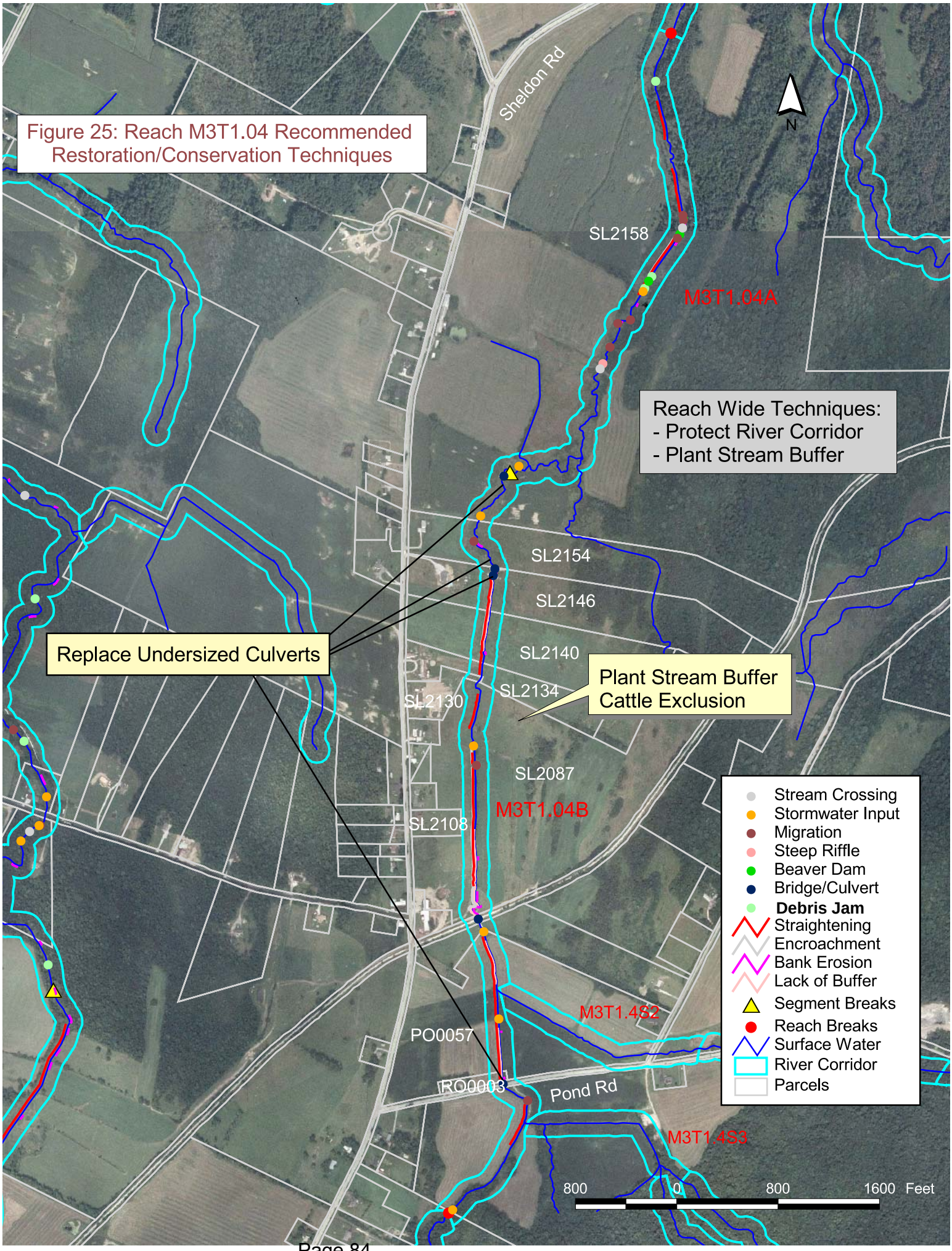


Figure 25: Reach M3T1.04 Recommended Restoration/Conservation Techniques
Sheldon Rd
N
SL2158
M3T1.04A
Reach Wide Techniques:
- Protect River Corridor
- Plant Stream Buffer
SL2154
SL2146
SL2140
SL2134
SL2130
Replace Undersized Culverts
Plant Stream Buffer
Cattle Exclusion
SL2087
M3T1.04B
SL2108
M3T1.4S2
PO0057
RO0003
Pond Rd
M3T1.4S3
Stream Crossing
Stormwater Input
Migration
Steep Riffle
Beaver Dam
Bridge/Culvert
Debris Jam
Straightening
Encroachment
Bank Erosion
Lack of Buffer
Segment Breaks
Reach Breaks
Surface Water
River Corridor
Parcels
800
0
800
1600 Feet

5.1.11 Reach M4S1.01 Description and Project Identification

Reach M4S1.01 extends from its confluence with M04 just north of Woods Hill Road upstream for just over one mile in the Town of Swanton. The reach was segmented into two parts, Segments A and B, due to differences in the channel dimensions and streambank and boundary conditions. Segment A is the downstream end of the reach and is approximately 0.3 miles long. The segment was classified as a B6 Plane-Bed, a departure from its reference stream type (C6 Riffle-Pool) due to minor historic channel degradation and widening which has caused it to move into Evolution Stage III (Widening). Despite the stream type departure, only minor incision was noted (ratio of 1.2), and no active head cuts or areas of bank erosion were observed. The riparian corridor was dominated by corn fields with narrow buffers ranging from 0 to 50 feet. The habitat assessment showed relatively poor aquatic habitat conditions due to a lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns. Segment B consists of the upstream end of the reach, and is approximately 0.7 miles long. This segment was found to be highly incised with an incision ratio of 1.9 due to historic straightening, extensive agricultural activities, and other channel management techniques. The Segment was classified as a C6 Riffle-Pool stream, consistent with its reference type. Despite the high incision, no bank erosion was noted and no active head cuts were observed. The reach was found to be in Evolution Stage II (incised) and has not yet begun to erode its banks and widen (Evolution Stage III). The riparian corridor was dominated by hay fields with 26-100 foot wide buffers. Remnants of an old stone dam were identified near the upstream end of the reach, though it was no longer impounding any water and had been partially breached. The habitat assessment showed relatively poor aquatic habitat due to a lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Given the current condition of Segment A, the recommended remedial strategies are to protect the existing undeveloped river corridor to retain the sediment and nutrient attenuation assets of the reach and enhance the riparian buffer. Permanent woody buffer establishment is needed to reduce sediment and nutrient inputs and improve the aquatic habitat. Other instream

aquatic habitat improvement techniques, such as introduction of woody debris for cover could also be considered. In addition, the current culvert on Woods Hill Road is undersized, creating a channel and floodplain constriction. Replacing this structure would improve habitat and reduce future erosion hazards. The techniques for Segment B are similar to those for Segment A, though given its high incision, the highest priority action would be floodplain restoration. There are both passive and active remedial techniques which could be utilized, though like the other highly incised reaches in the watershed, the active approach would be most effective. This approach would involve physical manipulation of the channel and adjacent corridor using heavy equipment to construct a more stable meander pattern and accessible floodplain. In conjunction with either technique, or as a stand alone project if active restoration is not feasible, woody buffer vegetation planting should be conducted to improve aquatic habitat. One privately owned culvert was also identified as a channel and floodplain constriction within the Segment. Replacing this structure would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. Table 15 and Figure 26 below describe and show the locations of the recommended projects. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 15: Projects and Practices Table - Hungerford Brook
Reach M4S1.01

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M4S1.01A	Protect River Corridor - Segment currently undeveloped dominated by crop land. Slightly incised (ratio of 1.2), corridor should be protected to allow for floodplain re-connection and meander development.	High	Medium	26	Yes	Landowner Cooperation, should be completed in conjunction with buffer planting
M4S1.01A	Plant Stream Buffer - Segment currently has little to no buffer.	High	Medium	32	Yes	Landowner Cooperation, planting plans
M4S1.01A	Replace undersized Culvert - Woods Hill Road culvert undersized; acts as channel/floodplain constriction	Medium	Low	56	Yes	Cooperation/planning with Town of Swanton, may need further Phase III Assessment prior to replacement, current structure only ~40% of channel width
M4S1.01B	Protect River Corridor - Segment currently undeveloped dominated by hay with little woody buffer. Highly incised (ratio of 1.9) and historically straightened, corridor should be protected in conjunction with active floodplain restoration.	Low as stand alone project	Low as stand alone project	72	Yes	Landowner Cooperation, should be completed in conjunction with buffer planting, cattle exclusion measures and active floodplain restoration. Due to cohesive soils channel evolution would be slow to progress so corridor protection alone not a high priority for this reach.
M4S1.01B	Restore Incised Reach - Segment highly incised (ratio of 1.9) active floodplain creation needed to reduce future erosion and re-establish sediment and nutrient attenuation zone	High	Medium	25	Yes	Should be conducted in conjunction with corridor protection and buffer planting, landowner cooperation needed, further survey and Phase III needed prior to design. Overall, lower watershed priority due to small size of subwatershed.
M4S1.01B	Plant Stream Buffer - Segment currently has 25-50' herbaceous buffer, but few trees	Medium	Low	63	Yes	Landowner Cooperation and planting plans.
M4S1.01B	Replace undersized Culvert - Private culvert on farm road upstream of Route 207 noted as channel constriction, should be replaced with wider structure	Medium	Low	50	Yes	Cooperation/planning with landowner, may need further Phase III Assessment prior to replacement, current structures only ~25% of channel width

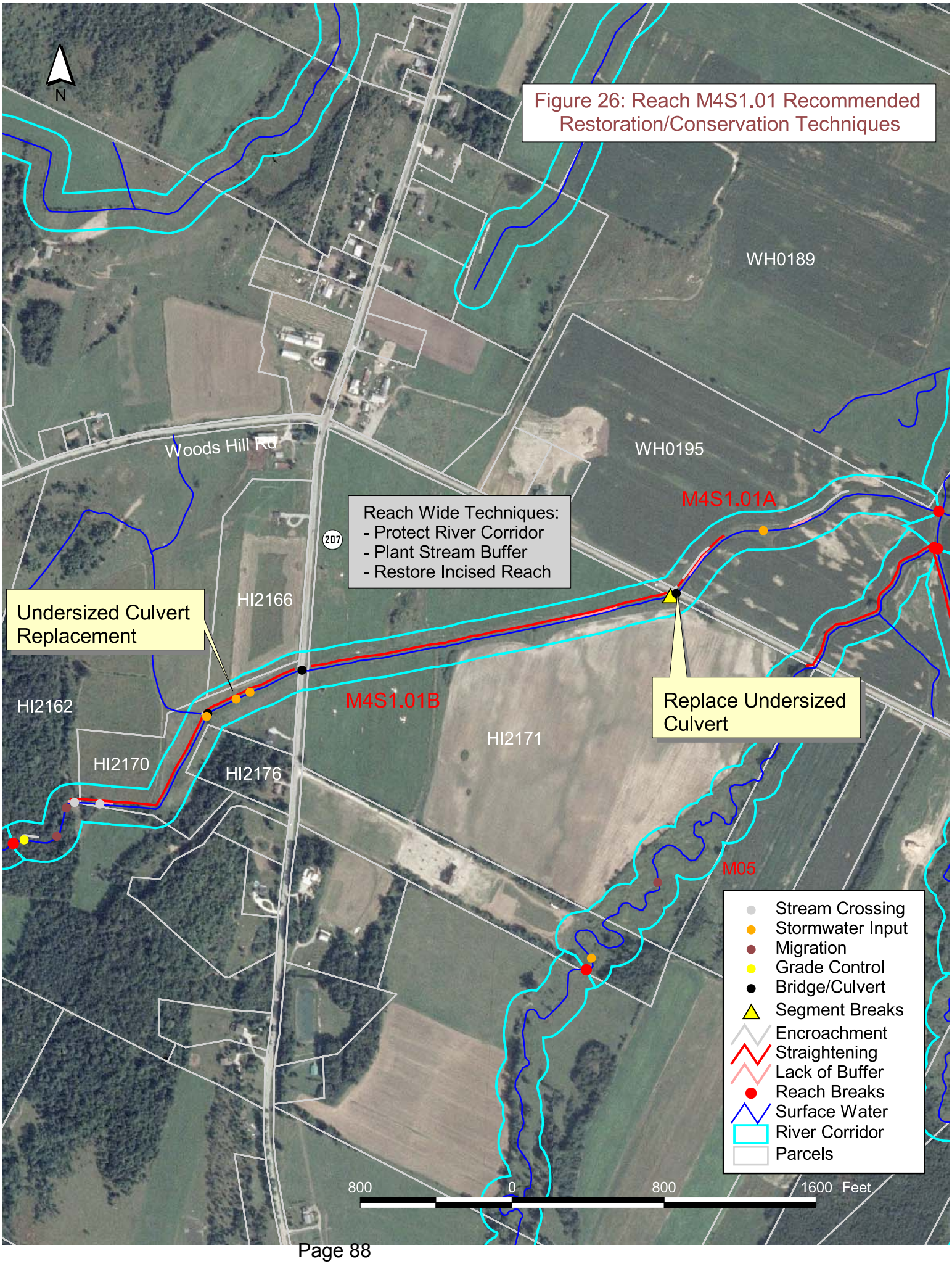


Figure 26: Reach M4S1.01 Recommended Restoration/Conservation Techniques
N
WH0189
WH0195
Woods Hill Rd
207
M4S1.01A
Reach Wide Techniques:
- Protect River Corridor
- Plant Stream Buffer
- Restore Incised Reach
Undersized Culvert Replacement
HI2166
HI2162
HI2170
HI2176
M4S1.01B
HI2171
Replace Undersized Culvert
M05
Stream Crossing
Stormwater Input
Migration
Grade Control
Bridge/Culvert
Segment Breaks
Encroachment
Straightening
Lack of Buffer
Reach Breaks
Surface Water
River Corridor
Parcels
800
0
800
1600 Feet

5.1.12 Reach M4T2.01Description and Project Identification

Reach M4T2.01 extends from its confluence with M04, approximately ¼ mile north of Woods Hill Road upstream to ¼ mile south of Woods Hill Road. This reach was found to be highly incised with an incision ratio of 2.3 due to historic straightening, extensive agricultural activities, and other channel management techniques, and only has access to the floodplain during extreme high flow events. The reach was classified as a G5 Dune-Ripple stream, a departure from its E5 reference type due to the high incision. Despite the high incision only minor bank erosion was noted and no active head cuts were observed. The reach was found to be in Evolution Stage II (incised) and due to cohesive soils and narrow riparian buffers, has not yet begun to erode its banks and widen (Evolution Stage III). The riparian corridor was dominated by corn fields downstream of Woods Hill Road, and a mix of forest and hay fields upstream of the road with buffers of 0-25 feet. The habitat assessment showed relatively poor aquatic habitat due to a lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Given the current condition of M4T2.01, the highest priority remedial strategy is to re-establish floodplain connection to restore the sediment and nutrient storage potential of the Reach. There are both passive and active remedial techniques which could be utilized, though as with the other incised reaches in the watershed, the active approach would be the most effective. This approach would involve physical manipulation of the channel and adjacent corridor using heavy equipment to construct a more accessible floodplain. In conjunction with floodplain restoration, or as a stand alone project if active restoration is not feasible, woody buffer vegetation planting should be conducted. Other instream aquatic habitat improvement techniques, such as introduction of woody debris for cover, could also be considered once greater channel stability has been reached. The culvert passing under Woods Hill Road was noted as a channel and floodplain constriction. Replacing or retrofitting this structure would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. Table 16 and Figure 27 below describe and show the locations of the recommended projects.

Table 16: Projects and Practices Table - Hungerford Brook
Reach M4T2.01

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M4T2.01	Protect River Corridor - Corridor largely undeveloped with mix of forest (upstream of Woods Hill Road) and crop (downstream of road). Reach highly incised (ratio of 2.3) and historically straightened downstream of road so extensive channel adjustments anticipated over the long term.	Low as stand alone project	Low as stand alone project	66	Yes	Landowner negotiations, due to high incision and cohesive soils corridor protection should be combined with active floodplain restoration to reduce future erosion during channel adjustment and increase sediment and nutrient attenuation assetts.
M4T2.01	Plant Stream Buffer - Area downstream of Woods Hill Road has little buffer on both banks. Upstream of road has adequate buffer.	Medium	Medium	37	Yes	Landowner cooperation, should be conducted as part of larger restoration project with floodplain restoration
M4T2.01	Restore Incised Reach - Segment highly incised (ratio of 2.3) as part of corridor protection, active floodplain creation needed to reduce future erosion and re-establish sediment and nutrient attenuation zone	High	High	1	Yes	Should be conducted in conjunction with corridor protection and buffer planting, landowner cooperation needed, further survey and Phase III may be needed prior to design
M4T2.01	Replace undersized structure - Culvert under Woods Hill Road is undersized (43% of channel width) with scour and erosion up and downstream.	Medium	Low	52	Yes	May need more detailed Phase III assessments prior to initiating replacement, Town road - cooperation with Town of Swanton needed

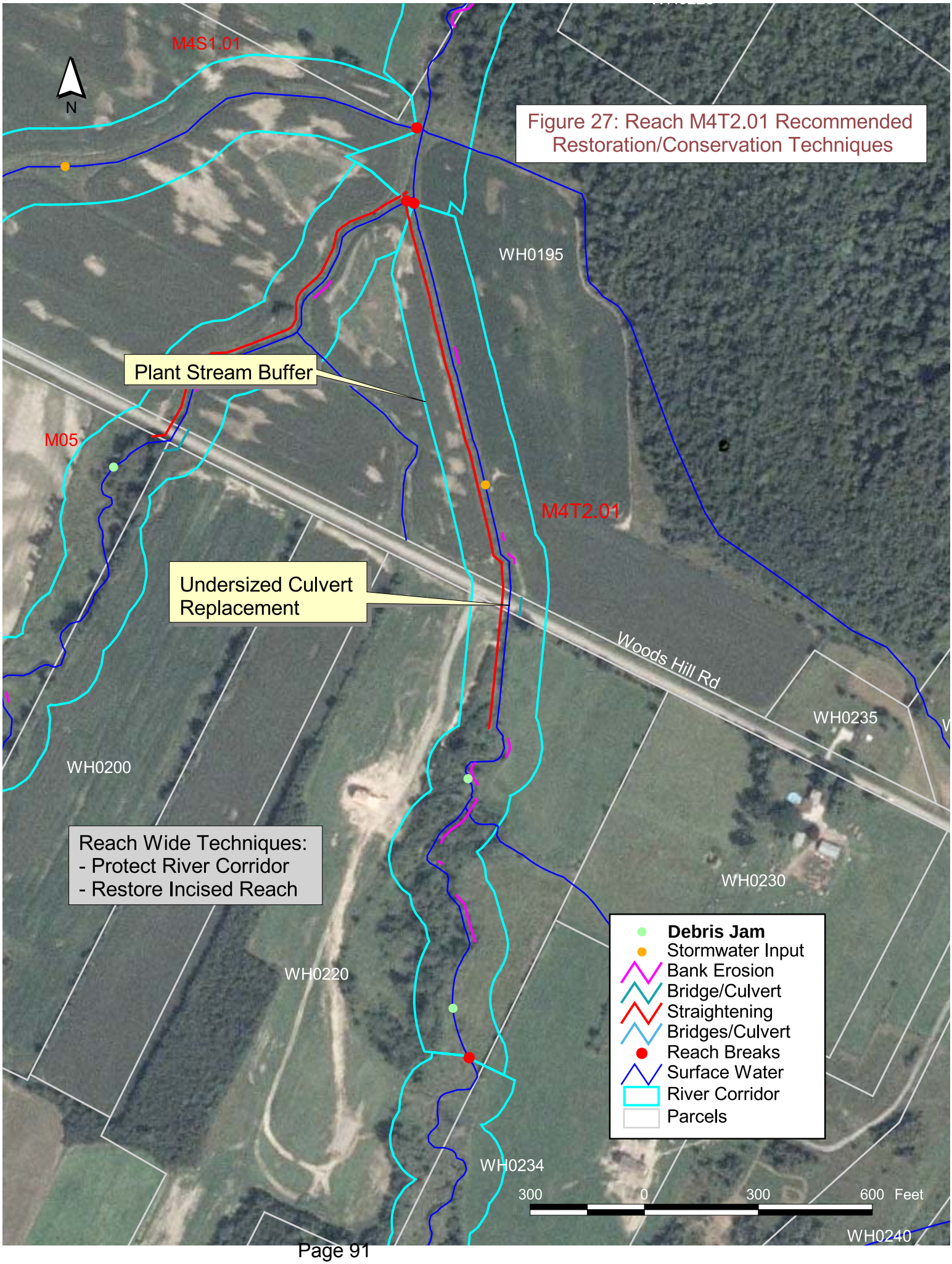


Figure 27: Reach M4T2.01 Recommended Restoration/Conservation Techniques
M4S1.01
N
WH0195
Plant Stream Buffer
M05
M4T2.01
Undersized Culvert Replacement
Woods Hill Rd
WH0235
WH0200
Reach Wide Techniques:
- Protect River Corridor
- Restore Incised Reach
WH0230
WH0220
Debris Jam
Stormwater Input
Bank Erosion
Bridge/Culvert
Straightening
Bridges/Culvert
Reach Breaks
Surface Water
River Corridor
Parcels
WH0234
300 0 300 600 Feet
WH0240

5.1.13 Reach M4T2.02 Description and Project Identification

Reach M4T2.02 extends from the upstream end of M4T2.01, just south of Woods Hill Road, to approximately 1 mile south. Overall, the reach was relatively stable with no incision noted. The existing stream type of E5 Riffle-Pool was consistent with its reference stream type. Only a few minor areas of bank erosion were noted, and the reach was found to be in Evolution Stage I, or Reference, with little active adjustments occurring. This reach was one of the few within the watershed with naturally occurring bedrock grade controls. The riparian corridor was dominated by a mix of crop and pasture with buffer widths ranging from 26-100 feet. The habitat assessment showed overall good aquatic habitat.

Given the current relative stable condition of M3T1.02, the recommended remedial strategies are to protect the existing undeveloped river corridor to retain the reach's nutrient attenuation assets, and enhance the riparian buffer to increase those assets. Most of the reach has adequate woody buffer, but the upstream ~1,000 feet runs through pasture with no fencing to prevent the cattle from accessing the stream channel. This area should be targeted for buffer establishment and proper cattle fencing to reduce nutrient inputs. An aerial view of the reach is shown on Figure 28, and descriptions of the recommended projects are shown in Table 17. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 17: Projects and Practices Table - Hungerford Brook
Reach M4T2.02

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M4T2.02	Protect River Corridor - Corridor largely undeveloped with mix of forest and small amount of pasture at upstream end of reach. Reach currently has good floodplain access (incision ratio of 1.0) and acts as sediment and nutrient attenuation zone. Corridor protection needed to retain this function.	High	High	9	Yes	Landowner negotiations and agreements, should be implemented in conjunction with cattle fencing in upstream portion of reach.
M4T2.02	Plant Stream Buffer/Cattle exclusion - upstream ~1,000' of reach runs through pasture with narrow buffers and cattle access to channel. Buffer enhancement/cattle exclusion should be concentrated here. Remainder of reach has >100 foot buffers.	Medium	Low	49	Yes	Landowner cooperation, planting plans and fencing design needed

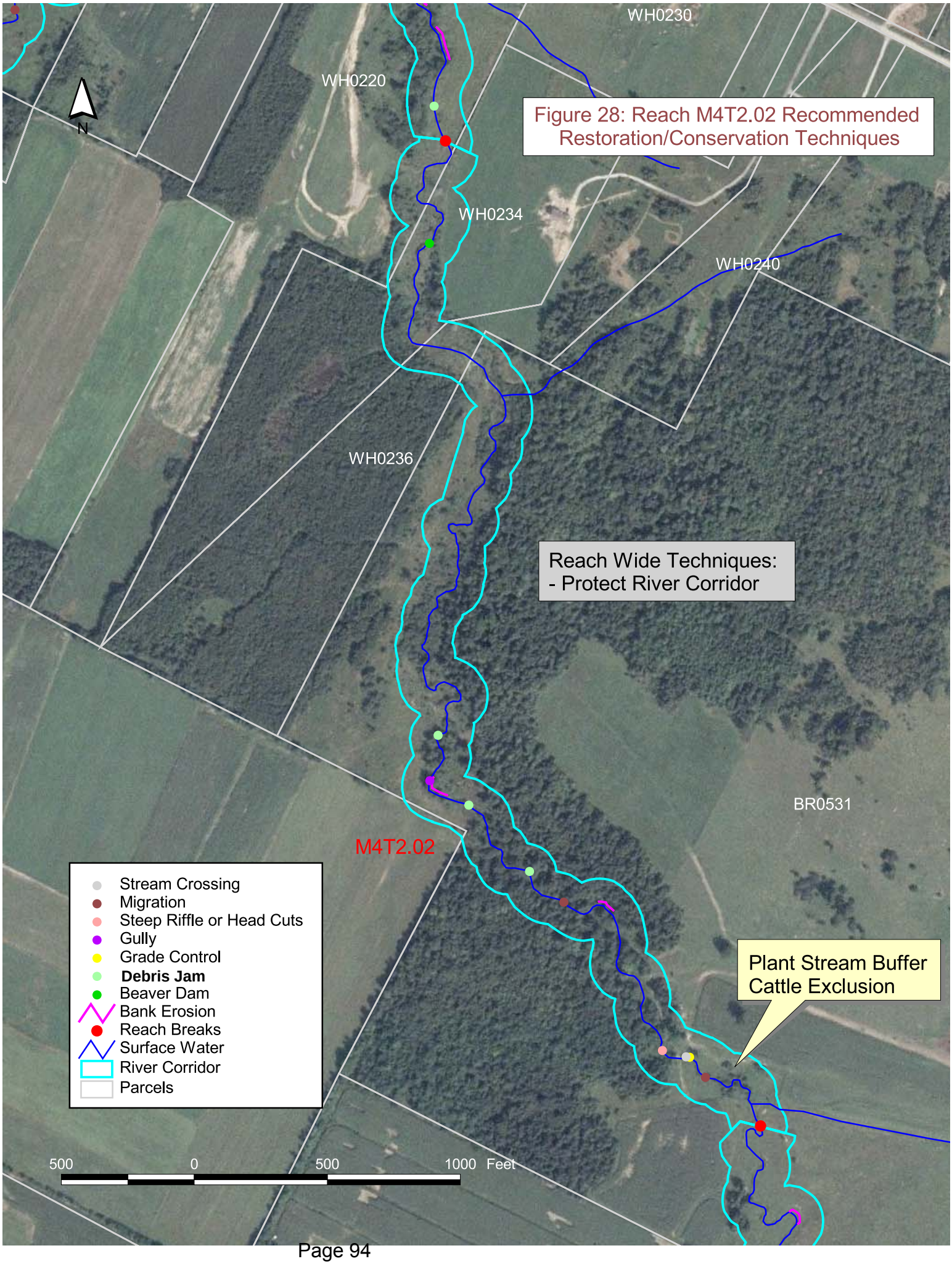


Figure 28: Reach M4T2.02 Recommended Restoration/Conservation Techniques
WH0230
WH0220
WH0234
WH0240
WH0236
BR0531
M4T2.02
N
Reach Wide Techniques:
- Protect River Corridor
Plant Stream Buffer
Cattle Exclusion
Stream Crossing
Migration
Steep Riffle or Head Cuts
Gully
Grade Control
Debris Jam
Beaver Dam
Bank Erosion
Reach Breaks
Surface Water
River Corridor
Parcels
500
0
500
1000 Feet

5.1.14 Reach M4T2.03 Description and Project Identification

Reach M4T2.03 extends from the upstream end of M4T2.02 upstream for approximately 1 mile to just south of Bushey Road in Swanton. Overall, the reach was relatively stable with no incision noted. The existing stream type of E5 Riffle-Pool was consistent with its reference stream type. Only a few minor areas of bank erosion were noted, and the reach was found to be in Evolution Stage I, or Reference, with little active adjustments occurring. This reach was one of the few within the watershed with naturally occurring bedrock grade controls. The riparian corridor was dominated by pasture with narrow buffer widths ranging from 0-25 feet. Cows were noted in the stream channel throughout the Reach. The habitat assessment showed relatively poor aquatic habitat due to lack of available cover, sediment deposition, and very few favorable sediment types and flow patterns.

Given the current relative stable condition of M4T2.03, the recommended remedial strategies are to protect the existing undeveloped river corridor to retain the reach's nutrient attenuation assets, and enhance the riparian buffer to increase those assets. Nearly the entire reach is dominated by pasture land with little to no buffer, and no fencing to prevent cattle access to the stream channel. Woody buffer establishment combined with cattle fencing would reduce nutrient inputs and erosion hazards, and improve aquatic habitat. In addition, the culvert underlying Bushey Road was identified as a channel and floodplain constriction. Replacing or retrofitting this structure would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. An aerial view of the reach is shown on Figure 29, and descriptions of the recommended projects are shown in Table 18. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 18: Projects and Practices Table - Hungerford Brook
Reach M4T2.03

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M4T2.03	Protect River Corridor - Corridor largely undeveloped, mostly pasture with small amount of shrub/sapling. Reach currently has good floodplain access (incision ratio of 1.0) and acts as sediment and nutrient attenuation zone. Corridor protection needed to retain this function.	High	High	10	Yes	Reach has multiple bedrock grade controls so it is less sensitive to future incision than other reaches. Landowner negotiations and agreements, should be implemented in conjunction with cattle fencing and buffer establishment.
M4T2.03	Plant Stream Buffer/Cattle exclusion - majority of reach runs through pasture with narrow buffers and cattle access to channel.	High	Medium	22	Yes	Landowner cooperation, planting plans and fencing design needed
M4T2.03	Replace Bushey Road Culvert - Culvert not assessed as part of Phase 2 but listed as channel/floodplain constriction in RGA with structure width only 59% of channel width	Medium	Low	57	Yes	Further assessment may be needed to determine if replacement is warranted, cooperation with Town of Swanton needed.

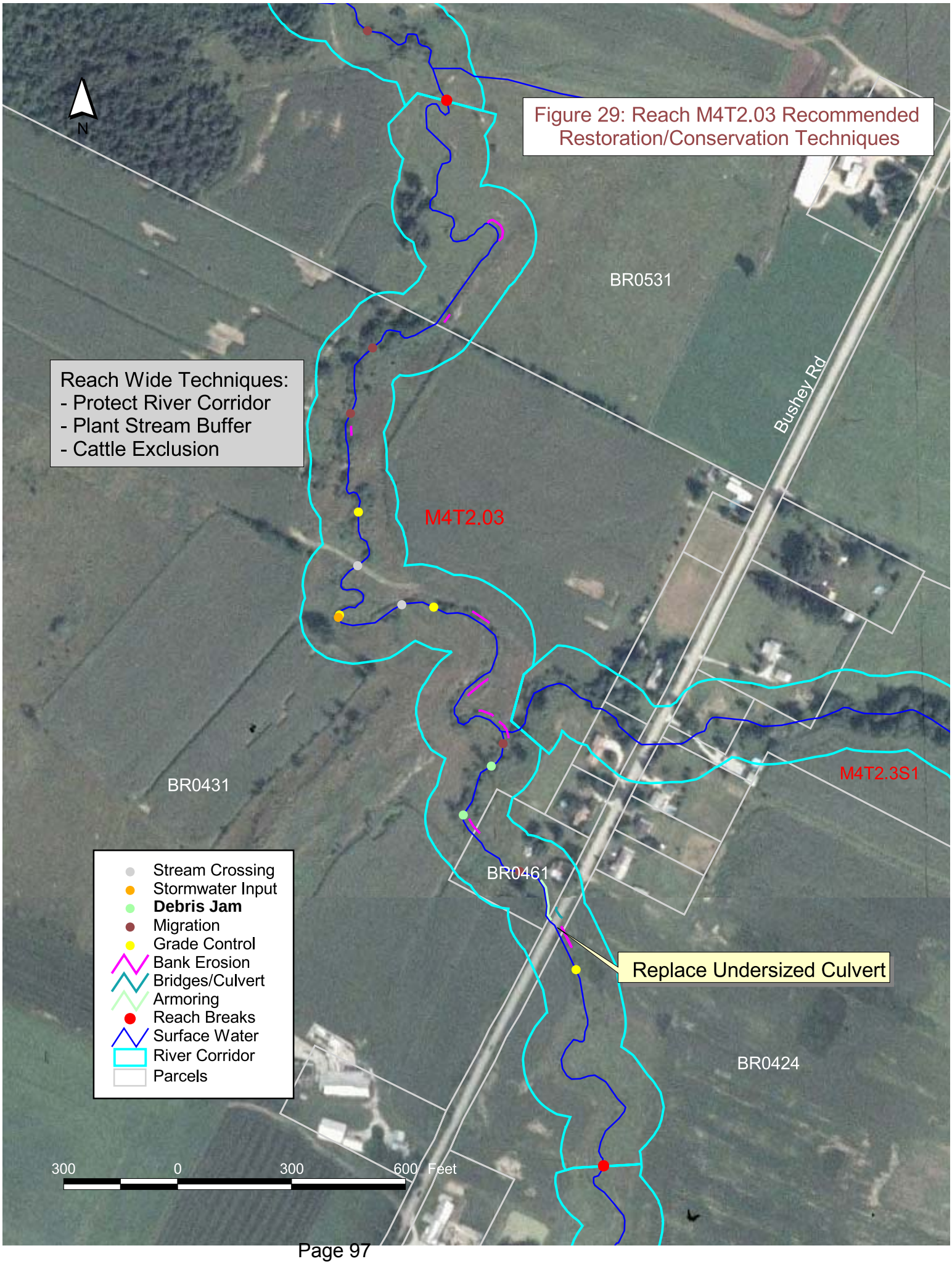


Figure 29: Reach M4T2.03 Recommended Restoration/Conservation Techniques
N
BR0531
Bushey Rd
Reach Wide Techniques:
- Protect River Corridor
- Plant Stream Buffer
- Cattle Exclusion
M4T2.03
M4T2.3S1
BR0431
BR0461
BR0424
Replace Undersized Culvert
Stream Crossing
Stormwater Input
Debris Jam
Migration
Grade Control
Bank Erosion
Bridges/Culvert
Armoring
Reach Breaks
Surface Water
River Corridor
Parcels
300
0
300
600 Feet

5.1.15 Reach M4T2.04Description and Project Identification

Reach M4T2.04 extends from just south of Bushey Road upstream for approximately three miles. The Reach was segmented into four parts (Segments A, B, C, and D) due differences in streambank and boundary conditions and channel planform and slope. Segment A consists of the downstream portion of the reach, and is approximately 1.5 miles long. It was found to be moderately incised with an incision ratio of 1.4 due to historic channel management and extensive upstream and downstream agricultural activities, and only has limited access to its floodplain during high flow events. The Segment was classified as an E4 Riffle-Pool, consistent with its reference type, and in Evolution Stage II (incised). Only minor bank erosion was noted throughout the segment. The riparian corridor was dominated by forest with buffers greater than 100 feet. Despite the dominant woody buffer, the habitat assessment showed relatively poor aquatic habitat due to high embeddedness, lack of favorable sediment types and flow patterns.

Segment B is 1.3 miles long. It was found to be highly incised with an incision ratio of 1.7 due to historic channel management and extensive upstream and downstream agricultural activities, and only has limited access to its floodplain during high flow events. Segment B was classified as a G5 Dune-Ripple stream, a departure from its E5 reference type due to the high incision. Despite the high incision only minor to moderate bank erosion was noted and no active head cuts were observed. It was found to be in Evolution Stage II (incised) and, due to cohesive soils and narrow riparian buffers, has not yet begun to erode its banks and widen (Evolution Stage III). The riparian corridor was dominated by a mix of corn and hay fields with narrow buffers of 0 to 25 feet. A small portion of the reach runs along the Missisquoi Valley Rail Trail, which acts as a floodplain constriction. The habitat assessment showed relatively poor aquatic habitat due to a lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Segment C is a short, 1,000 foot long section of stream dominated by wooded corridor. Like other parts of the Reach, it was found to be highly incised with an incision ratio of 2.3 due

to historic upstream and downstream straightening, extensive agricultural activities, and other channel management techniques, and only has access to the floodplain during extreme high flow events. It was classified as a B4 Riffle-Pool stream, a departure from its E5 reference type due to the high incision and widening processes impacting the area. Despite the wooded buffer, large areas of bank erosion were noted as the channel has entered Evolution Stage III (widening). The habitat assessment showed relatively poor aquatic habitat.

Segment D is the upstream end of the Reach (approximately 2,000 feet long). It was found to be very highly incised with an incision ratio of 3.6 due to historic straightening, extensive agricultural activities, and other channel management techniques, and only has access to the floodplain during the most extreme high flow events. The Segment was classified as a G5 Dune-Ripple stream, a departure from its E5 reference type due to the high incision. Despite the high incision, only minor bank erosion was noted and no active head cuts were observed. The Segment was in Evolution Stage II (incised) and due to cohesive soils and narrow riparian buffers, has not yet begun to erode its banks and widen (Evolution Stage III). The riparian corridor was dominated by corn fields with no riparian buffers present. The habitat assessment showed very poor aquatic habitat due to a lack of woody cover, channel alterations, and very few favorable sediment types and flow patterns.

Given the current condition of Segment A, the recommended remedial strategy is to protect the existing undeveloped river corridor to allow for passive floodplain restoration and retain its limited attenuation assets. As the majority of the Segment is already forested, active restoration and buffer planting are not feasible options in this area.

The restoration priorities for Segment B are to re-establish floodplain connection to restore the sediment and nutrient storage potential of the Reach, and re-establish adequate woody buffer. There are both passive and active remedial techniques which could be utilized, though as with the other highly incised reaches in the watershed, the active approach would be the most

effective. This approach would involve physical manipulation of the channel and adjacent corridor using heavy equipment to construct a more stable meander pattern and accessible floodplain. In conjunction with floodplain restoration, or as a stand alone project if active restoration is not feasible, woody buffer vegetation planting should be conducted to improve aquatic habitat and reduce nutrient inputs. Other instream aquatic habitat improvement techniques, such as introduction of woody debris for cover, could also be considered once greater channel stability has been reached. Two culverts and one bridge were identified as channel and floodplain constrictions during the Phase 2 Assessment. Replacing or retrofitting these structures would improve water and sediment flow patterns, improve aquatic habitat, and reduce future erosion hazards. One additional lower priority project for this Segment would be to remove or retrofit the existing Rail Trail berm to restore floodplain connection along the portion of the reach adjacent to the trail. As the berm is only present along one side of the stream, this option would be more costly and labor intensive than creating floodplain on the other side of the channel which is currently cornfield.

Restoration options for Segment C are similar to those for Segment A. As the entire Segment is currently forested, active floodplain restoration and buffer planting are not feasible here. The most promising technique is to protect the existing river corridor to allow for passive floodplain restoration and natural channel evolution to occur over the long term.

The restoration priorities for Segment D are to re-establish floodplain connection to restore the sediment and nutrient storage potential of the Reach, and re-establish adequate woody buffer. There are both passive and active remedial techniques which could be utilized, though as with the other highly incised reaches in the watershed, the active approach would be the most effective. In conjunction with floodplain restoration, or as a stand alone project if active restoration is not feasible, woody buffer vegetation planting should be conducted to improve aquatic habitat. Other instream aquatic habitat improvement techniques, such as introduction of woody debris for cover, could also be considered once greater channel stability has been reached.

Table 19 and Figures 30 and 31 below describe and show the locations of the recommended projects. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 19: Projects and Practices Table - Hungerford Brook
Reach M4T2.04

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M4T2.04A	Protect River Corridor - Corridor largely undeveloped and mostly forest. Reach moderately incised (ratio of 1.4) and channel adjustments anticipated.	Medium	Low	62	Yes	Landowner negotiations, due to current land use (forest) corridor protection here less critical than in other reaches
M4T2.04A	Replace undersized culvert - Viens Road culvert undersized (width is only 75% of channel width), acts as channel and floodplain constriction	Medium	Low	61	Yes	Town owned culvert (Swanton), more detailed assessment of upstream and downstream conditions should be done prior to implementation
M4T2.04B	Protect River Corridor - Corridor largely undeveloped pasture and cropland and highly incised (ratio of 1.7). Historic straightening and dredging also present so major channel adjustments likely	Low as stand alone project	Low as stand alone project	70	Yes	Negotiations with current landowner needed, due to high incision, extensive historic channel alterations (straightening, dredging), and cohesive soils,active restoration techniques such as floodplain restoration are also be warranted here, any restoration should include buffer establishment
M4T2.04B	Plant Stream Buffer - Entire segment has little to no buffer on both banks.	High	Medium	34	Yes	Landowner cooperation needed, due to anticipated future channel adjustments planting should be conducted as part of larger restoration project with possible floodplain restoration to avoid loss of plantings along eroding banks
M4T2.04B	Restore Incised Reach - Segment highly incised (ratio of 1.7) as part of corridor protection, active floodplain creation needed to reduce future erosion and re-establish sediment and nutrient attenuation zone	High	High	5	Yes	Should be conducted in conjunction with corridor protection and buffer planting, landowner cooperation needed, further survey and Phase III may be needed prior to design
M4T2.04B	Replace undersized structure - 2 culverts and 1 bridge noted in Phase 2 as channel and floodplain constrictions structure widths only 88%, 100%, and 62% of channel width	Medium	Low	59	Yes	Further Bridge and culvert assessments needed to determine if replacement warranted. 1 Structure on Swanton Town Road, remaining are privately owned.
M4T2.04B	Remove Berm - segment runs along rail trail berm which limits floodplain access. Retrofit/redesign of rail trail to restore floodplain access	Low	Low	65	Yes	Further survey of rail trail needed, Berm runs along one side of stream, floodplain access could be restored to other side with less cost and effort without disrupting rail trail.
M4T2.04C	Protect River Corridor - Corridor largely undeveloped forest and highly incised (ratio of 2.3). Historic upstream and downstream straightening and dredging also present so major channel adjustments likely	Low as stand alone project	Low as stand alone project	73	Yes	Negotiations with current landowner needed, segment currently forested so active restoration techniques such as floodplain restoration probably not feasible here
M4T2.04D	Protect River Corridor - Corridor largely undeveloped Corn and Hay fields and highly incised (ratio of 3.6) and straightened. Straightening and dredging also present so major channel adjustments likely, active floodplain restoration needed in conjuction with corridor protection	Low as stand alone project	Low as stand alone project	71	Yes	Negotiations with current landowner needed, due to high incision, extensive historic channel alterations (straightening, dredging), and cohesive soils which would slow progress of passive restoration, active techniques such as floodplain restoration are warranted here, any restoration should include buffer establishment
M4T2.04D	Plant Stream Buffer - Entire segment has little to no buffer on both banks.	High	Medium	38	Yes	Landowner cooperation needed, due to anticipated future channel adjustments should be conducted as part of larger restoration project with possible floodplain restoration to avoid loss of plantings along eroding banks
M4T2.04D	Restore Incised Reach - Segment highly incised (ratio of 3.6), active floodplain creation needed to reduce future erosion and re-establish sediment and nutrient attenuation zone	High	High	6	Yes	Should be conducted in conjunction with corridor protection and buffer planting, landowner cooperation needed, further survey and Phase III may be needed prior to design

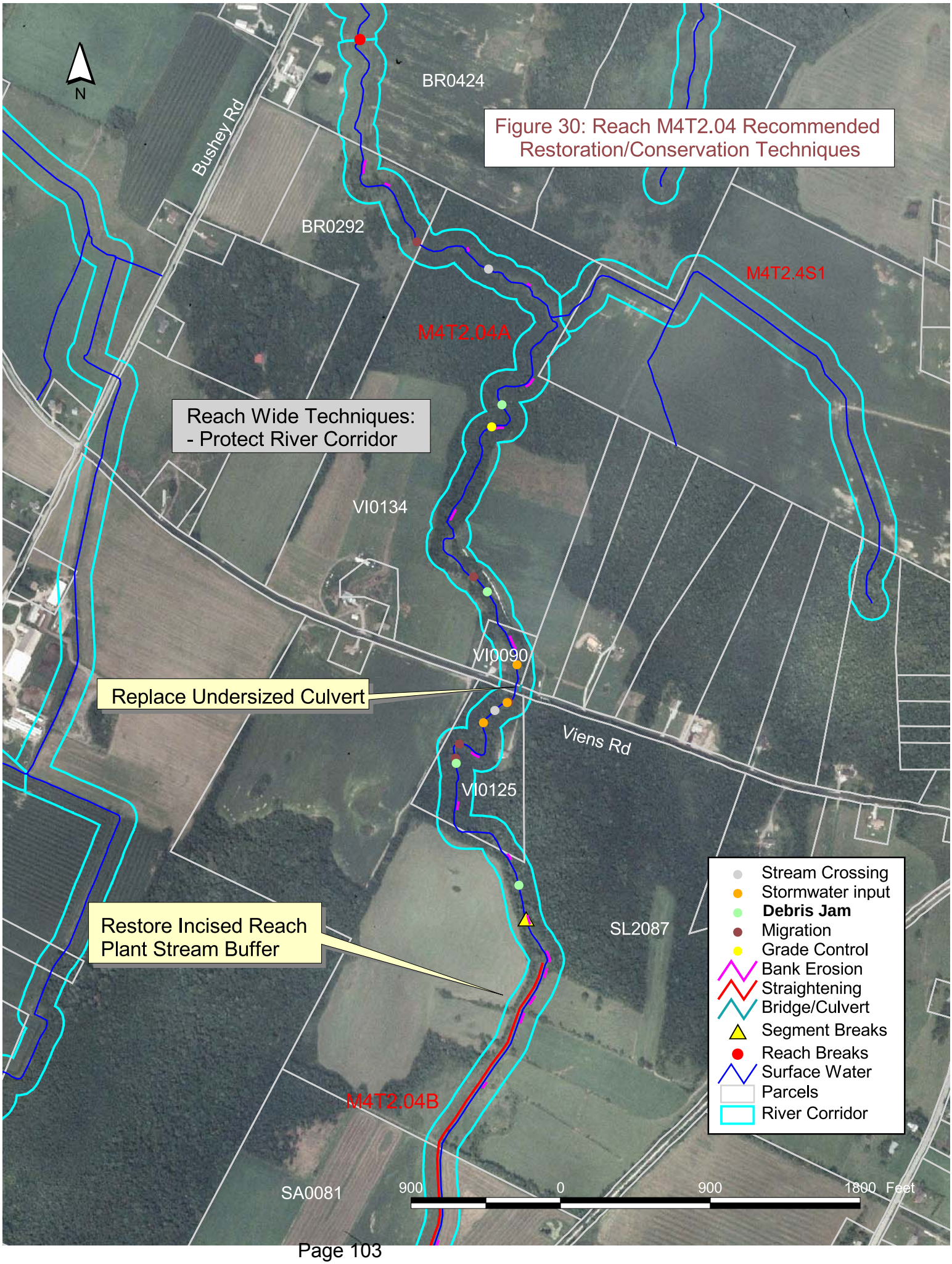


Figure 30: Reach M4T2.04 Recommended Restoration/Conservation Techniques
N
Bushey Rd
BR0424
BR0292
M4T2.4S1
M4T2.04A
Reach Wide Techniques:
- Protect River Corridor
VI0134
VI0090
Replace Undersized Culvert
Viens Rd
VI0125
Restore Incised Reach
Plant Stream Buffer
SL2087
M4T2.04B
SA0081
Stream Crossing
Stormwater input
Debris Jam
Migration
Grade Control
Bank Erosion
Straightening
Bridge/Culvert
Segment Breaks
Reach Breaks
Surface Water
Parcels
River Corridor
900
0
900
1800 Feet

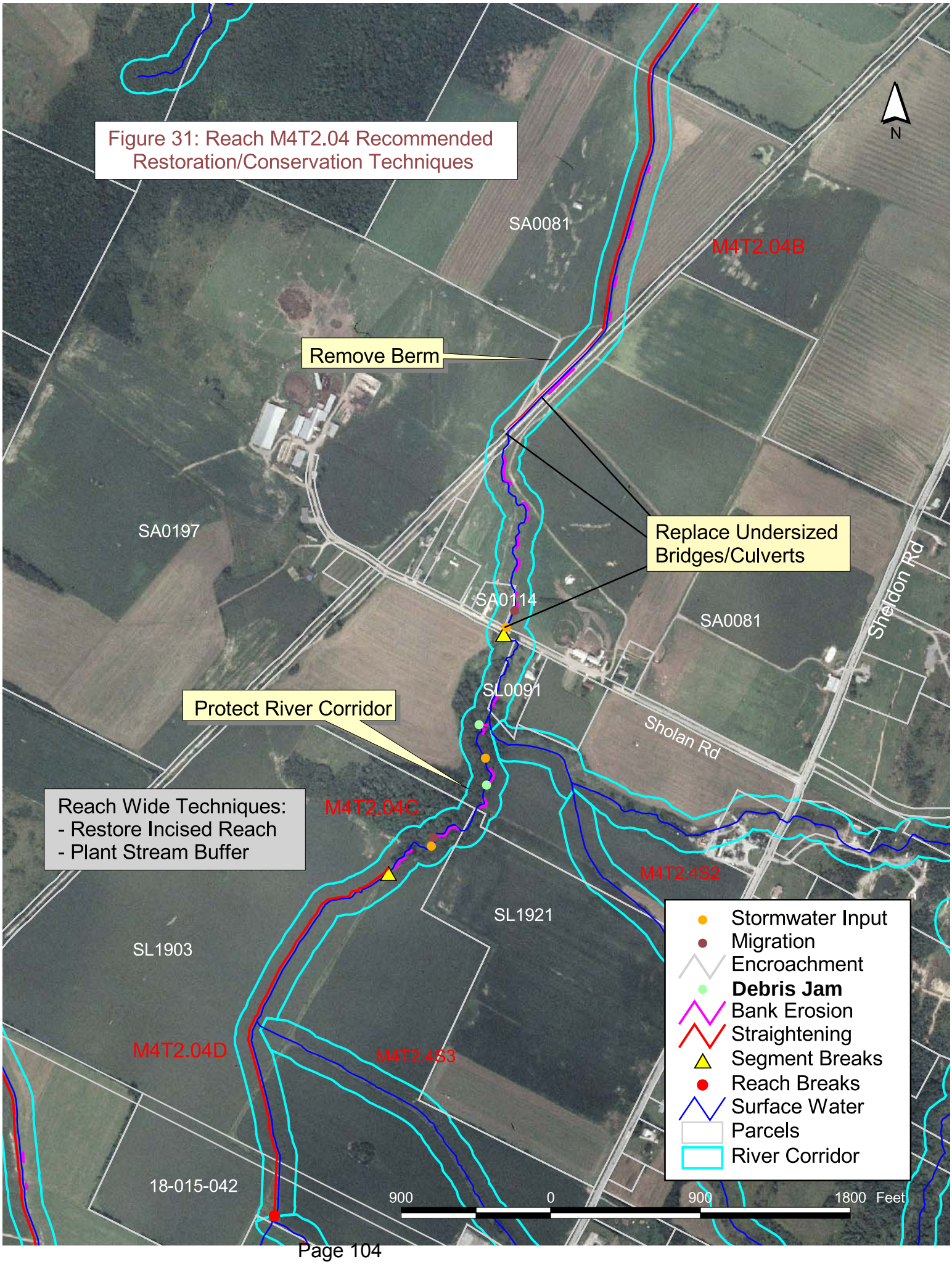


Figure 31: Reach M4T2.04 Recommended Restoration/Conservation Techniques
N
SA0081
M4T2.04B
Remove Berm
SA0197
Replace Undersized Bridges/Culverts
SA0114
SA0081
Sheldon Rd
SL0091
Protect River Corridor
Sholan Rd
Reach Wide Techniques:
- Restore Incised Reach
- Plant Stream Buffer
M4T2.04C
M4T2.4S2
SL1921
SL1903
M4T2.04D
M4T2.4S3
18-015-042
Stormwater Input
Migration
Encroachment
Debris Jam
Bank Erosion
Straightening
Segment Breaks
Reach Breaks
Surface Water
Parcels
River Corridor
900
0
900
1800 Feet

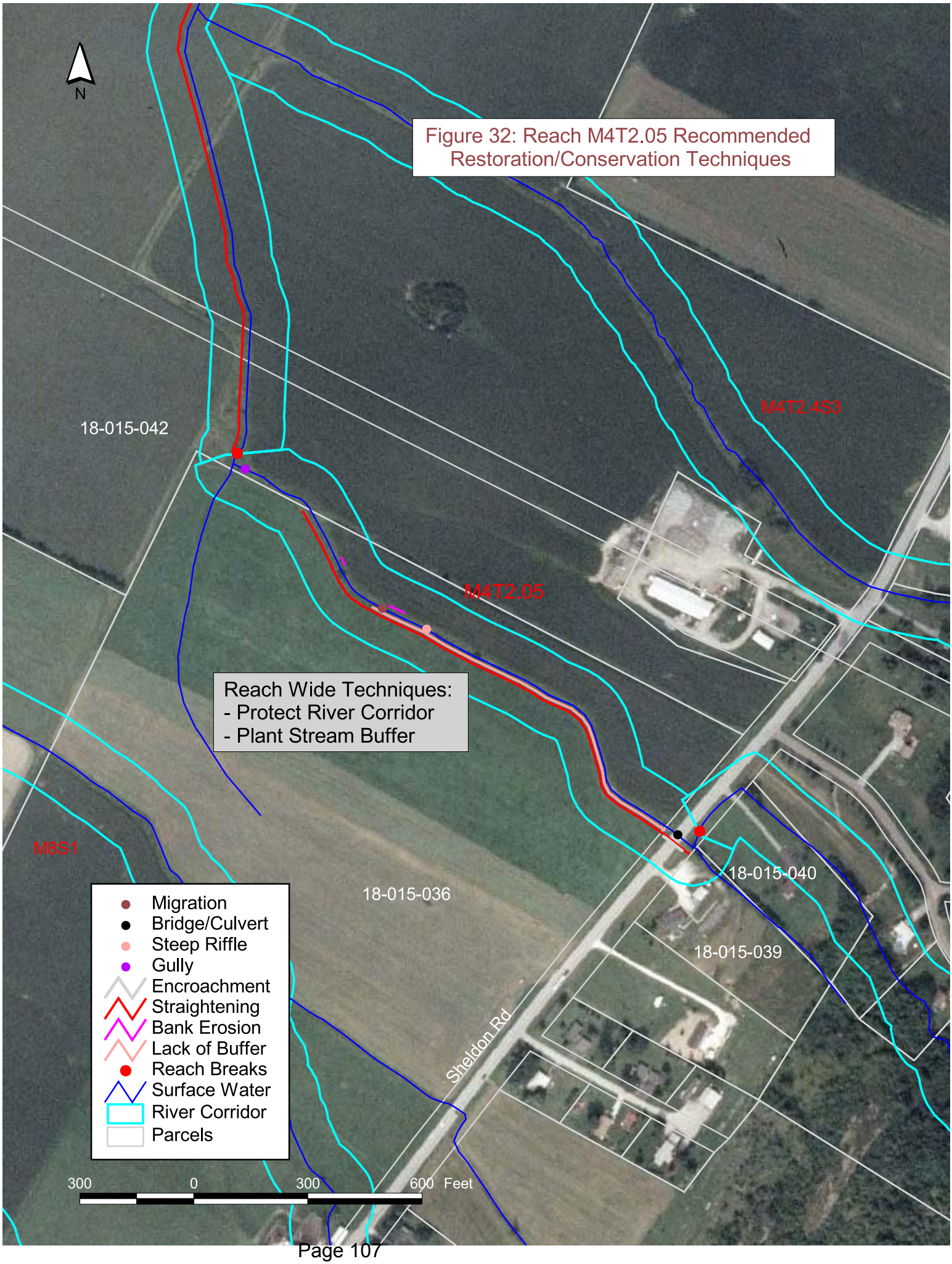
5.1.16 Reach M4T2.05 Description and Project Identification

Reach M4T2.05 extends from the upstream end of M4T2.04 south to Route 105 in St. Albans. The reach was moderately incised with a ratio of 1.4 and showed evidence of extensive channel alterations including ditching and straightening. The existing stream type of E5 Plane-Bed was consistent with its reference stream type. Only a few minor areas of bank erosion were noted, and the reach was found to be in Evolution Stage II (Incised). The riparian corridor was dominated by a hay fields on the left and corn on the right with no riparian buffer. The habitat assessment showed relatively poor aquatic habitat due primarily to a lack of adequate woody cover, and few favorable sediment types and flow patterns.

Given the current condition of M4T2.05, the recommended remedial strategies are to protect the existing river corridor to retain the reach's limited nutrient attenuation assets, allow for passive floodplain re-connection, and enhance the riparian buffer to increase those assets. The entire reach lacks adequate woody buffer, so re-establishing this feature is also a top priority for this reach. An aerial view of the reach is shown on Figure 32, and descriptions of the recommended projects are shown in Table 20. A prioritized list of all identified projects for the watershed is shown in Table 21.

Table 20: Projects and Practices Table - Hungerford Brook
Reach M4T2.05

River Segment	Restoration/Conservation Technique	Reach Priority	Watershed Priority	Table 21 Project Number	Completed Independent of other Practices	Next Steps/Project Notes
M4T2.05	Protect River Corridor - Corridor largely undeveloped, dominated by hay and crop with no buffer. Reach moderately incised (ratio of 1.4) Corridor protection needed to allow for passive floodplain restoration.	High	Medium	27	Yes	Cooperation/negotiations with landowner needed, due to small size of subwatershed corridor protection lower priority here than in downstream reaches.
M4T2.05	Plant Stream Buffer - Entire reach dominated by hay on left and corn on right with no buffer.	High	Medium	33	Yes	Landowner cooperation and planting plans needed


N
Figure 32: Reach M4T2.05 Recommended Restoration/Conservation Techniques
18-015-042
M4T2.4S3
M4T2.05
Reach Wide Techniques:
- Protect River Corridor
- Plant Stream Buffer
M8S1
18-015-036
18-015-040
18-015-039
Sheldon Rd
Migration
Bridge/Culvert
Steep Riffle
Gully
Encroachment
Straightening
Bank Erosion
Lack of Buffer
Reach Breaks
Surface Water
River Corridor
Parcels
300 0 300 600 Feet

5.2 PROJECT PRIORITIZATION

Historically, most of the study area acted as a sediment and nutrient attenuation zone, where incoming fine sediments from upstream were stored on the floodplain, and inputs of coarse sediment slowly moved through the watershed and were essentially equal to outputs of coarse sediment. Due to the historic and ongoing adjustment processes and stressors documented in the watershed, it has largely been transformed into a sediment and nutrient source and transport zone where floodplain access is limited and sediment and nutrients are funneled through the system to downstream receiving waters. Intense agricultural activity has also greatly increased the nutrient inputs into the system. Given these stressors, and current and predicted future adjustments, the highest priority projects are those that attempt to restore the sediment and nutrient attenuation assets which once dominated the system. Other important project types include riparian buffer enhancement to filter out excess nutrients, help stabilize streambanks, and provide shade, cover, and overall improvements to aquatic habitat, and replacement of undersized bridges and culverts to reduce channel constrictions, and restore normal flow patterns. Overall, the Hungerford Brook watershed is still largely undeveloped and provides opportunities for river corridor restoration. Obviously, there is a large amount of human investment within the river corridor, primarily in agricultural land, but also in homes, businesses, and infrastructure but the goals of this and other river corridor plans is to find areas within the watershed where a balance can be reached between these human investments and the health and wellbeing of river systems. Some of the larger scale active restoration projects may require conversion of considerable acres of agricultural land to floodplain and buffer; however, considerable strides may also be made through implementation of relatively narrow buffer strips and other agricultural best management practices. Table 21 below lists potential projects in the Hungerford Brook watershed in order of recommended priority. It is important to note that this Table is an ever-evolving document and that current priorities can change over time. For the purposes of this Plan, projects were prioritized first upon overall benefit to the watershed (sediment and nutrient attenuation, habitat improvement, and re-establishment of geomorphic equilibrium). Other considerations taken into account were technical feasibility, social

feasibility, current landowner involvement, amount of additional investigation necessary to complete the project, as well as overall relative costs. For similar types of projects in different reaches and/or segments priority was given to those that provide the maximum benefits (including nutrient retention, erosion prevention, and/or habitat improvement depending on the type of project). As an example, for corridor protection projects priority was given to non-forested segments over forested ones, since protecting these areas would lead to a larger increase in sediment and nutrient storage and habitat improvement. For buffer enhancement type projects priority was given to crop land over hay fields (these areas tend to contribute greater quantities of sediment and nutrients during runoff events) and reaches with longer stretches of un-buffered lands were given priority over shorter ones. The third column in the Table lists the project type, which allows for identification and prioritization of projects that are similar. It also allows certain groups who may be interested in one type of project (i.e. citizens groups who want to focus on tree planting) to target higher priority sites.

Table 21: Corridor Planning Project and Strategy Summary Table Hungerford Brook - Franklin County, VT

Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
1 (27)	M4T2.01 - Fair-Very High	Restore Incised Reach	Highly incised reach (ratio of 2.3), historically straightened, Lowermost portion of large tributary to Hungerford with extensive sediment deposits upstream. Reach currently undeveloped cropland, bisected by Woods Hill Road	Active floodplain resotration to restore sediment/nutrient retention function and reduce future erosion hazards. Ideally combined with buffer planting and river corridor protection (see project #s 37 and 66).	Feasible; river corridor undeveloped, high watershed priority, possible issues related to bridge midreach	Wildlife habitat improvement, possible demonstration project for other reaches, sediment and nutrient retention	Design/permitting costs, construction costs, possible easement transactions and buffer planting costs	Mostly cropland downstream of road, mix of crop and pasture upstream converted to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC
2 (18)	M06 - Fair-Very High	Restore Incised Reach	Highly incised reach (ratio of 1.8) increased flows and load due to extensive cropping and other ag activities. Reach currently undeveloped cropland, hayfields and pasture.	Active floodplain resotration to restore sediment/nutrient retention function and reduce future erosion hazards. Ideally combined with buffer planting and river corridor protection (see project #s 13 and 67).	Feasible; river corridor undeveloped, high watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, sediment and nutrient retention	Design/permitting costs, construction costs, possible easement transactions and buffer planting costs	Crop land, hay fields, and pasture land converted to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC
3 (17)	M05 - Fair- Very High	Restore Incised Reach	Highly incised reach (ratio of 1.8). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland, bisected by Woods Hill Road	Active floodplain resotration to restore sediment/nutrient retention function and reduce future erosion hazards. Ideally combined with buffer planting and river corridor protection (see project #s 39 and 68).	Feasible; river corridor undeveloped, high watershed priority, possible issues related to bridge midreach	Wildlife habitat improvement, possible demonstration project for other reaches, sediment and nutrient retention	Design/permitting costs, construction costs, possible easement transactions and buffer planting costs	Mostly cropland downstream of road, mix of pasture and abandoned ag land upstream converted to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC
4 (20)	M08B - Fair - Very High	Restore Incised Reach	Highly incised reach (ratio of 1.8). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland, bisected by Rail Trail	Active floodplain resotration to restore sediment/nutrient retention function and reduce future erosion hazards. Ideally combined with buffer planting and river corridor protection (see project #s 16 and 69).	Feasible; river corridor undeveloped, high watershed priority, possible issues related to rail trail culvert midreach	Wildlife habitat improvement, possible demonstration project for other reaches, sediment and nutrient retention	Design/permitting costs, construction costs, possible easement transactions and buffer planting costs	Hay and Crop fields to floodplain and buffer	VT RMP, NRCS, F&W, MRBA, NRPC
5 (30, 31)	M4T2.04B - Fair - Very High	Restore Incised Reach	Highly incised reach (ratio of 1.7). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland and hay fields, bisected by Rail Trail	Active floodplain resotration to restore sediment/nutrient retention function and reduce future erosion hazards. Ideally combined with buffer planting and river corridor protection (see project #s 34 and 70).	Feasible; river corridor undeveloped, high watershed priority, possible issues related to rail trail culvert midreach	Wildlife habitat improvement, possible demonstration project for other reaches, sediment and nutrient retention	Design/permitting costs, construction costs, possible easement transactions and buffer planting costs	Hay and Crop fields to floodplain and buffer	VT RMP, NRCS, F&W, MRBA, NRPC

Table 21: Corridor Planning Project and Strategy Summary Table Hungerford Brook - Franklin County, VT

Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
6 (31)	M4T2.04D - Fair - Very High	Restore Incised Reach	Highly incised reach (ratio of 3.6). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland.	Active floodplain resotration to restore sediment/nutrient retention function and reduce future erosion hazards. Ideally combined with buffer planting and river corridor protection (see project #s 38 and 71).	Feasible; river corridor undeveloped, high watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, sediment and nutrient retention	Design/permitting costs, construction costs, possible easement transactions and buffer planting costs	Agricultural fields to floodplain and buffer	VT RMP, NRCS, F&W, MRBA, NRPC
7 (19)	M07B - Fair - Moderate	Arrest Head Cut	Slightly incised reach (ratio of 1.2) with active head cut dominated by pasture land, bisected by Bushey Road, no natural grade controls located upstream	Install permanent grade control to arrest current head cut and prevent further loss of floodplain access	Feasible, river corridor undeveloped pasture, high watershed priority	reduce future incision and bank erosion	Design/permitting costs, construction costs	No land use conversion	VT RMP, NRCS, F&W, MRBA, NRPC
8 (18)	M06 - Fair-Very High	Arrest Head Cut	Highly incised reach (ratio of 1.8) with active head cut, dominated by cropland, hay fields, and pasture land no natural grade controls located upstream until M07B, ideally combined with floodplain resotoration described in Project #2	Install permanent grade control to arrest current head cut and prevent further loss of floodplain access	Feasible, river corridor undeveloped ag land, high watershed priority	reduce future incision and bank erosion	Design/permitting costs, construction costs	No land use conversion	VT RMP, NRCS, F&W, MRBA, NRPC
9 (23)	M4T2.02 Reference - Moderate	Corridor Protection	Relatively stable reach with no incision, currently acts as sediment and nutrient attenuation asset, dominated by pasture and crop land, protection needed to retain sediment/nutrient attenuation	Protect existing river corridor to prevent channel management and incision, ideally combined with buffer enhancement (see project # 49) to further enhance nutrient retention	Feasible, river corridor undeveloped ag land, high watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag and pasture land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
10 (29)	M4T2.03 - Good - Moderate	Corridor Protection	Relatively stable reach with no incision, currently acts as sediment and nutrient attenuation asset, dominated by pasture, protection needed to retain sediment/nutrient attenuation	Protect existing river corridor to prevent channel management and incision, ideally combined with buffer enhancement (see project # 22) to further enhance nutrient retention	Feasible, river corridor undeveloped ag land, high watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag and pasture land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC

Table 21: Corridor Planning Project and Strategy Summary Table Hungerford Brook - Franklin County, VT

Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
11 (16)	M04 - Good - High	Corridor Protection	Relatively stable reach with only minor incision, currently acts as sediment and nutrient attenuation asset, dominated by abandoned pasture and other ag lands, protection needed to retain sediment/nutrient attenuation	Protect existing river corridor to prevent channel management and incision, ideally combined with tree planting (see project # 64) to enhance riparian habitat and further enhance nutrient retention	Feasible, river corridor undeveloped former ag land, high watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Former ag and pasture land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
12 (24)	M3T1.03 - Good - High	Buffer Enhancement/ Cattle Exclusion	Relatively stable reach with only minor incision, dominated by crop and pasture with little to no buffer, cows have access to stream	Tree/buffer planting project combined with cattle fencing to reduce nutrient inputs and enhance sediment and nutrient attenuation, may also need stream crossing and/or watering systems for cows	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting/fencing design and installation, CREP payments	Crop and pasture lands to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
13 (18)	M06 - Fair-Very High	Buffer Enhancement/ Cattle Exclusion	Highly incised reach (ratio of 1.8) increased flows and load due to extensive cropping and other ag activities. Dominated by cropland, hayfields and pasture with little to no buffer and cows in stream.	Tree/buffer planting project combined with cattle fencing to reduce nutrient inputs and enhance sediment and nutrient attenuation, may also need stream crossing and/or watering systems for cows	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting/fencing design and installation, CREP payments	Crop and pasture lands to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
14 (25)	M3T1.04B - Fair - Very High	Buffer Enhancement/ Cattle Exclusion	Moderately incised reach (ratio of 1.4) increased flows and load due to extensive cropping and other ag activities. Dominated by cropland, hayfields and pasture with little to no buffer and cows in stream.	Tree/buffer planting project combined with cattle fencing to reduce nutrient inputs and enhance sediment and nutrient attenuation, may also need stream crossing and/or watering systems for cows	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting/fencing design and installation, CREP payments	Crop and pasture lands to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
15 (19)	M07B - Fair - Moderate	Buffer Enhancement/ Cattle Exclusion	Moderately incised reach (ratio of 1.2) increased flows and load due to ag activities and residential encroachment. Dominated by pasture with little to no buffer and cows in stream.	Tree/buffer planting project combined with cattle fencing to reduce nutrient inputs and enhance sediment and nutrient attenuation, may also need stream crossing and/or watering systems for cows	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting/fencing design and installation, CREP payments	Crop and pasture lands to buffer	VT RMP, NRCS, F&W, MRBA, NRPC

Table 21: Corridor Planning Project and Strategy Summary Table Hungerford Brook - Franklin County, VT

Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
16 (20)	M08B - Fair - Very High	Buffer Enhancement	Highly incised reach (ratio of 1.8). Increased flows and load due to extensive ag activities. Little to no buffer. Reach currently undeveloped cropland, bisected by Rail Trail	Tree/buffer planting project to reduce nutrient inputs, ideally combined with active floodplain restoration project (see project #4)	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Crop and hay fields to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
17 (22)	M3T1.01B - Good - High	Buffer Enhancement/ Cattle Exclusion	Moderately incised reach (ratio of 1.4). Increased flows and load due to extensive ag activities. Little to no buffer with cows in stream. Reach currently dominated by pasture	Tree/buffer planting project combined with cattle fencing to reduce nutrient inputs and enhance sediment and nutrient attenuation, may also need stream crossing and/or watering systems for cows	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting/fencing design and installation, CREP payments	Cow pasture to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
18 (23)	M3T1.02 - Good - High	Buffer Enhancement/ Cattle Exclusion	Relatively stable reach with no incision (ratio of 1.0). Increased flows and load due to extensive ag activities. Little to no buffer with cows in stream near Woods Hill Road. Reach currently dominated by pasture in this area.	Tree/buffer planting project combined with cattle fencing to reduce nutrient inputs and enhance sediment and nutrient attenuation, may also need stream crossing and/or watering systems for cows	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting/fencing design and installation, CREP payments	Cow pasture to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
19 (21)	M09A - Fair - Very High	Buffer Enhancement/ Cattle Exclusion	Relatively stable reach with minor incision (ratio of 1.2). Increased flows and load due to extensive ag activities. Little to no buffer with cows in stream. Reach currently dominated by pasture and crop land.	Tree/buffer planting project combined with cattle fencing to reduce nutrient inputs and enhance sediment and nutrient attenuation, may also need stream crossing and/or watering systems for cows	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting/fencing design and installation, CREP payments	Cow pasture to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
20 (21)	M09B - Fair - Very High	Arrest Head Cut	Slightly incised reach (ratio of 1.2) with active head cut, dominated by hay fields, no natural grade controls located upstream	Install permanent grade control to arrest current head cut and prevent further loss of floodplain access	Feasible, medium watershed priority	reduce future incision and bank erosion	Design/permitting costs, construction costs	No land use conversion	VT RMP, NRCS, F&W, MRBA, NRPC

Table 21: Corridor Planning Project and Strategy Summary Table Hungerford Brook - Franklin County, VT

Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
21 (21)	M09B - Fair - Very High	Buffer Enhancement	Relatively stable reach with minor incision (ratio of 1.2). Increased flows and load due to extensive ag activities. Inadequate woody buffer, reach currently dominated by hay fields.	Tree/buffer planting project to reduce nutrient inputs	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Hayfields to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
22 (29)	M4T2.03 - Good - Moderate	Buffer Enhancement/ Cattle Exclusion	Relatively stable reach with no incision (ratio of 1.0) and several bedrock grade controls. Increased flows and load due to ag activities. Little to no buffer with cows in stream. Reach currently dominated by pasture.	Tree/buffer planting project combined with cattle fencing to reduce nutrient inputs and enhance sediment and nutrient attenuation, may also need stream crossing and/or watering systems for cows	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting/fencing design and installation, CREP payments	Cow pasture to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
23 (24)	M3T1.03 - Good - High	Corridor Protection	Relatively stable reach with only minor incision (ratio of 1.2), dominated by crop and pasture with little to no buffer, cows have access to stream	Protect existing river corridor to prevent channel management and incision, ideally combined with tree planting/cattle exclusion (see project # 12) to enhance riparian habitat	Feasible, river corridor undeveloped former ag land, medium watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag and pasture land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
24 (19)	M07B - Fair - Moderate	Corridor Protection	Moderately incised reach (ratio of 1.2) increased flows and load due to ag activities and residential encroachment. Dominated by pasture with little to no buffer and cows in stream.	Protect existing corridor to prevent channel management and incision, ideally combined with tree planting/cattle exclusion (project # 15) to enhance habitat, could be combined with corridor protection in M07A (project #51) for a more complete project	Feasible, river corridor undeveloped former ag land, medium watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag and pasture land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
25 (26)	M4S1.01B - Fair - Very High	Restore Incised Reach	Highly incised reach (ratio of 1.9). Increased flows and load due to ag activities. Reach currently undeveloped hay fields.	Active floodplain resotration to restore sediment/nutrient retention function. Overall lower watershed priority than other floodplain restoration projects due to small size of subwatershed	Feasible; river corridor undeveloped, medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, sediment and nutrient retention	Design/permitting costs, construction costs, possible easement transactions and buffer planting costs	Agricultural fields to floodplain and buffer	VT RMP, NRCS, F&W, MRBA, NRPC

Table 21: Corridor Planning Project and Strategy Summary Table Hungerford Brook - Franklin County, VT

Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
26 (26)	M4S1.01A - Fair - High	Corridor Protection	Moderately incised reach (ratio of 1.2) increased flows and load due to ag activities. Dominated by crop land with minimal buffers.	Protect existing river corridor to reduce channel management and prevent further incision, could be combined with corridor protection in Segment B (Project # 72) for a more complete project	Feasible, river corridor undeveloped ag land, medium watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC
27 (32)	M4T2.05 - Good - Very High	Corridor Protection	Moderately incised reach (ratio of 1.4) increased flows and load due to ag activities. Dominated by hay and crop land with 0-25 foot buffers.	Protect existing river corridor to reduce channel management and prevent further incision, ideally combined with buffer planting project (#33) to reduce nutrient inputs and improve habitat	Feasible, river corridor undeveloped ag land, medium watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
28 (25)	M3T1.04B - Fair - Very High	Corridor Protection	Moderately incised reach (ratio of 1.4) increased flows and load due to ag activities. Dominated by hay, crop, and pasture land with 0-25 foot buffers.	Protect existing river corridor to reduce channel management and prevent further incision, ideally combined with buffer planting project (#14) to reduce nutrient inputs and improve habitat, could be combined with corridor protection for Segment A (Project #35)	Feasible, river corridor undeveloped ag land, medium watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
29 (21)	M09A - Fair - Very High	Corridor Protection	Moderately incised reach (ratio of 1.2) increased flows and load due to ag activities. Dominated by hay and pasture land with 0-25 foot buffers.	Protect existing river corridor to reduce channel management and prevent further incision, ideally combined with buffer planting project (#19) to reduce nutrient inputs and improve habitat	Feasible, river corridor undeveloped ag land, medium watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
30 (21)	M09B - Fair - Very High	Corridor Protection	Moderately incised reach (ratio of 1.2) increased flows and load due to ag activities. Dominated by hay with 26-50 foot buffers.	Protect existing river corridor to reduce channel management and prevent further incision, ideally combined with buffer planting project (#21) to reduce nutrient inputs and improve habitat	Feasible, river corridor undeveloped ag land, medium watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC

Table 21: Corridor Planning Project and Strategy Summary Table Hungerford Brook - Franklin County, VT

Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
31 (23)	M3T1.02 - Good - High	Corridor Protection	Relatively stable reach with no incision (ratio of 1.0) increased flows and load due to ag activities. Dominated by mx of forest, hay, and pasture with 26-50 foot buffers.	Protect existing river corridor to reduce channel management and prevent further incision, ideally combined with buffer planting project (#18) to reduce nutrient inputs and improve habitat	Feasible, river corridor undeveloped ag land, medium watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
32 (26)	M4S1.01A - Fair - High	Buffer Enhancement	Moderately incised reach (ratio of 1.2) increased flows and load due to ag activities. Dominated by crop land with minimal buffers.	Tree/buffer planting project to reduce nutrient inputs	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Hay and crop to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
33 (32)	M4T2.05 - Good - Very High	Buffer Enhancement	Moderately incised reach (ratio of 1.4) increased flows and load due to ag activities. Dominated by hay and crop land with no buffers. Reach straightened and ditched.	Tree/buffer planting project to reduce nutrient inputs	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Hay and crop to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
34 (30, 31)	M4T2.04B - Fair - Very High	Buffer Enhancement	Highly incised reach (ratio of 1.7). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland and hay fields with 0-25 foot buffers, bisected by Rail Trail	Tree/buffer planting project to reduce nutrient inputs, ideally combined with floodpplain restoration project (#5)	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Hay and crop to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
35 (25)	M3T1.04A - Fair - Very High	Corridor Protection	Relatively stable reach with only minor incision (ratio of 1.1). Increased flows and load due to extensive ag activities. Reach currently undeveloped hay and cropland in downstream half with 26-50 foot buffers.	Protect existing river corridor to reduce channel management and prevent further incision, Could be combined with corridor protection in Segment A (Project # 28)	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Hay and crop to buffer	VT RMP, NRCS, F&W, MRBA, NRPC

Table 21: Corridor Planning Project and Strategy Summary Table Hungerford Brook - Franklin County, VT

Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
36 (22)	M3T1.01B - Good - High	Corridor Protection	Relatively stable reach with moderate incision (ratio of 1.4) increased flows and load due to ag activities. Dominated by mx of forest and pasture with 0-25 foot buffers.	Protect existing river corridor to reduce channel management and prevent further incision, ideally combined with buffer planting project (#17) to reduce nutrient inputs and improve habitat	Feasible, river corridor undeveloped ag land, medium watershed priority	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	Ag land to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
37 (27)	M4T2.01 - Fair-Very High	Buffer Enhancement	Highly incised reach (ratio of 2.3), historically straightened. Reach currently undeveloped cropland with 0-25 foot buffers, bisected by Woods Hill Road	Tree/buffer planting project to reduce nutrient inputs and improve habitat, ideally combined with floodplain restoration (project #1)	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Crop to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
38 (31)	M4T2.04D - Fair - Very High	Buffer Enhancement	Highly incised reach (ratio of 3.6). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland with 0-25 foot buffers.	Tree/buffer planting project to reduce nutrient inputs and improve habitat, ideally combined with floodplain restoration (project #6)	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Crop to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
39 (17)	M05 - Fair- Very High	Buffer Enhancement	Highly incised reach (ratio of 1.8). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland with no buffer downstream of road, bisected by Woods Hill Road	Tree/buffer planting project to reduce nutrient inputs and improve habitat, ideally combined with floodplain restoration (project #3)	Feasible; medium watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Crop to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
40 (20)	M08A - Good - High	Corridor Protection	Relatively stable reach with moderate incision (ratio of 1.4) increased flows and load due to ag activities. Dominated by forest with adequate buffers.	Protect existing river corridor to prevent further incision and allow for passive floodplain restoration, could be combined with corridor protection for Segment B (project #69)	Feasible, river corridor undeveloped former ag land, low watershed priority due to existing forested buffer	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC

Table 21: Corridor Planning Project and Strategy Summary Table Hungerford Brook - Franklin County, VT

Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
41 (20)	M08B - Fair - Very High	Replace Undersized Structure(s)	Three private culverts locted within Reach, all documented channel and floodplain constrictions with structure width/channel width ratios of 30%, 60%, and 30%.	Replace undersized structure(s) with adequately sized ones	Feasible, river corridor undeveloped ag land, all structures privately owned, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC
42 (18)	M06 - Fair-Very High	Replace Undersized Structure(s)	Reach contains 3 bridges and two culverts, all documented constrictions with structure width/channel width ratios of 46%, 25%, 133%, 25%, and 44%. Three of the structures located on Swanton Town Roads, remainder are priveately owned.	Replace undersized structure(s) with adequately sized ones	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton
43 (17)	M05 - Fair- Very High	Replace Undersized Structure(s)	Reach contains 1 bridge and 1 culvert, both documented constrictions with structure width/channel width ratios of 140% and 33%. Bridge located on Swanton Town Road, culvert is priveately owned.	Replace undersized structure(s) with adequately sized ones	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton
44 (23)	M3T1.02 - Good - High	Replace Undersized Structure(s)	Reach contains 2 culverts and 1 bridge, all documented constrictions with structure width/channel width ratios of 95%, 22%, and 22%. Bridge located on Sheldon Town Road, culverts are priveately owned.	Replace undersized structure(s) with adequately sized ones	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Sheldon
45 (25)	M3T1.04A - Fair - Very High	Replace Undersized Structure(s)	Reach contains 1 privately owned culvert documented as a constriction with structure width/channel width ratio of 25%.	Replace undersized structure(s) with adequately sized one	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC

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Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
46 (19)	M07A - Good - High	Buffer Enhancement	Relatively stable reach with only minor incision (ratio of 1.2), dominated by crop and hay in downstream end with little to no buffer, upstream end has adequate forested buffer	Tree/buffer planting project to reduce nutrient inputs and improve habitat	Feasible; overall low watershed priority due to relatively small area in need of buffer (~200')	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Crop and hay to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
47 (25)	M3T1.04A - Fair - Very High	Buffer Enhancement	Relatively stable reach with only minor incision (ratio of 1.1), dominated by crop and hay along left bank in downstream half with little buffer, upstream end has adequate forested buffer	Tree/buffer planting project to reduce nutrient inputs and improve habitat	Feasible; overall low watershed priority due to relatively small area in need of buffer	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Crop and hay to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
48 (19)	M07B - Fair - Moderate	Replace Undersized Structure(s)	Reach contains 2 culverts and 1 bridge, all documented constrictions with structure width/channel width ratios of 88%, 50%, and 44%. Bridge located on Swanton Town Road, culverts are privately owned.	Replace undersized structure(s) with adequately sized ones	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton
49 (28)	M4T2.02 Reference - Moderate	Buffer Enhancement/ Cattle Exclusion	Relatively stable reach with no incision (ratio of 1.0). Upstream ~1,000 feet runs through pasture with narrow buffers and cows in stream. Remainder of reach has >100' buffers.	Tree/buffer planting project combined with cattle fencing to reduce nutrient inputs and enhance sediment and nutrient attenuation, may also need stream crossing and/or watering systems for cows	Feasible; overall low watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting/fencing design and installation, CREP payments	Cow pasture to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
50 (26)	M4S1.01B - Fair - Very High	Replace Undersized Structure(s)	Reach contains 1 privately owned culvert documented as a constriction with structure width/channel width ratio of 25%.	Replace undersized structure(s) with adequately sized one	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC

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Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
51 (19)	M07A - Good - High	Corridor Protection	Relatively stable reach with only minor incision (ratio of 1.1). Dominated by forest with adequate buffers.	Protect existing river corridor to prevent further incision and retain sediment and nutrient attenuation assets, could be combined with corridor protection for M07B (project # 24) for a more complete project	Feasible, river corridor undeveloped, overall low watershed priority due to existing forested buffer	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC
52 (27)	M4T2.01 - Fair-Very High	Replace Undersized Structure(s)	Reach contains 1 Town of Swanton owned culvert on Woods Hill Road documented as a constriction with structure width/channel width ratio of 43%.	Replace undersized structure(s) with adequately sized one	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton
53 (21)	M09A - Fair - Very High	Replace Undersized Structure(s)	Reach contains 1 culvert on Route 105 documented as a constriction with structure width/channel width ratio of 35%.	Replace undersized structure(s) with adequately sized one	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of St. Albans/State of Vermont
54 (21)	M09B - Fair - Very High	Replace Undersized Structure(s)	Reach contains 1 privately owned culvert documented as a constriction with structure width/channel width ratio of 40%.	Replace undersized structure(s) with adequately sized one	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC
55 (25)	M3T1.04B - Fair - Very High	Replace Undersized Structure(s)	Reach contains 3 culverts, all documented constrictions with structure width/channel width ratios of 25-50%. One located on Swanton Town Road, the other 2 are privately owned.	Replace undersized structure(s) with adequately sized ones	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton

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Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
56 (26)	M4S1.01A - Fair - High	Replace Undersized Structure(s)	Reach contains 1 Town of Swanton owned culvert on Woods Hill Road documented as a constriction with structure width/channel width ratio of 40%.	Replace undersized structure(s) with adequately sized one	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton
57 (29)	M4T2.03 - Good - Moderate	Replace Undersized Structure(s)	Reach contains 1 Town of Swanton owned culvert on Bushey Road documented as a constriction with structure width/channel width ratio of 59%.	Replace undersized structure(s) with adequately sized one	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton
58 (22)	M3T1.01B - Good - High	Replace Undersized Structure(s)	Reach contains 1 Town of Sheldon owned culvert on Cook Road documented as a constriction with structure width/channel width ratio of 67%.	Replace undersized structure(s) with adequately sized one	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Sheldon
59 (30, 31)	M4T2.04B - Fair - Very High	Replace Undersized Structure(s)	Reach contains 2 culverts and 1 bridge, all documented constrictions with structure width/channel width ratios of 88%, 100%, and 62%. One located on Swanton Town Road, the other 2 are privately owned.	Replace undersized structure(s) with adequately sized ones	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton
60 (24)	M3T1.03 - Good - High	Replace Undersized Structure(s)	Reach contains 2 bridges, both documented constrictions with structure width/channel width ratios of 77% and 93%. One located on Route 105, the other is privately owned.	Replace undersized structure(s) with adequately sized ones	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton/State of Vermont

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Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
61 (30)	M4T2.04A - Fair - High	Replace Undersized Structure(s)	Reach contains 1 Town of Swanton owned culvert on Viens Road documented as a constriction with structure width/channel width ratio of 75%.	Replace undersized structure(s) with adequately sized one	Feasible, river corridor undeveloped ag land, overall low watershed priority	Aquatic habitat improvement, possible demonstration project for other reaches, reduce erosion associated with undersized structures	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC, Town of Swanton
62 (30)	M4T2.04A - Fair - High	Corridor Protection	Relatively stable reach with moderate incision (ratio of 1.4). Dominated by forest with adequate buffers.	Protect existing river corridor to prevent further incision and retain/enhance sediment and nutrient attenuation assets	Feasible, river corridor undeveloped, overall low watershed priority due to existing forested buffer	Possible wildlife habitat improvement, possible demonstration project for other reaches, retain sediment and nutrient retention	Easement transaction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC
63 (26)	M4S1.01B - Fair - Very High	Buffer Enhancement	Highly incised reach (ratio of 1.9). Increased flows and load due to ag activities. Reach currently undeveloped hay fields with 25-50' herbaceous buffer but few trees.	Tree/buffer planting project to reduce nutrient inputs and improve habitat	Feasible; overall low watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Hay to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
64 (16)	M04 - Good - High	Buffer Enhancement	Relatively stable reach with only minor incision (ratio of 1.1). Dominated by forest with adequate buffers except along right bank near downstream end of reach and along left bank near upstream end.	Tree/buffer planting project to reduce nutrient inputs and improve habitat	Feasible; overall low watershed priority	Wildlife habitat improvement, possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Planting design and installation, CREP payments	Hay to buffer	VT RMP, NRCS, F&W, MRBA, NRPC
65 (31)	M4T2.04B - Fair - Very High	Berm Removal	Highly incised reach (ratio of 1.7). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland and hay fields with 0-25 foot buffers, bisected by Rail Trail which is bermed along right bank. Ag fields along left bank	Retrofit/redesign of rail trail to allow for floodplain acces restoration	Feasible; low watershed priority, more costly than creating floodplain access along left bank	possible demonstration project for other reaches, reduce nutrient inputs, improve water quality	Design/permitting costs, construction costs	None	VT RMP, NRCS, F&W, MRBA, NRPC

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Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
66 (27)	M4T2.01 - Fair-Very High	Corridor Protection	Highly incised reach (ratio of 2.3), historically straightened, Lowermost portion of large tributary to Hungerford with extensive sediment deposits upstream. Reach currently undeveloped cropland. Project would be more feasible if combined with active restoration (project #1)	Protect existing river corridor to prevent further incision and allow for passive floodplain restoration	Feasible, river corridor undeveloped, overall low watershed priority due to cohesive soils which would inhibit channel evolution	Possible wildlife habitat improvement, increase sediment and nutrient retention	Easement transaction costs	Potential Ag land to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC
67 (18)	M06 - Fair-Very High	Corridor Protection	Highly incised reach (ratio of 1.8) increased flows and load due to extensive cropping and other ag activities. Reach currently undeveloped cropland, hayfields and pasture. Project would be more feasible if combined with active restoration (project #2)	Protect existing river corridor to prevent further incision and allow for passive floodplain restoration	Feasible, river corridor undeveloped, overall low watershed priority due to cohesive soils which would inhibit channel evolution	Possible wildlife habitat improvement, increase sediment and nutrient retention	Easement transaction costs	Potential Ag land to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC
68 (17)	M05 - Fair- Very High	Corridor Protection	Highly incised reach (ratio of 1.8). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland. Project would be more feasible if combined with active restoration (project #3).	Protect existing river corridor to prevent further incision and allow for passive floodplain restoration	Feasible, river corridor undeveloped, overall low watershed priority due to cohesive soils which would inhibit channel evolution	Possible wildlife habitat improvement, increase sediment and nutrient retention	Easement transaction costs	Potential Ag land to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC
69 (20)	M08B - Fair - Very High	Corridor Protection	Highly incised reach (ratio of 1.8). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland. Project would be more feasible if combined with active restoration (project #4).	Protect existing river corridor to prevent further incision and allow for passive floodplain restoration, could be combined with corridor protection for Segment A (project #40)	Feasible, river corridor undeveloped, overall low watershed priority due to cohesive soils which would inhibit channel evolution	Possible wildlife habitat improvement, increase sediment and nutrient retention	Easement transaction costs	Potential Ag land to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC
70 (30, 31)	M4T2.04B - Fair - Very High	Corridor Protection	Highly incised reach (ratio of 1.7). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland and hay fields. Project would be more feasible if combined with active restoration (project #5).	Protect existing river corridor to prevent further incision and allow for passive floodplain restoration	Feasible, river corridor undeveloped, overall low watershed priority due to cohesive soils which would inhibit channel evolution	Possible wildlife habitat improvement, increase sediment and nutrient retention	Easement transaction costs	Potential Ag land to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC

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Project # (Figure #)	Reach/Segment Condition-Sensitivity	Project Type	Site Description including Stressors and Constraints	Project or Strategy Description	Technical Feasibility & Priority	Other Social Benefits	Cost	Land Uses Conversion & Landowner Commitment	Potential Partner Commitments
71 (31)	M4T2.04D - Fair - Very High	Corridor Protection	Highly incised reach (ratio of 3.6). Increased flows and load due to extensive ag activities. Reach currently undeveloped cropland. Project would be more feasible if combined with active restoration (project #6).	Protect existing river corridor to prevent further incision and allow for passive floodplain restoration	Feasible, river corridor undeveloped, overall low watershed priority due to cohesive soils which would inhibit channel evolution	Possible wildlife habitat improvement, increase sediment and nutrient retention	Easement transaction costs	Potential Ag land to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC
72 (26)	M4S1.01B - Fair - Very High	Corridor Protection	Highly incised reach (ratio of 1.9). Increased flows and load due to ag activities. Reach currently undeveloped hay fields. Project would be more feasible if combined with active restoration (project #25).	Protect existing river corridor to prevent further incision and allow for passive floodplain restoration, could be combined with corridor protection for Segment A (project #26)	Feasible, river corridor undeveloped, overall low watershed priority due to cohesive soils which would inhibit channel evolution	Possible wildlife habitat improvement, increase sediment and nutrient retention	Easement transaction costs	Potential Ag land to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC
73 (31)	M4T2.04C - Fair - High	Corridor Protection	Highly incised reach (ratio of 2.3). Increased flows and load due to ag activities. Reach currently undeveloped forest. Due to cohesive soils and forested buffer active resotration not really feasible here.	Protect existing river corridor to prevent further incision and allow for passive floodplain restoration	Feasible, river corridor undeveloped, overall low watershed priority due to cohesive soils which would inhibit channel evolution	Possible wildlife habitat improvement, increase sediment and nutrient retention	Easement transaction costs	Potential Ag land to floodplain	VT RMP, NRCS, F&W, MRBA, NRPC

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