HUNTINGTON RIVER
CORRIDOR PLAN UPDATE:
REACHES M1-M18; T16, T22 &T26

Prepared by: **September 14, 2009**

Dori Barton, Principal/ Ecologist and
Aaron Worthley, Staff Scientist/GIS Specialist

Prepared for:
Vermont Agency of Natural Resources/
Department of Environmental Conservation
River Management Program

ARROWWOOD ENVIRONMENTAL
950 BERT WHITE ROAD
HUNTINGTON, VT 05462
(802) 434-7276 FAX: (802) 434-2102

TABLE OF CONTENTS

List of Tables

List of Figures

List of Maps

EXECUTIVE SUMMARY

The Huntington River is noted for its natural beauty, fisheries and wildlife habitat, natural resources, ecologic integrity, and recreational values. In the winter of 2006 the Huntington Conservation Commission as part of a project funded by the Vermont Department of Environmental Conservation River Corridor Grant Program, initiated development of a community-based river corridor management plan for the upper Huntington River (including the portion of the river that flows through the town of Huntington). The Corridor Plan was completed in February 2008. An additional 13 reaches were assessed by Arrowwood Environmental between 2007 and 2008. It is these thirteen reaches that are now being incorporated into the February 2008 Corridor Plan.

The Huntington River watershed study area is characterized by a combination of agricultural, forest and residential landuses. There is a significant agricultural presence within the river valley of the Huntington River with increasing residential development in the surrounding woodlands.

Many land uses are incompatible with the meandering and ever-changing nature of rivers and streams. Rivers and streams are often straightened, armored, dredged, bermed, or encroached upon to protect property investments or to make floodplain available for other land uses. Channel straightening and bank armoring remove or alter natural meanders, while undersized bridges and culverts act as channel constrictions, forcing the stream to flow faster through a narrow area. These channel alterations directly affect the stream by increasing its slope and power, resulting in areas of bed and bank erosion.

Streams naturally exhibit erosion and deposition processes. When systems are not in equilibrium, the degree and rate of erosion may overwhelm the streams natural ability to transport sediment and natural depositional processes. Sedimentation and associated degradation of aquatic habitat are concerns in the Huntington River and its tributaries. At the watershed scale, erosive materials present in upper sideslopes of steep valley walls, alluvial soils on exposed streambanks, and bed materials contribute to a high sediment-load system. Geomorphic instability related to the downcutting (and loss of floodplain access) of many of the study reaches have resulted in adjustment processes that are manifested largely in redistribution of the sediment loads as the river tries to regain equilibrium and establish a new floodplain.

Watershed and reach scale stressors were evaluated for each study 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. 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.

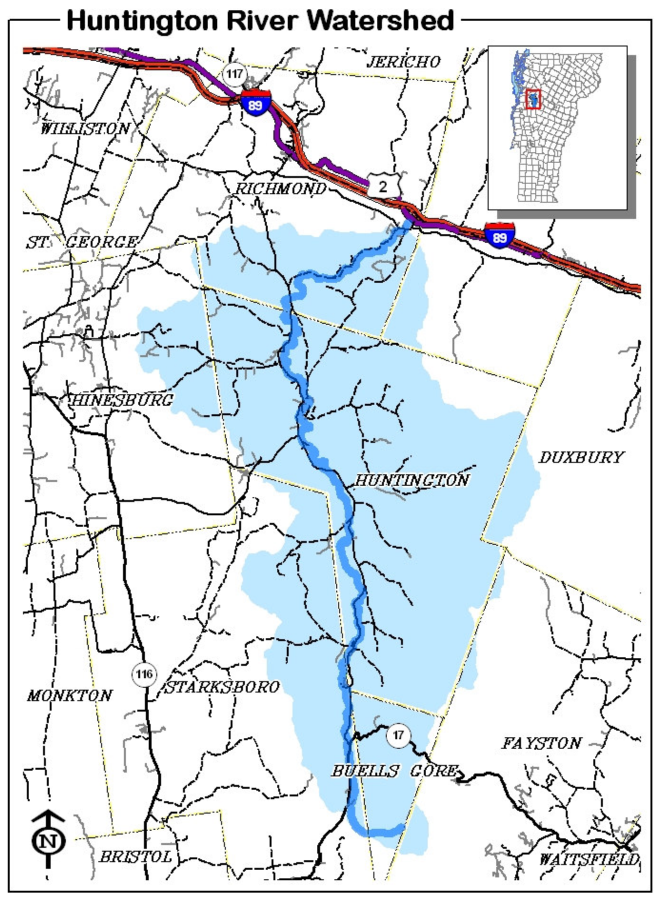
The findings of the Huntington River Corridor Plan are summarized as follows:

- Historically, the Huntington River watershed acted as a sediment and nutrient attenuation zone, with incoming fine sediments from upstream stored on the floodplain, and inputs of coarse sediment essentially in balance and equal to outputs of coarse sediment.
- The watershed 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, due to the historic and ongoing adjustment processes and stressors documented in the watershed.
- The highest priority projects developed 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 and corridor enhancement to filter out excess nutrients, help stabilize streambanks, restore wetlands, 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.

This Corridor Plan encourages coordination of landowner and municipal efforts to approach restoration with an eye to watershed scale dynamics. The Huntington Conservation Commission can play a critical role in coordinating restoration efforts, and this Plan aims to facilitate such coordination in a way that can help landowners understand the part their properties play within the context of the entire watershed.

1.0 PROJECT OVERVIEW

A Phase 1 stream geomorphic assessment was completed for the Huntington River watershed in the summer of 2005 by Arrowwood Environmental (AE). The Phase 1 report identified priority reaches for the Phase 2 assessment. The initial fieldwork for the Phase 2 assessment was conducted by Dori Barton of AE and Kari Dolan of the National Wildlife Federation (NWF) in 2005. In 2007 the Huntington Conservation Commission, initiated development of a community-based river corridor management plan for the main branch of the Huntington River within the Huntington town boundaries. The Corridor Plan was completed in February 2008.



Map 1. Watershed Map

An additional 13 reaches were assessed by Arrowwood Environmental between 2007 and 2008. It is these thirteen reaches that are now being incorporated into the February 2008 Corridor Plan.

2.0 INTRODUCTION

The Huntington River is a tributary of the Winooski River. Watershed origins include the towns of Huntington, Hinesburg, Starksboro, Fayston, Duxbury, Bolton, Richmond and Buels Gore, as such reaching three counties within the State of Vermont - Chittenden, Addison and Washington.

The main branch of the Huntington River is approximately 18 miles long, from its headwaters in Buels Gore to its mouth at the Winooski River in the village of Jonesville (Richmond), Vermont.

Approximately 10 miles of the river are located within the town of Huntington with another 5 miles within the town of Richmond. The Huntington River is designated by the State of Vermont as Class B water. According to the Vermont Water Quality Standards (effective July 10, 2000) Class B waters should be suitable for, among other uses; aquatic habitat, boating, swimming and public water supply with filtration and disinfection.

The Huntington River is recognized by the Huntington Town Plan (adopted January 2007) as the most notable surface water feature in the town and is considered by the Huntington Conservation Commission (HCC) to be of critical importance to the residents and the natural resources of the town of Huntington. Further demonstrating the Town's commitment to the protection of the River, a 100' setback to the river was established in the Town's 2009 Zoning Regulations. The river is the centerpiece for town settlement and transportation. It provides fishing, swimming, boating and scenic beauty to the residents of Huntington and Richmond and critical habitat to the wildlife of the town and greater region. The Huntington River is host to at least eight swimming holes within the town of Huntington alone, frequented by the public during the summer months.

The Town of Richmond recognizes the Huntington River in its 2007 Town Plan as a special resource worthy of efforts for protection of its health and stability. The Huntington River flows through and drains the south-eastern corner of Richmond and is home to one of the most famous swimming holes in all of Vermont, the Huntington Gorge. Each summer the Gorge and surrounding swimming holes host countless swimmers from throughout Northern Vermont. The Huntington River in Richmond is also home to several other swimming holes heavily used by local residents.

Since 2002, the Huntington Conservation Commission has coordinated regular water quality testing at approximately 20 sites along the Huntington River in Huntington, with funding from the Vermont Agency of Natural Resources. The tests have shown high levels of *E. coli* that often exceed the State's stringent limit for swimming of 77 organisms/100 ml, and the US

Environmental Protection Agency's (EPA's) less stringent limit of 235 organisms/100 ml (lab tests based on the Most Probable Number method). Due to these water quality issues, the State of Vermont included portions of the Huntington River on the 2006 Impaired Waters Listing.

In winter of 2005, Richmond and Huntington began a collaborative public outreach effort to educate residents in the Huntington River Watershed of potential threats to the watershed and positive steps they could take to address these threats. To better understand and monitor the condition of the Huntington River, the Richmond Conservation Commission began coordinating regular water quality testing along the Richmond portion of the river in the summer of 2006.

The towns of Huntington and Richmond, through their Conservation Commissions and Planning Commissions are committed to protecting, enhancing and improving the health of the Huntington River.

The following excerpt is from the Huntington Town Plan (2007), website (http://www.huntingtonvt.org/), and serves to summarize the goals the town has for the River and its watershed and also to identify strategies to accomplish those goals.

Huntington Town Plan Project Goals

1. Restore water quality so that the Huntington River maintains a Class B status of rivers and streams. Improve the quality of shallow ground waters where it has been degraded.

2. Improve the in-stream habitats of Huntington's surface waters to benefit fisheries and river dynamics.

The following excerpt is from the Richmond Town Plan (2007), website (http://www.richmondvt.com/), and serves to summarize the general goals the town has for its natural resources, including the Huntington River.

Richmond Town Plan General Goals

"The Town's natural resources, in particular its two major rivers, forests and open landscape, help to make Richmond special. Efforts shall be made to protect the health and stability of the natural environment." (page 32)

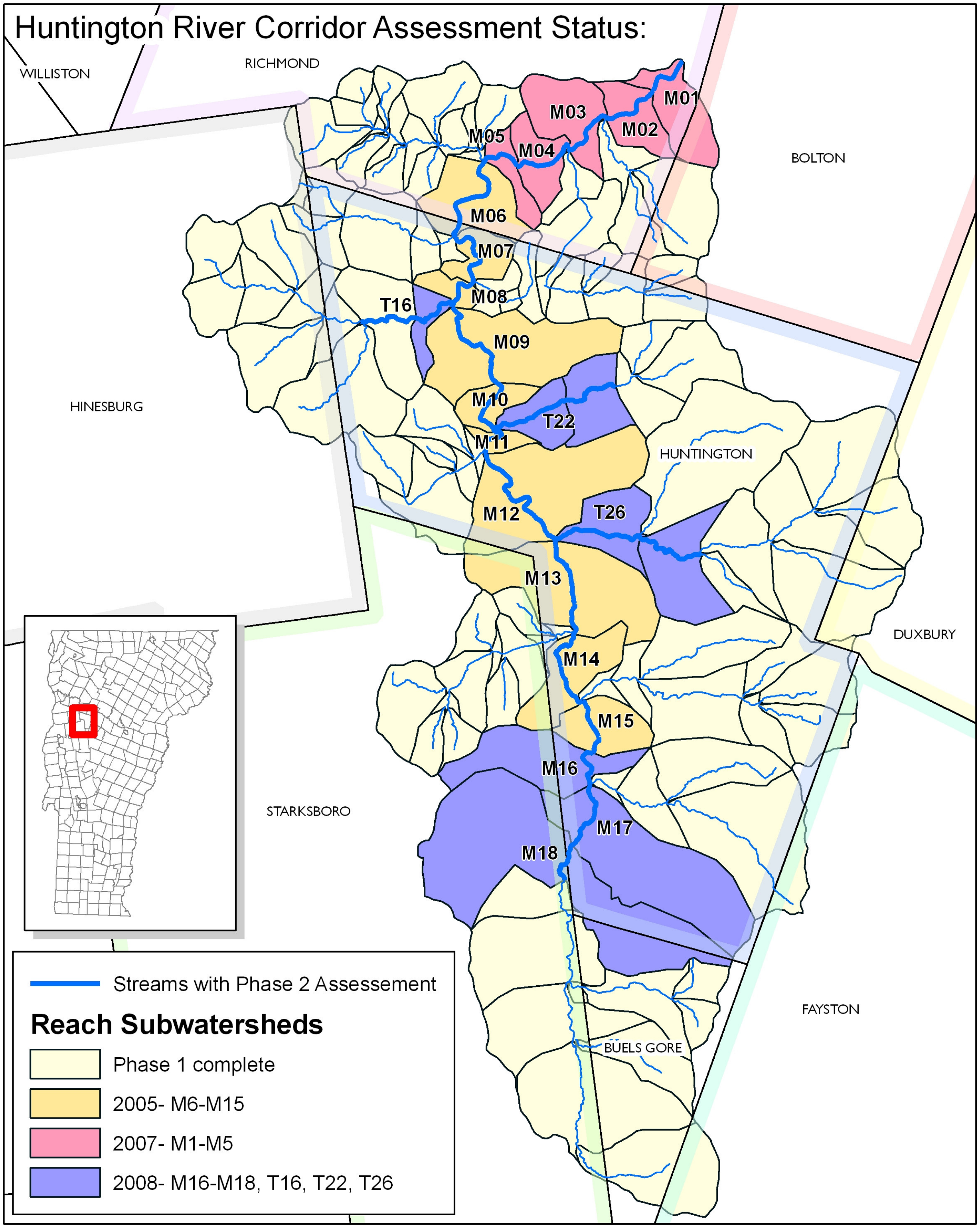
3.0 BACKGROUND INFORMATION

3.1 GEOGRAPHIC SETTING

3.1.1 Watershed description

The Huntington River has a watershed size of 66 square miles. The main stem of the Huntington River flows northerly for approximately 21 miles, from its headwaters in Camels Hump State Forest in Buels Gore and Starksboro, to its confluence with the Winooski River in Jonesville. The watershed drains land found in the town boundaries of Buels Gore, Duxbury, Fayston, Starksboro, Huntington, Richmond, Bolton and Hinesburg.

The initial Phase 2 geomorphic assessment study focused on stream reaches on the main stem of the Huntington River within the Town of Huntington, from the Richmond/Huntington town line downstream to Hanksville upstream (Reaches M06 through M15). The second round of Phase 2 assessments focused on the main stem reaches in the Town of Richmond (M01-M05) and the southern end of the Town of Huntington (M16 through M18). In addition, the beginning reaches of three major tributaries in the town of Huntington (Texas Hill Brook, Fargo, and Brushy Brooks) were assessed. This second round of assessed reaches is incorporated into this Corridor Plan Update.



Map 2. Reach Location Map

3.1.2 Land use history and current general characteristics

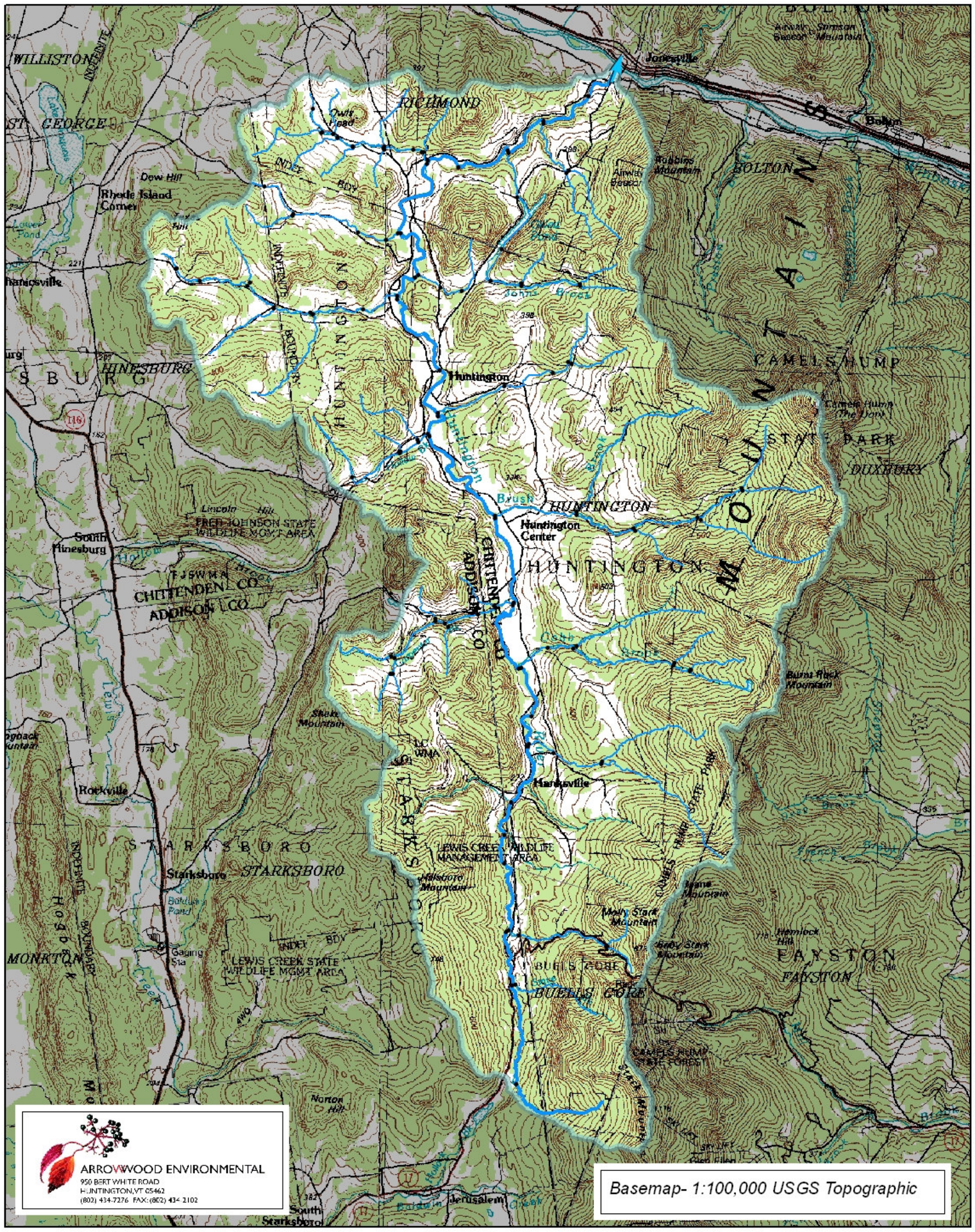
The Huntington River watershed is predominately a rural area. The dominant watershed land cover/land use within the subwatersheds of the focus reaches is forest. There is a large agricultural and residential component within the study area as well, with 10 of the 23 reaches having a subdominant landuse of crop/agriculture and 11 of the 23 reaches having a subdominant landuse of urban. The remaining 2 reaches have a subdominant landuse of field.

Exposed or cultivated soils account for 0%-15% of the landcover in the study reaches (NOAA Landsat Landcover, 2001). Development within the 23 study reaches ranges from 3% to 41% (Statewide E911 buildings and road centerline GIS data buffered by 150' and 50', respectively).

3.2 GEOLOGIC SETTING

The Huntington River is located within the Northern Green Mountains biophysical region. The Northern Green Mountains of today are primarily metamorphic rocks, mainly schist's, phyllites, gneisses, and quartzite's. Over the millions of years since their formation, the Green Mountains have eroded to only a fraction of their original height. In more recent geologic time, glaciers advanced from northwest to southeast over the Green Mountains. Much of the biophysical region is covered with glacial till. Glacial Lake Vermont extended up the Winooski River Valley. into the Huntington River Valley in the Town of Huntington. There are extensive areas of glacial lake sediments, primarily sand, in this valley as a result. Kame deposits are also common in the higher valleys of the region. (Thompson and Sorenson, 2000)

Basin characteristics for the Huntington River corridor, however, include hilly (at the mouth of the River) to extremely steep valley walls on both sides for all reaches included in the Project area. With glacial outwash deposits forming parent materials, stream processes over time have created alluvial deposits that comprise the bulk of the valley bottom and floodplains. While the soil formations in the lowest elevations are generally considered of low erosive potential due to gentle slopes, the materials are highly erodible and can be a significant source of sediment from unstable stream banks. The dominant surficial geology of the Huntington River consists of alluvium, glacial till, and ice contact deposits. Table 1 provides a summary of the corridor soil properties and valley side slopes at a reach scale for the target reaches.



Map 3. Huntington River USGS Topographic Map

Table 1. Huntington River Geology and Soils Summary

Reach **ID**	Geologic materials			Valley side slopes		Soil Properties		
	Dominant	% Dom	Sub-Dominant	Left	Right	Hydrologic Group	%	Erodibility
M1	Ice-Contact	52.6	Alluvial	Hilly	Hilly	B	55	Slight
M2	Ice-Contact	50.9	Till	Extremely Steep	Extremely Steep	A	51	Very Severe
M3	Till	51.2	Glacial Lake	Extremely Steep	Extremely Steep	C	32	Very Severe
M4	Till	51.2	Ice-Contact	Extremely Steep	Extremely Steep	C	51	Severe
M5	Alluvial	51.6	Other	Extremely Steep	Extremely Steep	B	59	Slight
M6	Alluvial	66.2	Ice-Contact	Extremely Steep	Extremely Steep	B	79	Slight
M7	Ice-Contact	45.4	Alluvial	Extremely Steep	Extremely Steep	B	49	Moderate
M8	Alluvial	57.7	Till	Extremely Steep	Extremely Steep	B	58	Moderate
M9	Alluvial	73.8	Ice-Contact	Extremely Steep	Extremely Steep	B	81	Slight
M10	Alluvial	47.1	Ice-Contact	Steep	Extremely Steep	B	80	Slight
M11	Alluvial	69.5	Other	Extremely Steep	Very Steep	B	64	Slight
M12	Alluvial	80.2	Till	Extremely Steep	Extremely Steep	B	82	Slight
M13	Alluvial	77.2	Ice-Contact	Extremely Steep	Extremely Steep	B	81	Slight
M14	Alluvial	68.8	Till	Extremely Steep	Steep	B	64	Slight
M15	Alluvial	60.3	Till	Extremely Steep	Extremely Steep	B	64	Moderate
M16	Alluvial	48	Ice-Contact	Extremely Steep	Extremely Steep	B	53	Moderate
M17	Ice-Contact	89.7	Till	Extremely Steep	Extremely Steep	A	83	Moderate
M18	Ice-Contact	50.4	Glacial Lake	Extremely Steep	Extremely Steep	A	50	Severe
T16.01	Other	29.2	Alluvial	Extremely Steep	Extremely Steep	Not rated	29	Moderate
T22.01	Till	84.3	Alluvial	Extremely Steep	Extremely Steep	C	94	Very Severe
T22.02	Till	92	Ice-Contact	Extremely Steep	Extremely Steep	C	55	Severe
T26.01	Alluvial	65.9	Ice-Contact	Extremely Steep	Extremely Steep	B	72	Slight
T26.02	Till	67.6	Ice-Contact	Extremely Steep	Extremely Steep	C	68	Severe

3.3 GEOMORPHIC SETTING

For the purpose of geomorphic assessment and corridor planning, the Huntington River has been divided into 'reaches'. A reach is a section of stream with similar characteristics; this determination is primarily based on physical characteristics such as slope, sinuosity, dominant bed material, bed form, and valley confinement. The Phase 2 studies (2005-2008), as well as this Corridor Plan Update, focus on twenty-three stream reaches on the main stem of the Huntington River within the Towns of Richmond and Huntington, from the mouth of the Huntington River upstream to the Richmond/Huntington town line (M01-M05), from the Richmond/Huntington town line to Hanksville upstream (Reaches M06 through M15), and from Hanksville to the Starksboro townline (M16-M18), and the first reaches of Texas Hill (T16.01), Brushy (T26.01-T26.02) and Fargo Brooks (T22.01-T22.02) in the town of Huntington. The combined length of the stream reaches assessed is approximately 52 miles. See Map 2, page 12 for reach locations.

The relationship of the stream channel to its valley setting is variable throughout the Project area, making this section of river relatively non-homogenous. The Phase 1 assessment conducted for the Huntington River concluded that the 'reference type' for the 23 study reaches included five B type, step pool systems, one B type, plane bed system, one B type, riffle-pool, two C type step-pool, and fourteen C type, riffle-pool systems (Rosgen, 1994).

The B type stream is typically associated with moderately steep channels in confined "V" type valleys, usually in forested systems. These stream types are moderately entrenched with moderate width to depth ratios and sinuosity.

The C type system is typically found in unconfined, alluvial valleys, noted for its meandering nature, and uses floodplains to reduce energy during flood events. C type channels are lower gradient streams that are slightly entrenched and have high width to depth ratios.

Table 2 briefly summarizes the Phase 1 assessment of the study reaches. Further detailed descriptions of the reaches, with associated Phase 1 and 2 observations, are found in Section 6 of this report along with maps depicting Phase 2 segment delineations in the attachment.

Table 2. Huntington River Phase 1 reference reach summary statistics

Reach ID	Drainage Area (sq mi)	Valley width (ft)	Valley Type	Channel width (ft)	Channel Slope (%)	Sinuosity	Reference Stream Type	Channel Bedform	Bed Material
M1	66	500	BD	83	0.78	1.04	C	Riffle-Pool	Cobble
M2	66	115	NW	83	1.24	1.03	B	Plane Bed	Cobble
M3	64	147	NW	81	0.47	1.03	B	Step-Pool	Boulder
M4	60	252	NW	80	1.77	1.03	B	Plane Bed	Cobble
M5	60	1271	BD	79	0.14	1.13	C	Riffle-Pool	Cobble
M6	56	1026	VB	76	0.85	1.25	C	Riffle-Pool	Gravel
M7	54	657	BD	75	0.12	1.49	C	Riffle-Pool	Cobble
M8	53	529	BD	74	0.50	1.22	C	Riffle-Pool	Cobble
M9	47	980	VB	70	0.34	1.16	C	Riffle-Pool	Cobble
M10	45	951	VB	68	0.46	1.32	C	Riffle-Pool	Cobble
M11	42	997	VB	66	0.31	1.53	C	Riffle-Pool	Cobble
M12	40	729	VB	64	0.60	1.16	C	Riffle-Pool	Gravel
M13	29	801	VB	55	0.62	1.13	C	Riffle-Pool	Cobble
M14	24	907	VB	50	0.27	1.54	C	Riffle-Pool	Cobble
M15	19	354	BD	44	1.44	1.11	C	Riffle-Pool	Cobble
M16	18	434	BD	47	0.98	1.26	C	Riffle-Pool	Boulder
M17	14	185	NW	41	2.17	1.04	B	Step-Pool	Boulder
M18	12	209	NW	38	2.61	1.10	B	Plane Bed	Cobble
T16.01	6	519	VB	28	1.42	1.21	C	Riffle-Pool	Cobble
T22.01	3	106	NW	20	3.92	1.07	B	Step-Pool	Boulder
T22.02	2	355	VB	18	3.88	1.09	B	Step-Pool	Cobble
T26.01	9	564	VB	35	2.34	1.20	B	Step-Pool	Boulder
T26.02	6	195	NW	29	3.77	1.19	B	Step-Pool	Boulder

3.4 HYDROLOGY

3.4.1 Huntington River Flood History

Historical records indicate major floods occurred in the Huntington River basin in 1804, 1858, 1927, 1938 and 1976. These floods are on record as doing major damage to bridges, mills or other infrastructure.

Although there was substantial flooding along the Winooski River both up and downstream from the mouth of the Huntington with devastating damage done to roads, bridges and homes, there is not a great deal on record concerning flooding of the Huntington River in 1927.

The UVM Landscape Change Program includes a photograph of the Huntington River following the 1927 flood in which it appears that the river avulsed significantly near a bridge, but left the bridge standing (Figure 1).

Figure 1. 1927, avulsed river after flood, UVM Landscape Change Program

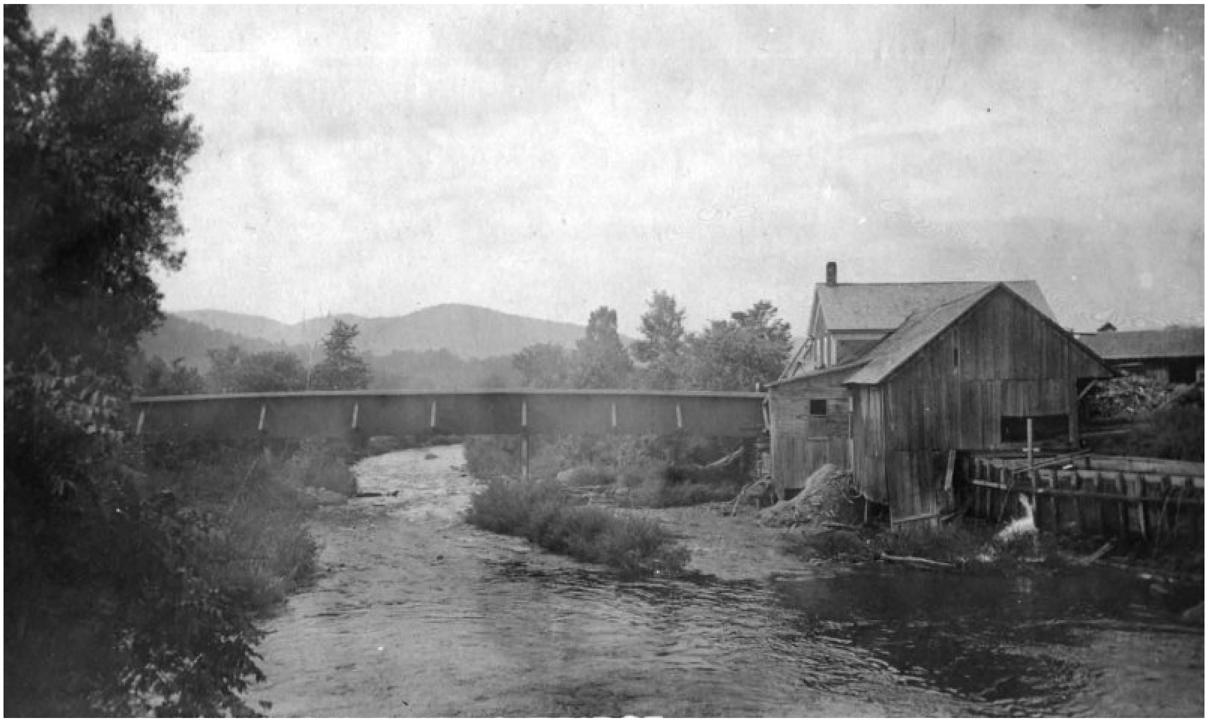


Figure 2. 1907-1913, mill on current Bridge St, UVM Landscape Change Program

There is substantial historical reference to “freshets” having occurred on a regular basis, frequently causing some level of damage within the town of Huntington. Presumably, a result of extensive hillside deforestation, the Huntington River was subject to regular flooding or high water events, especially during the 1800s. Loss of working mills was a regular occurrence, and mills were plentiful on the Huntington River during the 1800s to early 1900s (Figure 2 above). A map of historical use of the Huntington River compiled by the Huntington Historical Society (Figure 3) notes no fewer than 20 mill, factory and creamery locations on the banks of the Huntington River between 1800 and 1953. Many of the structures at these locations appear to have been rebuilt numerous times after being destroyed by flooding. The mill shown near the bridge in Figure 2 was apparently rebuilt no fewer than 5 times between 1832 and 1892.

In August of 1976, Hurricane Belle blew through New England dropping as much as 6 inches of rain on parts of Vermont with 4 to 5 inches in the mountains of the Huntington River watershed. (Paul Kocin,1976). The Hurricane resulted in 5 deaths nationwide, two of which were in Huntington when a mother and child drowned following the collapse of a footbridge they were using to cross Fargo Brook (Tributary T22). (Miles B. Lawrence, 1977, and Worthley, 2008.)

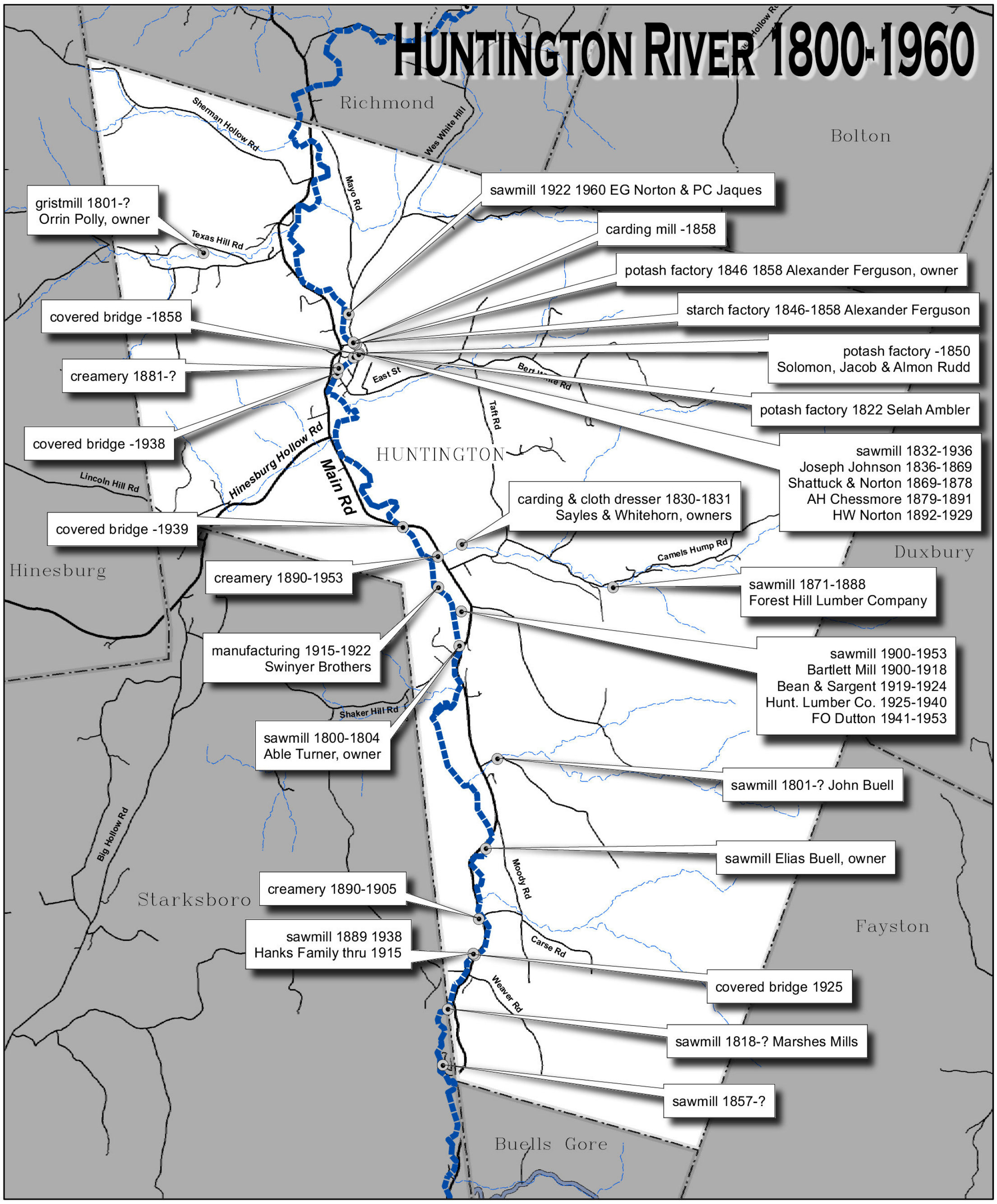


Figure 3. Mills and Bridges on the River

The town of Huntington lost several bridges during the river surge that accompanied Hurricane Belle, and travel was curtailed throughout the area until temporary bridges could be erected.

The bed of the river was significantly altered both by the flooding and subsequently by the channelization efforts by the State of Vermont. Residents recall large bulldozers working their way down the river straightening, berming and relocating the channel.

No major floods have occurred since the 1976 event, however annual high water fluctuates, and does on occasion rise high enough to cause minor damage or close roads.

3.5 ECOLOGICAL SETTING

The Huntington River, as a free-flowing river hosts a native resident fish community that includes such species as brook trout, Slimy sculpin and Blacknose dace along with naturalized Rainbow and Brown trout. In addition the river is currently used as an Atlantic salmon nursery for the Winooski River/Lake Champlain Salmon restoration efforts by the US Fish and Wildlife Service and Vermont Dept. of Fish and Wildlife.

The Vermont Department of Fish and Wildlife annually stocks the Huntington River with Brook trout to support recreational sport fishing. Currently, and apparently for some time, the Huntington River has been relatively poor for Brook trout reproduction, although the headwater tributaries may support self sustaining populations. (Worthley, 2008 and Behney, 1936) Although the State has not stocked Rainbow or Brown trout in the River for several years, there apparently is some reproduction of these species, especially in the case of Brown trout as anecdotal evidence includes occasional takings by anglers.

The VT ANR DEC Biomonitoring section conducted fish inventories in the Huntington River in September 2000 and June and September 2008. Table 3 shows the fish collected at a site just downstream from the "Audubon Bridge" along Main Road near the Richmond town line (M07).

Table 3: Fish Species Collection Data

Sample Date	**9/00**		**6/24/08**		**9/8/08**	
Species Collected	**#**	**%**	**#**	**%**	**#**	**%**
Atlantic Salmon	209	24.3				
Blacknose Dace	263	30.5	13	10.3	10	7.5
Brook Trout	1	0.1	44	34.9	12	9
Brown Trout	3	0.3	1	0.8		
Common Shiner	130	15.1				
Creek Chub	50	5.8				
Long nose Dace	141	16.4				
Pumpkinseed	1	0.1				
Slimy Sculpin	12	1.4	68	54	112	83.6
Tessellated Darter	22	2.6				
White Sucker	29	3.4				

The Atlantic salmon number indicates the importance of the river for Atlantic salmon restoration in the Winooski River Basin's Anadromous Fish Restoration Program. The US Fish and Wildlife Service coordinates the Winooski River/Lake Champlain Salmon restoration program. According to Nick Staats, USFW fisheries biologist, the very characteristics that make the Huntington River poor Brook trout habitat (i.e. warm water, uniform bed sediment, etc.) make the river an exceptional Salmon nursery (personal communication). Numerous fingerlings are released into the Huntington River each year, and fish leaving the watershed are trapped near the mouth, documented for further study and released.

Wetland habitats are sparsely distributed in the watershed largely due to the geological setting (contributing primarily well and moderately drained settings), and are not well documented. Most of the wetlands that were likely to have existed prior to settlement were most likely beaver and flood plain influenced wetlands in the mainstem river valley. Most of these wetlands have long been lost to agricultural activity, ditching, tiling and filling.

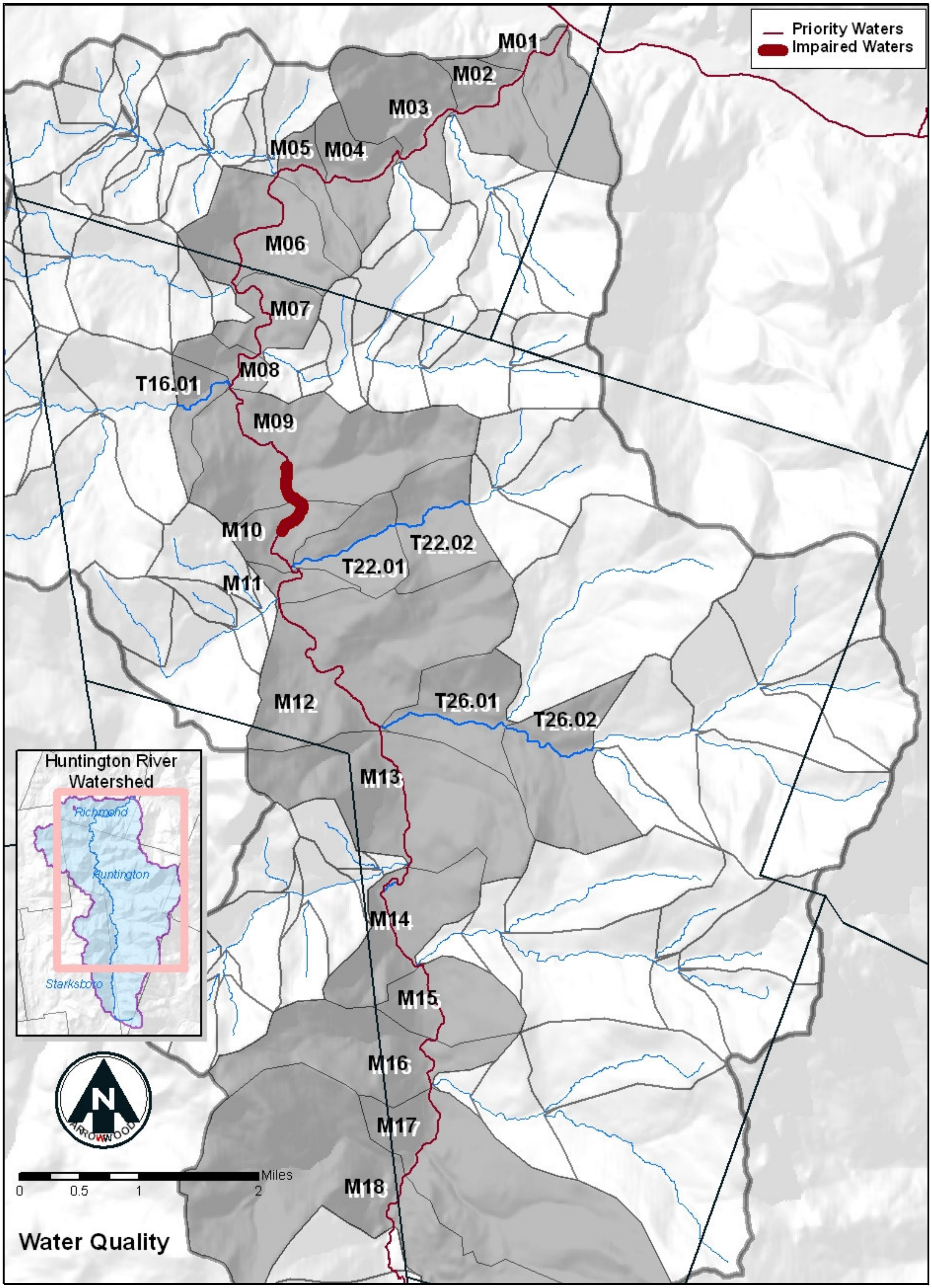
Riparian habitat has been heavily influenced by human habitation in the last two hundred years, with intensive agriculture and development largely occupying what would likely be floodplain forest habitats. Some remnants of these communities exist as small patches of riparian buffer strip that suggest floodplain communities such as the Sugar-maple ostrich fern floodplain forest and silver maple floodplain forest. Riparian habitat is a rare commodity near development centers or flat farmland along the Huntington River, but does still exist in those spots too steep or otherwise inaccessible for development and modern farming. Some riverside hillsides that were cleared during the mid 1800s have reverted to middle aged forest and now provide quality riparian habitat and boundary resistance.

3.4 WATER QUALITY

The Huntington River is defined as a Class 2 waterway by the State of Vermont. Class 2 waters should meet standards conducive to recreational use including swimming, boating and fishing, and be drinkable with treatment. In 2006, the State of Vermont listed a portion of the Huntington River (M07-M10) as impaired due to high levels of e.coli bacteria.

Since 2002, the Huntington Conservation Commission has coordinated regular water quality testing at approximately 20 sites along the Huntington River in Huntington, with funding from the Vermont Agency of Natural Resources. The tests have shown high levels of *E. coli* that often exceed the State's stringent limit for swimming of 77 organisms/100 ml, and the US Environmental Protection Agency's (EPA's) less stringent limit of 235 organisms/100 ml (lab tests based on the Most Probable Number method). Due to these water quality issues, the State of Vermont included portions of the Huntington River on the 2006 Impaired Waters Listing. See Map 4 for location of Impaired Waters and priority waters as provided by the State of Vermont.

In winter of 2005, Richmond and Huntington began a collaborative public outreach effort to educate residents in the Huntington River Watershed of potential threats to the watershed and positive steps they could take to address these threats. To better understand and monitor the condition of the Huntington River, the Richmond Conservation Commission began coordinating regular water quality testing along the Richmond portion of the river in the summer of 2006.



Map 4. Water Quality Listing Map

4.0 METHODS

4.1 STREAM GEOMORPHIC ASSESSMENT

In an effort to provide a sound basis for decision-making and project prioritization and implementation, the Vermont Agency of Natural Resources (VTANR) has developed protocols for conducting geomorphic assessments of rivers. The results of these assessments provide the scientific background to inform planning in a manner that incorporates an overall view of watershed dynamics as well as the reach-scale dynamics that have been a primary focal point of project planning in the past. Incorporating upstream and downstream dynamics in the planning process can help increase the effectiveness of implemented projects by addressing the sources of river instability that are largely responsible for erosion conflicts, increased sediment and nutrient loading, and reduced river habitat quality (VTANR, 2007). Trainings have been held to provide consultants, regional planning commissions, and watershed groups with the knowledge and tools necessary to make accurate and consistent assessments of Vermont's rivers.

The stream geomorphic assessments are divided into three phases. A Phase 1 assessment is a preliminary analysis of the condition of the stream through remote data sources such as aerial photographs, maps, and 'windshield survey' data collection. Phase 2 involves rapid assessment fieldwork to inform a more detailed analysis of what adjustment processes are taking place and predicting how the river will continue to evolve in the future. Phase 3 involves detailed fieldwork for the identification and implementation of management and restoration projects.

Arrowwood Environmental and the National Wildlife Federation conducted a Phase 1 Stream Geomorphic Assessment (SGA) of the Huntington River watershed in 2005, and a Phase 2 SGA for the main stem of the Huntington River within the town of Huntington in 2005. The reaches incorporated into this update received Phase 2 assessments in 2007 and 2008.

4.2 QUALITY ASSURANCE AND QUALITY CONTROL

Arrowwood Environmental completed the Phase 1 – Quality Assurance Worksheet to document: (a) the tools used to collect the Phase 1 data, (b) the confidence level in the data, (c) the date the assessment was completed, and (d) the date each Phase 1 step was checked by the local and state

QA teams. Arrowwood Environmental then rated the confidence level in the Phase 1 data from moderate to high. A few of the reaches could not be accessed due to poor accessibility or lack of landowner permission. For these reasons, the quality of the data was rated as moderate to high rather than high. In addition, some of the historic instream and floodplain modifications were not known.

The ArcView Shapefiles for the Huntington River Phase 1 study were submitted to Peter Spatz and Shayne Jacquith of the VTANR, River Management Division. SGAT generated data and database entries were made to the Online Geomorphic Assessment Database for a QA review from approximately November 2004 to May 2005. Some revisions to stream type classifications were made by ANR staff during the QA review. The Phase 2 – Quality Assurance Worksheet was completed to document the tools used to collect the Phase 2 data, the confidence level in the data, the date the assessment was completed, and the date each Phase 2 step was checked by the local QA team. The Microsoft Access Phase 2 database and field forms were submitted to the ANR for a QA review in December 2005. ANR Staff subsequently conducted QA changes.

Arrowwood Environmental completed the Phase 2 – Quality Assurance protocols for the thirteen stream reach Phase 2 Assessments conducted for this Corridor Plan Update. The Microsoft Access Phase 2 database and field forms were submitted to the ANR for QA reviews in December 2007 and October 2008. ANR Staff subsequently conducted QA changes.

5.0 RESULTS

The following sections summarize the results of the Phase 1 and 2 SGA data collection for the Huntington River. Stressor, departure, and sensitivity maps are presented as a means to organize the data that has been collected and show the interaction of watershed and reach-scale dynamics. In addition, these maps should assist in identifying practical restoration and protection actions that can move the river towards a healthy equilibrium. Alterations to watershed-scale hydrologic and sediment regimes can greatly influence reach-scale dynamics, and if not considered adequately can undermine protection and restoration efforts at the reach level.

The data, tables, and maps described in Section 5 will be used to identify restoration and conservation techniques on a reach scale basis that meet the goals and objectives of reducing fluvial erosion hazards, increasing sediment and nutrient attenuation sites, and improving aquatic and riparian habitat.

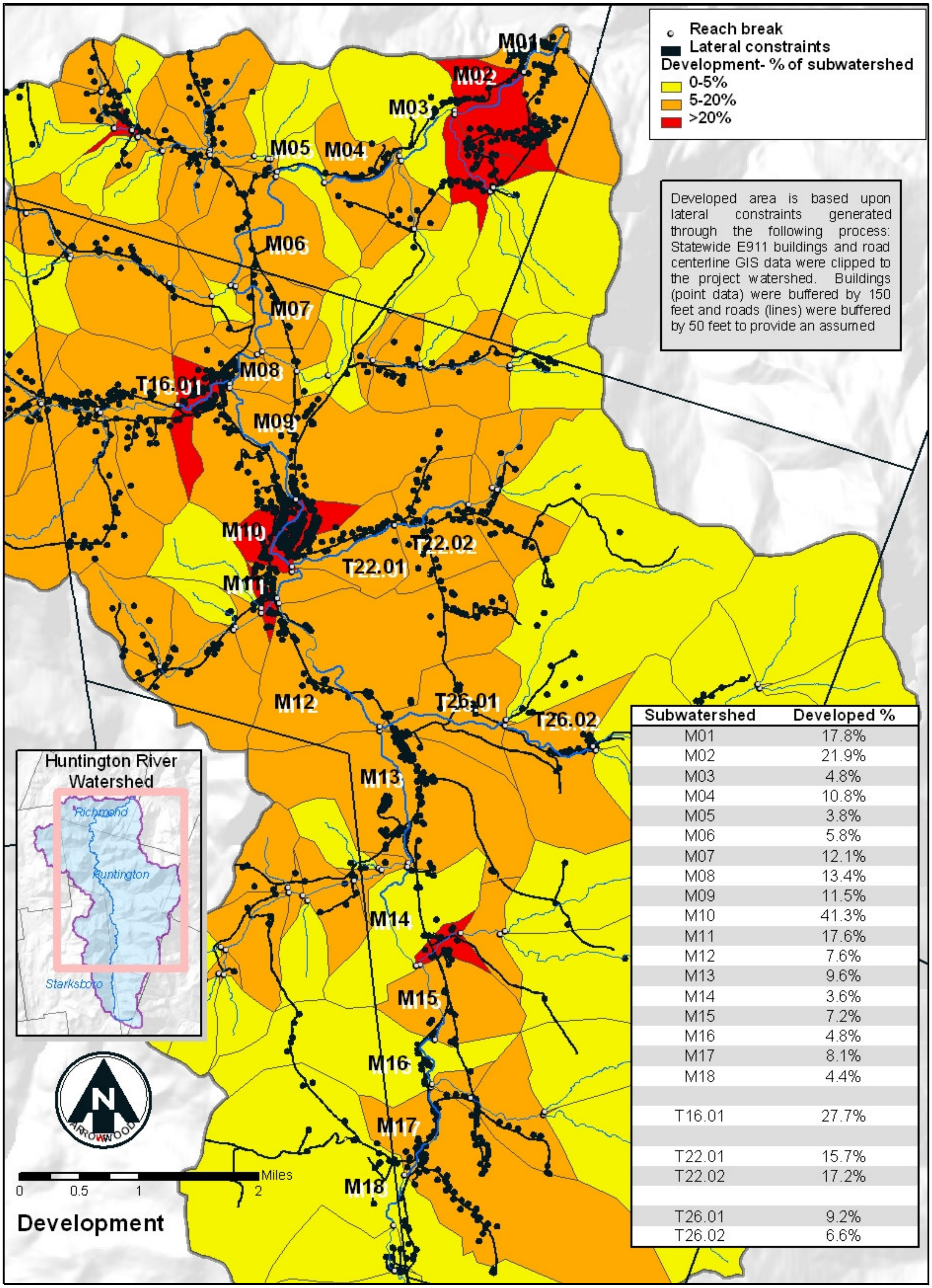
5.1 DEPARTURE ANALYSIS

Section 5.1 summarizes watershed-scale stressors on the physical stability and habitat conditions of the river. Section 5.1 also characterizes reach-scale stressors.

5.1.1 Hydrologic regime stressors

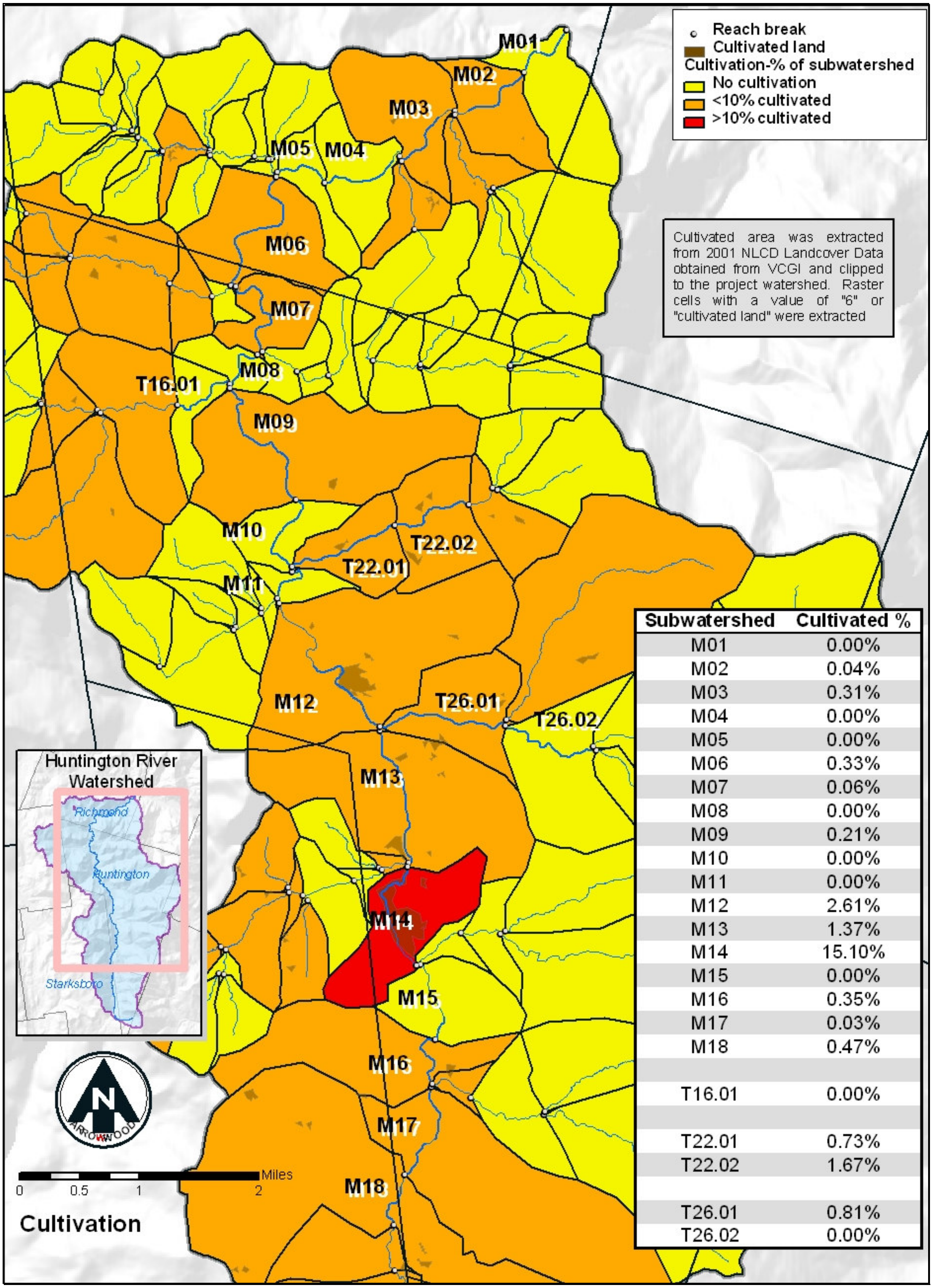
The hydrologic regime involves the timing, volume, and duration of flow events throughout the year and over time; as addressed in this section, the regime is characterized by the input and manipulation of water at the watershed scale. When the hydrologic regime has been significantly changed, stream channels will respond by undergoing a series of channel adjustments. Where hydrologic modifications are persistent, the impacted stream will adjust morphologically (e.g., enlarging when stormwater peaks are consistently higher) and often result in significant changes in sediment loading and channel adjustments in downstream reaches (VTANR, 2007).

Natural land cover types (e.g. forests, wetlands) play important roles in watersheds by storing and filtering run-off, trapping sediment, reducing peak flood levels, and maintaining base flows during summer. Deforestation and urban and agricultural development increase rainwater runoff by decreasing the amount of natural vegetation to naturally filter water and sediment. Additionally, urban lands contain large amounts of impervious surfaces where stormwater will quickly run off into adjacent drainages rather than slowly percolate through the soil, resulting in higher peak flood levels with high nutrient and sediment inputs. These levels can trigger a channel to enlarge and incise due to consistently high stormwater runoff.



Subwatershed	Developed %
M01	17.8%
M02	21.9%
M03	4.8%
M04	10.8%
M05	3.8%
M06	5.8%
M07	12.1%
M08	13.4%
M09	11.5%
M10	41.3%
M11	17.6%
M12	7.6%
M13	9.6%
M14	3.6%
M15	7.2%
M16	4.8%
M17	8.1%
M18	4.4%
T16.01	27.7%
T22.01	15.7%
T22.02	17.2%
T26.01	9.2%
T26.02	6.6%

Map 5. Developed Land within the Huntington River Watershed



Subwatershed	Cultivated %
M01	0.00%
M02	0.04%
M03	0.31%
M04	0.00%
M05	0.00%
M06	0.33%
M07	0.06%
M08	0.00%
M09	0.21%
M10	0.00%
M11	0.00%
M12	2.61%
M13	1.37%
M14	15.10%
M15	0.00%
M16	0.35%
M17	0.03%
M18	0.47%
T16.01	0.00%
T22.01	0.73%
T22.02	1.67%
T26.01	0.81%
T26.02	0.00%

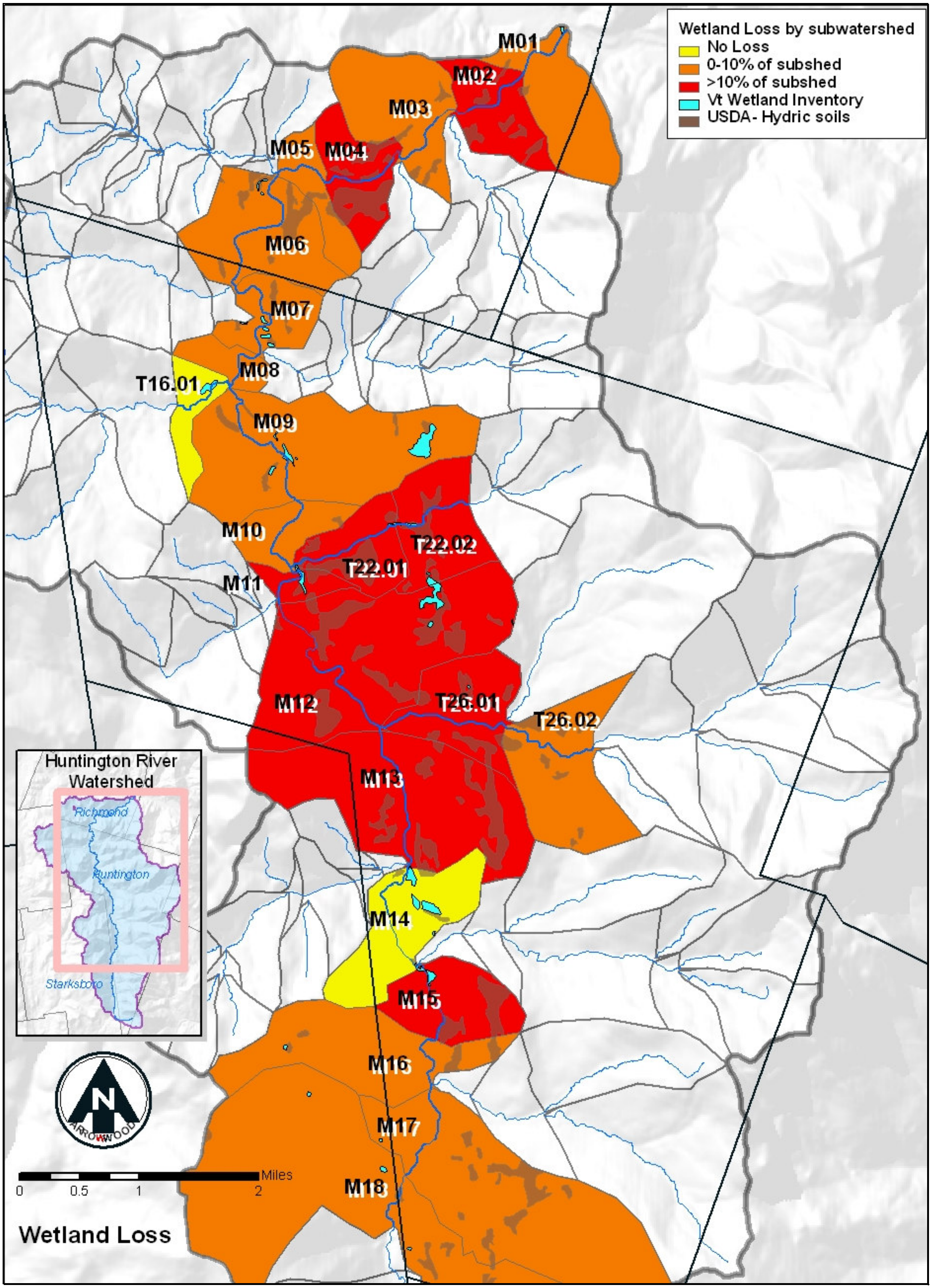
Map 6. Cultivated Land within the Huntington River Watershed

The Huntington River watershed study area is characterized by a combination of agricultural, forest and residential landuses. There is a significant agricultural presence within the river valley of the Huntington River with increasing residential development in the surrounding woodlands.

Land use and land cover within the stream corridor is particularly important with respect to sediment deposition and erosion during annual flood events. Wetlands, ponds, and perennial vegetation moderate stormwater and sediment runoff, while impervious surfaces within urban areas and the exposed soils found in cropland have the potential to increase watershed inputs.

Lakes, wetlands, and perennial vegetation play an important role in a watershed by storing water and trapping sediment, which helps reduce flood peaks and maintain summer base flows in rivers and streams. Urban development and cropland typically increase the peak and change the duration of stormwater and sediment runoff events.

Analysis of hydric soils and existing agricultural and developed land uses indicates significant loss of wetland attenuation of precipitation inputs. Wetlands have been filled, ditched, diverted and otherwise manipulated resulting in a loss of hydrologic function. See Map 7 Wetland Losses within the Huntington River Watershed map below.

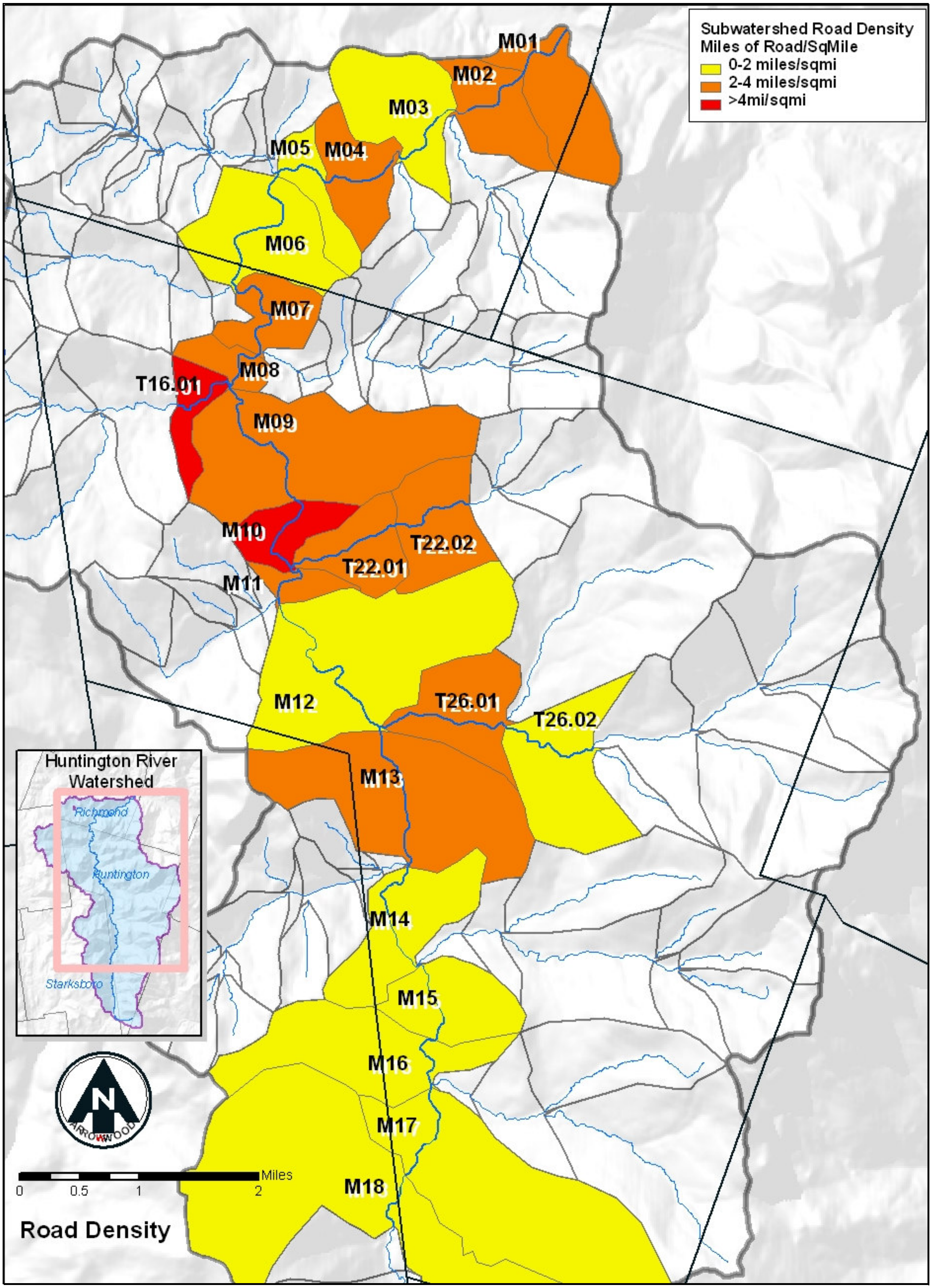


Map 7. Wetland Losses within the Huntington River Watershed

Many of the roads and crop lands have been ditched over time, contributing to intensified inputs to the river, but the primarily historical nature of downcutting in the stream channel observed in the Huntington is likely related to historical deforestation in the watershed. Historical clearing (late 18th and 19th centuries) in the Huntington watershed initially contributed to higher runoff of both water and sediment, which accumulated in the valley. Additionally, removal of large woody debris from stream channels, likely related to use of the stream for log drives and agricultural uses, combined with road developments to change the rainfall-runoff regime in such a way that water inputs intensified through deposited sediments, and the watershed's hydrologic regime became more "flashy". See Map 8 Road Density within the Huntington River Watershed map below.

The downcutting observed throughout the watershed has been sufficient to limit access to the historical floodplain throughout much of the watershed, meaning that high volume flows are now contained within the channels and smaller precipitation events can generate levels of impact previously associated with more extreme precipitation events. Under these conditions, thunderstorms, mid-winter rains, and snow melt events can cause significant hydrologic impacts.

One of the most significant hydrologic stressors for the Huntington River 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. The Huntington River 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).



Map 8. Road Density within the Huntington River Watershed

5.1.2 Sediment regime stressors

Streams naturally exhibit erosion and deposition processes. When systems are not in equilibrium, the degree and rate of erosion may overwhelm the streams natural ability to transport sediment and natural depositional processes. Sedimentation and associated degradation of aquatic habitat are concerns in the Huntington River and its tributaries. At the watershed scale, erosive materials present in upper sideslopes of steep valley walls, alluvial soils on exposed streambanks, and bed materials contribute to a high sediment-load system.

Geomorphic instability related to the downcutting (and loss of floodplain access) of the mainstem Huntington have resulted in adjustment processes that are manifested largely in redistribution of the sediment loads noted above as the river tries to regain equilibrium and establish a new floodplain. Additional stressors in this system can include sheet and gully erosion on exposed soils of tilled croplands in the river corridor in particular, where the extensive ditching system can transport these materials easily in runoff events. On lower elevation sideslopes, multiple occurrences of mass failures increase sediment loads to the river.

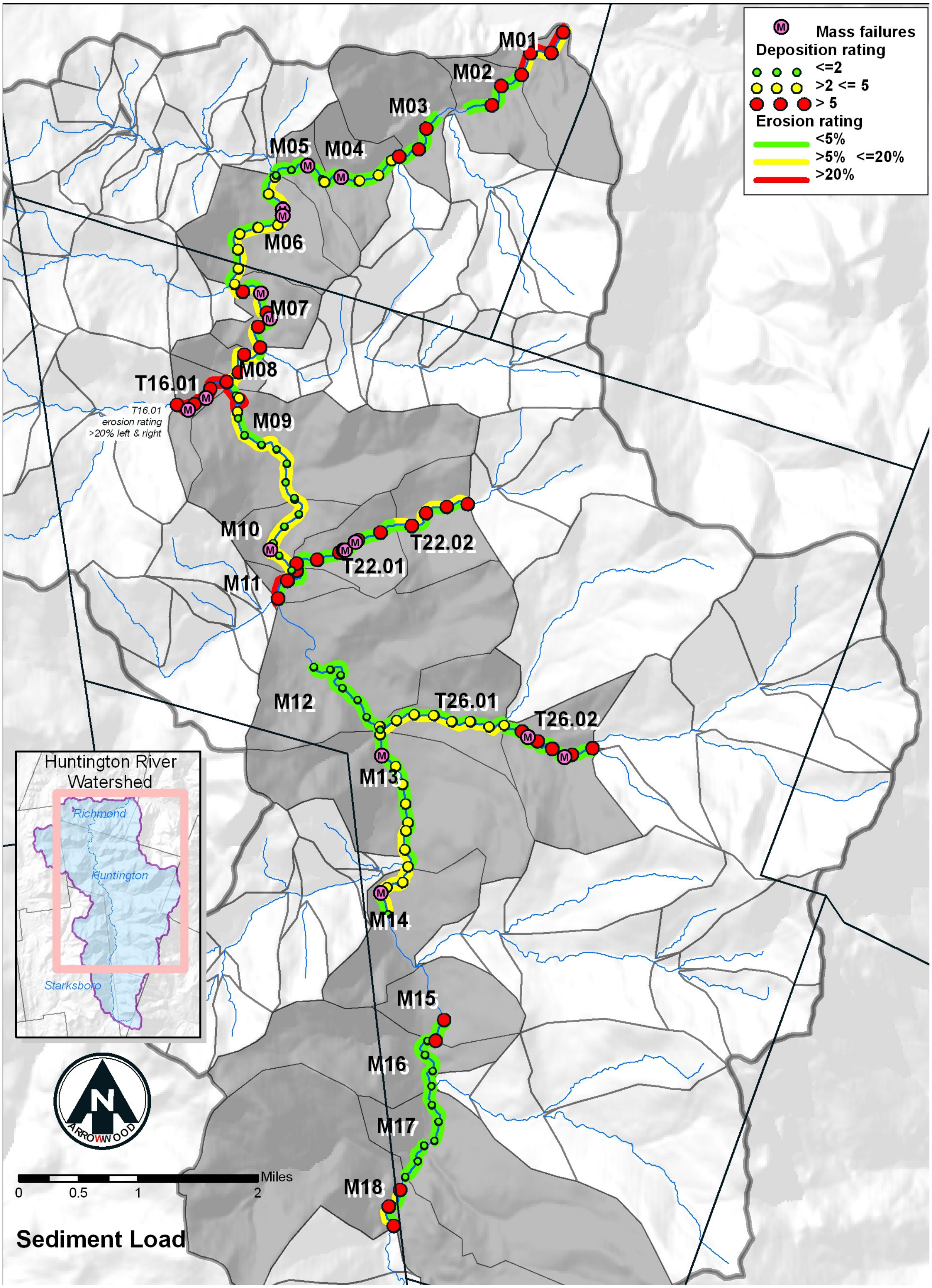
Data collected in Phase 2 can be evaluated to determine whether the transport capacity of the channel has been exceeded, indicating a high sediment load. The stream deposition rating (indicating the number of steep riffles, mid-channel bars, delta bars, flood chutes, avulsions, and braiding present per mile) and the erosion rating (indicating the percentage of the reach/segment length eroding), number of mass wasting or gullies per reach/segment, and presence of rejuvenating tributaries is used to determine which reaches/segments are experiencing increased sediment loads.

5.1.3 Reach scale sediment regime stressors

Watershed scale stressors provide a backdrop for understanding the timing and degree to which reach-scale modifications are contributing to field observed channel adjustments (VTANR 2007). Modifications to the valley, floodplain, and channel, as well as boundary (bank and bed) conditions, at the reach scale can change the hydraulic geometry, and thus change the way sediment is transported, sorted and distributed. Phase 1 and Phase 2 assessments provide semiquantitative data-sets for examining stressors and their effects on sediment regime when channel hydraulic geometry is modified.

Many land uses are incompatible with the meandering and ever-changing nature of rivers and streams. Rivers and streams are often straightened, armored, dredged, bermed, or encroached upon to protect property investments or to make floodplain available for other land uses. Channel straightening and bank armoring remove or alter natural meanders, while undersized bridges and culverts act as channel constrictions, forcing the stream to flow faster through a narrow area. These channel alterations directly affect the stream by increasing its slope and power, resulting in areas of bed and bank erosion.

The following Sediment Load Stressors Map (Map 9) shows that the major tributaries have high deposition ratings as well as the same high erosion ratings as the lower reaches of the main branch of the Huntington River (M01 through M03). These reaches together have increased sediment loads caused by one or more hydrologic stressors. Historic landuses and resulting stream alterations changed the hydraulic geometry of the channel, and thus changed the way sediment is transported, sorted and distributed. Multiple mass failures were identified upstream of M03 from M04 through M07, which are likely contributing the excess sediment observed in the downstream reaches. Multiple mass failures and high erosion ratings were identified within each of the three study tributaries, providing an explanation for the high sediment ratings observed within these reaches and within the main stream reaches downstream of them (M11, and M08). Encroachments (roads, houses, etc) and subsequent channel management are likely to have triggered incision and mass wasting processes within these reaches.



Map 9. Sediment Load Stressors Map

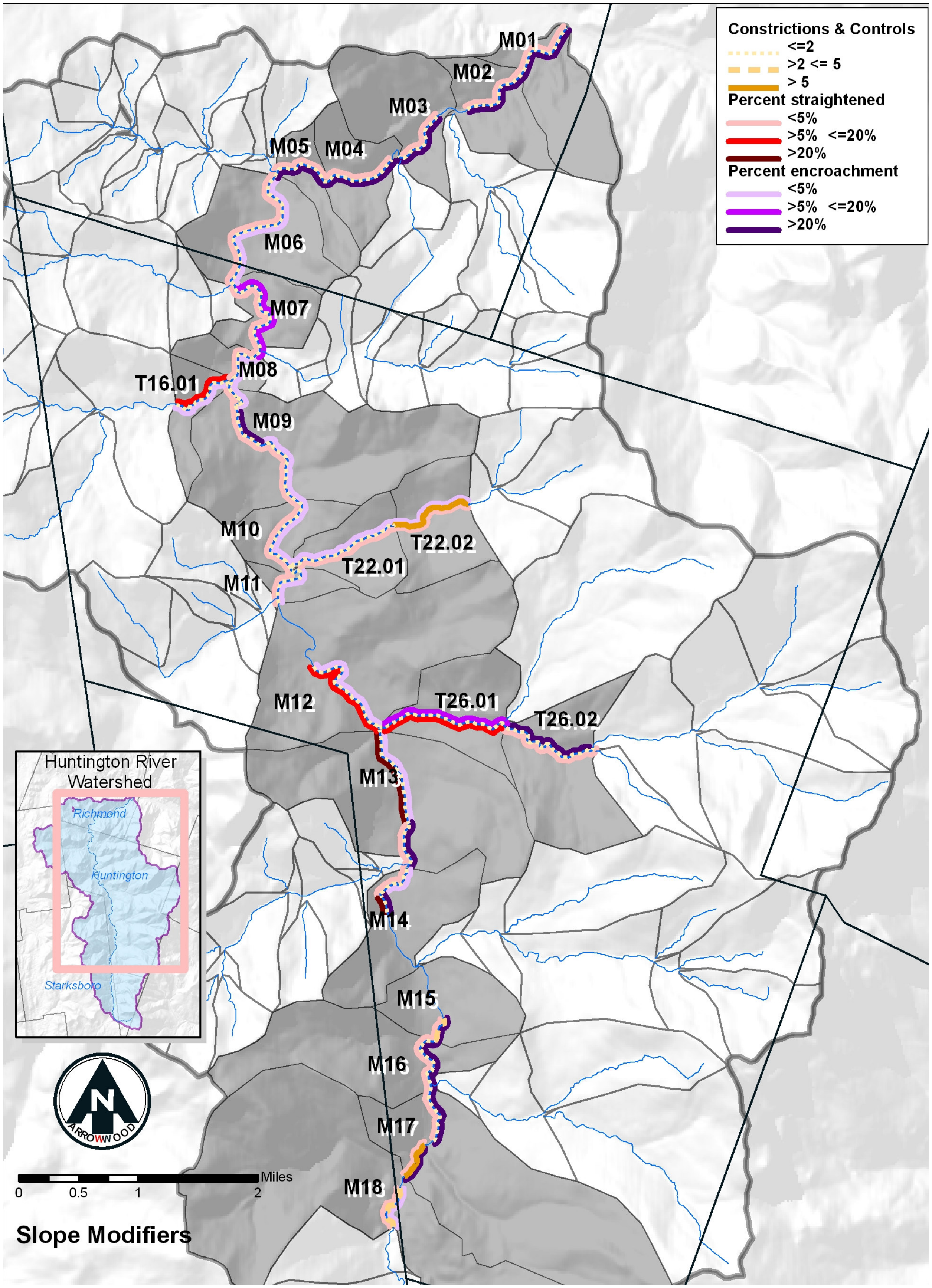
5.1.4 Channel slope modifiers

Results for the Huntington River indicate that primary stressors include areas of extensive corridor encroachments in the form of development and roads (Map 10). Encroachments within the river corridor can indirectly lead to increased channel slope when structural measures are used to protect those encroachments. Increased slope can result in increased flow velocities that result in increased bed and bank erosion. Increased bed and bank erosion can result in increased incision resulting in loss in floodplain access. Loss of floodplain access can play a significant role in enhancing sediment transport capacity as a result of the increased slope and depth at flood stage. With a significant increase in sediment load from upstream, the enhanced transport capacity has also resulted in stress to reaches downstream: instead of storing some of the increased load, reaches are now conveying sediment.

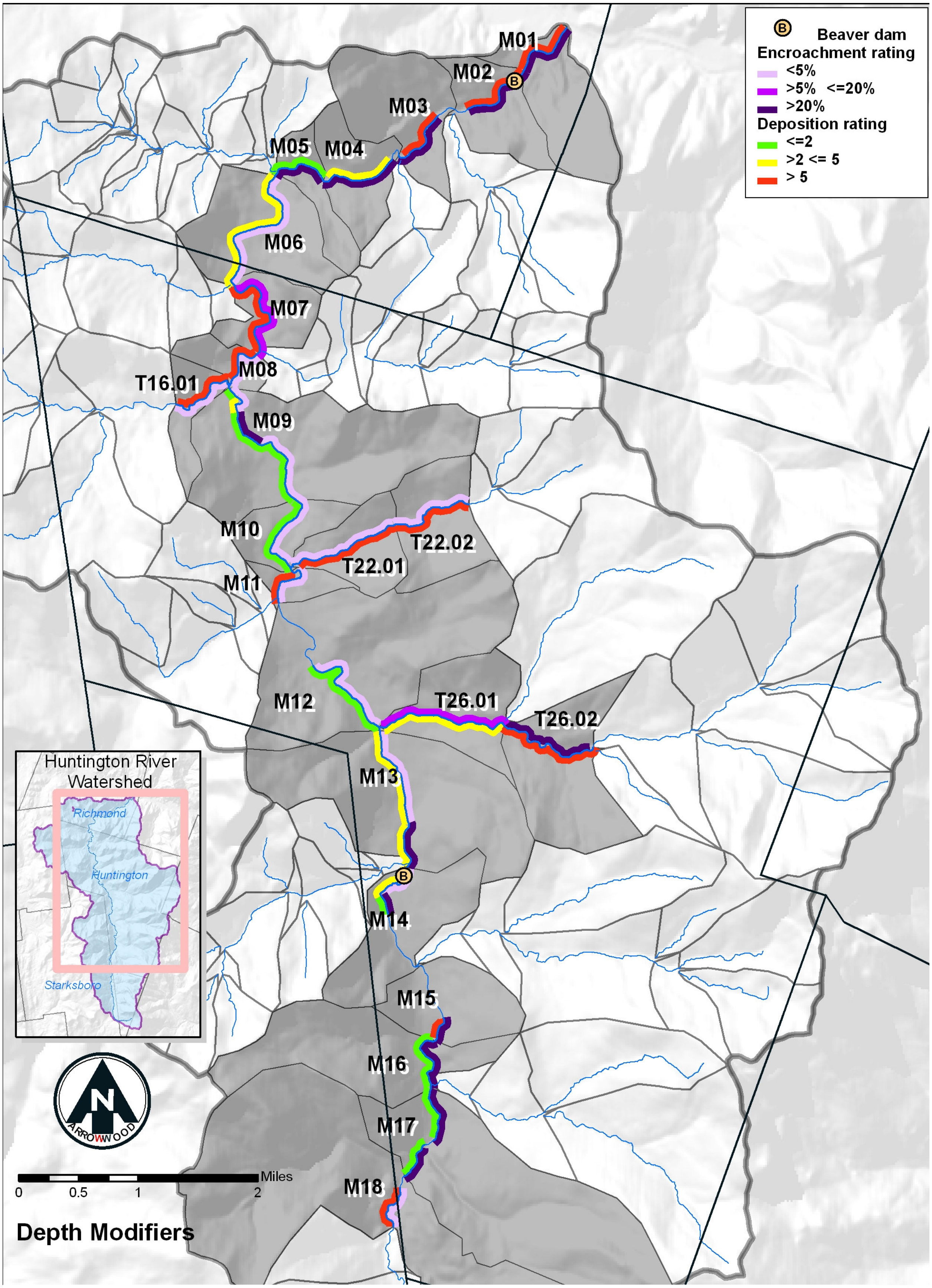
There are twenty-four natural grade controls and twenty-three bridges within the Project area serving to decrease channel slope and reduce stream power (Map 10). Phase 2 data collection indicated that seven of the bridges and culverts are sized at 25% less than bankfull capacity. Most of the bridges evidence insufficiency in transporting sediment, with sediment deposition noted both upstream and downstream of the structures, and scour of the bridge structures also noted.

The following maps present summary data collected during the Phase 2 assessment related to potential slope modifiers (increasers and decreasers) within the study reaches. Collectively, these modifications indicate the potential for increased erosion, possible incision, and decreased channel stability in some study reaches.

The Slope Modifiers Map, presented below, shows that the lower and mid reaches of the Huntington (M01-M05, M13-M14 and M16-M17) as well as Brushy Brook (T26), have been significantly altered by corridor encroachments in the form of roads and development. These same reaches have generally been identified as sediment load stressors with out of balance sediment regimes.



Map 10. Slope Modifiers Map



Map 11. Depth Modifiers Map

5.1.5 Channel depth modifiers

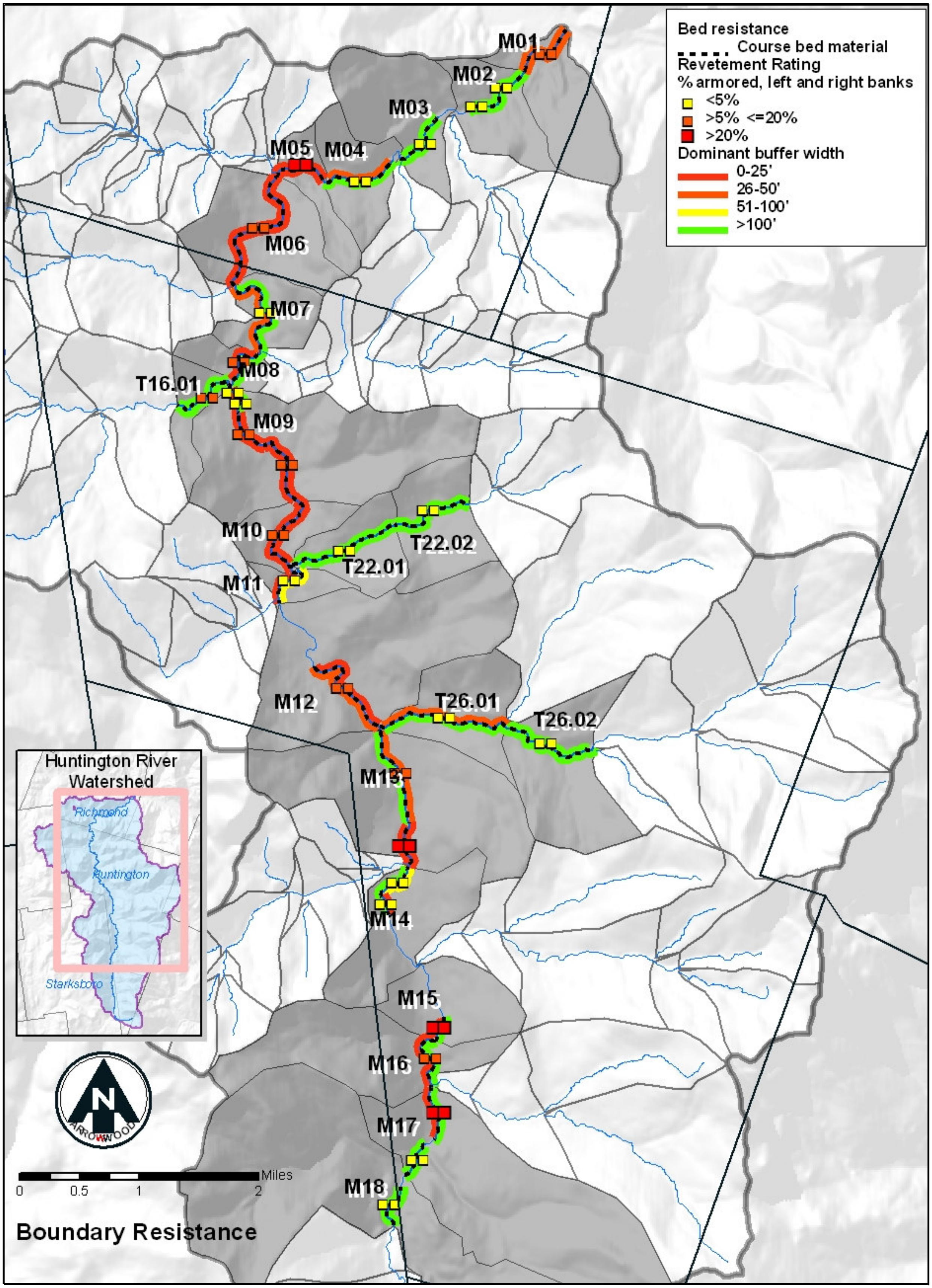
Phase 2 data collection indicated a high impact of corridor encroachment in several reaches of the Huntington which serves to reduce the effective width of the valley and floodplain (Maps 10 and 11). Encroachments within the river corridor increase the depth of flood flows, and thus also increase stream power. Significant deposition creates the potential for more shallow depths during moderate flows due to the mid-channel deposits. Stream power is reduced leading to further deposition.

Many of the reaches within the Huntington River 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 incision, and ultimately decreased sediment and nutrient attenuation capacity as the stream has lost access to its historic floodplain.

5.1.6 Boundary condition and riparian modifiers

Stream boundaries include bed and banks, and are also affected by the condition of buffer vegetation in the riparian corridor. Root systems from woody vegetation help bind stream bank soils. The resistance of the channel boundary materials to the shear stress and stream power exerted, will, in large part, determine whether the channel will undergo adjustment. Riparian vegetation and human-placed bed and bank armoring are effective means of resisting erosion, although, armoring is considered a temporary condition. (VTANR, River Corridor Planning Guide, 2007) The following map presents the condition of the riparian buffers within the study reaches.

Phase 2 data indicate that dominant buffer widths for fifteen of the eighteen assessed main stem reaches were generally less than 25ft, likely contributing to the moderate and high amounts of erosion recorded in ten of the eighteen main branch reaches. Reaches M02 and M03 have good buffer vegetation and low erosion levels. The study tributary reaches generally have good buffers with low erosion ratings with the exception of T16.01 and T26.01. It is clear that the presence of wooded buffers could greatly aid the stability of the banks in the project area.



Map 12. Boundary Resistance Map

The primary hydrologic and sediment stressors in each assessed segment of the Huntington River watershed are identified in Table 4.

Table 4. Huntington River Stressors Identification table indicating some of the hydrologic and sediment load stressors that are likely causing or contributing to channel adjustment and a departure from equilibrium conditions.

	Watershed Scale Stressors		Reach Scale Stressors	
River Segment	**Hydrologic (Increased Flows)**	**Sediment Load (Increased)**	**Stream Power**	**Boundary Resistance**
M01	Increased flood flows from watershed development and roads	Increased loads due to erosion and stormwater runoff from roadside ditches. High deposition rating.	Increased stream power due to historic incision and encroachments	Decreased due to loss of floodplain access and bank erosion. Overall poor buffers. Increased due to bank armoring in locations
M02a	Increased flood flows from watershed development , roads and wetland loss	Increased load with high deposition rating	Decreased stream power due to decreased slope and increased depth in the area of the beaver Increased stream power due to high encroachments and historic incision	Increased due to lack of floodplain access.
M02b	Increased flood flows from watershed development , roads and wetland loss	Increased load with high deposition rating	Increased stream power due to high encroachments	
M03b		Increased with high deposition rating	Decreased stream power due to one grade control Increased stream power due to historic incision and high encroachments	Decreased due to lack of floodplain access
M04b	Increased flood flows from watershed development , roads and wetland loss	Increased load due to mass failure and stormwater runoff from roadside ditches. Moderate deposition rating	Decreased stream power with one grade control Increased stream power due to historic incision and high encroachments	Decreased due to poor buffers and lack of floodplain access

	Watershed Scale Stressors		Reach Scale Stressors	
River Segment	**Hydrologic (Increased Flows)**	**Sediment Load (Increased)**	**Stream Power**	**Boundary Resistance**
M05		Increased load due to mass failure and stormwater runoff from roadside ditches.	Increased stream power due to high encroachments	Decreased due to poor buffers. Increased due to bank armoring in locations.
M6		Increased load due to mass failures. High deposition rating.	Decreased stream power with one grade control Increased stream power due to localized historic straightening	Decreased due to poor buffers. Increased due to bank armoring in locations.
M7	Increased flood flows from watershed development and roads	Increased sediment load due to mass failures. High deposition rating.	Increased stream power due to moderate encroachments and historic localized straightening	Increased due to bank armoring
M8	Increased flood flows from watershed development and roads	Increased sediment load with high deposition rating.		Decreased due to poor buffers
M9A	Increased flood flows from watershed development and roads	Increased sediment load with high deposition rating.		Decreased due to poor buffers
M9B	Increased flood flows from watershed development and roads	Increased sediment load with high deposition rating.		Decreased due to poor buffers
M9C	Increased flood flows from watershed development and roads	Increased sediment load with moderate deposition rating.	Increased due to high encroachments	Decreased due to poor buffers Increased due to bank armoring in locations.
M9D	Increased flood flows from watershed development and roads	Increased sediment load with moderate deposition rating.		Decreased due to poor buffers Increased due to bank armoring in locations.
M10	Increased flood flows from significant watershed development roads	Increased load due to mass failure. High deposition rating.		Decreased due to poor buffers Increased due to bank armoring

	Watershed Scale Stressors		Reach Scale Stressors	
River Segment	**Hydrologic (Increased Flows)**	**Sediment Load (Increased)**	**Stream Power**	**Boundary Resistance**
M11	Increased flood flows from watershed development , roads and wetland loss	Increased sediment load with high deposition rating.		Decrease due to poor buffers
M12B	Increased flood flows from watershed wetland loss		Decreased stream power due to 2 grade controls Increased stream power due to historic straightening	Decreased due to poor buffers Increased due to bank armoring in locations.
M13A	Increased flood flows from watershed development , roads and wetland loss	Increased deposition load due to mass failure and exposed crop land. High deposition rating.	Increased stream power due to historic straightening	Increased due to bank armoring in locations.
M13B	Increased flood flows from watershed development , roads and wetland loss	Increased load due to exposed crop land. High deposition rating.	Increased stream power due to high encroachments	Decreased due to poor buffers Increased due to bank armoring in locations.
M14A		Increased load due to exposed crop land. High deposition rating.	Decreased stream power due to a beaver dam	Decreased due to poor buffers
M14B		Increased load due to mass failure and exposed crop land. Low deposition rating.	Increased stream power due to historic straightening and high encroachments	Decreased due to poor buffers
M15B	Increased flood flows from roads and wetland loss	Increased load due to exposed crop land. High deposition rating.	Increased stream power due to high encroachments	Decreased due to poor buffers Increased due to bank armoring in locations.
M16		Increased load due to stormwater runoff from roadside ditches	Increased stream power due to historic incision and high encroachments	Decreased due to poor buffers and lack of floodplain access. Increased due to bank armoring in locations.

	Watershed Scale Stressors		Reach Scale Stressors	
River Segment	**Hydrologic (Increased Flows)**	**Sediment Load (Increased)**	**Stream Power**	**Boundary Resistance**
M17a		Increased load due to stormwater runoff from roadside ditches	Decreased stream power with one grade control (ledge) Increased stream power due to historic incision and high encroachments	Decreased due to poor buffers and lack of floodplain access. Increased due to bank armoring in locations.
M17c		Increased load due to stormwater runoff from roadside ditches	Decreased stream power with 6 grade controls (ledges) Increased stream power due to high encroachments	
M18b	Increased flood flows from watershed wetland loss	Increased load due to erosion. High deposition rating.	Decreased stream power with 2 grade controls (ledges)	Decreased due to erosion. Increased due to armoring in locations.
T16.01	Increased flood flows from watershed development , and roads	Increased load due to high erosion and 2 mass failures. High deposition rating.	Increased stream power due to historic straightening and incision	Decreased due to erosion and lack of floodplain access. Increased due to armoring in locations.
T22.01	Increased flood flows from watershed development , roads and wetland loss	Increased load with high deposition rating	Decreased stream power due to 3 grade controls (ledges) Increased stream power due to historic incision	Decreased due to lack of floodplain access
T22.02	Increased flood flows from watershed development , roads and wetland loss	Increased load due to high erosion, 3 mass failures and stormwater runoff from roadside ditches	Decreased stream power with 4 grade controls (ledges)	Decreased due to erosion
T26.01	Increased flood flows from watershed development , roads and wetland loss	Increased load due to erosion with moderate deposition rating.	Decreased stream power with 1 grade control (ledge) and two undersized bridges Increased stream power due to historic straightening and incision and encroachments	Decreased due to poor buffers, erosion and lack of floodplain access.

River Segment	Watershed Scale Stressors: Hydrologic (Increased Flows)	Watershed Scale Stressors: Sediment Load (Increased)	Reach Scale Stressors: Stream Power	Reach Scale Stressors: Boundary Resistance
T26.02		Increased load due to 2 mass failures and stormwater runoff from multiple roadside ditches	Decreased stream power with 2 grade controls. Increased stream power due to high encroachments	

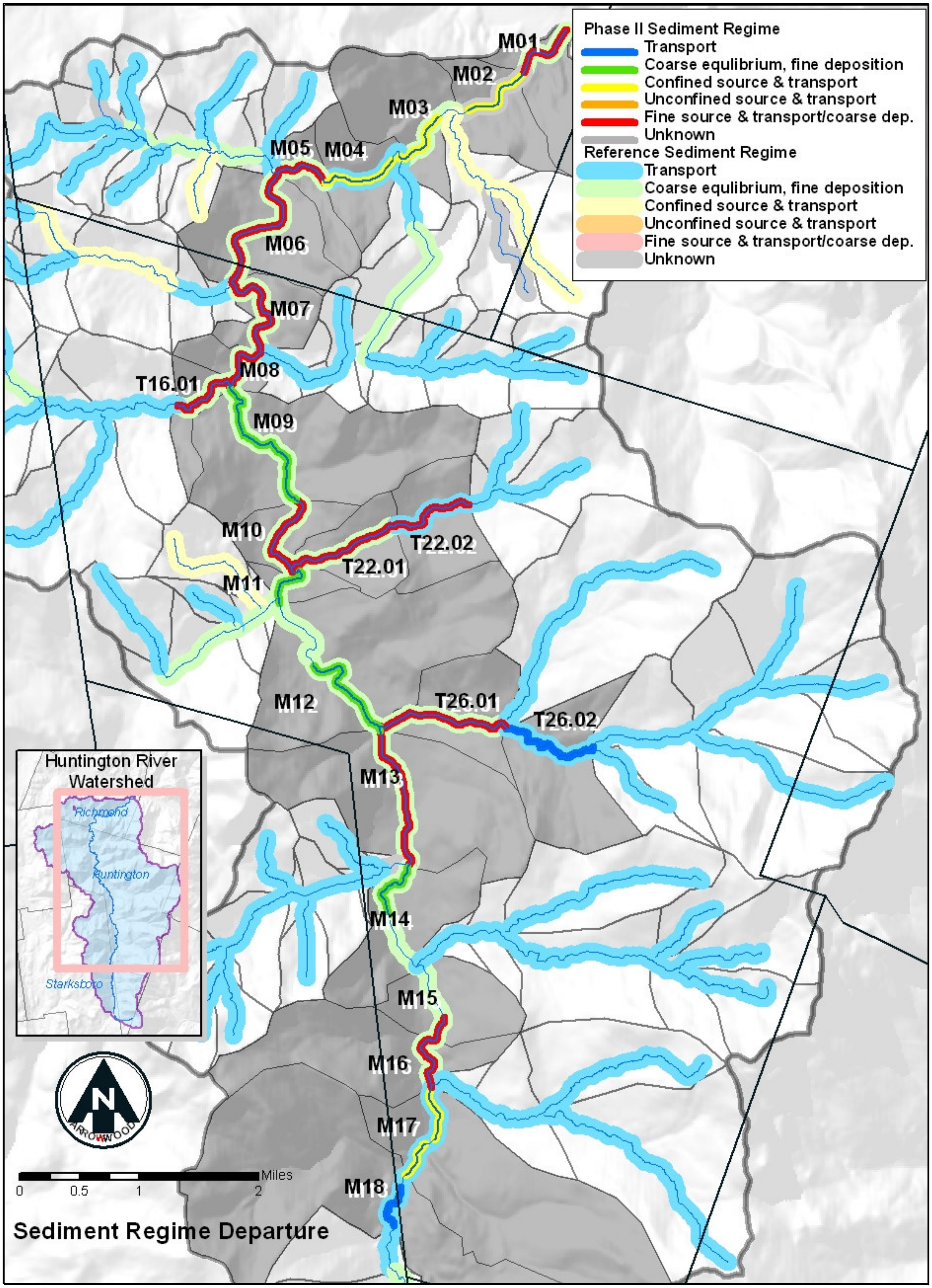
5.1.7 Sediment regime departure, constraints to sediment transport, and attenuation

Within a reach, the principals of stream equilibrium dictate that stream power and sediment will tend to distribute evenly over time (Leopold 1994). Changes or modifications to watershed inputs and hydraulic geometry create disequilibrium and lead to an uneven distribution of power and sediment. Whether a project works with or against the physical processes at play in a watershed is primarily determined by examining the source, volumes, and attenuation of flood flows and sediment loads from one reach to the next within the stream network. If increasing loads are transported through the network to a sensitive reach, where conflicts with human investments are creating a management expectation, little success can be expected unless the restoration design accommodates the increased load or finds a way to attenuate the loads upstream (VTANR 2007).

Under reference conditions, the sediment regime of the Huntington would be one in which all but one of the main branch reaches (M04) from the mouth to M17, and each of the first reaches of the three study tributaries (T16.01, T22.01, and T26.01) would provide for coarse particle equilibrium (in = out: stream power, which is produced as a result of channel gradient and hydraulic radius—is balanced by the sediment load, sediment size, and channel boundary resistance and fine sediment deposition at annual flood flows). Reach M04 is a confined, steep, bedrock gorge which is characterized by a transport sediment regime in reference condition. Main branch reaches M17 and M18, as well the second reaches of the three study tributaries, are also characterized by a transport sediment regime in reference condition.

The existing sediment regime has been converted to one in which several reaches of the Huntington River now function as transport reaches, with coarse deposition occurring when stream power is reduced or sediment load exceeds the carrying capacity of the stream. Eleven of the twenty-three assessed segments have been converted to 'Fine Source and Transport & Coarse Deposition' reaches. Four of the twenty-three reaches have been converted to "Confined Source and Transport". Three of the twenty-three reaches are characterized by the reference sediment regime of "Coarse Equilibrium and Fine Transport". The remaining reach is characterized by the reference sediment regime of "Transport". Little sediment and nutrient attenuation is occurring because the channel has lost much of its historic floodplain access. The result of this conversion is that sediment and nutrients are no longer retained in the watershed, but carried downstream to other reaches and receiving waters, namely the Winooski River and eventually Lake Champlain.

With much of the stream channel in the Huntington incised sufficiently to prevent unfettered access to historical floodplains, efforts of the river to re-establish equilibrium are causing and will continue to cause widening of channels and lateral migration until it is able to rebalance the power of the water in the channel with the amount of sediment being moved. Hence, it is important to identify areas where sediment and nutrients can be stored within the Huntington River Corridor.



Map 13. Sediment Regime Departure Map

Phase 2 work assessed the twenty-three study reaches of the Huntington River as being at Stage I to V of channel evolution (Table 5). Schumm (1977 and 1984) has described the five stages of channel evolution (F-stage model) for reaches such as those found in the study area, where the stream has a bed and banks that are sufficiently erodible to be shaped by the stream over time, paraphrased from the SGA protocols (VTANR 2006, Appendix C) as follows:

I. Stable – in regime, reference to good condition. Insignificant to minimal adjustment; planform is moderate to highly sinuous.
II. Incision – Fair to poor condition, major to extreme channel degradation. High flow events are contained in the channel, and channel slope is typically increased.
III. Widening/Migration – Fair to poor condition, major to extreme widening and aggradation.
IV. Stabilizing – Fair to good condition, major reducing to minor aggradation, widening and planform adjustments
V. Stable – In regime, reference to good condition. Insignificant to minimal adjustment.

Table 5. Applicable sediment regime criteria (VTANR 2007) and Huntington River existing sediment regimes

Sediment Regime	Stage of Channel Evolution Geomorphic Condition	Common Existing Stream Type	Delimiting criteria related to Sediment supply, transport, and storage	Natural Valley Type
Fine Source and Transport & Coarse Deposition	Stage II-IV Fair-Poor	E3, E4, E5 C3, C4, C5, B3c, B4c, B5c, F3, F4, F5	Bank armor < 50% W/d > 30 Incision ratio ≥ 1.3	NW, BD, VB
	Stage II-IV Fair-Poor	D3, D4, D5	Bank armor < 50% Incision ratio ≥ 1.3	NW, BD, VB
Confined Source and Transport	Stage II-IV Fair-Good	A3, B3	Incision ratio ≥ 1.3	NC, SC, NW
	Stage II-IV Fair-Good	A4, A5, B4, B5	Incision ratio ≥ 1.3	Any Type
Transport	Stage I or V Good-Ref	A1, A2, B1, B2, G1, G2, G3, F1, F2, F3	Bedrock Gorge	NC, SC, NW
	Stage I or V Good-Ref	A3, B3, B4	Incision ratio < 1.3	NC, SC, NW
Coarse Equilibrium (in=out) & Fine Deposition	Stage II-IV Fair-Poor	D3, D4, D5	Bank armor < 50% Incision ratio ≥ 1.3	NW, BD, VB
	Stage I or V Fair-Good-Ref	C2, C3, E3	W/d < 30 Incision ratio < 1.3	NW, BD, VB
	Stage I or V Fair-Good-Ref	C4, C5 E4, E5	W/d > 30 Incision ratio < 1.3	NW, BD, VB

Sediment Regime Reach Summary Table: Huntington River

Sediment Regime	Stage of Channel Evolution Geomorphic Condition	Common Existing Stream Type	Delimiting criteria related to Sediment supply, transport, and storage	Natural Valley Type
Reach M01 Straightened: <5% Bank Armor: <20%	Stage III: Fair	C4	Incision ratio 1.8 W/d 41.9	NW
Reach M02 Straightened: <5% Bank Armor: <5%	2A: Stage IV: Fair 2B: Stage V: Good 2C: NA	B3 B3	Incision ratio 1.8 W/d 46.7 Incision ratio 1.4 W/d 30.8	NW NW
Reach M03 Straightened: <5% Bank Armor: <5%	3A: NA 3B: Stage IV: Fair	B3	Incision ratio 2.6 W/d 45.8	NW
Reach M04 Straightened: <5% Bank Armor: <5%	4A: NA 4B: Stage IV/Good	B4	Incision ratio 1.8 W/d 19.6	SC
Reach M05 Straightened: <5% Bank Armor: <5%	Stage III: Fair	C3	Incision ratio 1.4 W/d 30.6	VB
Reach M6 Straightened: <5% Bank Armor: <20%	Stage III: Fair	C4	Incision ratio 1.6 W/d 30.4	VB
Reach M7 Straightened: <5% Bank Armor: <20%	Stage III: Fair	C4	Incision ratio 1.6 W/d 32.5	BD
Reach M8 Straightened: <5% Bank Armor: <20%	Stage III: Fair	C4	Incision ratio 1.3 W/d 39.8	BD
Reach M9 Straightened: <5% Bank Armor: <20%	9A: Stage III/Fair 9B: Stage III/Fair 9C: Stage III/Good 9D: Stage IV/Fair	C4 D4 B4 C4	Incision ratio 1.2 W/d 40.4 Incision ratio 1.26 W/d 67.69 Incision ratio 1.0 W/d 22.1 Incision ratio 1.2 W/d 17.5	BD VB VB BD
Reach M10 Straightened: <5% Bank Armor: <20%	Stage III/Fair	C4	Incision ratio 1.5 W/d 26.5	VB
Reach M11 Straightened: <5% Bank Armor: <5%	Stage III/Fair	C4	Incision ratio 1.0 W/d 21.6	VB
Reach M12 Straightened: ≤20% Bank Armor: <20%	12A: NA 12B: Stage IV/Fair	C4	Incision ratio 1.0 W/d 29.5	BD
Reach M13A Straightened: >20% Bank Armor: 5-20%	M13A: Stage III/Fair	C4	Incision ratio 1.4 W/d 33.4	VB
Reach M13B Straightened: <5% Bank Armor: 5-20%	M13B: Stage II: Fair	C4	Incision ratio 1.8 W/d 14.8	VB
Reach M14 Straightened: >20% 14A; 5-20% 14B Bank Armor: <5%	14A: Stage IId/Fair 14B: Stage IIc/Fair 14C: NA	D4 C4	Incision ratio 1.0 W/d 47.8 Incision ratio 1.0 W/d 25.6	BD VB

Sediment Regime	Stage of Channel Evolution Geomorphic Condition	Common Existing Stream Type	Delimiting criteria related to Sediment supply, transport, and storage	Natural Valley Type
Reach M15B Straightened: <5% Bank Armor: 5-20%	15A: NA 15B: Stage II/Fair	B3	Incision ratio 1.6 W/d 26.7	NW
Reach M16 Straightened: <5% Bank Armor: <5%	Stage IV: Fair	C4	Incision ratio 1.6 W/d 23.5	BD
Reach M17 Straightened: <5% Bank Armor: <5%	17A: Stage III: Fair 17B: NA 17C: Stage I: Good	B3 B1	Incision ratio 2.0 W/d 20.5 Incision ratio 1.4 W/d 20.3	NW NW
Reach M18 Straightened: <5% Bank Armor: <20%	18A: NA 18B: Stage III: Fair	B4	Incision ratio 1.2 W/d 25.3	NW
Reach T16.01 Straightened: <20% Bank Armor: <5%	Stage III: Fair	F4	Incision ratio 2.8 W/d 19.2	VB
Reach T22.01 Straightened: <5% Bank Armor: <5%	Stage III: Fair	C4	Incision ratio 2.1 W/d 15.3	NW
Reach T22.02 Straightened: <5% Bank Armor: <5%	Stage III: Fair	B4	Incision ratio 1.3 W/d 12.2	VB
Reach T26.01 Straightened:<20% Bank Armor: <5%	Stage III: Fair	F3	Incision ratio 2.3 W/d 15.7	VB
Reach T26.02 Straightened: <5% Bank Armor: <5%	Stage III: Fair	B3	Incision ratio 1.2 W/d 16.4	NW

Under the existing sediment regime, which includes limited floodplain access and increased stream power, erosion, widening, and lateral migration are likely to increase and deposition is primarily occurring in the Huntington River when sediment load exceeds carrying capacity, or when channel geometry changes sufficiently to decrease stream power.

The combination of increased stream power and sediment transport along with erosive materials on both bed and banks raise the following issues on the Huntington River:

a) both bed and banks are susceptible to further erosion as part of a process of channel evolution as the stream attempts to regain equilibrium;

b) maintenance of banks through continued channelization increases the likelihood of further bed incision (including potential headcuts, none of which were identified in Phase 2 work) that would further limit access to floodplain and initiate further channel adjustments

c) lack of access to floodplain and extensive channel straightening means that the bulk of sediment deposition impacts is being transferred to downstream reaches;

d) deposition is occurring whenever stream power is reduced, and will likely continue to accumulate quickly in these areas (building on the further decrease of stream power caused by that deposition), increasing the likelihood of channel avulsions in the highly erodible materials along the river corridor;

e) lack of access to floodplains and meanders for sediment storage means that nutrients are being transported downstream.

The primary lateral constraints to stream processes identified in both Phase 1 and Phase 2 work on the Huntington River are road and development encroachment in the river corridor, along with maintenance of highly-valued agricultural resources along the river corridor. Given the existing sediment transport regime and stage of channel evolution of reaches in the study area, likely entailing increased erosion and widening as the river attempts to reestablish equilibrium with the increased stream power, restoration of floodplain access would be a critical component in re-establishing a reference sediment regime. Identification of “attenuation assets” to accommodate high flows and sediment deposition would include areas where the river can be allowed to reestablish meanders (rather than being straightened) as well as access to the floodplain.

Table 6. Attenuation Asset Summary Table

	Constraints		Sediment Transport-Type Stream		Attenuation (storage type stream)		
River Segment	Vertical	Lateral	Natural Transport Type	Converted by Human Constraints	Natural Deposition Zone	Increased Sediment Supply	Asset to Future Deposition
M01		bridge, roads, development, revetments		X	X	X	
M02a		roads, development		X	X	X	X
M02b		roads		X			
M02c	Gorge						
M03a		development		X			
M03b	Ledge	roads, development		X	X	X	Limited (lower reach)
M04a		roads					
M04b	Ledge	roads, development,				X	
M05		roads, agriculture, revetments		X		X	
M6	ledge	agriculture, bridge		X		X	X
M7		bridge, roads		X		X	X
M8		roads, development		X		X	Limited
M9A		roads, development					
M9B						X	X
M9C		roads					X
M9D		bridge, roads, development				X	
M10		roads, development, bridge (new)		X		X	
M11		agriculture, development				X	Limited

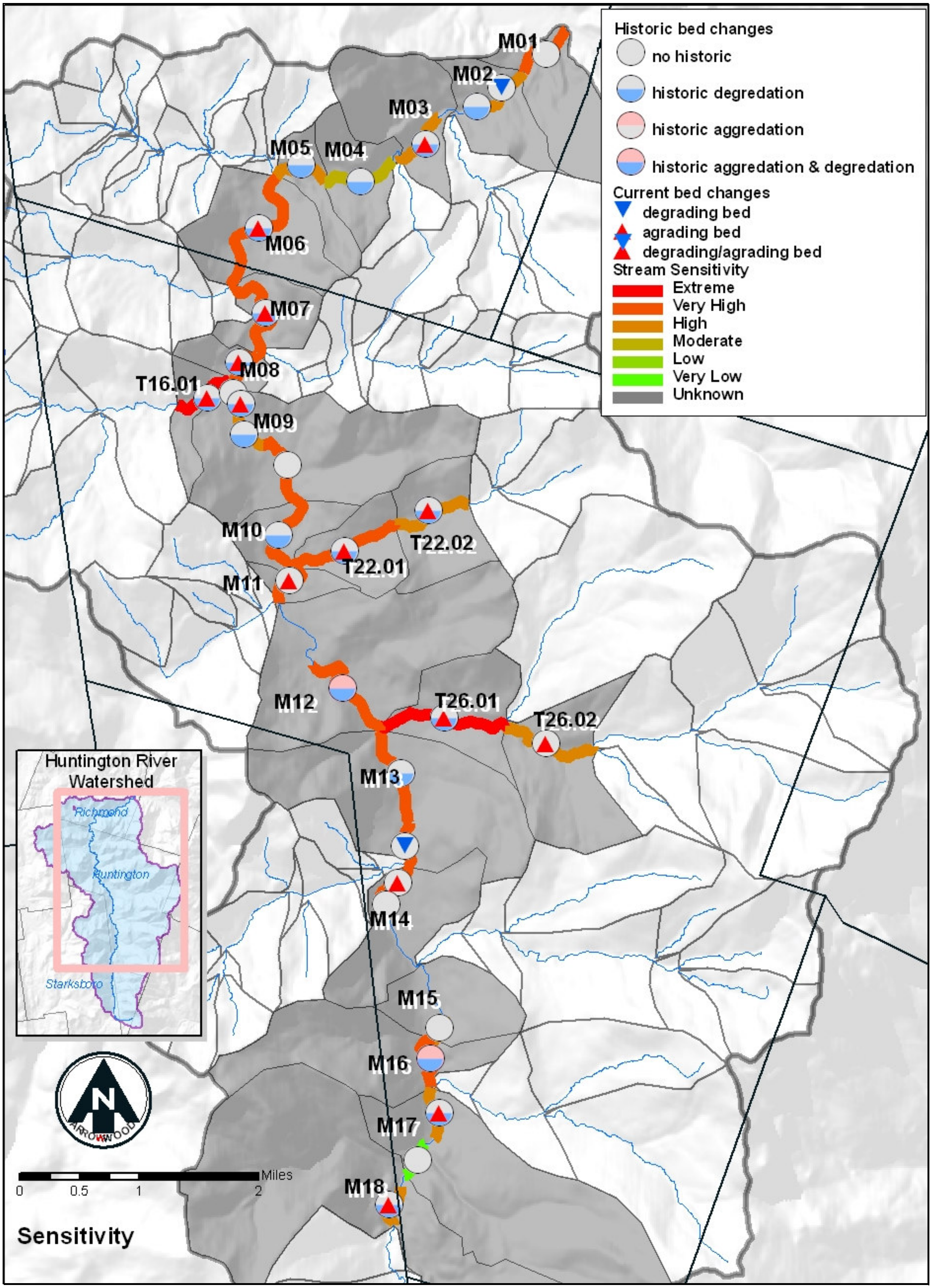
M12B	ledges	bridge, roads, development, berm				X	Limited
M13A		agriculture, bridge		X		X	X
M13B		agriculture, roads, development		X		X	Limited
M14A		agriculture				X	X
M14B		agriculture, berm, roads				X	Limited
M15B		roads, development, bridge, agriculture		X		X	Limited
M16		roads, development, revetments				X	
M17a	Ledge	bridge, roads, development, revetments				X	
M17b	Water Fall	bridge, roads					
M17c	Ledges	roads, development					Limited (Upper Reach)
M18a	Gorge						
M18b	Ledges	development, revetments		X	X	X	X
T16.01		bridge, development, revetments				X	X
T22.01	Ledges	development				X	Limited (Lower Reach)
T22.02	Ledges	3 bridges, development, revetments,		X		X	X
T26.01	Ledge	4 bridges, roads, agriculture, revetments		X		X	X
T26.02	Ledge	2 bridges, roads, development, revetments		X	X	X	

5.2 SENSITIVITY ANALYSIS

The preceding departure analysis identifies the watershed and reach scale stressors that help explain the sediment regime departure currently existing in several reaches of the Huntington. Designing stream corridor protection and restoration projects that are compatible with channel evolution processes, and prioritizing them at the watershed scale, also requires an understanding of stream sensitivity.

Sensitivity refers to the likelihood that a stream will respond to a watershed or local disturbance or stressor, and an indication as to the potential rate of channel evolution (VTANR 2006, Phase 2 Step 7.7; VTANR 2007 Sec. 5.2). While every stream changes in time, a sensitivity rating indicates that some streams, due to their setting and location within the watershed, are more likely to be in a state of change or adjustment (VTANR 2006, Phase 3 Step 6.2).

Alteration of sediment and flow regimes that have converted 15 of the 23 study reaches of the Huntington to transport reaches, combined with fine-grained and erosive boundary conditions and high levels of current erosion create a situation with generally high to extreme sensitivity (Map 14). A stream type departure was indicated for M09C assessed in Phase 2, converting this stream segment to B (moderately entrenched) from C (slightly entrenched). Two stream type departures were indicated for T16.01 and T26.01, converting these reaches to an F (entrenched) from C (slightly entrenched). This is indicative of the loss of floodplain access that is contributing to elevated stream sensitivity. Two additional stream type departures were identified in reaches M09B and M14A converting from C type channel to a D, indicting destabilization of the channel within these segments.



Map 14. Stream Sensitivity Map

The channel aggradation/degradation and lateral extension processes, notably active in "C" stream types, are inherently dependent on the natural stability of streambanks, the existing upstream watershed conditions and flow and sediment regime. C-type channels can be significantly altered and rapidly de-stabilized when the effects of changes in bank stability, watershed condition, or flow regime are combined to cause an exceedance of a channel stability threshold. (Rosgen, D.L. and H.L. Silvey. 1996. Applied River Morphology. Wildland Hydrology Books, Fort Collins, CO)

Although the lack of floodplain access has currently converted a significant part of the Huntington to a transport regime, the high sediment load and high sensitivity of the reaches, along with relatively limited constraints within parts of the corridor at present, indicates good possibilities for success of passive geomorphic projects, which would allow the river to utilize its own energy and watershed inputs to re-establish its meanders, floodplains, and self maintaining equilibrium conditions over time.

6.0 PRELIMINARY PROJECT IDENTIFICATION

The preceding departure and sensitivity analysis provides the watershed and reach scale background to guide prioritization and selection of projects in a manner that maximizes their effectiveness and reduces the likelihood of failure, specifically by assessing the underlying causes of channel instability. With the information from these maps and tables, a step-wise process has been conducted to identify the following actions, in order of priority, in a manner designed to facilitate restoration of the stream to equilibrium conditions (VTANR 2007):

Step 6.1. Protecting River Corridors
Step 6.2. Planting Stream Buffers
Step 6.3. Stabilizing Stream Banks
Step 6.4. Arresting head cuts and nick points
Step 6.5. Removing Berms and other constraints to flood and sediment load attenuation
Step 6.6. Removing/Replacing Structures (e.g. undersized culverts, constrictions, low dams)
Step 6.7. Restoring Incised Reaches
Step 6.8. Restoring Aggraded Reaches

As indicated in Section 5.2 of this report, the high to extreme sensitivity of the majority of the reaches in the Huntington study area indicates that passive geomorphic projects, particularly given the high sediment load and the rapidity of channel evolutions evidenced in the past, is generally an appropriate management alternative. This places a very high priority, throughout the study area, on the first two items identified in the stepwise procedure above. The third item, stabilization of stream banks, is generally not recommended due to vertical instability and widening in channel evolution processes in more than 50% of the study reaches, increasing the likelihood of failure of such efforts. This recommendation needs to be assessed in regards to site specific recommendations and critical infrastructure. It should be recognized, however, that the current conversion of fifteen of the twenty-three Huntington reach sediment regimes to transport types will mean that further armoring of banks will aggravate downstream deposition impacts.

Bed materials are sensitive to erosion, and although no headcuts were documented in Phase 2, the incised nature of the Huntington makes Step 6.4 an item to be regularly assessed.

Reach maps are included in the attachment and were created from available GPS data and field sketches.

6.1 REACH DESCRIPTIONS

Preliminary project identification for the Huntington River is presented on a reach by reach basis in the following pages. Results of the Phase 2 study are summarized below by reach number. Field measurements and locations of other features are overlayed on 2008 aerial photos (NAIP).

6.1.1 Preliminary project identification: Reach M01

M01 Summary Data	
Reach/Segment Length	3187 ft
Valley Confinement	Narrow
Incision Ratio	1.8
Reference Stream Type	C2
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Widening/ historic planform changes
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors
Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M01	Plant Stream Buffers	Stream is still widening so plantings should be set back from immediate stream bank. Contact landowners, investigate possible grant programs for plantings. Corridor plantings are recommended for the right bank for habitat connectivity to existing forestlands to the west/upstream
M01	Stormwater Runoff (1 roadside ditch)	Talk to the town regarding roadside maintenance activities
M01	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.2 Preliminary project identification: Reach M02

M02a Summary Data	
Reach/Segment Length	2602 ft
Valley Confinement	Narrow
Incision Ratio	1.8
Reference Stream Type	B3
Existing Stream Type	B3
Geomorphic Condition	Fair
Channel Evolution Stage	IV
Adjustment Process	Some aggradation/ historic widening
Habitat Condition	Good
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M02b Summary Data	
Reach/Segment Length	846 ft
Valley Confinement	Narrow
Incision Ratio	1.4
Reference Stream Type	B3
Existing Stream Type	B3
Geomorphic Condition	Good
Channel Evolution Stage	V
Adjustment Process	Widening/ historic planform changes
Habitat Condition	Reference
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M02c Summary Data Bedrock Gorge: Not Assessed	
Reach/Segment Length	625 ft
Valley Confinement	
Incision Ratio	
Reference Stream Type	B3
Existing Stream Type	
Geomorphic Condition	
Channel Evolution Stage	
Adjustment Process	
Habitat Condition	
Stream Sensitivity	

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M02a	Protect River Corridor	Landowner cooperation needed. Asset to future deposition.
M02a,b	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

Figure 4. Reach M02B at the cross section

6.1.3 Preliminary project identification: Reach M03

M03a Summary Data Bedrock Gorge: Not Assessed	
Reach/Segment Length	878 ft
Valley Confinement	
Incision Ratio	
Reference Stream Type	B2
Existing Stream Type	
Geomorphic Condition	
Channel Evolution Stage	
Adjustment Process	
Habitat Condition	
Stream Sensitivity	

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M03b Summary Data	
Reach/Segment Length	2917 ft
Valley Confinement	Narrow
Incision Ratio	2.6
Reference Stream Type	B2
Existing Stream Type	B3
Geomorphic Condition	Fair
Channel Evolution Stage	IV
Adjustment Process	Aggrading/historic degradation and widening
Habitat Condition	Reference
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M03b	Protect River Corridor (Downstream section of segment)	Landowner cooperation needed. Limited asset to future deposition.
M03b	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.4 Preliminary project identification: Reach M04

M04a Summary Data
Bedrock Gorge: Not Assessed

Reach/Segment Length	756 ft
Valley Confinement	
Incision Ratio	
Reference Stream Type	B4
Existing Stream Type	
Geomorphic Condition	
Channel Evolution Stage	
Adjustment Process	
Habitat Condition	
Stream Sensitivity	

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M04b Summary Data

Reach/Segment Length	3602 ft
Valley Confinement	Semi-Confined
Incision Ratio	1.8
Reference Stream Type	B4
Existing Stream Type	B4
Geomorphic Condition	Good
Channel Evolution Stage	IV
Adjustment Process	Stable/historic degradation
Habitat Condition	Good
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

Segment ID	Project	Next Steps and other Project Notes
M04b	Plant Stream Buffers	Stream is relatively stable so plantings can be set closer to the stream bank. Contact landowners, investigate possible grant programs for plantings.
M04b	Stormwater Runoff (roadside ditches)	Talk to the town regarding roadside maintenance activities
M04b	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited
M04a,b	Wetland Restoration Potential	Approximately 4.4 acres of wetlands may have been lost within the corridor based on presence of hydric soils. Field investigation of wetland restoration potential within the corridor is needed.

6.1.5 Preliminary project identification: Reach M05

M05 Summary Data	
Reach/Segment Length	2788 ft
Valley Confinement	Very Broad
Incision Ratio	1.4
Reference Stream Type	C3
Existing Stream Type	C3
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Widening/historic degradation & planform changes
Habitat Condition	Good
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors
Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M05	Plant Stream Buffers	Stream is still widening so plantings should be set back from immediate stream bank. Contact landowners, investigate possible grant programs for plantings. Corridor plantings are recommended for the right bank for habitat connectivity to existing forestlands to the south
M05	Stormwater Runoff (3 roadside ditches)	Talk to the town regarding roadside maintenance activities
M05	Invasive Plant Removal	Landowner contacts; labor intensive; multi-year project; results may be limited

6.1.1 Preliminary project identification: Reach M06

M06 Summary Data	
Reach/Segment Length	7088 ft
Valley Confinement	Very Broad
Incision Ratio	1.63
Reference Stream Type	C4
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Aggradation
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M06	Protect River Corridor	Landowner cooperation needed. Asset to future deposition.
M06	Plant Stream Buffers	Stream is actively adjusting, so plantings should be set back from the immediate stream bank. Contact landowners, investigate possible grant programs for plantings.
M06	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.2 Preliminary project identification: Reach M07

M07 Summary Data	
Reach/Segment Length	5178 ft
Valley Confinement	Broad
Incision Ratio	1.58
Reference Stream Type	C3
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Widening w/ historic Incision
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M07	Protect River Corridor	Audubon Vermont is primary landowner and has no development plans within the corridor; Asset to future deposition
M07	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.3 Preliminary project identification: Reach M08

M08 Summary Data	
Reach/Segment Length	2599 ft
Valley Confinement	Broad
Incision Ratio	1.32
Reference Stream Type	C3
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Widening and Planform change/historic incision
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M08	Protect River Corridor	Landowner cooperation needed. Limited opportunity on left bank due to corridor encroachments; Limited attenuation asset.
M08	Plant Stream Buffers	Stream is actively adjusting, so plantings should be set back from the immediate stream bank. Contact landowners (high priority for left bank), investigate possible grant programs for plantings.
M08	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.4 Preliminary project identification: Reach M09

M09A Summary Data

Reach/Segment Length	501 ft
Valley Confinement	Broad
Incision Ratio	1.17
Reference Stream Type	C3
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Widening an planform changes
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M09B Summary Data

Reach/Segment Length	1051 ft
Valley Confinement	Very Broad
Incision Ratio	1.26
Reference Stream Type	C3
Existing Stream Type	D4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Active segment: widening/planform changes
Habitat Condition	Fair
Stream Sensitivity	Extreme

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M09C Summary Data	
Reach/Segment Length	2063 ft
Valley Confinement	Very Broad
Incision Ratio	1.0
Reference Stream Type	C3
Existing Stream Type	B4
Geomorphic Condition	Good
Channel Evolution Stage	III
Adjustment Process	Widening and aggradation/historic degradation & planform changes
Habitat Condition	Fair
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M09D Summary Data	
Reach/Segment Length	3463 ft
Valley Confinement	Broad
Incision Ratio	1.23
Reference Stream Type	C3
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	IV
Adjustment Process	Aggradation and widening/historic planform changes
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M09A, B, C	Protect River Corridor	Landowner cooperation needed. Asset to future deposition (left bank primarily for C).
M09A, B, C, D	Plant Stream Buffer	Stream is actively adjusting, so plantings should be set back from the immediate stream bank. Contact landowners, investigate possible grant programs for plantings.
M09B,C,D	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.5 Preliminary project identification: Reach M10

M10 Summary Data	
Reach/Segment Length	4381 ft
Valley Confinement	Very Broad
Incision Ratio	1.4
Reference Stream Type	C3
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Widening/historic degradation & planform changes
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M10	Plant Stream Buffer	Stream is actively adjusting, so plantings should be set back from the immediate stream bank. Contact landowners, investigate possible grant programs for plantings.
M10	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

Figure 5. Reach M10 at cross section

6.1.6 Preliminary project identification: Reach M11

M11 Summary Data	
Reach/Segment Length	2607 ft
Valley Confinement	Very Broad
Incision Ratio	1.05
Reference Stream Type	C3
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Widening and aggradation/historic degradation
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors
Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M11	Protect River Corridor	Landowner cooperation needed. Limited asset to future deposition. Discussions have been initiated with landowners.
M11	Plant Stream Buffer	Stream is actively adjusting, so plantings should be set back from the immediate stream bank. Contact landowners, investigate possible grant programs for plantings.
M11	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.7 Preliminary project identification: Reach M12

M12B* Summary Data	
Reach/Segment Length	5370 ft
Valley Confinement	Broad
Incision Ratio	1.00
Reference Stream Type	C4
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	IV
Adjustment Process	Widening
Habitat Condition	Fair
Stream Sensitivity	Very High

*M12A not assessed due to lack of landowner permission

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M12B	Protect River Corridor	Landowner cooperation needed. Limited asset to future deposition.
M12B	Plant Stream Buffer	Stream is relatively stable, so plantings can be closer to the stream bank. Contact landowners, investigate possible grant programs for plantings.
M12B	Remove Berms	Further field review to confirm impact on downstream
M12B	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.8 Preliminary project identification: Reach M13

M13A Summary Data

Reach/Segment Length	4566 ft
Valley Confinement	Very Broad
Incision Ratio	1.39
Reference Stream Type	C3
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Widening and historic degradation and planform changes
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M13B Summary Data

Reach/Segment Length	2162 ft
Valley Confinement	Very Broad
Incision Ratio	1.79
Reference Stream Type	C3
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	II
Adjustment Process	Degradation
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M13A	Protect River Corridor	Landowner cooperation needed. Asset to future deposition.
M13A,B	Plant Stream Buffer	Stream is actively adjusting, so plantings should be set back from the stream bank. Contact landowners, investigate possible grant programs for plantings.
M13A,B	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.8 Preliminary project identification: Reach M14

M14A Summary Data

Reach/Segment Length	3180 ft
Valley Confinement	Broad
Incision Ratio	1.00
Reference Stream Type	C3
Existing Stream Type	D4
Geomorphic Condition	Fair
Channel Evolution Stage	IId
Adjustment Process	Widening and planform changes
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M14B* Summary Data

Reach/Segment Length	924 ft
Valley Confinement	Very Broad
Incision Ratio	1.00
Reference Stream Type	C3
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	IIc
Adjustment Process	Widening /historic planform changes
Habitat Condition	Fair
Stream Sensitivity	Very High

*M14C not assessed due to lack of landowner permission.

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

Segment ID	Project	Next Steps and other Project Notes
M14A	Protect River Corridor	Landowner cooperation needed. Asset to future deposition.
M14B	Protect River Corridor	Landowner cooperation needed. Limited asset to future deposition; encroachments on right bank
M14B	Plant Stream Buffer	Stream is actively adjusting, so plantings should be set back from the stream bank. Contact landowners (right bank high priority), investigate possible grant programs for plantings.
M14B	Remove Berms	Further field review to confirm impact on downstream
M14A,B	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.10 Preliminary project identification: Reach M15

M15B* Summary Data

Reach/Segment Length	1165 ft
Valley Confinement	Narrow
Incision Ratio	1.59
Reference Stream Type	C3
Existing Stream Type	B3
Geomorphic Condition	Fair
Channel Evolution Stage	II
Adjustment Process	Degradation
Habitat Condition	Good
Stream Sensitivity	High

*M15A not assessed due to lack of landowner permission

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M15B	Plant Stream Buffer	Stream is actively adjusting, so plantings should be set back from the stream bank. Contact landowners (left bank high priority), investigate possible grant programs for plantings.
M15B	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.6 Preliminary project identification: Reach M16

M16 Summary Data

Reach/Segment Length	3073 ft
Valley Confinement	Broad
Incision Ratio	1.6
Reference Stream Type	C2
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	IV
Adjustment Process	Stable/historic aggradation and widening
Habitat Condition	Fair
Stream Sensitivity	Very High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M016	Plant Stream Buffers	Stream is relatively stable so plantings can be set close to stream bank. Contact landowners, investigate possible grant programs for plantings.
M16	Stormwater Runoff (1 roadside ditch)	Talk to the town regarding roadside maintenance activities
M16	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.7 Preliminary project identification: Reach M17

M17a Summary Data	
Reach/Segment Length	2575 ft
Valley Confinement	Narrow
Incision Ratio	2.0
Reference Stream Type	B2 (Step-Pool)
Existing Stream Type	B3 (Plane Bed)
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Aggradation/ Historic degradation
Habitat Condition	Fair
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M17b Summary Data Bedrock Gorge: Not Assessed	
Reach/Segment Length	446 ft
Valley Confinement	Narrow
Incision Ratio	
Reference Stream Type	B2
Existing Stream Type	
Geomorphic Condition	
Channel Evolution Stage	
Adjustment Process	
Habitat Condition	
Stream Sensitivity	

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M17c Summary Data	
Reach/Segment Length	**1824 ft**
Valley Confinement	**Narrow**
Incision Ratio	**1.4**
Reference Stream Type	**B2**
Existing Stream Type	**B1**
Geomorphic Condition	**Good**
Channel Evolution Stage	**I**
Adjustment Process	**Stable**
Habitat Condition	**Reference**
Stream Sensitivity	**Very Low**

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors
Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M17c	Protect River Corridor (Upstream section of segment)	Landowner cooperation needed. Limited asset to future deposition.
M17a	Plant Stream Buffers	Stream is still adjusting so plantings should be set back from immediate stream bank. Contact landowners, investigate possible grant programs for plantings.
M17a,c	Stormwater Runoff (roadside ditches)	Talk to the town regarding roadside maintenance activities
M17a	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited
M17a,b	Dump sites	Contact landowner. Research grants for removal and disposal costs.

6.1.8 Preliminary project identification: Reach M18

M18a Summary Data Bedrock Gorge: Not Assessed	
Reach/Segment Length	568 ft
Valley Confinement	Narrow
Incision Ratio	
Reference Stream Type	B2
Existing Stream Type	B1
Geomorphic Condition	
Channel Evolution Stage	
Adjustment Process	
Habitat Condition	
Stream Sensitivity	

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream
Bank
Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

M18b Summary Data	
Reach/Segment Length	2229 ft
Valley Confinement	Narrow
Incision Ratio	1.2
Reference Stream Type	B3
Existing Stream Type	B4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Aggradation/ historic degradation
Habitat Condition	Fair
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream
Bank
Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
M18b	Protect River Corridor	Landowner cooperation needed. Asset to future deposition.
M18a,b	Wetland Restoration Potential	Approximately 8.8 acres of wetlands may have been lost within the corridor based on presence of hydric soils. Field investigation of wetland restoration potential within the corridor is needed.
M18b	Dump sites	Contact landowner. Research grants for removal and disposal costs.
M18B	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.9 Preliminary project identification: Reach T16.01

T16.01 Summary Data Texas Hill Brook	
Reach/Segment Length	3371 ft
Valley Confinement	Very Broad
Incision Ratio	2.8
Reference Stream Type	C3
Existing Stream Type	F4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Aggradation/ widening/ planform/ historic degradation
Habitat Condition	Fair
Stream Sensitivity	Extreme

Habitat Stressors

- Invasive Plants
- Dump Sites
- Animal
- Crossings
- Dredging
- Poor Stream Bank Vegetation

Reach Stressors

- Poor Buffers
- Erosion
- Mass Failures
- Encroachments
- Straightening
- Revetments
- Constrictions
- Rejuvenating
- Tributaries
- Dredging
- Stormwater inputs
- Headcuts
- Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
T16.01	Protect River Corridor	Landowner cooperation needed. Asset to future deposition.
T16.01	Plant Stream Buffers (Downstream section of reach)	Stream is still widening so plantings should be set back from immediate stream bank.
T16.01	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.10 Preliminary project identification: Reach T22.01

T22.01 Summary Data Fargo Brook	
Reach/Segment Length	5303 ft
Valley Confinement	Narrow
Incision Ratio	2.1
Reference Stream Type	C2
Existing Stream Type	C4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Aggradation/ widening/historic degradation
Habitat Condition	Good
Stream Sensitivity	Very High

Habitat Stressors

- Invasive Plants
- Dump Sites
- Animal Crossings
- Dredging
- Poor Stream Bank Vegetation

Reach Stressors

- Poor Buffers
- Erosion
- Mass Failures
- Encroachments
- Straightening
- Revetments
- Constrictions
- Rejuvenating
- Tributaries
- Dredging
- Stormwater inputs
- Headcuts
- Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
T22.01	Protect River Corridor (Downstream section of reach)	Landowner cooperation needed. Limited asset to future deposition.
T22.01	Dump Site Removal (Upstream of M12 reach break)	Contact landowner. Research grants for removal and disposal costs.
T22.01	Wetland Restoration Potential	Approximately 1.3 acres of wetlands may have been lost within the corridor based on presence of hydric soils. Field investigation of wetland restoration potential within the corridor is needed.

6.1.11 Preliminary project identification: Reach T22.02

T22.02 Summary Data Fargo Brook	
Reach/Segment Length	4020 ft
Valley Confinement	Very Broad
Incision Ratio	1.3
Reference Stream Type	B3
Existing Stream Type	B4
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Aggradation/ widening/historic degradation
Habitat Condition	Fair
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
T22.02	Protect River Corridor (Upstream section)	Landowner cooperation needed. Asset to future deposition.
T22.02	Plant Stream Buffers	Stream is still widening so plantings should be set back from immediate stream bank. Contact landowners, investigate possible grant programs for plantings.
T22.02	Stormwater Runoff (1 roadside ditch)	Contact town regarding roadside ditch maintenance procedures.
T22.02	Wetland Restoration Potential	Approximately 2.4 acres of wetlands may have been lost within the corridor based on presence of hydric soils. Field investigation of wetland restoration potential within the corridor is needed.
T22.02	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.12 Preliminary project identification: Reach T26.01

T26.01 Summary Data Brushy Brook	
Reach/Segment Length	6161 ft
Valley Confinement	Very Broad
Incision Ratio	2.3
Reference Stream Type	C2
Existing Stream Type	F3
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Aggradation/ widening/ historic degradation
Habitat Condition	Fair
Stream Sensitivity	Extreme

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
T26.01	Protect River Corridor	Landowner cooperation needed. Asset to future deposition.
T26.01	Plant Stream Buffers	Stream is still widening so plantings should be set back from immediate stream bank. Contact landowners, investigate possible grant programs for plantings.
T26.01	Bridge replacement (Salvas Rd; 28' wide bridge)	Undersized bridge, skewed to the roadway. Contact the Town and research grant possibilities
T26.01	Invasive Plant Removal	Landowner contacts; labor intensive; multi- year project; results may be limited

6.1.13 Preliminary project identification: Reach T26.02

T26.02 Summary Data Brushy Brook	
Reach/Segment Length	5117 ft
Valley Confinement	Narrow
Incision Ratio	1.2
Reference Stream Type	B3
Existing Stream Type	B3
Geomorphic Condition	Fair
Channel Evolution Stage	III
Adjustment Process	Aggradation/ widening
Habitat Condition	Good
Stream Sensitivity	High

Habitat Stressors

Invasive Plants
Dump Sites
Animal
Crossings
Dredging
Poor Stream Bank Vegetation

Reach Stressors

Poor Buffers
Erosion
Mass Failures
Encroachments
Straightening
Revetments
Constrictions
Rejuvenating
Tributaries
Dredging
Stormwater inputs
Headcuts
Berms

Preliminary project recommendations are presented in the following table.

River Segment ID	Project	Next Steps and other Project Notes
T26.02	Plant Stream Buffers	Stream is still widening so plantings should be set back from immediate stream bank. Contact landowners, investigate possible grant programs for plantings.
T26.02	Stormwater Runoff (5 roadside ditches)	Contact town regarding roadside ditch maintenance procedures.

Figure 6. Outfall from a roadside ditch in T26.02.

6.2 PROJECT PRIORITIZATION

This Corridor Plan encourages coordination of landowner and municipal efforts to approach restoration with an eye to watershed scale dynamics. The Huntington Conservation Commission can play a critical role in coordinating restoration efforts, and this Plan aims to facilitate such coordination in a way that can help landowners understand the part their properties play within the context of the entire watershed.

With the majority of the assessment area in Stage III and Stage IV of channel evolution, indications are that the Huntington River and its tributaries are starting to migrate laterally in efforts to reestablish functional floodplains. This is likely to aggravate erosion problems in particular, and situations are likely to arise calling for bank stabilization and channelization as short-term remedies. Restoration plans/projects should be consistent with the objective of returning streams to dynamic equilibrium, while taking into account human and capital constraints. In some cases, land use conflicts along the river corridor (such as roads or residential development) may make reinforcing current stream banks a priority. However, the critical issues for long-term stability in the watershed will involve identifying and protecting key areas that allow for floodplain access and reestablishment of river meander patterns to facilitate diffusion of stream power under high flow conditions as well as sediment and nutrient storage within the watershed.

Preliminary project identification has resulted in the selection of five primary restoration methods for the study reaches within the Huntington River watershed. Those methods include the following:

Protecting River Corridors
Planting Stream Buffers
Removing/Replacing Structures
Removing Berms
Corridor Enhancement Projects

Watershed and reach priority projects for each of the identified restoration methods are identified in this section.

6.2.1 Protecting River Corridors

High sensitivity reaches identified as potential attenuation assets are targeted as high priority reaches for establishing a protected river corridor. The targeted priority reaches have been evaluated for the potential to store flood flows, capture and store sediments, and reduce fluvial erosion hazards.

M02A: Segment M02A is a highly sensitive segment in Stage IV of channel evolution with an average incision ratio of 1.8. This reach has lost access to its floodplain. This reach has road encroachments with little development and good buffer widths. This reach has been identified as a potential attenuation asset. The high level of corridor encroachments immediately upstream and downstream and the limited opportunity for attenuation assets immediately upstream and downstream, makes protection of this reach segment both a reach and watershed priority.

M06: Reach M06 is a very highly sensitive reach in Stage III of channel evolution with an incision ratio of 1.63. This reach has lost access to its floodplain. There is little development within the river corridor. There is significant agricultural investment in the corridor of this reach. This reach has been identified as an attenuation asset.

M07: Reach M07 is a very highly sensitive reach in Stage III of channel evolution with an incision ratio of 1.60. This reach has lost access to its floodplain. There is little development present within the river corridor. This reach has been identified as an attenuation asset.

M09 B & C: Segment M09B is an extremely sensitive segment in Stage III of channel evolution with an incision ratio of 1.26. Segment M09C is a highly sensitive reach in Stage III of channel evolution with an incision ratio of 1.8. Segment M09A has access to a floodplain. Segment C has lost access to its floodplain. There is little development in the corridor of both of these segments. Each segment has been identified as an attenuation asset.

M13A: Segment M13A is a very highly sensitive segment in Stage III of channel evolution with an incision ratio of 1.4. Segment M13A has limited access to its floodplain. There is little development present within the corridor. There is a significant agricultural investment within the river corridor. This reach segment has been identified as an attenuation asset.

M14A: Segment M14A is a very highly sensitive segment in Stage II(d) of channel evolution with an incision ratio of 1.0. This segment still has access to its floodplain. While there are no corridor encroachments from development, there is a significant agricultural investment within the corridor. This reach segment has been identified as an attenuation asset.

M17C: Segment M17C is a very low sensitivity reach in Stage I of channel evolution with an incision ratio of 1.4. This reach is stable and has limited access to its floodplain. This reach has high road encroachments in the corridor with little development and buffer widths. This reach has been identified as a limited potential attenuation asset. Protection of this segment is a reach priority.

M18B: Segment M18B is a highly sensitive reach in Stage III of channel evolution with an incision ratio of 1.2. This reach has access to its historic floodplain. It is in the process of widening as evidenced by low to moderate levels of erosion. The river corridor has few encroachments from development. M18B is one of the few reaches in the study area to have access to its floodplain for dissipation of flood flows and protection of this reach is a high watershed priority.

T16.01: Reach T16.01 is an extremely sensitive reach in Stage III of channel evolution with an incision ratio of 2.8. This reach has lost access to its floodplain. It is in the process of widening as evidenced by high levels of erosion. The river corridor has few encroachments and relatively good buffers. Reach T16.01 is a priority for corridor protection. Regaining access to its floodplain through active restoration or through passive restoration will result in a key attenuation asset for the watershed.

T22.01: Reach T22.01 is a very highly sensitive reach in Stage III of channel evolution with an incision ratio of 2.1. This reach has lost access to its floodplain. The river corridor has few encroachments in the downstream section and good buffers. This reach has been identified as a reach and watershed attenuation asset, particularly in the downstream section of the reach.

T22.02: Reach T22.02 is a highly sensitive reach in Stage III of channel evolution with an incision ratio of 1.3. This reach has limited access to its floodplain. It is in the process of widening as evidenced by low to moderate levels or erosion. The river corridor has few encroachments in the upstream section and good buffers. This reach has been identified as a reach and watershed attenuation asset, particularly in the upstream section of the reach.

T26.01: Reach T26.01 is an extremely sensitive reach in Stage III of channel evolution with an incision ratio of 2.3. This reach has lost access to its floodplain. It is in the process of widening as evidenced by low to moderate levels of erosion. This reach has an agricultural component in its riparian corridor with few encroachments, but relatively poor buffers. Given the high level of corridor encroachments and limited opportunity for attenuation immediately upstream, makes protection of this reach segment both a reach and watershed priority.

6.2.2 Planting Stream Buffers

Stream buffer planting is a high priority in sensitive reaches that are vertically stable. The majority of the study reaches for the Huntington River are in Stages II, III and IV of channel evolution and actively adjusting.

Sixteen of the twenty-three study reaches, M01 (C4), M04 (B4), M05 (C3), M06 (C4), M07 (C4), M08 (C4), M09A&D (C4), M09B (D4, STD), M09C (B4, STD), M10 (C3), M11(C4), M12B (C4), M13A&B (C4), M14B (C4), M15B (B3), M16 (C4), M17A (F3, STD) and T26.01 (F3, STD), have generally poor buffer widths. Each of these reaches is in Stage II, III or Stage IV of channel evolution with high to extreme stream sensitivity. Of concern, is the absence of vegetated buffers on the C stream type reaches within the study area. In these stream types, vegetation has a great influence on channel stability. When it is lacking, these channel types are highly sensitive to disturbance which may result in increased levels of streambank erosion and downcutting. These streams are highly sensitive to changes in sediment and stream flow. Due to the instability of the study reaches, planting of vegetation on the immediate stream banks is generally not a high project priority. Plantings within the corridor, set back from the streambanks, are a high priority in each of these reaches.

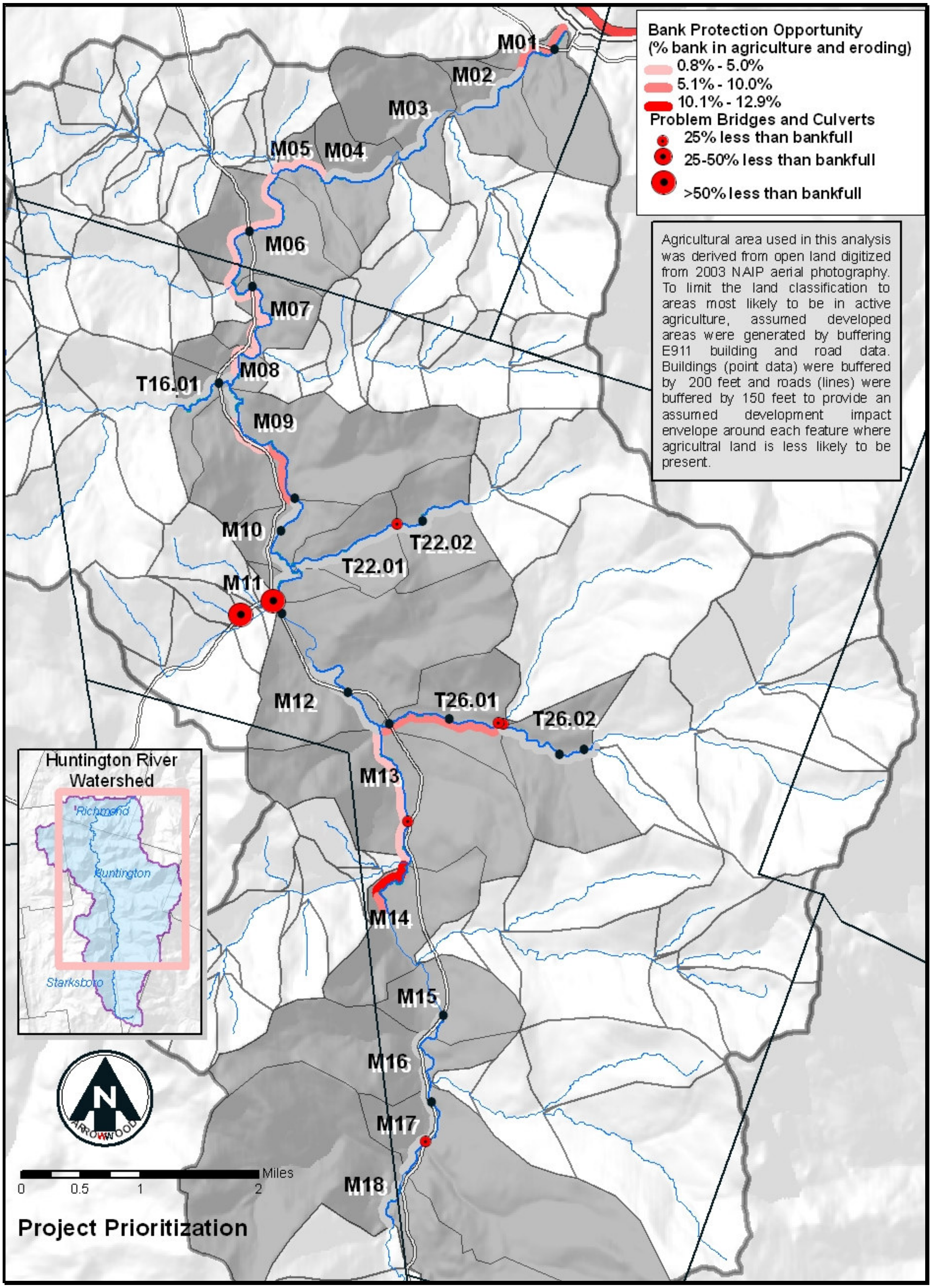
Map (15) below shows the bank protection opportunity within the watershed as percentage of banks in agricultural production that are currently eroding. Areas with high percentage of erosion in agricultural production should be prioritized for stream buffer plantings, particularly Reach M01, M09, T26.01 and M14.

Locations of invasive plant species were inventoried and mapped for all 23 of the study reaches. Invasive species were identified in all of the assessed reaches and segments except for the following: M04A, M09A, M13A, M13B, M17B, M17C, M18A, T22.01, and T26.02. Locations of species populations identified during the field assessments are included on the reach field maps. Invasive plant species removal and/or control are difficult tasks. There are various methods of control and possibly eradication including chemical treatments, biological and mechanical or manual removal. Any option likely involves multiple treatments over many years. This topic is included in the method of planting stream buffers because ideally the invasive species treatment would involve a step of planting native species in treatment areas.

6.2.3 Removing/Replacing Structures

Removing or replacing structures is a high priority for structures no longer in use or structures that contribute to a significant increase in erosion hazard or structures likely to result a channel avulsion during a storm event.

A total of twenty-three bridges were assessed in the 23 study reaches (Map 15). Phase 2 data collection indicated that seven of the bridges are sized at 25% less than bankfull capacity. Most of the bridges evidence insufficiency in transporting sediment, with sediment deposition noted both upstream and downstream of the structures, and scour of the bridge structures also noted. The three most undersized structures have been targeted for replacement. Two culverts are located within reach T23.01 on Hinesburg Hollow Road, and serve as significant constrictions of the stream channel and the floodplain. The third structure is a bridge located in T26.01, on Salvas Road. This bridge is significantly undersized and poorly aligned. The bridge is only 28' wide while the bankfull channel is 37' wide, resulting in both a channel and floodplain constriction in the location of the bridge. Table 7 provides summary data for all of the structures identified in the study area.



Map 15. Project Prioritization Map

Table 7: Bridge and Culvert Summary Data Table

Segment ID	SGAID	Town	Road Name	Stream Name	Type	Road Surface	Structure Width	Ph2 Bankfull Width	Problem	% less than Bankfull Width
M01-	100003000004111	Richmond	COCHRAN RD	Huntington River	Bridge	Paved	138.0	106.0		-30.2%
M06-	200211009R04112	Huntington	MAIN RD	Huntington River	Bridge	Paved	165.0	76.0		-117.1%
M07-	200211001304082	Huntington	MAIN RD	Huntington River	Bridge	Paved	140.4	91.1		-54.1%
M09D	100408001104081	Huntington	BRIDGE ST	Huntington River	Bridge	Paved	114.0	56.0		-103.6%
M10-	100408004204081	Huntington	EAST ST	Huntington River	Bridge	Paved	180.0	76.9		-134.1%
M11-	100408003904081	Huntington	SPENCE RD	Huntington River	Bridge	Gravel	85.0	71.3		-19.2%
M12B	200211001404082	Huntington	MAIN RD	Huntington River	Bridge	Paved	165.0	88.6		-86.2%
M13A	**100408003804081**	**Huntington**	**SHAKER MTN RD**	**Huntington River**	**Bridge**	**Gravel**	**70.0**	**77.4**	**Width**	**9.6%**
M15B	200211000804082	Huntington	MAIN RD	Huntington River	Bridge	Paved	61.0	58.7		-3.9%
M17A	100031000004081	Huntington	CARSE RD	Huntington River	Bridge	Gravel	45.0	45.0		0.0%
M17C	**200211001504082**	**Huntington**	**MAIN RD**	**Huntington River**	**Bridge**	**Paved**	**42.0**	**48.0**	**Width**	**12.5%**
T16.01-	100211000004082	Huntington	MAIN RD	Texas Brook	Bridge	Paved	50.0	24.0		-108.3%
T22.02-	100000000004083	Huntington	Private Drive	Fargo Brook	Bridge	Trail	27.0	14.0		-92.9%
T22.02-	**700000000004083**	**Huntington**	**Private Drive**	**Fargo Brook**	**Bridge**	**Gravel**	**12.5**	**14.0**	**Width**	**10.7%**
T22.02-	400004000004081	Huntington	EAST ST	Fargo Brook	Bridge	Gravel	15.0	14.0		-7.1%
T23.01*	**70000101090408X**	**Huntington**	**HINESBURG HOLLOW RD**	**Huntington River**	**Culvert**	**Paved**	**7.7**	**17.6 (Ph1)**	**Width**	**56.4%**
T23.02*	**70000201110408X**	**Huntington**	**HINESBURG HOLLOW RD**	**Huntington River**	**Culvert**	**Paved**	**4.5**	**17.6 (Ph1)**	**Width**	**74.4%**
T26.01-	**100004000104081**	**Huntington**	**CAMELS HUMP RD**	**Brushey Brook**	**Bridge**	**Gravel**	**36.0**	**37.0**	**Width**	**2.7%**
T26.01-	100004000004081	Huntington	CAMELS HUMP RD	Brushey Brook	Bridge	Gravel	60.0	37.0		-62.2%
T26.01-	200211001604082	Huntington	MAIN RD	Brushey Brook	Bridge	Paved	60.0	37.0		-62.2%
T26.01-	**100021000004081**	**Huntington**	**SALVAS RD**	**Brushey Brook**	**Bridge**	**Gravel**	**28.0**	**37.0**	**Width**	**24.3%**
T26.02-	700000000104083	Huntington	Trail	Brushey Brook	Bridge	Trail	40.0	32.5		-23.1%
T26.02-	100022000004081	Huntington	CAMELS HUMP RD	Brushey Brook	Bridge	Gravel	33.0	32.5		-1.5%

**note: T23.01 & T23.02: no Ph2 assessment has been conducted on T23 bankfull width is from Ph1 calculated channel width. Red font used to identify undersized structures.*

6.2.4 Removing Berms

Removing berms is a priority project in reaches where a significant portion of the river corridor would become accessible to the stream if the berm were removed or if the berm is the predominant reason for why the channel is incised. Two sections of berms were identified during the Phase 2 investigation in reaches M12B and M14B.

Reach M12B has an incision ratio of 1.00 and the berm segment (right bank only) has not significantly impacted stream access to the river corridor. Berm removal is not a priority in this reach.

Reach M14B is a highly sensitive C4 stream channel in Stage IIc of channel evolution with an incision ratio of 1.00. The section of berm is approximately 300' in length and located on the right bank. This reach has been historically straightened along a significant portion of its length. Berm removal is not a priority in this reach segment.

Identification of berms during the Phase 2 assessment is a difficult process. The Phase 2 assessment is primarily conducted from the stream channel where visibility of the near bank is often obscured by vegetation. Further investigation for the presence of berms is likely warranted in a watershed with such a high agricultural component as the Huntington River.

6.2.5 Corridor Enhancement Projects

Dump Sites: The Phase 2 field assessments resulted in the identification of four riverside dump sites. Two of the sites are located in M17, one each in segments A and B. The segment A site is characterized by wood debris. The segment B site has miscellaneous items. The third site is located in reach T22.01, just upstream of the M12 reach break. The T22.01 site contains old junk cars and metal scraps. The fourth dump site is in M18B at the upstream end of the segment.

Figure 7. T22.01 dump site. (9/22/08)

Dump cleanup projects provide an opportunity to engage landowners and volunteers in a river enhancement project with immediate visual results and improved water quality and overall stream habitat. The Vermont Youth Conservation Corps was involved in a successful dump cleanup along the main stem of the Huntington River in 2007.

Stormwater Runoff: Although usually considered an urban issue, stormwater management should also be considered for rural areas because hydrology and sediment regimes can be altered by road construction and maintenance.

Gravel roads can be a significant phosphorus source depending on how the roads are maintained and upgraded. The majority of gravel roads are maintained by towns. Gravel roads effectively become part of the stream network during a rainstorm or spring melt, with the roadside ditches more often than not discharging directly into streams. Eroded material contains significant amounts of phosphorus and thus, as with all eroded soil, is eventually a source of phosphorus to Lake Champlain.

Stormwater runoff from roadside ditches is a major source of sediment to the Huntington River. Roadside ditches were identified as drainage features in 7 of the 23 study reaches: M01(1 ditch), M04B(2 ditches), M05(3 ditches), M16(1 ditch), M17A(1 ditch), M17C(3 ditches), T22.02(1 ditch), T26.02(5 ditches). With the exception of reaches M05 and M17, each of the identified reaches has a moderate to high deposition rating, and only with the exception of M05, each of the reaches immediately downstream of the affected reaches has a moderate to high deposition rating.

The Vermont Better Backroads Program offers assistance to towns, including on-site technical assistance, project funds for addressing erosion problems, and a manual of cost-effective procedures for reducing the impact of roads on water resources. Grants are also available to towns through the Vermont Better Backroads Program to inventory roads and develop budgets to fix road erosion problems (http://www.anr.state.vt.us/cleanandclear/bbroads.htm)

The Vermont Better Backroads Program offers the following:

- grants to towns to fix road erosion problems
- grants to towns to inventory and develop capital budgets to fix road erosion problems
- on-site technical assistance to towns
- the Vermont Better Backroads Manual which details cost-effective procedures towns can use to reduce the impact of their roads on streams, lakes and wetlands.

The Better Backroads Program has been offering grants and technical assistance since 1997. New additional funding made available through Clean and Clear will significantly increase the funds available for grants and technical assistance.

7.0 Flood and Fluvial Erosion Hazard Mitigation

Several strategies can be used by state agencies and municipalities to reduce human conflicts with the river. The first strategy, planning and zoning to minimize future encroachment, includes tools such as corridor-based zoning ordinances, participation in the National Flood Insurance Program, and fluvial erosion hazard protection areas.

The National Flood Insurance Program (NFIP) was created by Congress through the National Flood Insurance Act of 1968. It enables property owners in participating communities to purchase insurance protection against flood related losses. The insurance provides an alternative to disaster assistance by covering damage repairs to buildings and their contents. Participation in the NFIP is based on an agreement between the Federal Government and local communities that states the Federal Government will make flood insurance available if a community adopts and enforces a floodplain management ordinance to reduce flood risks to new construction in Special Flood Hazard Areas (SFHA). The SFHAs and other risk premium zones that affect participating communities are depicted on Flood Insurance Rate Maps. The Mitigation Division within the Federal Emergency Management Agency manages the NFIP, and oversees the floodplain management and mapping components of the Program (http://www.fema.gov/business/nfip/).

Mapping of Fluvial erosion hazard (FEH) protection areas uses the geomorphic data collected in Phases 1 and 2 to rate the erosion hazards in the zone along the river based on the predicted movement of the river (http://www.anr.state.vt.us/cleanandclear/rivstrm.htm).

FEH mapping is based on identifying the degree or likelihood that vertical and lateral adjustments (erosion) associated with fluvial processes (natural and/or human-induced) can be anticipated, and may occur as to justify certain fluvial erosion hazard ratings indicating different levels of risk to investments and infrastructure within the river corridor. Phase 2 geomorphic assessment data provides the basis for FEH map development. Phase 2 assessments enable FEH mapping by identifying the sensitivity of each reach of a stream. Some streams, due to their setting or physical characteristics, are inherently sensitive and are more likely to experience rapid adjustment in channel dimension and location. In addition, the inherent sensitivity of a stream may be increased by human alterations of the channel or watershed.

The Vermont Fluvial Erosion Hazard Risk Assessment and Mapping Methodology outlines the following steps in the identification and mapping of fluvial erosion hazard types and corridors for a segment of stream:

1. Conduct remote sensing and field assessments at the stream segment level to determine the existing and reference geomorphic stream type and the presence of ongoing channel adjustment processes;
2. Assign a stream sensitivity rating based on whether the assessed reach is in reference condition, experiencing major adjustment, or represents a departure from the reference or equilibrium geomorphic stream type that would exist in the absence of human stressors;
3. Assign and map fluvial erosion hazard types based on the stream sensitivity rating; and
4. Develop an FEH river corridor based on belts widths, valley confinement, and sensitivity characteristics.

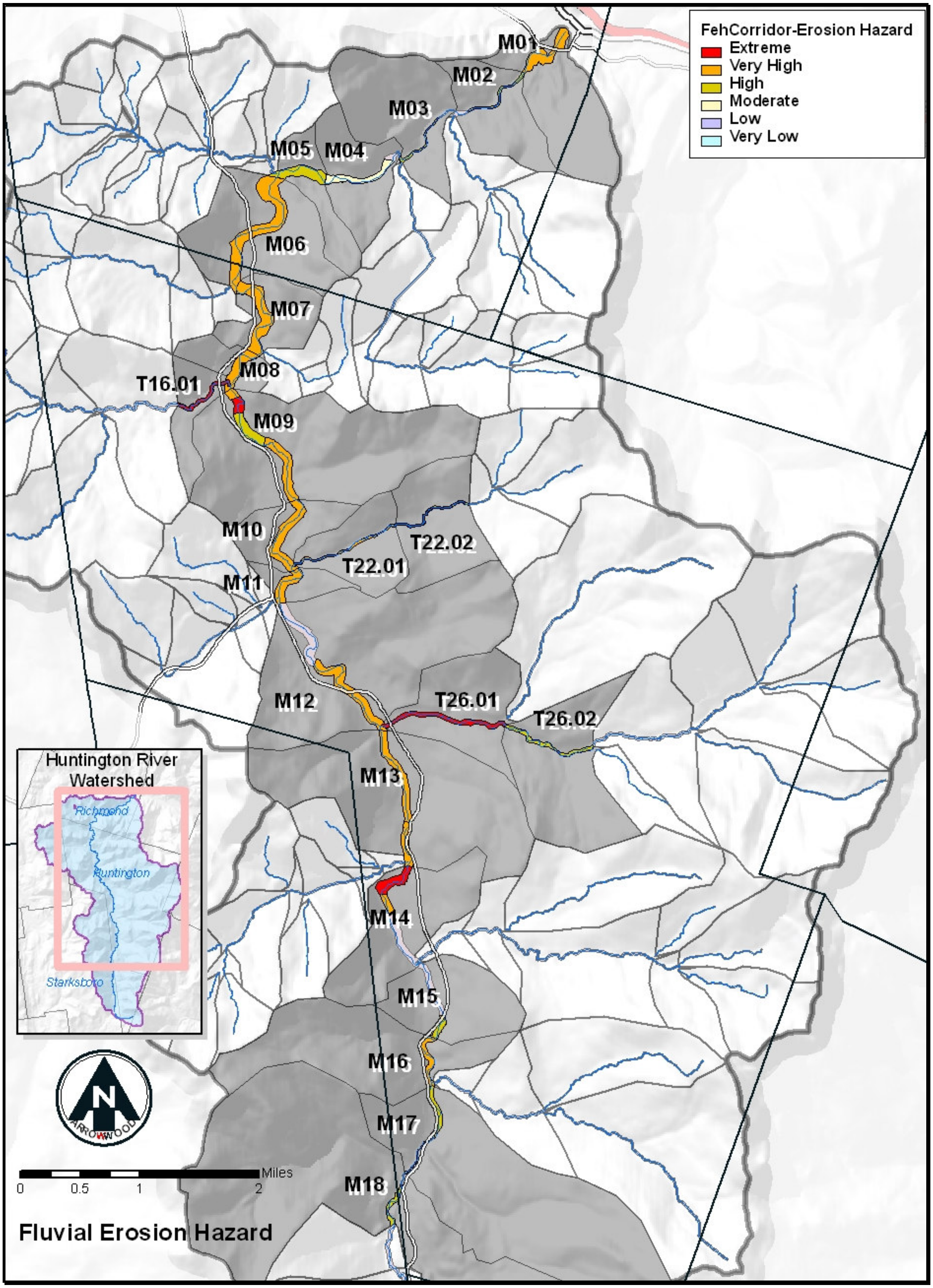
The Huntington River watershed in general has high sensitivity ratings, ranging from moderate to extreme (Table 8).

Table 8: Reach Sensitivities and Fluvial Erosion Hazard Rating.

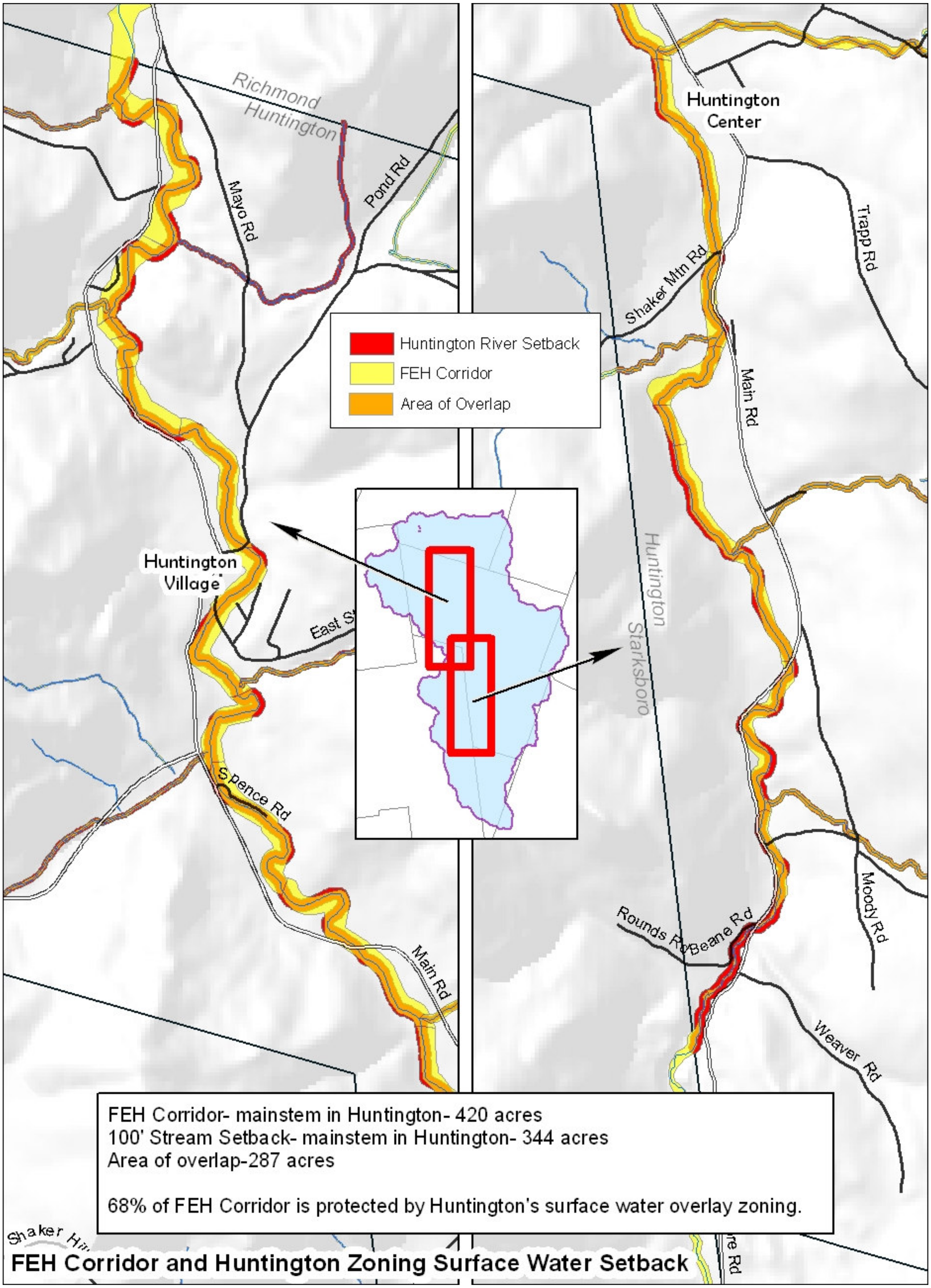
Stream Segment ID	Stream Sensitivity/FEH Rating
M1	VH
M2A	HI
M2B	HI
M3B	HI
M4B	MD
M5	HI
M6	VH
M7	VH
M8	VH
M9A	VH
M9B	EX
M9C	HI
M9D	VH
M10	VH
M11	VH
M12B	VH
M13A	VH
M13B	VH

Stream Segment ID	Stream Sensitivity/FEH Rating
M14A	EX
M14B	VH
M15B	HI
M16	VH
M17A	HI
M17C	VL
M18B	HI
T16.01	EX
T22.01	VH
T22.02	HI
T26.01	EX
T26.02	HI

Mapping of FEH protection areas was completed for the Huntington River by Arrowwood Environmental in the winter of 2008. The FEH zone was developed based upon the Phase 2 data and modified to reflect the geomorphic conditions (i.e., important potential floodplain areas that are currently undeveloped) and administrative boundaries. The RMP conducted a formal QA review of the data and approved the draft map. The Huntington River FEH Protection Areas map can now be made available to the towns in the Project Area. In each town, corridor-based municipal zoning ordinances can be considered as a means to limit encroachment and landuse conflicts within the FEH zones identified. The map (Map 16) was updated in 2009 to include Phase 2 data from thirteen assessed reaches.



Map 16. Huntington River FEH Protection Areas Map (Updated 2009)



Map 17. FEH Protection Areas and 100' setback on the Huntington River

The Huntington Planning Commission proposed and the Town of Huntington approved a 100' setback on the Huntington River (as measured from the top of the bank/top of slope) in its recently adopted Zoning Regulations (March, 2009). The preceding map (Map 17) presents the FEH protection areas and an approximate 100' setback. The overlay shows that approximately 70% of the FEH protection areas zone is contained within and protected by the new set back. Conservation efforts should focus on the remaining 30% of the FEH protection areas zone.

In addition to the setback for the Huntington River, a 50' setback was established for Texas Hill Brook (T16), Sherman Hollow Brook (T12), Johns Brook (T36), Jenkins Brook, Fargo Brook (T22), Hollow Brook (T23), Carpenter Brook (T30), Cobb Brook (T33), Brushy Brook (T26), Jones Brook, and Weaver Brook, up to an elevation of 1300' (as measured from the top of bank/toe of slope).

8.0 RECOMMENDATION FOR FUTURE ASSESSMENTS

The following assessments are recommended for the Huntington River watershed.

1. **Stream geomorphic assessments:** Phase 2 assessments of the main branch ended on M18. It is recommended that Phase 2 assessments of M19-M21 be conducted to provide a complete picture of the main stem of the river. Reaches M22 and M23 are high elevation, mountain streams and further assessment is not recommended at this time. In addition to the main branch, Phase 2 assessments of the following tributaries are recommended:

   - Hollow Brook (T23): There is a new development within this watershed (lower two reaches). This tributary is relatively unique within the Huntington watershed due to its flat topography and extensive wetland inputs.

   - Cobb Brook (T33): There are relatively few impacts in this subwatershed making it a good reference stream comparison.

2. **Wetland Restoration Potential**: An analysis of hydric soils and mapped wetlands indicates significant wetland loss within the Huntington River watershed. Reaches with greater than 10% wetland loss within the mapped river corridor were targeted for potential wetland

restoration. These reaches include: M04, M18, T22.01, and T22.02. Field analysis of wetland potential within the corridor of these reaches is recommended.

3. **Stormwater runoff, inventory road projects:** Stormwater runoff from roadside ditches is a major source of sediment to the Huntington River. Roadside ditches were identified as drainage features in 7 of the 23 study reaches: M01(1 ditch), M04B(2 ditches), M05(3 ditches), M16(1 ditch), M17A(1 ditch), M17C(3 ditches), T22.02(1 ditch), T26.02(5 ditches). With the exception of reaches M05 and M17, each of the identified reaches has a moderate to high deposition rating, and only with the exception of M05, each of the reaches immediately downstream of the affected reaches has a moderate to high deposition rating. Further investigation of roadside ditches throughout the watershed is warranted given the high sediment loads evidenced within the river and its tributaries.

4. **Identification of berms:** Identification of berms during the Phase 2 assessment is a difficult process. The Phase 2 assessment is primarily conducted from the stream channel where visibility of the near bank is often obscured by vegetation. Further investigation for the presence of berms is likely warranted in a watershed with such a high agricultural component as the Huntington River.

9.0 RECOMMENDATIONS FOR CORRIDOR PLAN UPDATES

It is recommended that periodic Huntington River Corridor Plan updates be made, preferably at least every five years. The Huntington Conservation Commission appears well situated to continue coordinating such efforts provided funding is available. These updates could include:

- Assessment of management strategies in light of project implementation and further geomorphic assessments
- Identification of additional reach and watershed scale management options
- Updates on financial and technical resources available to riparian landowners
- Public outreach and education concerning these efforts

10.0 LITERATURE CITED

Arrowwood Environmental. Huntington River Corridor Plan. February 22, 2008.

Behney, William Hudson. 1936. Preliminary Survey of the Huntington River. Zoology Department, University of Vermont.

Leopold, L.B. 1994. A View of the River.
Cambridge, MA.: Harvard University Press.

Johnson, L.B. 1928. Vermont in Floodtime. Reissued as The '27 Flood: An Authentic Account of Vermont's Greatest Disaster, 2nd ed. 1998. Randolph Center, VT: Greenhills Books.

Kocin, Paul. Hydrometeorological Prediction Center, August 7-11 1976 rainfall map

Rosgen, D.L. and H.L. Silvey. 1996. Applied River Morphology. Wildland Hydrology Books, Fort Collins, CO

Lawrence, Miles B. Atlantic Hurricane Season of 1976, National Hurricane Center, NWS, NOAA Miami Fla, April 1977

Rosgen, D. L. 1994. A classification of natural rivers. *Catena*, 22(3), 169 - 199.

Schumm, S.A. 1977. The fluvial system. John Wiley and Sons, New York.

Schumm, S.A. 1984. Incised Channels: Morphology, Dynamics and Control. Water Resources Publication (ISBN-0918334-53-5), Littleton, CO.

VT DEC-RMP 2003. Alternatives for River Corridor Management: Toward resolving river and land-use conflicts in an economically and ecologically sustainable manner. Vermont Department of Environmental Conservation River Management Program Position Paper.
http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_managementAlternatives.pdf

VTANR 2006. Vermont Agency of Natural Resources Protocol Handbooks. Vermont Agency of Natural Resources.
http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm

VTANR 2007. Vermont Agency of Natural Resources River Corridor Planning Guide: To Identify and Develop River Corridor Protection and Restoration Projects.
http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_rivercorridorguide.pdf

Worthley, Aaron. 2008. Personal recollection.