WATERSHED MANAGEMENT PLAN FOR THE HURON RIVER IN THE ANN ARBOR – YPSILANTI METROPOLITAN AREA

Prepared on behalf of and with funding support from
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Revised October 2011

ACKNOWLEDGEMENTS

The authors would like to thank the following individuals, who provided content, review comments, and original documents for this watershed management plan.

Washtenaw County Drain Commissioner – Janis Bobrin, Harry Sheehan, Michelle Bononi

City of Ann Arbor – Molly Wade, Craig Hupy, Earl Kenzie

City of Ypsilanti – Vicki Putala (Orchard, Hiltz & McCliment, Inc.), Stan Kirton, Bill Bohlen

Ypsilanti Township – John Foley

Van Buren Township – Dan Swallow

Dexter Township – Donna Dettling

Superior Township – Deborah Kuehn

Pittsfield Township – Jan BenDor

Lodi Township – Jan Godek

Salem Township – Bill De Groot

University of Michigan – Heather Blatnik

Michigan Department of Environmental Quality – Janna Sebald, Peter Vincent, Robert Sweet, Deborah Snell

Technical assistance was provided by the **Huron River Watershed Council**:
Ric Lawson – main author/editor and facilitator
Dieter Bouma, intern – secondary research and author
Kris Olsson – GIS map production
Laura Rubin – Education plan author
Erica Powell, intern -- research

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CHAPTER 1: INTRODUCTION

1.1 THE MIDDLE HURON WATERSHED

For the purposes of this plan, the watershed within the Ann Arbor-Ypsilanti Metropolitan Area (see Figure 1.1) will be referred to as the Middle Huron Watershed. The Middle Huron Watershed is part of the Huron River Watershed (see Figure 1.1), one of Michigan's natural treasures. The Huron River supplies drinking water to approximately 150,000 people, supports one of Michigan's finest smallmouth bass fisheries, and is the State's only designated Scenic River in southeast Michigan. The Huron River Watershed is a unique and valuable resource in southeast Michigan that contains ten Metroparks, two-thirds of all southeast Michigan's public recreational lands, and abundant county and city parks. In recognition of its value, the State Department of Natural Resources has officially designated 27 miles of the Huron River and three of its tributaries as "Country-Scenic" River under the State's Natural Rivers Act (Act 231, PA 1970). The Huron is home to one-half million people, numerous threatened and endangered species and habitats, abundant bogs, wet meadows, and remnant prairies of statewide significance.

The Huron River basin encompasses approximately 900 square miles (576,000 acres) of Ingham, Jackson, Livingston, Monroe, Oakland, Washtenaw, and Wayne counties (Figure 1.1). The main stem of the Huron River is approximately 136 miles long, originating at Big Lake and the Huron Swamp in Springfield Township, Oakland County. The main stem of the river meanders from the headwaters through a complex series of wetlands and lakes in a southwesterly direction to the area of Portage Lake. Here, the river begins to flow south until reaching the Village of Dexter in Washtenaw County, where it turns southeasterly and flows to its final destination of Lake Erie. The Huron is not a free-flowing river. At least 98 dams segment the river system, of which 17 are located on the main stem.

The immediate drainage area to the Middle Huron Watershed is 217 square miles (138,593 acres), representing approximately 24% of the Huron River Watershed. The Middle Huron Watershed is defined as the land area that drains to the Huron River downstream of the confluence with Mill Creek and through Ford and Belleville Lakes. All or portions of 13 local communities are situated in the Middle Huron Watershed, of which the largest portions are within the Cities of Ann Arbor and Ypsilanti, and the townships of Scio, Ann Arbor, Superior, Pittsfield, Ypsilanti and Van Buren. Other communities with smaller areas in the watershed include the townships of Webster, Northfield, Salem, Lodi, as well as the Village of Dexter and the City of Belleville. The entire watershed lies in Washtenaw County, with the exception of the majority of the drainage to Belleville Lake, which is in Van Buren Township and the City of Belleville in Wayne County.

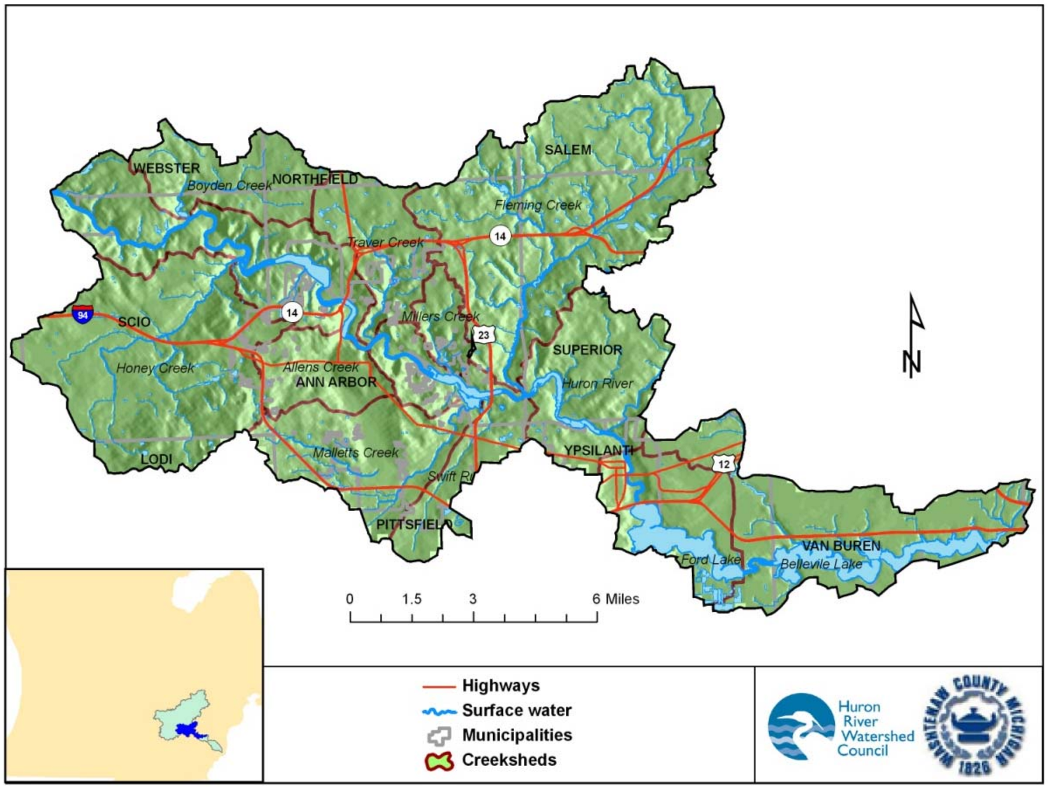

Figure 1.1 The Middle Huron Watershed boundary within the Ann Arbor-Ypsilanti Metropolitan Area, showing municipal and creekshed boundaries.

The segment of the Huron River in the Middle Huron Watershed begins at the outfall of Mill Creek in Dexter and ends at the French Landing Dam, which creates the Belleville Lake impoundment. From the Mill Creek outlet, the river flows unrestricted toward the southeast until it reaches a series of impoundments beginning with Barton Pond and ending in Belleville Lake. Nine major tributaries and the two lake drainages run directly into the Huron River system. These eleven distinct sub-basins are also known as "creeksheds." The mainstem of the Huron River in the Middle Huron Watershed is approximately 40 miles long with additional 593 miles of contributing streams. A relatively significant elevation drop from watershed inlet to outlet coupled with intensive urban development means that fewer lakes and wetlands remain in the Middle Huron than in the Upper Huron watersheds or other watersheds in Michigan. The elevation drops 199.5 feet over 40 river miles for an average gradient of 5.0 ft/mi. This gradient compares to an average of 3.3 ft/mi for the entire Huron River. Approximately 5,393 acres (8.4 sq. miles) of wetlands remain in the Watershed as of 2000, comprising about 6% of the total watershed area. The Middle Huron area contains 378 lakes and impoundments, of which 43 are greater than 5 acres and 10 of which are greater than 20 acres. All the waters greater than 20 acres in size are impoundments.

The watershed contains a few small protected natural areas including Dexter-Huron Metropark, Delhi Metropark, Barton Park, Bird Hills Park, Nichols Arboretum, Matthaei Botanical Gardens, and Belleville Park, as well as numerous other public and private local parks. The watershed's land cover is dominated by urban and sub-urban residential, commercial and industrial uses, with low-density residential areas, grasslands/old agricultural fields, forested lands, and wetlands scattered primarily in the northern and western fringes of the watershed.

In recent decades, the Huron River Watershed has experienced amplified development pressures from a growing economy and urban sprawl. According to the U.S. Census data and the Southeast Michigan Council of Governments (SEMCOG)[1], the total population of the seven communities* that comprise over 90% of the Middle Huron Watershed's population increased 5.5% from 1990 to 2007. The forecast to 2030 shows a 13.5% increase in population from 2007 levels. This growth rate falls in between that of other subwatersheds of the Huron River: Wayne and Oakland Counties' populations are hovering at a constant rate or declining, while rapid growth is occurring in Livingston County.

Washtenaw County continues to be one of the fastest growing counties in the state, reflecting a trend in growth out from Detroit to the more outlying areas spurred by highway improvements, the establishment of infrastructure, and a desire for open space, among other factors. According to SEMCOG, Washtenaw County's population increased by almost 9% from 2000 to August 2007, compared with 2.2% in Oakland County, -0.9% in Wayne County (excluding Detroit) and 23% in Livingston County. SEMCOG predicts that most of Washtenaw County's growth in the next 23 years will take place in Scio, Superior and Ypsilanti Townships, with projected growth rates all over 30%. The more developed municipalities are projected to experience more modest growth below 10%.

If current development practices are employed to accommodate the projected increase in population and associated infrastructure, then SEMCOG estimates 40% of the remaining open spaces will be developed within the Huron River Watershed by 2020. Much of this projected conversion of undeveloped land will occur in the Middle Huron area where it will hasten degradation of the hydrology and water quality of surface waters. Common practices that impact hydrology and water quality include draining wetlands, straightening and dredging streams ("drains"), removing riparian vegetation, installing impervious surfaces and storm sewers, inadequately controlling soil erosion, and poorly designing stream crossings. Such practices result in altered hydrology ("flashy" flows and flooding), soil erosion and sedimentation, elevated nutrients, nuisance algal blooms, dangerous levels of pathogens, and degraded fisheries.

1.2 Purpose of the Watershed Management Plan

The Watershed Management Plan (WMP) for the Huron River in the Ann Arbor-Ypsilanti Metropolitan Area is part of an effort led by communities in the Middle Huron Watershed seeking to plan activities to address water quality issues highlighted in the State of Michigan's Clean Water Act §303(d) report on impaired waters. The original WMP was completed in 1994 and then updated in 2000. This version is the second update of the WMP, and was carried out as a major redraft. Much data and other information on the Middle Huron has been compiled over this time, and the authors have sought to include as much as possible. This version was also reformatted to be consistent with the structure and content of other WMPs in the Huron River Watershed.

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* Includes Scio Township, City of Ann Arbor, Ann Arbor Township, Superior Township, City of Ypsilanti, Ypsilanti Township, and Van Buren Township.

Portions of the Middle Huron Watershed fail to meet minimum water quality standards or provide designated uses protected under Michigan law. In 1996, based on water quality monitoring studies, the Michigan Department of Environmental Quality (MDEQ) listed the Middle Huron River Watershed as significantly contributing phosphorus to the impaired waterbodies of Ford and Belleville lakes. The MDEQ placed the lakes on the State's 303(d) list of impaired waters, which means that their quality is poor enough to require the establishment of a Total Maximum Daily Load (TMDL). A TMDL is the maximum amount of a particular pollutant a waterbody can assimilate without violating numerical and/or narrative water quality standards. The reason for the impaired status was cited as excess phosphorus loading from point and nonpoint sources in the Middle Huron River Watershed.

Both point and nonpoint source contributions need to be reduced if the goal is to be met. The communities of the Middle Huron are under mandate from the State of Michigan to reduce phosphorus loading to the river by 50% in order to meet the TMDL. As a result of field studies, MDEQ established a TMDL target concentration of 50 micrograms per liter (µg/L) of phosphorus for Ford Lake, and 30 micrograms per liter (µg/L) of phosphorus for Belleville Lake to significantly reduce or eliminate the presence of nuisance algal blooms (Kosek, 1996). Scientists estimate that the areas covered under this WMP contribute about 75% of total phosphorus to the Middle Huron, with Mill Creek contributing the remainder.

The primary purpose of this plan is to address this impairment as well as others listed for the Middle Huron Watershed (see section 1.2.1). The Ann Arbor-Ypsilanti Watershed Management Plan represents a broad effort to restore and protect the integrity of water quality and quantity of the Middle Huron system. This plan presents a state-approved methodology to diminish the adverse effects of nonpoint source pollution to meet the established TMDLs and proactively address others that will be developed within the watershed. This plan outlines both quantitative and qualitative steps considered necessary to meet water quality goals for the Middle Huron River and its Watershed.

In order for the State of Michigan to approve a watershed plan, the plan must meet the following criteria as established in State Rule 324.8810:

> *A watershed management plan submitted to the MDEQ for approval under this section shall contain current information, be detailed, and identify all of the following:*
>
> *(a) The geographic scope of the watershed.*
> *(b) The designated uses and desired uses of the watershed.*
> *(c) The water quality threats or impairments in the watershed.*
> *(d) The causes of the impairments or threats, including pollutants.*
> *(e) A clear statement of the water quality improvement or protection goals of the watershed management plan.*
> *(f) The sources of the pollutants causing the impairments or threats and the sources that are critical to control in order to meet water quality standards or other water quality goals.*
> *(g) The tasks that need to be completed to prevent or control the critical sources of pollution or address causes of impairment, including, as appropriate, all of the following:*
>
> *(i) The best management practices needed.*

(ii) Revisions needed or proposed to local zoning ordinances and other land use management tools.
(iii) Informational and educational activities.
(iv) Activities needed to institutionalize watershed protection.

(h) The estimated cost of implementing the best management practices needed.

(i) A summary of the public participation process, including the opportunity for public comment, during watershed management plan development and the partners that were involved in the development of the watershed management plan.

(j) The estimated periods of time needed to complete each task and the proposed sequence of task completion.

The above criteria are necessary for approval under the Clean Michigan Initiative guidelines. To be approved for funding under federal Clean Water Act section 319, a plan must meet the "9 Minimum Elements:"

a. *An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan). Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed.*
b. *An estimate of the load reductions expected for the management measures described under paragraph (c) below. Estimates should be provided at the same level as in item (a) above.*
c. *A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.*
d. *An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.*
e. *An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.*
f. *A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.*
g. *A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.*
h. *A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.*
i. *A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.*

The communities involved in the development of this plan are committed to protecting the sensitive natural areas of the Middle Huron Watershed, mitigating impacts of existing point and nonpoint source pollution, and restoring degraded areas.

1.2.1 Total Maximum Daily Load Program

A Total Maximum Daily Load (TMDL) is the maximum amount of a particular pollutant a waterbody can assimilate without violating state water quality standards. Water quality standards identify the applicable "designated uses" for each waterbody, such as swimming, agricultural or industrial use, public drinking water, fishing, and aquatic life. MDEQ establishes scientific criteria for protecting these uses in the form of a number or a description of conditions necessary to ensure that a waterbody is safe for all of its applicable designated uses.

The state also monitors water quality to determine the adequacy of pollution controls from point source discharges. If a waterbody cannot meet the state's water quality criteria with point-source controls alone, the Clean Water Act requires that a TMDL must be established. TMDLs provide a basis for determining the pollutant reductions necessary from both point *and nonpoint* sources to restore and maintain the water quality standards. Point sources is the term used to describe direct discharges to a waterway, such as industrial facilities or waste water treatment plants. Nonpoint sources are those that enter the waterways in a variety of semi- or non-traceable ways such as stormwater runoff.

In Michigan, the responsibility to establish TMDLs rests with the MDEQ. Once a TMDL has been established by the MDEQ, affected stakeholders must develop and implement a plan to meet the TMDL, which will bring the waterbody into compliance with state water quality standards

As of the 2006 303(d) List of Nonattaining Waterbodies from the DEQ, ten waterbodies in the Middle Huron are listed for water quality problems. To date, four TMDLs have been established for Ford and Belleville Lakes (phosphorus), Geddes Pond (pathogens), Malletts Creek (poor fish and macroinvertebrates), and Swift Run (poor macroinvertebrates). Six TMDLs for other pollutants are scheduled for future establishment in the watershed, as described in Table 1.1.

Table 1.1: Waterbodies requiring TMDLs in the Middle Huron Watershed
(Source: MDEQ 2006 303(d) list of nonattaining waterbodies)

Waterbody	Pollutant or Problem	TMDL Status	Location/Area
Ford Lake/ Belleville Lake	Nutrient enrichment (phosphorus)	Approved in 2000	Impoundments of the Huron River located between the cities of Ypsilanti and Romulus.
Huron River (Geddes Pond and Allen Creek)	Pathogens (rule 100)	Approved in 2001	Geddes Pond Dam upstream to Argo Dam, Ann Arbor

Waterbody	Pollutant or Problem	TMDL Status	Location/Area
Malletts Creek	Poor fish and macroinvertebrate communities	Approved in 2004	Huron River confluence u/s to Packard Rd.
Swift Run	Poor macroinvertebrate community	Approved in 2004	SE Ann Arbor: Huron River confluence upstream to Ellsworth Rd
Honey Creek	Pathogens (rule 100)	Approved in 2009	Confluence of Huron River upstream to Wagner Rd..
Barton Pond	Fish Consumption Advisory for Polychlorinated Biphenyls (PCBs)	Scheduled for 2010	Impoundment of Huron River in vicinity of Barton Hills (suburb of Ann Arbor). From dam u/s to Conrail RR bridge crossing.
Ford Lake/ Belleville Lake	Fish Consumption Advisory for Polychlorinated Biphenyls (PCBs)	Scheduled for 2010	Impoundments of the Huron River located between the cities of Ypsilanti and Romulus.
Huron River	Water Quality Standard Exceedance for Polychlorinated Biphenyls (PCBs)	Scheduled for 2010	Lake Erie confluence upstream to include all tributaries.
Second Sister Lake	Fish Tissue-Mercury	Scheduled for 2011	W of Ann Arbor.
Unnamed Lake	Fish Consumption Advisory for PCBs, and Fish Tissue-Mercury	Scheduled for 2010 (PCBs) and 2011 (Mercury)	S. of Ford Lake in the NE corner of Sec. 26, T3S, R7E (Textile Road and Burton Road).

These individual TMDLs are discussed in greater detail in Chapter 2. Concerns related to established TMDLs in the watershed, and primarily nonpoint source-related actions to address those TMDLs, are included in this plan. However, because the problems associated with Mercury and PCB TMDLs are likely to be linked to broadly diffuse air-deposition or specific point sources yet to be defined, actions designed to address such TMDLs are not emphasized in this plan. The TMDLs to be developed for those waterbodies will identify source reductions to be implemented. This plan should be updated following development of those TMDLs, if necessary, to incorporate implementation activities.

1.2.2 Other Subwatershed Management Plans

This Plan was developed with the intention of fulfilling the watershed management planning criteria for the U.S. EPA's Clean Water Act §319 Program and MDEQ's Clean Michigan Initiative Program. In addition, many of the communities have developed plans to comply with the NPDES Phase II Stormwater Program, and these plans are referenced within. It should also be noted that several other "subwatershed" plans have been developed previously through a combination of community, public and private collaborative efforts. These include the Millers Creek Plan (see Appendix E), the

Malletts Creek Plans (Appendices F and X), the Fleming Creek Plan (Appendix G), the Ford Lake Plan (Appendix H), Allens Creek Plan (Appendix I), and the Swift Run Plan (Appendix Y). These plans and efforts are described in further detail in other chapters of the plan.

It is intended that this WMP will serve as an "umbrella" plan to incorporate and reference those other plans and consolidate their recommendations. Due to the broader scope of this plan, the evaluation, analysis and recommended actions will also be broader and less specific than those in subwatershed plans. For example, this plan recommends implementation of a number of individual best management practices (BMPs) in targeted areas. The subwatershed plans will often recommend specific locations for implementation of these BMPs. In many sections of this plan, references are made to elements within subwatershed plans. Users are encouraged to refer to those plans for more specific analysis and recommendations.

1.3 The Watershed Management Plan Community Input

The first task involved in developing the original 1994 Watershed Management Plan was the formation of a Policy Advisory Committee, with members representing each of the communities in the project area. In January 1993, an initial meeting of this group was convened to discuss issues related to nonpoint source pollution in the planning area and individual community concerns. Following this introductory meeting, goals and objectives for controlling water quality were developed and submitted to committee members for review and approval. Since that time the Committee has continued to meet on a regular basis to assist in watershed planning activities throughout the Middle Huron basin. Currently, the Middle Huron Partnership Initiative coordinates the meeting of these communities with the expressed intent to plan and implement activities to address the Ford and Belleville Lakes TMDL for phosphorus.

Efforts to update the Ann Arbor-Ypsilanti WMP are being coordinated under the leadership of the Washtenaw County Drain Commissioner (WCDC) in conjunction with the Huron River Watershed Council. For this 2007 update, an Advisory Committee was established, with representation from each of the communities in the Middle Huron Watershed, with the exception of Van Buren Township and the City of Belleville, as Belleville Lake was added to the geographic scope late in the update process. Project staff held bi-monthly meetings with the Advisory Committee to get feedback on different sections of the WMP. Materials were also distributed to Committee members and other interested parties for review, comment and input. All communities were given draft copies of the WMP for review prior to finalizing. The recommendations contained in this Watershed Plan update were the result of formal and informal meetings with community officials and staff since adoption of the initial plan in 1994 and its 2000 update. This update will again be presented to these communities to integrate with their commitments under other plans.

1.3.1. Technical Advisory Committees

Several Technical Advisory Committees were established to provide input to individual components of this plan. A Committee was established to assist in revising the Drain Commissioner's standards governing the design of stormwater management systems in new developments. Members included staff from local planning, engineering, building inspection and utilities departments. Private engineering and planning consultants were also represented, as well as the Huron River Watershed Council, the County Soil Conservation District and the MDNR. Committee members were provided with working drafts of the Drain Commissioner's standards (including explanations about how revisions work to improve water quality and quantity control) and asked to provide feedback on their practicality for implementation within Washtenaw County. Revised standards were adopted in 1994. Public involvement and review also guided the 2000 update and this 2007 update. That group was developed specifically to recommend stormwater permit standards. Those standards are not scheduled for revision prior to adoption of the WMP.

Additionally, the Middle Huron Partnership Initiative was formed to address the Ford and Belleville Lakes TMDL. The Partnership originally formed in 1999 following development of the TMDL, and an updated Cooperative Agreement was signed in 2005 (see Appendix B). This voluntary agreement commits the DEQ and community partners to specific steps to address the phosphorus reduction targets described in the TMDL. The Partnership meets twice a year to report on progress and also serves as a de facto advisory body for this WMP.

1.3.2 Input from Local Subwatershed and Creek Groups

Creek groups have contributed a unique community involvement component to the development of the original WMP and updates. Several creek groups have formed since the development of the original WMP, and several of these have developed subwatershed plans or other sets of recommendations. These include plans for Allens, Millers, Malletts, and Fleming Creeks, and Ford Lake. This plan incorporates these components not simply as feedback for the update, but as a basic framework for updating the plan. Recommendations made in this document represent a collaborative effort between the Huron River Watershed Council, the Office of the Washtenaw County Drain Commissioner, the individual creek groups and the greater creekshed communities.

Staff from the Huron River Watershed Council and the Washtenaw County Drain Office have met, and will continue to meet with creek groups, throughout the process of developing and implementing watershed plans. Involving these groups will continue to foster community support for WMP implementation and creek restoration activities. Representatives of the Huron River Watershed Council and the Drain Office will remain involved in these groups to assist in their development, management planning, grant proposals, policy and technical assistance, and special event coordination. In addition, creek group representatives will continue to advise the Drain Office and the Huron River Watershed Council in program development as they have for current and past restoration projects, the Huron River Watershed Council's Adopt-A-Stream program and others.

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[1] Southeaset Michigan Council of Governments. Community Profiles. http://www.semcog.org/data/communityprofiles. Accessed August 2007.

CHAPTER 2: CURRENT CONDITIONS

An effort has been made to collect all readily available information to establish a baseline of current conditions of the Watershed. Primarily, this effort focused on the review of relevant information from other subwatershed plans and related efforts. The information collection effort included requests to Advisory Committee members and researchers in the area. Numerous studies and datasets of relevance were obtained in this process. In addition, spatial data was gathered and analyzed in a Geographic Information System. This chapter presents a summary of all this information, with references to original sources. These original sources contain much more detail than is presented here.

2.1 LANDSCAPE AND NATURAL FEATURES

2.1.1 Climate and Topography

Seasonal variation is the most important feature of Michigan's, and therefore the watershed's, climate. The Huron River Watershed receives an average of 30 inches of precipitation annually as Southeast Michigan tends to be drier than other portions of Michigan. Seasonal precipitation patterns are fairly stable due to warmer winter temperatures that hold more moisture in the air, thereby moderating temperature fluctuation. Since southern Michigan climes produce regular thaws and refreezes throughout most of the winter, the Huron River flows do not vary as much as northern Michigan rivers.

Evaporation in the watershed is higher than most of the state, due to higher temperatures and slightly drier air found in southeast Michigan. As a result, the Watershed has one of the lowest amounts of total annual runoff in Michigan. For a 30-year period, the average high temperatures ranged from 32^{o}F in January to 84^{o}F in July in the Watershed, while the average low temperatures ranged from 15^{o}F in January to 59^{o}F in July.

The Middle Huron Watershed falls into three distinct regional landscape ecosystems according to the USGS classification: the Jackson Interlobate, the Ann Arbor Moraines, and the Maumee Lake Plain[1]. The Nature Conservancy identifies the Huron River Watershed as located within the North Central Till Plain and the Great Lakes ecoregions. Ecoregions are areas that exhibit broad ecological unity, based on such characteristics as climate, landforms, soils, vegetation, hydrology and wildlife. The Middle Huron Watershed lies in the North Central Till Plain and Great Lakes ecoregions.

2.1.2 Geology and Soils

Glacial Outwash Plains and coarse to medium textured end moraines characterize much of the Watershed (Figure 2.2). Glacial outwash plains were created by melting glaciers whose runoff sorted soils into layers of similarly sized particles. These well-sorted soils include sand and gravel that allow rapid infiltration of surface water to groundwater aquifers and stream systems. End moraines are areas where glacial processes deposited huge quantities of rock and soil material of various sizes in one place. The mixture of varying sized soil particles increases the soils' ability to hold moisture and nutrients, which is conducive to agriculture. Coarse textured end moraines, which are found mainly in the northern and western portions of the Watershed, have low to moderate permeability, while the medium textured end moraines in patches around the Watershed's periphery have lower permeability.

The soils in the Middle Huron River Watershed are largely end moraines of medium-textured till or lacustrine sand and gravel glacial outwash. Sand and gravel line the riparian zone of the river and its major tributaries. Figure 2.3 shows hydric soil groups and Figure 2.9 shows the soils according to their hydrological classification, ranging from rapid to slow infiltration. The general trend of soil infiltration in the Middle Huron River Watershed is moderately slow infiltration in the West, slow infiltration in the central areas, and moderately rapid infiltration in the East.

2.1.3 Significant Natural Features and Biota

Since the Middle Huron Watershed frames the cities of Ann Arbor and Ypsilanti, significant building pressure has caused the land to become altered and degraded. Still, pockets of high quality habitat and diverse species persist due to conscientious planning and policy-making efforts that seek to preserve wildlife habitat. The expansiveness and ecological quality of the remaining open spaces and native habitats directly impact the quality of life and quality of water in the Watershed. Researchers have recognized plant and animal species and plant community types as integral parts of the Watershed that deserve protecting. Among those conservation targets are the threatened and endangered species that have been observed in the watershed (Table 2.1). Many of the 90 plant and animal occurrences in the table are partially or entirely dependent on aquatic ecosystems for survival.

Table 2.1. Threatened, Endangered, and Special Concern Occurrences in the Ann Arbor-Ypsilanti Metroarea Watershed from 1968-Present, some of which may have since been extirpated[2]

SC = Special Concern *T = Threatened* *C= being considered for federal status*
PE = Proposed Endangered *E = Endangered* *X= Extirpated from state*

Common name	*Scientific NAME*	*State status*	*Federal status*
ANIMALS			
Blanchard's Cricket Frog	*Acris crepitans blanchardi*	SC	
Elktoe	*Alasmidonta marginata*	SC	
Smallmouth Salamander	*Ambystoma texanum*	E	
Grasshopper Sparrow	*Ammodramus savannarum*	SC	
Swamp Metalmark	*Calephelis mutica*	SC	
Marsh Wren	*Cistothorus palustris*	SC	
Redside Dace	*Clinostomus elongatus*	E	
Kirtland's Snake	*Clonophis kirtlandii*	E	
Least Shrew	*Cryptotis parva*	T	
Purple Wartyback	*Cyclonaias tuberculata*	SC	
Blanding's Turtle	*Emydoidea blandingii*	SC	
Snuffbox	*Epioblasma triquetra*	E	
Wild Indigo Duskywing	*Erynnis baptisiae*	SC	
Dukes' Skipper	*Euphyes dukesi*	T	
Bald Eagle	*Haliaeetus leucocephalus*	T	
Wavy-rayed Lampmussel	*Lampsilis fasciola*	T	
Woodland Vole	*Microtus pinetorum*	SC	
Indiana Bat or Indiana Myotis	*Myotis sodalis*	E	PE
American Burying Beetle	*Nicrophorus americanus*	E	PE
Silver Shiner	*Notropis photogenis*	E	
Brindled Madtom	*Noturus miurus*	SC	
Northern Madtom	*Noturus stigmosus*	E	
Southern Redbelly Dace	*Phoxinus erythrogaster*	E	
Gravel Pyrg	*Pyrgulopsis letsoni*	SC	
King Rail	*Rallus elegans*	E	
Eastern Massasauga	*Sistrurus catenatus catenatus*	SC	C
Regal Fritillary	*Speyeria idalia*	E	
Laura's Snaketail	*Stylurus laurae*	SC	
Eastern Box Turtle	*Terrapene carolina carolina*	SC	
Rainbow	*Villosa iris*	SC	
Hooded Warbler	*Wilsonia citrina*	SC	
PLANTS			
Hairy Angelica	*Angelica venenosa*	SC	
Virginia Snakeroot	*Aristolochia serpentaria*	T	
Purple Milkweed	*Asclepias purpurascens*	SC	
Sullivant's Milkweed	*Asclepias sullivanti*	T	
Willow Aster	*Aster praealtus*	SC	
Cooper's Milk-vetch	*Astragalus neglectus*	SC	
Murray Birch	*Betula murrayana*	SC	
Side-oats Grama Grass	*Bouteloua curtipendula*	T	
Frank's Sedge	*Carex frankii*	SC	
False Hop Sedge	*Carex lupuliformis*	T	
Sedge	*Carex squarrosa*	SC	
Hairy-fruit Sedge	*Carex trichocarpa*	SC	
Purple Turtlehead	*Chelone obliqua*	E	
Yellow Nut-grass	*Cyperus flavescens*	SC	
White Lady-slipper	*Cypripedium candidum*	T	
Purple Coneflower	*Echinacea purpurea*	X	
Love Grass	*Eragrostis capillaris*	SC	

Common name	*Scientific NAME*	*State status*	*Federal status*
Small Love Grass	*Eragrostis pilosa*	SC	
Wahoo	*Euonymus atropurpurea*	SC	
Upland Boneset	*Eupatorium sessilifolium*	T	
Showy Orchis	*Galearis spectabilis*	T	
White Gentian	*Gentiana flavida*	E	
Downy Gentian	*Gentiana puberulenta*	E	
Stiff Gentian	*Gentianella quinquefolia*	T	
Pale Avens	*Geum virginianum*	SC	
Kentucky Coffee-tree	*Gymnocladus dioicus*	SC	
Whiskered Sunflower	*Helianthus hirsutus*	SC	
Green Violet	*Hybanthus concolor*	SC	
Goldenseal	*Hydrastis canadensis*	T	
Twinleaf	*Jeffersonia diphylla*	SC	
Water-willow	*Justicia americana*	T	
Least Pinweed	*Lechea minor*	SC	
Virginia Flax	*Linum virginianum*	T	
Purple Twayblade	*Liparis liliifolia*	SC	
Broad-leaved Puccoon	*Lithospermum latifolium*	SC	
Red Mulberry	*Morus rubra*	T	
Mat Muhly	*Muhlenbergia richardsonis*	T	
Ginseng	*Panax quinquefolius*	T	
Leiberg's Panic-grass	*Panicum leibergii*	T	
Low-forked Chickweed	*Paronychia fastigiata*	SC	
Pale Beard Tongue	*Penstemon pallidus*	SC	
Orange and Yellow Fringed Orchid	*Platanthera ciliarus*	T	
Bog Bluegrass	*Poa paludigena*	T	
Jacob's Ladder or Greek-valerian	*Polemonium reptans*	T	
Swamp or Black Cottonwood	*Populus heterophylla*	T	
Prairie Buttercup	*Ranunculus rhomboideus*	T	
Hairy Ruellia	*Ruellia humilis*	T	
Canadian Burnet	*Sanguisorba canadensis*	T	
Clinton's Bulrush	*Scirpus clintonii*	SC	
Tall Nut-rush	*Scleria triglomerata*	SC	
Compass-plant	*Silphium laciniatum*	T	
Cup-plant	*Silphium perfoliatum*	T	
Lesser Ladies'-tresses	*Spiranthes ovalis*	T	
Trailing Wild Bean	*Stophostyles helvula*	SC	
Virginia Spiderwort	*Tradescantia virginiana*	SC	
Toadshade	*Trillium sessile*	T	
Edible Valerian	*Valeriana edulis* var. *ciliate*	T	
Wild-rice	*Zizania aquatica* var. *aquatica*	T	
NATURAL COMMUNITIES AND GEOGRAPHIC FEATURES			
Prairie fen	Alkaline Shrub/herb Fen, Midwest	n/a	n/a
Oak barrens	Barrens, Central Midwest Type	n/a	n/a
Mesic Sand Prairie	Moist Sand Prairie, Midwest Type	n/a	n/a
Wet Prairie	Wet Prairie, Midwest Type	n/a	n/a
Woodland Prairie	High Prairie, Midwest Type	n/a	n/a

Recovering these species requires protecting the ecosystems on which they depend. Key conservation areas of the Middle Huron Watershed system include critical habitat for plant and animal communities (including habitat for rare, threatened or endangered species), such as wetlands; large forest tracts; springs; spawning areas; the aquatic corridor, including floodplains, stream channels, springs and seeps; steep slopes; and riparian forests (Figure 2.4). Priority areas are those with intact, native ecosystems due to floral and faunal integrity.

In addition to their importance as wildlife habitat, undeveloped areas, such as forest, meadow, prairie, wetlands, ponds and lakes, and groundwater recharge areas, provide a host of services to the Watershed otherwise unobtainable by human invention, including the following:

- Groundwater. Natural systems allow rainwater and snowmelt to infiltrate into groundwater aquifers. About 50% of Michigan residents rely on groundwater for drinking water. Groundwater also provides irrigation water for agriculture and cooling water for industry.
- Surface water. By intercepting runoff and keeping surface waters supplied with a constant flow of clean, cool groundwater, natural systems keep streams, rivers and lakes clean. New York City has recognized the benefits natural systems provide to their drinking water system. The City has budgeted $660 million towards protecting the upper Hudson River Watershed, which drains into their drinking water supply. The City calculated that if the watershed undergoes development without watershed protection, the water source would degrade, making a $4 billion water treatment plant necessary.
- Pollutant removal. As water infiltrates into the ground or passes through wetlands, soil filters out many pollutants. Vegetation also takes up nutrients and other pollutants, including phosphorus, nitrogen, bacteria, and even some toxic metals.
- Erosion control. Vegetation intercepts water and soil absorbs it, keeping it from eroding streambanks and hillsides. River- and lakeside wetlands are especially important for erosion control along riverbanks and lakeshores.
- Air purification. Vegetation purifies the air we breathe.
- Flood and drought control. Vegetation and soil intercept runoff water, moderating floods and droughts. In the 1970s, the U.S. Army Corps of Engineers purchased about 8,500 acres of wetlands along the Charles River in Massachusetts after concluding that preserving natural systems was a more cost effective way to control flooding than building more dams on the river.
- Wildlife habitat and biodiversity. Natural systems are vital to the survival of aquatic and terrestrial wildlife. In addition to its aesthetic value, maintaining the biodiversity of species is vital to our economy and health. For instance, 118 of the top 150 prescription drugs are based on natural sources.
- Recreation. Natural areas provide recreation such as hiking, bird-watching, canoeing, hunting, and fishing that generate revenues for the local community.
- Cooling. Tracts of land soak up solar heat and prevent heat islands from forming. Heat islands warm water runoff, which leads warm water to flow into streams and disrupts the aquatic climate.
- Property values. Natural areas enhance the value of neighboring properties.

The remaining undeveloped, natural areas in the Huron Watershed were mapped and prioritized in 2002, and updated in 2007 through the Bioreserve project of the Huron River Watershed Council.[1] In order to help prioritize protection and conservation efforts, the mapped sites were ranked based on the following ecological and hydrological factors: size; core size, presence of water; presence of wetlands; groundwater recharge potential; potential for rare remnant plant community; topographical diversity; glacial diversity, how connected they were or could be to other natural areas, vegetation quality, potential for restoration, and biodiversity. 152 sites

(17,654 acres) in the Middle Huron Watershed were identified as priority natural areas, with 12 sites (3426 acres) ranked as highest priority for protection, 89 sites (11,502 acres) ranked as medium priority for protection, and 51 sites 2727 acres) ranked as lower priority for protection.[3, 4] The results of the project are shown in Figure 2.5.

2.1.4 Hydrology

The Huron River begins at an elevation of 1016 feet in the headwaters and descends 444 feet to an elevation of 572 feet at its confluence with Lake Erie, for an average gradient of 3.3 feet per mile. By comparison, the Middle Huron River portion of the Huron River is steeper than the average for the whole river, dropping 199.5 feet between the Hudson Mills Metropark and Belleville Lake, averaging a change of 5.0 feet per mile. In its natural state, the river reflected this gradient, with numerous sections of rapids identified prior to the construction of dams. It is this gradient that, in fact, creates the desirable conditions for dam construction. The many mills and other control structures that have been constructed have since muted the impacts that the fast flowing water had on the topography and river habitat. The river channel gradient is a controlling influence on river habitat such as flow rates, depth, width, channel meandering, and sediment transport.

Stream flow data for the Huron River in the Middle Huron Watershed has been collected at the U.S. Geological Survey (USGS) gage stations at the Huron River (#04174500) between Argo and Geddes dams since 1904 (near Wall Street, its current location since 1947) and on Mallets Creek (#04174518) at Chalmers Road since 1999. Mean annual flow at the Wall Street station is 451.3 cubic feet per second (cfs), representing a drainage area of 729 square miles, or .62 cfs per square mile.[5] Mean annual flow at the Chalmers Road station is 9.20 cubic feet per second (cfs), representing a drainage area of 10.9 square miles, or .84 cfs per square mile.[6] See section 2.4.6 for more details on the Mallets station. A comparison of the mean monthly streamflows for four typical rainfall years and the mean monthly streamflow based on the 59 years of record in the Huron River at Wall St. is presented in Figure 2.1. Seasonally high flows generally occur in early spring during winter snowmelt and spring rains, with baseflow conditions most apparent between July and October. While monthly streamflow naturally varies from year to year, Figure 2.1 shows that conditions in the watershed vary most in the spring and early winter and remain relatively constant over the summer months. One possible reason for the lack of variation is the presence and operation of control structures above the gage station.

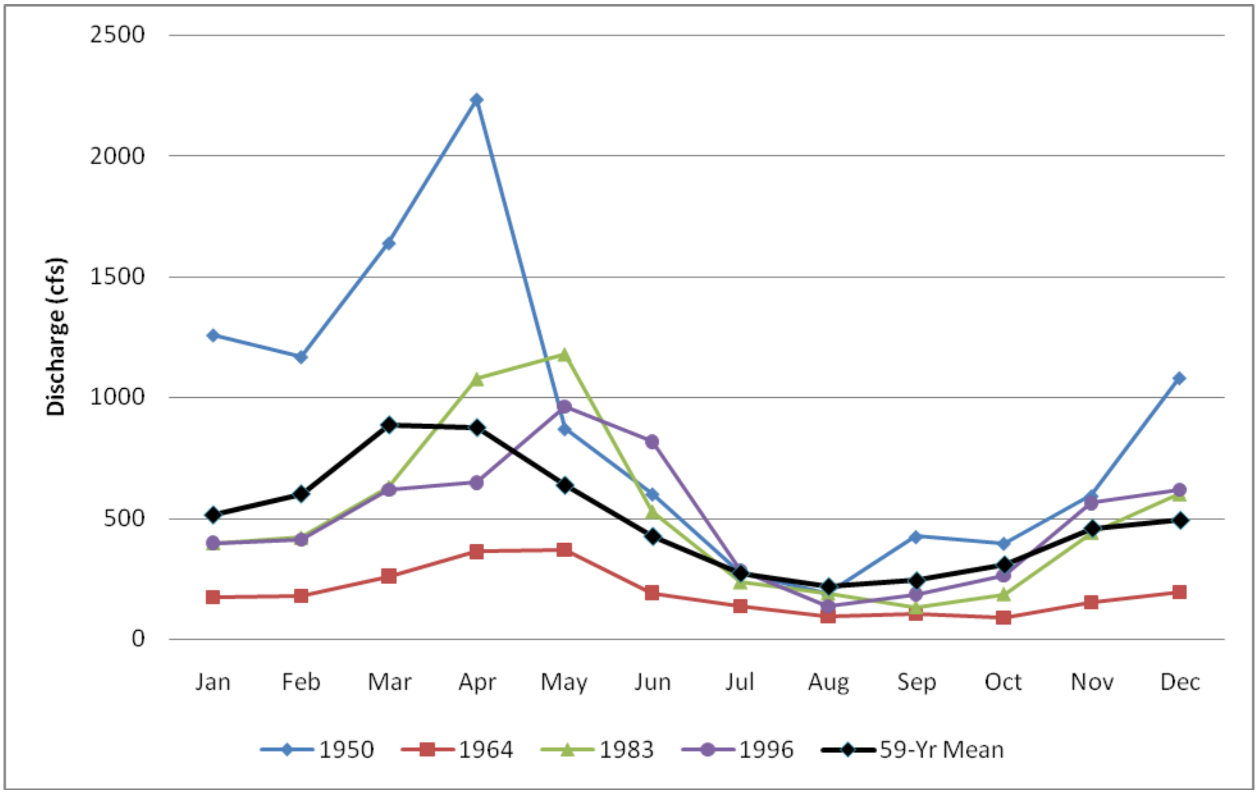


Figure 2.1. Monthly mean discharge of the Huron River at the Wall St. flow gage (USGS station #041744500). A range of dry to wet years are shown with a 59-year average.[7]

Increasing development and resulting changes to the hydrology and hydraulics are still a significant threat to the watershed. Human impacts and development have generally increased daily fluctuations in the Huron's streamflow. Land drainage for urban or agricultural use has degraded the original, fairly stable flow regime. Draining wetlands, channelizing streams, and creating new drainage channels have decreased flow stability by increasing peak flows and diminishing recharge in groundwater tables. All tributaries to the Huron River suffer from comprehensive channelization, lack of cover, and large flow fluctuations as a result of efforts to accelerate drainage through these streams. Summer water temperatures have become warmer and more variable due to lower base flows, channel widening and clearing of shading stream-side vegetation. Landscape alterations and increased peak flows have accelerated erosion within the basin and increased the sediment load to the river.[8]

Additional factors important in reviewing and understanding the hydrology of the watershed are direct drainage, depth to groundwater, soil permeability, and groundwater recharge that indicate the infiltration potential of groundwater.

Direct drainage areas (Figure 2.6) are areas that have significant spatial and temporal influence on the quantity and quality of water entering the river system via groundwater or surface water flows. Much of this flow may come from direct flow from impervious surfaces. Excluded from direct drainage are portions of the landscape that form depressions where the dominant flow of water reaches the groundwater directly through infiltration. The map presented in Figure 2.6 is derived from a model that calculates flow accumulation based, in part, on the amount of imperviousness in each area.

The groundwater recharge potential map utilizes Darcy's Law to predict the probability of groundwater recharge areas in the watershed. As shown in Figure 2.7, Darcy's Law predicts that areas adjacent to the river and tributary systems generally hold the greatest probability of having groundwater recharge. Figures 2.8 and 2.9 illustrate the depth to groundwater and soil permeability characteristics for the watershed. Such information is useful when considering the applicability of certain stormwater control structures (i.e., best management practices), especially infiltration-based, and the appropriateness of certain development proposals that may require added water quality precautions within the watershed (i.e., gas stations, chemical storage facilities, etc.). Some of this data yield conflicting results. A more detailed analysis of groundwater recharge should be undertaken to resolve or clarify these areas of conflict.

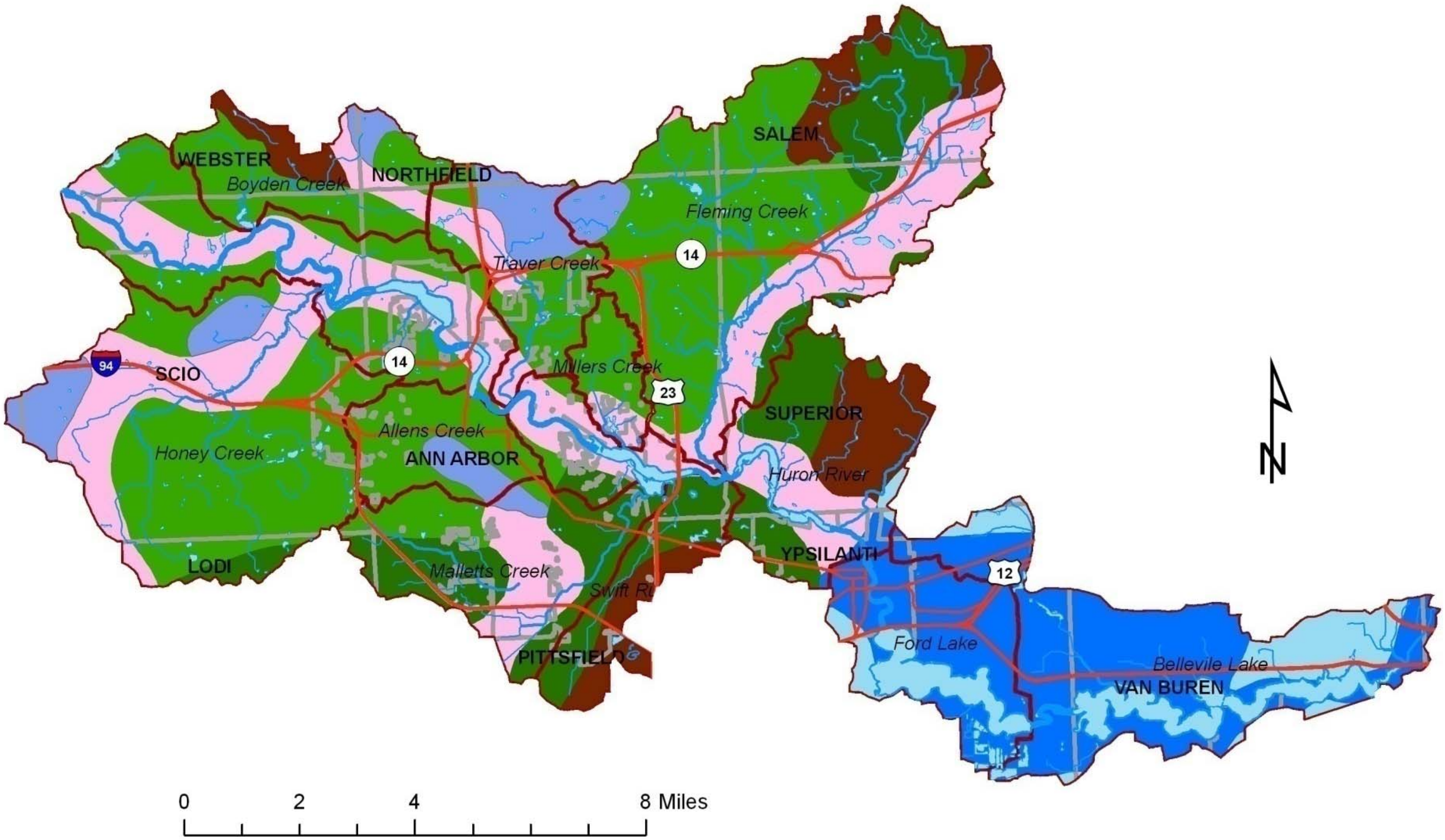
Another attribute contributing to the hydrology of the Middle Huron Watershed is the presence of dams and impoundments. According to the National Inventory of Dams, 23 dams are located in the watershed (Figure 2.10 and Table 2.2). Dams may be constructed for uses such as hydropower, recreation, or stormwater and flood control. Most of the dams in the Middle Huron were developed for recreational purposes, though several significant dams continue to be used for active hydropower or flood control. Dams that were previously useful can outlive their intended purposes and become hazards and ecological detriments to the river. Dams can create hazards by collecting debris or simply by requiring recreationalists to circumnavigate them. They act as ecological detriments by holding back silt and nutrients, altering river flows, decreasing oxygen levels in impounded waters, blocking fish migration and eliminating spawning habitat, increasing nuisance plant growth in impoundments, altering water temperatures, and injuring or killing fish.

Table 2.2 Inventoried Dams in the Middle Huron Watershed[9]

Dam Name	Waterway	Community	Downstream Hazard Potential	Purpose	Date Built	Dam Height (Feet)	Pond Area (acres)
Barton	Huron River	Ann Arbor	High	Hydropower	1915	24	302
Argo Dam	Huron River	Ann Arbor	High	Retired Hydropower, Recreation	1920	18	92
French Landing	Huron River	Belleville	High	Hydropower	1925	38	1270
Geddes	Huron River	Ann Arbor	High	Retired Hydropower, Recreation	1919	25	261
Peninsula Paper	Huron River	Ypsilanti	High	Other	1914	16	177
Rawsonville (Ford)	Huron River	Ypsilanti	High	Hydropower	1932	45	1050
Superior	Huron River	Ann Arbor	High	Hydropower	1920	27.5	93
Fishbeck	Fleming Creek		Low	Recreation	1973	15	6
Geddes Ridge Storm Ret.	Foster Drain Trib.		Low	Flood & Storm		10	7
L. Geddes Lk Sub	Huron River Trib.		Low	Recreation	1914	9	4
Parker	Fleming Creek		Low	Other		19	30
Pittsfield-Ann Arbor #1	Pittsfield-Ann Arbor?	Pittsfield & Ann Arbor	Low	Recreation	1978	10	3
Pittsfield-Ann Arbor #2	Pittsfield-Ann Arbor?	Pittsfield & Ann Arbor	Low	Recreation	1978	10	4

Dam Name	Waterway	Community	Downstream Hazard Potential	Purpose	Date Built	Dam Height (Feet)	Pond Area (acres)
Traver Creek #1	Traver Creek	Ann Arbor	Low		pre-1901	0	2
Traver Creek #2	Traver Creek	Ann Arbor	Low		pre-1901	0	2
Traver Creek #3	Traver Creek	Ann Arbor	Low		pre-1901	0	2
Traver Creek #4	S. Branch Traver Creek	Ann Arbor	Low		pre-1901	0	2
Traver Creek #5	S. Branch Traver Creek	Ann Arbor	Low		pre-1901	0	2
Traver Creek #6	S. Branch Traver Creek	Ann Arbor	Low		pre-1901	6	5
Traver Creek Retention	Traver Creek	Ann Arbor	Low	Other	1981	13	2
Traver Lake #5	M. Branch Traver Creek	Ann Arbor	Low	Recreation	1971	34	2
Whittaker and Gooding	Fleming Creek		Low		Pre-1901	6	10
Waterway Trucking Ser.	Fleming Creek		Low		Pre-1901	0	2

Middle Huron Watershed Glacial Geology



Data Source: Automated from "Quarternary Geology of Michigan," 1982, compiled by W. R. Farrand, University of Michigan, and MDEQ Geological Survey Division

Figure 2.2

Highways	**Glacial Geology**	Glacial outwash sand and gravel
Surface water	Fine-textured glacial till	Lacustrine clay and silt
Creeksheds	End moraines of medium-textured till	Lacustrine sand and gravel
Municipalities	End moraines of fine-textured till	Medium-textured glacial till

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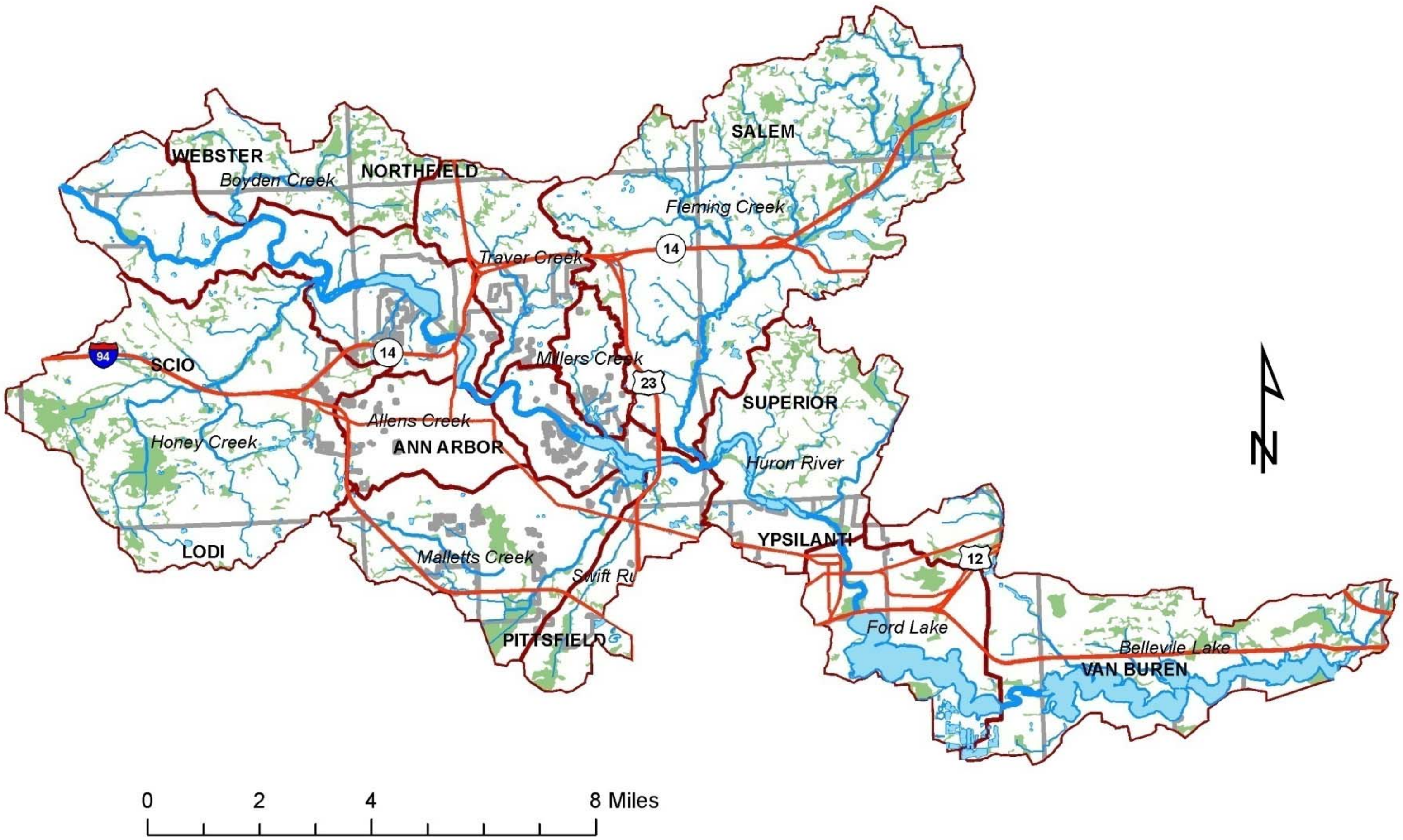
Middle Huron Watershed Hydric Soils



Data Source: USDA Natural Resources Conservation Services

Figure 2.3

Highways
Surface water
Creeksheds
Municipalities
Hydric Soils

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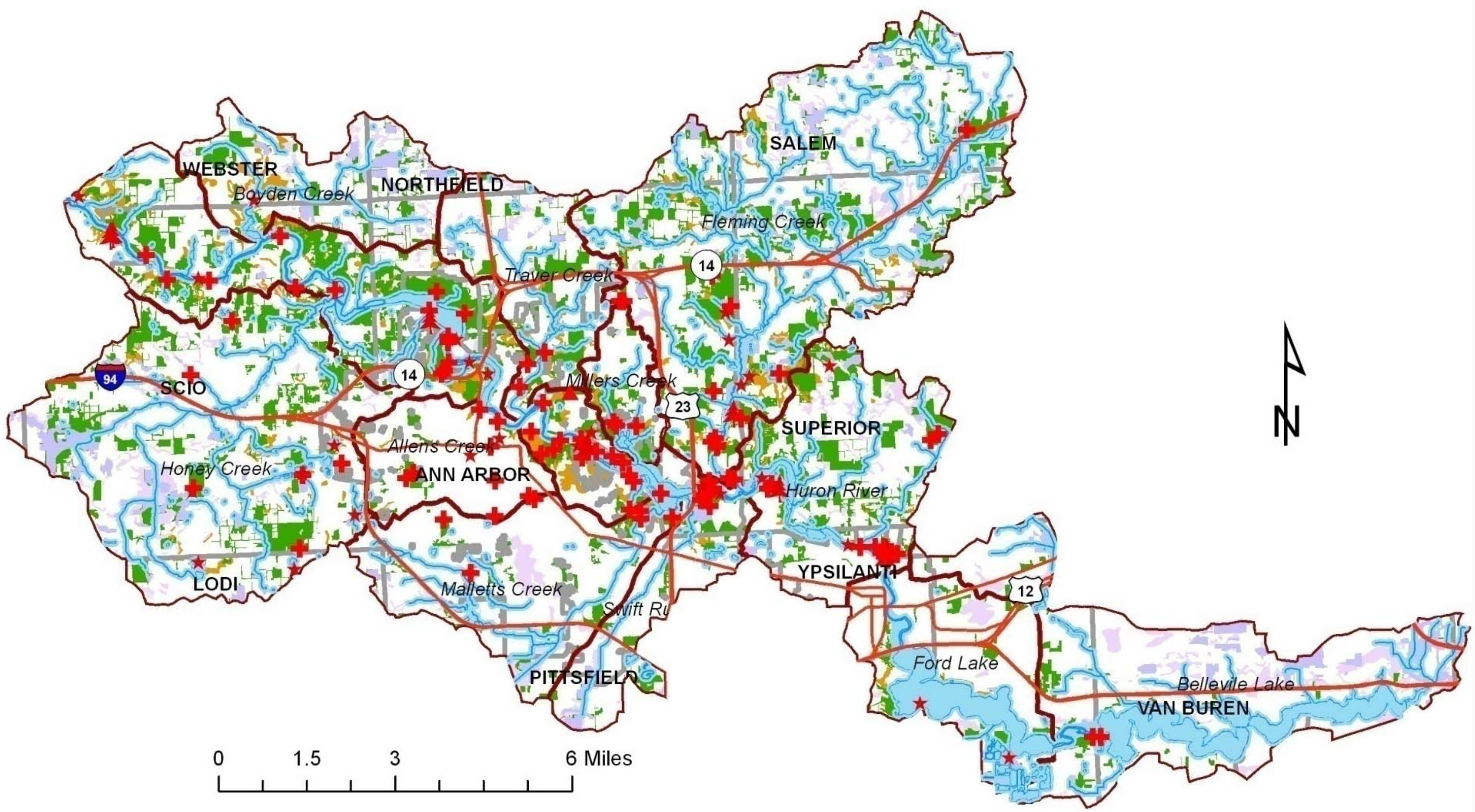
WASHTENAW COUNTY MICHIGAN 1826

Middle Huron Watershed Environmentally Sensitive Areas



Data Sources: Michigan Natural Features Inventory: SEMCOG: NRCS Soil Survey: HRWC; Washtenaw County Planning

Highways
Surface water
Creeksheds
Municipalities
Floodplains & 300 ft. buffer around waterways

Woodland
Wetlands
Slopes over 12%
Hydric soils

Endangered/threatened species/communities
Animal
Community
Other
Plant

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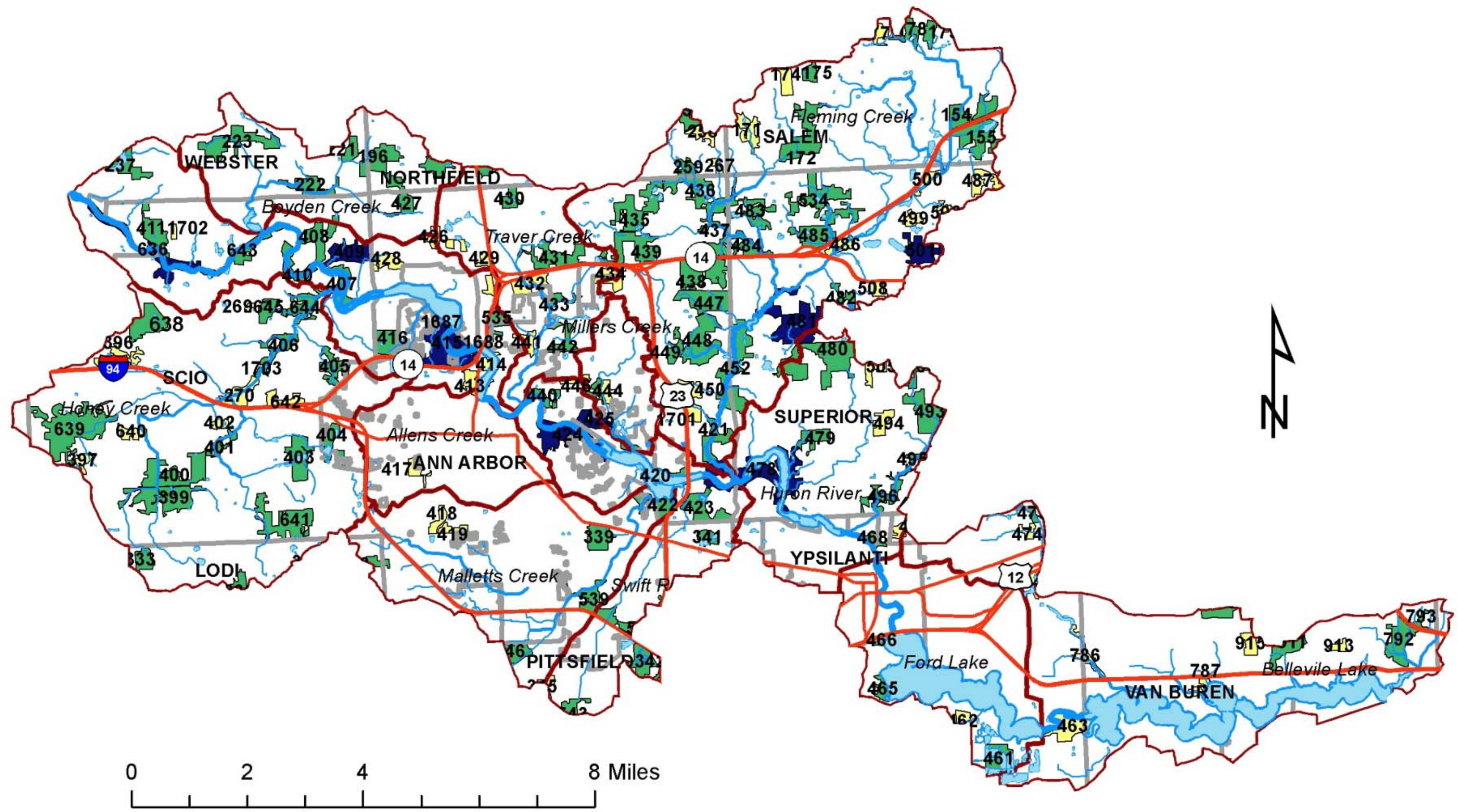
Figure 2.4

Middle Huron Watershed Bioreserve Sites



Data Source: Sites delineated from digital orthophotos circa 2000, ranked based on 15 ecological factors, including: size, presence of water, presence of wetlands, groundwater recharge potential, potential for rare remnant plant community, topographic diversity, glacial diversity, connectivity to other natural areas, restorability potential, and quality of vegetation.

June 2007

Figure 2.5

Highways
Surface water
Creeksheds
Municipalities

Bioreserve Sites Priority
- Lower
- Medium
- Highest

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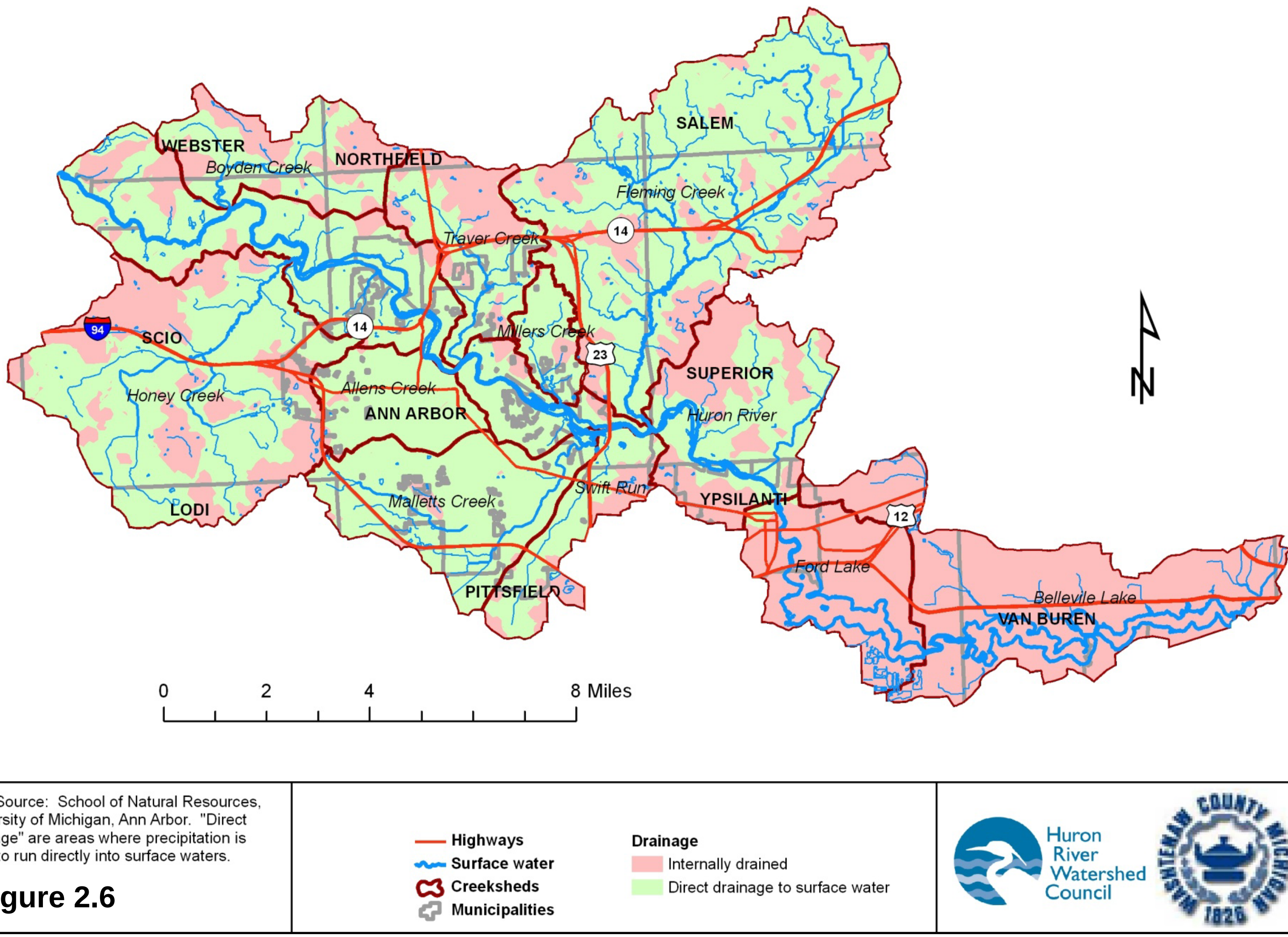
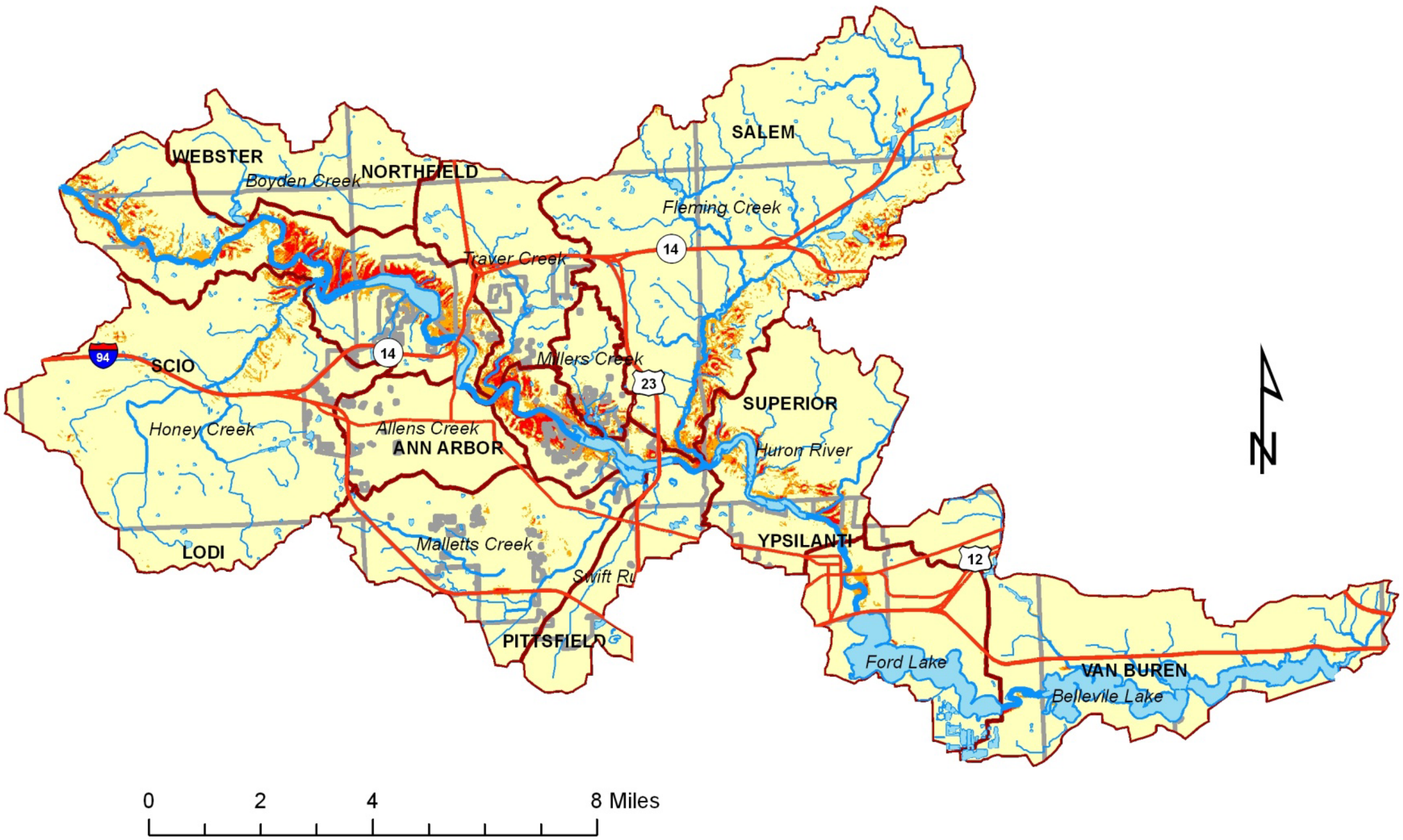
Middle Huron Watershed Direct Drainage Areas



Data Source: School of Natural Resources, University of Michigan, Ann Arbor. "Direct drainage" are areas where precipitation is likely to run directly into surface waters.

Figure 2.6

Figure 2.7 Middle Huron Watershed Groundwater Recharge



Data Source: School of Natural Resources and Environment, University of Michigan, Ann Arbor. Areas of high elevation, permeable soils, and coarse-textured glacial geology have a high probability of being groundwater recharge areas.

Highways
Surface water
Creeksheds
Municipalities
Lower
Higher

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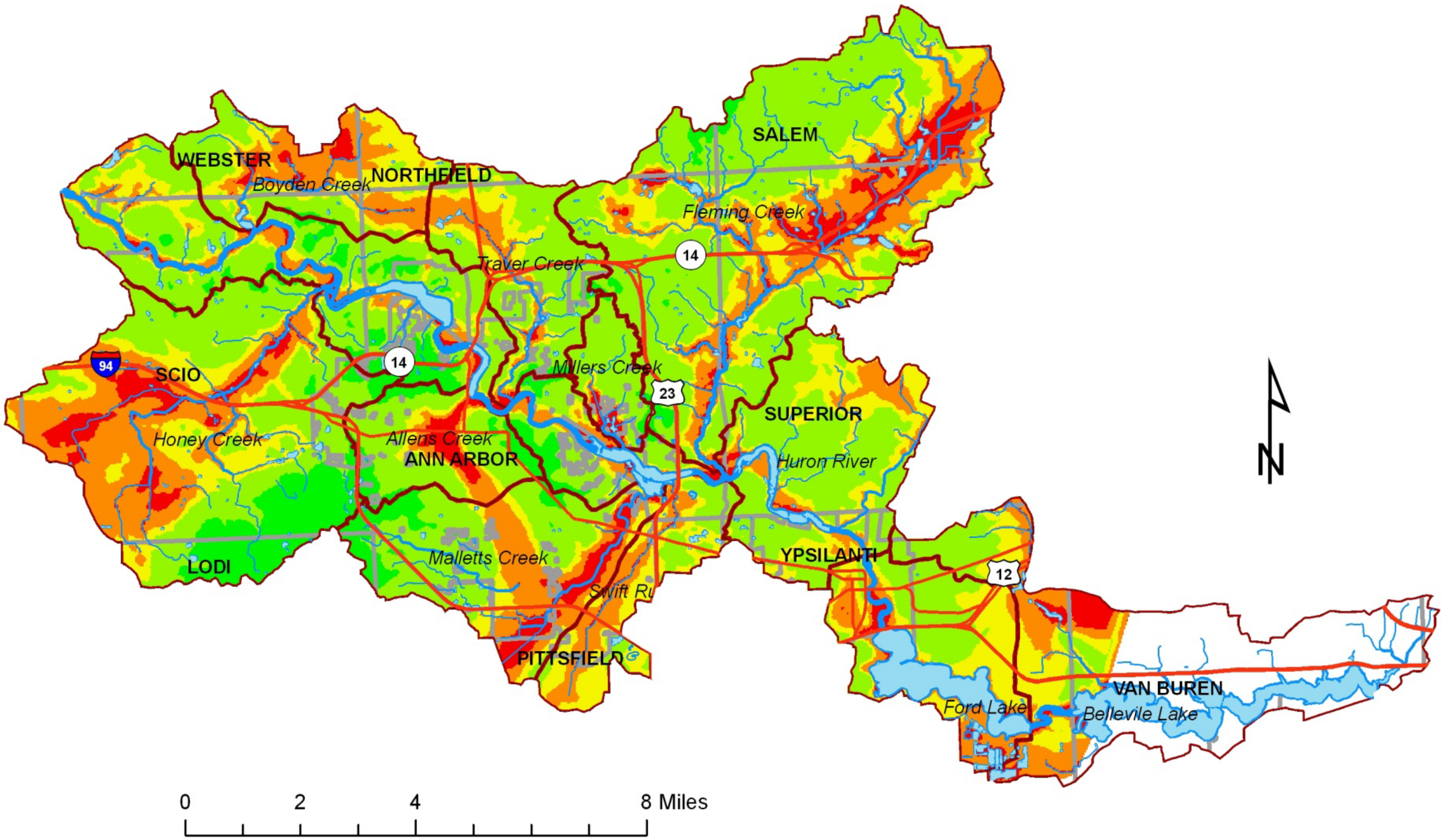
Washtenaw County Michigan 1826

Middle Huron Watershed Depth to Water Table



Data Source: Well log records from the Michigan Geology Survey

Figure 2.8

Highways
Surface water
Creeksheds
Municipalities

Depth to water table

- 0 - 15 feet
- 15 - 30 feet
- 30 - 45 feet
- 45 - 100 feet
- over 100 feet
- no data available

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Middle Huron Watershed Soil Permeability

Data Source: USDA Soil Surveys

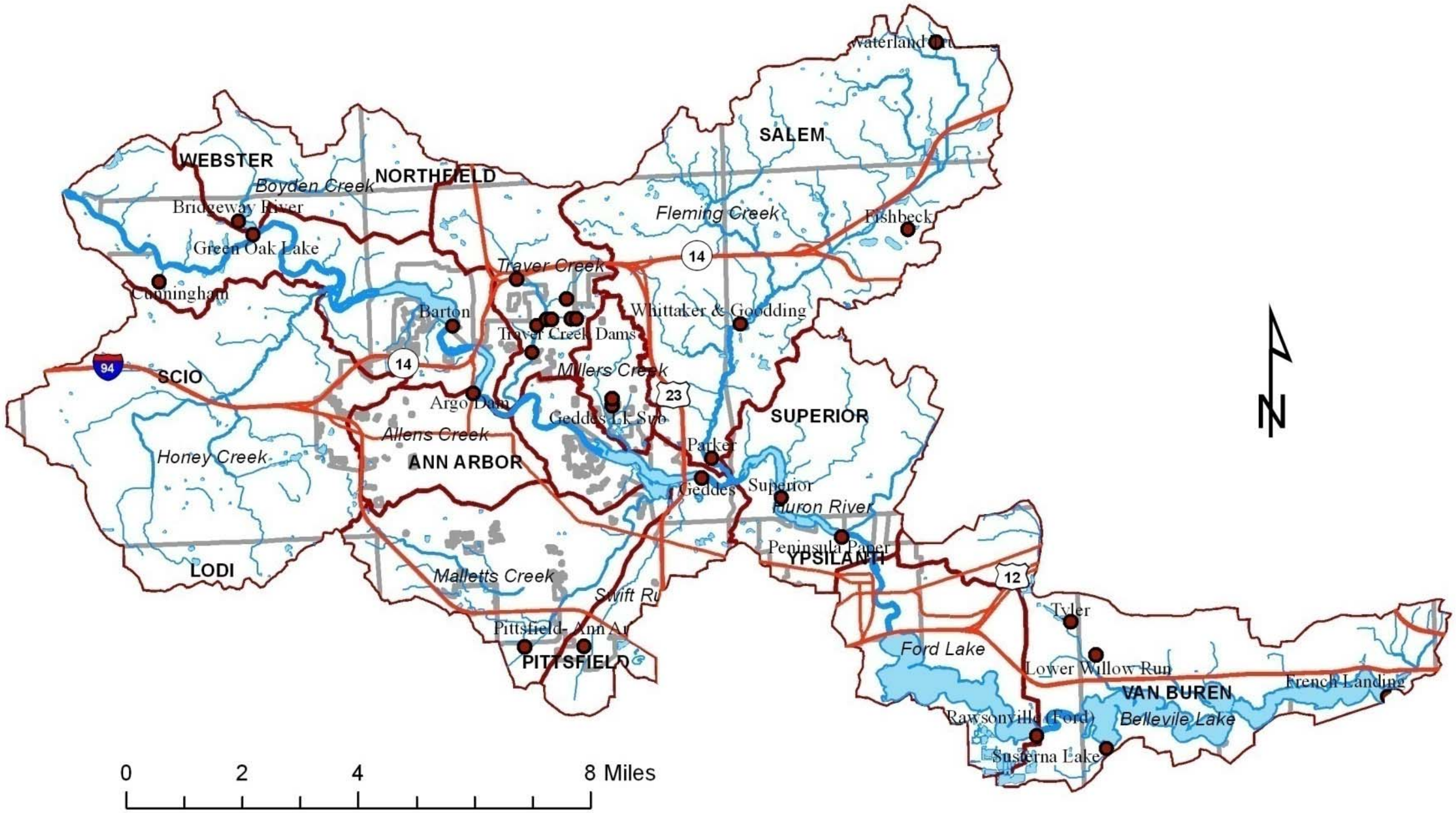
Figure 2.9

- Highways
- Surface water
- Creeksheds
- Municipalities
- moderately rapid
- moderately slow
- moderately well
- rapid
- slow
- very slow

Huron River Watershed Council

WASHTENAW COUNTY MICHIGAN 1826

Middle Huron Watershed Dams



Data Source: National Inventory of Dams

Figure 2.10

- Dams
- Highways
- Surface water
- Creeksheds
- Municipalities

Huron River Watershed Council

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2.2 Communities and Current Land Use

2.2.1 Political Structure

With an area of 217 square miles, the Middle Huron Watershed encompasses portions of 15 communities in two counties. The majority (89%) of the watershed is located in all or part of 13 communities in Washtenaw County, with the remaining 11% in Van Buren Township and the City of Belleville in southwestern Wayne County.

Each local government in the watershed has a zoning code and holds regularly scheduled meetings where rulings are made on policy additions and changes, budgets, land use issues, and other important local business. Working with the guidance of statewide procedures, townships and other local governments have power to formulate land use and development policy, among other important activities. The cities of Ann Arbor, Ypsilanti and Belleville also have jurisdiction over and management responsibility for sewers and stormwater infrastructure, such as gutters, catch basins, pipes and outlets. Drains, including roadside ditches, pipes, bridges, and culverts under state highways and county roads that are not designated county drains are maintained by the county Road Commissions.

Political jurisdictions regarding the Huron River and its tributaries, riparian zones, and land are controlled by federal and state laws, county and local ordinances, and town by-laws. Regulatory and enforcement responsibility for water quantity and quality regulation often lies with the United States Environmental Protection Agency (U.S. EPA) and MDEQ. Major activities regulated by the state, through the MDEQ, are the alteration/loss of wetlands, pollutant discharges (NPDES permits), control of stormwater, and dredging/filling of surface waters. The State of Michigan maintains that:

> "'Surface waters of the state' means all of the following, but does not include drainage ways and ponds used solely for wastewater conveyance, treatment, or control:
>
> (i) The Great Lakes and their connecting waters.
>
> (ii) All inland lakes.
>
> (iii) Rivers.
>
> (iv) Streams.
>
> (v) Impoundments.
>
> (vi) Open drains.
>
> (vii) Wetlands.
>
> (viii) Other surface bodies of water within the confines of the state."[10]

The Huron River and its tributaries are public and subject to public trust protection. The Michigan Natural Rivers Act (PA 231, 1970) designated a 27.5-mile stretch of the Huron River from Kent Lake Dam in Oakland County to Barton Pond in Washtenaw County as a "country-scenic river." The most western portion of the Huron River within the Middle Huron Watershed is part of this stretch. The Natural Rivers District includes 400 feet on either side of the ordinary watermark where development is severely limited. On private lands, zoning requires 125 feet building setbacks on the mainstem and 50 feet setbacks on tributaries. Minimum lot width for new construction is 150 feet, with a 125 foot septic setback, and 50 feet of natural vegetation along the river. All restrictions apply to public lands as well, and the natural vegetation requirement increases to 100 feet for public lands. Within the District, no new commercial, industrial or extractive development is permitted within 300 feet of the river or tributaries.

County government assumes responsibility for carrying out certain state policies. In most cases, county governments enforce the state erosion control policy, under the Michigan Soil Erosion and Sedimentation Control Act 347 of 1972 and Part 91 of Act 504 of 2000, although local governments may also administer this program, and county road commissions typically self-regulate their erosion control. At the time of this publication the City of Ann Arbor was the only local government in the Middle Huron Watershed known to administer its own soil erosion and sediment control program.

Designated county drains in the watershed may be open ditches, streams or underground pipes, retention ponds or swales that convey stormwater. The Drain Commissioner Offices of Washtenaw and Wayne Counties are responsible for operation and maintenance of these storm water management systems ("county drains"). These systems are designed to provide storm water management, drainage, flood prevention, and stream protection for urban and agricultural lands. The Drain Code gives the Drain Commissioners authority for construction or maintenance of drains, creeks, rivers and watercourses and their branches for flood control and water management.

In addition to oversight of these drains, the County Drain Commissioners are required to maintain established lake levels throughout the watershed. Through the Inland Lake Level Act (Act 146, P.A. of 1961), a board of commissioners may file a petition in circuit court to establish a special assessment district to pay the costs of establishing and maintaining a lake level. The Drain Commissioner must determine the apportionment of costs incurred and assess for maintenance of the lake level. Section 24 of the Inland Lake Level Act requires inspection of all lake level control structures on all inland lakes that have normal levels established under this Act to be completed once every three years by a licensed professional engineer.

While state and county governments take an active role in many relevant watershed or water quality regulations and policies, local governments assume much leadership in land and water management by passing and enforcing safeguards. These local ordinances can be more protective than state laws, though state regulations set minimum protections that cannot be violated. Working under numerous established procedures, local governments may enact ordinances to control stormwater runoff and soil erosion and sedimentation; protect sensitive habitats such as woodlands, wetlands and riparian zones; and establish watershed-friendly development standards and lawn care and landscaping practices, among other options. Local governments oversee enforcement of their policies.

2.2.2 Growth Trends

Prior to European settlement, the region around the watershed was occupied by Chippewa and Potawatomi Native American tribes who had long used the land for farming. Despite an unfavorable report by the U.S. Surveyor-General in 1815 that characterized the soils in the area as being unsuitable for farming, European settlers soon began to recognize the area's agricultural potential, which subsequently became an important area for livestock and grain in the 19th century. This agricultural trend thrived until, in the wake of World War II, growth in southeast Michigan was catalyzed by the baby boom, increased automobile ownership, and establishment of better road systems. As a result, the influence of agriculture began to diminish as land was transferred to suburban uses in a trend that continues today.

The watershed area has experienced tremendous economic growth and development pressures due to it's proximity to suburban Detroit. Downstream (eastern) portions of the watershed in Belleville, Ypsilanti and Ann Arbor and portions of the surrounding townships have been urbanized and assimilated into the metro Detroit area. Growth around these urbanized areas continues at high rates. These growth pressures continue to radiate westward through the watershed, reflecting a trend in growth from Detroit to more outlying areas spurred by road and highway improvements, infrastructure, and a desire for open space.

A discussion of growth trends in the watershed is challenged by the fact that readily available demographic data is based on political, rather than hydrologic boundaries. Furthermore, for several of the watershed's 15 communities, only small portions of their areas are located in the watershed. As such, growth trends in these peripheral communities are not necessarily indicative of growth trends in the watershed as a whole. Therefore, this section focuses on ten communities in Washtenaw County, as well Van Buren Township in Wayne County, which cumulatively represent 96% of the watershed area. Growth and development trends in these core communities are generally indicative of the watershed as a whole.

In examining growth and land use trends in the Middle Huron Watershed, it is helpful to place it in the larger context of trends in the five-county area of southeast Michigan. SEMCOG has combined U.S. Census data and land use data to determine changes in growth and land use that have occurred in the region between 1990 and 2000. Among the key findings are the following[11]:

- Developed land in the region increased by 17.7% (163,634 acres), which equates to an 8.1% decrease in undeveloped land. Residential development accounted for 76% of all developed land.
- The region's population grew by 5% (243,000 people), a major factor in land use change.
- Residential housing development saw a dramatic decrease in density. In 1990, housing density averaged 2.85 units per acre. Residential units built between 1990 and 2000 averaged 1.23 units per acre
- Average household size has decreased and average home size has increased
- The average number of persons per household decreased from 2.66 in 1990 to 2.58 in 2000.

In summary, much of the undeveloped land in southeast Michigan is being developed to accommodate new housing demands from an increasing population. The average home in southeast Michigan is increasing in size and consuming more land while housing fewer people. These trends, which have serious implications for environmental impacts in the region and can be expected to continue, are also evident in the communities comprising the Middle Huron Watershed.

According to U.S. Census data, Washtenaw County's population increased between 1990 and 2000 by approximately 14%. From 2000 to October 2007, SEMCOG estimates that the County's population increased by 8.9%, from just over 322,700 to just over 351,500. By comparison, the population in southeast Michigan increased during this same period by 1.1%, while Livingston County saw an increase of 23.8% and Oakland County increased by 2.2%[12]. From 2007 to 2030, SEMCOG projects that Washtenaw County's population will increase over 27.5% to 448,020, an increase of over 96,000[13]. Population changes for communities that are located primarily in the Middle Huron Watershed are listed below in Table 2.3. Note that these data are for the entire communities, not just their areas within the Middle Huron Watershed.

Table 2.3. 1990-2030 Population Changes for Core Communities in the Middle Huron Watershed[14]

	1990 Census	2000 Census	Change 1990-2000	2007 SEMCOG estimate	Change 2000-2007	2030 SEMCOG forecast	Change 2007-2030
Pittsfield Twp.	17,650	30,167	70.9%	35,029	16.1%	63,764	82.0%
Ypsilanti Twp.	45,307	49,182	8.6%	53,616	9.0%	70,141	30.8%
Ypsilanti City	24,846	22,237	-10.5%	21,038	-5.4%	22,110	5.1%
Dexter Village	1,497	2,338	56.2%	3,559	52.2%	5,472	53.8%
Ann Arbor City	109,608	114,024	4.0%	114,510	0.4%	116,270	1.5%
Ann Arbor Twp.	3,463	4,385	26.6%	4,478	2.1%	5,112	14.2%
Scio Township	9,578	13,421	40.1%	16,408	22.3%	23,164	41.2%
Superior Twp.	8,720	10,740	23.2%	13,058	21.6%	18,174	39.2%
Van Buren Twp.	21,010	23,559	12.1%	27,811	18.0%	29,556	6.3%
Salem Twp.	3,734	5,562	49.0%	6,724	20.9%	11,388	69.4%
Webster Twp.	3,235	5,198	60.7%	6,350	22.2%	13,222	108.2%
TOTAL	248,648	280,813	12.9%	302,581	7.8%	378,373	25.0%

Not surprisingly, the urbanized areas represented by the City of Ann Arbor and Ypsilanti show a small projected population gain and projected population loss, respectively, through 2030 because they have less land available for new development and more people moving into suburban areas. Pittsfield and Webster Townships show by far the largest projected populations gains, doubling their 2005 population. These communities currently lie on the fringe of the urbanized areas. The combined population of these core communities is projected to be over 378,000 people by 2030, an increase of 25.0%.

Table 2.4 illustrates the relation of the number and density of housing units in the watershed's core communities between 1990 and 2000. The change in number of housing units range widely from community to community during this time period. Ypsilanti City shows a decrease of 2% in housing units, while Webster Twp., Salem Twp., Dexter Village and Pittsfield Twp. experienced around 60% increases. All of the building permits issued during this period for these communities were for single family detached homes, a trend which continues through the most current data available in 2005[15].

The change in average density of these housing units is less dramatic. The communities of Dexter Village, Scio Twp., Van Buren Twp., Salem Twp., and Webster Twp. all exhibit an increase in density. The Village of Dexter increased dramatically in density due to a lack of available land, whereas the other communities' increases in density can be better attributed to strategic planning. Additionally, Ann Arbor Twp., City of Ann Arbor, and Superior Twp. show only a slight decrease in density.

Table 2.4. Housing Units and Densities for Communities in the Huron Chain of Lakes Watershed[16]

	Housing Units in 2000	Increase in Housing Units, 1990-2000	Average Density of All Housing Units in 2000 (units per acre)	Density of Housing Units Built 1990-2000 (units per acre)
Pittsfield Twp.	12,337	58.4%	2.56	1.95
Ypsilanti Twp.	21,196	13.6%	3.79	2.92
Washtenaw Co.	130,974	17.7%	1.85	1.22
Ypsilanti City	9,120	-2.2%	7.27	n/a
Dexter Village	1,106	63.6%	2.97	4.23
Ann Arbor Twp.	1,893	29.3%	1.05	1.04
Ann Arbor City	47,218	9.6%	5.64	5.10
Scio Township	5,234	45.8%	0.94	1.24
Superior Twp.	4,097	29.8%	1.13	1.05
Van Buren Twp.	10,417	23.5%	2.38	4.95
Salem Twp.	2,031	61.4%	0.57	0.96
Webster Twp.	1,857	58.3%	0.51	0.55

2.2.3 Land Use and Development

As the Middle Huron communities develop, the potential increases for negative environmental impacts, including water *quality* impacts from erosion, sedimentation, and increased inputs of stormwater pollutants. Potential impacts on water *quantity* also increase as wetlands, woodlands, floodplains and other natural features that regulate water quantity are altered or replaced with impervious surfaces.

Prior to permanent European settlement, grasslands of oak barrens and forests of several species of oak and hickory dominated the landscape of the Middle Huron Watershed. This dominant landscape was interspersed with patches of wetlands, such as lowland hardwood and lakeplain prairie, which were also found throughout the low-lying areas (Figure 2.11).

Upon permanent settlement, the land began to be used for human benefit. Initial activities on the land centered on the clearing of grasslands for agricultural production and the use of forested areas for wood and wood by-products. By 2000, SEMCOG aerial photographic data indicates the significant changes to the landscape (2.12). Permanent mixed density residential land use is the single largest use of the watershed (29.5%), followed closely by forest (27.1%), and rural (20.9%). Prairie and grasslands, forested lands, and to a lesser extent, wetlands, experienced moderate to significant reductions in coverage as the area was developed from the mid-1800s to late-1900s. The remainder of the land is either commercial/industrial (12.8%), water (4.2%), active construction (3.0%) or roadways (2.7%).

The watershed also contains a scattering of small public lands for conservation and recreation (Figure 2.14). Most of the public lands are owned by local government, with a few held by the local universities, public schools, non-profit organizations, and State Government. The Huron-Clinton Metropolitan Authority owns the Dexter-Huron and Delhi Metroparks, which are located in the watershed. The cities of Ann Arbor and Ypsilanti also own several small parks along the river.

Table 2.5 shows the percentage increases for selected land uses in the watershed between 1990 and 2000. With the exception of the City of Ypsilanti, the land use categories of single family and multi-family, commercial, and industrial show moderate to significant percentage increases. With the exception of a low to moderate increase in grassland and shrubs in a number of communities and a low increase in woodlands and wetlands in Ypsilanti Twp., Ypsilanti and Van Buren Twp., the land use categories of active agriculture, grassland and shrub, and woodland and wetland all showed moderate to substantial decreases in all core communities.

Table 2.5. Land Use Change, 1990-2000 for Core Communities in the Middle Huron Watershed[17]

	Single Family	Multi-Family	Commercial	Industrial	Active Agriculture	Grassland and Shrub	Woodland and Wetland
Pittsfield Twp.	98.4%	69.3%	45.1%	86.0%	-38.1%	22.8%	-14.8%
Ypsilanti Twp.	18.4%	15.8%	13.2%	4.6%	-27.4%	0.8%	1.3%
Ypsilanti City	-0.3%	0.3%	4.4%	12.1%	n/a	-21.9%	3.8%
Dexter Village	24.2%	381.6%	52.4%	86.4%	-78.9%	-7.7%	-19.5%
Ann Arbor Twp.	20.1%	53.9%	14.0%	82.5%	-13.1%	2.0%	-0.9
Ann Arbor City	6.5%	15.9%	1.3%	13.5%	-56.8%	-40.1%	-9.4%
Scio Township	29.4%	293.6%	53.0%	15.6%	-20.0%	-0.2%	-3.2%
Superior Twp.	33.8%	8.9%	-5.7%	16.7%	-17.9%	5.5%	-0.4%
Van Buren Twp.	9.0%	28.0%	26.6%	64.3%	-29.3%	-5.2%	3.8%
Salem Twp.	29.3%	n/a	438.7%	79.1%	-24.9%	25.5%	-4.4%
Webster Twp.	51.5%	n/a	193.8&	60.6%	-13.0	28.2%	-1.4%

Future land use trends in the Middle Huron Watershed can be predicted by studying each community's master plan. A master plan is a community's comprehensive guide for all aspects of future development. This future development is also known as a "build-out" scenario, as it displays what a community's land use would look like if it were fully developed according to its master plan. Build-out scenarios can also be constructed using a community's zoning ordinances. The Middle Huron Watershed's build-out scenario according to community master plans is shown in Figure 2.13.

All land use types expand in the future build-out scenario at the expense of open land and agriculture. The most notable change is the expansion of residential areas into areas that currently are actively farmed or are open; residential use is projected to more than double from 29% to 67% of the total land area of the watershed. Commercial/industrial land use is projected to increase from 15% to 22%. The combined current land uses of agriculture (21%) forest (8%), open space (23%) and public/recreation (4%) account for 56% of the watershed area. In the build-out scenario, these land uses will account for only 11% of the watershed area.

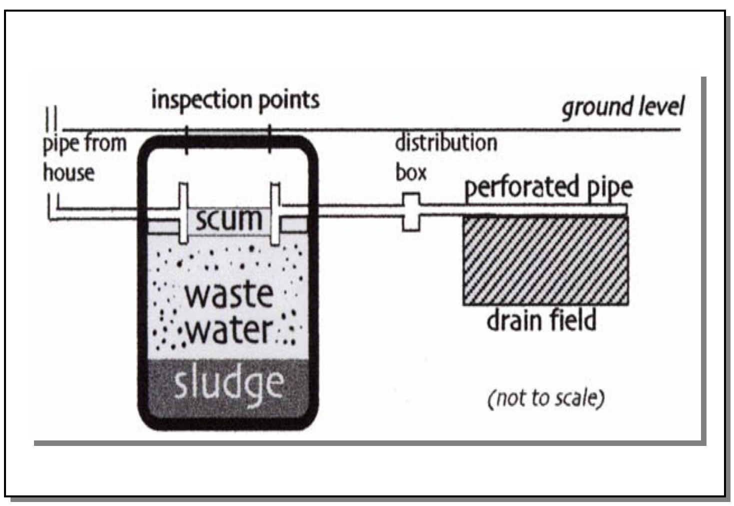
2.2.4 Existing Point Sources

There are several point source facilities in the watershed that hold NPDES permits issued by the State of Michigan (Figure 2.16). The number of permitted point sources is not static due to expiring old permits and activation of new permits. At the writing of this document, fifty permits were in issuance[18]. Two point sources in the Middle Huron Watershed are considered major contributors for the amount of discharge they emit. These facilities are the Loch Alpine Sanitary Authority, serving the small community of Loch Alpine in Webster and Scio Townships, and the Ann Arbor Waste Water Treatment Plant, serving the city of Ann Arbor and parts of Ann Arbor Township.

The remaining permitees are considered minor point source dischargers and are privately owned. Receiving waters for the discharges include direct drainage to the Huron River, all major tributaries (except Traver Creek), numerous secondary streams or drains, and impoundments along these water bodies. Forty-eight of the permits are issued for the purpose of conveying stormwater to local waterways, 27 are for discharge of various types of industrial wastewater, one for discharge from a municipal separate storm sewer, one is for a construction project and two are for discharge from the municipal wastewater treatment plants mentioned above. The remaining 17 are standard discharge permits.

Due to the nutrient TMDL in Ford and Belleville Lakes, waste load allocations for phosphorus contributions from permitted point sources have been established in all upstream contributing portions of the Huron River Watershed. These waste load allocations place restrictions on the total amount of phosphorus that can be discharged into waters flowing to these TMDL areas. Such restrictions have implications for determining the amount of phosphorus that may be discharged by existing NPDES permitees. Waste load allocations also factor into determining whether additional phosphorus-discharging facilities may be permitted to locate in a TMDL area. For additional information on phosphorus load allocations in the phosphorus TMDL, refer to Section 2.5.1 and Appendix A.

2.2.5 Sanitary Sewer Service Areas and Privately Owned Septic Systems



The Middle Huron Watershed has a mix of households whose waste discharges are treated by publicly owned wastewater treatment plants (WWTP) or on-site decentralized wastewater systems (privately-owned septic systems). Sanitary sewers rely on the connection of pipes from residential, commercial, and industrial sites that ultimately are received at a wastewater treatment plant where treatments are applied before discharge. Privately owned on-site septic systems, or septic tanks, allow wastewater from a single (sometimes multiple) entity to be treated via biological and infiltration processes. Both technologies are effective methods of wastewater treatment if maintained and operated properly; however, impairments do occur. Households currently served by sanitary sewers are located in the urbanized areas of the watershed, while remaining areas are served by on-site septic systems (Figure 2.16).

Improperly functioning sewer systems and privately owned septic systems can have a profound impact on the water quality. By carrying nutrients (phosphorus and nitrogen), bacteria, pharmaceutical agents, and other pollutants to waterbodies with little or no treatment, impaired systems can result in unhealthful conditions to humans (i.e., bacterial contamination) and to aquatic organisms (i.e., low dissolved oxygen from plant growth).

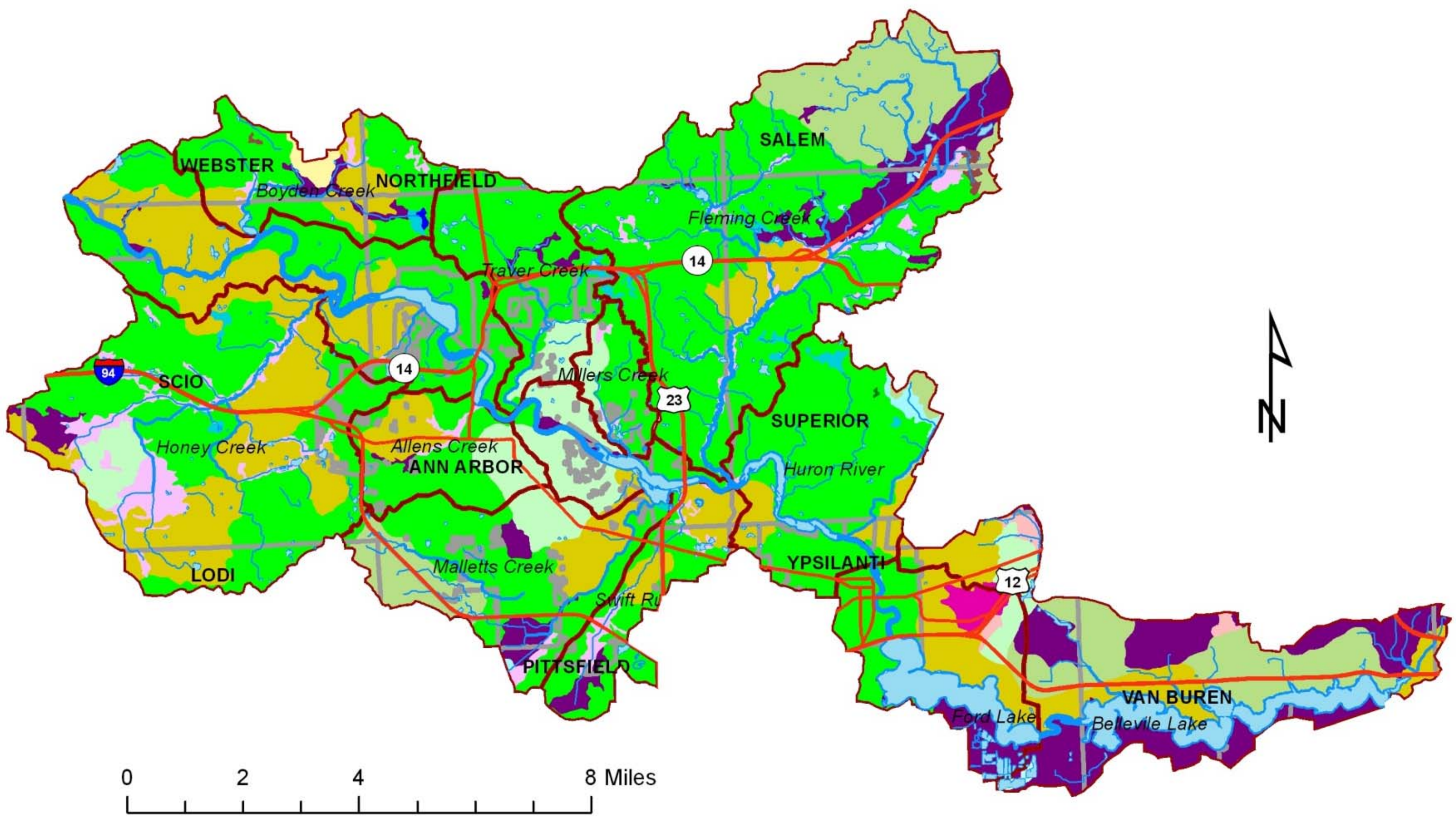
If either system is designed, constructed, or maintained improperly, it can be a significant source of water pollution and a threat to public health. The health departments of Livingston, Oakland, and Washtenaw Counties regulate the design, installation, and repair of privately owned septic systems. However, only Washtenaw County currently requires regular maintenance and inspection to assure proper functioning of these systems, which occurs at the time the property is sold. Through implementation of the time-of-sale program, Washtenaw County has determined that 20% of privately owned septic systems in the county are failing and require repair.

Sanitary sewer systems can suffer from improper installation and maintenance. For instance, in many older developments sanitary sewer pipes can be inadvertently connected to stormwater drainage systems, causing what is termed an “illicit discharge.” These discharges can have an even greater impact on water quality than impaired septic systems, depending on the type, volume, and frequency of the activity. Both county and local units of government covered by Phase II stormwater permits are required to identify and eliminate illicit discharges in their communities through an Illicit Discharge Elimination Program (IDEP).

Recent legislation has facilitated the ability of new development projects to utilize community wastewater systems, also known as decentralized wastewater systems, which provide on-site wastewater treatment for multiple homes much like a giant septic system. Community wastewater systems are increasingly being used to build high density developments in un-sewered areas where soils are not suitable for individual septic systems.

A drawback of these large septic systems is the potential discharge of large quantities of septic waste into a localized groundwater area. Conversely, community wastewater systems can also be a tool for mitigating the impacts of individual septic systems over a larger area; rather than locating several individual septic systems in close proximity to a lake or waterway where they could pose a greater risk to surface waters or groundwater, a community wastewater system could allow the homes to be built near the waterbody, while the community septic system would be located at a greater distance from the waterbody. Due to the potential impacts of community wastewater systems, communities should be aware of their complexities and plan accordingly for their location, construction, and operation.

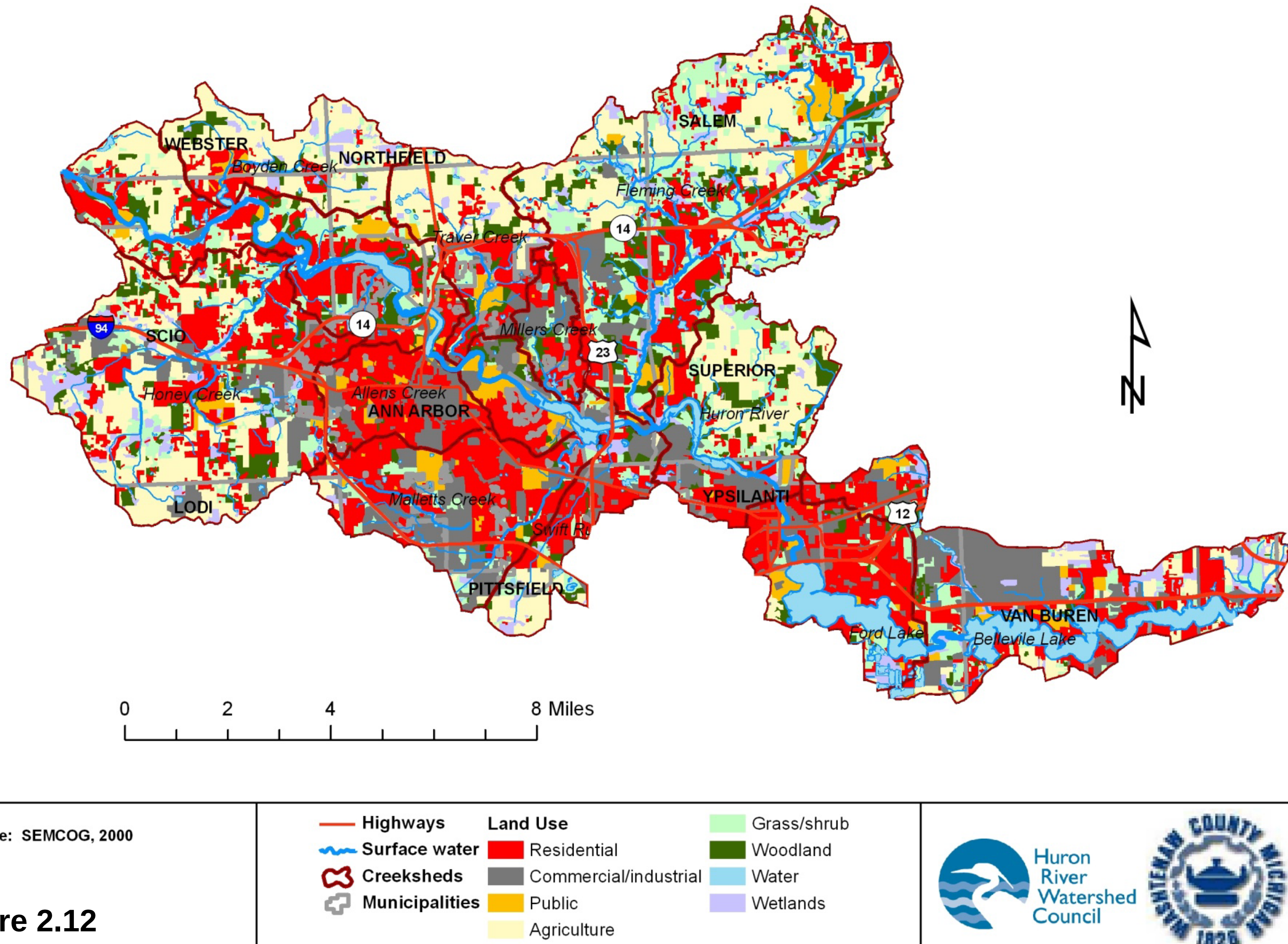
Middle Huron Ecosystems, circa 1830's



Data Source: Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, D.L. Price, J.R. Moore, D.M. Kashian & D.W. Schuen 1995. Michigan's Native Landscape as Interpreted from the General Land Office Surveys 1816 - 1856. Michigan Natural Features Inventory. Lansing. MI digital map.

Figure 2.11

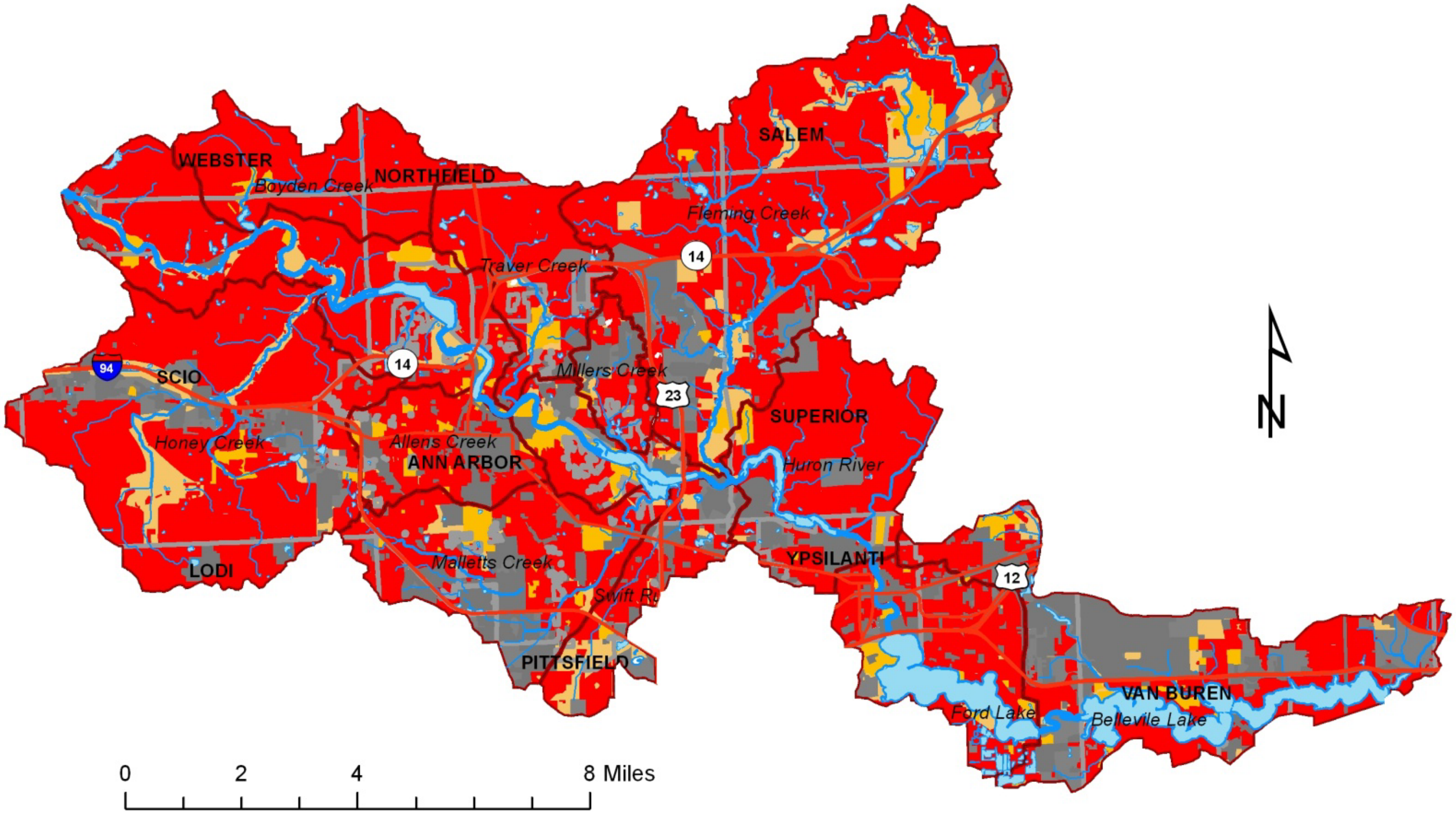
Middle Huron Watershed Land Use, 2000



Data Source: SEMCOG, 2000

Figure 2.12

Middle Huron Watershed Future Land Use



Data Source: Existing SEMCOG, 2000 land uses were overlayed onto SEMCOG's 2001 master plan composite map.

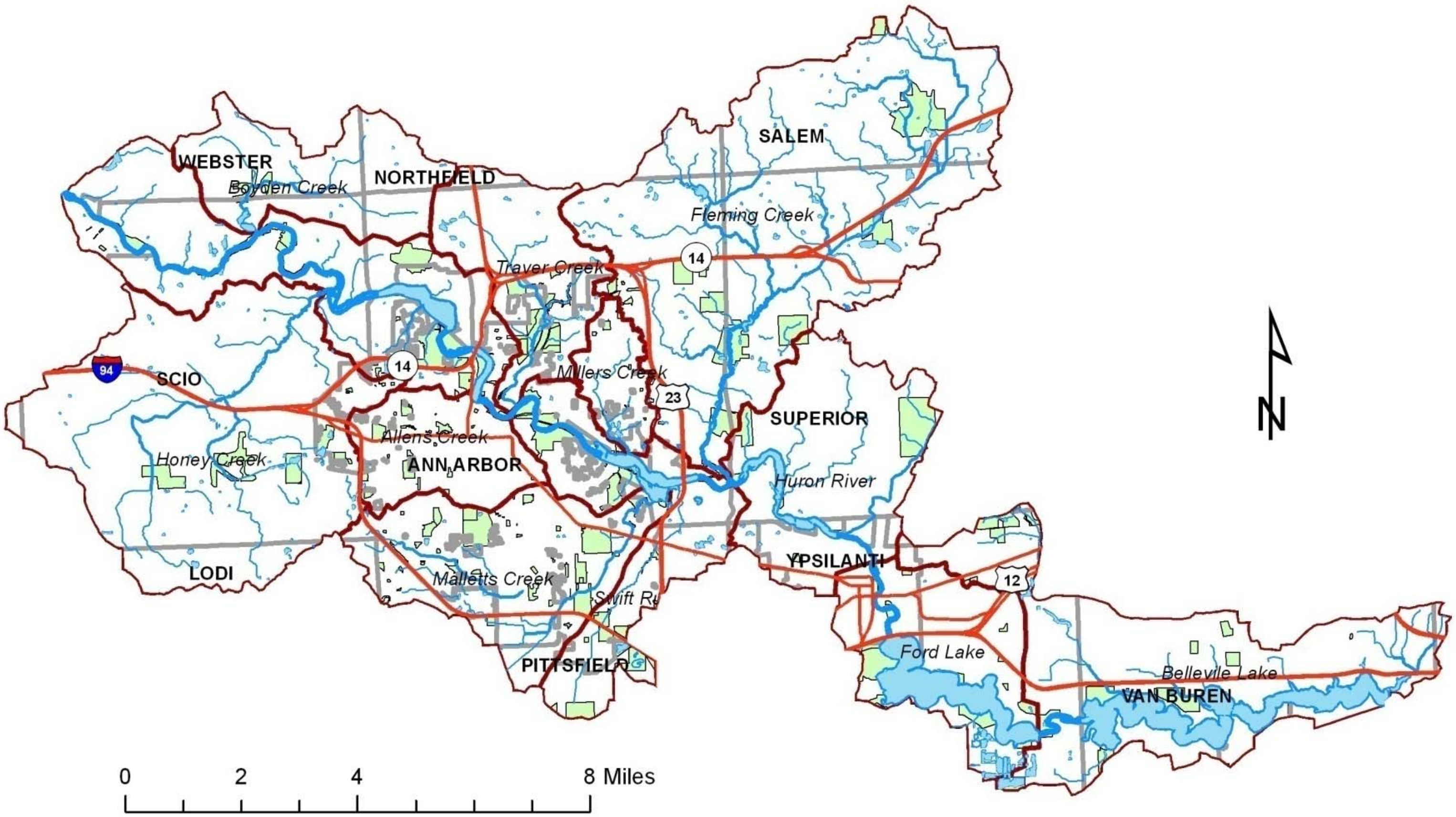
Figure 2.13

Highways	**Future Land Use**
Surface water	Commercial
Creeksheds	Public/Conservation
Municipalities	Residential

Huron River Watershed Council

WASHTENAW COUNTY MICHIGAN 1826

Middle Huron Watershed Conservation and Recreation Lands



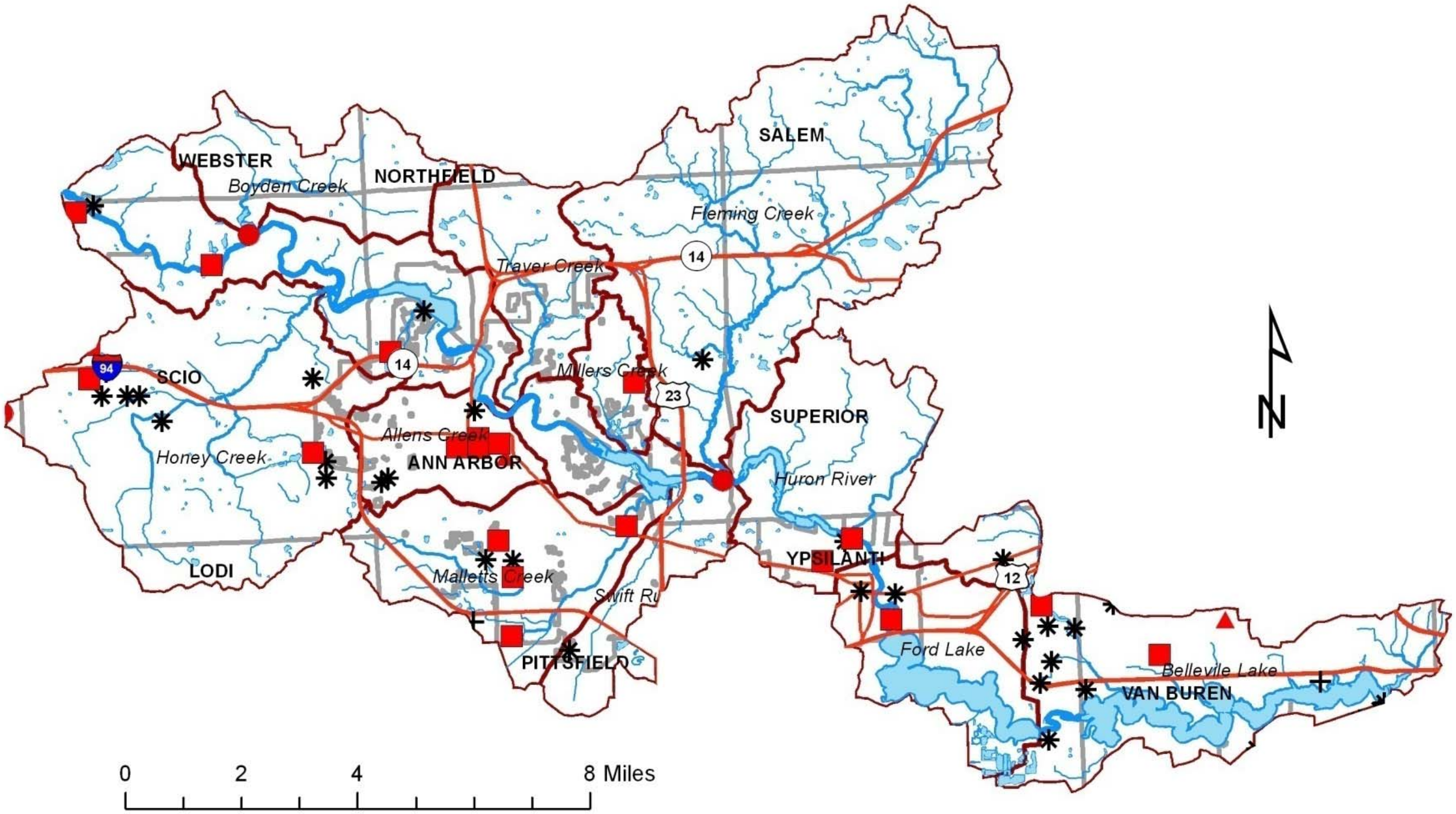
Data Source: The Nature Conservancy, Conservation and Recreation Lands.

Figure 2.14

- **Highways**
- **Surface water**
- **Creeksheds**
- **Municipalities**
- Conservation and Recreation Lands

Huron River Watershed Council

Middle Huron Watershed NPDES Facilities



Data Source: MDEQ

Highways
Surface water
Creeksheds
Municipalities

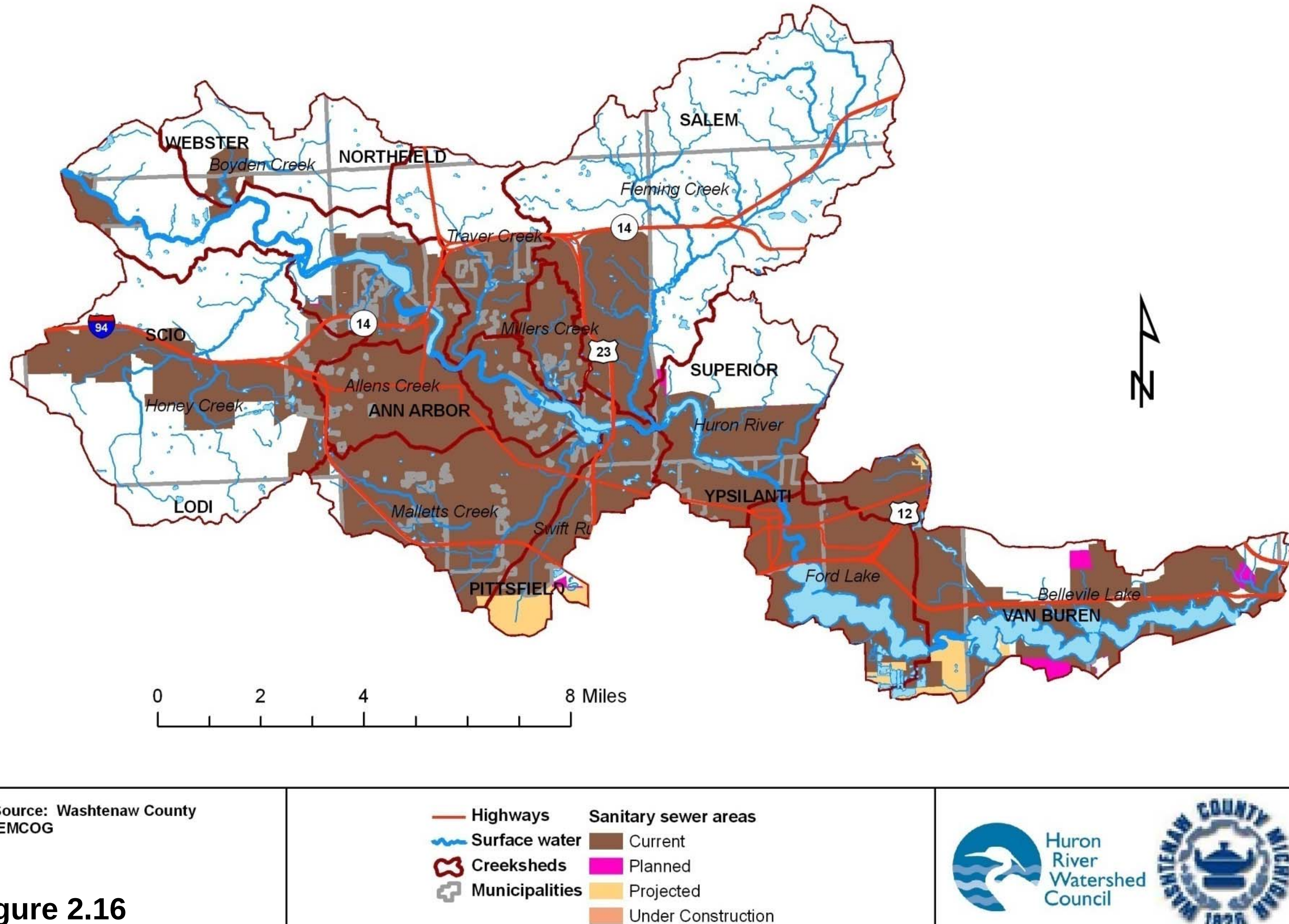
Npdes stormwater permits
Construction Sites
Industrial Storm Water

Npdes permits
Municipal Separate Storm Sewer System
Non-Industrial Sanitary Wastewater
Standard (All others)

Huron River Watershed Council

Figure 2.15

Middle Huron Watershed Sanitary Sewer Areas



Data Source: Washtenaw County and SEMCOG

Figure 2.16

2.3 WATER QUALITY INDICATORS

This section provides a synopsis of common indicators for gauging water quality. These water quality parameters include phosphorus, nitrogen, sediment, turbidity and dissolved/suspended solids, conductivity, dissolved oxygen, bacteria, temperature, pH and benthic macroinvertebrate assessments (aquatic insects and mussels). A general discussion of basic limnology (lake behavior) is also presented. While these indicators are important and useful in evaluating overall water quality, data for all of these parameters were not readily available for all creeksheds in the watershed.

2.3.1 Chemical and Physical Indicators

Phosphorus

Phosphorus and nitrogen are nutrients essential for the growth of aquatic plants. Phosphorus is needed for plant growth and is required for many metabolic reactions in plants and animals. Generally, phosphorus is the limiting nutrient in freshwater aquatic systems. That is, if all phosphorus is used up, then plant growth will cease no matter how much nitrogen is available. Phosphorus is the main parameter of concern that causes excessive plant and algae growth (eutrophication) in lakes and impoundments. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient-poor or low plant productivity), mesotrophic (moderate nutrient levels and moderate plant productivity), eutrophic (nutrient-rich, high plant productivity) and hypereutrophic (excessive plant productivity and excessive nutrients). Eutrophic and hypereutrophic conditions are characterized by depletion of dissolved oxygen in the water. Low levels of dissolved oxygen adversely affect aquatic animal populations and can cause fish kills. High nutrient concentrations interfere with recreation and aesthetic enjoyment of waterbodies by causing reduced water clarity, unpleasant swimming conditions, foul odors, blooms of toxic and nontoxic organisms, and interference with boating.

Phosphorus enters surface waters from point and nonpoint sources, with nonpoint sources accounting for the vast majority of phosphorus loading in the Watershed. Wastewater treatment plants are the primary point sources of the nutrient. Additional phosphorus originates from the use of industrial products, such as toothpaste, detergents, pharmaceuticals and food-treating compounds. Tertiary treatment of wastewater, through biological removal or chemical precipitation, is necessary to remove more than 30% of phosphorus.

Nonpoint sources of phosphorus include human, natural, and animal sources. Because phosphorus has a strong affinity for soil, stormwater runoff from activities that dislodge soil or introduce excess phosphorus (such as conversion of land to urban uses and over-fertilization of lawns) is frequently considered the major nonpoint source of phosphorus contribution to waterbodies. Eroded sediments from agricultural areas carry phosphorus-containing soil to surface waters. Septic system failures and illicit connections also are routes for phosphorus introduction. Domesticated animal and pet wastes that enter surface waters comprise another nonpoint source of phosphorus. Natural sources include phosphate deposits and phosphate-rich rocks that release phosphorus during weathering, erosion and leaching; and sediments in lakes and reservoirs that release phosphorus during seasonal overturns. MDEQ considers total phosphorus concentrations higher than 0.03 mg/L (parts per million) to have the potential to cause eutrophic conditions.

Nitrogen

Nitrogen is also considered essential in determining algae growth in lakes and is found in a number of forms, including molecular nitrogen, ammonia, nitrates, and nitrites. Nitrogen is often found in waterbodies at higher concentrations than phosphorus. Consequently, nitrogen is often not considered the limiting nutrient to detrimental growth. Additionally, unlike phosphorus loading, nitrogen loading is often difficult to reduce due to the high water solubility of nitrogen. Therefore, concerns regarding nitrogen and its role in eutrophication often are considered secondary to phosphorus in southeast Michigan. However, studies have shown that high nitrate concentrations, even without Phosphorus limitations, can promote eutrophication. Typical sources of nitrogen in surface waters include human and animal wastes, decomposing organic matter, and runoff from fertilizers. Improperly operated wastewater treatment plants and septic systems, as well as sewer pipeline leaks also can act as additional sources of nitrogen to waterbodies. MDEQ considers total nitrogen levels greater than 1 to 2 mg/L to have the potential to cause eutrophic conditions[19]. Nitrate levels above 10 mg/L are considered unsafe for drinking water[20].

Sediment

Stream bottoms or substrate, can be composed by a number of different materials, depending on the geology of the stream bed and surrounding drainage area. This substrate can vary from a predominance of large particles such as gravel, cobble or even bedrock to moderately sized sands to fine organic particles in silt and clay. Silt, which is the fine-grained particulate matter that results from eroded soil, can be deposited in streams over substrate naturally naturally composed of larger particles. Silt in riffles can limit the number of creatures living in a creek because it fills the spaces between surfaces and reduces oxygen in the substrate. Eroded silt also degrades water quality because soil binds pollutants, like phosphorus, which helps to create nuisance algae blooms. Many streambeds in the Huron River system are sandy or gravelly naturally. When fine sediments build up too fast the natural aquatic ecology cannot adapt quickly enough and the biotic diversity may be degraed. Erosion is a natural process, but dramatic increases in fine sediment suggest unnaturally high erosion rates.

Stormwater carries sediment directly into the nearest waterway.
Photo: HRWC files

Turbidity and Suspended Sediments or Solids

Turbidity is the measure of the relative clarity of water and is an approximation of suspended solids in the water that reduce the transmission of light. This relationship depends on several factors including the size and shape of the suspended particles along with their density in the water, as well as the degree of turbulence at the sample site. Turbidity should not be confused with color since darkly colored water can still have low turbidity or high relative clarity. Total suspended solids (TSS) include all particles suspended in water that will not pass through a filter of a specified size. Suspended solids are any particles/substances that are neither dissolved nor settled in the water. Total Dissolved Solids (TDS) include anything present in water other than water other simple molecules such as minerals, salts, metals, cations or anions dissolved in water. A third measure, suspended sediment concentration (SSC) is now being promoted by MDEQ, USGS and EPA as a more accurate measure for open channel monitoring. SSC differs from TSS in the methods of calculation. Both express the amount of sediments suspended in a sample of water.

High turbidity and TSS/SSC result from soil erosion, stormwater runoff, algal blooms and bottom sediment disturbances. Turbid water absorbs heat from the sun. Warmer water holds less oxygen than cooler water, resulting in less oxygenated water. Water with high turbidity loses its ability to support diverse aquatic biology. Suspended solids can be diverse in composition, including clay, silt and plankton as well as industrial wastes and sewage or other components. High amounts of suspended solids can clog fish gills, reduce growth rates and disease resistance in aquatic organisms, decrease photosynthesis efficiency, reduce dissolved oxygen (discussed in a later section) levels, and prevent egg and larval development. Settled particles can accumulate on the stream bottom and smother fish and amphibian eggs and aquatic insects including larvae of benthic macroinvertebrates.

Michigan Water Quality Standards set a narrative standard that waters of the state shall not have any of the following unnatural physical properties in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foam, settleable solids, suspended solids, and deposits. Most observers consider water with a TSS concentration less than 20 mg/l to be relatively clear. Water with TSS levels between 40 and 80 mg/l tends to appear cloudy, while water with concentrations over 150 mg/l usually appears dirty. The nature of the particles that comprise the suspended solids may cause these numbers to vary.[21] Standards have not been established for turbidity and TDS, but levels for these indicators have been set for stream segments that have been listed for impairment of biota.

A simple, though somewhat subjective, method of measuring water clarity in lakes uses a Secchi disk, which is an 8-inch diameter plate with alternating quadrants painted black and white. The observer lowers the disk into water until it disappears from view and then raises it until it becomes just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi disc reading. Nearly all Secchi disc measurements on Michigan inland lakes will be between one and forty feet, and this score is also an indicator of nutrient levels in the lake. MDEQ classifies Secchi disk readings greater than 16 feet as indicative of oligotrophic (low nutrient) conditions. Secchi disk readings between 6.5 and 16 feet indicate mesotrophic conditions, and Secchi disk readings less than 6.5 feet indicate eutrophic (high nutrient) or hypereutrophic conditions.[22] Most lakes in southeast Michigan are classified as either mesotrophic or eutrophic.

Conductivity

Conductivity, a broad indicator of general water quality, increases with the amount of dissolved ions, such as salts or metals. There is some evidence that average conductivity measured at a site over 800 microSiemens (µS) can be correlated with lower stream biodiversity.[23] Conductivity over 800 µS may indicate the presence of toxic substances, but it can also be high due to naturally occurring ions. Many toxins are also not detected by conductivity measures. A high conductivity measurement signals a need for further investigation to better determine the cause and potential sources.

Conductivity has been recorded at ten sites in the Middle Huron Watershed by the Middle Huron Stream Nutrient Monitoring program. Monitoring data is collected once monthly from May through September from 2002 through 2006. Figure 2.17 depicts the mean levels and range for each site. The data are discussed further in section 2.4.

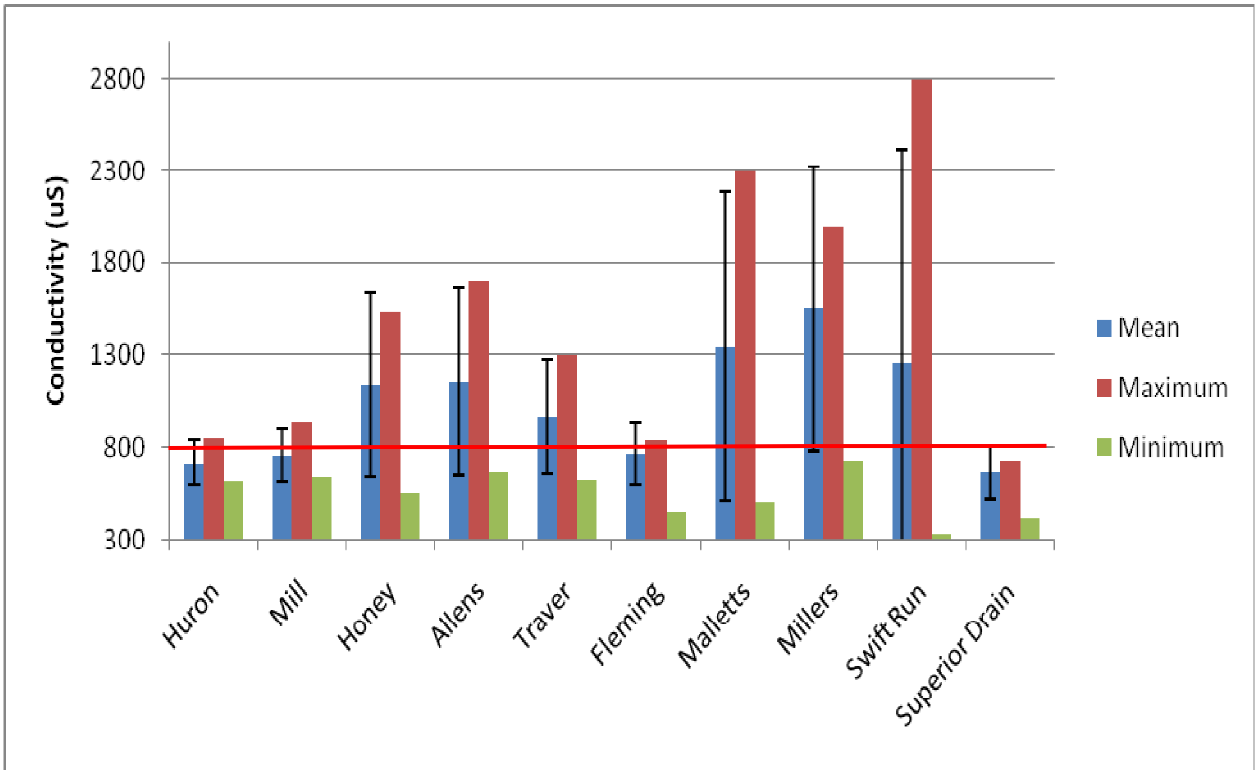


Figure 2.17. Conductivity measurement statistics for ten sites in the Middle Huron Watershed. Error bars indicate standard deviation and the 800 µS standard is highlighted.

Salts

Salts are compounds composed of positively charged ions paired with negatively charged ions. A common example is table salt: sodium (Na) and chloride (Cl). Salts typically enter waterways from road salting (de-icing) operations or from water softener backwash discharged into the environment. The most common de-icing product, sodium chloride, is used locally by MDOT, county road commissions, homeowners, and business/commercial establishments. Most highway and road commissions have specific policies and procedures regarding salt application, salt/sand mixtures, and storage.

There are several environmental concerns regarding the use of de-icing salts and water softener backwash discharge. Salts are highly soluble in water and easily wash off pavement into surface waters and leach into soil and groundwater. High concentrations of salt can damage and kill vegetation, disrupt fish spawning in streams, reduce oxygen solubility in surface water, interfere with the chemical and physical characteristics of a lake, and pollute groundwater making well water undrinkable.

However, Michigan has no water quality standards for salt concentrations and little is known about “how much salt is too much.” Furthermore, the ecological impacts of salt in freshwater systems vary considerably according to localized site conditions, making it difficult to establish general limits for acceptable quantities of salt application or environmental concentrations.

Best management practices to reduce salt inputs may include the use of alternative road de-icers such as calcium carbonate or calcium acetate that are not as detrimental to water quality.

In addition to salt alternatives, proper calibration of salt dispensing equipment and optimizing the timing of de-icing applications can reduce over-use of salt and alternative de-icers.

Dissolved Oxygen

Dissolved oxygen (DO) refers to the volume of oxygen that is contained in water.
DO is essential for fish and is an important component in the respiration of aerobic plants and animals, photosynthesis, oxidation-reduction processes, solubility of minerals, and decomposition of organic matter. Aquatic plants, algae and phytoplankton produce oxygen as a by-product of photosynthesis. Oxygen also dissolves rapidly into water from the atmosphere until the water is saturated. Dissolved oxygen diffuses very slowly and depends on the movement of aerated water. DO levels fluctuate on a diurnal basis. They rise from morning through late afternoon as a result of photosynthesis, reach a peak in late afternoon, then drop through the night as a result of photosynthesis stopping while plants and animals continue to respire and consume oxygen. DO levels fall to a low point just before dawn.

The amount of oxygen an organism requires varies according to species and stage of life. DO levels below 1-2 mg/L do not support fish. DO levels below 3 mg/L are stressful to most aquatic organisms. Minimal DO levels of 5-6 mg/L usually are required for growth and activity. Low DO levels encourage the growth of anaerobic organisms and nuisance algae. The accumulation of organic wastes and accompanying aerobic respiration by microorganisms as they consume the waste depletes DO in freshwater systems. High levels of bacteria from sewage pollution and high levels of organic matter can lead to low DO levels. Michigan Water Quality Standards states that surface waters protected for warmwater fish and aquatic life must meet a minimum dissolved oxygen standard of 5 mg/l.[24]

Dissolved oxygen levels have been recorded at ten sites in the Middle Huron Watershed by the Middle Huron Stream Nutrient Monitoring program. Monitoring data is collected once monthly from May through September from 2002 to 2006. Figure 2.18 depicts the mean levels and range for each site. All sites in the watershed averaged well above standard criteria, and only Mill Creek and Swift Run had single measurements below the standard. The data are discussed further in section 2.4.

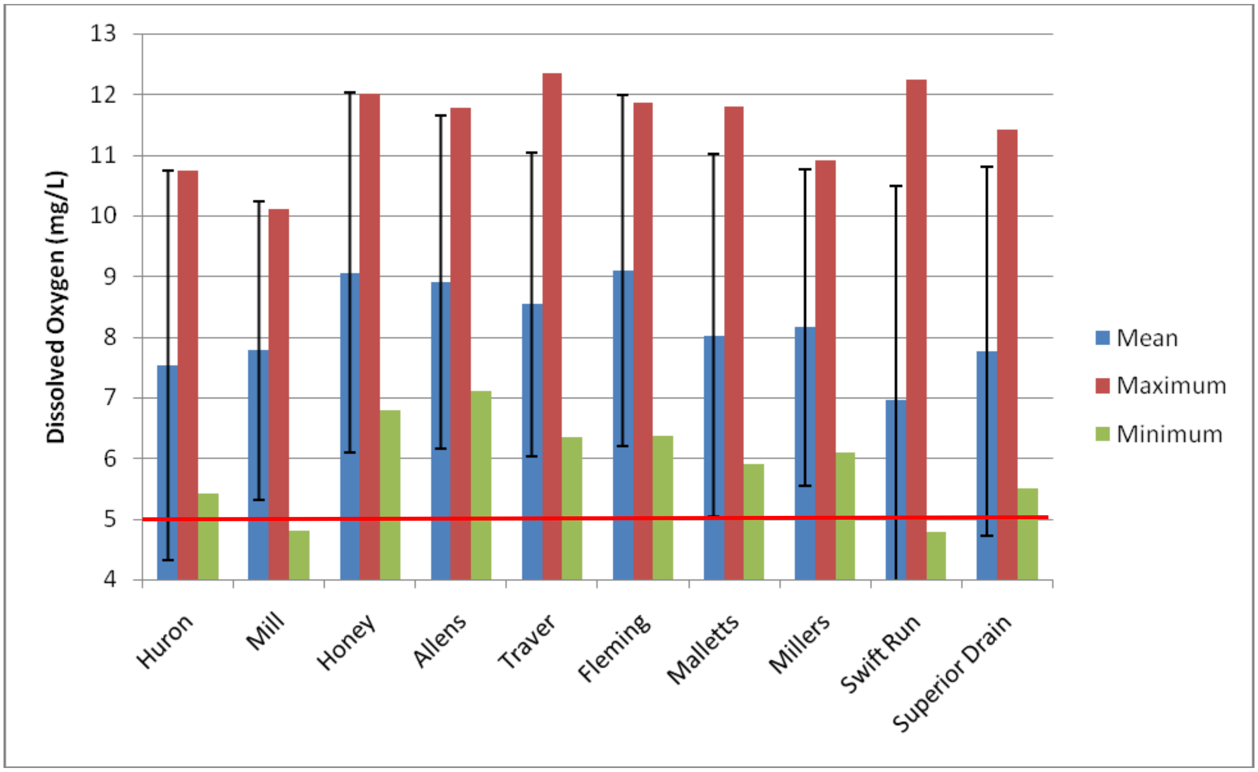


Figure 2.18. Dissolved oxygen levels for ten sites in the Middle Huron Watershed for May-September 2002 to 2006. Error bars indicate one standard deviation, and the water quality standard of 5 mg/L is highlighted in red.

Bacteria

Bacteria are microorganisms that are found everywhere. Coliform is a group of bacteria that includes a smaller group known as fecal coliforms, which are found in the digestive tract of warm-blooded animals. Their presence in freshwater ecosystems indicates that pollution by sewage or wastewater may have occurred and that other harmful microorganisms may be present. A species of fecal coliform known as *Escherichia coli* or *E. coli* is analyzed to test for contamination. *E. coli* counts are used as a measure of possible drinking water contamination, as high concentrations can result in serious illness. The potential sources of *E. coli* in surface waters are varied and difficult to pinpoint. They include human sources such as failed septic fields, but also wildlife sources such as geese and raccoons and pet or feral sources as well.

Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 451) limits the concentration of microorganisms in surface waters of the state and surface water discharges. Waters of the state that are protected for total body contact recreation must meet limits of 130 *Escherichia coli* (*E. coli*) per 100 milliliters (ml) water as a monthly geometric mean of five sampling events (3 samples per event) and 300 *E. coli* per 100 ml water for any single sampling event during the May 1 through October 31 period. The limit for waters of the state that are protected for partial body contact recreation is a geometric mean of 1000 *E. coli* per 100 ml water for any single sampling event at any time of the year.[25]

In 2006, the stream monitoring program under the Middle Huron Partnership Initiative began to collect grab samples for *E. coli* counts along with other standard measurements from May through September. All sites except the Huron River site exceeded the single event standard, which indicates that *E. coli* bacteria pollution is a significant concern in the watershed. Individual site results are shown in figure 2.19 and discussed in section 2.4.

Monitoring of public bathing beaches in the watershed is performed by the County Health Departments. However, there are no public bathing beaches in the Middle Huron Watershed.

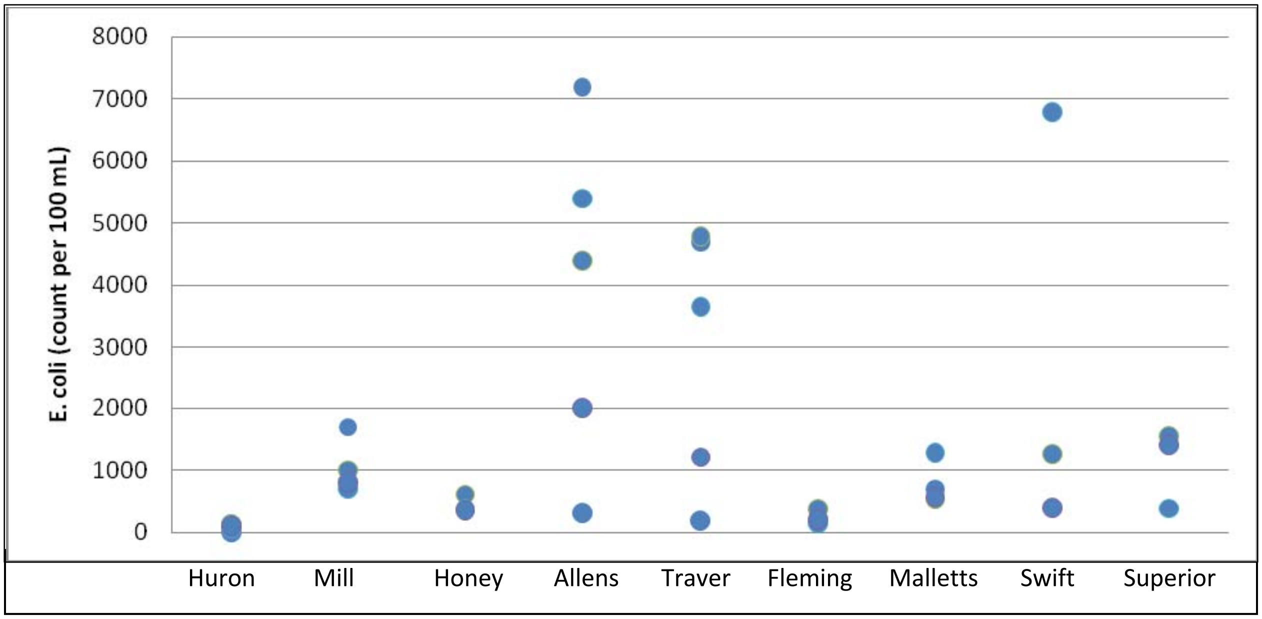


Figure 2.19. *E. coli* counts measured for nine sites during the growing season in 2006.

Temperature

Water temperature directly affects many physical, biological, and chemical characteristics of a river. Temperature affects the amount of oxygen that can be dissolved in the water, the rate of photosynthesis by algae and larger aquatic plants, the metabolic rates of aquatic organisms, and the sensitivity of organisms to toxic wastes, parasites, and diseases. These factors limit the type of macroinvertebrate and fish communities that can live in a stream.

An average summer temperature of about 72º F is the warmest water that will support coldwater fish, such as sculpin and trout. Fish that can survive in warmer waters up to 77º F include smallmouth bass, rockbass, sunfish, carp, catfish, suckers, and mudminnows. Average summer temperatures above 77º F exclude many fish and cool water insects[26]. Fluctuations in temperature also affect biodiversity. Extreme fluctuation in summer temperature, as defined by a difference of more than 18º F between the average maximum and average minimum stream temperature, have been found to decrease fish diversity at warm sites.[27]

Thermal pollution—the discharge of heated water from industrial operations, dams, or stormwater runoff from hot pavement and other impervious surfaces—often causes an increase in stream temperature. The Michigan Water Quality Standards specify that the Great Lakes and connecting waters and inland lakes shall not receive a heat load that increases the temperature of the receiving water more than 3º F above the existing natural water temperature (after mixing with the receiving water). Rivers, streams and impoundments shall not receive a heat load that increases the temperature of the receiving water more than 5º F for warmwater fisheries. These waters shall not receive a heat load that increases the temperature of the receiving water above monthly maximum temperatures (after mixing).[28]

Acidity (pH)

Measuring pH provides information about the H+ concentration in the water. pH is measured on a logarithmic scale that ranges from 0-14, so river water with a pH value of 6 is 10 times more acidic than water with a pH value of 7. Organisms that live in rivers and streams can survive only in a limited range of pH values. In Michigan surface waters, most pH values range between 7.6 and 8.0. Michigan Water Quality Standards require pH values to be within the range of 6.5 to 9.0 for all waters of the state. The pH of rivers and streams may fluctuate due to natural events, but humans also can cause unnatural fluctuations in pH. For example, chemical contamination from spills can cause short-term pH changes.

pH levels have been recorded at ten sites in the Middle Huron Watershed by the Middle Huron Stream Nutrient Monitoring program. Monitoring data is collected once monthly from May through September from 2002 to 2006. Figure 2.20 depicts the mean levels and range for each site. All monitoring sites averaged within the acceptable range. Only one measurement in Honey Creek was below the acidity standard. The data are discussed further in section 2.4.

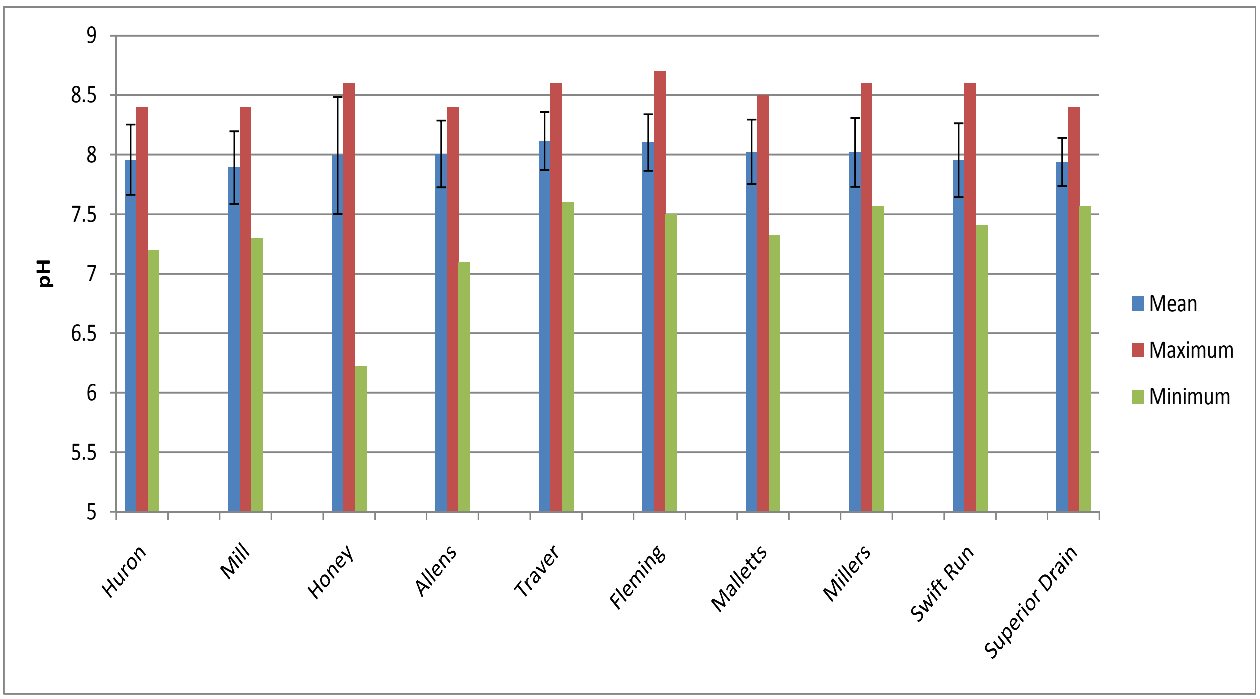


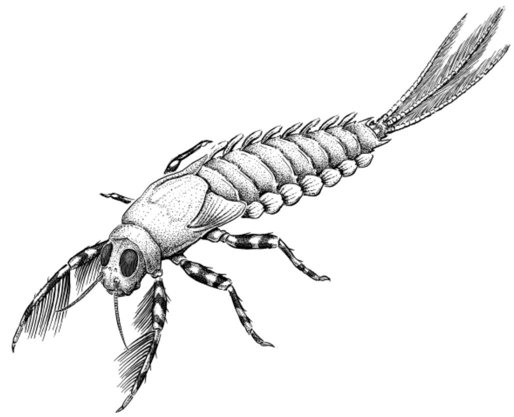
Figure 2.20. pH statistics for ten sites in the Middle Huron Watershed. Data was collected May-September, 2002 through 2006. Error bars depict standard deviation.

2.3.2 Aquatic Biological Communities

Aquatic insects

Insects living in the creek compose the benthic macroinvertebrate (no backbone) population, along with clams and other mollusks, crayfish, among other taxa. Typically, monitoring focuses on insects (in aquatic stages of development) as they are representative of a variety of trophic levels, are sensitive to local environmental conditions and are easy to collect. Since the benthic population depends on the physical conditions of the stream as well as water quality, its composition indicates the overall stream quality. Insect diversity indicates good stream quality, and is measured by the number of different insect families. 87 benthic insect families are found in the Huron River Watershed.[29]

Much of the benthic macroinvertebrate data in this document is from Huron River Watershed Council's Adopt-A-Stream Program, which relies on trained volunteers to monitor more than 70 sites in the watershed, including 30 in the Middle Huron Watershed. Monitoring data has been gathered since as early as 1994 at some sites through annual spring and fall collection days, and a winter stonefly search each January. Not all sites have been monitored at each collection event, but all sites have been monitored at least once per year since monitoring began at the site.



*Brush-legged Mayfly (*Ephemeroptera isonychiidae*) drawing: Matt Wimsatt*

Insect families belonging to the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) are known as the EPT families, which are indicators of alterations in stream flow, temperature, oxygen and other changes that raise metabolic rates.

Sensitive insect families, such as Perlidae (Perlid stonefly) and Brachycentridae (log-cabin caddisfly), are highly sensitive to organic pollution; 19 of the 87 benthic insect families living in the Huron River Watershed are sensitive.[30]

The presence of winter stoneflies, which are active in January and require high levels of oxygen, are indicators of good stream quality. Absence of winter stoneflies suggests that toxic pollutants may be present. This is because organic pollutants, such as fertilizer and human or animal waste, are associated with stormwater runoff in warmer months. Because there is usually little or no stormwater runoff in January, there is a greater likelihood that any pollutants in the stream are persistent (long-lasting) inorganic toxic substances are present in the bottom of the streambed. Conversely, at a site where insect diversity is lower than expected but winter stoneflies are present, organic pollutants are more likely to be the problem.

The Adopt-A-Stream Program also rates the “ecological conditions” at each site, which is determined by both the biological and physical conditions of the site. Biological conditions include the diversity of insect families, EPT families, and sensitive families. Physical conditions are determined by conductivity results and “measuring and mapping” assessments of habitat. These assessments involve examining characteristics such as the stream banks, stream widths and depths, and bed material (such as sand, gravel, or muck). When interpreting the biological and physical conditions, more diversity is generally expected at larger sites or sites with cooler summer stream temperatures.

Fish

Fish depend upon aquatic insects for food, and they also need good quality stream habitats and free-flowing reaches for all life cycle phases. More than 90 species of fish are native to the Huron River Watershed, however at least 99 species now live in its waters due to human-induced changes to the river's fish communities. Many native species still are present and abundant, yet many have declined to the point of rarity and are considered threatened or endangered. Increased peak flows, reduced summer base flows, increased and more varied temperatures, and increased turbidity and sediment loads have negatively affected critical fish habitat requirements, particularly as they relate to spawning and survival of young fishes. Dams have also affected fish populations by altering temperature and flow patterns, as well as inundating more high-gradient reaches and blocking migrations among critical seasonal habitats within the river.[31]

No information is available on the pre-European settlement fish community in the Middle Huron system. The headwaters and most tributaries of the Huron River had fairly stable flows. Summer water temperatures remained cool due to substantial water volumes, shaded banks, and local inflow of additional groundwater. Diverse habitats existed, including extensive gravel and cobble riffles, deep pools with cover, channel-side marshes, and flood plain wetlands. A 1938 survey of the headwaters and tributaries upstream of Ann Arbor found about 25 species.[32] Higher-gradient stretches with extensive gravel riffles and pools held mudminnow, hornyhead chub, silver shiner, rosyface shiner, common shiner, lake chubsucker, northern hog sucker, golden redhorse, black redhorse, yellow bullhead, stonecat, tadpole madtom, brindled madtom, longear sunfish, rock bass, smallmouth bass, rainbow darter, fantail darter, and greenside darter. Vegetation-dependant mud pickerel, northern pike, blackstripe topminnow, and least darter were also present. Most common in the faster flowing, low gradient stretches connecting natural lakes were white sucker, largemouth bass, bluegill, pumpkinseed, Johnny darter, logperch, and yellow perch. Neither muskellunge nor walleye were found in the 1938 survey. These may have been originally present but extirpated during early settlement.

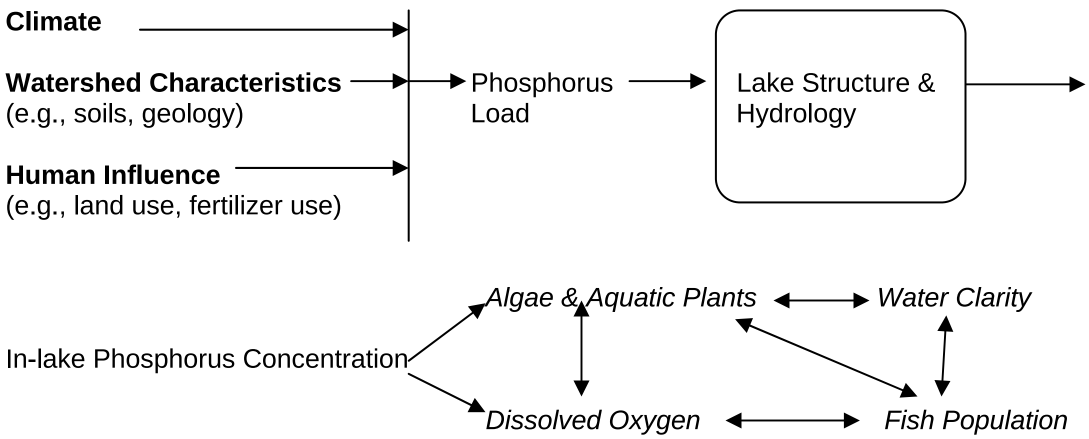
The Huron River and its tributaries in the Middle Huron Watershed are considered warmwater fish habitat, mostly of second quality. Second quality warmwater feeder streams (tributaries of the mainstem of the Huron River) are those that contain significant populations of warmwater fish, but game fish populations are appreciably limited by such factors as pollution, competition, or inadequate natural reproduction. Small streams are often difficult to fish because of their small size; typically less than 15 feet wide.[33]

2.3.3 Lake Behavior (Limnology)

Limnology is the physical, chemical, and biological science of study of freshwater systems, including lakes. The Middle Huron includes several significant impoundments. A general review of lake behavior in response to nutrients is useful for understanding how lake and river system dynamics differ.

While numerous water quality parameters are studied to determine the trophic status and water quality status of lakes, in-lake phosphorus concentrations are often the determining factor. Trophic status is a useful means of describing the water quality of a lake since it defines the expected productivity and biotic composition of the system. While many factors influence the overall trophic status of a lake, the interaction of climate, watershed characteristics (e.g., soils), and human influences are the most dominant (Figure 2.21).

Figure 2.21: Illustrative Schematic of Phosphorus Load Determinants and Lake Response.[34]



Generally, a lake with concentrations of phosphorus less then .01 mg/L will be considered oligotrophic. A lake will be considered mesotrophic at concentrations of .01 mg/L to .02 mg/L and eutrophic to hypereutrophic at or greater than .02 mg/L or .03 mg/L.[35] Oligotrophic and mesotrophic lakes normally support coldwater fisheries (e.g., trout, some species of bass) and numerous recreational activities. The water in these lakes is also often suitable for drinking water supply. Eutrophic lakes often support warm water fisheries (e.g. bass, bluegill, catfish, carp, etc.) and have a more limited recreational value compared to oligotrophic or mestrophic lakes because of periodic nuisance algal blooms and aquatic macrophyte growth. Hypereutrophic lakes, which experience frequent and intense nuisance algal blooms, do not ordinarily support cold or warm water fisheries and offer little or no recreational value. In addition, these lakes often exhibit decrease in open water surface areas because of layers of algal and aquatic plant masses.

Temperate zone lakes, like those in the watershed, experience changes in water chemistry and biology throughout the year. As winter ice thaws in the spring, winds and temperature changes in surface waters cause mixing within the water column. The result is water with temperature, dissolved oxygen, and other variables that are essentially equal at all depths This event is often referred to as a spring turnover. In the summer months, warm air temperatures interact with surface waters causing stratification or layering of lake water due to water temperature and density relationships. During this time of thermal stratification, little mixing of lake water occurs. Lakes that receive increased pollutant loading can exhibit quantifiable reductions in water quality at this time because of the lack of oxygen in the bottom water. As fall approaches, cooler air temperatures increase surface water density and mixing establishes uniformity within the water column in what is termed as fall turnover. During the winter months, the lake may stratify again.

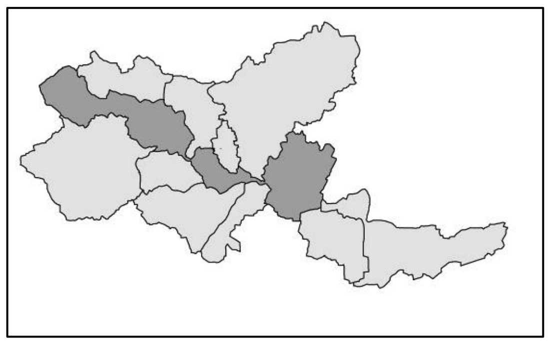
2.4 CREEKSHED REVIEWS

In order to gain a perspective on the past and present general water quality conditions in the watershed, efforts were made to compile and summarize relevant and readily available existing water quality data. This effort included, but was not limited to acquisition of studies conducted by state researchers, as well as requests to Advisory Committee members and researchers in the area.

Numerous studies and datasets of relevance were obtained in this process; however, spatial and temporal data may be somewhat limited in certain areas, especially for areas of the watershed drained by minor tributaries. Due to these limitations, the following narrative should be considered a snapshot of water quality in the watershed rather than a comprehensive review.

This Watershed Management Plan focuses on the sources and distribution patterns of nonpoint source pollution throughout the watershed. Therefore, rather than attempting to present data on the many lakes throughout the watershed, emphasis was placed on water quality conditions in the Huron River, its major tributaries, and directly connected major lakes and impoundments. Because the large size of the watershed, an effort was made to categorize the analysis based on drainage areas in the watershed. Eleven hydrologically distinct drainage areas, or creeksheds, were delineated and their water quality summaries are reviewed below.

2.4.1 Huron River Direct Drainage



Water Quality Conditions

The MDEQ has collected annual water quality data at monthly intervals for two sites on the Huron River upstream of Ford and Bellville Lakes to determine the progress toward meeting the phosphorus goal established for the lakes' TMDL. Total phosphorus concentrations cannot exceed 50 µg/L in the Huron River, just upstream of Ford Lake, in order to meet the goal of 30 µg/L for total phosphorus in Belleville Lake. Data was collected from April to September during the years 1994-1999, 2001-2003, and 2004-2006 at a site located at Bandemer Park, just downstream from Barton Pond and another site located ten miles downstream at Michigan Avenue where the Huron empties into Ford Lake.

Total phosphorus concentrations at the Bandemer Park station remained at or below 40 µg/L over the years of monitoring, with a few exceptions when spikes were observed in August 1996 and July 1998. The Michigan Avenue station exhibited higher total phosphorus concentrations compared to the Bandemer Park station over the years of monitoring. The target phosphorus TMDL goal of 50 µg/L was exceeded on most sampling dates each year of monitoring. However, at both stations, no clear trends in phosphorus concentration can be identified when compared to historical data.[36, 37, 38, 39, 40, 41]

The Middle Huron Stream Monitoring Program has collected water quality data on the Huron River as it passes into the Hudson Mills Metropark at North Territorial Road annually from May to September since 2003. Measurements include total phosphorus, total suspended solids, conductivity, pH, and dissolved oxygen. [42] Results from this program for conductivity, pH and dissolved oxygen are described in section 2.3.1. Phosphorus loading curves have been developed for all ten sites in the program. Figure 2.22 shows the curve for the Huron River site at North Territorial Road. The slope of the loading curve is an indication of the storm flow effect on the overall loading to the measurement site. In the case of the Huron River site, the low relative slope (when compared to other sites) indicates that the phosphorus load does not change much as the discharge (flow) increases,. The constancy of the water's phosphorus concentration indicates that less of the overall load may originate from stormwater runoff, in comparison to tributary sites. Total suspended solids curves have also been developed for each of the ten sites. These curves and their calculations can be found in Appendix K. Four sites were monitored in 2007 during storm events. This data along with a comparison between TP and TSS is being analyzed at the current time as part of the 2007 Middle Huron Partners Annual Report.

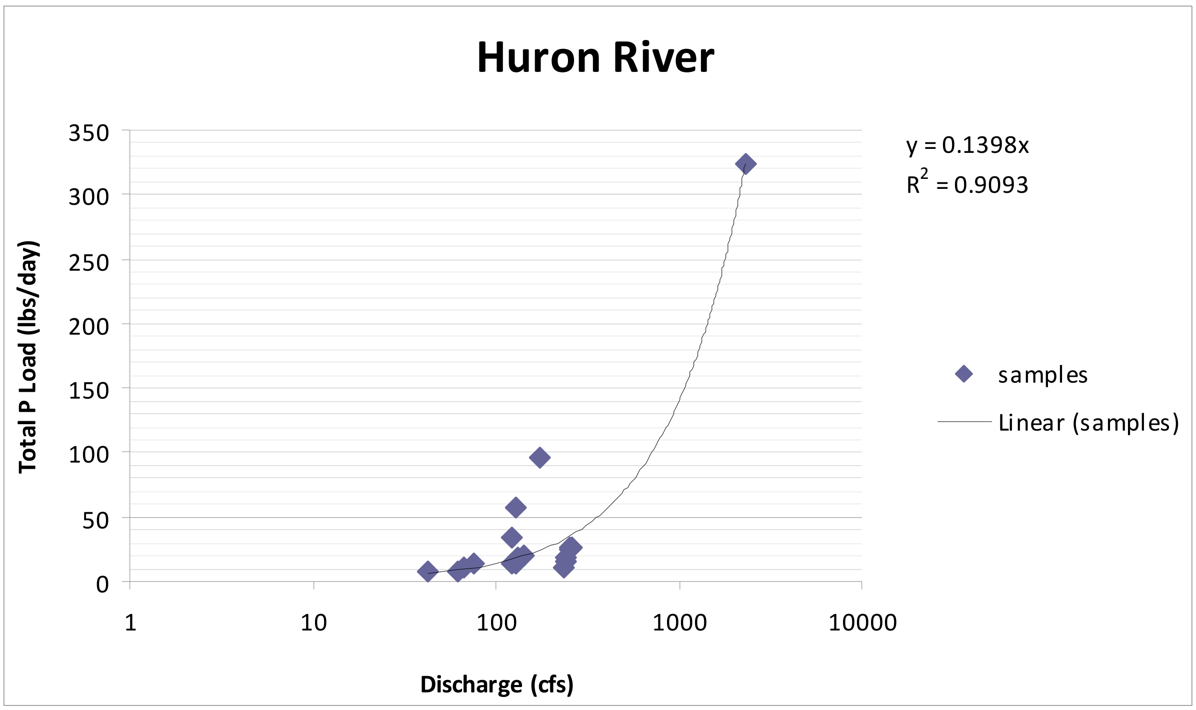


Figure 2.22. Instantaneous total phosphorus loading calculations by measured discharge for monthly measures May-September 2003-2006 at the Huron River site at the North Territorial Road crossing.

Dr. John Lehman with the University of Michigan is conducting a study on the nutrient dynamics and algae growth in Ford and Belleville Lakes and the Huron River upstream. As part of this study, Dr. Lehman and his team sampled twelve sites along the Huron River and sites in Barton Pond and the two lakes. Sampling of these sites occurred between June 2003 and October 2005 once or twice weekly in the summer months, weekly in spring and fall, and biweekly in winter months. Parameters measured at the river sites included several forms of phosphorus and nitrogen, dissolved organic matter, specific conductance and pH. Section 2.5.1 discusses some of Dr. Lehman's findings regarding phosphorus loading in the system. [43]

The MDEQ also conducted biological surveys of the Huron River and its tributaries from July to September of 1997 and 2002. Water quality parameters such as conductivity, Kjeldahl nitrogen, total phosphorus, and total suspended solids were measured in 2002 for the Huron River at

Forest Street in Ypsilanti. These measurements fell within the range of reference sites for the region. [44, 45]

The Huron is monitored at Zeeb Road near Dexter, Island Park in Ann Arbor, and Cross Street in Ypsilanti by the Adopt-A-Stream program at the Huron River Watershed Council. The Adopt-A-Stream Program uses stream water conductivity as an indicator of possible water pollution. A threshold of 800 µS is used as a guideline, above which water quality degradation may be occurring. For the three Adopt-a-Stream sites in the Middle Huron, the Zeeb Rd. site has an average conductivity level of 738 µS, including a reading of 707 µS in April 2007. Lastly, the Island Park site indicated an average conductivity level of 768 µS with an April 2007 reading of 735 µS.

The MDEQ collected *E. coli* data in 2001 and 2002 for Geddes Pond and its tributaries in support of the development of the Geddes Pond *E. coli* TMDL. The *E. coli* water quality standard of 130 *E. coli* per 100 mL as a 30-day geometric mean for Geddes Pond was exceeded in 2001. The results of routine monitoring conducted from May to October of 2002 indicated that Geddes Pond exceeded the water quality standard during the second half of July, all of August, and during one sampling event in September.[46]

The Washtenaw County Drain Commission (WCDC) coordinated a research project to identify agents causing high bacterial levels (>10,000 cfu/100 ml) during both wet and dry weather in Geddes Pond. Sampling took place at Sheridan Road and Buckingham Road. Researchers employed library-based genotypic bacteria source tracking (BST) to match bacterial strands with specific species. Storm sewer samples validated 2003 data, indicated seasonal differences (Spring had greater levels than Fall), and displayed climatic differences (wet weather had greater levels than dry weather). BST analysis indicated that the primary culprits were raccoons and pets – cats to a greater extent than dogs. Unknown bacterial strands may be attributed to rats or deer. The WCDC will be addressing these issues by improving public education on feral cats, promoting best household practices for trash containment, and creating a dog park. Efforts to reach TMDL levels will not be realized despite these measures. [47]

Freshwater Biological Communities

The Huron is monitored at Zeeb Road near Dexter, Island Park in Ann Arbor, and Cross Street in Ypsilanti by the Adopt-A-Stream program. The ecological condition of these sites over the past five years (2001-2005), as determined by a combination of biological and physical data, has been rated as excellent, fair, and poor respectively. The biological data include the diversity of insect families, the number of insects of the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), and the number of sensitive insect families. The physical data include water conductivity and habitat assessment information.

The aquatic invertebrate communities at these sites have been stable over the past five years (2001-2005). During the Fall 2005 search, twenty different insect families were found at the Zeeb Road site of which eight were mayflies, stoneflies, or caddisflies compared to only nine insect families found at the Cross Street site, of which four were mayflies, stoneflies, or caddisflies. Winter stoneflies, which indicate good stream quality, have always been found at these sites when they were searched in the winters of 2002-2006. The only exception was the 2006 search at Cross Street during which no stoneflies were found. [48]

The 2002 MDEQ Huron River Survey also found the macroinvertebrate community at Zeeb Road to be of excellent condition. The macroinvertebrate community at Forest Street in Ypsilanti was rated as excellent in 1997 but dropped to acceptable in 2002. [49]

Limno-Tech, Inc. conducted a survey of aquatic macrophytes on Barton, Argo, Geddes, and South Ponds in 2006. Areas of dense vegetation have been noted by residents and staff of the City of Ann Arbor and have interfered with recreational use of the impoundments, degraded aesthetic value, and disrupted the City of Ann Arbor water intake and treatment operations on Barton Pond. Over 600 sites in total on the four impoundments were surveyed over a two week period in September. Each species was recorded as well as its density, distribution, and relative height in the water column. These data were used to analyze percent occurrence of each species, community biodiversity, and community quality.

The data suggest that the total number of species observed in each of the ponds is similar to conditions that would be expected in an impoundment. However, these totals are lower than would be expected in a relatively undisturbed lake system in southeast Michigan. Moreover, the biodiversity scores are indicative of disturbed conditions, meaning that the plant communities are in an unstable state. Such a state can allow for the establishment and proliferation of invasive species and a variety of nuisance conditions.

The most commonly observed density patterns of macrophytes in the impoundments were "common" and "present". These patterns indicate that most of the plant species are capable of inhabiting many areas of the pond as opposed to narrowly defined habitats in which rare species would be found. Additionally, the mixtures of distribution types observed during the survey are representative of systems with fairly good habitat complexity.

Overall, the plant communities surveyed are indicative of disturbed conditions with a predominance of opportunistic species such as Eurasian watermilfoil and coontail. Density and distribution observations indicate moderately good habitat structure complexity in each of the systems.

The results of the aquatic macrophyte survey were used to develop a preliminary review of aquatic plant management alternatives for each of the impoundments. The main objectives for aquatic plant management are to reduce nuisance plant growth in order to minimize or eliminate interference with recreational use and improve aesthetics, prevent disruption of City of Ann Arbor water intake and treatment operations on Barton Pond, and support economical, ecologically-protective, and sustainable management of the impoundments. The management alternatives that were considered potentially feasible for each impoundment are as follows:

- Barton Pond: harvesting operations, dredging, and water level drawdown;
- Argo Pond: harvesting operations, selective control using herbicides, dredging;
- Geddes Pond: harvesting operations, selective control using herbicides, dredging; and
- South Pond: harvesting operations, selective control using herbicides, dredging. [50]

As part of the Department of Natural Resources (DNR) Water Survey of the Huron River, Argo Pond, Geddes Pond, and Barton Pond were each sampled for their fish populations. From May 3-5, 2000, DNR researchers trapped fish two consecutive nights on the 86.5 acre impoundment of Agro Pond. Four trap nets at five locations were used. Eighteen different species of panfish, large gamefish, rough fish and others were caught. Panfish were in the greatest abundance, with blue gills totaling 23.8 fish per net lift. Bluegills yielded a 2.75 Schneider Index rating, which put their population levels as poor to acceptable. The "Schneider Index" uses size scores of length frequency and growth data and relates them to an adjective ranking system ranging from "very poor" to "superior"[51]. Also, rockbass yielded a higher count than in past years. Of the large gamefish, channel catfish were the most abundant, with poor showings of largemouth bass and walleye. No northern pike were observed, but no deep water sampling took place either. Suckers, white and shorthead redhorse, dominated the rough fish category. The DNR recommended that channel catfish yearling stockings continue, and that Argo dam be removed to create better habitat for smallmouth bass and restore riverine mussel populations. [52]

The Geddes Pond study took place on June 20, 1996. Unfortunately, heavy rain conditions and only one testing day hindered fish trappings for the 261 acre impoundment. Trapping took place at four different locations using trap nets. Since 1980, Geddes Pond has been stocked with tiger muskellunge, largemouth bass, and, most recently, channel catfish. Channel catfish are relatively old and large in size, because they were stocked from 1987 to 1991. However, limited reproduction has led to homogeneity in fish age, with few small catfish. The DNR has recommended future stockings of channel catfish. The pond also has a large number of carp, which accounted for 40% of the catch by weight. Anglers use the pond in the Spring, Summer and Fall to catch smallmouth bass, largemouth bass, black crappie, channel catfish, and carp. [53]

The Barton Pond study was conducted from June 18-19, 1996. The surrounding land remains largely undeveloped, with meadow and woods as the predominant habitat. Testing of the 302 acre impoundment took place at four different locations along the river using trap nets. Carp and white and redhorse suckers accounted for 75% of the catch by weight. Two channel catfish and seven walleye were also caught. Anglers typically fish by boat and target walleye, largemouth and smallmouth bass, crappie and channel catfish. Timing, duration of study and weather hindered the monitoring at this site. [54]

Table 2.6. Ecological Conditions and Aquatic Insect Families at HRWC Adopt-A-Stream Program Monitoring Sites in the Huron River Direct Drainage[55]

Study Site	Ecological Conditions*	Population Diversity	Avg. Insect Families	Avg. EPT Families	Avg. Sensitive Families	Winter Stonefly
Zeeb Road	Excellent	Stable	20	8	1	Present 4 years
Island Park	Fair	Stable	11	5	1	Present 3 years
Cross Street	Poor	Stable	9	4	0	Present 2 years

** categories: excellent, good, fair, and poor*

<u>Additional Data</u>

The MDEQ collected qualitative habitat data including substrate and instream cover, channel morphology, and riparian and bank structure for two sites on the Huron River during the 2002 survey. Habitat condition was rated as excellent at Zeeb Rd. due to high epifaunal substrate availability and cover and little sediment deposition or embeddedness. Habitat condition at Forest Street was considered slightly impaired due to low availability of epifaunal substrate, bank instability, and high stream flashiness. [56]

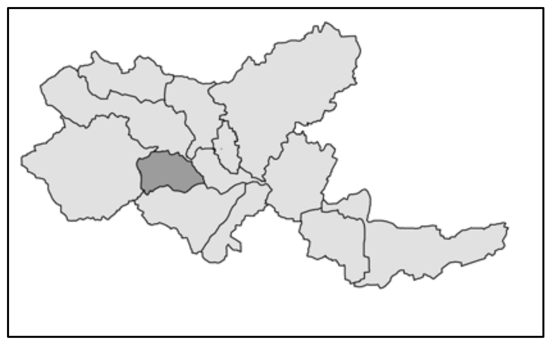
A feasibility study was conducted in 2002 by Barr Engineering, Co. for the removal of Argo Dam on the Huron River in Ann Arbor[57]. The study sought to identify whether significant contaminated sediment or soil exists in Argo Pond and to obtain a rough estimate of the magnitude of the volume of sediments at the pond site. Sediment samples were collected from three representative sites within the pond and were analyzed for concentrations of nutrients, pesticides, and metals. A series of soundings at 15 sections throughout the pond was performed to obtain a rough estimation of volumes and locations of sediments in the pond.

Results indicated that the sediments do not appear to be significantly contaminated and that they may be acceptable as vegetated soils at the surface if Argo Pond were to be drained. The study also found that there are approximately 184,000 CY of sediment deposited in the pond.

The City of Ann Arbor conducted a series of tests in 2004 to explore the occurrence and removal of pharmaceuticals, personal care products, and endocrine disrupting compounds through the Ann Arbor Water Treatment Plant. Researchers compared samples of source water to finished drinking water and wastewater influent to treated wastewater effluent. Samples were drawn in February, April, June and August 2004 for each of the four sites. Samples were tested for antibiotics, analgesics, antiepileptics, sterols and hormones and miscellaneous compounds, totaling 22 compounds. Results indicated that the water treatment process reduced the number of compounds in source water to drinking water from 10 to 4, respectively. Additionally, of the 4 remaining compounds, each were reduced a minimum of 23%. 17 compounds in the wastewater influent were reduced to 15 compounds in the treated wastewater effluent, with a reduction of 90% for 10 of the 15 remaining compounds. [58]

2.4.2 Allens Creek

Water Quality Conditions



The Middle Huron Stream Monitoring Program has collected water quality data for Allens Creek at its outfall to the Huron River annually from May to September since 2003. Measurements include total phosphorus load, total suspended solids, conductivity, pH, and dissolved oxygen. [59] Results from this program for conductivity, pH and dissolved oxygen are described in section 2.3.1. Phosphorus loading curves have been developed for all ten sites in the program. Figure 2.23 shows the curve for the Allens Creek site at its outlet to the Huron River. The slope of the loading curve is an indication of the storm flow effect on the overall loading to the measurement site. In the case of the Allens Creek site, the low slope seems to indicate that, while the instantaneous TP load increases as the discharge increases, the phosphorus concentration does not change much. However, as of the time of this analysis, no high flow measurements had been calculated. Allens Creek was monitored during storm events during July through September 2007. Those results are in the process of being analyzed. Total suspended solids curves have also been developed for each of the ten sites. These curves and their calculations can be found in Appendix K. This data along with a comparison between TP and TSS is being analyzed at the current time as part of the 2007 Middle Huron Partners Annual Report.

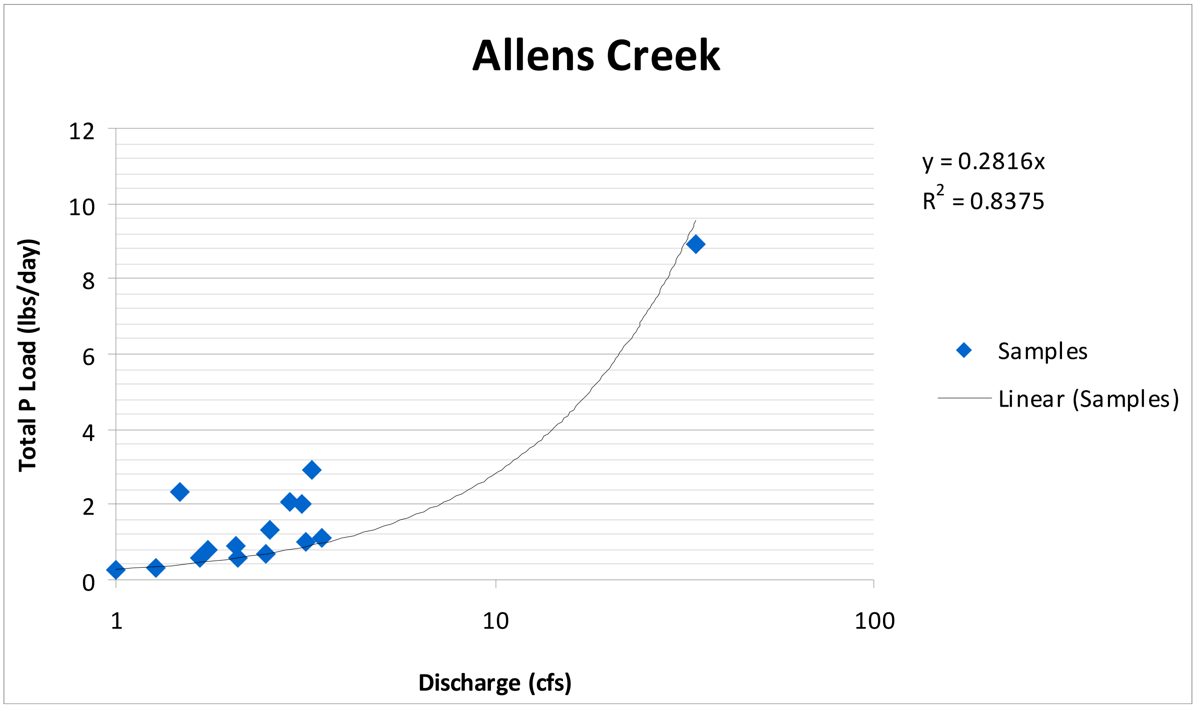


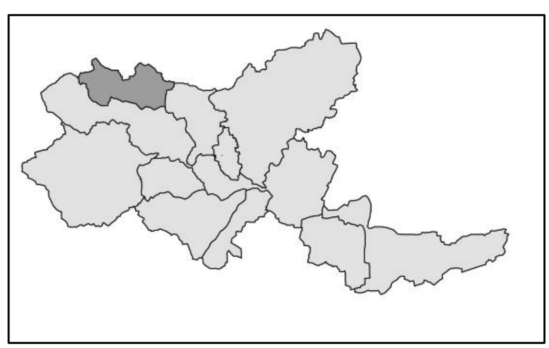
Figure 2.23. Instantaneous total phosphorus loading calculations by measured discharge for monthly measures May-September 2003-2006 at the Allens Creek site at its outlet to the Huron River.

The MDEQ collected *E. coli* data in 2001 and 2002 for Geddes Pond and its tributaries in support of the development of the Geddes Pond *E. coli* TMDL. Water quality standards of 300 *E. coli* per 100 mL in Allens Creek were exceeded in 2001 and remained elevated in 2002. There was also visual evidence of illicit connections in Allens Creek. Additional *E. coli* sampling in 2006 for the Middle Huron Stream Monitoring Program demonstrated that E. coli again exceeded the water quality standard each month from June through September, ranging from 2000 to 7200 *E. coli* per 100 mL. [60]

In 2005 and 2006, the Washtenaw County Drain Commissioner's office made rain garden assistance grants available to Allens Creek residents through State Non-Point Source Pollution funding. Grants provided interested homeowners with rain garden design plans. Over the course of the two year program, nineteen homeowners installed rain gardens in their yards. As a result, an estimated 25,000 gallons of rainfall will flow into and through the created rain gardens during each 1 inch rain event. [61]

Further information about Allens Creek can be found in the Allens Creek Watershed Plan in Appendix I.

2.4.3 Boyden Creek



Water Quality Conditions

Very little water quality data has been collected for the Boyden Creekshed other than data collected by the Loch Alpine Sanitary Authority from their intake and outfall. That data had not been obtained by the date of this publication.

The Adopt-A-Stream Program uses a stream water conductivity threshold of 800 µS as a guideline for water pollution, above which water quality degradation may be occurring. In Boyden Creek, there are Delhi and the Golf Course. At Delhi, the average conductivity level is 701 µS. Also, an April 2007 measurement indicated a conductivity level of 641 µS. At the Golf Course site, average conductivity levels are measured at 772 µS with levels of 704 µS in April 2007.

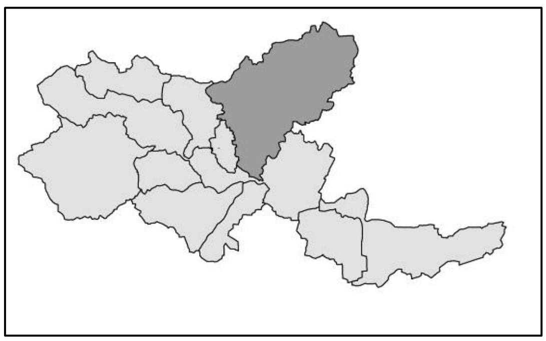
Freshwater Biological Communities
Boyden Creek is monitored at North Delhi Road, Loch Alpine Golf Course, and Huron River Drive by the Adopt-A-Stream Program. The ecological condition of these sites over the past five years (2001-2005) as determined by a combination of biological and physical data has been rated as fair at the North Delhi Road and golf course sites and poor at the Huron River Drive site. The aquatic invertebrate communities at all three sites have been stable over the past five years (2001-2005). Winter stoneflies have always been found at the North Delhi Road and golf course sites when they were searched in the winters of 2002-2006 but have never been found at the Huron River Drive site. [62]

Table 2.7. Ecological Conditions and Aquatic Insect Families at HRWC Adopt-A-Stream Program Monitoring Sites in the Boyden Creekshed[63]

Study Site	Ecological Conditions*	Population Diversity	Avg. Insect Families	Avg. EPT Families	Avg. Sensitive Families	Winter Stonefly
Delhi	Fair	Stable	13	4	0	Present 3 years
Golf Course	Fair	Stable	6	3	0	Present all 5 years
Huron River Dr	Poor	Stable	11	4	1	None

** categories: excellent, good, fair, and poor*

2.4.4 Fleming Creek



Water Quality Conditions
The Middle Huron Stream Monitoring Program has collected water quality data for Fleming Creek at Parker Mill County Park annually from May to September since 2003. Measurements include total phosphorus load, total suspended solids, conductivity, pH, and dissolved oxygen. [64] Results from this program for conductivity, pH and dissolved oxygen are described in section 2.3.1. Phosphorus loading curves have been developed for all ten sites in the program. Figure 2.24 shows the curve for the Fleming Creek site at Parker Mill. The slope of the loading curve is an indication of the storm flow effect on the overall loading to the measurement site. Compared to the other sites, the load curve for Fleming Creek has a moderate slope. This indicates that some amount of the overall load is originating from stormwater runoff, when compared to tributary sites, but it does not have extreme storm loading. The scatter in the Fleming Creek data also indicate that there may be some other non-runoff sources of phosphorus. Fleming

Creek also has the third highest median phosphorus load of the nine tributary sites. Total suspended solids curves have also been developed for each of the ten sites. These curves and their calculations can be found in Appendix K. This data along with a comparison between TP and TSS is being analyzed at the current time as part of the 2007 Middle Huron Partners Annual Report.

The Adopt-A-Stream Program at the Huron Watershed Council uses stream water conductivity as an indicator of possible water pollution. A threshold of 800 µS is used as a guideline, above which water quality degradation may be occurring. Conductivity at the Warren Road site has never exceeded this threshold. Conductivity at Galpin Road and the Botanical Gardens have occasionally exceeded the threshold slightly, but it averages less than 800 µS. Radrick Farms and Geddes Road, which are quite close together, tend to hover around the threshold level. Trend analysis indicates that average conductivity values in Fleming Creek over time are not changing.

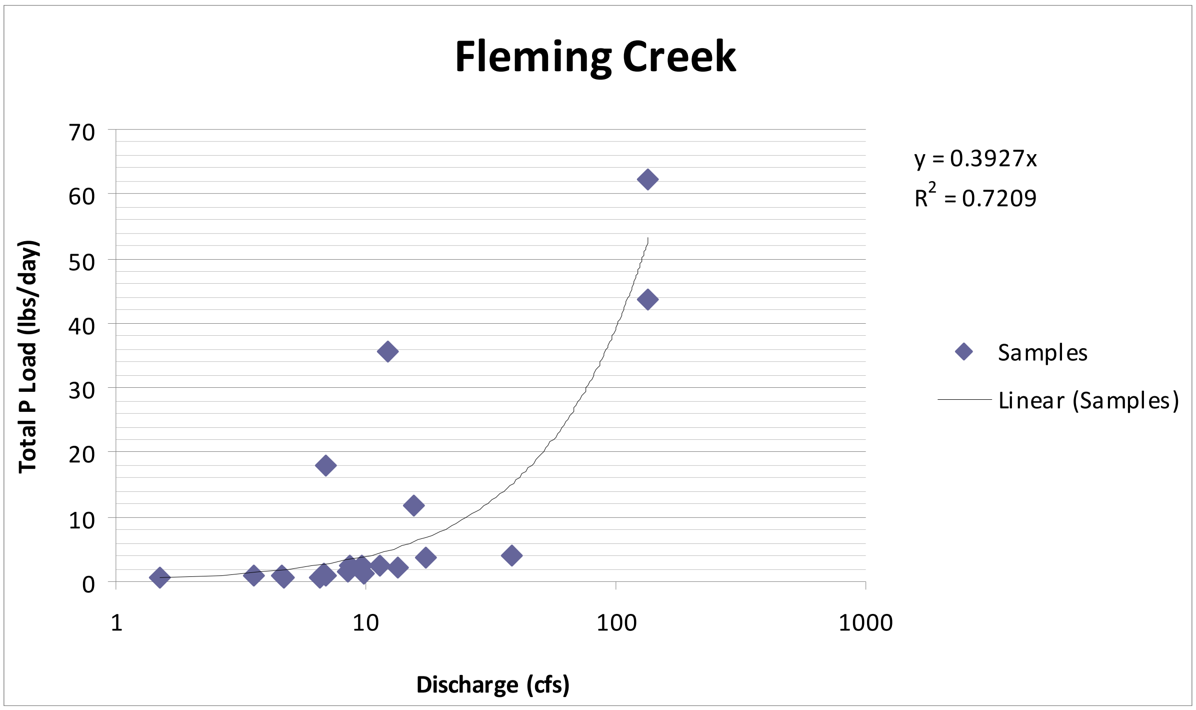


Figure 2.24. Instantaneous total phosphorus loading calculations by measured discharge for monthly measures May-September 2003-2006 at the Fleming Creek site at Parker Mill.

The MDEQ conducted a biological survey of the Huron River and its tributaries from July to September of 1997 and 2002. Water quality parameters such as conductivity, Kjeldahl nitrogen, total phosphorus, and total suspended solids were measured in 2002 for Fleming Creek at a site in the Matthei Botanical Gardens. These measurements fell within the range of reference sites for the region. [65]

Freshwater Biological Communities

Fleming Creek is monitored in the Matthei Botanical Gardens and Radrick Farms Golf Course and at Geddes Road and Warren Road by the Adopt-A-Stream program. A new site has also been added at Galpin Road but too few samples have been collected to detect any trends in ecological condition or aquatic invertebrate communities. See Table 2.8 for results.

The ecological condition of the sites over the past five years (2001-2005) as determined by a combination of biological and physical habitat data has been rated as good at the Botanical Gardens and Warren Road sites and fair at the Geddes Road and Radrick Farms sites. The "good" rating at the Botanical Gardens site is an improvement from a previous rating of "fair". The improvement is attributed to the establishment of riparian vegetation along the stream which stabilizes the channel somewhat and provides additional cover and shade.

Although the aquatic invertebrate communities at the Geddes and Warren Roads sites have remained stable over the past five years (2001-2005), the golf course site has exhibited a significant decline in both insect and sensitive family diversity. In comparison with the 14 kinds of aquatic insects and two sensitive families found during the Fall 2005 search at the Warren Road site, only six kinds of insects and no sensitive families were found at the golf course site. However, winter stoneflies have always been found at all five sites when they were searched in the winters of 2002-2006. [66]

Table 2.8. Ecological Conditions and Aquatic Insect Families at HRWC Adopt-A-Stream Program Monitoring Sites in the Fleming Creekshed[67]

Study Site	Ecological Conditions*	Population Diversity	Avg. Insect Families	Avg. EPT Families	Avg. Sensitive Families	Winter Stonefly
Botanical Gardens	Good	NA	13	6	1	Present all 3 years
Galpin Road	NA	NA	14	4	0	Present all 2 years
Geddes Road	Fair	Stable	10	4	0	Present all 4 years
Radrick Farms	Fair	Declining	6	3	0	Present all 1 years
Warren Road	Good	Stable	14	8	2	Present all 4 years

** categories: excellent, good, fair, and poor*

The 1997 and 2002 MDEQ Huron River Surveys also found the macroinvertebrate community in Fleming Creek at the Matthei Botanical Gardens and Geddes Road to be in acceptable condition. [68, 69]

Additional Data

The MDEQ collected qualitative habitat data including substrate and instream cover, channel morphology, and riparian and bank structure for two sites on Fleming Creek during the 2002 survey. Habitat condition was rated as slightly impaired at both the Matthei Botanical Gardens and Geddes Road due to low availability of epifaunal substrate, bank instability, and high stream flashiness. [70]

The Fleming Creek Plan indicates that sediment is a threat to the macroinvertebrate community in Fleming Creek. Excepting the west branch, which is of high quality, all other branches of the stream have only slightly above average macroinvertebrate populations.

HRWC's Adopt-a_Stream program also conducted a flow study of Fleming Creek through 2007. The results of that study have been compiled and show Fleming Creek to express hydrology that is consistent with an undeveloped watershed. Peak flows are slow to emerge and the return to base flow is slow. Base flow levels are also reasonable for a creekshed of its size. Figure 2.25 illustrates the Fleming Creek (at the Galpin monitoring station) response to a storm event in comparison to the response of neighboring Millers Creek (a highly developed and degraded creek). Millers Creek shows the flashy response typical of degraded streams with high amounts of imperviousness in the creekshed. Fleming, on the other hand, shows a more natural flow response, with longer response times and larger baseflow, more typical of a stream with more input from groundwater.

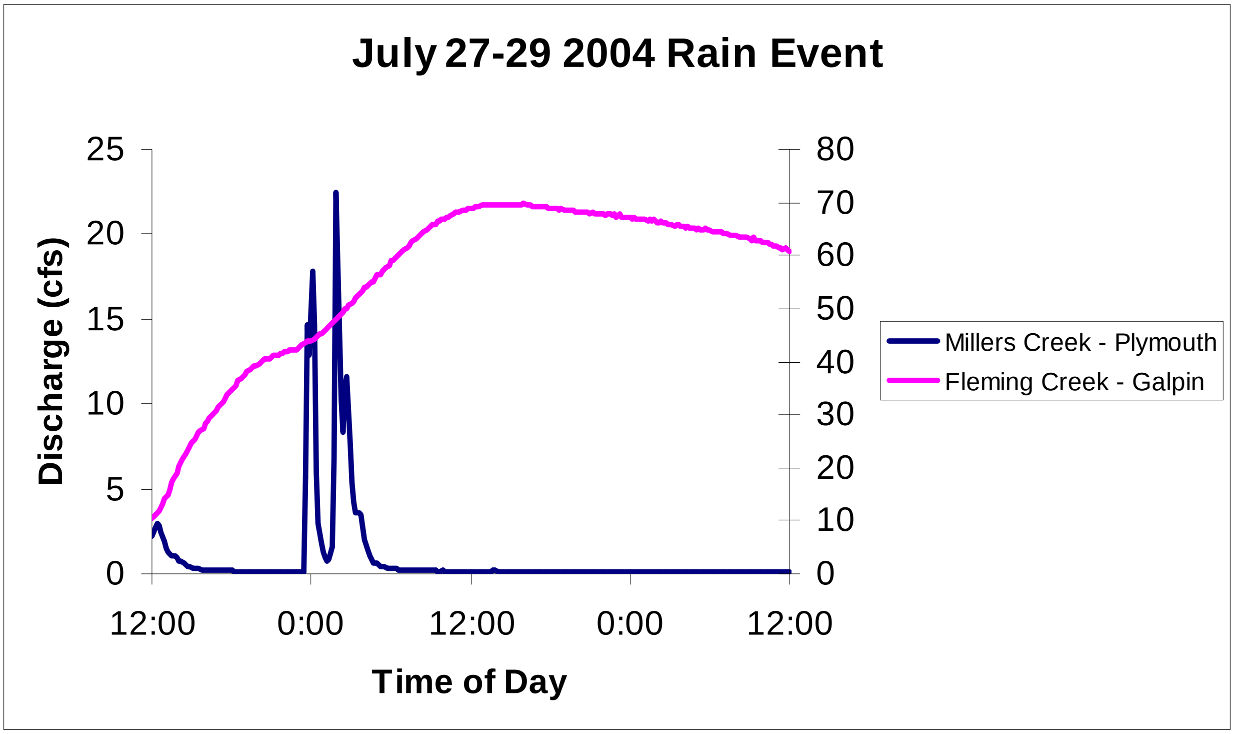
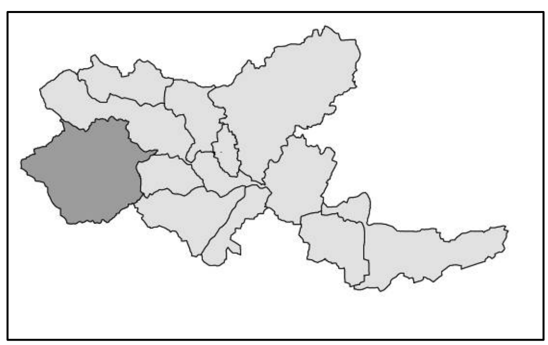


Figure 2.25 Graph showing the flow response of Fleming and Millers Creeks to a single rain event. Millers Creek scale is on the left and Fleming Creek on the right.

2.4.5 Honey Creek

Water Quality Conditions



The Middle Huron Stream Monitoring Program has collected water quality data for Honey Creek at Wagner Road annually from May to September since 2003. Measurements include total phosphorus load, total suspended solids, conductivity, pH, and dissolved oxygen. [71] Results from this program for conductivity, pH and dissolved oxygen are described in section 2.3.1. Figure 2.26 shows the phosphorus loading curve for the Honey Creek site at Wagner Road. The slope of the loading curve is an indication of the storm flow effect on the overall loading to the measurement site. In the case of the Honey Creek site, the higher than average slope indicates that the TP load increases significantly as the discharge increases. This indicates that a significant portion of the overall load from Honey Creek is originating from stormwater runoff, when compared to tributary sites. Total suspended solids curves have also been developed for each of the ten sites. These curves and their calculations can be found in Appendix K. This data along with a comparison between TP and TSS is being analyzed at the current time as part of the 2007 Middle Huron Partners Annual Report.

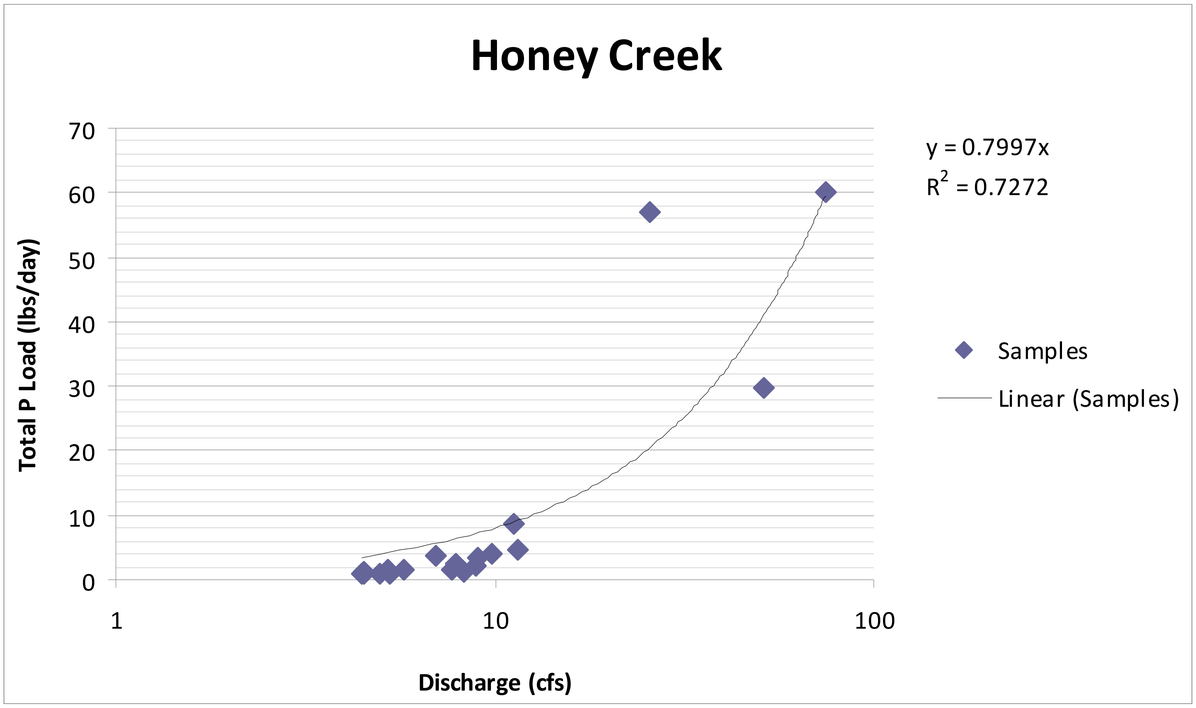


Figure 2.26. Instantaneous total phosphorus loading calculations by measured discharge for monthly measures May-September 2003-2006 at the Honey Creek site at Wagner Road.

The Adopt-A-Stream Program at the Huron Watershed Council uses a stream water conductivity threshold of 800 µS as an indicator of possible water pollution, above which water quality degradation may be occurring. Honey Creek is monitored at Jackson Road, Pratt Road, and Wagner Road by the Adopt-A-Stream program. At Jackson Road, the average conductivity level is 788 µS. In April 2007, conductivity levels were measured at 772 µS at this site. The average conductivity at Pratt Road is 1085 µS, with April 2007 levels at 987 µS. The Wagner Road site has a conductivity average of 1135 µS with an April 2007 level of 1032.

The MDEQ conducted a biological survey of the Huron River and its tributaries from July to September of 1997 and 2002. Water quality parameters such as conductivity, Kjeldahl nitrogen, total phosphorus, and total suspended solids were measured in 2002 for Honey Creek at Huron River Drive. These measurements fell within the range of reference sites for the region. [72, 73] In 2008, MDEQ will be collecting *E. coli* data from three to four locations for development of a TMDL in 2009.

<u>Freshwater Biological Communities</u>

The ecological condition of all three Adopt-a-Stream sites over the past five years (2001-2005) as determined by a combination of biological and physical data has been rated as poor. The aquatic invertebrate communities at the Jackson and Pratt Road sites have been stable over the past five years (2001-2005). Insect diversity has been steadily increasing over several years of sampling at the Wagner Road site. Winter stoneflies have not been found consistently at the Jackson or Pratt Road sites when they were searched in the winters of 2002-2006. However, winter stoneflies have always been found at the Wagner Road site when it was searched in 2002 and 2004-2006. [74]

Table 2.9. Ecological Conditions and Aquatic Insect Families at HRWC Adopt-A-Stream Program Monitoring Sites in the Honey Creekshed[75]

Study Site	Ecological Conditions*	Population Diversity	Avg. Insect Families	Avg. EPT Families	Avg. Sensitive Families	Winter Stonefly
Jackson Rd	Poor	Stable	11	3	0	Present 3 years
Pratt Rd	Poor	Stable	16	3	0	Present 2 years
Wagner Rd	Poor**-Declining	Increasing	11**	2	2	Present 4 years

** categories: excellent, good, fair, and poor; **statistically significant trends over the past 5 years at 10% level.*

The 2002 MDEQ Huron River Survey found that the macroinvertebrate community in Honey Creek at Huron River Drive improved from fair condition in 1997 to a good condition in 2002. [76]

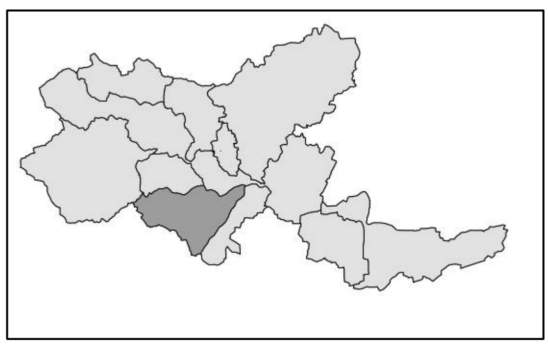
Additional Data

The MDEQ collected qualitative habitat data including substrate and instream cover, channel morphology, and riparian and bank structure for Honey Creek at Huron River Drive during the 2002 survey. Habitat condition was rated as slightly impaired due to low availability of epifaunal substrate, bank instability, and high stream flashiness. [77]

Groundwater in parts of Washtenaw County, including areas in the City of Ann Arbor and Ann Arbor and Scio Townships, is contaminated with the industrial solvent 1,4-dioxane. Most of this contamination is within the Honey Creekshed. Gelman Sciences, now Pall Life Sciences (PLS), used 1,4-dioxane in their manufacturing process through the mid-1980s, and the chemical seeped into and contaminated the groundwater.[78] Monitoring and clean-up activities are on-going through coordination between MDEQ, the City of Ann Arbor and PLS.

2.4.6 Malletts Creek

Water Quality



The Middle Huron Stream Monitoring Program has collected water quality data for Mallets Creek annually from May to September since 2003. Measurements include total phosphorus load, nitrates and nitrites, total suspended solids, conductivity, pH, and dissolved oxygen. [79] Results from this program for conductivity, pH and dissolved oxygen are described in section 2.3.1. Phosphorus loading curves have been developed for all ten sites in the program. Total suspended solids curves have also been developed for each of the ten sites. These curves and their calculations can be found in Appendix K. This data along with a comparison between TP and TSS is being analyzed at the current time as part of the 2007 Middle Huron Partners Annual Report.

The U.S. Geological Survey also maintains a gage station at Chalmers Drive near the mouth of Malletts Creek. This gage has been in place since 1999. Figure 2.27 shows four separate years of monthly mean flows along with the 7-year average. On a monthly basis, there is little consistent seasonal pattern. However, flows on average are higher in the late spring months, and much lower in late fall to early winter.

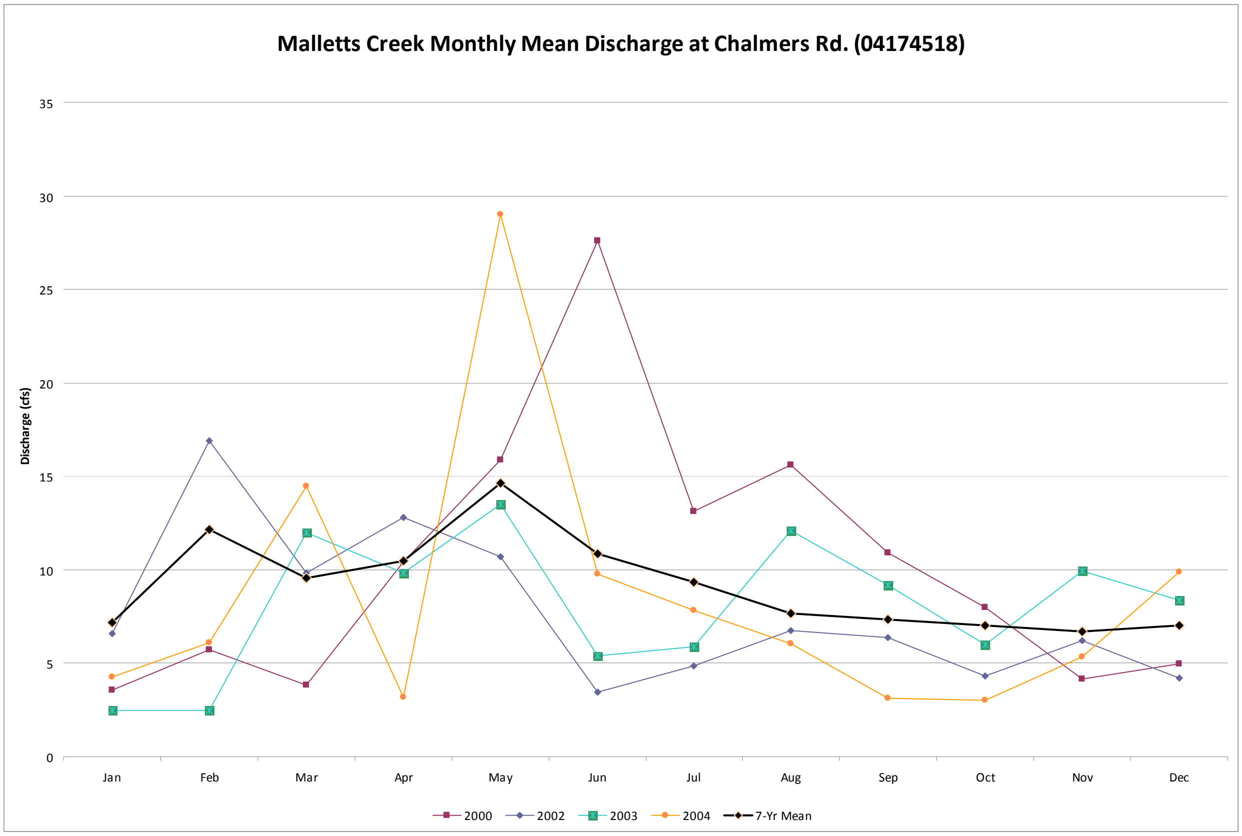


Figure 2.27. Malletts Creek monthly mean discharge for four selected years along with the 7-year mean.

Combining flow and nutrient data (i.e. phosphorus, nitrate/nitrite, and total suspended solids) can yield estimates of loading of these compounds to the main river system. Malletts Creek was determined to be one of the highest phosphorus-loading tributaries in the Middle Huron system (second only to Mill Creek), when a full analysis was conducted in 1996 for the development of the Ford and Belleville Lakes phosphorus TMDL (see section 2.5.1). The annual total phosphorus loading at that time was estimated at 3,945 pounds. Figure 2.28 shows how phosphorus loads increase exponentially as the flow increases. The load curve for Malletts Creek shows the highest slope at more than twice that of the next highest tributary. This indicates that much of the phosphorus load is flushing out of the Malletts system during larger rain events. When combined with historical discharge data, a seasonal load duration curve can be plotted (Figure 2.29). This indicates that Malletts Creek exceeds target phosphorus levels during high and low flow periods, but the exceedences are greater during high flow and storm conditions. This further suggests loading from nonpoint source runoff.

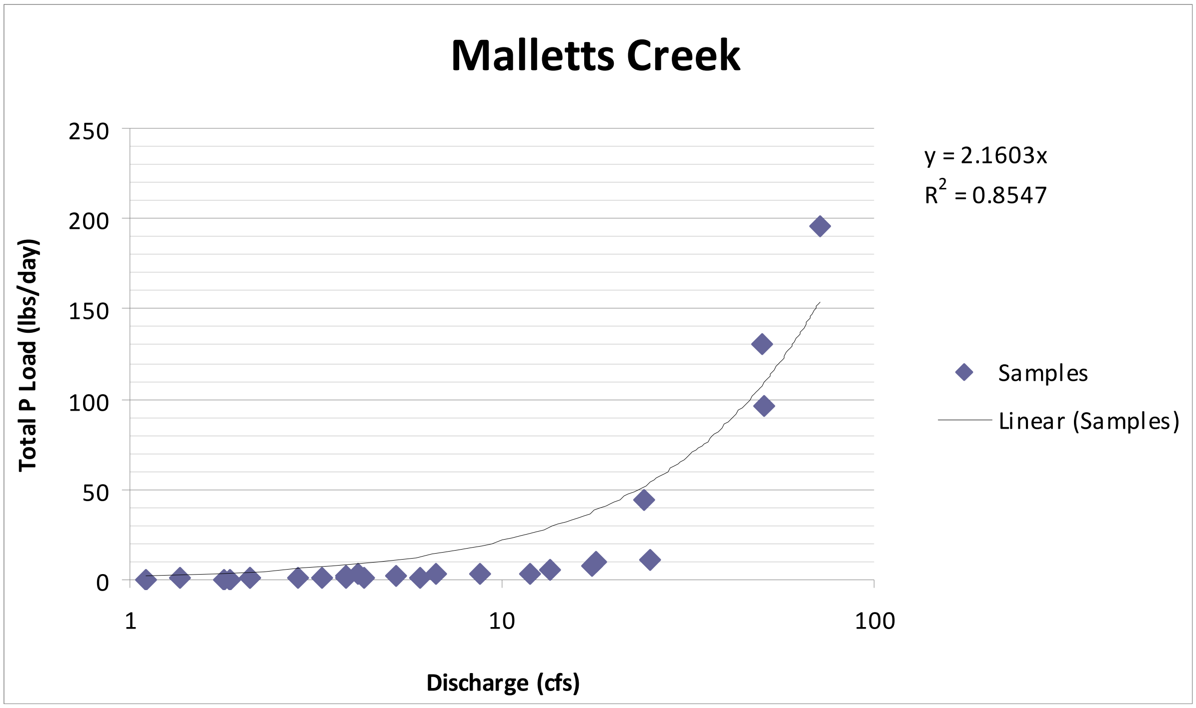


Figure 2.28. Instantaneous total phosphorus loading calculations by measured discharge for monthly measures May-September 2003-2006, and storm samples July-September, 2007 at the Malletts Creek site at the Chalmers Road crossing.

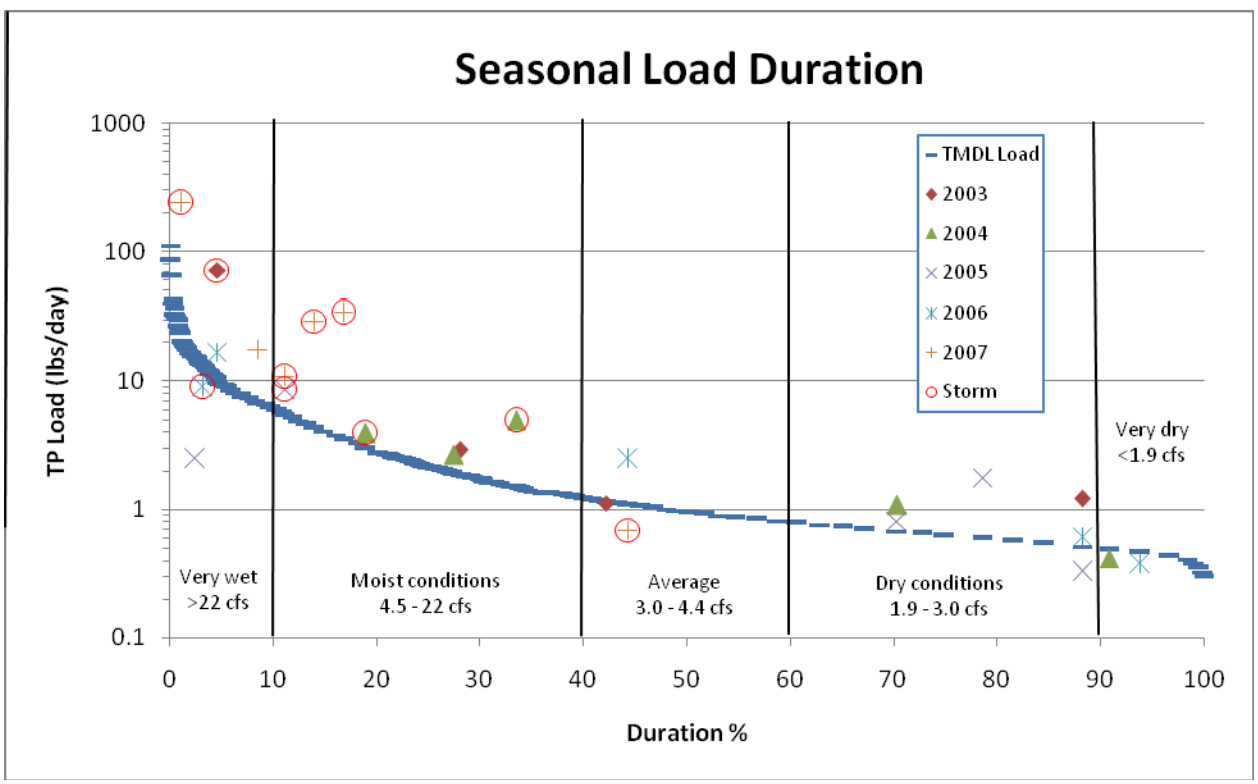


Figure 2.29. Seasonal (April-September) phosphorus load duration curve for Malletts Creek. Target TMDL curve is shown with field measurements by year. Storm samples are circled in red.

Using the sampling data along with the long-term flow data from the gage station, a new loading estimate was calculated for Malletts Creek for the April to September growing season. This new phosphorus load estimate is 2,863 pounds over the growing season. This suggests a larger annual load than was originally estimated in 1996, and much greater than that calculated from field measurements at that time. This estimate is similar to the one calculated for the TMDL study in 2001 (see Appendix F). See Appendix K for the load calculation methodology. Note that the method used was a rough estimate and should be refined and extended to generate a more accurate annual load estimate.

The MDEQ conducted a biological survey of the Huron River and its tributaries from July to September of 1997 and 2002. Water quality parameters such as conductivity, Kjeldahl nitrogen, total phosphorus, and total suspended solids were measured in 2002 for Mallets Creek at Chalmers Road and Scheffler Park. These measurements fell within the range of reference sites for the region. [80, 81]

The Adopt-A-Stream Program at the Huron Watershed Council uses a stream water conductivity threshold of 800 µS as an indicator of possible water pollution, above which water quality degradation may be occurring. Mallets Creek is monitored at Chalmers Road, 1-94, Main Street, and Scheffler Road by the Adopt-A-Stream program. However, only the Main Street site has been measured for conductivity. The Main Street site average conductivity level is 2170 µS, or almost three times the threshold amount. In April 2007, the conductivity level was measured at 1929 µS.

The MDEQ collected *E. coli* data in 2001 and 2002 for Geddes Pond and its tributaries in support of the development of the Geddes Pond *E. coli* TMDL. Water quality standards of 130 *E. coli* per 100 mL in Mallets Creek were exceeded in 2001 and remained elevated in 2002. Data collected from July through October of 2002 at the Eisenhower Commerce Park site showed high spikes in three of the six samples collected. [82]

<u>Freshwater Biological Communities</u>

The ecological condition of all four Adopt-a-Stream sites over the past five years (2001-2005) as determined by a combination of biological and physical data has been rated as poor. The aquatic invertebrate communities at all four sites have been stable over the past five years (2001-2005). The Fall 2005 search demonstrated that insect diversity and the number of mayflies, stoneflies, caddisflies, and sensitive species was very low. Additionally, no winter stoneflies were found at any of the sites when they were searched during the winters of 2002-2006. [83]

The 2002 MDEQ Huron River Survey found the macroinvertebrate community in Malletts Creek at Scheffler Park to be in acceptable condition. The survey also indicated that the macroinvertebrate community at the Chalmers Road site improved from good condition in 1997 to excellent condition in 2002. [84]

Table 2.10. Ecological Conditions and Aquatic Insect Families at HRWC Adopt-A-Stream Program Monitoring Sites in the Malletts Creekshed[85]

Study Site	Ecological Conditions*	Population Diversity	Avg. Insect Families	Avg. EPT Families	Avg. Sensitive Families	Winter Stonefly
Chalmers Rd	Poor	Stable	5	1	0	None
I-94	Poor	Stable	6	1	0	None
Main St	Poor	Stable	5	1	0	None
Scheffler	Poor	Stable	8	2	0	None

** categories: excellent, good, fair, and poor*

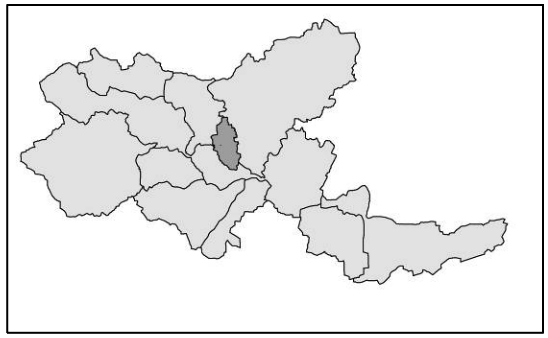
Additional Data

The MDEQ collected qualitative habitat data including substrate and instream cover, channel morphology, and riparian and bank structure for Malletts Creek at Chalmers Road and Scheffler Park during the 2002 survey. Habitat condition was rated as slightly impaired due to low availability of epifaunal substrate, bank instability, and high stream flashiness. [86]

As part of the Malletts Creek Restoration project, the Washtenaw County Drain Commissioners office will be adding natural features to a stormwater pond in Mary Beth Doyle Park. The project is an attempt to add wildlife habitat, reduce Phosphorous pollution by 34% (25% reduction of phosphorus load from Malletts Creekshed), and prevent flooding. Construction began July 2006 and ended August 2007. [87]

The Mallett's Creek Restoration project includes a variety of projects that are at various stages of completion. Completed projects include implementing the illicit discharge elimination program, continuing USGS stream gage operations, enforcing existing ordinances, continuing public education through HRWC, and designing and beginning construction of Mary Beth Doyle Park Pond. On-going projects include sampling benthic macroinvertebrate, conducting routine stream maintenance, studying local detention pond systems, monitoring at the pond, and cleaning watershed catch basins. Some projects will not be implemented or have had no action to date, including sampling for phosphorous, designing effective flood prevention for Oakbrook Drive Crossing, investigating 100-year storm flooding problems, designing structural stream repairs, and increasing residential street sweeping.[88]

2.4.7 Millers Creek



Water Quality

The Middle Huron Stream Monitoring Program has collected water quality data for Millers Creek annually from May to September since 2003. Measurements include total phosphorus load, total suspended solids, conductivity, pH, and dissolved oxygen. [89] Results from this program for conductivity, pH and dissolved oxygen are described in section 2.3.1. Phosphorus loading curves have been developed for all ten sites in the program. Figure 2.30 shows the curve for the Millers Creek site at "the Meadows". Data collection from this site was discontinued after 2005, due to private property access restrictions. The slope of the loading curve is an indication of the storm flow effect on the overall loading to the measurement site. In the case of the Millers Creek site, all measurements were taken in low flow conditions, so no conclusions about storm loading can be drawn. Total suspended solids curves have also been developed for each of the ten sites. These curves and their calculations can be found in Appendix K. This data along with a comparison between TP and TSS is being analyzed at the current time as part of the 2007 Middle Huron Partners Annual Report.

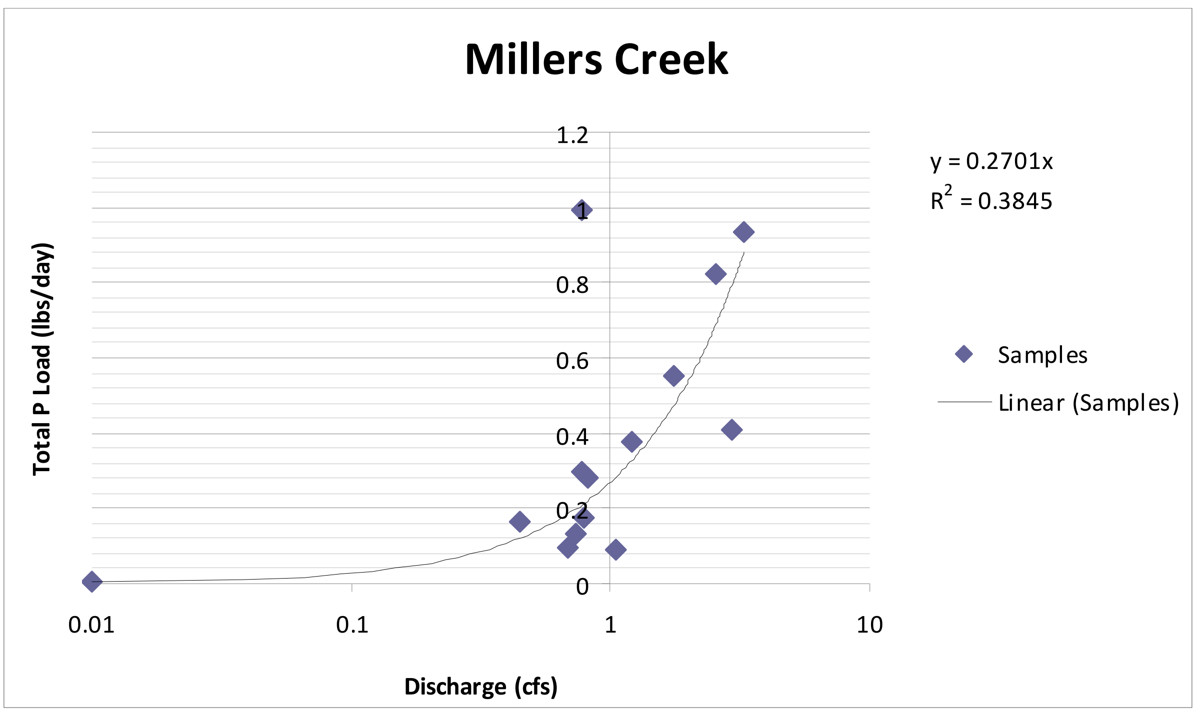


Figure 2.30. Instantaneous total phosphorus loading calculations by measured discharge for monthly measures May-September 2003-2005 at the Millers Creek site at "the Meadows".

The Adopt-A-Stream Program at the Huron Watershed Council uses a stream water conductivity threshold of 800 µS as an indicator of possible water pollution, above which water quality degradation may be occurring. Millers Creek is monitored at nine sites, by the Adopt-A-Stream program. The average conductivity at these sites ranges from 716 µS at Green Road to 4081 µS at Baxter Road, or over five times the threshold amount. All but the Green Road site averaged over the threshold amount. This suggests that ion (i.e. salt) contamination in Millers Creek is impairing wildlife.

The MDEQ collected *E. coli* data in 2001 and 2002 for Geddes Pond and its tributaries in support of the development of the Geddes Pond *E. coli* TMDL. Water quality standards of 130 *E. coli* per 100 mL in Millers Creek were exceeded in 2001 and remained elevated in 2002. Concentrations in 2002 at the east and west branches of Millers Creek at Plymouth Road were higher than concentrations at other locations. [90]

Freshwater Biological Communities

Millers Creek is monitored at eight sites by the Adopt-A-Stream program: the east branch at Baxter Road, Glazier Way, the Green Road tributary, Hubbard Road, Huron Parkway, the Lakehaven Court tributary, Meadows Road, and the west branch at Plymouth Road. The ecological condition of all eight sites over the past five years (2001-2005) as determined by a combination of biological and physical data has been rated as poor. The aquatic invertebrate communities at six of the sites have been stable over the past five years (2001-2005). However, the number of insect families is declining at the Meadows Road site and the number of mayflies, stoneflies, and caddisflies is declining at the Glazier Way site. Additionally, winter stoneflies were only found at three of the sites when they were searched during the winters of 2002-2006: Glazier Way in 2002, the Green Road tributary from 2003-2006, and the Lakehaven Court tributary in 2006. [91]

Table 2.11. Ecological Conditions and Aquatic Insect Families at HRWC Adopt-A-Stream Program Monitoring Sites in the Millers Creekshed[92]

Study Site	Ecological Conditions*	Population Diversity	Avg. Insect Families	Avg. EPT Families	Avg. Sensitive Families	Winter Stonefly
Glazier Way	Poor	Declining	9	1**	0	Present 1 year
Plymouth Rd (W Branch)	Poor	Stable	3	0	0	None
Baxter Rd (E Branch)	Poor	Stable	8	1	1	None
Lakehaven Ct (Tributary)	Poor	Stable	9	1	0	Present 1 year
Green Rd (Tributary)	Poor	Stable	4	2	1	Present all 4 years
Huron Pkwy	Poor	Stable	9	1	0	None
Hubbard	Poor	Stable	9	2	0	None
Meadows	Poor	Declining	4**	1	0	None

** categories: excellent, good, fair, and poor; **statistically significant trends over the past 5 years at 10% level.*

Additional Data

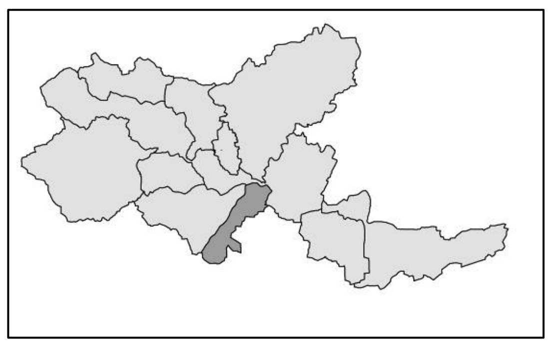
Millers Creek Action Team, a unique public and private sector partnership, managed a comprehensive study of the Millers Creek watershed and development of a 10-year Millers Creek Watershed Improvement Plan (MCWIP), a project that was funded by Pfizer, Inc. The MCWIP was approved by MDEQ for inclusion in the overall Huron River watershed improvement plan.

MCAT began implementation of the MCWIP in 2004 and has made progress on many watershed improvement activities. Ann Arbor public schools received a grant to implement stormwater improvements at Thurston Pond and the Huron River Watershed Council received a grant that will be used in 2007 and 2008 to educate the public on residential storm water management. Other successes include the first annual Millers Creek film festival, meetings with local landowners and property managers, tree planting and turf-grass conversion projects, repairs to an exposed sanitary sewer pipe, and public education.

Several projects and activities are currently being planned for the watershed. These projects include completion of stormwater improvements to Thurston Pond, construction of stream bank improvements between Hubbard Road and Glazier Way in Spring 2008 by the City of Ann Arbor, and implementation of several public involvement projects including the 2008 Film Festival, a rain barrel program, and promoting more citizen involvement within MCAT. MCAT is also working to determine the feasibility of creating a Millers Creek drainage district (a county drain) to provide a more stable funding source for creek maintenance activities.[93]

HRWC has also conducted a flow study of Millers Creek at a number of locations. A summary of these results was presented in section 2.4.4 and figure 2.25. They show that Millers Creek is a highly flashy creek, with rapid spikes in discharge during rain events that quickly dissipate to baseflow (or no flow). The high peak flows and low base flows likely have lead to the observed erosion of the stream channels and low amount of aquatic diversity.

2.4.8 Swift Run



Water Quality

The Middle Huron Stream Monitoring Program has collected water quality data for Swift Run from May to September since 2003. Measurements include total phosphorus load, total suspended solids, conductivity, pH, and dissolved oxygen. [94] Results from this program for conductivity, pH and dissolved oxygen are described in section 2.3.1. Phosphorus loading curves have been developed for all ten sites in the program. Figure 2.31 shows the curve for the Swift Run site at Shetland Road. The slope of the loading curve is an indication of the storm flow effect on the overall loading to the measurement site. In the case of the Swift Run site, the higher than average slope indicates that, the TP load increases significantly as the discharge increases. Swift Run had the second highest slope of the nine tributary sites. This indicates that a significant portion of the overall load from Swift Run is originating from stormwater runoff, when compared to tributary sites. Additional storm samples were taken July-September 2007. These data are in the process of being analyzed and will be improve the reliability of the slope calculation. Total suspended solids curves have also been developed for each of the ten sites. These curves and their calculations can be found in Appendix K. This data along with a comparison between TP and TSS is being analyzed at the current time as part of the 2007 Middle Huron Partners Annual Report.

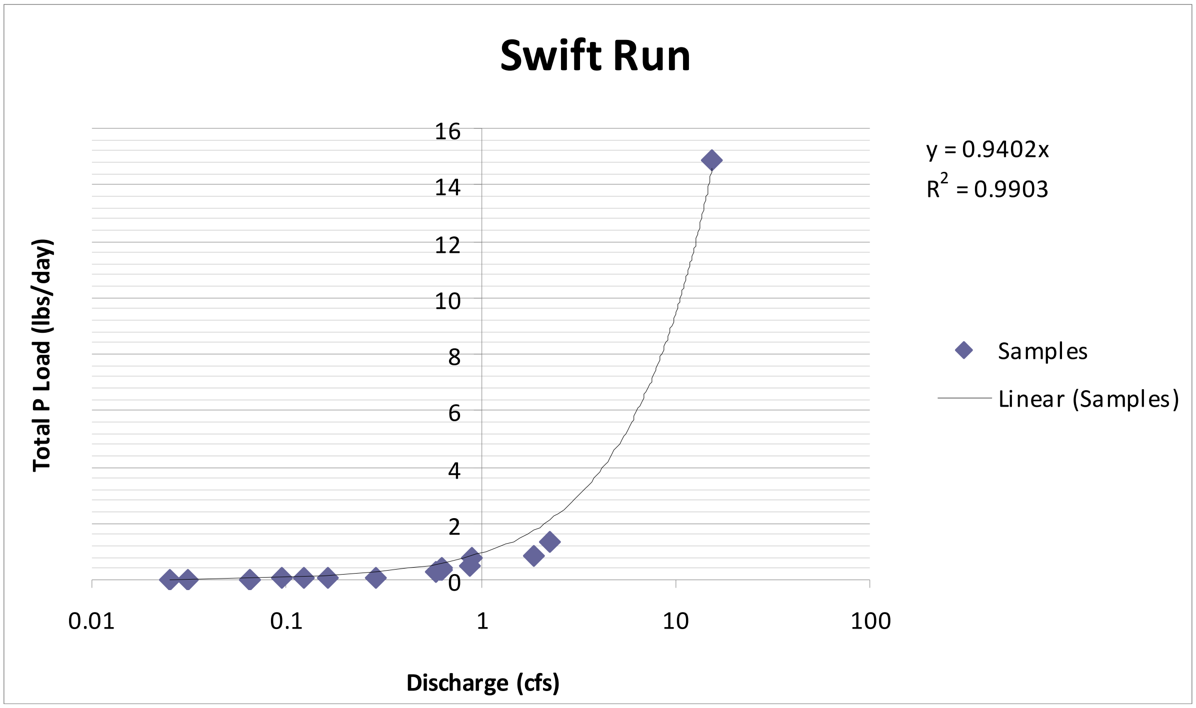


Figure 2.31. Instantaneous total phosphorus loading calculations by measured discharge for monthly measures May-September 2003-2006 at the Swift Run site at the Shetland Road crossing.

The MDEQ collected *E. coli* data in 2001 and 2002 for Geddes Pond and its tributaries in support of the development of the Geddes Pond *E. coli* TMDL. Water quality standards of 130 *E. coli* per 100 mL in Swift Run were exceeded in 2001 and remained elevated in 2002. Sampling in the early portion of the 2002 monitoring season indicated elevated concentrations at various locations while the last four weeks of the season were dry or stagnant. [95]
The Adopt-A-Stream Program at the Huron Watershed Council uses stream water conductivity as an indicator of possible water pollution. A threshold of 800 µS is used as a guideline, above which water quality degradation may be occurring. At the Swift Run site, the average conductivity level is 1688 µS, more than double the threshold level. Samples taken in April 2007 indicated a conductivity level of 1590 µS.

Freshwater Biological Communities

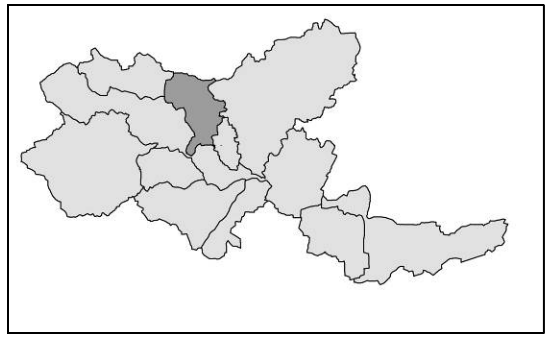
Swift Run is monitored at one site on Shetland Drive by the Adopt-A-Stream program. The ecological condition of the site over the past five years (2001-2005) as determined by a combination of biological and physical data has been rated as poor. The aquatic invertebrate community at the site has been stable over the past five years (2001-2005). During the Fall 2005 search only seven different insect families were found, of which two were mayflies, stoneflies, or caddisflies. Additionally, no winter stoneflies were found at this site when it was searched during the winters of 2002-2006. [96]

Table 2.11. Ecological Conditions and Aquatic Insect Families at HRWC Adopt-A-Stream Program Monitoring Sites in the Swift Run[97]

Study Site	Ecological Conditions*	Population Diversity	Avg. Insect Families	Avg. EPT Families	Avg. Sensitive Families	Winter Stonefly
Swift Run	Poor	Stable	7	2	0	None

** categories: excellent, good, fair, and poor*

2.4.9 Traver Creek



Water Quality

The Middle Huron Stream Monitoring Program has collected water quality data for Traver Creek annually from May to September since 2003. Measurements include total phosphorus load, total suspended solids, conductivity, pH, and dissolved oxygen. [98] Results from this program for conductivity, pH and dissolved oxygen are described in section 2.3.1. Phosphorus loading curves have been developed for all ten sites in the program. Figure 2.32 shows the curve for the Traver Creek site at Wagner Road. The slope of the loading curve is an indication of the storm flow effect on the overall loading to the measurement site. In the case of the Traver Creek site, the low slope indicates that, the TP load increases little as the discharge increases. However, no significant storm samples are included in this data. Additional storm samples were taken July-September 2007. These data are in the process of being analyzed and will be improve the reliability of the slope calculation. Total suspended solids curves have also been developed for each of the ten sites. These curves and their calculations can be found in Appendix K. This data along with a comparison between TP and TSS is being analyzed at the current time as part of the 2007 Middle Huron Partners Annual Report.

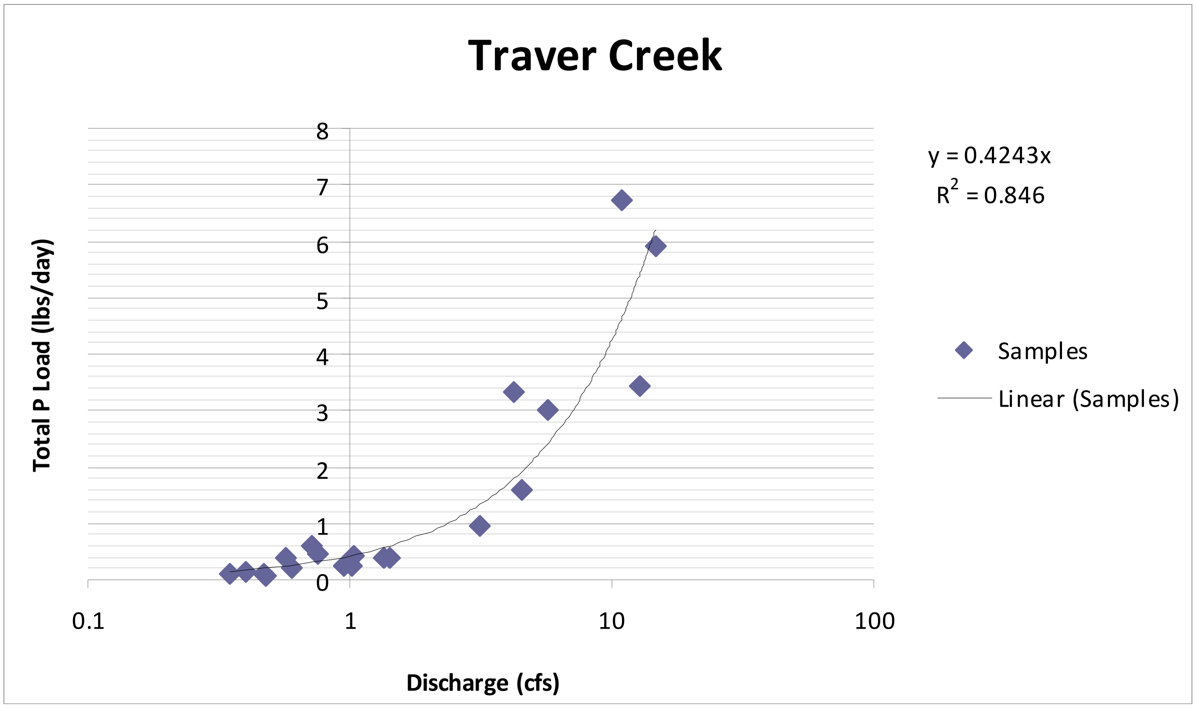


Figure 2.32. Instantaneous total phosphorus loading calculations by measured discharge for monthly measures May-September 2003-2006, and storm samples July-September, 2007 at the Traver Creek site at the Neilson Court crossing.

The MDEQ collected *E. coli* data in 2001 and 2002 for Geddes Pond and its tributaries in support of the development of the Geddes Pond *E. coli* TMDL. Water quality standards of 130 *E. coli* per 100 mL in Traver Creek were exceeded in 2001 and remained elevated in 2002. Some of the highest concentrations were found at the mouth of the tributary. [99]

The Adopt-A-Stream Program at the Huron Watershed Council uses a stream water conductivity threshold of 800 µS as an indicator of possible water pollution, above which water quality degradation may be occurring. Traver Creek is monitored at two sites, by the Adopt-A-Stream program. The average conductivity at these sites is 1032 µS at Broadway Road and 798 µS upstream at Dhu Varren Road. This suggests that ion (i.e. salt) loading may be occurring as the creek flows into Ann Arbor.

Freshwater Biological Communities

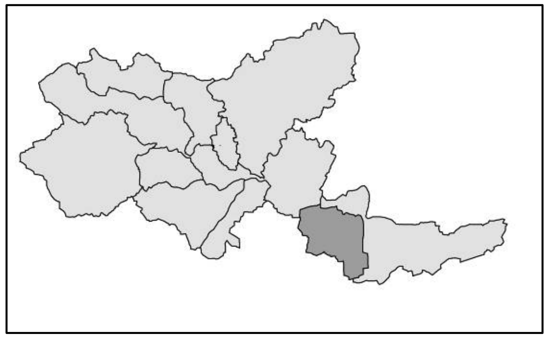
Traver Creek is monitored at Broadway and Dhu Varren Road by the Adopt-A-Stream program. The ecological condition of the sites over the past five years (2001-2005), as determined by a combination of biological and physical data, has been rated as poor and fair respectively. The aquatic invertebrate communities at the sites have been stable over the past five years (2001-2005). During the Fall 2005 search, only four different insect families were found at the Broadway site of which two were mayflies, stoneflies, or caddisflies compared to eleven insect families found at the Dhu Varren site, of which four were mayflies, stoneflies, or caddisflies. Winter stoneflies were found at these sites when they were searched during the winters of 2002-2006 with the exception of the Broadway site in 2006. [100]

Table 2.12. Ecological Conditions and Aquatic Insect Families at HRWC Adopt-A-Stream Program Monitoring Sites in the Traver Creekshed[101]

Study Site	Ecological Conditions*	Population Diversity	Avg. Insect Families	Avg. EPT Families	Avg. Sensitive Families	Winter Stonefly
Broadway	Poor	Stable	4	2	0	Present 2 years
Dhu Varren Rd	Fair	Stable	11	4	0	Present 4 years

** categories: excellent, good, fair, and poor*

2.4.10 Ford Lake

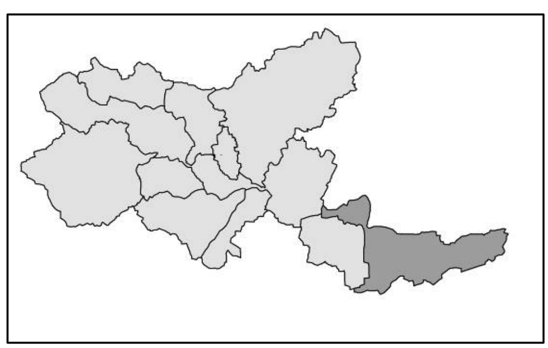


The MDEQ has collected annual water quality data at monthly intervals at four stations in Ford Lake to determine the progress toward meeting the phosphorus goal established for the Ford and Bellville Lakes TMDL. Total phosphorus concentrations cannot exceed 50 µg/L in the Huron River, immediately upstream of Ford Lake, in order to meet the goal of 30 µg/L for total phosphorus in Bellville Lake. Data was collected from April to September during the years 1994-1999, 2001-2003, and 2004. The most recent monitoring data collected during the 2004 season indicates that the average total phosphorus concentrations found in Ford Lake ranged from 40 to 61 µg/L. Comparison of historical data to current data for Ford Lake shows no clear trends in average total phosphorus concentrations.

The MDEQ also measured secchi depths in Ford Lake over the same monitoring seasons. These measurements showed the largest changes in apparent water quality from 1994 to 2001. However, water quality conditions did not continue to improve after 2002. Thermocline data for 2004 showed tremendous variability in the timing and degree of thermal stratification in Ford Lake when compared to historical data. Overall water quality indicators for Ford Lake demonstrate that this lake is a eutrophic impoundment. [102, 103, 104, 105, 106, 107]

The DNR conducted a study on the fish population of Ford Lake in 1998 to gauge the levels of white perch inhabiting the lake, fearing they may become nuisance. Besides the white perch, Ford Lake has not seen any gains or loses in fish species over the last twenty-two years. Fish species found through electrofishing were “carp, gar, log perch, pumpkinseed sunfish, bluegill, yellow perch, green sunfish, largemouth bass, smallmouth bass and walleye.” White perch were not found at high enough levels to classify them as “nuisance.” [108]

2.4.11 Belleville Lake



The MDEQ has collected annual water quality data at monthly intervals at four stations in Belleville Lake to determine the progress toward meeting the phosphorus goal established for the Ford and Bellville Lakes TMDL. Total phosphorus concentrations cannot exceed the target of 30 µg/L in Bellville Lake. Data was collected from April to September during the years 1994-1999, and 2001-2006. The most recent monitoring data collected during the 2004 season indicates that the average total phosphorus concentrations found in Belleville Lake all exceeded the 30 µg/L threshold and ranged from 31 to 67 µg/L. Comparison of historical data to current data for Belleville Lake shows no clear trends in average total phosphorus concentrations.

The MDEQ also measured secchi depths in Belleville Lake over the same monitoring seasons. These measurements showed the largest changes in apparent water quality from 1994 to 2001. However, water quality conditions did not continue to improve after 2001. Thermocline data for 2004 showed tremendous variability in the timing and degree of thermal stratification in Ford Lake when compared to historical data. Overall water quality indicators for Ford Lake demonstrate that this lake is a eutrophic impoundment. [109, 110, 111, 112, 113, 114]

In 1994, a collaboration between multiple shareholders in federal, state and local government; business; and academia came together to create a plan to clean-up the Willow Run Creek Site to avert designation as a US EPA "Superfund" site for hazardous waste. The site had been used as a dumping ground for manufacturing since 1941 with most hazardous waste poured into the Willow Run Sludge Lagoon, Tyler Pond and Edison Pond. The Creek Site was remedied over the course of four years by treating and confining the dried, hazardous sediments to a landfill site according to MDEQ requirements. In the future, the partnership plans to clean up nearby wetlands affected by the Lagoon and two ponds, mitigate the lost wetlands and institute a long-term monitoring plan for erosion and surface and groundwater[115].

2.5 CRITICAL AREAS

In order to establish an effective plan for addressing the key threats and impairments in the watershed, it is helpful to determine which areas in the Middle Huron Watershed are contributing the most to its impairment. Accordingly, this plan's is role is to identify these "Critical Areas" and provide direction for further, more specific analysis. Additional subwatershed or creekshed plans have been—and will continue to be—developed to identify more specific critical area targets for addressing key pollutants.

The first step in identifying critical areas is to examine the TMDL coverage of impaired waters. Figure 2.33 indicates the impaired waters in the Middle Huron Watershed that are listed for current or future TMDL development. These areas require specific analysis and treatment activities to address the listed impairments. Specific loading calculations for these areas are discussed in Section 2.5.1.

In addition to these specific impairments, general measures of potential impairment were also considered. Based on the most recent (2000) land use data developed by the Southeast Michigan Council of Governments (SEMCOG) and imperviousness statistics developed by the Rouge River Wet Weather Demonstration Project,[116] watershed imperviousness maps and statistics were calculated. The amount of imperviousness in a watershed is a strong indicator of likely impacts to hydrology and water chemistry including higher nutrient and sediment values. Figure 2.34 displays imperviousness across the watershed according to key breakpoints that are indicative of impairment. Generally, research indicates that once the impervious cover in a watershed exceeds 10%, surface waters begin to show signs of impairment. Imperious cover over 25% generally results in significant impairment, and watersheds with over 50% impervious cover required extensive and expensive management actions to maintain even modest water and habitat quality.

Figure 2.35 shows the impervious cover by creekshed. From this graphic, it is apparent that Allens, Millers and Malletts Creeksheds, along with the drainages to both Ford and Belleville Lakes, are challenged by high amounts of imperious cover. These are the most urbanized creeksheds in the Middle Huron Watershed. The only creekshed with less than 10% impervious cover is the Boyden Creekshed, thus the entire watershed is challenged from this perspective. This conclusion is even more apparent when one analyzes future projections. Using master planning documents from municipalities in the watershed, a future land use map was projected, assuming that each municipality is built-out according to its master plan (see figure 2.13). With this method, imperviousness was assumed to be consistent with current land use based on zoning classifications. The build-out scenario is not much different than the current estimates, except that Boyden Creek would move to over 10% imperviousness, and Swift Run would become more than 50% impervious (see figure 2.36).

One other way to look at this issue is to examine the impact within a riparian buffer zone on either side of the river and tributary creeks. Protection of the riparian buffer zone by maintaining it as natural area as much as possible has been shown to provide increased pollutant removal capacity and flow attenuation. Analysis of a 300-foot buffer of surface waters in the Middle Huron Watershed shows a mix of land uses (see figure 2.37). However, several creeksheds show a high percentage of undisturbed lands within the buffer zone (see figure 2.38). This may mitigate the impact of impervious development in these creeksheds somewhat. Other creeksheds such as Boyden, Traver and Honey could be targets for better riparian buffer protection and restoration.

Taken together, the main conclusion of the critical area analysis is that the entire watershed is impacted to some degree, with most of the creeksheds being highly impacted by impervious area. The results from monitoring efforts confirm that impairments are occurring, and that they are likely caused by the high rates of impervious area in each creekshed. These areas, which will require the development of TMDL plans, are the critical areas for initial focus. Addressing the impairments in these areas will take many years and millions of dollars. The activities to address these impacts will also likely have complementary benefits (beyond meeting TMDL targets) to the watershed by addressing other impairments in the watershed. Beyond these critical areas, implementation activities should focus on restoring and protecting riparian buffers throughout the watershed and managing development in the region to minimize the impact of stormwater runoff from newly developed areas.

Middle Huron Watershed Impaired Waters

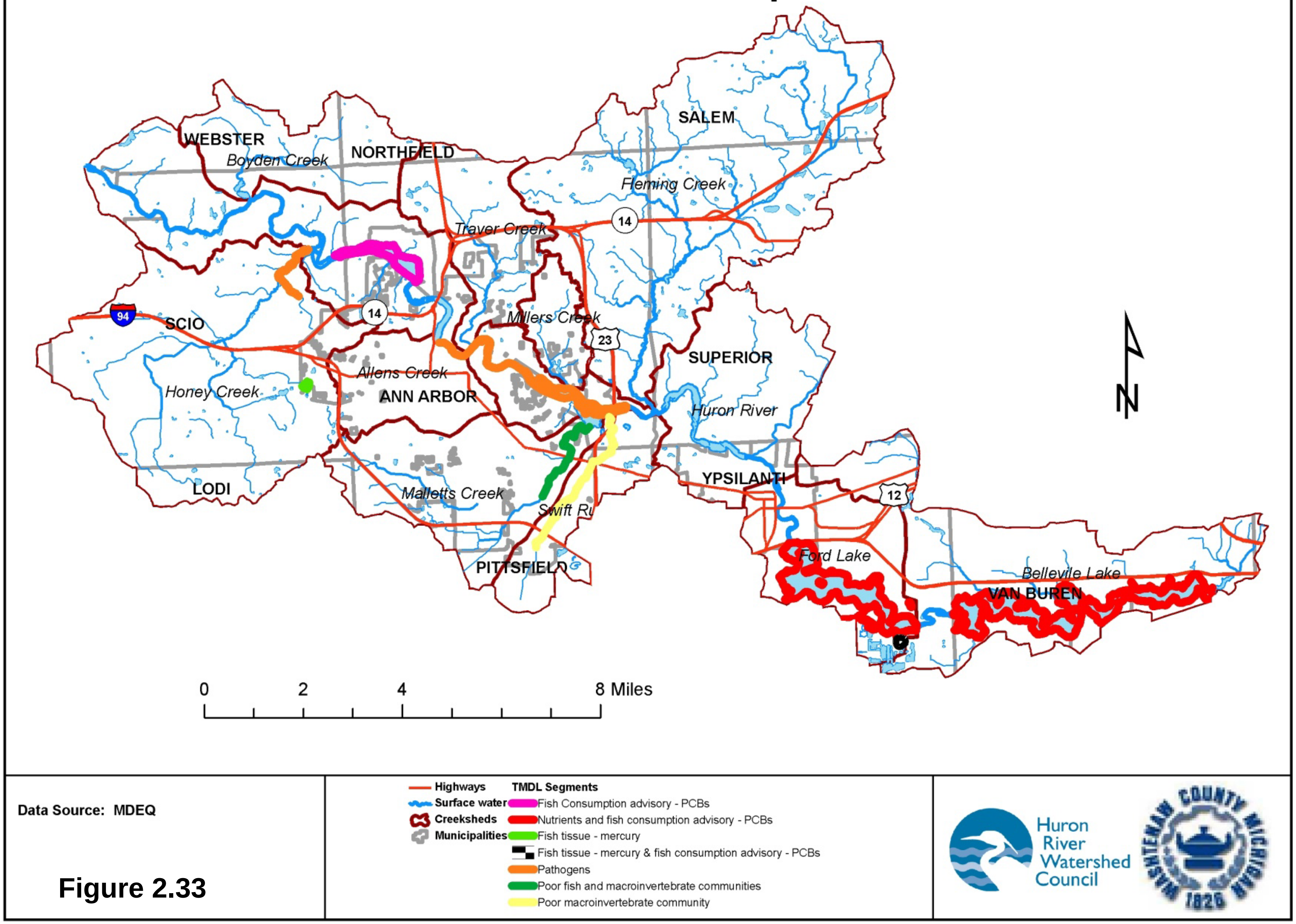
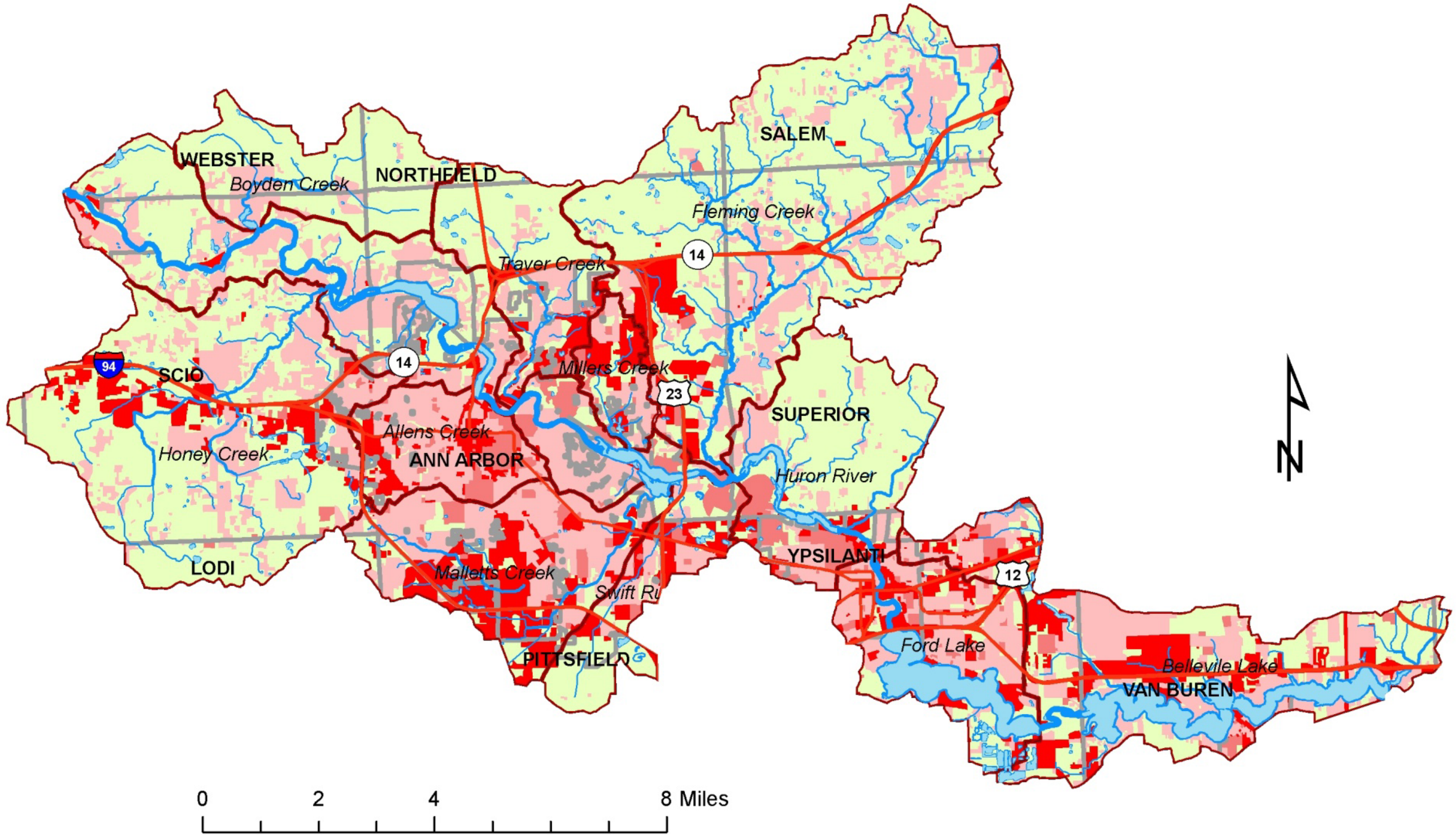


Figure 2.33

Middle Huron Watershed 2000 Impervious Surface



Data Source: SEMCOG, 2000
& Rouge River Wet Weather
Demonstration Project

Figure 2.34

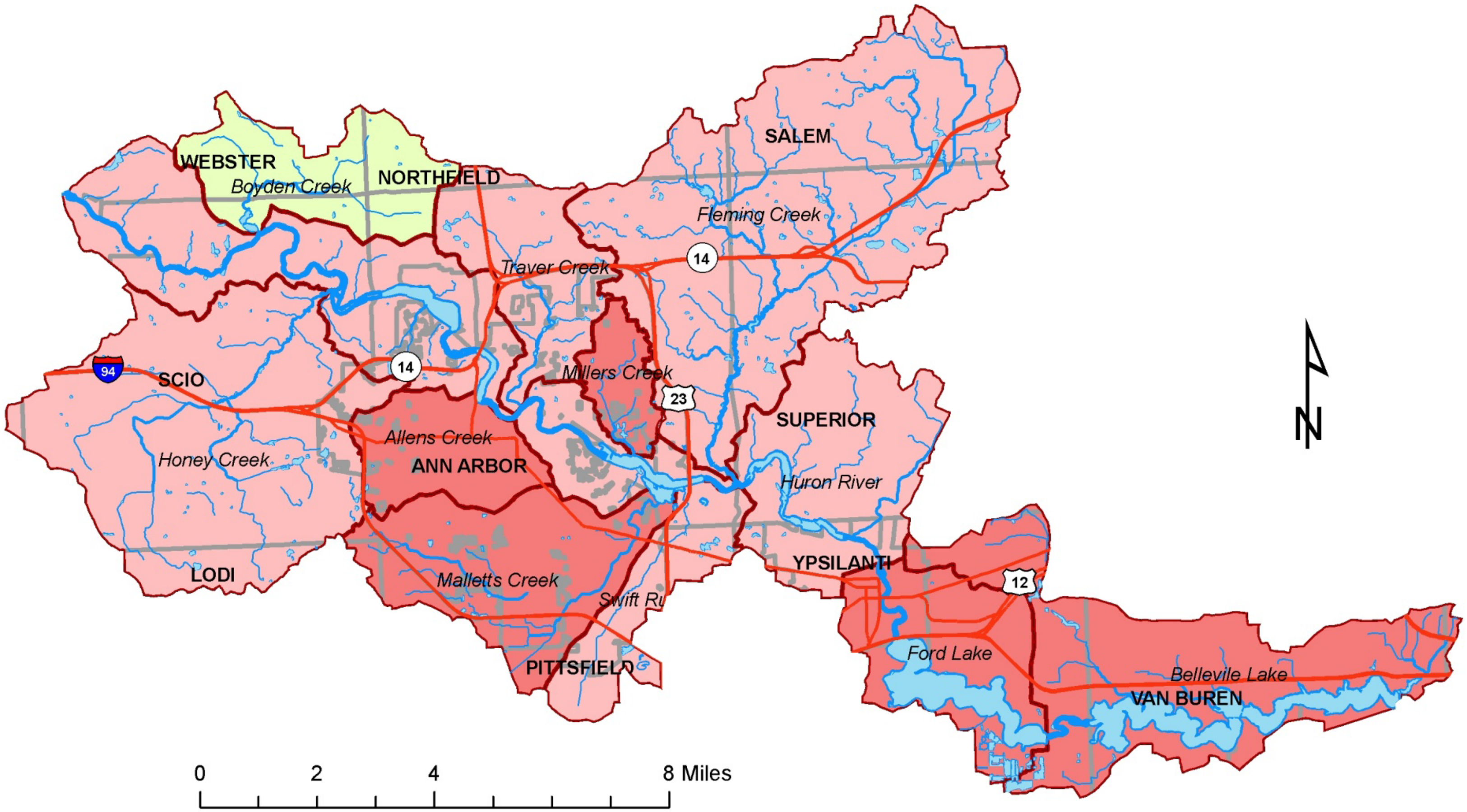
Highways
Surface water
Creeksheds
Municipalities

Impervious cover%
Under 10%
10 - 25%
25 - 50%
Over 50%

Huron River Watershed Council

WASHTENAW COUNTY MICHIGAN 1826

Middle Huron Watershed 2000 Impervious Surface Average per Sub-basin



Data Source: SEMCOG, 2000 & Rouge River Wet Weather Demonstration Project

Figure 2.35

Highways
Surface water
Creeksheds
Municipalities

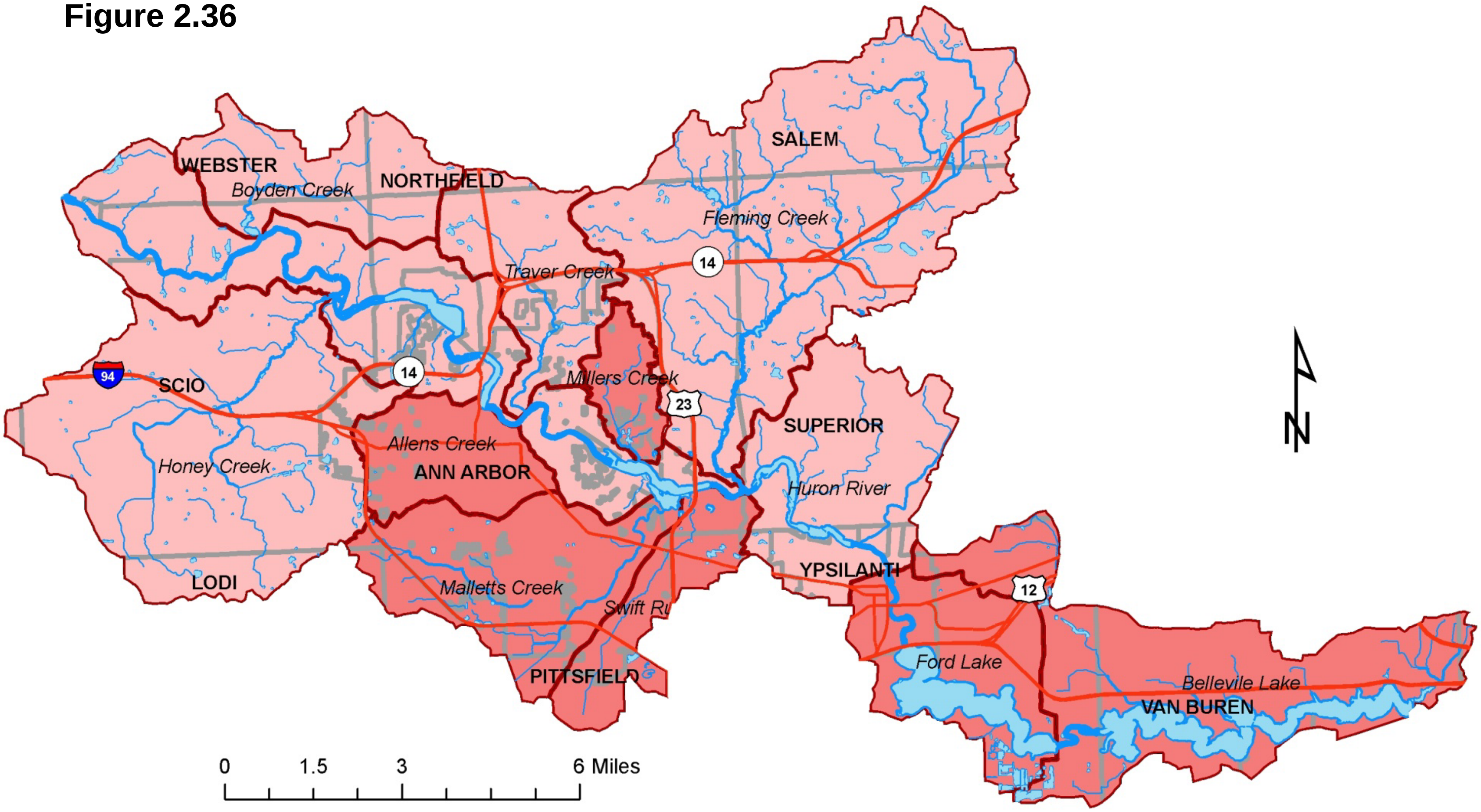
Creekshed Imperviousness
Under 10%
10 - 25%
25 - 50%
Over 50%

Huron River Watershed Council

Washtenaw County Michigan 1826

Middle Huron Watershed Future Impervious Cover

Figure 2.36



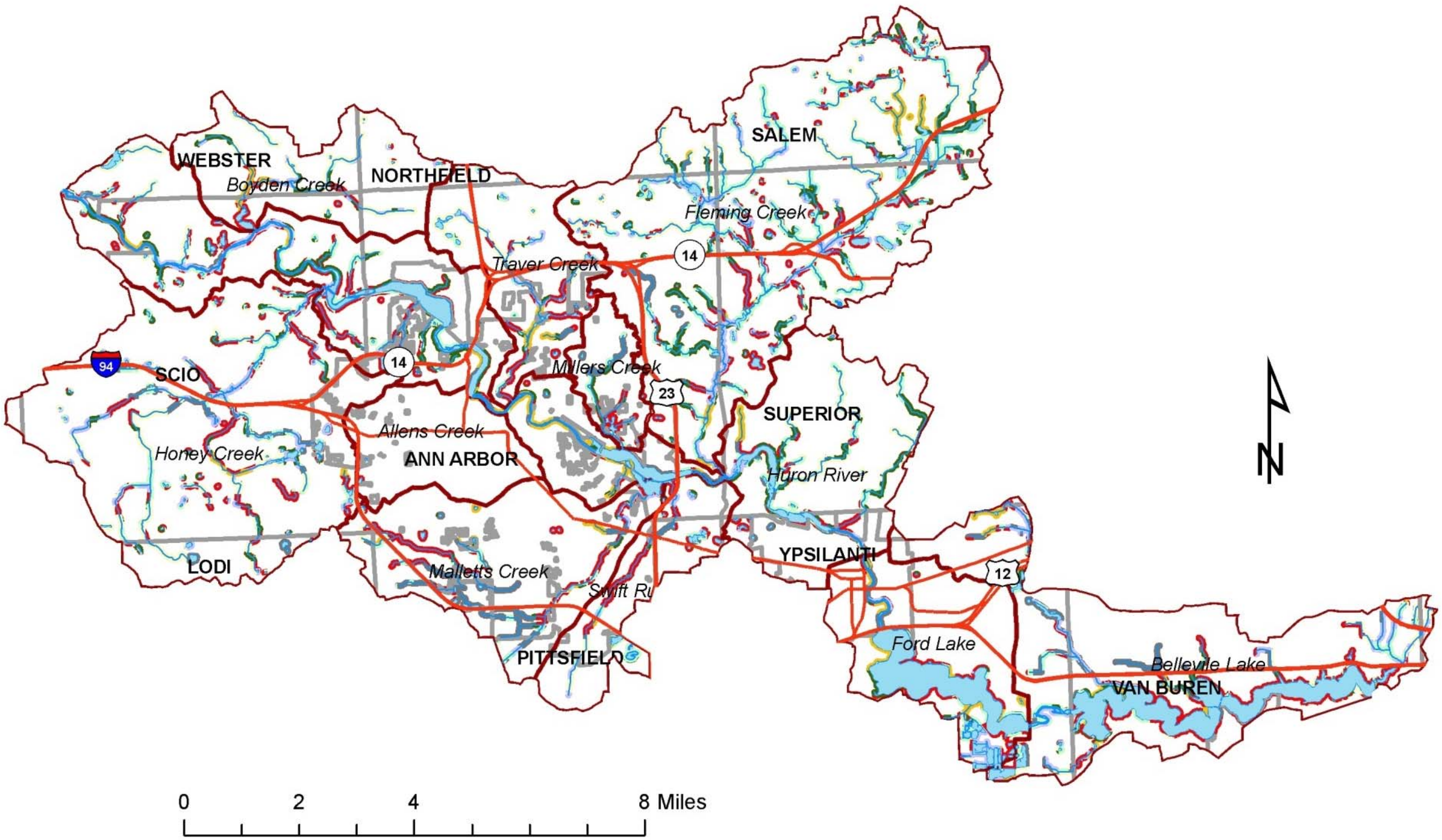
Data Source: Existing SEMCOG, 2000 land uses were overlayed onto SEMCOG's 2001 master plan composite map, then associated with impervious cover percentages from Rouge Wet Weather Demonstration Project

Highways	Under 10%
Surface water	10 - 25%
Creeksheds	25 - 50%
Municipalities	Over 50%

Huron River Watershed Council

WASHTENAW COUNTY MICHIGAN 1826

Middle Huron Watershed Land Use within 300 Foot Buffer



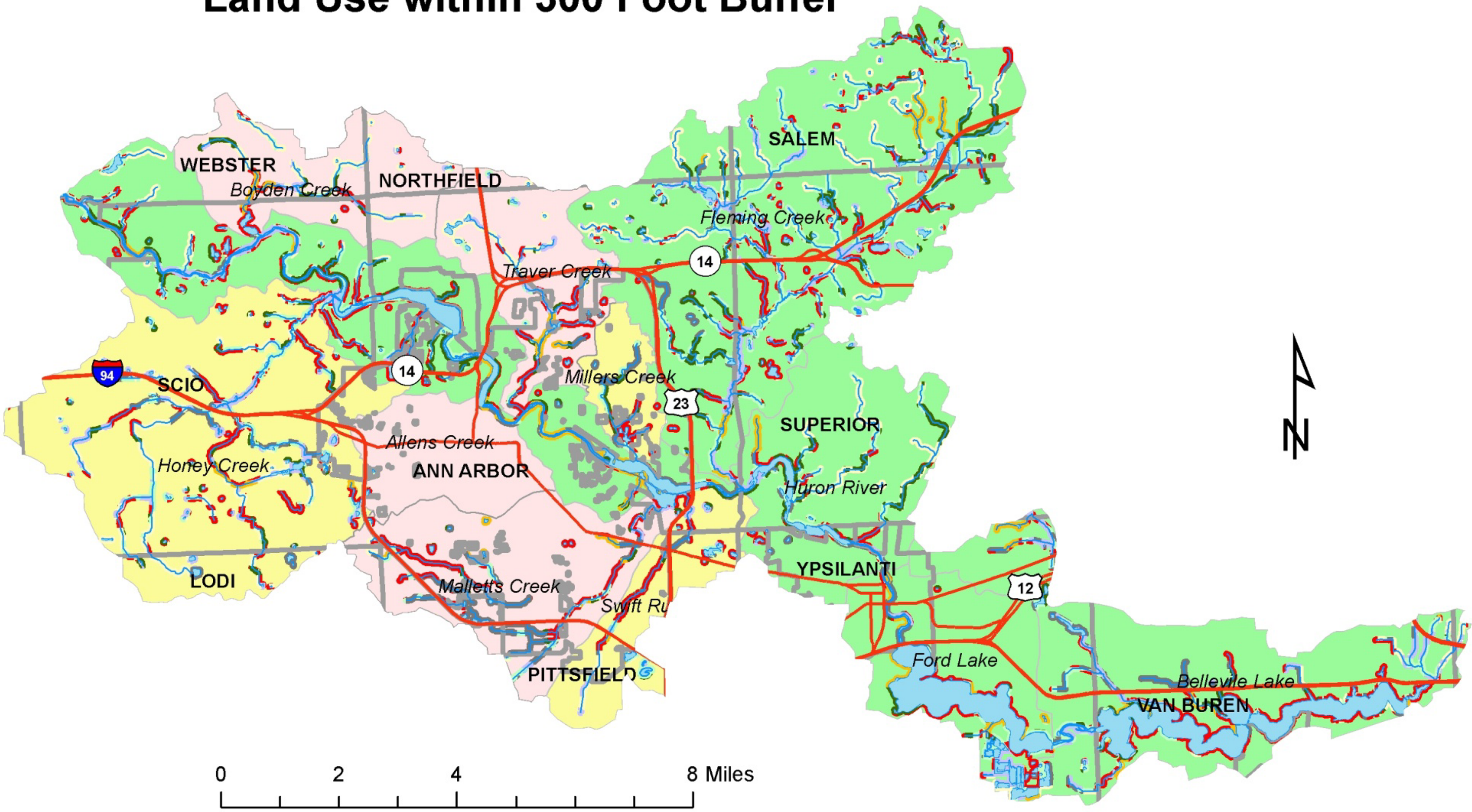
Data Source: SEMCOG Land Use, 2000

Figure 2.37

Highways	**Land Use**	Grass/shrub
Surface water	Residential	Woodland
Creeksheds	Commercial/industrial	Water
Municipalities	Public	Wetlands
	Agriculture	

Huron River Watershed Council

Middle Huron Watershed Percent Undisturbed Land Use within 300 Foot Buffer



Data Source: SEMCOG Land Use, 2000

Figure 2.38

- Highways
- Surface water
- Municipalities

Land Use
- Residential
- Commercial/industrial
- Public
- Agriculture
- Grass/shrub
- Woodland
- Water
- Wetlands

Creeksheds
% of buffer undisturbed
- Under 30%
- 30 - 43%
- 43 - 64%

Huron River Watershed Council

WASHTENAW COUNTY MICHIGAN 1826

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2.5.1 Loadings of Pollutants to Impaired Waters

Phosphorus Total Maximum Daily Load for Middle Huron TMDL

In December of 1993, a 12-month phosphorus loading analysis was initiated by the MDEQ to investigate the water quality of the Middle Huron. The analysis showed that Ford and Belleville lakes were impaired as they failed to meet water quality standards due to phosphorus enrichment, which contributed to nuisance algae blooms. Based on water quality sampling and accepted mathematical models, a phosphorus TMDL of 50 µg/L at Michigan Avenue and 30 µg/L in Belleville Lake was established for the months of April to September. This TMDL was originally approved by the U.S. EPA in 2000 and the most recent version was published by MDEQ in September 2004 (see Appendix A).

According to MDEQ, the TMDL should assure the attainment of water quality standards for Belleville Lake, and significantly reduce problems in Ford Lake, in addition to meeting the requirements of Water Quality Standard R 323.1060(2) which states “nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi, or bacteria which are or may become injurious to the designated uses of the waters of the state.”

Based on three years of scheduled monitoring and the employment of the Walker methodology of lake trophic assessment, the TMDL estimated that the annual total phosphorus load was 80,000 lbs/year. Approximately half of this load was derived from point sources, and half was from nonpoint sources. The Mill Creek Subwatershed, the only subwatershed not covered by this plan, was estimated from water quality monitoring to be contributing nearly one-fourth of the total phosphorus. The Mill Creek Subwatershed Management Plan[117] estimates the phosphorus loading from Mill Creek to be 12,000 to 15,000 lbs/year, and 15,000 lbs/yr enter the system from sources upstream of Mill Creek. The remaining 50,000 to 53,000 lbs/year are contributed by Middle Huron Watershed as defined in this plan (downstream of the Mill Creek outflow). To reach the TMDL goal will require a reduction in current phosphorus loads by 50 percent, which is approximately 25,000-26,500 lbs/year.

Recent and current phosphorus contributions from the major point sources in the Middle Huron Watershed (including Mill Creek) are determined from self-reporting to the MDEQ, and shown in tables 2.13 and 2.15. Altogether, the four major point source facilities contribute approximately 16,800 pounds per year of total phosphorus to the Middle Huron system. The loading from these facilities is down 29% from 23,800 pounds per year in 2003 (the last time a full estimate was made) and down 41% from the original loading calculations in 1996. The Ann Arbor Waste Water Treatment Plant is by far the largest contributor to the system, making up 96% of the total point source load.

Table 2.13. Current Total Phosphorus Loads from Major NPDES Facilities in the Middle Huron Watershed (source: Reports from the facilities)

*Based on most recent annual reporting**	**Avg Daily Flow (mgd)**	**Avg Concentration (mg/L)**	**Avg Daily Loading (lb/day)**	**Annual Load (lb/yr)**
Chelsea WWTP	0.85	0.13	0.83	297.77
Dexter WWTP	0.33	0.26	0.70	255.79
Loch Alpine SA	0.16	0.23	0.31	112.70
Ann Arbor WWTP	18.92	0.28	44.25	16,147.08
Total	**20.26**		**46.09**	**16,813.34**

* September 2006 through August 2007.

The total allocated pounds per day for the major point sources in the Middle Huron Watershed ranges from 166 lb/day in April to 55 lb/day in July and August. The larger permitted allocation in April is to account for the higher spring discharge. As shown in table 2.14, the majority of the waste load allocation is assigned to the Ann Arbor WWTP. The original allocation included the contributions from the DaimlerChysler proving grounds in Chelsea. As of 2004, that facility no longer contributed effluent containing phosphorus to the watershed. The company opted to connect to Sylvan Township's new pipeline that removes the effluent from the Proving Grounds and transports it to a treatment facility west of the Washtenaw County line in Jackson County's Leoni Township, and out of the Huron River Watershed. Therefore, the Chelsea Proving Grounds no longer holds a NPDES permit from MDEQ to send effluent to Letts Creek. The 210 lbs/yr of Total Phosphorus that the company previously contributed has been removed (whether temporarily or permanently is not clear) from the watershed as a result.

Table 2.14. Total Phosphorus Wasteload Allocation (WLA) (lb/day) for Middle Huron TMDL
(source: Kosek,1996)

	Apr	May	Jun	Jul	Aug	Sep
Ann Arbor WWTP	150	60	60	50	50	60
Chelsea WWTP	9.5	2.2	2.2	1.8	1.8	2.2
*DaimlerChrysler-Chelsea**	*0.5*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*
Dexter WWTP	3.0	0.9	0.9	0.8	0.8	0.9
Loch Alpine SA	1.5	0.6	0.6	0.5	0.5	0.6
Other Point Sources	1.5	1.7	1.7	1.7	1.7	1.7
Total Point Source WLA	166	66	66	55	55	66

* DaimlerChrysler-Chelsea is no longer a point source to the Huron River.

Based on water quality monitoring data of discharges from 2003 to 2007, average monthly phosphorus discharges from the major point sources in the Middle Huron ranged from 45 lbs/day in April to 72 lbs/day in September. This data indicates that, over the five-year timespan, on average, the point sources have stayed under their allocations as a group every month except September. Dexter WWTP is also over their allocation for the month of May. While the number and degree of exceedances since 1995 have decreased, the Ann Arbor and Dexter waste water treatment plants continue to experience exceedences of their WLA defined in the TMDL.

Table 2.15. Average Monthly Wasteload from Subwatershed Point Sources (lb/day) from 2003-07 (source: MDEQ, from reports from the facilities)

	Apr	May	Jun	Jul	Aug	Sep
Chelsea WWTP	0.7	0.9	0.7	1.0	0.8	0.7
Dexter WWTP	0.9	1.1	0.7	0.6	0.7	0.8
Loch Alpine SA	0.4	0.5	0.4	0.3	0.3	0.5
Ann Arbor WWTP	43.0	47.7	43.6	45.3	47.9	70.2
Average Point Source WLA	**45.0**	**50.2**	**45.4**	**47.2**	**49.7**	**72.2**

The major point sources are all operating under permits that were revised in December 2006 following a negotiated settlement between the point sources and the State of Michigan (see Appendix B). Under this agreement, the permit limits were adjusted slightly from 1993 levels, but not as far as TMDL limits. It is further stated that the permit levels will be set to TMDL levels in 2012. If the facilities increased the concentration level of phosphorus in their effluent to the current permit limits, then their annual load would jump to over 59,000 pounds per year of total phosphorus (see Table 2.16).

Table 2.16. Potential Total Phosphorus Loads from Major NPDES Facilities in the Mill Creek Subwatershed Operating at Current Permit Limits (source: MDEQ)

	Avg Daily Flow (mgd)	Max. Avg. Concentration (mg/L)	Avg Daily Load (lb/day)	Annual Load (lb/yr)
Chelsea WWTP	1.3	0.8	9.8	3577.0
Dexter WWTP	0.58	0.6	2.9	1058.5
Loch Alpine SA	0.31	0.8	2.1	766.5
Ann Arbor WWTP	29.5	1.0	147.6	53,880.6
Total	**31.7**		**162.4**	**59,282.6**

The total load allocation among the nonpoint sources and point sources in shown in table 2.17. In all months except May, the load allocated to the point sources exceeds that of the nonpoint sources. If the reductions are met, then the load allocation for April through July provides a buffer of 4 to 48 pounds of total phosphorus, while the allocation would just meet the TMDL in August and September.

Table 2.17. Total Phosphorus Load Allocation (LA) (lb/day) and TMDL for Middle Huron (Source: Kosek, 1996)

	Apr	May	Jun	Jul	Aug	Sep
Nonpoint Source LA	91	100	61	29	19	37
Point Source WLA	166	66	66	55	55	66
LA + WLA	257	166	127	84	74	103
TMDL	304	214	139	88	74	103
Remaining	**47**	**48**	**12**	**4**	**0**	**0**

Assuming that the Mill Creek sources will be addressed by the activities outlined in the Mill Creek Subwatershed Management Plan, there remains a phosphorus load of 50,000 to 53,000 lbs/yr coming from the Ann Arbor-Ypsilanti Metropolitan Area covered by this plan.Extrapolating these figures into seasonal loads suggests that the maximum load should reach 28,036 lbs April through September to be compliant with the TMDL. The TMDL assumes that about half (39,574 lbs) of the total modeled load comes during this growing season. This requires a total load reduction of 11,538 lbs. Of the total load, 24,293 lbs (61%) were estimated to be coming from nonpoint sources, with the remainder (15,561 lbs) from point sources. Again extrapolating from load allocations, the load reduction required of nonpoint sources is 14,035 lbs over the April to September growing season, while point sources are required to reduce by 1,165 lbs.

Based on reporting from 2003-07 (Table 2.15), point sources have reduced loading to 34% below waste load allocations to 9,438 lbs, though some monthly violations still occur. This represents a load reduction of 6,123 lbs from 1996 levels. While the nonpoint source load reduction target will remain 14,035 lbs for the purposes of this plan, the point source reduction represents a solid buffer for any load reduction shortfalls. Monthly point source load limit violations will need to be eliminated, and nonpoint source load reductions also must be accounted for to reach the TMDL for phosphorus in the watershed. See section 3.5.3.1 for a summary of specific nonpoint source load reduction practices and targets.

Modeling data from the TMDL development also makes suggestions about annual loading. For 2003, the point source phosphorus load was reported as 23,800 lbs/yr. Loading from tributaries estimated by the 1996 model used for TMDL development indicates 22,000 lbs/yr was being contributed by nonpoint sources (see Table 2.18). As indicated previously, the most recent reporting indicates an annual load of 16,813 lbs/yr by point sources – a 53% reduction from 1996 levels.

Table 2.18. Total Phosphorus Loading from Tributary Sources (Source: Kosek, 1996)

Significant Sources	Load from '96 Sampling	Load from '96 Model	Percent of Total	Percent Difference
Upstream Sources	30,000	30,000	37.5%	
Boyden Creek		961	1.2%	
Honey Creek		1,039	1.3%	
Other sources (upper section)	2,000		0.0%	
HBP Subtotal	32,000	32,000	40.0%	
Allens Creek	1,000	1,813	2.3%	81%
Traver Creek		1,855	2.3%	
Malletts Creek	700	3,945	4.9%	464%
Miller Creek		1,957	2.4%	
Swift Run	300	1,210	1.5%	303%
Other sources (middle section)	9,700	920	1.2%	-91%
Dixboro Road Subtotal	43,700	43,700	54.6%	
Ann Arbor WWTP	28,000	28,000	35.0%	0%
Fleming Creek	1,300	1,300	1.6%	0%
Superior Drain			0.0%	
Other sources (lower section)	7,000	7,000	8.8%	0%
Michigan Avenue Total	80,000	80,000	100.0%	

Dr. John Lehman with the University of Michigan also studied phosphorus loading through the river system in a mass balance study between 2003 and 2005 (see section 2.4.1.) By comparison, his team found the following results:

1. From June 2003 to December 2004, 33427 kilograms (KG) of total phosphorus (TP) entered Ford Lake. During the same time period, AAWWTP reports discharging 12427 KG TP to the Huron River (37%).
2. Of the 12427 KG P that AAWWTP discharged to the Huron River, only 8854 KG (71%) emerged from Superior Pond. This represents 26% of the load to Ford Lake.
3. More TP entered Ford Lake during May 2004 as a result of the 22 May flood than had been discharged by AAWWTP in the previous year.
4. From June 2003 to March 2005, 4279 KG of dissolved P (DP) was discharged from Barton Pond into the Huron River above Ann Arbor. During the same time, 12205 KG

DP was present below Geddes Pond and upstream of the AAWWTP outfall. This represents an increase of 7926 KG added within Ann Arbor above its WWTP.

5. Also from June 2003 to March 2005, 22804 KG DP exited Superior Dam, an increase of 10599 KG from upstream of the WWTP (N.B. This is less than the reported discharge by AAWWTP owing to retention within Superior Pond).
6. 23002 KG DP entered Ford Lake, an increase of 198 KG from Superior Rd to Spring St.
7. For Particulate P (PP; DP + PP = TP), 16771 KG discharged from Barton Pond; 12043 KG discharged from Geddes Pond. This is a net loss of 4728 KG PP removed by Argo and Geddes Ponds. The balance between PP retention and DP release resulted in the net addition of 3198 KG P to the River within Ann Arbor.
8. From June 2003 to March 2005, 16190 KG discharged from Superior Dam. This is an increase of 4147 KG compared to upstream of the AAWWTP. The N/P ratio of this added particulate matter is too low for it to be biological matter. It is almost surely eroded soil. 18349 KG PP entered Ford Lake. This is an increase of 2159 KG. The N/P ratio of this particulate matter is too low for it to be biological matter. It is soil, too.
9. 41351 KG TP entered Ford Lake and 32445 KG exited. This was a removal of 8906 KG or a retention of 21.5%. The proportioning between dissolved and particulates was such that 19.3% of DP and 24.3% of PP were retained. [118]

An updated analysis of phosphorus loading to Ford and Belleville Lakes can be reviewed in Appendix C.

E. coli TMDL for Geddes Pond

In August 2001, a TMDL for *E. coli* was established for the Huron River downstream of Argo Dam to Geddes Dam (see Appendix A). To remove the reach from the impaired waters list, it will need to meet the water quality standard for pathogens. For the TMDL, the standard organism count of 130 per 100 milliliters (ml) as a 30-day geometric mean between May 1 to October 31 was used. Following the establishment of the TMDL, an implementation plan was compiled by affected stakeholders. It was revised in 2011. Refer to Appendix D for details.

Data on counts for *E. coli* and fecal coliform bacteria vary widely throughout this reach and the contributing tributaries. Historical data indicate that Lower Geddes Pond has consistently exhibited the highest bacteria concentrations among all Huron River reaches in the Ann Arbor area. Additional sampling conducted in 2001 by the DEQ corresponds with the findings of the historical data and indicates that the listed reach and its tributaries continue to exceed the WQS for *E. coli*.

The results of 2002 sampling for the implementation plan indicated that Geddes Pond exceeded the 30-day geometric mean for full body activities during the second half of July and all of August. There was one additional sampling event that exceeded the full body activity daily maximum standard (300 *E. coli* per 100 ml) in September. Each tributary sampled had elevated *E. coli*, and seemed to be influenced by wet weather events. Allens Creek typically had high *E. coli* concentrations and had visual evidence of illicit connections. Millers Creek, at the east and west branches at Plymouth Road, were typically higher than other locations. Sampling on Malletts Creek was started in July and showed high *E. coli* concentrations for the period sampled. Early season sampling on Swift Run Creek indicated elevated concentrations at various locations. However, the last four weeks of sampling were dry or stagnant. Traver Creek *E. coli* concentrations decreased later in the sampling season, but some of the highest concentrations overall were found at the creek mouth.

DNA sampling was also conducted during one sampling event on August 27, 2002, in the hopes of determining whether sources of *E. coli* were human or non-human. Unfortunately, the results were inconclusive.

Bacteria sources have been determined to consist of a range of wet and dry weather-driven sources. However, the primary loading of pathogens enters the Huron River directly through the tributaries and storm sewers within the listed reach. Potential pathogen sources for the listed waterbody include sources typically associated with urban and suburban runoff because the immediate watershed is primarily composed of these land types. Source evaluation indicates that bacteria loads from a large part of Ann Arbor enter Geddes Pond/Huron River via the storm water system. Bacteria loads are also delivered to Geddes Pond/Huron River by tributaries that drain a large portion of the Ann Arbor area. Other pathogen sources for Geddes Pond/Huron River likely include upstream inputs, illicit sewer connections, pet and wildlife feces, and a small number of malfunctioning septic systems. Agricultural land uses located in the upstream reaches of the Traver Creek watershed make livestock and horse feces other likely sources.

Since the bacteria standard is concentration based, the TMDL is also concentration, rather than mass loading based. Further, since low concentrations were detected to be coming from river sources, the focus was placed on tributary sources.

Based on this reasoning, and considering other relevant factors monthly average concentration maxima were established for each of the tributaries (see Table 2.19).

Table 2.19. Allowable *E. coli* Concentrations for the Subwatersheds of the Huron River.

Tributary	May	June	July	August	September	October
Monthly Average *E. coli* Concentration (per 100 ml)						
Allens Creek	300	300	300	300	300	300
Traver Creek	130	130	130	130	130	130
Millers Creek	130	130	130	130	130	130
Malletts Creek	130	130	130	130	130	130
Swift Run	130	130	130	130	130	130
Direct Drainage	300	300	300	300	300	300

Since a concentration standard is used, a total loading of bacteria from the creeks was not established for the TMDL. However, loading allocations were established for each creekshed based on these allowable concentrations and monthly stream flow averages. Based on this information, no fixed pathogen loading figures have been established, nor specific reduction targets. The Geddes E. coli Implementation Plan lays out a strategy to eliminate or reduce all major pathogen sources to meet the monthly average concentration goals.

Biota TMDL for Malletts Creek

The reach of Malletts Creek from its confluence with the Huron River at South Pond Park upstream to Packard Road has been listed as an impaired water due to poor fish and macroinvertebrate monitoring results (See Table 2.). The listed impairment is based on data collected by DEQ in August 1997. A TMDL was established to address this impairment in August 2004 (see Appendix A).

Data collected by DEQ in 2002 and 2003 at two sites in the Malletts Creekshed indicated that fish and macroinvertebrate populations were acceptable. Habitat assessments conducted during the same time rated the sites as "good." However, individual measures of flow and bank stability suggested unstable conditions. Also, HRWC data through 2005 for lower Malletts sites have consistently rated the sites as “poor.” For these reasons, the reach remains listed as impaired and the TMDL was established.

The primary sources of concern for poor fish and macroinvertebrate conditions are hydrologic alteration and excessive sedimentation due to urban and suburban development. Reductions in storm sewer runoff rates and solids loads from both commercial and municipal storm water runoff sites, along with reduced stream bank erosion through more stable flow management are necessary to reduce impacts on the aquatic life.

Biota impairments also do not lend themselves to direct loading calculations. Because of this fact, along with the concern about sediment dynamics in the system, the focus of loading calculations for the TMDL establishment was on total suspended solids (TSS). While the primary goal is to improve fish, macroinvertebrate, and habitat measures, TSS measurements will be used by DEQ to further assess improvements in Malletts Creek as a secondary goal. This secondary goal is represented by a mean annual, in-stream TSS concentration target of 80 mg/l to characterize wet weather runoff/washoff events. The mean annual target concentration of 80 mg/l TSS is based on a review of existing conditions and published literature on the effects of TSS by the DEQ. This secondary numeric target may be overridden by achievement of the biological and habitat numeric targets. However, if the TSS numeric target is achieved, but the biota or habitat numeric targets are not achieved, then the TSS target may have to be reevaluated.

This secondary goal has the added benefit of being consistent with goals to reduce phosphorus loading under the Ford and Belleville Lakes TMDL. According to the Malletts Creek Restoration Plan (see Appendix F), the plan targets a 50% reduction in total phosphorus, which is characterized as “…functionally equivalent to the mean TSS concentration of 80 mg/l.”

Table 2.20. Annual TSS loads based on NPDES permitted point sources and various land use categories in the Malletts Creek watershed. Estimated annual TSS loads and recommended TSS reductions (WLA and LA) are derived. *(Source: Malletts Creek TMDL, MDEQ)*

Source Category	Acres	Estimated Current TSS (Pounds/Year)	TMDL Target Load TSS (Pounds/Year)
WLA Components:			
NPDES Individual/General Permitted Point Source TSS Load:		127,396	127,396
NPDES Permitted Storm Water TSS Load:			
Residential	2422	496,343	
Industrial	535	202,971	
Commercial and Service	686	405,831	
Transportation/Comm/Util.	232	68,643	
Subtotal:		1,173,788	985,853 (16% reduction)
WLA Total:	3875	1,301,184	1,113,249
LA Components: **Agricultural Land**			
Cropland	787	53,822	29,695 (45% reduction)
(Background Sources)			

Forested/Shrub/Open Land			
Deciduous Forest	437	10,512	10,512
Openland/Shrub/Rangeland	1559	37,500	37,500
Conifer Forest	8	192	192
Wetland			
Forested	9	191	191
Water Body			
Lake/Reservoir	21	445	445
LA Subtotal:	2821	102,662	78,535
Overall Totals:	6696	1,403,846	1,191,784 (Total 15% reduction)

At the time of the TMDL development, the estimated total annual TSS load from all point sources, which includes NPDES permitted storm water discharge, was approximately 651 tons (1.3 million pounds). Additional non-point source discharge and background sources account for 51 tons, for an overall total load of 702 tons (1.4 million pounds). The TMDL target load of 596 tons of TSS will require a 15% overall reduction in loading (106 tons) – 16% reduction in storm water sources and 45% reduction in agricultural sources.

A TMDL Implementation Plan was developed by relevant Malletts Creek governing agencies. The plan was revised in 2011. See Appendix X for details.

Biota TMDL for Swift Run

The reach of Swift Run from its confluence with the Huron River at South Pond Park upstream to Ellsworth Road has been listed as an impaired water due to poor macroinvertebrate monitoring results (See Figure 2.31). The listed impairment is based on data collected by DEQ in August 1997. A TMDL was established to address this impairment in November 2004 (see Appendix A).

Data collected by DEQ in 1997 at Hogback Road rated the macroinvertebrate community as “poor.” Further sampling by DEQ in 2003 at Shetland Drive also rated macroinvertebrate communities as poor. Habitat assessments conducted during the same times rated the Hogback site as “fair” or moderately impaired, and the Shetland site as “good.” However, individual measures of flow and bank stability suggested unstable habitat conditions at both sites. Also, HRWC data through 2005 for lower Swift Run at Shetland have consistently rated the site as “poor.” For these reasons, the reach remains listed as impaired and the TMDL was established.

As with the TMDL for biota in Malletts Creek to the west, the primary sources of concern for poor macroinvertebrate conditions in Swift Run are hydrologic alteration and excessive sedimentation due to urban/comercialized development. Reductions in storm sewer runoff rates and solids loads from both commercial and municipal storm water runoff sites, along with reduced stream bank erosion through more stable flow management are necessary to reduce impacts on the aquatic life.

Biota impairments also do not lend themselves to direct loading calculations. Because of this fact, along with the concern about sediment dynamics in the system, the focus of loading calculations for the TMDL establishment was on total suspended solids (TSS). While the primary goal is to improve fish, macroinvertebrate, and habitat measures, TSS measurements will be used by DEQ to further assess improvements in Swift Run as a secondary goal. This secondary goal is represented by a mean annual, in-stream TSS concentration target of 80 mg/l to characterize wet weather runoff/washoff events. The mean annual target concentration of 80 mg/l TSS is based on a review of existing conditions and published literature on the effects of TSS by the DEQ. This secondary numeric target may be overridden by achievement of the biological and habitat numeric targets. However, if the TSS numeric target is achieved, but the biota or habitat numeric targets are not achieved, then the TSS target may have to be reevaluated.

This secondary goal has the added benefit of being consistent with goals to reduce phosphorus loading under the Ford and Belleville Lakes TMDL. According to the Malletts Creek Restoration Plan (see Appendix F), the plan targets a 50% reduction in total phosphorus, which is characterized as "…functionally equivalent to the mean TSS concentration of 80 mg/l."

Table 2.21. Land use categories and TSS loads in the Swift Run Creek watershed, Washtenaw County, Michigan (*Source: Swift Run TMDL, MDEQ; Scott Wade – LTI [2003a] using 2002 [Ann Arbor] and 1998 [Township] land use coverages*)

Source Category	Acres	Estimated Current TSS (Pounds/Year)	TMDL Target Load TSS (Pounds/Year)
<u>WLA Components</u>:			
NPDES Individual/General Permitted Point Source TSS Load:		None	None
NPDES Permitted Storm Water TSS Load:			
Residential	678	138,943	138,943
Industrial	13	9,861	5,295 (46% reduction)
Commercial and Service	627	185,514	185,514
Transportation/Comm/Util.	600	177,526	177,526
Subtotal:		511,844	507,278 (<1% reduction)
WLA Total:	1,918	511,844	507,278
<u>LA Components</u>:			
Agricultural Land			
Cropland	349	23,868	13,168 (45% reduction)
(Background Sources) **Forested/Shrub/Open Land**			
Openland/Shrub/Rangeland	702	16,886	16,886
Water Body			
Lake/Reservoir	9	191	191
LA Subtotal:	1,060	40,945	30,245
Overall Totals:	2,978	552,789	537,523 (Total 3% reduction)

At the time of the TMDL development, the estimated total annual TSS load from all point sources, which includes NPDES permitted storm water discharge, was approximately 256 tons (511,844 pounds). Additional non-point source discharge and background sources account for

20 tons, for an overall total load of 276 tons. The TMDL target load of 269 tons of TSS will require a 3% overall reduction in loading (<1% reduction in storm water sources and 45% reduction in agricultural sources), or a total load reduction of 7.6 tons per year. Section 3.5.2.3 describes the Swift Run Improvement Strategy to address this TMDL. A TMDL Implementation Plan was developed in 2011 to address biota and TSS impairments. See Appendix Y for details.

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CHAPTER 3:
ACTION PLAN FOR THE MIDDLE HURON WATERSHED

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

This chapter outlines designated and desired uses of surface waters in the Watershed, the threats (impairments) posed to them, and the sources and causes of those threats. A set of goals and objectives has been updated by the Advisory Committee to ensure that the designated and desired uses in the watershed will be met. Because surface water quality is ultimately a function of what water carries off of the land, much of the discussion will focus on how human activities impact the land and actions that can be taken to improve human land use from a water quality/quantity perspective. These recommended actions are described and summarized in the Action Plan (Table 3.6) at the end of this chapter.

3.1 DESIGNATED AND DESIRED USES

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

All surface waters of the state of Michigan are designated for and shall be protected for all of the following uses. [1] The designated uses that apply to the Middle Huron Watershed are in boldface:

- **Agriculture**
- **Industrial water supply**
- **Public water supply at the point of intake**
- Navigation
- **Warmwater fishery**
- **Other indigenous aquatic life and wildlife**

- **Partial body contact recreation**
- **Total body contact recreation between May 1 and October 31**
- Coldwater fishery

Due to human impacts and the impairments they cause throughout the Middle Huron Watershed, not all of the designated uses are fulfilled. The following is a summary of the major impairments to the watershed, which are discussed in more detail in Chapter 2:

The warmwater fishery is impaired due to elevated levels of PCBs in Barton Pond, Ford and Belleville Lakes, and an unnamed lake. The PCB levels also impair the public water supply intake in Barton Pond. High mercury levels in fish tissue samples from Second Sister Lake and the unnamed lake also impair the warmwater fishery. The fishery is also damaged by habitat impairments in Malletts Creek. Other indigenous aquatic life and wildlife is impaired in the watershed due to poor macroinvertebrate communities in portions of Swift Run and Malletts Creek. Partial or total body contact is impaired in the Huron River between the Argo and Geddes Dams, and in a section of Honey Creek due to periodic high pathogen counts, specifically *Eschrichia coli (E. coli)* bacteria. Aquatic life and warmwater fisheries may be threatened throughout the watershed as high nutrient loads have been cited within a phosphorus TMDL that has been established for the watershed draining to Ford and Belleville Lakes. High nutrient loads can lead to low dissolved oxygen levels and cause nuisance algal blooms in such lake environments.

In addition to state-designated uses, the residents of the watershed wish to use its surface waters in ways that are not yet achievable. The following desired uses have been identified by the communities in the watershed over the course of the development and updating of the WMP:

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

- **Hydrologic functions of natural features**
  Protect and enhance natural features related to water quantity and quality, including wetlands, floodplains, riparian buffer zones, and stream channels that regulate the flow of stormwater runoff, protect against flooding, and reduce soil erosion and sedimentation.

- **Open space, recreation and urban amenities**
  Protect priority natural habitat, recreational areas and trails, agricultural lands, and urban open spaces from development in order to maintain their natural functions, preserve rural character, and enhance recreational opportunities for present and future generations.

3.2 Impairments, Their Sources, and Their Causes

Various pollutants, or impairments, to the water quality of the Huron River and its tributaries are found throughout the Middle Huron Watershed, which present challenges to meeting the designated and desired uses. Analysis of existing data indicates that the Middle Huron Watershed has areas of medium-quality and low-quality waters that require mitigation of existing impairments. This section summarizes current impairments in the watershed and identifies the sources and causes of those impairments. The authors, with assistance from the Advisory Committee have compiled and updated the information necessary to identify and understand these impairments and their sources and causes, as well as to prioritize them from greatest to least threat. This prioritization of impairments is based upon the results of analysis of existing data, Advisory Committee member observations, and citizen input. Although the partners in this plan intend to address all of these challenges in the long term with targeted programs, it has been important to rank the most pressing concerns in the watershed so that resources can be spent cost-effectively in a phased approach. Table 3.1 presents this prioritized listing of impairments, sources, and causes in the Middle Huron Watershed.

The sources and causes of each impairment in Table 3.1 are presented in priority order, based on the availability of data indicating direct linkages and assessments of the degree of contribution to the chain from cause to impairment. Known causes (k) are listed before suspected causes (s). Known impairments, sources or causes are defined as those where there exists direct data (i.e. a study or observation) or information establishing a connection. Elements listed as suspected are those for which a connection is implied by land use analysis, anecdotal evidence or common sense. In cases where impairments, sources, or causes were suspected since not enough information was known about them, effort was made to gather additional information. Methods ranged from field work to desktop analyses using a geographic information system, to review of available literature and water quality studies. While much data was compiled to eliminate most suspected items in the table below, some items require further investigation to confirm their presence in the watershed and/or determine the extent to which they are hindering the designated uses in the watershed. As additional information is obtained that indicates that a lower ranked impairment, source or cause should be elevated in priority, the priority ranking should be adjusted to reflect the new information.

3.2.1 Excess Phosphorus

A certain amount of nutrients are found in water resources naturally. In excess, nutrients can cause aquatic systems, both flowing and impounded, to become out of balance favoring certain organisms over others and changing the function, use and look of creeks, ponds and the river. Phosphorus is the primary nutrient of concern in the Middle Huron Watershed because phosphorus is usually the limiting growth factor for algae and other nuisance plants in Michigan aquatic ecosystems. When excess phosphorus enters waterways from excess fertilizer or other sources, it encourages the accelerated growth of plants and algae, reducing the dissolved oxygen and light entering the water and creating an environment where it is difficult for most fish and aquatic insects to live. High nutrient concentrations interfere with recreation and aesthetic enjoyment of waterbodies by causing reduced water clarity, unpleasant swimming conditions, foul odors, blooms of toxic and nontoxic organisms, and interference with boating.


Excess phosphorus from nonpoint sources encourages algae blooms. Photo: HRWC

Due to the persistent and systemic presence of high concentrations of phosphorus in Ford and Belleville Lakes, as well as the Huron River and tributaries upstream in the watershed, high nutrient loading is the top challenge identified in this Plan. A TMDL for excessive phosphorus loading from point and nonpoint sources has been established for Ford and Belleville Lakes and their contributing waters. While the flowing Huron River and its tributaries do not generally show signs of excessive phosphorus concentrations, the impoundments along these waterways tend to act as sinks for phosphorus loading, which can lead to eutrophic conditions. Sources of phosphorus in the watershed include: fertilizers from lawns, golf courses, and croplands; failing septic systems; sediment and eroded soils; pet/wildlife wastes; illicit connections between sanitary sewers and storm drains; wastewater treatment plants; and contributions from Mill Creek and the Huron River upstream. Most of these sources are associated with existing or newly developed areas, which continue to increase and therefore are a source of additional nutrient loads on water bodies in the watershed. Eroded soils can serve as significant sources of phosphorus to streams since the nutrient bonds with particles in the soil.

3.2.2 Altered Hydrology

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

Undercut banks are a sign of flashy flows
Photo: HRWC

When vegetated areas are replaced by roads, rooftops, sidewalks, and lawns, a larger proportion of rainwater and snowmelt falls onto impervious (hard) surfaces. In less developed areas, this stormwater runoff flows either into roadside ditches that drain to the nearest creek, or, in the more densely developed areas, it flows into a system of storm drainpipes that eventually outlet to the creek. During a rain event, this increased runoff causes the flow rate of the creek to increase dramatically over a short period of time, resulting in what is referred to as "flashy flows." In addition to rapidly increasing flows during storm events, the increase in impervious surface also decreases base flows during non-storm conditions because less water infiltrates into the ground to be slowly released into the creek via groundwater seeps.

Extreme flashiness can lead to rapid erosion of streambanks (especially in areas where the streambank vegetation has been removed or altered) and sedimentation. These impacts create unstable conditions for the macroinvertebrates and fish. Directly connected impervious landscapes pose a significant problem to hydrology. An example of a directly connected impervious surface is a rooftop connected to a driveway via a downspout that is then connected to the street where stormwater ultimately flows into the storm drain and into local creeks and streams.

The Huron River and its tributaries in the Middle Huron Watershed have been altered substantially by wetlands drainage, stream channelization, dam construction, deforestation, and urbanization. These activities have affected the hydrology of the Huron River and its tributaries: flow volume and flow stability have changed substantially, along with channel morphological features, such as gradient and shape. The extensive network of dams and lake control structures, developed areas, engineered drains, and construction sites all play a role in producing flashy, sediment-laden flows. These hydrologic alterations are particularly significant problems in Millers Creek, where streambanks have been severely eroded; Malletts Creek, where fish and macroinvertebrate habitat have been severely degraded to require a TMDL to be established; and Allens Creek, where most of the creek has been engineered into undersized drains leading to potentially severe future flooding and further impacts on the Huron River downstream of its outlet.

3.2.3 Sediment

While some sedimentation in a river system is natural, as the streambanks in one area erode and the soil is deposited downstream, the Middle Huron experiences heavy sedimentation on the Huron main-stem, its tributaries, and lakes and impoundments. Impacts of soil erosion and sedimentation on downstream water resources include decreased aesthetic quality with increased turbidity, decreased light penetration and decreased plant growth, and decreased aquatic habitat quality with sediment covering and clogging gills of fish and aquatic insects and sediment islands blocking fish migration. In addition, nutrients and other pollutants often bond with soil particles, increasing the detrimental impacts of sedimentation on water resources.

Many streambeds in the Huron River system are naturally composed of sand, gravel, and cobble. However, a problem arises when a dramatic shift from these coarse materials to more fine sediments occurs. Silt (fine-grained sediment) content in bottom composition is an important factor when examining a creek's habitat quality. Silt is smaller than sand and larger than clay. Dramatic increases in fine sediment suggest unnaturally high erosion rates. Excessive deposits of fine sediment are known to impair macroinvertebrate communities. This is occurring in a number of locations in the Middle Huron, including Honey Creek, lower Millers Creek, Malletts Creek, Swift Run and Superior Drain. TMDLs for macroinvertebrate habitat degredation have been established for Malletts Creek and Swift Run. Numerous other sites with sediment problems likely exist, but have not been reported or documented.

Increased stormwater flows result in increased sediment loadings for a variety of reasons. Soil particles are picked up by stormwater as it flows over roads, through ditches, and off of bridges into surface waters. Increased flows from stormwater runoff or dam discharge have enough energy to scour soils and destabilize stream banks, carrying bank sediments downstream. In addition, runoff from some construction sites can be sources of sediment. This problem arises if proper soil erosion and sedimentation controls are not in place on bare soil that has been exposed during the construction process. Sediment enters the water at bridges as a result of inadequate construction and maintenance practices, and via road ditches, which convey sediment from unpaved roads into the stream. Other sources of sediment include wash-off from paved streets and parking lots. Active agricultural land may be a source of concern in the rural areas of the watershed since traditional farming practices leave soil bare and tilled at certain times of the year, which leaves soil vulnerable to wind and water erosion.

3.2.4 Pathogens

Excess pathogens in water resources can become a public health concern and cause the public to lose recreational opportunities such as wading and canoeing. Major sources of pathogens, specifically *E. coli,* in the Middle Huron include wildlife living in or near storm drains and outlets, pet and wildlife waste washed into streams from upland areas, failing septic systems, land application of untreated waste from these septic systems, and illicit discharges of sanitary waste into storm sewers that are mainly located in more urbanized areas.

Two stream sections have been identified as impaired by pathogens in the Middle Huron Watershed. The Huron River mainstem between Argo and Geddes Dams has exhibited periodic high *E. coli* counts. Lower Geddes Pond has consistently exhibited the highest bacteria concentrations among all Huron River reaches in the Ann Arbor area. Geddes Pond is also the receiving water for three direct tributaries (Millers Creek, Malletts Creek and Swift Run Creek), plus Traver Creek and Allens Creek that enter immediately upstream. Historic data indicate that each of these tributaries exceed the WQS for pathogens as well. The Washtenaw County Drain Commissioner's office conducted a study to determine the source of bacteria. DNA sampling was conducted during one sampling event on August 27, 2002, in the hopes of determining whether sources of *E. coli* were human or non-human (included in Appendix D). Unfortunately, the results were inconclusive. Should additional DNA sampling be conducted, it might be best performed earlier in the season (mid-summer perhaps) when *E. coli* numbers are typically highest, and even better, when the DNA analysis methodology increases in sophistication. Honey Creek from Wagner Road to the outflow into the Huron River has also been found to have periodic high *E. coli* counts. The specific sources of this bacteria has yet to be fully determined. Acceptable levels of pathogens are critical to overall water quality and BMPs must be implemented to ensure that pathogen levels are maintained or reduced throughout the watershed. See Appendix D for detailed results of *E. coli* sampling and analysis.

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

- 18% of the septic systems inspected were failing or inadequate.
- One out of every 18 septic systems (5.5%) had an illicit discharge.
- 15% of the wells inspected did not have adequate protection against contaminants.
- One out of every 7 wells tested (14%) showed chemical or bacterial contamination.[2]

Septic systems can fail for a number of reasons including inadequate soil conditions, long term use, and lack of proper maintenance or use. Failing septic systems may allow untreated human waste to eventually be discharged to nearby surface waters, where it can affect drinking water supplies, cause unacceptable water quality, and present a public health risk. In Washtenaw County, 19% of all inspected septic systems have been found to be non-conforming as part of its ordinance requiring inspection of all septic systems at time of property transfer.[3] As a means of comparison, Wayne County also has a time-of-sale septic system inspection ordinance, which has demonstrated a failure rate of 26% of all inspected septic systems between 2000 and

2003. An inspection program in the City of Southfield in Oakland County has shown a failure rate of 20%.

Illicit discharges may be broadly defined as the introduction of untreated pollutants into surface waters through improperly connected pipes or improper disposal (illegal dumping). Illicit connections, which can originate in residential or commercial areas, can include floor drains, toilets, or washing machines that are improperly connected to storm drains instead of sanitary sewers. Septic systems that connect to storm drains are also illicit connections. Other examples of illicit discharges include pouring used motor oil or holding tank waste from a boat, RV, or mobile home into a storm drain or roadside swale. The frequency of illicit connections is difficult to estimate accurately. In Oakland County, the Rouge River Watershed has implemented a successful program to detect and eliminate illicit connections, and their findings indicate that the pollutants carried by these discharges can result in overabundance of *E. coli*, high ammonia levels, fecal coliform bacteria, phosphorus, and excessive algal growth in surface water. In 2004, with 353 facilities dye-tested, 97 illicit connections (24%) were identified. 82 of these were discharges related to floor drains.

3.2.5 Salts, Organic Compounds and Heavy Metals

Salts typically enter waterways from road salting (de-icing) operations or from water softener backwash discharge into the environment. De-icing products, primarily sodium chloride, are used locally by MDOT, county road commissions, homeowners, and business/commercial establishments. Salts are highly soluble in water and easily wash off pavement into surface waters and leach into soil and groundwater. High concentrations of salt can damage and kill vegetation, disrupt fish spawning in streams, reduce oxygen solubility in surface water, interfere with the chemical and physical characteristics of a lake, and pollute groundwater making well water undrinkable.

Salt entering local waterways from road de-icing efforts is a common concern among watershed residents. However, little data was found regarding salt concentrations in local waterways or impacts of salts on water quality. Conductivity data collected through the Middle Huron Monitoring Program and HRWC's Adopt-A-Stream program show consistently excessive conductivity readings in all tributaries except Superior Drain (see Section 2.3.1). These high conductivity readings may suggest the presence of high concentrations of dissolved salt ions, although the extent to which other non-salt ions are influencing the readings is unknown.

A study by the USGS in Oakland County on the effects of urban land use change on streamflow and water quality showed a strong positive correlation between salt ions (sodium, potassium, and chloride) and residential and commercial landcovers, as well as overall percentage of the watershed built, and population density. These ions were negatively correlated with agriculture, open space, forest, and wetland land covers.[4] While it may reasonably stated that the rapid urbanization in the Middle Huron Watershed has lead to increased salt concentrations in the water, the extent to which this is occurring and the impacts of these salt concentrations requires additional monitoring data and studies.

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

In the watershed, potential sources of organic compounds and heavy metals include urban areas, roads, permitted industries, existing in-stream contamination from historic activities, chemicals from lawns, and runoff from agricultural operations. Little data exists for organic compounds and heavy metals in the Middle Huron. As discussed in Chapter 2, Huron River water chemistry data collected in 2002 showed that all contaminants covered under Michigan Rule 57 (which includes a variety of organic compounds, trace and heavy metals, and PCBs) were in compliance with water quality values, with the exception of PCBs, which were not measured. TMDLs for PCBs in fish tissue leading to fish consumption advisories are scheduled to be established for Barton Pond, Ford and Belleville Lakes and an unnamed lake south of Ford Lake. In addition, the entire Huron River system is scheduled for a TMDL due to water quality exceedances for PCBs in Lake Erie. TMDLs for mercury in fish tissue are scheduled to be established for the unnamed lake and Second Sister Lake. Further data on these contaminants will be collected prior to establishment of these TMDLs.

3.2.6 Elevated Water Temperature

Water temperature directly affects many physical, biological, and chemical characteristics of a waterbody. Temperature affects the amount of oxygen that can be dissolved in the water; the rate of photosynthesis by algae and larger aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases. These factors limit the type of macroinvertebrate and fish communities that can live in a stream. Thermal pollution, the discharge of heated water from industrial operations, dams, or stormwater runoff from hot pavement and other impervious surfaces often cause an increase in stream temperature. Suspended sediment loads can also contribute to elevated water temperatures.

All waters in the Middle Huron are warmwater fish streams. However, some coldwater fish species are found in portions of watershed, and the presence of EPT and sensitive aquatic insect families at many monitoring sites is an indication of adequately cool stream temperatures. Low flows below impoundments, removal of streambank vegetation, and inputs of stormwater runoff (which are typically substantially warmer than base stream flows) are all potential contributing factors to elevated water temperatures.

3.2.7 Litter/Debris

Observations from Advisory Committee members and watershed residents indicate that debris and litter is a problem throughout the Middle Huron Watershed. Debris refers to broken down pieces of materials such as those used in construction while litter refers to strewn trash and wastepaper. The presence of debris and litter reduces the aesthetic value of water resources and also poses potential hazards to humans and wildlife. Field observations indicate that the sources of debris and litter include roadways, residential areas, parks, urban areas. Several groups in the watershed conduct annual River clean-ups to remove litter and debris.

3.2.8 Pharmaceuticals and Endocrine Disruptors

A number of international, national and regional studies over the past two decades have documented the presence of pharmaceuticals and personal care products (PPCPs) and endocrine disrupting compounds (EDCs) in surface waters. PPCPs include substances such as drugs and cosmetics. EDCs are any chemicals that have been shown to interfere with the normal function of the human endocrine system. Both types of compounds have potential human health and wildlife impacts. Researchers are currently working to evaluate the effects of environmental exposure to PPCPs and EDCs. For this reason, PPCPs and EDCs are considered suspected impairments of the watershed within this plan. These substances can enter the environment through a number of routes including: wastewater treatment discharge, industrial discharge, runoff from confined animal feeding operations, and land application of animal waste. The U.S. Geological Survey conducted a national study of 139 streams in 30 states and found that 80% of those streams contained at least one of the 95 compounds they targeted. A more targeted study conducted for the City of Ann Arbor assessed city waters for 22 compounds of concern. The researchers in that study found that ten of the 22 compounds were present in the source water in Barton Pond, with four remaining in finished drinking water; and 17 of the 22 compounds were found in wasterwater influent, with 15 compounds making their way into the effluent discharged to the Huron River. The existing treatment processes for both drinking water and wastewater reduced the concentrations for most, but not all of the target compounds[5].

Table 3.1. Prioritized Impairments, Sources and Causes in the Middle Huron Watershed

Note: k = Known impairments, sources or causes, and s = suspected.

Impairment 1: High Nutrient Loading (k)	
Sources	**Causes**
1. NPDES permitted facilities (k)	Nutrients in effluent (k)
2. Fertilizers from residential, commercial, and golf courses (k)	Lack of buffers (k) Limited nutrient control ordinances (k) Lack of nutrient management plans (k) Overuse/improper application of fertilizers (s)
3. Excessive runoff from developed areas (k)	Lack of BMPs at existing development areas (k) Impervious surfaces (k) Poor storm drain maintenance (s)
4. Legacy nutrients in lake / impoundment sediment (k)	Sediment deposition (k) Resuspension during storm events (k) Dissolution during summer stratification (k)
5. Illicit discharges (k)	Aging sanitary sewer infrastructure (s) Inadequate inspection/detection and repair due to cost (s) Illegal septic application and trailer waste disposal (s)
6. Pet and wildlife waste (k)	Wildlife in storm drains (k) Improper disposal of pet waste (k) Ponds increase habitat for waterfowl, wildlife (s)
7. Failing septic tanks (k)	Old units are too small or don't meet codes (k) Lack of a required maintenance program (k) Poor maintenance/lack of education (s)
8. Agricultural runoff from fertilizers/ livestock waste (k)	Lack of nutrient management plans (k) Lack of BMPs (upland and riparian buffers) (s) Exposed soils (s)

Impairment 2: Altered Hydrology (k)

Sources	Causes
1. Runoff from developed areas (k)	Lack of BMPs at existing development areas (k) Impervious surfaces (k) Removal of woodland/forest, wetlands, and other pervious areas (k)
2. Runoff from construction sites, new development (k)	Removal of woodland/forest, wetlands, and other pervious areas (k) Decentralized development increasing imperiousness (k) Rerouting channel for development (k) Lack of resources for enforcement/inspection (s) Site exemptions (s) Lack of education on alternatives (s)
3. Engineered drains and streams (k)	Loss of connection between stream and floodplain from channelization (k) Loss of storage and infiltration capacity (k) Removal of riparian buffer (k)
4. Impoundment of streams (k)	Dam construction (k) Natural damming (k)

Impairment 3: Sedimentation, Soil Erosion (k)	
Sources	**Causes**
1. Eroding stream banks and channels (k)	Flashy flows (k) Channelization (k) Drain maintenance (k) Eroding crossing embankments (k) Clear cutting/lack of riparian buffers (k)
2. Construction sites (k)	Clear cutting/lack of riparian buffers (k) Lack of resources for enforcement/inspection (s) Lack of soil erosion BMPs and BMP education (s) Insufficient penalties for noncompliance with ordinances (s) Exposed soils (s) Site exemptions (s)
3. Developed areas (k)	Lack of BMPs at existing development areas (k) Impervious surfaces (k) Clearcutting/lack of riparian buffers (k)
4. Dirt, gravel roads (k)	Poorly designed/maintained road stream crossings (k) Poor road maintenance (s)
5. Sediments in impoundments (k)	Legacy sedimentation, settling, then resuspension (k) Ineffective maintenance of dams (s)
6. Agricultural field runoff (s)	Lack of BMPs (upland and riparian buffers) (s) Exposed soils (s)

Impairment 4: Pathogens (k)	
Sources	**Causes**
1. Pet and wildlife waste (k)	Wildlife in storm drains (k) Improper disposal of pet waste (runoff from paved areas) (k) Ponds increase habitat for waterfowl, wildlife (s)

Impairment 4: Pathogens (k)	
Sources	**Causes**
2. Illicit Discharges (k)	Aging development sanitary sewer infrastructure (k) Illegal septic application and trailer waste disposal (s) Incomplete inspection/detection and repair due to cost (s) Lack of education (s)
3. Failing septic tanks (k)	Old units are too small or don't meet codes (k) Lack of a required maintenance program (k) Inadequate enforcement by Health Departments (s) Poor maintenance/lack of homeowner education (s)
4. Illegal/improper septage application (s)	Lack of adequate septage disposal facilities (s)
5. Livestock waste from agricultural operations (s)	Lack of BMPs (s)

Impairment 5: Salts, Organic Compounds and Heavy Metals (k)	
Sources	**Causes**
1. Legacy pollution (k)	PCBs in Barton Pond, Ford and Belleville Lakes, and unnamed lake (k) Excessive mercury in Second Sister and Unnamed Lakes (k) Illegal dumping (s)
2. Developed areas (k)	Lack of stormwater BMPs (k) Waste incineration (atmospheric deposition) (k) Illegal dumping (s) Illicit connections (s)
3. Roads (k)	Auto emissions (k) Lack of BMPs during road de-icing (s) Poor road maintenance (s)
4. NPDES permitted facilities (s)	Inadequate inspection (s) Lack of BMPs (upland and riparian buffers) (s)
5. Turfgrass chemicals from residential, commercial lawns (s)	Improper lawn care (s) Illegal disposal (s)
6. Agricultural runoff (s)	Lack of BMPS (upland, riparian buffers) (s)

Impairment 6: High Water Temperature (k)	
Sources	**Causes**
1. Directly connected impervious areas (k)	Heated stormwater from urban areas (k) Lack of groundwater recharge (s)
2. Eroded soil areas (s)	Soil erosion from channel and upland (k)
3. Solar heating (s)	Lack of vegetated canopy in riparian zone (k)

Impairment 7: Debris/Litter (k)	
Sources	**Causes**
1. Roadways, parks, urban areas, residential areas (k)	Illegal littering/dumping (s) Unsecured garbage containers and vehicles (s) Inadequate refuse containers (s)

Impairment 8: Pharmaceuticals and Endocrine Disruptors (s)	
Sources	**Causes**
1. NPDES permitted facilities (k)	Human excretion (s) Residential disposal via sewer system (s) Waste from medical facilities (s)
2. Septic systems (s)	Inadequate containment or treatment (s)
3. Landfills (s)	Inadequate treatment of leachate (s)
4. Livestock waste from agricultural operations (s)	Lack of BMPs (s)

3.2.9 Overarching Challenges

Several overarching challenges play a role in generating the impairments discussed above. Addressing these challenges is a prerequisite to mitigating the sources and causes of the impairments in order to reach the designated and desired uses in the Middle Huron Watershed.

Land Use Changes

New development along surface waters often increases the amount of nonpoint sources of pollution in the waterbody. Photo: HRWC

Perhaps the greatest concern and threat to water quality degradation in the watershed is land use change. Between 1982 and 1992, Michigan lost approximately 854,000 acres of farmland to suburban development, which is comparable to losing the area of 3.75 Michigan townships per year.[6] Moreover, the conversion of farmland to other uses accelerated from 1992 to 1997 by 67% over the previous 5-year period.[7] The economic impact of such changes in land use is potentially significant. In fact, the Michigan Economic and Environmental Roundtable (2001) estimates that the state loses $66 billion of economic output annually from decreased tourism and recreation, farming, forestry, and mining due to poorly planned suburbanization. The U.S. Department of Agriculture considers much of southeast Michigan to be high-quality farmland facing high development pressure.[8]

When land is converted from natural areas and low-density use, as in a rural area, to a more intensive use such as medium density residential or commercial land use, water quality and quantity can be negatively impacted. Increased flow rates and velocities, increased stormwater pollutants, as well as a decrease of natural areas can lead to sedimentation, stream bank erosion, loss of wildlife habitat, water temperature increase, algal blooms, decreased dissolved oxygen and other impacts.

Loss of Natural Features

The loss of natural features often goes hand in hand with new development. Natural features - including groundwater recharge areas, woodlands, wetlands, watercourses, permeable soils, vegetative buffers, and steep slopes – provide many natural functions in the landscape with regard to protecting water quality, regulating water quantity and providing wildlife habitat to receiving watercourses. In natural areas, most of the stormwater is infiltrated and utilized where it falls, allowing most pollutants to be filtered through soils. When these areas are lost and their functions are not replaced (with infiltration, detention or restoration measures), nearby water resources are impacted negatively with increased flow and increased pollutant loads.

Areas where riparian vegetation is still fairly intact should be prioritized for preservation and restoration based on the critical importance of this natural feature to the whole Huron River watershed. Riparian vegetation has many benefits to water resources, including stream bank stabilization, terrestrial and aquatic wildlife habitat structure, and shading and cooling of water. The impacts of losing riparian vegetation include the increase of stream bank erosion, loss of habitat and warmer water, which could threaten the survival of fish and aquatic insects.

Studies indicate that half of the state's inland wetlands and 70% of the coastal wetlands no longer exist.[9] Permitted fills for commercial and industrial development, housing, roads, agriculture, and logging claim an estimated 500 acres of wetlands statewide each year. The Huron River Watershed has lost approximately 66% of its wetlands to human activities. This great change in the landscape has the potential to contribute to increased flooding, loss of property values, water pollution, and diminished and fragmented wildlife habitat. Wetlands smaller than 5 acres or not within 500 feet of another waterbody are not regulated by the state. Such wetlands often serve as many or more important functions than do the larger wetlands.[10] Therefore, local protection of these systems is necessary.

Need for Public Awareness and Action

A general lack of awareness exists regarding the wide range of behaviors and policies that affect water quality, and a misperception exists about who contributes to the pollution in the watershed. For example, the basic concept of a watershed is not grasped by a majority of the public. Likewise, many people are unaware that storm drains lead directly to surface waters without treatment of stormwater. Another common misperception is that point sources such as wastewater treatment plants and industrial facilities, rather than nonpoint sources, are responsible for a majority of the pollutants in our waterways. Such misperceptions lead to complacent attitudes and a lack of personal responsibility, which in turn translate into a lack of community-based action to protect and restore local water resources. The impact of this lack of awareness and action has direct and indirect consequences. Directly, it encourages the further degradation of the resource by continuing to allow stormwater runoff and pollutants into our waterways. Indirectly, lack of public awareness and action can lead to a lack of interest by local decision-makers and thus lack of initiatives, programs, policies, and funding to either protect or restore water resources.

Need for Administrative Support and Institutional and Financial Arrangements

The communities within the Middle Huron Watershed have made commitments to protect and restore water resources with a broad spectrum of projects and programs. There is a corresponding need for additional support within these communities in order to implement, document and report on the various aspects of these increased responsibilities. Some communities have responded to this need to integrate stormwater projects and education into their regular activities by contracting with a consultant or hiring new personnel. With this need for additional support comes a need for additional funding. Creative partnerships, new fees, and grant funds need to be explored. The potential impact of inadequate program support, financial resources and institutional arrangements is the failure to create and implement programs, policies and projects that ensure the designated and desired uses.

Monitoring Programs and Data

Integrated and coordinated water quality monitoring needs to be more firmly established within the watershed. Review of readily available and relevant data reveals a number of concerns. In some cases, studies and data significant to water quality decisions are only minimally distributed within the area of interest. In other cases, existing datasets are not complete enough to be used as a basis for watershed decisions. Other datasets are nearly non-existent, especially those dealing with emerging issues such as the presence or absence of endocrine disrupting compounds (EDCs) in the water, sediments, and biota. The wide range of EDCs includes birth control pills, steroids, pesticides, inorganics, and industrial chemicals. In addition, the quality of some of the existing data causes concerns, given that the quality assurance/quality control (QA/QC) protocols of sampling parties is unknown. The type of data that has been historically collected is often not useful for answering the key questions about the watershed. Moreover, the lack of time-series data prohibits the detection of trends.

3.3 Goals and Objectives for the Middle Huron Watershed

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

Due to the complex ecological nature of the response of watersheds to management practices, it is difficult to predict when these goals will be met. Some of the administrative long-term goals might realistically be met in the next few years, whereas some of the ecological goals will require more study and improvements, and may ultimately take many years to achieve. Rather than attempting to predict when these goals will be achieved, the partners will continuously strive to meet these goals by implementing best management practices (BMPs) that are recommended for addressing the goals. The watershed partners will understand what progress is being made to achieve these goals by using an iterative process of implementing BMPs and evaluating the effects of these BMPs by regularly monitoring the river for change and degree of improvement. Indeed much progress has been made since this WMP was originally drafted in 1996 and then updated in 2000. Please see Chapter 4 for a summary of progress that has been made.

The long-term goals and objectives as agreed upon by the Advisory Committee are presented in Table 3.2. Short-term objectives are presented for each goal, and will be partially or wholly fulfilled within five years of implementation of this updated plan. Progress has already been made toward the achievement of many of these objectives at this point. Long-term objectives are developed for some of the goals, and may be partially fulfilled during the first five years of plan implementation, but realistically will be fulfilled in subsequent implementation phases.

The goals and objectives are listed in priority order. These priorities were determined in discussion with the Advisory Committee after reviewing the previous version of this plan, progress made to date, and the current list of priority impairments, sources and causes, all of which is based on analysis of relevant data as presented in previous sections of this plan. The Committee determined that the combined actions implied by these goals and objectives would be the most effective way to address high-priority watershed impairments.

Table 3.2. Prioritized Goals and Objectives for the Middle Huron Watershed, and the Designated and Desired Uses They Address
(Short Term = within five years; Long Term = Beyond five years)

Long-Term Goal	Short-Term Objective	Uses Addressed
1. Reduce flow variability	a. Adopt County and local stormwater management requirements that minimize flow fluctuations in receiving waterways, and associated bank erosion, channel widening and habitat destruction.	Designated Uses: Warmwater fishery, Aquatic life and wildlife
	b. Encourage local ordinances, strategies and programs that: 1. Prevent unnecessary modification of the Huron River, its tributaries and adjacent riparian areas.	Desired Uses: Coordinated development; Hydrologic functions
	2. Maintain and restore hydraulic function of floodplains and floodways by discouraging their alteration and encouraging restoration.	
	c. Promote local site planning review standards that favor utilization of stormwater as an on-site resource.	
	d. Monitor flow dynamics of the river and tributaries through established monitoring program.	
	Long-Term Objectives	
	e. Preserve natural infiltration and the recharge of groundwater, by protecting and restoring open spaces and natural recharge areas, installing infiltration BMPs, and reducing the amount of impervious area.	
	f. Meet TMDL goals for biota in Mallets Creek and Swift Run.	
2. Reduce nonpoint source loading and reduce soil erosion and sedimentation	**Short-Term Objective**	Designated Uses: Warmwater fishery; aquatic life and wildlife; partial and total body contact recreation; industrial
	a. Adopt County and local stormwater management requirements that minimize pollutant loading to receiving waterways by capturing and treating or infiltrating the smaller, more frequent storm event.	

	b. Encourage local ordinances, strategies and programs that: 1. Minimize the adverse effects of stormwater runoff from new highways and streets.	water supply; public water supply
	2. Encourage the use of native landscapes and reduced dependence on chemical applications.	Desired Uses: Coordinated development; hydrologic functions
	c. Promote local site planning review standards that foster a hierarchy to guide the selection of stormwater management approaches and favors source reduction.	
	d. Maintain stable oxygen levels in the hypolimnion of Ford and Belleville Lakes	
	e. Improve application and enforcement of soil erosion and sediment controls both during and after construction activity.	
	f. Identify and repair the most eroded and susceptible stream channels and banks.	
	g. Maintain water quality monitoring programs to measure progress toward TMDL goals.	
	h. Maintain baseline monitoring of sedimentation in the River and tributaries.	
	i. Increase education on BMPs among property owners and developers.	
	Long-Term Objectives	
	k. Meet TMDL goals for phosphorus concentration in Ford and Belleville Lakes	
	l. Meet TMDL goals for pathogens in Geddes Pond and Allens Creek	
	m. Increase clarity in surface waters.	
3. Protect and mitigate loss of natural features for stormwater treatment and wildlife habitat	**Short-Term Objectives**	Designated Uses: Warmwater fishery; aquatic life and wildlife; industrial water supply; public water supply
	a. Encourage local ordinances, strategies and programs that: 1. Preserve natural infiltration and the recharge of groundwater, by protecting and restoring open spaces and natural recharge areas, and reducing the amount of impervious area.	
	2. Promote buffering of waterways from the direct impacts of stormwater-related pollution.	Desired Uses: All
	b. Monitor water quality and biota to measure progress.	
	c. Educate local decision makers and the public about the benefits of critical habitat protection.	
	Long-Term Objectives	
	d. Meet TMDL goals for biota in Malletts Creek and Swift Run.	
4. Increase public awareness and involvement in protecting water resources	**Short-Term Objectives**	Designated Uses: all
	a. Conduct on-going programs to raise the public and practitioners' awareness of watershed management and nonpoint pollution issues and solutions.	Desired Uses: all
	b. Increase opportunities for public involvement in the protection of watershed resources.	
	Long-Term Objective	
	c. Reduce pollution and hydrologic impacts to the	

	watershed by increasing public awareness and behavior change.	
5. Gain broad implementation of watershed management plan and associated plans	**Short-Term Objective**	Designated Uses: all Desired Uses: all
	a. Promote intergovernmental coordination and cooperation in land use planning, natural resource protection, nonpoint source pollution control and stormwater management.	
	b. Establish financial and institutional arrangements for WMP fulfillment	
	c. Ensure the long-term viability of the Middle Huron Partnership Initiative.	
	d. Increase public awareness of progress in WMP implementation.	
6. Continue monitoring and data collection for water quality, water quantity and biological indicators	**Short-Term Objectives**	Designated Uses: all Desired Uses: all
	a. Maintain an adaptive monitoring strategy that yields data to measure progress toward achievement of WMP goals and objectives.	
	b. Develop a comprehensive database, using the best available and most appropriate technology, to serve the stormwater management, flood control and water quality planning and monitoring information needs of the watershed.	
	c. Track and report on short- and long-term maintenance of public and private stormwater conveyance and storage facilities.	

3.4 WATERSHED MANAGEMENT ALTERNATIVES

Once the current conditions were identified and reviewed – specifically, the priority list of impairments, sources and causes – the existing management approaches were reviewed. Management practices recommended from previous plans and other subwatershed plans were reviewed and considered. Participating communities also submitted their Phase II stormwater plans for consideration. The authors and Advisory Committee identified existing ordinances, policies, and practices that contribute to the group's vision of a healthy watershed, as well as gaps and inconsistencies that present opportunities for improvement. Understanding current management provides a starting point for identifying alternatives to improve protection of critical sensitive areas and mitigation of critical degraded areas. It is also important to consider practices that have been unsuccessful or difficult to implement, so as to seek better ways to address the underlying concerns.

3.4.1 Selection of Management Alternatives (Menu of Best Management Practices)

In the field of watershed management, management alternatives to address the sources and causes of the challenges are called Best Management Practices, or BMPs. BMPs cover a broad range of activities that vary in cost, effectiveness, and feasibility, depending on a complex set of factors. A stormwater best management practice is a technique, measure, or structural control that is used for a given set of conditions to manage the quantity and improve the quality of stormwater runoff in the most cost effective manner. BMPs fall into one of three categories:

Structural BMPs are engineered and constructed systems that improve the quality and/or control the quantity of runoff such as detention ponds and constructed wetlands. Structural BMPS are inherently site-specific and are designed to treat or manage stormwater at a specific location.

Vegetative BMPs are natural processes that preserve existing vegetation or establish ground cover to minimize soil erosion. Vegetative BMPs are sometimes considered as a sub-set of structural BMPs.

Non-structural BMPs, also known as *Managerial BMPs*, consist of institutional, educational or regulatory pollution prevention practices designed to limit the generation of stormwater runoff or reduce the amounts of pollutants contained in the runoff.

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

Structural Practices

Structural stormwater BMPs are physical systems that are constructed for a development – new or existing – that reduce the stormwater impact of development. Such systems can range from underground, in-line storage vaults to manage peak flows, to slightly graded swales vegetated with wildflowers to slow flows as well as treat pollutants. Structural BMPs can be designed to meet a variety of goals, depending on the needs of the practitioner. In existing urbanized areas and for new developments, structural BMPs can be implemented to address a range of water quantity and quality considerations. Because the effect of these physical systems can often be quantitatively measured by monitoring inflow and outflow parameters, recent studies have suggested certain pollutant removal efficiencies of various BMPs.   These data are summarized in table 3.4.

Residential stormwater BMPs, most of which are designed to reduce stormwater runoff via capture and later use by homeowners, or via enhanced onsite infiltration, have several advantages: they can be readily applied in older development areas where space for drainage area BMPs is often limited; they are often low in cost, easily installed and maintained; and they act as educational vehicles for pollution reduction. Some examples of such practices include rain barrels (cisterns), rainwater gardens, concrete grid (porous pavers) walkways, and vegetated roofs. The application of individual homeowner BMPs can sometimes be variable and yield uncertain pollutant removal rates. However, the importance of individual homeowner BMPs and managerial BMPs should not be discounted, and recommendations for implementation are provided below.

No single BMP type is ideally suited for every situation and each brings with it various performance, maintenance and environmental advantages and disadvantages. BMPs which consistently achieve moderate to high levels of removal for particulate and soluble pollutants include: wet ponds, sand filters, and infiltration trenches. Wet ponds have demonstrated a general ability to continue to function as designed for relatively long periods of time without routine maintenance. BMPs which are generally not capable of predictable pollution reduction rates until their fundamental design is improved or modified include: infiltration basins, grass filters and swales, and oil/grit separators.[11]

Table 3.4. Pollutant Removal Efficiencies for Stormwater Best Management Practices

	Pollutant Removal Efficiencies					
Management Practice	**Total Phosphorus**	**Total Nitrogen**	**TSS**	**Metals**	**Bacteria**	**Oil and Grease**
High-powered street sweeping	30-90%		45-90%			
Riparian buffers	forested: 23-42%; grass: 39-78%	forested: 85%; grass: 17-99%	grass: 63-89%			
Vegetated roofs	Note: 70-100% runoff reduction, 40-50% of winter rainfall. 60% temperature reduction. Structural addition of plants over a traditional roof system.					
Vegetated filter strips (150ft strip)	40-80%	20-80%	40-90%			
Bioretention	65-98%	49%	81%	51-71%		
Wet extended detention pond	48 - 90%	31-90%	50-99%	29-73%	38-100%	66%
Constructed wetland	39-83%	56%	69%	(-80)-63%	76%	
Infiltration trench	50-100%	42-100%	50-100%			
Infiltration basin	60-100%	50-100%	50-100%	85-90%	90%	
Grassed swales	15-77%	15 - 45%	65-95%	14-71%	(-50) - (-25)%	
Catch basin inlet devices		30-40% sand filter	30-90%			
Sand and organic filter	41-84%	22-54%	63-109%	26-100%	(-23) - 98%	
Stabilize soils on construction sites			80-90%			
Sediment basins or traps at construction sites			65%			

Sources: Claytor, R. and T. R. Schueler. 1996. Design of Stormwater Filtering Systems. Center for Watershed Protection, Ellicott City, MD.
Ferguson, T., R. Gignac, M. Stoffan, A. Ibrahim and J. Aldrich. 1997. Cost Estimating Guidelines, Best Management Practices and Engineered Controls. Rouge River National Wet Weather Demonstration Project.
Brown, W. and T. Schueler. 1997. National Pollutant Removal Performance Database for Stormwater BMPs. Center for Watershed Protection, Ellicott City, MD.
Schueler, T. R. and H. K. Holland. 2000. The Practice of watershed Protection. Center for Watershed Protection, Ellicott City, MD.
Tetra Tech MPS. 2002. Stormwater BMP Prioritization Analysis for the Kent and Brighton Lake Sub-Basins, Oakland and Livingston Counties, Michigan.
Tilton and Associates, Inc. 2002. Stormwater Management Structural Best Management Practices – Potential Systems for Millers Creek Restoration. Ann Arbor, MI.
U.S. EPA. 2002. National Menu for Best Management Practices for Storm water Phase II.

Information regarding the pollutant removal efficiency, costs, and designs of structural stormwater management alternatives is evolving and improving constantly. As a result, information contained in Table 3.4 is dynamic and subject to change. While potential locations are recommended for some management alternatives in the Action Plan, general guidelines can be consulted for their common sense placement. The location guidelines shown in Table 3.5 are adapted from the Rapid Watershed Assessment Protocol of the Center for Watershed Protection.

Table 3.5. General Guidelines for Locating BMPs

Amount of Development	***Undeveloped***	***Developing***	***Developed***
Philosophy	Preserve	Protect	Retrofit
Amount of Impervious Surface	< 10 %	11 - 26 %	> 26 %
Water quality	Good	Fair	Fair-Poor
Stream biodiversity	Good-Excellent	Fair-Good	Poor
Channel stability	Stable	Unstable	Highly unstable
Stream Protection Objectives	Preserve biodiversity; channel stability	Maintain key elements of stream quality	Minimize pollutant loads delivered to downstream waters
Water quality objectives	Sediment and temperature	Nutrients and metals	Bacteria
BMP selection and design criteria	Maintain pre-development hydrology	Maintain pre-development hydrology	Maximize pollutant removal and quantity control
	Minimize stream warming and sediment	Maximize pollutant removal, remove nutrients	Remove nutrients, metals and toxics
	Emphasize filtering systems	Emphasize filtering systems	
Example locations	Rural headwater areas like parts of Scio, Lodi and Webster Twps	Suburban and developing areas like Pittsfield, Suprior, and Scio Twps	Heavily urbanized areas like Ann Arbor and Ypsilanti

Non-Structural Practices

Non-structural stormwater BMPs include managerial, educational, and regulatory practices designed to prevent pollutants from entering stormwater runoff or reduce the volume of stormwater requiring management. These BMPs focus on modifying behaviors and practices through education programs, public involvement programs, land use planning, natural resource protection, regulations, operation and maintenance, or any other initiative that does not involve designing and building a physical stormwater management mechanism. Although most of these non-structural BMPs are difficult to measure quantitatively in terms of overall pollutant reduction and other stormwater parameters, research demonstrates that these BMPs have a large impact on changing policy, enforcing protection standards, improving operating procedures and changing public awareness and behaviors to improve water quality and quantity in a watershed over the long term. Moreover, they target source control which has been shown to be more cost effective than “end-of-the-pipe” structural solutions. Therefore, these BMPs should not be overlooked, and in some cases, should be the emphasis of a stormwater management program.

Considerations in Selection of BMPs

The Advisory Committee took steps to determine which BMPs are more environmentally effective and more cost effective toward meeting the goals for the Middle Huron Watershed and addressing the priority impairments, sources and causes. An extensive, but not exhaustive, list of possible BMPs and their potential effectiveness at addressing specific impairments, cost, and feasibility was discussed and additions were included based on those included in other plans and ideas generated at meetings. The plan authors and the Advisory Committee considered which BMPs would (1) best address the priority impairments for the watershed, (2) be among the more environmentally effective at addressing priority sources and causes, and (3) be more likely to be implemented. This list of BMPs was shared among the Advisory Committee members and others in the Middle Huron communities in order to coordinate ideas and resources, as well as to solicit suggestions from participants, identify gaps and ensure that watershed goals were being addressed adequately. These steps have resulted in the development of the Action Plan (Table 3.6).

The watershed is comprised of diverse communities, from rural townships to urban centers. Consequently, a variety of structural and non-structural management alternatives, or practices could be considered across the watershed. The alternatives described in this chapter may apply to one community but not to another, and so it is important to note that each of the alternatives is a unique solution to a specific pollution source that is a priority in the specific geography. Since this plan is meant to be an umbrella plan to consolidate and reference other subwatershed plans, the Action Plan presents the broad range of practices and general information about their application. The additional plans included in the appendices should be reviewed for information about areas for specific geographic implementation. Although it is not an exhaustive list of all of the possible management alternatives that could be considered, the recommended management alternatives for the watershed are summarized below in Section 3.5.

3.5 Middle Huron Watershed Action Plan

To prepare the Action Plan Table, Advisory Committee members assessed the information available from previous subwatershed, and jurisdictional plans for the types of management alternatives and their appropriateness and efficiencies, the goals and objectives developed for the Middle Huron Watershed, and their existing policies and programs. The management alternatives that are listed in the Action Plan include activities that the communities have selected as priorities to implement, as well as other BMPs that may contribute to achieving the plan’s goals and objectives but are not feasible to implement at this time.

While the individual communities and entities are responsible for meeting the goals and objectives of the Plan by implementing the recommended actions, the Action Plan is intended as a resource for *all* stakeholders in the Watershed. Local planners and governmental officials can draw upon these tools in their everyday decisions in their jobs. Local citizens can become involved at the grass roots level to implement some of these ideas, and also press their elected and local officials to carry out the management alternatives. Watershed-wide awareness of—

and active support for--the management alternatives in the Action Plan is ultimately needed to ensure that the goals and objectives of the Plan are realized.

The management alternatives presented in the Action Plan are described briefly below in the order in which they appear on the Action Plan.

3.5.1 Recommended Actions to Achieve Watershed Goals and Objectives

Managerial Actions: Ordinances and Policies

Adopt Ordinance and Rules for Stormwater Management

Regulations that can guide land development with regard to protecting the water quality, water quantity and biological integrity of the receiving surface water are important in undeveloped and soon-to-be-developed areas. This regulation can use existing data to determine the development impact that can be tolerated by the surface waters before that system will become degraded. Future development or redevelopment can be guided to control runoff so that local streams and water resources are not negatively affected by the development to the greatest extent practicable. The ordinance can incorporate requirements for managing the quality and quantity of stormwater runoff from new development sites, including residential, commercial and institutional sites. Adopting the Rules of the County Drain Commissioner's Office can be an element of the ordinance in order to be protective of local water resources. Modifications to existing engineering and design standards for stormwater management BMPs is a necessary element of this activity.

Improve Soil Erosion and Sediment Control (SESC) by adopting Erosion and Sedimentation Ordinance, Comply with Practices and Recommendations of a Soil Erosion and Soil Sedimentation Control Guide or Manual, and Improve Enforcement of SESC Policy

Regular inspection of control measures is essential to maintain the effectiveness of during-construction and post-construction stormwater best management practices. Generally, inspection and maintenance of practices can be categorized into two groups—expected routine maintenance and non-routine (repair) maintenance. Routine maintenance refers to checks performed on a regular basis to keep the practice in good working order. In addition, routine inspection and maintenance is an efficient way to prevent potential nuisance situations (odors, mosquitoes, weeds, etc.), reduce the need for repair maintenance, and reduce the chance of polluting stormwater runoff by finding and correcting problems before the next rain. In addition to maintaining the effectiveness of stormwater BMPs and reducing the incidence of pests, proper inspection and maintenance is essential to avoid the health and safety threats inherent in BMP neglect. The failure of structural storm water BMPs can lead to downstream flooding, causing property damage, injury, and even death.[12]

Adopt Development Standards Zoning Ordinance for Structural and Non-Structural BMPs

Pittsfield Township has enacted this ordinance which covers a wide-range of land use laws. Their description reads as follows: The township development standards, part of the Zoning Ordinance, include requirements for implementation of appropriate non-structural and/or structural BMPs. There is a 25 ft. buffer preservation for wetlands, 100 ft. buffer along water bodies, establishment of easements for vegetative filters and infiltration, and provision for reducing imperviousness through deferred parking requirements.

Adopt Illicit Discharge Ordinance and Include Enforcement Language

Adopt On-Site Sewage Disposal Ordinance
Septic tank and sanitary sewer maintenance measures can be used to prevent, detect and control spills, leaks, overflows and seepage from occurring in the sanitary system. Identify dry weather, illicit inflows and infiltration problems first within the sanitary system. Wet weather flows, which are more difficult to locate, can then be located using smoke testing, sewer televising and/or dye testing. On-site sewage disposal systems should be designed, sited, operated and maintained properly to prevent nutrient/pathogen loadings to surface waters and to reduce loadings to groundwater. Septic tanks should be pumped at least every three years depending on the size of the family or group using the tank. Educational materials should be distributed to new and current homeowners that maintain septic tanks so that pollution prevention is emphasized.

Adopt Purchase of Development Rights Ordinance
The purchase of development rights, known as PDR, is an effective tool for local government or non-governmental organizations such as land conservancies or land trusts, to purchase the development rights of a property to limit development and protect natural features, open space or agricultural land in perpetuity. The ordinance is a tool for guiding growth away from sensitive resources and toward delineated development centers. A PDR ordinance identifies areas that may be protected through conservation easements or purchased for public ownership either outright or through PDR. Communities in southeast Michigan have adopted PDR ordinances and garnered the resources to purchase important parcels of land for preservation in perpetuity.

Establish Master Plans & Ordinances that Protect Natural Features, such as Natural Rivers Ordinance, Natural Feature Protection Ordinance, Wetlands Ordinance, Tree/Woodlands Protection Ordinance, Riparian Buffer Ordinance, and Site Design Ordinance
Many of the native plants and shrub landcover of the watershed have been replaced with non-native plants and shrubs and turfgrass, both of which require intensive cultivation and application of chemicals. Native plant and shrub species are adapted to this area and require less water and less maintenance because of their deep root system and resistance to disease. Natives improve stormwater infiltration and stabilize soils by replacing turf grass or other introduced cover with native grasses, flowers, shrubs and trees. In addition, native species provide habitat and food to insects and wildlife. Native landscaping resources are available in southeast Michigan from plant growers to landscaping consultants. A native landscaping ordinance would promote planting of native species and remove any existing obstacles to growing these plants on residential and commercial lands.

Wetlands serve as giant sponges, which soak up storm water during wet weather events allowing the water to infiltrate into the soil instead of running off directly to surface waters. As the stormwater infiltrates into the soil, pollutants are filtered out before it reaches groundwater. Wetlands serve to reduce storm water velocities, reduce peak flows and to filter out storm water pollutants, they also provide habitat for numerous wildlife species. A subset of all wetlands are regulated by state and federal authorities. These regulated wetlands are at least five acres or larger in area, within 500 feet of a water body, or located in counties where 100,000 or more people reside, A wetlands ordinance that is more protective than required by the state or federal government is necessary to protect those smaller, isolated wetlands which are still important natural resources to a community. A model wetlands ordinance is available to local communities from the Huron River Watershed Council and the Michigan Coastal Zone Program of the MDEQ.

Zoning maps may be amended to increase protection for water resources. Inclusion of natural features and open space zoning are two of the most common and useful ways. Allowing for compact development design increases the ability to preserve a significant amount of open, undeveloped land by grouping buildings and paved surfaces to provide more compact developments while maintaining open spaces.

Adopt New Standards for Lawn Care, such as Native Landscaping Ordinance, Local Fertilizer Ordinance, Local Weed Ordinance, or Lawn Care Chemical Ordinances (including administration)

Often native plantings are used within stormwater conveyance swales, depressions and wet ponds. However, native landscaping as an alternative to traditional lawns is becoming more common. Native plants, especially those adapted to prairie environments, require little to no irrigation, fertilizer or pesticides and allow stormwater to percolate more efficiently down into the soil. Local weed ordinances, however, indirectly prohibit the use of native landscaping without a variance. Communities should adopt ordinances that allow and encourage native landscaping as an alternative to lawns while not negating the intent of common weed ordinances.

Nitrogen, phosphorus, potassium and other nutrients are necessary to maintain optimum growth of lawns and most gardens. While phosphorus is a naturally occurring nutrient in Michigan waters, human activities such as turfgrass fertilizing contribute excess amounts of phosphorus to lakes and rivers. Over-nutrification of freshwater systems can create nuisance algal blooms that deplete oxygen needed by aquatic organisms, which can lead to fish kills, and prevent water-based recreation. A local phosphorus fertilizer reduction ordinance can address the proper selection, use, application, storage and disposal of fertilizers, and incentives to reduce residential and commercial herbicide/fertilizer use. The ordinance should be combined with a coordinated information and education campaign to communicate the need for the ordinance. Research has shown that phosphorus is not needed as a soil additive in most areas within southeast Michigan. The City of Ann Arbor, Pittsfield Township, Hamburg Township, West Bloomfield Township and Commerce Township have successfully implemented such ordinances.

Adopt Pet Waste Ordinance

Pet waste can be washed into nearby surface waters and wetlands via direct runoff or storm water systems, thereby adding *E. coli* and nutrients to these freshwater systems. An ordinance that states proper pet waste management practices and provides for education, enforcement and necessary infrastructure (e.g., bag dispensers) can reduce the incidences of pet waste entering the watershed.

Develop and Adopt Floodplain Ordinance

Adopt Site Design & Road Standards that Reduce Impervious Surface

Utilizing a Low Impact Development (LID) Plan for new developments can reduce directly connected impervious surfaces. LID plans combine a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. The result will be a reduction in stormwater peak discharge, a reduction in runoff volume and the removal of storm water pollutants. LID principles can apply to new residential, commercial and industrial developments. Under the umbrella of LID are specific options such as reducing street widths, right of ways, minimum cul-de-sac radius, driveway widths and parking ratios, allowing for pervious materials to be used in spillover parking areas, and establishing a minimum percentage of parking lot area that is required to be landscaped (with native plants, preferably). Communities are encouraged to minimize the total impervious cover in Zoning Ordinances to protect water resources in the build-out scenario.

Alternative: Once natural resources have been protected to the greatest extent possible, impervious surfaces (roads, rooftops and parking lot dimensions) should be minimized, in order to maintain the natural balance between stormwater infiltration and runoff. Current studies suggest that when the amount of impervious area passes a threshold level of approximately 8%, downstream impacts become evident, as stream channels are destabilized and aquatic habitats are degraded. While minimizing the imperviousness may be a difficult objective, it is necessary to keep in mind that for every percent this threshold is surpassed in a given area, downstream effects are compounded significantly.

Adopt a Policy Requiring Any Development which is Financed or Subsidized by Local Government, or Receives a Tax Abatement, to Meet or Exceed LEED Standards Pertinent to Storm Water Management where Authority to Regulate is Present

Create Jurisdictional Authority Under Drain Code for Protection and Restoration

Establish an Environmental Protection Overlay Zoning District

Zoning maps may be amended to increase protection for water resources. Inclusion of natural features and open space zoning are two of the most common and useful ways. Allowing for compact development design in an area zoned for lower density development increases the ability to preserve a significant amount of open, undeveloped land. By clustering buildings and paved surfaces around natural areas and open spaces, a development can encompass the same amount of total area while avoiding the destruction of these resources. While individual lots can lose area in this type of zoning district, residents or tenants of the entire subdivision benefit from increased access to natural and open spaces.

Enact Ordinance Revisions to Reduce Runoff From Single and Two-Family Residences

Incorporate Methods for Capturing and Treating Storm Water Runoff within Road Construction and Improvement Projects

Regulate Maintenance of Stormwater Control Facilities by Requiring Permits for Their Use and Anniversary Dates for Inspections, Maintenance, and Permit Renewals Contingent on Functional Integrity of Structures

Establish Dog Parks with Appropriate BMPs

Managerial Actions: Practices

Create and Maintain Street Cleaning and Roadside Cleaning Programs (including Adopt-a-Road)

High-powered street sweeping is a management measure that involves pavement cleaning practices on a regular basis to minimize pollutant export to receiving waters. These cleaning practices are designed to remove sediment debris and other pollutants from road and parking lot surfaces that are a potential source of pollution impacting urban streams. Recent improvements in street sweeper technology (e.g., regenerative air or vacuum assisted systems) have enhanced the ability of the current generation of street sweeper machines to pick up the fine grained sediment particles that carry a substantial portion of the stormwater pollutant load. Many of today's sweepers can now dramatically reduce the amount of street dirt entering streams and rivers. Street sweeping is recommended as a pollution prevention measure in cold climate areas during or prior to spring snowmelt.

Create and Maintain Yard Waste/Compost Pick-Up Programs

Identify and Label Catch Basins/Storm Drains

The purpose of catch basin and storm water drain marking is to eliminate waste entering the Huron River through storm drains by creating public awareness of the danger of dumping into these drains. This process works by marking storm drains with a warning stating that any waste entering the drain goes straight to the Huron River. Along with the marking, the project places educational fliers on the doors of residences in the vicinity of newly marked drains. Markers are continuously placed on drains and replaced every few years when old markers begin to fade or fall off.

Comply with BMPs for Fleet Maintenance

Inspect Sanitary Sewer and Septic Systems for Elimination/Minimize Infiltration

Regularly Inspect and Maintain Storm Water System

Create Catch Basin Inspection/Maintenance Programs

Comply with BMPs for Municipal Landscaping Practices (i.e. Integrated Pest Management, Soil Testing, and Native Plantings)

Organize, Implement and Expand County Clean-up Programs

Inspect Facilities for Pollution Prevention

Implement the Pump Station Contingency Plan for Pump Station Flooding

Clean-Up Accident Spills and Establish Communications to Coordinate Efforts

Spay and Neuter Cats and Dogs to Reduce Feral Population and Decrease Habitat for the Local Canada Goose Population

Place Dog Bags in Local Parks

This program provides bags for pet waste clean-up in order to reduce pet waste in parks, subsequently reducing the amount of *E. coli* entering surface waters from pet waste.

Managerial Actions: Studies and Inventories

Conduct Natural Features Inventories

The composition and condition of natural features throughout most of the watershed is virtually unknown. Conducting natural features inventories is the typical approach to gathering natural features information. Several dozen state-listed and federally-listed plant and animal species have been sighted in the watershed. The distribution and status of those species should be surveyed and management plans for their survival and sustainability developed. These species and the habitats that they need for survival can serve as bellwethers for how management of the Middle Huron Watershed is proceeding. HRWC has developed a Bioreserve Map and project to address this need.

Create a Geographic Information System (GIS) of Municipal Separate Storm Sewer Systems (MS4s)

GIS offers a universal tool for inventorying and manipulating data, producing accurate maps and associated databases, and provide a basis on which to develop comprehensive land use plans. As GIS data becomes more readily available to land use decision makers, incorporating information about critical natural resources, hydrology, and stormwater systems can more readily be incorporated into master plans and individual site plan reviews. GIS information can be incorporated into flow and water quality modeling and provide a framework for watershed-scale stormwater management. Lastly, GIS technology facilitates the transfer of information between agencies, governments and the public.

Develop GIS for Road Drainage Facilities

Construct and Monitor Strategic, Innovative BMPS, including permeable pavements and Vegetated Roofs, and Develop and Refine Standards Accordingly

Porous pavement can be made of concrete, stone or plastic and promote the absorption of rain and snowmelt. The most common type of porous pavement is paving blocks and grids which are modular systems that contain openings filled with sand and/or soil. Some pavers can support grass or other suitable vegetation providing a green appearance. Porous pavement can be effective in reducing the quantity of surface runoff for small to moderate-sized storms, and may also reduce the amount of pollutants associated with these events. Typically, these systems will work better when overlaid on sandy, permeable soils (as opposed to less permeable clay soils). Effectiveness of these pavements can be improved by maximizing the opening in the paving material and providing a sub-layer of at least 12 inches. This type of pavement is particularly applicable for overflow and special event parking, driveways, utility and access roads, emergency access lanes, fire lanes and alleys.

Conduct Frog and Toad Survey

Continue water quality sampling and bio-monitoring, Expand to Monitor Strategic Points Along the Waterways, and Issue Annual Reports to the Public

A consistent dataset of water quality parameters, biotic indicators and stream flow is needed for a better understanding of conditions in the middle Huron River Watershed and to use as baseline when measuring conditions following implementation of recommended management alternatives. Further, pollutant removal efficiencies should be measured as part of any implementation project since the literature remains incomplete. Monitoring should include dry and wet weather events and seasonal variation over multiple years. Some of the monitoring could be conducted by trained volunteers affiliated with the Huron River Watershed Council's Adopt-A-Stream program. The Middle Huron Monitoring Program accomplishes this and issues annual reports. However, funding needs to be maintained to ensure sustainability of the program.

Continue Ford Lake Water Quality Monitoring

Investigate Whether There is Adequate Means for Fish to Pass through the Middle Huron River Tributaries and Dams

Study Locations to Identify Public Properties to Serve as Overflow and Diversion Points During High Water Periods

Managerial Actions: Public Information and Education

Create and Maintain a Public Hotline for Soil Erosion, OSDS, Illicit Discharge and Improper Disposal of Hazardous Wastes

An estimated 75% of the nonpoint source pollutants in the Huron River Watershed are the result of individual practices. Audiences need to include homeowners, local governments, riparian landowners, lake and home associations, commercial lawn care businesses, general businesses and services, and institutions. It is critical that these target audiences understand and respond to their impacts on the river system. Preventing pollutants from reaching the river is far more cost effective than waiting until restoration is required.

This project should target nonpoint source pollution prevention through traditional marketing outlets including print advertising, direct mail and retail promotions. Behaviors addressed by the campaign should include: proper lawn care practices; home toxics disposal; septic system maintenance; water conservation; storm drain awareness; land use; and pet waste. Market research would be used to determine core behavioral motivations and how to use these motivations to inspire behavior change. Messages would focus on items of interest to the homeowner, such as savings in time and money, with water quality protection positioned as an "added benefit." Individual impacts should be stressed to empower homeowners with the message that "their actions do make a difference." Consistency of messages across the watershed and repetition will be crucial to success of the campaign.

Specific actions that can help fulfill the objectives for this goal are:

- **Educate Public on the Availability, Location and Requirements of Facilities for the Disposal or Drop-Off of Household Hazardous Wastes, E-wastes, Pharmaceuticals/Personal Care Products and Others**

- **Educate Public about Application and Disposal of Pesticides and Fertilizers**

- **Educate Public about the Ultimate Discharge Point and Potential Impacts from Storm Water Pollutants**

- **Educate Public about Native Vegetation and Non-native, Invasive Species**

- **Educate Public about Management of Riparian Lands**

- **Educate Public about Soil Erosion and Sedimentation Control**

- **Educate Public about Septic System Maintenance**

- **Educate Public about Residential and Non-Commercial Car Washing**

- **Educate Public about Citizen Responsibility and Stewardship Practices**

- **Educate Public on Conservation Easements**

- **Educate Cat and Dog Owners and Veterinarians about the Importance of Proper Fecal Waste Disposal and Keeping Cats Indoors**

- **Educate Homeowners on the Importance of Securing Waste Receptacles, Putting Trash Out the Day of Pick-Up, and Reducing Access to Trash by Wildlife**

- **Educate RV Owners about Proper Disposal of Waste to Prevent Illicit Discharges**
  This program seeks to prevent the illicit discharge of black water from RVs. The plan can educate RV owners about proper waste disposal to prevent illicit discharges through signs and fliers. The plan may prohibit RVs from parking overnight in parking lots, except in parking lots posted for RV parking.

- **Increase Watershed and Stream Crossing Signage**

Distribute Educational Handbooks on Municipal Ordinances and Citizen Stewardship for Local Government and Citizen Groups

Maintain Website for Watershed Education and Information

Increase Mass Media Efforts (i.e. Radio, Newspaper, Television)

Increase the Number of Environmental Articles in Local Media Sources

Continue the Drain Commissioner's Field Inspection Division Apprenticeship Program

Continue to Offer Public Presentations and Workshops, such as WCDC's Land Use Presentations Series and Water Resource Workshops

Develop School Curriculum for Storm Water

Establish and Maintain GIS Database to Assist Hydraulic, Hydrologic, and Water Quality Modeling

A comprehensive study of the hydrology of the Middle Huron River system would provide an understanding of the interaction of precipitation, infiltration, surface runoff, stream flow rates, water storage, and water use and diversions. A hydraulics study would yield information about the river's velocity, flow depth, flood elevations, channel erosion, storm drains, culverts, bridges and dams. Information resulting from these studies would provide greater detail on the sources and causes of problems related to hydrology-induced erosion and flooding. The studies are prerequisite to identify the most appropriate management alternatives and best locations for practices that can restore the hydrology of the river and its tributaries.

Washtenaw County has made a major commitment to developing multiple GIS layers that are useful in local government agency and citizen watershed management practices: With foundation grant funding, the HRWC and the Land Information Access Association (LIAA) worked with Washtenaw County and local communities to develop an easily accessible set of map-based data designed to improve the quality of local land use decisions. The City of Ann Arbor is currently establishing a comprehensive GIS and hydrologic model of the system within the city's jurisdiction.

Use Stormwater in Public Art Works such as Fountains, Sculptures, and Landscaping Water Features

Initiate and Develop a Waterway Stewardship Program for Citizen Participation

Use Opportunities Provided by Public Projects (i.e. Street/Sidewalk, Sewer and/or Culver Repair) to Provide Public Education and Enjoyment (i.e. Small Sitting Areas, Vestpocket Parks, and Signage Regarding BMPs)

Increased watershed education and watershed ethic among residents is needed along with a coordinated information and education campaign. Public participation and involvement programs are meant to be activities where people learn about the watershed and how to work together to control stormwater pollution. These programs would be based on the following four objectives: 1) promote a clear identification and understanding of the problem and solutions; 2) identify responsible parties/target audiences; 3) promote community ownership of the problems and solutions; and 4) integrate public feedback into program implementation. To achieve these objectives the audience needs to be identified, the program carefully designed and the program effectiveness periodically reviewed.

Public participation and involvement programs can include the following activities:

- Adopt-A-Stream programs – trained citizen volunteers conduct benthic macroinvertebrate and habitat monitoring on a regular basis
- Program identity – program message, logo and tag line
- Collateral material – newsletters, fact sheets, brochures, posters
- Coordinating committees – focus groups, stewardship/protection groups that meet regularly
- Residential programs – storm drain stenciling, demonstration lawns and gardens, rain barrels
- Presentations – environmental booths, speakers' bureau and special events

- School education – facility tours, contests and curriculum, outdoor education, schoolyard habitats
- Southeast Michigan Stewardship Network –brings together volunteer stewards to share their experiences and learn from each other about how to protect and restore natural areas in and around their neighborhoods. Volunteers study creeks, remove invasive species, collect seed from native plants, map the land around waterways, burn prairies, and participate in many other activities

Public information and education activities implemented by the communities in the Middle Huron River Watershed will dovetail with each community's MDEQ-approved Public Education Plan.

Train Staff to Implement and Enforce Soil Erosion/Sedimentation and IDEP Policies and Procedures

Educate Local Government Staff to Receive Pesticide Certification

Managerial Actions: Illicit Discharge Elimination

Illicit discharge detection and elimination requires: 1) the prevention, detection and removal of all physical connections to the storm water drainage system that conveys any material other than storm water; 2) the implementation of measures to detect, correct and enforce against illegal dumping of materials into to streets, storm drains and streams; and 3) implementation of spill prevention, containment, cleanup and disposal techniques of spilled materials to prevent or reduce the discharge of pollutants into storm water. Crews must be trained on how to identify illicit discharges and locate illicit connections. Although this effort can be labor intensive, the pay off is a reduction in the amount sanitary sewage and chemicals that enters surface waters.

Specific activities within an Illicit Discharge Identification and Elimination program include:

Identify and Eliminate Illicit Discharges and Connections

Conduct dye testing for illicit connections for all new construction, whenever property changes ownership, or when water quality sampling or inspection programs show evidence of illicit connections or illegal discharges

Illicit discharge identification and elimination activities implemented by the communities in the Middle Huron River Watershed will dovetail with each community's MDEQ-approved Illicit Discharge Elimination Plan.

Managerial Actions: Coordination and Funding

Designate an Entity to Produce and Coordinate Technical Watershed-Wide Information

Establish a Storm Water Advisory Committee and Public Involvement Programs for Creekshed Communities

Increased watershed education and watershed ethic among watershed residents is needed along with a coordinated information and education campaign. Public participation and involvement programs are meant to be activities where people learn about the watershed and/or work together to control stormwater pollution. These programs would be based on the following four objectives: 1) promote a clear identification and understanding of the problem and solutions; 2) identify responsible parties/target audiences; 3) promote community ownership of the problems and solutions; and 4) integrate public feedback into program implementation. To achieve these objectives the audience needs to be identified, the program carefully designed and the program effectiveness periodically reviewed.

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Continue Community Partners for Clean Streams (CPCS) and Promote Riversafe Homes

The CPCS program was developed and adopted in 1996 with funding under Section 319 of the Federal Clean Water Act, and is currently supported by the general fund of Washtenaw County as well as grant funds. Implementation of the program is ongoing and increasing. As of this writing, there are ___ current and ___ pending CPCS members.

The RiverSafe Homes program is administered by the Washtenaw County Drain Commission Office and encourages local residents to practice environmentally-friendly behavior that protects the Huron River Watershed. For participation, the program requires residents to follow practices that related to Home Toxics Disposal, Yard Care and Outdoor Housekeeping, Car and Vehicle Care, and Pet and Urban Wildlife Waste.

Coordinate OSDS inspection program with other communities and agencies

Encourage dam removal where opportunities exist

Collaborate with and Provide Technical Assistance to Sub-Watershed Groups

Establish a Single Unit in Local Government to Oversee Stormwater Management

Review Construction Site Plans for Storm Water Enforcement and BMP Recommendations

Community site plan review standards can be revised to include, if applicable, the 100-year floodplain, location of waterbodies and their associated watersheds, location of slopes over 12 percent, site soil types, location of landmark trees, groundwater recharge areas, vegetation types within 25 feet of waterbodies, woodlands and other vegetation on site, and site topography.

Develop and Implement Creekshed and Watershed Management Plans

Managerial Actions: Vegetative

Restore Wetlands/Natural Areas

A restored wetland is the rehabilitation of a drained or degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to the natural conditions to the greatest extent possible. A constructed wetland is a man-made wetland with more than 50% of its surface area covered by wetland vegetation. It is ideal for large, regional tributary areas (10 to 300 acres) where there is a need to achieve high levels of particulate and nutrient removal. Wetland size and configuration, hydrologic sources, and vegetation selection must be considered during the design phase. Constructed wetlands provide a suspended solid removal of approximately 70%, while nutrient removal capabilities vary widely (between 40% and 80%) because no standard design criteria exists. These wetlands also benefit the area by providing fish and wildlife habitat and aesthetic benefits.

Plant and Promote Rain Gardens

The term "rain garden" refers to a constructed depressed area of land that is used as a landscape tool to improve water quality. Rain gardens should be placed strategically to intercept water runoff, and typically are placed beside impervious surfaces such as driveways, sidewalks, or below downspouts. Rain gardens are designed to allow for ponding of the first flush and increased infiltration. Nutrient removal occurs as the water comes into contact with the soil and the roots of the trees, shrubs or other vegetation, as such plant choices should center on native wildflowers and grasses that are adapted to local conditions. A rain garden can be as simple to establish and maintain as a traditional garden.

Plant Grassed Swales

Grassed swales are open channel management practices designed to treat and attenuate stormwater runoff. As stormwater runoff flows through these channels, it is filtered first by the vegetation in the channel, then through a subsoil matrix, and finally infiltrates into the underlying soils. Grassed swales are improvements on the traditional drainage ditch and are well suited for treating highway or residential road runoff. Grassed channels are the most similar to a conventional drainage ditch, with the major differences being flatter side and longitudinal slopes and a slower design velocity for water quality treatment of small storm events. The type and coverage of vegetation grown in the swales will influence pollutant treatment. Pollutant reduction values in this analysis assume the use of well-established turf grasses consistent with traditional residential settings. Other plantings may provide greater pollutant reduction, but may also alter conveyance hydraulics.

Protect and Manage Roadside Vegetation

Plant buffers along sensitive areas

Ensure minimum disturbance of soils and vegetation

Reduce Turf by Planting Shrubs and Trees

Unlike conventional turfgrass, native trees, shrubs and grasses have extensive, deep root systems that can improve stormwater infiltration. Research of stormwater runoff from various land surfaces indicates that runoff coefficients from turfgrass can more closely resemble runoff coefficients for paved areas due to the shallow root structure of turfgrass and more compacted soils on which it grows. A popular technique for reducing turf is to use native landscaping for attractive borders. Because native plants have adapted to local soils and pests, they require less watering and need no chemicals or fertilizers to protect them. So less turfgrass can mean cost savings.

Replacing turfgrass with native plants increases infiltration
Photo: Center for Watershed Protection

Stabilize priority streambeds

Habitat restoration techniques include in-stream structures that may be used to correct and/or improve fish and wildlife habitat deficiencies over a broad range of conditions. Examples of these techniques include: channel blocks, boulder clusters, covered logs, tree cover, bank cribs, log and bank shelters, channel constrictors, cross logs and revetment and wedge and "K" dams.[13] The majority of these structures require trained installation with hand labor and tools. After construction, a maintenance program must be implemented to ensure long-term success of the habitat structures. In areas that experience high stormwater peak flows, in-stream habitat restoration should be installed after desired flow target is reached, to ensure the success of the habitat improvement project.

Protect, stabilize and restore stream banks and channels through engineering/bio-engineering

Soil erosion control is the process of stabilizing soils and slopes in an effort to prevent or reduce erosion due to storm water runoff. Source areas are construction sites where soil has been disturbed and exposed, streambanks that are eroding due to lack of vegetation and an excess of peak flows during storm events, and road crossing over streams where the integrity of the structure is compromised or where the road itself contributes gravel or dirt. Soils can be stabilized by various physical or vegetative methods, while slopes are stabilized by reshaping the ground to grades. Both techniques will improve surface drainage and reduce the amount of soil eroding from a site. In areas where development activity is underway, it is important to emphasize the Soil Erosion and Sediment Control ordinance inspection and enforcement, which often entails hiring an adequate number of field staff.

Managerial Actions: Structural

Install inlet filters

Construct New Storm Water Facilities and Retrofit Existing Storm Water Facilities to Detain First Flush and Bank Full Storms and Remove Sediment.

Stormwater infiltration basins are any stormwater device or system, which causes the majority of runoff from small storms to infiltrate into the ground rather than be discharged to a stream. Most infiltration devices also remove waterborne pollutants by filtering water through the soil. Stormwater infiltration can provide a means of maintaining the hydrologic balance by reducing the impacts of impervious areas. Infiltration devices can include any of the following: basins, trenches, permeable pavement, modular pavement or other systems that collect runoff and discharge it into the ground. Infiltration devices should only be used on locations with gentle slopes, permeable soils and relatively deep water tables and bedrock levels. In new developments, permeable soil areas should be preserved and utilized as stormwater infiltration areas.

Extended wet detention ponds, or wet ponds, are constructed basins designed to contain a permanent pool of water in order to detain and settle stormwater runoff. The primary pollutant removal mechanism is settling as stormwater resides in the pool and pollutant uptake occurs through biological activity in the pond. Wet ponds are among the most cost-effective and widely used stormwater practices. A sediment forebay should be incorporated into the pond design, which promotes increased settling of sediments and helps prevent outlet clogging. Landscaping design requirements should include a natural vegetated buffer around the pond to increase aesthetics, reduce pollutants entering the area, and discourage goose habitation. Studies indicate that wet ponds may outperform dry detention basins for nutrient and sediment removal, and dry detention basins do not treat first flush stormwater.

Install/Retrofit Water Quality Sumps into Catch Basins, including Regular Maintenance and Cleanout

A catch-basin is an inlet to the storm drain system that typically includes a grate or curb inlet and a sump to capture sediment, debris, and associated pollutants. A number of proprietary technologies are now available to augment the pollutant capture of these systems. These technologies generally employ additional sump chambers to enhance the capture of solids, and many employ filtering media to capture additional pollutants or fractions of the pollutant inflows. The generic term “catch-basin inserts” is used here to describe a variety of in-sump or in-line designs.

Complete Ford Lake Nuisance Algae Pilot Project, Engineering Implementation Project and Oxygen Injection Equipment

Prioritize and Execute Infrastructure Repairs to Drains and Tributaries and Expand Removal of Sediment Islands to County Drains

Stabilize Roads and Bridges

The gravel and sand/gravel composite used for road surface can be the source of sediment pollution to surface waters when precipitation washes it into the stream or when road grading builds piles of the surface along the sides of the road. Stabilization of the eroding road and bridge surfaces at the sites identified in the field inventory may involve structural techniques such as retrofitting the bridge to prevent runoff from entering the stream or managerial techniques such as altering grading practices and selecting a different road and bridge surface.

Local units of government, specifically the townships, will need to work through the county governments to implement this practice.

Construct appropriate recreational access points to reduce erosion and protect banks and shorelines. Engage livery and marina operations to establish no wake zones and similar managerial BMPs to properly control erosion associated with recreational uses

In order to encourage public awareness and concern for rivers, streams and wetlands, it is important to increase opportunities for people to access these water resources. If provided with aesthetic and accessible, well-advertised recreational areas - be it a canoe livery, a fishing pier, or a trail system - the public will be able to experience the human benefits that the water offers and in turn, may want to work to protect the resource. First, the designated and desired uses must be restored so that it is safe for the public to use the resource in the manner it is intended; i.e., reduce sediment in order to construct a canoe livery. Then, the recreational amenity can be planned, built and promoted.

Daylight Streams, where Technically Feasible and Cost-Effective

Modify Roof Drain of Directly Connected Impervious Areas

Inventory Opportunities and Promote LID (i.e. Rain Gardens, Rain Barrels, Green Roofs, Porous Pavement)

Land use planning and management involves a comprehensive planning process to promote Low Impact Development (LID) and control or prevent runoff from developed land uses. LID is a low cost alternative to traditional structural stormwater BMPs. It combines resource conservation and a hydrologically functional site design with pollution prevention measures to reduce development impacts to better replicate natural watershed hydrology and water quality. Through a variety of small-scale site design techniques, LID reduces the creation of runoff, volume, and frequency. Essentially, LID strives to mimic pre-development runoff conditions. This micro-management source control concept is quite different from conventional end-of-pipe treatment or conservation techniques. The LID planning process involves the following steps: 1) determine water quality and quantity goals with respect of human health, aquatic life and recreation; 2) identify planning area and gather pertinent hydrological, chemical and biological data; 3) determine and prioritize the water quality needs as they relate to land use and the proposed development; 4) develop recommendations for low impact development to address the problems and needs that have been previously determined; 5) present recommendations to a political body for acceptance and 6) implement adopted recommendations.

Construct BMP demonstration sites on both private and public lands

Additional Resources for Stormwater Management Alternatives

Additional information on stormwater management alternatives can be found at the following web-based resources:

International Stormwater BMP Database:
http://www.bmpdatabase.org/

Low Impact Development Center:

http://www.lowimpactdevelopment.org/

MDEQ's Guidebook of Best Management Practices for Michigan Watersheds:
http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-103496--,00.html

MDEQ's Index of Individual BMPs:
http://www.michigan.gov/deq/0,1607,%207-135-3313_3682_3714-13186--,00.html

MDOT Approved BMPs:
http://www.michigan.gov/documents/SWMP_05_MDOT_v_4_120609_7.0_Appendix_D.pdf

The Stormwater Manager's Resource Center:
http://www.stormwatercenter.net/

US EPA's National Menu of BMPs for Stormwater Phase II:
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/menu.cfm

3.5.2 Understanding the Action Plan Table

As previously mentioned, the Action Plan Table is intended to provide a broad, though not complete, list of management alternatives to address the Plan's goals and objectives. Not all management alternatives apply to all permitted entities; neither must they all be implemented in order to achieve the Plan's goals and objectives, and address the priority impairments, sources and causes.

Each of the items in the Action Plan is numbered for reference and includes the following information:

- A brief description of the action to be undertaken;
- The main goals addressed by the activity;
- The entities responsible for implementation;
- The level of effort required for the activity to be considered fulfilled;
- The estimated initial capital costs;
- The estimated annual maintenance or continuation costs;
- The expected duration or timeline for the project's implementation;
- A general description of the recommended locations for implementation; and
- Technical and financial resources that may assist implementation.

Table 3.6. Action Plan for the Middle Huron River Watershed

	Management Alternative	Goals and Objectives Addressed							Responsible	Level of Effort	Cost		Project Duration/Timeline	Recommended Locations	Technical/Financial Resources
		1 Reduce Flow Variability	2 Reduce NPS Nutrient Loading	3 Natural Features Protection & Mitigation	4 Increase Public Awareness	5 Reduce Erosion and Sedimentation	6 Implementation of WMP	7 Continue Monitoring & Data Collection			Capital	Annual			
Managerial: Ordinances and Policies															
1	Adopt ordinance and rules for storm water management	✔	✔	✔		✔	✔		Washtenaw County; Local Governments	All Phase II municipalities w/in 2 years; all w/in 5 years.	$2500-$3500 each [1]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All jurisdictions	Ordinance, WCDC, AATWP
2	Improve Soil Erosion and Sediment Control (SESC) by adopting Erosion and Sedimentation Ordinance, comply with practices and recommendations of a Soil Erosion and Soil Sedimentation Control Guide or Manual, and improve enforcement of SESC policies	✔	✔	✔		✔			Local Governments	50% of municipalities by 2 years; all in 5 years	$5,000-$10,000[2]; additional staffing costs for inspecting, processing violations [2]	$40,000-$50,000 [1]	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All jurisdictions	obtain sample ordinances; MDOT, MDEQ, MACDC, APA
3	Adopt Development Standards Zoning Ordinance for structural and non-structural BMPs	✔	✔			✔			Local Governments	1-2 municipalities by year 2; half by year 5	$5,000-$10,000[2]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years		obtain sample ordinances, legal review
4	Adopt Illicit Discharge Ordinance and include enforcement language		✔						Local Governments	1-2 MS4s by year 2; all MS4s by year 5	$5,000-$10,000[2]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All MS4 communities	obtain sample ordinances, legal review
5	Adopt On Site Sewage Disposal Ordinance		✔						Local Government	1-2 municipalities by year 2; remaining by year 5	$5,000-$10,000[2]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All, as appropriate	obtain sample ordinances, legal review
6	Adopt Purchase of Development Rights ordinance			✔					Washtenaw County; Local Governments	1 municipality by year 2; 3 by year 5	$5,000-$10,000[2]	Variable, based upon the availability of development right funds	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All, especially Dexter Village and Lodi Twp.	obtain sample ordinances; HCMA
7	Establish Master Plans & ordinances that protect natural features, such as a Natural Rivers Ordinance, Natural Feature Protection Ordinance, Wetlands ordinance, Tree/Woodlands Protection Ordinance, Riparian Buffer Ordinance, and Site Design Ordinance	✔	✔	✔		✔			Local Governments; UM	2 new ordinances per year	$2500-$10,000/ordinance[1, 2]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All jurisdictions	ordinance inventory, obtain sample ordinances, legal review
8	Adopt new standards for lawn care, such as Native Landscaping Ordinance, Local Weed Ordinance or Lawn Care Chemical Ordinances (including administration)		✔	✔		✔			Local Governments, especially City of Ann Arbor, Scio Twp., Pittsfield Twp. (Phosphorus); UM;	1 municipality by year 2, 3 by year five	$2500-$5,000/ordinance[1, 4]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All, especially City of Ann Arbor, Ann Arbor Twp., Pittsfield Twp. and Ypsilanti Township	obtain sample ordinances, legal review
9	Adopt Pet Waste Ordinance		✔		✔				Local Governments	2 municipalities by year 2, 5 by year 5	$2500-$5,000/ordinance[1, 4]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All jurisdictions, with focus on E. coli area	obtain sample ordinances, legal review
10	Develop and adopt Floodplain Ordinance	✔		✔		✔			Local Governments	1 municipality by year 2, 3 by year five	$50,000 [6]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All, especially City of Ann Arbor	obtain sample ordinances, legal review
11	Adopt site design & road standards that reduce impervious surface		✔			✔			Local Governments, WCRC	2 jurisdictions by year 2, 5 by year 5	$3,000 [1]	enforcement	Revision every 3-5 years	All	obtain sample ordinances, legal review
12	Adopt a policy requiring any development which is financed or subsidized by local government, or receives a tax abatement, to meet or exceed LEED standards pertinent to stormwater management where authority to regulate is present	✔	✔	✔		✔			Local Governments	1 municipality by year 2, 3 by year five	$2500-$5,000/ordinance[1, 4]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All	obtain sample ordinances, legal review, MCA, MCCC
13	Create jurisdictional authority under drain code for protection and restoration where jurisdiction does not exist (when requested by local Units)	✔	✔	✔		✔			WCDC	Draft language by year 2, finalize by year 5	$1,000,000 [6]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	Where local units request	Sample language, legal review
14	Establish an Environmental Protection Overlay Zoning District		✔	✔					Local Governments	2 municipalities by year 2, 5 by year 5	$2500-$5,000/ordinance1, 4	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All	obtain sample ordinances, legal review
15	Enact ordinance revisions to reduce runoff from single and two-family residences	✔	✔			✔			Local Governments	2 jurisdictions by year 2, 5 by year 5	$1,000	enforcement	Revision every 3-5 years	All	obtain sample ordinances, legal review
16	Incorporate methods for capturing and treating storm water runoff within road construction and improvement projects	✔	✔			✔			Local Governments, WCRC	2 jurisdictions by year 2, 5 by year 5	$3,000 [1]	enforcement	Revision every 3-5 years	All	Engineering and legal review

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Table 3.6. Action Plan for the Middle Huron River Watershed

#	Management Alternative	Goals and Objectives Addressed: 1 Reduce Flow Variability	2 Reduce NPS Nutrient Loading	3 Natural Features Protection & Mitigation	4 Increase Public Awareness	5 Reduce Erosion and Sedimentation	6 Implementation of WMP	7 Continue Monitoring & Data Collection	Responsible	Level of Effort	Cost: Capital	Cost: Annual	Project Duration/Timeline	Recommended Locations	Technical/Financial Resources
17	Regulate maintenance of stormwater control facilities by requiring permits for their use and anniversary dates for inspections, maintenance, and permit renewals contingent on functional integrity of structures	✔	✔			✔			WCDC, local governments	2 jurisdictions by year 2, 5 by year 5	$3,000 [2]	enforcement	New ordinances: 1 year; Enforcement: on-going; revision every 3-5 years	All	Engineering and legal review
	Managerial: Practices														
18	Create and maintain street cleaning and roadside cleaning (including Adopt-a-Road)	✔	✔		✔	✔			Local Governments, WCRC	50% by year 2, all by year 5	$100,000-200,000 [1,2]	$30-$65 curb/mile	On-going	All	SOPs
19	Create and maintain yard waste/compost pick-up		✔						Local Governments; Private Landowners	1 community by year 2, 3 by year 5	Recycling station expenses[2]	$10-20/cubic yd disposal	On-going	All	Recycling engineers
20	Identify and label catch basin/storm drain	✔				✔			Local Governments; UM	sewered areas	$1.50 lexon marker, $3.00 crystal-coaterd marker[2]	Repeat coverage every 5 years	On-going	All	HRWC design
21	Comply with BMPs for Fleet Maintenance		✔						Washtenaw County; Local Government; UM	All Phase II entities by year 2, remainder by year 5	variable	Maintenance costs, retraining	On-going	All	SEMCOG
22	Inspect Sanitary Sewer and Septic Systems for Elimination/Minimize Infiltration		✔						Washtenaw County; Local Government; Private Property	sewered areas		$100-$300 per inspection[2]	On-going	All	SOPs, SEMCOG
23	Regularly inspect and maintain storm water system	✔	✔						Washtenaw County; Local Governments	All MS4s		1-2 FTEs	five year rotational inspection	All MS4s	SOPs
24	Create Catch Basin Inspection/Maintenance Programs	✔	✔			✔			WCDC, WCRC, local governments	25% by year 2, 50% by year 5		$100-$300 per inspection[2]	Yearly inspection, minimum	All MS4s	SOPs
25	Comply with BMPs for landscaping on municipal properties (i.e. Integrated Pest Management, soil testing, and native plantings)	✔	✔	✔		✔			Local Governments	50% by year 2, all by year 5		$100/ac/year	Continuous implementation	All municipal properties	SEMCOG, SOPs
26	Organize, implement and expand County clean-up programs		✔						WCDC; Local Governments	2 communities by year 2, 5 by year 5	$10,000 start-up	variable annual administraion	On-going	All	HRWC
27	Inspect facilities for pollution prevention							✔	WCPE; Local Governments	All MS4s by year 2; 100% by year 5		$100-300 per inspection	On-going	All municipal properties	SOPs, SEMCOG
28	Implement the Pump Station Contingency Plan for pump station flooding		✔						Ann Arbor Township	one station (others as relevant)	$10,000		On-going	Ann Arbor Twp.	Reference plans, engineering review
29	Establish dog parks with appropriate BMPs and place dog bags in local parks		✔	✔					Washtenaw County, Local Governments, private landowners	2 municipalities by year 2, 5 by year 5	$20,000 - 50,000 per dog park	2-5% of construction costs; $50/park for bags	Contruction 1 year, maintenance on-going	E. coli TMDL area	Humane Society
30	Clean-up accident spills and establish communications to coordinate efforts		✔						Washtenaw County; Local Governments; UM	as needed	Site/Substance-specific		On-going	All municipal operations	SOPs
31	Expand Trap, Neuter and Release program to reduce feral popuation, educate pet owners & residents and decrease habitat for the Canada goose population		✔		✔				Washtenaw County; communities in E. coli TMDL area	WCDC by year 2, then Ann Arbor	$20,000 pilot program		0 year pilot, then on-going implementation	E. coli TMDL area	State grant funding,
	Managerial: Studies and Inventories														
32	Conduct Natural Features Inventories			✔	✔		✔	✔	Local Governments; UM	2 municipalities by year 2, 5 by year 5	$1,200 per site[2]		1 year per inventory, revise every 5 years	All	HRWC, MNFI
33	Create a GIS of MS4s and use for study of hydrology and hydraulics							✔	Local Governments; UM	all MS4s by year 2	$100/hr per municipal staff[2]		1 year to prepare; 5 year updates	All	HRWC, state data
34	Develop GIS for Road Drainage Facilities							✔	Washtenaw County; Local Governments; UM	All MS4s by year 2; 100% by year 5	$100/hr per municipal staff[3]		2 years to prepare; 5 year updates	All	WCDC, WCRC
35	Construct and monitor strategic, innovative BMPs, including permeable pavements and vegetated roofs, and develop or refine standards accordinly	✔	✔			✔		✔	WCRC; Local Governments; Private Owners; Commercial Retailers	1 pilot project each year	variable, depending on project	$100,000 permeable pavement [6]	2-3 year projects	All	Grant funding
36	Conduct Frog and Toad Survey			✔					Local Governments	2 municipalities by year 2, 5 by year 5		volunteer recruitment	Annual	wetlands	State Government (MDNR), consultants

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Table 3.6. Action Plan for the Middle Huron River Watershed

	Management Alternative	Goals and Objectives Addressed: 1 Reduce Flow Variability	2 Reduce NPS Nutrient Loading	3 Natural Features Protection & Mitigation	4 Increase Public Awareness	5 Reduce Erosion and Sedimentation	6 Implementation of WMP	7 Continue Monitoring & Data Collection	Responsible	Level of Effort	Cost: Capital	Cost: Annual	Project Duration/Timeline	Recommended Locations	Technical/Financial Resources
37	Continue water quality sampling and bio-monitoring and expand to strategic points on the waterway to determine trends and effectiveness of BMPs and issue annual reports to the public	✔	✔	✔		✔		✔	State Government (MDEQ, MDNR); Washtenaw County; Local Governments; UM; HRWC	Dry and wet weather monitoring; seasonal variation	$50,000-$100,000 [1, 2]; $1,650,000 [6]	$40,000 [1]	On-going	see monitoring plan	Volunteers, HRWC
38	Pilot stormwater audit program with property owners - Downspout Disconnections - Rain Barrels - Native Landscaping - Rain Gardens		✔		✔				Washtenaw County, Local Governments, HRWC	Pilot program with 1/4 FTE		$30,000	1-year study	Target residential neighborhoods	Staff, grant
39	Continue Ford & Belleville Lake Water Quality monitoring		✔					✔	WCDC; Ypsilanti Twp.; UM	Year-round monitoring regimen	N/A	$30,000 [5]	On-going	Ford & Belleville Lake	WCAC, MDEQ
40	Investigate whether there is adequate means for fish to pass through Middle Huron River tributaries and dams			✔					DNR; WCDC; Local Governments	Regionwide study	$100,000, depending on focus		3-year study	All dams	MDNR, HRWC, MDEQ, dam operators
41	Study locations to identify public properties to serve as overflow and diversion points during high water periods	✔	✔			✔		✔	WCDC; City of Ann Arbor	Targeted study	$200-300,000		3-year study	Flood prone areas	MDEQ, FEMA
Managerial: Public Information & Education															
42	Create and maintain a public hotline for reporting soil erosion, OSDS, illicit discharge and improper disposal of hazardous wastes					✔			WCDC; WCHD; WCOSESC; Local Governments; UM	50% of entities by year 2, all by year 5		$100/hr municipal staff[2]	On-going	All municipalities	WCDC, training
43	Educate and involve communities on the availability, location and requirements of facilities for the disposal or drop-off of household hazardous wastes, e-wastes, pharmaceuticals/personal care products and others		✔		✔		✔		Local Government; UM	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	HRWC
44	Educate and involve communities about application and disposal of pesticides and fertilizers		✔		✔		✔		Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	MSU Extension; HRWC
45	Educate and involve communities about the ultimate discharge point and potential impacts from storm water pollutants		✔		✔				Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	HRWC
46	Educate and involve communities about native vegetation and non-native, invasive species	✔	✔	✔			✔		Washtenaw County; Local Governments; UM; HRWC	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]; $12,000 [3]	Annual campaign with rotational messages	All municipalities	HRWC, Pfizer
47	Educate and involve communities about management of riparian lands			✔	✔				Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	HRWC; WCDC
48	Educate and involve communities about soil erosion and sedimentation control		✔		✔	✔	✔		Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	HRWC
49	Educate and involve communities about septic system maintenance		✔		✔				Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	HRWC
50	Educate and involve communities about residential and non-commercial car washing		✔		✔				Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	HRWC
51	Educate and involve communities about citizen responsibility and stewardship practices				✔		✔		Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	HRWC
52	Educate and involve communities about conservation easements			✔	✔		✔		Washtenaw County; Local Governments	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	HRWC
53	Educate cat and dog owners and veterinarians about the importance of proper fecal waste disposal and keeping cats indoors		✔						Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section		$0.03/Doggie flyer; $0.80 storm water calendars [4]	Annual campaign with rotational messages	All municipalities	HRWC

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Table 3.6. Action Plan for the Middle Huron River Watershed

	Management Alternative	Goals and Objectives Addressed							Responsible	Level of Effort	Cost		Project Duration/Timeline	Recommended Locations	Technical/Financial Resources
		1 Reduce Flow Variability	2 Reduce NPS Nutrient Loading	3 Natural Features Protection & Mitigation	4 Increase Public Awareness	5 Reduce Erosion and Sedimentation	6 Implementation of WMP	7 Continue Monitoring & Data Collection			Capital	Annual			
54	Educate homeowners and customers on the importance of securing waste recepticals, putting trash out the day of pick up, and reducing access to trash by wildlife								Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section		$.02/hh for print ads; $0.5/piece for print and mail[2]	Annual campaign with rotational messages	All municipalities	HRWC
55	Educate RV owners about proper disposal of waste to prevent illicit discharges		✔						Washtenaw County; Local Governments; UM	community-wide; (# households determined by each PEP), see I&E section	$0.03/flier; $20 per 24"x30" sign, or $23 per 24"x36" sign, plus cost of sign post and installation	$2,000 [4]	On-going	UM; City of Ann Arbor	HRWC, UM-OSEH
56	Increase watershed and stream crossing signage				✔				Washtenaw County; Local Governments	20% per year; Strategic locations on county roads	$20 per 24"x30" sign, or $23 per 24"x36" sign, plus cost of sign post and installation[2]		5 years to complete, then maintenance	Priority stream crossings	WCDC; WCRC
57	Distribute educational handbooks on municipal ordinances and citizen stewardship for local government and citizen groups				✔				Local Governments	3 communities by year 2, 6 by year 5	$1/booklet		5 years	Communities that establish new ordinances	HRWC
58	Maintain website for watershed education and information				✔				Washtenaw County; Local Governments; UM	50% by year 2, all by year 5	$5,000 to develop	$50-100/hr to update website[2]	On-going	Watershed-wide	Linkages, templates, resources
59	Increase Mass Media Efforts (i.e. radio, newspaper, television)				✔				Washtenaw County; Local Governments; UM	1 pilot campaign per year	$100/hr+cost for cable TV, consult w/ local media [3]; $50-$100/hr/press release [2]		1 year pilot with follow-up evaluation	Watershed-wide	WEMU, HRWC, SEMCOG
60	Increase the number of environmental articles in local media sources	✔	✔		✔				Washtenaw County; Local Governments; UM	One article per month		$50-100/article [2]	On-going	Watershed-wide news media	HRWC, news reporters
61	Continue the Drain Commissioner's Field Inspection Division Apprenticeship Program								WCDC	2 apprentices per year		$30,000	On-going	Washtenaw County	Universities
62	Continue to offer public presentations and workshops, such as WCDC's Land Use Presentations Series and Water Resource Workshops				✔				Washtenaw County; Local Governments; UM	3 presentations/workshops per year		$100/presentation	On-going	Watershed-wide	sponsorship
63	Develop school curriculum for storm water	✔	✔	✔	✔	✔			Local Governments; UM; Public & Private Schools	Pilot project by year 2	$50-100/hr to develop; $5000 printing		3-5 years	Ann Arbor, Dexter	Public schools, MDE
64	Establish and maintain GIS database to assist hydraulic, hydrologic, and water quality modeling	✔	✔						Washtenaw County; Local Governments, HRWC	Inventory resrouces by year 2, update year 5	$2,000-3,000 per inventory		2-3 year repeat and maintenance	Watershed-wide	HRWC, MDEQ
65	Use stormwater in public art works such as fountains, sculptures, and landscaping water features				✔				Local Governments	Pilot with municipal project by year 5	$20,000 - $1,000,000	maintenance	5 years	Urban center	MCA, MCCC, HRWC
66	Initiate and develop a waterway stewardship program for citizen participation	✔	✔	✔	✔	✔			Local Governments	Develop model by year 3, implement by year 5.	$5,000	$50-100/hr	5 years to establish	Watershed-wide	MCA, MCCC, HRWC
67	Promote homeowner soil testing		✔	✔			✔		Washtenaw County; Local Governments	Integrate into educational materials	no additional cost		On-going	Watershed-wide	HRWC, MSU Extension
68	Use opportunities provided by public projects (i..e.street/sidewalk, sewer and/or culver repair) to provide public education and enjoyment (i.e. small sitting areas, vestpocket parks, and signage regarding BMPs)				✔				Local Governments	Opportunistic implementation of 1-2 projects by year 2, 3-5 by year 5	Variable	maintenance	1-2 year project development	Watershed-wide	Engineering
69	Train staff to implement and enforce soil erosion/sedimentation and IDEP policies and procedures		✔	✔	✔	✔			WCDC, local governments	All MS4s by year 2	$100/hr municipal staff[2]		Annually, repeat every 5 years	All MS4s	WCDC
70	Educate local government staff to receive Pesticide Certification		✔						Local Governments	50% of applicators by year 2, all by year 5	$100/hr municipal staff[2]		Annually, repeat every 5 years	All municipal properties	SEMCOG
Managerial: Illicit Discharge Elimination															
71	Identify and Eliminate Illicit Discharges and Connections. Monitor dry weather flows to enable targeted efforts to find illicit discharges and evaluate effectiveness. Educate about dumping, and encourage calling the tipline		✔			✔			Washtenaw County; Local Governments; UM	ID and remove 50% by year 2, 100% by year 5	$100/staff investigation per property[2]	$600/dye test; $100/staff investigation per property; $5,000-$15,000 enforcement per property	5 years, then follow-up	All MS4s	WCDC, MDEQ, Washtenaw County

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#	Management Alternative	Goals and Objectives Addressed: 1 Reduce Flow Variability	2 Reduce NPS Nutrient Loading	3 Natural Features Protection & Mitigation	4 Increase Public Awareness	5 Reduce Erosion and Sedimentation	6 Implementation of WMP	7 Continue Monitoring & Data Collection	Responsible	Level of Effort	Cost: Capital	Cost: Annual	Project Duration/Timeline	Recommended Locations	Technical/Financial Resources
72	Conduct dye testing for illicit connections for all new construction, whenever property changes ownership, or when water quality sampling or inspection programs show evidence of illicit connections or illegal discharges		✔			✔			WCDC; Local Governments	All new properties or transfers	$600/dye test[2]		On-going	All MS4s	WCDC
Managerial: Coordination and Funding															
73	Designate an entity to produce and coordinate technical watershed-wide information						✔		WCDC; WCRC; Local Governments; UM	Opportunistic communication	$50-100/hr		On-going	Watershed-wide	HRWC
74	Establish a storm water advisory committee and public involvement programs for creekshed communities	✔	✔	✔	✔		✔		Local Governments; HRWC	2 creeksheds by year 2, 4 by year 5	$209,000 [3]	N/A	On-going	All creeksheds	HRWC
75	Continue Community Partners for Clean Streams and promote Riversafe Homes				✔				WCDC; Local Governments; Private Landowners	WCDC annual coordination		$50-100/hr	On-going	All communities	
76	Develop a dam assessment strategy and encourage dam removal where opportunities exist	✔	✔						Washteanw County; Local Governments	Opportunistic removal plans for 1 dam by year 2, 2 by year 5	$200-300,000 per assessment		5-7 years per dam	Priority dams from inventory	HRWC, AA IMP, DNR, DEQ
77	Collaborate with and provide technical assistance to sub-watershed groups	✔	✔	✔	✔	✔			Local Governments	Staff support for relevant groups		$2000/group	On-going	Malletts Creekshed Millers Creekshed, Fleming Creekshed, Ford Lake; Whitmore Lake	HRWC
78	Establish a single unit in local government to oversee stormwater management								Local Government	2 communities by year 2		1-3 FTEs	On-going	Phase II communities	MCA, MCCC
79	Review construction site plans for storm water enforcement and BMP recommendations	✔	✔	✔		✔			Local Governments; UM	50% of Phase II communties by year 2, all by year 5		$100/plan review	On-going	All Phase II	Training
80	Develop and Implement Creekshed and Watershed Management Plans								WCDC; Local Governments; Creek Groups	Plans complete, update every 3-5 years	$125,000-$200,000/plan development [6]; $300,000 Implementation [6]		Update every 3-5 years	Huron River Watershed, Allens Creekshed, Traver Creekshed, Fleming Creekshed, Swift Run Creekshed, Newport Creekshed	HRWC
Vegetative															
81	Restore Wetlands/Natural Areas	✔	✔	✔	✔		✔		Washtenaw County; Local Governments; UM; Private Landowners	100 acres by year 2, 200 by year 5	$700-2,000/acre[2]; $344.559 [3]	2-4% Construction Costs [1]	1-3 years per project	Millers Creekshed	Ecological, engineering design
82	Plant and promote rain gardens			✔	✔		✔		Washtenaw County; Local Governments; UM; Private Landowners	20 per year	$500/homesite, or $3-5/sq ft up to $10-12/sq ft for professional work[2]; $50,000 [6]	4% Construction Costs [1]	5 Years	All, especially Ypsilanti Twp.	WCDC
83	Protect, restore and maintain grassed swales		✔	✔		✔		✔	Washtenaw County; Local Governments; UM; Private Landowners	1,000 linear feet per year	$.50/sq. foot [1]	$.02/sq. foot [1]	1-2 Years per project	Target areas based on subwatershed plans	subwatershed plans
84	Protect, restore and maintain roadside vegetation	✔	✔			✔			WCRC; Local Governments; UM	Annual maintenance		$50-100/hr	annually	all roads in target areas	GIS, SOPs, SEMCOG
85	Plant buffers along sensitive areas	✔	✔	✔		✔			Washtenaw County; Local Governments; UM; Private Landowners	5000 linear feet of 25 ft min buffers by year 2; 15,000 by year 5.	$0.40/linear ft @ 25' buffer		1-2 Years per project	Target areas based on subwatershed plans	subwatershed plans, HRWC, technical guidelines
86	Ensure minimum disturbance of soils and vegetation		✔	✔		✔			Washtenaw County; Local Governments; UM; Private Landowners	All new construction proejcts by year 2	no additional cost		2 years to implement	Watershed-wide	WCDC
87	Reduce turf by planting shrubs and trees and native landscapes	✔	✔	✔		✔			WCRC; Local Governments; UM; Private Landowners	100 acres by year 2, 200 by year	$40/tree [6]; $5000/half acre of tree & shrub seedlings and groundcover		10 Years	Target areas based on subwatershed plans	subwatershed plans
88	Stabilize priority streambeds		✔			✔			WCDC; Local Governments	1 project by year 2, 3 by year 5	$3,500,000 [6]		3-5 year projects	Target areas based on subwatershed plans	subwatershed plans, engineering design, funding

[1] Mill Creek WMP [2] Chain of Lakes WMP [3] Millers Creek WIP [4] NPS-RIP [5] Ypsilanti Twp. [6] City of Ann Arbor [7] Lower Huron WMP

Table 3.6. Action Plan for the Middle Huron River Watershed

	Management Alternative	Goals and Objectives Addressed							Responsible	Level of Effort	Cost		Project Duration/Timeline	Recommended Locations	Technical/Financial Resources
		1 Reduce Flow Variability	2 Reduce NPS Nutrient Loading	3 Natural Features Protection & Mitigation	4 Increase Public Awareness	5 Reduce Erosion and Sedimentation	6 Implementation of WMP	7 Continue Monitoring & Data Collection			Capital	Annual			
89	Protect, stabilize and restore stream banks and channels through engineering/bio-engineering	✔	✔	✔		✔			Washtenaw County; Local Governments; UM; Private Landowners	2 project by year 2, 3 by year 5	$90/ft. [1]; $1,650,000 [3]	$1.80/ft [1]	1-2 year projects	Target areas based on subwatershed plans	subwatershed plans, engineering design, funding
Structural															
90	Install swirl concentrators	✔	✔						WCDC, local governments	1-2 pilot projects by year 2; evaluation report by year 3			1-year per project	Target inlets based on subwatershed management plans	Engineering design, construction
91	Construct new storm water facilities and retrofit existing storm water facilities to detain first flush and bank full storms and remove sediment. Execute capital improvements to create new storm structures.	✔	✔						Washtenaw County; Local Governments; UM; Private Landowners	1-2 new projects by year 2, 5 by year 5	Construction -- Mobilization: 3%-5% of construction costs; Site prep.: $3000-$6000 per acre for clearing; $2.50-$6/cu. yd for excavation; $3000-$7000 for each inlet/outlet. Design and contingencies 25-30% construction costs. [2]		1-2 years per project	Target areas based on subwatershed plans	WCRC, WCDC, AAPS, Pfizer
92	Install/retrofit water quality sumps or other pre-treatment devices into catch basins, including regular maintenance and cleanout	✔	✔			✔			WCDC; Local Governments	1-2 new projects by year 2, 5 by year 5			1-year per project	Target catch basins based on subwatershed management plans	Engineering design, construction
93	Ford Lake nuisance algae engineering pilot project, engineering implementation project and oxygen injection equipment		✔						Ypsilanti Township, City of Ypsilanti	Continue experimentation under Dr. Lehman		$60,000 pilot project [5]; $100,000 implementation project [5]; $22,000 injection equipment [5]	3-5 years	Ford Lake	U of M
94	Prioritize and execute infrastructure repairs to drains and tributaries and expand removal of sediment islands to county drains.	✔	✔			✔			WCDC; WCRC; Local Governments	2-3 proejcts per year			Annual	Priority drains based on inventory	WCDC
95	Stabilize roads and bridges								WCRC; Local Governments; UM	1-2 projects per year	construction -- Mobilization: 3%-5% of construction costs; Site prep.: $250/ton avg. for mulching; $2-4/sq. yd for geotextile fabric; $1.50-$6 for seeding; $2-$3.50 for sod; $30/sq. yd. For rirap; design and contingencies 25-30% construction costs. [7]		1-2 years per project	Priority roads and bridges based on inventory	WCRC, MDOT
96	Construct appropriate recreational access points to reduce erosion and protect banks and shorelines. Engage livery and marina operations to establish no wake zones and similar managerial BMPs to properly control erosion associated with recreational uses					✔			Local Governments	1-2 projects per year			1 year per project	Heavy access points from inventory	MDNR
97	Daylight streams, where technically feasible and cost-effective	✔	✔	✔		✔			WCDC; Local Governments	275 feet (Millers Creek)	$540,000 [3]			See "Millers Creek Watershed Improvement Plan"	Pfizer
98	Modify roof drains from directly connected impervious areas	✔		✔		✔			Local Governments	500 disconnections by year 2; 1,500 by year 5	Variable, depending on the length of drain [1]; $374,000 [3]	N/A	5 years	See "Millers Creek Watershed Improvement Plan" and others	HRWC, WCDC
99	Inventory opportunities and promote LID (i.e. rain gardens, rain barrels, green roofs, porous pavement)	✔	✔	✔					WCDC; Local Governments	Complete desktop analysis by year 1, USSR by year 3, complete plan by year 5	$100/rain barrel; $12-$24/sq. ft. of green roof [7]; $40,000-$80,000/acre of porous pavement [7]; $7,000 pilot project		5 years	Watershed-wide	LID guidebook, training, CWP
100	Construct BMP demonstration sites on both private and public lands	✔	✔	✔		✔			Local Governments; Private Landowners	1-2 demonstrations per year	Variable, depending on BMP		5 years	Target areas based on subwatershed plans	Subwatershed plans, HRWC, WCDC

[1] Mill Creek WMP [2] Chain of Lakes WMP [3] Millers Creek WIP [4] NPS-RIP [5] Ypsilanti Twp. [6] City of Ann Arbor [7] Lower Huron WMP

3.5.3 Action Plan Strategies

The action items in Table 3.6 present the commitments by the communities within the Middle Huron Watershed to comprehensively address the impairments in the watershed. The community partners have developed separate schedules for addressing each of the major impairments for which TMDLs have been established. The following sections include updated implementation summaries for addressing phosphorus, E. coli, and biota/sediments. Finally, the specific Public Information and Education Plan is included.

3.5.3.1 Phosphorus Reduction Strategy

In order to meet the phosphorus reduction target of 50% for the region, the participating community partners to the Middle Huron Cooperative Agreement (see Appendix B) developed a TMDL Implementation Plan to address and reduce both point and non-point sources of phosphorus. The plan, completed in 2011, is included in Appendix C along with an updated table of phosphorus reduction activities that includes loading reduction estimates, a schedule, and cost estimates.

As discussed in section 2.5.1, the nonpoint source phosphorus load reduction target is 14,035 lbs/yr. This target includes the Mill Creek Subwatershed. The point sources in the system are already exceeding their reduction targets by 6,123 lbs.

Table 3.7 is a summary of the non-point source reduction activities from the Middle Huron Non-point Source RIP along with their loading reduction estimates, schedule and cost estimates. Loading reduction estimates are based on published estimates when available or analysis using the Watershed Treatment Model.[14] See Appendix K for the model and additional load reduction calculations.

Table 3.7 Non-point Source Reduction Implementation Plan Summary of Major Activities

Activity Category	P Load Reduction Estimate (lbs/yr)	Implementation Timeframe	Cost Estimate over Five Years
Mill Creek Subwatershed Management Plan	9,043	Scheduled 2004-2008.	$5.21 M
Illicit Discharge Elimination	533	Complete implementation by 2006; investigations ongoing	$278,000
Septic Inspection and Repair	1,440	Ongoing program	$32.0 M
Phosphorus Fertilizer Reduction Ordinance	2,077	Enact in 2006. Ongoing O&M.	$96,000
Yard Waste and other public education	992	Current. Annual campaigns ongoing.	$200,000
Pet Waste education	1,951	Began in 2003. Annual campaigns ongoing.	$200,000
Street sweeping	359	Annual sweeping in sections of Ann Arbor, Ypsilanti and U of M	$967,500
Construction Site Runoff Control	1,641	Ongoing program. Regular inspection, O&M.	$3.13 M
Malletts Creek Regional Detention	1,000	Construction complete in 2007. O&M and monitoring through 2009.	$2.75 M

Malletts Creek Reconstruction Plan Activities	1,000	Schedule through 2009.	$16.4 M
Millers Creek Watershed Improvement Plan	383	Schedule through 2014	$9.5 M
Totals	**20,419**		**$70.77 M**

Thus, the activities conducted by the point sources, along with those included in the Non-point Source RIP will account for more than the needed load reduction in order to meet the reduction target for the watershed.

3.5.3.2 Pathogen Reduction Strategy

As indicated in section 2.5.1, no specific loading targets were set for the *E. coli* TMDL since it is concentration based. It is quite difficult to estimate loading reductions for pathogen impairments. It also is not entirely appropriate to focus on load reductions since the impairment itself is based on point counts or concentrations. The focus is better placed on activities to reduce *E. coli* sources.

The E. coli TMDL Implementation Plan was developed to establish an effective strategy to reduce potential sources through a set of implementation activities. Please refer to that strategy found in Appendix D for more details on activities, impacts, schedules and cost estimates. In addition to the programs and activities included in that plan, a Trap, Neuter and Release (TNR) Program will be initiated by the Washtenaw County Drain Commission. That program will do the following:

- Trap, neuter, and release feral cats to reduce feral populations;
- Educate cat owners about neutering at the point of contact, veterinarian offices and the Humane Society;
- Educate pet owners about E. coli pollution and scooping waste at points of contact; and
- Produce I & E materials for individual distribution and media.

3.5.3.3 Biota Improvement Strategy

Biota TMDLs have been established for Malletts Creek and Swift Run. A completed plan for addressing the biota impairments in Malletts Creek can be found in the implementation plan in Appendix F and in the TMDL Implementation Plan in Appendix X. The overall phosphorus reduction under this plan is 50% and well over the 106 tons per year of TSS reduction required by the TMDL. These reductions come at a cost of $19.1 million. This plan indicates that activities designed to address the phosphorus TMDL for Ford and Belleville Lakes will have the secondary benefit of more than addressing the sediment loading reduction targets set for the biota TMDLs.

<u>Swift Run Improvement Strategy</u>

A TMDL Implementation Plan for Swift Run was developed in 2011, and can be found in Appendix Y. Below is a summary of earlier proposed actions. Refer to Appendix Y for more updated information.

Table 3.6 lists a number of actions that can be undertaken to address the hydrologic degradation and sediment transport that is targeted as the source of biota impairment. Some of the broad-based programs will have the effect of mitigating peak flows and reducing sediment transport in Swift Run. In addition to these programs, a desktop analysis of the creekshed, looking at land use patterns, hydrology, and critical areas for sediment transport was conducted to inventory potential areas for projects specifically designed to reduce hydrologic and sedimentation impacts on aquatic habitat in Swift Run. A set of 34 "Improvement Opportunities" were identified within the creekshed that could control erosion, reduce sediment transport, detain or slow runoff, reduce channel erosion or increase storage capacity. These opportunities will be further evaluated to determine the feasibility of each potential project and prioritize each project for implementation. It is anticipated that a selection of these projects will be implemented over the next five years to address the problem sources in the creekshed and improve the aquatic habitat to allow for improvement of bentic biota measures.

The improvement opportunities were classified into the following eight categories:

- Channel Improvement – including streambank and streambed stabilization;
- Crop BMPs – including planting grassed swales, grade stabilization, buffer planting, conservation cover, rotation and tillage, filter strips, drain naturalization, drain tile removal, and nutrient management;
- New Detention – including construction of detention ponds, wetlands, bioswales or infiltration basins;
- Residential BMPs – including rain barrels, rain gardens, downspout disconnections, tree planting, and targeted education;
- Basin Retrofits – including reconstruction of existing flood control structures to provide sediment trapping and longer retention times;
- Enhanced Floodplain – including floodplain connections, native planting and seeding, and access reduction;
- Vegetative BMPs – including buffer planting, natural area restoration, and reforestation; and
- Wetland Improvement – including hydrologic restoration, invasives removal, and establishment of native species.

Specific activities are described in section 3.5.1 and Table 3.6. A map of improvement opportunity locations is included as Figure 3.1. Relevant broad-scale project activities and the above improvement activities are listed in Table 3.8 for use in estimating anticipated load reductions toward TMDL targets. In this case, TSS load reductions are estimated based on the WTM model and five-year cost estimates are also indicated based on figures from Table 3.6 (unless otherwise indicated).

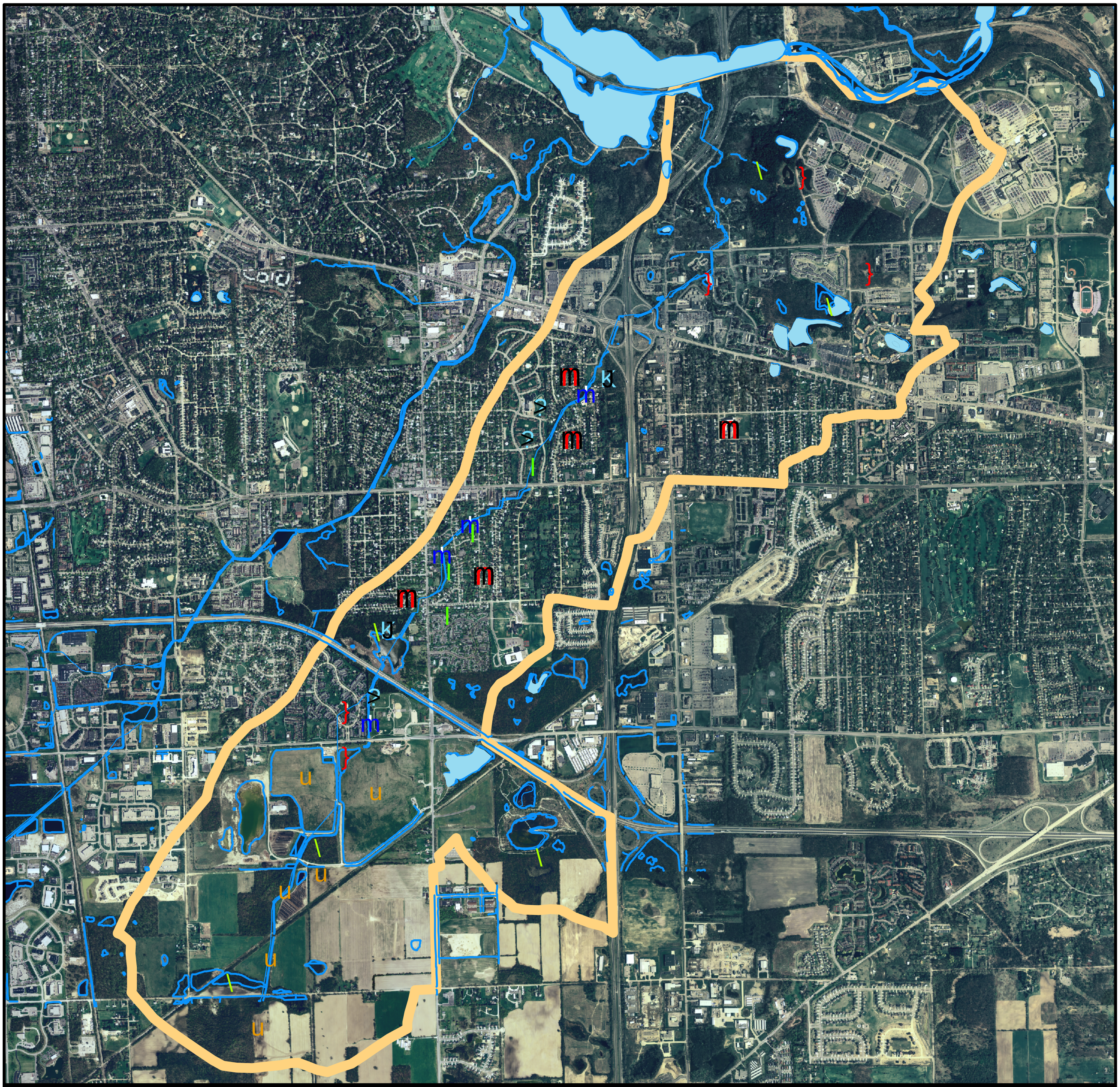
Table 3.8 Inventory of management practices to address biota TMDL (TSS based) for Swift Run

Management Practice	Responsibility	Level of effort	Estimated TSS Load Reduction (tons/year)	Estimated 5-year Costs
Public Education	WCDC, Ann Arbor, Ann Arbor Twp, Pittsfield Twp	Across creekshed	UNKNOWN	
Street Sweeping	Ann Arbor, WC Road Commission	Twice per year	7.4	$14,525

Construction Site Erosion Control	WCDC, Ann Arbor, Ann Arbor Twp, Pittsfield Twp	New construction in creekshed	36.4	$122,000
Channel Improvement	WCDC, Ann Arbor	4,500 linear feet	2.4	$1,500,000
Crop BMPs	WCDC, NRCS	6 projects in headwaters agriculture property	5.0	$69,500[1]
New Detention	WCDC, Ann Arbor, Ann Arbor Twp, Pittsfield Twp	3 potential projects	1.0	$90,000
Residential BMPs	WCDC, Ann Arbor, Ann Arbor Twp, Pittsfield Twp	Targeted residential areas . ~ 200 acres	3.8	$74,074[2]
Basin Retrofits	WCDC, Ann Arbor, Ann Arbor Twp, Pittsfield Twp	4 potential projects	4.9	$200,000
Enhanced Floodplain	WCDC, Ann Arbor	8 acres	2.0	$500,000[3]
Vegetative BMPs	WCDC, Ann Arbor, Ann Arbor Twp, Pittsfield Twp	0.75 stream miles	0.25	$30,300
Wetland Improvement	WCDC, Ann Arbor, Ann Arbor Twp, Pittsfield Twp	100 acres	2.2	$75,600
Totals			65.35	$2.68 M

(1) Estimated from Mill Creek Subwatershed Plan
(2) Estimate from Millers Creek 319 project extrapolation
(3) Estimate from Millers Creek Improvement Plan

The activies under this plan exceed the load reduction target by a factor of almost ten. Specific projects need to be identified and prioritized. Opportunistic implementation can then follow by working toward the most promising projects first. Note that some project types, like channel improvement rely on prerequisite implementation of other projects in order for them to be effective. This sequencing will also need to be taken into account.



Legend

Improvement Opportunities

- Channel Improvement
- Crop BMPs
- New Detention
- Residential BMPs
- Basin Retrofits
- Enhanced Floodplain
- Vegetative BMPs
- Wetland Improvement
- Swift Run Creekshed

0 5 10 20 Miles

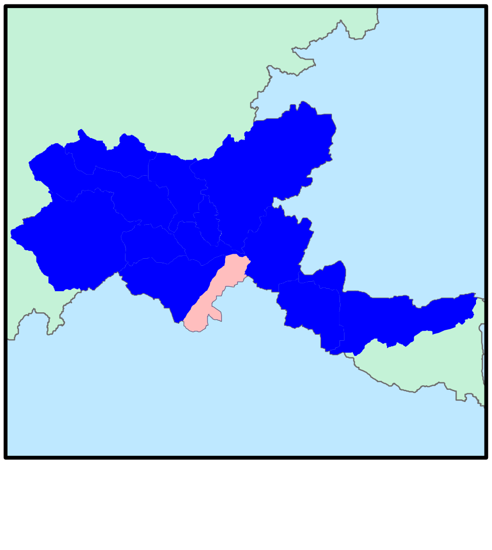
Huron River Watershed Council

Protecting the river since 1965

Washtenaw County Michigan 1826

1

Figure 3.1



3.5.3.4 Information and Education Plan

The Information and Education Plan for the Middle Huron Watershed follows the model laid out in *Developing a Communications Plan: A Roadmap to Success*[15], which was developed for communities in the Huron River Watershed through funding provided by the MDEQ and U.S. EPA. As a result of having an Information and Education Plan already developed for the Huron River Watershed, market research did not need to be conducted for the watershed since it had been completed previously.

Goal of the Information and Education Plan

The goal of the plan is to create an awareness of water quality and watershed issues that will promote positive actions to protect and enhance the integrity of the Middle Huron Watershed.

Measurable Objectives

The objectives of the plan are to

1. Reduce pollution that impacts the Middle Huron Watershed by providing practical knowledge to key audiences;

2. Increase the general public's awareness and knowledge of the Watershed and the interconnectedness of the system;

3. Increase activities that result in preservation, restoration and protection of the Watershed system; and

4. Increase participation in Watershed stewardship and recreation.

Audience and Message Priorities

Target audiences were selected based on the goals and objectives for the Information and Education Plan. In general, the communities in the Watershed can be characterized as either urban centers surrounded by suburban sprawl, such as the Ann Arbor and Ypsilanti, or suburban communities facing issues of rapid development, such as Pittsfield and Scio Townships. Socio-economic variability between communities will also be taken into account when determining messages. The land uses within these communities determine how to tailor the message to Watershed communities.

The following groups were selected: households, with riparian and lakeshore landowners being an important sub-group; local government decision makers; businesses; development community; education/school system; partner organizations; and to a lesser extent, the agricultural community.

With the target audiences identified, water resource-related behaviors associated with the audiences were brainstormed and prioritized according to which behaviors will have the most impact on the goal and objectives of the Information and Education Plan. Concurrently the plan integrates community interest in what is most important to accomplish and what is feasible to accomplish given organizational resources.

What we do in our own backyards has detrimental impacts many homeowners never conceive. The plants in our yards and businesses, and the way we maintain them, are significant sources of water quality and environmental pollution (Swan, 1999). Nonetheless, surveys indicate that less than one-fourth of homeowners rate fertilizers as a water quality concern (Syferd, 1995 and Assing, 1994). The majority of land owners with lawns are not aware of the phosphorus or nitrogen content of the fertilizer they apply or that mulching grass clippings into lawns can reduce or eliminate the need to add fertilizer (Morris and Traxler, 1996). Understanding motivations of homeowners is key to guiding them to behaviors that are less degrading to water resources.

The prioritized messages by target audience, based on current knowledge of audiences' behaviors, are the following:

Households
1. Creekshed awareness: sense of place within watershed, water cycle and how we impact it, including key pollutant sources
2. Water-friendly lawn and garden practices: mowing habits; fertilizer/pesticide use; yard waste disposal; erosion control; landscaping with native plants; water conservation
3. Housekeeping practices and toxics disposal
4. Septic system maintenance
5. Surface water retention: e.g., retaining water via rain barrels and washing cars on lawn

Riparian and Lakeshore Landowners
1. Creekshed awareness: sense of place within watershed, water cycle and how we impact it, including key pollutant sources
2. Riparian land management including importance of vegetated buffers
3. Water-friendly lawn and garden practices: mowing habits; fertilizer/pesticide use; yard waste disposal; erosion control; landscaping with native plants; water conservation
4. Septic system maintenance
5. Housekeeping practices and toxics disposal

Local Government Decision Makers
1. Participation in watershed & education plan network
2. Identification and protection of key habitats and features: aquatic buffers, woodland, wetlands, steep slopes, etc.
3. Coordinate master plans and planning issues with neighboring communities
4. Ensure use of Low Impact Development in development oversight
5. Ensure use of innovative stormwater BMPs

Development Community
1. Advantages of and opportunities for open space protection & financial incentives for conservation
2. Advantages of and opportunities for Low Impact Development
3. Impact of earth moving activities/Importance of soil erosion & sedimentation control practices
4. Identification and protection of key habitats and features: aquatic buffers, woodland, wetlands, steep slopes, etc.
5. Creekshed awareness: sense of place within watershed, water cycle and how we impact it, including key pollutant sources

Businesses
1. Water-friendly lawn and garden practices: mowing habits; fertilizer/pesticide use; yard waste disposal; erosion control; landscaping with native plants; water conservation
2. Proper toxic chemical use, storage & disposal
3. Advantages of and opportunities for innovative stormwater management
4. Storm drain use and awareness

Participation in the Community Partners for Clean Streams Program, through the Washtenaw County Drain Commissioner's Office, provides businesses with information on these messages.

Educators/School Systems
1. Adoption and promotion of state-approved watershed curriculum
2. Creekshed awareness: sense of place within watershed, water cycle and how we impact it, including key pollutant sources
3. Active participation in creekshed activities and stewardship projects
4. Water-friendly lawn practices: mowing habits; fertilizer/pesticide use; yard waste disposal; erosion control; landscaping with native plants; water conservation
5. Partnerships with the private sector

Partners Organizations
1. Creekshed awareness: sense of place within watershed, water cycle and how we impact it, including key pollutant sources
2. Active participation in creekshed activities and stewardship projects
3. Communicate creekshed issues to members and residents
4. Participate in public communications plan network

Agricultural Community
1. Advantages of and opportunities for buffer and filter strips
2. Impact of tillage methods/Importance of agricultural soil erosion & sedimentation control practices
3. Impacts of fertilizer/pesticide use and mitigation options
4. Impacts of livestock waste and mitigation options
5. Opportunities for farmland conservation partnerships

In this world of limited resources, it is necessary to further prioritize the audiences and messages in terms of the level of effort to be directed toward an audience. By asking "Which audience will be most important for our education program so as to restore and protect water quality and quantity?" a prioritization of audiences was determined. The audience priorities for this plan are:
1. Households
2. Riparian and Lakeshore Landowners
3. Local Government Decision Makers
4. Development Community
5. Businesses
6. Educators/School Systems
7. Partner Organizations
8. Agricultural Community

To establish a methodology for reaching the target audiences, a two-pronged strategy was developed and projected for five consecutive years. Effectiveness of the media campaign and the personal communication strategy should be evaluated annually. Results from the evaluation should be used to assess the previous year's efforts and be a guide to shape the work in the coming year. Expect the level of effort to change as success is achieved and positive behavioral changes occur in the coming years. A full review of the Information and Education Plan should be conducted upon completion of the third and fifth years.

One part of the strategy involves passive mechanisms to reach target audiences via multiple mass media outlets. This strategy can include print, radio, television advertising, and direct mail, marketing, door hangers, or point of sale literature. These methods and many more are described in Jennifer Wolf's *Marketing the Environment – Achieving Sustainable Behavior Change through Marketing* (2002), a guidebook to understanding and using commercial marketing techniques to create lasting behavior change. The audiences deemed appropriate by the Workgroup for the strategy were (1) households, (2) riparian and lakeshore landowners, (3) businesses, and (4) agricultural community.

The second prong of the strategy is more hands-on in nature using a tailored approach to reach audiences about targeted behaviors which affect watershed quality and what audiences can do to alter their behavior for the better. The focus of this effort should be on (1) local government decision makers, (2) the development community, (3) businesses, (4) educators/school system, and (5) partner organizations via presentations and other face-to-face interaction/communication. Table 7.1 illustrates the suggested breakdown of communications strategy per target audience.

Table 3.9. Prioritized Target Audiences per Communications Strategy

Communications Strategy	
Mass Media	Personal Communication/Interaction
Households Riparian and Lakeshore Landowners Businesses Agricultural Community	Local Government Decision Makers Development Community Businesses Educators/School Systems Partner Organizations

Information and Education Strategy

The main foci of the first year will be on communicating with household members within the Watershed, with a concerted effort to reach residents along waterways and waterbodies and farmers. Some 85 percent of the efforts to be expended in this first year will be directed toward households, with the remaining 15 percent concentrated on businesses. In the second and third years, efforts focused on businesses will drop down to 10 percent, with a corresponding increase in reaching households. In the fourth and fifth years, the efforts will focus entirely on households with an increased emphasis on farmers and residents in riparian and lakeshore areas.

The primary goal of the first and second years will be to develop awareness within the communities in the Watershed of the water cycle and how we impact it, including key pollutant sources, and a sense of place within Watershed. Educating residents on practices and behaviors they can implement in their lives which will result in improvement and protection of the Watershed will be an emphasis as well. In the third, fourth and fifth years, messages will build on those developed in the preceding years.

HRWC's *Developing a Communications Plan* will be combined with pre-existing information and education plans created by each community (Phase I and II public education plans and SWIPPIs) to guide the process of determining appropriate materials, media, budgets and timeframes, and measurements of progress. However, the following recommended educational message and initiatives can provide the framework for further development of the public communications efforts:

- Acceptable application and disposal of pesticides and fertilizers and simple lawn water quality-friendly maintenance alternatives
- Availability, location and requirements of facilities for disposal or drop-off of household hazardous wastes, travel trailer sanitary wastes, chemicals, grass clippings, leaf litter, animal wastes, and motor vehicle fluids
- Encourage public reporting of the presence of illicit discharges or improper disposal of materials into a separate stormwater drainage
- Preferred cleaning materials and procedures for residential car washing
- Public responsibility for and stewardship of their watershed, and promote awareness of and participation in existing stewardship and monitoring programs
- Management of riparian lands to protect water quality
- Ultimate discharge point and potential impacts of pollutants from the separate storm water drainage system serving their place of residence. For example, promote awareness of stormwater runoff, simple mitigation activities, and the importance of imperviousness to water quality.
- Impact of impaired septic systems on water quality and promote knowledge of maintenance guidelines
- Awareness of the watershed concept, sense of place within the watershed, and the benefits of a healthy watershed
- Importance of proper erosion and soil control measures and existence of current oversight programs
- Promote education of local government employees on water quality-related good housekeeping/pollution prevention
- Alternatives to current development and land use practices within the Watershed
- Build knowledge, awareness, and support of the Watershed plan and its recommendations
- Encourage watershed-friendly business practices and site development (e.g., Washtenaw County's Community Partners for Clean Streams)
- Benefits of proper pet waste and livestock waste handling
- Benefits of water conservation measures for households
- Benefits of landscaping with native plantings

Several programs and initiatives are recommended for initiation in this Watershed plan. Below is a list of subwatershed-wide programs to be implemented in stages I and II of this plan. ‘

1. Targeted Advertising in local papers as appropriate for participating partners. Likely topics include yard and garden maintenance best practices and storm drain awareness.

2. Direct Mail Piece consisting of tip cards, brochure or community calendar. Topics will be similar to advertising.

3. Rain Garden and Rain barrel Promotion through the Washtenaw County Drain Commissioner and the HRWC respectively.

4. HRWC's Adopt-A-Stream Program River monitoring and stewardship program. Program involved 400 volunteers per year monitoring ~75 sites per year.

5. Washtenaw County's River Safe Home Program. The RiverSafe Homes program enables Washtenaw County residents to identify water quality protection activities they currently practice around their homes, and to commit to additional pollution prevention practices that they may not have considered before.

6. Content for Websites, newsletters, and informational booths and material.

Earlier in this chapter, the Action Plan (Table 3.6) presents recommended public information and education strategies listed with details about priority pollutants addressed, costs, evaluative mechanisms, responsible parties, and so on.

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

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

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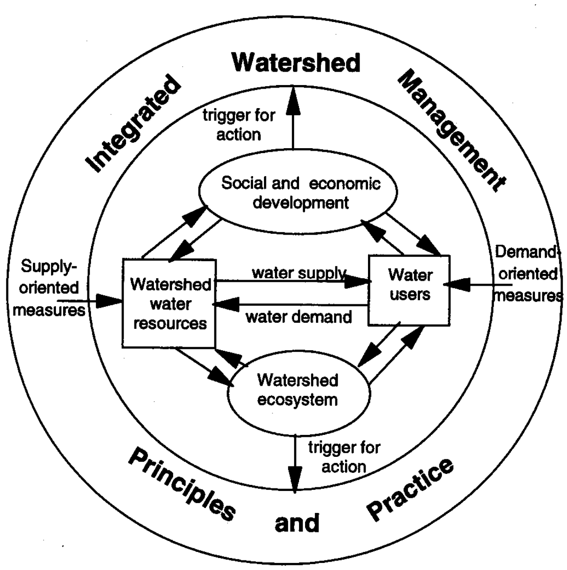
CHAPTER 4:
IMPLEMENTATION AND EVALUATION

This chapter outlines considerations in the implementation and evaluation of the Middle Huron Watershed Management Plan, as well as the interplay between evaluation and implementation, which shapes the revision process. A successful watershed plan is ultimately defined not by what is written on the pages of the plan, but by how the recommended plans and programs are put into action. A successful plan for implementation also recognizes that the state of the watershed changes over time. As such, evaluating the effectiveness and appropriateness of the actions taken to implement the plan, as well as the ability to adapt these actions to the changing conditions of the watershed, is critical.

4.1 INTEGRATED WATERSHED MANAGEMENT AND ADAPTIVE MANAGEMENT

A watershed is a complex, integrated system, and its whole is greater than the sum of its parts. This complexity stems from the ever-changing interaction of social, economic, and biophysical forces. The interplay of these forces, as shown in Figure 4.1, is the basis for the concept of integrated watershed management.

Figure 4.1. Forces Affecting Integrated Watershed Management[1]



Integrated watershed management is, by definition, dynamic in nature. Implementing the Middle Huron Watershed Management Plan in a way that follows the principles of integrated watershed management therefore requires continuous evaluation of the effectiveness of the management alternatives in meeting the Plan's goals and objectives. The concept of "adaptive management" is central to successful implementation of the Plan. Adaptive management incorporates research into conservation action. Specifically, it is the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn.

The goals and recommendations of this Plan are based on the understanding of the conditions of the natural watershed ecosystem at the time this Plan was developed. However, both the conditions of the watershed and the goals and actions will change over time as new information is collected, available resources for implementation are assessed, and the values and needs of the watershed's residents evolve.

As stated by Veissman (1990) in Heathcote's Integrated Watershed Management: Principles and Practices:[2]

> *Watershed management institutions evolve from needs identified at some milestone in time. The problem is that times change, and so do needs. Unfortunately, institutions seem to march on with entrenched constituencies, and many in existence today are addressing yesterday's goals or addressing today's problems with yesterday's practices.*

Changes in social and economic forces can trigger changes in watershed management practices. Similarly, changes in a watershed's ecosystem can indicate a need for altered watershed management practices. Adaptive management recognizes the dynamic interplay of these forces, which implies a need to continually evaluate progress toward meeting the Plan's goals and objectives.

4.2 Watershed Plan Implementation

The communities in the Middle Huron Watershed will implement and report on progress through two primary vehicles. First, all the communities have signed a voluntary Cooperative Agreement with MDEQ to address the TMDL for phosphorus in Ford and Belleville Lakes through the Middle Huron Partnership. Second, the WCDC convenes Washtenaw communities quarterly to discuss and coordinate Phase II stormwater activities. Both of these bodies provide a structure for

- reporting out on progress toward the WMP goals and objectives,
- coordinate regional activities and projects,
- discuss new developments that require attention or action,
- consolidating funding for watershed management activities,
- providing public input and involvement,
- educating community representatives, and
- discussing WMP updates.

To ensure successful implementation, nine key elements should be addressed, as summarized in Table 4.1.

Table 4.1. Nine Key Elements of Successful Watershed Plan Implementation[3]

1.	Appoint a single lead agency to act as an advocate and facilitator for the plan with the community and with political representatives.
2.	Strong linkages to existing programs, including local and regional land use planning processes, water quality and flow monitoring programs, and similar programs, to optimize use of available information and minimize duplication of effort.
3.	Clear designation of responsibilities, timetables, and anticipated costs for project actions.
4.	Effective laws, regulations, and policies to provide a framework for the tasks identified in Element 3.
5.	Ongoing tracking of the degree of implementation of management actions and of the success of those actions once implemented.
6.	Ongoing monitoring and reporting of progress, both to assess the effectiveness of individual actions and to sustain public and political interest in and enthusiasm for the plan.
7.	Ongoing public education and communication programs to consolidate and enhance the social consensus achieved in the planning process.
8.	Periodic review and revision of the plan.
9.	Adequate funding for these activities.

4.2.1 Advisory Committee Structure

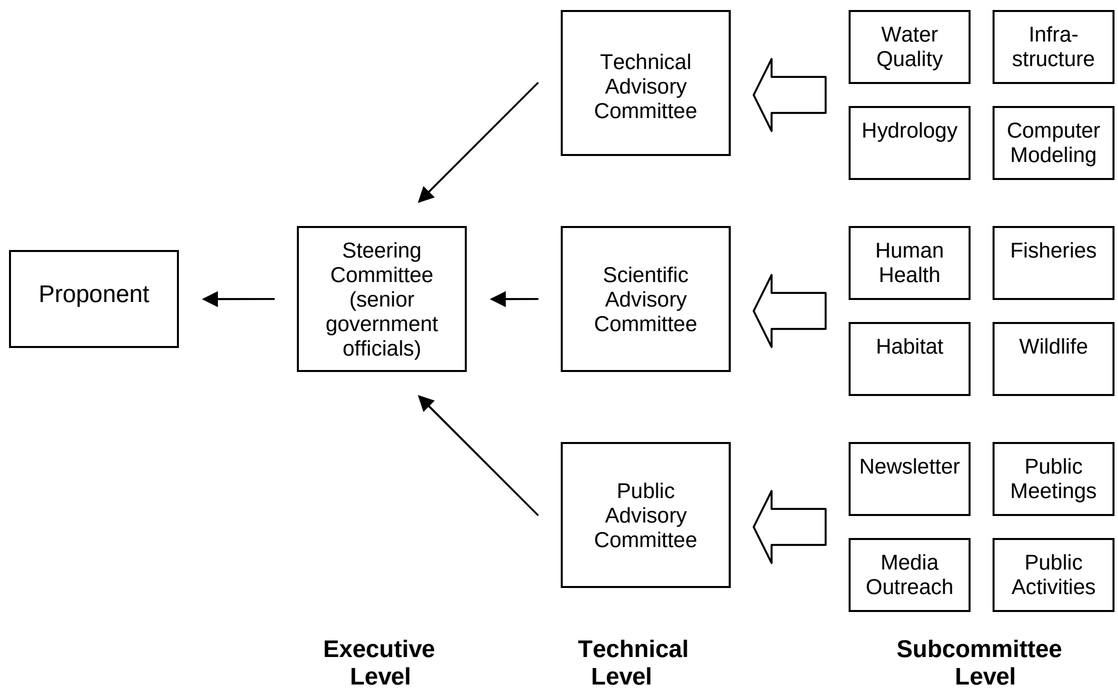
To facilitate implementation of the Middle Huron Watershed Management Plan over time, a framework for a series of working groups within the Middle Huron Partnership Initiative and Washtenaw Phase II Citizen's Advisory Committee will help to provide a useful feedback loop for determining how, and the extent to which, the goals and objectives of the Plan are being successfully implemented. These working groups would ideally be comprised of the following groups of stakeholders:

- Managers, planners, coordinators, and their staff members
- Boards and steering committees
- Volunteers (citizens and watershed stewards)
- Environmental Interest Groups
- Funding Groups

These groups of stakeholders should ultimately allow for input and implementation assistance from a broad cross-section of all stakeholder and interest groups in the watershed. Figure 5.2 provides a theoretical example of a two-tier advisory committee structure that could be employed to oversee the implementation and evaluation of the Middle Huron Watershed Management Plan.

A multi-tiered advisory structure is better suited for large watershed planning projects, as is the case in the Middle Huron Watershed, as opposed to a single-tiered structure which is better suited for smaller, short-term projects.[4]

Figure 4.2. A Typical Two-tier Advisory Committee Structure



A committee structure based on the organization shown in Figure 5.2 could be used to implement, evaluate, and revise the watershed plan over time. The "proponent" (lead agency) in this schematic would be the Washtenaw County Drain Commissioner's Office, which would ultimately provide support for, and oversight of, the activities of the Steering Committee and smaller committee/ subcommittee levels. The "Steering Committee," in this watershed would be the Middle Huron Partners, which is comprised of environmental program managers and staff who recommend final decisions to be coordinated with support from the Huron River Watershed Council and Washtenaw County Drain Commissioner. The "advisory committees" might be staffed by land use planners, commissions, boards, interested citizens, environmental group advocates, scientists, etc. that will pull together various aspects of the data and results during the implementation phases of the Plan.

The importance of public representation and broad stakeholder involvement throughout any advisory committee structure must be stressed, as these individuals are in a position to explain and influence community opinion and help to build support for needed changes. Following the approval of this Plan, the Washtenaw County Drain Commissioner's office and current members of the Middle Huron Partnership should consider an advisory committee structure that allows for involvement by a broad range of stakeholders as discussed above.

The Middle Huron Partnership Initiative

The original 1999 Agreement for Voluntary Reduction of Phosphorus Loading to the Middle Huron states that this cooperative approach to meeting the TMDL will be pursued by the partner communities and agencies, and then reevaluated in 2004 to determine whether the goals have been attained. With the expiration of the 1999 Agreement in April 2004, the partners formed a sub-committee to create a replacement agreement since the phosphorus reduction goal of the TMDL has not yet been attained. The 2004-2009 Agreement was completed in early fall 2004 after review by the partners. All current partners were presented with the opportunity to sign the current agreement; as of completion of this annual report not all of the partners that intend to sign the document have done so. Several of the larger businesses that have NPDES permits to discharge to the middle Huron River Watershed also were approached during the drafting of the Agreement to gain their support as signatories. Interested businesses are included at the end of the Agreement.

Washtenaw County Phase II Citizens Advisory Committee

4.2.2 Community Involvement

Implementation of this watershed plan depends on active participation and involvement of local communities and their citizens. Stakeholders critical to the success of this plan include local officials, local government department heads, public agency representatives, engineers, planners, businesses, residents, citizen groups and homeowner associations. Community involvement activities undertaken in preparation of the original version of this watershed plan include:

- Input from local governments
- Participation of local sub-watershed groups (Creek Groups)
- Program specific community involvement activities

INPUT FROM LOCAL GOVERNMENTS

Policy Advisory Committee

The first task involved in developing the original 1994 Watershed Management Plan was the formation of a Policy Advisory Committee, with members representing each of the communities in the project area. In January 1993, an initial meeting of this group was convened to discuss issues related to nonpoint source pollution in the planning area and individual community concerns. Following this introductory meeting, goals and objectives for controlling water quality were developed and submitted to committee members for review and approval. Since that time the Committee has continued to meet on a regular basis to assist in watershed planning activities throughout the Middle Huron basin. Currently, the Middle Huron Initiative coordinates this Committee.

Project staff has also met with representatives from each municipality independently, so that individual concerns and priorities could be addressed more effectively. These meetings were also conducted to ensure that the recommendations made within this plan are realistic and desirable for each community within the project area. During these sessions, information about nonpoint source pollution and effective BMPs was disseminated. Local government representatives provided information about the policies and practices currently in place within each municipality, local opportunities and/or limitations for improving water quality, and the feasibility of adopting new BMPs.

Finally, a draft Watershed Plan was submitted for comment to key staff and officials in all local communities, as well as to County and State agencies, private sector representatives and citizens that had participated in the planning process. Subsequent to this review, the Washtenaw County Drain Commissioner presented the plan to each community within the project area to inform communities about the Watershed Plan and gain support for implementation of its recommendations. Each community, in turn, formally adopted the plan. The recommendations contained in this Watershed Plan update were the result of formal and informal meetings with community officials and staff since adoption of the initial plan in 1994. This plan update will again be presented to these communities for their collective implementation of the objectives and recommendations.

Technical Advisory Committees

Several Technical Advisory Committees were established to provide input to individual components of this plan. A Committee was established to assist in revising the Drain Commissioner's rules governing the design of stormwater management systems in new developments. Members included staff from local planning, engineering, building inspection and utilities departments. Private engineering and planning consultants were also represented, as well as the Huron River Watershed Council, the County Soil Conservation District and the MDNR. Committee members were provided with working drafts of the Drain Commissioner's rules (including explanations about how revisions work to improve water quality and quantity control) and asked to provide feedback on their practicality for implementation within Washtenaw County. Revised rules were adopted in 1994. Public involvement and review also guided the March 2000 update.

A Technical Advisory Committee was established in 1998 to oversee development of the Malletts Creek Restoration Plan. The Committee included representatives from the City of Ann Arbor Departments of Planning, Engineering, Building, Parks and Utilities; Pittsfield Township Department of Municipal Services; the Washtenaw County Drain Commissioner and Deputy Drain Commissioner; and a representative of the Malletts Creek Association (Malletts Creek Group). The committee met on a monthly basis to provide input and assistance in data collection, modeling, public involvement, final recommendations, timeframe and costs. While some of the recommendations are specific to Malletts, many, especially those related to ordinance revisions and public education are or will be implemented community wide.

Similar committees have been established for individual project components of this plan including: Land Use Decision Makers, Middle Huron Initiative and the Impervious Surface Reduction Study, and development of Salem Township’s model stormwater ordinance. Their feedback provided the basis for numerous recommendations of this plan update.

INPUT OF LOCAL SUB-WATERSHED GROUPS (CREEK GROUPS)

Creek groups have contributed a unique community involvement component to the development of this Watershed Plan update. The Malletts Creek, Allens Creek, Millers Creek and Ford Lake groups have completed separate management plans on their own to guide and prioritize their activities; the Fleming Creek Group is in the process of doing the same. These management plans establish goals and objectives, desired uses, impairments to water resources and recommendations as viewed by the citizen-stakeholders who have written them. The Creek Groups secured input and review from local governments and agencies in the planning area. The Malletts Creek Group Management Plan has been adopted by the Ann Arbor City Council and Pittsfield Township Board; Ypsilanti City Council and the Superior Township Board have adopted The Ford Lake Management Plan. The Millers Creek Watershed Improvement Plan was approved by the State of Michigan and is included as an example of good watershed planning by the U.S. EPA.

This document, the *Watershed Plan for the Huron River in the Ann Arbor - Ypsilanti Metropolitan Area*, incorporates these components not simply as feedback for the update, but as a basic framework for updating the plan. Recommendations made in this document represent a collaboration effort between the Huron River Watershed Council, the Office of the Washtenaw County Drain Commissioner, the individual creek groups and the communities within which they operate.

Staff from the Huron River Watershed Council and the Washtenaw County Drain Office have met, and will continue to meet with creek groups, throughout the process of developing and implementing watershed plans. Support of these groups will continue to foster community buy-in for Watershed Plan implementation and creek restoration activities. Representatives of the Huron River Watershed Council and the Drain Office will remain involved in these groups to assist in group development, management planning, grant proposals, policy and technical assistance, and special event coordination. In addition, creek group representatives will continue to advise the Drain Office and the Huron River Watershed Council in program development as they have for the Malletts Creek Restoration Project, the Huron River Watershed Council's Adopt-A-Stream program and others.

PROGRAM SPECIFIC COMMUNITY INVOLVEMENT ACTIVITIES

Several programs currently under the coordination of the Huron River Watershed Council and the Drain Commissioner's Office are the result of recommendations made in the 1994 Watershed Plan: Community Partners for Clean Streams, Information and Education Campaign and the GIS Initiative. Other programs have continued or expanded as recommended by that 1994 Plan: Adopt-A-Stream, and Land Use Decision Makers.

It is important to recognize the instrumental role of these programs in defining the objectives for this Watershed Plan update and in developing specific recommendations for the future. Of particular note is the insight gained through two-way dialogue with stakeholders in a variety of public meetings, focus groups, steering committees, workshops and stewardship activities. Additionally, these programs have provided venues for disseminating information about water quality issues and effective methods for stormwater management and mitigation of nonpoint source pollution. Significant contributions of these individual programs include:

Community Partners for Clean Streams (CPCS)

Community Partners for Clean Streams (CPCS) has enlisted over 150 non-residential landowners, most of whom are within the project area, to incorporate additional best management practices into their day-to-day activities. Practices include maintenance of stormwater structures, equipment and vehicle maintenance, building and pavement maintenance, landscape maintenance, waste management, and site construction and design.

This program has been enlarged to broaden its availability within the project area. Close coordination with other programs such as Malletts Creek Restoration should be fostered to facilitate successful implementation of both programs and make the most effective use of available resources. Creek groups can become involved by encouraging increased participation in the program.

Information and Education Campaign

The Huron River Watershed Council's Information and Education campaign has brought the message of water resource stewardship to individual households. Informational tip cards have been mailed to residents within Salem Township, the City of Ann Arbor and the City of Ypsilanti. The tip cards provide residents with the proper knowledge base to incorporate creek protection into everyday activities. Tip card topics include lawn fertilization, water conservation, septic system maintenance, hazardous material disposal and storm water runoff. Media outlets such as the Ann Arbor News and local radio have been used to convey and reemphasize these same messages. The program has shown success in changing behavior; In the Spring of 1999, a soil testing advertisement resulted in over 200 lawn soil samples being sent to Michigan State University for phosphorus testing. This is about a hundred-fold increase in testing over previous years.

Strategic information and education must continue to achieve permanent, long-term changes in peoples' behavior. (The continuing education that has fostered solid waste recycling is a good example of what it takes to secure widespread public understanding and buy-in.) The existing coordination between this program and the City of Ann Arbor's Phase I Stormwater Permit education should be fostered. Additional coordination should be sought as Phase II regulations are implemented in planning area communities.

Adopt-a-Stream

The program has proved to be a powerful tool in raising public awareness and appreciation of local water resources in the project area. Through experience gained while sampling for life within the creeks, mapping waterways and surveying habitat, residents have become aware of the threats and impairments to water resources. In many cases, participants have become further involved in stewardship activities: founding creek groups, submitting input to local planning decisions, running for public office and participating in creek cleanups. Input from creek groups has been particularly instrumental in the development of this Watershed Plan.

The water quality, habitat and bio-monitoring data collected by adopters has been analyzed and published. These Creek Reports have been disseminated to the public and to local decision makers to increase awareness of water quality threats and to enlist support for creekshed protection.

Land Use Decision Makers Program

The Land Use Decision Makers Program introduced and furthered the notion of watershed protection to public officials. Key considerations in watershed protection including impervious cover, first flush detention, bank-full treatment, native landscaping and riparian corridor conservation, are now commonly discussed as elements of master planning and site plan review.

Ordinances to protect water resources have been adopted or are under consideration in every community within the planning area.

The existing presentation available to decision makers has been updated. As new programs and stormwater and site design BMPs evolve, they can be included into the presentation to provide a comprehensive picture of watershed stewardship activities within the planning area.

Malletts Creek Restoration
The Malletts Creek Restoration Plan is a regional model for watershed restoration. A Technical Advisory Committee made up of engineers, planners, public officials and citizen activists guided the Restoration Plan. Four public meetings were held in conjunction with development of the Restoration Plan to incorporate public input into the overall strategy of restoration. Focus groups were convened to involve businesses, homeowners, and other potential stakeholders into the early stages of plan development. Additional opportunities for public involvement will be available as implementation of specific restoration projects begin.

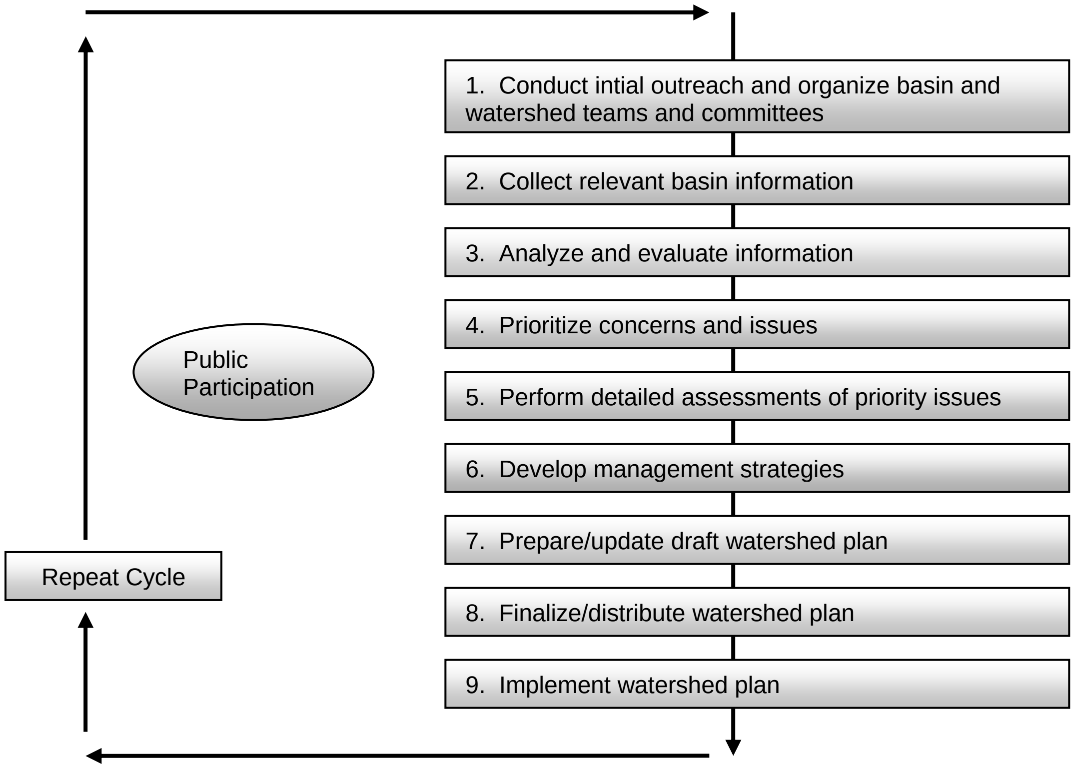
Geographic Information Project
Washtenaw County and the Huron River Watershed Council are to develop a comprehensive Geographic Information Systems (GIS) database to provide local decision makers and citizen activists with a single comprehensive source of digital land information: land use, natural features, demographics, etc. A steering committee made up of individual stakeholders will be convened to secure community input and help guide implementation of this project.

4.2.3 Watershed Plan Revisions

The original version of this watershed plan was revised once before in 2000, roughly six years after initial publication. This current update follows seven years later. It is the intent of the partners in the watershed that this plan should be revised, on average, every five years. Several of the collaborative groups previously mentioned in this plan will continue to meet on a regular basis to ensure that the plan is being implemented on a watershed-wide basis. Many partners have a vested interest in assuring that the plan is implemented. In addition, updates regarding watershed plan implementation and activities related to it and subwatershed plans will be updated on the WCDC’s website.

Applying the concept of adaptive management to the revision process is essential for successful implementation of the plan. Evaluation of a specific management alternative (using the methods discussed in the next section) may suggest a change is needed to affect the desired result, or a shift in focus from one management alternative to another may be needed. The iterative nature of watershed planning, implementation, and revision is shown below in Figure 4.3.

Figure 4.3. Typical Steps in a Watershed Management Cycle[5]



4.3 Evaluation Methods for Measuring Success

How can we measure whether the management alternatives listed in the Action Plan have been successful at reducing pollutants? That is to say, have changes in behavior occurred among target audiences, how many management practices have been implemented, or have documented improvements in water quality occurred? There are a number of different ways to measure progress toward meeting the goals for the Middle Huron Watershed. Objective markers or milestones will be used to track the progress and effectiveness of the management practices in reducing pollutants to the maximum extent possible (see Table 4.2). Evaluating the management practices that are implemented helps establish a baseline against which future progress at reducing pollutants can be measured. The U.S. EPA identifies the following general categories for measuring progress:

1. **Tracking implementation over time.** Where a BMP is continually implemented over the permit term, a measurable goal can be developed to track how often, or where, this BMP is implemented.
2. **Measuring progress in implementing the BMP.** Some BMPs are developed over time, and a measurable goal can be used to track this progress until BMP implementation is completed.

3. **Tracking total numbers of BMPs implemented.** Measurable goals also can be used to track BMP implementation numerically, e.g., the number of wet detention basins in place or the number of people changing their behavior due to the receipt of educational materials.
4. **Tracking program/BMP effectiveness.** Measurable goals can be developed to evaluate BMP effectiveness, for example, by evaluating a structural BMP's effectiveness at reducing pollutant loadings, or evaluating a public education campaign's effectiveness at reaching and informing the target audience to determine whether it reduces pollutants to the MEP. A measurable goal can also be a BMP design objective or a performance standard.
5. **Tracking environmental improvement.** The ultimate goal of the NPDES storm water program is environmental improvement, which can be a measurable goal. Achievement of environmental improvement can be assessed and documented by ascertaining whether state water quality standards are being met for the receiving water body or by tracking trends or improvements in water quality (chemical, physical, and biological) and other indicators, such as the hydrologic or habitat condition of the water body or watershed.

Although achievement of water quality standards is the goal of plan implementation, the Steering Committee members need to use other means to ascertain what effects individual and collective BMPs have on water quality and associated indicators. In-stream monitoring, such as physical, chemical, and biological monitoring, is ideal because it allows direct measurement of environmental improvements resulting from management efforts. Targeted monitoring to evaluate BMP-specific effectiveness is another option, whereas ambient monitoring can be used to determine overall program effectiveness. Alternatives to monitoring include using programmatic, social, physical, and hydrological indicators. Finally, environmental indicators can be used to quantify the effectiveness of BMPs.

Environmental indicators are relatively easy-to-measure surrogates that can be used to demonstrate the actual health of the environment based on the implementation of various programs or individual program elements. Some indicators are more useful than others in providing assessments of individual program areas or insight into overall program success. Useful indicators are often indirect or surrogate measurements where the presence of the indicator points to likelihood that the activity was successful. Indicators can be a cost-effective method of assessing the effectiveness of a program because direct measurements sometimes can be too costly or time-consuming to be practical. A well-known example is the use of fecal coliform bacteria as an indicator of the presence of human pathogens in drinking water. While *E. coli* is now the preferred indicator of bacterial contamination, fecal coliform has been successfully used for more than a century and is still in widespread use for the protection of public health from waterborne, disease-causing organisms.

Table 4.2 presents environmental indicators that have been developed specifically for assessing stormwater programs.[6] Water quality indicators 1 through 16—physical, hydrological, and biological indicators—can be integrated into an overall assessment of the program and used as a basis for the long term evaluation of program success. Indicators 17 through 26 correspond more closely to the administrative and programmatic indicators and practice-specific indicators.

Table 4.2. Environmental Indicators for Assessing Stormwater Programs

Category	#	Indicator Name
Water Quality Indicators This group of indicators measures specific water quality or chemistry parameters.	1	Water quality pollutant constituent monitoring
	2	Toxicity testing
	3	Loadings
	4	Exceedence frequencies of water quality standards
	5	Sediment contamination
	6	Human health criteria
Physical and Hydrological Indicators This group of indicators measures changes to or impacts on the physical environment.	7	Stream widening/downcutting
	8	Physical habitat monitoring
	9	Impacted dry weather flows
	10	Increased flooding frequency
	11	Stream temperature monitoring
Biological Indicators This group of indicators uses biological communities to measure changes to or impacts on biological parameters.	12	Fish assemblage
	13	Macroinvertebrate assemblage
	14	Single species indicator
	15	Composite indicator
	16	Other biological indicators
Social Indicators This group of indicators uses responses to surveys, questionnaires, and the like to assess various parameters.	17	Public attitude surveys
	18	Industrial/commercial pollution prevention
	19	Public involvement and monitoring
	20	User perception
Programmatic Indicators This group of indicators quantifies various non-aquatic parameters for measuring program activities.	21	Number of illicit connections identified/corrected
	22	Number of BMPs installed, inspected and maintained
	23	Permitting and compliance
	24	Growth and development
Site Indicators This group of indicators assesses specific conditions at the site level.	25	BMP performance monitoring
	26	Industrial site compliance monitoring

Measurement and evaluation are important parts of planning because they can indicate whether or not efforts are successful, and they also provide a feedback loop for improving project implementation as new information is gathered. If the watershed partners are able to show results, then the plan likely will gain more support from the partnering communities and agencies, as well as local decision makers, and increase the likelihood of project sustainability and success. Monitoring and measuring progress in the watershed necessarily will be conducted at the local level by individual agencies and communities, as well as at the watershed level, in order to assess the ecological affects of the collective entity actions on the health of the Huron River and its tributaries in the Middle Huron Watershed.

Monitoring and measuring progress in the watershed will be two-tiered. First, individual agencies and communities will monitor certain projects and programs on the agency and community levels to establish effectiveness. For example, a community-based lawn fertilizer education workshop will be assessed and evaluated by that community. Also, with the implementation of a community project such as the retrofitting of detention ponds, the individual community responsible for the implementation of that task may monitor water quality/quantity parameters before and after the retrofit in order to measure the improvements. Secondly, there will be a need to monitor progress and effectiveness on a regional – subwatershed or watershed – level in order to assess the ecological affects of the collective community and agency actions on the health of the river and its tributaries.

The watershed partners recognize the importance of a long-term water quality, quantity and biological monitoring programs to determine where to focus resources as they progress toward meeting collective goals. These physical parameters will reflect improvements on a regional scale. The monitoring program should be established on a watershed scale since this approach is the most cost effective and consistent if sampling is done by one entity for an entire region.

4.3.1 Qualitative Evaluation Techniques

As seen in the Middle Huron Action Plan, and the subwatershed plans in the appendices, there are and will be a range programs and projects implemented—ranging from wet detention ponds to public education—to improve water quality, water quantity and habitat in the Middle Huron Watershed. Finding creative ways to measure the effectiveness of each of these individual programs is a challenge. Many of the evaluation techniques utilized for individual projects are listed in the Action Plan or subwatershed plans themselves.

A set of qualitative evaluation criteria can be used to determine whether pollutant loading reductions are being achieved over time and whether substantial progress is being made toward attaining water quality standards in the watershed. Conversely, the criteria can be used for determining whether the Plan needs to be revised at a future time in order to meet standards. A summary (Table 4.3) of the methods provides an indication of how these programs might be measured and monitored to evaluate success in both the short and the long term. Some of these evaluations may be implemented on a watershed basis, such as a public awareness survey to evaluate public education efforts, but most of these activities will be measured at the local level. By evaluating the effectiveness of these programs, communities and agencies will be better informed about public response and success of the programs, how to improve the programs, and which programs to continue. Although many of these methods of measuring progress are not direct measures of environmental impact, it is fair to assume that successful implementation of these actions and programs, collectively and over time, will have a positive impact on in-stream conditions.

Table 4.3. Summary of qualitative evaluation techniques for the Middle Huron Watershed

Evaluation Method	Program/Project	What is Measured	Pros and Cons	Implementation
Public Surveys	Public education or involvement program/project	Awareness; Knowledge; Behaviors; Attitudes; Concerns	Pro: Moderate cost. Con: Low response rate.	Pre- and post- surveys recommended. By mail, telephone or group setting. Repetition on regular basis can show trends. Appropriate for local or watershed basis.
Written Evaluations	Public meeting or group education or involvement project	Awareness; Knowledge	Pro: Good response rate. Low cost.	Post-event participants complete brief evaluations that ask what was learned, what was missing, what could be done better. Evaluations completed on-site.
Stream Surveys	Identify riparian and aquatic improvements.	Habitat; Flow; Erosion; Recreation potential; Impacts	Pro: Current and first-hand information. Con: Time-consuming. Some cost involved.	Identify parameters to evaluate. Use form, such as Stream Crossing Inventory, to record observations. Summarize findings to identify sites needing observation.
Visual Documentation	Structural and vegetative BMP installations, retrofits	Aesthetics. Pre- and post- conditions.	Pro: Easy to implement. Low cost. Con: Good, but limited, form of communication.	Provides visual evidence. Photographs can be used in public communication materials.
Phone call/ Complaint records	Education efforts, advertising of contact number for complaints/ concerns	Number and types of concerns of public. Location of problem areas.	Con: Subjective information from limited number of people.	Answer phone, letter, emails and track nature of calls and concerns.
Participation Tracking	Public involvement and education projects	Number of people participating. Geographic distribution of participants. Amount of waste collected, e.g. hazardous waste collection	Pro: Low cost. Easy to track and understand.	Track participation by counting people, materials collected and having sign-in/evaluation sheets.
Focus Groups	Information and education programs	Awareness; Knowledge; Perceptions; Behaviors	Pro: Instant identification of motivators and barriers to behavior change. Con: Medium to high cost to do well.	Select random sample of population as participants. 6-8 people per group. Plan questions, facilitate. Record and transcribe discussion.

Adapted from: Lower One SWAG, 2001

4.3.2 Quantitative Evaluation Techniques

In addition to measuring the effectiveness of certain specific programs and projects within communities or agencies, it is beneficial to monitor the long-term progress and effectiveness of the cumulative watershed efforts in terms of water quality, water quantity and biological health. Watershed-wide long-term monitoring will address many objectives established for the Middle Huron Watershed. A monitoring program at the watershed level will require a regional perspective and county or state support. Wet and dry weather water quality, stream flow, biological and other monitoring will afford communities and agencies better decision making abilities as implementation of this plan continues. Suggestions for the monitoring program are presented below. Details for the monitoring program will be decided and approved on an ongoing basis by the various advisory bodies in the watershed.

Parameters and Establishing Targets for River Monitoring
Beyond the data collected for the original Watershed Management Plan and its updates, it was recognized that there is a need to augment the type of parameters monitored, the number of locations in the watershed, and the frequency of wet weather monitoring. A holistic monitoring program has been established to help communities and agencies to identify more accurately water quality and water quantity impairments and their sources, as well as how these impairments are impacting the biological communities that serve as indicators of improvements.

Parameters
The long-term monitoring program has been established so that progress can be measured over time. The program includes the following components:

- Stream flow monitoring to determine baseflows and track preservation and restoration activities upstream. This is ongoing at eight tributary sites and one river site in the watershed. Additionally, physical and hydrological indicators such as stream widening/downcutting, physical habitat, stream temperature, and a variety of geomorphology measures are collected at HRWC Adopt-a-Stream sites throughout the waterhshed.

- Wet and dry weather water quality data are being collected in the watershed to identify specific pollution source areas within the watershed, and measure impacts of preservation and restoration activities upstream. Included as water quality indicators are: water quality pollutant monitoring; and loadings. However, due to limited funding, only limited collection of this data has been performed. More regular collection of these parameters along with exceedence frequencies of water quality standards, sediment contamination, and human health criteria need to be added to complete the program.

- Biological monitoring of macroinvertebrates is conducted regularly at sites throughout the watershed. Additional monitoring of fish and mussels would improve the scope of biological knowledge. These indicators are used as measures of the potential quality and health of the stream ecosystem. Include as biological indicators: fish assemblage; macroinvertebrate assemblage; single species indicators; composite indicators; and other biological indicators.

- Identification of major riparian corridors and other natural areas is being conducted via HRWC's Bioreserve Program in order to plan for recreational opportunities, restoration and linkages.

- There is a need to review and revise currently established benchmarks and dates based on new data.

- The monitoring within the watershed maximizes the use of volunteers to encourage involvement and stewardship.

Based on the goals of the watershed, the monitoring program currently includes measurement of Dissolved Oxygen (DO), Bacteria (*E. coli*), Phosphorus (P), total suspended solids (TSS), Nitrate-Nitrite, stream flow, conductivity, fisheries (limited), aquatic macroinvertebrates, temperature, physical habitat, and channel structure. However, many of these measures are collected on a limited basis, and subject to insecure funding. Establishing a sustainable plan for monitoring is a goal for this watershed.

Establishing Targets

Measuring parameters to evaluate progress toward a goal requires the establishment of targets against which observed measurements are compared. These targets are not necessarily goals themselves, because some of them may not be obtainable realistically. However, the targets do define either Water Quality Standards, as set forth by the State of Michigan, or scientifically-supported numbers that suggest measurements for achieving water quality, water quantity and biological parameters to support state designated uses such as partial or total body contact, and fisheries and wildlife. Using these scientifically-based numbers as targets for success will assist the advisory bodies in deciding how to improve programs to reach both restoration and preservation goals and know when these goals have been achieved. These targets are described below.

Dissolved Oxygen: The Michigan Department of Environmental Quality (MDEQ) has established state standards for Dissolved Oxygen (DO). The requirement is no less than 5.0 mg/l as a daily average for all warm water fisheries. The Administrative Rules state:

> . . . for waters of the state designated for use for warmwater fish and other aquatic life, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 4 milligrams per liter, or below 5 milligrams per liter as a daily average, at the design flow during the warm weather season in accordance with R 323.1090(3) and (4). At the design flows during other seasonal periods as provided in R 323.1090(4), a minimum of 5 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.
>
> (Michigan State Legislature. 1999)

Bacteria: State standards are established for Bacteria (*E. coli*) by the MDEQ. For the designated use of total body contact (swimming), the state requires measurements of no more than 130 *E. coli* per 100 milliliters as a 30-day geometric mean during 5 or more sampling events representatively spread over a 30-day period. For partial body contact (wading, fishing, and canoeing) the state requires measurements of no more than 1000 *E. coli* per 100 milliliters based on the geometric mean of 3 or more samples, taken during the same sampling event. These uses and standards will be appropriate for and applied to the creek and those tributaries with a base flow of at least 2 cubic feet per second.

Phosphorus: State water quality standards for phosphorus require that “phosphorus which is or may readily become available as a plant nutrient shall be controlled from point source discharges to achieve 1 mg/l of total phosphorus as a maximum monthly average effluent concentration unless other limits, either higher or lower, are deemed necessary and appropriate.” In the case of the Middle Huron Watershed, the Ford and Belleville Lakes TMDL defines effluent standards for point sources (see Section 2.5.1) and establishes an environmental standard of 50 µg/L at Ford Lake and 30 µg/L at Belleville Lake. The State also requires that “nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi or bacteria which are or may become injurious to the designated uses of the waters of the state.” Monitoring frequency and number of sites for phosphorus and nitrogen needs to be increased to capture seasonal variation and dry and wet weather conditions, and effectively estimate changes in loading of these nutrients.

Total Suspended Solids/Sediment: No numerical standard has been set by the state for Total Suspended Solids (TSS) for surface waters. However, the state requires that “the addition of any dissolved solids shall not exceed concentrations which are or may become injurious to any designated use.” To protect the designated uses of fisheries and wildlife habitat, as well as the desired recreational and aesthetic uses of the surface waters in the watershed, there are recommended targets established on a scientific basis. From an aesthetics standpoint, it is recommended that TSS less than 25 mg/l is “good”, TSS 25-80 mg/l is “fair” and TSS greater than 80 mg/l is “poor.”[7] The TSS target, therefore, will be to maintain TSS below 80 mg/l in dry weather conditions. Another measurement that can be used to determine the impacts of sediment loading is to determine the extent of embeddedness of the substrate (how much of the stream bottom is covered with fine silts) and the bottom deposition (what percentage of the bottom is covered with soft muck, indicating deposition of fine silts). These are measurements taken by the Surface Water Assessment Section (SWAS) protocol habitat assessment conducted by MDEQ every five years, and by the Adopt-A-Stream program more frequently. Rating categories are from “poor” to “excellent.” The target should be to maintain SWAS “excellent” and “good” designations at sites where they currently exist, and to improve “fair” and “poor” sites to “good.” Further standards for TSS are established by TMDLs for Malletts Creek and Swift Run (see Section 2.5.1)

MDEQ, USGS and U.S. EPA are currently recommending using the alternate measure of Suspended Sediment Concentration (SSC) as a more accurate measure for open channel monitoring. While this may be true, the Middle Huron Monitoring Program cannot make a rapid change in measures for several reasons. First, the analytical lab at the Ann Arbor Water Treatment Plant does not conduct SSC analyses. This would necessitate alternative laboratory arrangements that would add logistical difficulty and expense. Second, biota TMDLs for Malletts Creek and Swift Run use a TSS standard. SSC measures may be inconsistent with these limits. Finally, the program has been monitoring progress toward meeting the TMDL for over five years. It is unclear if the new measure will be comparable to past data. The Middle

Huron Partners will consider these implications and plan for a possible transition to SSC at some point in the future.

Stream Discharge: Stream flow, or discharge, for surface waters do not have a numerical standard set by the state. Using the health of the fish and macroinvertebrate communities as the ultimate indicators of stream and river health is most useful in assessing appropriate flow. Recommended flow targets for the river and its tributaries will be established once the necessary research has been conducted that will determine the natural, pre-development hydrology and current hydrology. Peak flow data is needed to compare more accurately observed flow to the target flow. As describe in chapter two, USGS stream gages are located on the Huron River between Argo and Geddes Dams and on Malletts Creek near its mouth. These provide continuous measurement of discharge. HRWC also has a set of sensor that have been deployed in Millers Creek and Fleming Creek, and in 2007 in Traver Creek and Swift Run. The City of Ann Arbor deployed level sensors in Allens Creek, including a specialized sensor that can account for backflow situations. Data generated by these stations can assist in establishing an appropriate flow targets and assessing any progress made toward such a goal, as well as contributing to loading calculations.

Conductivity: Conductivity measures the amount of dissolved ions in the water column and is considered an indicator for the relative amount of some types of suspended material in the stream. The scientifically-established standard for conductivity in a healthy Michigan stream is 800 microSiemens (μS), which should be the goal for the Huron River and its tributaries. Levels higher than the standard may indicate the presence of suspended materials from stormwater runoff, failing septics, illicit connections, ground water seeps or other sources.

Fisheries: Numerical or fish community standards have not been set by the state. However, the Michigan Department of Environmental Quality has developed a system to estimate the health of the predicted fish communities through the SWAS 51 sampling protocol. This method collects fish at various sites and is based on whether or not certain expected fish species are present, as well as other habitat parameters; fish communities are assessed as poor, fair, good, or excellent. The state conducts this protocol every five years in the Huron River Watershed. The target should be to maintain SWAS 51 scores of "excellent" and "good" at sites where they currently exist, and to improve "fair" and "poor" sites to "good." The SWAS 51 protocol also identifies whether or not there are sensitive species present in the Huron River and its tributaries, which would indicate a healthy ecosystem. Certain species are especially useful for demonstrating improving conditions. These species tend to be sensitive to turbidity, prefer cleaner, cooler water, and their distribution in the Huron Watershed is currently limited. The target is to continue to find species currently found in self-sustaining population numbers, at a minimum. Improvements in habitat and water quality should also result in the expansion or recruitment of additional species.

Benthic Macroinvertebrates: Similar to the assessment of fish communities, the state employs the GLEAS 51 protocol for assessing macroinvertebrate communities on a five-year cycle for the Huron River Watershed. The HRWC Adopt-A-Stream program monitors macroinvertebrate health and physical habitat on 30 sites in the Middle Huron Watershed using an adaptation of the GLEAS 51 procedure. The sites are monitored for macroinvertebrates two or three times each year and periodically for physical habitat health. The monitoring target for macroinvertebrate communities will be to increase MDEQ and Adopt-A-Stream monitoring sites to improve the existing database and attain GLEAS 51 scores of at least "fair" at sites that currently are "poor," and improve "fair" sites to "good," while maintaining the "good" and "excellent" conditions at the remaining sites.

Temperature: The state lists temperature standards only for point source discharges and mixing zones – not ambient water temperatures in surface water. However, recommendations for water temperature can be generated by assessing fish species' tolerance to temperature change and these guidelines are found within the statute. Although some temperature data have been collected in the Middle Huron system by the HRWC Adopt-A-Stream program and as part of the monitoring for the Middle Huron Partnership Initiative, additional studies are needed to establish average monthly temperatures and whether increased temperatures are limiting biota habitat.

Wetlands: An annual review should be done of MDEQ wetland permit information and local records in order to track wetland fills, mitigations, restoration and protection to establish net loss or gain in wetlands in the watershed. The target for this parameter is to track the net acres of wetland in the watershed to determine action for further protection or restoration activities. In addition, the Bioreserve Project should be completed to capture additional small, non-regulated wetlands. Once identified, these should also be tracked as above.

Details regarding responsible parties, monitoring standards, sampling sites, and frequency of monitoring for qualitative and quantitative evaluation techniques need to be periodically reviewed by the Middle Huron Partners and subwatershed groups. Results from monitoring and progress evaluation are reported through a variety of mechanisms. The Middle Huron Partnership Initiative reports on progress toward the Ford and Belleville Lakes TMDL every two years, on average. The most recent version of this report is included in Appendix Q. Many of the communities and other responsible agencies in the Middle Huron submit annual reports as part of Phase II stormwater compliance. HRWC produces a summary of results on the Adopt-a-Stream program once per year.

4.3.3 Evaluation Monitoring for the Middle Huron Watershed

Based on an evaluation of the above information, the goals and objectives of this plan, and the causes and sources of water quality impairments in critical areas, the monitoring plan detailed in Table 4.4 has been established. Monitoring sites included in this plan are shown in Figure 4.4. This plan is contingent upon funding and participation of community partners and monitoring agencies.

The monitoring plan is based around four programs administered by three organizations. First, HRWC's Adopt-a-Stream Program collects data on benthic macroinvertebrates three times a year, including a special collection of winter stoneflies. Adopt also does a complete stream habitat assessment of each site every 4-5 years, which includes a number of geomorphic characteristics along with general habitat characteristics as with the MDEQ protocol. Adopt collectors also sample for water conductivity at each macroinvertebrate event. Summer temperatures are also documented every 5 years. The Adopt program uses volunteers to collect the vast majority of the data. Results from this program are included in section 2.4

The second program is MDEQ's rotational watershed assessments. MDEQ returns to the watershed every five years to collect benthic macroinvertebrates, habitat assessment data and, in some cases, a suite of water chemistry parameters. Site selection varies each year.

HRWC also administers the Middle Huron Tributary Monitoring Program on behalf of the Middle Huron Partnership. HRWC uses volunteers and staff to collect water samples and deliver to the Ann Arbor Water Treatment Plant for analysis. Analytes include total phosphorus, nitrates, nitrites, total suspended solids and E. coli. Volunteers also collect stream discharge data from all ten sites to allow for the calculation of pollutant loads. Currently, data is collected once or twice per month (depending on site) with additional storm event and high flow samples collected opportunistically during the April to September growing season.

Finally, MDEQ conducted a water quality monitoring of six lake sites in Ford and Belleville Lakes and two sites on the Huron River. Nutrients and other parameters were collected once per month from April to September. This program was in effect through 2006 when it was halted due to funding cuts. It is anticipated that the program will restart once funding is restored.

Table 4.4 Middle Huron River Watershed Monitoring and Evaluation

Monitoring Site[1]	Parameter Target	Type of Analysis	Protocol	Frequency	Test Agent
Huron River Adopt (24,26,61,62) Middle Huron (MH01) MDEQ (HR1, HR2, F1, F2 F3, F4, B1, B2, B3, B4)	S,N,DO,T,I, B, Bio[2]	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC, MDEQ[3]
		Total Suspended Solids	SM20 2540 D[5]	1x/Mo Apr-Sept	HRWC to AA WTP[4]
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1x/Mo Apr-Sept	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1x/Mo Apr-Sept	HRWC to AA WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC, MDEQ
		Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
Mill Creek Adopt (31,32,33,34,55, 57,79,80) Middle Huron (MH02A, MH02B)	S, N, DO, T, I, B, Bio	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC, MDEQ
		Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC, MDEQ
Boyden Creek Adopt (2,3,4)	Bio, T, I	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC
		Conductivity	HRWC Protocol	2-3x/year	HRWC
		Avg Max Daily Summer Temp	HRWC Protocol	3 yr interval:Summer	HRWC
Honey Creek Adopt (18,19,20,22) Middle Huron (MH03)	S, N, DO, T, I, B, Bio	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC, MDEQ
		Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC, MDEQ

Monitoring Site	Parameter Target	Type of Analysis	Protocol	Frequency	Test Agent
Allens Creek Middle Huron (MH04)	S, N, DO, T, I, B	Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP
Traver Creek Adopt (42,43) Middle Huron (MH05A, MH05B)	S, N, DO, T, I, B, Bio	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC, MDEQ
		Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC, MDEQ
Millers Creek Adopt (35,72,73,74,75, 76,77,78,86) Middle Huron (MH08)	S, N, DO, T, I, B, Bio	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC, MDEQ
		Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC, MDEQ
Malletts Creek Adopt (27,28,29,56) Middle Huron (MH07)	S, N, DO, T, I, B, Bio	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC, MDEQ
		Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC, MDEQ

Monitoring Site	Parameter Target	Type of Analysis	Protocol	Frequency	Test Agent
Swift Run Adopt (41) Middle Huron (MH09)	S, N, DO, T, I, B, Bio	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC, MDEQ
		Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC, MDEQ
Fleming Creek Adopt (9,11,12,13,84) Middle Huron (MH06)	S, N, DO, T, I, B, Bio	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC, MDEQ
		Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC, MDEQ
Superior Drain #1 Middle Huron (MH10)	S, N, DO, T, I, B	Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP

1) Adopt = HRWC Adopt-a-Stream; Middle Huron = Middle Huron Partners tributary nutrient monitoring; MDEQ = DEQ lake monitoring

2) S= Sediment; N= Nutrients; DO= Dissolved Oxygen; T= Temperature; I= Ions; B= Bacteria; Bio= Biota

3) Specific sites will be included as part of MDEQ Water Bureau's rotational water quality monitoring program; Lakes program monitors water quality monthly

4) HRWC staff and volunteers to collect samples and deliver to Ann Arbor Water Treatment Plant for analysis under their direction.

5) Analytical protocols follow “Standard Methods for the Examination of Water and Wastewater”, 20th edition, by the American Waterworks Association

4.4 EVALUATION OF PREVIOUS PLANS

4.4.1 Watershed Management Activities 1994-2000

When the original *Watershed Plan for the Huron River in the Ann Arbor-Ypsilanti Metropolitan Area* was completed in 1994, several watershed management activities were underway. Of those, several have been completed, while others have continued and expanded. The update in 2000 also contained activities that have been since completed. Also, important new initiatives have been undertaken since the update. This section provides an update of completed, ongoing and recently undertaken major watershed activities within the project area.

ACTIVITIES COMPLETED

1. Public Education and Involvement

Information and Literature – During the 1994 Watershed Plan Development Process, public education materials were developed and disseminated to promote involvement and support for river protection. These included a display used at public gatherings to engage the public one-on-one, and a citizens' guide to nonpoint source pollution. The citizen's guide, still available to residents, provided pollution prevention and source control information.

Presentations -- A series of presentations were made to local community boards and planning commissions in the Fall of 1994 to inform communities about the Ann Arbor-Ypsilanti Watershed Plan and gain support for implementation of its recommendations. All communities in the planning area passed resolutions supporting the plan, and committed to its implementation.

Monitoring Sites in the Middle Huron

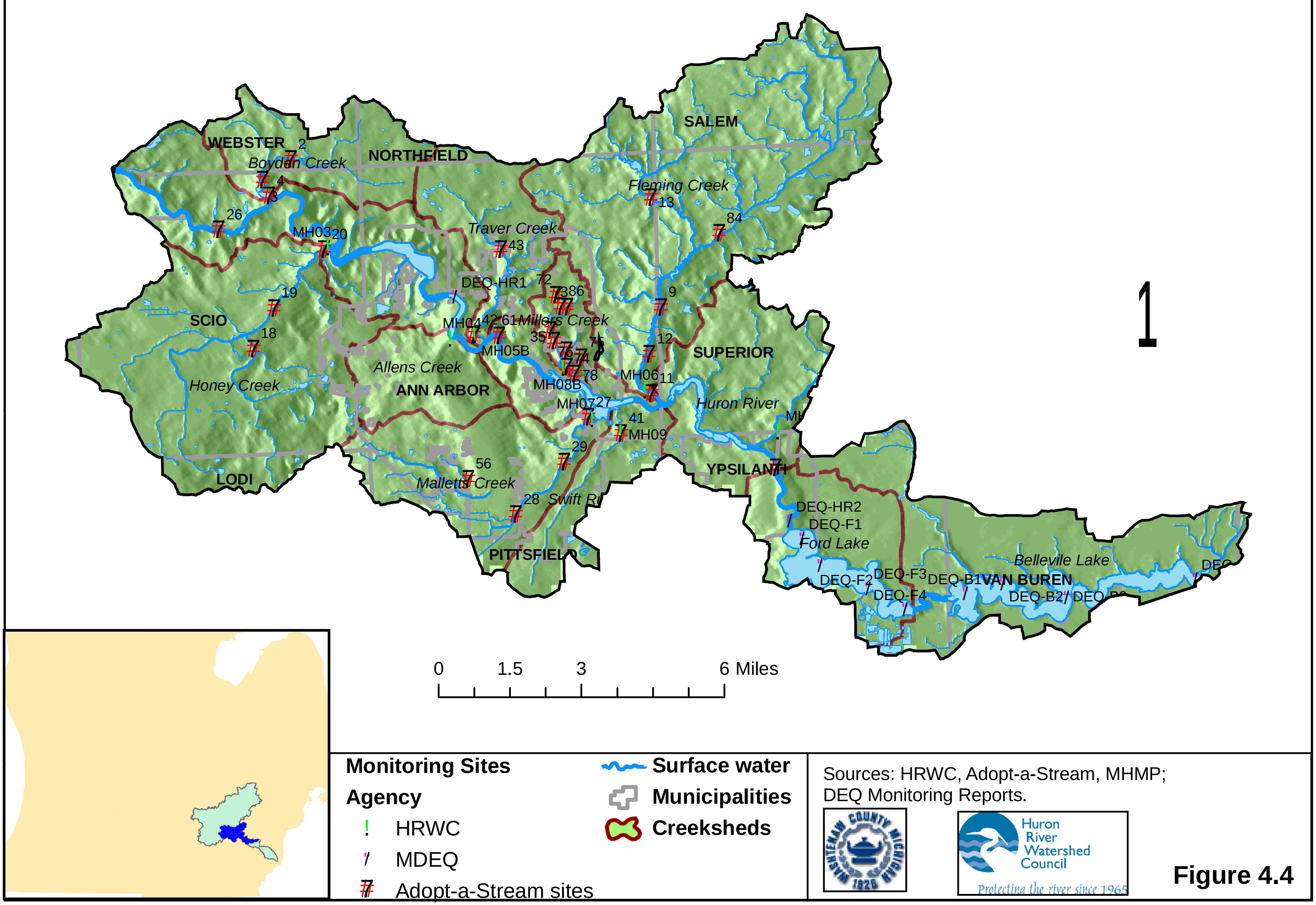


Figure 4.4

Presentations were also made to local community groups and university classes. A major educational presentation was also made to the local engineering and development design community, to appraise them of the impacts of stormwater runoff to the health of local waterways.

2. Water Quality and Quantity Monitoring
The City of Ann Arbor conducted stormwater testing of runoff concentrations during preparation of its stormwater permit application (1994-95). Results of this sampling and the National Urban Runoff Pollution Study were used to model “Wet year”, “Dry Year”, and “Normal Year” nonpoint source pollutant delivery. Concurrent with development of the 1994 Watershed Plan, a flow and water quality study was completed in the Honey Creek basin. Results were documented in the Honey Creek Stormwater Modeling Project.[8]

3. Land Use Decision Maker Program
This educational program provided public officials and decision makers with tools to reduce the impact of development on water quality, including model ordinances, literature, and low-impact design guidelines. A focus group of planning commissioners guided program design. Road agencies were brought into the process; a roads/watershed roundtable was created as a forum to discuss potential measures for mitigating road impacts (imperviousness, pollutant wash-off) on waterways. Among the final tasks of the program was a major conference on use of native landscapes as a stormwater management tool. The program included slide presentations, education materials, and model ordinances designed to make water quality protection a fundamental part of land use planning and site design review processes.

CONTINUING ACTIVITIES

1. Review of Best Management Practices
Research and monitoring data relating to BMPs for water resource protection are continually being reviewed via professional journals and conference proceedings. Additionally, thorough BMP reviews were completed as work tasks for special projects including the Malletts Creek Restoration Project, the Impervious Surface Reduction Study, and the Drain Rules revision of February 2000. These projects are discussed in more detail in the remainder of this section.

2. Adopt-A-Stream
Bio-monitoring activities of Huron River Watershed Council’s Adopt-A-Stream program have continued on existing sites and expanded to include additional sites both within the Ann Arbor-Ypsilanti area and throughout the Huron River Watershed. In total, 52 sites are being monitored, providing an invaluable experiential education to more than 500 residents of the watershed. The complete data collected over a period of 14 years have been compiled and analyzed to identify correlations between land use and water quality.

The Adopt-A-Stream program publishes regular reports on its events and trends and the relevant data for the Middle Huron is discussed in chapter two. The Adopt-A-Stream program has written informational reports, or Creek Reports, for several creeksheds and contributes to annual reports for the Middle Huron Partners. The reports summarize current conditions, sources of water quality impairments, opportunities for water resource protection, and bio-monitoring results to a general audience. Over thousands of reports have been disseminated to the general public, township/city officials and schools. Presentations have been given to local land use decision makers.

3. Water Quality and Quantity Monitoring
Wet and dry weather samples have been collected from Malletts Creek. The MDEQ tested in 1994, and the Malletts Creek Restoration Project tested in 1999. Measurements included TP, TSS, BOD, dissolved P, Temp, DO, pH and conductivity. A comprehensive hydraulic and water quality model was also created for Malletts and shared with the communities involved. Modeling and sampling results were included in the Malletts Creek Restoration Plan completed in 2000. An instream flow gauge was installed at the mouth of Malletts Creek in the Spring of 1999. The gauge monitors flow at 15-minute intervals and will be maintained indefinitely by the USGS for the City of Ann Arbor. Another gauging station exists in the main stem of the Huron River at Wall Street, Ann Arbor.

The MDEQ is conducting ongoing phosphorus and other testing in Ford and Belleville Lakes and two upstream sites that began in 1995. As part of the Middle Huron Initiative, HRWC has been monitoring 10 stations monthly from April through September for flow, phosphorus, suspended sediments, and additional background measures. *E. coli* was added to the list of parameters in 2006. Additional water quality data may be collected at the Huron River (Wall Street) and Malletts gauging station locations over the next several years by the USGS. These facilities will allow future monitoring of water quality trends.

4. Revision of the Rules of the Washtenaw County Drain Commissioner
Revised *Rules of the Washtenaw County Drain Commissioner* were published in draft in 1997 and, after extensive ongoing review, finalized in March 2000. Public participation helped guide these processes. The latest rules reflect the experience gained over five years of implementation of a major 1994 revision. The requirements for treatment of first flush, bank-full and 100-year storms remain in effect. Revisions include increased emphasis on practical aspects of stormwater system design and maintenance, as well as criteria for ensuring proper construction and system performance. Most communities in the planning area, as well as Livingston and Wayne Counties have either adopted these rules or are using very similar standards. These standards are currently in the process of being revised again.

5. Community Partners for Clean Streams (CPCS)
CPCS is a program recommendation of the 1994 Plan. Implementation began in 1996. CPCS engages business and institutional landowners to inform them about the impacts of their activities on local waterways and to aid in the preparation of individual “water quality action plans” for each site. The action plans integrate appropriate BMPs into existing on-site activities to reduce nonpoint source pollution and stormwater impacts. Partners are provided technical assistance throughout the process and community recognition in appreciation of their commitment. Washtenaw County Government funding has allowed this program to continues a permanent operation of the Drain Commissioner’s office once 319 funding was terminated. Currently, there are 150 partners.

6. Middle Huron Initiative
In 1994 the MDEQ established a Total Maximum Daily Load (TMDL) for phosphorus entering Ford Lake. The Huron River Watershed Council, working with State technical experts and local municipalities, developed the *Middle Huron Initiative Phosphorus Reduction Strategy for the*

Middle Huron River Watershed. The initiative provides recommendations for best management practices along with cost estimates for implementation of the TMDL over a 5-year period. The initiative focuses on point and nonpoint source phosphorus initially, then takes a broader, phased approach for addressing other watershed concerns. The program includes monthly monitoring and annual reporting. All communities within the area served by this Watershed Plan have signed a Cooperative Partnership Agreement for phosphorus reduction, which extends through 2009. See Appendix B for the Agreement.

7. Sub-watershed Group Management Plans (Creek Groups)
Adopt-A-Stream volunteers and other concerned citizens have established creek groups in Fleming, Malletts, Allens, Ford Lake and Traver Creeks. These five organizations developed by citizens and facilitated by the Huron River Watershed Council and the Washtenaw County Drain Commissioner's office, are active on the local level to promote stewardship of area creeks and Ford Lake. They have become regular participants in townships and city planning activities affecting water resources including:

- Involvement in local decisions making: master planning, park planning, individual site plan review,
- Drafting sub-watershed management plans that serve as a foundation for this update
- Staffing informational tables at public events,
- Submitting issues for print in the Ann Arbor News,
- Developing and distributing public educational materials.

The Malletts Creek Group Management Plan (Appendix F) has been adopted by the Ann Arbor City Council; Ypsilanti City Council and the Superior Township Board have adopted The Ford Lake Management Plan (Appendix H).

The Fleming Creek Advisory Council, a creek group active in Ann Arbor, Salem and Superior Townships, has produced a brochure for new residents and a preliminary plan (Appendix G). *Welcome to Your Watershed* provides homeowners with an identity to the creek and creekshed they live in and informs them of threats to the local water resources. Actions to protect the creek and its source waters are included to enable homeowners to become active stewards. The Allens Creek Group has also produced a plan (Appendix I) and a group was formed to contribute to the Millers Creek Plan (Appendix E).

8. Information and Education Through Mass Media (I & E)
In January 1995, the MDEQ awarded a nonpoint source planning grant to the Huron River Watershed Council for the purpose of developing a model Information, Education, and Communication (I/E) Strategy for the Huron River Watershed.

The I & E program employs advertising and marketing methods traditionally employed by the consumer sector to elicit meaningful behavioral change in homeowner activities such as lawn care and water conservation. Demographic tools are utilized to target mass media (print, radio and mailings) messages that are coordinated and timed to complement one another.

The objectives of the Plan are to:

- Reduce pollution that impacts the watershed by providing procedural knowledge to key audiences;
- Increase the general public's awareness and knowledge of the watershed and the inter-connectedness of the system;
- Increase activities that result in preservation, restoration, and protection of the watershed ecosystem;
- Increase participation in watershed recreation and stewardship; and
- Expand the communications plan and graphics usage to other target watershed organizations.

This plan continues to be implemented and supported by communities through their stormwater plans and through subsequent grants and other funding sources.

9. Malletts Creek Restoration
The Drain Commissioner, the City of Ann Arbor and Pittsfield Township have undertaken the Malletts Creek Restoration Project. The project has established a Technical Advisory Committee (TAC), made up of representatives from pertinent City and Township departments who have expertise or whose departmental activities may be affected by project recommendations. It also included a member of the Malletts Creek Association. The TAC has been involved in every aspect of the decision-making process.

Four public meetings were held in conjunction with development of the Restoration Plan to incorporate public input into the overall strategy of restoration. Focus groups were convened to involve businesses, homeowners and other potential stakeholders into the early stages of plan development. Additional opportunities for public involvement will be available as implementation of specific restoration projects begin.

The plan (Appendix F) details current impairments and establishes a cost-effective, environmentally sound, technically feasible and acceptable approach to meet its objectives, which are:

- Control stream volume and velocity
- Cut phosphorus loads by 50%
- Improve habitat

As part of the Mallett's Creek Restoration project, the Washtenaw County Drain Commissioners office added natural features to a human-made pond in Mary Beth Doyle Park. It is estimated that sediment and phosphorus will be reduced by between 57% and 31% from Malletts Creek. The project is an attempt to add wildlife habitat and prevent flooding. Construction began July 2006 and ended August 2007, with landscaping continuing and monitoring to complete the project. Construction costs were about $3 million. A Clean Michigan Initiative nonpoint source grant funded $1.25 million in construction costs. The balance was financed through the State Revolving Fund for the Malletts Creek Drainage District. Partners involved are City of Ann Arbor, Pittsfield Charter Township and Huron River Watershed Council.

10. Imperviousness Study
The Drain Commissioner's Office, in partnership with Ann Arbor, Scio and Superior Townships, has completed an Impervious Surface Reduction Study. The project sought to reduce the build-

out imperviousness of Honey and Fleming Creeksheds and to mitigate the impact of nonpoint source phosphorus using integrated stormwater BMPs.

A complete imperviousness build-out of the townships was modeled on a GIS system. Alternative futures were also modeled based on impervious reductions through flexible design standards for roads, parking lots and open space developments. Literature pertaining to existing and innovative BMPs was evaluated to gauge their long-term and sustained efficacy in treating and mitigating phosphorus export.

Based on the findings, recommended amendments to township ordinances governing development standards were proffered. In addition, a *Stormwater Management and Treatment Ordinance* was drafted for consideration by the townships. The stormwater ordinance establishes a performance standard requiring new development to limit phosphorus export.

Representatives of local governments participated in every phase of ordinance development. Informational presentations were made to planning commissions and boards of three communities considering adoption of study recommendations. A summary document detailing the components, processes and results of the Impervious Surface Reduction Study has been published and disseminated to local communities.

11. Millers Creek Study

Funded primarily by Pfizer, Inc., the Millers Creek Improvement Plan (Appendix E) was the result of work by a broad group of stakeholders in this small, but severely impacted creekshed. The study was prompted by flooding and bank erosion on Pfizer's Ann Arbor campus. With assistance from the Washtenaw County Drain Commissioner (WCDC) and HRWC, Pfizer initiated the Millers Creek Action Team and this project.

Following the development of the improvement plan, the team was awarded a state grant to conduct extensive improvement projects within the creekshed. Since receiving the grant, Pfizer's corporate parent decided to close the Ann Arbor research facility and eliminate funding for the program. The project has been revised to focus on upland projects and education and will carry forward with the reduced funding.

12. Phosphorus Fertilizer Ordinance

The City of Ann Arbor and Pittsfield Township passed ordinances (Appendix P) to reduce the amount of phosphorus applied to lawns throughout their jurisdictions. Ann Arbor passed its ordinance in February 2006 and it took effect January 1, 2007. That ordinance bans the application of phosphorus fertilizer except when a soil test confirms the need for phosphorus amendment. It also was accompanied by a broad educational campaign. The city anticipates that if there were full compliance with the policy, 22% of the phosphorus in the Huron River would be removed.

13. Septic Inspection Program

Septic systems are currently in use throughout the planning area, including a limited number in the urban areas. Many of these systems are aging, some have failed, and still others have been abandoned following sewer hookup. Studies across southeast Michigan show that an estimated 20% of existing septic systems are not operating properly due to improper maintenance or damage, and are a threat to local waterways. Once installed, septic systems require proper management and maintenance. To correct the problem of septic system neglect, routine inspection and clean-out is required. In 1999, Washtenaw County passed an ordinance requiring septic inspection at the time of title transfer. The program is administered by the Washtenaw County Environmental Health Department.

14. Interagency Cooperation
Project specific advisory committees made up of local officials have regularly met to coordinate, collaborate, share knowledge and facilitate resolution of cross-jurisdictional watershed protection activities:

- Land Use Decision Makers
- Malletts Creek Restoration
- Middle Huron Initiative
- Sub-watershed Creek Groups
- Phase II Stormwater Communities

In addition to these major activities, the communities and other partners in the watershed have made many contributions toward reducing impairments, many of which are conducted through Phase II stormwater programs and activities related to other of the numerous collaborative bodies in the watershed.

4.5 Parting Words

The Middle Huron Watershed Management Plan was created to provide a strong foundation and framework for improving water quality in the Middle Huron Watershed and protecting its valuable natural resources for future generations. The authors hope that choosing a consensus-based approach to developing the Plan will pay off in the form of a strong sense of ownership and unanimous support for the Plan in the years to come.

The task ahead—continued implementation of this watershed management plan—demands patience, persistence, determination, and cooperation of many partners and stakeholders at all levels. No matter how much effort and dedication was put into the Plan, it is of little value if the Plan itself remains the primary end-point. Fortunately, the partners who contributed to the Plan are well on their way toward implementing many of its remedial activities. The partners have put in a great effort to date and progress is obvious. However, as these communities continue to face the challenges of balancing growth with natural resource protection, the costs of maintaining the status quo and the benefits of long-term planning on a watershed scale will become increasingly apparent.

Each community in the watershed has a choice. It can regard the Plan as merely another plan required for state funding or regulation and move on to the next requirement, or it can use the Plan as it is intended: to guide each community not only in fulfilling its own requirements, but also in partnering with other stakeholders throughout the watershed to protect the land and water that connects us all.

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[1] *Ibid.*
[2] Heathcote, I.W. 1999. Integrated Watersehed Management: Principles and Practices. New York: John Wiley and Sons, Inc.

[3] *Ibid.*
[4] *Ibid.*
[5] Adapted from: MSU Institute of Water Research, et al. 2000. Developing a Watershed Management Plan for Water Quality. Lansing, MI: Michigan State University.
[6] Claytor, R. in Schueler, T. R. and H. K. Holland. 2000. The Practice of Watershed Protection. Ellicott City, MD: The Center for Watershed Protection.
[7] Riggs.
[8] Washtenaw County Drain Commissioner, 1994. "Physical and Biological Description of the Huron River, its Watershed and Tributaries in the Ann Arbor-Ypsilanti Area".

Middle Huron Water Watershed
Storm Management Plan

Appendices

2011 WMP Appendices (Zip file)