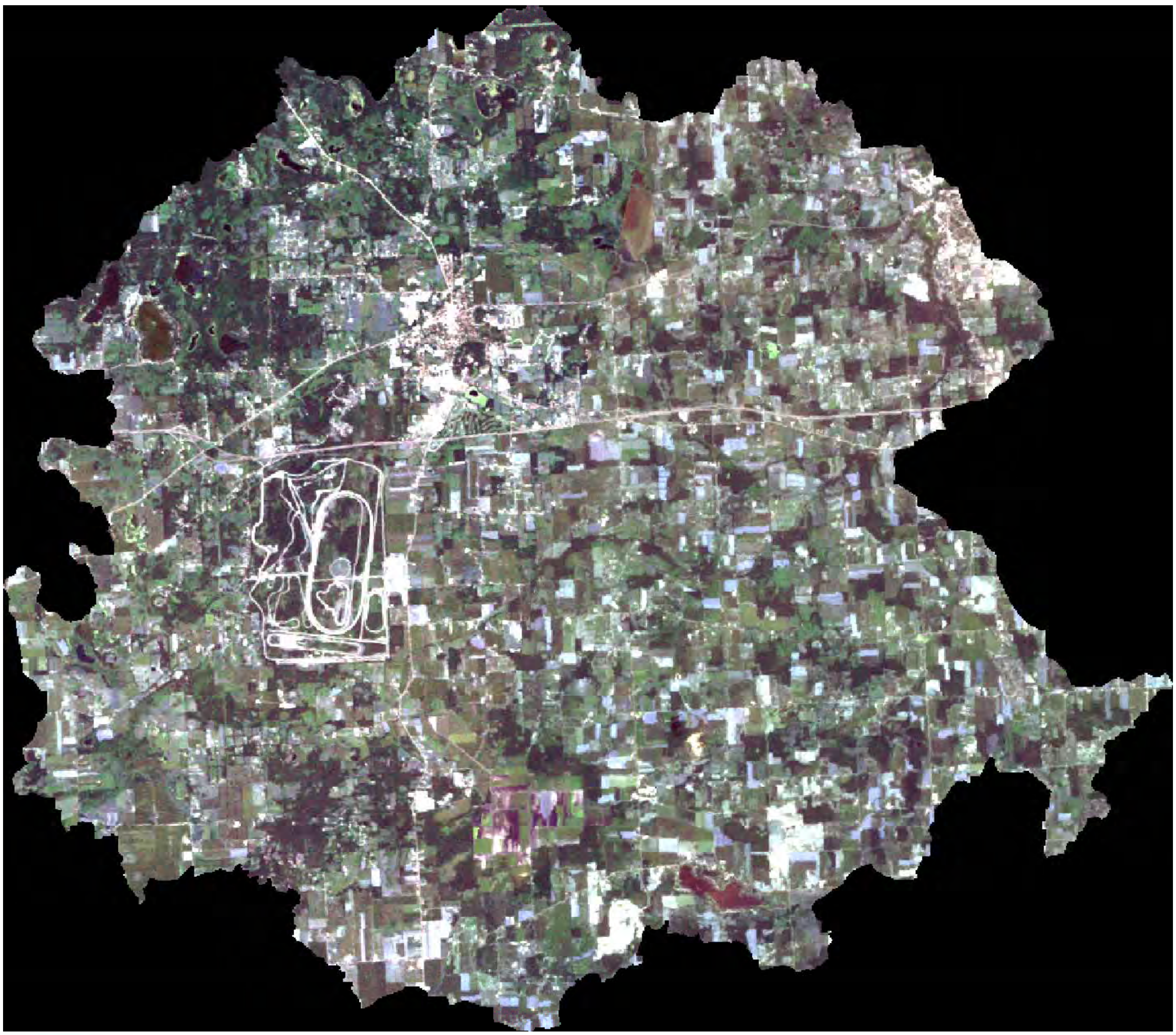
MILL CREEK SUBWATERSHED MANAGEMENT PLAN

HURON RIVER WATERSHED (HUC 04090005), MICHIGAN



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THE HURON RIVER WATERSHED COUNCIL

APPROVED BY THE MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY, SEPTEMBER 2003, *REVISED FEBRUARY 2006*

The time for planning the future of Mill Creek is now. This is an opportunity for careful consideration of alternate strategies for protection, rehabilitation, and enhancement of recreational and aesthetic aspects of Mill Creek. Though watershed planning is necessarily a political process, it must be based on sound technical science. Stream systems are constrained by a series of hydrologic, geomorphic, and biologic realities. What Mill Creek becomes in the future will depend not only on our actions and desires, but also on the basic nature of its catchment and its connections to larger, regional ecosystems.

- P. Seelbach and M. Wiley, 1996

Mill Creek Subwatershed Management Plan

Prepared by the Mill Creek Subwatershed Stakeholder Advisory Group

For the communities of Village of Chelsea, Village of Dexter, Dexter Township,
Freedom Township, Lima Township, Lodi Township, Lyndon Township,
Scio Township, Sharon Township, Sylvan Township, Webster Township

With technical assistance from the Technical Working Group
and the Huron River Watershed Council

September, 2003

Revised February, 2006

Mill Creek Subwatershed Management Plan

Prepared by the Mill Creek Subwatershed Stakeholder Advisory Group (SAG):

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Mill Creek Subwatershed Management Plan

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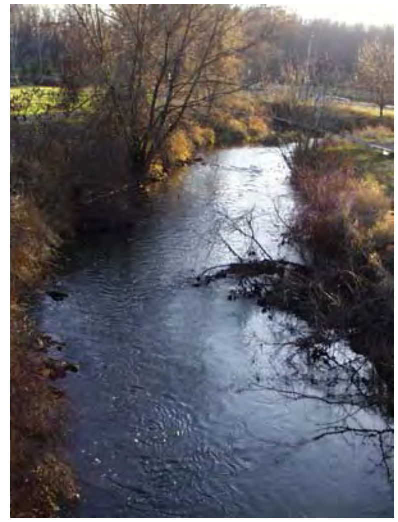
Chapter 1 Executive Summary

Mill Creek Subwatershed

Mill Creek Subwatershed is located in western Washtenaw County and extreme eastern Jackson County in Michigan's southeast Lower Peninsula. The 145 square-mile (92,600 acres) area contains 560 lakes covering approximately 2,600 acres, and 5,850 wetlands providing numerous values, including water quality and habitat for species of special concern. Mill Creek has two main channels, the North Fork and the South Branch. The entire stream network runs 226 miles and empties into the Huron River just north of the Village of Dexter. The Subwatershed comprises all or portions of the villages of Chelsea and Dexter, and the townships of Dexter, Freedom, Lima, Lodi, Lyndon, Scio, Sharon, Sylvan, and Webster. Land use in the Mill Creek Subwatershed ranges from commercial and residential areas in the villages to rural residential and agricultural throughout much of the townships. Agricultural land uses are rapidly being converted to urban and suburban uses as increasing development pressures face Mill Creek communities. The Pinckney-Waterloo State Recreation Area figures prominently in the northwest portion of the Subwatershed as the largest extant of publicly owned land. The State Recreation Area along with village parks provides more than 1,100 acres for recreational pursuits. The Nature Conservancy has recognized the ecological value of the northwest portion of the Subwatershed and counts it among the Conservancy's aquatic conservation priorities in Michigan.



Mill Creek at Jackson Road
Photo: D. Weiker

Mill Creek is a small stream draining an agriculture-dominated landscape. Escalating rates of suburban expansion from the east (Ann Arbor), north (Dexter), and west (Chelsea/Manchester) make it clear that this basin is facing a change in land use that will have profound effects on Mill Creek in coming decades. Seelbach and Wiley present this challenge in their 1996 assessment of ecological restoration in Mill Creek:

> We have an opportunity for careful consideration of alternate strategies for protection, rehabilitation, and enhancement of recreational and aesthetic aspects of Mill Creek. Though watershed planning is necessarily a political process, it must be based on sound technical science. Stream systems are constrained by a series of hydrologic, geomorphic, and biologic realities. What Mill Creek becomes in the future will depend not only on our actions and desires, but also on the basic nature of its catchment and its connections to larger, regional ecosystems.

Problem Statement

Portions of the Mill Creek Subwatershed fail to meet minimum water quality standards or provide designated uses. In 1996, based on water quality monitoring studies, the Michigan Department of Environmental Quality (MDEQ) listed Mill Creek, part of the middle Huron River Watershed, as *impaired* on the State's 303(d) list of impaired waters requiring Total Maximum Daily Load (TMDL) establishment. 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 Subwatershed. The communities of the Mill Creek Subwatershed are under mandate from the State of Michigan to reduce phosphorus loading to the river by 50% in order to meet the TMDL. Both point and nonpoint source contributions need to be reduced if the goal is to be met. Scientists estimate that Mill Creek contributes nearly 25% of total phosphorus to the middle Huron.

Mill Creek appeared again on the State's 303(d) list in 2000 as *impaired* due to poor fish and aquatic insect communities in a 1.4-mile stretch of Letts Creek, a tributary of Mill Creek. Nonpoint sources of pollution to the Creek were the reason for the impaired status. In addition to high nutrient concentrations and poor aquatic habitat, other problems include streambank destabilization, soil erosion and sedimentation, bacteria, flow and temperature alteration, loss of wetlands and other natural habitat.

Nonpoint source pollution is defined as a diffuse source of pollution that cannot be traced to a particular discharge such as an industrial or wastewater treatment plant. Rainfall or snowmelt moving over and through the ground is the main cause of nonpoint source pollution. As the runoff travels, it picks up and carries pollutants to lakes, rivers, and wetlands, or even to underground sources of drinking water. Pollutants often found in stormwater runoff are numerous and include phosphorus and nitrogen, dirt and sediments, oils/greases, vehicle lubricants, herbicides and insecticides, metals, and garbage.

The intensity and frequency of nonpoint source pollution is related directly to the amount of hard (impervious) surfaces in a Subwatershed because these areas facilitate the travel of water over ground. The anticipated increase in development and subsequent hard surfaces in the Mill Creek Subwatershed, combined with the loss of unaltered land, is expected to cause an increase in already excessive nonpoint source pollution situation.

Purpose of the Management Plan

The Mill Creek Subwatershed Management Plan is a comprehensive, long-term effort to restore and protect water quality of the area with the goal of attaining the Total Maximum Daily Loads for Mill Creek and the Huron River. Secondly, the Mill Creek Subwatershed contains a few (4) communities that are required to be permitted for stormwater runoff contributions through Phase II of the National Pollutant Discharge Elimination System. This plan aims to establish a protocol to help those communities required to obtain a permit to meet the minimum requirements of the program.

Stakeholder Advisory Group (SAG)

In 2001, communities, county agencies, business interests, farmers, citizens, and other stakeholders in the Subwatershed were invited to participate in establishing an Advisory Group to help guide the development of the Subwatershed plan. This group has met quarterly since fall of 2001 and is the essential guiding group in the development of this Subwatershed plan. Group members provided input to focus the project on specific issues and areas of concern as well as to determine overall direction for the watershed project. The support and approval of the final watershed management plan by all the stakeholder groups is vital for successful implementation. As part of the planning process, group members assisted with conducting field inventories and in meeting with local municipalities to gain adoption of the plan and subsequent implementation.

Technical Working Group

A watershed plan based on sound scientific ground is vital for successful implementation so a Technical Working Group formed in 2001 to provide expertise and direction on the scientific aspects of the plan. The Group met every other month and is comprised of professionals from the fields of engineering, hydrology, natural resource management, fisheries ecology, aquatic ecology, and others disciplines. Areas in which members have assisted include: determining the causes and sources of water quality threats and impairments; identifying effective best management practices and their associated costs and benefits; assisting with writing discrete sections of the plan; and participating in field inventories.

The SAG, as a result of discussions at regular meetings, developed a prioritized list of challenges/ pollutants facing the subwatershed as well as the sources and causes of those challenges. Based on that prioritization, they developed goals and objectives to address the impairments and threats to local water resources and to meet federal water quality standards (see tables below). The SAG presents this vision statement as the condition to which it strives to achieve through long-term implementation of this watershed management plan:

Protect and restore Mill Creek, its floodplains, tributaries, wetlands, lakes and groundwater so that beneficial functions and uses are achieved and maintained.

Prioritization of Challenges (Pollutants), Sources and Causes in the Mill Creek Subwatershed

Challenge	Known or suspected source	Known or suspected cause
1. High stormwater peak flows/ altered hydrology	1. Drains	Loss of connection between stream and floodplain from channelization
	2. Loss of wetlands and natural features	Wetlands drained and converted for crops
	3. Developed and developing areas	1. Directly connected impervious areas 2. Insufficient stormwater management practices
	4. In-stream structures	Dams, in-line detention, and lake control structure
2. Sedimentation, soil erosion	1. Stream banks	1. Erratic flow fluctuations 2. Insufficient riparian vegetation on banks
	2. Agricultural land	1. Insufficient upland conservation practices 2. Insufficient vegetated riparian buffers 3. Wind erosion on unprotected erosion-prone soils
	3. Developed areas/construction sites	1. Insufficient upland conservation practices 2. Insufficient vegetated riparian buffers 3. Inadequate soil erosion practices 4. Inadequate inspection, compliance with regulations
	4. Road-stream crossings	1. Undersized culverts 2. Poorly stabilized headwalls 3. Erosive road or bridge surface
3. High nutrient load	1. Fertilizers and livestock waste from agricultural land	Insufficient upland conservation practices
	2. Fertilizers from residential, commercial and golf courses	1. Improper application of phosphorus fertilizers 2. Insufficient vegetated riparian buffer 3. Improper sewage lagoon function (s=suspected)
	3. Failing on-site septic systems	Poor design, lack of maintenance
	4. Pet and wildlife waste	1. Storm sewers create direct pathways 2. Ponds increase habitat for waterfowl, wildlife
	5. NPDES permitted facilities	Nutrients permitted in effluent
4. Oil, grease, metals, brine/salt	1. Roads, parking lots, driveways	1. Insufficient stormwater management practices 2. Road culverts drain directly into streams 3. Impervious surfaces directly connected to storm sewers
	2. Existing in-stream pollution	1997 oil spill in Letts Creek
	3. NPDES stormwater permitted facilities (s)	1. Inadequate inspection 2. Insufficient vegetated riparian buffer and upland conservation practices
5. High water temperature (s)	1. Directly connected impervious areas	Heated stormwater from urbanizing areas
	2. Suspended solids	Soil erosion from channel and upland
	3. Solar heating	Lack of vegetated canopy in riparian zone
6. Pathogens (s)	1. Human waste from failing on-site septic systems	Poor design, lack of maintenance
	2. Livestock waste from agricultural operations	1. Insufficient upland controls 2. Uncontrolled livestock access to streams
	3. Pet and waterfowl waste	Storm sewers create direct paths to streams
	4. Human waste from sewered areas (s)	Illicit connections of sanitary sewer to storm sewers (s)
7. Pesticides (s)	1. Agricultural land	1. Insufficient upland conservation practices 2. Inadequate vegetated riparian buffers
	2. Turfgrass chemicals: residential, commercial lawns	1. Improper application and usage 2. Insufficient vegetated riparian buffers

(s) = suspected

Long-term Goals and Objectives for the Mill Creek Subwatershed, and the Designated and Desired Uses they Address

#	Long-term Goal	Objectives	Use(s) Addressed
1	Restore the hydrologic regime	Reduce flow variability. Stabilize channel morphology. Reconnect stream network to floodplains, and creek to river. Monitor water quantity to measure progress.	**Warmwater fishery** **Aquatic life and wildlife**
2	Meet mandated 50% phosphorus loading reductions	Reduce nutrient loadings from nonpoint and point sources. Reduce soil erosion and sedimentation. Monitor water quality to measure progress.	**Partial and total body contact recreation** **Warmwater fishery**
3	Restore the natural warmwater fishery	Replace in-stream habitat structure, create pools and riffles. Remove any barriers to fish migration that prevent natural recolonization; selectively re-introduce pre-disturbance native fish. Regulate stream temperature. Monitor biota to measure progress.	**Warmwater fishery** **Aquatic life and wildlife** **Partial body contact recreation**
4	Restore the natural aquatic animal and plant communities	Protect and enhance threatened and endangered species and habitats. Protect critical stream substrates by keeping sand and silt out of streams. Re-establish stream buffer. Restore tree canopy in riparian buffer and other overhead cover. Monitor water quality and biota to measure progress.	**Aquatic life and wildlife** Natural features as regulators of stormwater runoff
5	Protect and enhance recreation opportunities	Increase opportunities for passive and active recreational uses. Establish a recreation trail system along Mill Creek and its tributaries, wherever possible. Reduce pathogens, nutrients, sedimentation and other pollutants in surface waters.	**Partial and total body contact recreation** Recreation trails
6	Protect and mitigate the loss of natural features	Preserve and enhance existing wetlands, floodplains and stream channels that regulate the flow of stormwater runoff, protect against downstream flooding, and curb erosion and sedimentation. Protect groundwater recharge areas and wellhead protection areas from contamination and overdrafting through diversions and withdrawals. Restore natural features.	Natural features as regulators of stormwater runoff **Aquatic life and wildlife** **Warmwater fishery** Groundwater protection
7	Achieve environmental and economic benefits through coordinated planning and development	Integrate stormwater management in planning and land use approval process. Educate land use decision makers on development impacts to watersheds and tools for low impact development. Increase regional planning efforts and implementation among local units of government.	Coordinated development Open and agricultural land and All
8	Protect existing open and agricultural land	Address issues of urban sprawl.	Open and agricultural land **Aquatic life and wildlife** **Warmwater fishery**
9	Establish an environmental ethic among the public	Increase public participation and understanding of their role in protecting Mill Creek.	All
10	Attain full plan implementation	Establish financial and institutional arrangements for fulfillment of the plan. Enforce action plans and increase accountability for stormwater management.	All

Bold text indicates the Designated Uses in the Subwatershed protected under Michigan law.

Management Alternatives

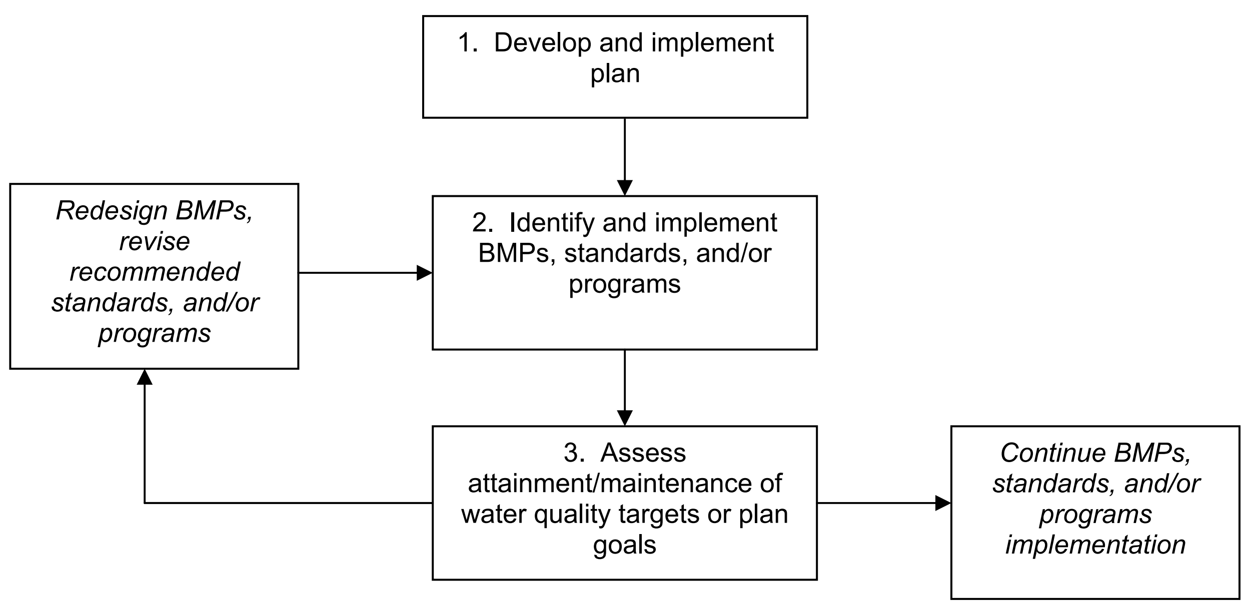
After establishing goals and objectives for the Subwatershed, the SAG discussed various management alternatives that could meet the Total Maximum Daily Load and address Subwatershed concerns. Recommended strategies include managerial, vegetative and structural practices intended to be implemented in combination rather than in isolation for greatest effect. Recommendations for staging the practices in sequences are provided along with estimated capital and maintenance costs, potential locations, responsible parties, level of effort and measures of success. The Action Plan presents the management alternatives in Chapter 8. Reducing phosphorus loads by 50 percent in Mill Creek will require removing 6,000-7,500 lb/year from current sources. Several combinations of management alternatives may yield that reduction; possible scenarios are presented in Chapter 8.

Subwatershed Plan Implementation, Coordination, and Assessment

Implementation, coordination of activities, and assessment of successes and failures are crucial components to this Subwatershed Management Plan. In order to provide a well-organized process for implementing this Subwatershed plan, a Mill Creekshed Steering Committee (Committee) composed of Workgroup members and other key stakeholders is proposed as well as a resolution for local government and agency adoption. The basis of the resolution and agreement and Committee is the Middle Huron Initiative (MHI) and to a lesser extent the Lake Macatawa Coordinating Committee. During implementation and review of the plan, new data and information may become available which might require a decision to revise or not to revise the plan. The process employed to make this decision at regular Committee meetings is based on the Lower One Rouge River Subwatershed Management Plan and is illustrated below.

Following the presentation of this plan to the stakeholders, identification and subsequent implementation of the strategies recommended in the Action Plan will follow. Performance of the strategies will be assessed at regular time intervals in order to determine their impact on meeting subwatershed plan goals and objectives. Upon evaluation, the Committee should have the information it needs to decide whether to continue pursuing the recommended strategies or to redesign the strategies if the current path is not yielding desired results.

Subwatershed Plan Revision Process



Chapter 2 Introduction

2.1 The Huron River Watershed

The Huron River Watershed is one of Michigan's natural treasures. The Huron River supplies drinking water to approximately 140,000 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 has officially designated 37 miles of the Huron River and three of its tributaries as Michigan Department of Natural Resources 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.

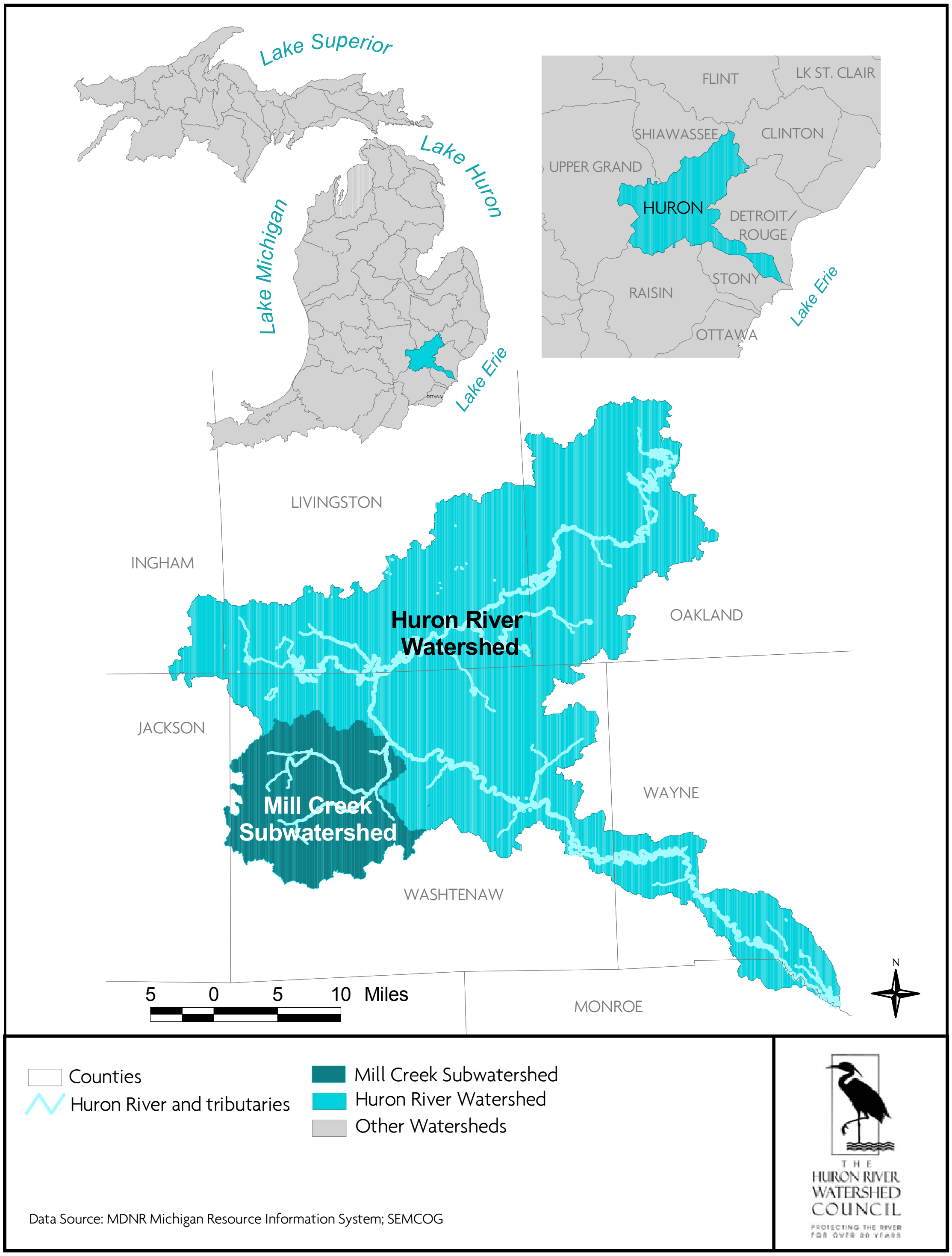
The Huron River Watershed is located in southeastern Michigan and encompasses approximately 900 square miles (576,000 acres) of Ingham, Jackson, Livingston, Monroe, Oakland, Washtenaw, and Wayne counties (Figure 2.1). The mainstem of the Huron River is approximately 136 miles long, with its origin located at Big Lake and the Huron Swamp in Springfield Township, Oakland County. The mainstem of the river meanders from the headwaters through a complex series of wetlands and lakes in a southwesterly fashion 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 proceeds 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 mainstem.

The drainage area that provides water to Mill Creek is located in the middle Huron River Watershed and is designated the Mill Creek Subwatershed (Figure 2.1). This 145-square mile (92,600 acres) area is unique in draining an area of loamy soils supporting the primary agricultural area within the basin. The vast majority of the Subwatershed lies within Washtenaw County and comprises all or portions of eleven municipalities. Only the most extreme western lands of the Subwatershed are located in Jackson County. Approximately 15,400 acres of wetland remain in the Subwatershed. Included in the Subwatershed are one Metropark, two state recreation areas, and one state game area, along with a few local and county parks, totaling roughly 11,800 acres of publicly owned land.

In recent years, the Mill Creek Subwatershed and the Huron River Watershed have experienced amplified development pressures from a growing economy and urban sprawl. According to the Southeast Michigan Council of Governments (SEMCOG), the population of Washtenaw County where the Subwatershed is located increased 38% from 1970 to 2000 with 2002 providing the most recent census estimate of 333,503 individuals. Projections to 2030 estimate a further 38% increase in population from 2000 levels to 448,020 individuals. Accommodating the increased population and related necessary infrastructure, SEMCOG estimates 40% of the remaining open spaces will be developed within the watershed under current development practices (HRWC, unpublished). Much of this projected conversion of undeveloped land will occur in the Mill Creek Subwatershed where it will further threaten the hydrology and water quality of groundwater and surface waters.

The projected development and corresponding hard (impervious) surfaces combined with the conversion of undeveloped land is of particular concern since these areas are significant contributors of nonpoint source pollution (NPS). NPS is defined as diffuse sources of pollution that cannot be traced to a particular discharge such as an industrial plant. For instance, when rain or snowmelt occurs on impervious surfaces such parking lots, rooftops, lawns, and roads or disturbed land like found on construction sites, the resulting water runoff—called stormwater runoff—picks up pollutants that may be on these surfaces and carry them, often untreated, to local streams, lakes, or wetlands. Pollutants found in stormwater runoff are often numerous and include phosphorus and nitrogen, dirt and sediments, oils/greases, vehicle lubricants, herbicides and insecticides, animal wastes, metals, and garbage. But because there are hundreds or thousands of sources of stormwater runoff in the Subwatershed, addressing NPS is often

Figure 2.1. Huron River Watershed and Mill Creek Subwatershed



complex and problematic. Another nonpoint source is impaired decentralized wastewater treatment systems, or septic systems, which can be a significant source of phosphorus, nitrogen, bacteria, and untreated pharmaceuticals to surface and ground waters.

As a result of point sources and nonpoint sources of pollution, increasing numbers of waterbodies in the Huron River Watershed are degraded to the point that they're violating the water quality standards protected by the federal Clean Water Act. For instance, lakes and reservoirs increasingly are experiencing nuisance algae blooms as the result of phosphorus enrichment. These algae (or algal) blooms threaten to alter the ecological web of plants and animals, decrease dissolved oxygen in the water, and degrade designated uses for waterbodies by causing recreational loss, fish kills, and other environmental and human health consequences.

2.2 Purpose of the Mill Creek Subwatershed Management Plan

Portions of the Mill Creek Subwatershed 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 Mill Creek, part of the middle Huron River Watershed, as a significantly contributing area of 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 requiring Total Maximum Daily Load (TMDL) establishment. 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 Mill Creek Subwatershed and the downstream middle Huron communities 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 Mill Creek contributes nearly 25% of total phosphorus to the middle Huron.

Mill Creek appears again on the State's 303(d) list in 2000 as *impaired* due to poor fish and aquatic insect communities in a 1.4-mile stretch of Letts Creek, a tributary of Mill Creek. Nonpoint sources of pollution to the Creek were the reason for the impaired status. The MDEQ will develop a TMDL in 2004 to address this impairment. In addition to high nutrient concentrations and poor aquatic habitat, other problems include streambank destabilization, soil erosion and sedimentation, bacteria, flow and temperature alteration, loss of wetlands and other natural habitat.

The Mill Creek Subwatershed Management Plan represents a broad effort to restore and protect the integrity of water quality and quantity of the Mill Creek system. This plan presents a state-approved methodology to diminish the adverse effects of nonpoint source pollution to meet the established phosphorus TMDL and proactively address the forthcoming Letts Creek TMDL. This plan outlines both quantitative and qualitative steps considered necessary to meet water quality goals for Mill Creek and its Subwatershed.

In order for a watershed plan to be approved by the State of Michigan, it 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.

2.3 Community Participation/Coordination

Community-based partnerships are essential to effective watershed management. Through a partnership, different people and organizations work together to address common interests and concerns. As such, partnerships represent the easiest way to develop and implement a successful watershed management plans because everyone is involved from the beginning. Consequently, the final plan achieves input and consensus of all parties who have a stake in the watershed. Local communities and residents showed a willingness to participate in watershed planning activities, as evidenced by the formation of the Mill Creek Research Council and participation in the USDA NRCS' Mill Creek Sub-basin Resource Plan.

To develop a successful implementation plan for reducing phosphorus, sediment and other pollutants in the Mill Creek Subwatershed, it was necessary to build community support and participation. Two groups were built and their meetings were held on a regular basis. Following is a description of the groups, their functions and membership.

Mill Creek Subwatershed Stakeholder Advisory Group

A Stakeholder Advisory Group (SAG) formed in Summer and Fall 2001 in order to understand the water quality and environmental concerns for the Subwatershed by local communities and residents and to garner community support for the watershed management process. Key stakeholders throughout the Subwatershed were identified and contacted about possible participation. Invitees included representatives from all local governments within the Subwatershed, county departments such as health, road, drain, and planning, state agency employees, environmental interest groups, concerned citizens and landowners, agricultural representatives, recreation groups and development interests.

Overall, the goal of the SAG was to guide the creation of a watershed management plan to meet TMDL targets for the Mill Creek Subwatershed. The SAG is the main decision-making group for the Mill Creek Subwatershed Management Plan. Note that all communities were invited, however not all chose to participate. A list of SAG participants is presented earlier in this document.

Mill Creek Subwatershed Technical Working Group

A watershed plan based on sound scientific information is vital for successful implementation, so the Technical Working Group (TWG) formed in Fall 2001.The TWG was comprised of professionals from the fields of hydrology, natural resource management, aquatic ecology, wetland restoration, wildlife conservation, environmental health, stormwater management, land use planning and landscape architecture. The TWG was charged with providing expertise and direction on the scientific aspects of the watershed management plan. Areas in which members assisted were (1) determining the causes and sources of water quality threats and impairments, (2) identifying effective best management practices and their associated costs and benefits, (3) assisting with writing discrete sections of the plan, and (4) participating in field inventories as needed.

Community Involvement and Education

Subwatershed Project staff and group members extended the base of planning input to the broader Mill Creek community through surveys, public meetings, workshops, presentations and field visits. Public meetings were held early in the project in Fall 2001 to introduce the project and its objectives to Mill Creek residents, and to solicit community concerns and knowledge about the Subwatershed. Approximately 600 households received surveys in the mail requesting input on residents' water quality concerns. From those meetings and mail surveys, a list of watershed concerns was generated and concerns were prioritized based on the frequency an issue was raised.

Presentations to community groups and government officials were conducted throughout the project. Nine of the communities received presentations to their board of trustees about project propose and scope, updates in the project, and their role in sustaining the plan. Several planning commissions received presentations on topics such as alternative storm water management techniques and watershed planning basics. Community groups such as the Chelsea Rotary Club received presentations about conditions in Letts Creek and opportunities for volunteer involvement, and the Mill Creek Research Council featured project updates at its annual meetings. Residents were invited to assist with field inventory work in Fall 2002; they were trained in field surveying techniques in order to complete qualitative inventories of nearly 50 creek sites in the Subwatershed.

Residents and local officials took advantage of educational trainings to enhance their skills and knowledge of land use principles and policy tools related to watershed health through a citizen planner course called "Land Use Planning for a Healthy Watershed: Training for Effective Local Decisionmaking." In addition to the multi-week course, trainings on the Informed Planning in Washtenaw County CD-ROM were offered to residents and local officials with some of the workshops in the Subwatershed. These "train the trainer" events provided knowledge of how to use the CD to people who commit to training groups in their own communities.

Chapter 3 Characteristics of the Mill Creek Subwatershed

3.1 Climate and Topography

Seasonal changes are the most important feature of Michigan's, and therefore the Subwatershed's, climate. The Mill Creek area receives an average of 30 inches of precipitation annually as the Huron River Watershed is located in the drier portion of Michigan. This amount of rainfall is equivalent to 2.2 cubic feet per second per watershed square mile per year. Seasonal patterns of this precipitation are fairly stable due to warmer temperatures that hold more moisture in the air. Since southern Michigan thaws and refreezes regularly through most of the winter, the Huron River does not experience as much variability as more northern rivers with their low and high flows (Hay-Chmielewski et al).

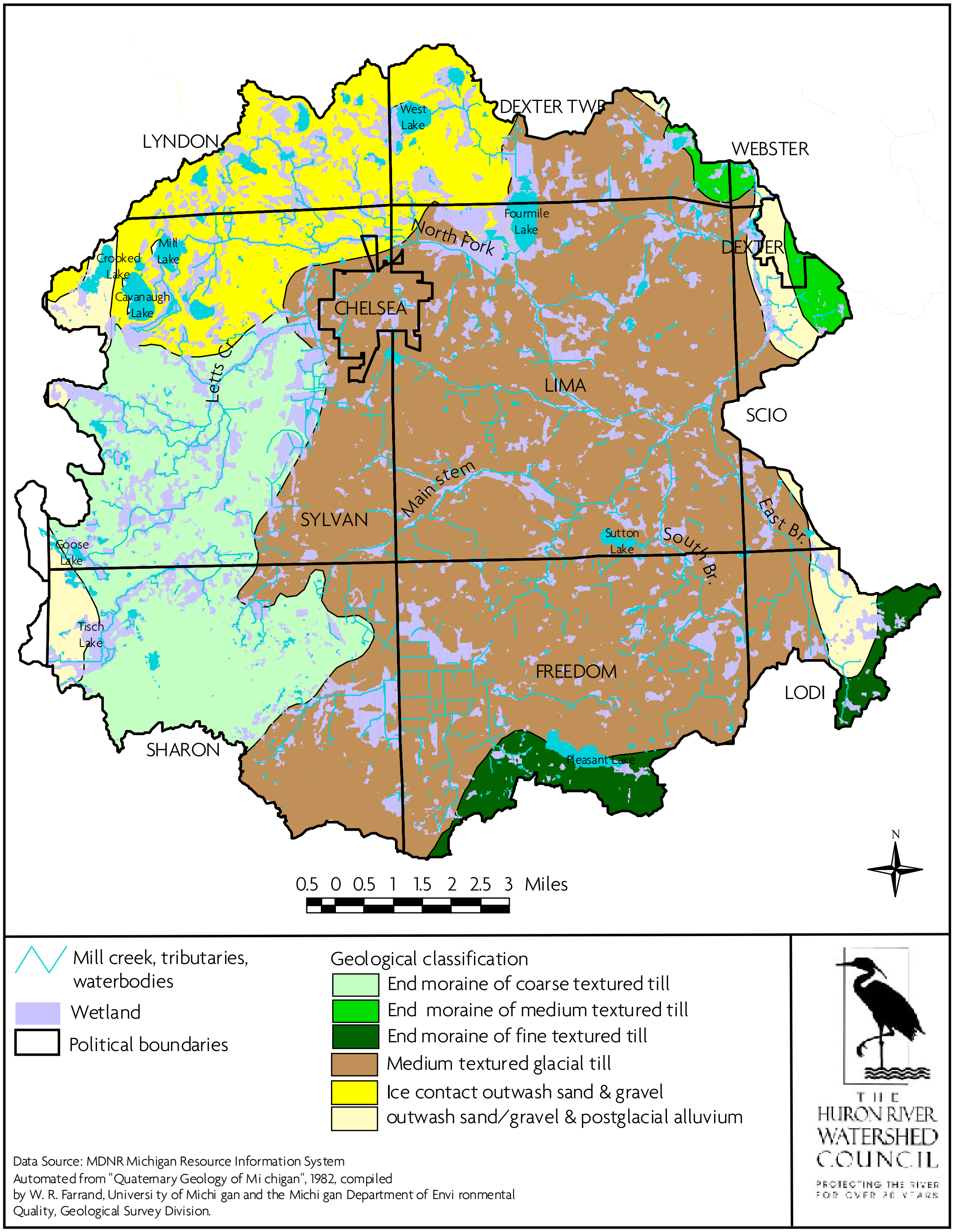
Evaporation in the watershed is higher than most of the state, due to higher temperatures and slightly drier air found in southeast Michigan (Sommers in Hay-Chmielewski et al). As a result, the watershed has one of the lowest amounts of total annual runoff in Michigan. For a 30-year period, the average high temperatures ranged from 32^{o}F in January to 84^{o}F in July in the Subwatershed, while the average low temperatures ranged from 15^{o}F in January to 59^{o}F in July (U.S. Geological Survey, 2003).

The Mill Creek Subwatershed falls into two distinct regional landscape ecosystems according to the USGS classification, the Jackson Interlobate area and the Ann Arbor Moraines. 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 Mill Creek region lies entirely within the North Central Till Plain ecoregion. Bedrock topography conforms substantially to the present surface topography (US Dept of the Interior, 1979).

3.2 Geology and Soils

The most recent glaciation in Michigan's history, the Wisconsonian, created the landscape of today's Mill Creek Subwatershed. End or recessional moraines, with associated till plains and outwash deposits of the Jackson interlobate characterize much of the region (see Figure 3.2). Mill Creek's catchment comprises rolling till plain, surrounded by a low rim of fine-textured recessional moraines (east and south), and coarse-textured moraines and ice contact hills (north and west). More specifically, nearly 50 percent of the Subwatershed is till, and approximately 25 percent each is outwash and end moraine (Hay-Chmielewski, et al). Small and large kettle lakes resulted from the glacial activity. The two dozen lakes of the Subwatershed are located mostly in the northern drainage arising from the glacial hills in the west and northwest regions. The few lakes in the southern drainage result from impoundments. Till plains consist of sorted fine sediments and are conducive to surface runoff into streams and create flows that are more "flashy." Mill Creek has the highest proportion of till of any creekshed and is very flashy (Hay-Chmielewski et al).

Figure 3.1. Geology of the Mill Creek Subwatershed

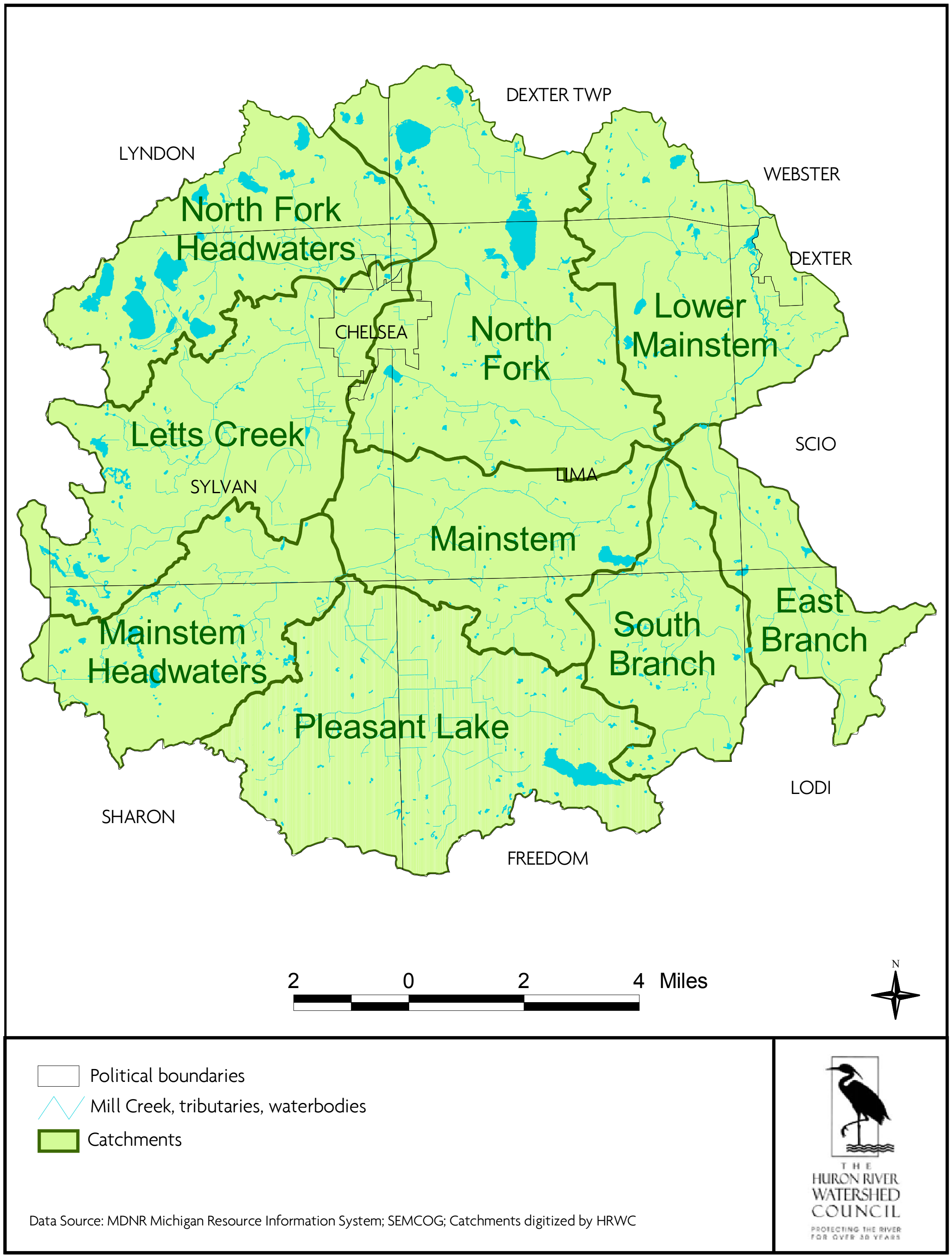


Mill Creek Subwatershed is unique for having nearly all loam and silty-loam soils over medium-textured glacial till. These normally poorly-drained soils make very productive farmland once drained.

Given the large size of the Subwatershed, the following soil descriptions are organized by nine hydrologic regions in order to provide better focus on the conditions found throughout the study area. Figure 3.2 illustrates the locations of the nine regions.

Part of the morainal landscape in the North Fork Headwaters catchment on Bush Road. Photo: HRWC

Figure 3.2. Catchments of the Mill Creek Subwatershed



Soils: East Branch
Soils in this catchment include two major and two minor soil associations. The major associations include the Miami-Conover-Brookston, and Morley-Blount associations. These soils are nearly level to very steep, well drained to very poorly drained soils that are underlain by medium textured to fine textured glacial till material. They are generally loam soils located on till plains and moraines. The two minor soil associations include the Boyer-Fox-Sebewa and Fox-Boyer-Fox variant associations. These are nearly level to steep, well drained to very poorly drained soils that are underlain by coarse textured material. They are generally loamy sand, sandy loam to loam soils found on outwash plains, valley trains, terraces and moraines.

Throughout the basin are interspersed poorly drained soils and mucks, particularly in close proximity to the watercourse. Areas of erodable soils are scattered throughout the catchment.

Soils: Letts Creek
Soils in the Letts Creek catchment include three major soil associations. The Boyer-Kidder-Houghton association is nearly level to very steep, well drained soils that are underlain by coarse textured and moderately coarse textured material; and nearly level, very poorly drained organic soils. These are generally loamy sand and sandy loam soils on moraines, and organic muck soil in low areas. The Boyer-Fox-Sebewa association is nearly level to steep, well drained to very poorly drained soils that are underlain by coarse textured material. This includes loam, loamy sand and sandy loam soils on outwash plains, valley trains, terraces and moraines. The other association is the Miami-Conover-Brookston association, which is nearly level to very steep, well drained to very poorly drained soils that are underlain by medium textured to fine textured glacial till material. Soils included are loams on till plains and moraines.

Highly permeable soils are located extensively throughout the sub-basin, but are particularly abundant in central Sylvan Township. Erodable soils, i.e. slopes of 12% or greater, are scattered throughout the sub-basin but correspond frequently with areas of high permeability.

Soils: Lower Mainstem
The Lower Mainstem catchment has three major soil associations. The Boyer-Kidder-Houghton association is nearly level to very steep, well drained soils that are underlain by coarse textured and moderately coarse textured material; and nearly level, very poorly drained organic soils. These are generally loamy sand and sandy loam soils on moraines, and organic muck soil. The Spinks-Boyer-Wasepi association is nearly level to moderately steep, well drained and somewhat poorly drained soils that have a coarse textured or moderately coarse textured subsoil and coarse textured underlying material. These soils are generally loamy sand and sandy loam soils found on outwash plains, terraces, lake plains and deltas. The Miami-Conover-Brookston association, which is nearly level to very steep, well drained to very poorly drained soils that are underlain by medium textured to fine textured glacial till material. Soils included are loams on till plains and moraines.

Highly permeable soils cut a wide swath along the riparian corridors and surround the western tributary that empties near the impoundment. Small pockets of erodable soils, i.e. slopes of 12% or greater, are scattered throughout the sub-basin.

Soils: Mainstem
The Main Stem has one major and one minor soil association. The major association is the Miami-Conover-Brookston association, which is nearly level to very steep, well drained to very poorly drained soils that are underlain by medium textured to fine textured glacial till material. Soils included are loams on till plains and moraines. The minor association is the Boyer-Fox-Sebewa association, which is nearly level to steep, well drained to very poorly drained soils that are underlain by coarse textured material. This includes loam, loamy sand and sandy loam soils on outwash plains, valley trains, terraces and moraines.

Erodable soil areas are scattered throughout the catchment.

Soils: Mainstem Headwaters
The Mainstem Headwaters catchment has two major soil associations. The Boyer-Kidder-Houghton association includes nearly level to very steep, well drained soils that have a moderately coarse textured or moderately fine textured subsoil and coarse textured or moderately coarse textured underlying material; and nearly level, very poorly drained organic soils. Soils are generally loamy sand and sandy loams on outwash areas, and organic muck soil in low areas. The Boyer-Fox-Sebewa association includes nearly level to steep, well drained and very poorly drained soils that have a moderately coarse textured to moderately fine textured subsoil and coarse textured underlying material. These are generally loamy sand and sandy loam soils found on outwash plains, valley trains, terraces and moraines.

Erodable soils are scattered throughout the catchment, with higher predominance in the south-central catchment. A large area of highly permeable soils is found in the south portion of the catchment, and smaller areas of permeable soils are also scattered throughout the catchment.

Soils: North Fork
Two major soil associations and one minor association encompass the North Fork catchment. One major association is the Boyer-Spinks-Houghton association which is nearly level to very steep, well drained soils that have a moderately coarse textured or coarse textured subsoil and coarse textured underlying material; and nearly level, very poorly drained organic soils. These are loamy sand and organic muck soils on outwash areas. The other major association is the Miami-Conover-Brookston association, which is nearly level to very steep, well drained to very poorly drained soils that are underlain by medium textured to fine textured glacial till material. Soils included are loams on till plains and moraines. The Boyer-Fox-Sebewa association is the minor soil association in this catchment. It includes nearly level to steep, well drained to very poorly drained soils that are underlain by coarse textured material. These are loam, loamy sand and sandy loam soils on outwash plains, valley trains, terraces and moraines.

Soil permeability is generally high, especially in the northwest where the moraine is typified by higher topography and unsorted deposits. Somewhat tighter soils are common in the southern portion of the sub-basin. Muck soils associated with wetlands are also common. Small pockets of erodable soils, i.e. slopes of 12% or greater, are scattered throughout the sub-basin.

Soils: North Fork Headwaters
The North Fork Headwaters catchment has two soil associations. The Boyer-Spinks-Houghton association is nearly level to very steep, well drained soils that have a moderately coarse textured or coarse textured subsoil and coarse textured underlying material; and nearly level, very poorly drained organic soils. The Boyer-Fox-Sebewa association includes nearly level to steep, well drained to very poorly drained soils that are underlain by coarse textured material. These are loam, loamy sand and sandy loam soils on outwash plains, valley trains, terraces and moraines.

Much of this area can be identified by the numerous steeply sloping ridges surrounded by large expansive wetland systems and kettle lakes and is uniquely different from the remainder of Mill Creek catchments. Sandy well-drained soils occupy much of the upland areas, while muck soils occupy much of the lowland.

Soils: Pleasant Lake
The Pleasant Lake catchment has two major and one minor soil associations. The largest is the Miami-Conover-Brookston association which includes nearly level to very steep, well-drained to very poorly drained soils that have a medium textured and moderately fine textured subsoil and medium textured underlying material. These are loam soils found in the eastern and central portions of the catchment on till plains and moraines. The next largest association is the Boyer-Kidder-Houghton, which includes nearly level to very steep, well drained soils that have a moderately coarse textured or moderately fine textured subsoil and coarse textured or moderately coarse textured underlying material; and nearly level, very poorly drained organic soils. These loamy sand, sandy loam and organic soils are located on moraines in the western side of the catchment. The minor soil association is the Fox-Boyer-Fox variant, which includes nearly level to moderately steep, well drained soils that have a moderately fine textured to

moderately coarse textured subsoil and coarse textured underlying material. These are loamy sand, sandy loam and cobbly sandy loam soils on moraines and outwash plains.

Most of the erodable soils are concentrated on the west side of the catchment in the Sharon Short Hills area. There are also scattered areas of erodable soils in the south and eastern portions of the catchment. A moderate sized area of highly permeable soils is found in the southwest corner of the catchment, as well as smaller areas scattered in the southeast to central and northern portions of the catchment.

Soils: South Branch
There are two major soil associations in the South Branch catchment; they include the Miami-Conover-Brookston association, and the Morley-Blount association. These are nearly level to very steep, well drained to very poorly drained soils that are underlain by medium textured to fine textured glacial till material. They are generally loam soils on till plains and moraines, with poorly drained soils and mucks found close to the watercourse.

Much of the southern half of this catchment is rolling, with large areas wetlands and erodable soil areas predominate.

3.3 Hydrology

The Huron River begins at an elevation of 1,018 feet in the headwaters, and then descends nearly 500 feet to an elevation of 572 feet at its confluence with Lake Erie (Hay-Chmielewski et al). Twenty-four major tributaries flow into the mainstem of the Huron River. Mill Creek is the largest tributary to the Huron River, with approximately 265 intermittent and perennial stream miles. Stream order ranges from first order headwater streams to a fifth order segment in the Lower Mainstem.

As with many tributaries of the Huron River, most of Mill Creek has been dredged and channelized. Alterations to the Mill Creek system began as early as the first European settlements were established in the early 19th century. Prior to these alterations, forests covered much of the Mill Creek Subwatershed interspersed with oak barrens and oak openings, inland wet prairie, and lowland swamps and marshes. The creek and its tributaries ran cool and clear due to the dominance of groundwater inputs and profusion of riparian and in-stream vegetation that shaded the water. Pools, riffles and runs were prolific as the narrow, deep channel meandered through its floodplain. The substrate was primarily gravel, whereas today the substrate consists primarily of silt and sand (Schaeffer, 2001).

Mill Creek's hydrology has been drastically altered in the past 200 years due to human activities of deforestation, dam construction, drainage of wetlands, stream channelization, and urbanization. Among the hydrological factors affected are flow stability, river channel gradient, and geomorphology. A discussion of these factors is provided below.

Flow stability is a determining factor in ecological and evolutionary processes in streams and is positively related to fish abundance, growth, survival and reproduction. The frequency of high flows in Mill Creek shows that it is one of two most unstable creeks in the Huron River Watershed (Hay-Chmielewski et al, 1995; Seelbach and Wiley, 1996). According to U.S. Geological Survey flow stability classifications, the South and East branches of the Mill Creek system have poor stability, the Mainstem, and Letts Creek downstream to its confluence with the North branch have fair stability, and the North branch and Lower Mainstem exhibit poor flow stability. The Creek's instability results from channelization and extensive drainage of wetlands (Hay-Chmielewski et al). Flooding affects

Evidence of scouring flows is seen along the mainstem near Sager Road in the form of these incised banks. Photo: HRWC portions of Mill Creek during the wettest months. However, the presence of groundwater input to Mill Creek provides very stable base flows.

Baseflows for the major tributaries of Mill Creek are influenced by their principal differences in catchment geology, slope, and land use/cover. The Main Branch, which begins in and near the Sharon Short Hills, features a mix of outwash and coarse-textured morainal features that provide high infiltration rates and elevation head to drive groundwater to the northeast. Seelbach and Wiley (1996) note that springs and artesian wells attest to the availability of groundwater that provide substantive baseflow to this portion of Mill Creek. Cool, fairly stable water temperatures and moderate flows even in the late summer can be attributed to the baseflows. The North Branch drains an expansive area of high-relief, ice-contact and coarse morainal landscape that is highly charged with groundwater. However, baseflow yields are surprisingly very low possibly due to extensive wetland complexes in the headwaters (Chelsea Proving Grounds, Waterloo State Recreation Area) that increase storage and evapotranspiration, thereby reducing stream flows. Dredging and channelization of wetlands in this part of Mill Creek is to a much shallower depth than in the Main Branch. Extensive wetlands remain in place, and local water tables remain relatively high. The Chelsea Wastewater Treatment Plant currently adds small amounts to the baseflow, and continued growth in Chelsea could significantly augment summer flows. The South and East branches have similar baseflows to the North Branch. In the South Branch, baseflows are very low, with smaller streams becoming very warm, oxygen-limited, and often intermittent during the summer. Higher slopes provide better baseflow conditions in the East Branch but the rolling till surfaces more readily generate runoff and prevent extensive infiltration. See Seelbach and Wiley's (1996) excellent discussion of Subwatershed hydrology for more detail (Appendix I).

River channel gradient is a controlling influence on river habitat. Steeper gradients allow faster water flows with accompanying changes in depth, width, channel meandering and sediment transport (Knighton 1984 in Hay Chmielewski et al 1995). Gradient is measured as elevation change in feet per river mile. Most of the Huron River is a low-gradient channel of under 3 ft/mi. (Hay-Chmielewski et al). Areas of different gradient create diverse types of channels with different habitat for fish and other aquatic organisms. Many of the high gradient locations on the Huron have been dammed or channelized, such as on Mill Creek at Dexter.

The creek is wider than expected for its flow, due to flow instability and lack of a riparian corridor (Hay-Chmielewski, et al., 1995). In addition, Mill Creek lacks adequate vegetative buffers in areas of agriculture or urban land uses. Large flow fluctuations have resulted from channelization, lack of vegetated cover, and other efforts to accelerate drainage through the creek. Approximately 80 percent of the mainstem of Mill Creek and its major tributaries are designated county drains. Drain typically are narrow, simple channels with accelerated flows in channelized areas, but wide and shallow in other sections. Most drains provide little hydraulic diversity, as pool and riffle sequences are lacking almost entirely in Mill Creek and its tributaries (Riggs and Weiker, 2003).

The majority of the Mill Creek system is channelized such as this stretch near Peckins Road. Photo: HRWC

Drainage of the Main Branch sub-basin, and of isolated wetlands throughout the other sub-basins, has produced a creek with increased water yields and a more extensive drainage network compared to its pre-19th century configuration. Seelbach and Wiley applied the Soil Conservation Service (SCS) Synthetic Unit Hydrograph, which suggested that stormflow volumes experienced by the lower channel system have increased by about 40% (Table 3.1) compared to early land cover conditions as described in the original Land Office Survey notes (Comer et al. 1995). According to model estimates, rise times and event time-base have decreased by 30% reflecting historical losses of storage in the catchment.

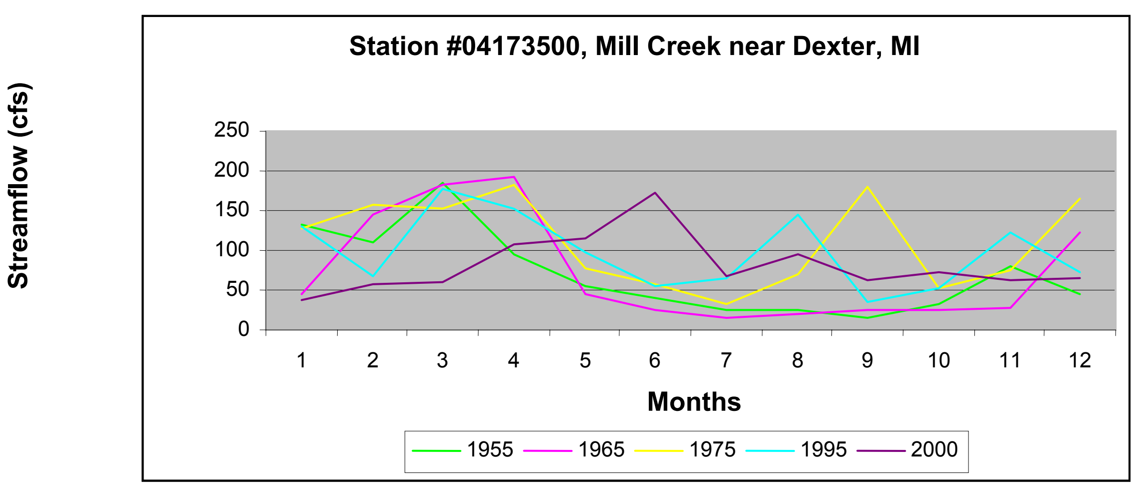
Table 3.1. Results of a synthetic unit hydrograph analysis of the Mill Creek Subwatershed. SCS Unit Hydrograph Model was employed using slope, 1978 land cover, and hydrologic soil class data from the Michigan Rivers Inventory database. Pre-settlement land cover was taken from digital maps of Comer et. al 1995. (source: Seelbach and Wiley, 1996)

Date of Land Cover data	Average catchment SCS runoff curve #	Rise time	Time base	Peak Q (runoff only)
1978 (MIRIS)	77	7 hrs	18 hrs	374 cfs
Pre-1820 (Comer et. al 1995)	64	10 hrs	26 hrs	263 cfs
Percent change	**+20%**	**-30%**	**-31%**	**+42%**

Extensive drainage of wetlands has reduced storage and increased storm runoff during periods of saturation. Another important consequence of drainage is that most riparian wetlands have been disconnected vertically from the stream channel hydrology, through a lowering of both the channel itself and the local water table (Seelbach and Wiley, 1996). Several valuable functions of naturally-connected floodplain appear to have been entirely lost; including episodic storage and dissipation of storm waters and their erosive power, seasonal export and deposition of nutrient-rich silts, and seasonal use by fishes as spawning and refuge. Loss of floodplain function has contributed to high sediment loads entering the Huron River, poor in-stream habitat, and the absence of historic fish populations (i.e., northern pike).

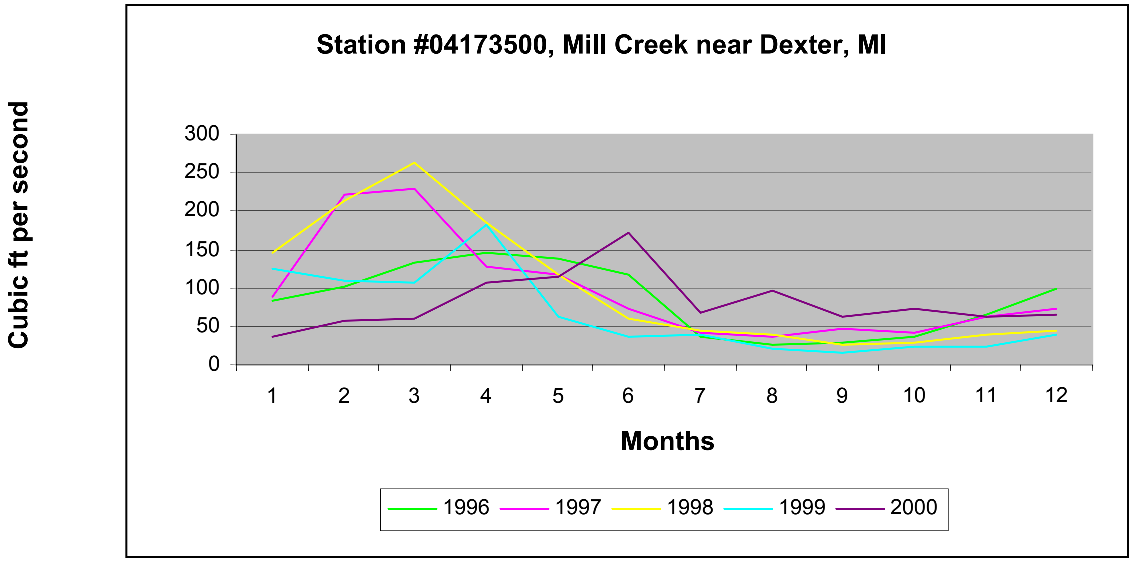
The mean monthly streamflow in cubic feet per second (ft^3/sec), according to the U.S. Geological Survey (USGS) gage station at Mill Creek near Dexter (#04173500), is presented in Figure 3.3. The information presented represents the monthly mean streamflow for five typical rainfall years of 1955, 1965, 1975, 1995 and 2000. The data represent a drainage area of 128 mi^2 of the Mill Creek Subwatershed. Flow conditions of the Subwatershed have not been constant over the past 50 years. The first two rainfall years, 1955 and 1965, show similar patterns of high flows in the spring and tapering through the rest of the year. By contrast, the later three rainfall years show peak flows in spring and again later in the year. The additional peaks may be in response to high precipitation events, or to impacts of impervious surfaces on Mill Creek's hydrology.

Figure 3.3. Mean Monthly Streamflow for Five Typical Hydrologic Years for the USGS Gage Station # 04173500 (Mill Creek near Dexter).



By taking another look at five recent hydrologic years, Figure 3.4 shows peak flows occurring from February to June with no high flow events for July to December. However, the amount of water coursing through the Creek from 1996 to 2000 tended to be greater than in the years shown in the previous figure; for example, hydrologic years 1997 and 1998 exceeded 200 cfs, while peak flows in Figure 3.3 remained below 200 cfs.

Figure 3.4. Mean Monthly Streamflow for Five Recent Hydrologic Years for the USGS Gage Station # 04173500 (Mill Creek near Dexter).



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

Direct drainage areas (Figure 3.5) are those 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. Excluded from the direct drainage are portions of the landscape that form depressions where the dominant flow of water is to groundwater through infiltration.

The groundwater recharge potential map utilizes Darcy's Law to predict the probability of groundwater recharge areas in the Subwatershed. As illustrated in Figure 3.6, Darcy's Law predicts that, in general, areas adjacent to the river and tributary streams hold the greatest probability of having groundwater recharge. Figures 3.7 and 3.8 illustrate the depth to groundwater and soil permeability characteristics for the Subwatershed. 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 Subwatershed (i.e., gas stations, chemical storage facilities, etc.).

Figure 3.5. Direct Drainage of the Mill Creek Subwatershed

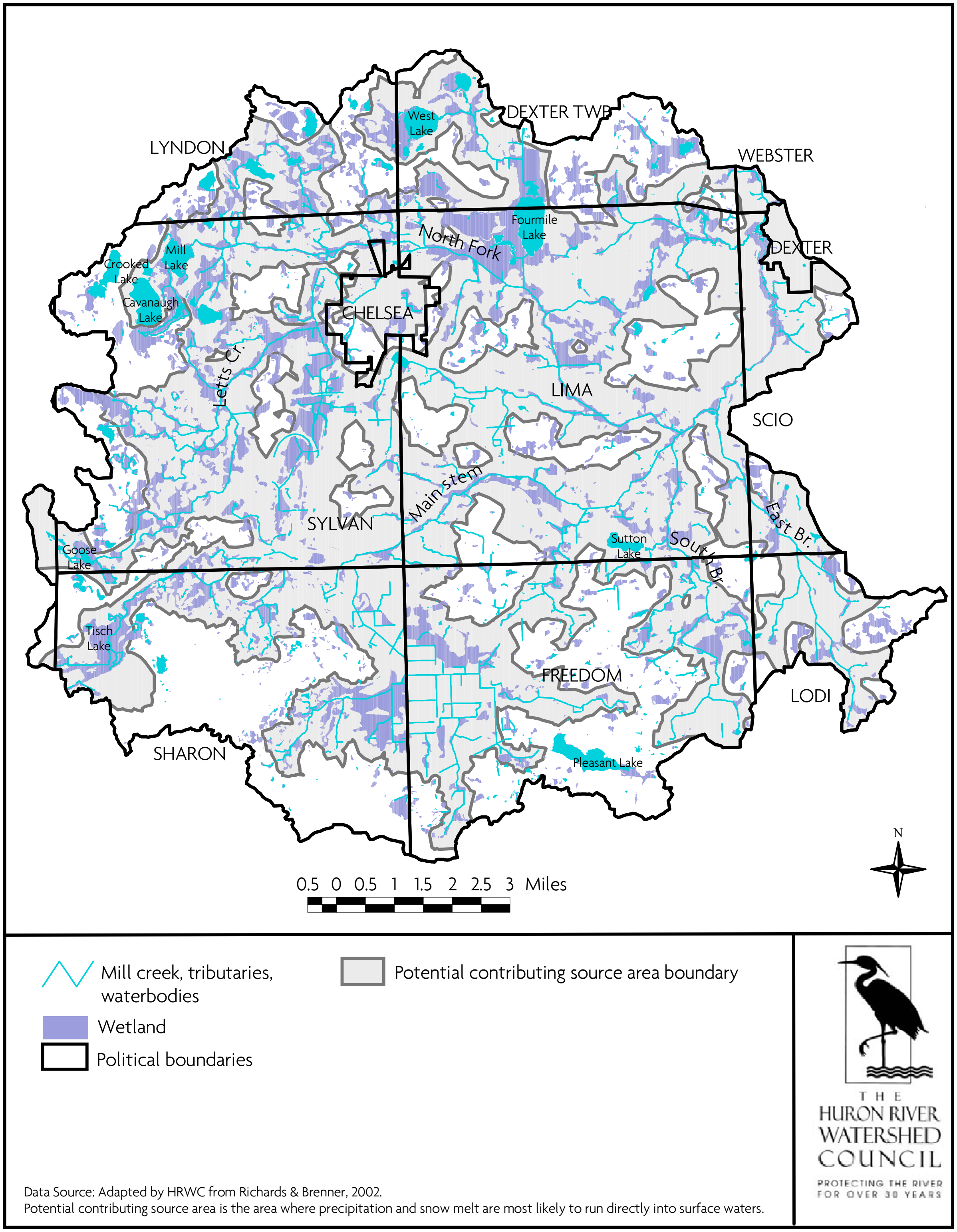


Figure 3.6. Probability of Groundwater Recharge Areas

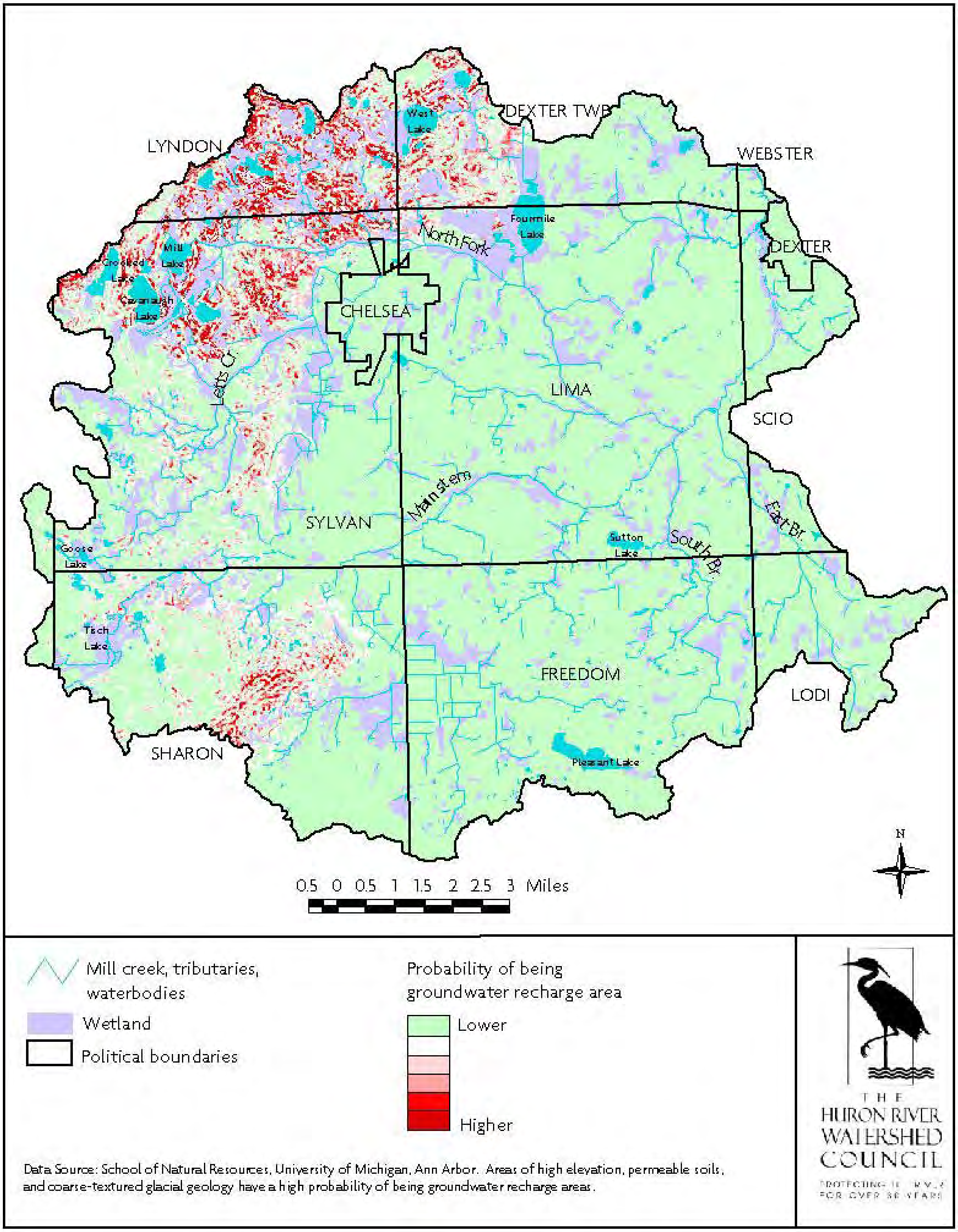


Figure 3.7. Depth to Groundwater

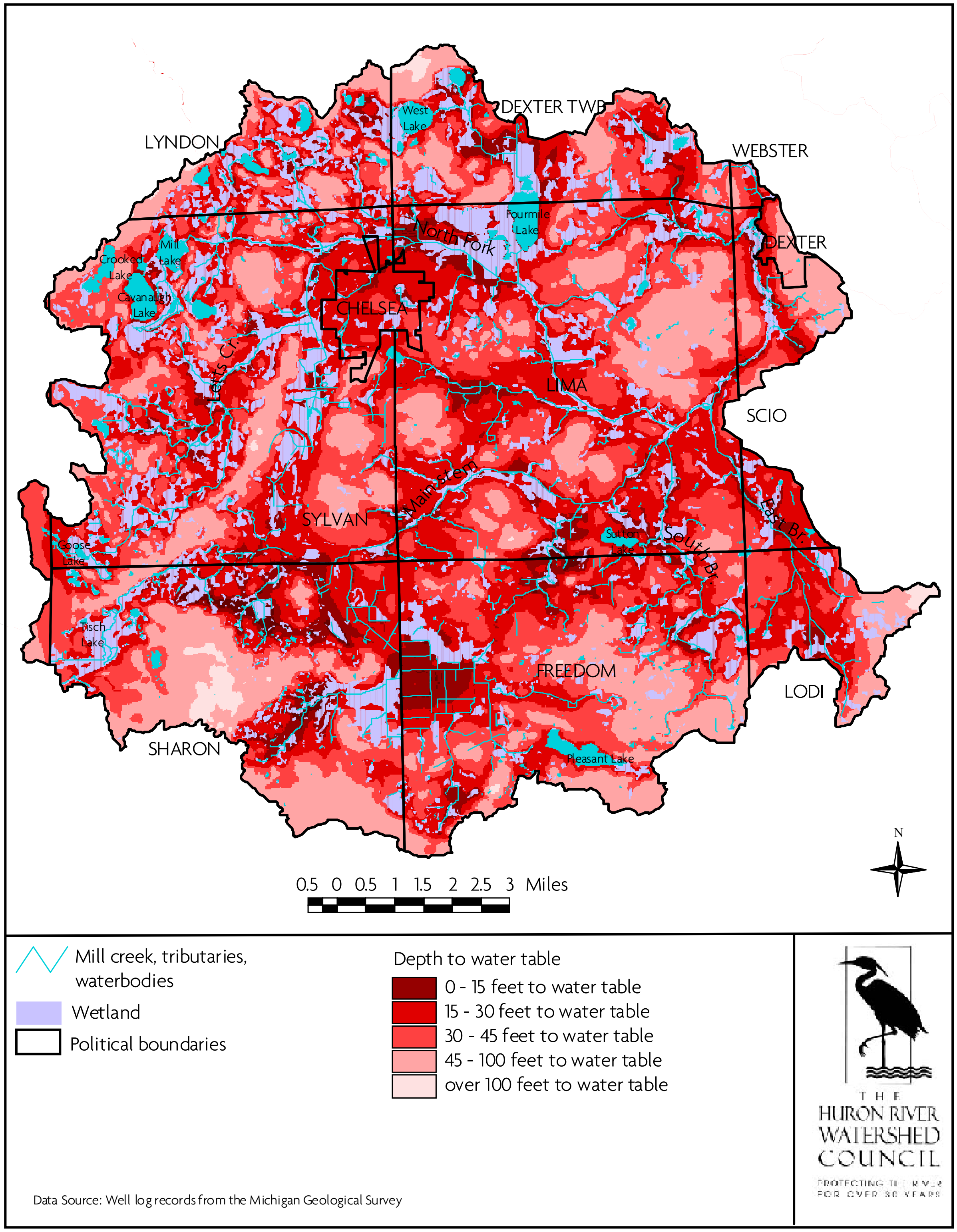
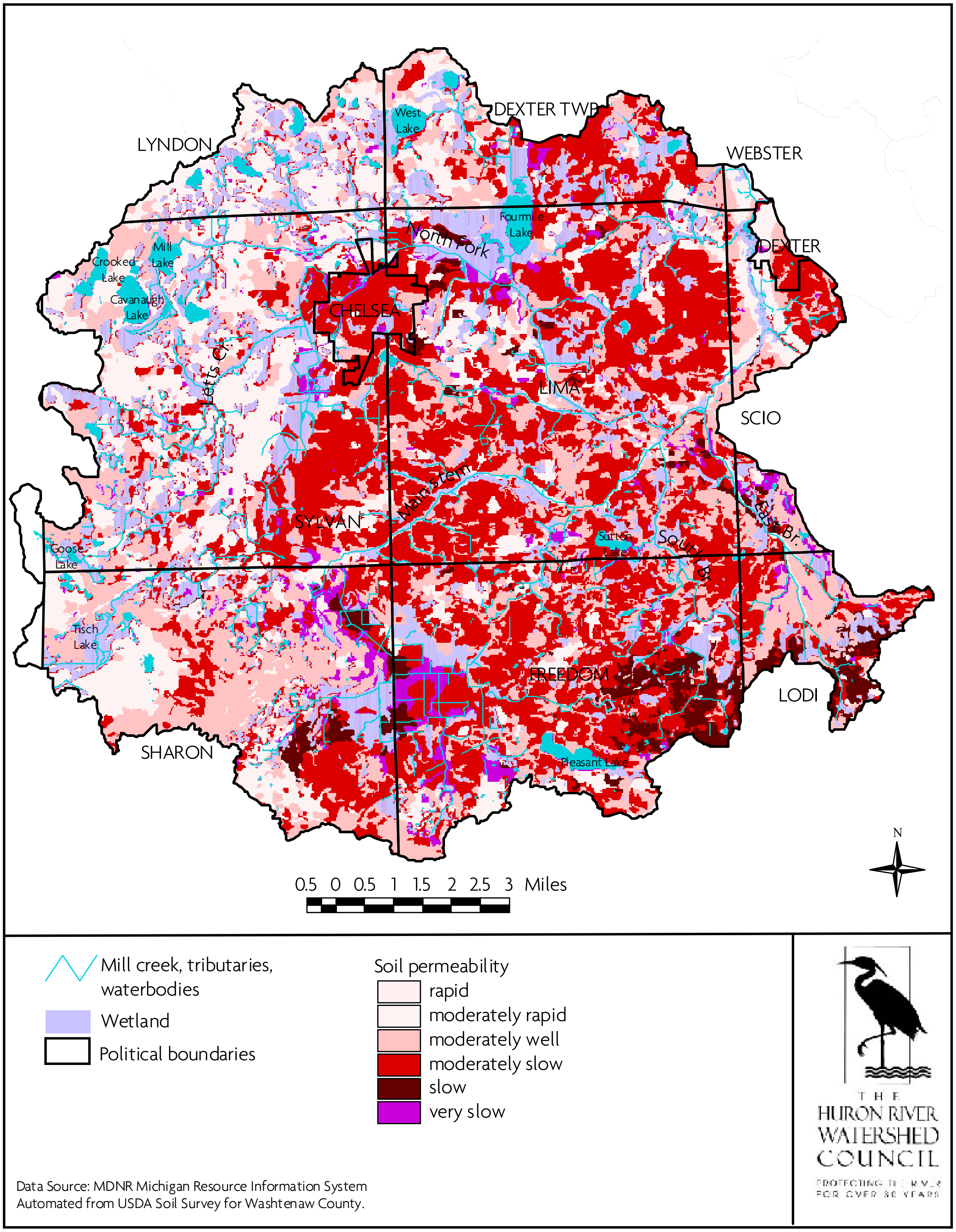


Figure 3.8. Soil Permeability



Another attribute contributing to the hydrology of the Mill Creek Subwatershed is the presence of dams or impoundments. According to the National Inventory of Dams, 5 dams or control structures are located in the Mill Creek Subwatershed (Figure 3.9 and Table 3.2).

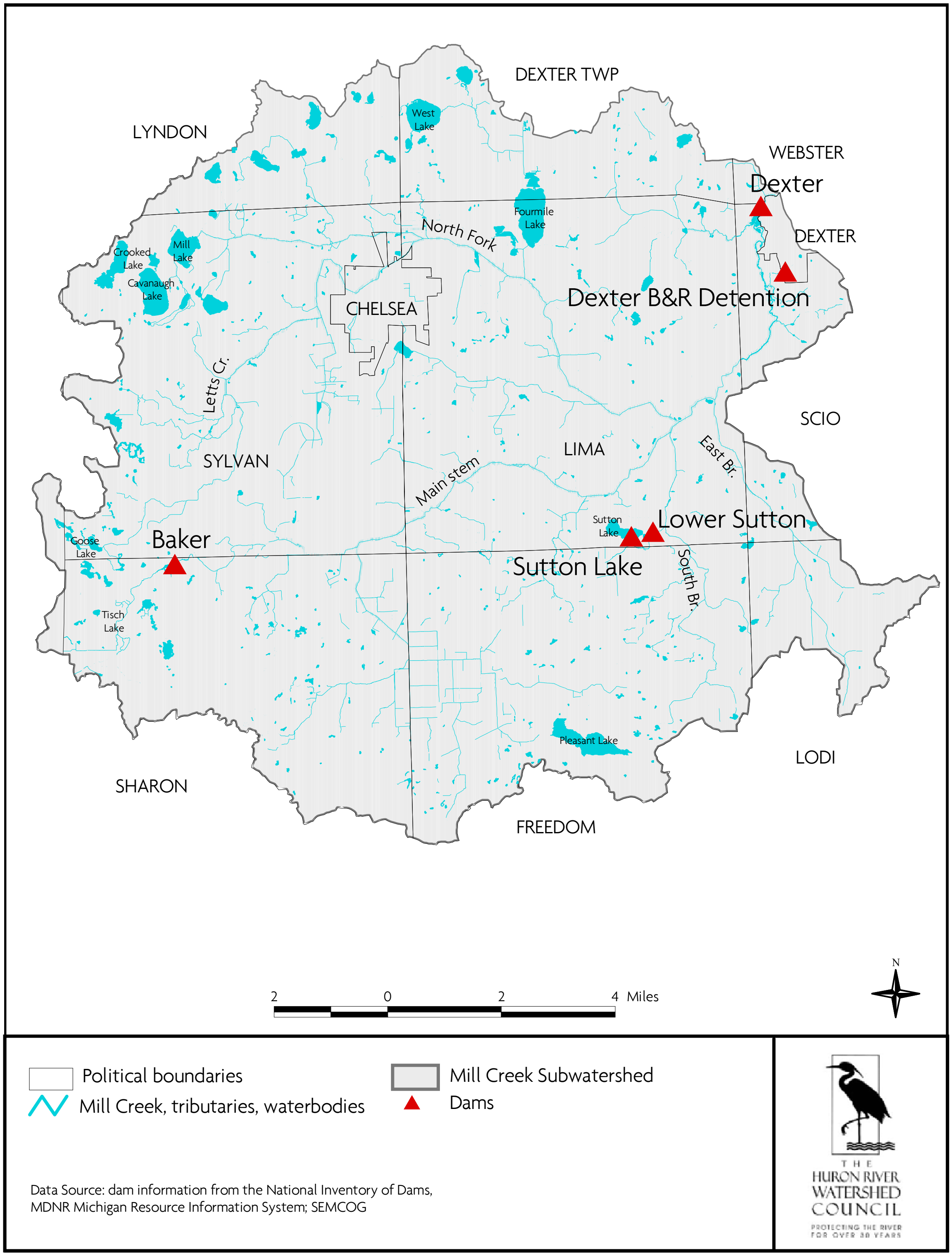
Table 3.2. Inventoried Dams of the Mill Creek Subwatershed (Source: Michigan Dept. of Natural Resources (MDNR))

	Dam Name				
	Baker	**Mill Pond**	**Sutton Lake**	**Dexter Business & Research Detention**	**Lower Sutton**
Waterway	Mill Creek, Mainstem Headwaters	Mill Creek, Lower Mainstem	Mill Creek tributary	Mill Creek tributary to Lower Mainstem	Mill Creek tributary to South Branch
Community	Sharon Township	Dexter Village	Lima Township	Dexter Village	Lima Township
Downstream Hazard Potential	Low	Significant	Low	Low	Low
Purpose	N/A	Recreation	Recreation	Stormwater Control	Recreation
Dam Type	N/A	Gravity	Earth	Earth	Earth
Date Built	1826	1932	1959	1989	N/A
Dam Height (ft)	6	15	12	14	6
Pond Surface Area (ft)	10	22	64	2	8

Mill Pond Dam in Dexter is slated for removal within the next couple of years. Photo: HRWC

Dams may be constructed for uses such as hydropower or recreation. Once useful dams can outlive their intended purpose and become a hazard and detriment to river health. Dams hold back silt, debris and nutrients, alter river flows, decrease oxygen levels in impounded waters, block fish migration and eliminate spawning habitat, increase nuisance plant growth in reservoirs, alter water temperatures, and injure or kill fish. The most significant dam on the Mill Creek system is the Mill Pond Dam in Dexter on the Lower Mainstem given its size and location near the confluence of the creek with the Huron River. Mill Creek is biologically isolated from the Huron River due to the presence of the dam.

Figure 3.9. Dams of the Mill Creek Subwatershed



3.4 Land Use and Growth Trends

Prior to European settlement of the area, most of the Mill Creek Subwatershed was vegetated by old growth forest, with occasional oak openings and wet prairie (Figures 3.10-3.11). White oak and hickory and oak barrens dominated the eastern portions of the Mill Creek watershed with pockets of black oak and white oak found at higher elevations. Lowland hardwoods appeared in patches in the lower elevations of the southern drainage of Mill Creek, while significant expanses of tamarack dotted the landscape, particularly in today's Pleasant Lake area. Emergent marsh and black and white oak stands composed much of the landscape mosaic in the northwest region of the Subwatershed. Inland wet prairie was found throughout the watershed, especially as part of the Letts Creek system, along with small patches of buttonbush/dogwood willow swamps.

Conifers, cattails and dogwood surround this wetland on Cavanaugh Lake Road. Photo: HRWC

Figure 3.10. Ecosystems in the Mill Creek Subwatershed, circa 1830s by percentage

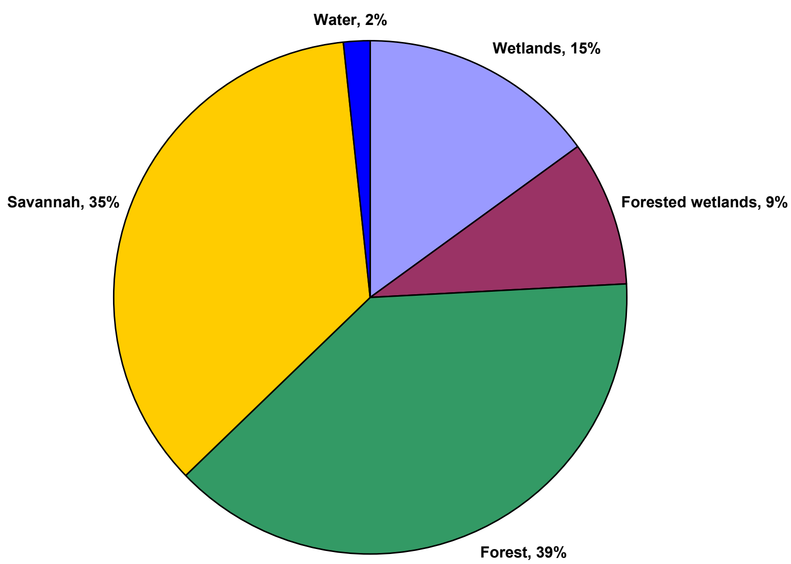
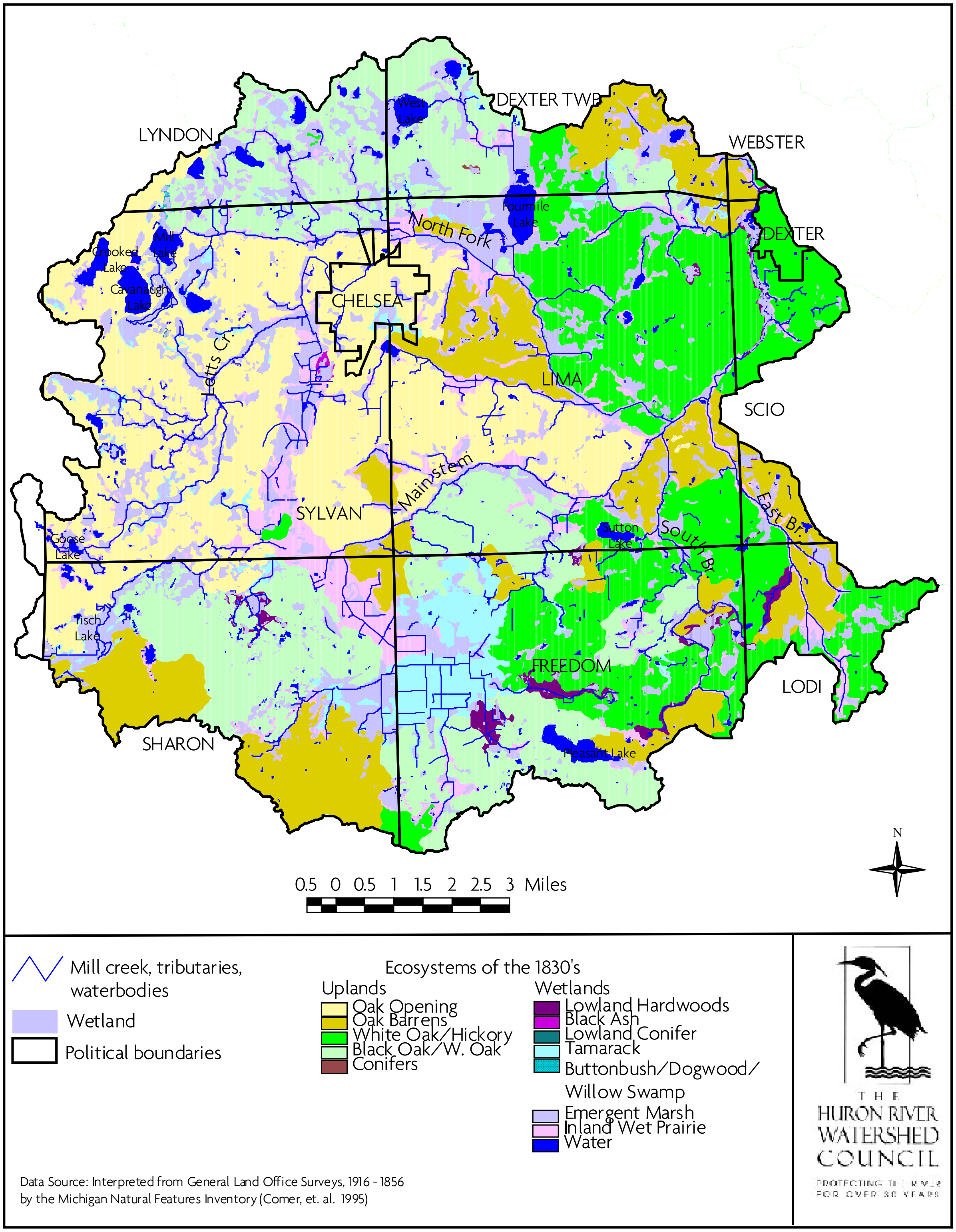


Figure 3.11. Ecosystems in the Mill Creek Subwatershed, circa 1830s



Permanent human settlement brought great change to the Mill Creek landscape as the land began to be altered for human benefit. Initial land alterations centered on draining and filling wetlands for agricultural production, and harvesting forested areas for wood and wood by-products. The creek system was dammed to produce hydropower for mills and channelized for agricultural drainage. By 1938, nearly all of the Mill Creek system had been channelized, and by the middle of the 20th century, the Subwatershed changed rapidly through a combination of intensified agriculture, industrialization, urbanization and additional dam construction (Hay-Chmielewski, et al).

Recent data derived from aerial photography reveals these landscape alterations (Figures 3.12-3.13). The greatest changes in land uses during a nearly 50-year period in the 20th century were a 7.3 percent increase in urban land use and an almost 8 percent decrease in agricultural lands (Newman 1996). As of 1998, agriculture occupied 40 percent of land in the Subwatershed, representing a 20 percent decrease from 50 years earlier. Urban land uses (i.e., residential, commercial, industrial, institutional, extractive) covered only 2 percent of the Subwatershed in the 1930s; that number grew to nearly 15 percent by 1998. Natural areas, including woodlands, wetlands and open water, have decreased to less than 40 percent of the Subwatershed. The most significant losses of natural communities since presettlement times are a nearly 100 percent decline in inland wet prairie, and a similar decrease in conifer stands. Shrub-dominated natural communities and planted hardwood stands have benefited most from human alterations to the landscape (Olsson et al, 1999).

Increasingly, Chelsea is ringed by large-lot residences and their associated infrastructure, replacing farm fields. Photo: HRWC

Figure 3.12. Current Land Covers by Percentage in the Mill Creek Subwatershed

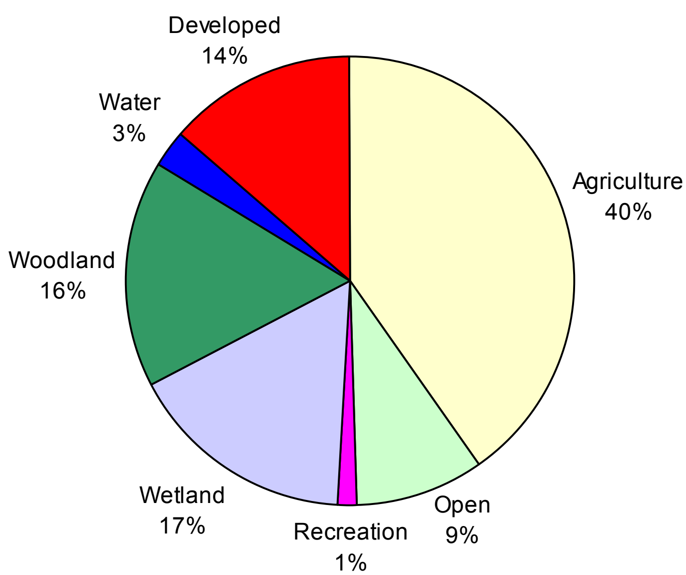
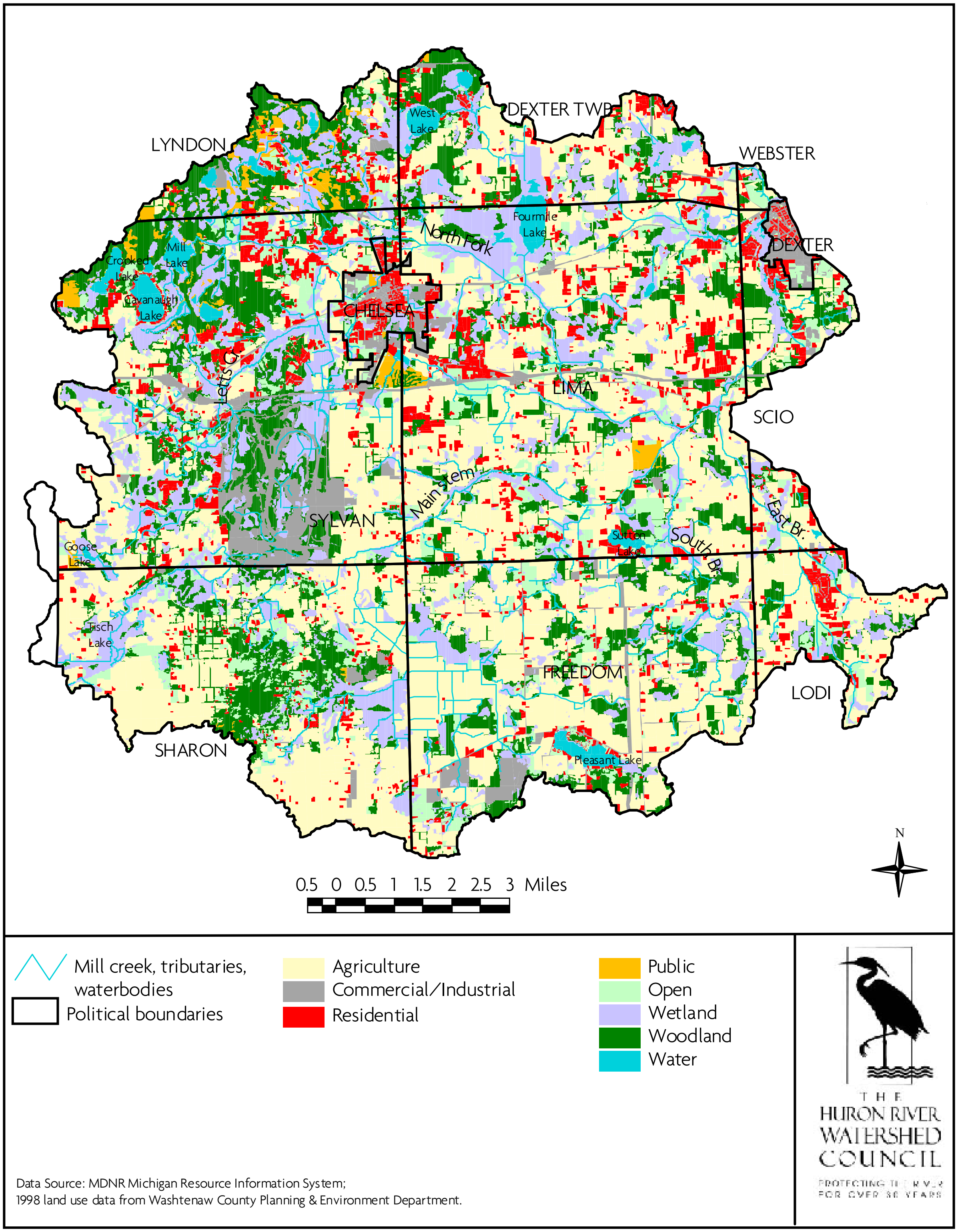


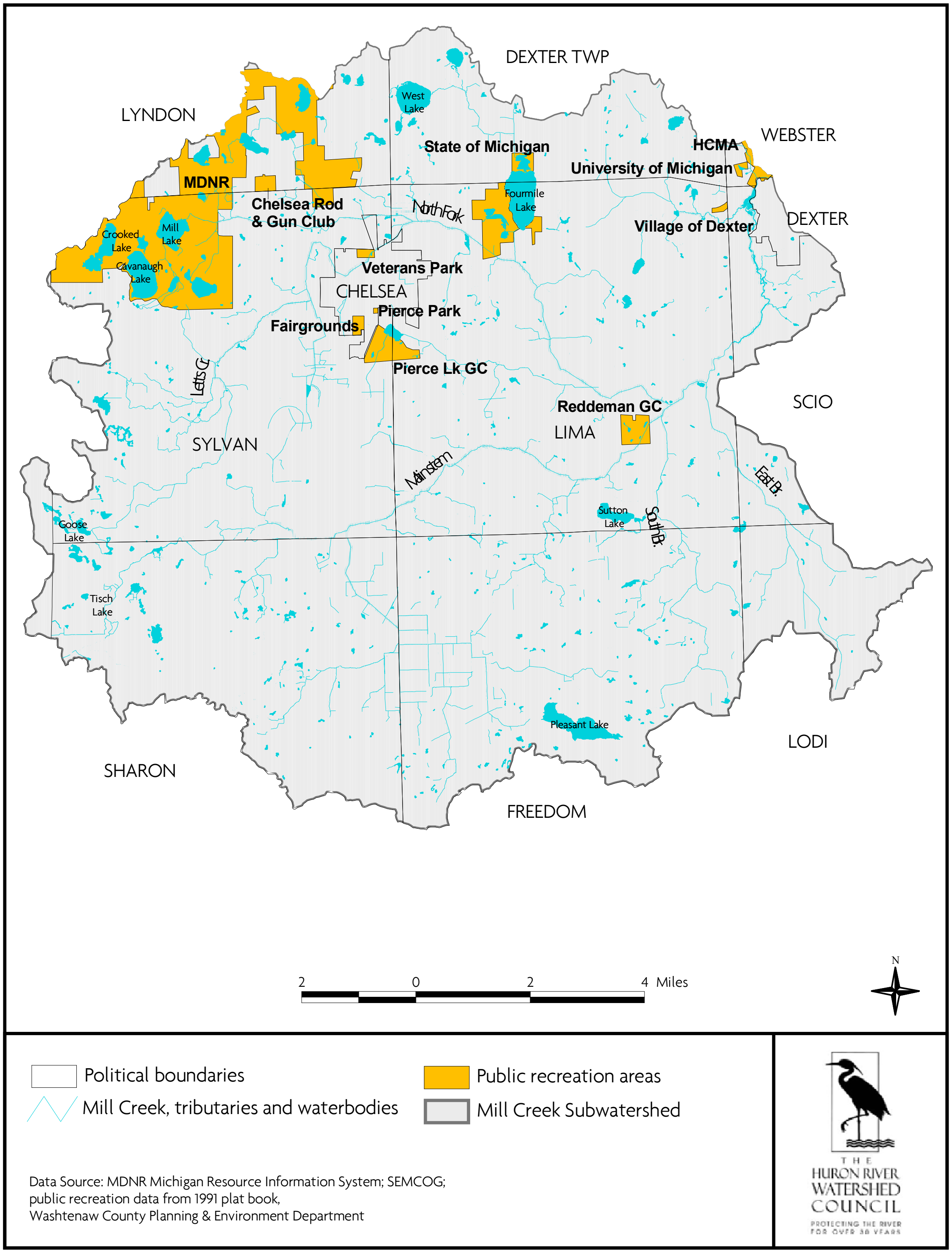
Figure 3.13. Current Land Covers in the Mill Creek Subwatershed



Land ownership is highly fragmented and varied in the Subwatershed. There are 1,800 unique land owners in the Subwatershed including individuals, trusts, government, business and university entities. Access to the creek system and lakes is limited by the pattern of private land ownership. The State of Michigan is a major landowner in the northwest portion of the Subwatershed in the Pinckney and Waterloo Recreation Areas (Figure 3.14). Commercial sand and gravel operations are located in Sharon and Freedom townships, with the larger operations being near the headwaters of the Pleasant Lake tributary of Mill Creek, and on the east side of the Sharon Short Hills. The most significant business landowner is DaimlerChrysler, which owns the Chelsea Proving Grounds in Sylvan Township. Chapter 4.3 provides more detailed land ownership and land use descriptions for the nine catchments of the Subwatershed.

DaimlerChrysler's Chelsea Proving Grounds cover hundreds of acres in the headwaters region of Letts Creek and the Mainstem in Sylvan Township. Photo: HRWC

Figure 3.14. Public Lands in the Mill Creek Subwatershed



Watershed science research literature has established the crucial importance of naturally vegetated buffers to the health of lake, wetland, and river ecosystems. An analysis of current land uses within 300 feet of open waterbodies and stream channels in the Subwatershed shows that significant stretches of Mill Creek and its tributaries and lakes lack naturally vegetated buffers (Figure 3.17). At least 40 percent of the 15,900 acres in the 300 foot riparian buffer is a land cover other than natural vegetation (Figure 3.15; Washtenaw County, 1998). Of the more than 8,100 acres of land within a 300 foot buffer around the lakes, approximately half of that area does not have natural vegetation (Figure 3.16; Washtenaw County, 1998).

Figure 3.15. Land Covers within a 300 ft Riparian Buffer of the Mill Creek System by Percentage

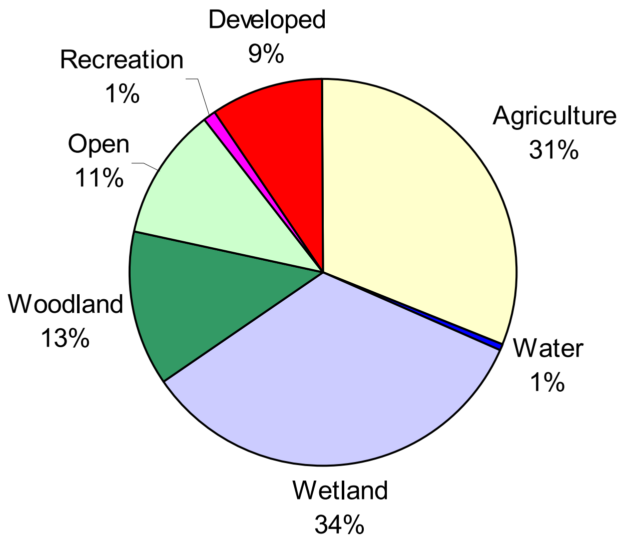


Figure 3.16. Land Covers within a 300 ft buffer of lakes in the Mill Creek Subwatershed by Percentage

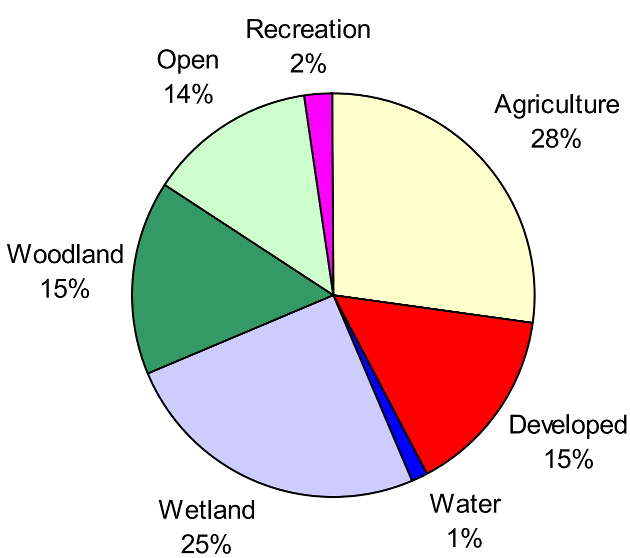
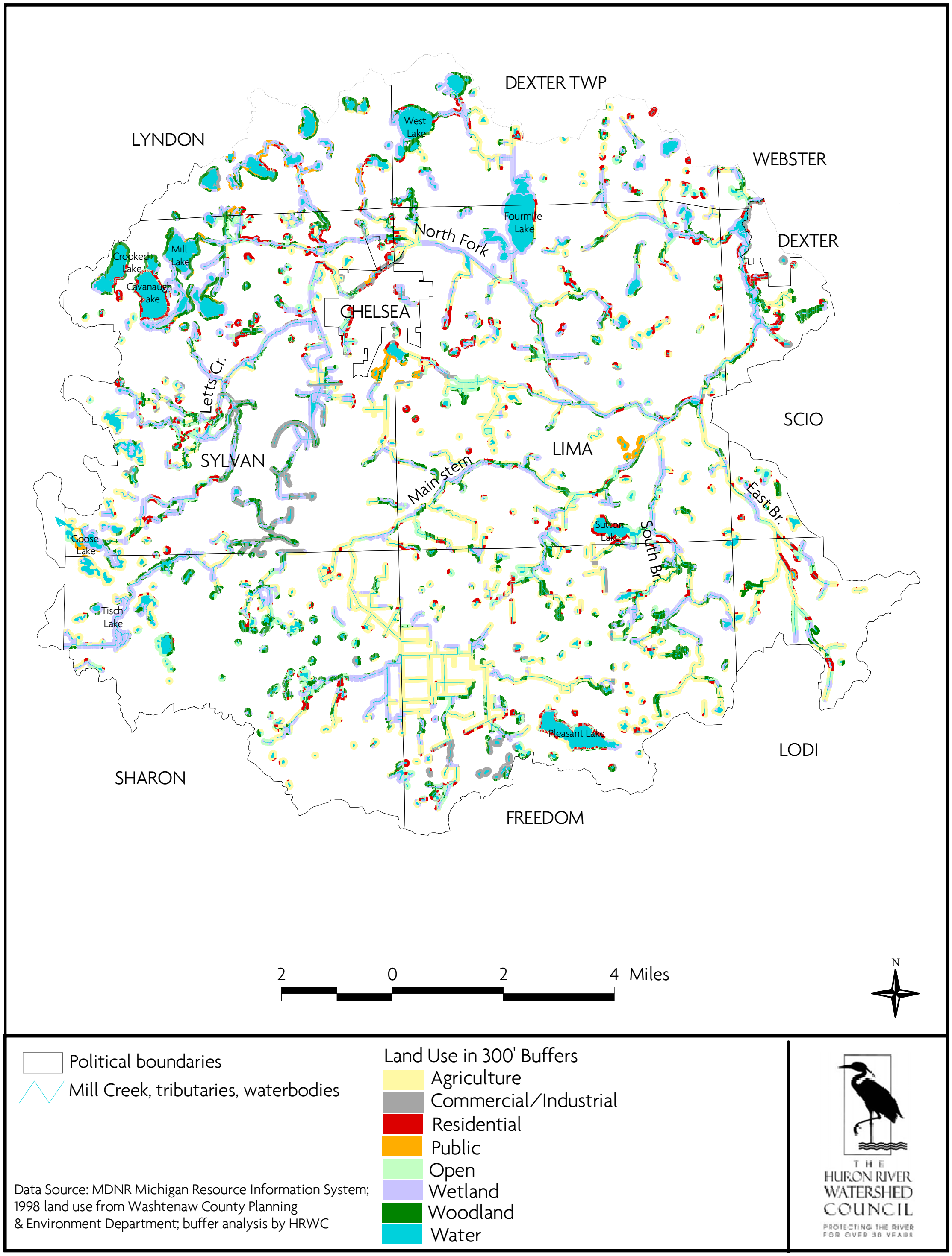


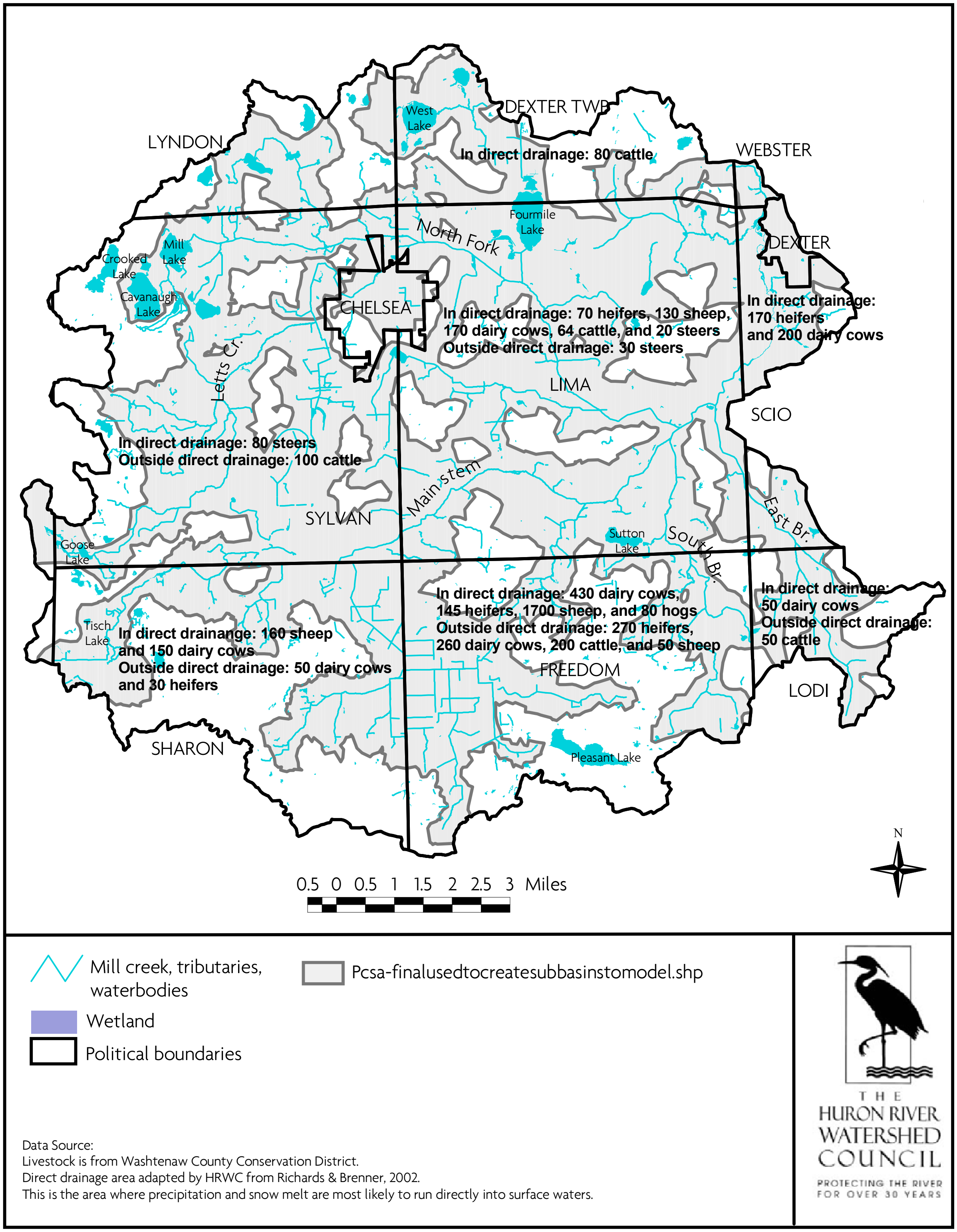
Figure 3.17. Land Covers within a 300 ft Buffer of Surface Waters



In order to gain a more complete understanding of the type of agricultural-related activities occurring in the Subwatershed, the numbers and types of livestock were inventoried. The information presented in Figure 3.18 has been generalized to show the number and type of livestock by township within the Subwatershed. Installation of best management practices to address potential negative impacts to the Creek by livestock would be most beneficial in the direct drainage portions of the Subwatershed.

More than 1,300 dairy cows live in the Mill Creek Subwatershed including these on a Freer Road farm. Photo: HRWC

Figure 3.18. Livestock by Township in the Mill Creek Subwatershed



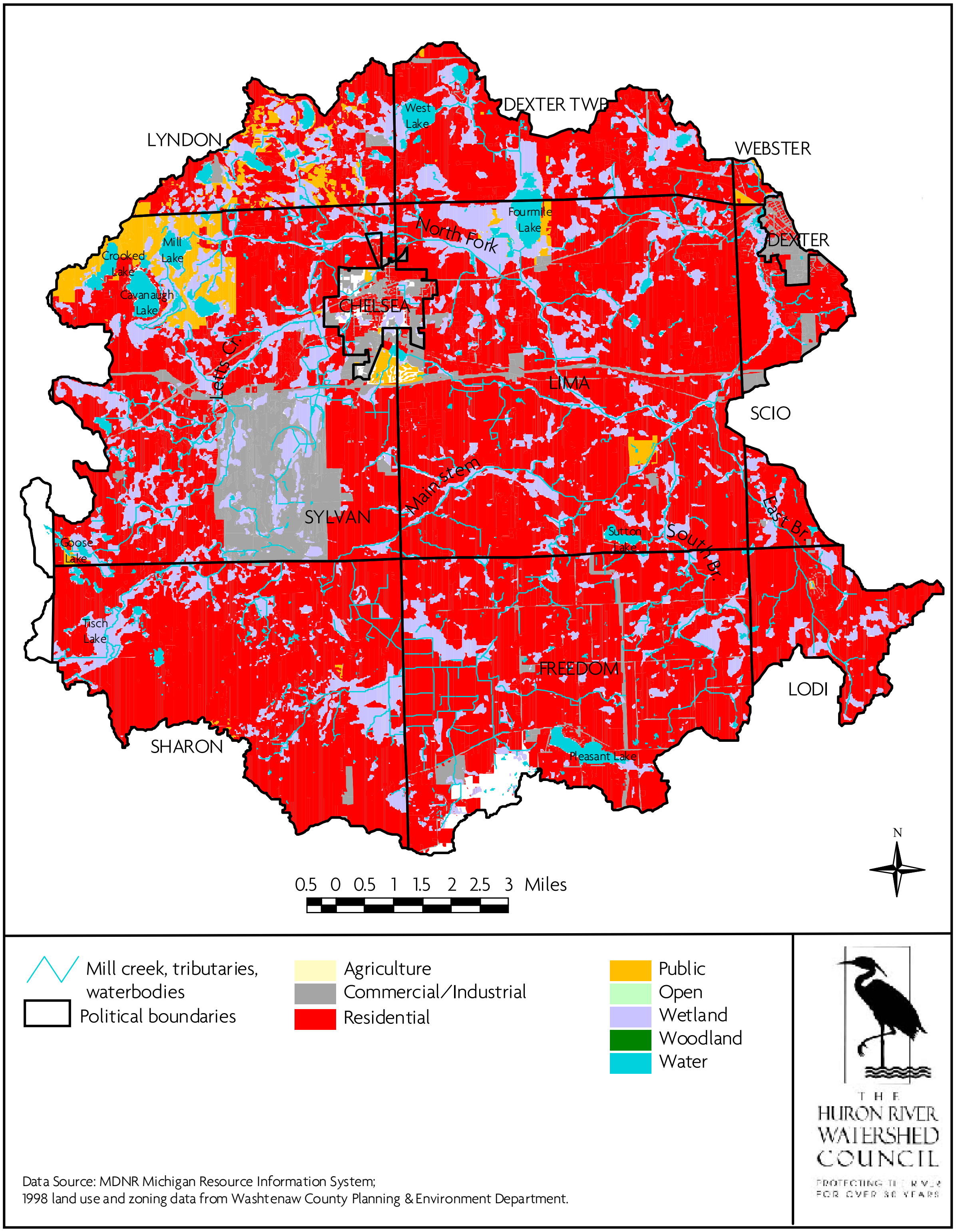
The Southeast Michigan Council of Governments (SEMCOG) projects that 40 percent of the remaining open space in southeast Michigan will be urbanized by 2010. The majority of this new development will occur within the Huron River Watershed, with over half of the communities in the upper and middle watershed expected to grow by more than 40 percent in the next twenty years. Some prominent new development is occurring during the writing of this plan that will alter the landscape of the Subwatershed, such as the west-east development corridor in Sylvan Township near I-94, and a 600+-unit manufactured housing park in Lima Township. If current trends continue, thousands of acres of farm land, woodlands, and other open spaces will be developed, further altering the hydrology and quality of local groundwater and surface water resources.

Agriculture covers 40 percent of the Subwatershed with much of it facing high development pressure. Photo: HRWC

Growth trends in the Mill Creek Subwatershed are derived predominantly from the build-out plans of local governments as prescribed in their master plans. Build-out analyses are a snapshot of the land use circumstances that may exist when all lands meet zoning codes. Figure 3.19 illustrates the expected land use scenario in the Subwatershed communities, which serves as a useful gauge of future development and impervious surface trends. Although the communities have agriculture as a zoning category, the allowable density of that land ranges from 2-acre to 5-acre to 10-acre lots depending on the community. Freedom Township is the only community in the Subwatershed that employs a sliding scale density that provides zoning more protective of agriculture.

Although not represented in Figure 3.19, a few properties will remain in their current use in perpetuity through land preservation techniques. Through conservation easements or outright purchase by the Washtenaw Land Trust, three properties will be preserved including the 68-acre Sharon Hills Nature Preserve in the southwest corner of the subwatershed. Easements will be completed on an additional 84 acres in Lima Township and Freedom Township (Hanson, pers. comm.). Washtenaw County Parks and Recreation Department intends to purchase 180 acres in Freedom Township (the Brauer property) through its Natural Areas Program. The County likely will make modest trail improvements but leave the property in its current condition with its outstanding maple swamp, wooded areas, streams, ponds and wetlands, with scenic views across the rolling land from the road (Lonik, pers. comm.)

Figure 3.19. Zoning-based Build Out of the Mill Creek Subwatershed



3.5 Political Jurisdictions

Political jurisdictions regarding the creek, riparian zones, and land are controlled by federal and state laws, county and township ordinance, 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, control of stormwater, and dredging/filling of surface waters.

The Huron River and its tributaries are public and subject to public trust protection. The mainstem is navigable, and the tributaries, including Mill Creek, are presumed navigable. The Michigan Natural Rivers Act (PA 231, 1970) designated portions of the Huron River as “country-scenic river,” including Mill Creek from Parker Road downstream to the incorporated village limits of Dexter. The stretch of the Huron River where Mill Creek empties also bears that designation. The Natural Rivers District includes 400 feet on either side of the ordinary water mark 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 125 feet septic setback, and 50 feet natural vegetation strip along the river. All restrictions apply to public lands yet the natural vegetation strip increases to 100 feet. In 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 Washtenaw County enforces 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. Communities in the Mill Creek Subwatershed that currently administer their own soil erosion and sediment control programs are the villages of Chelsea and Dexter.

Designated county drains are common in the Subwatershed, which may be an open ditch, stream or underground pipe, retention pond or swale that conveys stormwater. The Office of the Washtenaw County Drain Commissioner is responsible for operation and maintenance of storm water management systems ("county drains") in Washtenaw County. These systems are designed to provide storm water management, drainage, flood prevention and stream protection for urban and agricultural lands. The Drain Commissioner also develops standards and design criteria for management of storm water runoff in new developments, with a goal of protecting private property and natural resources (Washtenaw County, 2003). The Drain Code gives the Drain Commissioner authority for construction or maintenance of drains, creeks, rivers and watercourses and their branches for flood control and water management. A listing of the county drains located in the Subwatershed is provided in Table 3.3. In addition to oversight of these drains, the Washtenaw County Drain Commissioner’s Office is required to maintain a lake level of 890.65 feet above sea level in Four Mile Lake.

Table 3.3. Designated County Drains by Township in the Mill Creek Subwatershed. (Source: Washtenaw County Drain Commissioner's Office, 2002)

Dexter Township	Freedom Township	Lima Township	Lodi Township	Lyndon Township	Scio Township	Sharon Township	Sylvan Township
Dexter No. 3	East Branch Pleasant Lake Extension	Frey-Fitzsimmons	Frey-Fitzsimmons	Clark Lake Drain	Kaercher Tile	Comstock	Mill Creek Consolidated
Four Mile Lake Drain	Grau	Four Mile Lake Drain	Jedele			Feldkamp	Mill Creek Extension
Wandering Hills Subdivision	Pleasant Lake Extension	Pleasant Lake Extension				Pleasant Lake Extension	Pleasant Lake Extension
	Koebbe	Mill Lake					Mill Lake
	Haas	Haas					Sibley Tile
	Lambart	Lima and Sylvan					Young
	Zahn	Luick					Pierce Lake
		Mill Creek					Chelsea-M52/Dries
		Palmer Baldwin					Palmer Baldwin
		Downer					Looney & Walsh
		Finkbeiner					East Branch of Wilkinson
		Mill Creek Consolid-ated					Clark Lake

Note: No county drains are present in Webster Township within the Mill Creek Subwatershed.

While state and county governments take an active role in many local policies, local governments assume leadership in land and water management by passing and enforcing safeguards which can be more protective than state laws. Working under numerous established procedures, local governments may enact ordinances to control stormwater runoff and soil erosion and sedimentation, protect sensitive habitats such as wetlands and woodlands, establish watershed-friendly development standards and lawn care and landscaping practices, and so forth. Local governments oversee enforcement of their policies.

The Subwatershed is located predominantly in west/northwest Washtenaw County and comprises all or portions of eleven local units of government (Figure 3.20). They are the townships of Dexter, Freedom, Lima, Lodi, Lyndon, Scio, Sharon, Sylvan and Webster, and the villages of Chelsea and Dexter. Chelsea is moving forward with the process of becoming a city; a status it expects to obtain within the next year.

Figure 3.20. Local Units of Government in the Mill Creek Subwatershed

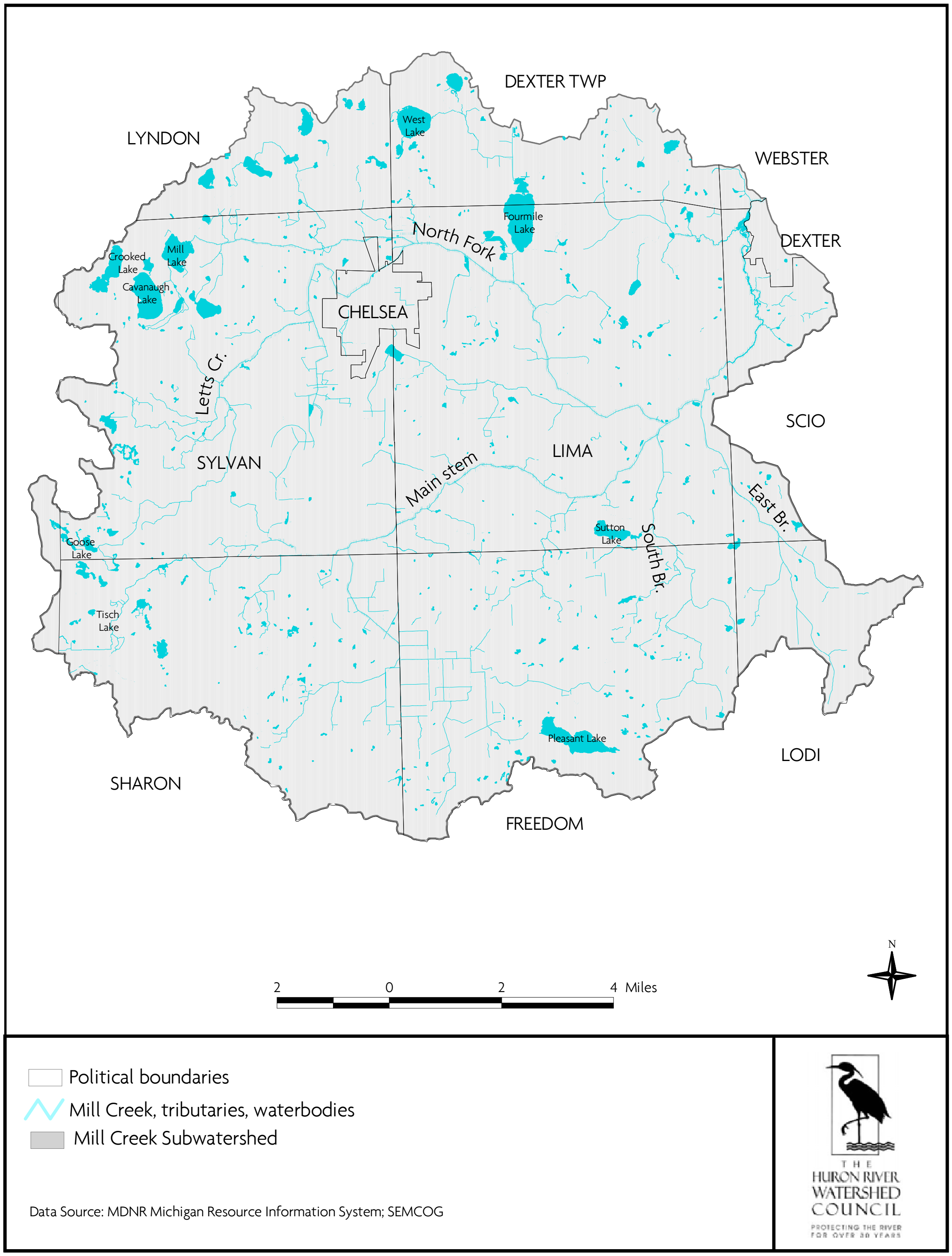


Table 3.4. Land Area and Population of Each Local Unit of Government in the Mill Creek Subwatershed. (Source: 1990 Census, SEMCOG; MIRIS)

Village/Township	Acres in Subwatershed	Percentage of Community within Subwatershed	Population within Subwatershed
Village of Chelsea	1,488	100%	3,772
Village of Dexter	503	54%	808
Dexter Township	6,382	30%	1,322
Freedom Township	15,672	68%	1,010
Lima Township	22,884	100%	2,132
Lodi Township	3,447	16%	624
Lyndon Township	4,441	20%	446
Scio Township	3,299	16%	1,532
Sharon Township	13,464	56%	765
Sylvan Township	20,130	91%	2,282
Webster Township	271	1%	32
Total			14,725

Each jurisdiction is zoned and holds regularly scheduled meetings of township governmental bodies 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 jurisdictions have the power to formulate land management, land use and development policy, among other important activities. Drains, including roadside ditches, pipes, bridges and culverts under roads that drain state highways and county roads that are not designated county drains are maintained by the Washtenaw County Road Commission.

3.6 Point Sources

The number of permitted point sources is not static due to old permits expiring and new permits commencing. At the writing of this document, eighteen permits were issued to facilities from the State of Michigan. Three point sources within the Mill Creek Subwatershed are considered major contributors by the Middle Huron phosphorus TMDL for the amount of discharge they emit. The facilities are the municipally-owned wastewater treatment plants in Dexter and Chelsea, and the DaimlerChrysler, Chelsea Proving Grounds. Discussion about these facilities is continued in Chapter 3.10.

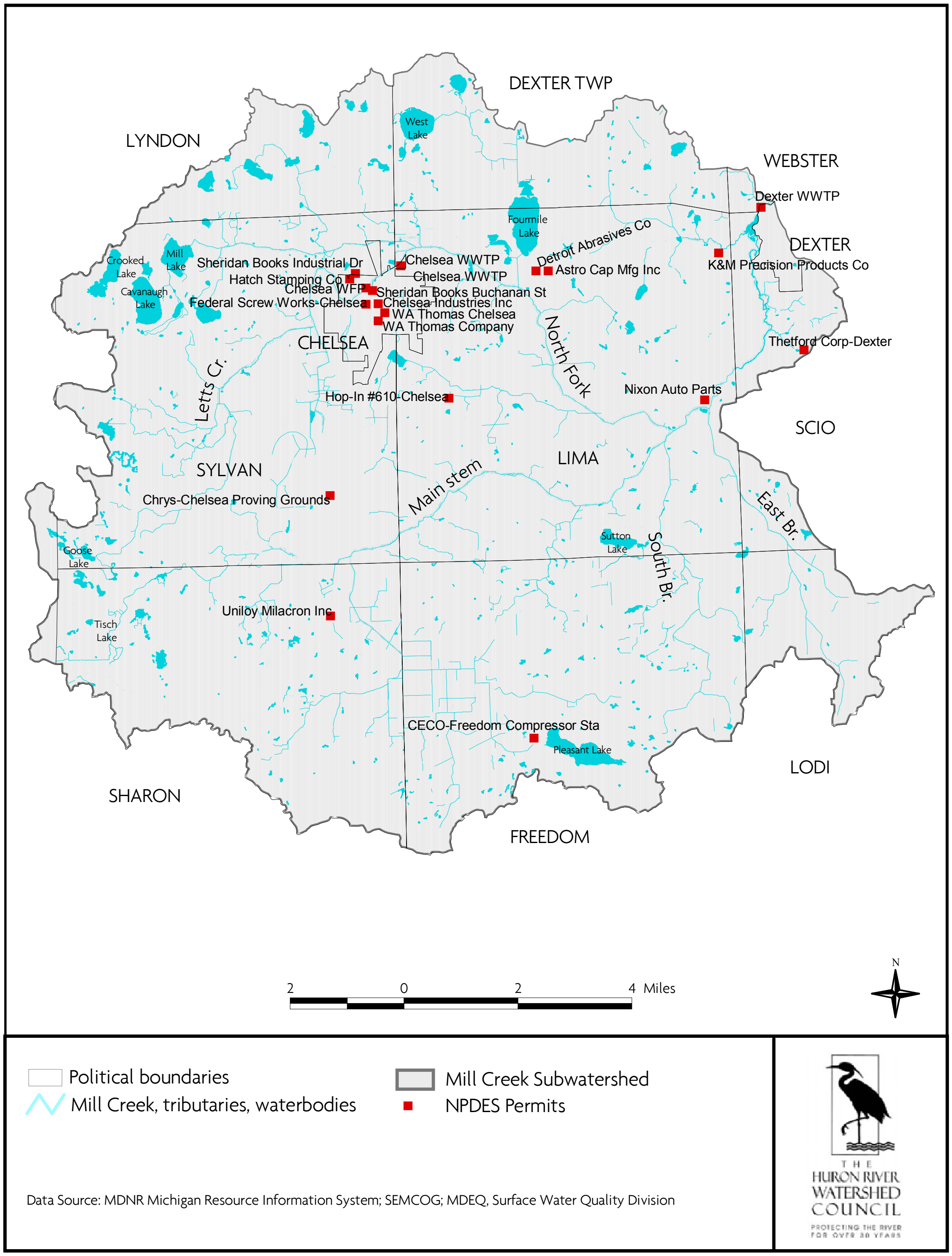
The remaining permittees are considered minor point source discharges and are privately-owned operations, with the exception of the Chelsea Water Filtration Plant. Waters receiving the permitted pollution include Mill Creek, tributaries such as Letts Creek, and lakes such as Four Mile Lake and Pleasant Lake. Eleven of the permits are issued for the purpose of conveying stormwater to local waters; those permit numbers beginning with MIS in Table 3.5 are stormwater permits. These facilities are mapped in Figure 3.21 below.

Table 3.5. National Pollutant Discharge Elimination System Permittees in the Mill Creek Subwatershed. (Source: Michigan Department of Environmental Quality, Surface Water Quality Division, 2002.)

Permit #	Designated Permit Holder	Owner-ship	Date Permit Expires	Permit Status	Township	Receiving Waters
MIS410043	Astro Cap Mfg Inc.	Private	4/1/2004	In Effect	Lima	Four Mile Lake
MI0002038	CECO-Freedom Compressor Station	Private	10/1/2003	In Effect	Freedom	Pleasant Lake
MIS410047	Chelsea Industries Inc.	Private	4/1/2004	In Effect	Sylvan	Letts Creek
MIG640206	Chelsea WFP	Public	4/1/2005	In Effect	Sylvan	Letts Creek
MI0020737	Chelsea WWTP	Public	10/1/2003	Stayed (contested)	Lima	Letts Creek
MI0020737	Chelsea WWTP	Public	9/30/1988	In Effect	Lima	Letts Creek
MI0046540	DaimlerChrysler-Chelsea Proving Grounds	Private	10/1/2003	In Effect	Sylvan	Mill Creek
MIS410049	Detroit Abrasives Co.	Private	4/1/2004	In Effect	Lima	Four Mile Lake
MI0022829	Dexter WWTP	Public	10/1/2003	Stayed (contested)	Webster	Mill Creek
MI0022829	Dexter WWTP	Public	10/1/1993	In Effect	Webster	Mill Creek
MIS410046	Federal Screw Works-Chelsea	Private	4/1/2004	In Effect	Sylvan	Mill Creek
MIS410024	Hatch Stamping Co.	Private	4/1/2004	In Effect	Sylvan	Letts Creek
MIG080751	Hop-In #610-Chelsea	Private	4/1/2005	In Effect	Lima	Mill Creek tributary
MIS410058	K&M Precision Products Co.	Private	4/1/2004	In Effect	Lima	Mill Creek
MIS410225	Nixon Auto Parts	Private	4/1/2004	In Effect	Lima	Mill Creek
MIS410390	Sheridan Books Buchanan St.	Private	4/1/2004	In Effect	Sylvan	Mill Creek
MIS410391	Sheridan Books Industrial Dr.	Private	4/1/2004	In Effect	Sylvan	Mill Creek
MI0036951	Thetford Corp-Dexter	Private	10/1/2003	In Effect	Scio	Mill Creek
MIS410278	WA Thomas Chelsea	Private	4/1/2004	In Effect	Sylvan	Mill Creek
MIS410361	WA Thomas Co.	Private	4/1/2004	In Effect	Sylvan	Letts Creek

Future prospects for the issuance of new NPDES permits to discharge phosphorus in the middle Huron River Watershed are uncertain due to the federal mandate to reduce phosphorus concentration in the River by 50% of 1996 levels. The MDEQ requires any new wastewater treatment facilities to meet the 30 micrograms per liter of phosphorus concentration in its effluent; a level that has been difficult for current available technology to meet predictably. As a result, recently approved manufactured housing projects in the Subwatershed are connecting to sewer lines that discharge the effluent to watersheds outside of the Huron River Watershed that do not yet have phosphorus limitations. However, recent permit applications for proposed wastewater treatment facilities in the middle Huron appear more likely to be approved by the MDEQ, as in the case of Lima Woods Manufactured Housing Community, due to use of treatment technology purported to meet the stringent phosphorus levels.

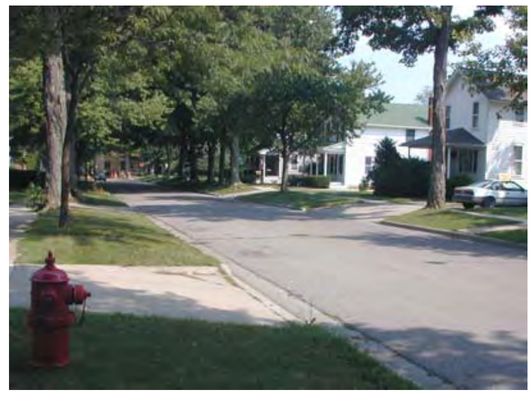
Figure 3.21. NPDES-permitted Facilities in the Mill Creek Subwatershed



3.7 Sewer Service Areas and Privately-Owned Septic Systems

The Mill Creek Subwatershed 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 WWTP 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 Subwatershed, specifically Chelsea and Dexter villages, while remaining areas are served by on-site septic systems (Figure 3.22). As of 1990, approximately 4,124 (28%) of the total Subwatershed population of 14,727 individuals rely on sanitary sewer systems for wastewater treatment. The remaining 10,603 residents use approximately 4,600 on-site septic systems for wastewater treatment. Sylvan Township is in the process of building a sewer collection network for several of its lake communities within the Subwatershed, including Crooked, Cavanaugh and Cedar lakes. In addition, the township completed water and sewer infrastructure construction that involves a pipeline spanning much of the width of the township to carry sewage out of the Huron River Watershed to a WWTP in Jackson County. Once completed, the network will serve slightly more than 1,000 households.



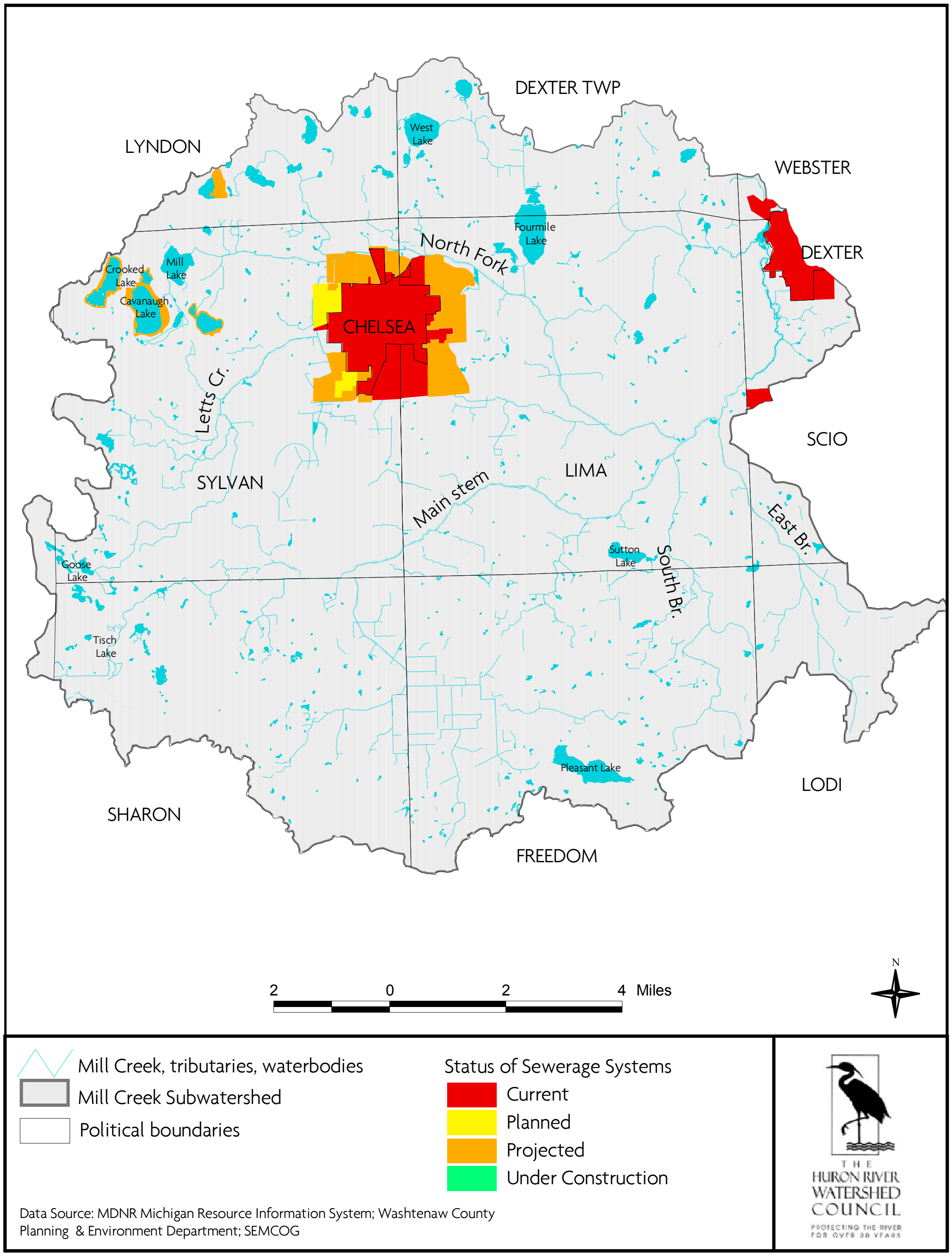
Sanitary sewer services are limited primarily to the traditional neighborhoods found in the villages, such as Chelsea. Photo: HRWC

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 Washtenaw County Environmental Health department regulates the design, installation, and repair of privately-owned septic systems. Washtenaw County is one of a handful in Michigan that requires regular maintenance and inspection to assure proper functioning of these systems, which occurs at time of property sale. 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. The County has an active program to identify and eliminate such connections through the Illicit Discharge and Elimination Program (IDEP). Local units of government covered by Phase II stormwater permits are required to identify and eliminate illicit discharges in their communities.

Figure 3.22. Sewer Systems in the Mill Creek Subwatershed



3.8 Demographics

For hundreds of years, the land that is now Washtenaw County was inhabited by Native American indigenous tribes including the Potawatomi, Ojibwa, Shawnee and Wyandot. By 1807 the whole of southeastern Michigan was ceded by the tribes through the Treaty of Detroit, and by 1823, the first permanent European settlement was established a mile southeast of Ypsilanti. When Ann Arbor became the county seat one year later, the "county" was home to 15-30 settlers. Formal organization of Washtenaw County occurred on January 1, 1827. The origin of the name Washtenaw is unclear; with some claiming it was a Potawatomi word for river. However, a museum curator at the University of Michigan wrote that Washtenaw derived from the Algonquin and meant 'Far Country' with Detroit as the point of reference (Washtenaw County website, 2003).

Today, Washtenaw County is home to more than 327,000 people (U.S. Census Bureau, 2001). The county's population is expected to increase nearly 40 percent by 2030 (see table 3.6) far ahead of the state's expected increase of 12 percent. If predictions are correct, then the human population of the Mill Creek Subwatershed will explode by nearly 80 percent. The rate of expected population growth in the Subwatershed communities is nearly double the rate for Washtenaw County, and more than six times the rate of southeast Michigan. While all Mill Creek Subwatershed communities are expected to see considerable population gains in the next 30 years, three communities will more than double their current populations: Village of Dexter; Sylvan Township; and Webster Township.

Table 3.6. Population by Community (Source: U.S. Census 2000; SEMCOG 2003)

Total Population	1990 Census	2000 Census	2030 Forecast	Percent Change from 2000-2030
Chelsea	3,772	4,398	7,300	66%
Dexter	1,497	2,338	5,472	134%
Dexter Township	4,407	5,248	6,029	15%
Freedom Township	1,486	1,562	2,169	39%
Lima Township	2,132	2,517	4,359	73%
Lodi Township	3,902	5,710	7,862	38%
Lyndon Township	2,228	2,728	3,403	25%
Scio Township	9,578	13,421	23,164	73%
Sharon Township	1,366	1,678	2,938	75%
Sylvan Township	2,508	2,734	7,262	166%
Webster Township	3,235	5,198	13,222	154%
Total	**36,111**	**47,532**	**83,180**	**78%**

Total Population	2000 Census	2030 Forecast	Percent Change
Washtenaw Co.	322,895	448,020	39%
SE Michigan	4,833,493	5,408,349	12%

All communities of the Subwatershed will see the age structure of their populations remain relatively unchanged from 2000 to 2030. The most notable change will be an increase in the percentage of the population in the age 65 and older group. Nearly two-thirds of the total population is, and will continue to be, between the ages of 18-64, which is considered the typical workforce group. The youngest residents of the Subwatershed (i.e., ages 0-4) will continue to comprise 5-8 percent of the population. An expected increase in the number of eligible workers may translate into more people in the workforce commuting to and from jobs.

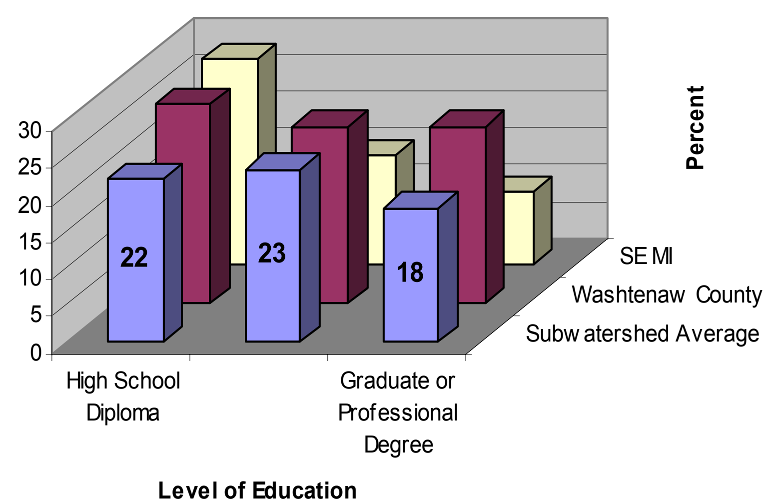
The community average for 2000 median household income in the Subwatershed is approximately $71,000, or 28 percent more than the median household income in Washtenaw County, and 30 percent more than the median household income in southeast Michigan (see table 3.7). All Subwatershed communities have fewer households in poverty (households earning less than $15,000) compared to the Washtenaw County or southeast Michigan levels. For the purpose of this Subwatershed plan, it can be instructive to know what percentage of the Subwatershed is not meeting basic needs when planning community education and outreach activities.

Table 3.7. Median Household Income and Poverty by Community, in 1999 dollars (Source: SEMCOG Community Profiles, 2003)

	2000 Median Household Income	Households Earning <$15k
Chelsea	$51,132	12%
Dexter	$50,510	6%
Dexter Twp	$75,085	3%
Freedom Twp	$62,321	5%
Lima Twp	$68,934	3%
Lodi Twp	$88,419	3%
Lyndon Twp	$71,595	3%
Scio Twp	$81,976	4%
Sharon Twp	$75,979	4%
Sylvan Twp	$72,115	2%
Webster Twp	$90,830	1%
Average	**$71,718**	**4%**
Washtenaw County	$51,990	13%
SE Michigan	$49,979	13%

Based on census reporting from 2000, the residents of the Mill Creek Subwatershed are more highly-educated compared to their southeast Michigan neighbors, on average (see figure 3.23). The highest level of education attained for 22 percent of Mill Creek community residents is a high school diploma, while 28 percent of southeast Michigan residents complete their education at that level (U.S. Census Bureau, 2000). Approximately 41 percent of Mill Creek residents hold an undergraduate degree or higher, compared to the southeast Michigan average of 25 percent. On average, 27 percent of Washtenaw County residents completed their formal education at the high school level, and 48 percent hold an undergraduate degree or higher. The remainder of the population is either not a high school graduate, or completed some college but did not obtain a degree, or obtained an associate degree.

Figure 3.23. Education Level of Residents Age 25+ in the Mill Creek Subwatershed



The vast majority of new residential construction was as single family during the years 1991-2000 (see Table 3.8). Single family residential lots consume more land per resident and, thus, contribute more to sprawling land use patterns than the increased density of multi-family residential. While manufactured homes may provide more density than single family residential, they can contribute to sprawl by being located away from water and sewer infrastructure and increasing vehicle miles traveled by the influx of significant numbers of new residents to a community.

Table 3.8. Residential Construction in Mill Creek Subwatershed Communities, 1991-2000 (Source: SEMCOG 2030 Regional Development Forecast)

Community	Total new housing units	Residential Type (approximately)		
		Single family	Two- and Multi-family	Mobile Homes
Chelsea	200	85%	15%	0%
Dexter	455	80%	20%	0%
Dexter Twp	415	100%	0%	0%
Freedom Twp	64	100%	0%	0%
Lima Twp	237	100%	0%	0%
Lodi Twp	676	70%	0%	30%
Lyndon Twp	227	100%	0%	0%
Scio Twp	2,001	75%	20%	5%
Sharon Twp	190	100%	0%	0%
Sylvan Twp	231	100%	0%	0%
Webster Twp	806	100%	0%	0%
Total	**5,502**			

Once a predominantly agricultural region, the workforce in the Mill Creek Subwatershed is diversifying into other areas, such as retail trade and services. As the amount of arable land continues to decrease from development, fewer people will be employed in the agriculture, mining and natural resources class. More people and more people working away from their homes and fields means increased drive time. Two of the 25 largest employers in Washtenaw County are based in the Subwatershed - DaimlerChrysler Chelsea Proving Grounds and Chelsea Community Hospital (Washtenaw Development Council, 2001).

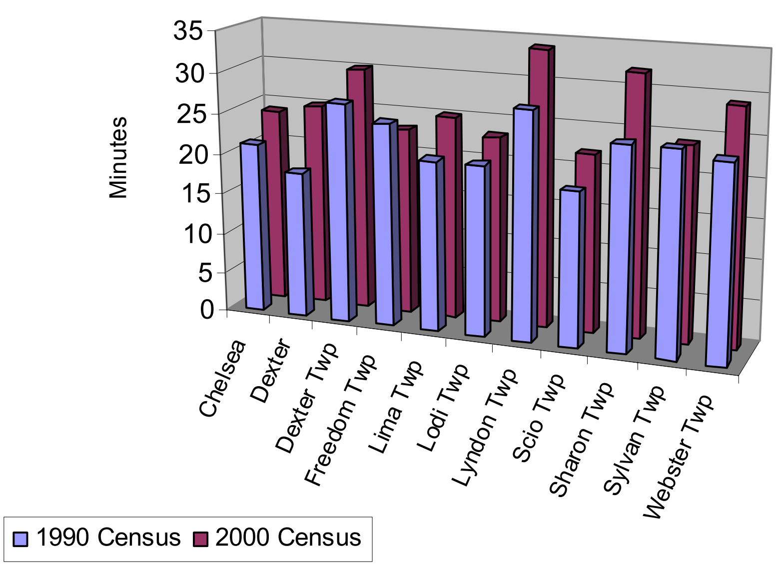
The communities of the Mill Creek Subwatershed, as a whole, face employment trends similar to those expected for Washtenaw County with few exceptions (see Table 3.9). Significant declines in the agriculture, mining and natural resources industry are forecasted over the next 25 to 30 years; in particular, Freedom and Sharon townships could experience declines of more than 30 percent and 40 percent, respectively. Manufacturing jobs may decline slightly in the Subwatershed according to forecasting by SEMCOG. All other industry sectors are forecasted to experience moderate to high increases in employment, with retail trade and services leading the gains in the Subwatershed. The Mill Creek communities, as well as Washtenaw County, should expect healthy job growth over the next quarter century given current predictions.

Table 3.9. Forecast: Change in Jobs by Industrial Class, 2000-2030
(Source: SEMCOG 2030 Regional Development Forecast)

Industry	Washtenaw County Total Jobs 2000	Washtenaw County Total Jobs 2030	Washtenaw County Percent Change	SEMCOG Region Total Jobs 2000	SEMCOG Region Total Jobs 2030	SEMCOG Region Percent Change
Agriculture, Mining and Natural Resources	4,605	3,900	-15%	31,480	41,096	31%
Manufacturing	32,910	34,168	4%	490,969	454,700	-7%
TCU	9,209	11,498	25%	140,673	153,231	9%
Wholesale Trade	6,611	10,079	53%	145,380	179,055	23%
Retail Trade	37,619	50,254	34%	469,193	546,061	16%
Finance/Insurance/Real Estate	10,721	14,507	35%	206,393	238,599	16%
Services	120,059	149,276	24%	1,096,573	1,384,334	26%
Public Administration	8,480	11,712	38%	92,569	102,399	11%
Total	**230,214**	**285,394**	**24%**	**2,673,230**	**3,099,475**	**16%**

Mill Creek Subwatershed residents reported they rely almost entirely on personal automobiles for transportation. Limited ride share, mass transit, and alternative modes of transportation are used. Not surprisingly, the average drive time to work increased from 1990 to 2000 for most residents (Figure 3.24). The greatest increase was 7 minutes in Dexter Township, however most communities increased 3 to 4 minutes. Two communities, Sylvan and Freedom townships, actually reported slightly reduced travel times. In Washtenaw County, average driving time to work increased from 19 minutes in 1990 to 22 minutes in 2000. A similar 3-minute jump occurred in the southeast Michigan region during the same decade, from 23 minutes to 26 minutes (U.S. Census, 2000). This trend likely will continue unless innovative transportation options are invested in by state, county and local governments; the Detroit Area Regional Transportation Authority (DARTA), a rapid mass transit system, is in the planning and discussion stages and could service the Mill Creek communities.

Figure 3.24. Residents' Average Driving Time to Work by Community



3.9 Significant Natural Features to be Protected

While much of the Mill Creek Subwatershed has been altered and degraded, pockets of high quality habitat and diverse species remain. The extent and ecological quality of the remaining open spaces and native habitats directly impact the quality of life and quality of water in the Subwatershed. Plant and animal species as well as plant community types have been recognized by researchers as significant for protection in the Subwatershed. For example, The Nature Conservancy has marked aquatic conservation targets in the headwater lakes of the northwest, and terrestrial conservation targets in the Pinckney-Waterloo State Recreation Area as ecoregional priorities for its conservation efforts (TNC, 2001). Among those conservation targets are the threatened and endangered species, or element occurrences, that have been observed in the Subwatershed (Table 3.10). Of the 22 element occurrences in the table, three-fourths are partially or entirely dependent on aquatic ecosystems for survival.

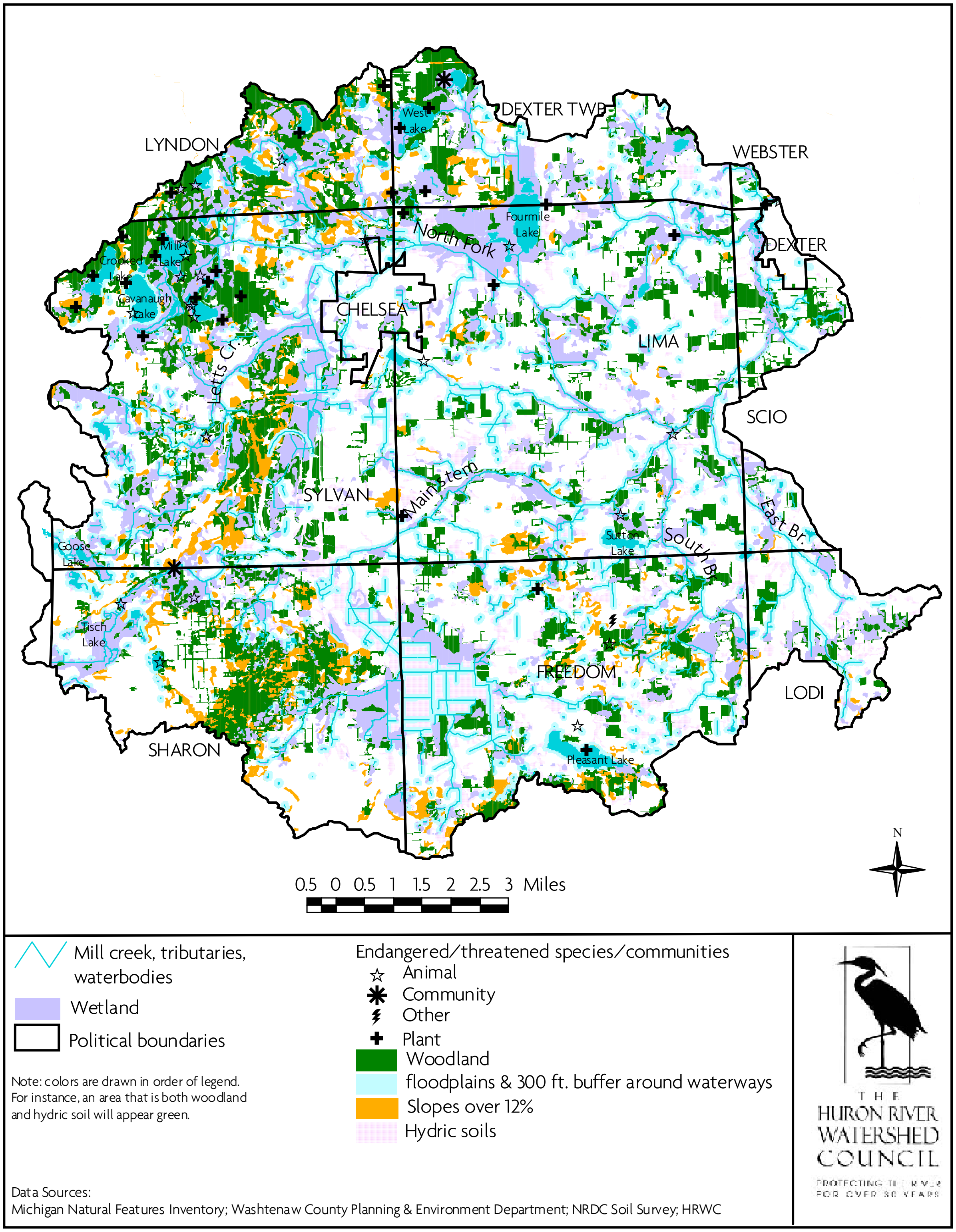
Table 3.10. Element Occurrences in the Mill Creek Subwatershed (source: Michigan Natural Features Inventory)

COMMON NAME (*SCIENTIFIC NAME*)	STATE STATUS	FEDERAL STATUS
ANIMALS		
Pugnose shiner (*Notropis anogenus*)	SC	
Brindled madtom (*Noturus miurus*)	SC	
Northern madtom (*Noturus stigmosus*)	E	
Least shrew (*Cryptotis parva*)	T	
Spotted turtle (*Clemmys guttata*)	SC	
Massasauga rattlesnake (*Sistrurus catenatus*)	SC	C2
American burying beetle (*Nicrophorus americanus*)	E	E
Snuffbox mussel (*Dysnomia triquetra*)	T/PE	
Smallmouth salamander (*Ambystoma texanum*)	T/PE	
Blanchard’s cricket frog (*Acris crepitans blanchardi*)	SC	
Smallmouth salamander (*Ambystoma texanum*)	T/PE	
Blanchard’s cricket frog (*Acris crepitans blanchardi*)	SC	
Smallmouth salamander (*Ambystoma texanum*)	T/PE	
Least shrew (*Cryptotis parva*)	T	
PLANTS		
Edible valerian (*Valeriana ciliata*)	SC	
Yellow cyperus (*Cyperus flavescans*)	SC	
Spike-rush (*Eleocharis caribaea*)	T	
White lady slipper (*Cypripedium candidum*)	T	C3
Orange/yellow fringed orchid (*Platanthera ciliaris*)	T	
Bog bluegrass (*Poa paludigena*)	T	C2
Water willow (*Justicia americana*)	T	
Swamp/black cottonwood (*Populus heterophylla*)	T/PE	

Key: SC = Special Concern E = Endangered T = Threatened
PE = Proposed Endangered C2/C3 = Candidate

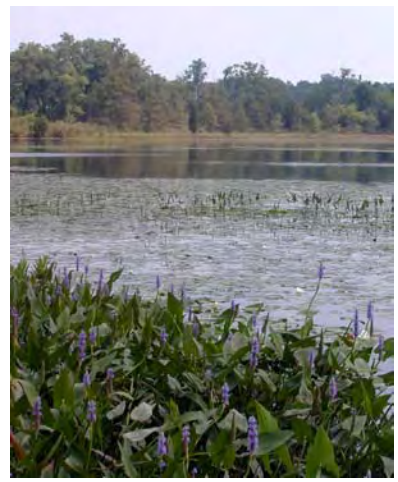
Recovering these species requires protecting the natural systems on which they depend. Key conservation areas of the Mill Creek system include critical habitat for plant and animal communities, such as freshwater wetlands, large forest tracts, springs, spawning areas, habitat for rare, threatened or endangered species, and native vegetation areas; the aquatic corridor, including floodplains, stream channels, springs and seeps steep slopes, and riparian forests.

Figure 3.25 Sensitive Areas of the Mill Creek Subwatershed



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 ecological services to the Subwatershed including the following:

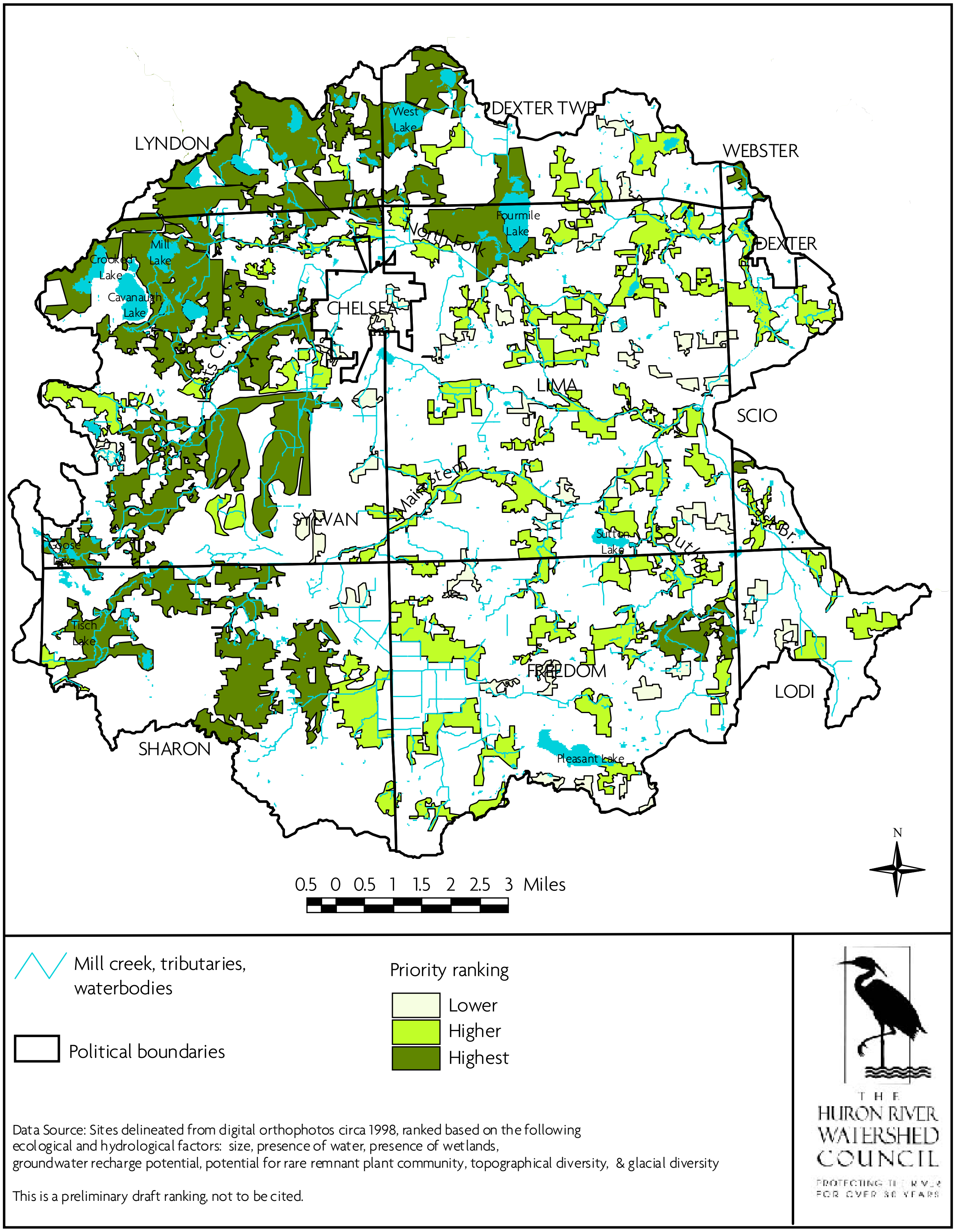
- Groundwater. Natural systems allow rain water and snowmelt to infiltrate into groundwater aquifers. About 50% of Michigan residents rely on groundwater for drinking water. Groundwater also provides irrigation water for agriculture and cooling water for industry.
- Surface water. By intercepting runoff 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 will 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 and soil soaks up water, 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 to the local community.
- Property values. Natural areas enhance the value of neighboring properties.



Mill Lake, in the North Fork Headwaters Catchment, is considered a top priority for protection in the Conservation Planning in the Huron Watershed project. Photo: HRWC

Remaining undeveloped, or natural areas, in the Huron Watershed were mapped in 2002 through the Conservation Planning in the Huron Watershed project of the Huron River Watershed Council. In order to help prioritize protection and conservation efforts, the mapped sites were ranked based on the following ecological and hydrological factors: size; presence of water; presence of wetlands; groundwater recharge potential; potential for rare remnant plant community; topographical diversity; and glacial diversity. One hundred fifty-one sites (28,570 acres) in the Mill Creek Subwatershed were identified as priority natural areas, with 32 sites (15,391 acres) ranked as highest priority for protection, 73 sites (10,847 acres) ranked as medium priority for protection, and 46 sites (2,330 acres) ranked as lower priority for protection (Olsson, 2002). The results of the project are shown in Figure 3.26.

Figure 3.26. Protection and Restoration Priority Areas in the Mill Creek Subwatershed



Wetlands provide valuable ecological services described above. A two-year study facilitated by the Watershed Council characterized the functions of wetlands in the northern drainage of the Mill Creek Subwatershed and generated assessments for over 300 wetlands in the study area (Olsson and Worzalla, 1999). Key findings of the study are that (1) all of the wetlands provide at least 1 function; (2) most wetlands provide at least 3 functions; and (3) wetlands smaller than 5 acres provide as many functions as larger wetlands (Figures 3.27 and 3.28). Wetlands perform many functions, for free, and it is in the best interest of communities to protect wetlands in order to continue to benefit from these services. The surveyed wetlands are shown in Figure 3.29.

Figure 3.27. Services Provided by Surveyed Wetlands Based on Size

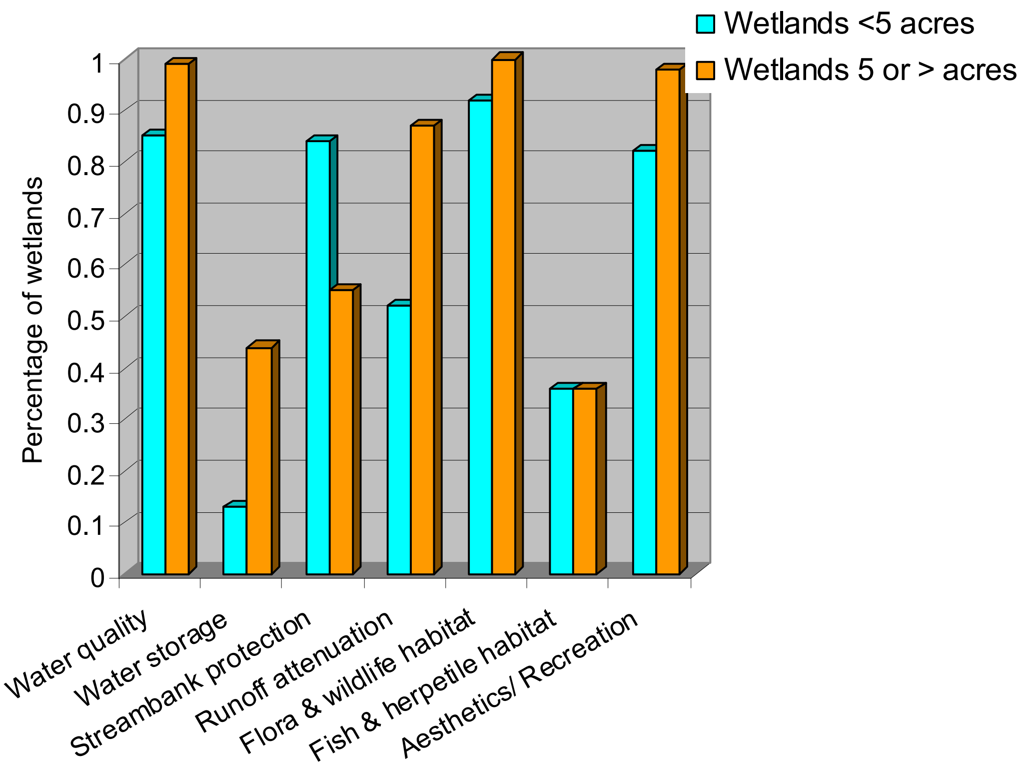


Figure 3.28. Frequency of Wetlands Surveyed Providing a Number of Functions.

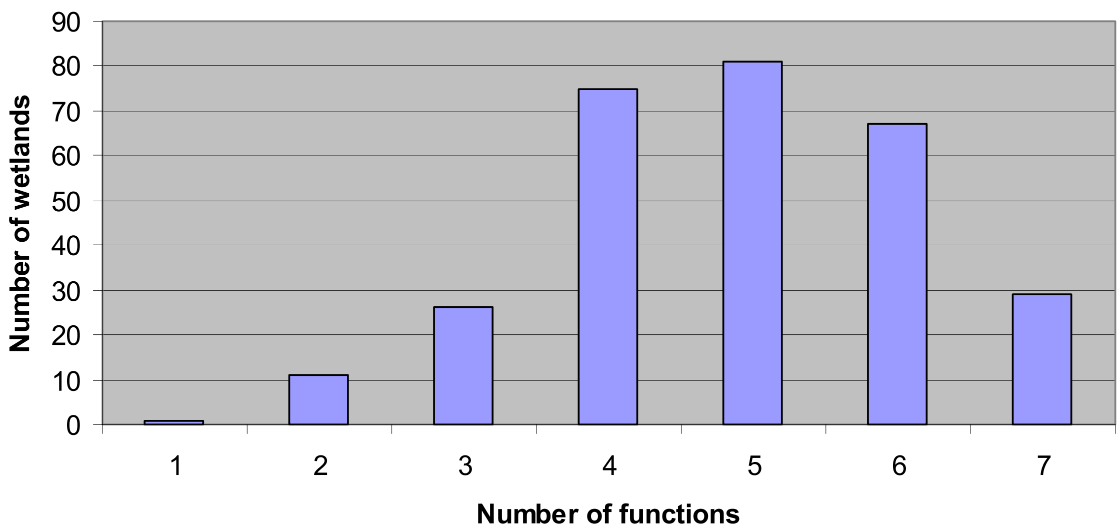
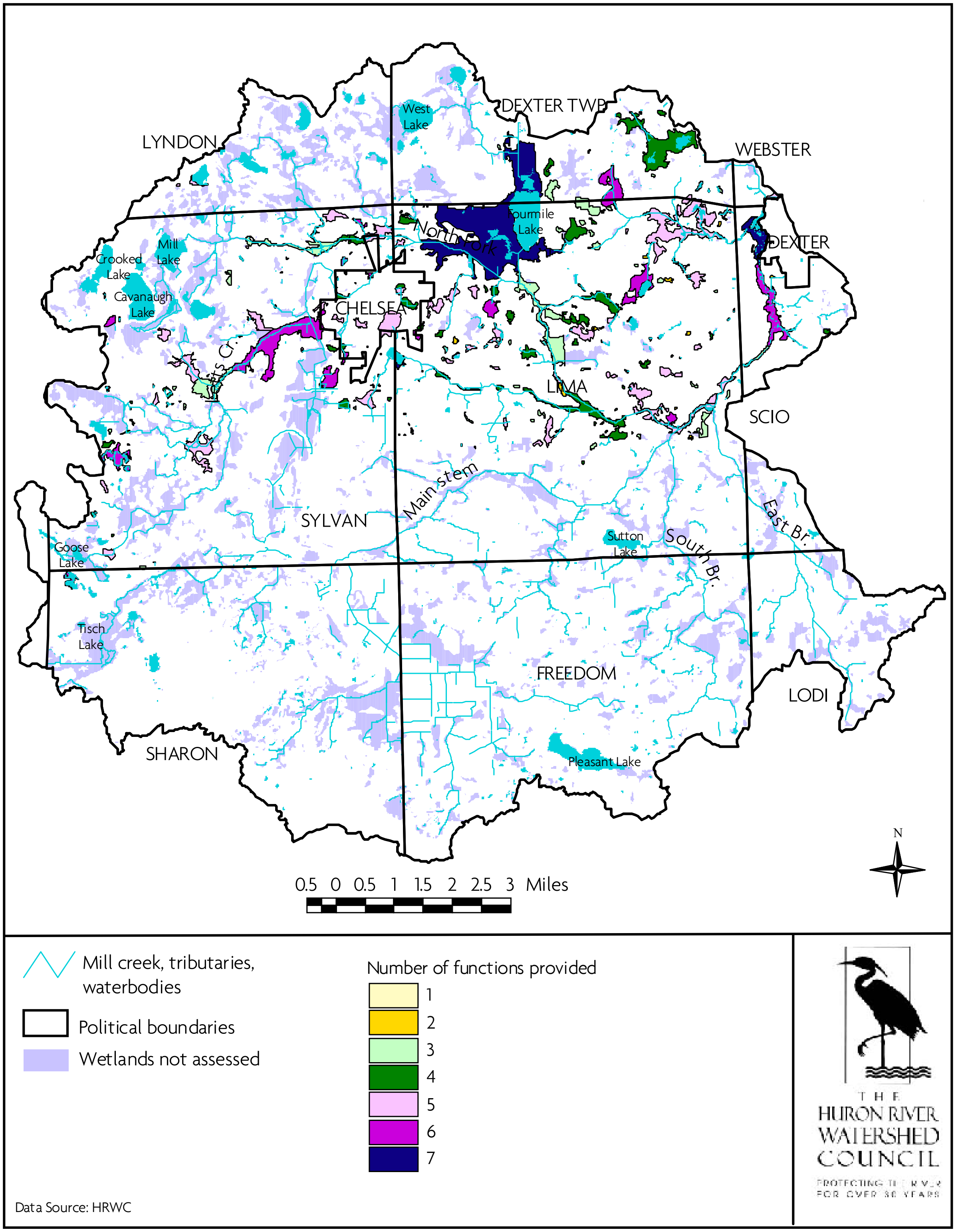


Figure 3.29. Wetlands Assessment of North Fork Drainage, Mill Creek Subwatershed



Seelbach and Wiley prescribed specific restoration priorities to wetland types in their 1996 study of ecological restoration and rehabilitation opportunities in the Mill Creek Subwatershed.

- The highest protection priority is effluent riparian wetlands in the headwaters, including marshes, fens, and swamps adjacent to the present channel network in the ice-contact and morainal hills surrounding the Mill Creek system. For example, the rheotrophic wetlands, fen and tamarack complex in sections 7, 8, 17, 18 of Freedom Township.
- Category 2 protection priority is palustrine/lacustrine wetlands in coarse morainal, outwash and ice-contact areas, which are spread throughout the western and northern edges of the Subwatershed.
- Category 3 protection priority is influent riparian wetlands (floodplains) on the Lower Mainstem. Restoring natural hydrologic function and structure in this portion of the creek will provide significant fisheries, aesthetic and possibly economic value.
- Category 4 protection priority is palustrine/lacustrine wetlands in till plains of the central part of the Subwatershed.
- Category 5 protection priority is influent riparian wetlands in till plain, principally on the North Branch.

Tisch Lake wetland, a headwater wetland in the southwest corner of the Subwatershed, is an example of a wetland requiring the highest protection priority. Photo: HRWC

The creek has special status as a State Natural River Zone from Parker Road downstream to the Dexter Village limits. Only three creeks in the Huron River Watershed boast that designation. Under this designation, the creek benefits from protections that keep its banks intact including restriction on zoning and land alterations to maintain a natural buffer along the creek.

3.10 Relevant Federal, State and Regional Programs

3.10.1 Total Maximum Daily Load Program and Mill Creek

As previously discussed, a Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a waterbody can receive or assimilate without resulting in a failure, or threatened failure, to meet state, territory, or tribally set quantitative or qualitative water quality standards. In addition, a TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonable variation in water quality (U.S. EPA, 2000).

<u>Federal Total Maximum Daily Load Program</u>
Section 303(d) of the Clean Water Act provides that states, territories, and authorized tribes are to list waters for which technology-based limits alone do not ensure attainment of water quality standards. While this section of the Clean Water Act has required TMDLs since 1972, states, territories, authorized tribes, and the U.S. EPA have not taken the initiative to establish them until recently. As a result, beginning in the early to mid-1990s, numerous citizen organizations brought legal actions against the U.S. EPA seeking the listing of impaired waters and establishment of TMDLs. To date, about 40 legal actions have been taken in 38 states. The resulting court orders or consent decrees call for the agency to ensure that TMDLs are established, either by the state or by the U.S. EPA.

Beginning in 1992, states, territories, and authorized tribes were required to submit their list of impaired waters to the U.S. EPA each even-numbered year and to include a set of priority rankings for all listed waters, taking into account the severity of the pollution and the intended uses of the waters. Additional information regarding regulations for implementing section 303(d) are codified in the Water Quality Planning and Management Regulations at 40 CFR Part 130, specifically sections 130.2, 130.7, and 130.10.

In Michigan, the Michigan Department of Environmental Quality (MDEQ) administers the programs of the Clean Water Act. The Michigan Natural Resources and Environmental Protection Act (NREPA), Public Act 451 of 1994, authorizes the MDEQ to develop Water Quality Standards (WQS) to protect the quality of state waters. The purposes of the Water Quality Standards are to: (1) establish water quality requirements for the Great Lakes, their connecting waterways, and all other surface waters of the state, (2) protect public health and welfare, (3) enhance and maintain the quality of water, (4) protect the state's natural resources, and (5) carry out the aims of the federal Clean Water Act (CWA) and the Great Lakes Water Quality Agreement between the U.S. and Canada. These standards are used to set the minimum water quality requirements for state waters.

Michigan’s WQS for surface waters are based on uses designated by the state and are protected accordingly. These designated uses are: agricultural, industrial water supply, public water supply, navigation, warm-water fishery, cold-water fishery, partial body contact recreation, total body contact recreation between May 1 and October 31, and use by indigenous aquatic life and wildlife. Fishable waters are those where the protection and propagation of fish, shellfish, and wildlife are guaranteed. Swimmable waters are those that are safe for recreation on and in the water.

After the state designates the uses of its waters and develops water quality requirements to protect them, it monitors surface water quality to determine the adequacy of point source pollution controls that discharge to the waters. For those surface waters that do not or are not expected to meet the requirements with technology-based point source controls alone, the CWA requires the state to develop additional water quality-based requirements, the TMDL, to restore and protect water quality.

To gain a picture of the water quality of the state, MDEQ evaluates each watershed in the state and National Pollutant Discharge Elimination System (NPDES) permits once every five years. Monitoring of water quality in a watershed generally occurs two years prior to reissuing NPDES permits and NPDES permits. All waterbodies in a watershed are assessed at the same time. In addition, the monitoring program identifies those waters in nonattainment and/or threatened to be in nonattainment of designated uses.

Nonattainment waterbodies either contain contaminant concentrations that exceed the state water quality values or are expected to exceed those values with the application of technology-based point source controls. Similarly, threatened waterbodies are those that currently have contaminant levels that do not exceed the maximum acceptable concentrations, but are expected to exceed them before April 2000. The list of Michigan waterbodies identified as in nonattainment or threatened is the basis for the TMDL program. The 2002 state report of Impaired Waters, called the Michigan 303(d) Report, identifies 21 waters in the Huron River Watershed which do not meet water quality standards, 15 of which are in the Middle Huron region and 2 are in Mill Creek (see Table 3.11 below). This list is available to the public from MDEQ, and will be updated in 2004.

Table 3.11. Impaired Waters of the Mill Creek Subwatershed
(Source: 2002 Michigan Section 303(d) Report; 2004 Michigan Section 303(d) Report)

Waterbody	Pollutant	TMDL Status
Letts Creek - ½ mile upstream of M-52 to its confluence with the North Fork, Mill Creek	Fish and macroinvertebrate communities rated poor	Removed in 2004. Biota reassessed as acceptable.
Four Mile Lake	Mercury	To be developed in 2011
South Lake	Mercury	To be developed in 2011

<u>Phosphorus Total Maximum Daily Load for Middle Huron TMDL</u>
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. According to MDEQ, this value 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 current annual total phosphorus load is 80,000 lbs/year. Approximately half of this load is derived from point sources, and half is from nonpoint sources. The Mill Creek Subwatershed was identified as a significant contributor of phosphorus to the middle Huron as water quality monitoring estimated nearly one-fourth of total phosphorus came from this region. To reach this goal requires reducing current phosphorus loads by 50 percent in the Mill Creek Subwatershed, which is approximately 6,000-7,500 lbs/year.

Based on water quality monitoring data of discharges from 1995 to 2002, average monthly phosphorus discharges from the point sources in the Subwatershed ranged from 2.5 lb/day in July to 3.4 lb/day in April and June. While the total phosphorus loading from the three point sources during those 8 years meets their voluntary limits, two of the point sources tended to exceed the WLA defined in the TMDL–Chelsea Proving Grounds and the Dexter WWTP. The WWTPs are operating under their 1993 permits until their contested 2001 permits are resolved through litigation or alternative negotiations with the state of Michigan.

Table 3.12. Average Monthly Wasteload from Subwatershed Point Sources (lb/day) from 1995-2002 (source: MDEQ, from reports from the facilities)

	Apr	May	Jun	Jul	Aug	Sep
Chelsea WWTP	1.3	1	1	0.8	1	1
DaimlerChrysler-Chelsea	0.7	0.8	0.8	0.4	0.7	0.5
Dexter WWTP	1.4	1.4	1.6	1.3	1.5	1.3
Average Point Source WLA	3.4	3.2	3.4	2.5	3.2	2.8

Recent and current phosphorus contributions from the major point sources in the Mill Creek Subwatershed are determined from self-reporting to the MDEQ, and shown in tables 3.12 and 3.13. The facilities contribute approximately 867 pounds per year of total phosphorus to the Mill Creek system through their voluntary reduction of the nutrient to meet the TMDL.

Table 3.13. Current Total Phosphorus Loads from Major NPDES Facilities in Mill Creek Subwatershed (source: Reports from the facilities)

Based on reporting from 2002-2003	**Avg Daily Flow (mgd)**	**Avg Concentration (mg/L)**	**Avg Daily Load (lb/day)**	**Annual Load (lb/yr)**
Chelsea WWTP	0.72	0.12	0.70	271.82
Dexter WWTP	0.33	0.37	1.10	385
DaimlerChrysler CPG	0.19	0.48	0.5	210
Total	1.238		2.30	866.82

If the facilities increased the concentration level of phosphorus in their effluent to the current permit limits, then annual load would jump to 4,840 pounds per year of total phosphorus (see Table 3.14).

Table 3.14. Potential Total Phosphorus Loads from Major NPDES Facilities in the Mill Creek Subwatershed Operating at Current Permit Limits (source: MDEQ)

	Avg Daily Flow (mgd)	**Avg Concentration (mg/L)**	**Avg Daily Load (lb/day)**	**Annual Load (lb/yr)**
Chelsea WWTP	0.90	1.00	7.51	2739.69
Dexter WWTP	0.58	1.00	4.84	1765.58
DaimlerChrysler CPG	0.11	1.00	0.92	334.85
Total	1.59		13.26	4840.12

The total allocated pounds per day for the three point sources in the Mill Creek Subwatershed ranges from 13 lb/day in April to 2.9 lb/day in July and August. Bold names are facilities located in the Mill Creek Subwatershed. As shown in table 3.15, the three facilities represent a fraction of the total point source wasteload allocation with the majority of the allocation going to the Ann Arbor WWTP.

Table 3.15. 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

The load allocation among the nonpoint sources and point sources in shown in table 3.16. 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. The phosphorus TMDL for the Middle Huron/Ford Lake and Belleville Lake was approved by the U.S. EPA in December, 2000. See Appendix C for the federally-approved TMDL.

Table 3.16. 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**

As of 2004, the Chelsea Proving Grounds no longer contributed effluent containing phosphorus to Letts Creek. 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, temporarily or permanently is not clear, from the watershed as a result.

3.10.2 Middle Huron Watershed Initiative

Phosphorus Reduction Strategy for the Middle Huron River Watershed

Sampling and modeling of in-lake phosphorus concentrations, conducted by the MDEQ, demonstrated that continued regulatory reductions of phosphorus from the area's wastewater treatment plants alone would be insufficient to meet water quality targets set for Ford and Belleville lakes. In 1994, MDEQ (then MDNR) staff convened a meeting of representatives from 17 middle Huron communities, requesting they develop a voluntary strategy to meet these phosphorus reduction goals. These communities and MDEQ, along with the Washtenaw County Drain Commissioner and the Huron River Watershed Council formed the Middle Huron River Watershed Initiative to develop this strategy.

Of the total phosphorus added to the Huron River between Bell Road and Michigan Avenue (at the mouth of Ford Lake) approximately half originates from point sources (wastewater treatment plants (WWTPs) and other industrial inputs) and half from non-point sources. The sub-basins contributing the largest quantity of non-point sources of phosphorus (> 38 percent of the total phosphorus load) were Mill Creek, direct drainage to Ford and Belleville lakes and Malletts Creek (Brenner and Rentschler, 1996). The urban sub-basins contribute the greatest loading per acre.

A series of best management practices (BMPs) were developed and evaluated for (i) controlling stormwater runoff from residential, commercial and industrial sources; (ii) controlling rural soil erosion and feedlot runoff; and (iii) point sources. From that analysis, strategies were proposed that involve (i) the development of policies to protect sensitive areas; (ii) an education and information plan; (iii) improvement of design and construction of stormwater detention; and (iv) increasing the effectiveness of current controls on building site soil erosion. The strategies also involved (v) the voluntary establishment of filter strips, wetlands and stream bank restoration projects, and (vi) reducing loads from WWTPs.

If all proposed management practices for non-point source phosphorus loading are implemented and spring/summer phosphorus discharge concentrations from the major point sources are reduced, then the average annual reduction of phosphorus will equal 74 lb/day. This estimated reduction would be sufficient to meet targets for the months of April, May, June and September. However, it may be insufficient to meet targets in July and August in dry years.

Communities within the Middle Huron have been encouraged to join the Middle Huron Partnership Agreement (Appendix C) to enable the collaborative process to move forward. The aim of this partnership is to develop a mechanism by which these strategies can be implemented in the most cost effective manner possible. Ultimately, the Partnership Agreement provides a mechanism for communities throughout the Huron River Watershed to develop and implement strategies to reduce phosphorus and other pollutants of concern. Since 1999, the 20 partners have met twice a year to report on their progress in reducing phosphorus, share new information on water quality monitoring and other information related to the TMDL, and identify obstacles to progress. The signatories to the Partnership Agreement are:

Ann Arbor Charter Township
City of Ann Arbor
Village of Barton Hills
City of Belleville
Village of Chelsea
Village of Dexter
Dexter Township
Lima Township
Pittsfield Charter Township
Salem Township
Superior Charter Township
Scio Township
Van Buren Charter Township
City of Ypsilanti
Ypsilanti Charter Township
DaimlerChrysler, Chelsea Proving Grounds
University of Michigan
Washtenaw County Drain Commissioner
MDEQ
Huron River Watershed Council

Mill Creek Subwatershed communities that are signatories to the Agreement are the villages of Chelsea and Dexter, and the townships of Dexter, Lima and Scio. While Lodi Township has not signed the Agreement, the community otherwise has been an active partner since 2001. All other Subwatershed communities opted to not sign the Agreement and have not participated as partners in the Middle Huron Initiative; those communities are Freedom, Lyndon, Sylvan, Sharon and Webster townships.

3.10.3 National Pollutant Discharge Elimination System, Phase II

The U.S. EPA has begun implementing the Phase II Storm Water Regulations that require approximately 125 southeast Michigan municipalities to obtain a NPDES permit by March 2003 to cover their storm water discharges. A few communities in the Mill Creek Subwatershed will be required to obtain a permit for stormwater runoff under the National Pollutant Discharge Elimination System (NPDES) Phase II program. The townships of Dexter, Lodi, Scio, and the Village of Dexter have Phase II-regulated areas. Other communities, such as the Village of Chelsea, may be regulated under Phase II as a significant contributing area of stormwater to the Huron River.

The MDEQ is offering two distinct permit coverage options—Jurisdiction- and Watershed-based General Permit Coverage. The Jurisdiction-based permit covers the standard EPA six minimum measures. The Watershed-based permit covers the six minimum measures through cooperative watershed planning, and action planning that is customized to the characteristics and programs applicable to that watershed, as well as strong components of public education and illicit discharge. This program involves multiple communities in meeting the requirements rather than responsibility of the jurisdiction for all minimum measures and planning.

This watershed planning process to improve and protect the water quality of Mill Creek will address many of the requirements for Federal Phase II Storm Water Regulations. However, expansion or revision of activities and text in this plan to reflect specific jurisdictional conditions will be required. The Phase II communities of Washtenaw County have the opportunity to coordinate their permit activities through the County Intergovernmental Coordinating Committee hosted by the Washtenaw County Drain Commissioner.

Chapter 4 Current Conditions of the Mill Creek Subwatershed

An effort has been made to collect all readily available water quality and quantity data to establish a baseline comprehension of current conditions of the Subwatershed. This effort included, but was not limited to, requests to SAG and Technical Advisory Group members, lake associations, and researchers in the area. Comprehensive literature searches resulted in acquisition of studies conducted by state researchers, as well. Numerous studies and datasets of relevance were obtained in this process; however, the information reviewed here should not be considered comprehensive.

4.1 Water Quality Indicators

In order to provide a perspective on the general conditions of Mill Creek and the Mill Creek Subwatershed, readily available and relevant water quality data were complied and summarized. Unfortunately, yet not surprisingly, spatial and temporal data for the Subwatershed were found to be somewhat limited.

Total phosphorus and nitrogen were selected as parameters for gauging water quality. Total phosphorus and nitrogen loads were calculated where sufficient data existed. While the results are unreliable due to limited data sets, the results are informative on a comparative basis. Other data reflective of water quality were collected and are reviewed below. These datasets include freshwater benthic macroinvertebrate (insects and mussels) and fish community assessments, and physical habitat evaluations.

4.1.1 Phosphorus

Phosphorus and nitrogen are nutrients essential for the growth of all plants in waterbodies, such as lakes. 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, then plant growth will cease no matter how much nitrogen is available. Phosphorus is the main parameter of concern for lake and impoundment eutrophication for its role in producing blue-green algae. Excessive algae and plant growth can lead to depletion of the dissolved oxygen in the water. Depletion of dissolved oxygen adversely affects many 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. Wastewater treatment plants are the primary point sources of the nutrient, as the average adult excretes 1.3-1.5 g of phosphorus per day (MDEQ, 2001). 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 natural, human and animal sources. Natural sources include phosphate deposits and phosphate-rich rocks which release phosphorus during weathering, erosion and leaching; and sediments in lakes and reservoirs which release phosphorus during seasonal overturns. As 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 mining and 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. MDEQ considers total phosphorus concentrations higher than 0.05 mg/L to have the potential to cause eutrophic conditions.

4.1.2 Nitrogen

Nitrogen is also considered essential in determining algae growth in lakes, and it 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. 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 nitrogen levels greater than 1 to 2 mg/L to have the potential to cause eutrophic conditions.

4.1.3 Sediment Fines

Silt, which is fine-grained sediment, is an important factor when considering a creek's quality. 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. Erosion also degrades water quality because soil binds pollutants, like phosphorus, which helps to create nuisance algae blooms. Silt is smaller than sand and larger than clay. Many streambeds in the Huron River system are sandy naturally, but a problem arises when a dramatic shift from gravel and rocks to more fine sediments occurs. Erosion is a natural process, but dramatic fine sediment increases suggest unnaturally high erosion rates.

4.1.4 Conductivity

Conductivity, a measure of general water quality, increases with the amount of dissolved ions, such as salts or metals. If the average conductivity measured at a site is 800 microSiemens (μS) or less, then it is considered natural for stream water in the Huron River Watershed (Dakin and Martin, 2003). Conductivity over 800 μS may indicate the presence of toxic substances; however many toxins are not measured by conductivity. A high conductivity measurement signals a need for further investigation of what is dissolved in the water.

4.1.5 Freshwater Biological Communities

Aquatic insects living on the bottom of the creek compose the benthic macroinvertebrate (no backbone) population, along with clams and crayfish. 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. The families Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) 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 (Dakin and Martin, 2003). van der Schalie's study of the distribution of freshwater mussels provides information of the community found in Mill Creek circa 1938; at least 14 species of mussel were found. However no comprehensive study has been conducted since.

Fish depend upon aquatic insects for food, and good quality stream habitat 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. No information is available on the pre-European settlement fish community in the Mill Creek system other than reports that indicated the existence of a good northern pike fishery (Hay-Chmielewski et al). In 1938, 65 fish species were observed in the Mill Creek Subwatershed, and by 1996, 24 species had disappeared while another 35 species had reduced their distribution (Newman 1999). Only 6 species did not show any change in their populations.

By extrapolating conditions in other tributary headwaters, the Mill Creek headwaters historically had stable flows, cool summer temperatures and clear water. Diverse habitats existed and stream channels were edged with marshes. The lower two-thirds of the Creek system naturally had more variable flows, lower summer base flows, warmer, more variable summer temperatures, and low gradients. Prior to the extensive channelization that occurred in the early 20th century, seasonal and wooded wetlands were extensive along the stream channel. State fisheries biologists have suggested that Mill Creek should be reclassified as a second-quality warmwater fishery due to altered hydrology and water temperatures, a downgrade from its earlier listing as a top-quality warmwater fishery (Hay-Chmielewski et al). During the period of 1938-1977, studies found that 11 vegetation-dependent fish species declined; 5 gravel-dependent fish species declined; and 4 silt-dependent species increased.

4.1.6 Imperviousness

When natural open spaces are converted to residential, commercial, and industrial land uses, the result is an increase in the amount of impervious surfaces. Roads, parking lots, rooftops, and, to a lesser degree, managed lawns, all add to the amount of these surfaces in a Subwatershed. Many of these surfaces can be directly-connected—areas that drain directly to surface waters—without the benefit of water quality-improving treatment such as detention or infiltration. In general, as land is developed, stream flows become "flashy," with increased volume and velocity of flow, which impact water quality and can affect infrastructure and property (Table 4.1). Development also impacts groundwater hydrology by decreasing the amount of pervious area available for infiltration of rainwater. Less infiltration results in less recharge as baseflow for rivers and lakes, meaning lower lake levels and river flows. As described in Chapter 3.3, the hydrology of the Mill Creek system is highly interconnected with groundwater.

Table 4.1. Impacts of Development on Hydrological Conditions (source: Lower One SWAG, 2001)

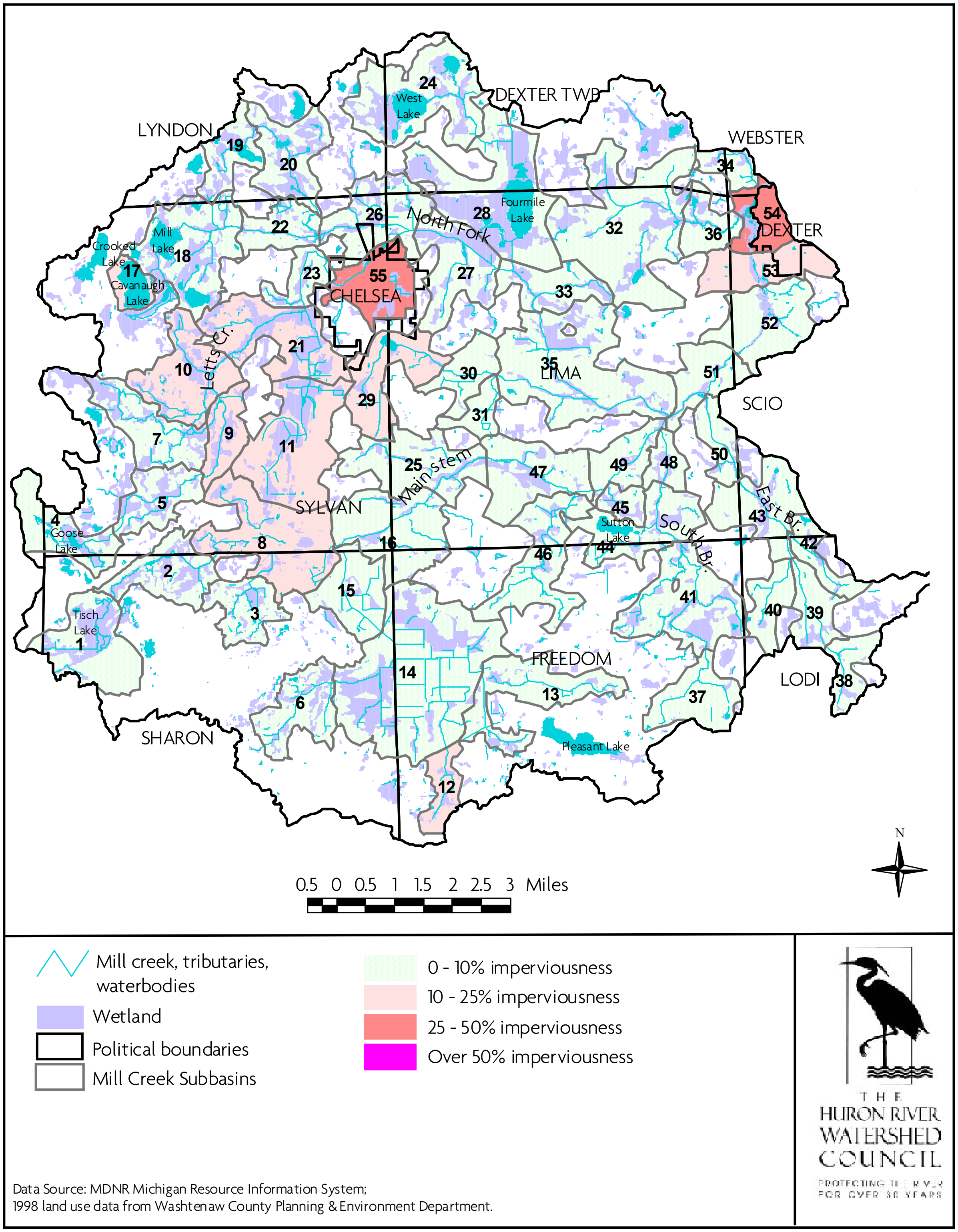
	Storm Frequency (yr)	24-Hour Rainfall (in)	Estimated Runoff (in)	Runoff as Percentage of Rainfall
Half-acre Forest	2	2.8	0.14	5
	10	4.0	0.53	13
	100	5.0	1.4	24
Half-acre Residential	2	2.8	0.60	21
	10	4.0	1.33	33
	100	5.0	2.64	66

The amount of impervious surface in a Subwatershed is directly related to its water quality. It is well-documented that as the amount of these surfaces increases in a Subwatershed the velocity, volume, and pollution of surface runoff also increases (Schueler, 1994). Subsequently, flooding, erosion, and pollutant loads in receiving waters also tend to increase while groundwater recharge areas and water tables decline, streambeds and flows are altered, and aquatic habitats are lost.

Commercial development outside downtown Chelsea increases the amount of impervious surfaces in the Subwatershed. Photo: HRWC

As of 1998, data derived from aerial photography reveals Mill Creek Subwatershed has an imperviousness rate of approximately 6.5 percent (see Figure 4.1). Research reveals that water quality degradation is first notable as impervious surfaces in the Subwatershed achieve 8 percent of the total landscape (Martin and Wiley, 1999). When the Subwatershed reaches this threshold, the impacts of incremental increases in surface runoff noticeably affect the aquatic macroinvertebrate and fish populations and, subsequently, water-based recreation activities.

Figure 4.1 Current Imperviousness of the Mill Creek Subwatershed



Utilization of current zoning land use codes and maps and their associated imperviousness rates from the Rouge River Project can be used to predict potential future land use and impervious conditions of the Subwatershed. The overall Mill Creek Subwatershed imperviousness rate is expected to increase from 6.5 percent to 10.5 percent if each community in the Subwatershed meets build-out scenario as set forth in its master plan. Future economic and population trends, and leadership, can alter this prediction. Since these predicted increases in impervious rates threaten to critically impact the quality of Mill Creek, its tributaries, and the Huron River, significant efforts to mitigate these effects should be a priority for the Subwatershed communities (Figure 4.2).

Note that figures 4.1 and 4.2 show imperviousness based on sub-basins described in detail in Chapter 5 and illustrated in Figure 5.1. The sub-basins represent the area directly draining to the Mill Creek system via surface flow. While the current imperviousness rate is 6.5 percent for the entire sub-watershed, the current rate for the direct drainage area is 7.45 percent, which is nearly a percentage point closer to the 8 percent threshold for stream health. That threshold is projected to be exceeded within 10-20 years with future imperviousness at 10.5 percent for the sub-watershed and 12 percent in the direct drainage. Analyzing imperviousness at the sub-basin level is more useful for land use decision making than at the sub-watershed level since the higher level of resolution provides a clearer cause and effect connection at the local level. The watershed modeling and management recommendations for the Mill Creek sub-watershed are focused on the sub-basin level (discussed in chapters 5 and 8, respectively), as well.

Figure 4.2. Zoning-based Build-out Imperviousness in the Mill Creek Subwatershed

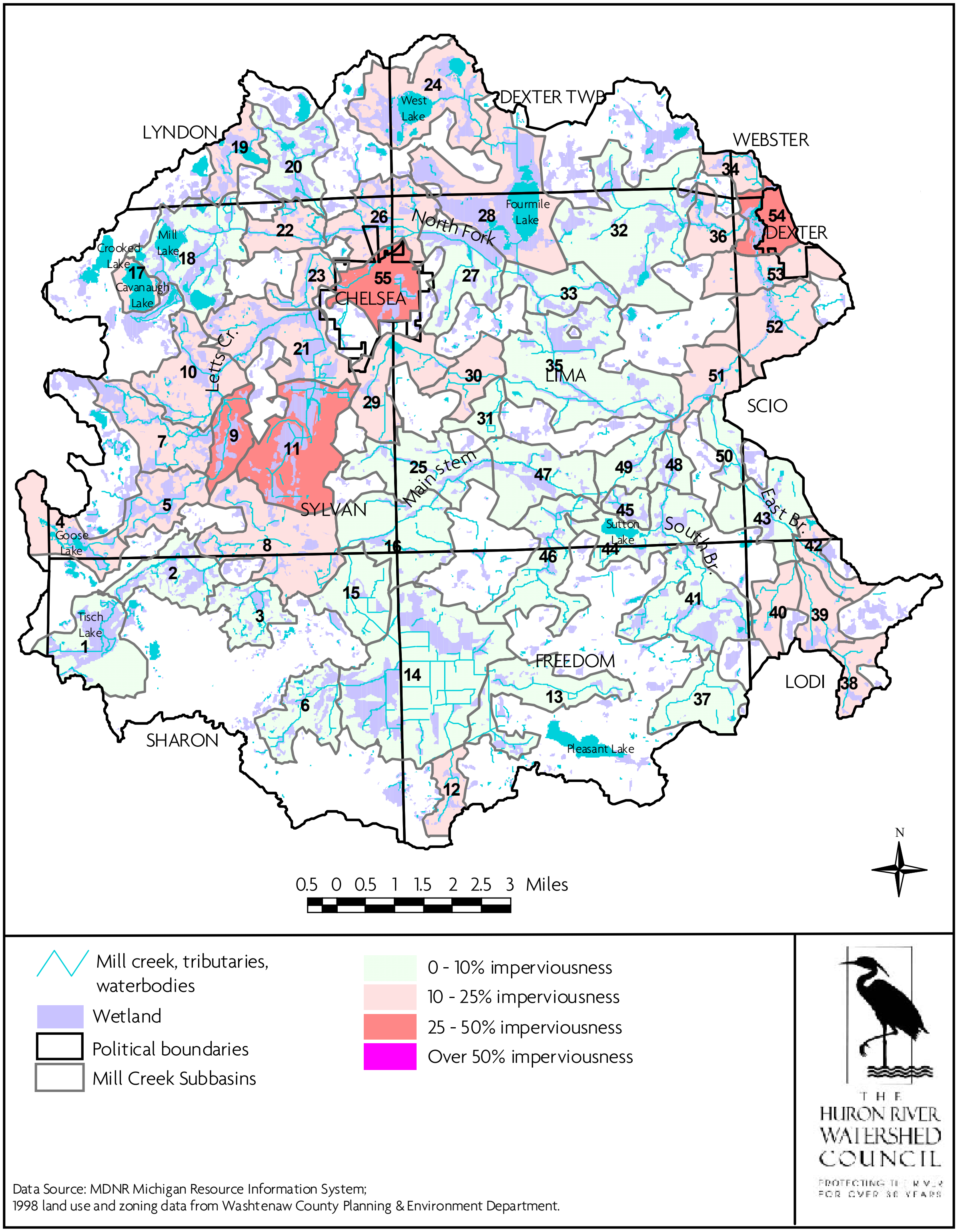


Table 4.2 presents typical pollutant concentrations from stormwater runoff in southeast Michigan. As one might assume, developed land uses of residential, commercial, and roads have noticeably higher concentrations of pollutants compared to managed and unmanaged open space.

Table 4.2. Typical Pollutant Concentration from Land Uses (source: Cave, K., et al., 1994)

Land Use	Pollutant (mg/L)				
	Total Phosphorus	Total Nitrogen	Total Suspended Sediment	Biological Oxygen Demand	Lead
Road	0.43	1.82	141	24	0.014
Commercial	0.33	1.74	77	21	0.049
Industrial	0.32	2.08	149	24	0.072
Low Density Residential	0.52	3.32	70	38	0.057
High Density Residential	0.24	1.17	97	14	0.041
Forest	0.11	0.94	51	3	0.000
Urban Open	0.11	0.94	51	3	0.014
Pasture/Agriculture	0.37	1.92	145	3	0.000

4.2 Catchment Reviews

In order to gain a better perspective on the past and present water quality conditions in the Subwatershed, efforts were made to obtain and review all readily available and relevant water quality data. Because the large size of the Subwatershed makes an efficient review of water quality data difficult, an effort was made to categorize the analysis based on drainage areas in the Subwatershed. Nine hydrologically-distinct drainage areas, or catchments, (Figure 3.2) were delineated and their water quality summaries are reviewed below. Note that not all the lakes within the Subwatershed are reviewed either because these lakes have not been studied, or data requests and literature review did not produce relevant studies. Due to these limitations, the following narrative may be considered a snapshot of water quality in the Subwatershed rather than a comprehensive review.

4.2.1 East Branch

The East Branch sub-basin drains a 5,500-acre area, where the third order stream flows northward toward its confluence with Mill Creek at Jackson Road. The branch drains rolling depressional terrain consisting of medium-textured end moraine. Most of the branch has been channelized for use as drains, specifically Frey-Fitzsimmons and Jedele drains. In presettlement times, lowland hardwoods dominated the area south of Scio Church Road, and marshes and fens followed the creek. Today, land ownership is mostly in the hands of individuals, with most parcels smaller than 100 acres.

Agriculture is the current dominant land use in the sub-basin, with pockets of low-density residential developments and wooded areas scattered between the township-section-range roads that crisscross the area. A large subdivision (Lone Oak), located in an area bounded by Scio Church, Waters, and Strieter roads, is on close proximity to three tributaries of the East Branch system, making it a significant potential source of nonpoint source pollution. The abundance of open agricultural land, easy access to Interstate 94 and close proximity to the expanding Detroit-Ann Arbor metropolitan area make this sub-basin a prime candidate for future development. In fact, Lima Woods manufactured housing community is planned for development, which will bring nearly 500 additional households to the sub-basin and treated effluent from its wastewater treatment plant.

Forested and scrub-shrub wetlands occur in the sub-basin, and mostly occur in internally drained depressions in the southern region. A large wooded wetland exists in the southeast portion of the sub-basin between Scio Church and Waters roads, which is an important groundwater recharge area. A survey of the wetlands relation to local topography would be needed to verify their role as recharge areas and whether they act as nutrient sinks in the sub-basin.

Water quality data
A study by Allan and others at the University of Michigan provided the only reliable nutrient concentration data for the East Branch. Total phosphorus levels at Scio Church Road were measured in winter 1999 and spring 2000 to capture baseflow and wet weather conditions. Baseflow concentration was 0.131 mg/L and the average spring wet weather concentrations measured 0.194 mg/L (Allan, et. al, not yet published). No flow measurements are available for that time so loading of total phosphorus to the stream cannot be estimated. All sources of phosphorus are considered nonpoint as no point source discharges are known. Historical data is not known to be available for the East Branch catchment. Nitrogen was measured as nitrate and ammonia at Scio Church Road during that same study. Nitrate concentrations were 5.2 mg/L in baseflow conditions, and averaged 6.1 mg/L during wet weather conditions. Ammonia measured 0.024 mg/L at baseflow, and averaged 0.096 mg/L during wet weather. Total suspended matter, or suspended solids, was found to be 72.7 mg/L at background levels, and averaged 38.4 mg/L during wet weather. Monitoring conducted at Liberty Road from 1999-2000 by Allan and others measured conductivity levels averaging 886 μS (n=4).

Freshwater Biological Communities
Monitoring conducted by Allan and others at Liberty Road in 2000 found 10 total taxa, of which 9 were Ephemeroptera/Plecoptera/Trichoptera families and 3 were sensitive families. As a supplement to aquatic insect monitoring, habitat assessments were performed in 2000. Aquatic habitat of the East Branch at Liberty Road, Scio Church and Waters roads was evaluated using the MDEQ procedure 51 in 1999 and 2000 (Allan, et. al, not yet published) receiving overall scores of 59, 61 and 65 respectively out of a possible 130 points. Note scores rise moving downstream to upstream. These overall scores are considered “poor” due to a variety of factors including the lack of variety of in-stream habitat; the stream is straight with all flat, shallow water with only an occasional riffle near Waters Road and Liberty Road.

Fish data was collected at the intersection of Liberty Road and the East Branch by the University of Michigan in 1991-1992 where they observed five species. Three species--Rainbow Darter, hybrid sunfish and Brook Stickleback—were predicted by the Michigan Rivers Inventory database modeling to be present were conspicuously absent (Richards, 2002). Fish data also was collected by Allan and others in the summers of 1999 and 2000 at Liberty Road when they observed 6 species. The scarcity of riparian shade-producing canopy likely makes it a warm water stream and more appropriate to species tolerant to those conditions. Seelbach and Wiley suggest that only fish species tolerant of warm conditions could live in the East Branch, and that Northern Pike could use this creek for spawning if floodplain marshes existed and

Additional data
The Washtenaw County Road Commission surveyed the bridge over the East Branch at Jerusalem Road for evidence of erosion. The bridge score a 5 for Slope Protection, indicating that the channel is in fair condition, and scored a 7 for channel protection indicating that the bank protection and river control devices are in need of minor repair (Berkholz, 2002). The condition of other bridges and culverts were assessed in the Mill Creek Subwatershed field inventory, which is described later.

In spring 2001, a large snowmelt rainstorm event was observed at Scio Church Road, where the culvert was submerged completely, and farmland was flooded for 200 feet (Richards, 2002). Much of the flooding occurred behind the culvert and resulted from backup at the culvert. Areas behind this culvert, and others throughout the Subwatershed, should be targeted for review as problem areas for hydrology and nonpoint sources of pollution. Field reconnaissance found that upstream reaches of the East Branch are lacking barriers to keep livestock from accessing the stream and recent evidence of livestock in stream was documented.

4.2.2 South Branch

The South Branch drains 6,500 acres to the west of the East Branch catchment and joins the mainstem of Mill Creek upstream of the confluence of the North Fork and East Branch. This stream is quite similar to the East Branch in terms of topography, soils, hydrology, and land cover. A tributary of the South Branch was dammed in 1959 to create Sutton Lake, which is surrounded by low-density residences and natural woodland and wetland areas.

Water quality data

Readily available historic and current water quality data was not identified during creation of this plan. Nonpoint sources of total phosphorus cannot be determined based on field data. Conductivity levels of 637 μS were measured at Liberty Road in 2000, which is well within acceptable limits of a Michigan stream (Allan, et. al, not yet published).

Freshwater biological communities

Limited information is available regarding macroinvertebrate health and physical habitat of the stream. A habitat assessment conducted in 2000 by Allan and others at Liberty Road found stable stream banks, but problems with flow stability and siltation were observed as well. This site earned a habitat quality score of 70, which is slightly better than the East Branch site. The dominant vegetation is shrub along the stream, which is the most beneficial vegetation for stream habitat. A good amount of stream bank surfaces are covered by vegetation.

Fish populations are somewhat limited in the South Branch catchment compared to the other catchments. Six fish species were observed in 1999 and 2000 at Liberty Road including Mottled Sculpin, an indicator of cool groundwater sources, and Johnny Darter, a silt-dependent species. Species predicted by Seelbach and Wiley to be found in the stream are Brook Stickleback, hybrid sunfish, and Rainbow Darter, but only the last was observed.

4.2.3 Mainstem

The Mainstem catchment drains nearly 5,000 acres including portions of southern Lima Township, eastern Sylvan Township and northern Freedom Township. The creek is a fourth order stream flowing through a mostly agricultural region where 50 percent of the land is farmed. This catchment, characterized as geological till plain, contains highly permeable soils. Riparian wetlands occur along 70 percent of the riparian corridor in this stretch of the Mainstem. Sutton Lake provides 65 acres of open water due to the installation of a 12 ft high dam in 1959. Channelization has occurred in the Mainstem and in the two drains that feed it within the catchment. In addition to farming, pockets of single family residences are scattered throughout.

Water quality data

Limited water quality data was found for this catchment. A 1973 study for the Huron-Clinton Metroparks Authority measured total phosphorus at Liberty and Klinger roads during summer months, and reported a range of 0.027-0.68 mg/L (n=16), with average flows ranging from 22.8-73.3 cubic feet per second (Gannon 1974). Using this information from the study, average phosphorus loads were 228 lb/day. Conductivity levels of 844 μS were measured in the creek at Klinger Road in 1999 (n=1) by the Adopt-A-Stream program.

Freshwater biological communities

The mainstem at Klinger Road is monitored by the Adopt-A-Stream program. One new site has been added at Klinger Road. Data collected at the site indicate an overall decrease in species richness for macroinvertebrates, dropping from 16 to 8 total taxa from 2001-2003. EPT families dropped from an already low 3 to 1 during that same time. Sensitive families have not been found at the site since 2001. Habitat assessment results are not yet available for the site. In lieu of an assessment, field reconnaissance in August 2001 revealed that the stream substrate was very silty and mucky and that vertical incising of the channel has created cut banks of 6-8 feet high in some places (Riggs, 2001). Moreover, measurements conducted by Adopt-A-Stream volunteers in 2000 found the stream substrate at the Klinger Road site was composed of nearly 68 percent fine sediment, which indicates a substantial external source of silt above levels natural to the creek.

Potential exists in the Mainstem catchment for 11 fish species according to Seelbach and Wiley. The hydrology and water temperature regimes place the Main Branch somewhere between coldwater and warmwater conditions. Nine species were observed in a 1996 survey during which no trout were observed giving an indication that the Main Branch tends to be warmwater.

Additional data

According to the Washtenaw County Road Commission, of the 7 bridges in this catchment that are reviewed using federal bridge inspection guidelines, 5 were rated as a 4 or 5 (2 bridges were not evaluated) indicating medium to high levels of erosion and or deposits impeding flow. The evaluated bridge structures are located at Sager Road (5), Lima Center Road, (4), Liberty Road (5), Dancer Road (4), and Jerusalem Road (4).

According to Michigan Natural Features Inventory, two threatened plant species and one endangered animal species have been observed in the catchment. A threatened plant species has been observed on a tributary to the Mainstem in the western portion of Section 31 of Lima Township. Another threatened plant species has been observed near the second order stream in the northern portion of Section 4 of Freedom Township. The endangered animal species is located in a small tributary to the Mainstem at the mouth of the tributary in the northwestern portion of Section 34 of Lima Township.

4.2.4 Pleasant Lake

The Pleasant Lake catchment is a 15,052-acre area that comprised the Pleasant Lake Drain and its several extensions, plus a number of private drains south and east of its confluence with Mill Creek. The catchment includes most of the western half of Freedom Township, most of the eastern one-third of Sharon Township, including a unique rolling landscape referred to as the Sharon Short Hills, and a few acres in the southeast corner of Sylvan Township. Agricultural production occupies almost two-thirds of the catchment making it the largest land use type. Elaborate drainage systems have resulted in a Pleasant Lake Drain with many 90 degree angles; little, if any, of the stream remains unchannelized.

Residential areas continue to grow and are scattered throughout the catchment. Large parcels of farmland cover much of the catchment, however there also are 10-20 acre parcel splits concentrated in the northwest portion of the catchment in and around the Sharon Short Hills and along M-52, as well as in and around Pleasant Lake. Little remains of presettlement vegetation but remnants of an extensive fen and tamarack complex remains in Sections 7, 8, 17, 17 of Freedom Township, and Sections 1 and 12 of Sharon Township (Seelbach and Wiley, 1996).

Pleasant Lake is a 202-acre groundwater-fed kettle lake located in the southeast corner of the catchment. The lake surface elevation is an expression of the groundwater table, and has a single, perennial outlet to the Pleasant Lake Drain. Although the lake does not have a significant hydrologic connection to the Mill Creek system, the many residences and their accompanying impacts to the lake merit attention. Fusilier notes that on-site residential septic systems, lawn fertilization practices and a large geese population are primary sources of phosphorus to the lake (Fusilier, 2001). Consumers Energy Co. carries an NPDES permit to discharge non-contact cooling water to the lake. However flow is recirculated into the facility's intake channel so there almost never is a net discharge to Pleasant Lake.

Water quality data

Readily available data for nutrients and other parameters of concern are lacking for this catchment. Limited monitoring of conductivity was conducted by Allan and others at Waldo Road in 2000 where levels were found to be 948 μS. Although Pleasant Lake is not hydrologically connected to the surface waters of Mill Creek, its condition is worth noting as its one of the larger lakes in the Mill Creek Subwatershed and impacted by residential development. MDEQ reported in the U.S. EPA STORET database total phosphorus concentrations of 0.029 mg/L in 1975 (n=3). Measurements taken by Fusilier during 1984-1985, 1993-1994, and 2001 show concentrations in the lake averaged 0.025 mg/L.

According to data collected through the Cooperative Lakes Monitoring Program in 2002, summer total phosphorus concentrations averaged 0.0165 mg/L (n=2). Although available data seems to suggest a decline in the concentration of total phosphorus in the lake, more consistent data collection would be necessary before trends could be detected.

Freshwater biological communities
Aquatic macroinvertebrates were not monitored on this stretch of the Mill Creek system. A habitat assessment was conducted at Waldo Road in 2000 that resulted in a score of 46 making this site the lowest scoring in the Mill Creek Subwatershed. The poor physical habitat at the site is characterized by more than 50 percent of stream substrate being covered by fine silt and sand, a highly altered stream channel and lack of vegetated buffers. The prevalence of drainage tiles in the catchment contributes to the degraded condition of the Pleasant Lake Drain. Field reconnaissance has revealed visible signs of animal waste in the stream at Waldo Road, an indication that livestock may have access to the water.

Fish populations were surveyed by Allan and others in 1999 and 2000 at Waldo Road where 11 species were observed. The Pleasant Lake catchment has the potential for 22 species, according to Seelbach and Wiley, but actual populations are limited by lack of required habitat, and isolation from the Huron River, among other reasons. Historic mussel populations were surveyed in the 1930s by van der Schalie who reported two species of mussels at Pleasant Lake (in Hay-Chmielewski, et al). More recent surveys have not been conducted in the catchment.

Additional data
According to Michigan Natural Features Inventory, two listed species have been observed in the catchment. An endangered animal species occurs north of the intersection at Lima Center and Pleasant Lake roads in Sections 15 and 16 of Freedom Township. A plant species of special concern occurs in or near the north shore of Pleasant Lake, south of Pleasant Shore Drive, Section 22 of Freedom Township.

Information gathered pertaining to erosion at road-stream crossings indicates failing channel protection at two roads. An evaluation conducted by the Road Commission at Peckins Road documents sedimentation to the waterway due to erosion of bank protection and from major damage of the embankments (Berkholz, 2002). Problems are evident at Waldo Road as well, although less severe than at Peckins Road, related to slumping of the bank and minor damage of embankment protection.

4.2.5 Mainstem Headwaters

The Mainstem Headwaters catchment is an 8,400-acre area that drains the mainstem of Mill Creek upstream of the confluence with the Pleasant Lake Extension Drain. The headwaters begin in and near the Sharon Short Hills located on the southwest edge of the Mill Creek Subwatershed. Seelbach and Wiley note the presence of springs and artesian wells as evidence of groundwater that provides a substantive baseflow to this stretch of Mill Creek. This catchment is characterized as a mix of outwash a coarse-textured morainal features where infiltration rates are high. The area includes north and northwestern Sharon Township and a small portion of south-central Sylvan Township. As of 1998, agricultural production occupied more than one-third of the catchment with another one-third as woodlands and wetlands, and the remaining land in various forms of development. Most of the land is privately-owned by individuals in 5-acre, 10-acre or significant agricultural parcels, while DaimlerChrysler's Chelsea Proving Grounds occupies scores of acres in the catchment. Drainage improvements in this catchment appear to be more recent than on more downstream stretches of the Creek. In addition to hydrologic alterations caused by channel straightening, widening and deepening, the obstruction of the creek by Baker Dam creates the Mill Pond impoundment in Section 5 of Sharon Township.

Field reconnaissance identified locations in the sub-basin that lack management practices to keep cattle and animal waste on-site.

Water quality data
Readily available data for nutrients and other parameters of concern are lacking for this catchment. Limited monitoring of conductivity was conducted by Allan and others at Grass Lake Road in 2000 where average levels were 606 μS (n=2). In addition, measurements conducted at Manchester Road (M-52) by Adopt-A-Stream volunteers found average levels of 798 μS (n=4).

Freshwater biological communities
Mill Creek at Manchester Road is monitored for benthic macroinvertebrates and physical habitat by the Adopt-A-Stream program. Exceptional biological health characterizes this site as the high number of EPT and sensitive families can attest; During the spring and fall monitoring events in 2001 and 2002, the average number of total taxa was 13, Ephemeroptera, Plecoptera or Trichoptera families was 4 and sensitive families was 3. However physical habitat is considered poor by Adopt-A-Stream evaluations due to unstable stream flows that are evidenced by bare banks on 90 percent of the stream banks and undercutting of the banks. In 1999, fine sediment in the stream substrate covered more than 22 percent of the site, down from 56 percent in 1993. The site was ranked as the sixth best site among the more than 50 sites monitored by the Adopt program in Spring 2001. Upstream at Grass Lake Road, Allan's University of Michigan researchers scored the site as "good" for physical habitat due to stable flows, a variety of habitat and good bank stability.

The Mainstem Headwaters has the potential for 22 fish species according to Seelbach and Wiley. However only 5 species were observed by Allan and others in 1999 and 2000 including the vegetation-dependent Grass Pickerel and Central Mudminnow as well as Mottled Sculpin, which is indicative of a cool, groundwater source.

Additional data
The East, South, Pleasant Lake Mainstem Headwaters and Mainstem catchments make up the southern drainage of the Mill Creek Subwatershed. According to data collected by MDEQ during 1994-1995, the annual mean total phosphorus concentration was 0.07 mg/L (n=12). During those same periods, the annual average flow was estimated to be 50.58 cubic feet per second. Therefore, average annual total phosphorus loading from the southern drainage is estimated to be 6,963 lb/yr based on these field investigations.

4.2.6 Letts Creek

The Letts Creek catchment contains a tributary of the same name and drains 12,428 acres to just upstream of the creek's confluence with the North Fork northeast of Chelsea. The area contains high relief, ice contact and coarse morainal landscape as is found throughout the North Fork drainage. The creek system is composed of first, second and third order streams with low baseflow yields perhaps due, in part, to extensive wetland complexes in the headwaters at the Proving Grounds that increase storage and evapotranspiration (Seelbach and Wiley, 1996). Letts Creek has experienced significant drainage improvements creating flow stability that can only be considered fair by the U.S. Geological Survey.

The oak savanna, inland wet prairie and conifer swamps that occupied this area have given way to farm fields and development, but natural areas remain the second most common land use after agriculture. More intense development is located near Chelsea, and as part of the Chelsea Proving Grounds. A wellhead protection area of more than 1,700 acres has been demarcated in the west and south portions of Chelsea. Much of Sylvan Township, central and western Chelsea and extreme northwest Sharon Township comprise the political boundaries of the catchment. Continued population growth in and around Chelsea could increase summer flows from the Chelsea WWTP, which discharges treated wastewater effluent to the Creek. Chelsea WWTP and the Water Filtration Plant are the two permitted discharges to Letts Creek, and six industrial permits for stormwater discharge are located in Chelsea.

Water quality data
According to MDEQ data reported in the U.S. EPA STORET database, the mean total phosphorus concentration in Letts Creek during 1981-1982 was 0.04 mg/L (n=26). Annual average flow is 7.3 cubic feet per second, so total phosphorus load was approximately 1.58 lb/day or 575 lb/yr. Using that same

source, the mean nitrogen concentration during that reporting period was 0.26 mg/L, thus contributing a load of 10.23 lb/day or 3,736 lb/yr. This low phosphorus to nitrogen ratio helps set the right conditions for algal blooms since phosphorus is the limiting nutrient. Conductivity measurements taken from 1981 to present show a possible trend toward increasing levels. Data collected by MDEQ during 1981-1982 and reported in the EPA STORET database given an average conductivity of 780 μS (n=3). More recently, researchers found average levels between 860 and 925 μS (n=14) at Veterans Park and Sibley Road, respectively.

<u>Freshwater biological communities</u>
The state conducted biological assessments of Letts Creek in 1982 and 1989 in the vicinity of the Chelsea WWTP. In 1982, state biologists found that WWTP discharge degraded macroinvertebrate communities for about three-quarters of a mile downstream of the facility (Wuycheck, J. 1982). By 1989, after appropriate recommendations were implemented at the WWTP, the trend was towards overall improvement in stream quality downstream, although biological impairment still was present. Macroinvertebrate organisms found upstream of the WWTP in 1989 indicated good stream quality.

Letts Creek at M-52 (Veterans Park) continues to be monitored by the Adopt-A-Stream program. Population diversity has been measured at the site since 1997 when an oil spill caused the aquatic population to crash. Biological health at the site is considered acceptable with number of total taxa ranging from 10-30 during the spring and fall monitoring events of 2001 and 2002, and EPT families averaging 6 with 1-2 sensitive families. Physical health of the site is poor due to bare, unstable eroding stream banks as well as deep muck and more than 75 percent embeddedness of the stream substrate. Fine sediment jumped from covering about one-third of the stream in 1993 to more than two-thirds in 1999 according to Adopt-A-Stream data. In Spring 2002, the site appeared to have returned to its pre-oil spill conditions. However, construction in downtown Chelsea during Summer and Fall 2002 sent high sediment loads to the creek once again impairing the site. Drainage pipes, an adjacent parking lot and highly impervious land uses upstream contribute to the poor conditions at the site. Upstream of Letts Creek at M-52 at Sibley Road, Allan and others found 29 total taxa, 9 EPT families and 2 sensitive families during a 2000 inventory. Physical habitat at the Sibley Road site rated as fair/good and did not exhibit the same level of degradation as the M-52 site downstream, yet streamside cover was lacking and problems with siltation were observed.

The potential fish species diversity in Letts Creek is 25 species according to Seelbach and Wiley. Only 9 species were observed in 1996 by Seelbach and Wiley, and 12 species were recorded by Allan and others in 1999 at Sibley Road. Species at Sibley Road included several gravel and riffle-associated species such as Greenside Darter, Hogsucker and Hornyhead Chub. Mottled Sculpin was observed as well. In terms of expectations for Letts Creek, low summer baseflows would create warm, variable water temperatures suited only to certain warmwater, small stream fish.

<u>Additional data</u>
The Michigan Natural Features Inventory identifies two rare species found in the Letts Creek catchment. An animal species has been observed in the open wetlands west of the northwest portion of the Chelsea Proving Grounds. A plant species of special concern has been identified in woodland habitat west of Chelsea.

4.2.7 North Fork Headwaters

The North Fork Headwaters catchment is situated in the northwest section of the Mill Creek Subwatershed where it drains 9,870 acres from Lyndon Township, Sylvan Township, northwest Lima Township and northern Chelsea. The North Fork merges with Letts Creek at the downstream end of the catchment at the edge of Chelsea. A substantial portion of the catchment occurs within a geologic area referred to as the Jackson Interlobate Area, which can be described as coarse-textured end moraines, outwash and ice contact landforms created during glacial retreat of the late Wisconsonian age 13,000 to 16,000 years ago. Much of the area is characterized by the numerous steeply sloping ridges surrounded by expansive wetland systems and kettle lakes. Due to the high permeability of the soils and expansive areas of high relief, the groundwater in the catchment is highly charged (Seelbach and Wiley, 1996). The catchment is uniquely different from all other Mill Creek catchments.

Farming and development have replaced the native oak communities and oak openings, inland wet prairie and tamarack stands in most areas of the catchment. These plant communities still can be found throughout the area where impacts associated with farming and development have not occurred. Much of the open space that exists today is encompassed by the Waterloo State Recreation Area. Single family residential development is scattered throughout in parcels if less than 20 acres with the exception of higher densities adjacent to some lakes, Cavanaugh Lake for example, and within the Village. Agricultural land is limited to the west due to low yields associated with glacial soils, yet the limited farming appear likely to decrease in the face of development pressures.

Water quality data

Available nutrient data for the catchment is limited. Monitoring conducted at Waterloo Road in 1999 and 2000 by Allan and others found total phosphorus concentrations to be 0.015 mg/L at baseflow, increasing to an average of 0.033 mg/L (n=4) during wet weather. The nitrate level at baseflow was 0.08 mg/L, and the average of snowmelt and wet weather conditions was 0.31 mg/L (n=4). Flow measurements are unavailable for this stretch of the North Fork, so nutrient load cannot be determined. In addition to stream conditions, nutrient concentrations in two lakes were monitored by MDEQ in 1980. According to the U.S. EPA STORET database, Cedar Lake had a mean total phosphorus concentration of 0.019 mg/L and mean nitrogen concentration of 1.103 mg/L (n=3). According to that same source, the total phosphorus concentration and nitrogen concentration measured 0.02 mg/L and 0.56 mg/L (n=3), respectively, in Mill Lake. The average conductivity at Ivey Road is 521 μS (n=9) according to surveys conducted by Adopt-A-Stream volunteers. Based on the conductivity data, the stretch of Mill Creek within the North Fork Headwaters catchment appears to remain healthy.

Freshwater biological communities

The Adopt-A-Stream program monitors a site at Ivey Road, which has exceptional biological health. Species richness for aquatic insects ranged from 13 to 15 during three monitoring events in 2001 and 2002, while 6 EPT families and 2 sensitive families were observed on average. Physical habitat was rated acceptable in the most recent assessment completed in 1999 when ecologists found the stream somewhat silted. Fine sediment decreased 12 percent during a 6-year period, dropping from 45 percent to 33.5 percent by 1999. Allan and others rated the Ivey Road site as the healthiest of all sites they surveyed. They also surveyed conditions upstream of Ivey Road at Waterloo Road and, interestingly, found a less healthy site due to lack of streamside cover, lack of habitat variety, and problems with siltation in the stream and sedimentation as evidence of past dredging activities. Portions of three drains are maintained within the catchment and records indicate that up to 8 inches of sediment have been reported in the channel (Washtenaw County, 2002).

The potential fish assemblage for the catchment is 27 species according to Seelbach and Wiley yet 11 species were observed in 1999 and 2000 at Ivey Road. Species dependent on vegetation or gravel were present as was Mottled Sculpin indicating presence of cool groundwater contributions to the creek. Te main limiting factors for the lower than predicted species richness include the dam in Dexter and degraded channel habitat downstream from this catchment. The only readily available mussel population information was that gathered by van der Schalie in the late 1930s. He recorded two species at Cedar Lake and one species at Cavanaugh Lake.

Additional data

The location and functions of wetlands of the North Fork Headwaters catchment were inventoried using a rapid assessment method. Wetlands assesses ranged from 1 acre to 1,227 acres in size. Based on the rapid assessment conducted by the Huron River Watershed Council of 35 wetlands, 33 of those wetlands provide 3 or more functions. These functions are: flora and wildlife (34 wetlands provide); aesthetics and recreation (34); water quality protection (32); fish and herptile (23); runoff attenuation (23); water storage (6); and stream bank/shoreline protection (1). The Michigan Natural Features Inventory database reports 27 locations in the catchment for plant and animal species and communities that are endangered, threatened or of special concern. Almost all of these sites are associated with lakes and wetlands.

Visual reconnaissance of each road crossing in the catchment was conducted in Spring 2002 and, with exception of the M-52 crossing, stream banks were observed to be stable. Most of the swiftly flowing crossings were observed to have sand and coarse gravel substrates. Sedimentation was observed in the creek on the east side of M-52 where a large diameter storm sewer pipe discharges residential and road runoff.

4.2.8 North Fork

The North Fork catchment includes all of the drainage between the confluence of Letts Creek upstream to confluence of the North Fork with the mainstem of Mill Creek downstream, which amounts to more than 15,600 acres and includes the Four Mile Lake wetland complex. North Fork of Mill Creek is a county drain within the entire reach of this catchment and drains much of Lima Township, eastern Chelsea, southwest Dexter Township and extreme southeast Lyndon Township. Nearly half of the catchment is engaged in agricultural production with much of the remaining land privately owned as undeveloped or as residential uses. In many places, residential and commercial development abuts waterways and wetlands. Only remnants remain of the oak savanna and wooded and emergent wetland communities that covered the catchment prior to European settlement of the land. The State of Michigan owns a large area of land in the form of the Chelsea State Game Area.

The hydrology of the creek in the North Fork catchment has been altered along its entire length. Drainage improvements are widespread on the North Branch, a fourth order stream, and on a second order tributary in the southwest part of the catchment. Seelbach and Wiley note that dredging and channelization of wetlands in this part of Mill Creek is to a much shallower depth than in the South Branch. Extensive wetlands remain and local water tables remain relatively high. Many existing drains are intermittent during the growing season. The Chelsea WWTP adds small amounts (mean discharge is 0.72 million gallons per day) to the baseflow currently, but continued growth in Chelsea could augment summer flows significantly. One NPDES-permitted facility is located in the catchment and is permitted to discharge total phosphorus and total residual chlorine as part of a groundwater clean-up. Two facilities hold industrial stormwater permits with Four Mile Lake serving as the receiving water for both.

Water quality data

According to MDEQ monitoring data in the STORET database, the August 1982 mean total phosphorus concentration at five sites in the catchment was 0.08 mg/L (n=20). The mean nitrogen concentration during that same reporting period was 0.97 mg/L (n=20). Stream flow was not measured so nutrient load within the catchment cannot be calculated. Conductivity averaged 827 μS at those same sites (n=20). In 1999 and 2000, Allan and others found conductivity at Lima Center Road was 864 μS (n=2). Limited data is available for Four Mile Lake from September 1980 when MDEQ monitored nutrient concentrations. The STORET database reports total phosphorus concentration was 0.016 mg/L and nitrogen concentration was 0.985 mg/L (n=2). More recent data for the lake is not readily available.

Freshwater biological communities

Aquatic macroinvertebrate populations are being monitored at Fletcher Road by the Adopt-A-Stream program. This site is considered to have poor biological and physical health based on surveying that has taken place since 1994. The Spring 2002 monitoring event recorded 8 total taxa, 4 EPT families and one sensitive family. Physical habitat rated poor when last assessed in 1999; significant sedimentation, more than 50 percent embeddedness, and deep muck were found at the site. Sediment in the stream more than tripled from 15 percent in 1993 to nearly 50 percent in 1999. Similar problems were observed at Lima Center Road by Allan and others around that same time. Washtenaw County Drain Office staff noted 12-24 inches of sediment in the channel at Lima Center Road in 1998.

Up to 27 fish species could potentially live in the North Branch based on conditions at Dancer Road. However, only six species were observed by Allan and others at Lima Center Road in 1999 and 2000 including the groundwater-associated Mottled Sculpin. Low summer baseflows and warm temperatures characteristic of this site would suit some warmwater, small steam fish.

Additional data

The largest of the numerous wetlands in the catchment is the Four Mile Lake complex. The complex comprises nearly 1,000 acres of highly functioning, contiguous wetland surrounding the lake. According to the wetlands assessment performed by the Huron River Watershed Council in 1998, the wetland complex serves all seven functions: flora and wildlife; fish and herptile; water storage; runoff attenuation; water quality; shoreline/stream bank protection; and aesthetics and recreation. About half of the remaining wetlands in the catchment were assessed and found to be performing at least four of these functions, with many performing five or six. Higher functioning wetlands generally are located on the main stem and at the headwater of the tributaries in the catchment.

Four bridge structures surveyed under the National Bridge Inventory program are located in the North Fork catchment. The structures are located at Dexter-Chelsea Road, Trinkle Road, Seitz Road, Jackson Road and Dancer Road. Erosion at the road crossings is occurring at Seitz, Jackson and Dancer roads, and slope protection is failing at Dancer Road.

The Letts Creek, North Fork, and North Fork Headwater catchments make up the northern drainage of the Mill Creek Subwatershed. According to data collected by MDEQ during 1994-1995, the annual mean total phosphorus concentration was 0.05 mg/L (n=11). During the reporting period, the annual average flow was estimated to be 41 cubic feet per second. Therefore, average annual total phosphorus loading from the northern drainage is estimated to be 4,273 lb/yr based on these field investigations.

4.2.9 Lower Mainstem

The Lower Mainstem catchment is a nearly 9,000-acre area that drains the mainstem of Mill Creek downstream of the confluence of the East Branch to the Creek's confluence with the Huron River. This catchment is downstream of the other eight catchments thus the condition of Mill Creek in this catchment can be a reflection of both factors from within the catchment and conditions from the rest of the Mill Creek Subwatershed. Mill Creek from Parker Road to the confluence with the Huron River received designation from the State of Michigan as a Natural River, and is protected through the Natural Rivers Act and by the Natural Rivers Program. The Huron River from the John Flook Dam to the Scio-Ann Arbor Township line, excluding the Village of Dexter, also is designated as Natural River. Two county drains are maintained in the catchment for the purpose of draining active agricultural lands.

Main Street in Dexter. Photo: HRWC

The inland wet prairie, white oak/hickory communities, oak barrens and tamarack stands long ago gave way to agricultural production, which occupies one-third of the catchment. Residential areas continue to grow in the catchment are scattered throughout with the Village of Dexter and surrounding areas containing the highest density. Most of the area resembles a patchwork of private landownership with parcels varying in size from hundreds of acres to less than 10 acres. Non-individual landowners include Dexter Community Schools, churches, subdivisions and condominium associations, Detroit Edison and the Huron-Clinton MetroParks Authority. The catchment drains southeast Dexter Township, extreme southwest Webster Township, western Dexter, northeast Lima Township and northwest Scio Township.

Mill Creek, as it flows through the Lower Mainstem catchment, has a steep gradient in an old glacial river valley with riffles and riparian floodplain forest and wetlands habitats providing complex channel structure and shading (Seelbach and Wiley, 1996). The Lower Mainstem is a first order stream with two second order streams feeding it. The hydrologic regime has been altered significantly since the 1820s and, as a result, today a 40 percent increase in storm flow volumes over mid-1800 levels is measured in the lower channel system. Moreover, during a 1-inch, 1-hour storm event the creek flow increases approximately 100 cubic feet per second at Dexter. A 30 percent decrease in rise times and event time-base reflects historical losses of storage in the catchment. Tributary cross-section data taken at Dexter showed the channel to be overwide due to anthropogenic changes to the Creek's hydrology. The expected width of the channel is 30.7 feet while the measured width is 42 feet. Seelbach and Wiley note that the vertical incision upstream of Mill Creek at Parker Road appears to have been engineered. The increase of flashy flows in the Creek contributes to systemic bank erosion near that site, and possible throughout much of the South Branch and North Fork. Flow stability at Parker Road is considered poor by the U.S. Geological Survey as a result of channelization and extensive wetland drainage.

Two water control structures are located on the waterways of the Lower Mainstem catchment: the Mill Pond Dam on the mainstem in Dexter, and the Dexter Business & Research Detention on an eastern tributary to the Creek. The Dexter Business & Research Detention earth structure was built in 1989 for stormwater runoff control at the Dexter Business & Research Park on the Village's south side. The structure creates a 2-acre detention basin located at the head of a tributary to the Creek. Increased development in the Park is increasing the amount of runoff to the detention basin, and the frequency of flashy flows that are causing bank cutting downstream on residential property (Riggs, 2002).

The Mill Pond Dam is a gravity dam that was built in 1932 for the purpose of generating hydropower. The dam no longer serves that purpose but impounds about 22 acres of water on the Lower Mainstem. A 1989 study of the Mill Pond Dam found heavy siltation in the impoundment and extensive sediment deposits that indicate substantial sediment input from nonpoint sources located upstream. The artificial pond-type community that now exists behind the dam is characterized by slow water flow, increased abundance of large beds of macrophytic plants, and a reduction in running water habitats typical of a high gradient river. Plans for its removal are underway by a variety of stakeholders including the Village of Dexter, the Washtenaw County Road Commission, the Huron River Watershed Council, and the State of Michigan.

Invasive Purple Loosestrife blooms in late summer on the impoundment behind the Mill Pond Dam in Dexter. Photo: HRWC

The Lower Mainstem of Mill Creek is receiving water for two NPDES-permitted facilities and two stormwater-permitted facilities. Thetford Corporation discharges non-contact cooling water, leak test water and storm water runoff to the Creek and Dexter WWTP discharges treated sanitary wastewater. An additional WWTP discharge may be added to the catchment within the next 3-5 years if the Lima Woods Manufactured Housing Community receives all required permits.

<u>Water quality data</u>
According to MDEQ data reported in the STORET database, mean total phosphorus concentration was 0.16 mg/L for monitoring conducted during 1966-1967, 1972-1973, and 1981 (n=37). By 1994 to 1995, the MEQ reported a significantly lower mean concentration of 0.063 mg/L (n=4). Mean nitrogen concentration was 1.26 mg/L (n=17) during monitoring in 1972-1973 and 1981. Nitrogen was not reported in the 1994-1995 study. Given that the annual average flow for 1994 to 1995 was 88.25 cubic feet per second, the estimated total phosphorus load during that period was 29.95 lb/day as measured at Main Street in Dexter, approximately one mile upstream from Mill Creek's confluence with the Huron River. Allan and others also measured nutrients at Marshall Road in 1999 and 2000 and recorded baseflow concentration of .019 mg/L, and a wet weather average of 0.122 mg/L. Nitrate levels were 1.65 mg/L at baseflow, and 4.5 mg/L during wet weather conditions. However flow was not measured at the time of the monitoring so nutrient load cannot be calculated. Conductivity measured 948 μS at Marshall Road (n=1).

Freshwater biological communities

Mill Creek at Jackson Road has been monitored for aquatic macroinvertebrates since 1996 by the Adopt-A-Stream program. Biological health at the site is considered poor and only four other sites ranked lower than it in a recent ranking of all Adopt sites in the Huron River Watershed. Total taxa at the site dropped from 21 in Fall 2001 to 5 in Spring 2002, 6 EPT families have been recorded on average, and 0-2 sensitive species have been recorded during the past four monitoring events. In January 2003, two more sites were added on the Lower Mainstem to begin gathering information about current conditions with the Dexter dam in place. Monitoring at the two sites will continue during and following the planned dam removal. Physical health of the site is considered poor based on surveys by the Adopt-A-Stream program. Fine sediment increased from 12.5 percent in 1997 to nearly 38 percent in 2001. Physical assessment in 2001 found 25-50 percent of stream substrate was silted, and filamentous algae were present indicating high levels of nutrients.

The MDEQ monitored Mill Creek at Shield Road and the downstream dam site in 1989. The sampling yielded 18 total taxa upstream of the dam, and 12 total taxa downstream of the dam. Overall habitat was classified as poor upstream of the dam, and good in the downstream reach. Unlike the on-going Adopt-A-Stream monitoring, the state sampling was conducted once.

Mussel populations in the Lower Mainstem catchment were last inventoried comprehensively in 1938 by van der Schalie. That survey recorded 7 mussel species at the mouth of Mill Creek, 7 species near the millrace at the dam in Dexter, 3 species below the dam, and 7 species 1.5 miles upstream of Dexter (Hay-Chmielewski, 1995). More recent observations are not readily available.

The Lower Mainstem catchment has the potential for 38 fish species. However only half that number of fish species were observed in the late 1990s by Seelbach and Wiley as several factors limit fish populations in this catchment: lack of connection to the Huron River due to the dam; major high-gradient reach is flooded by the impoundment; existing channel habitat is poor and homogenous due to channelization and scouring from accentuated storm flows; high in-channel sediment storage at low flows is present due to the overwide channels; and floodplain wetland spawning habitats have been destroyed. Silt-dependent species such as Green Sunfish, Johnny Darter, and White Sucker are present in the Lower Mainstem, yet some gravel and riffle-associated species are present as well including Common Shiner, Creek Chub, and Greenside Darter Madtom. The slow, clear water with emergent and submergent vegetation provided by the impoundment provides habitat for Yellow Bullhead.

Additional data

Approximately 132 wetlands are located in the Lower Mainstem catchment. HRWC performed rapid assessments on 85 wetlands and found the following functions are provided: flora and wildlife (61 wetlands); fish and herptile (24); water storage (18); runoff attenuation (42); water quality (55); shoreline/stream bank protection (4); and aesthetics and recreation (52). In general, higher functioning wetlands are located on the mainstem and at the headwaters of the tributaries in this catchment. Of the 85 wetlands, one provides all 7 functions, 7 wetlands provide 6 functions, 19 wetlands provide 5 functions, 13 wetlands provide 4 functions, 13 wetlands provide 3 functions, and 12 wetlands provide fewer than 3 functions. Two wetlands harbor threatened or endangered species according to data in the Michigan Natural Features Inventory.

The Michigan Natural Features Inventory has identified three species occurrences with threatened or endangered status in the catchment. The smallmouth salamander (*Ambystoma texanum*) is a threatened/possibly extinct species that occurs near the confluence of Mill Creek with Huron River. The water willow (*Justicia americana*) is a threatened plant species that occurs below the dam on the mainstem in open wetland habitat. An unidentified plant species of special concern occurs in the open wetland habitat of northeast Lima Township.

Five bridge structures surveyed under the National Bridge Inventory program are located in the catchment at Jackson Road, Parker Road, Marshall Road, Shield Road and Main Street (Berkholz, 2002). The Parker Road and Shield Road crossings are exhibiting problems in the stream due to failing channel protection. Erosion from the crossing is resulting in sedimentation in the Creek due to failing slope protection at Jackson Road and Main Street crossings.

Measuring the influence of Mill Creek on the Huron River

Water quality measurements were taken upstream of the Mill Creek confluence with the Huron River and downstream on the same days in winter 1999 and spring 2000 for total phosphorus and nitrate, among other parameters (Allan, et. al, not yet published). Mill Creek is the sole tributary that drains to the river between the upstream site at North Territorial Road and the downstream site at Delhi Metropark, with the exception of small direct drainages. The influence of the Mill Creek system is visible in the data collected as the concentrations of phosphorus and nitrate increase significantly after the contribution of Mill Creek waters to the Huron (Figures 4.3 and 4.4). Total phosphorus increases from 50 percent to nearly 800 percent in the downstream river waters during baseflow and wet weather conditions. Nitrogen, in the form of nitrate, increases from 25 percent to 300 percent during the months sampled. Most of the increase can be attributed to Mill Creek as it drains the largest creekshed in the Huron River Watershed, and the stretch of the Huron between the two sampling points is primarily designated Natural River Zone.

Figure 4.3. Huron River Total Phosphorus Concentrations (micrograms per liter) at Sites Upstream and Downstream of Mill Creek Confluence (source: Allan, et. al, not yet published)

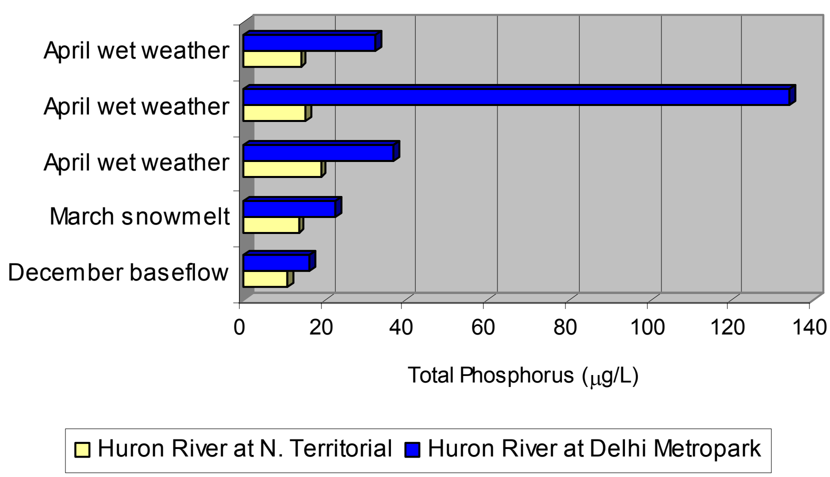
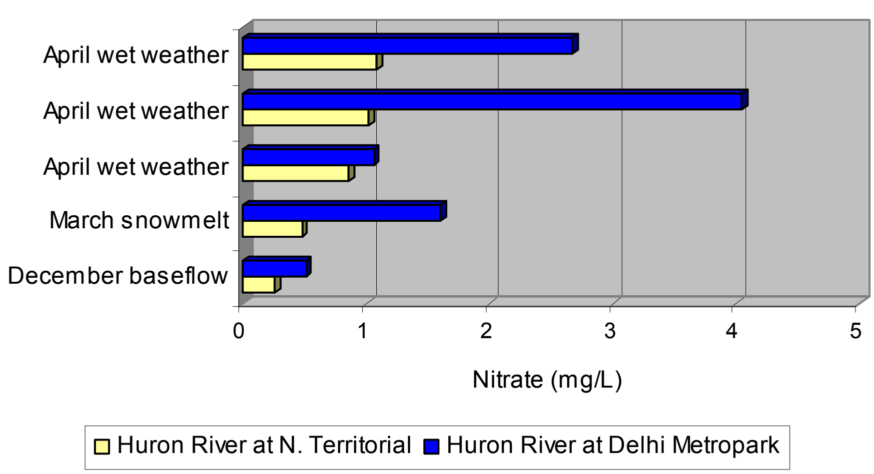


Figure 4.4. Huron River Nitrate Concentrations (milligrams per liter) at Sites Upstream and Downstream of Mill Creek Confluence (source: Allan, et. al, not yet published)



According to data collected by MDEQ during the periods of 1966-1967, 1972-1973, 1981, and 1994-1995 as reported in the U.S. EPA STORET database and MDEQ reports, the annual mean total phosphorus concentration in the Lower Mainstem was 0.15 mg/L (n=41). During those same periods, the annual average flow was estimated to be 88.47 cubic feet per second. Therefore, average annual total phosphorus loading from all of the catchments including the Lower Mainstem to Main Street in Dexter is estimated to be 26,155 lb/yr based on these field investigations. However, by using only the data collected by MDEQ during 1994-1995, the annual mean total phosphorus concentration in the Lower Mainstem was 0.063 mg/L (n=4), and the average flow was 88.25 cubic feet per second, giving a total phosphorus loading of 10,933 lb/yr. The high concentrations of total phosphorus during the 1960s and 1970s skew the loading upward.

Lake Behavior

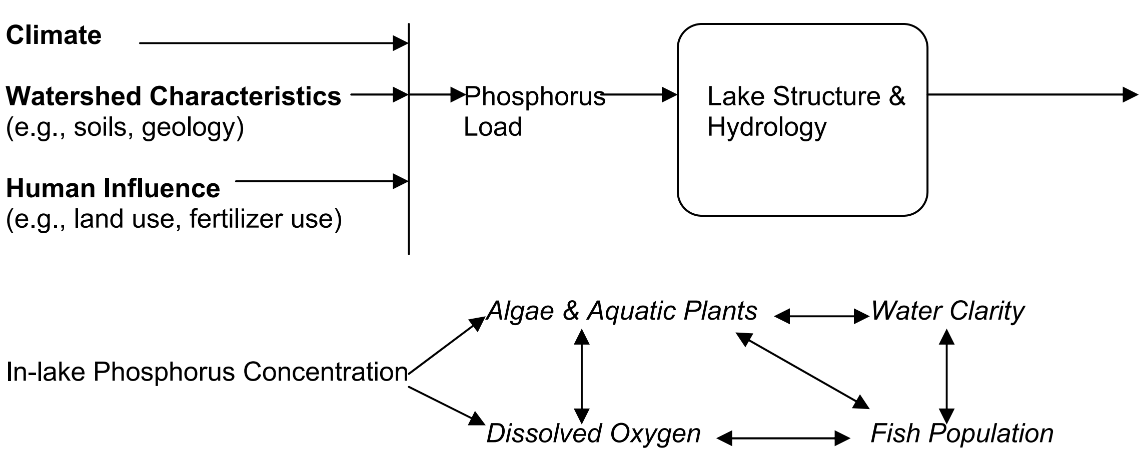
The previous discussion focuses on the condition of the stream network in the Subwatershed for the reason that water quality violations to date have occurred here. Yet the presence of many lakes in the area, particularly in the northern drainage of the Subwatershed, makes a general review of lake behavior in response to nutrients useful when considering conditions of natural and manmade lakes in the Subwatershed. Limnology is the physical, chemical, and biological science of freshwater systems, including lakes. Monitoring surveys of Pleasant Lake, Sutton Lake, Four Mile Lake and Nordman Lake have been conducted by Fusilier, and provide detailed synopses of limnological conditions in those waterbodies.

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 assessing the water quality of a lake since it affects the productivity or growth 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 4.5).

Ordinarily, a lake with concentrations of phosphorus less then 10 micrograms/liter (μg/L) is often considered oligotrophic. A lake is considered mesotrophic at concentrations of, 10 to 20 μg/L and eutrophic to hypereutrophic at or greater than 20 to 30 μg/L (U.S. EPA, 2000). Oligotrophic and mesotrophic lakes normally support uses such as cold water fisheries (e.g., trout, various 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., carp) and have limited recreational value compared to oligotrophic or mestrophic lakes because of periodic nuisance algal blooms. 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 Subwatershed, experience changes in water chemistry and biology throughout the year. During the winter months, water temperature, dissolved oxygen, and other variables are essentially equal at all depths. As ice thaws in the Spring, winds and temperature changes in surface waters cause mixing within the water column. 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 water mixing. 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.

Figure 4.5. Illustrative Schematic of Phosphorus Load Determinants and Lake Response. (adapted from U.S. EPA, 1980)



4.3 Field Inventory Summary

Once existing available studies and data pertaining to the health of the Mill Creek Subwatershed were gathered and reviewed, a field inventory was designed to increase understanding of current conditions in the area that could not be captured through the information already gathered. Nearly 20 people, nearly half Subwatershed residents, were trained to use the Field Survey developed for this reconnaissance effort. With more resources a comprehensive field inventory would entail walking the length of the Mill Creek system and documenting the channel and upland conditions. An abbreviated version of that full inventory was pursued due to limited time available to cover this large creek system.

Methodology

Eight survey teams conducted visual assessments of the Mill Creek Subwatershed stream corridors in November 2002. The 49 survey sites that were selected were fairly evenly distributed through the Subwatershed to capture the geographic variability of the area. These field sites were located at road crossings for easy access and identification (Figure 4.6).

Survey data collection was qualitative and made by observations rather than by quantitative measurements that would require use of tools or equipment and special training. The Field Survey consisted of a checklist of inventory items of interest and characteristics of the surrounding environment, both upstream and downstream (see Appendix D). The Field Survey was reviewed by the MDEQ for clarity and completeness. Data gathered represents a snapshot in time of the physical condition and characteristics of these stream corridors.

Summary of Findings

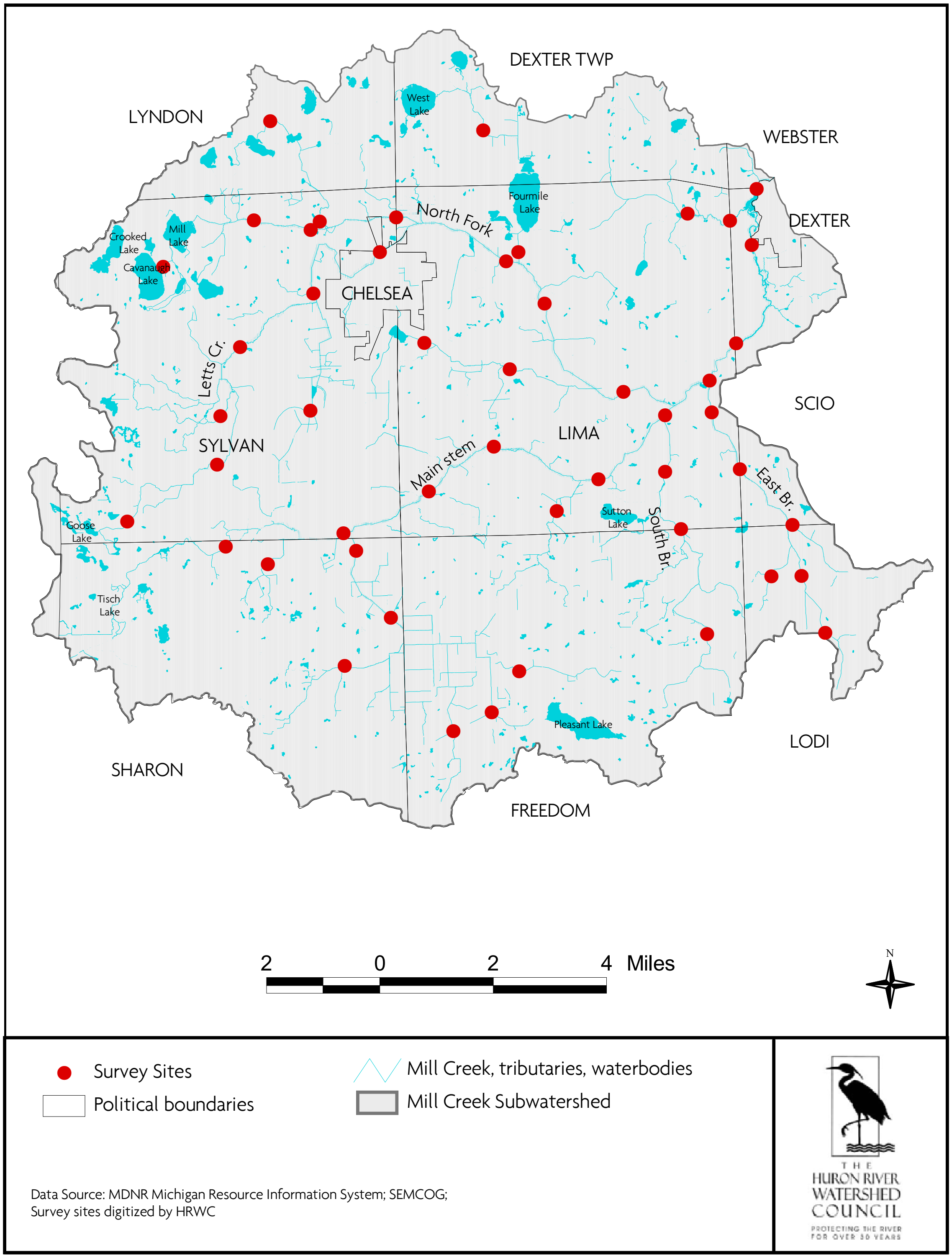
Stream Corridor Characteristics

Several characteristics typical of a stream corridor were assessed at each survey site. These characteristics are water flow, channel width, buffer width, canopy cover, and bank erosion. Additional information collected for each field site was the number of livestock crossings, number of drainage pipes or swales, an estimate of overall erosion at the road crossing and “unnatural” items seen in the corridor, such as sheds, houses, roads, construction waste, etc.

Stream flow throughout the system was low to medium as would be expected for a drier than average November. Forty-two percent of the sites were estimated as low flow and 58 percent as medium flow. Two channels were found to be dry and at one site there was no visible channel. Channel widths ranged from less than 5 ft to greater than 40 ft. More than 75 percent of the sites had channel widths estimated between 5 and 30 ft; approximately 45 percent of these sites had channels less than 10 ft wide. No attempt was made to determine whether the observed channel widths were what would be expected for the conditions of the sites. Rather much of the information gathered by the Field Survey serves as baseline data for the Subwatershed that can be utilized for future visual assessments.

The presence of vegetated riparian buffers are important to stream health for their ability to attenuate water runoff, filter pollutants, provide shade to regulate water temperatures, provide riparian and in-steam habitat to aquatic organisms, and hold stream bank vegetation and soils in place. Buffer widths ranged from less than 25 ft to greater than 75 ft. However, more than 65 percent of the sites had buffers less than 50 ft wide, with the majority of the buffers less than 25 ft wide. With regard to canopy cover, 55 percent of the sites had moderate to abundant cover while 24 percent of the sites had no canopy cover at all.

Figure 4.6. Survey Sites for Mill Creek Subwatershed Inventory



Bank erosion was estimated to be either “none” or minimal at more than 80 percent of the sites. Less than 4 percent of the sites were considered to have severe bank erosion. Overall erosion at the road crossing itself was found to be “none” or minor at 58 percent of the sites. Approximately 28 percent of the sites had moderate erosion at the crossing while 6 percent were estimated as severe. The remainder of the sites was reported as having minor to moderate erosion at the road crossings.

Typical items that have been installed or built in the riparian corridor include utilities, houses, and roads or drive paths. Various other items such as farm equipment, construction waste, fencing, scrap metal and auto parts, tires, sheds, bridges, drums, and furniture also were noted.

Physical Appearance of Stream

Information about the physical appearance of the stream at the survey site was gathered using a simple checklist of items or features related specifically to the stream itself. Items of particular interest were odor, aquatic plants, oil sheen, foam, bacterial sheen/slime, natural riffles, turbidity, trash and flow obstructions. Also noted was whether the stream channel meandered or had been straightened as a result of channelization.

At a majority of the survey sites, none of the above elements were observed. Six of the sites reported flow obstructions in the stream and 8 of the sites noted aquatic plants visible in the stream. The lack of aquatic plants may be due to the time of year the survey was conducted. Only 5 sites reported having natural riffles, suggesting sediment deposition on the stream bottom, with bank erosion and surface water runoff as possible causes of excess sediment loadings in the streams. Additionally, obstructions in a stream channel are often made worse by sediment deposition, causing the obstruction to “grow” and further impeding water flow.

Discussion

Based on the findings of the visual assessment, the most significant problems at the road crossings and, by extrapolation, to the rest of the Mill Creek system are inadequate buffer width and plant materials, items in the stream corridor, lack of channel diversity from drainage improvements, and erosion and related problems caused by inadequate slope and stream bank protection at road crossings. The Field Survey Assessment was designed as an accessible means to gather qualitative information that may indicate larger problems upstream of survey sites. The Field Survey Assessment not designed to conduct a complete survey of the entire stream system.

Several recommendations can be made to mitigate the problems identified in the Assessment. First, buffer widths need to be extended throughout the watershed to a minimum of 100 ft wide on both sides starting from the stream bank. Second, residential areas along the stream corridor should be encouraged neither to plant nor maintain their lawns up to the stream’s edge. Third, trees or other native woody plants could be planted in areas where there is none or minimal canopy cover. Fourth, erosion at road crossings should be remedied to prevent further bank erosion and reduce sediment loadings in the streams. Finally, manmade items should be removed or minimized from the floodplain and stream corridor.

Chapter 5 Challenges and Goals in the Mill Creek Subwatershed

5.1 Challenges to the Subwatershed

Watershed management planning provides the opportunity for communities to assess the current condition of the watershed and peer into the future to see what their watershed will look like if the status quo is maintained. Most often, the quality of life desired by the community for future residents is not in step with the realities of where the community is headed. For the Mill Creek Subwatershed, the SAG identified how their expectations were not being met due to degraded conditions and prioritized the pollutants and threats to the water resource, as well as the sources and causes of them.

5.1.1 Designated and Desired Uses in Mill Creek

Designated Uses of Waterbodies in the Mill Creek Subwatershed
According to the Michigan Department of Environmental Quality, the primary criterion for water quality is whether the waterbody meets 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, as listed in the box below that apply to the waterbody. It is important to note that not all of the uses listed below may be attainable, but that as ultimate goals, they provide a positive direction toward which the Subwatershed can move. These designated and desired uses for Mill Creek will be managed by the communities through which it traverses according to the above goals and the action plan of the Stakeholder Advisory Group (SAG).

It is the assumption of the SAG that if the communities and agencies take action toward the goals listed above, that the designated uses appropriate for the Creek, will be under restoration and improved considerably. Taking actions and measuring the progress toward reaching these goals will be characterized by an iterative approach. The goals and actions need to be compared to results of regular monitoring, and on a subwatershed and watershed level, to determine reasonable and steady progress toward these goals, related water quality standards, and designated/desired uses over the long term.

All surface waters of the state of Michigan are designated for and shall be protected for all of the following uses (Brown, et. al, 2000). Those that apply to the Mill Creek Subwatershed (according to discussions and understanding of the SAG) are in **boldface**:

1. **Agriculture**
2. **Industrial water supply**
3. Public water supply at the point of intake
4. Navigation
5. **Warmwater fishery**
6. **Other indigenous aquatic life and wildlife**
7. **Partial body contact recreation**
8. **Total body contact recreation between May 1 and October 31**
9. Coldwater fishery

Due to anthropogenic impacts to the Mill Creek Subwatershed, not all of the designated uses are fulfilled. **Warmwater fishery use** and **Other Indigenous aquatic life and wildlife use** are ***impaired*** along a stretch of Letts Creek where an oil spill obliterated life in the Creek in 1997. In 2004, the MDEQ will consider whether this impacted stretch of Letts Creek requires the development of a Total Maximum Daily Load to bring back a healthy stream. **Total and partial body contact recreation uses** are ***threatened*** throughout the Mill Creek system due to high nutrient loads that can cause nuisance algal blooms in non-riverine environments. Communities of the Mill Creek Subwatershed are part of the area identified as the Middle Huron River Watershed, which is under federal mandate to reduce phosphorus loading to the

River by 50 percent of mid-1990 levels in order to meet the phosphorus concentrations allowable in the Total Maximum Daily Load for Ford and Belleville lakes.

Desired Uses of Waterbodies in the Mill Creek Subwatershed
In addition to the Designated Uses of the Mill Creek system established by state and federal water quality programs are uses of the waterbodies that are desired but not yet achieved. Through public meetings, mailed surveys and discussions with members of the SAG, the desired uses identified are:

1. **Water quality and quantity functions of natural features**:
Protect and enhance natural features, including wetlands, floodplains and stream channels that regulate the flow of stormwater runoff, protect against downstream flooding, and curb erosion and sedimentation

2. **Coordinated development**:
Promote and achieve the environmental and economic benefits of intentional communities through coordinated planning and development

3. **Threatened and endangered species and habitats**:
Protect and enhance threatened and endangered species and habitats on which they depend

4. **Open land and agricultural land**:
Protect these lands from development and preserve them to maintain a viable farming economy, maintain the rural character of the communities, and maintain natural functions of these lands provided by woodlands, wetlands, and other natural areas

5. **Groundwater and wellhead area**:
Protect groundwater recharge areas and wellhead protection areas from contamination and overdrafting through diversions and withdrawals

6. **Recreation trails**:
Establish a recreation trail system along Mill Creek and its tributaries where desired and feasible

It is the intent of the SAG that future decisions and actions place equal emphasis on desired uses as designated uses.

5.1.2 Pollutants and Threats to Creek Health, and their Sources and Causes
The diverse landscapes in the Mill Creek Subwatershed create a variety of challenges and threats to the water quality of the waterways that flow through the basin. These challenges, or pollutants and threats, along with their causes and sources are listed in the tables in this chapter. Although communities and agencies within the Subwatershed intend to address all of these pollutants and threats in the long term with various targeted programs, it has been important to prioritize and identify the most pressing concerns in the Subwatershed so that resources can be spent cost-effectively in a phased approach, addressing the most important concerns first. These concerns and challenges, as well as their impacts, are summarized below.

Land Use Changes: The greatest concern and threat to water quality degradation in the rural areas of the Mill Creek system is pending land use change. Future development is of utmost concern in the rural and headwaters communities where high water quality is threatened by the potential impacts of growth. 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 (AFT, 2001). Moreover, the conversion of farmland to other uses accelerated from 1992 to 1997 by 67% over the previous 5-year period (AFT, 2002). 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 uncoordinated suburbanization. The Mill Creek Subwatershed, and much of southeast Michigan, is considered high-quality farmland facing high development pressure by the U.S. Department of Agriculture (AFT, 2002).

New development along lakeshores, in this case along Pierce Lake, often increases the amount of nonpoint sources of pollution in the waterbody. Photo: HRWC

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, increased algae, decreased dissolved oxygen and other impacts. Many of the challenges listed below (high stormwater flows, excess nutrients, erosion and sedimentation, loss of natural features) are actually subsets of these land use change concerns.

High Stormwater Peak Flows: In the Mill Creek Subwatershed, high stormwater flows are a current concern throughout the system in both rural and developed communities. Agricultural drain tile systems coupled with county drains are adept at moving water away from productive farm fields thereby creating high stormwater flows in headwaters and main branches alike. In areas where drainage “improvements” have not been made, peak stormwater flows in headwaters tributaries are currently maintaining levels sufficient for water quality and habitat, but are at risk of experiencing increases due to future development. High stormwater flows, and decreasing base flows, also result from increased impervious surfaces in the landscape. The largest concern with developed landscapes is those that have “directly connected” impervious surfaces. 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, quickly and untreated, into the storm drain and into local creeks and streams. In undeveloped areas, mitigation of the effect of impervious surfaces often utilizes the preservation of natural features, incorporating detention ponds or infiltration basins, and other on-site stormwater control systems. In developed areas, managing this flow is difficult, since there is usually limited land on which to build a detention pond or other on-site management system. In urban areas, underground storage systems as well as smaller on-site systems (such as residential rain barrels) can be used to control flow. Increased flow rates and velocities can lead to flooding, bank erosion, sedimentation, loss of aesthetics, increased stormwater pollution and loss of aquatic habitat.

Erosion and Sedimentation: Increased soil erosion and sedimentation in Mill Creek is also a result of certain land uses and land use changes all over the Subwatershed. Soil erosion from construction sites in the most rapidly developing areas of the Subwatershed is of major concern. In many cases, development is so intense, the jurisdiction responsible for soil erosion and sedimentation control (SESC) does not have the resources to regularly inspect and enforce infractions on all sites under construction. Additionally, a lack of understanding of installation and maintenance practices for SESC controls on site can exacerbate erosion problems. Other large sources of sediments include sediments washed off of paved streets and parking lots, as well as unpaved roads. In addition to these sources, high stormwater flows can have enough energy to scour soils and destabilize stream banks, carrying bank sediments downstream. Evidence of channel downcutting along the Mainstem of the Creek indicates destabilizing flows in the agricultural landscape. In the rural areas of the Subwatershed, active agricultural land is known to be a source of concern. Traditional farming practices leave soil bare and tilled at certain times of the year which leaves soil vulnerable to wind and water erosion. Impacts of soil erosion and sedimentation

New development is one source of soil erosion to surface waters in the Subwatershed. Photo: HRWC

Road work is another source of soil erosion to the Mill Creek system, such as along this stretch of Letts Creek. Photo: HRWC

on downstream water resources include decrease of aesthetic quality with an increase of turbidity, decreased light penetration and decreased plant growth, and decrease in aquatic habitat with increased sediment islands blocking fish migration and sediment covering and clogging gills of fish and aquatic insects. In addition, nutrients and other pollutants often bond with soil particles, increasing the detrimental impact of sedimentation on water resources.

Excess Nutrients: A certain amount of nutrients are found in water resources naturally. In excess, however, 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 (U.S. EPA, 2000b). In the Mill Creek Subwatershed, the nutrient of greatest concern is phosphorus (P) because in Michigan aquatic ecosystems, P is the limiting growth factor for algae and other nuisance plants. When excess P 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. Eroded soils can serve as a main source of phosphorus to the Creek since the nutrient adsorbs to particles in the soil. Imbalanced plant and algae growth limits recreational opportunities and aesthetics.

Algae forms in the presence of excess nutrients, such as phosphorus, to the waterbody. Photo: HRWC

Threat of Loss of Natural Features: The loss of natural features often comes hand in hand with development in the Subwatershed. 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, reducing 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 negatively impacted with increased flow and increased pollutant loads. As reported earlier in the Field Survey summary, the areas where the riparian vegetation is still fairly in tact 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. Protecting and restoring the riparian corridor is of particular importance along the smaller tributaries to Mill Creek where sensitive fish species such as the Mottled Sculpin have been found.

Studies indicate that half of the state's inland wetlands and 70 percent of the coastal wetlands no longer exist (MLUI, 1999). Permitted fills for commercial and industrial development, housing, roads, agriculture, and logging claim an estimated 500 acres of wetlands statewide each year. While wetland loss rates are currently unsubstantiated in the Mill Creek Subwatershed, the Huron River Watershed has lost approximately 66% of its wetlands to human activities (HRWC, unpublished). This massive 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 thereby requiring permits for most earthmoving activities. Such wetlands often serve as many or more important functions than do the larger wetlands (Olsson and Worzalla, 1999). Therefore, local protection of these systems is imperative.

Uncontrolled Sources of Bacteria: Major sources of bacteria include failing On-Site Sewage Disposal Systems (OSDS), or septic systems, which are located throughout most of the Subwatershed and illicit discharges of sanitary waste into storm sewers that are mostly located in older, urban areas. The septic system inspection program administered by the Washtenaw County Environmental Health department reports that approximately 20 percent of septic systems in the county are failing and require repair. Pet, livestock and waterfowl wastes are also sources of bacteria, but it is very difficult to measure the magnitude of these sources as compared to the sources listed above. However, the increase in households and the subsequent increase in pets, increase in waterfowl habitat in the form of lawn adjacent to detention ponds, and the presence of small horse farms and livestock operations in the Subwatershed suggests that these sources should be considered as having a significant impact on water resources. Impacts of bacteria in water resources include loss of recreational opportunities such as wading and canoeing due to public health concerns.

Pet waste is one of the many sources of E. coli in the Mill Creek system. Photo: HRWC

Need for Public Awareness and Action: The public generally regards the Mill Creek and its tributaries as degraded systems providing neither active or passive recreational opportunities nor aesthetic qualities in their communities. Mill Creek tends to be perceived as an agricultural drain with virtually no public access rather than as a natural ecosystem and a regional amenity. This perception has lead to a lack of awareness or understanding about the high quality areas in the headwaters and the potential for recreation along Mill Creek and in other areas. There is also a general misperception about who contributes to the pollution of the river, although non-point source education has increased awareness and a sense of civic responsibility in the watershed overall in the past five years. These misperceptions or lack of awareness has in turn caused 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, these negative or complacent attitudes toward, or lack of understanding about, the Creek encourages the further degradation of the resource by allowing debris and pollutants to enter stormdrains and the river. 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: Some of the communities and agencies in the Mill Creek Subwatershed have made a commitment to protect and restore water resources in their jurisdictions with a broad spectrum of short term and long term projects and programs. However, it is increasingly apparent that there is a need for additional support within certain communities and agencies in order to implement, document and report on the various aspects of these increased responsibilities. Some communities, primarily those required to have NPDES Phase II storm water permits, 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. For the future operation of a watershed-wide effort, the communities and other stakeholders will need to decide if a collaborative institutional arrangement is the preferred way to provide the resources and coordination necessary to continue moving the effort forward. The potential impact of inadequate program support, financial resources and institutional arrangements is the failure to create and implement programs, policies and projects that meet the goals set forward in this watershed management plan.

Monitoring Programs and Data: Integrated and coordinated water quality monitoring needs to be more firmly established within the Mill Creek Subwatershed. Review of readily available and relevant data reveals a number of concerns. In some cases, studies and data significant to water quality decisions was only minimally distributed within the area of interest. In other cases, existing datasets are not complete enough to be used as a basis for Subwatershed decisions. Other datasets are nearly non-existent, especially those dealing with sediment contamination, illicit connection and septic system failure rates, and emerging issues such as the presence or absence of endocrine-disrupting chemicals in the water, sediments, and biota. 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 Subwatershed; therefore, data trends cannot be detected confidently given the lack of time-series data.

Identification of community-centered concerns for the Subwatershed is essential in order to develop a grassroots appeal and sustainability for the watershed management project. Community concerns were generated from two public meetings, the SAG, and mail surveys to more than 500 residents; a nearly 8 percent response rate was achieved for the mailing. As a result, many challenges were identified to preserving the current and future water quality of the Mill Creek Subwatershed, and are listed in Table 5.1. Prioritization was based on the frequency with which a concern was identified. The number next to each concern is the number of responses the concern received.

Table 5.1. Prioritized List of Subwatershed Concerns

Area of Concern	Concern/Need	Total Votes
Hydrology/ Stream Quality		**78**
Water Quality	Nonpoint source pollution from agriculture and industry Sewage in streams Increased water temperatures Loss of biodiversity Impacts of dams on water quality/quantity	32
Stream Characteristics	Flooding/developed floodplains Degraded stream habitat Flashy runoff Low base flows Log jams Unstable stream channels Water diversions/water budget	27
Sedimentation	Eroding streambanks	19
Development		**73**
Development/Sprawl	Increased development as urban sprawl Commercial lawn care Inadequate infrastructure to support new development Erosion and runoff from development	27
Planning	Lack of coordinated planning and development Lack of land use plans Lack of natural features setback ordinance Lack of open space Lack of stormwater and soil erosion control management and ordinances Poor site design impacts on hydrology	26
Sewer and Water	Failing septic systems Sewer back-ups, overtaxed municipal systems New developments with on-site treatment system Illegal sewage connections Water and sewer access	16
Road runoff	Oil. Gas. Salt and brine usage on roads near water	4
Habitat and Wildlife		**52**
	Loss/degradation of wetlands Loss/degradation of wildlife habitat and forests Loss/degradation of riparian vegetation/buffers Mismanagement of deer/degraded fish populations/invasive species	24 20 4 4
Agriculture		**18**
	Loss of farmland and open space Lack of agricultural drain maintenance Factory farming	12 4 2
Groundwater		**10**
	Chemical/nitrate impacts on groundwater	5
	Groundwater contamination	3
	Overuse of groundwater	2
Recreation		**8**
	Recreation corridors and impacts on riparian corridors Lack of public access to creek and riparian areas Too much emphasis on motorized recreation	3 4 1

The SAG and Technical Working Group spent one year gathering the information necessary to understand what are the challenges to the Subwatershed, and their sources and causes, as well as to prioritize them according to greatest need for mitigation. These exercises were conducted for each of the 9 catchments and for the overall Subwatershed. The prioritization reflects the information collected to this point from a variety of sources on the conditions of the watershed.

In cases where pollutants, sources or causes were suspected since not enough information was known about them, when feasible, effort was made to gather the information needed in order to make a determination. Methods to collect information ranged from field work to desktop analyses utilizing computer programs and aerial photos. The Field Survey was coordinated as a means to clarify whether more could be known about particular sources and causes of pollutants.

While much data and information was compiled to eliminate most suspected items in the table below, some remain due to the lack of previous research. High water temperatures, pathogens and pesticides require further monitoring to determine the extent to which these pollutants are impairing the Mill Creek system. Due to the historic and continued alteration of flow in the creek that is a driving factor in the amount of sediment and nutrients in the Mill Creek system, high stormwater peak flows is the number one challenge to address. Prioritization of pollutants and their sources and causes for the 9 catchments was conducted by the SAG and are available in Appendix J.

Table 5.2. Prioritization of Challenges (Pollutants), Sources and Causes in the Mill Creek Subwatershed

Challenge	Known or suspected source	Known or suspected cause
1. High stormwater peak flows/ altered hydrology	1. Drains	Loss of connection between stream and floodplain from channelization
	2. Loss of wetlands and natural features	Wetlands drained and converted for crops
	3. Developed and developing areas	1. Directly connected impervious areas 2. Insufficient stormwater management practices
	4. In-stream structures	Dams, in-line detention, and lake control structure
2. Sedimentation, soil erosion	1. Stream banks	1. Erratic flow fluctuations 2. Insufficient riparian vegetation on banks
	2. Agricultural land	1. Insufficient upland conservation practices 2. Insufficient vegetated riparian buffers 3. Wind erosion on unprotected erosion-prone soils
	3. Developed areas/construction sites	1. Insufficient upland conservation practices 2. Insufficient vegetated riparian buffers 3. Inadequate soil erosion practices 4. Inadequate inspection, compliance with regulations
	4. Road-stream crossings	1. Undersized culverts 2. Poorly stabilized headwalls 3. Erosive road or bridge surface
3. High nutrient load	1. Fertilizers and livestock waste from agricultural land	Insufficient upland conservation practices
	2. Fertilizers from residential, commercial and golf courses	1. Improper application of phosphorus fertilizers 2. Insufficient vegetated riparian buffer 3. Improper sewage lagoon function (s=suspected)
	3. Failing on-site septic systems	Poor design, lack of maintenance
	4. Pet and wildlife waste	1. Storm sewers create direct pathways 2. Ponds increase habitat for waterfowl, wildlife
	5. NPDES permitted facilities	Nutrients permitted in effluent
4. Oil, grease, metals, brine/salt	1. Roads, parking lots, driveways	1. Insufficient stormwater management practices 2. Road culverts drain directly into streams 3. Impervious surfaces directly connected to storm sewers
	2. Existing in-stream pollution	1997 oil spill in Letts Creek
	3. NPDES stormwater permitted facilities (s)	1. Inadequate inspection 2. Insufficient vegetated riparian buffer and upland conservation practices
5. High water temperature (s)	1. Directly connected impervious areas	Heated stormwater from urbanizing areas
	2. Suspended solids	Soil erosion from channel and upland
	3. Solar heating	Lack of vegetated canopy in riparian zone
6. Pathogens (s)	1. Human waste from failing on-site septic systems	Poor design, lack of maintenance
	2. Livestock waste from agricultural operations	1. Insufficient upland controls 2. Uncontrolled livestock access to streams
	3. Pet and waterfowl waste	Storm sewers create direct paths to streams
	4. Human waste from sewered areas (s)	Illicit connections of sanitary sewer to storm sewers (s)
7. Pesticides (s)	1. Agricultural land	1. Insufficient upland conservation practices 2. Inadequate vegetated riparian buffers
	2. Turfgrass chemicals: residential, commercial lawns	1. Improper application and usage 2. Insufficient vegetated riparian buffers

Once the challenges and their sources and causes were prioritized by the SAG, how best to apply limited resources to mitigate the challenges and return surface waters to designated uses was examined. A multi-layered methodology was employed then to identify the critical areas of the Subwatershed where alternative management practices should be focused.

5.2 Critical Sub-basins

Experience and observation, field surveys, scientific data and literature, and aerial photography and GIS were combined with watershed modeling to delineate areas of the Subwatershed that are critical to meeting the goals and objectives set forth in this plan. Identifying the critical areas in the Mill Creek Subwatershed focuses our planning efforts in order to address the "hot spots" of pollution and natural features protection, rather than classifying all parts of the watershed as equally important. Limited resources in the planning process and in the local municipalities make prioritization of areas essential. Working definitions of the two types of critical areas are:

- Areas of the watershed that have been identified as critical areas due to their ecological contributions to the Subwatershed, such as waterways, lakes, riparian wetlands, floodplains, wooded wetlands, and groundwater recharge areas; and
- Areas of the watershed that have been identified as critical areas due to the type and estimated amount of pollutants they contribute to the Subwatershed.

5.2.1 Purpose and Methodology

Critical areas prioritization was pursued to address watershed restoration and protection via targeted initiatives that will produce the most cost-effective solutions. The methodology (see Figure 5.2) employed for the Subwatershed is based on five tenets: (1) information on current land use, associated impervious cover, and future land use; (2) areas of hydrological direct drainage to the Creek system; (3) nutrient and sediment loading output utilizing the Generalized Watershed Loading Function (GWLF) computer model; (4) field survey results; and (5) input from the public, SAG and Technical Working Group.

Sub-basin Delineation

To delineate the hydrologically connected areas, the Subwatershed was divided into sub-basins based on topography, and relation to direct surface water drainage to the creek system (hydrological connectivity). This delineation process produced 55 sub-basins for the Mill Creek Subwatershed (Figure 5.1). Approximately 64 percent of the Subwatershed contributes runoff to the Mill Creek system based on this delineation. Direct drainage areas represent those 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. The parts of the landscape excluded from the contributing areas map are crucially important for the pervious areas they provide for groundwater recharge and other water cycle functions, protection of groundwater aquifers, and plant and animal habitat. However, those areas are not considered in the subsequent discussion on identifying critical sub-basins.

Figure 5.1. Sub-basins of the Mill Creek Subwatershed

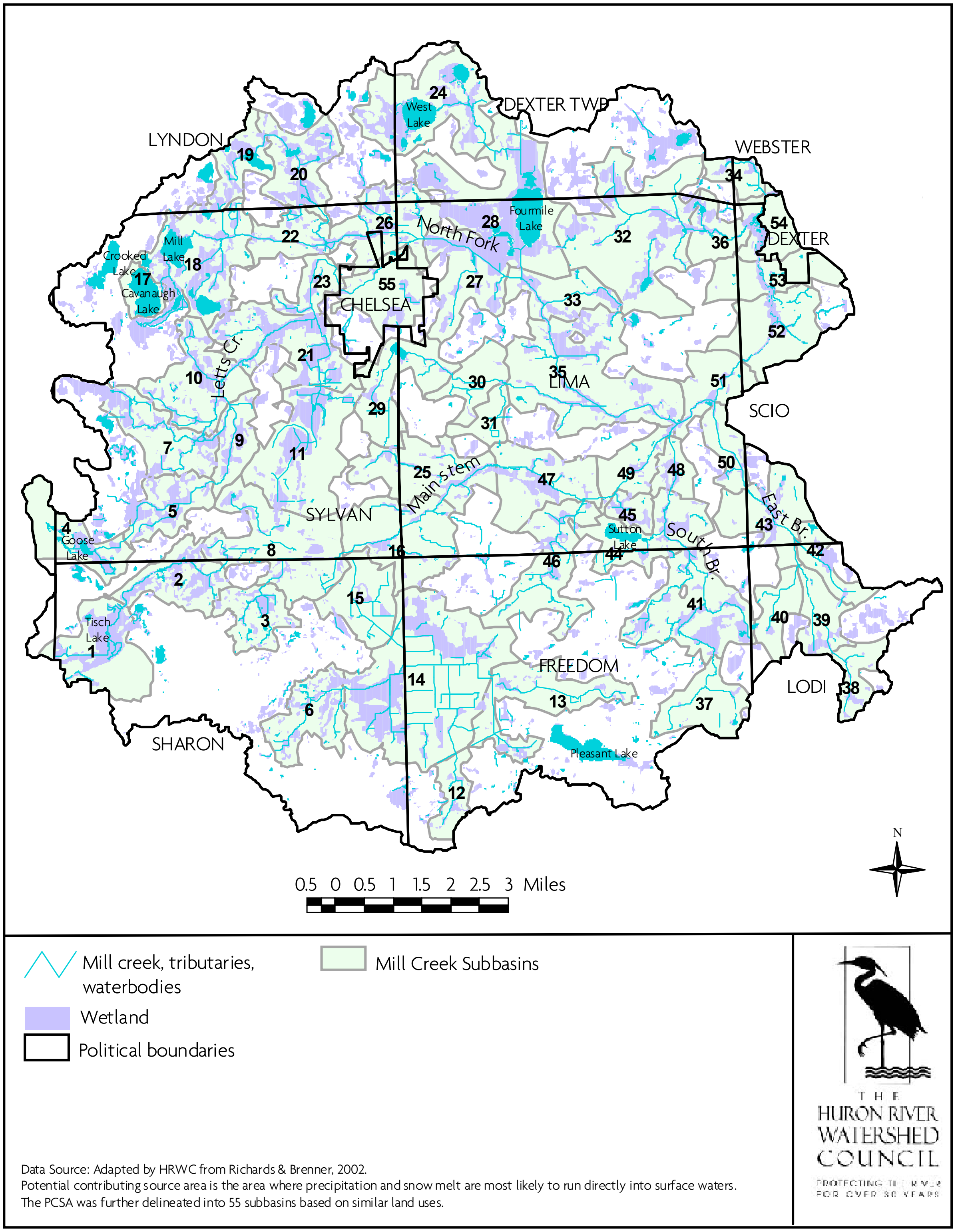
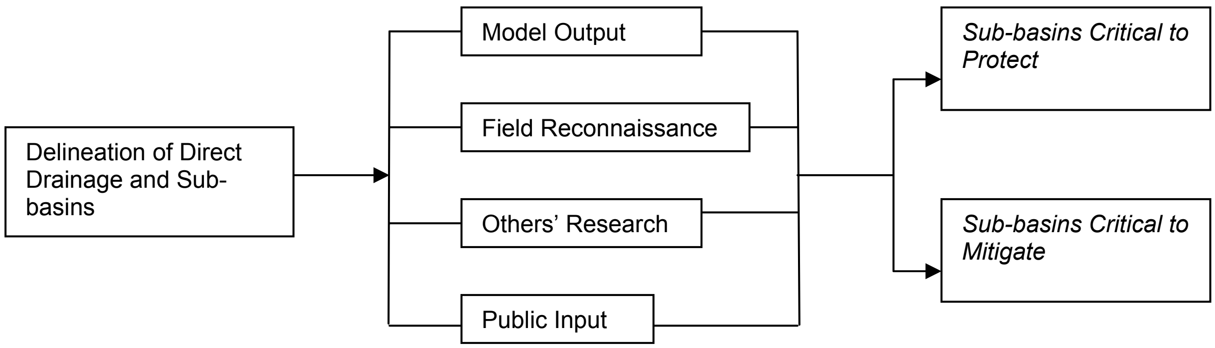


Figure 5.2. Components of the Critical Area Identification Methodology.



Critical Sub-basin Identification

The Generalized Watershed Loading Function (GWLF) model was employed to establish yearly phosphorus loading rates on a sub-basin scale to achieve a greater degree of specificity regarding the source location of significant phosphorus loading. The GWLF model provides a moderately detailed simulation of precipitation-driven runoff, pollution, and sediment delivery within a watershed or Subwatershed. The model uses watershed-specific information regarding number and type of septic systems, land use and cover, pollutant event mean concentrations, soil type and physical characteristics, known point sources, evapotransporation, and other specific variables to predict particulate and dissolved-phase pollutant loading to a stream, river, or lake. This continuous simulation model uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads based on the daily water balance accumulated to monthly values. See Appendix A for more detailed methodology regarding GWLF.

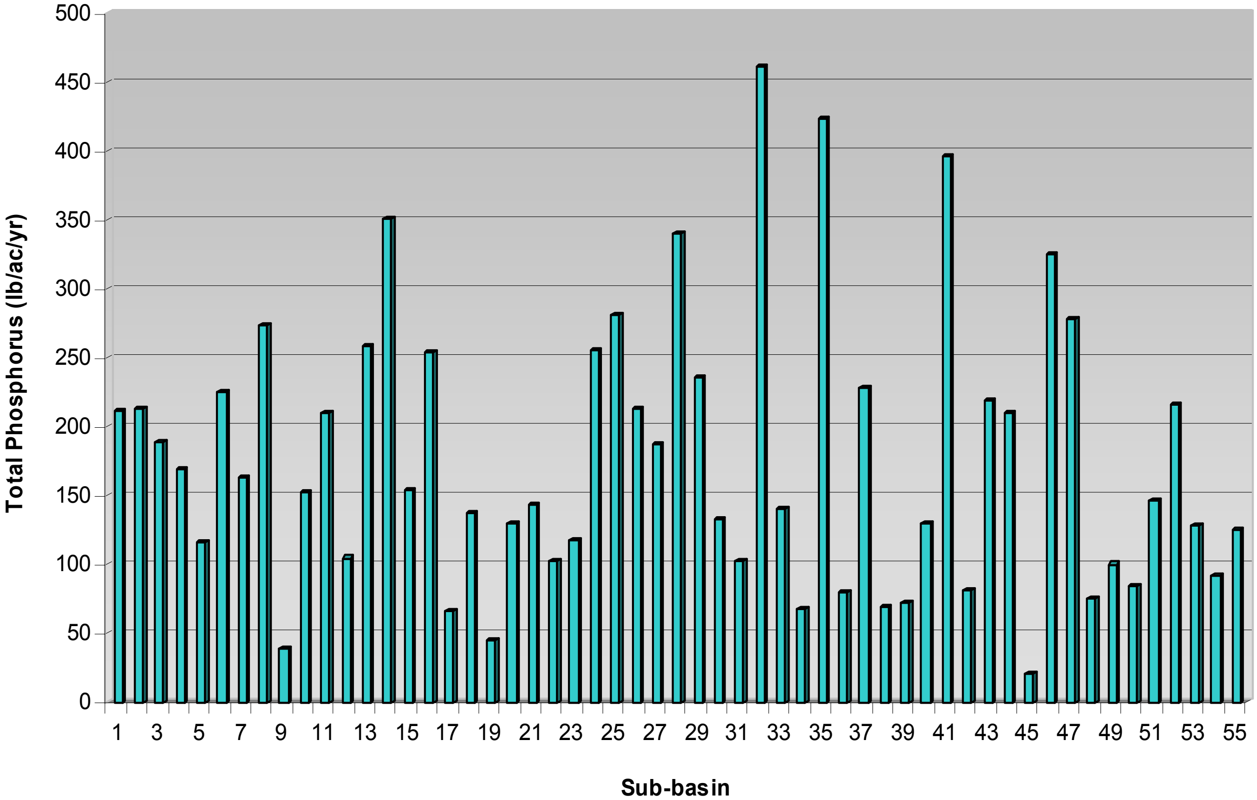
HRWC methodology yielded very accurate results in previous modeling activities. For instance, when the model was employed for the Upper Huron Watershed area, it predicted overall phosphorus loadings within 10 percent of actual measured loads. Acceptable level of error is considered to by 25-30 percent. Therefore, the model and the methodology to utilize the model were deemed sound.

However, results for the Mill Subwatershed yielded phosphorus loading numbers that were 40-45 percent off of measured numbers. This discrepancy could be explained by the following factors:

- The measured data was taken over the course of a year, at different parts of the Subwatershed with inconsistent number and frequency of measurements for nutrients and stream flow.
- The measured data was taken in 1995 – 1996, whereas the model used weather data spanning 6 years, from 1995 – 2000. Also, the model used land use data from 1998.
- The Mill Creek Subwatershed is predominantly agricultural. The input data (soil curve numbers, slope numbers, phosphorus concentration, etc.) for agricultural land varies a great deal depending on crop type and management. Unfortunately, only average values were available for these parameters for the Mill Subwatershed.

Note that the purpose of the GWLF modeling was not necessarily to obtain an accurate phosphorus loading number for the Subwatershed, but to get an idea of the relative phosphorus runoff, and sediment contributions from each of the 55 sub-basins modeled to help target protection and mitigation efforts. Normalized (for area) annual phosphorus loads per sub-basin are presented in Figure 5.3.

Figure 5.3. Normalized Annual GWLF Phosphorus Nonpoint Source Load Estimate for Mill Creek Sub-basins (lb/ac/yr)



In addition to the model outputs, information gained from field reconnaissance, scientific studies and natural resource management reports, and public input was incorporated into the critical sub-basin identification. Only information that was available for the entire Subwatershed was considered. For instance, some information such as chemistry data and livestock numbers is available only for discrete parts and cannot be extrapolated to other areas. The following table lists the information that comprises the critical areas analysis and identification:

Table 5.3. Parameters Weighted to Identify Critical Sub-basins

Critical to Protect	Critical to Mitigate
Current imperviousness < 10%	Current imperviousness > 10%
Extent of Natural Features: wetlands, woodlands, steep slopes	Future imperviousness increase
Protection priorities, 1996 Seelbach & Wiley study and The Nature Conservancy	Field inventory
Aquatic macroinvertebrate studies	Aquatic habitat studies
Natural areas identified by the "Conservation Planning" Project	Fine sediment studies
Element Occurrences (threatened, endangered species and communities)	Presence of NPDES permitted facilities
	Phosphorus loading estimate by GWLF model
	Loading Estimate by GWLF model for Nitrogen, Erosion and Sediment

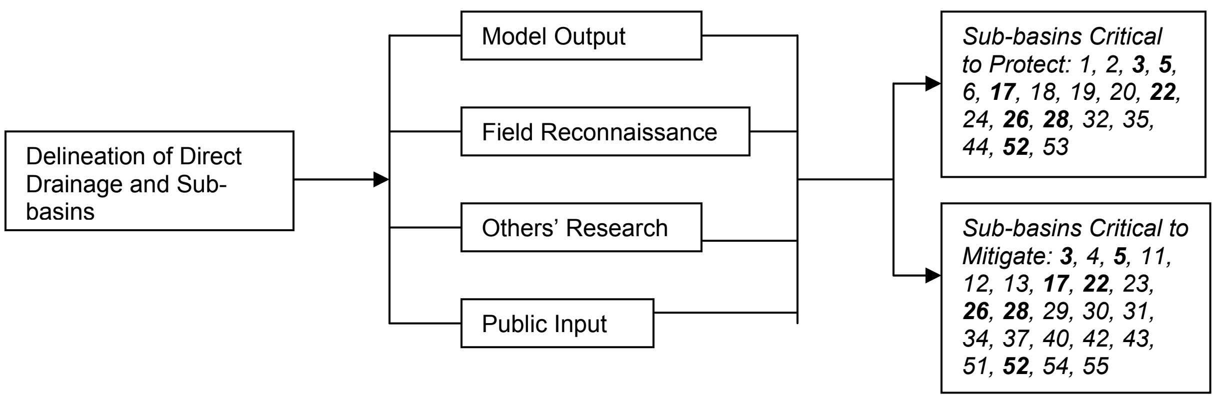
Each sub-basin received a weighted score for each parameter and then scores for each sub-basin were grouped into Critical–to-Protect and Critical-to-Mitigate categories. Each sub-basin received two scores, then, for the two different critical assessments. The Critical Areas analysis reveals those sub-basins that received higher scores in order to help focus the limited resources available to manage the Mill Creek watershed.

5.2.2 Identification of Critical Sub-basins

The Critical Areas flowchart and map (Figures 5.3-5.4) illustrate the cumulative information gathered since the onset of the watershed management planning process. Two definitions of "critical" are reflected in the map: sub-basins that are impaired and require mitigation, and sub-basins that are abundant in high-quality natural features and require protection and preservation. These sub-basins allow land use decision makers to work on a smaller scale to focus protection and restoration projects rather than considering the entire Mill Creek watershed. See Appendix B for a detailed methodology of the critical sub-basin determination

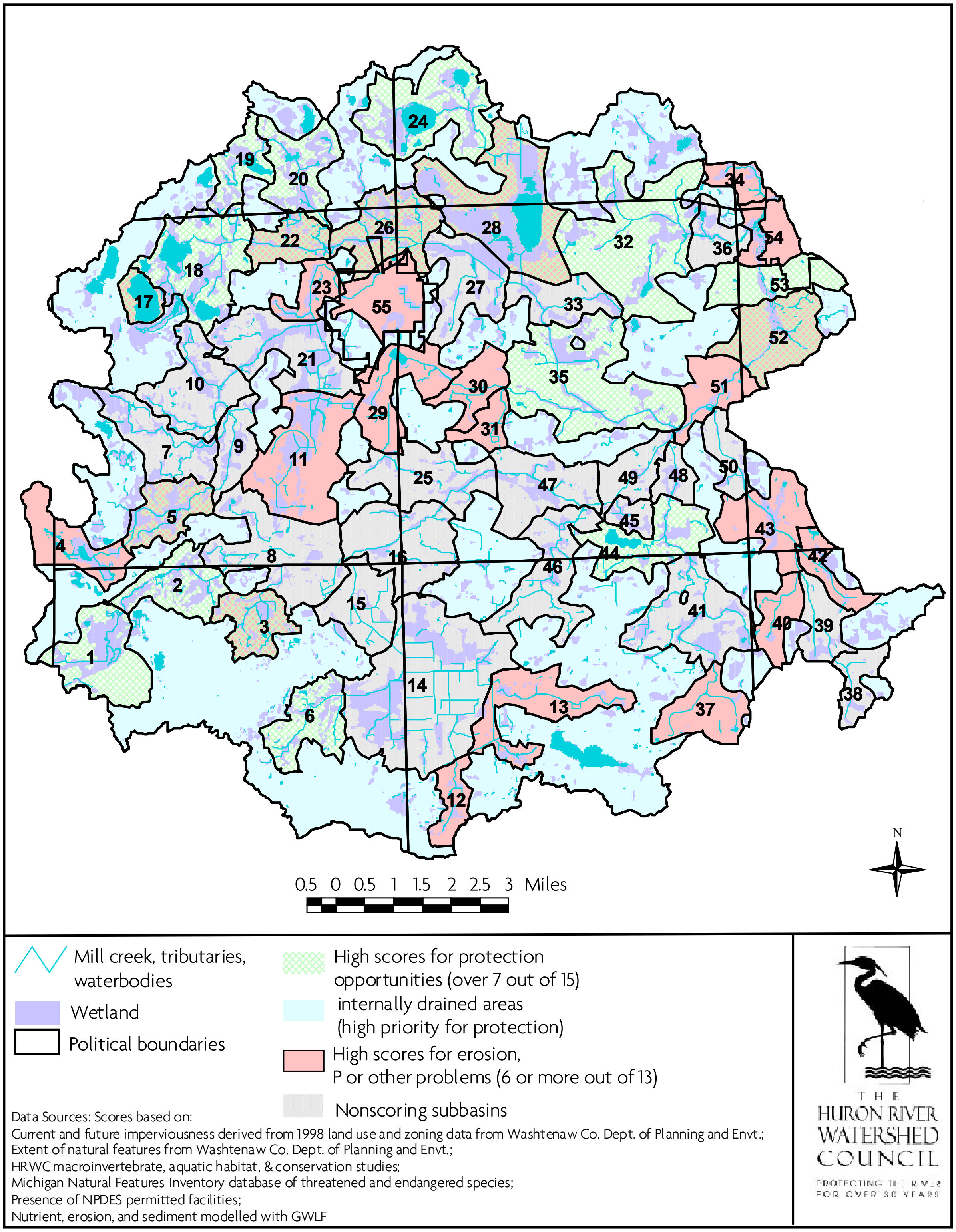
Eighteen sub-basins are identified as critical to protect based on the type and abundance of natural features and relatively low human disturbance and are shown in the Critical Areas map. Twenty-three sub-basins are identified as critical to mitigate based on the current and predicted extent of human disturbance to the Mill Creek Subwatershed. Employment of restoration and protection techniques in these sub-basins ought to achieve maximum benefits. Selection and placement of retrofitted and new stormwater BMPs to meet the TMDL target of a 50% reduction in current phosphorus loading will focus on these priority sub-basins.

Figure 5.4. Components of the Critical Area Methodology and Mill Creek Subwatershed Priority Sub-basins



Bold numbers indicate sub-basins that are both critical to protect and critical to mitigate.

Figure 5.5. Critical Sub-basins of the Mill Creek Subwatershed



5.3 Mill Creek Subwatershed Vision and Goals

Vision for the Mill Creek Subwatershed

The SAG presents this vision statement as the condition to which it strives to achieve through long-term implementation of this watershed management plan:

> *Protect and restore Mill Creek, its floodplains, tributaries, wetlands, lakes and groundwater so that beneficial functions and uses are achieved and maintained.*

Goals and Objectives for the Mill Creek Subwatershed

The designated and desired uses for the Mill Creek Subwatershed provide a basis from which to build long-term goals and objectives. In the list of goals and objectives below, it is important to realize that the SAG is striving not only for the restoration of impairments in the Subwatershed, but also for the protection of high quality waters and existing natural features which define many of the tributaries in the Subwatershed as described in Chapter 3. In addition to defining long term goals for the restoration and protection of these natural systems through improving ecological parameters, the SAG has also incorporated into its goals administrative parameters that will define the long term institutional framework and sustain the planned restoration and protection efforts over time.

Long term goals, for the purposes of this plan, are defined as a future condition of the Creek toward which the communities and agencies of the SAG will work. Long-term goals are roughly defined as goals that 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. Progress in achieving the goals will be defined by monitoring the physical and biological conditions of the river. These long-term goals have been developed on a Subwatershed-wide basis. This means that the goals have been established to identify the direction toward which the Subwatershed communities will collectively strive to improve or protect the condition of the Creek. As a result, no single community or agency is responsible for achieving all of the goals or any one of the goals on its own. However, the goals represent the desired end product of many individual actions, which will collectively and synergistically protect and improve the water quality, water quantity and biology of the river. The Subwatershed communities and agencies 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, their individual jurisdictions, their authority and their resources.

Due to the complex ecological nature of the response of the Creek to stormwater management, it is difficult to predict when these goals will be met in the future. 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 take ten to twenty years to achieve, or more. Rather than attempting to predict when these goals will be achieved, the SAG will continuously strive to meet these goals by implementing various best management practices (BMPs) that are recommended for addressing the various goals. The SAG 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.

Listed below (Table 5.4) are the long term goals and objectives as agreed upon by the Stakeholder Advisory Group. Neither the goals nor the objectives are listed in any specific priority. The designated uses with impaired or threatened uses are shown in boldface type.

Table 5.4. Long-term Goals and Objectives for the Mill Creek Subwatershed, and the Designated and Desired Uses they Address

#	Long-term Goal	Objectives	Use(s) Addressed
1	Restore the hydrologic regime	Reduce flow variability. Stabilize channel morphology. Reconnect stream network to floodplains, and creek to river. Monitor water quantity to measure progress.	**Warmwater fishery** **Aquatic life and wildlife**
2	Meet mandated 50% phosphorus loading reductions	Reduce nutrient loadings from nonpoint and point sources. Reduce soil erosion and sedimentation. Monitor water quality to measure progress.	**Partial and total body contact recreation** **Warmwater fishery**
3	Restore the natural warmwater fishery	Replace in-stream habitat structure, create pools and riffles. Remove any barriers to fish migration that prevent natural recolonization; selectively re-introduce pre-disturbance native fish. Regulate stream temperature. Monitor biota to measure progress.	**Warmwater fishery** **Aquatic life and wildlife** **Partial body contact recreation**
4	Restore the natural aquatic animal and plant communities	Protect and enhance threatened and endangered species and habitats. Protect critical stream substrates by keeping sand and silt out of streams. Re-establish stream buffer. Restore tree canopy in riparian buffer and other overhead cover. Monitor water quality and biota to measure progress.	**Aquatic life and wildlife** Natural features as regulators of stormwater runoff
5	Protect and enhance recreation opportunities	Increase opportunities for passive and active recreational uses. Establish a recreation trail system along Mill Creek and its tributaries, wherever possible. Reduce pathogens, nutrients, sedimentation and other pollutants in surface waters.	**Partial and total body contact recreation** Recreation trails
6	Protect and mitigate the loss of natural features	Preserve and enhance existing wetlands, floodplains and stream channels that regulate the flow of stormwater runoff, protect against downstream flooding, and curb erosion and sedimentation. Protect groundwater recharge areas and wellhead protection areas from contamination and overdrafting through diversions and withdrawals. Restore natural features.	Natural features as regulators of stormwater runoff **Aquatic life and wildlife** **Warmwater fishery** Groundwater protection
7	Achieve environmental and economic benefits through coordinated planning and development	Integrate stormwater management in planning and land use approval process. Educate land use decision makers on development impacts to watersheds and tools for low impact development. Increase regional planning efforts and implementation among local units of government.	Coordinated development Open and agricultural land and All
8	Protect existing open and agricultural land	Address issues of urban sprawl.	Open and agricultural land **Aquatic life and wildlife** **Warmwater fishery**
9	Establish an environmental ethic among the public	Increase public participation and understanding of their role in protecting Mill Creek.	All
10	Attain full plan implementation	Establish financial and institutional arrangements for fulfillment of the plan. Enforce action plans and increase accountability for stormwater management.	All

CHAPTER 6 SUBWATERSHED MANAGEMENT ALTERNATIVES

6.1 Assessment of Stakeholder Policies and Programs

With critical protection and mitigation areas of the Mill Creek Subwatershed identified, it is necessary to assess the existing management approaches being utilized by the communities and other stakeholders in regards to the Mill Creek system. Understanding current management provides a starting point for recommending alternatives to improve protection of critical areas and mitigation of degraded areas. The primary method employed to make this assessment was a Code & Ordinance Worksheet tailored to the Mill Creek communities, which evaluates the level of watershed protection afforded by a community's building codes and ordinances. Discussions with the SAG at quarterly meetings yielded information beyond that captured in the Worksheet.

6.1.1 Summary of Code & Ordinance Worksheet for Better Site Design

The Code & Ordinance Worksheet (COW) was developed by the Center for Watershed Protection in Maryland, and has been used in several states, such as Maryland, Virginia, Georgia, Washington, North Carolina, and Pennsylvania. The Worksheet was adapted for conditions in Michigan, and the communities in the Huron River Watershed are the first in Michigan to complete it. The Worksheet, or COW, provides an in-depth review of standards, ordinances and building codes that shape how development occurs in a community. It is a useful guide to review development rules, and serves as a basis for determining where future improvements could be made. In essence, the codes and ordinances on the books do impact the water quality and quantity in the Mill Creek Subwatershed, and changing them can improve local waterways.

The opportunity to participate in the Worksheet process was provided to all 11 communities and 6 chose to be involved; they are the villages of Chelsea and Dexter and the townships of Lodi, Lima, Lyndon and Webster. Nonparticipating communities are the townships of Dexter, Freedom, Scio, Sharon, and Sylvan. The Worksheets and letters of introduction were mailed and phone calls were made to the community representatives within two weeks of the mailing to assist with questions and to verify receipt of the packet. Various people took responsibility for completing the Worksheet, including local government staff, interested residents, and consultants. Several communities requested the assistance of project staff for this project.

The responses on the completed worksheets were compared to the set of Model Development Principles. These Principles, taken together, reduce impervious cover, conserve natural areas and prevent stormwater pollution from new development, while at the same time maintaining quality of life within your community. Each participating community received the community's results, prioritized recommendations for improving codes and ordinances, and supporting resources to move forward on implementing those recommendations. In addition, the general results were presented to the SAG at a quarterly meeting.

Although half of the communities did not participate in the COW process, it can be fairly assumed that most of the recommendations made to the participating communities can be extended to the nonparticipating communities given similarities in administrative resources and socioeconomic conditions, among other factors. The gaps in local policies that were identified through this process yielded opportunities that are presented in Table 6.1 along with the objectives they fulfill.

Table 6.1. Policy Opportunities Identified in Mill Creek Subwatershed Communities.

Objective	Recommendation
• Reduce the amount of sediment • Reduce the amount of nutrients • Reduce the amount of oil, grease, metals, and salt • Reduce hydrologic impacts from loss of floodplains and wetlands, and increased imperviousness • Reduce stream temperature	Adopt and implement ordinances for stream buffers, wetlands with natural features setback, and floodplains. Incorporate plans for buffer maintenance and management in the ordinances.
• Reduce the amount of nutrients • Reduce the amount of sediment • Reduce the amount of pesticides	Establish a land runoff program for water quality improvement; i.e. adopt a phosphorus reduction ordinance to reduce non-point sources of phosphorus to local waterways; provide incentives for reduction of fertilizer & herbicide use.
• Reduce hydrologic impacts from loss of floodplains and wetlands, and increased imperviousness • Reduce the amount of oil, grease, metals, salt	Incorporate requirements for managing the quality and quantity of stormwater runoff from new development sites, including residential, commercial and institutional.
• Reduce hydrologic impacts from loss of floodplains and wetlands, and increased imperviousness	Provide preservation and conservation options in your development code: - Develop land conservation incentives - Adopt and implement a farmland preservation ordinance - Preserve specimen trees - Establish open space management requirements
• Reduce hydrologic impacts from loss of floodplains and wetlands, and increased imperviousness	Establish open space management standards for new developments
• Reduce hydrologic impacts from loss of floodplains and wetlands, and increased imperviousness • Reduce the amount of nutrients • Reduce the amount of sediment	Allow for and promote more on-site retention of stormwater, i.e. allow for bioretention islands in landscaped areas of parking lots; allow for rooftop runoff to be discharged over pervious areas on residential sites.
• Reduce hydrologic impacts from loss of floodplains and wetlands, and increased imperviousness • Reduce stream temperature	Establish a minimum percentage of parking lot area that is required to be landscaped
• Reduce hydrologic impacts from loss of floodplains and wetlands, and increased imperviousness	Establish minimum requirements for building setbacks and road frontages.
• Reduce hydrologic impacts from loss of floodplains and wetlands, and increased imperviousness • Reduce stream temperature	Incorporate options in development code to reduce impervious surface cover, i.e. street widths, right of ways, minimum cul-de-sac radius, driveway widths and parking ratios. Allow for pervious materials to be used in spillover parking areas.

Recommended alternative policies and programs deemed to yield the most benefit for the cost are included in the Subwatershed Action Plan in Chapter 8. For a summary of the results from the Code and Ordinance Worksheet, see appendix F. Based on the responses, there are many opportunities for enhancing current standards within the Mill Creek Subwatershed. The following areas seem particularly promising:

- Wetland and stream buffer requirements, education, and maintenance activities;
- Stormwater management in the site plan review process;
- Floodplain and wetland (<5 acres in size) protection criteria & standards;
- Impervious surface reduction through promoting incentives for clustering, reducing residential street widths and lengths, reducing setbacks, and reducing cul-de-sac radii;
- Open space requirements/encouragement (consolidation, use/alteration restrictions);
- Native landscaping techniques, soil testing, and integrated pest management;
- Enhanced soil erosion control standards and enforcement (e.g., based on site specific particle size analysis); and
- Rewarding the use of ecological landscaping design (e.g., capture of smaller and more frequent storms, disconnection of downspouts, utilization of bioretention, recycling of captured stormwater for on-site irrigation, reduced grading and alteration of natural slope, etc.)

In addition to implementing the Code and Ordinance Worksheet process, the SAG brainstormed the existing programs and policies of the represented entities that address water resource concerns. Note that the following list represents only a partial list of all programs and policies in place in the Mill Creek area since not all stakeholders provided information.

Table 6.2. Current Water Protection Programs and Policies in Mill Creek Subwatershed (partial list)

Stakeholder	Existing Program or Policy	Pollutant Addressed
USDA, Natural Resources Conservation Service	Wetland restoration (Wetlands Reserve Program)	Hydrologic flow
	Controlling erosion/soils information	Sediment
	Streambank stabilization expertise	Sediment
	Riparian re-vegetation (Continuous Reserve Program)	
	Forested re-vegetation/filter strips	
	Agricultural waste management (Environmental Quality Incentives Program)	Nutrients
	Soil testing	
	Cross wind strips	Wind erosion
Washtenaw County Road Commission	Leave buffers when grading gravel roads	Sediment
	Assess and manage erosion at stream crossings	
	Follow soil erosion and sediment control practices	
Village of Chelsea	Soil erosion and sediment controls and stormwater retention requirements on new developments	Sediment
	Stormwater calculations must account for roads in new development in addition to the other development	Hydrologic flow
	Large detention on WTP site	
	Stormwater collectors, proprietary treatment devices	
	Oil and grease separators installed; add outlet devices to existing development	Sediment, oil/grease
DaimlerChrysler Chelsea Proving Grounds	Leave buffers along creek (of minimal width) Switching products to no or low phosphorus alternatives	Nutrients
	On-going monitoring of phosphorus levels in Letts Creek for NPDES permit	
	Pursuing alternative treatment chemical to reduce P	
	Soil erosion and sediment control permits and practices	Sediment
	Oil-grease separators installed	Oil/grease
	Devices in manholes are checked monthly	
Washtenaw County Drain Commissioner's Office	Planning incentives or requirements for infiltration	Hydrologic flow
	Require first flush and wet ponds	
	Implementation of Phase II NPDES stormwater permits	All
	Work to balance drain maintenance and channel protection	
	Drains are being entered into a GIS for enhanced use	
	Community Partners for Clean Streams program encourages business and community partners to improve operations to protect streams	
	Stormwater BMP Demonstration Park nearly complete	
Scio Township	Adopted Drain Office standards	Hydrologic flow
	Follows County Soil Erosion and Sediment Control rules	Sediment
Sylvan Township	Part of regional plan to limit sprawl	All
	Lake communities connecting to sanitary sewer	Nutrients

Existing agricultural BMPs in the Subwatershed as of November 2002 also were summarized by the SAG and project staff. The summary of practices in each of the 9 catchments described in Chapter 4.2 is provided in table 6.3 below.

McCann and others (1997) surveyed a group of farmers in Washtenaw County about their agricultural practices and adoption of selected conservation practices. Although the survey focuses on an area larger than the Subwatershed, the responses can be considered representative of the Subwatershed. More than two-thirds of farmers use crop rotations with legumes, while about half do not use hedgerows or tree windbreaks. No-till is practiced by one-third of farmers surveyed, and grassed waterways are used by one-third, as well. More than three-fourths of farmers test their soil, however most farmers report that soil test are conducted by chemical fertilizer dealers. Overall, the group of farmers indicates a fairly high rate of applying conservation practices; organic farmers adopted 75% of conservation practices applicable to their farming operations, while conventional farmers adopted slightly more than 57% of applicable conservation practices.

Table 6.3. Mill Creek Subwatershed Summary of Agricultural Best Management Practices by Catchment (source: USDA NRCS, Washtenaw County Conservation District

AG BMP	EAST BRANCH	LETTS CREEK	LOWER MAINSTEM	MAINSTEM	MAINSTEM HEAD-WATERS	NORTH FORK	NORTH FORK HEAD-WATERS	PLEASANT LAKE	SOUTH BRANCH	TOTALS
CONSERVATION TILLAGE	1220.8 ac.	1013.2 ac.	1465.8 ac.	1956.1 ac.	946.9 ac.	2461.8 ac.	373.0 ac.	2598.3 ac.	1138.7 ac.	**13,174.6 ac.**
COVER & GREEN MANURE CROP	-	-	-	-	-	-	-	1,139.5 ac.	-	**1,139.5 ac.**
FILTER STRIPS	-	-	1.3 ac.	8.5 ac.	-	6.6 ac.	-	19.1 ac.	-	**35.5 ac.**
FILTER STRIPS-ANIMAL WASTE MANAGEMENT	-	-	2.8 ac.	.7 ac.	-	-	-	.5 ac.	-	**4.0 ac.**
GRADE STABILIZATION STRUCTURES	-	-	-	3 no.	-	-	-	3 no.	-	**6 no.**
GRASSED WATERWAY	-	-	-	2.3 ac.	-	-	-	-	-	**2.3 ac.**
NUTRIENT MANAGEMENT	75.6 ac.	-	333.6 ac.	539.8 ac.	-	432.0 ac.	-	1,858.6 ac.	-	**3,239.6 ac.**
PEST MANAGEMENT	-	-	-	-	-	-	-	1,139.5 ac.	-	**1,139.5 ac.**
RIPARIAN FOREST BUFFERS	3.1 ac.	-	6.7 ac.	-	-	-	-	-	-	**9.8 ac.**
SEDIMENT BASINS	-	-	2 no.	-	-	-	-	-	-	**2 no.**
STREAMBANK & SHORELINE PROTECT.	-	-	-	4,450 ft.	-	-	-	-	-	**4,450 ft.**
WASTE STORAGE FACILITY	-	-	-	1 no.	-	-	-	3 no.	-	**4 no.**
WASTE UTILIZATION	71.0 ac.	-	289.1 ac.	313.9 ac.	-	270.9 ac.	-	663.3 ac.	-	**1,608.2 ac.**
WETLAND RESTORATION	-	-	-	-	-	-	-	-	13.4 ac.	**13.4 ac.**
WILDLIFE HABITAT MANAGEMENT	-	-	-	80.0 ac.	-	-	-	215.0 ac.	47.7 ac.	**342.7 ac.**
CRP/WHIP PROGRAMS	-	-	-	71.5 ac.	-	-	-	80.8 ac.	-	**152.3 ac.**

6.2 Description and Performance of Best Management Practices Proposed

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, as will be described in this chapter, that will vary in cost, effectiveness, and feasibility, depending on a set of complex 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 can be either engineered and constructed systems (structural practices) that improve the quality and/or control the quantity of runoff such as detention ponds and constructed wetlands, or institutional, education or pollution prevention practices designed to limit the generation of stormwater runoff or reduce the amounts of pollutants contained in the runoff (vegetative or managerial practices). No single BMP can address all stormwater problems. Each type 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 BMP or group of BMPs for a particular location.

In order to determine which BMPs would be the most environmentally effective and most cost effective toward meeting the Mill Creek Subwatershed goals, the SAG has taken several steps during the planning process. At a SAG meeting, a broad list of possible BMPs, and their potential effectiveness, cost, and feasibility, was discussed and additions were included based on ideas generated at that meeting. SAG members considered which BMPs would (1) best address their priorities for the creek in their locality, (2) be the most environmentally effective in their community, and (3) be most likely to be implemented in their community. Communities and agencies determined which BMPs are to be implemented in the short term (defined as those to be initiated within 5 years) and long term (defined as those to be initiated after 5 years) actions that would be recommended for the Subwatershed Action Plan. These lists were shared among the Subwatershed members at a subsequent SAG meeting in order to coordinate ideas and resources, as well as offer suggestions among participants, identify gaps and ensure that Subwatershed goals were being addressed adequately. These steps have resulted in the development of the Subwatershed Action Plan, described in Chapter 8.

Phasing or Sequencing Practices

A key consideration when planning to implement BMPs to address various Subwatershed goals is how the various BMPs will be phased or sequenced in relation to one another over time. Determining which actions will need to take place before other actions will be important in achieving the full potential of each activity. The best order in which to implement BMPs can be based on a number of factors such as ecological factors, elements of cost, political realities, length of time for developing the BMP, and/or priority concerns within the Subwatershed. For example, in the Mill Creek Subwatershed, increased flow variability is a major concern. In addition to working toward a goal of reducing flow variability, the need exists for habitat improvement and bank stabilization in receiving streams and the creek. Implementing BMPs to address each of these concerns should follow a phased approach for ecological reasons whereby before streambank stabilization and vegetation projects get underway, the Subwatershed will need to have reduced the peak flow problems so that newly stabilized banks are not destroyed by continued high storm water volumes and velocities. In other words, it is crucial to solve the cause or source of the problem (high peak flows) before an attempt is made to solve the actual problem (bank erosion and loss of habitat).

Listed below are three major phases under which most BMPs can be categorized in terms of their dependence on various factors (Lower One SWAG, 2001). A stage (I, II, or III) is indicated for each type of BMP described below. This staging sequence is a recommendation only and individual circumstances may suggest alternative staging, depending on various factors. These staging recommendations should be taken into consideration as NPDES Phase II communities and agencies develop their under their Storm Water Permits.

Stage I: BMPs that can be initiated right away, require minimal cost or planning, address the upstream sources/causes of a downstream problem, usually non-structural

BMPs. Examples include education programs, standards adoption, and some master plan revisions/updates. Actions under this category may be completed in 1 to 3 years; however, certain actions may require continual implementation.

Stage II: BMPs that require significant planning and development, design specifications, require major additional costs, address sources/causes of a problem, can be structural or non-structural BMPs. Examples include new projects/programs, ordinances, pilot projects or demonstration sites, studies, and design and construction of structural BMPs. Actions under this category may be completed in 2 to 5 years; however, certain actions may require continual implementation.

Stage III: BMPs for which success may depend on the success of a previously implemented BMP, mostly structural BMPs. Examples include instream and streambank restoration projects, lake treatment techniques, and nutrient/sedimentation reduction techniques such as dredging. Actions under this category may be completed in 4 to 8 years; however, certain actions may require continual implementation.

The Subwatershed is comprised of diverse local communities, from rural townships to urban centers surrounded by suburbia. Consequently, a variety of structural and non-structural management alternatives, or BMPs, that could be considered across the Subwatershed. The alternatives listed below 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 or problem. Although each of these alternatives will most likely apply to at least one of the communities or agencies in the Subwatershed, not all of them apply to every community. Although it is not an exhaustive list of all of the possible management alternatives that could be considered, the range of recommended management alternatives for the Subwatershed are summarized below.

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 6.4.

Because the application of individual homeowner BMPs can sometimes be variable and with uncertain pollutant removal rates, drainage area structural or vegetative BMPs were the main focus of the effort to demonstrate the ability to meet the established TMDL phosphorus reduction goal of 50 percent. In existing urbanized areas, new developments, and existing agricultural areas, structural and vegetative BMPs can be implemented to address a range of water quantity and quality considerations. However, the importance of individual homeowner BMPs and managerial BMPs should not be discounted, and recommendations for implementation are provided below.

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 attractions. For instance, these practices can be readily applied in older development areas where space for drainage area BMPs is often limited, often low in cost, easily installed and maintained, and act as an educational vehicle for pollution reduction. Some examples of such practices include rain barrels (cisterns), rainwater gardens, concrete grid (porous pavers) walkways, and vegetated roofs.

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 incapable of providing reliable pollution reduction until their fundamental design is improved or modified include: infiltration basins, grass filters and swales, and oil/grit separators (Galli, 1992).

Non-structural Practices

Non-structural BMPs include managerial, educational, regulatory and vegetative practices designed to prevent pollutants from entering stormwater runoff or reduce the volume of stormwater requiring management. These BMPs include 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 solutions. Therefore, these BMPs should not be overlooked, and in some cases, should be the emphasis of a stormwater management program.

Note: Appendices G and H provide performance and siting considerations for the recommended agricultural and urban BMPs. The table below includes performance information primarily for BMPs located in urban and suburban areas.

Table 6.4. Pollutant Removal Efficiencies for Stormwater Best Management Practices

Management Practice	Pollutant Removal Efficiencies: 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.

It should be noted that information regarding the pollutant removal efficiency, costs, and designs of structural stormwater BMPs is constantly evolving and improving. As a result, information contained in this table is dynamic and subject to change. While locations are recommended for potential placement of BMPs in the Mill Creek Subwatershed Action Plan, general guidelines can be consulted for common sense placement of alternative management practices. The BMP location guidelines shown in table 6.4 are adapted from the rapid watershed assessment protocol of the Center for Watershed Protection. Brief descriptions of the BMPs recommended for employment in the Subwatershed follow the table and are organized by the goal, or task they address.

Table 6.5. 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	Headwater areas on North Fork and South Branch	Suburban and developing areas like Scio and Lodi	Chelsea; Village of Dexter

Based on the assessment of stakeholder policies and programs, and the general performance information available about best management practices, specific practices were identified by the SAG for implementation in the Mill Creek Subwatershed to meet the stated goals and objectives. The recommended BMPs are discussed below in the order that they appear on the Action Plan found in Chapter 8.

6.2.1 Restore the Hydrologic Regime

Restore Wetlands (Stage II)
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. Seelbach and Wiley recommend many locations where restoration efforts should be focused in order to help restore the hydrology of Mill Creek, especially riparian wetlands. A constructed wetland is a man-made wetland with over 50 percent 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 percent, while nutrient removal ranges widely due to a lack of standard design criteria,

but is in the range of 40-80 percent. These wetlands also benefit the area by providing fish and wildlife habitat and aesthetic benefits.

Implement Local Wetlands Ordinances (Stage I)
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, i.e. in counties with 100,000 people or more, wetlands 5 acres or larger and wetlands within 500 feet of a waterbody are regulated. A wetlands ordinance that is more protective than the state or federal government requires is necessary to protect those smaller, isolated wetlands deemed important 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.

Initiate Mill Creek Hydrologic and Hydraulics Studies (Stage I)
A comprehensive study of the hydrology of the Mill Creek 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 Mill Creek'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. The studies are prerequisite to identify the most appropriate BMPs and best locations for BMPs that can restore the hydrology of the creek.

Remove In-stream Structures and Obstructions (Stage II)
This BMP involves planned removal of Mill Pond Dam on the lower mainstem of the creek to restore the hydrologic and biological connection of Mill Creek to the Huron River system. Pre-removal studies of the creek will be required for designing the dam removal techniques, sediment management and creek restoration. A team of stakeholders and technical advisors is coordinated by the Huron River Watershed Council to assist the Village of Dexter. This BMP also may involve the detection of site-specific stream flow problems that are caused by blockages of debris, log jams, sediment islands, and branches or trees that have fallen into the creek. Woody debris in the creek, if managed appropriately, can actually provide bank protection against erosion and wildlife habitat. However, if removal is required to solve a flow, erosion or flooding problem, it is important to do so in an environmentally friendly manner, and keep disruptions to habitat to a minimum. Both communities and individuals should be encouraged to get involved with the process of monitoring and maintaining stream flow conditions, checking for obstructions that are hindering the flow of the creek and causing upstream ponding problems and removing smaller obstructions before they become a major problem.

Implement Natural Features Ordinances (Stage I)
In order to direct land development while protecting key local natural resources, local ordinances that clarify why the protection of certain features is important and how they will be protected under the law are necessary. These local ordinances can be more protective than state or federal law and can better reflect the priorities of a local community. The Code and Ordinance Worksheet process identified the following components that local communities could consider in a Natural Features Ordinance: woodlands, preserve specimen trees, natural features setback, floodplains, provide preservation and conservation options in development code such as develop land conservation incentives; adopt and implement a farmland preservation ordinance, and establish open space management requirements. Plans for natural features buffer maintenance and management should be included in the ordinances. Sample language is available from resource agencies and organizations such as the Huron River Watershed Council and Washtenaw County Planning.

Implement Stormwater and Water Resource Protection Ordinances (Stage II)
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 Washtenaw County Drain Commissioner's Office can be an element of the ordinance and many communities have done so in order to be protective of local water resources.

Construct and Maintain Stormwater Retention/Detention (Stage II)
Design the practice to meet or exceed the County Drain Office Rules and allow for water infiltration or evaporation where possible. A sediment forebay should be used as system with detention ponds as it allows for settling of sediments without clogging outlets, and facilitates maintenance of the pond. Nutrient removal studies indicate that wet ponds may outperform dry ponds so the former practice is described below. Design specifications are included in appendix H.

Construct/Maintain Wet Detention Ponds (Stage II)
Wet detention ponds are small man-made ponds or shallower areas with emergent wetland vegetation around the banks designed to capture and remove particulate and certain dissolved constituents. Wet ponds and wetlands are ideal for large, regional tributary areas (10 to 300 acres) where there is a need to achieve high levels of particulate and some dissolved nutrient removal. They can be used on individual sites, as well. Washtenaw County Drain rules require a permanent pool of water in all ponds unless the developer can give an acceptable reason for not doing so. The pond or wetland should be sized to treat runoff, accumulate sediment and route floods. The outlet should be sized based on the design method. The pond should be configured for aesthetics, safety and maintenance. Landscaping design requirements should include a natural vegetated buffer around the pond/wetland to reduce pollutants entering the area as well as decrease goose habitat, and increase aesthetics. Floating vegetation should be used in the pond to shade water and prevent algae blooms as opposed to chemical herbicides. It should be noted that the successful establishment of emergent and other wetland plants, and specific wetland hydrology, will only be achieved with proper monitoring and maintenance for approximately five to ten years after construction.

Install and Maintain Bioretention Systems (Stage II)
Bioretention areas are landscaping features commonly located in parking lot islands or within small pockets of residential land uses that are adapted to provide on-site treatment of stormwater runoff. Surface runoff is directed into shallow landscaped depressions where it pools above the mulch and soil in the system, then filters through the mulch to underdrain systems and a prepared soil bed. Typically, filtered runoff is collected in a perforated underdrain and returned to the storm drain system. Emergency overflow outlets are provided to direct flows in excess of the system's capacity to the stormwater conveyance system during large storm events. Design specifications are included in appendix H.

Bioretention System. Photo: Center for Watershed Protection

Construct and Maintain Infiltration Trenches (Stage II)
An infiltration trench is a rock-filled trench with no outlet that receives stormwater runoff. Stormwater runoff must pass through a pre-treatment measure, such as a swale or detention basin, to remove or reduce the amount of suspended solids prior to reaching the infiltration trench. Within the trench, runoff is stored in the voids of the stones and infiltrates through the bottom where it is again filtered by the underlying soils. Trenches are appropriate in most residential areas where curb and gutter would be considered. Design specifications are included in appendix H.

Infiltration trench. Photo: Center for Watershed Protection

Install and Maintain Stormwater Retention/Infiltration Basins and other Infiltration Devices (Stage II or III)
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 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. Design specifications are included in appendix H.

Install Grassed Swales (Stage II)
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. Design specifications are included in appendix H.

Reduce Directly Connected Impervious Surfaces (Stage I)
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 storm water 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. Communities are encouraged to minimize the total impervious cover in Zoning Ordinances to protect water resources in the buildout scenario. In some cases, disconnecting impervious areas can reduce the effective impervious cover in a watershed by 20-50 percent (Claytor and Schueler, 1996). In urban communities, especially older areas, there may be opportunities to disconnect impervious areas through downspout disconnection and the discharge of footing drains /sump pumps to green space rather than to stormwater conveyance systems.

Install and Maintain Extended Wet Detention Ponds (Stage II or III)
Wet ponds, or extended wet detention basins, 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. Design specifications are included in appendix H.

Install and Maintain Rain Gardens (Stage II)
The term "rain garden" refers to a constructed depressional area 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 first flush and increased infiltration. Nutrient removal occurs as the water comes in 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. Design specifications are included in appendix H.

Install and Maintain Vegetated ("Green") Roofs (Stage II or III)
The green roof concept is akin to the popular, but traditionally heavy and difficult to maintain, garden roofs found atop buildings worldwide. Essentially, a green roof is the structural addition of plants over a traditional roof system. Green roofs reduce stormwater runoff and increase energy efficiency. In the past there were many concerns regarding the safety and durability of these structures; however, recent advances have dramatically and successfully addressed these concerns. A recent, highly visible green roof was installed on the roof of a large building at the Ford Motor Company's Rouge Plant in Dearborn, Michigan. Examples of smaller residential green roofs are present in Washtenaw County. Design specifications are included in appendix H.

Implement Private Roads Ordinances (Stage I)
A private roads ordinance complements efforts to reduce directly connected impervious surfaces by permitting roads to be built that are narrower than county road standards. Narrower roads produce a smaller area of impervious surface. The ordinance can promote rural character by allowing narrow roads in certain developments in order to preserve open space, as has been done in other Washtenaw County townships. Census data shows that all Mill Creek communities will experience an increase in population and development, so this ordinance can be a preemptive means of protecting water resources. Sample ordinance language is available through Washtenaw County Planning and the Huron River Watershed Council.

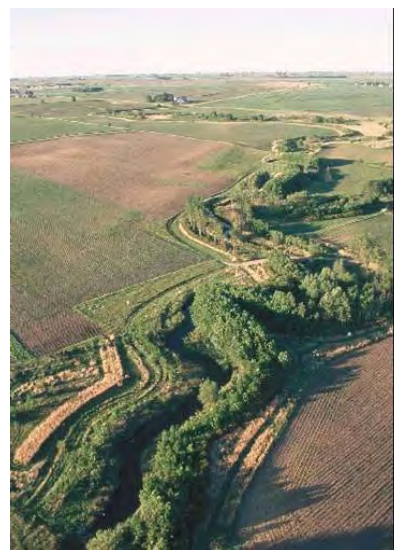
Establish Flow Limits in Stormwater Permits (Stage II)
The MDEQ is the agency responsible for permitting industrial and commercial entities to send untreated stormwater to local surface waters. These stormwater permits are allowed through the NPDES program under the federal Clean Water Act. The NPDES program regulates pollutants discharged directly into waterways from wastewater sources. Discharge that goes to a storm sewer rather than to a municipal treatment facility is considered a direct discharge and must obtain a permit. However, no flow limit is established for stormwater runoff in the permits. At least a dozen stormwater permits are held by businesses in the Subwatershed and their impact to the Mill Creek system is unknown to the MDEQ. Flow limits in stormwater runoff should be reviewed for inclusion in NPDES permits.

Implement Alternative Drain Practices and Rehabilitation (Stage II or III)
The historic channelization of the Mill Creek system to drain the land is the root of many problems in the Subwatershed today. While the responsibilities of Drain Commissioners continue to include maintenance of drains to prevent flooding by removing obstructive vegetation and sediment, opportunities to return stretches of drains to their more natural condition should be identified. In the Subwatershed, locations where agricultural uses have given way to development are candidates for alternative drain practices and rehabilitation; e.g., the Chelsea vicinity and the Frey-Fitzsimmons drain in the East Branch catchment. Breaking of drainage tiles in developing areas can be pursued in conjunction with rehabilitation of drains in order to increase the opportunity to restore hydrologic function to the creek. This practice should be done in conjunction with development, rather than after the fact. Often the tiles are not part of the Drain, but are torn up as a result of development.

6.2.2 Reduce Soil Erosion and Sediment Load

Implement Streambank Stabilization Measures (Stage I)
Streambank stabilization measures are treatments used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries. Understanding the cause of the erosion problem Is paramount to implementing any streambank stabilization measure. If the cause is extreme peak storm water flows, then first address peak flow problems before stabilization measures can be expected to succeed. Streambank stabilization measures work by either reducing the force of flowing water and/or by increasing the resistance of the bank to erosion. Vegetating streambanks also provides important ecological benefits such as shading water and providing crucial habitat for both terrestrial and aquatic wildlife species. Three types of streambank stabilization methods exist: engineered, bioengineered and biotechnical. Engineered structures include riprap, gabions, deflectors and revetments. Bioengineering refers to the use of live plants that are embedded and arranged in the ground where they serve as soil reinforcement, hydraulic drains, and barriers to the earth movement and/or hydraulic pumps. Examples of bioengineering techniques include: live stakes, live fascines, brush mattresses, live cribwall and branch packing. Biotechnical measures include the integrated use of plants and inert structural components to stabilize channel slopes, prevent erosion and provide a natural appearance. Examples of biotechnical techniques include: joint plantings, vegetated gabion mattresses, vegetated cellular grids and reinforced grass systems. Bioengineered or biotechnical methods should be implemented in lieu of engineered methods, where possible, so as to increase habitat and aesthetics.

Install and Maintain Riparian Buffers (Stage II)
The effects of urbanization on low order stream (1^{st}-3^{rd} order) are well documented, and include alterations that results in degraded stream habitat and aquatic communities. Riparian buffer systems are streamside ecosystems managed for the enhancement of water quality through control of nonpoint source pollution and protection of the stream environment. These systems may be placed along a shoreline, stream or wetland. The primary function of the practice is to physically protect and separate the natural feature from future disturbance or encroachment by development. Buffers remove stormwater pollutants such as sediment, nutrients and bacteria, and slow runoff velocities. The degree to which buffer systems remove pollutants is dependent on loading rates from upland land uses, stream order and size, and the successful establishment and sustainability of the practice (Lowrance, et. al, 1997). Design and size of the buffer also plays a large role in effectiveness; design specifications are included in appendix H. The three-tiered system recommended by the Center for Watershed Protection is detailed in the publication Better Site Design. On agricultural lands, land owners can be eligible for USDA programs that help pay for the practices.


Riparian buffer. Photo: USDA NRCS


Grassed waterway. Photo: Washtenaw Co. Conservation District

Establish Grassed Waterways (Stage II)
A grassed waterway is a natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation. This practice is used primarily on agricultural lands. On agricultural lands, land owners can be eligible for USDA programs such as Environmental Quality Incentives Program (EQIP) and Conservation Reserve Program (CRP) to help pay for the practice.

Install Grade Stabilization Structures (Stage II)
A grade stabilization structure is used to control the grade and head cutting in natural or artificial channels (like a grassed waterway). This

practice is used primarily on agricultural lands. On agricultural lands, land owners can be eligible for USDA programs such as Environmental Quality Incentives Program (EQIP) and Conservation Reserve Program (CRP) to help pay for the practice.

Utilize Conservation Cover (Stage I)
This BMP involves establishing and maintaining permanent vegetative cover to protect soil and water resources. This practice is used primarily on agricultural lands.

Practice Conservation Crop Rotation with Cover Crop and Mulch/No-till (Stage I)
This BMP involves a system of three individual practices. Conservation crop rotation describes the practice of growing crops in a recurring sequence on the same field. The crops may be grasses, legumes, forbs or other herbaceous plants established for seasonal cover and conservation purposes. Residue management as mulch till is the practice of managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round, while growing crops where the entire field is tilled prior to planting. Residue Management as no-till and/or strip till is the practice of managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-around, while growing crops in previously untilled soil and residue.

No-till crop. Photo: Washtenaw Co. Conservation District

Install and Maintain Sediment Trapping Devices (Stage I)
Sediment trapping devices such as a barrier, basin or other devices are designed to remove sediment from runoff. Sediment basins should be located at the downstream end of drainage areas larger than 5 acres, and before a treatment train of other BMPs such as a wet detention pond or constructed wetland that is built to treat excess sediments and other pollutants. Dikes, temporary channels and pipes should be used to divert runoff from disturbed areas into the basin and runoff from undisturbed areas around the basin. Simpler devices for areas less than 5 acres include a sediment trap and sand bag barrier, silt fences and straw bales. Silt fences and straw bales can be placed along level contours downstream of exposed areas where only sheet flow is anticipated. Sediment trapping devices can also be used on storm drain inlets and can include filter fabric, excavated drop traps, gravel filters and sandbags (Lower One SWAG, 2001). Maintenance is a key requirement of any of these soil erosion control BMPs. Sediment traps, barriers, basins and filters should be inspected frequently for repairs and sediment removal.

Install and Maintain Catch-basin Inserts (Stage I)
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. Design specifications are included in appendix H.

Control Soil Erosion/ Stabilize Soil on Construction Sites and Road Crossing Embankments (Stage I)
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, which 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.

Construct and Maintain Media/Sand and Organic Filters (Stage II)
A media filter is essentially a settling basin followed by a sand filter for particulate removal. Other filters may be used to provide dissolved pollutant removal. The most common media utilized is sand, while some use a peat/sand mixture. Filters are usually two-chambered storm water practices; the first is a settling chamber, and the second is a filter bed filled with sand or another filtering media. As stormwater flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as storm water flows through the filtering medium. Modifications include surface sand filter, underground sand filter, perimeter sand filter, organic media filter, and multi-chamber treatment train. Design specifications are included in appendix H.

High-Powered Street and Paved Area Sweeping (Stage II)
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 in cold climate areas during, or prior, to spring snowmelt as a pollution prevention measure. Design specifications are included in appendix H.

Replace Undersized Culverts/Repair Misaligned or Obstructed Culverts (Stage III)
During the field inventory, several road-stream crossing sites were found to have erosion problems in the stream due to undersized culverts or because of culverts that are poorly aligned with the current channel shape or that are obstructed by an in-stream object. Where undersized culverts are the cause of the problem, the proper size culvert will need to be determined by the County Road Commission in order to accommodate existing and anticipated future flows. Where misalignment or obstruction are the problems, the remedy may not be as straightforward as replacing the culvert. Changes in hydrology from upstream development or from an in-stream obstruction will need to be determined in order to find the appropriate solution.

Stabilize Eroding Road and Bridge Surfaces (Stage III)
In the Mill Creek Subwatershed, the majority of county roads are unpaved. 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.

6.2.3 Reduce Nutrient Load to Meet Mandated Reductions

Practice Nutrient Management (Stage I)
This BMP involves managing the amount, source, form, placement and timing of the application of nutrients and soil amendments on agricultural lands. In rural areas, smaller agricultural establishments and small horse farms may contribute to higher nutrient concentrations and bacteria counts if manure is not managed properly. State agencies have the authority to control agricultural practices through voluntary measures called Generally Accepted Agricultural Management Practices, or GAAMPs. GAAMPs provide agricultural landowners guidelines to follow with regard to nutrient and pesticide application and storage, manure management, groundwater protection, and a host of other agricultural BMPs to protect surface and groundwater as well as habitat. There are established outreach programs for

landowners to educate about these recommended practices through the County Conservation District, which should be utilized as much as possible to control potential pollutants from this land use.

Waste storage facility. Photo: Washtenaw Co. Conservation District

Construct and Maintain Waste Storage Facilities (Stage III)
Waste storage facilities are impoundments made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure to store liquid and/or solid waste on a temporary basis, until land spreading takes place. On agricultural lands, land owners can be eligible for USDA programs such as Environmental Quality Incentives Program (EQIP) and Conservation Reserve Program (CRP) to help pay for the practice.

Install and Maintain Livestock Use Exclusion (Stage II)
Livestock with access to streams and other surface waters create degraded water quality conditions by contributing nutrients and bacteria to the water via their waste, eliminating riparian vegetation, and creating erosion and sedimentation problems by trampling streambanks. In a few places in the Subwatershed, livestock continue to have access to the Mill Creek system. Exclusion techniques such as fences need to be installed and maintained for the purpose of keeping livestock at least 25 feet from surface waters. On agricultural lands, land owners can be eligible for USDA programs such as Environmental Quality Incentives Program (EQIP) and Conservation Reserve Program (CRP) to help pay for the practice.

Install and Maintain Vegetated Filter Strips (Stage I)
This BMP is a strip of grass or other permanent vegetation designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and by providing some infiltration into underlying soils. A Cross Wind Trap Strip – Field, a type of filter strip, is an herbaceous cover resistant to wind erosion, established in one or more strips across the prevailing wind erosion direction. A Cross Wind Trap Strip – Filter, another type, is an herbaceous cover resistant to wind erosion, established adjacent to surface drainage ditches across the prevailing wind erosion direction. This practice is used primarily on agricultural lands. On agricultural lands, land owners can be eligible for USDA programs such as Environmental Quality Incentives Program (EQIP) and Conservation Reserve Program (CRP) to help pay for the practice. Design specifications are included in appendix H.

Vegetated filter strip. Photo: Washtenaw Co. Conservation District

Implement Native Landscaping Ordinances (Stage I)
Most of the native plants and shrubs of the Mill Creek Subwatershed have been converted to crops 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 Washtenaw County from plant sources 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. In order to brink back the natives, a **Native Vegetation Restoration**

Program (Stage II) could be developed in coordination with Washtenaw County. Trained staff would be available to provide technical consultation services to the public. The program would study, locate, coordinate, and implement native landscaping techniques and demonstration projects in key public locations throughout the Subwatershed. Particular emphasis will be placed on reestablishing native habitats in key locations along the streambanks of Mill Creek.

Identify and Eliminate Illicit Discharges (Phase II or III)
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. Dye-testing at the time of Certificate of Occupancy and time of home sale may be added to a community's program. 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. This activity is a minimum measure required of Phase II stormwater communities.

Implement Golf Course Nutrient Management (Stage II)
Presently two golf courses operate in the Subwatershed; however several more are planned. Golf courses tend to use fertilizers and herbicides to maintain turf which enter surface waters untreated, and both courses have stretches of Mill Creek traversing them. A golf course nutrient management program is offered by the Michigan State University-Extension that leads to certification of golf courses that adhere to environmentally sensitive buying and landscaping practices. Potential improvements to older and, in some cases, newer courses are alternative turf management, reestablishment of wetland and watercourse buffers, and retrofitting of water hazards to stormwater detention basins. The Washtenaw County golf course, Pierce Lake, has begun the Michigan Turfgrass Stewardship Program; however it is not yet a certified member. Both golf courses, and any future golf course, should become certified members of the program.

Implement Phosphorus Fertilizer Reduction Ordinances (Stage I)
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 (see photo) that depletes oxygen needed by aquatic organisms, which can lead to fish kills, and prevents 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 Ann Arbor. The MSU-Extension Service provided soil sample results from 913 soil tests performed in the past few years from soils in Washtenaw County. The MSU-Extension Service states that no phosphorus application is recommended for lawns if the test is above 40 lbs/acre. The review of the 913 tests shows that 84 percent of the samples do not need phosphorus. Hamburg Township, West Bloomfield Township and Commerce Township have implemented such ordinances, and the City of Ann Arbor will be implementing its own in the near future.

Implement Septic System Ordinances (Phase I)
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 inflow 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. An ordinance can provide for all of the aforementioned tasks and require the regular inspection of on-site sewage disposal

systems at an interval determined by the community. For example, the Village of Barton Hills requires inspection every 4 years as a companion regulation to the County inspection at time of sale of the home. Educational materials should be distributed to new and current homeowners that maintain septic tanks so that pollution prevention is emphasized.

6.2.4 Preserve/Improve Natural Features & Natural Aquatic Animal and Plant Communities

Implement Natural Features Protection Ordinances (Stage II)
Practice described above.

Utilize In-stream Habitat Restoration Techniques (Stage III)
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 (Lower One SWAG, 2001). 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 so as to ensure the success of the habitat improvement project. The site of the Mill Pond Dam is an example of a location appropriate for utilizing these techniques once the dam is removed. In their 1996 survey of Mill Creek, Seelbach and Wiley suggest other stretches where fish habitat restoration is needed.

6.2.5 Reduce Oil, Grease, Metals and Brine/salt

Construct and Maintain Media/Sand and Organic Filters (Stage II)
Practice described above.

Install and Maintain Oil and Grease Traps (Stage I)
Oil and grease traps remove high concentrations of petroleum products, grease and grit by gravity and coalescing plates. These devices are particularly useful on industrial sites, vehicle maintenance and washing facilities, areas where heavy mobile equipment is used, restaurant kitchens and restaurant dishwashing equipment. Conventional oil/water separators have the appearance of septic tanks, but are much longer in relationship to the width. Separators for large facilities have the appearance of a municipal wastewater primary sedimentation tank. These devices are only effective for reducing abnormally high concentrations of oils and greases. Their performance is unproven for urban storm water runoff; however, communities with Phase II stormwater permits must address grease pollution so traps may be an appropriate tool to employ as part of an overall strategy.

Reduce Directly Connected Impervious Surfaces (Stage I)
Practice described above.

Install and Maintain Infiltration Trenches (Stage II)
Practice described above.

Install and Maintain Bioretention Systems (Stage II)
Practice described above.

Implement Municipal Well Field Protection (Stage I)
Nearly all residents of the Mill Creek Subwatershed obtain their drinking water from groundwater aquifers in the area. Both Chelsea and the Village of Dexter have delineated their municipal well field areas and are implementing plans to protect their communities’ drinking water source through compatible land use planning, education and outreach to residents and other mechanisms. Given the crucial importance of clean groundwater to the residents of the Subwatershed and the inextricable connectedness of ground water and surface water, complete implementation of the wellhead protection plans is needed. Delineating the location of groundwater resources is a critical exercise for other Subwatershed

communities, as well, and could be completed in conjunction with a County-wide effort to protect groundwater sources from inter-basin withdrawals and transfers, compromised quality due to pollution and development and overdrafting by users.

6.2.6 Increase Watershed Monitoring and Stewardship

Monitor for Water Quality, Water Quantity and Biota and Initiate Volunteer Monitoring Program (Stage II)
A consistent dataset of water quality parameters, biotic indicators and stream flow is needed for a better understanding of conditions in the Mill Creek Subwatershed and to use as baseline when measuring conditions following implementation of recommended BMPs. Further, pollutant removal efficiencies should be measured as part of any BMP implementation project since the literature remains incomplete, especially for performance of agricultural BMPs. Monitoring needs to include dry and wet weather events and seasonal variation over multiple years. Some of the monitoring could be conducted by trained volunteers through a **Mill Creek Subwatershed volunteer monitoring program** (Stage II) composed of residents.

Survey Species of Concern Distribution and Status and Develop Management Strategies (Stage II)
Few recent studies have been conducted that examine the condition of plant and animal species of concern, such as freshwater mussels. The distribution and status of those species should be surveyed and management plans for their survival and sustainability developed. Survey locations could match the locations used by researchers in previous studies for comparative purposes. These species can serve as a bellwether for how management of the Mill Creek system is proceeding.

Increase Watershed Education and Ethic (Stage I)
Public education and involvement programs are meant to be activities where people learn about the Subwatershed 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. Public participation/education 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
- Community Partners for Clean Streams – a cooperative effort between the Washtenaw County Drain Commissioner's office, businesses and institutions with a common goal to promote business practices that protect Washtenaw County's watersheds and waterways.
- School education – facility tours, contests and curriculum, outdoor education, schoolyard habitats
- 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

Implement a Coordinated Information and Education Campaign (Stage I)
An estimated 75% of the nonpoint source pollutants in the Huron River Watershed are the result of individual practices. In the Mill Creek Subwatershed, that number is higher still. Audiences should include homeowners, local governments, riparian landowners, lake and home associations, commercial lawn care businesses, businesses, and institutions (see Chapter 7 recommendations). With the conversion of open lands and farms to residential communities, it is critical that homeowners understand and respond

to their impacts on the River system. Preventing pollutants from reaching the River system 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; 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 Subwatershed and repetition will be crucial to success of the campaign. A Task Force is to be charged with implementation and refinement of the Subwatershed education plan and programs as described in Chapter 7.

6.2.7 Increase Watershed-based Land Use Planning and Integrate into Operating Procedures

Enhance the Site Plan Review Requirements (Stage I)
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.

Implement Low Impact Design Planning (Stage I)
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. Less developed communities in the Subwatershed should be especially interested in adopting LID principles. 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.

Study Opportunities for Recreation Trail and Other Recreation Enhancements (Stage II)
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 promote a canoe livery. Then, the recreational amenity can be planned, built and promoted.

Integrate Stormwater Management into Regional Community Planning (Stage I)
In every community, and most importantly in less developed communities, it is important to have a strong and defensible plan for the community and the protection of its natural resources. As new information becomes available about watershed management, communities will need to stay informed. Planning commissions and departments, as well as boards and councils, who are responsible for recommending how the land is developed need to have a master plan, zoning ordinance and other ordinances that reflect how their community will be shaped and what natural resources will be preserved. Since these decision-makers may not have knowledge about stormwater practices and the benefits of natural resources, it may be important to keep new members informed about the community’s resources and priorities on a regular

basis so that they are able to make informed decisions in the site plan review process and larger environmental issues. Protection of water resources and natural features should not be an afterthought in the planning process, but rather one of the first considerations made by local land use decision makers. Resources for integrating stormwater management into regional community planning are available from the Huron River Watershed Council, some planning consultants, and Washtenaw County Planning & Environment.

Implement Purchase of Development Rights Ordinances (Stage I)
This type of ordinance, known as PDR, is a public or private government initiative that acquires the development rights of property to limit development and protect natural features, open space or agricultural land. The ordinance is a tool for guiding growth away from sensitive resources and toward delineated development centers. Identify areas that should be protected through conservation easements or purchased for public ownership either outright or through PDR. Keep in mind potential greenway corridors for wildlife and recreation. Washtenaw Land Trust and Consultant Barry Lonik have worked with many communities in Washtenaw County to adopt a PDR ordinance and garner the resources to purchase important parcels of land for preservation in perpetuity. Washtenaw County Parks and Recreation department will continue to focus on high quality lands for preservation through the millage passed by County votes in 2001.

6.2.8 Increase Plan Participation and Implementation

Implement a Subwatershed Task Force to Carry Out Watershed Actions (Stage I)
Watersheds are formed by hydrologic boundaries, not political boundaries. Therefore, some level of institutional arrangements must be established so that the various local, county, state and federal jurisdictions of the Subwatershed are coordinated. It is recommended that the coordination of the watershed level be tiered as it is in government. Watersheds are often broken down into subwatersheds or tributary groups that consist of 10-15 parties so as to have a more manageable working group. These subwatersheds then have a representative at the watershed level to coordinate watershed-wide initiatives and decisions. For example, in the Rouge River Watershed, the Rouge Program Office has been working as a watershed-wide research assistance organization coordinated under Wayne County, the Rouge Steering Committee includes representatives from seven Subwatershed groups to take care of watershed-wide decisions, and the seven Subwatershed Advisory Groups (SWAGs) include representatives from each of the associated communities and agencies. Program maturity and funding sources will help to determine which institutional arrangements will work best to continue restoration and protection efforts.

Implement Creative Financial Solutions (Stage II)
Integrating stormwater management programs into the daily procedures of a community likely will incur new costs. In many cases, communities and agencies will need to explore creative solutions to finance new staff, new programs, or new commitments. Grants may be available, often with a local match involved, but these are short term solutions for one-time projects. Long terms solutions that have been tested in other areas include the following: implementing a stormwater utility fee, incurred by users of the stormwater system; use impervious cover as basis for user fees; give credits to fees if private detention/retention practices exist; one-time septic system installation fee; establish forest and wetland mitigation banking system; Buffer Restoration Incentive Program to $500/acre payment to landowners; purchase of environmental easements by the private sector; and statewide Purchase/Transferable Development Right Bank (PDR/TDR).

Chapter 7 Involving the Public

7.1 Public Participation Process in the Planning Phase

The planning process for the Mill Creek Subwatershed recognizes the importance of public involvement in developing the plan and in its short-term acceptance for long-term sustainability. Efforts were made to engage stakeholders in the process of creating the watershed management plan, and to foster stewardship in residents of water and other natural resources through education outreach and training opportunities. A representative work group was cultivated to increase local commitment to watershed management and to sustain the project by integrating it into community work plans. The group met quarterly for the duration of the planning phase and guided the direction of the plan and provided feedback to the project staff.

Efforts were made to increase the awareness and knowledge of the Subwatershed among Mill Creek communities as part of the public participation process. To that end, a subgroup of residents received an informational brochure about the Mill Creek Subwatershed and its challenges and opportunities. Groups such as local elected boards, planning commissions, neighborhood groups, and volunteer service clubs received presentations from project staff on watershed concepts as they related to Mill Creek. Finally, residents and local officials took advantage of educational trainings to enhance their skills and knowledge of land use principles and policy tools related to watershed health. A citizen planner course called “Land Use Planning for a Healthy Watershed: Training for Effective Local Decisionmaking” provided information to attendees on the topics of:

- Needs of a Healthy River System and the Impact of Development
- Overall Process of Land Use Decision Making: Role of Master/Comprehensive/General Development Plan and Zoning Ordinances
- Natural Feature Protection Ordinances/Development Standards
- Conservation or Open Space Planning/Sustainable Development
- Evaluating Site Plans for Impact on Natural Resources
- Strategies for Communicating and Problem Solving on Land Use Issues
- Discussion with Experienced Land Use Activists and Decision Makers

In addition to the multi-week course, trainings on the Informed Planning in Washtenaw County CD-ROM were offered to residents and local officials with some of the workshops in the Subwatershed. These “train the trainer” events provided knowledge of how to use the CD to people who commit to training groups in their own communities. Representatives from the communities of Chelsea and Dexter, Sylvan Township, Lyndon Township, Webster Township, Lodi Township, and Lima Township, as well as several departments of Washtenaw County have received the training.

In the early stages of the planning process, public meetings were organized to introduce the purpose of watershed management planning to residents. The meetings also were opportunities to collect concerns from residents about water resources in the Subwatershed and provide clarification about the planning process. Meeting attendees generated the list of concerns discussed in Chapter 5. Additional input was garnered from residents who responded to a direct mail survey the information from which is reflected in that same list. Public meetings also were organized at the end of the planning process in order to present the findings of the planning process, present recommendations and discuss local efforts to implement the plan. While the public meetings bookend the planning process, an email group of interested residents was created to provide updates along the way and to send a mid-term progress update.

Finally, hands-on public participation was incorporated in the form of a field survey which was conducted at 50 sites where county roads cross the Mill Creek system. That survey is discussed in detail in Chapter 4. The field survey component provided training to a small group of residents who joined teams to visually assess the conditions at each site.

7.2 Public Communications Plan

The Public Communications Plan for the Mill Creek Subwatershed follows the model laid out in *Developing a Communications Plan: A Roadmap to Success* (Brush, 1996), 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 a Public Communications Plan developed already for the Huron River Watershed, market research did not need to be conducted for the Subwatershed as it was completed previously. However, a goal, objectives, target audiences and messages for the Subwatershed did need to be developed as well as a strategy for marketing the Plan. Pieces of the plan were developed through discussion with and review by the Stakeholder Advisory Group (SAG).

7.2.1 Goal and Objectives of the Plan

<u>Goal of the Public Communications Plan</u>
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 Mill Creek Subwatershed.

<u>Measurable Objectives</u>
The objectives of the plan are to

1. Reduce pollution that impacts the Mill Creek Subwatershed by providing practical knowledge to key audiences;

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

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

4. Increase participation in Subwatershed stewardship and recreation.

7.2.2 Audience and Message Priorities

After developing a goal and objectives for the Public Communications Plan, SAG members began to discuss which audiences should be targeted. In general, the communities in the Subwatershed can be characterized as either suburban communities facing issues of rapid development, such as Scio Township, or rural communities dealing with intense growth pressure, such as Sylvan and Lima townships, or urban centers surrounded by suburban sprawl, such as Chelsea. The SAG, in settling on target audiences, also considered the land uses in the Subwatershed and recognized that agricultural activities, old and new residential areas and commercial areas, and new developments all are found on today's landscape. They selected the following groups: households, with riparian and lakeshore landowners being an important sub-group; agricultural community; local government decision makers; businesses; development community; education/school system; and partner organizations.

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 Public Communications Plan. While this process is not exact, the guiding principles are knowing what is most important to accomplish, and understanding 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.

Farmers represent a significant population of the Mill Creek Subwatershed. While farmers are not a homogeneous group, understanding their attitudes is crucial to identifying methods to modify or change behaviors detrimental to the environment. Survey results and interviews (McCann, et. al, 1997) show that farmers agree their decisions can have an important effect on the environment. Conventional and organic farmers in the study were asked questions to measure their environmental awareness and agricultural pollution concerns. Conventional farmers are neutral on whether agricultural pollution is a serious environmental problem, while organic farmers agree it is a problem. Organic farmers feel more strongly that agricultural pollution is a serious threat to human health, while conventional farmers were neutral. Both types of farmers agree with equal intensity that soil erosion is serious problem in the United States, while they slightly disagreed that it is a problem on their farms.

While the farmers surveyed agree that pollution from the use of agricultural chemicals is a serious problem in the United States, they disagree that pollution from agricultural chemicals is a problem on their farms. Of the types of agricultural pollution, water pollution is cited by nearly half of farmers as the type that most concerns them, with groundwater pollution concerning one-quarter of them. The study found farmers in Washtenaw County are somewhat willing to very willing to risk a slightly reduced yield to try a new farming method designed to protect the environment. Moreover, farmers are somewhat willing to very willing to adopt conservation practices that take some time to pay off.

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

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

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

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 the plan are:

1. Households
2. Riparian and Lakeshore Landowners
3. Agricultural Community
4. Local Government Decision Makers
5. Development Community
6. Businesses
7. Educators/School Systems
8. Partner Organizations

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 Public Communications Plan should be conducted upon completion of the third and fifth years.

In order to assess a general level of effort to be applied per audience, the question posed was “To what extent can we target behavior change within each audience through the Public Communications campaign?” To this end, a general percentage of effort was assigned to audiences based upon outreach methodology for the 5-year timeframe of the watershed management plan. The percentages represent the extent to which the Public Communications Plan should target behavioral change with a media campaign or with more hands-on, personal communication. The percentages represent an overall sense of which audiences are accessible through these two approaches rather than a precise breakdown.

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 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) agricultural community, (4) and businesses.

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 7.1. Prioritized Target Audiences per Communications Strategy.

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

The general level of effort for this audience prioritization then was approximated based on a combination of importance of reaching that audience and the feasibility that actions could be taken to meet the goal and objectives of the Public Communications Plan and the Management Plan for the Subwatershed. The breakdown for both communications strategies are presented in the figures below.

Figure 7.1. Percentage of Educational Effort by Audience via Mass Media Strategies.

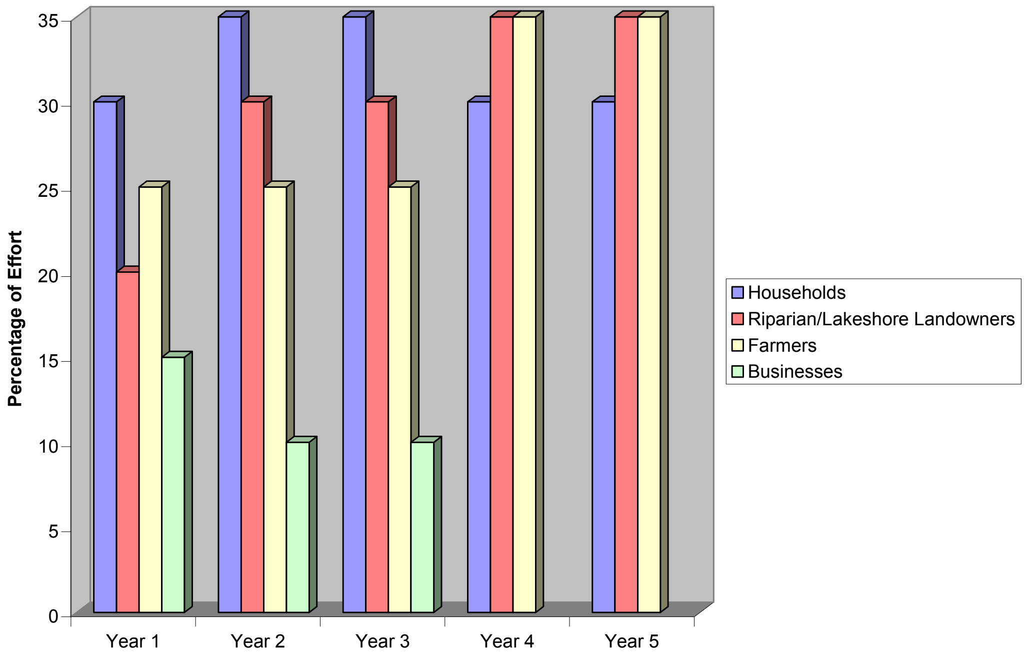
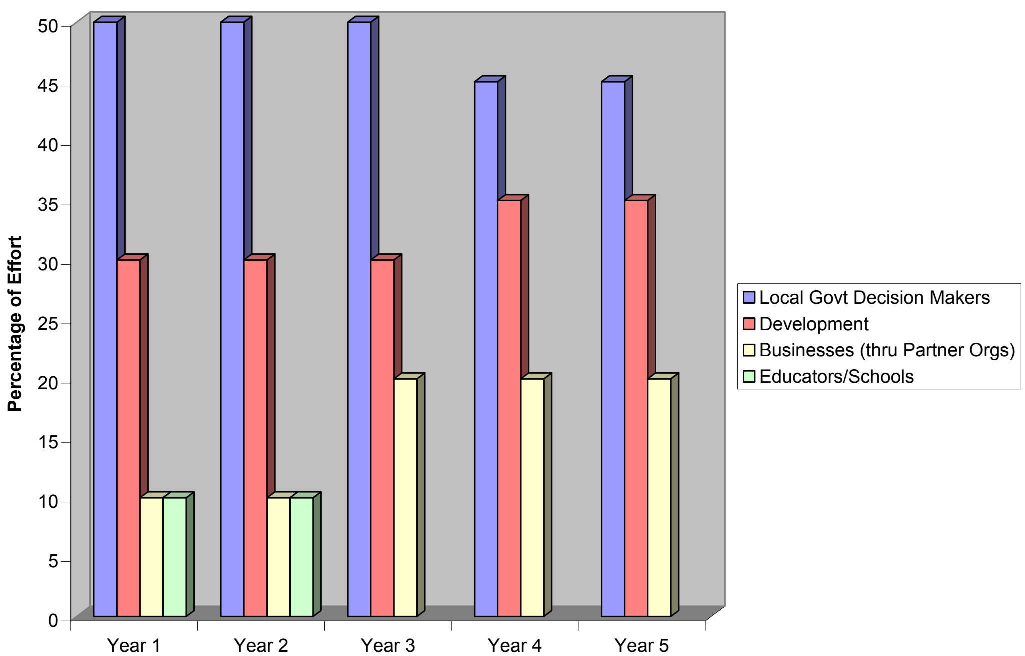


Figure 7.2. Percentage of Educational Effort by Audience via Personal Communications Strategies.



7.2.3 Public Communications Strategy

The main foci of the first year will be on communicating with household members within the Subwatershed, with a concerted effort to reach residents along waterways and waterbodies and farmers. Some 75 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 Subwatershed of the water cycle and how we impact it, including key pollutant sources, and a sense of place within Subwatershed. Educating residents on practices and behaviors they can implement in their lives which will result in improvement and protection of the Subwatershed will be an emphasis as well. In the third, fourth and fifth years, messages will build on those developed in the preceding years.

A work group focused on public outreach and education needs to establish specific responsibilities, collaborative opportunities, outreach mechanisms, and evaluation processes prior to, upon, and after implementation of the Public Communications Plan. Brush's *Developing a Communications Plan* can guide a work group in 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 Subwatershed *
- Build knowledge, awareness, and support of the Subwatershed 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 *

** appropriate for NPDES Phase II Storm Water Permit requirements*

Several programs and initiatives are recommended for initiation in this Subwatershed plan. Below is a list of specific programs to be implemented in stages I and II of this plan.

Lake and Riparian Landscaping Alternatives Program and Assistance –

This program can provide educational workshops and technical assistance to land owners regarding the use of native landscapes on lakefront properties and other riparian areas. Opportunities to coordinate with Huron River Watershed Council, MSU Extension, County Conservation District, Master Gardeners, and local businesses will be explored.

Homeowner-based Stormwater BMP Initiative –

Program to promote and assist in the implementation of individual homeowner-based stormwater BMPs. Includes the dissemination of guidebooks for homeowners and homeowners associations on a wide range of water quality topics, such as management of landscapes to citizen-based stormwater BMP maintenance. The MSU Home*A*Syst Program and a "Watershed Pledge Book" will be key components of this activity.

Storm Drain Stenciling and Door Hanger Program –

Initiative to label storm drains with "Dump no Waste, Goes to Creek" or similar wording in Chelsea and Dexter, and any other areas with storm sewer systems. An educational door hanger will also be distributed in conjunction with labeling efforts. Local governments can initiate involvement from community volunteers in helping to organize this program.

Watershed and Stream Crossing Signage Program –

A partnership with the Washtenaw County Road Commission and the Drain Commissioner's office has been developed to place signage on County roadways at key areas within the Subwatershed.

In Chapter 8, the Action Plan (Table 8.1) presents recommended public information and education strategies listed in Chapter 7.2.3 with details about priority pollutants addressed, costs, evaluative mechanisms, responsible parties, and so on.

CHAPTER 8 MILL CREEK SUBWATERSHED ACTION PLAN

8.1 Action Plan Development

Developing this Subwatershed Action Plan has been an iterative and inclusive process. After discussing stream threats and challenges and developing goals, the Stakeholder Advisory Group began looking at what actions could improve river quality in the Subwatershed. The Best Management Practices matrices (Appendix G) were created as a group effort to identify a variety of Best Management Practices (BMPs) for managing stormwater in the various urban and rural communities represented in the geographic area. See the 5-Year Mill Creek Subwatershed Action Plan (Table 8.1) at the end of this chapter for the summary of tasks to be implemented to meet the goals and objectives of this management plan.

The table includes recommended strategies, responsible partners, level of effort, costs, measures of success, recommended locations where feasible, and available resources from partner organizations. The strategies either have already been implemented and will continue or will be implemented within the first five years of implementing the plan. Communities may wish to review their existing programs or standards and revise as they see fit. In other cases, model provisions are available from resource agencies and organizations for communities that have no such existing program or standard. In the long term, ongoing programs will be reviewed for effectiveness and modified if necessary, and structural projects will be maintained on a regular basis.

To be clear, the strategies recommended in the Action Plan are not mandatory for the stakeholders. The exception to this statement is communities that are required to have an NPDES Phase II Storm Water permit who either need to utilize this plan to fulfill their requirements or develop their own. Given the diversity among Subwatershed communities and stakeholders, not all recommended strategies apply to all communities and stakeholders throughout the Subwatershed; when feasible, recommended locations for the strategies are noted in the Action Plan. While the Mill Creek Subwatershed Management Plan is not enforceable per se, it represents the most holistic approach available to meeting and sustaining the quantifiable TMDL reductions for the Middle Huron region of which Mill Creek Subwatershed is a part. Pollution reduction is the responsibility of all entities contributing pollutants to the surface waters.

Table 8.1 Mill Creek Subwatershed Action Plan Matrix

5-Year Action Plan for the Mill Creek Subwatershed (2004-2008)

Task	Recommended Strategy	Responsible	Level of Effort	Capital Cost	Annual Cost*	Measure of Success	Recommended Locations	Resources
Restore the Hydrologic Regime	Wetland Restoration, recreate storage	Private Landowners; Local Governments; WCDC	920 acres	$700-2,000/ac $644,000-1.84m total	2-4% construction costs	**1 restoration underway by year 3**	see Seelbach & Wiley (1996)	USFWS; USDA; Ducks Unlimited
	Local Wetlands Ordinance	Local Governments	10 governments without ordinances	$500-1,500 $5,000-15,000 total	enforcement	Adoption by all Local Governments by year 3	All except Chelsea	HRWC: model ordinance; policy assistance
	Mill Creek Hydrologic and Hydraulic Study	Local Governments; Washtenaw County	Basin-wide: ~92,000 ac.	$150,000	Not applicable	**Completed by year 3**	All	State Government (MDEQ, MDNR)
	In-stream Structure Removal	Local Governments; Dam Owner(s)	1 structure	$30,000-75,000	Not applicable	**Dam removal by 2007**	Mill Pond Dam, Dexter (sub-basin 54)	Village of Dexter; HRWC; State Government (MDEQ, MDNR)
	Natural Features Ordinance	Local Governments	11 governments without ordinances	$2,000 $22,000 total	enforcement	Adoption by all Local Governments by year 3	All	HRWC
	Stormwater Management Ordinance	Local Governments	9 local governments without review by County Drain Office	$2,000 $18,000 total	enforcement	**Adoption by all Local Governments by year 5**	Chelsea, Village of Dexter, Freedom, Lima, Lodi, Lyndon, Scio, Sylvan, Webster	HRWC; WCDC
	Stormwater Retention/Detention	Washtenaw County; WCRC; Local Governments; Private Landowners	Variable, depends upon amount of development and retrofit opportunities.	$41,600/ 1 acre-ft pond for 10-year storm	3-5% construction costs	100% of new developments incorporate practices, as appropriate.	Sub-basins 11,17, 44, 54, 55	
	Bioretention	Private Landowners; Local Governments; Washtenaw County	Variable, depends upon amount of development and retrofit opportunities.	$6.80/ft3 * volume	2% for O & M	75% of new developments incorporate practices, as appropriate.	Sub-basins 11, 23, 26, 34, 42, 43, 51, 52, 53, 54, 55	
	Infiltration Trench	Private Landowners; Local Governments; Washtenaw County	Variable, depends upon amount of development and retrofit opportunities.	$5/ft3	<5% construction costs	20% of new developments incorporate practices, as appropriate, based on A & B soils.	Sub-basins 11, 29, 34, 53, 54, 55	
	Infiltration Basin	Private Landowners; Local Governments; Washtenaw County	Variable, depends upon amount of development and retrofit opportunities.	$2/ ft3	<5% construction costs	75% of new developments incorporate practices, as appropriate.	Sub-basins 11, 23, 26, 34, 42, 43, 51, 52, 53, 54, 55	

	Recommended Strategy	Responsible	Level of Effort	Capital Cost	Annual Cost*	Measure of Success	Recommended Locations	Resources
	Grassed Swales	Private Landowners; Local Governments; Washtenaw County	Variable, depends upon amount of development and retrofit opportunities.	$0.50/ ft2	$0.02 ft2/yr	75% of new developments incorporate practices, as appropriate.	All critical sub-basins	
	Disconnect Directly-connected Impervious Areas	Local Governments; Private Landowners	1st priority: new development; 2nd priority: retrofit opportunities	$50/ house	Not applicable.	Disconnections underway by year 2	Sub-basins 11, 23, 26, 34, 42, 43, 51, 52, 53, 54, 55	
	Wet Extended Detention Pond	Private Landowners; Local Governments; Washtenaw County	Variable, depends upon amount of development.	$1.30/ ft3	4% construction costs	100% of new developments incorporate practices, as appropriate.	Sub-basins 11, 23, 26, 34, 42, 43, 51, 52, 53, 54, 55	
	Residential Rain Gardens	Private Landowners	variable, households with appropriate soils; 1st priority: new development' 2nd priority: retrofit	$500/homesite, or $3-5/ft2 up to $10-12/ft2 for professional work	4% construction costs	**Pilot installation by year 4**	Sub-basins 17, 22, 23, 26, 34, 43, 54, 55	
	Vegetated Roofs	Private Landowners	1 demonstration site.	$12-24/ ft2	minimal	Demonstration site by year 5	11, 54, 55	
	Private Roads Ordinance	Local Governments; Washtenaw County	New development	$2,000	enforcement	Adoption by all Local Governments by year 4	All	HRWC; Washtenaw County
	Minimize Total Impervious Cover in Zoning Ordinance	Local Governments	11 Local Governments; Nested Jurisdictions	$3,000 $33,000 total	enforcement	Build-out scenario less than 10% imperviousness	All	HRWC; Washtenaw County
	Flow Limits in Stormwater Permits	MDEQ	Statewide	$50,000	enforcement	**Agreement secured with MDEQ to add flow limits by year 5**	All	
	Alternative Drain Practices and Rehabilitation	Washtenaw County	All designated drains of Mill Creek system	variable; depends upon practice; petition by drainage district	To be determined	**Alternatives selected by Drain Commissioner by year 4**	see Seelbach & Wiley (1996)	U.S. EPA; Trout Unlimited; U.S. FWS; MDNR
Reduce Soil Erosion and Sediment Load from Streambanks	Bank Restabilization	Private Landowners; Local Governments; WCRC; WCDC	200 ft	$90/ft $18,000 total	$1.80/ft $360 total	**Complete Veteran's Park project as demonstration by year 3**	Veteran's Park, City of Chelsea, **Chelsea Park Friends**	SE MI RC&D; Chelsea
	Riparian Buffer	Private Landowners; Local Governments; WCRC; WCDC	6210 acres	$350/ac $2.17 million total	1-2% installation costs $43,500 total	25% stream miles by year 5	Sub-basins 6, 8, 9, 11, 13, 14, 15, 17, 22, 23, 26, 29, 31, 32, 36, 37, 38, 39, 40, 42, 43, 50, 52, 53, 54, 55	USDA Programs; technical assistance from NRCS, WCCD

Task	Recommended Strategy	Responsible	Level of Effort	Capital Cost	Annual Cost*	Measure of Success	Recommended Locations	Resources
Reduce Soil Erosion and Sediment Load from Agricultural Lands	Grassed Waterways	Private Landowners	98 ac (1st tier only)	$3,500/ac w/o tile $4,500/ac w/ tile $343-441,000 total	$70-90/ac $6,800-8,800 total	25% of total acres in 1st tier sub-basins by year 3	1st tier: Sub-basins 1, 13, 14, 15, 16, 25, 31, 32, 35, 37, 38, 40, 42, 43, 46, 47, 48, 50 2nd tier: Sub-basins 2, 3, 5-8, 10-12, 21-24, 26-30, 33, 34, 36, 39, 41, 44, 45, 49, 51-53	USDA Programs: EQIP, CRP Technical assistance from NRCS, WCCD
	Grade Stabilization Structures	Private Landowners	66 no. (1st tier only)	Geotextile: $5-6,000 Fabricated: $8,500-9,500 each structure $330,000 - 627,000 total	$50-95 ea $3,300 - 6,300 total			
	Conservation Cover	Private Landowners	665 ac (1st tier only)	$225/ac $147,375 total	$11.15/ac $7,400 total			
	Conservation Crop Rotation with Cover Crop and Mulch/No-Till	Private Landowners	1,965 ac (1st tier only)	Cover Crop: $170/ac $334,050 total Mulch/No-Till: $10-15/ac $19,650 - 29,475 total	Cover Crop: Same Mulch/No-Till: Same Both are annual practices			
Reduce Soil Erosion and Sediment Load from Developed Areas/ Construction Sites	Soil Erosion and Sediment Control Regulation Enforcement	Local Governments; Washtenaw County	1 FTE addition to County staff and creation of volunteer program	Not applicable.	$40,000-50,000	**Expanded staff by year 4**	All	
	Sediment Traps or Basins at Construction Sites	Private Landowners; Developers	All sites	$6,000 ea (Ag figure)	10% installation costs	**All sites pass inspection by year 3**	All	
	Catch Basin Inlet Devices	Local Governments	All catch basin inlets	$800/device; $150,000 vactor truck	$3/basin inspection; $25/basin cleaning	Initiated by year 2 with cleaning 2-3 times/yr	Sub-basins 29, 52, 54, 55	
	Stabilize Soils on Construction Sites	Local Governments; Private Landowners; Developers	New development	Incurred by developers and private landowners	Incurred by developers and private landowners	**All sites pass inspection beginning in year 3**	All	Washtenaw County; HRWC; MDEQ
	Sand and Organic Filter	Private Landowners; Local Government	Variable, depends upon amount of development; 1st priority: new development; 2nd priority: retrofits	$5/ft3	$0.54/ft3/year	**50% of new developments by year 5**	Sub-basins 29, 52, 54, 55	
	High-powered Street Sweeping	Local Governments; WCRC	Once every 1-2 weeks except during freeze	$100,000-200,000	$15-30/ curb mile	**Programs established in Chelsea and Dexter by year 3**	Sub-basins 29, 53, 54, 55	
Reduce Soil Erosion and Sediment Load from Road-stream Crossings	Soil Stabilization at Crossing Embankments	WCRC	12 sites			Repair all sites by year 5	See results of field inventory	MDOT; WCRC
	Culvert Replacement	WCRC	1 site			Repair all sites by year 5	See results of field inventory	MDOT; WCRC

	Recommended Strategy	Responsible	Level of Effort	Capital Cost	Annual Cost*	Measure of Success	Recommended Locations	Resources
	Misaligned/ obstructed Culvert Repair	WCRC	9 sites			Repair all sites by year 5	See results of field inventory	MDOT; WCRC
	Road/bridge Surface Stabilization	WCRC	3 sites			Repair all sites by year 5	See results of field inventory	MDOT; WCRC
Reduce Nutrient Loading (Phosphorus, Nitrogen) from Agricultural Lands to Meet Mandated Reductions	Nutrient Management	Private Landowners	6,551 ac (1st tier only)	$10/ac average $65,510 total	Same-annual practice	25% of total acres in 1st tier sub-basins by year 3	1st tier: Sub-basins 1, 13, 14, 15, 16, 25, 31, 32, 35, 37, 38, 40, 42, 43, 46, 47, 48, 50 2nd tier: Sub-basins 2, 3, 5-8, 10-12, 21-24, 26-30, 33, 34, 36, 39, 41, 44, 45, 49, 51-53	USDA Programs: EQIP, CRP Technical assistance from NRCS, WCCD
	Waste Storage Facility	Private Landowners	15-20 no. (1st tier only)	$100-250,000 ea/avg. $1.5-5 million total	$2-5,000 ea $30-100,000 total			
	Livestock Use Exclusion	Private Landowners	8,000 ft. (1st tier only)	$3/ft $24,000 total	$.10/ft. $800 total			
	Vegetated Filter Strips	Private Landowners	170.5 ac (1st tier only)	$200/ac $34,100 total	$4/ac $682 total			
Reduce Nutrient Loading (Phosphorus, Nitrogen) from Urban and Suburban Sources to Meet Mandated Reductions	Native Landscaping Ordinance	Local Governments	11 governments	$2,000 $22,000 total	enforcement	Adoption by 25% of Local Governments by year 4	All	Lawn*A*Syst
	Illicit Connection Correction	Local Governments; Washtenaw County; Private Landowners	Sewered areas	Not applicable	$600/dye test; $100/staff investigation per property; $5,000-15,000 enforcement per property	Investigation 50% complete by year 5	Sub-basins 29, 53, 54, 55	Washtenaw County; MDEQ
	Golf Course Nutrient Management	Private Landowners; Washtenaw County	2 golf courses	$15,000	Depends upon practices employed	Certified Members of MI Turfgrass Stewardship Program by year 3	Sub-basins 29, 49	MSU Extension; WCDC
	Native Vegetation Restoration Program	Private Landowners; Washtenaw County; Local Governments; WCDC; WCRC	920 acres	$600-800/ac installation $552,000-736,000 total	$500/ac	**2 restorations underway by year 4**	All sub-basins, especially 53, 54, 55	MSU Extension; Conservation District; NRCS
	Information and Education: Yard and Lawn Care; Septic System Maintenance; Native Landscaping	Local Governments; Washtenaw County	# households (to be determined in public infor and outreach plan)	$/ piece * # households	(to be determined in public infor and outreach plan)	50% households reached in year 1; 100% reached by year 2	Begin with Sub-basins 17, 23, 26, 29, 30, 34, 42, 52, 53, 54, 55; then all sub-basins	Community Partners for Clean Streams; HRWC; MSU Extension

	Recommended Strategy	Responsible	Level of Effort	Capital Cost	Annual Cost*	Measure of Success	Recommended Locations	Resources
	Phosphorus Reduction Ordinance and Incentives to Reduce Herbicide/Fertilizer Use	Local Governments	11 governments	$3,000 $33,000 total	enforcement	**Adoption by 50% of Local Governments by year 5**	All, especially Chelsea and Dexter villages	HRWC; MSU Extension
	Information and Education: Proper Pet Waste Handling; Storm Drain Awareness	Local Governments	# households (to be determined in public infor and outreach plan)	$/piece * # households	(to be determined in public infor and outreach plan)	50% households reached in year 1; 100% reached by year 2	Sub-basins 29, 39, 42, 53, 54, 55	HRWC
	Septic System Ordinance	Private Landowners; Local Governments	9 Local Governments with septic systems	$2,000 $18,000 total	$200/septic tank	Adoption by 25% of Local Governments by year 4	All sub-basins, except 54, 55	Washtenaw County
Preserve/Improve Natural Features & Natural Aquatic Animal and Plant Communities	Stream Habitat Restoration	Local Governments; Dam Owner(s)	1-mile reach impacted by dam			**Begin restoration post dam removal in year 4 or 5**	Sub-basin 54 at site of Mill Pond Dam	MDNR; MDEQ; universities; HRWC
Reduce Oil, Grease, Metals, and Brine/salt in Runoff from Roads and Developed Areas	Sand and Organic Filter	Private Landowners; Local Governments	Variable, depends upon level of development and retrofit opportunities	$5/ft3 stormwater treated	$0.54/ft3/year	**50% of new developments by year 5**	Sub-basins 29, 52, 54, 55	
	Directly-connected Impervious Area Disconnection	Private Landowners; Local Governments	1st: new development; 2nd: retrofits	$50/ house	Not Applicable	**100% disconnection by year 5**	Sub-basins 11, 23, 26, 34, 42, 43, 51, 52, 53, 54, 55	
	Infiltration Trench	Private Landowners; Local Governments; Washtenaw County	Variable, depends upon level of development	$5/ft3 stormwater treated	5-10% construction costs	**Installed in 50% of recommended locations by year 5**	Sub-basins 11, 29, 34, 53, 54, 55	
	Bioretention	Private Landowners; Local Governments; Washtenaw County	Variable, depends upon amount of development	$6.80/ft3 * volume	2% for O & M	**Installed in 50% of recommended locations by year 5**	Sub-basins 11, 23, 26, 34, 42, 43, 51, 52, 53, 54, 55	
	Municipal Well Field Protection	Local Governments; MDEQ	2 well fields	see community Wellhead Protection Plans	see community Wellhead Protection Plans	Activity timelines are met	Chelsea and Dexter villages	
Increase Watershed Monitoring and Stewardship Increase Watershed Monitoring and Stewardship	Monitor for water quality (including pathogens, pesticides), water quantity and biota	MDEQ; MDNR; Washtenaw County; Local Governments	day and wet weather monitoring; seasonal variation	$50,000	$40,000	**Initial measurements in recommended locations by year 2**	Biota (Adopt-A-Stream) locations: 8, 16, 22, 27, 51, 53, 54, 55 Water quality and flow locations: 15, 21, 26, 35, 48, 50, 54	HRWC; Washtenaw County

Recommended Strategy	Responsible	Level of Effort	Capital Cost	Annual Cost*	Measure of Success	Recommended Locations	Resources
Mill Creek Subwatershed volunteer monitoring program	Mill Creek Research Council	Trained Monitoring Corps of 12	$10,000	$10,000	**Training and monitoring begun by year 2**	All	HRWC
Expand Stewardship Network to Mill Creek Subwatershed	Mill Creek Research Council	1-2 stewardship activities in Mill Creek per year	$5,000	$3,000	Expansion by year 3	All	HRWC; Stewardship Network
Measure pollutant removal efficiency in BMP implementation projects		All implementation projects			**100% monitoring of all newly installed BMPs**		
Species of concern distribution and status survey (esp. mussels) and management strategies	State Government; Local Governments	Locations identified by previous surveys	$150,000	Not applicable	**Begin surveying in year 3**	All	Universities; MI Natural Features Inventory; The Nature Conservancy
Implement Public Information and Education Plan	Local Governments; Washtenaw County; Mill Creek Research Council	11 Local Units of Government	Listed by strategy below	Listed by strategy below	**Execute plan elements each year of the 5-year time frame**	All	HRWC
Public Information and Education Strategies							**Priority Pollutants Addressed**
Introductory piece: map of creekshed, details about problems, and suggestions for ways to participate	Local Governments; HRWC	All households		$5,818 + staff time	No formal evaluation	All	Altered hydrology, sediment/soil erosion, nutrients
Calendar for 2006	Local Governments; HRWC	All households		$5,250 calendar $1,301 postage $1667 handling and letter	Survey at back for return to HRWC office	All	Sediment/soil erosion; nutrients; oil, grease, metals (toxics); pathogens; pesticides (12 nonpoint source pollution prevention tip for residents)
Print advertising	Local Governments; HRWC	All households First ad runs w/ introductory piece, second set runs concurrent w/calendar distribution		Ongoing $2,459 to date + staff time	Toxics facility will measure # of drop-off appointments in the month following ad placement	All	Altered hydrology, nutrients, toxics
Tip cards: run concurrent with workshops; topics are lawn care and riparian buffers	Local Governments; HRWC	All households		$4,270 + staff time	# workshop registrations generated by mailings, which will be determined by a survey of workshop participants	All	Altered hydrology, sediment/soil erosion, nutrients, pathogens, pesticides, high water temperature

	Recommended Strategy	Responsible	Level of Effort	Capital Cost	Annual Cost*	Measure of Success	Recommended Locations	Resources
	Public Information and Education Strategies							**Priority Pollutants Addressed**
Increase Watershed Monitoring and Stewardship	Workshops: w/ MSU-Ext on lawn care practices; stream and lake property owners learn how to restore and strengthen banks	Local Governments; HRWC	Property owners, esp. residential with lakeshore and riverfront properties		$500 space rental $1,000 materials & mailings + staff time	Survey at end of workshops; survey one month later; participation levels at plant sales	All	Altered hydrology, sediment/soil erosion/ nutrients, high water temperature, pathogens, pesticides
Increase Watershed Monitoring and Stewardship	Roundtables	Local Governments; HRWC	w/ farmers; w/ interested members of general public		Staff time	Farmer feedback at end of meeting; implementation of farmer recommendations; on-going involvement of citizen action groups and retail entities	All	All
Increase Watershed Monitoring and Stewardship	Creek steward walks	Local Governments; HRWC; Mill Creek Research Council	Interested members of general public		Staff time	# of participants; informal survey at end of walk	Letts Creek in Chelsea; Mill Creek near Dexter	All
Increase Watershed Monitoring and Stewardship	Portable banner displays	Local Governments; HRWC	2 traveling displays		$700 each + staff time	Feedback from clerks, residents, CVT representatives	All CVTs	Altered hydrology, sediment/soil erosion, nutrients, toxics, pathogens
Increase Watershed Monitoring and Stewardship	Direct mail: Additional topics with coupons	Local Governments; HRWC	All households		$4,270 est. each + staff time	Coupon redemption levels (see next)	All	
Increase Watershed Monitoring and Stewardship	Cross promotions	Local Governments; HRWC	Retailers, local restaurants and small business, w/ media outlets (radio, print)		$500 printing + staff time	Participation levels in promotions (coupons, contest entries, etc.)	All	All
Increase Watershed Monitoring and Stewardship	Events: booth or contest	Local Governments; HRWC	Chelsea Fair, Dexter Daze		$200 materials + staff time	# of entries submitted during event	Chelsea, Dexter	TBD
Increase Watershed Monitoring and Stewardship	River tours/cleanups	Local Governments; HRWC; MCRC	By canoe w/ livery donating canoes		Staff time + no donation, $19 per canoe est.	Surveys before and after event	Urban, suburban reaches of creek	All
Increase Watershed Monitoring and Stewardship	School-based program	Local Governments; HRWC	School districts partner with City of Ann Arbor program on drinking water source protection		Staff time	Student test before and at end of program to measure awareness; possible survey of families	All	Sediment/soil erosion, nutrients, toxics, pathogens, pesticides
Increase Watershed Monitoring and Stewardship	Native tree and plant (shrub, grass) planting	Local Governments; HRWC	Nurseries and County partner for sales for streambank stabilization		Staff time	Level of participation indicated through use of coupons	All	Altered hydrology, sediment/soil erosion, nutrients, high water temperature

	Recommended Strategy	Responsible	Level of Effort	Capital Cost	Annual Cost*	Measure of Success	Recommended Locations	Resources
	Public Information and Education Strategies							**Priority Pollutants Addressed**
Increase Watershed Monitoring and Stewardship	Print advertising for workshops or behavior change	Local Governments; HRWC			Local papers only $360 per placement +staff time & design	If for workshops, survey participants for level of ad recall; if for behavior change, use coupon or other measure (e.g., survey how people at a toxics drop-off heard about event; or include coupon for tree discount)	All	TBD
	Additional workshops: Bank stabilization, riverfront/lakefront living, vegetated buffers	Local Governments; HRWC	Property owners, esp. residential with lakeshore and riverfront properties		$500 rental space $350 materials + staff time	# of restorations in first year; site assessments, and survey of site owner to determine ease of project, challenges and suggested improvements	All	Altered hydrology, sediment/soil erosion/ nutrients, high water temperature, pathogens, pesticides
	Storm drain labeling w/ door hangers	Local Governments; HRWC	Urban and suburban residences on storm sewer		$3.50 per drain + volunteer time	Survey residents in labeled areas at end of program	Chelsea, Dexter and surrounding areas w/ storm sewers	All
	Watershed and stream crossing signage	Local Governments; Washtenaw County Road Commission and Drain Office	Strategic locations on county roads		$150/sign est. + design + implementation	Survey people seeking permits from Road Commission and Drain Office on awareness and recall of signs	All	None directly, all indirectly
	Film contest see model in Miller's Creek	Local Governments; HRWC	Open to all residents of Mill Creek and surrounding areas		Volunteer and staff time	Participation levels and publicity generated	All	All
	Publicity	Local Governments; HRWC	Of all activities above		Staff time	Placements on paper and on radio	All	All
Increase Watershed-based Land Use Planning and Integrate into Operating Procedures	Site Plan Review Requirement Enhancement	Local Governments; Washtenaw County; Nested Jurisdictions	11 Local Units of Government			Required by 50% of Local Governments by year 4	All	HRWC; WCDC
	Low Impact Design Implementation	Local Governments; Washtenaw County; Nested Jurisdictions	11 Local Units of Government			Implemented by 25% of Local Governments by year 4	All	HRWC
	Recreation Trail System Study	Local Governments; Washtenaw County	11 Local Units of Government			**Conduct initial meeting with county parks in year 3**	Sub-basins 23, 52, 53, 54, 55; others as feasible	Washtenaw County; Universities
	Regional Planning and Implementation	Local Governments; Washtenaw County; Nested Jurisdictions	3 existing regional groups			Continue existing regional planning efforts; 1-2 creekshed-wide planning meetings	All	Washtenaw County

	Recommended Strategy	Responsible	Level of Effort	Capital Cost	Annual Cost*	Measure of Success	Recommended Locations	Resources
	Purchase of Development Rights Ordinance Implementation	Local Governments	4 Local Units of Government	$500-1,000 $2,000-4,000 total	Not Applicable	Adopted ordinance in five communities	Dexter, Lima, Lodi, Lyndon, Sylvan townships	Washtenaw Land Trust; Washtenaw County; Barry Lonik
Increase Plan Participation and Implementation	Mill Creek Subwatershed Task Force	Local Governments; Washtenaw County; Private Landowners	Full stakeholder representation in group			Formation of group in year 1 with regular meetings	All	HRWC; Washtenaw County Conservation District

** Average Operations, Maintenance and Research factor to use in estimating long-term costs is 4% for all types of restoration projects (PA DEP, 2001)*

8.2 Anticipated Pollutant Reductions

The strategies, or management measures, that need to be implemented to achieve the estimated load reductions have been determined using the best available information. Total phosphorus was selected as the variable for analysis based on the TMDL targets established for the Middle Huron. BMP-specific phosphorus removal efficiency data were used to calculate estimated reductions in annual loads of total phosphorus. Phosphorus removal efficiencies for each BMP were based on information included in the U.S. EPA BMP Menu website (http://www.epa.gov/npdes/menuofbmps/menu.htm), the range of phosphorus removal efficiencies found in the literature search and recorded in the BMP Specifications Spreadsheet (Appendix H), and consultation from USDA NRCS professionals. Cost data, like the values for phosphorus removal efficiencies, were based on the U.S. EPA BMP Menu website and the range of costs found in the literature search and recorded in the BMP Specifications Spreadsheet.

Measuring pollutant removal effectiveness of stormwater BMPs is an evolving area of study with greatly varying results. To date, research pertaining to effectiveness of urban and suburban practices is more prevalent than agricultural practices, a finding based on literature searches, inquiries to other watershed planning groups and federal and state agencies. Additional research is needed in other climates and practices to capture performance data. For instance, the performance of infiltration practices in the Mid-Atlantic region often does not draw suitable comparison to how those practices perform in Michigan's freeze-thaw climate.

Phosphorus removal effectiveness of practices has been calculated when possible. By using the "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual" developed by the MDEQ, the following estimates were calculated for recommended agricultural practices. Note that the Action Plan serves as the guide for determining the location and frequency of practice implementation; refer to the Recommended Locations column of the Action Plan for more details.

Table 8.2. Estimated Load Reduction of Total Phosphorus from Select BMPs (Sources: MDEQ; Grigar; Lemunyon; and Gangwer)

Management Practice	Estimated Load Reduction of Total Phosphorus (lb/yr)
Grassed Waterway	800
Grade Stabilization Structures	89
Conservation Cover	2,155
Cons. Crop Rotation w/ Tillage	1,960
Waste Storage Facility	360
Livestock Use Exclusion	500
Vegetated Filter Strips	3,179
Nutrient Management	Unknown*
Total	**9,043**

*Estimates for this practice are beyond current levels of scientific and technical expertise within NRCS and leading academics. A lack of research in this area, along with very complex, site-specific natural processes does not allow adequate estimates to be made.

Recall that the estimated mean annual load of total phosphorus in the Mill Creek system is a range of 12,000-15,000 lb/yr. In order to satisfy the TMDL for the Middle Huron, a 50 percent reduction of total phosphorus, or 6,000-7,500 lb/yr, must be realized. The estimates in Table 8.2 indicate that less than full implementation of the management practices would fulfill the mandated phosphorus reduction for the Mill Creek Subwatershed. The SAG realizes that many combinations of BMPs, both agricultural and urban/suburban, can be implemented to realize pollutant reduction goals. The most effective combination necessarily will be the one that is most feasible for the stakeholders based on cost, acceptability and sustainability.

Efforts continue at national and global levels to identify pollutant removal effectiveness of BMPs and estimated pollutant reductions expected from employing BMPs. The effort to improve this information continues for the Mill Creek Subwatershed management planning process, as well. We may not have all the answers to the question of which practices will meet our pollutant reduction goals due to lack of data for the practices and site-specific conditions. Yet, in the interest of determining a path to pollutant reductions appropriate to the Subwatershed, best available information has been referenced to estimate phosphorus removal expectations.

8.3 Priority Restoration Opportunities in the Mill Creek Subwatershed

Prior to and during the development of this plan, site-specific restoration opportunities were identified (see Table 8.2). Previous surveys of the Subwatershed provided insight such as the Mill Creek Subbasin Resource Plan prepared through the USDA's Southeast Michigan River Basin Study and Seelbach and Wiley's Assessment of the Potential for Ecological Rehabilitation and Restoration in Mill Creek. Existing surveys coupled with information gathered from field reconnaissance generated the following short and incomplete list of restoration opportunities.

Stakeholders in the Subwatershed will need to initiate and coordinate the implementation of these and any other improvements. Support is available in the form of funding, from sources such as Clean Michigan Initiative, federal §319 nonpoint source program, and private foundations, and in the form of technical support, from sources such as USDA NRCS, Washtenaw County Conservation District and Drain Commissioner's office, Ducks Unlimited and the Huron River Watershed Council. The opportunities listed below are considered Stage II or III in the timing sequence.

Table 8.3. Priority Restoration Opportunities in the Mill Creek Subwatershed

Waterway	Community	Threatened/Impaired Designated Use	Pollutant	Cause/Source	Potential Action
Lower Mainstem, Mill Creek	Village of Dexter	Partial and total body contact recreation; Indigenous aquatic life and wildlife; Warmwater fishery	Hydrologic flow; sediment; nutrients	Mill Pond Dam and impoundment	Stream restoration through dam removal and habitat revitalization
*Letts Creek	Chelsea	Indigenous aquatic life and wildlife; Warmwater fishery	Hydrologic flow; sediment	Incremental degradation via nonpoint source runoff; loss of riparian buffer	Streambank stabilization at Veterans' Park
North and South branches	Multiple	Partial and total body contact recreation; Indigenous aquatic life and wildlife	Hydrologic flow; sediment	Incising of stream from channelization	Reactivate floodplains to provide stormwater and sediment storage
Mainstem Headwaters and East Branch	Sharon Twp; Lodi Twp; Scio Twp	Partial and total body contact recreation; Indigenous aquatic life and wildlife	Sediment; nutrients; bacteria	Stream access by livestock	Exclude livestock use and create waste storage facility
Tributary to Lower Mainstem	Village of Dexter	Indigenous aquatic life and wildlife	Hydrologic flow; sediment	Incremental degradation via nonpoint source runoff; improper detention basin controls	Stormwater BMP retrofit at Dexter Business Park

*Segment identified on the Michigan 303(d) List of Impaired Waterbodies requiring the establishment of a Total Maximum Daily Load (TMDL).

Extensive planning and organization is required in order to assure successful implementation of restoration techniques. Typically, the major phases of plan development after identifying potential areas for restoration, are to establish goals and objectives, collect required information and data, select restoration designs, obtain required permits, secure funding, initiate construction, and establish monitoring and management guidelines. Many activities, such as exploring funding mechanisms can occur concurrently with other phases of the planning process. It is intended that restoration planning will follow guidelines proposed by The Federal Interagency Stream Restoration Working Group (2001).

Some of the recommended strategies in the Action Plan involve retrofitting existing developments that do not manage for stormwater. When a community decides to pursue retrofit opportunities to improve management of stormwater, several factors should be considered when selecting locations. To make stormwater retrofits more feasible, communities of the Subwatershed should revise or initiate programs that trigger reviews for potential retrofit opportunities. For example, a process for reviewing and promoting stormwater BMP retrofits kicks in when a parking lot at an existing commercial development is set for redevelopment or extensive maintenance. The following table is excerpted from retrofit suggestions from the Center for Watershed Protection (CWP, 1995):

Table 8.4. Potential Structural Stormwater BMP Retrofits based on Existing Condition or Potential Location.

Condition/Location	Type of Retrofit
Existing stormwater detention facilities	Can be retrofitted to a wet pond or stormwater wetland
Immediately upstream of existing road culverts	Can be retrofitted to a wet pond or stormwater wetland
Immediately below or adjacent to existing storm drain outfalls	Retrofit to water quality BMPs, such as sand filters, vegetative filters or other small storm treatment facilities
Directly within urban drainage and flood control channels	Addition of small-scale weirs or other flow attenuation devices can be built to facilitate settling of solids within open channels
Highway rights-of-way and cloverleaves	Variety of options, but usually application of stormwater ponds or wetlands
Within large open spaces, such as golf courses and parks	Variety of options, but usually application of stormwater ponds or wetlands
Within or adjacent to large parking lots	Retrofit to water quality BMPs such as sand filters or other organic media filters (e.g., bioretention)

A long-term maintenance plan and budget for the future operation and maintenance of new ponds should be developed as is required in the Washtenaw County Drain Rules.

Chapter 9 Evaluation Methods for Measuring Success

A well-planned evaluation process will provide measures of the effectiveness of implementing this Subwatershed Management Plan and achieving its goals. Measurement and evaluation are important parts of planning because they can indicate whether or not efforts are successful and provide a feedback loop for improving project implementation as new information is gathered. Also, if the subwatershed group is able to show results because of an evaluation program, the plan will likely 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 subwatershed necessarily will be conducted at the local level by individual agencies and communities as well as at the Subwatershed level in order to assess the ecological affects of the collective community and agency actions on the health of Mill Creek and its tributaries.

In continuing to work as a collaboratively toward goals for the creek, the Stakeholder Advisory Group (SAG) recognizes the importance of a long-term water quality, quantity and biological monitoring program to determine where they should focus resources as they progress toward meeting those collective goals. These physical parameters will reflect improvements on a regional scale. The monitoring program should be established on a subwatershed scale since this approach is the most cost effective and consistent if sampling is done by one entity for an entire region.

9.1 Qualitative Evaluation Techniques

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 towards attaining water quality standards in the Subwatershed. Conversely, the criteria can be used for determining whether this subwatershed plan needs to be revised at a future time in order to meet standards. A summary (Table 9.1) 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 subwatershed 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 these methods of measuring progress are not directly tied to measurements in the river, it is assumed that the success of these actions/programs, collectively and over time, will have a positive impact on the in-stream conditions and measurements of the creek that are investigated concurrently as described in 9.2 below.

Table 9.1: Summary of Qualitative Evaluation Techniques for the Mill Creek Subwatershed (adapted from: Lower One SWAG, 2001)

Evaluation Method	Program/Project	What is Measured	Pros and Cons	Implementation
Public Surveys	Public education or involvement program/project	Awareness; Knowledge; Behaviors; Attitudes; Concerns	Moderate cost. 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 Subwatershed basis.
Written Evaluations	Public meeting or group education or involvement project	Awareness; Knowledge	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. Identify recreational opportunities.	Habitat; Flow; Erosion; Recreation potential; Impacts	Current and first-hand information. Time-consuming. Some cost involved.	Identify parameters to evaluate. Use form, such as Mill Creek field inventory sheet, to record observations. Summarize findings to identify sites needing observation.
Visual Documentation	Structural and vegetative BMP installations, retrofits	Aesthetics. Pre- and post- conditions.	Easy to implement. Low cost. 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.	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. haz. waste collection	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	Medium to high cost to do well. Instant identification of motivators and barriers to behavior change.	Select random sample of population as participants. 6-8 people per group. Plan questions, facilitate. Record and transcribe discussion.

Among some of the programmatic indicators that can be studied to evaluate recommended strategies using these qualitative techniques are number of illicit connections identified/corrected, number of BMPs installed, inspected and maintained, permitting and compliance, and growth and development (e.g. impervious amounts), and on-site BMP performance monitoring.

9.2 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 subwatershed efforts in terms of a water quality, quantity and biological monitoring. A monitoring program at the subwatershed level most likely will require a regional perspective and county or state support. This subwatershed-wide long-term monitoring will address the Action Plan strategy to improve in stream monitoring in the subwatershed. Communities and agencies in the subwatershed agree that there has not been adequate data collection (number of sites or frequency) to most effectively manage the subwatershed. Increased wet and dry weather water quality, stream flow, biological and other monitoring will afford communities and agencies better decisionmaking abilities based on more data as implementation of this plan continues. This proposed monitoring program is described below.

9.2.1 Parameters and Establishing Targets for Creek Monitoring

Upon reviewing the data collected over the years for this subwatershed management plan, the SAG would like to augment the type of parameters monitored, the number of locations in the Subwatershed, and the frequency of wet weather monitoring. This improved monitoring program will help communities and agencies to more accurately identify 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. Implementation for some of the monitoring program already has begun through existing programs of partner organizations. New programs likely will begin in the 2005 field season when a specific plan has been determined and funding is secured.

Parameters
Establish a long-term monitoring program so that progress can be measured over time that includes the following components:

- Increase stream flow monitoring to determine baseflows and track preservation and restoration activities upstream. Include as physical and hydrological indicators: stream widening/downcutting; physical habitat monitoring; impacted dry weather flows; increased flooding frequency; and stream temperature monitoring.

- Collect wet and dry weather water quality data in the subwatershed to better identify specific pollution source areas within the subwatershed, and measure impacts of preservation and restoration activities upstream. Include as water quality indicators: water quality pollutant constituent monitoring, loadings, exceedence frequencies of water quality standards, sediment contamination, and human health criteria.

- Increase biological data monitoring (fish, macroinvertebrates, and mussels) and use these as indicators of the potential quality and health of the stream ecosystem. Include as biological indicators: fish assemblage; macroinvertebrate assemblage; single species indicator; composite indicator; and other biological indicators.

- Identify major riparian corridors and other natural areas in order to plan for recreational opportunities, restoration and linkages.

- Review and revise currently established benchmarks and dates based on new data.

- Increase the use of volunteers where possible, for monitoring program (habitat, macroinvertebrates) to encourage involvement and stewardship.

Based on the goals of the subwatershed, the monitoring plan will measure Dissolved Oxygen (DO), Bacteria (*E. coli*), Phosphorus (P) and its forms, Nitrogen (N) and its forms, total suspended solids and sediments (TSS), stream flow, conductivity, fisheries and aquatic macroinvertebrates, temperature, physical habitat, wetlands, and recreation potential. Pesticides and herbicides should be monitored, as well, and the specific compounds to be monitored should be selected by the subwatershed group.

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 realistically obtainable. 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, quantity and biological parameters to support state designated uses such as partial or total body contact, and fisheries and wildlife. Using these scientifically-based targets as targets for success will assist the subwatershed 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.

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, which includes the entire Mill Creek system. 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)*

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, or greater than, 2 cubic feet per second.

In the TMDL-designated region of the Middle Huron Watershed, of which Mill Creek Subwatershed is a part, the phosphorus (P) concentration limit is 0.05 mg/L for surface waters in order to prevent nuisance plant growth in receiving lakes and impoundments. The state 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.

Total suspended solids (TSS) for surface waters does not have a numerical standard set by the state. 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 subwatershed, 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". 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 sediment load 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 GLEAS 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 for this measurement is to maintain the current ratings and improve ratings where possible.

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. The best existing research for recommended flow targets in Mill Creek comes from the Seelbach and Wiley report (1996), which estimates the pre-1820 peak stream flow for the entire Subwatershed to be 263 cfs. This pre-development scenario represents the natural hydrology of the Subwatershed. Current available data estimates peak stream flow has increased more than 40 percent to 374 cfs as a result of wetlands conversion, loss of floodplain storage and increase of impervious surfaces. More recent peak flow data is needed to more accurately compare observed flow to the target flow. Data generated at the USGS stream gage at Parker Road should be used to assist in reviewing these suggested targets and establishing an appropriate target for the downstream end of the subwatershed.

Conductivity measures the amount of dissolved ions in the water column and is considered an indicator for the relative amount 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 Mill Creek and its tributaries. Levels higher than the standard indicate the presence of stormwater runoff-generated suspended materials.

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 GLEAS 51 (Great Lakes Environmental Assessment Section) sampling protocol. This method collects fish at various sites in the creek and 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. See Chapter 4 for results of recent fish assessments by the state and others. The target will be to maintain GLEAS 51 scores of “excellent” at sites where they are attained currently, “good” at sites where they are attained currently, improve “fair” sites to “good”, and improve “poor” to “good” through the implementation of this plan. The GLEAS 51 protocol also identifies whether or not there are sensitive species present in the creek, 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, assuming that stable or increasing numbers mean that habitat and water quality is maintained or improved.

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 Adopt-A-Stream program of the Huron River Watershed Council currently monitors macroinvertebrate health and physical habitat on 8 sites on the Mill Creek system using the GLEAS 51 procedure. The sites are monitored for macroinvertebrates 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,” and maintain the “good” and “excellent” conditions at the remaining sites.

A wetland review for the southern drainage of the Subwatershed may need to be conducted to determine a baseline acreage and number of wetlands similar to the exercise completed in the northern drainage. An annual review needs to 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 subwatershed. The target for this parameter is to track the net acres of wetland in the subwatershed to determine action for further protection or restoration activities.

The state standard 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 (SWAG, 2001). Temperature studies need to be conducted for the Mill Creek system in order to determine the average monthly temperatures and whether increased temperatures are a problem for stream health. In tributaries that support warm water fish communities, such as the Central Mudminnow and Brook Stickleback, warmer temperatures are especially a concern. These representative species cannot tolerate certain higher summer temperature increases. The state standards recommend that temperatures for warm water fisheries not exceed temperatures greater than the monthly maximum temperatures listed in the table below.

State standards do not exist for aesthetics or recreation potential. However, an area with high aesthetic qualities will add, in either a passive or active context, recreational opportunities for the public and a greater appreciation or awareness of the subwatershed's natural resources. Measuring aesthetics of an area is inherently a qualitative effort. However, progress toward attaining aesthetically pleasing places can be measured and evaluated effectively using a standard tool, such as a survey, at regular intervals in time. A visual field survey would include regular field investigations of specific sites in the subwatershed where aesthetics are of most concern, such as a park area or future park area, most likely along a stretch of the river or a tributary. Measurements in the survey, dependent upon community and subwatershed priorities, should include assessing water clarity, ambient odors, vegetative diversity, wildlife use, streambank erosion, debris, evidence of public use, and other parameters that indicate positive or negative aesthetic qualities. Aesthetics monitoring could be added to an inventory such as the field inventory conducted by the SAG and project team in 2002. These efforts will be used to develop a program across the subwatershed. Volunteers and/or community field staff will most likely be utilized for this effort.

Measuring and mapping areas with recreation potential should be a community and a subwatershed effort and should be done by or closely with local or county parks departments and staff. The first component of this effort is a one-time recreational opportunities study of the subwatershed to determine where opportunities and access can be improved. The goal is to identify areas in the subwatershed, both along the riparian corridor and on the landscape that can provide passive recreation or active recreation. Within the subwatershed, these areas should be linked where possible to provide linear corridors that connect, or greenways, for both people (hiking, biking trails) and wildlife. This activity would begin with mapping existing areas dedicated to recreation or preservation, and then completing a stream walk to record information including: evidence of current public use, potential for public access, linkages to other natural areas (greenways potential), ownership of property, vegetation types (forested, wetland area, in need of riparian cover, etc.), excessive woody debris, etc. This survey would include photographs of potential recreation areas and would assist communities and the subwatershed in prioritizing new areas for preservation and recreation for the public, offering the public more opportunity for using and appreciating Mill Creek's natural resources. Finally, these activities should lead to the identification of funding mechanisms for purchase of land and conservation easements, as well as any necessary infrastructure (construction of trails, boardwalks, canoe livery, etc.) that would support new or improved recreational opportunities.

Details regarding responsible parties, monitoring standards, sampling sites, and frequency of monitoring for the qualitative and quantitative evaluation techniques will need to be defined in project work plans as funding resources are secured.

9.2.2 Key Milestones for Selected Environmental Indicators

Indicators are a set of criteria that are directly related to pollutant load reduction or prevention, or are direct measures of environmental quality. The environmental indicators selected as measures of watershed health in Mill Creek (Table 9.2) were selected from a larger group of possible indicators because they most appropriately meet the following criteria:

1. relevant to Mill Creek watershed
2. provide data that are useful and interpretable
3. have long-term sustainability in terms of money, equipment, time, knowledge and interest
4. fit well into a suite of indicators (Physical, Biological, Chemical and Social)
5. provide data that are accessible and get used

These criteria were recommended by the MDEQ in the presentation “Choosing Environmental Indicators.” Interim measurable milestones, based on the indicators, were identified to track overall progress toward meeting Water Quality Standards and/or goals of this watershed management plan. Data collected through the HRWC’s Adopt-A-Stream program was used to establish most of the milestones. Milestones for peak discharge reduction and nutrient reduction were based on reasonable estimates given the current conditions in the watershed.

Table 9.2 presents the interim, measurable milestones recommended to track overall progress toward meeting Water Quality Standards and/or goals of this watershed management plan during implementation of the 5-Year (2004-2008) Action Plan presented in Table 8.1.

Table 9.2. Environmental Indicators and Interim, Measurable Milestones to Track Overall Progress Toward Meeting WMP Goals and WQS

Parameter	Priority Pollutant Addressed	Environmental Indicator (EPA Minimum Element h.)	Milestones (EPA Minimum Element g.)
Physical: Stream Discharge (Q)	Altered Hydrology	Stream widening/downcutting Physical habitat monitoring Stream connectedness	Reduce peak discharge (Q) by 10% from current level based on 5-year average level at USGS gage #04173500: 807 cfs Attain Procedure 51 score of ≥ 65% at all 9 monitored sites Remove Mill Pond Dam in Dexter to reconnect Mill Creek to Huron River
Physical: Sediment	Soil Erosion and Sedimentation	Bottom deposition of fine silts	Attain ≤ 50% of fine silts in bottom deposition at all 9 monitored sites Measure Conductivity < 800 μS at all 9 monitored sites
Chemical: Nutrients	Excess Nutrients	WQ pollutant concentration and loading Exceedence frequencies of WQS (0.05 mg/L TP)	Attain 15% reduction of TP load from 2003 levels, or 1,800-2,250 lb/yr Reduce exceedences of WQS for TP to 25% of water samples collected from April to October
Physical: Stream Habitat	Altered Hydrology; Soil Erosion and Sedimentation	Fluvial morphology Riparian corridor vegetation and bank stability Instream cover	Attain Procedure 51 score of ≥ 65% at all 9 monitored sites Attain Ecological Condition classification ≥ Good at all 9 monitored sites
Biological: Freshwater Biota (Benthic Macroinvertebrates)	Altered Hydrology; Soil Erosion and Sedimentation; Excess Nutrients	Macroinvertebrate assemblage Composite indicator: EPT	Collect and identify ≥ 12 macroinvertebrate insects at all 9 monitored sites Collect and identify ≥ 5 EPT species at all 9 monitored sites Collect and identify ≥ 1 sensitive species at all 9 monitored sites Winter stoneflies present at each Stonefly Search at all 9 monitored sites
Social: Volunteer Participation	Altered Hydrology; Soil Erosion and Sedimentation; Excess Nutrients	Number of volunteers participating in monitoring	Attain 12% participation rate of Mill Creek residents among all volunteers, or approx. 55-60 people

Chapter 10 Steps for Plan Sustainability

10.1 Steering Committee for Plan Implementation and Monitoring

Success of the Mill Creek Subwatershed Plan depends upon consistent involvement and support from local, county, and state governments, citizens, and business interests. While each community has unique situations that require case-by-case consideration and implementation, many of the recommendations in the Subwatershed Action Plan require coordination among all the communities of the drainage area to be cost-effective at reducing pollutant loads. Formation of a Mill Creekshed Steering Committee (Committee) would provide sustainability towards plan implementation, coordination, evaluation, and revision.

The Committee would serve as a forum for discussing Mill Creekshed issues and generating support for plan implementation and improved watershed planning. The Committee necessarily would be composed of representatives from local, county, and state governments, utilities, citizens, and business interests in order to involve the key decisionmakers. An example of a creekshed-based committee is the Malletts Creek Coordinating Committee, which is composed of stakeholders and meets monthly to review germane issues facing the creek such as proposed developments. If time and resources are limited severely, the Mill Creekshed Steering Committee could opt to meet in conjunction with the semi-annual meetings of the Middle Huron Initiative. However, a creek-based group is needed to sustain the planning efforts.

The Committee ought to consider forming several task forces to handle specific areas of plan implementation. The intent for the task forces is to report to the Committee findings and recommendations specific to its purpose as outlined below. The Committee will discuss task force findings and, based on consensus building processes, make recommendations for further action. Potential sub-committees that the Committee ought to consider as it develops are:

- **Environmental Advisory Task Force**

  This task force is composed of citizens to assist trustees, zoning administrators, zoning board of appeals, and planning commissioners on environmental issues. Possible duties include periodic assessment of the community's environmental quality, investigation and recommendation on measures to protect/restore sites, assessment of environmental impact from new developments, and coordination and involvement with Mill Creekshed Steering Committee. Hamburg Township's Environmental Review Board and Pittsfield Township's Natural Features Committee are local examples for such a task force.

- **Water Quality Task Force**

  This task force is composed of Mill Creekshed Steering Committee members, concerned citizens, scientists, and the Huron River Watershed Council, and is charged with the implementation and coordination of water quality monitoring activities. The task force will study, recommend, and implement strategies to expand the scientific body of knowledge pertaining to the condition of the Subwatershed with particular emphasis on water quality. Specific duties may include development of a comprehensive monitoring program, prioritization of potential areas of illicit connection, and coordination of stormwater best management practice retrofitting and water resource restoration Other interested parties include Washtenaw County Drain Commissioner's office, health department staff and the Conservation District.

- **Education Task Force**

  Composed of local government representatives, Washtenaw County, citizens, business interests, academia, and media and marketing experts. The task force coordinates implementation of the Public Communications Plan for the Subwatershed (see Chapter 7), including developing specific timetables, securing funding and seeking cooperative arrangements.

The existence of the Middle Huron Initiative Partnership to address the Ford and Belleville lakes TMDL makes a similar group for the Mill Creekshed repetitive. The Partnership is composed of the signatories to the Cooperative Agreement to voluntarily reduce phosphorus loading to the Middle Huron. The Partners attend semi-annual meetings, prepare written implementation status reports, participate in subgroups, and generally put forth best efforts to reduce point and nonpoint source pollution. Meeting summaries, water quality sampling, and progress and successes are gathered by the Huron River Watershed Council and submitted annually to the MDEQ and U.S. EPA for approval. Based on the overall success of this Partnership in the implementation, assessment, and coordination of programs to reduce pollutant loading, the Mill Creek Subwatershed plan promotes participation by the Mill Creek communities in this existing Partnership. Mill Creek communities that are not signatories to the Cooperative Agreement are encouraged to sign on and become active in the Partnership.

Program work through partner organizations that will further the goals and objectives of the Subwatershed Plan and sustain implementation efforts is expected to continue. The work of the Middle Huron Initiative will continue to include water quality monitoring during the April-October field season, semi-annual meetings of the partners, implementation of best management practices, and promotion of ordinances to protect water resources. The USDA NRCS and the Conservation District will continue to work with agricultural landowners to implement conservation practices through CRP, EQIP and other Farm Bill programs. The Adopt-A-Stream program will continue to provide data that measures changes in physical habitat and biota in response to pollutants and impact reductions and serve as stewards to observe changes in the field. The HRWC will continue to provide technical assistance to the Mill Creek communities throughout both watershed planning and implementation, and will provide follow-up assistance as a part of their normal service to member communities. Financial support for strategy implementation will be sought through the Clean Michigan Initiative, federal §319 grant opportunities, and other grantmaking sources.

Long range regional planning is underway that involves all of the local units of government in the Subwatershed, and is coordinated by the Washtenaw County Planning and Environment Department. This intensive process has focused the attention of the communities on planned growth in relation to their Zoning Ordinances and Master Plans. Like the Subwatershed Management Plan, the regional plans are advisory in nature and do not carry any regulatory authority. However, active involvement and support of the plans by the stakeholders may translate into enforceable mechanisms to implement the recommendations.

10.2 Local Partner Resolution and Agreement

Sustainability of the Subwatershed Plan can be augmented through public recognition and support of the Plan. A stakeholder can acknowledge the problem of nonpoint source pollution, express support and intent to participate in the Committee, and consider and implement pollution reduction recommendations by signing the Local Government Partner Resolution or Community Partner Agreement. A sample Local Government Partner Resolution is presented below. Although communities may wish to edit the resolution to meet their particular needs, any edits should maintain the spirit and intent of the sample resolution.

Local Government Partner Resolution
for the Mill Creek Subwatershed Management Plan Implementation

WHEREAS the (community) recognizes that the quality of life and economic well-being in the Mill Creek Subwatershed and Huron River Watershed are inextricably linked to the health of the river system; its tributaries, lakes, groundwater, wetlands, and uplands; and

WHEREAS studies have shown that a significant source of phosphorus, and other pollutants, within the Mill Creek Subwatershed is nonpoint source runoff; and

WHEREAS the Michigan Department of Environmental Quality determined and the U.S. Environmental Protection Agency has concurred, that the level of phosphorus in Mill Creek from upstream nonpoint sources have reached unacceptable levels, and have therefore established a phosphorus reduction target; and

WHEREAS such phosphorus levels are damaging to the aquatic ecosystem and are preventing recreational use of waterways, and that the problem will likely intensify unless a comprehensive, coordinated, cross-jurisdictional plan is enacted to reduce phosphorus loading from nonpoint source pollution;

THEREFORE BE IT RESOLVED, that (community) shall implement, where feasible, the recommendations in the Mill Creek Subwatershed Plan to address nonpoint source phosphorus pollution, and other types of pollution identified in the Plan, and appoint a representative to the Mill Creekshed Steering Committee.

Approved on: ______________________________

Signature(s): ______________________________

Date: ______________________________

The Community Partner Agreement is available for non-governmental partners who participated in the plan development process or who wish to acknowledge support for the plan and assist in its implementation. Such groups may take the form of subdivision associations, lake associations, citizen groups, businesses, etc. A draft agreement is presented below.

Community Partner Agreement
for the Mill Creek Subwatershed Management Plan Implementation

Background
The Huron River Watershed, located in southeastern Michigan and encompassing approximately 900 square miles (576,000 acres) of Ingham, Jackson, Livingston, Monroe, Oakland, Washtenaw, and Wayne counties, is one of the State's most significant natural and cultural resources.

Important linkages exist between the basin's land and water resources and its residents' quality of life and economic well being. The watershed contains two-thirds of all southeast Michigan's public recreational lands while serving as a source of industrial water supply, hydroelectricity, and drinking water for over 140,000 of the approximately 530,000 residents. In recognition of its value, the State has officially designated 37 miles of the river and three tributaries as Michigan Department of Natural Resources Country Scenic River under the State's Natural Rivers Act (Act 231, PA 1970).

The Mill Creek Subwatershed is located in the southwest portion of the Huron River Watershed. The Subwatershed lies mostly within Washtenaw County and comprises all or portions of 11 communities. The Subwatershed also is part of the larger area defined as the Middle Huron River Watershed, which encompasses more than 300 square miles from the Mill Creek Subwatershed downstream to the Belleville Lake Subwatershed in western Wayne County.

Vision for the Mill Creek Subwatershed
Protect and restore Mill Creek, its floodplains, tributaries, wetlands, lakes and groundwater so that beneficial functions and uses are achieved and maintained.

Statement of Intent

(Community partner name) supports the environmental integrity of the Mill Creek Subwatershed and Huron River Watershed for use and enjoyment by current and future generations. Moreover, we recognize that quality of life and economic vitality are linked inextricably to the preservation, restoration, and sustainability of natural resources of the Mill Creek Subwatershed. Therefore, we support the creation of the Mill Creek Steering Committee as the appropriate body to implement the Subwatershed Plan, and (Community partner name) shall implement, where feasible, the recommendations in the Mill Creek Subwatershed Plan to address nonpoint source pollution. We understand that this agreement is voluntary and non-binding.

(Community partner name) acknowledges the importance of Mill Creek and its Subwatershed as irreplaceable yet vulnerable natural resources. Specifically:

1. *(Community partner name) acknowledges that the Michigan Department of Environmental Quality developed, and U.S. Environmental Protection Agency approved, the document "Total Maximum Daily Load for Phosphorus in Ford and Belleville Lakes," in which nonpoint source phosphorus loading to the lakes accounts for half of the annual phosphorus load to the River.*

2. *(Community partner name) acknowledges the need to improve the water quality and quantity management and to attain water quality standards through phosphorus, and other pollutant, load reductions.*

3. *(Community partner name) agrees to implement, to the greatest feasible extent, the voluntary Mill Creek Subwatershed Plan to meet TMDL targets.*

Organization: ______________________________________

Signed: ______________________________________

Date: ______________________________________

References

Adopt-A-Stream macroinvertebate and stream habitat monitoring data. 1992-2002. Ann Arbor, MI: Huron River Watershed Council.

Allen, J. D., A. J. Brenner, G. Helfand and J. Nassauer. 2001. unpublished data. Development and Testing of a Decision Support System for River Restoration. Ann Arbor, MI: University of Michigan.

American Farmland Trust. 2002. Farming on the Edge. Washington, D.C.: American Farmland Trust.

American Farmland Trust. 2001. Protecting farmland makes fiscal sense for two townships in Calhoun County. AFT, East Lansing, MI.

Assing, J. 1994. Survey of Public Attitudes -- February and July, 1994. Russian Hill Associates. San Francisco CA: Alameda County Urban Runoff Clean Water Program.

Berkholz, A. 2002. Results of Federal Bridge Inspections for channel protection and slope protection. Ann Arbor, MI: Washtenaw County Road Commission.

Brenner, A. and P. Rentschler. 1996. The Middle Huron Initiative: Phosphorus Reduction Strategy for the middle Huron River Watershed. Ann Arbor, MI: Huron River Watershed Council.

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.

Brown, W., and T. Schueler. 1997a. The Economics of Stormwater BMPs in the Mid-Atlantic Region: Final Report. Ellicott City, MD: Center for Watershed Protection.

Brown, W. and T. Schueler. 1997b. National Pollutant Removal Performance Database for Stormwater BMPs. Ellicott City, MD: Center for Watershed Protection.

Brush, L. 1996. Developing a Communications Plan: A Roadmap to Success. Ann Arbor, MI: Huron River Watershed Council.

Cave, K., T. Quasebarth, and E. Harold. 1994. Selection of Stormwater Pollutant Loading Factors. Rouge River National Wet Weather Demonstration Project.

Center for Watershed Protection. 1995. Assessing the Potential for Urban Watershed Restoration. Watershed Protection Techniques. 1(4): 166-172. Ellicott City, MD: Center for Watershed Protection.

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

Claytor, R., and T. R. Schueler. 1996. Design of Stormwater Filtering Systems. Ellicott City, MD: Center for Watershed Protection.

DaimlerChrysler, Chelsea Proving Grounds. 2002-2003. NPDES Permit Water Quality Reports.

Dakin, T.D. and J. S. Martin. 2003. The Quality of a Hidden Treasure: The Davis Creek Report. Ann Arbor, MI: Huron River Watershed Council.

Federal Interagency Stream Restoration Working Group (15 Federal agencies of the US gov't). 2001. Stream Corridor Restoration: Principles, Processes, and Practices. GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3.

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.

Fusilier, W., and B. Fusilier. 2001. Pleasant Lake Water Quality Studies, 1984-2001.

Hay-Chmielewski, E.M., P. Seelbach, G. Whelen, and D. Jester. 1995. Huron River Watershed Assessment. Lansing, MI: Michigan Department of Natural Resources, Fisheries Division.

Galli, J. August 1992. Analysis of Urban BMP Performance and Longevity in Prince George's County, Maryland. Dept of Environmental Programs, Metropolitan Washington Council of Governments.

Gangwer, M. 2003. Personal Communication. USDA NRCS Nutrient Management Specialist.

Gannon, J. 1974. Mill Creek Water Quality Evaluation for the Period 12/1/1972-11/30/1973. School of Public Health, University of Michigan, for HCMA.

Grigar, J. 2003. Personal Communication. USDA NRCS State Agronomist.

Hanson, B. 2003. Personal communication. Washtenaw Land Trust Executive Director.

Huron River Watershed Council. 2002. The Brighton Lake Subwatershed Management Plan: A Strategy to Meet the Total Maximum Daily Load for Brighton Lake.

Kosek, S. 1996. Total Maximum Daily Load (TMDL) for Phosphorus in Ford and Belleville Lakes. Lansing, MI: Michigan Department of Environmental Quality, Surface Water Quality Division.

Kosek, S. 1995. Phosphorus Loading Analysis and Proposed TMDL for Ford and Belleville lakes. Lansing, MI: Michigan Department of Environmental Quality, Surface Water Quality Division.

Lemunyon, J. 2003. Personal Communication. NRCS USDA Agronomist.

Lonik, B. 2003. Personal communication. Land Preservation Consultant.

Lower One Subwatershed Advisory Group. 2001. Lower One Rouge River Subwatershed Management Plan. Rouge River Wet Weather Demonstration Project.

Lowrance, R., L.S. Altier, J.D. Newbold, R.R. Schnabel, P. M. Groffman, J. M. Denver, D. L. Correll, J. W. Gilliam, J. L. Robinson, R. B. Brinsfield, K. W. Staver, W. Lucas and A. H. Todd. 1997. Water Quality Functions of Riparian Forest Buffers in Chesapeake Bay Watersheds. Environmental Management Vol. 21, No. 5, pp. 687-712.

McCann, E., S. Sullivan, D. Erickson, and R. De Young. 1997. Environmental Awareness, Economic Orientation and Farming Practices: A Comparison of Organic and Conventional Farmers. Environmental Management Vol.21, No.5, pp.747-758.

Michigan Department of Environmental Quality. 2003. MDEQ Website. Lansing, MI: Michigan Department of Environmental Quality.

Michigan Department of Environmental Quality, Geological Survey Division. 1984. Quaternary Geology of Michigan. Lansing, MI: Michigan Department of Environmental Quality.

Michigan Department of Environmental Quality, Surface Water Quality Division. 2002. Clean Water Act Section 303(d) List Michigan Submittal for Year 2002. Lansing, MI: Michigan Department of Environmental Quality.

Michigan Department of Environmental Quality, Surface Water Quality Division, Jackson District. September 2001. NPDES Permits in the Mill Creek Watershed. Jackson, MI: Michigan Department of Environmental Quality.

Michigan Department of Environmental Quality, Surface Water Quality Division, Jackson District. September 2001. NPDES Stormwater Permits in the Mill Creek Watershed. Jackson, MI: Michigan Department of Environmental Quality.

Michigan Department of Environmental Quality, Surface Water Quality Division. 2000. Clean Water Act Section 303(d) List Michigan Submittal for Year 2000. Lansing, MI: Michigan Department of Environmental Quality.

Michigan Department of Environmental Quality, Surface Water Quality Division. 1998. Clean Water Act Section 303(d) List Michigan Submittal for Year 1998. Lansing, MI: Michigan Department of Environmental Quality.

Michigan Department of Natural Resources. 2000. National Inventory of Dams database. Lansing, MI: Michigan Department of Natural Resources.

Michigan Natural Features Inventory. 1999. Lansing, MI: Michigan Department of Natural Resources.

Michigan Resource Information System. 1995. Lansing, MI: Michigan Department of Natural Resources.

Michigan Land Resource Project. 2001. Public Sector Consultants, Inc. for the Michigan Economic and Environmental Roundtable. Lansing, MI.

Michigan Land Use Institute. 1999. Evidence of Deep Ideological Attack on the State Wetlands Law. MLUI. Winter 1999 Great Lakes Bulletin.

Michigan State Legislature. Part 4. Water Quality Standards. Promulgated pursuant to Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Effective: December 13, 1973, Latest revisions effective: April 2, 1999.)

Morris, W. and D. Traxler. 1996. Dakota County Subwatersheds: residential survey on lawn care and water quality. Dakota County, Minnesota, Decision Resources, Ltd.

The Nature Conservancy. August 2001. Draft Landscape Project Area Strategic Plan for the Shiawassee-Huron-Clinton Headwaters and Shiawassee River (internal document).

Newman, K.R. 1999. Effects of changing land cover and human development on the fish community and hydrology of the Huron River Watershed. Doctoral dissertation. East Lansing, MI: Michigan State University.

Olsson, K.Y. and E.H. Worzalla. 1999. Advance Identification of Wetlands: Enhancing Community Wetlands Protection and Restoration in the North Fork, Mill Creek. Final Report Submitted to the U. S. Environmental Protection Agency Prepared. Ann Arbor, MI: Huron River Watershed Council.

Olsson, K.Y. 2002. Conservation Planning in the Huron River Watershed. Final Report submitted to the U. S. Environmental Protection Agency Great Lakes National Program Office. Ann Arbor, MI: Huron River Watershed Council.

Richards, P.L. 2002a. Personal communication.

Richards, P. L., and A. J. Brenner, 2002b. Potential Contributing Source Areas for Runoff in Glacial Landscapes. Submitted to Journal of Hydrology.

Richards, P. L. February 2002c. Calibrating GWLF for southeast Michigan.

Riggs, E.H.W. and D. Weiker, 2003. A Field Inventory of the Mill Creek Subwatershed. Ann Arbor, MI: Huron River Watershed Council.

Riggs, E.H.W. 2001. Personal communication.

Schaeffer, J.S. 2001. Effects of Removal of the Mill Creek Dam on the Aquatic Community, Report to Dexter Village Council and Mill Creek Dam Task Force. Dexter, MI.

Schueler, T. 1994. The Importance of Imperviousness. Subwatershed Protection Techniques 1 (Fall 1994). Ellicott City, MD: Center for Watershed Protection.

Schueler, T. R. and H. K. Holland. 2000. The Practice of Watershed Protection. Ellicott City, MD: Center for Watershed Protection.

Seelbach, P. W. and M. J. Wiley, November 1996. An Assessment of the Potential for Ecological Rehabilitation and Restoration in Mill Creek. Ann Arbor, MI: Huron River Watershed Council.

Sheehan, H. 1999. Imperviousness Reduction and Mitigation in Tributaries of the Huron River: A Stormwater Management Study of Ann Arbor, Scio and Superior Townships. Ann Arbor, MI: Washtenaw County Drain Commissioner's Office.

Southeast Michigan Council of Governments. 2002. Community Profiles at http://www.semcog.org.

Swan, C. 1999. A Survey of Residential Nutrient Behaviors in the Chesapeake Bay. Widener-Burrows, Inc. Chesapeake Research Consortium. Center for Watershed Protection. Ellicott City, MD.

Syferd, E. 1995. Water Quality Consortium. Research Summary Report. Seattle, WA.

Tetra Tech MPS. 2002. Stormwater BMP Prioritization Analysis for the Kent and Brighton Lake Sub-Basins, Oakland and Livingston Counties, Michigan. Ann Arbor, MI: Huron River Watershed Council.

Tilton and Associates, Inc. 2002. Stormwater Management Structural Best Management Practices – Potential Systems for Millers Creek Restoration. Ann Arbor, MI.

U. S. Census Bureau. 2002. 2000 Census at http://www.census.gov/.

U. S. Department of Agriculture, Natural Resource Conservation Service. May 1997. Southeast Michigan River Basin Report.

U. S. Department of Agriculture, Natural Resource Conservation Service. March 1997. Mill Creek Subbasin Resource Plan. Southeast Michigan River Basin Study.

U. S. Department of the Interior, U.S. Heritage Conservation and Recreation Service. 1979. Mill Creek Metropark Final EIS.

U.S. Environmental Protection Agency, Office of Water. 2002. National Menu for Best Management Practices for Storm Water Phase II.

U. S. Environmental Protection Agency, Office of Water. accessed 2003. Storage and Retrieval (STORET) Water Quality Database. http://www.epa.gov/ow.

U. S. Environmental Protection Agency, Office of Water. 2000a. Nutrient Criteria Technical Guidance Manual: Lakes and Reservoirs, 1st Edition. Report No. EPA-822-B00-001.

U. S. Environmental Protection Agency, Office of Water. 2000b. National Nutrient Guidance Manual: Rivers and Streams, Water Quality Criteria and Standards, http://www.epa.gov/ost/criteria/nutrient/guidance/rivers/index.html.

U. S. Environmental Protection Agency. 1980. Modeling Phosphorus Loading and Lake Response under Uncertainty: A Manual and Compilation of Export Coefficients. EPA 440/5-80-011.

U. S. Geological Survey. 2003. http://www.usgs.gov.

Village of Chelsea, Michigan. 2002-2003. NPDES Permit Water Quality Reports.

Village of Dexter, Michigan. 2002-2003. NPDES Permit Water Quality Reports.

Washtenaw County, Department of Environment and Planning. 1998. Geographic Information Systems data.

Washtenaw County, Drain Commissioner's Office. 2002. Township Drain Maps.

Washtenaw County, Drain Commissioner's Office. 1998-2002. Drain Inspection and Maintenance Reports.

Washtenaw Development Council. October 2001. www.wdc-econdev.com/who.html.

Wiley, M. and J. Martin. 1999. Current Conditions, Recent Changes, and Major Threats to the Huron River: A Report on Eight Years of an Ongoing Study. Ann Arbor: Huron River Watershed Council.

Wolf, J. 2002. Marketing the Environment – Achieving Sustainable Behavior Change through Marketing. Ann Arbor, MI: Huron River Watershed Council.

Wuycheck, J. 1983. A Qualitative Biological Assessment of Letts Creek and N. Fork Mill Creek in the Vicinity of the Chelsea Wastewater Treatment Plant, Washtenaw County, August 12, 1982. Lansing, MI: Michigan Department of Natural Resources, Surface Water Quality Division.