7. Watershed Objectives and Recommended Actions

In this chapter, the objectives for protecting and restoring the Huron Creek Watershed are listed (Section 7.1). Next, recommended actions for protecting and restoring the Huron Creek Watershed are described in detail (Section 7.2). The recommended actions are presented under the categories of physical improvements, monitoring plans, and ordinances (Sections 7.3, 0, and 7.5). Along with the descriptions, potential partners, implementation timelines and milestones, and estimated costs for each action are given. Following the recommended actions, sources for best management practices (BMPs) are given, which provide guidance on how best to implement the recommended actions (Section 7.6). Next, potential funding sources for implementing the recommended actions are listed (Section 7.7). Finally, pollutant reductions associated with the recommended actions are estimated (Section 7.8).

7.1. Goals and Objectives

In Table 7.1, the watershed goals listed in Chapter 4 are associated with specific objectives to be completed. These objectives have been designed to address priority pollutants and critical areas. The objectives are expanded into recommended actions in Section 7.2 and into information/education plans in Chapter 8.

Table 7.1 Goals and Objectives for the Huron Creek Watershed

Goals	Objectives
Improve and protect aquatic and terrestrial ecosystems	***Manage copper and iron pollution through:*** - Reclamation or removal of stamp sand areas near the creek - Continued operation of the leachate collection system by City of Houghton - Continued monitoring of copper and iron concentrations in Huron Creek ***Manage the "flashiness" of stormwater flows through:*** - Installation or improvement of stormwater detention ponds - Implementation of stormwater management and buffer ordinances - Establishment of flow monitoring system and calibration of flow model ***Manage sediment pollution through:*** - Installation of or improvement stormwater detention ponds - Stabilization of creek banks and channel in the Kestner Waterfront Park, landfill leachate system area, "Shopping Cart Creek," and the Critical Erosion Locations - Implementation of stormwater management and buffer ordinances - Education about proper construction techniques and stabilization practices for minimizing erosion - Continued monitoring of erosion and sediment deposition sites in Huron Creek ***Protect and improve the vegetative buffer through:*** - Implementation of a buffer ordinance - Enhancement of buffer vegetation in the Kestner Waterfront Park, landfill leachate system area, and the creek re-route/mitigation area ***Control the establishment of invasive vegetative species through:*** - Continued monitoring of establishing species - Removal of invasive plants combined with re-establishment of native vegetation ***Protect and improve biodiversity through:*** - Completing a biodiversity study or studies in the wetland mitigation and potential wetland restoration areas. - Recommending improvements to habitat areas that are designed to increase biodiversity.

Goals	Objectives
Protect recreational use by reducing copper and iron, bacteria and nutrient concentrations in the creek	***Manage copper and iron pollution through*** - Reclamation or removal of manageably-sized stamp sand areas near creek - Continued operation of the leachate collection system by City of Houghton - Continued monitoring of copper and iron concentrations in Huron Creek ***Manage bacterial pollution through:*** - Connection of Dakota Heights and/or other areas to public sewers - Continued monitoring of coliform bacteria in Huron Creek ***Manage nutrient concentrations through:*** - Connection of Dakota Heights and/or other areas to public sewers - Continued monitoring of nutrient concentrations in Huron Creek - Education about use of residential & commercial fertilizers - Implementation of a buffer ordinance - Implementation of a stormwater ordinance (infiltration practices)
Protect and improve the vegetative buffer	***Protect and improve the vegetative buffer through*** - Implementation of a buffer ordinance - Enhancement of buffer vegetation in the Kestner Waterfront Park, landfill leachate system area, and the creek re-route/mitigation area
Improve and restore the creek areas in the Kestner waterfront park and maintain access to creek	***Restore the creek in the waterfront park by:*** - Leveling out steep bank areas - Stabilization of the toe of the bank to protect against future erosion - Planting the banks with native vegetation while leaving areas open for access & viewing - Repair or replace the walkway near the mouth with a bridge
Encourage use of the Wal-Mart wetland mitigation area for educational and outreach purposes	***Use the wetland mitigation area for education and outreach by:*** - Working with City of Houghton for permission and access - Educating about wetland and watershed health at the site - Creating signage and/or an "education station" for use by classes and/or organizations
Install interpretive signs on watershed health and historical heritage	***Install interpretive and educational signage through:*** - Working with WAC & historical experts to determine appropriate locations and topics - Identifying funding sources and technical assistance

7.2. Summary of Recommended Actions

Recommended actions include physical improvements, monitoring plans, ordinances, and an information and education strategy (described in Chapter 8 and summarized in Table 8.1). Table 7.2, Table 7.3, and Table 7.4 provide a summaries of recommended actions and their corresponding potential partners, estimated costs, potential funding sources and milestones. Implementation timelines are presented on a 10-year timeline, with short-term (0-3 years), mid-term (3-7 years) and long term (7-10 years) proposed schedules. Continuously implemented items are expressed as 0-10 years.

The recommended actions are presented in order of their recommended priority (highest to lowest). The order of priority is based on several factors including the (a) the priority of the associated pollutant or characteristic (see Section 6.1), (b) potential availability of funding for the action, (c) anticipated interest in the action by the local community.

In Sections 7.3, 7.4 and 7.5, each recommended action is described in more detail, as well as the following information:

- related objectives (from Table 7.1)
- potential partners
- implementation timeline
- milestones
- estimated cost

The potential partners are suggested groups and organizations that could potentially provide financial and/or technical assistance associated with the recommended action. Simple milestones have also been suggested as interim targets for project completion. Associated costs are provided in the form of a cost range as some actions may vary in scope or are difficult to target. These quantities and costs are rough estimates and should be verified and/or recalculated prior to grant application or implementation[19]. All costs are based on 2008 prices. Detailed calculations of estimated costs are provided in Appendix O.

[19] The quantities and costs estimated for the Kestner waterfront park improvements were completed as part of a detailed estimate (included in Appendix P) and have been reviewed by the City of Houghton. All other costs are summarized in Table 8.5 and Appendix O.

Table 7.2 Summary of Recommended Actions: Physical Improvements

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.3.1. Reduce Metals and Ammonia Loads to Huron Creek	City of Houghton, HKCD, NRCS MDEQ, CWS	Short-term (0-3 yr)	1. Mitigate stamp sand area next to Huron Creek in vicinity of Ridge Road Landfill	10/09: Soil and vegetation cover plan established 10/10: Soil and vegetation cover placed 10/11: Vegetation established	$800 to $1,200	MDEQ-NPS
	City of Houghton, HKCD, NRCS MDEQ, CWS	Short-term (0-3 yr)	2. Mitigate stamp sand in wetlands mitigation area	10/09: Soil and vegetation cover plan established 10/10: Soil and vegetation cover placed 10/11: Vegetation established	$1,000 to $3,800	MDEQ-NPS
	City of Houghton, MDEQ, CWS	Long-term (0-10 yr)	3. Evaluate performance of landfill leachate collection system	10/09 to as needed: Monitor leachate collection system performance	$500 to 1,000/yr	
7.3.2. Further Study of Stormwater Management Issues	HKCD, MDEQ, CWS, NRCS, Houghton County Drain Commissioner	Short-term (0-3 yr)	Conduct survey of stormwater systems and stormwater modeling; assess best management alternatives for reducing the flashy flows.	5/10: Develop outline of stormwater management study and hire consulting firm or other organization to perform study 5/11: Complete study	$50,000	MDEQ-NPS, MDEQ-Revolving Fund
7.3.3. Improve Huron Creek in Kestner Waterfront Park	City of Houghton, HKCD, MDEQ, Master Gardeners	Short-term (0-3 yr)	Stabilize banks and establish vegetative buffer	10/09: Banks stabilized 06/10: Vegetation planted 06/11: Vegetation stabilized	$70,000 to $85,000	CZM, EPA GLNP
7.3.4. Septic System and Sanitary Sewer Improvements	City of Houghton, Portage Township	Short-term (0-3 yr)	Connect Dakota Heights to sanitary sewer	10/09: Bid contract 6/10: Complete construction	Approximately $1 million, with a USDA grant covering $724,000	City of Houghton, Portage Township, Property Owners, USDA

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.3.5. Improve "Shopping Cart Creek" Area	HKCD, MDEQ, Copper Country Mall, Wal-Mart of Houghton	Short term (0-3 yr)	1. Install stormwater detention pond at the source of Shopping Cart Creek.	12/10: Develop plans for detention pond 6/11: Begin construction of detention pond 10/11: Complete construction of detention pond	$200,000	EPA GLNP, NPS, Private
	HKCD, MDEQ, NRCS, Houghton County Drain Commissioner	Mid-term (3-7 years)	2. Stabilize erosion areas	6/11: Develop plans for stabilizing erosion areas 6/12: Begin stabilization efforts 10/12: Complete stabilization efforts	$10,000 to $36,000	EPA GLNP, MDEQ-NPS, Private
	HKCD, MDEQ, CWS, NRCS, Houghton County Drain Commissioner	Short to Long-term (0-10 yr)	3. Establish baseline data for headcut and continue to monitor.	10/09: Collect baseline data and develop monitoring program 10/09 to indefinite: Continue monitoring	$0 to $1,900/yr	City of Houghton, CWS
7.3.6. Improve Wetland Mitigation and Creek Re-route Areas	City of Houghton, SWS, MDEQ, MSUE, MG, Landowners	Short to Long-term (0-10 yr)	1. Remove invasive species and establish native plant species	10/10: Establish plan for reducing existing invasive species 5/11: Begin removal of invasive species 7/11: Complete removal of invasive species and begin planting of native species 10/11: Complete removal of invasive species and begin planting of native species 10/11 to indefinite: Monitor vegetation	$22,500 to $45,000	Private, NPS, U & CF, NAWCA
	City of Houghton, CCTU	Short to Long-term (0-10 yr)	2. Physical Improvements	10/10: Establish plans for physical improvements 5/11: Begin construction- create pools, place coarse woody debris and boulders 10/11: Complete physical improvements 10/11 to indefinite: Monitor improvements	$2,000 to $3,000	City of Houghton, TU

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.3.7 Mitigate Erosion Areas	City of Houghton, HKCD, MDEQ, MSUE, Adjacent Businesses	Short-term (0-3 yr)	1. Improve Ridge Road Landfill Area	10/10: Erosion control replaced 10/11: Vegetation planted 10/12: Vegetation established	$13,000 to $18,000	NPS, U & CF
	HKCD, MDEQ, Landowners	Mid-term (3-5 yr)	2. Mitigate Critical Erosion Locations (A, B, C, D, E, G)	10/10: Plans for mitigation established 5/11: Begin mitigation construction 10/11: Complete mitigation construction	$100 to $3,000 for each location	EPA GLNP, NPS, Private
7.3.8 Wetland Restoration	City of Houghton, Portage Twp., SWS, HKCD, MDEQ, MSUE, MG, Landowners	Short to Long-term (0-10 yr)	Plan and implement wetland restoration	10/10: Establish plan for wetland restoration and prioritize sites 10/11 to indefinite: Implement and monitor at least one wetland restoration project each year	$3,500-$140,000	Private, NPS, U & CF, NAWCA

[1] Potential Partners

HKCD = Houghton-Keweenaw Conservation District
MDEQ = Michigan Department of Environmental Quality
MSUE = Michigan State University Extension
CWS = MTU Center for Water and Society
SWS = MTU Chapter of the Society of Wetland Scientists
MG = Houghton Area Master Gardeners
MTU C&E = MTU Civil & Environmental Engineering Department (Courses)
MTU Micro = MTU Microbiology Club
HAS = Houghton Area Schools
WUP Center = Western Upper Peninsula Center for Science, Mathematics and Environmental Education
CCTU = Copper Country Trout Unlimited

[2] Potential Funding Sources

CZM = MDEQ Coastal Zone Management Grant
EPA GLNP = US Environmental Protection Agency Great Lakes National Program Office Grant
U & CF = Urban and Community Forestry Grant
NPS = MDEQ Nonpoint Source Grant
Private = Private Funding/Landowners
NAWCA = North American Wetlands Conservation Act Grant
USDA = Rural Development Housing & Community Facilities
TU = Trout Unlimited Embrace-A-Stream Program.

Table 7.3 Summary of Recommended Actions: Monitoring Plans

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.4.1. Water Quality Monitoring	MTU C&E, MTU Micro, HAS, WUP Center	Long-Term (0-10+ yr)	Evaluate changes and/or trends in water quality	5/09: Gain commitment of organization(s) to carry out monitoring 10/09 to indefinite: Complete monitoring on regular basis	$1,200 to $1,400/yr	NPS
7.4.2. Erosion and Geomorphologic Monitoring	MTU C&E	Long-Term (0-10+ yr)	Evaluate changes and/or trends erosion & sediment	5/09: Gain commitment of organization(s) to carry out monitoring 10/09 to indefinite: Complete monitoring on regular basis	$0 to $100/yr	NPS
7.4.3. Invasive Vegetative Species Monitoring	SWS	Long-Term (0-10+ yr)	Create watershed-wide invasive species management plan and monitor invasive species	5/10: Create monitoring plan and gain commitment of organization(s) to carry out monitoring 10/11 to indefinite: Complete monitoring on regular basis	$0 to $100/yr	Club Funds

[1] Potential Partners
HKCD = Houghton-Keweenaw Conservation District
MDEQ = Michigan Department of Environmental Quality
MSUE = Michigan State University Extension
CWS = MTU Center for Water and Society
SWS = MTU Chapter of the Society of Wetland Scientists
MG = Houghton Area Master Gardeners
MTU C&E = MTU Civil & Environmental Engineering Department (Courses)
MTU Micro = MTU Microbiology Club
HAS = Houghton Area Schools
WUP Center = Western Upper Peninsula Center for Science, Mathematics and Environmental Education
CCTU = Copper Country Trout Unlimited

[2] Potential Funding Sources
CZM = MDEQ Coastal Zone Management Grant
EPA GLNP = US Environmental Protection Agency Great Lakes National Program Office Grant
U & CF = Urban and Community Forestry Grant
NPS = MDEQ Nonpoint Source Grant
Private = Private Funding/Landowners
NAWCA = North American Wetlands Conservation Act Grant
USDA = Rural Development Housing & Community Facilities
TU = Trout Unlimited Embrace-A-Stream Program.

Table 7.4 Summary of Recommended Actions: Ordinances

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.5.1 Develop and Implement Stormwater Management Ordinance	City of Houghton, Portage Township, CWS	Short-term (0-3 yr)	Create and implement stormwater ordinance	7/09: Begin working with municipalities on ordinance 10/09: Approve final version of ordinance Identify regulatory structure 11/09: Begin enforcing ordinance	Dependent on time required by government officials to pass/enforce.	City of Houghton, Portage Township

[1] Potential Partners

HKCD = Houghton-Keweenaw Conservation District
MDEQ = Michigan Department of Environmental Quality
MSUE = Michigan State University Extension
CWS = MTU Center for Water and Society
SWS = MTU Chapter of the Society of Wetland Scientists
MG = Houghton Area Master Gardeners
MTU C&E = MTU Civil & Environmental Engineering Department (Courses)
MTU Micro = MTU Microbiology Club
HAS = Houghton Area Schools
WUP Center = Western Upper Peninsula Center for Science, Mathematics and Environmental Education
CCTU = Copper Country Trout Unlimited

[2] Potential Funding Sources

CZM = MDEQ Coastal Zone Management Grant
EPA GLNP = US Environmental Protection Agency Great Lakes National Program Office Grant
U & CF = Urban and Community Forestry Grant
NPS = MDEQ Nonpoint Source Grant
Private = Private Funding/Landowners
NAWCA = North American Wetlands Conservation Act Grant
USDA = Rural Development Housing & Community Facilities
TU = Trout Unlimited Embrace-A-Stream Program.

7.3. Physical Improvements

7.3.1. Reduce Metals and Ammonia Loads to Huron Creek

Related objective(s) from Table 7.1:
Manage copper and iron pollution
Manage nutrient concentrations

Potential Partners[1]	Proposed Timeline	Task/ BMP/ Action	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
City of Houghton, HKCD, NRCS MDEQ, CWS	Short-term (0-3 yr)	1. Mitigate stamp sand area next to Huron Creek in vicinity of Ridge Road Landfill	10/09: Soil and vegetation cover plan established 10/10: Soil and vegetation cover placed 10/11: Vegetation established	$800- $1,200*	MDEQ-NPS
City of Houghton, HKCD, NRCS MDEQ, CWS	Short-term (0-3 yr)	2. Mitigate stamp sand in wetlands mitigation area	10/09: Soil and vegetation cover plan established 10/10: Soil and vegetation cover placed 10/11: Vegetation established	$1,000- $3,800	MDEQ-NPS
City of Houghton, MDEQ, CWS	Long-term (0-10 yr)	3. Evaluate performance of landfill leachate collection system	10/09 to as needed: Monitor leachate collection system performance	$500- 1,000/yr	

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations

Task 1: Mitigate stamp sand areas next to Ridge Road Landfill . As mentioned in Chapter 6, stamp sands near Huron Creek pose a potential threat to water quality, especially with regard to copper, if they are eroded and subsequently transported into the creek. To remedy this, the area of stamp sands located within Critical Area 3 (see Figure 7.1) can be mitigated in a similar fashion as other local stamp sand areas. This procedure includes covering the stamp sand with a minimum of 6 inches of soil and planting various grasses and forbs for vegetative cover and soil stabilization. This stabilization method is

the same method used by the US Environmental Protection Agency to stabilize stamp sands in the Torch Lake Superfund site. Planting of shrubs and trees was not recommended (Jones, 2002).

Figure 7.1 Location of recommended actions for landfill area

Mitigating the stamp sand area in this manner reduces the amount of disturbance to nearby existing vegetation and soils, while stabilizing and therefore preventing the stamp sands from being transported to the creek. A native grass and/or forb seed mix is recommended for planting. As recommended for seeding in the landfill area, seed mix should be planted in a 50/50 mix with an annual nurse plant such as oats. Also, recommendations of the seeding supplier should be followed for proper seeding rate, mulching and fertilization.

Task 2: Mitigate stamp sand areas next to mitigation wetland. The suggested stabilization plan for the stamp sand area next to the mitigation wetland (see Figure 7.2) is the same as that recommended for the stamp sand area near the Ridge Road landfill. This includes covering with soil and planting with herbaceous vegetation. This stamp sand area is on a moderate slope however, so the high-end cost estimate provided above includes costs for erosion matting.

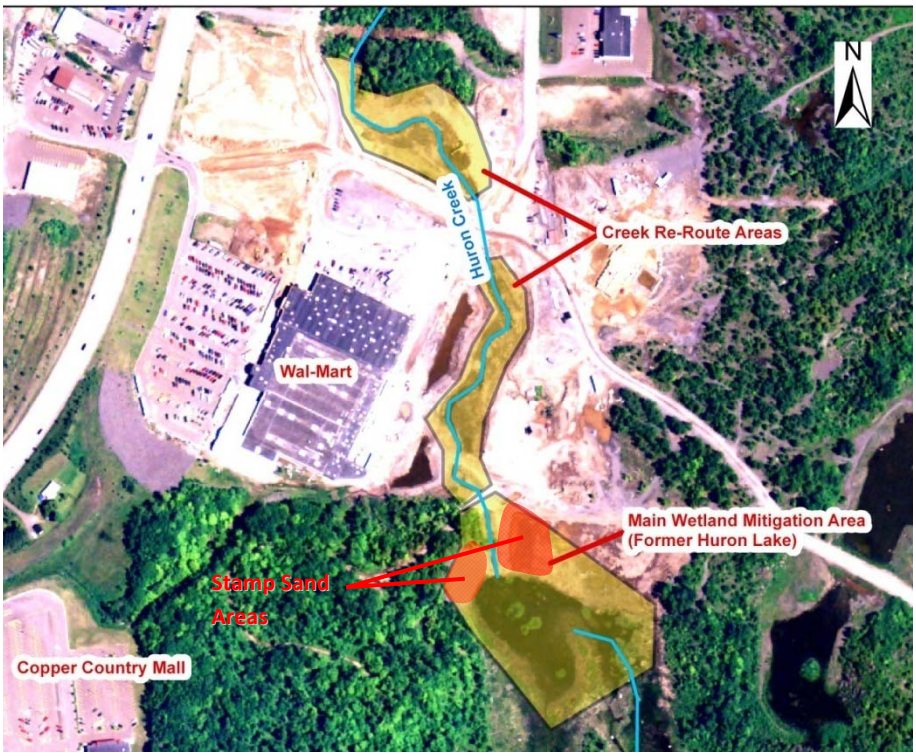


Figure 7.2 Huron Creek re-route and wetland mitigation area

Task 3: Evaluate performance of landfill leachate collection system. Since 2006, the City of Houghton has operated a leachate collection system that was installed at the base of the Ridge Road landfill on the west side of Huron Creek. This collection system was installed to prevent leachate from reaching Huron Creek that was documented by MDEQ[20] to contain levels of dissolved copper and ammonia that were in exceedance of the Final Acute Value (FAV). Water quality monitoring completed by the MTU Center for Water & Society has consistently indicated levels of dissolved copper downstream of the landfill in exceedance of the FAV (See Figure 5.7) from November 2006 to May 2008. Also during this time period, ammonia concentrations in exceedance of the Final Chronic Value (FCV) have been documented at the landfill monitoring site and downstream, with some sites upstream in occasional exceedance (See Figure 5.3). Iron bacteria blooms are also still observed along the landfill side (western banks) of the creek in the vicinity of the landfill. Based on this information, it may appear that landfill leachate is still entering the stream. However, as upstream concentrations of copper and ammonia sometimes also exceed MDEQ Aquatic Life Protection values, it is difficult to determine how much "background" or watershed-wide contributions are affecting concentrations.

Therefore, it is recommended that further studies are completed to evaluate the performance of the landfill leachate collection system, and to identify, if any, the effect leachate is having on ammonia and copper concentrations in Huron Creek. Once a study is formulated and completed, results can be used to identify any treatment, monitoring or recommended action alternatives that may be needed. In the

[20] Landfill seep analysis completed in July 2005. See Appendix M.

mean time, it is recommended that operation of the leachate collection system continues along with water quality sampling of Huron Creek at the landfill (LF) monitoring site. A long-term water quality monitoring plan is presented in Section 7.4.1. Ideally, these actions combined with mitigating stamp sand areas will ultimately reduce copper (and ammonia) concentrations below the Aquatic Protection Standards (FAV/FCV) and result in Huron Creek being removed from the MDEQ 303(d) Impaired Waters List.

7.3.2. Further Study of Stormwater Management Issues

Related objective(s) from Table 7.1:
Manage sediment pollution
Manage "flashy flows" of urban stormwater runoff

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
HKCD, MDEQ, CWS, NRCS, Houghton County Drain Commissioner	Short-term (0-3 yr)	Conduct survey of stormwater systems and stormwater modeling; assess best management alternatives for reducing the flashy flows.	5/10: Develop outline of stormwater management study and hire consulting firm or other organization to perform study 5/11: Complete study	$50,000	MDEQ-NPS, MDEQ-Revolving Fund

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations

In Section 5.4.2, results from hydrologic modeling efforts indicated that development in the Huron Creek watershed may be contributing to the increase in magnitude of "flashy" flow events, as evidenced by to more than 100% increases in peak flow rates in response to storm events. Increases in the magnitude of flows can results in channel erosion, generation of excess sediment, and compromising of aquatic habitat. These results imply that measures to reduce the magnitude of "flashy" flow events. The proposed detention pond to be installed at the head of Shopping Cart Creek described in Section 7.3.5 will partially address this issue of flashy flows in the watershed. The proposed stormwater ordinance described in Section 7.5 should help to reduce the possibility of future developments contributing even more towards flashy flows.

However, there are other, developed portions of the watershed that are likely to continue to contribute to flashy flows. The studies described in this management plan provide useful, but still limited information on which areas are contributing most towards the flashy flows. Before recommended specific measures for ameliorating flashy flows in these areas, a detailed survey of stormwater systems

and a detailed stormwater modeling effort should be conducted to determine which sites are contributing most towards the flashy flows. The survey and modeling effort can then be used to assess best management alternatives (e.g. detention ponds) for reducing the flashy flows at these sites.

7.3.3. Improve Kestner Waterfront Park (Critical Area #1)

Related objective(s) from Table 7.1:
Restore the creek in the Kestner Waterfront Park
Manage sediment pollution (from eroded banks)
Protect and improve the vegetative buffer

Potential Partners[1]	Proposed Timeline	Task[3]	Milestones[3]	Estimated Cost(s)[3]	Potential Funding Sources[2]
City of Houghton, HKCD, MDEQ, Master Gardeners	Short-term (0-3 yr)	Stabilize banks and establish vegetative buffer	10/09: Banks stabilized 06/10: Vegetation planted 06/11: Vegetation stabilized	$70,000-$85,000	CZM, EPA GLNP

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations
[3]Does not address replacement or repair of concrete walkway that crosses the mouth of the creek adjacent to the Portage Canal

Figure 7.3 shows the general location of proposed improvements of Huron Creek in the Kestner Waterfront Park, which focus on stabilization of the creek banks and producing a more natural creek channel. In spring 2009, funds were awarded to the City of Houghton to complete this work by the MDEQ Coastal Zone Management grant application, which was submitted in April 2008. The Coastal Zone Management grant program provides funds to protect coastal water quality and reduce nonpoint source pollution in coastal watersheds, among other similar project types. The grant program requires a 1:1 funding match which can include in-kind services, donations or cash. The City of Houghton has already allotted funds for the match as part of the city's adopted recreation plan, which was approved by the Houghton planning commission in March 2008. The grant application is also included in Appendix P.

The main components of the proposed improvements are as follows:

- Excavate slopes back to a shallower angle; 3H:1V where possible, otherwise 2H:1V given a buffer strip width of 12 to 18 feet.
- Install coir logs at the toe of the slope to provide protection against undercutting. Plant native shrubs into coir logs to provide additional toe and bank stabilization.
- Plant a mixture of native grasses, shrubs and trees within a 12 to 18-foot buffer strip along biotechnical stabilization areas. This will contribute to bank stabilization, help cover and prevent access to the gabions, and help create a more natural creek corridor.

Figure 7.3 Stabilization area in the Kestner Waterfront Park

Some areas of the buffer zone are to be left open without trees or shrubs for maintaining access to the creek, and also to preserve the viewscape. Detailed drawings, notes, suggested seed mixes and other materials information provided to the city of Houghton are included in Appendix P.

An additional concern in the waterfront park area is the condition of the concrete walkway that crosses the mouth of the creek adjacent to the Portage Canal. Portions of the walkway are slumping due to soil wash-outs near and under the walkway. It has been suggested in Huron Creek Watershed Advisory Committee (WAC) meetings that the walkway be repaired or removed and replaced with an open-span type bridge that would provide a more open connection between the creek and the portage. At this time, no specific recommendations, designs or cost estimates are provided for repair or replacement of the walkway, as bridge repair and design is outside of the scope of this plan. However, it is encouraged that this issue is addressed in the future by the WAC and the City of Houghton.

7.3.4. Septic System and Sanitary Sewer Improvements (Critical Area #2)

Related objective(s) from Table 7.1:
Manage/prevent nutrient pollution
Manage bacterial pollution

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
City of Houghton, Portage Township	Short-term (0-3 yr)	Connect Dakota Heights to sanitary sewer	10/09: Bid contract 6/10: Complete construction	Approximately $1 million, with a USDA grant covering $724,000	City of Houghton, Portage Township, USDA

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations

Portage Township recognizes the inadequacy of many septic systems in the Dakota Heights area, and recognizes the challenges created by having non-sewered residences and development areas. Therefore, Portage Township would like to move forward with a plan to first connect Dakota Heights to the city sanitary sewer system, and later connect other non-sewered portions of the Township. In April 2009, Portage Township received a 75 percent U.S. Department of Agriculture Rural Development grant to install a sewer line in Dakota Heights. The project will cost approximately $1 million, with the grant covering $724,000. The project will likely be bid out in fall 2009 and start in spring 2010.

This project has been made possible by a Spring 2008, agreement between the City of Hancock and Franklin Township with the City of Houghton to connect their sanitary sewer systems to a new sewer line that is to be constructed under the Portage Canal from Ripley to the This lift station pumps sewage through a main sewer line to the Portage Lake Water & Sewage Authority (PLWSA) Wastewater Treatment Plant (WWTP). Since sewage from City of Hancock and Franklin Township currently flows to the in northwest Houghton lift station, construction of the new sewer line has freed capacity in the lift station located in northwest Houghton. This new capacity will then be available for sewage from Portage Township, including the Dakota Heights area. In addition, sanitary sewer lines already exist on each side of Highway M-26 as it passes through Dakota Heights, which means that the highway will not need to be disturbed or directionally drilled under in order to connect all of Dakota Heights.

7.3.5. Improve "Shopping Cart Creek" (Critical Area #5)

Related objective(s) from Table 7.1:

Manage sediment pollution

Manage "flashy flows" of urban stormwater runoff

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
HKCD, MDEQ, Copper Country Mall, Wal-Mart of Houghton	Short term (0-3 yr)	1. Install stormwater detention pond at the source of Shopping Cart Creek.	12/10: Develop plans for detention pond 6/11: Begin construction of detention pond 10/11: Complete construction of detention pond	$200,000	EPA GLNP, NPS, Private
HKCD, MDEQ, NRCS, Houghton County Drain Commissioner	Mid-term (3-7 years)	2. Stabilize erosion areas	6/11: Develop plans for stabilizing erosion areas 6/12: Begin stabilization efforts 10/12: Complete stabilization efforts	$10,000 to $36,000	EPA GLNP, MDEQ-NPS, Private
HKCD, MDEQ, CWS, NRCS, Houghton County Drain Commissioner	Short to Long-term (0-10 yr)	3. Establish baseline data for headcut and continue to monitor.	10/09: Collect baseline data and develop monitoring program 10/09 to indefinite: Continue monitoring	$0-$1,900/yr	City of Houghton, CWS

[1]See footnotes in Table 7.2 for explanation of abbreviations

[2]See footnotes in Table 7.2 for explanation of abbreviations

Figure 7.4 Recommended action areas for Shopping Cart Creek

Task 1: Install stormwater detention pond at the source of Shopping Cart Creek. As mentioned in Chapter 6, increased peak flows have caused severe erosion at multiple locations in Shopping Cart creek. Hydrologic modeling of Shopping Cart creek completed as part of the Huron Creek geomorphology survey (see Appendix J) indicates a current (post-development) peak flow of 140 cubic feet per second (cfs) as a result of a 25-year, 24-hour storm event. This peak flow rate is approximately 14 times higher than the modeled pre-development flow rate of approximately 10 cfs for the same storm event.

Therefore, the first logical step towards bank stabilization in the creek would be controlling and reducing the peak flow rates of the creek, ideally, down to pre-development levels. Controlling and reducing the peak flow rates of the creek can be accomplished through construction of a stormwater detention pond where the Festival Foods ditch and Copper Country Mall culverts discharge at the "head" of the creek. The pond would then hold and slowly discharge the runoff at controlled rate that again, is ideally close to the pre-development flow rate of the creek. A potential construction location for the pond is indicated in Figure 7.4. This location was suggested as it is located where both runoff sources discharge to the creek and disturbance of the existing mall parking area would be minimal. The square indicating the pond location is not drawn to scale and does not necessarily reflect its actual footprint area.

An example stormwater detention pond for the head of Shopping Cart creek was designed as part of the Huron Creek geomorphology study. This pond was designed to detain runoff from the local 100-year, 24-hour storm event and release it at the pre-development flow rate of Shopping Cart Creek (10 cfs). Methods, calculations and HydroCAD® models for this design are included in Appendix J. As the size of a

pond required to detain runoff from a 100-year storm from both the Copper Country Mall and Festival Foods development areas would be quite large and costly to construct (see cost calculations, Appendix O), it is recommended that a pond be constructed as large as practicably possible given existing site and cost constraints. For example, a pond designed to detain a 2-year, 24-hour storm event would cost approximately $200,000.

Task 2: Stabilize severe erosion areas. The severe erosion areas described in the Shopping Cart Creek area in Chapter 6 include a steep, eroded bank area near the head of the creek and a headcut area downstream near Wal-Mart. These two locations were identified as "Critical Erosion Areas." It is recommended that current peak flow rates be reduced (through methods such as Task #1) prior to implementation of any bank stabilization projects or improvements, as such improvements may not be capable of withstanding velocities associated with the current peak flows.

Because of the depth and extent of erosion created by the headcut, it is recommended that assistance is obtained from regulatory agencies (MDEQ, NRCS) and/or professional consultants when designing a stabilization plan for this area. The following is a list of BMPs and other items that may be used individually or in combination with each other to re-stabilize the Shopping Cart creek headcut area:

- re-working the banks to decrease slopes;
- re-working the creek channel longitudinally to remove the headcut and create a slope rather than a small waterfall;
- rip-rap or gabions for stabilizing toe of bank slope;
- vegetated coir logs, live fascines or brush mattresses; and
- native plantings of forbs, grasses, shrubs and trees in newly re-worked areas, including installation of erosion blanket in newly seeded areas.

Stabilization of this part of Shopping Cart creek might be accomplished with methods similar to those proposed for the Kestner Waterfront Park. However, the type of stabilization materials and methods utilized will be dictated by whether or not a storm pond is installed upstream to first decrease peak flow rates.

Task 3: Establish baseline data for headcut and continue to monitor. The headcut is expected to continue to migrate upstream and may eventually reach the Copper Country Mall parking lot, creating a large gully at the storm sewer discharge location. The headcut also is expected to continue to cause sediment to be transported downstream into the Wal-Mart storm ponds, creating a maintenance issue. Until the point in time when the headcut area can be physically improved and stabilized, it is recommended that its location and size be determined under current conditions and then be monitored on an annual basis. The headcut location and size can be measured by surveying longitudinal profiles of the centerline of the creek from upstream of the headcut to downstream of the headcut. This involves use of a surveyor's tape, hand-held GPS unit to record location data, and a surveying level and rod for collecting elevation data. A more detailed description of methods can be found in the Huron Creek geomorphology survey report found in Appendix J.

7.3.6. Improve Wetland Mitigation and Creek Re-route Areas (Critical Area #4)

Related objective(s) from Table 7.1:
Protect and improve the vegetative buffer
Prevent establishment of invasive plant species
Protect and improve biodiversity

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)[3]	Potential Funding Sources[2]
City of Houghton, SWS, MDEQ, MSUE, MG, Landowners	Short to Long-term (0-10 yr)	1. Remove invasive species and establish native plant species	10/10: Establish plan for reducing existing invasive species 5/11: Begin removal of invasive species 7/11: Complete removal of invasive species and begin planting of native species 10/11: Complete removal of invasive species and begin planting of native species 10/11 to indefinite: Monitor vegetation	$22,500 to $45,000	Private, NPS, U & CF, NAWCA
City of Houghton, CCTU	Short to Long-term (0-10 yr)	2. Physical improvements	10/10: Establish plans for physical improvements 5/11: Begin construction-create pools, place coarse woody debris and boulders 10/11: Complete physical improvements 10/11 to indefinite: Monitor improvements	$2,000 to $3,000	City of Houghton, TU

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations
[3]Lowest price in range indicates cost with volunteer labor/manual labor, etc.

Remediation of stamp sands in the wetland mitigation area is covered in Section 7.3.1.

The City of Houghton currently owns and monitors the creek re-route and wetland mitigation areas near the Houghton Wal-Mart (see Figure 7.2). Monitoring includes documentation of establishment of vegetation, presence of wildlife and the general condition of the site. This monitoring is a requirement

of the wetland mitigation permit that was obtained by the city, and it will continue until vegetation is sufficiently established according to MDEQ requirements. The success of the re-vegetation effort includes having the appropriate type (native species versus invasive species) and amount of vegetation, and creating a generally healthy wetland and riparian habitat.

As mentioned in Chapter 6, the creek re-route area, in particular, currently has sparse native vegetation mixed with relatively dense areas of invasive plant species such as spotted knapweed and white sweet clover. Trees that were planted to eventually provide shade over Huron creek appear to have not taken hold or were affected by the drought of summer 2007. In contrast, the main wetland mitigation area supports a variety of native mesic, emergent and submergent vegetation. Wildlife from waterfowl to small mammals have also been observed in this area. However, invasive species are encroaching on the main mitigation site, especially from the northern side where the soil is not as saturated as the main open-water area. A few patches of reed canary grass, a particularly problematic invasive, have established along the western side of the wetland. With these issues in mind, the following tasks are recommended to manage invasive species, establish more native vegetation, and generally improve habitat.

Task 1: Remove invasive species and establish native plant species. It is recommended that removal of existing invasive species be completed to the maximum extent practicable in the Huron creek re-route and wetland mitigation area. Removal can include manual pulling, burning, herbicide treatments and other methods depending on the type of plant species. Information regarding removal of invasive species can be found in many published and on-line resources. For example, the *Global Invasive Species Team* website (http://tncweeds.ucdavis.edu) provides photos, descriptions and fact sheets by species. The websites listed below are links to main species websites and recommended removal methods sheets for each species that has been documented in the Huron Creek re-route and wetland mitigation area. These sheets can also be found in Appendix Q.

- Spotted Knapweed Main Website - http://tncweeds.ucdavis.edu/esadocs/centmacu.html
- Spotted Knapweed Removal Methods - http://tncweeds.ucdavis.edu/moredocs/cenmac02.pdf
- Sweet Clover Main Website - http://tncweeds.ucdavis.edu/esadocs/melioffi.html
- Sweet Clover Removal Methods - http://tncweeds.ucdavis.edu/esadocs/documnts/melioff.pdf
- Reed Canary Grass Main Website – http://tncweeds.ucdavis.edu/esadocs/phalarun.html
- Reed Canary Grass Removal Methods – http://tncweeds.ucdavis.edu/esadocs/documnts/phalaru.pdf

These or similar guidance documents should be referred to when implementing an invasive species removal project. Removal of these species should ideally be completed prior to planting additional native species. This is important as any remaining invasive plants may still out-compete the natives that are trying to establish. Additional guidance on invasive species can be found in the BMP manuals that are discussed in Section 7.6.

The next logical step after addressing invasive species and improving the physical habitat would be to establish additional native plant species where necessary. Some suggestions for choosing and planting vegetation in the creek re-route and wetland mitigation areas are:

- The vegetation selected should be native and similar to what exists in nearby habitats. A good reference habitat is the portion of Huron Creek downstream of the creek re-route area. Species identified in this area are listed in the vegetation survey in Appendix L.
- The areas currently without much native vegetation are exposed and sunny. The first types of vegetation established might best be those that are sunlight-tolerant. Later other species that require little to some shade may be planted.
- The soil moisture and hydrology should also be considered when choosing types of plants and choosing their placement. Vegetation planted next to or in areas where the creek might flood should be wetland or mesic species that can tolerate saturated soil conditions. Vegetation planted in regularly dry soils should be more of the upland variety.
- A variety of grasses, forbs, shrubs and trees should be planted to create as much vegetative diversity as possible. Balled-stock (root ball in place) shrubs and trees might be best for planting near Huron Creek as storm event flow velocities could wash away seeds or herbaceous "plug" type planting. Trees and shrubs planted as live stakes may also be a good choice. Preferably trees should be planted along the creek to provide shade to the water (reduce water temperatures).
- The selection of, grouping and placement of vegetation should be designed to increase and maintain biodiversity of mammals, amphibians, reptiles and various avian species. For example, trees or shrubs could be placed in groups to provide shelter for song birds, or various flowering plants could be utilized to attract butterflies and other pollinators. Ideally, a baseline biodiversity study and future biodiversity studies could be completed to monitor the effectiveness of these efforts.
- When planting seed, spread in 50/50 mix with an annual "nurse plant" such as oats to prevent establishment of invasive species[21].
- If planted species are not proliferating after a year or two, it may be necessary to revise the planting scheme and try different species at that location.
- Some nurseries and seed suppliers that sell native plants and can provide recommendations for planting include:
  - Lake Superior Tree Farm, Chassell,MI, 906-523-6200
  - Borealis Seed Co., Marquette, MI 906-226-8507
  - Great Lakes Nursery, Watervliet, MI, 269-468-3323, www.greatlakesnurseryco.com/
  - Cold Stream Nursery, Free Soil, MI, 231-464-5809, www.coldstreamfarm.net/
  - Engels Nursery, Fennville, MI, 296-543-4123, www.engelsnursery.com/

Task 2: Physical Improvements. A few simple physical improvements to the ground surface at various locations in the mitigation area can help establishment of plant species and improve habitat:

[21] Planting instructions per Borealis Seed Company, Marquette, Michigan.

- Create pools in the creek re-route area – Reducing Huron creek's rate of flow and pool at various locations will allow for slow, shallow water where aquatic vegetation can more easily establish without being washed away. Pooling also provides for a more slow transition from inundated soil to saturated soil to upland areas, allowing a greater diversity of species to establish. Existing rock, soil or woody debris could be used to "dam" or constrict portions of the creek to create pools.

- Place course woody debris and/or boulders in the riparian zone – The term course woody debris (CWD) in this case, is being used to refer to dead and down trees and their branches. CWD serves many functions in woodland and riparian habitats. These functions include providing a source of carbon and organics for soil via decomposition, providing habitat for many plant and animal species, and most importantly, providing habitat for fungi and mosses that serve critical functions in ecosystem health (The Dead Wood Cycle, 1998). These fungi and mosses help cycle and transport nutrients into the soil for use by vegetation, and serve as "launching platforms" for bacterial growth that is also necessary for growth of many plants (Stamets, 2007).

  In the Huron Creek re-route area this additional fungal growth may be especially necessary as spotted knapweed (present in the area) is known to out-compete other plants by reducing their necessary supply of mycorrhiza, a fungus that many native species rely on for uptake of nutrients (Spero News, 2007). Therefore, it is recommended that CWD and/or boulders are placed randomly throughout the creek re-route area, and in open areas around the mitigation wetland.

7.3.7. Improve Erosion Areas

Related objective(s) from Table 7.1:
Manage sediment pollution
Protect and improve the vegetative buffer

Potential Partners[1]	**Proposed Timeline**	**Task**	**Milestones**	**Estimated Cost(s)** [3]	**Potential Funding Sources**[2]
City of Houghton, HKCD, MDEQ, MSUE, Adjacent Businesses	Short-term (0-3 yr)	1. Improve Ridge Road Landfill Area	10/10: Erosion control replaced 10/11: Vegetation planted 10/12: Vegetation established	$13,000 to $18,000	NPS, U & CF
HKCD, MDEQ, Landowners	Mid-term (3-5 yr)	2. Mitigate Critical Erosion Locations (A, B, C, D, E, G)	10/10: Plans for mitigation established 5/11: Begin mitigation construction 10/11: Complete mitigation construction	$100 to $3,000 for each location	EPA GLNP, NPS, Private

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations
[3]Costs presented don't include labor for planting. Ideally, volunteer or in-kind labor would be available

Task 1: Ridge Road Landfill Area (Critical Area #3): Remove & replace failing erosion control materials, stabilize slopes and re-establish vegetation. Figure 7.1 shows the location of this area. In order to accomplish stabilization of currently exposed and/or unstabilized soil areas, slopes and banks in the Ridge Road landfill area, the following steps should be taken:

- Remove silt fencing and other construction debris that is in creek channel and on banks.
- Review areas of existing erosion matting. If erosion matting has washed out, shifted, or is overlain on bare rock, complete the following steps as appropriate:
    - Compare specifications for existing erosion matting with location of original installation. Ensure the type of matting is appropriate for the slope it has been placed on. Replace with appropriate type if necessary.
    - Prior to re-installation, ensure that a minimum of 12 inches of soil (3-6 inches of topsoil) exists under the erosion matting so that a grass and/or forb seed mix can be seeded and take hold. If soil needs to be brought in and spread, it should not be compacted.
    - After establishment/addition of topsoil layer apply a seed mix and fertilizer according to the application rates specified by the seed provider and fertilizer manufacturer.
    - Install erosion matting over seed and soil. Ensure it is staked down according to the appropriate staking pattern for the type of erosion mat and slope it is to be installed on.
    - Additional planting of native shrubs and trees will add to soil stabilization in areas where soils are deep/thick enough to support them.

      An expert should be consulted regarding the species of shrubs and trees (as well as for the grass/forb mix) to be used, and also for planting densities, fertilization, etc.

    - Initial planting of grass/forb seed mixes should be planted in a 50/50 mix with a "nurse crop" such as annual oats to assist in establishment. Preferably all seeds and seed mixes are certified weed free.
- For areas where rill and/or gully erosion has occurred on steep slopes adjacent to the creek:
    - In many locations, the steepness of the slope requires stabilization using rip-rap rather than erosion matting and seed. Choose the appropriate type of stabilization based on slope and soil conditions and install per the instructions above.
    - Where the rill or gully extends down to the creek underneath existing matting, repair this area after the upstream slope has been stabilized.
- For near level areas that remain unstabilized and/or unvegetated:
    - Planting of native grasses, forbs, shrubs and trees should be completed in bare areas. It is recommended that planted species are similar to those already found in that portion of the creek corridor (see vegetation survey in Appendix L).
    - As mentioned above, planting density/seed application rate, fertilizer and/or mulch application should be completed per supplier recommendations.

- The creek channel should be inspected for areas of bank failure (collapse). The application of "soft" bank stabilization materials such as coir logs, vegetative mats or wattles should be considered if necessary.
- Topography, soil and runoff velocity conditions vary in the Ridge Road landfill area. Professionals, academic experts, and/or state and federal agency representatives should be consulted prior to design and implementation of any stabilization or revegetation plan.

Figure 7.5 Critical erosion locations

Task 2: Mitigate Critical Erosion Locations (A, B, C, D, E, G)

Erosion problems that have been observed at each critical erosion location are described in detail in Chapter 6. Figure 7.5 shows the location of each critical erosion location. The following recommendations are suggestions for implementation. All improvements should be reviewed by the appropriate technical or regulatory expert. Also, property owners at each location should be contacted to gain access and approval for stabilization projects. Property owner information is provided in Appendix H. Mitigation for Erosion Location F is included in Task 1 of this Section. Mitigation for Erosion Locations H and I are included in Section 7.3.5.

Erosion Location A – Collapsed Rock Channel Wall. Assuming that the rock channel wall is preserved for its historical value and it is not removed in the future, the following steps should be taken to prevent continued erosion into the bank behind the wall:

- Remove vegetation that has established in wall collapse area.
- Repair the wall by mortaring in natural rock that is similar to the rock in the existing wall.
- Fill in soil behind the wall repair area and plant with forbs and grasses.

Erosion Location B – Undercut Concrete Bank. As the concrete "bank" that was previously installed has become complete undercut by the creek, it is only a matter of time until all of the soil underneath it is eroded, causing it to fall into the creek. Therefore it is recommended that the concrete is broken up and removed completely from the area. If bare soil remains after removal of the concrete, the area can be stabilized through placement of nearby creek stones and cobbles as a sort of "rip rap." If the area is large enough, cobble-sized stones can be brought in and placed in the area. Erosion location B is a rocky area, and it is not anticipated that an exposed soil area will be left that is large enough to warrant re-vegetation.

Erosion Location C – Gully Next to Culvert Entrance. At this location, water traveling down through rip-rap on the adjacent road slope appears to have caused slope erosion where the runoff travels over a non-rip-rapped area. Recommendations to repair this location include:

- Add a wider "apron" of rip-rap to the bottom end of the existing rip-rap area so that runoff is spread out down the slope and is less channelized.
- Fill in the gully with soil and either continue the rip-rap apron down slope to the culvert wing wall, or plant native shrubs to stabilize the soil.

Erosion Location D – Ditch on Northeast Corner of Sharon Avenue and M-26. At this location, undercut channel sides and sediment deposition are indicators of possible future erosion problems and a source of sediment load for Huron Creek (this ditch discharges directly to Huron Creek). It is likely that peak flow rates of runoff from the culvert under M-26 are cutting into the "banks" of the ditch, and that road-spread sand and sediment are depositing in its bottom. These two items can be addressed through use of check dams placed along the length of the creek. Check dams are piles of stone or hay bales that are placed across a channel to reduce flow and trap sediment before it reaches the creek. Recommendations for installation and maintenance of check dams can be found in the Best Management Practice (BMP) manuals that are referenced in Section 7.6.

Erosion Location E – Gully Below Culvert Between Taco Bell and Dairy Queen. This gully extends down slope from the parking lot culvert to Huron Creek where it forms a channelized "tributary" within a sediment deposition area. The gully ranges in width from 2 to 5 feet, and in depth from 6 inches to 2 feet. As with other erosion areas on slopes, it is best to stabilize from up-slope to down-slope. It is recommended that the channel be re-worked to be shallower and wider (rather than narrow and deep) and that check dams are installed at appropriate intervals down the slope. After the check dams are installed and have been monitored to ensure they are stable and reducing the culvert discharge, the lower areas of the channel should be planted with vegetation, as well as those areas disturbed on the slope from re-shaping of the channel.

Erosion Location G – Slope Failure Area on Razorback Drive. Erosion Location G is a slope location where non-rip-rapped soils adjacent to rip-rapped areas are shifting. In this case, the slope failure is a

grassy area located above a rip-rap zone. It appears that the rip-rap had shifted down slope since its installation and therefore made the soil it was supporting above it shift. Because the grassed soil area above the rip-rap has not yet had major failure/erosion, the best remedy may be to plant shrubs and trees to stabilize the topsoil in that area. Balled stock (plants with root ball attached) is recommended as they take hold quickly. Native, sunlight-tolerant species are recommended as this is an unshaded area.

7.3.8. Wetland Restoration

Related objective(s) from Table 7.1:
Protect and improve the vegetative buffer
Protect and improve wetlands in the watershed (not listed in Table 7.1***, but general goal of WAC)***

Potential Partners[1]	**Proposed Timeline**	**Task**	**Milestones**	**Estimated Cost(s)**	**Potential Funding Sources[2]**
City of Houghton, Portage Twp., SWS, HKCD, MDEQ, MSUE, MG, Landowners	Short to Long-term (0-10 yr)	Plan and implement wetland restoration	10/10: Establish plan for wetland restoration and prioritize sites 10/11 to indefinite: Implement and monitor at least one wetland restoration project each year	$3,500-$140,000	Private, NPS, U & CF, NAWCA

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations

Wetland restoration projects can provide a variety of benefits and opportunities to a watershed and community. Restoration of wetlands improves wildlife habitat and increases biodiversity. Also, wetlands retain and slowly release surface water runoff, which is important for reducing runoff during high rainfall events and for allowing groundwater recharge to occur.
These capabilities are particularly important in the Huron Creek watershed where existing impervious surfaces reduce infiltration and therefore the amount of base flow in Huron Creek. Wetland restoration projects can also serve as environmental education opportunities, and provide a chance for community members to become involved.

As discussed in Chapter 5 and indicated in Figure 5.25, various locations exist in the Huron Creek watershed that may provide opportunities for wetland restoration activities. Locations A, B and C in Figure 5.25 were highlighted as potential wetland restoration locations based on apparent disturbance activities, adjacency of existing wetlands and other factors. Note that Location A is part of the Ridge Road landfill recommended action area.

For any location at which a wetland restoration project is proposed, it is recommended that the following actions be taken prior to initiation of the project:

- Identify a potential restoration location and identify a clear set of restoration goals.
- Contact property owner(s), ensure their permission is obtained for restoration on their property, and create a plan that fits the owner's needs as well as the restoration goals.
- Examine site topography, delineate existing wetlands, determine locations of hydric soils and characterize hydrologic conditions and other pertinent site characteristics.
- Investigate the amount of funding and technical support required, including the amount of volunteer hours potentially available.
- After gathering relative field data and quantifying funding resources, construct a plan of action that is designed to achieve the established goals. At this point it may be best to consult someone knowledgeable in the fields of restoration and wetland sciences in order to create an appropriate restoration plan. Ideally, each restoration plan should have a monitoring component so that progress can be monitored and the plan of action can be adapted as necessary ("adaptive management").
- Implement the project.

Various resources can be referred to for guidance on implementation and funding of wetland restoration projects. A few of these resources are listed in Section 7.6 (BMPs). Additional resources include:

- An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement developed by the Interagency Workgroup on Wetland Restoration (US Army Corps of Engineers, US Environmental Protection Agency, NOAA, US Fish and Wildlife Service, NRCS, 1993): http://www.epa.gov/owow/wetlands/pdf/restdocfinal.pdf
- Michigan Department of Natural Resources Wetland Restoration Techniques Webpage: http://www.dnr.state.mi.us/publications/pdfs/huntingwildlifehabitat/landowners_guide/Habitat_Mgmt/Wetland/Wetland_Restoration_Techniques.htm

7.4. Monitoring Plans

7.4.1. Water Quality Monitoring

Related objective(s) from Table 7.1:
Manage sediment pollution
Manage copper and iron pollution
Manage nutrient pollution
Manage bacterial pollution

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)[3]	Potential Funding Sources[2]
MTU C&E, MTU Micro, HAS, WUP Center	Long-Term (0-10+ yr)	Evaluate changes and/or trends in water quality	5/09: Gain commitment of organization(s) to carry out monitoring 10/09 to indefinite: Complete monitoring on regular basis	$1,200 to $1,400/yr	NPS

[1]See footnotes in Table 7.3 for explanation of abbreviations
[2]See footnotes in Table 7.3 for explanation of abbreviations
[3]without equipment costs

As stated in Section 4, water quality monitoring of Huron Creek was completed in an effort to identify pollutants and create a platform for action towards improvement watershed-wide. Just as this monitoring provided a baseline of Huron Creek water quality, further monitoring can be utilized to identify if actions completed as part of this plan are meeting the goal of improving water quality and related goals such as habitat improvement. Continued monitoring can also help to identify any new water quality issues that arise. Furthermore, monitoring is a useful way to engage the public to interact with the creek. Table 7.5 lists recommended parameters, their associated pollutants and sampling frequencies for continued monitoring of Huron Creek.

Table 7.5 Recommended Water Quality Monitoring for Huron Creek

Parameter	Field or Laboratory Sample Analysis	Frequency
Alkalinity	Lab	Two times/yr: Apr., Sept.
Ammonia	Lab	Two times/yr: Apr.
Copper	Lab	Two times/yr: Apr.
Iron	Lab	Two times/yr: Apr.
Coliform Bacteria	Lab	Two times/yr: Apr.
Turbidity	Field	Two times/yr: Apr.
Temperature	Field	Two times/yr: Apr.
pH	Field	Two times/yr: Apr.
Dissolved Oxygen	Field	Two times/yr: Apr.
Conductivity	Field	Two times/yr: Apr.
Bio-Assessment	Field	Two times/yr: Apr.

These samples should be collected at the same monitoring locations that were utilized during recent monitoring events for consistency. These locations include the Green Acres (GA), Downstream of Wetland (DWL), Frog Pool (FP), Landfill (LF) and Houghton Waterfront Park (HWP) sites. The location of the sites is indicated in Figure 5.1.

The locations of these sites, and recommended procedures and equipment are provided in the Huron Creek Water Quality Monitoring Quality Assurance Project Plan (QAPP) in Appendix B. The bio-assessment listed refers to an aquatic macroinvertebrate survey, completed using such methods as the MDEQ Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers (http://www.dnr.state.mi.us/PUBLICATIONS/PDFS/ifr/manual/SMII%20Chapter25A.pdf), or the Izaak Walton League Survey Method (http://www.iwla.org/index.php?id=398).

Monitoring months and frequencies were selected based on the following:

- The frequency of two times per year is designed to provide enough data for drawing conclusions and observing trends while keeping the monitoring budget to a minimum. If budget allows, more monitoring events can be completed, with quarterly sampling being the next suggested step up.
- The months of April and September were selected so that water quality data could be obtained during both high-flow (April) and low-flow (September) seasons.

Costs provided above include costs for materials and sending alkalinity, ammonia, copper, iron and coliform samples to professional labs for analysis. The costs do not include equipment costs, since it is assumed that field equipment can be provided by MTU through courses. If MTU cannot provide equipment, an additional $1,500 to $2,000 should be added as an initial purchase cost. It is also assumed that MTU will be able to complete coliform analysis.

7.4.2. Erosion and Geomorphologic Monitoring

Related objective(s) from Table 7.1:
Manage sediment pollution

Potential Partners[1]	**Proposed Timeline**	**Task**	**Milestones**	**Estimated Cost(s)**[3]	**Potential Funding Sources**[2]
MTU C&E	Long-Term (0-10+ yr)	Evaluate changes and/or trends erosion & sediment	5/09: Gain commitment of organization(s) to carry out monitoring 10/09 to indefinite: Complete monitoring on regular basis	$0 to $100/yr	NPS

[1]See footnotes in Table 7.3 for explanation of abbreviations
[2]See footnotes in Table 7.3 for explanation of abbreviations
[3]One time cost of ~$2000 only if new survey equipment needs to be purchased

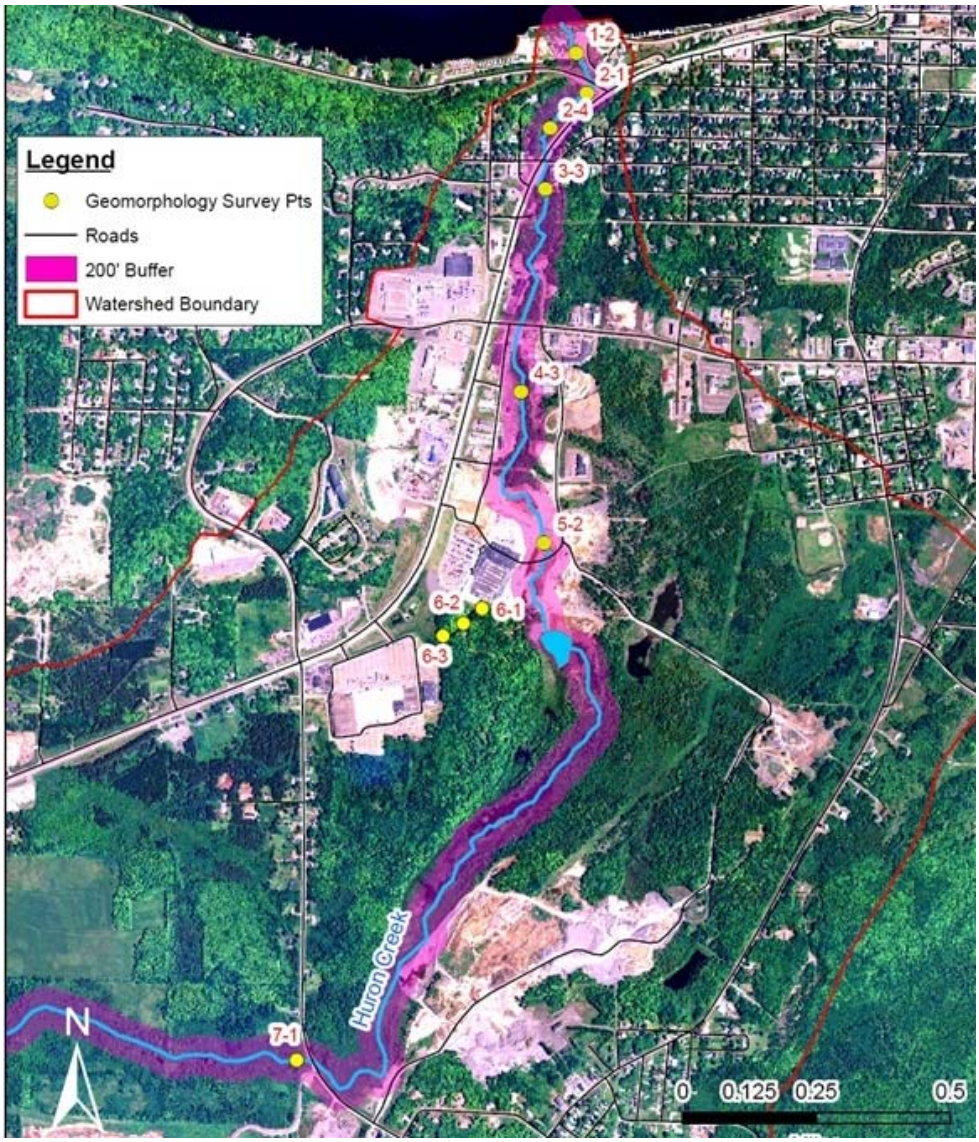
Geomorphologic and erosion monitoring was completed by the MTU Center for Water and Society in fall 2007. This monitoring resulted in the identification of the critical erosion areas listed in Chapter 6, and provided a basis for future monitoring so that more can be learned about sediment conditions in Huron Creek. Therefore, it is recommended that this monitoring be continued into the future according to the monitoring schedule presented in Table 7.6. Monitoring frequencies were chosen based on the estimated time required in order to observe a measurable change in the monitoring parameters. For example, it is likely that changes in cross-section and slope would occur at some time during a ten year period, but may not occur during a shorter time period.

Table 7.6 Recommended Erosion and Geomorphologic Monitoring for the Huron Creek Watershed

Location Name	Survey Type(s)[1]	Frequency (yrs)
1-2		
	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2
2-1	Sediment (sieve only)	5
2-4	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
3-3	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
4-3	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
5-2	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
6-1		
	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
6-2	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
6-3	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
7-1	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3

[1]BEHI = Bank erosion hazard index; HABITAT = Stream habitat evaluation; X-SECTION & SLOPE = Cross-section and longitudinal slope measurements; SEDIMENT = Monitoring using sediment pin and sieve analysis of sample

Following the schedule above, the condition and progress of improvement of the critical erosion locations can be monitored, and monitoring can be continued at already established sites for comparison. Critical erosion locations A-I are shown in Figure 7.5. All other monitoring locations are indicated in Figure 7.6 below.



It is recommended that methods and equipment used to complete monitoring follows that stated in the Huron Creek Geomorphology Survey Quality Assurance Project Plan (QAPP) provided in Appendix I. The costs listed above are based on MTU classes completing the monitoring. Factors contributing to the range in costs include materials if needed, and purchase of equipment if existing MTU equipment is not available.

7.4.3. Invasive Vegetative Species Monitoring

Figure 7.6 Geomorphology survey locations

Related objective(s) from Table 7.1:

Control the establishment of invasive species
Protect and improve the vegetative buffer

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
SWS	Long-Term (0-10+ yr)	Create watershed-wide invasive species management plan and monitor invasive species	5/10: Create monitoring plan and gain commitment of organization(s) to carry out monitoring 10/11 to indefinite: Complete monitoring on regular basis	$0 to $100/yr	Club Funds

[1]See footnotes in Table 7.3 for explanation of abbreviations
[2]See footnotes in Table 7.3 for explanation of abbreviations

It is recommended that numbers and locations of invasive vegetative species are monitored into the future. It is further recommended that the monitoring effort is utilized to create a watershed-wide invasive species management plan, as simply monitoring the spread of invasive species will not slow their spread. As many of the identified invasive species have not yet densely colonized (except for in the creek re-route area), the Huron Creek watershed is at a critical juncture for control of these plants. The more quickly that control measures are implemented, the better chance they can be managed into the future. These measures are also recommended as a supplementary action to invasive species removal in the Huron Creek re-route and mitigation areas. Removing invasive species in one small area while allowing seed sources from surrounding areas to proliferate will prove to make control efforts difficult. Costs listed above are generally based on volunteers completing monitoring. Some annual or one-time costs may need to be incurred for equipment purchase or rental.

Monitoring methods utilized should be similar to those used in the vegetation/invasive species survey already completed. These methods are described in the Vegetation Survey Quality Assurance Project Plan (QAPP) that is included in Appendix K. Other resources that can assist in the creation of an invasive species management plan include the *Global Invasive Species Team* website (http://tncweeds.ucdavis.edu), and the U.S. Department of Agriculture's invasive species website (http://www.csrees.usda.gov/invasivespecies.cfm).

7.5. Develop and Implement Stormwater Management Ordinance

Related objective(s) from Table 7.1:

Manage the "flashiness" of stormwater flows
Manage sediment pollution
Manage nutrient pollution

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
City of Houghton, Portage Township, CWS	Short-term (0-3 yr)	Create and implement stormwater ordinance	7/09: Begin working with municipalities on ordinance 10/09: Approve final version of ordinance Identify regulatory structure 11/09: Begin enforcing ordinance	Dependent on time required by government officials to pass/enforce.	City of Houghton, Portage Township

[1]See footnotes in Table 7.4 for explanation of abbreviations
[2]See footnotes in Table 7.4 for explanation of abbreviations

The most commonly used and effective action that can be taken to reduce non-point source pollution and improve surface water quality in a watershed is to implement and enforce a stormwater ordinance. In general, stormwater ordinances are designed to achieve water quality improvements through controlling runoff rates and encouraging use of stormwater infiltration and detention. Ideally these measures are implemented to the extent that post-development runoff is as close to pre-development runoff conditions as possible. Infiltration (retention) basins, detention basins, infiltration swales and bioretention structures are commonly suggested on-site treatment mechanisms used to accomplish this. Specific benefits of implementing these measures can include reduction in flooding and erosion, removal of sediment, reduced water temperature and reduced nutrient concentrations.

Currently, stormwater management is only required by law in the State of Michigan in municipalities with separate storm sewer systems that service populations greater than 100,000. These municipalities are referred to in Michigan as "MS4" municipalities[22]. This law was federally enacted through Phase II of the National Pollutant Discharge Elimination System (NPDES) under the U.S. Clean Water Act, and is enforced in the State of Michigan through Part 21 of the Natural Resources and Environmental Protection Act (Act 451).

As the current populations of the City of Houghton and Portage Township do not exceed 100,000, they are not required to follow the MS4 rules. However, a desire has been expressed by both City of Houghton and Portage Township officials to create and implement a local stormwater ordinance. Reasons cited for this include recent disputes over property damages from excess stormwater runoff

[22] More information can be found at http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-24366--,00.html.

and inadequacy of some existing stormwater management facilities (Bingham & MacInnes, Personal Interviews, 2008).

To this end, a draft stormwater ordinance for the city of Houghton has been included in Appendix R. This ordinance has been constructed using the Kent County, Michigan and City of DeWitt, Michigan[23] ordinances as guidance. The main components of the ordinance include stormwater permit and management plan requirements, design and construction standards, enforcement and maintenance. This ordinance is being provided in draft form only, and should be edited as desired by the adopting municipality. However, it is recommended that a stormwater professional or expert be consulted when finalizing the ordinance. Some items to consider when finalizing this document should include:

- Who will complete review and approval of permit applications?
- What review is needed when stormwater is routed to an existing storm sewer?
- Should construction site erosion control requirements beyond the existing state rules be included?
- What are appropriate application fees and financial guarantees?
- Are special requirements needed for development of easements?
- What is the appropriate minimum storm event for which detention ponds should be sized? Or should the language, "maximum extent practicable" be used?

These items are addressed in the draft stormwater ordinance, but may need specialization according to the needs or existing rules of the adopting municipality.

Although this ordinance was written for the City of Houghton, it can readily be modified for use by Portage Township. Primarily, Section 1.1 - Statement of Authority, should be modified for applicability to Charter Township jurisdiction. An example of this modification is:

> "This ordinance is adopted in accordance with the Charter Township Act, as amended, being MCL 42.1, et seq.; the Township and Village Public Improvement Act, as amended, being MCL 41.721, et seq.; the Drain Code of 1956, as amended, being MCL 280.1, et seq.; the Land Division Act, as amended, being MCL 560.1, et seq.; the Revenue Bond Act, as amended, being MCL 141.101, et seq.; and the Natural Resources and Environmental Protection Act, as amended, being MCL 324.101, et seq.; Section 401(p) of the Federal Water Pollution Control Act (also known as the Clean Water Act), as amended, being 33 USC 1342(p) and 40 CFR Parts 9, 122, 123 and 124; and other applicable state and federal laws."

The types of stormwater facilities required by the draft ordinance, in order of preference, are stormwater infiltration facilities followed by stormwater detention facilities. The reason for preference being given to infiltration is because these types of facilities control both peak runoff discharge rate and total runoff volume. Detention facilities such as storm ponds (ones that do not infiltrate) only control

[23] City of DeWitt: http://www.dewittmi.org/Watershed.asp. Kent County: http://www.accesskent.com/YourGovernment/DrainCommisioner/drain_stormwater.htm.

discharge rate. Infiltration is desirable as it allows recharge of the groundwater table thereby supplying water bodies such as Huron Creek with flow when storm event runoff is not a major contributor to flow.

It also provides for natural uptake of nutrients, removal of sediment, and cooling of runoff that has passed over warming impervious surfaces. Design guidelines and recommendations for a variety of stormwater infiltration and detention facilities are available in the BMP manuals that are discussed in Section 7.6.

Use of infiltration-based stormwater management techniques is a part of what is known as "low-impact development" or "LID." LID emphasizes protection and use of on-site natural features integrated with engineered, small-scale stormwater controls to manage stormwater and maintain or restore pre-development watershed hydrologic functions. Low impact development strategies focus on evaporating, transpiring and infiltrating stormwater on site through native soils, vegetation and bioengineering applications, rather than conveying stormwater at increased volumes through large structural systems to streams and wetlands (Hinman, 2001). Use of LID techniques is recommended for the Huron Creek watershed. More information on LID can be found at:

- US Environmental Protection Agency: http://www.epa.gov/owow/nps/lid/.
- Prince George's County, Maryland: http://www.co.pg.md.us/Government/AgencyIndex/DER/ESD/low-impact.asp.
- Southeast Michigan Council of Governments (SEMCOG): http://www.semcog.org/LowImpactDevelopment.aspx. SEMCOG is currently in the process of creating the Michigan Low-Impact Development Statewide Manual.
- Low-Impact Development Center, Inc.: http://www.lowimpactdevelopment.org/.

The proposed stormwater ordinance includes language related to vegetation buffers. The term "vegetation buffer," in the context of water quality management, generally refers to zones or strips of vegetation that are left between development areas (impervious surfaces) and waterways or wetlands. The primary purposes of vegetative buffer zones are to:

- Reduce runoff by increasing stormwater infiltration into soil. Less runoff means lower amounts of nutrients and other pollutants directly entering the water. Less runoff also means more water entering the waterway or wetland as baseflow (subsurface flow).
- Stabilize soils with plant root systems.
- Reduce stream bank and wetland erosion from high velocity runoff.
- Improve wildlife and fish habitat by providing food, shelter, and shade (Univesity of Minnesota Sustainable Urban Landscape Information Series, 2006).

The main legal mechanism through which vegetative buffer zones are required and protected is a buffer ordinance. These ordinances are implemented in the same manner as stormwater ordinances, and are sometimes combined with stormwater ordinances into one ordinance.

Currently, vegetative buffers are not required by federal or state of Michigan law. However, many counties, municipalities and states (Wisconsin, Minnesota, and several eastern states) have

implemented them as either a local ordinance or state-wide rule. Currently, Portage Township has a buffer zone rule for lakes and streams as part of the township zoning code:

> "Section 3.0 (Zoning Districts) – For RUR, RER, LAR, R-1, R-2, R-3 and R-4[24] zones, no dwelling can be located closer than 50 feet to the edge of a lake or stream. In cases of high banks 10 feet or higher, dwellings may be allowed to be closer." (The portion of the watershed that is in Portage Township falls into one of these zoning classifications. Figure 2.3 shows a zoning map for Portage Township.)

A stream buffer is also included for the length of Huron Creek that is in Portage Township in the Houghton County Land Use Plan that was approved in July 2006 (http://www.houghtoncounty.net/docs/LandUsePlanText.pdf).

At this time the City of Houghton does not require a vegetative buffer for either waterways or wetlands.

The draft stormwater ordinance provided in Appendix R includes a simple buffer zone rule that can be enforced as part of the ordinance (Article 3.4):

"3.4 Buffer Zones

> 1) No building or impervious surface shall be constructed within 50 feet of the ordinary high water mark of a lake, pond or stream. The definition of ordinary high water mark is as presented in article 1.5.
>
> 2) No building or impervious surface shall be constructed within 50 feet of the delineated boundary of a wetland as defined in article 1.5."

The distance of 50 feet was chosen for the following reasons because a 50-foot distance is already used by Portage Township, which establishes a precedent and 50 feet is often used as a maximum buffer distance in several other states' and counties' buffer ordinances. This example rule is a simplified version of the many buffer ordinances that currently exist. More thorough versions can include:

- buffer setbacks specified in the site plan requirements;
- buffer distances varied by quality and/or type of wetland or water body;
- permitted and prohibited uses and activities in buffer zones;
- vegetation type, permitted and prohibited uses dictated within the zone by distance from water body; and
- variances and related procedures.

Resources providing more information on writing waterway and wetland buffer ordinances include:

- Lower Dead River Model Buffer Ordinance (Provided by the Superior Watershed Partnership, Marquette, MI): www.superiorwatersheds.org/file.php?file=riparianbufferreportnew.pdf.
- Planning and Zoning Strategies for Water Quality Protection (St. Louis County, MI): http://www.cityofbn.com/downloads/PZManualFinalDraft.pdf.
- Stormwater Manager's Resource Center: http://www.stormwatercenter.net/.

[24] RUR = Rural Residential, RER = Resort Residential, LAR = Lakeshore Residential, R-1 = Low Density Single-Family Residential, R-2 = Medium Density Single-Family Residential, R-3 = High Density Single-Family Residential, R-4 = Medium Density Multi-Family Residential District

Generally speaking, the more thought-out and thorough the ordinance, the more effective the ordinance will be at providing the environmental and water quality control functions that buffer zones are designed for. However, the extent of the ordinance implemented will depend on the resources and funds available to the enforcing municipality.

7.6. Best Management Practices (BMPs)

Best Management Practices or BMPs, are any structural, vegetative or managerial practice used to treat, prevent or reduce water pollution. Such practices include temporary seeding on exposed soils, detention and retention basins for stormwater control, and scheduling the implementation of all BMPs to ensure their effectiveness (Peterson, Reznick, Hedin, Hendges, & Dunlap, 1998). The summary and descriptions of recommended physical improvements found in Table 7.2 and Section 7.3 indicate BMPs that would be applied in the recommended improvements. References and resources that can be used for specific guidance on BMP procedures and design include

- Michigan Natural Resource Conservation Service (NRCS) Field Office Technical Guide
- Michigan Department of Environmental Quality (MDEQ) Best Management Practices Design Manual
- Great Lakes Better Backroads Guidebook

Table 7.7 lists the BMPs from these guides that apply to the recommended actions and/or critical areas discussed in this chapter. These guidebooks include specifications which will provide the user with information to help design and implement the BMP. Each of these guidebooks presents BMPs that were developed for use in Michigan. These BMPs are provided in the guidebooks because have been proven to work when designed, installed and maintenance correctly. It is important to follow all specifications when designing and installing BMPs and it is also important that BMP projects be maintained. Maintenance is most often the largest shortcoming of BMP performance. It is highly recommended that these resources are consulted and utilized prior to implementation of the applicable recommended actions listed in this chapter.

Table 7.7 Best Management Practices for Critical Areas and/or Recommended Actions

	Related Critical Areas and/or Recommended Action[4]							
Best Management Practice	**HWP**	**LF**	**SCC**	**WET-MIT**	**CRIT**	**WET-REST**	**STORM**	**BUFF**
Michigan NRCS Field Office Technical Guide[1]								
channel stabilization	**X**		**X**		**X**			
conservation planning								
critical area planting	**X**	**X**	**X**		**X**			
MI riparian forest buffer								**X**
recreation trail and walkway				**X**				
seeding/sodding/spreading topsoil	**X**	**X**		**X**	**X**	**X**		
shrub plantings for wildlife				**X**		**X**		

	Related Critical Areas and/or Recommended Action[4]							
Best Management Practice	**HWP**	**LF**	**SCC**	**WET-MIT**	**CRIT**	**WET-REST**	**STORM**	**BUFF**
stream crossing								
stream habitat improvement & management		X	X	X				
streambank & shoreline protection	X	X	X		X			
tree/shrub establishment	X	X	X		X	X		
water & sediment control basin, O&M plan			X				X	
wetland enhancement		X		X		X		
wetland restoration		X		X		X		
MDEQ Best Management Practices Design Manual[2]								
construction - access roads, grading practices, land clearing, spoil piles, staging and scheduling, tree protection	X							
critical area stabilization	X	X	X		X			
lawn maintenance	X							
pond construction & management	X		X				X	
slope/shoreline stabilization	X	X	X		X			
stream bank stabilization	X	X	X		X			
check dams								
grassed waterways								
stabilized outlets					X			
detention basins			X				X	
modular pavement, porous asphalt pavement								
infiltration trenches and basins								
buffer/filter strips								X
seeding/sodding	X	X	X	X	X	X		
tree/shrubs & ground cover	X	X	X	X	X	X		
Great Lakes Better Backroads Guidebook[3]								
ditch velocity controls & energy dissipators								
stream crossings - bridge spans, culverts, ditch culverts								
outlet structures - rock aprons, riprap conveyance channels, plunge pools		X	X					
bank stabilization - seeding	X	X	X	X	X	X		
bank stabilization - shrubs & trees	X	X	X	X	X	X		
stabilization structures - gabions, timber cribs, riprap, revetments	X	X	X		X			
combination "hard" & vegetative stabilization	X	X	X		X			
stabilization mats, blankets & geotextiles	X	X	X		X			
sediment controls & traps								
storage & borrow areas								

Best Management Practice	Related Critical Areas and/or Recommended Action[4]							
	HWP	LF	SCC	WET-MIT	CRIT	WET-REST	STORM	BUFF

[1]: http://efotg.nrcs.usda.gov/treemenuFS.aspx, Click on Section IV - Conservation Practices
[2]: http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714-118554--,00.html)
[3]: http://www.huronpines.org/project/23
[3] Key:
HWP = Houghton Waterfront Park
WET-REST = Wetland Restoration Areas
LF = Landfill Area
STORM = Stormwater Ordinance
SCC = Shopping Cart Creek
BUFF = Buffer Ordinance
WET-MIT = Wetland Mitigation Area and Creek Re-route
CONS-DEV = Conservation Development
CRIT = Critical Erosion Locations
CONSTR = Construction Practices

7.7. Funding Sources

The following is a list of potential funding sources for the recommended actions listed in this chapter. This list is not all-inclusive as funding sources are continually changing and becoming available.

MDEQ Nonpoint Source Grants

These grants distribute funds from Section 319(h) of the federal Clean Water Act, and from the Clean Michigan Initiative Nonpoint Source Pollution Control Grants and Clean Water Fund. Approximately $3.2 million from federal funding and approximately $2.0 million of CMI funding was made available for the 2008 grant cycle. This program is the funding source through which this watershed management plan was created. Funds are also available for implementation of watershed management plans (see http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714-175889--,00.html).

Federal Targeted Watershed Grants Program

Implemented through the US Environmental Protection Agency, the Targeted Watersheds Grant (TWG) program encourages the protection and restoration of the country's water resources through cooperative conservation.

The program supports collaborative watershed partnerships that are ready to implement on-the-ground restoration and protection activities designed to achieve quick, measurable environmental results. In 2007, US Environmental Protection Agency awarded $12.4 million in implementation grants for 2006/2007. These grants are awarded through a competitive process, and all proposals must include a nomination letter from the Michigan Office of the Governor (see http://www.epa.gov/twg/implementation.html).

Urban and Community Forestry Program

This federal funding program is implemented through state forestry agencies, in Michigan's case, the Michigan DNR. These funds are made available for local government program development, education and technology transfer projects, library and nature center reference material acquisition, and tree planting projects. This program is a reimbursement program, meaning the proposed project must be completed prior to distribution of funds (see http://www.michigan.gov/dnr/0,1607,7-153-10366_37984_38165-126153--,00.html).

MDEQ Coastal Zone Management Program

The MDEQ Coastal Zone Management grant program provides funds for:

- Creation and enhancement of coastal public access
- Protection, management and/or restoration of coastal resources, habitats, and watersheds
- Control of development in erosion or flood hazard areas
- Preservation and restoration of historic and cultural coastal structures

The City of Houghton has a grant application in for 2009 funding for improvements to Huron Creek in the Kestner waterfront park. See http://www.michigan.gov/deq/0,1607,7-135-3313_3677_3696-11198--,00.html for details.

North American Wetlands Conservation Act Small Grants Program

This grant, administered through the U.S. Fish & Wildlife Service, provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands conservation projects in the United States, Canada, and Mexico for the benefit of wetlands-associated migratory birds and other wildlife. The Small Grants Program in particular funds project activities are usually smaller in scope and involve fewer project dollars.
Grant requests may not exceed $75,000, and funding priority is given to grantees or partners new to the Act's Grants Program.

Michigan Natural Resources Trust Fund

The Michigan Natural Resources Trust Fund provides financial assistance to local governments to purchase land or rights in land for public recreation or protection of land because of its environmental importance or its scenic beauty. It also assists in the appropriate development of land for public outdoor recreation. Applicants must include their community's adopted recreation plan along with their submission. The deadline for application is April 1 of each year (see http://www.michigan.gov/dnr/0,1607,7-153-10366_37984_37985-124961--,00.html).

Rural Development Housing & Community Facilities Program

This grant and loan program implemented by the U.S. Department of Agriculture (USDA) provides funds to communities and individuals for improvements and modernizations to homes and community facilities, including sewer and water improvements. The program is need-based. See http://www.rurdev.usda.gov/rhs/common/program_info.htm#SFH for details.

Great Lakes Protection Fund

The Great Lakes Protection Fund is a private, nonprofit corporation formed in 1989 by the Governors of the Great Lakes States. It is a permanent environmental endowment that supports collaborative actions to improve the health of the Great Lakes ecosystem. To date, the Fund had made 217 grants and program related investments representing more than $53 million in regional projects to improve the health of the Great Lakes ecosystem. To be successful, tying the project work into a larger, basin-wide effort would therefore be necessary. Projects should anticipate and prevent impacts to the Great Lakes ecosystem or the specific component (like a developed watershed) of the Great Lakes ecosystem rather than attempt to correct areas already impacted. Applications are accepted at any time (see http://www.glpf.org/).

US Environmental Protection Agency Great Lakes National Program Office Grant Program

US Environmental Protection Agency's Great Lakes National Program Office provides funding for the achievement of the goals in the Great Lakes Water Quality Agreement, the principal goal of that Agreement being the restoration and maintenance of the chemical, physical, and biological integrity of the Great Lakes basin. This program includes funding for sediment, monitoring, habitat and pollution prevention projects (see http://www.epa.gov/glnpo/fund/glf.html).

7.8. Estimate of Pollutant Discharge Reductions

The purpose of this section is to present calculations for demonstrating pollutant load reductions that are projected to occur through implementation of the recommended actions.

7.8.1. Sediment (Total Suspended Solids), Nitrogen & Phosphorus

The recommended actions that address streambank erosion include the Kestner Waterfront Park improvements, improvements to Shopping Cart Creek upstream of the headcut (Critical Erosion Location I), and Critical Erosion Locations B and D. The landfill area also has some channel erosion. The formula presented in the MDEQ guidance document for streambank erosion is (MDEQ, 1999):

Sediment from Channel Erosion (CE) = Length (ft) x Height (ft) x Lateral Recession Rate (LRR, ft/yr) x soil weight (tons/ft^3)

Recommended LRRs are found in Table 7.8.

Table 7.8 Recommended Lateral recession rates (LLRs)

Lateral Recession Rate (ft./yr.)	Category	Description
0.01 - 0.05	Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.
0.06 - 0.2	Moderate	Bank is predominantly bare with some rills and vegetative overhang.
0.3 - 0.5	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped.
0.5+	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross-section is U-shaped and streamcourse or gully may be meandering.

Source: Steffen, L.J., 1982.

A soil weight of 0.055 tons/ft^3 is used for sands and loamy sands as they are the most common soil textures found in watershed.

- Kestner Waterfront Park Sediment Reduction = 615 ft x 4 ft x 0.5 ft/yr x 0.055 tons/ft^3 = 68 tons/yr
- Shopping Cart Creek (Erosion Location I) Sediment Reduction = 50 ft x 6 ft x 0.5 ft/yr x 0.055 tons/ft^3 = 8 tons/yr
- Landfill Creek Channel Sediment Reduction = 60 ft x 0.5 ft x 0.1 ft/yr x 0.055 tons/ft^3 = 0.2 tons/yr
- Erosion Location B Sediment Reduction = 20 ft x 1 ft x 0.2 ft/yr x 0.055 tons/ft^3 = 0.2 tons/yr
- Erosion Location D Sediment Reduction = 100 ft x 0.5 ft x 0.05 ft/yr x 0.055 tons/ft^3 = 0.1 tons/yr

The majority of erosion in the landfill area and critical erosion locations A, C, E and H can be described as small to large gully erosion. Location G is not included as it has not yet eroded and is a preventative measure. The formula presented in the MDEQ guidance document for gully erosion is (MDEQ, 1999):

Sediment from Gully Erosion (GE) = [(Top Width + Bottom Width(ft))/2] x Depth (ft) x Length (ft) x Soil Weight (tons/ft^3)/(Estimated # of Years it Took to Erode)

- Landfill Area Sediment Reduction - approximately 3 significant slope gullies, on average 2-3 ft wide (top & bottom), 0.5 to 1 ft deep and approximately 30 ft long:

  $$= \frac{(2.5\text{ ft}) \times (0.75\text{ ft}) \times (30\text{ ft}) \times (0.055\text{ tons/ft}^3) \times 3\text{ gullies}}{2\text{ years}} = 5\text{ tons/yr}$$

- Erosion Location A Sediment Reduction:

  $$= \frac{[(3\text{ ft} + 0.5\text{ ft})/2] \times (1.5\text{ ft}) \times (3\text{ ft}) \times (0.055\text{ tons/ ft}^3)}{4\text{ years}} = 0.1\text{ tons/yr}$$

- Erosion Location C Sediment Reduction:

  $$= \frac{[(3\text{ ft} + 0.5\text{ ft})/2] \times (1\text{ ft}) \times (5\text{ ft}) \times (0.055\text{ tons/ ft}^3)}{4\text{ years}} = 0.1\text{ tons/yr}$$

- Erosion Location E Sediment Reduction:

  $$= \frac{[(5\text{ ft} + 2\text{ ft})/2] \times (3\text{ ft}) \times (30\text{ ft}) \times (0.055\text{ tons/ft}^3)}{8\text{ years}} = 2\text{ tons/yr}$$

- Erosion Location H (Shopping Cart Creek Headcut) Sediment Reduction:

  $$= \frac{[(8\text{ ft} + 4\text{ ft})/2] \times (5\text{ ft}) \times (80\text{ ft}) \times (0.055\text{ tons/ft}^3)}{20\text{ ears}} = 7\text{ tons/yr}$$

Combining the estimated sediment reduction from streambank and gully erosion sites gives 90.7 tons.

This value can then be used to calculate an estimated amount of total phosphorus and nitrogen reductions using the following formula (MDEQ, 1999):

> Nutrient load (lb/yr) = Sediment load (tons/yr) x Nutrient Concentration (lb/lb soil) x 2000 lb/ton x soil type correction factor

Where the average nitrogen concentration in soil = 0.001 lb N/ lb soil,and the average phosphorus concentration in soil = 0.0005 lb P/ lb soil. Using this formula, total estimated nitrogen and phosphorus reductions are:

Total Annual Nitrogen Reduction = (90.7 tons/yr) x (0.001 lb N/ lb soil) x (2000 lb/ton) x 0.85

= 154 lb/yr = 0.08 tons/yr

Total Annual Phosphorus Reduction = (90.7 tons/yr) x (0.0005 lb P/ lb soil) x (2000 lb/ton) x 0.85

= 77 lb/yr = 0.04 tons/yr

7.8.2. Copper

Table 5.1 and Figure 5.7 indicate that the Green Acres (GA) water quality monitoring site has not had levels of total dissolved copper in exceedance of the Final Chronic Value (FCV) or Final Acute Value (FAV) for any of the monitoring events completed between November 2006 and May 2008. It can also be seen that exceedances generally begin at the next monitoring site downstream (DWL), continue

downstream, and spike at the landfill (LF) monitoring site. Based on this information, it can be concluded that the GA location characterizes background water quality that is not influenced by copper-contributing runoff from stamp sands or the Ridge Road landfill, as they are both in downstream/down-gradient locations relative to the GA site. Therefore, the assumption is made that if recommended actions for the landfill and stamp sand locations are completed, dissolved copper levels in Huron Creek would be reduced to the approximate concentrations found at the GA site. Below, copper load reduction calculations are presented for:

1. Stamp sand stabilization in the wetland mitigation area using the average copper concentration of the DWL monitoring site (nearest downstream monitoring site), referred to as $\mathbf{L_{DWL}}$.
2. Stamp sand stabilization in the Ridge Road landfill area, and prevention of leachate from reaching Huron Creek using the average copper concentration of the FL monitoring site (nearest downstream monitoring site), referred to as $\mathbf{L_{LF}}$.

The general method used to complete the calculations is the "Simple Method" (Shaver, 2007). The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration as

$$L = QC$$

where L = annual load, Q = annual runoff and C = pollutant concentration. The average annual runoff volume, or streamflow, was reported in Section 5.4.1 as 3.5 cfs.

Because separate load calculations are being completed for two monitoring locations (representing separate recommended actions), the runoff contributing to creek flow at each location ($Q_{DWL,}$ Q_{LF}) must be calculated to determine an associated load reduction for each location. These runoff values are estimated by using a ratio of that monitoring location's influencing catchment area (A_{DWL}, A_{LF}) to the total watershed area (A_{TOT}), and multiplying it by the total runoff (Q), as in

$$Q_{DWL} = (A_{DWL}/A_{TOT})Q = (1634 \text{ ac}/2112 \text{ ac})\ 3.5 \text{ cfs} = 2.1 \text{ cfs}$$

$$Q_{LF} = (A_{LF}/A_{TOT})\ Q = (2009 \text{ ac}/2112 \text{ ac})\ 3.5 \text{ cfs} = 3.3 \text{ cfs}$$

The desired copper concentration reduction is calculated by subtracting the background copper concentration, taken as the average copper concentration at the Green Acres (C_{GA}) sampling site, from the average copper concentration at the monitoring locations (C_{DWL}, C_{LF}). Given C_{GA} = 0.0027 mg/L, C_{DWL} = 0.017 mg/L and C_{LF} = 0.036 mg/L, the concentration reductions are:

$$C_{DWL*} = (0.017 \text{ mg/L} - 0.0027 \text{ mg/L}) = 0.0143 \text{ mg/L}$$
$$C_{LF*} = (0.036 \text{ mg/L} - 0.0027 \text{ mg/L}) = 0.033 \text{ mg/L}$$

Next, the Simple Method can be used to calculate the load reduction associated with each monitoring location and therefore each recommended action. The results of these calculations are given in

Table 7.9 .

Table 7.9 Estimated Total Annual Copper Load Reductions

Location	Runoff, cfs (Q_{DWL}, Q_{LF})	Copper Concentration Reduction, mg/L (C_{DWL}, C_{LF})	Estimated Total Load Reduction (tons/yr)
DWL	2.7	0.014	0.04
LF	3.3	0.033	0.11

These load reductions would result in concentrations at DWL and LF (and downstream locations) being reduced to the target average concentration of the Green Acres site, which is below both the typical FCV of 0.009 mg/L, and the typical FAV of 0.027 mg/L.

7.8.3. Ammonia

As can be seen in Figure 5.3, for every monitoring event, the average concentration of ammonia significantly increases at the LF site compared to the next upstream monitoring point, "Frog Pool," (FP). Similar to the calculations for copper, it is assumed that if leachate from the Ridge Road landfill is prevented entirely from reaching Huron Creek, the average concentration would drop to that of the upstream site, FP. Calculations follow for an estimated ammonia reduction following completion of the recommended action for the landfill leachate collection system:

- Q_{LF} = 3.5 cfs
- C_{LF} for ammonia = 0.15 mg/L
- C_{FP} = 0.0825 mg/L
- $C_{LF*} = C_{LF} - C_{FP}$ = 0.15 mg/L – 0.0825 mg/L = 0.0675 mg/L

Using the Simple Method, the estimated annual ammonia load reduction, L_R is 0.23 tons/yr. Completion of the recommended action to ensure that leachate is not entering Huron Creek from the former landfill will reduce ammonia concentrations at the LF monitoring site and downstream, to the average concentration of the FP site, which is 0.0825 mg/L.

7.9. Target Criteria and Associated Actions for Eliminating Impairments and Threats

In Section 4.1, the designated use, "Aquatic Life and Wildlife Habitat," was identified as being impaired, due to excessive levels of copper and ammonia that have been measured in Huron Creek. Two designated uses, "Partial Body Contact Recreation" and "Total Body Contact Recreation," were identified as threatened. These designated uses were identified as threatened due to concerns over

potential contact with human wastes in the Kestner Waterfront Park and a nearby swimming beach, downstream of the Dakota Heights area. In this area, it is suspected that septic systems nearby the creek are not operating sufficiently.

The recommended actions described in Section 7.3 are expected to remove these impairments and threats to designated uses. Table 7.10 lists the water quality contaminants associated with these impairments and threats, the targets to be met to remove the impairments and threats, and the recommended actions expected to remove the impairments and threats. Each of the contaminants is addressed in the monitoring plans in Section 7.4, such that the success of meeting the targets and removal of the impairments and threats will be assessed.

Table 7.10 Target Criteria for Removal of Designated Use Impairments and Threats

Contaminant	Target	Associated Recommended Actions
Copper	Reduce concentrations to below Final Acute Value for copper: 0.027 mg/L	7.3.1 Reduce Metals and Ammonia Loads to Huron Creek
Ammonia	Reduce concentrations to below Acute Value Value: 0.32 mg/L	7.3.1 Reduce Metals and Ammonia Loads to Huron Creek
Fecal Coliform	Ensure that concentrations are below total body contact recreation standard: 130 E. coli/100 ml [1]	7.3.4 Septic System and Sanitary Sewer

[1] based on 30-day geometric mean