Section VI.
Portage Creek Management Strategy

Watershed residents share stories about the Portage Creek area.
credit: HRWC

Watershed management planning provides the opportunity for communities and other stakeholders to assess the current condition of their watershed, and also to peer into the future to see what the watershed will look like if they simply maintain the status quo. The quality of life that a community desires for its future residents often does not coincide with the realities of the direction in which the community is headed.

This chapter outlines designated and desired uses of surface waters in the Portage Creek watershed, the threats posed to them, and the sources and causes of those threats. The Portage Creek Watershed Advisory Group developed goals and objectives to ensure that the designated and desired uses in the watershed will be met. Because water quality in our river, streams, lakes and wetlands is ultimately a function of what water carries off of the land, how human activities impact the land is described as well as activities that can be taken to improve land use from a water quality/quantity perspective. These recommended activities are described in Section VII.

A. Designated and Desired Uses

According to the MDNRE, the primary criterion for water quality is whether or not the water body meets its designated uses. Designated uses are recognized uses of water established by state and federal water quality programs. In Michigan, the goal is to have all waters of the state meet all designated uses. It is important to note that not all of the uses listed below may be attainable, but they may serve as goals toward which the watershed can move.

All surface waters of the state of Michigan are designated for and shall be protected for all of the following uses.[i] The designated uses that apply to the Portage Creek watershed are in boldface:

- **Agriculture**
- **Industrial water supply**
- Public water supply at the point of intake
- Navigation
- **Warmwater fishery**
- **Other indigenous aquatic life and wildlife**
- **Partial body contact recreation**
- **Total body contact recreation between May 1 and October 31**
- **Coldwater fishery**

Based on the available information collected during the development of this plan, all of the designated uses are fulfilled in the Portage Creek watershed.

The residents of the watershed desire to use the surface waters in ways beyond the state designated uses. The following desired uses have been identified by the communities in the watershed over the course of the development of the watershed management plan:

- **Coordinated development**
  Promote a balance of environmental and economic considerations through intentional community planning and coordinated development within and among the Portage Creek communities

- **Hydrologic functions of natural features**
  Protect and enhance natural features related to water quantity and quality, including wetlands, floodplains, stream buffer zones, and stream channels that regulate the flow of stormwater runoff, protect against flooding, and reduce soil erosion and sedimentation (aka Green Infrastructure)
- **Natural areas, recreation and agricultural lands**
  Protect and enhance priority natural habitat, recreational areas and trails, and agricultural lands from development in order to maintain their natural functions, preserve rural character, and enhance recreational opportunities for present and future generations

B. Threats to the Watershed, Their Sources, and Their Causes

Various pollutants threaten the freshwater resources of the Huron River and its tributaries including Portage Creek, which could present challenges to meeting the designated and desired uses if they are allowed to persist and increase. Analysis of existing data indicates that the Portage Creek watershed has areas of medium-quality waters that require mitigation of existing threats to prevent future impairment. This section summarizes current threats in the watershed. **The sources and causes of those threats are presented by subwatershed in Section IV. Watershed Conditions since land use and land cover vary throughout the watershed.**

The authors, with assistance from the Advisory Group, have compiled the available information necessary to identify and understand these threats and their sources and causes, as well as to prioritize them from greatest to least threat. This prioritization of threats is based upon the Existing Data Analysis phase of the project, Advisory Group member observations, and citizen input. Although the partners in this plan intend to address all of these challenges in the long term with targeted programs, it has been important to rank the most pressing concerns in the watershed so that resources can be expended efficiently in a phased approach.

Five categories of pollutants have been identified as threats in the watershed during the development of this plan: excess nutrients; altered hydrology; salt, organic compounds, and heavy metals; pathogens; and sediment. Brief descriptions of these categories are provided below. The sources and causes of each threat are presented in priority order, based on the availability of data indicating direct linkages and assessments of the degree of contribution to the chain from cause to threat. Known causes (k) are listed before suspected causes (s). Known impairments, sources or causes are defined as those where there exists direct data (i.e., a study or observation) or information establishing a connection. Elements listed as suspected are those for which a connection is implied by land use/land cover analysis, anecdotal evidence or common sense. In cases where threats, sources, or causes were suspected since not enough information was known about them, effort was made to gather additional information. Methods ranged from field work to desktop analyses using a geographic information system, to review of available literature and water quality studies. While much data was compiled to eliminate most suspected items in the table below, some items require further investigation to confirm their presence in the watershed and/or determine the extent to which they are threatening the designated uses in the watershed. As additional information is obtained that indicates that a threat, source or cause should be elevated in priority, the priority ranking should be adjusted to reflect the new information.

- **Excess Phosphorus**

A certain amount of nutrients are found in water resources naturally. In excess, nutrients can cause aquatic systems, both flowing and impounded, to become out of balance favoring certain organisms over others and changing the function, use and look of creeks, ponds and the river. Phosphorus is the primary nutrient of concern in the Portage Creek watershed because phosphorus is usually the limiting growth factor for algae and other nuisance plants in Michigan aquatic ecosystems. When excess phosphorus enters waterways from fertilizer or other sources, it encourages the accelerated growth of plants and algae reducing the dissolved oxygen and light entering the water and creating an environment where it is difficult for most fish and aquatic insects to live. High concentrations also negatively impact amphibians often at low concentrations. Lower dissolved oxygen leads to anoxic conditions in winter often leading to significant die offs of aquatic life including fish, amphibians, and turtles that hibernate under water. High nutrient concentrations interfere with recreation and aesthetic enjoyment of waterbodies by causing reduced water clarity, unpleasant swimming conditions, foul odors, blooms of toxic and nontoxic organisms, and interference with boating.

Too much phosphorus encourages nuisance algae blooms. Photo: HRWC

Sources of phosphorus in the watershed include: fertilizers from lawns and croplands; failing septic systems; sediment and eroded soils; and pet/wildlife wastes. Eroded soils can serve as significant sources of phosphorus to streams since the nutrient bonds with particles in the soil. Most of these sources are associated with developed areas that continue to proliferate, so they will continue to be a source of additional phosphorus to the Portage Creek watershed.

- **Altered Hydrology**

Hydrology refers to the study of water quantity and flow characteristics in a river system. How much and at what rate water flows through a river system, and how these factors compare to the system's historic or "pristine" state, are critical in determining the long-term health of the waterway. In a natural river system, precipitation in the form of rain or snow is intercepted by the leaves of plants, absorbed by plant roots, infiltrated into groundwater, soaked up by wetlands, and is slowly released into the surface water system. Very little rainwater and snowmelt flows directly into waterways via surface runoff because there are so many natural barriers in between.

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When native vegetation is replaced by roads, rooftops, sidewalks, and lawns, more rainwater and snowmelt falls onto impervious (hard) surfaces. In rural areas, this runoff flows either into roadside ditches that drain to the nearest creek, or, in the more densely developed areas, it flows into a system of storm drainpipes that eventually outlet to the creek. When it's raining, the amount of water flowing in the creek increases dramatically over a short period of time, resulting in what is referred to as "flashy flows." In addition to rapidly increasing flows during storm events, the increase in impervious surface also decreases base flows during dry conditions because less water infiltrates into the ground to be slowly released into the creek via groundwater seeps.

Flashiness can lead to severe erosion of streambanks (especially in areas where the streambank vegetation has been removed or altered) and sedimentation in the stream. These impacts create unstable conditions for the aquatic insects and fish. Altered hydrology can also have significant impacts to floodplain wetland systems via lower water levels in early spring and flashfloods during summer rains wiping out wetland inhabitants.

The Huron River and portions of the Portage Creek watershed have been altered by wetlands drainage, stream channelization, dam construction, deforestation, and development. These activities affect the hydrology of the Huron River and its tributaries: flow volume and flow stability have changed substantially, along with channel morphological features, such as gradient and shape. The extensive network of dams and lake control structures, developed areas, engineered drains, and construction sites all play a role in producing flashy, sediment-laden flows. Once useful dams can outlive their purpose and become a hazard and detriment to stream health. Dams hold back silt, debris and nutrients, alter stream flows, decrease oxygen levels in impounded waters, block fish migration and eliminate spawning habitat, increase plant growth in reservoirs, alter water temperatures, and injure or kill fish.

- **Sediment**

Some sedimentation in a river is natural; streambanks are eroded in one area and the soil is deposited downstream. Many streambeds in the Portage Creek system are naturally composed of sand, gravel, and cobble. However, a problem arises when a dramatic shift from these coarse materials to more fine sediments occurs. Silt (fine-grained sediment) content in streambed composition is an important factor when assessing a creek's habitat quality. Silt is smaller than sand and larger than clay. Dramatic increases in fine sediment suggest unnaturally high erosion rates. Excessive deposits of fine sediment are known to impair aquatic insect communities.

This problem is occurring in a few locations in the Portage Creek watershed, such as in the agricultural drains and where they outlet to Portage Creek. Impacts of soil erosion and sedimentation on downstream water resources include decreased aesthetic quality with increased turbidity, decreased light penetration and decreased plant growth, and decreased aquatic habitat quality with sediment covering and clogging gills of fish and aquatic insects and sediment islands blocking fish migration. In addition, nutrients and other pollutants often bond with soil particles, increasing the detrimental impacts of sedimentation on water resources.

Increased runoff results in increased sediment loadings for a variety of reasons. Soil particles are picked up by runoff as it flows over roads, through ditches, and off of bridges into surface waters. Increased flows from runoff or dam discharge have enough energy to scour soils and destabilize stream banks, carrying bank sediments downstream. In addition, runoff from some construction sites can be sources of sediment. This problem arises if proper soil erosion and sedimentation controls are not in place on bare soil that has been exposed during the construction process. Sediment enters the water at bridges as a result of inadequate construction and maintenance practices, and via road ditches, which convey sediment from unpaved roads into the stream. Other sources of sediment include wash-off from paved streets and parking lots. Active agricultural land contributes sediment where farming best practices are not employed, and soil has been left bare and tilled at certain times of the year, which leaves soil vulnerable to wind and water erosion. Furthermore, agricultural drains collect runoff quickly and channel it downstream resulting in incised channels carved out by the rush of water; the eroded channel is another source of sediment.

- **Pathogens**

Excess pathogens in water resources can become a public health concern and cause the public to lose recreational opportunities such as wading, swimming and canoeing. Major sources of pathogens, specifically *E. coli,* in the Portage Creek watershed include wildlife living in or near storm drains and outlets, pet and wildlife waste washed into streams from upland areas, failing septic systems, and land application of untreated waste (septage) from these septic systems. However, Livingston County abolished the land application of septage in 2007 and requires collection and disposal of such waste by licensed haulers and facilities, respectively.

Local data on septic system performance is available as a result of some county governments requiring inspection of septic systems at the time of property transfer, i.e., at the time of sale. In Washtenaw County, 19% of all inspected septic systems have been found to be non-conforming as part of its ordinance requiring inspection of all septic systems at time of property transfer.[ii] As a means of comparison, Wayne County also has a time-of-sale septic system inspection ordinance, which has demonstrated a non-conformance rate of 26% for all inspected septic systems between 2000 and 2003. Ingham County also has a time of sale program but data from that program was not sought in the development of this plan.

Nearly half of the septic systems in Washtenaw County alone have reached their service life expectancy. Inspections over the first 18 months of the county's septic inspection program revealed:

- 18% of the septic systems inspected were nonconforming
- One out of every 18 septic systems (5.5%) had an illicit discharge (i.e., "failed system")
- 15% of the wells inspected did not have adequate protection against contaminants
- One out of every 7 wells tested (14%) showed chemical or bacterial contamination[iii]

Septic systems can fail (i.e., have an illicit discharge) for a number of reasons including inadequate soil conditions, long term use, and lack of proper maintenance or use. Failed septic systems may result in untreated human waste eventually discharging to nearby surface waters, where it can affect drinking water supplies, cause unacceptable water quality, and present a public health risk. The websites for the county health departments provide extensive information about septic systems and their maintenance for homeowners.

To date, no publicly-owned wastewater treatment operations send treated effluent to the Portage Creek watershed. As noted in Section IV. Watershed Conditions, the Village of Stockbridge maintains a POTW but that effluent is permitted for discharge to a tributary of the Grand River watershed, which flows into the Lake Michigan Basin. Should a community consider allowing the siting of a POTW or a privately-owned sewer system waste treatment facility within the watershed, scrutiny should be applied since the potential for operational failure at such a facility would impact the watershed. Furthermore, introduction of a facility can promote poorly planned development and significant increases in impervious surfaces that increase polluted runoff to the watershed.

- **Salt, Organic Compounds and Heavy Metals**

Salts typically enter waterways from road salting (de-icing) operations or from water softener backwash discharge into the environment. De-icing products, primarily sodium chloride, are used locally by MDOT, county road commissions, homeowners, and business/commercial establishments. Salts are highly soluble in water and easily wash off pavement into surface waters and leach into soil and groundwater. High concentrations of salt can damage and kill vegetation, disrupt fish spawning in streams, kill amphibians outright or destroy eggs or larvae, reduce oxygen solubility in surface water, reduce freezing point in water by inhibiting ice formation which acts as a insulator, increase colonization of invasive plants such as European cattail and phragmites, interfere with the chemical and physical characteristics of a lake, and pollute groundwater making well water undrinkable. Salt entering local waterways from road de-icing efforts is a common concern among watershed residents. However, little data was found regarding salt concentrations in local waterways or impacts of salts on water quality.

A study by the USGS in Oakland County on the effects of urban land use change on streamflow and water quality showed a strong positive correlation between salt ions (sodium, potassium, and chloride) and residential and commercial land covers, as well as overall percentage of the watershed built, and population density. These ions were negatively correlated with agriculture, open space, forest, and wetland land covers.[iv] While it may be reasonably stated that the addition of roads and other impervious surfaces in the Portage Creek watershed has lead to increased salt concentrations in the water, the extent to which this is occurring and the impacts of these salt concentrations requires additional monitoring data and studies.

Organic compounds (PCBs, PAHs, DDT, etc.) and heavy metals (lead, copper, mercury, zinc, chromium, cadmium, etc.) can potentially cause adverse impacts on river ecosystems. These chemicals and metals can disrupt the physiology of aquatic organisms and can accumulate in their fatty tissues. Organic chemicals such as PCBs are by-products of manufacturing processes and the combustion of fossil fuels. They are also present in automobile fluids such as gasoline and oils. Other organic chemicals are found in pesticides and herbicides. Heavy metals are also a common by-product of manufacturing, but these contaminants are also common in agricultural and road runoff.

In the watershed, potential sources of organic compounds and heavy metals include urban areas, roads, permitted industries, existing in-stream contamination from historic activities, chemicals from lawns, and runoff from agricultural operations. Little data exists for organic compounds and heavy metals in the Portage Creek watershed. Huron River water chemistry data collected in 2002 by state biologists showed that all contaminants covered under Michigan Rule 57 (which includes a variety of organic compounds, trace and heavy metals, and PCBs) were in compliance with water quality values, with the exception of PCBs, which were not measured. A Total Maximum Daily Load (TMDL) for the entire Huron River system is scheduled due to water quality exceedences for PCBs in Lake Erie. A TMDL for mercury in fish tissue is scheduled to be established for South Lake. Further data on these contaminants will be collected prior to establishment of these TMDLs.

C. Watershed Management Goals and Objectives

The designated and desired uses for the Portage Creek watershed provide a basis from which to build long-term goals and objectives. Long-term goals describe the future condition of the watershed toward which the Portage Creek communities will work. Long-term goals are not expected to be met within the first five years of plan implementation, but are to be met at some time beyond then. The long-term goals have been developed on a watershed-wide basis. They are dually-based on creating the most effective solutions to address priority threats, sources and causes in the watershed, and to proactively protect the high quality elements that remain. No single community or agency is responsible for achieving all of the goals or any one of the goals on its own. The goals represent the desired end product of many individual actions, which will collectively protect and improve the water quality, water quantity and biology of the watershed. The communities of the Portage Creek watershed will strive together to meet these long term goals to the maximum extent practicable by implementing a variety of best practices over time, as applicable to the individual communities and agencies, relative to their specific priorities, individual jurisdictions, authority, and resources.

Due to the complex ecological nature of the response of watersheds to management practices, it is difficult to predict when these goals will be met. Some of the administrative long-term goals might realistically be met in the next few years, whereas some of the ecological goals will require more study and improvements, and may ultimately take many years to achieve. Rather than attempting to predict when these goals will be achieved, the partners will continuously strive to meet these goals by implementing best practices that are recommended for addressing the goals. The watershed partners will understand what progress is being made to achieve these goals by using an iterative process of implementing best practices and evaluating their effects by regularly monitoring the creek for change and degree of improvement.

Goals for watershed management of Portage Creek, along with short-term (1-5 years) and long-term (5+ years) objectives, were developed by the Portage Creek Watershed Advisory Group with input from residents of the watershed communities. The long-term goals and objectives are presented in Table VI-A. Short-term objectives are presented for each goal, and will be partially or wholly fulfilled within five years of implementation of this plan. Long-term objectives are developed for some of the goals, and may be partially fulfilled during the first five years of plan implementation, but realistically will be fulfilled in subsequent implementation phases.

The goals and objectives are listed in priority order as determined in discussion with the Advisory Group. The Advisory Group determined that the combined actions implied by these goals and objectives would be the most effective way to address priority watershed threats and opportunities for protection.

Overall charge: The watershed management team recommends the ethic that growth or agricultural and natural area land conversion in the watershed not occur at the further expense of the environmental health of Portage Creek and its lakes, floodplains, wetlands, and groundwater.

Table VI-A. Watershed Management Goals and Objectives for Portage Creek

Goal	Objective: Short-Term (1-5 yrs)	Uses Addressed
1. Protect and enhance natural features for a functioning water cycle, storm water treatment, and wildlife habitat	Enact policies in at least 3 townships to protect existing natural shoreline areas to maintain the existing natural vegetated buffer system along waterways	Designated Uses: Agriculture; Industrial water supply; Warmwater fishery; Indigenous aquatic life and wildlife; Partial body contact recreation; Total body contact recreation; Public water supply Desired Uses: Green infrastructure; Natural and agricultural heritage; Coordinated community planning
	Increase extent of contiguous protected land through state acquisition, land conservation practices, and Huron Bioreserve project	
	Cap future total impervious area of subwatersheds at 10%	
	Objective: Long-Term (5+ yrs)	
	Restore a minimum of 10% of previously converted wetlands (500 acres), and maintain network of existing wetlands	
	Restore a minimum of 10% of stream buffers in priority subwatersheds (18,000 lineal feet)	
2. Reduce stream flow variability	**Objective: Short-Term (1-5 yrs)**	Designated Uses: Warmwater fishery; Indigenous aquatic life and wildlife Desired Uses: All
	Manage lake levels in response to natural flow fluctuations	
	Implement development standards that mimic pre-development hydrology in at least 3 communities, and prevent modification of the Portage Creek system with new developments and re-developments	
	Increase understanding of the Portage Creek system's flow regime through an established monitoring program	
	Objective: Long-Term (5+ yrs)	
	Restore a minimum of 10% of previously converted wetlands (500 acres), and maintain network of existing wetlands	
	Create more storage for floodwaters within the Portage Creek hydrologic system	

3. Maintain sensitive aquatic organisms in waterways in order to allow for clean and safe use of freshwater resources	**Objective: Short-Term (1-5 yrs)**	Designated Uses: All Desired Uses: All
	Improve aquatic insect community at Unadilla Road from “fair” to “good’ by addressing upstream sediment sources	
	Maintain the “excellent” aquatic insect community at Dexter-Townhall Road by maintaining or improving current land management upstream	
	No increase in aquatic and terrestrial invasive species	
	Maintain and enhance native fisheries, especially cisco (lake herring) and other indicator species	
4. Reduce nonpoint pollutant source loading	**Objective: Short-Term (1-5 yrs)**	Designated Uses: All Desired Uses: All
	Minimize agricultural sources of nutrients, sediment and pathogens (target parameters: TSS, TDS, TP, NO^2+NO^3, COD)	
	Minimize residential sources of nutrients, sediment and pathogens (target parameters: BOD, COD, TSS, TDS, TP, N, heavy metals)	
	Minimize transportation corridor sources of sediment, nutrients and salts, organic compounds, and heavy metals (target parameters: BOD, COD, TSS, TDS, TP, N, heavy metals)	
	Objective: Long-Term (5+ yrs)	
	Maintain or increase clarity in lakes	
	No increase in pollutants from nonpoint sources	
5. Expand monitoring and data collection for water quality, stream flow and biological indicators	**Objective: Short-Term (1-5 yrs)**	Designated Uses: All Desired Uses: All
	Implement an adaptive monitoring strategy that yields data to measure progress toward achievement of watershed management plan goals and objectives	
	Develop a comprehensive database, using best available and most appropriate technology, to serve the needs of the watershed	
	Produce periodic reports that synthesize data collected in the watershed to track progress	

6. Create an aware and involved public that protects the freshwater resources of the Portage Creek system	**Objective: Short-Term (1-5 yrs)**	Designated Uses: All Desired Uses: All
	Develop targeted educational programs to raise audience awareness and gain commitment to act on behalf of watershed resources	
	Increase responsible recreation use of waterways and lakes	
	Increase opportunities for public involvement in protecting watershed resources	
7. Make Portage Creek watershed a recreation destination in Michigan's Lower Peninsula	**Objective: Short-Term (1-5 yrs)**	Designated Uses: Warmwater fishery; Indigenous aquatic life and wildlife; Partial body contact recreation; Total body contact recreation Desired Uses: All
	Increase visitors to state lands and county parks during off-peak times	
	Attain *E. coli* bacteria counts at public beaches that meet state Water Quality Standards	
	Objective: Long-Term (5+ yrs)	
	Achieve coordinated management of Portage Creek for water-based recreation	
8. Secure broad and coordinated implementation of the Portage Creek Watershed Management Plan	**Objective: Short-Term (1-5 yrs)**	Designated Uses: All Desired Uses: All
	At least 4 watershed communities will participate in an intergovernmental effort to coordinate land use planning, protect watershed resources, reduce nonpoint source pollution, and manage storm water runoff	
	Establish financial and institutional arrangements to fulfill the watershed management plan	
	Increase public awareness of progress in implementing the watershed management plan	
	Objective: Long-Term (5+ yrs)	
	Assess implementation of the watershed management plan and revise as needed via the intergovernmental partnership	

D. Basis of Management Strategy

The watershed management strategy for the Portage Creek watershed has at its foundation the findings of the stream corridor and upland assessments conducted during the planning process. The Unified Stream Assessment provides baseline information on conditions within the Portage Creek corridor. The Portage Creek Watershed Hydrologic Study provides an analysis of stream flow conditions currently and over time. While the summary of agricultural practices provided in this section and the Comparative Subwatershed Assessments presented in section IV provide baseline information on upland conditions outside of the creek corridor. The recommended activities to meet the goals and objectives follow from this assemblage of watershed-specific information.

1. Stream Corridor Assessment

The results of the Unified Stream Assessment for Portage Creek and its two major tributaries are presented graphically on the following pages. The methodology for the Unified Stream Assessment is described in Section V. A total of 16 stream segments, or reaches, were assessed for overall stream conditions and for any impacts related to stream crossings, channel modification, severe bank erosion and impacted buffers.

The information collected through the stream assessment serves as the baseline condition for the Portage Creek system since no other effort of this scope has been undertaken previously. Future stream assessments should be conducted at regular intervals once improvement projects have been undertaken to measure the state of the creek. Selected characteristics of overall reach conditions in all 16 stream segments are presented in table VI-B. In addition, these characteristics are presented in the maps on the following pages:

- Stream Channel Substrate
- In-stream Habitat
- Vegetative Protection
- Streambank Erosion
- Floodplain Connection
- Vegetated Buffer Width
- Floodplain Vegetation
- Floodplain Encroachment

Information collected during the stream assessment on stream crossing impacts, impacted vegetated stream buffers, and channel modification are presented in maps on subsequent pages. Specifically, these impacts and opportunities for restoration are presented:

- Stream Crossings: Not Flow-aligned
- Stream Crossings: Sediment Deposition
- Stream Crossings: Downstream Scour
- Stream Crossings: Fish Blockage
- Stream Crossings: Narrow Crossing
- Stream Crossings: Restoration Potential: Culvert Repair/Stream Repair
- Channel Modification
- Channel Modification: Restoration Potential
- Impacted Buffers: Restoration Potential

The information collected during the stream assessment aids local land and water managers and decision-makers in selecting which protection and restoration activities to pursue, and what additional information is needed for project implementation.

Stream assessors did not record impacts from Severe Bank Erosion during this baseline assessment. However, streambank erosion conditions were recorded as part of the overall reach conditions that can indicate areas needing attention so problems do not intensify.

Table VI-B. Stream Assessment Selected Reach Characteristics

Survey Assessment ID	Date	Land Use 1	Land Use 2	Land Use 3	Land Use 4	Attached Aquatic Plants	Floating Aquatic Plants	Stream Shading	Access	AdditionalNotes
A	9/1/2008	Forested				lots	some	Halfway (>50%)	Fair	possible old dam site 20 min walk downstream from Toma Rd; no longer stops water but significant amount of concrete
B	6/24/2008	Forested				some	some	Halfway (>50%)	Fair	dilapidated footbridge (#26 on map on file) blocking river passage; needs to be removed by landowner
C	6/24/2008	Forested				some	some	Halfway (>50%)	Fair	Old car chassis in river (#25 on map on file), as been there for over 15 yrs and would be difficult to remove; private crossing above Patterson Lake Rd, new covered bridge of wood and concrete
D	6/19/2008	Suburban Residential	Forested			lots	some	Partially Shaded (>25%)	Fair	On lakes, seawalls have been built up to reduce erosion. On streams, some bridges could be better flow-aligned.
E1	5/19/2008	Forested				lots	some	Halfway (>50%)	Fair	There may be some dredging. Cattails
E2	5/19/2008	Suburban Residential				some	some	Unshaded (<25%)	Good	Houses built right to shore line, no riparian zone. Channelized.
F	5/28/2008	Suburban Residential	Forested			some	some	Halfway (>50%)	Fair	Beginning (near Unadilla) residential w/ some impacted buffers - further natural area w/ a lot of vegetation.
G	6/19/2008	Suburban Residential	Forested			some	some	Partially Shaded (>25%)	Fair	
H	6/19/2008	Suburban Residential	Forested			some	some	Halfway (>50%)	Fair	In the beginning, quite a few disturbances due to residential use. Later, mostly undisturbed. Abandoned remnant dam is fish barrier.
I	7/6/2008	Wetland				some		Mostly shaded (>75%)	Fair	Encroachment by residential development on north shore of reach between lake and Williamsville Rd
J	7/6/2008	Wetland				some	some	Mostly shaded (>75%)	Fair	channel straightened
K	7/9/2008	Forested	Wetland			some	some	Partially Shaded (>25%)	Difficult	Invasive multiflora rose, cattails
L	7/16/2008	Rural Residential	Forested	Cropland	Pasture	lots	some	Mostly shaded (>75%)	Difficult	Many natural obstructions and obstacles such as dead and fallen trees. Man made bridges are impediments. Small rock dam made by homeowner in effort to produce recreation site.
LCB	7/19/2008	Suburban Residential				lots	some	Partially Shaded (>25%)	Difficult	
LLA	7/26/2008	Suburban Residential	Forested			some	some	Halfway (>50%)	Difficult	
LLB	7/26/2008	Rural Residential	Cropland			some	lots	Partially Shaded (>25%)	Fair	This reach after the lake appears channelized
M	7/26/2008	Suburban Residential	Cropland			lots	none	Partially Shaded (>25%)	Fair	A lot of runoff, probably due to surrounding cornfields.

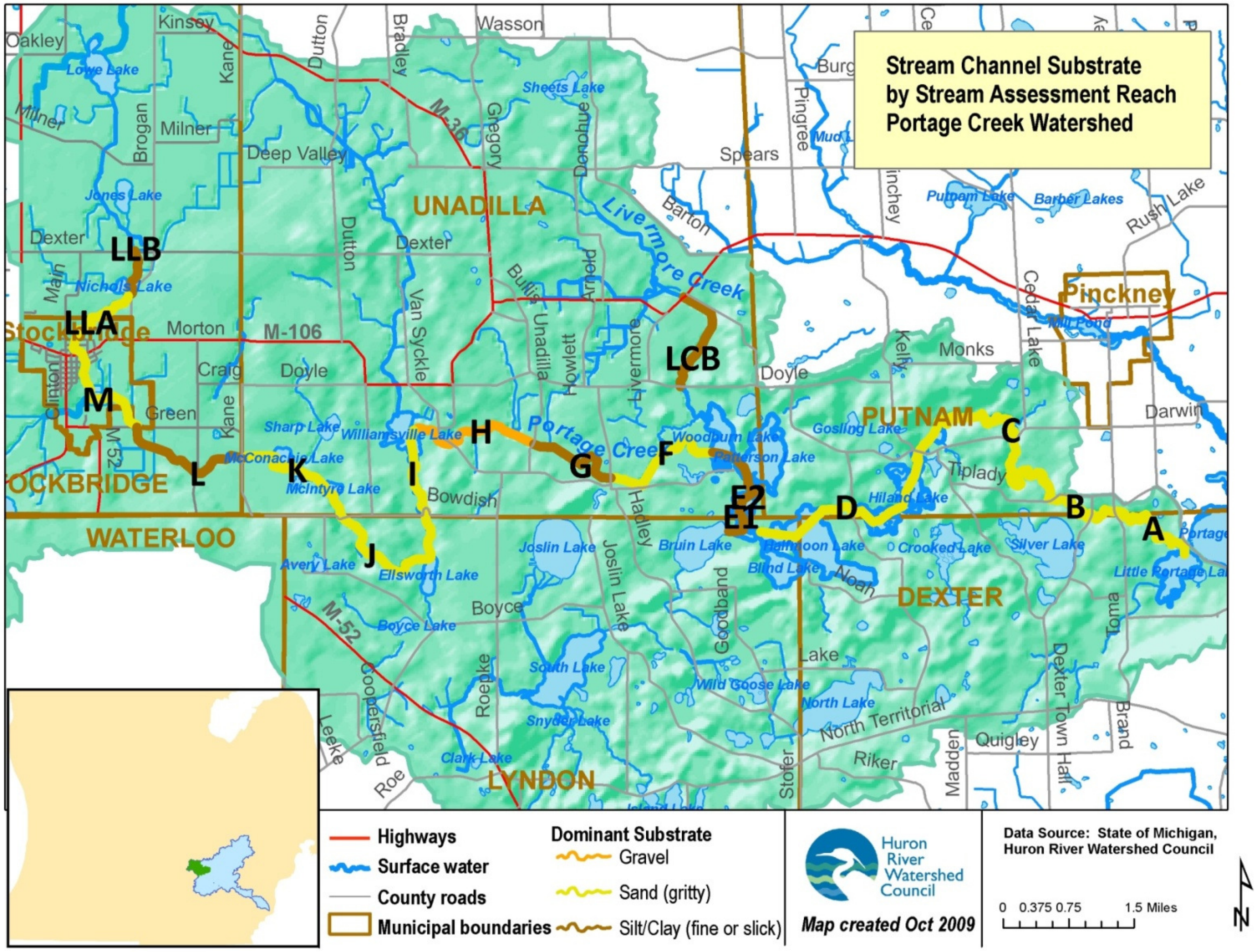

Figure VI-1. The channel substrate in Portage Creek is predominantly sand in the downstream reaches and reaches I, J, K and F as well as through the Village of Stockbridge. Silt and clay substrate dominate downstream of the Village of Stockbridge, reach G and in the channelized sections between the lakes in section E. Silt and clay are the dominant substrate in the two tributaries, Lowe Lake Drain and Livermore Creek. Reach H is nearly equal parts gravel and sand.

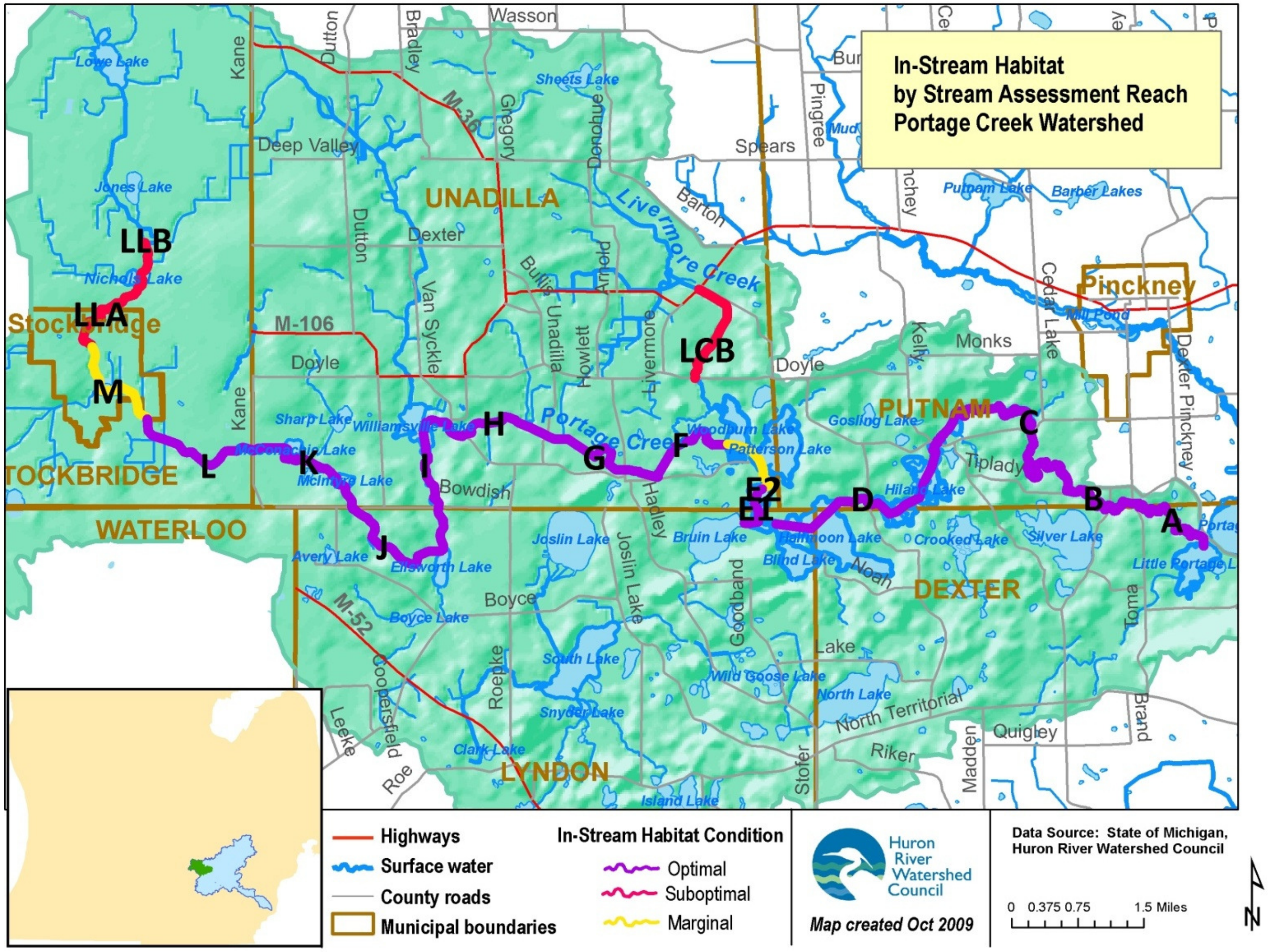

Figure VI-2. **Optimal** in-stream habitat is characterized by greater than 70% of substrate is favorable for epifaunal colonization and fish cover, mix of snags, submerged logs, undercut banks, cobble or other stable habitat. **Suboptimal** in-stream habitat is characterized by 40-70% of stable habitat, well-suited for full colonization potential, adequate habitat for maintenance of populations, presence of additional substrate in the form of newly fallen logs/snags, but not yet prepared for colonization. **Marginal** in-stream habitat is characterized by 20-40% mix of stable habitat, but habitat variability is less than desirable, and substrate frequently is disturbed or removed.

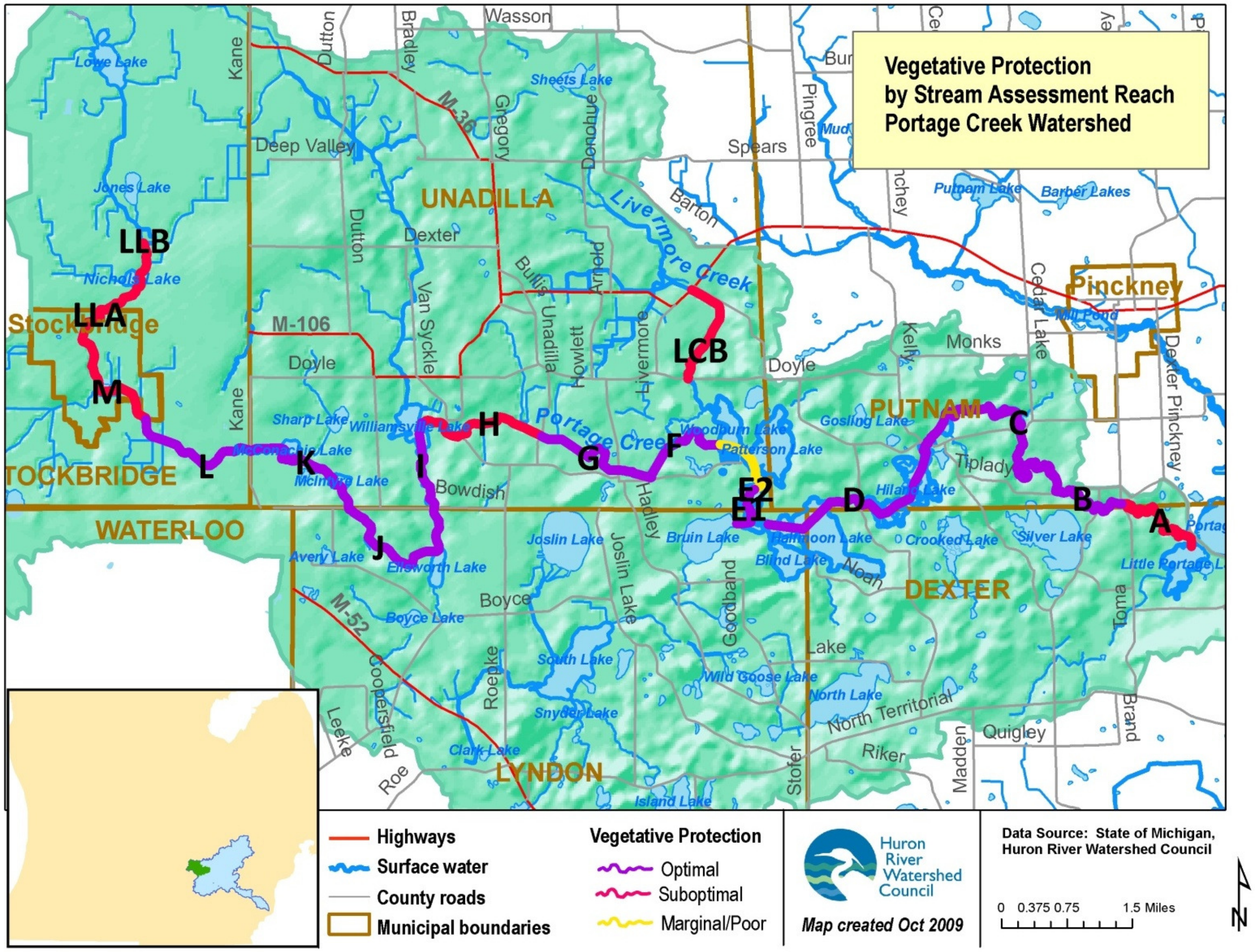

Figure VI-3. Optimal vegetative protection is characterized by more than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing in not evident; almost all plants are allowed to grow naturally. Suboptimal vegetative protection has 70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption is evident but not affecting full plant growth to any great extent. Marginal/Poor vegetative protection has 50-70% and less than 50% of the streambank surfaces covered by vegetation, respectively; disruption of vegetation is obvious to very high; patches of bare soil evident.

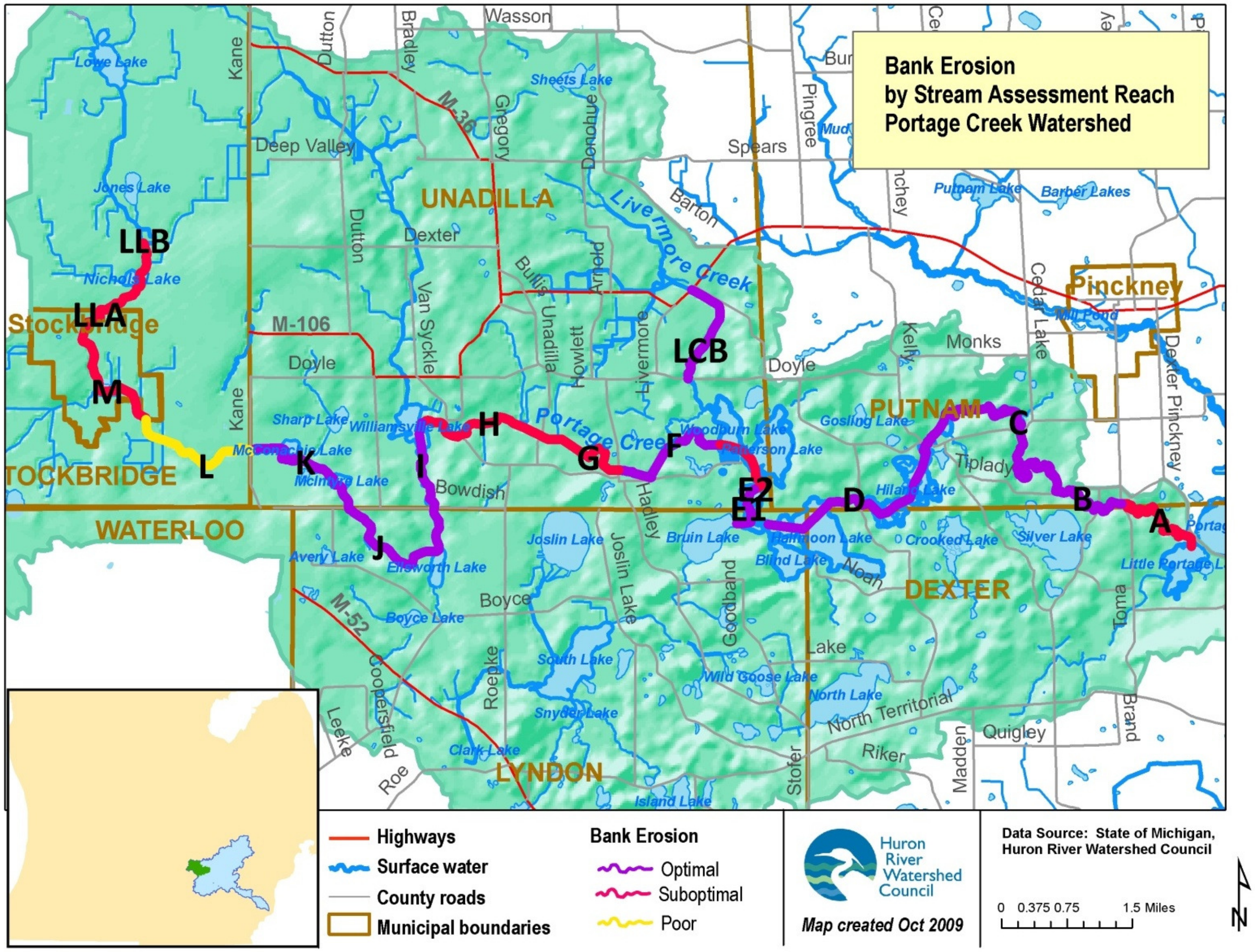

Figure VI-4. The optimal condition is stable banks with little to no evidence of erosion or bank failure, and little potential for future problems. Suboptimal conditions are isolated areas of bank failures/erosion likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use. Poor conditions are tall banks on both sides of the stream eroding at a fast rate with active downcutting; erosion is contributing a significant amount of sediment to the stream, obvious threat to property or infrastructure.

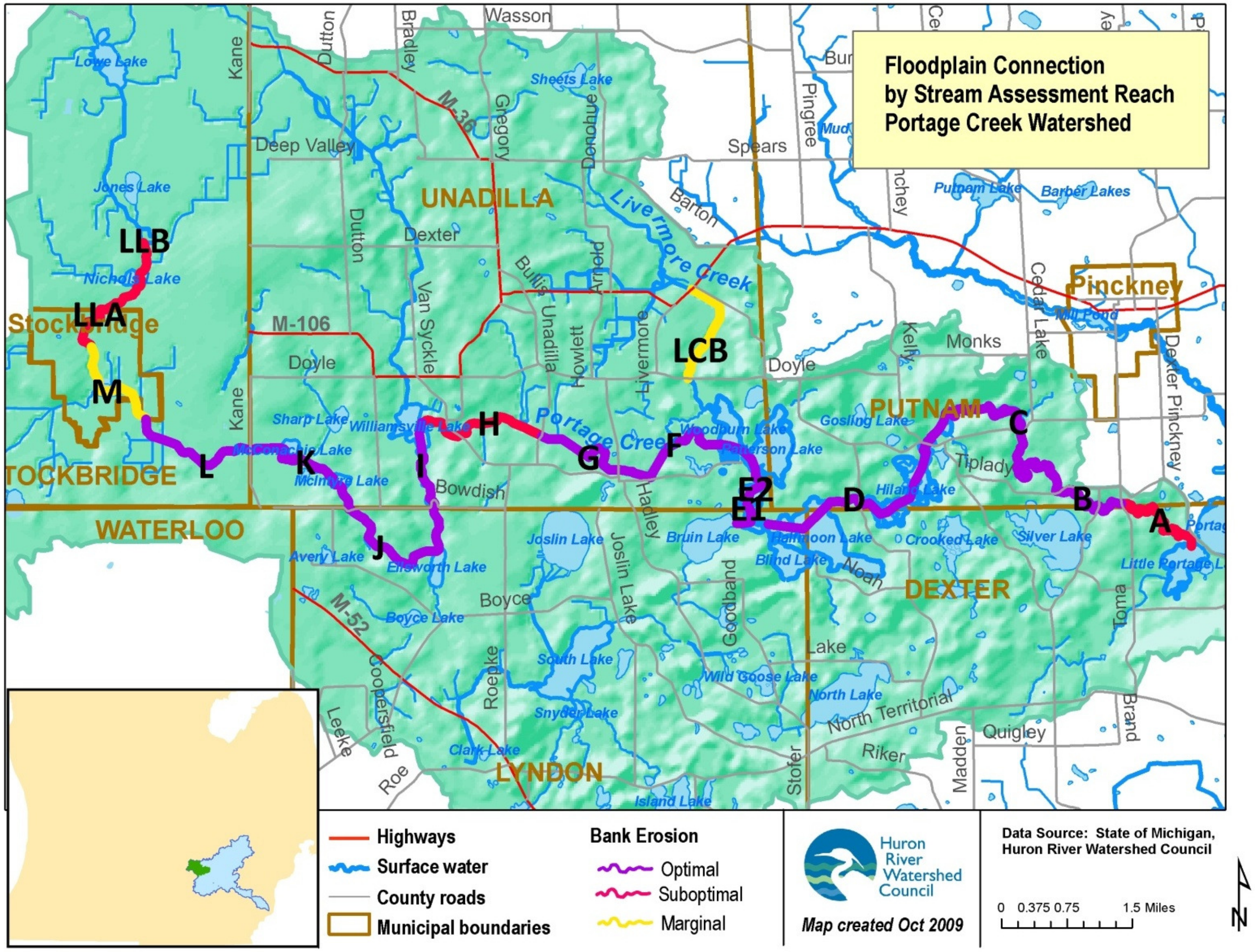

Figure VI-5. Optimal and suboptimal floodplain connection conditions are characterized by high flows being able to enter the floodplain, and a not deeply entrenched stream. Marginal conditions are high flows <u>unable</u> to enter floodplain and a deeply entrenched stream.

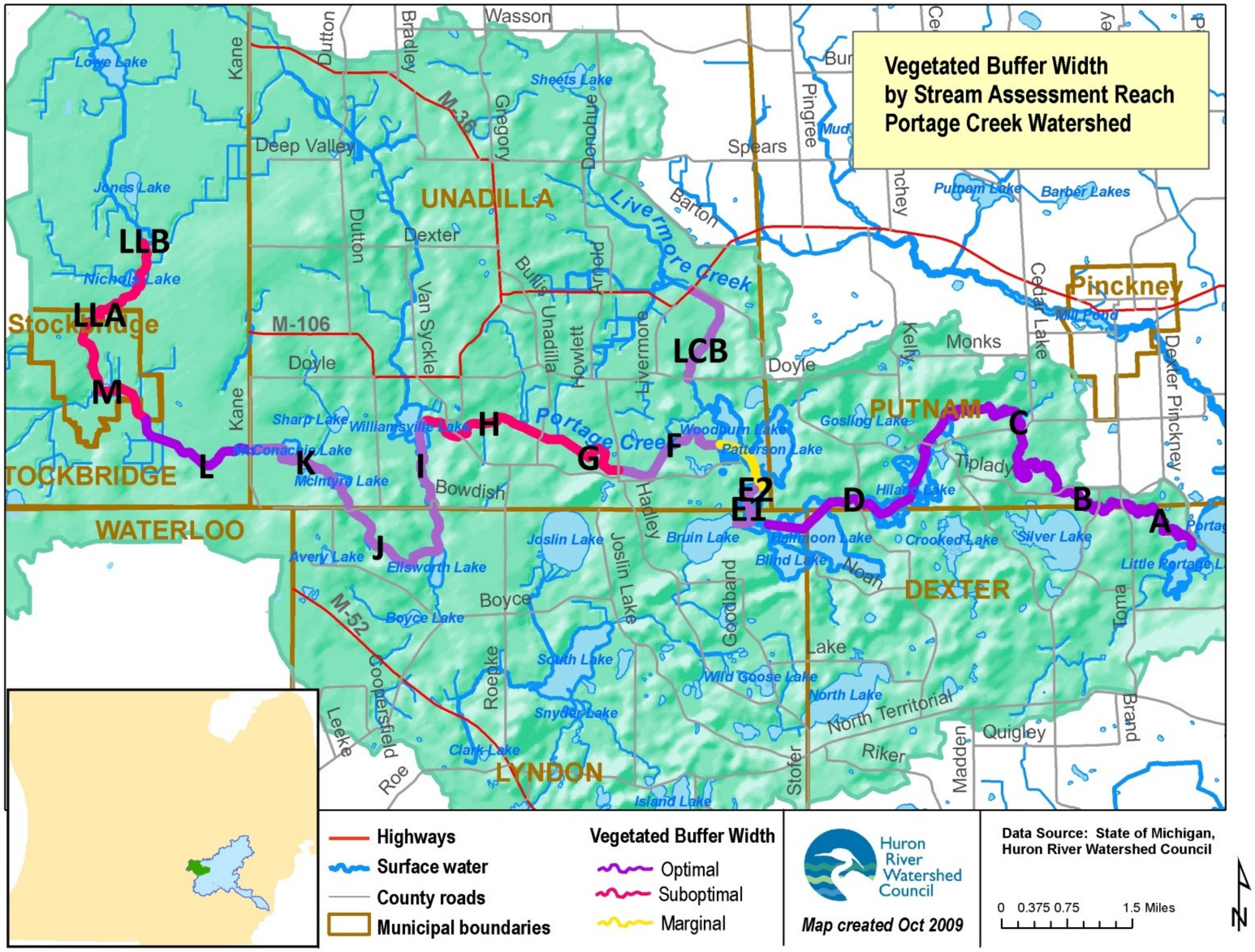

Figure VI-6. Optimal vegetated buffer width is greater than 100 ft on each side and human activities have not impacted the buffer. Suboptimal buffer width measures 50-100 ft on each side and human activities have impacted the buffer only minimally. Marginal buffer width measures 25-50 ft on each side and human activities have impacted the buffer a great deal.

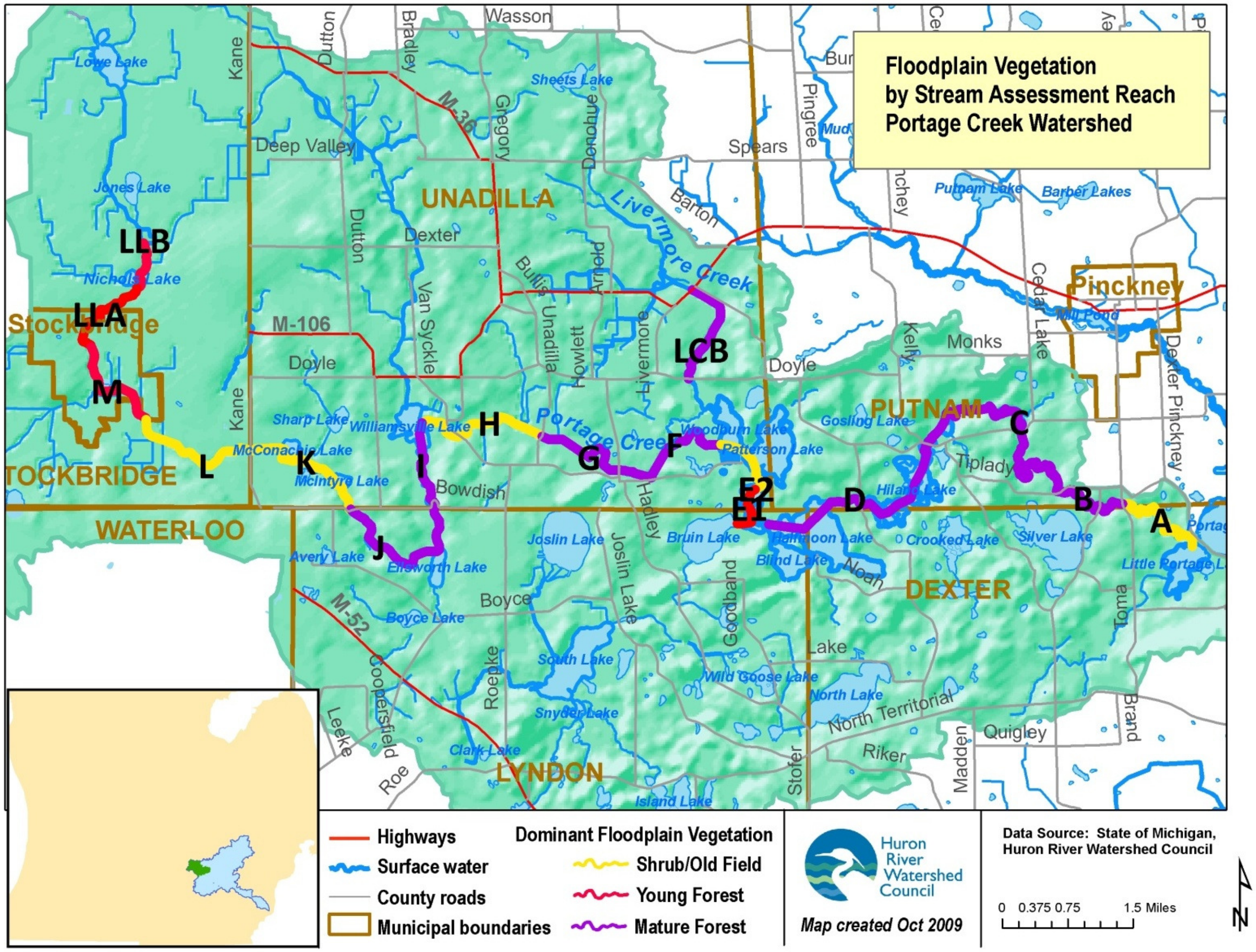

Figure VI-7. Optimal floodplain vegetation is mature forest. Suboptimal vegetation is young forest. Marginal vegetation is shrub and old field. Forests provide valuable functions such as removing pollution from runoff, maintaining stream flow and replenishing groundwater, stabilizing stream banks and reducing erosion, providing wildlife habitat, and cleaning the air.

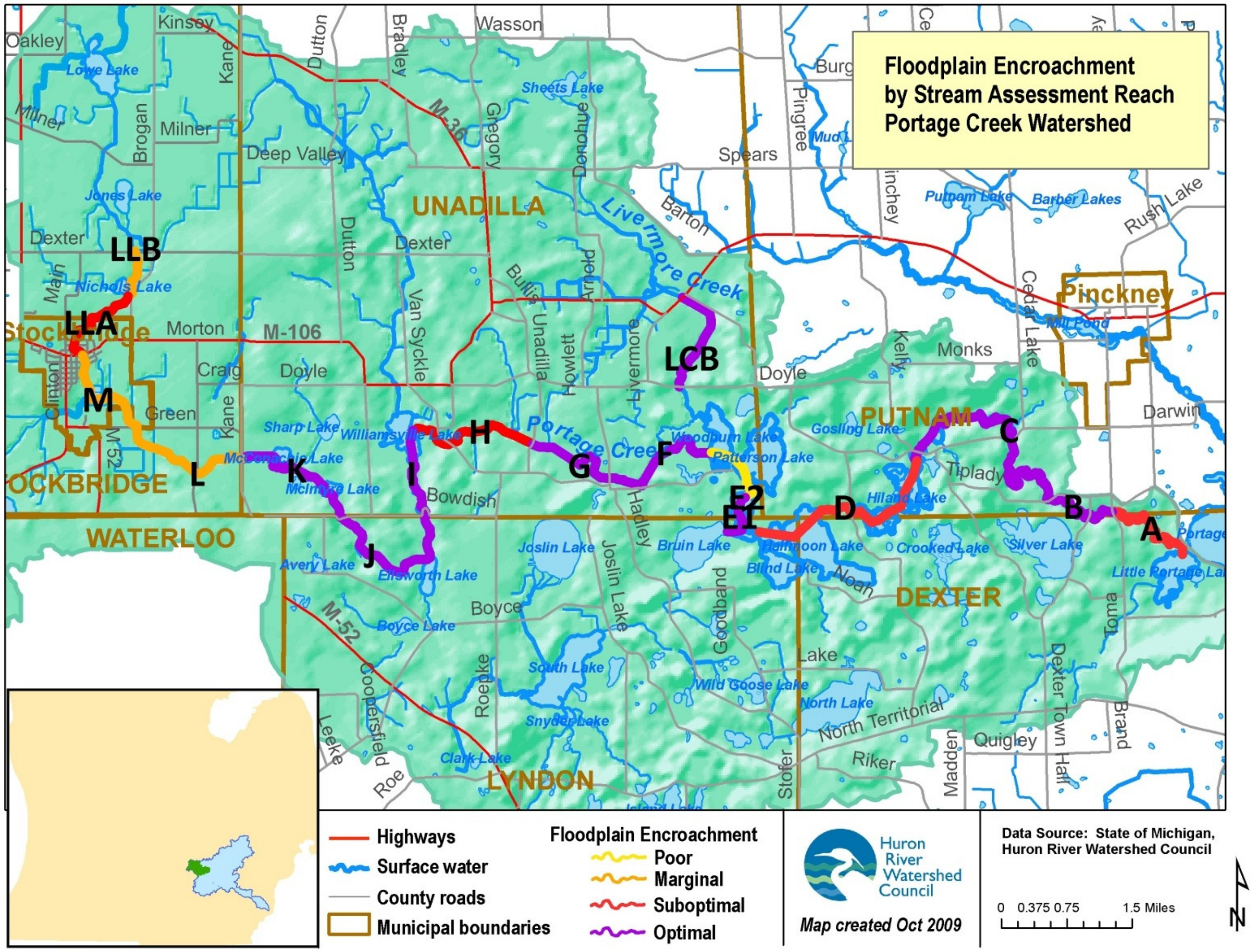

Figure VI-8. Optimal conditions for floodplain encroachment include no evidence of fill materials, land development or manmade structures. Suboptimal conditions are minor amounts of fill materials, land development or manmade structures but without effecting floodplain function. Marginal conditions for floodplain encroachment are moderate amounts of fill materials, land development or manmade structures resulting in some effect on floodplain function. Poor conditions are significant amounts of these activities resulting in significant effect on floodplain function.

Figure VI-9. Locations of Stream Crossings: Not Flow-Aligned

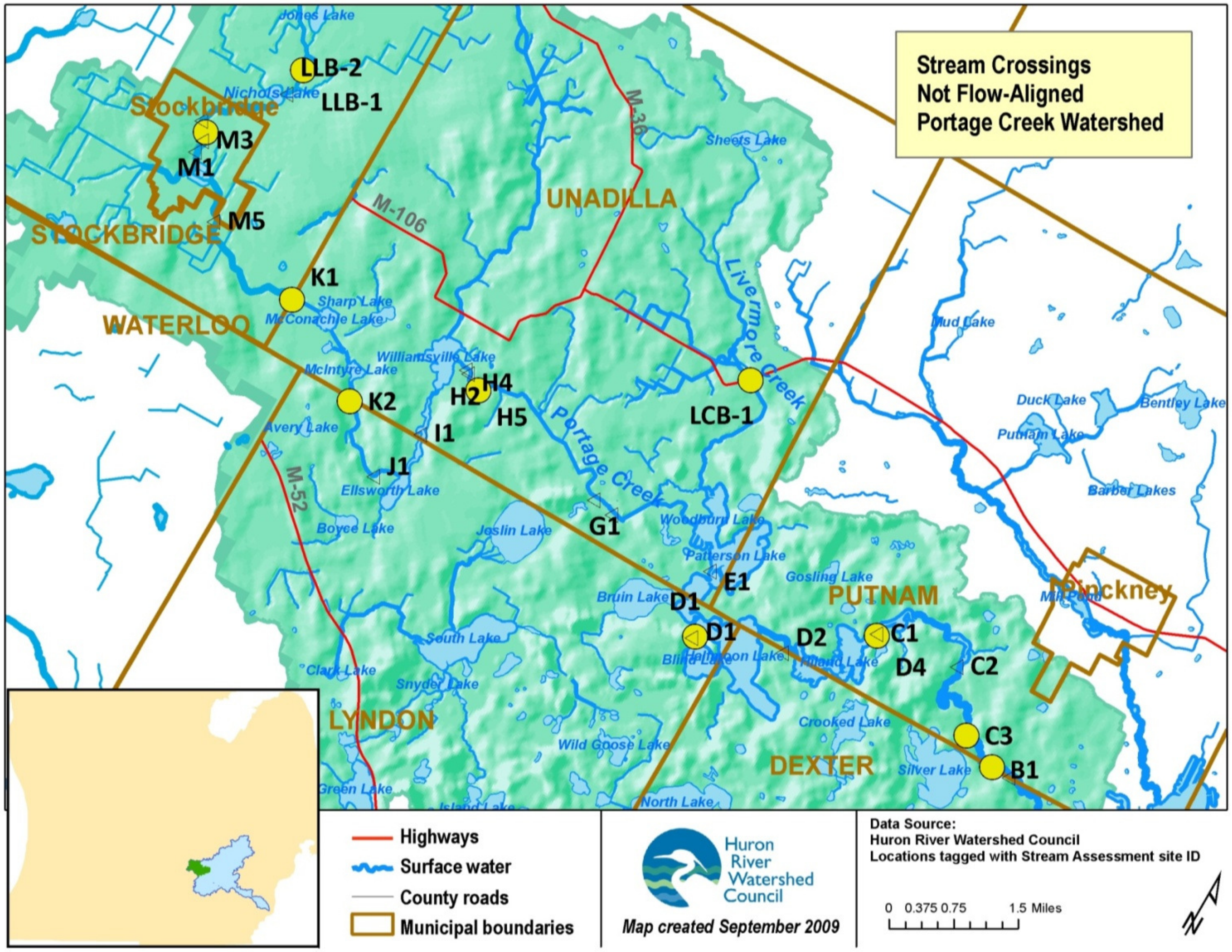

Table VI-C. Stream Crossings Not Flow-Aligned

Problem	SiteID	Latitude	Longitude	Type	Condition	Barrel diameter	Barrel height	Culvert length	Culvert width	Roadway elevation	Restoration potential	Fish blockage	Reason	Drop (ft)
Not flow-aligned	B1	42.424317	-83.949827	Road		8	0	60	0	12		Partial	Clogged culvert	
Not flow-aligned	C3	42.426791	-83.958417	Road	Cracking/ Chipping	0	5	30	24	7	Culvert repair/ replacement	Partial	Road erosion	
Not flow-aligned	D1	42.418595	-84.023161	Footbridge	Cracking/ Chipping	6	6	10	8	10	Culvert repair/ replacement	Partial	Too high	
Not flow-aligned	D4	42.433880	-83.987360	Manmade Dam		6	3	10	16	18	HiLand Dam	Total	Too high	14
Not flow-aligned	H5	42.436428	-84.093760	Road	Too narrow, sediment deposition	20	7	20	20	8	Culvert repair/ replacement	Partial	Road erosion	
Not flow-aligned	K1	42.434070	-84.140740	Road		0	5	32	53	0				
Not flow-aligned	K2	42.424043	-84.117915	Road		24	5	22	0	0				
Not flow-aligned	LCB-1	42.460668	-84.041161	Road	Sediment deposition	6	6	20	10	12		Partial	Too high	
Not flow-aligned	LLB-1	42.468460	-84.164587	Road		0	0	20	0	12	Culvert repair/ replacement	Partial	Too high	
Not flow-aligned	M1	42.451302	-84.176714	Road		6	5	100	0	12	Culvert repair/ replacement	Partial	Too high	

Figure VI-10. Locations of Stream Crossings with Deteriorating Conditions: Sediment Deposition

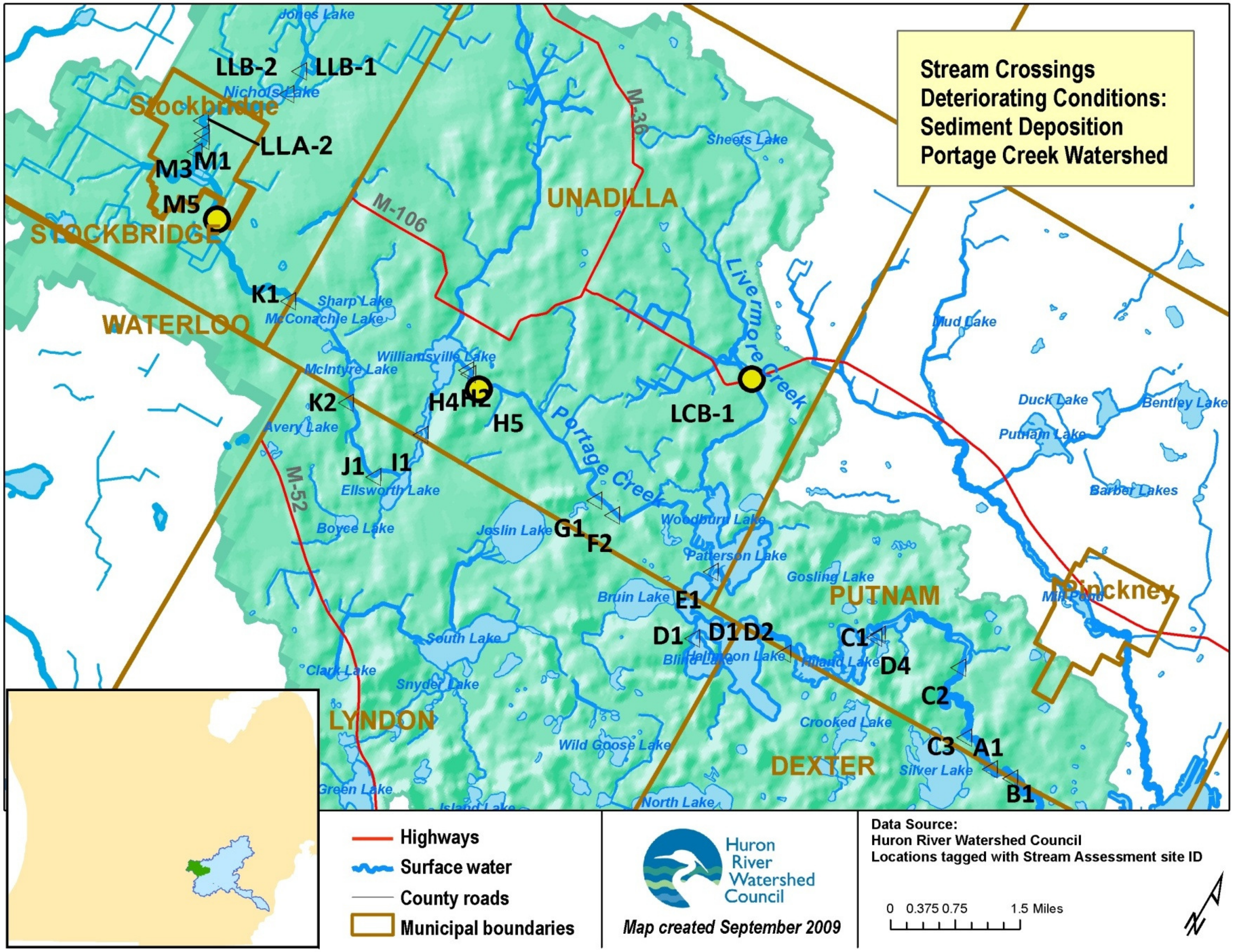

Table VI-D. Deteriorating Conditions at Stream Crossings: Sediment Deposition

Problem	SiteID	Latitude	Longitude	Type	Barrel diameter	Barrel height	Culvert length	Culvert width	Roadway elevation	
Deteriorating Conditions	H5	42.436428	-84.093760	Sediment Deposition	20	7	20	20	8	
Deteriorating Conditions	M5	42.439300	-84.164458	Sediment Deposition	20	10	20	20	25	
Deteriorating Conditions	LCB-1	42.460668	-84.041161	Sediment Deposition	6	6	20	10	12	
Deteriorating Conditions	A*	42.426830°	-83.958419°	Sediment Deposition						* problem appeared after stream assessment

Table VI-E. Deteriorating Conditions at Stream Crossings: Scour Downstream

Problem	SiteID	Latitude	Longitude	Type	Barrel diameter	Barrel height	Culvert length	Culvert width	Roadway elevation	
Deteriorating Conditions	LLA-2	42.45305	-84.178351	Downstream Scour	0	0	0	0	0	
Deteriorating Conditions	M3	42.450137	-84.175912	Downstream Scour	4	4	50	4	12	
Deteriorating Conditions	M4	42.447966	-84.176073	Downstream Scour	8	8	20	8	20	

Figure VI-11. Locations of Stream Crossings with Deteriorating Conditions: Scour Downstream

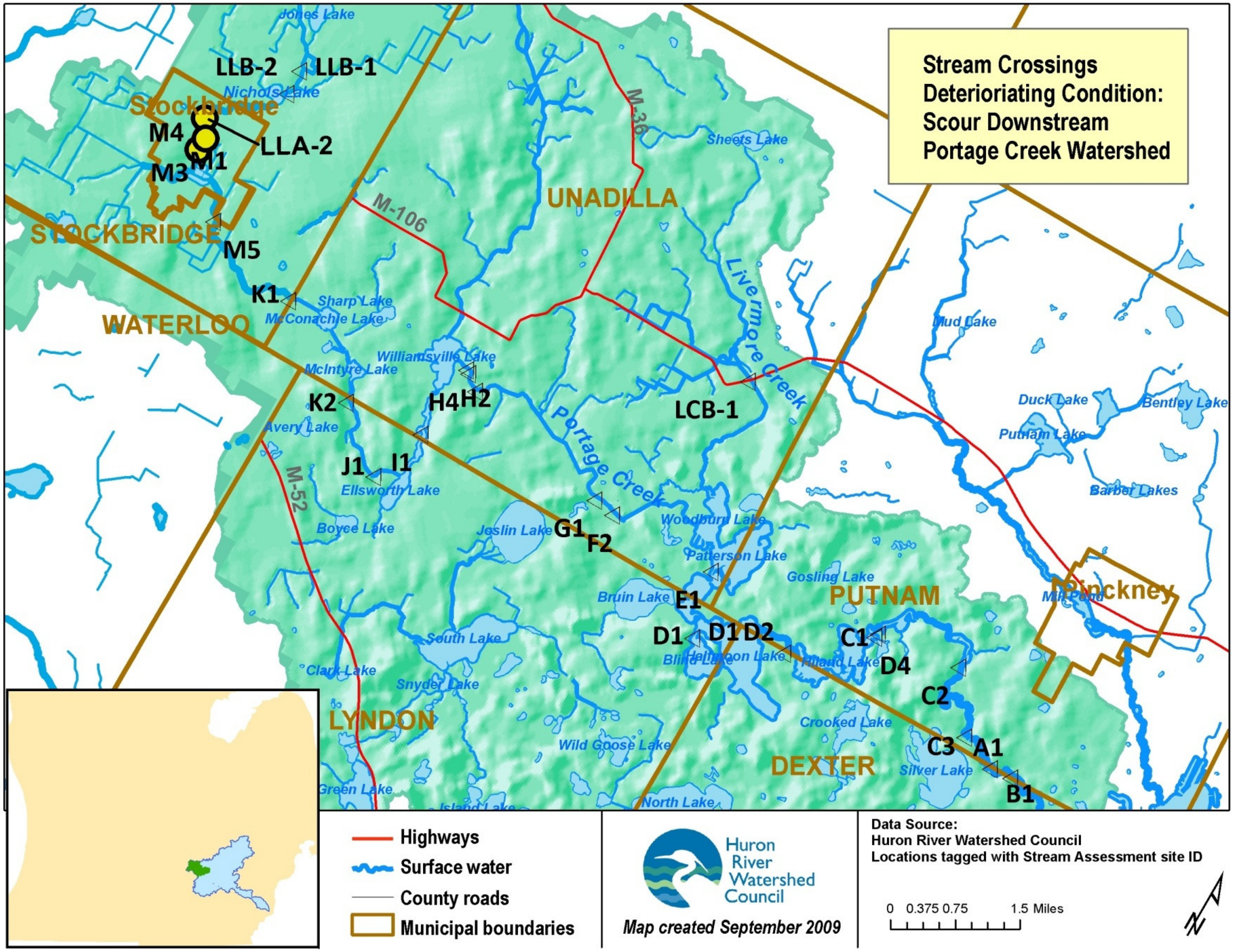

Table VI-F. Restoration Potential: Fish Barrier Removal/Retrofit

Problem	SiteID	Latitude	Longitude	Type	Shape	# of barrels	Material	Flow-aligned	Barrel diameter	Barrel height	Culvert length	Culvert width	Roadway elevation	Restoration potential	Fish blockage	Reason	Drop (ft)	Notes
Fish barrier	D4	42.433880	-83.987360	Manmade Dam			Concrete								Total	Too high	14	HiLand Lake Dam
Fish barrier	H4	42.438434	-84.097111	Manmade Dam			Concrete							Fish barrier removal	Total	Too high	3	Dam from old mill used to power Unadilla. obstructing flow, pooling on left side, all water diverted right. Michael Minix is property owner of dam and notices lots of erosion, losing his yard, but not interested in dam removal as of 10/2009
Fish barrier	M4	42.447966	-84.176073	Road/Trail Crossing	Circular	Single	Concrete	No	8	8	20	8	20	Fish barrier removal/ culvert repair or replacement	Partial	Too shallow		Lakelands Trail

Table VI-G. Restoration Potential: Culvert Repair

Restoration Potential	SiteID	Latitude	Longitude	Type	Condition	Shape	# of barrels	Material	Flow-aligned	Barrel diameter	Barrel height	Culvert length	Culvert width	Roadway elevation	Notes
Culvert repair/ replacement	C3	42.426791	-83.958417	Road crossing	Cracking/ Chipping	Box	Single	Concrete, metal	No	n/a	5	30	24	7	at Tiplady Rd; rock line on downstream side
Culvert repair/ replacement	D1	42.418595	-84.023161	Footbridge	Cracking/ Chipping	Box	Single	Wood	No	6	6	10	8	0	part of Potowatami Trail
Culvert repair/ replacement	H5	42.436428	-84.093760	Road crossing	Erosion; undersized	Span, bottomless	Single	Concrete, metal	No	20	7	20	20	8	50 ft span on Williamsville Rd
Culvert repair/ replacement	J1	42.415507	-84.104122	Road crossing	Sediment deposition	Circular	Single	Metal	Yes	3.5	0	30	0	4	Opening too small. 2-track road washed out. Erosion on-going. Fish likely able to pass.
Culvert repair/ replacement	M4	42.447966	-84.176073	Road/trail crossing	Downstream scour	Circular	Single	Concrete	Yes	8	8	20	8	20	Lakelands Trail

Table VI-H. Restoration Potential: Stream Repair

Restoration Potential	SiteID	Latitude	Longitude	Type	Condition	Shape	# of barrels	Material	Flow-aligned	Barrel diameter	Barrel height	Culvert length	Culvert width	Roadway elevation	Notes
Culvert repair/ replacement	J1	42.415507	-84.104122	Road crossing	Sediment deposition	Circular	Single	Metal	Yes	3.5	0	30	0	4	Opening too small. 2-track road washed out. Erosion on-going. Fish likely able to pass.

Figure VI-12. Locations of Stream Crossings with Restoration Potential: Fish Barrier Removal/Retrofit

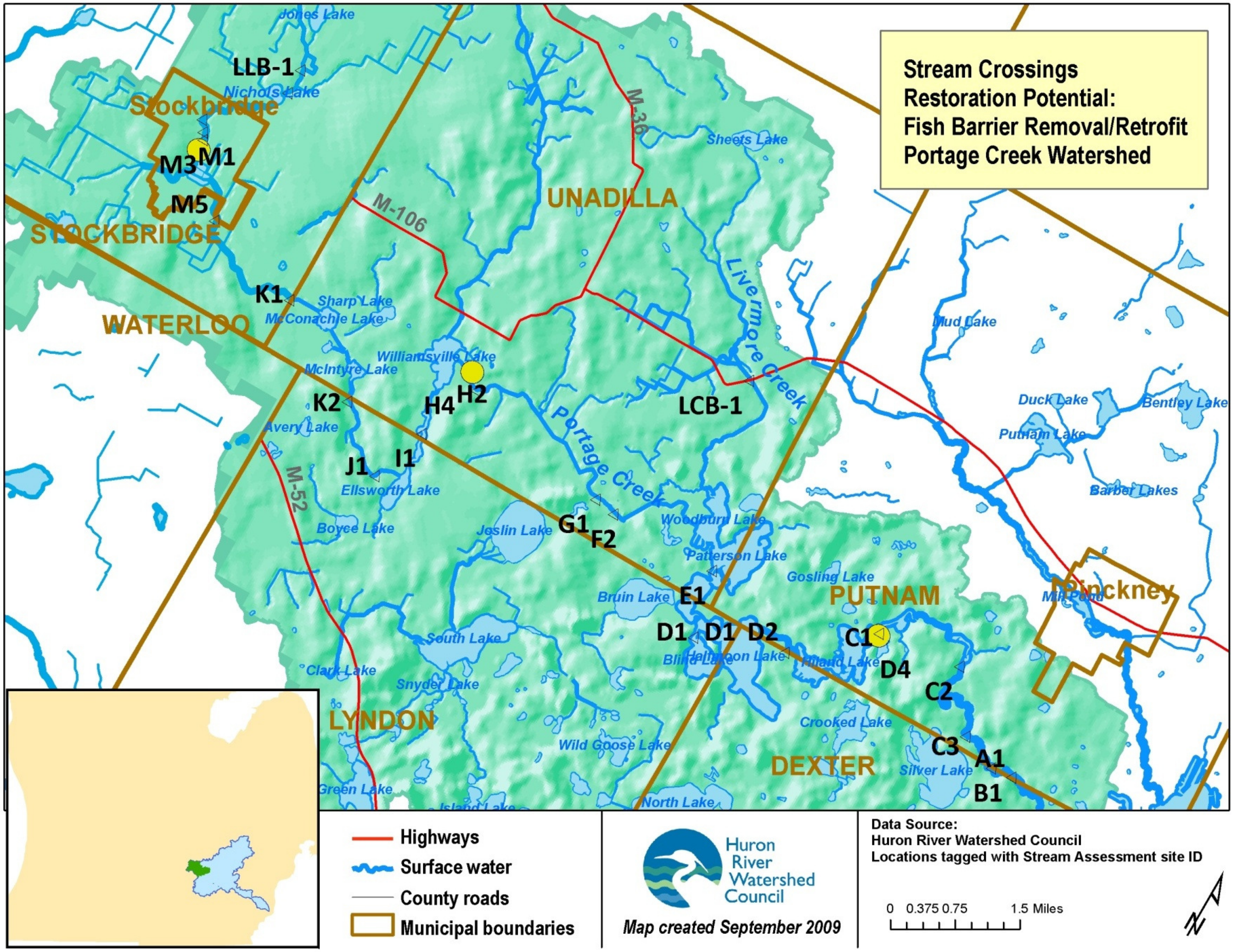

Figure VI-13. Locations of Stream Crossings with Restoration Potential: Culvert Repair

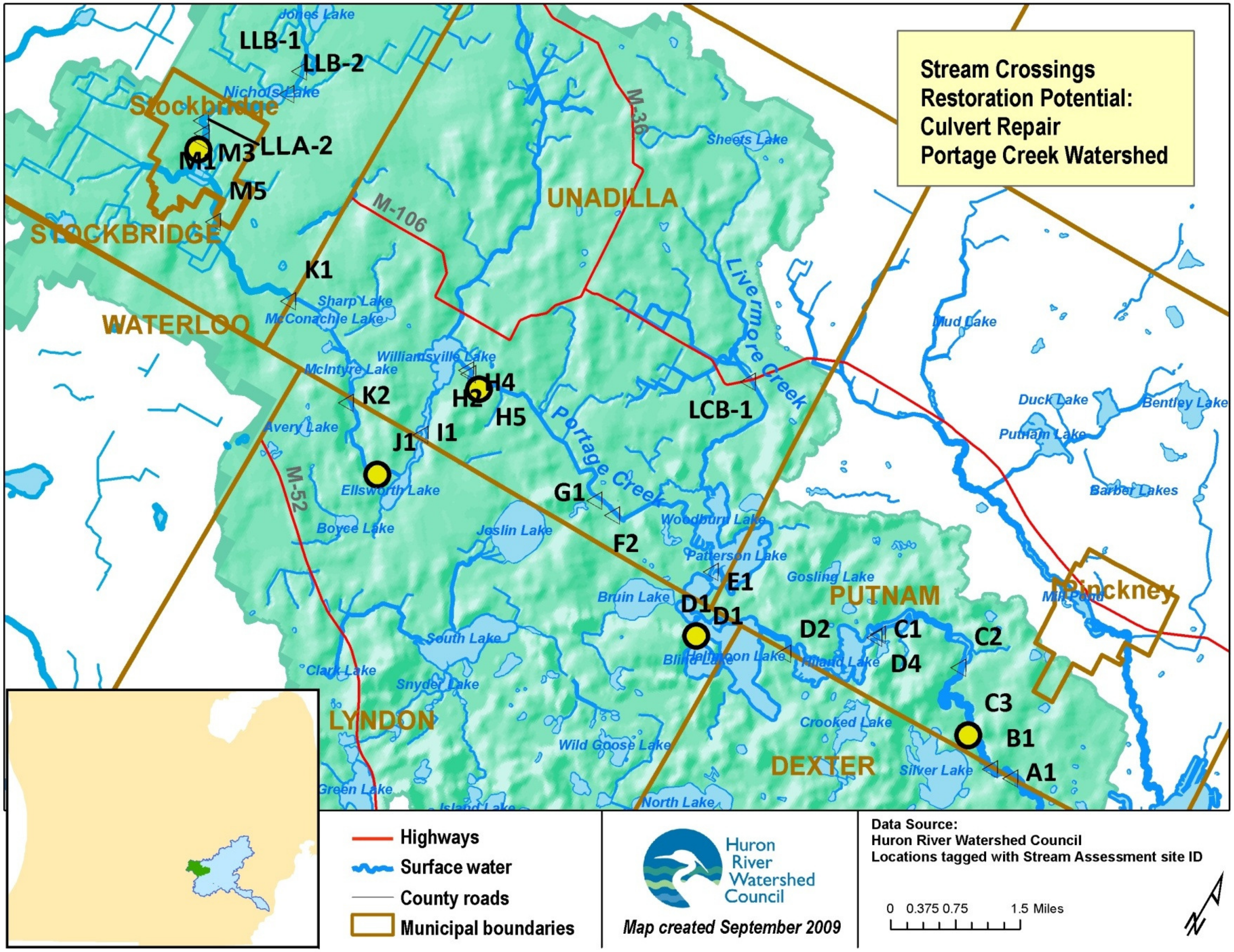

Figure VI-14. Locations of Stream Crossings with Restoration Potential: Stream Repair

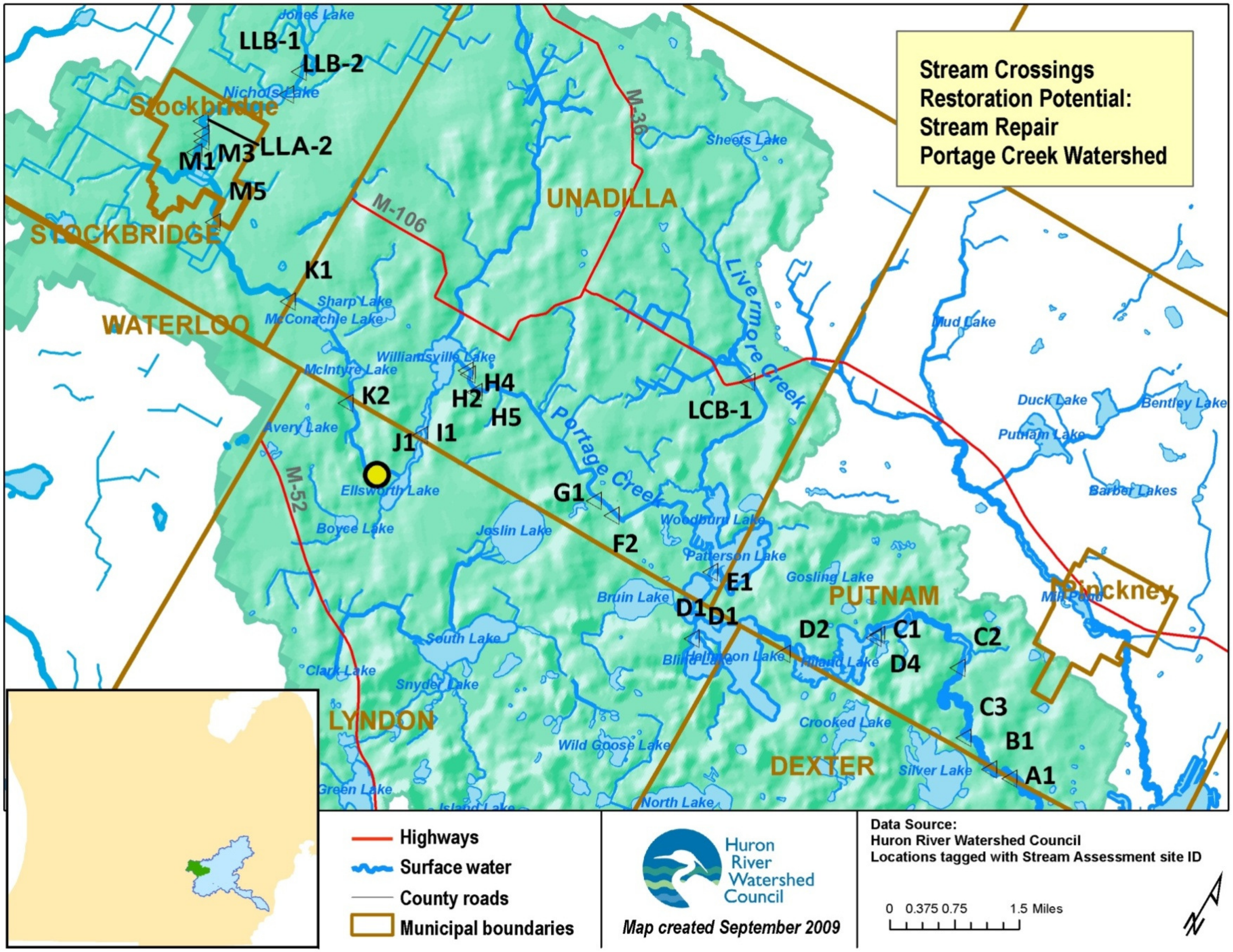

Figure VI-15. Locations of Channel Modification

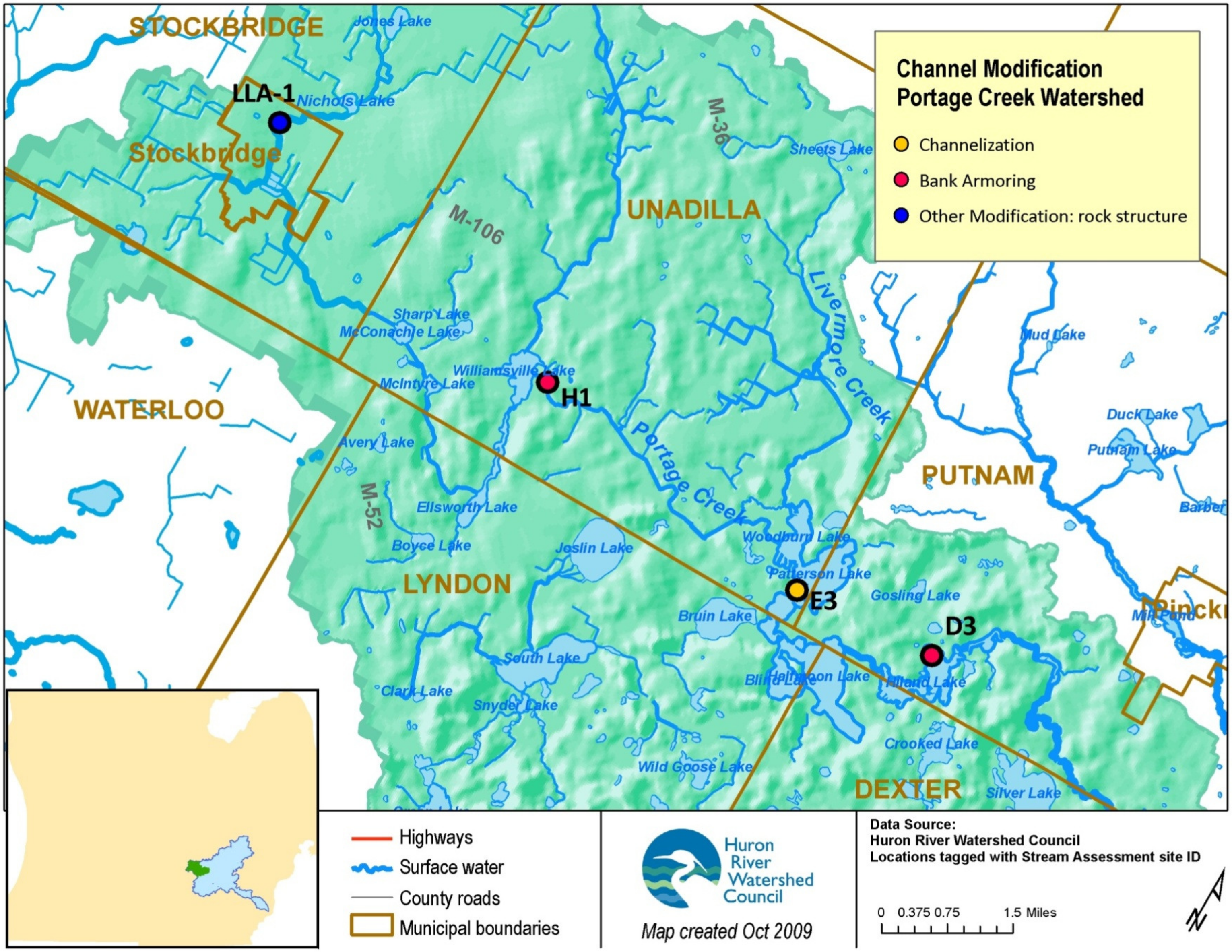

Figure VI-16. Locations of Channel Modification: Restoration Potential

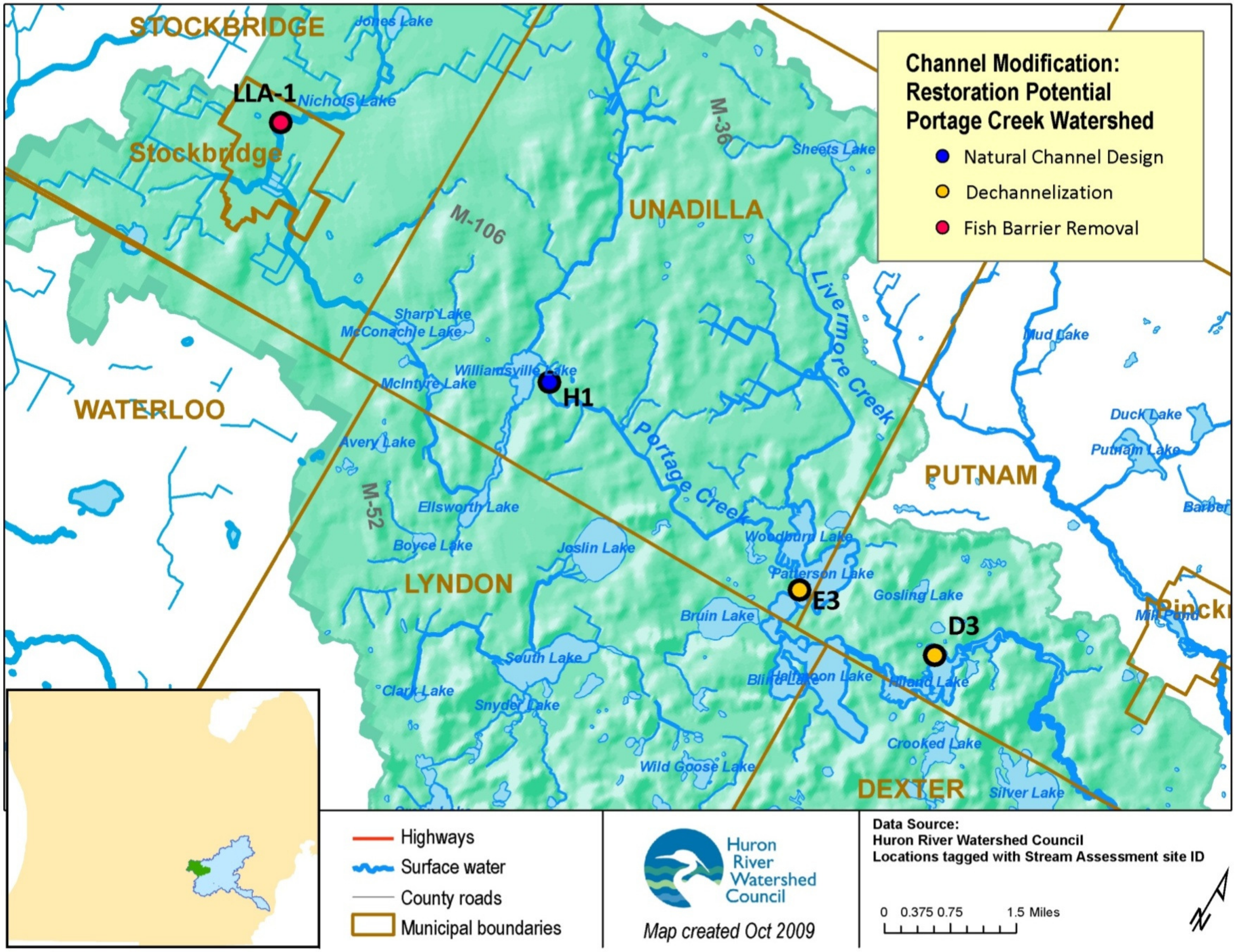

Table VI-I. Channel Modification and Restoration Potential

Problem	SiteID	Latitude	Longitude	Type	Material	Perennial Flow	Sediment deposition	Vegetation in channel	Channel connected to floodplain	Height	Bottom width	Top width	length	Depth of flow	% of channel bottom	Potential Restoration	Severity of Channelization	Notes
Channel modification	D3	42.431213	-83.993658	Channelization	Metal	Yes	No	Yes	No	12	100	100	500	6 in	100	No	2	Between upper and lower Hi-Land Lake. Homeowners constructing armored banks (seawalls) along channel betweeen lakes. Algae blooming. 42.431213, -83.993658
Channel modification	E3	42.429519	-84.026997	Channelization	n/a	Yes	No	No	Yes	2	25	25	300	24	100	No	1	There may have been some channelization/dredging.
Channel modification	H1	42.438812	-84.098106	Bank armoring	Wood	Yes	No	No	No	4	25	25	50	48	100	Natural Channel Design	2	
Channel modification	LLA-1	42.453909	-84.178517	Other	Rocks	Yes	Yes	No	Yes	1	12	12	3	0	0	Fish Barrier Removal	2	Bizarre zig-zag of rocks at Morton house next to large outflow pipe. Fast moving water here. Suggest contact property owner (#207 Morton) to mitigate?

Figure VI-17. Locations of Impacted Stream Buffers and Restoration Potential

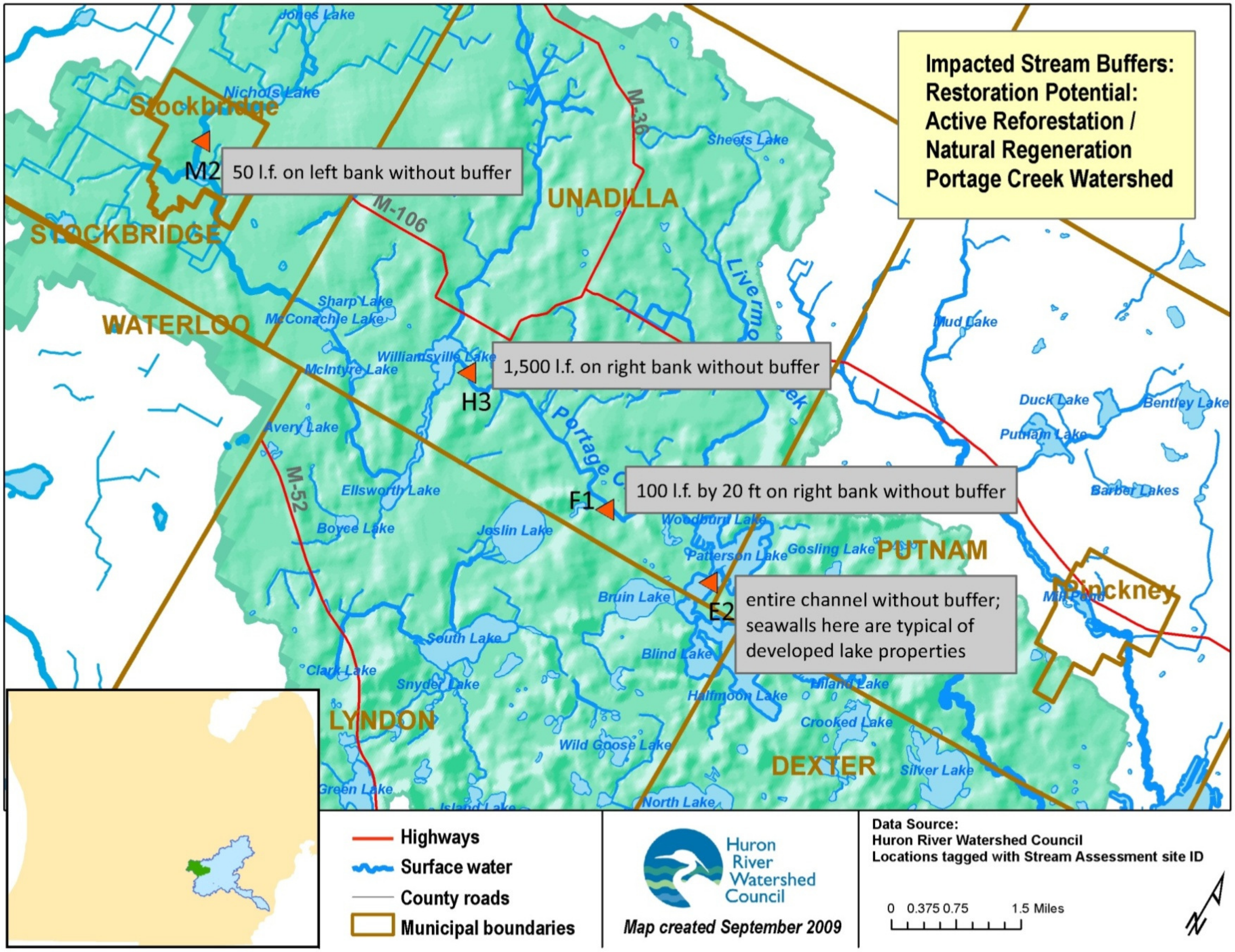

Table VI-J. Impacted Stream Buffers: Restoration Potential as Active Reforestation or Natural Regeneration

Problem	SiteID	Latitude	Longitude	Reason	Land Use Left	Land Use Right	Land Cover Left	Land Cover Right	Invasive Plants	Stream Shade	Potential Restoration	Restorable area Left Length	Restorable Area Left Width	Restorable area Right Length	Restorable Area Right Width	Restoration Potential	Notes
Impacted Buffer	E2	42.428063	-84.026474	Lack of vegetation	Private	Park	Turf Lawn	Shrub/Scrub	None	Partial	No						
Impacted Buffer	F1	42.430219	-84.054978	Lack of vegetation	Unknown	Private	Shrub/Scrub	Turf Lawn	Rare	None	Natural regeneration, Active reforestation	0	0	100	20	3	Need landowner permission
Impacted Buffer	H3	42.438805	-84.097744	Lack of vegetation	n/a	n/a	Trees	Turf Lawn	Rare	Partial	Natural regeneration	0	0	1500	20	3	
Impacted Buffer	M2	42.450210	-84.176023	Lack of vegetation	Private	Private	Turf Lawn	Tall Grass	Partial	None	Active reforestation	50	20	0	0		upstream of Elizabeth Rd

Table VI-K. Summary of Stream Corridor Impairment Remediation Costs

Type of Impairment	Level of Effort	Estimated Cost to Mitigate
Channel Alterations	75 lineal ft @ $65.00/lf	$4,875
Erosion Sites	7582 lineal ft @ $40.00/lf 250 lf (severe only)	$303,280 ($10,000 for severe only)
Fish Barriers	10 occurrences (2 dam removals, Hi-Land Dam at $175,000, remnant Unadilla dam at $25,000; 8 culvert replacements/repair at $150,000-200,00 per site)	$1,600,000 ($1,400,000 for culvert work only)
Inadequate Buffers	7 occurrences = 17 acres 4 acres (severe only) @ $ 500.00/ac	$ 8,500 $2,000 (severe only)
Unusual Conditions (Hot Spots)	1 site (area of concern at downstream reach of Portage Creek and Little Portage Lk; excessive sediment and shoreline erosion)	Unknown
*Cost estimates used above are taken from Huron Chain of Lakes WMP, Maryland-Cooperative Extension Riparian Buffer Cost and Benefit Manual 2000, and The Technical reference for Maryland's Tributary		
(does not include tributaries other than Lowe Lake Drain and Livermore Creek)		

2. Portage Creek Watershed Hydrologic Study

The results of the Portage Creek Watershed Hydrologic Study are presented in the report by the Hydrologic Studies Unit of the MDNRE in Appendix D, and a summary of the Study was included in Section III.

Seventeen sub-watersheds were delineated for the hydrologic analysis. These sub-watersheds (or sub-basins as they are called in Appendix D) are unique to this study and do not necessarily coincide with the boundaries of the sub-watersheds developed for the other analyses conducted for this watershed management plan. In fact, a recommended task, when revising the watershed management plan, is to make the sub-watersheds for all analyses coincide.

Based on the information collected to date from the USGS gage 04172500, and modeling and monitoring conducted specifically for the hydrologic study, Portage Creek peak flows are comparatively low at least partly because of the numerous lakes and a dam in the watershed. The creek benefits from low amounts of impervious surfaces and extensive natural areas, sandy soils and ponding due to the presence of wetlands and floodplains. The peak flows in Portage Creek are low compared to other similar sized watersheds in the area, and for the state generally.

The results of the Hydrologic Study support the protection of existing natural areas in the watershed, and the restoration of critical pieces of the watershed, namely wetlands and stream buffers and floodplains. The study points to the importance of minimizing runoff from the landscape and encouraging infiltration in developed areas and agricultural areas. The Hydrologic Study is a good start to understanding the flow regime of Portage Creek and its watershed.

Watershed partners can build off of this initial work to identify the ecological implications of an altered hydrologic regime. Specifically, watershed partners should consider focusing on identifying environmental flows of Portage Creek and how to achieve or maintain them. Many river restoration projects are focusing on restoring environmental flow regimes to improve ecosystem health in rivers -- and creeks -- that have been altered. In efforts to prevent future ecological impact, water managers are beginning to address the water needs of river ecosystems proactively by reserving some portion of river flows for ecosystem support.[v]

The results of the Hydrologic Study may be useful in identifying management options to improve the flow regime and decrease bank erosion and channel stability, particularly in the downstream reach of Portage Creek. The Advisory Group recorded observations from residents in sub-watershed 1 that excessive amounts of sediment enter Little Portage Lake and Portage Lake from Portage Creek. Some observations suggest that the source of the sediment may be the streambanks and lake shoreline rather than upstream contributions; the downstream reach of the creek is separated from the rest of the creek system at the Hi-Land Lake Dam, which holds back much of the sediment in its reservoir. The streambank and shoreline erosion in this area throughout the year may be linked to the lake levels maintained by the Flook Dam downstream of Portage Lake.

Additional steps were taken beyond the Unified Stream Assessment and Hydrologic Study to understand potential upland pollutant contributions. A combination of desktop tools, site reconnaissance, and information compiled by the authors and provided by Advisory Group members were used to identify upland contributions of pollutants to the Portage Creek system. Land use/land cover, management practices and a simple pollutant loading model were used to characterize current conditions and potential problem sites impacting Portage Creek.

3. Agricultural Practices Assessment

Land in agricultural production comprises one-third of the Portage Creek watershed, and is the single largest developed land use. Information on agricultural practices followed within the Portage Creek Watershed was collected by the Advisory Group for the three townships with the most farm land – Lyndon, Unadilla and Stockbridge. The results are summarized in Table VI-L and show that while conservation practices are used throughout the area, much opportunity remains to engage farmers in these practices. Furthermore, few farmers are taking advantage of the federal Farm Bill cost-share programs that encourage water resource conservation and protection.

Table VI-L. Summary of Farming Practices within the Portage Creek Watershed

	Community		
Farming Practice	**Lyndon Township**	**Unadilla Township**	**Stockbridge Township**
Crops (acres)			
Corn	50% row crops	2,000 acres	2,610 acres
Soybeans		1,000 acres	2,610 acres
Wheat	40%	600 acres	1,305 acres
Hay	10%	400 acres	435 acres
Tillage methods			
Moldboard Plow (conventional)	X	30%	10%
Mulch Tillage	X	40%	60%
No-Tillage	X	30%	30%
Livestock			
Dairy Farm	**Few livestock per property*	3	2
Horse Farms	0	2	2
Beef Farms	0	0	2
Conservation Practices Used			
Crop rotations	X		
Mulch and reduced tillage, no-till	X	X	X
Nutrient management	X	X	X
Pest management	X		
Grass filter strips	X		
Farmer interest in conservation practices			
NRCS EQIP	0	0	1
NRCS WRP	0	0	2

Source: USDA NRCS Field Offices, Ann Arbor and Mason

Sedimentation is the most significant agriculture related water quality impact in the Portage Creek watershed based on stream habitat monitoring conducted by state biologists and HRWC's Adopt-A-Stream program. Sedimentation reduces biological diversity, cobble available for fish spawning, and substrate for aquatic insects (macroinvertebrates). While some amount of erosion and sedimentation is natural in Michigan streams and rivers, the problem with excessive soil and sedimentation can be described as having three distinct, yet related components:

> *In-stream Historical*: Human activities have altered pre-settlement land cover and hydrology in order to accommodate settlement and farming. These activities have created large amounts of sediment that remain in the stream/drain channels.
>
> *In-stream Current Conditions*: Water flowing in any stream/drain causes erosion. This erosion increases as water velocity increases. Irrigation, ditching, drain tiles, impervious surfaces and other agricultural practices have greatly altered the volume and timing of water flow in stream and drains. With higher flow velocities and straightened, trapezoidal channels, water erodes the channel at a higher rate.
>
> *Out-of-stream Current Conditions*: Agricultural fields, building sites, transportation infrastructure, and steep slopes all contribute sediment to streams and drains. Also wind erosion from fields lacking cover, roads and construction sites contribute to sedimentation in streams. Further water erosion from these sites along with harvested timber sites and poorly maintained drain tiles add to the impact.

Nutrient runoff from agricultural fields as a result of wind and water is the second most significant impact to the Portage Creek system. Some of the excess nutrients (phosphorus, in particular) are the result of soil erosion. Soil particles entering streams and drains from agricultural fields have nutrients adsorbed (or attached) to them. Excess nutrients also may enter surface waters as a result of storm runoff washing fertilizer from crops located in close proximity to streams and drains.

Other agricultural related factors can impact surface waters such as:

- Nitrogen from cropped fields (coarse soil types, tile drainage and manure)
- Pesticides from agricultural production (forage, fruit and row crops)
- Flashy hydrology that increases stream channel erosion (from drains, drain tiling, and impaired wetlands)

Several agricultural best practices could be implemented throughout the watershed. The practices which could be the most effective for addressing the specific problems in the Portage Creek watershed are the following:

- Buffer Strips
- Wetland Restoration
- Conservation Tillage
- Comprehensive Nutrient Management Plan
- Channel/Drain Naturalization

These best practices are described in Section VII.

4. Comparative Subwatershed Assessments

The Comparative Subwatershed Assessments presented in section IV and discussed in section V further our understanding of upland impacts to the Portage Creek system. The level of protection and restoration opportunity for each subwatershed is identified relative to the other 13 subwatersheds, and the watershed threats, their sources and causes are prioritized. Recommended activities to reduce or eliminate the threats are provided.

5. Estimating Pollution in Portage Creek

As mentioned repeatedly in section IV, very little representative water data is available for the Portage Creek watershed that could help establish baseline conditions. As a result, the authors used the Simple Method to estimate pollution contributions to Portage Creek. The Simple Method is a lumped-parameter empirical model used to estimate water runoff pollutant loadings under conditions of limited data availability. The Simple Method relates watershed characteristics to pollutant loading for the following parameters: Biological Oxygen Demand; Chemical Oxygen Demand; Total Suspended Solids; Total Dissolved Solids; Total Phosphorus; Ortho-(Dissolved) Phosphorus; Total Kjeldahl Nitrogen; Nitrate +Nitrite Nitrogen; Lead; Copper; Zinc; and Cadmium.

The approach calculates pollutant loading using drainage area, pollutant concentrations, a runoff coefficient, and precipitation data. In the Simple Method, the amount of rainfall is assumed to be a function of the imperviousness of the contributing drainage area. More densely developed areas have more impervious surfaces causing more water runoff instead of water being absorbed into the soil. Watershed-specific values for the equation parameters were applied using the monitoring data collected by the Rouge River Program Office, Michigan (1997). Land Use/Land Cover data from SEMCOG (2000) were used to characterize current conditions, and data from the Michigan Natural Features Inventory as digitized from 1830s General Land Office maps were used to characterize baseline (presettlement) conditions.

All pollutants considered in this exercise increased from baseline conditions to current conditions, not surprisingly. Developed land uses contribute pollution to waterways and waterbodies. Increases in selected pollutants are presented in table VI-M; most pollutants show a triple digit increase over baseline conditions. Based on this modeling exercise, it appears that even the modest levels of growth in the watershed are resulting in detectable impacts to the Portage Creek system.

When this watershed management plan is updated, the method used to estimate loads will need to be revised in light of the clarification (provided by MDNRE reviewers) that the Simple Method was applied improperly. The PLOAD user’s manual indicates that the method has a size limitation of 1 sq mi if the Event Mean Concentration approach is used, as it was in this plan. As a result, the pollutant loads estimated by the Simple Method may be unreliable.

Table VI-M: Percent Change in Annual Load for Select Pollutants in the Portage Creek watershed using the Simple Method

Parameter	Presettlement Annual Load (lbs/yr)	Current Annual Load (lbs/yr)	Percent (%) Change
Biological Oxygen Demand	55,287	414,820	650
Chemical Oxygen Demand	497,575	1,896,171	281
Total Suspended Solids	939,858	2,571,569	174
Total Dissolved Solids	7,647,886	8,398,433	10
Total Phosphorus	2,264	9,094	302
Total Kjeldahl Nitrogen	17,322	55,257	219

The Simple Method was applied to each of the 14 subwatersheds in the Portage Creek watershed. Pollutant load estimations by subwatershed are presented in Appendix E. In summary, the agriculture subwatersheds show high pollutant contributions for Total Suspended Solids, Total Dissolved Solids, Total Phosphorus, Nitrite + Nitrate Nitrogen, and Chemical Oxygen Demand. The residential subwatersheds show high pollutant contributions for Biological Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Total Dissolved Solids, Total Phosphorus, Total Kjeldahl Nitrogen, and heavy metals (Zinc, Copper, Cadmium and Lead). Runoff from the transportation network of roads shows high pollutant contributions for Biological Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Total Dissolved Solids, Total Phosphorus, Total Kjeldahl Nitrogen, and heavy metals (Zinc, Copper, Cadmium and Lead).

E. Watershed Management Best Practices

Management alternatives to address the sources and causes of the threats to water resources are called best practices. Best practices cover a broad range of activities that vary in cost, effectiveness, and feasibility, depending on a complex set of factors. A watershed best practice is a technique, measure, or structural control that is used for a given set of conditions to manage the quantity and improve the quality of runoff in the most cost effective manner.

No single best practice can address all water quality problems. Each practice has certain limitations based on drainage area served, available land space, cost, pollutant removal efficiency, as well as a variety of site specific factors such as soil types, slopes, and depth of groundwater table. Careful consideration of these factors is necessary in order to select the appropriate best practices for a particular location or situation.

A set of 17 best practices has been developed for the Portage Creek watershed by the Advisory Group that are viewed as the most cost-effective practices to achieve fulfillment of the goals and objectives, especially in the short-term. These best practices are presented in Table VI-N and include vegetative, structural and programmatic activities to address the threats and opportunities identified in this planning process. The table summarizes the recommended best practices as well as costs to implement them in years 1-5 and estimated pollutant reduction for select water quality constituents.

To estimate the water quality benefits gained from the recommended best practices, the activities were run through a method that provides a gross estimate of sediment and nutrient load reductions (Appendix E). Best practices that employ vegetative and other physical techniques are appropriate for inclusion in the method rather than programmatic activities that are difficult to tie to water quality improvements.

The authors used the "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual" (Michigan Department of Environmental Quality, June 1999) that includes agricultural and urban BMPs. This workbook uses many simplifying assumptions to provide a general ESTIMATE of pollutant load reductions through BMP implementation. More accurate results of pollutant load reductions may be obtained through direct monitoring and/or a more detailed modeling application. In addition, the workbook does not estimate pollutant load reductions for dissolved constituents.

Table VI-N. Summary of Implementation Project Costs and Pollutant Reductions (Years 1-5)

Best Practice	Goal	Cost	Pollutant Reduction (lbs)
1. Restore Vegetated Stream Buffers[i]	82 acres	($500/ac + staff) $75,000	177,039 TSS, 1,543 N, 200 P
Natural Shoreline Demonstration Project	3 sites	$100,000	
2. Restore Wetlands[ii]	500 acres	($2,000/ac + staff) $1,000,000	132,349 TSS, 546 N, 136 P
3. Develop Environmental Flow Recommedations	set of recommendations	$25,000	
4. USDA Farm Best Practices and Farmer Outreach[iii]	5 projects	($25,000/site + staff) $139,625	382 TSS, 765 N, 382 P
5. Environmentally Sensitive Dirt and Gravel Roads Maintenance and Design[iv]	2 trainings, 1 demonstration project	$28,000	
6. Repair Erosion Sites[v]	7582 lineal ft; 250 lf (moderate/severe)	$303,280; $25,000 ($40/lf + staff) (moderate/severe)	166.2 tons Sediment, 332.7 N, 166.2 P
7. Remove Fish Barriers[vi]	10 sites	$1,600,000; $1,400,000 for culvert work only	
8. Detect and Correct Failing and High Risk Septic Systems[vii]		$35,000	10% reduction N, P
9. Coordinated Water Quality Monitoring System[viii]		$75,000	
10. Coordinated Public Information and Education Campaign[ix]		$136,000	
11. Develop Tourism Campaign		$60,000	
12. Easements on High Quality Natural Areas[x]	1,525 acres	($3,250/50 ac easement + staff) $150,000	147,979 TSS, 7,018 N, 1,099 P
13. Habitat for Reptiles and Amphibians[xi]	12-15 public land survey blocks in Pinckney SRA	$75,000	
14. Local Government Policy Improvements[xii]		$36,000	22% reduction P
15. Water-based Recreation Committee		$8,000	
16. Intergovernmental Watershed Group		$10,000	
17. Good Housekeeping Practices		$205,000	22%-31% TSS, 4%-8% P, and 4%-7% N
Total with All Programs (minimum)		$3,582,625	
Total with All Programs (maximum)		$4,060,905	

[I, ii, iii] cost estimate from USDA NRCS
[iv] Pennsylvania State University Center for Dirt and Gravel Road Studies
[v] Huron Chain of Lakes WMP, Maryland Cooperative Ext Riparian Buffer Cost and Benefit Manual 2000
[vi] Huron Chain of Lakes WMP, HRWC
[vii, viii, ix] HRWC
[x] Legacy Land Conservancy
[xi] Herpetological Resource & Management
[xii] Lower Huron River WMP

[i] Brown, E., A. Peterson, R. Kline-Roback, K. Smith, and L. Wolfson. February, 2000. Developing a Watershed Management Plan for Water Quality; and Introductory Guide, Institute for Water Research, Michigan State University Extension, Michigan Department of Environmental Quality, P.10.45 R323.1100 of Part 4, Part 31 of PA 451, 1994, revised 4/2/99.

[ii] The Rouge River Project. 2004. Overview Description of OSDS Management Program. http://www.rougeriver.com/techtop/osds/overview.html. Accessed 2005.

[iii] Washtenaw County Drain Commissioner. Septic System Website. http://www.ewashtenaw.org/living/environmental_health_and_services/environmental_portal/septic_systems. Accessed November 2007.

[iv] Aichele, Steven S. 2005. Effects of Urban Land-Use Change on Streamflow and Water Quality in Oakland County, Michigan, 1970-2003, as Inferred from Urban Gradient and Temporal Analysis. U.S. Geological Survey Scientific Investigations Report 2005-5016.

[v] Richter, Brian D., Andrew T. Warner, Judy L. Meyer and Kim Lutz. A Collaborative and Adaptive Process for Developing Environmental Flow Recommendations. River Research and Application 22: 297-318 (2006)