Acknowledgements

This Nonpoint Source Pollution Control project has been funded in part through the Michigan Nonpoint Source Program by the United States Environmental Protection Agency under assistance agreement [C9975474-01] to the Regents of the University of Michigan for the project. The contents of the document do not necessarily reflect the views and policies of the EPA, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

South Branch Flint River Watershed Management Plan

Table of Contents

Introduction

WHAT IS A WATERSHED

A watershed is any area of land that drains to a common point. That common point may be a lake, the outlet of a river, or any point within a river system. Throughout this Watershed Management Plan, the terms basin, sub-basin, watershed, sub-watershed, and catchments are used to describe the drainages of the river.

The largest watershed management unit is the basin. A basin drains to a major receiving water, such as a large river, estuary or lake. Within each basin are a group of sub-basins, that are a mosaic of many diverse land uses, including forest, agriculture, range and urban areas. Sub-basins are composed of a group of watersheds, which, in turn, are composed of a group of sub-watersheds. Within sub-watersheds are catchments, which are the smallest units in a watershed, defined as the area that drains an individual development site to its first intersection with a stream (Figure 2.2 and Table 2.1) (Center for Watershed Protection).

Table 1 Description of the Various Watershed Management Units

Watershed Management Unit	Typical Area (square miles)	Influence of Impervious Cover	Sample Management Measures
Catchment	0.05 to 0.50	Very strong	Best Management Practices (BMP) and site design
Sub-watershed	1 to 10	Strong	Stream Classification and management
Watershed	10 to 100	Moderate	Watershed-based zoning
Subbasin	100 to 1,000	Weak	Basin planning
Basin	1,000 to 10,000	Very weak	Basin planning

(CWP, 1998)

In Michigan's Flint River system, the South Branch Watershed drains into the larger Flint River Sub-basin that ultimately drains into the Saginaw River Basin. The Saginaw River ultimately terminates at the Saginaw Bay and Lake Huron The South Branch Watershed begins in Oxford Township in northern Oakland County and flows north through Metamora, Dryden and Lapeer Townships. The headwaters of the South Branch of the Flint River also conveys water carried by streams that drain portions of Addison Township in Oakland County and Attica Township in Lapeer County.

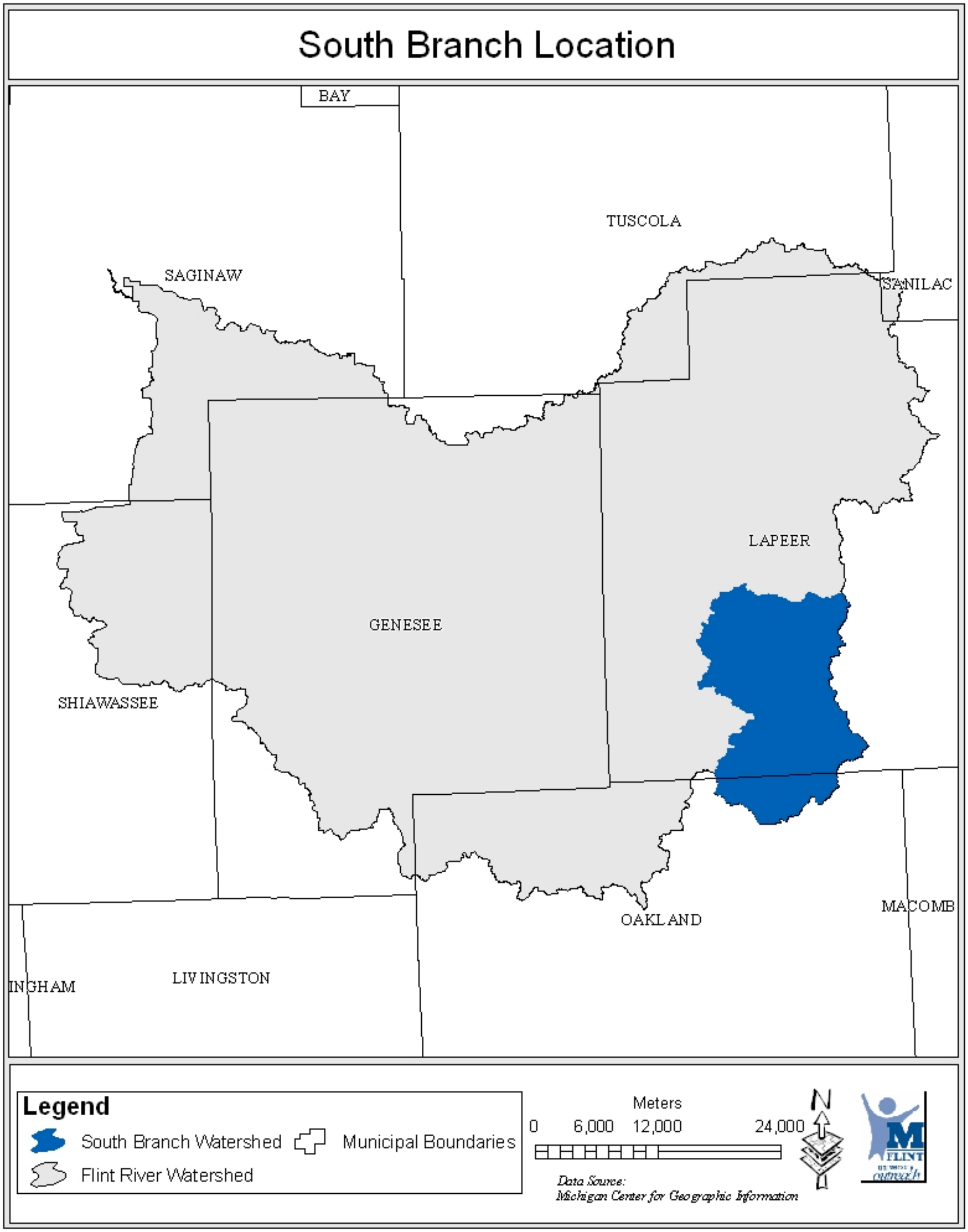


Figure 1: Location of South Branch Flint River Watershed

The Need for Management of the South Branch Headwaters Area

It is commonly accepted among water quality professionals working in the Flint River Watershed that the South Branch Watershed (SBW) is potentially the "healthiest" sub-watershed within the sub-basin because of its hydrologic stability, in-stream habitat and biologic diversity. The health of the watershed and its location in rapidly developing southeast Michigan, places the watershed at great risk of degradation. Recent research has identified the Flint River South Branch as one of the most threatened watersheds in the state based upon projected land use changes and existing water quality (Whylie 06). The threat of rapid water quality reduction from urban expansion has led stakeholders to look for tools to preserve and maintain the community's high quality water resources. In order to achieve this, the University of Michigan-Flint's Center for Applied Environmental Research in partnership with the Flint River Watershed Coalition received funding from the MDEQ Non-Point Source Pollution Program (NPS) to develop a watershed management plan (WMP) in cooperation with the communities in the watershed.

Watershed Plan Structure and Purpose

This watershed plan is intended to be used by a wide variety of stakeholders and it is structured so that the main body of the plan is user-friendly and easily understandable. Throughout the watershed plan are "Key Findings" that are of particular importance to the successful management and protection of the watershed. Scientific explanations, methods and assessments have been placed in a series of appendices for those individuals who would like more specific information about the planning process and its scientific basis.

The purpose of the South Branch Watershed Management Plan is to catalog the current conditions impacting the water quality and to identify actions that can be taken to resolve existing problems and prevent future degradation of water resources. It is built around the concept of designated uses, as the primary criteria for water quality, according to Michigan's Department of Environmental Quality, is whether the water body meets certain designated uses. The Water Resources Commission Act (P.A. 451 of 1994, Part 31, Chapter 1) requires all waters of the State of Michigan to be of the quality to meet eight designated uses (2000). According to this legislation all surface waters of the state of Michigan are designated for and shall be protected for all of the following uses:

1. Agriculture
2. Industrial water supply
3. Public water supply at the point of intake
4. Navigation
5. Warmwater fishery (Some waterbodies are also protected as a coldwater fishery)
6. Other indigenous aquatic life and wildlife
7. Partial body contact recreation
8. Total body contact recreation between May 1 and October 1

In addition to identifying pollution concerns the plan also provides recommendations on how to use Best Management Practices (BMPs) to restore and protect the water quality in the watershed. A BMP is a land management practice that landowners and municipalities implement to control sources or causes of pollution. There are three types of BMPs that treat, prevent or reduce water pollution. These include:

- Structural BMPs: “brick and mortar” practices that require construction activities to install, such as storm water basins, grade stabilization structures and rock rip-rap
- Vegetative BMPs: that use plants including grasses, trees, and shrubs to stabilize eroding areas
- Managerial BMPs: that involve changing the operating procedures

In addition to BMPs implemented at specific sites, management practices can also be implemented across political boundaries, such as the case with local land use and construction ordinances. The foundation for implementation of multi-jurisdictional management in this watershed is the Greenlinks program. Greenlinks is a planning and technical assistance program based on the concepts of green infrastructure that works to build the capacity of communities and conservation organizations. The Greenlinks program has worked with the planning team to identify Potential Conservation Areas (PCA) in the watershed. These PCAs are valuable to the health of animal and plant communities as well as water quality conditions. Similar PCAs also have been developed by Oakland County covering that portion of the South Branch watershed. Unlike any other watershed plan in the Flint River watershed, this one superimposes PCAs over parts of the watershed where designated uses are threatened as well as parts where designated uses are already impaired. This provides a watershed-wide framework municipalities can use to select the proper preservation or remediation BMPs and policies for individual sub-watersheds. The Lapeer and Oakland PCAs also bring the SBW Management Plan into a regional preservation effort that can help it tie into other watershed management plans, green space preservation, and master planning. Specific recommendation the integration of the GLS GReenLinks green infrastructure plan are identified in Appendix 2 as well as in the implementation work plan.

Watershed Description

Understanding of the physical characteristics of a watershed is important in order to identify priority pollutants, source areas, and specific causes of pollution affecting it. The following section of the watershed management plan is intended to provide information about the historic, current and future physical condition of the South Branch Flint River Watershed. In order to characterize the physical condition of the South Branch, CAER and its partners engaged in several activities including literature reviews of previous research, geographic information systems analysis, physical inventory activities and a public input process. A summary of these findings are presented in this section of the plan along with information about their relevance to future management activities. Detailed information about topics can be found in the various appendices that accompany this plan. Specific implementation activities based upon these findings are presented in the implementation work plan section.

Geography

The South Branch Watershed (SBW) begins in Oxford Township in northern Oakland County and flows north through Metamora, Dryden and Lapeer Townships. The stream also conveys water carried by streams that drain portions of Addison Township in Oakland County and Attica Township in Lapeer County. (Figure X) The Flint River South Branch Headwaters is composed of nine sub-watersheds. These include:

- Mirror Creek
- Hunters Creek
- Flint River Main Branch
- Pine Creek
- Pine Creek Headwaters
- South Branch Headwaters
- Whigville Creek
- Unnamed Creek
- Whigville Lake Watershed

The watershed also contains numerous small lakes and ponds. The number and types lakes and ponds are identified in Appendix 3.

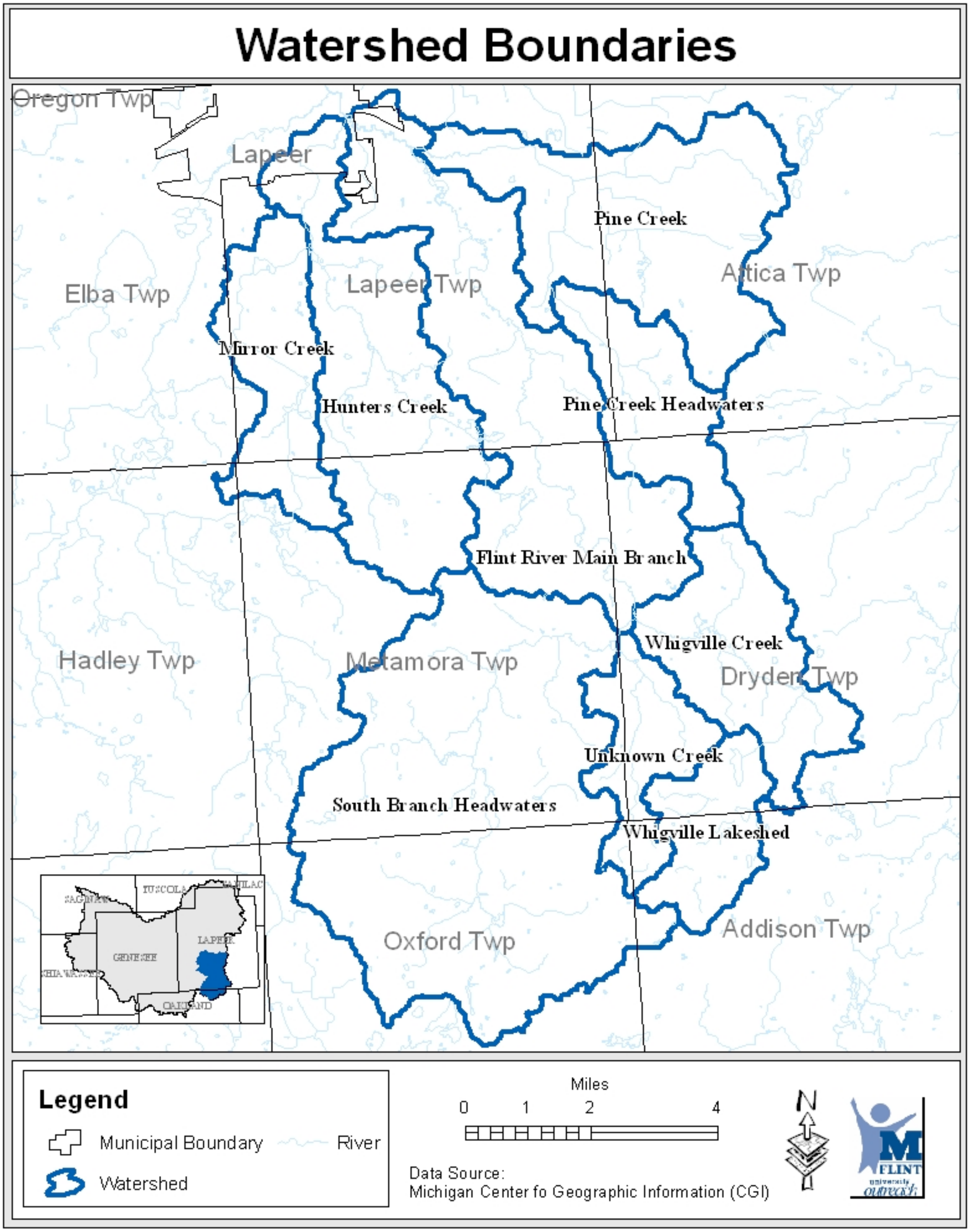


Figure 2. Sub-watersheds of the South Branch

Geology and Soils

The geology and soils of the South Branch Watershed are important to consider in this watershed management plan because it affects: (1) hydrology (2) temperature regime and (3) the feasibility of certain Best Management Practice (BMP) installations. Joe Leonardi (2001) summarized the importance of the geology and soils relationship to hydrology and water temperature of the Flint River when he wrote that:

> *Soil texture and particle size determines soil permeability to water. For example, water will percolate at a higher rate through coarse textured sand and gravel than it will through fine textured clay and silt. Permeable soils, if associated with topographic relief (usually moraines), can have high ground water elevation resulting in ground water inflow to a stream. Streams with high ground water inflow are typically cooler and have more stable flow regimes. Less permeable soils, high in clay content, produce greater surface water runoff resulting in unstable stream flow.*

The geology and soils of a watershed also influence the ability of stakeholders to successfully implement certain BMPs. The types and location of soils often determine what managerial, structural or vegetative activities are feasible. For example, specific geologic landforms and soils contain highly permeable soils that are more suitable for the installation of BMPs that function to increase infiltration. Likewise some soils types are susceptible to extensive erosion if managed incorrectly and need to be planned for with particular strategies in mind.

In this section of the watershed plan, information about the general soils and geologic nature of the watershed is presented along with key points to be considered in managing soils to protect water quality. This review does not provide the site-specific information required for the installation of some specific BMPs. The information provided here is intended to provide individuals who are implementing recommendations of the watershed management plan with a basis of information from which to begin a site-specific investigation prior to the installation of BMPs.

Geology and soils of the South Branch Watershed

The geology and soils of the South Branch Watershed are dominated by the remnants of glacial activity that took place between 10,000 and 13,000 years ago. Review of the geology and soils of the South Branch watershed identified several key points that need to be considered in the management of the watershed. These are related to the geology and soils impacts upon the hydrology of the watershed, the presence of significant amounts of highly and potentially highly erodable soil and the location of soils with moderate to severe limitations for septic system installations.

Infiltration capacity
The geology and soils of the South Branch Watershed play a large role in the hydrology of the watershed. The upstream portion of the watershed contains a large number of high infiltration soils. These soils are directly responsible for infiltrating precipitation and feeding the upper reaches of the watershed with groundwater inflow that function to moderate flows and maintain a cool water temperature regime.

- Key Point: Protection of these areas is extremely important to maintain existing high water quality. This area of the watershed provides the largest opportunity to affect the temperature regimes by implementing BMPs to increase infiltration and protect existing land uses. See Implementation section for specific BMPs.

Highly Erodable Lands

The United States Department of Agriculture Natural Resource Conservation Service maintains a data set identifying soils that are highly erodable or potentially highly erodable. The erodablity of soils is based upon two primary factors consisting of the physical properties of the soil and the slope of the soil. When these soils are disturbed by agricultural or construction activities they pose a potential threat to water quality from erosion and sedimentation. Several of the watersheds within the South Branch Watershed contain significant percentages of highly and potentially highly erodable soils. The Whigville Lake Watershed (28%), Unnamed Creek (27%) and South Branch Headwaters (15%) watersheds are most threatened by highly erodable lands. The relationship of these soils to land use is a key factor to consider in their management and protection. Both the Whigville Lake and Unnamed Creek Watersheds contain significant percentages of agricultural land with Whigville Lake at 28%, Unnamed Creek at 35% and South Branch Headwaters at 38%.

- Key Point: the Unnamed Watershed, Whigville Lake Watershed and South Branch Headwaters contain significant amounts of highly and potentially highly erodable soils. The combination of these highly erodable soils and moderate amounts of agricultural land uses result in a threat to water quality. Managerial, Vegetative and Education activities should take place to reduce these threats. Specific BMPs are identified in the Implementation section of the watershed plan.

Septic Limitations
Soils are a key factor in the proper functioning of onsite septic systems. Onsite septic systems installed in areas with poor soils are prone to problems and failures that can result in increased nutrient and bacteria loading to local waters.

- Key Point: The South Branch Watershed contains large areas identified as moderately to severely limited with regards to septic system installation and function. This combined with the lack of sanitary sewers in almost the entire watershed poses a potential threat to water quality. Communities in the watershed should work to adopt ordinances that require time of sale septic inspections. Communities also may want to use the septic suitability map provided in

Appendix 8 as a tool for future land use planning. A public education campaign would be useful to increase landowner awareness on the importance of properly maintaining their septic system. Specific ordinances and education activities are identified in the implementation section of the watershed plan and in Appendix 1.

Land Cover, Growth Trends and Population Density

By definition a watershed is the area of land that drains to a particular water body. As such, land use has a tremendous impact upon water quality. Because of the importance of linkages between land use and water quality, the planning team felt it important to examine the historic, current and future potential land use makeup of the Flint River South Branch Watershed. (Appendix 1).

Our observations revealed that the South Branch watershed has managed to avoid many of the negative water quality impacts that have been associated with rapid urban expansion in the southeast Michigan region. The largely rural area has maintained relatively stable land uses over the past decade but continues to face threats from urban expansion. (Michigan Land Transformation Model) The existing land covers, however have had some impacts on the water quality. Our observations revealed the most significant impacts are from agricultural land uses in the lower portion of the watershed. Based upon our experience we assert the largest future threat to the watershed is urban expansion from the southern portions of the watershed and along the M-24 corridor (see Figure 2-4 and 2-5). The following section of the watershed plan summarizes the major land use issues that are impacting the watershed. Specifics about the methods used to analyze and develop conclusions are included in Appendix 1. Specific BMPs to address these threats are included in the watershed implementation work plan.

Figure 3: M-24 road expansion

Figure 4: M-24 stream crossing

Agricultural Land Cover

- Agricultural land dominates the sub-watersheds of the SBW. This land use makes up approximately 50% of the land area within the watershed. The Pine Creek sub-watershed contains the highest percentage of agricultural land use at 57%. This is followed by Mirror Creek (49%), Flint River Main Branch (48%), Pine Creek Headwaters (37%), South Branch Headwaters (37%), Unnamed (35%), Whigville Creek (31%) and Whigville Lake (28%) respectively. The high percentage of agricultural landuses in the Pine Creek and Mirror Creek Watersheds also are coupled with the two lowest percentages of forested land uses in the watershed. Pine Creek's forest lands account for approximately 20% of the subwaterehed, and Mirror Creek's forested land is 22%.

- Key Point:
  The combination of high percentages of agricultural lands and reduced forest lands in the Pine Creek and Mirror Creek Watersheds are negatively impacting water quality. The land use combined with the drainage and ditching practices in the area appear to be increasing sediment delivery and hydrologic perturbations resulting in reduced water quality in these portions of the watershed. Figure 2-6 exemplifies these conditions. Specific recommendations for mitigating these impacts are presented in the implementation portion of the watershed plan including education, buffer strips and reforestation activities.

Figure 5: Pine Creek flowing through agricultural land (note lack of buffer on left bank)

Urban Land Uses

Urban land uses within the SBW land use has remained relatively stable from 1995 to 2000 with little to no significant increases in urban land use. The highest percentage of urban land uses are located within the Hunters Creek (6%), South Branch Headwaters (5%) and Mirror Creek (4%). These relatively higher percentages are associated with the Oxford urban center and the M-24 corridor.

- Key Point:

  Continued increases in urban land use poses a significant threat to future water quality within the SBW and are a major focus of the BMPs and education activities of this plans implementation section.

Riparian Corridor

The total amount of a particular land use impacts water quality in a watershed. Similarly, the location of that land use class will influence its impact on the health of the watershed. Research has shown that riparian lands, areas directly adjacent to the creek, are important in regulating flow, trapping sediment and providing critical habitat. These riparian areas often extend beyond the boundaries of the floodplain and act as a transition between aquatic and terrestrial environments (Forman and Wilson, 1995).

As part of the land use analysis of the South Branch Watershed, the planning team analyzed the land use within a 150 ft buffer from the center of a river or stream. The results of that analysis are located in Appendix 1. The analysis points to Pine Creek having the most significantly impacted riparian corridor with 53% of the riparian corridor in agricultural land covers. This is almost double that of Mirror Creek, which has 29%.

- Key Point:

The riparian corridor of Pine Creek and Mirror Creek and to a lesser extent Hunter's Creek are negatively impacting water quality through the introduction of agricultural sediments and increased solar radiation. Significant effort should be placed in management of the riparian corridor in order to restore the impacted and threatened cold water fishery and protect other designated uses in the Pine Creek Watershed. In addition efforts should be taken in the remainder of the watershed to protect the existing riparian corridors.

Hydrology
General
To understand the hydrology of the South Branch Watershed one needs to know how water moves through the drainage system. Reviewing information about the volume and rate at which water travels through the system before, during and after rain events can help us understand how the hydrology of the South Branch Watershed affects water quality. Appendix 3 contains specific information about the methods used to assess the hydrology of the South Branch Watershed

Hydrology of the South Branch Watershed
The hydrology of the South Branch Watershed appears to be relatively stable. The low percentages of urban land uses and historic stable land use has protected the watersheds hydrology from significant degradation The watershed is most hydrologically stable in the headwater reaches including the South Branch Headwaters, Unnamed, Whigville Creek, Pine Creek Headwaters and Flint River Main Branch. These areas hydrology are regulated by significant groundwater inflow.   The high ground water inflow is a direct result of the high percentage of permeable soils (hydrologic soil groups A and B) and the undulating landscape of this region of the watershed. The lower section of the watershed including Mirror Creek, Hunters Creek and Pine Creek exhibit less stable hydrology due to significant draining and ditching practices and higher percentages of agricultural land.

- Key Point:
  The stable hydrology of the upper reaches of the South Branch Watershed should be a priority for preservation. Preserving this hydrology can be done through the combination of private land preservation, natural feature setback and increases in the use of storm water management techniques that encourage infiltration. Communities may want to adopt local ordinances that require construction sites to not increase offsite runoff beyond pre-development states.

- Key Point:
  The hydrology of the Pine Creek Watershed and Mirror Creek are impacting and/or threatening designated uses. Efforts should be made to mitigate historic alterations to the hydrology. This can be achieved through a combination of BMPs that include wetland restoration, alternative drain and ditch design, and improvements in riparian corridor management.

Wetland Functionality Assessment
A functional wetland assessment was developed to serve as a watershed level analysis of wetland function in the South Branch Watershed. Previous assessments of wetlands in the South Branch Watershed (SBW) relied on simple calculation of area gained and lost over time. This assessment seeks a detailed understanding of the functional changes in the wetland communities of the SBW from 1800 to 1998. Watershed scale assessments of wetland functions rely on geospatial data and geographic information systems (GIS). The analysis was based on landscape and watershed-level functional wetland assessment methods developed by the United States Fish and Wildlife Service (USFWS) in the Northeastern US (Tiner, et al) . These methods involved enhancing the National Wetland Inventory (NWI) by adding descriptors for landscape position, land-form, and waterbody type (LLWW) and then applying correlations between wetland characteristics and functions (Tiner, Assessing cumulative Loss of Wetland Functions in the Nanticoke River Watershed Using Enhanced National Wetlands Inventory Data, 2005). Wetlands of potential significance were identified for five different functions: surface water detention, streamflow maintenance, nutrient transformation, sediment and other particulate reduction, and shoreline stabilization. Wetland data from 1800 and 1998 were compared to quantify the functional changes in the SBW wetland community. Below are the key findings from the study. Specific methods, maps, data tables can be found in Appendix 4.

- Key Point:

According to the 1800 wetlands data, 1,350 wetlands occupied 20% of the FRSBW. By 1998, the total land area occupied by wetlands in the FRSBW had decreased to 16% . The number of wetlands increased to 2,151. From 1800 to 1998, there was a total wetland area loss of 17% in the FRSBW. This loss was conservative when compared to more urbanized watersheds.

- Key Point:

Losses in the total area of wetlands performing all five functions ranged from 22 to 36% decreases. Wet-lands performing sediment and other particulate reduction exhibited the greatest decrease at 36% while the other four functions ranged between 22 and 24% losses in total area.

- Key Point:

The evaluation of functional units showed that potential functional capacity of the SBW had been reduced for all five wetland functions. The capacity for stream flow maintenance and shore-line stabilization had been impacted the most with reductions of 29 and 24% respectively. The watershed capacity to reduce sediment and other particulates had been reduced by 14%. Less substantial reductions in the wetland community’s capacity to transform nutrients and detain surface water were seen at 9 and 3% respectively. There were no increases in functional capacity.

- Key Point:

From 1800 to 1998, there was a 14% decrease in sediment reduction capacity, 24% decrease in shoreline stabilization, and a 29% decrease in stream flow maintenance capacity. Future wetland restoration and conservation efforts may target wetlands with high capacity to reduce sediment, stabilize shorelines and stream flow.

Water Quality Summary

Water quality standards for water and sediment chemistry, biological integrity, and physical habitat are generally being met however, some drains and tributaries have been identified impaired. (Leonardi 2001) Biological integrity and physical habitat of lower Pine Creek has been compromised due to ditching resulting in the loss of a brook trout fishery, a reduction of intolerant macroinvertebrates, increased water temperatures, and physical habitat loss. Elevated bacteria levels and nutrient loading from suspected failing septic systems, sewage lagoon discharge, and other non-point sources are a concern in unidentified drains located in Metamora, and Lapeer townships in Lapeer County (MDEQ 2000).

Wigvhille Creek, Whigville Lake, Pine Creek Headwaters and South Branch Headwaters maintains good biological integrity with high fish and macroinvertebrate diversity. Water and sediment chemistry values fall within the range considered acceptable for the Southern Michigan Northern Indiana Till Plain Ecoregion (Leonardi 2001). Stream flow is stable with moderate groundwater inflow. Pine Creek Headwaters was found to be meeting Water Quality Standards and designated uses. No fish or wildlife contaminant information is available for any of the sub-watersheds.

Sub-Watershed	Impaired Uses	Threatened Uses
Mirror Creek	**None**	**Warm Water Fish, Aquatic Life, Partial Body Contact**
Hunters Creek	**None**	**Warm Water Fish, Aquatic Life, Partial Body Contact**
Flint River Main	**Cold Water Fish**	**Full Body Contact**
Pine Creek	**None**	**Warm Water Fish, Aquatic Life**
Pine Creek Headwaters	**None**	**Cold Water Fish**
South Branch Headwaters	**Cold Water Fish**	**None**
Whigiville Creek	**None**	**None**
Whigville Lake	**None**	**None**
Unnamed Creek	**None**	**None**

Figure 9. Designated Use Attainment and Threats by Sub-watersehd

Implementation Strategy

Identification of Critical Areas

A critical area is a section of the watershed that contributes or has the potential to contribute a majority of the pollutants that impact water quality. Identifying critical areas reduces the geographic scope of watershed planning and implementation activities. In the South Branch Watershed we have identified two types of critical areas including preservation critical areas and restoration critical areas. Preservation critical areas consist of areas within the watershed that have positive impacts on water quality or have the potential to reduce water quality if management inappropriately. Preservation Critical areas are larger and more widespread in the South Branch Watershed and require a range of proactive policies and education activities to protect them. Preservation of these critical areas should be the major focus of both short and long term implementation activities. Restoration critical areas consist of areas within the watershed that are currently contributing a majority of the pollutants that are impairing or threatening designated uses. These areas are not extensive in the South Branch Watershed but are considered to be a moderate priority for short-term implementation activities.

Preservation Critical Areas

The lack of a large amount of restoration critical areas is not unexpected based upon the high water quality of the South Branch sub-watershed and the land use make up within the area. The lack of restoration needs in the watershed does not however indicate that watershed management activities are unnecessary. Recent research has indicated that the Flint River South Branch watershed is one of the most highly threatened watersheds in Michigan (Wyllie 06). Therefore, in addition to identifying critical areas contributing a majority of the pollutants affecting the water quality of the South Branch, the planning team felt it important to identify areas that if managed inappropriately would significantly reduce water quality. These include both areas that provide benefits to water quality such as high infiltration-rate soils and areas that have the potential to impact water quality such as highly erodable soils and soils that have significant limitations for septic system installations.

Pine Creek Headwaters

Our investigation revealed that the headwaters of Pine Creek contain high water quality. In spite of being a designated drain, this watershed maintains cold water conditions and contains a self-sustaining Brook Trout population. This high water quality appears to result from a combination of high groundwater inflow and land use within the watershed and it's riparian corridor. . Protection and enhancement of this watershed can be achieved by implementing several vegetative and managerial BMPs. Specific BMPs and education measures to address these pollutants and threats are identified in the Implementation Work Plan.

Special soil areas

In addition to specific watersheds that are identified as critical areas there are distinct regions of the watershed that are considered critical areas because of their physical properties and relationship to water quality. These consist of areas that have highly erodable soils, soils with high infiltration rates and soils that are moderately to severely limited with regards to septic system function. These areas are identified in figures 6-8 and Specific BMPs and education measures to address these areas are identified in the Implementation Work Plan.

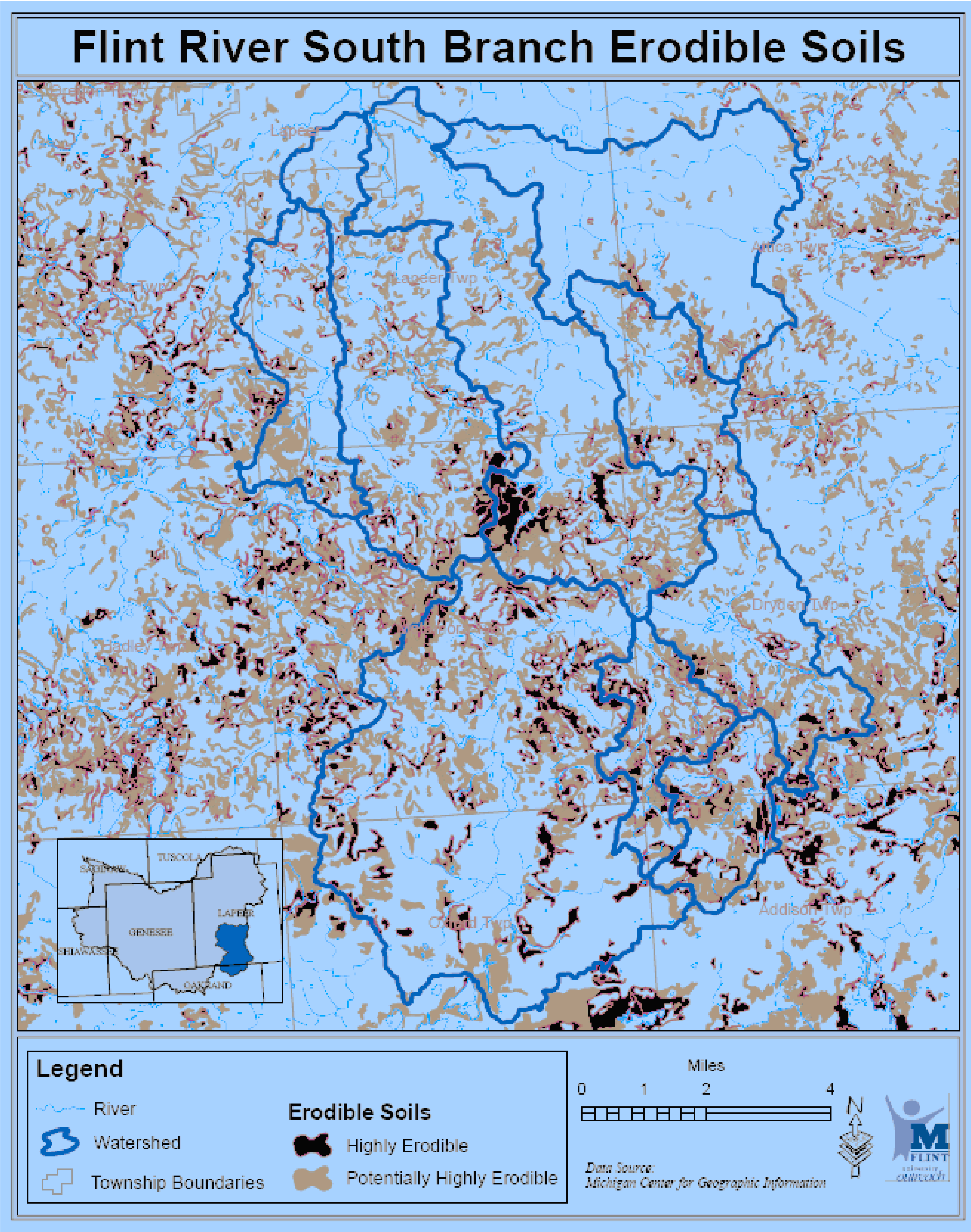


Figure 6. Highly and Potentially Highly Erodable Soils

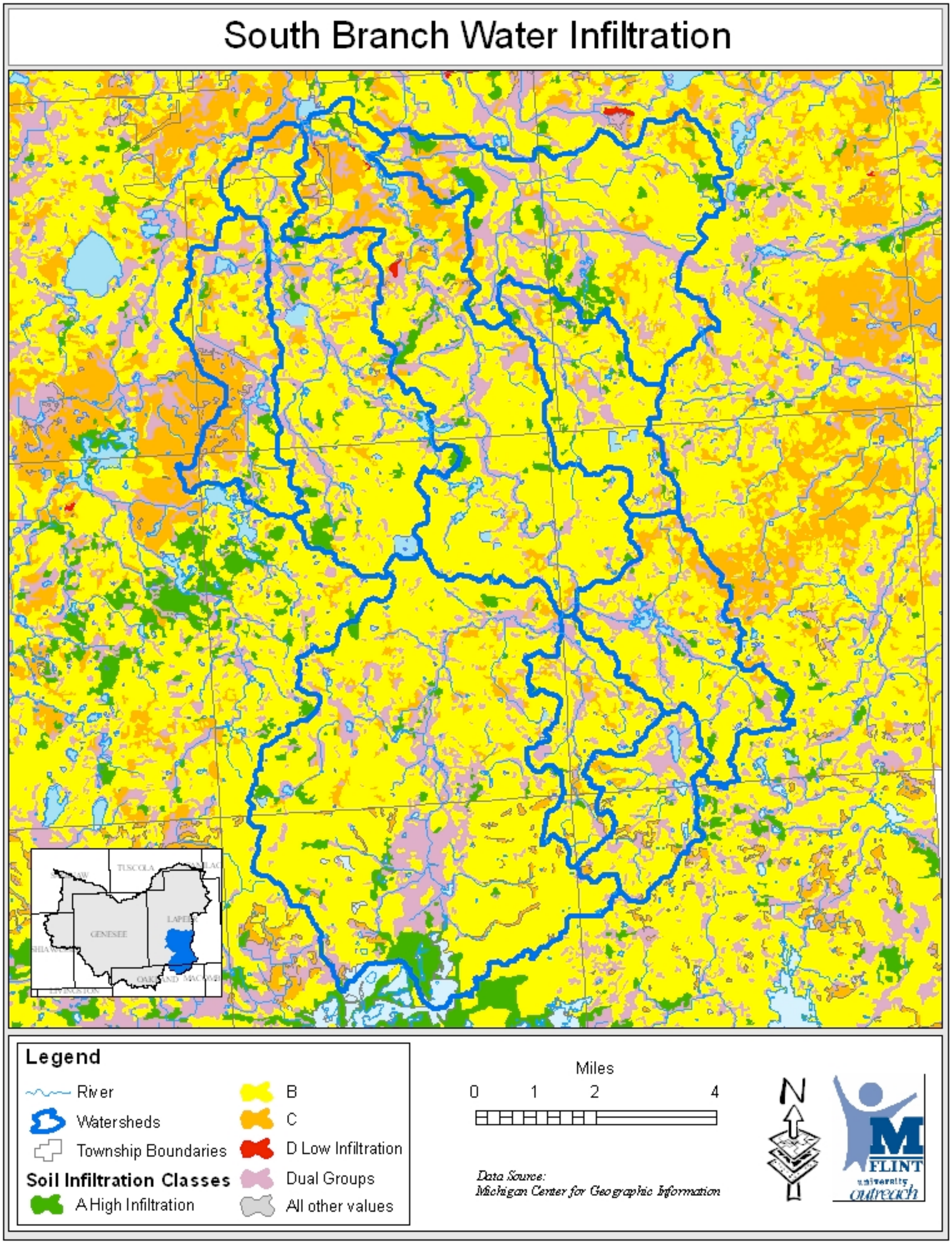


Figure 7. Water Infiltration (Hydrologic Soil Groups)

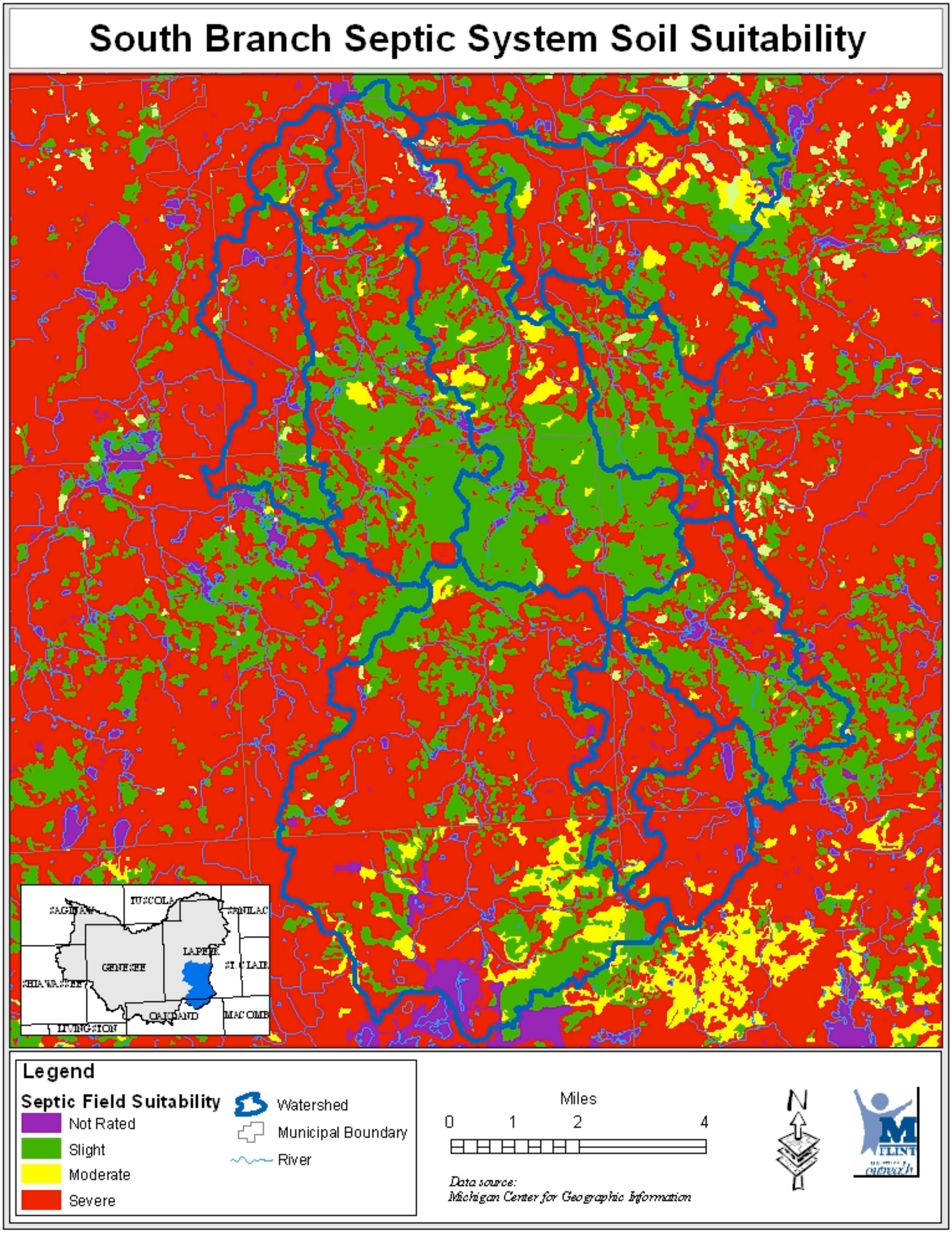


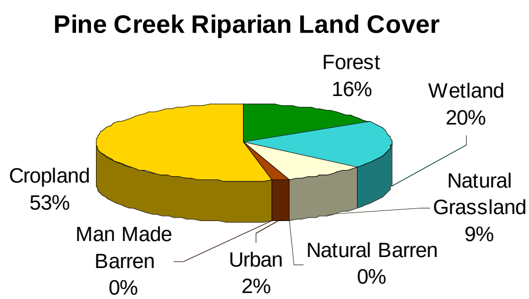
Figure 8. Septic Suitability Limitations

Restoration Critical Areas

Pine Creek, Mirror Creek and Hunters Creek Riparian Corridors

A review of the physical condition, water quality information, and observations made in the physical inventory process point to several restoration critical areas including the Pine Creek, Mirror Drain and Lower Hunters Creek riparian corridors. Our review has identified these corridors are the source areas for a majority of the pollutants that are currently impacting water quality within the watershed. The current condition of these corridors is responsible for introducing excess sediment and thermal inputs into these sub-watersheds and their receiving waters. These corridors are also suspected to be responsible for introduction E.coli, Nutrients and pesticides to the sub-watersheds.

The riparian corridor of the Pine Creek watershed is the highest priority for restoration. Pine Creek's riparian corridor has been significantly altered by human activity. Most notable is the percent of agricultural cropland within the 300 ft buffer used to examine the watersheds riparian corridors. This riparian corridor is also suspected to contain several gully erosion sites that are typical in the area. Pollution loading calculations were also conducted for these restoration activities. Restoration activities focused on the riparian corridor in Pine Creek will function to increase the possibility of restoring a previously destroyed cold water fishery and protect other designated uses.



The Mirror Creek and Hunters Creek riparian corridors are the second priority restoration critical area within the watershed. These sub-watersheds also have significant inputs of sediment and nutrients from agricultural activities within the 300ft buffer and isolated stream bank erosion sites. They are considered second priority to the Pine Creek corridor because they don't possess the opportunity for cold water fishery restoration. Specific location for restoration activities and pollution loading calculations are included in appendix 7.

Beyond the riparian corridors of the Pine, Mirror and Hunters Creek Watershed most restoration activities are scattered throughout the watershed at isolated locations. These locations consist of storm water runoff from commercial development along the M-24 and wetland destruction that has taken place since human settlement throughout the watershed. The extent and nature of this wetland loss is discussed in appendix 4.

Specific BMPs and education measures to address both the first and second priority Critical Areas are presented in the Implementation Work Plan.

Implementation of the watershed plan in intended to restore impaired designated uses and protect those that are threatened. A successful implementation plan will involve the development of goals, objectives to meet those goals and the tasks to complete objectives. Using a framework that identifies goals, objectives and tasks ensures that there is a direct linkage between the numerous tasks outlined in the implementation work plan and achieving the goals established to impact designated use attainment.

The implementation goals for the South Branch Watershed Plan include:

1. Reduce the impact of priority pollutants in restoration critical areas to restore impaired designated uses.
    a. Increase the use of govt. programs, private land conservation and education programs to encourage and implement buffer strips and improved riparian corridor management
    b. Mitigate all suspected gully erosion sites
    c. Mitigate known and suspected road surface runoff locations
    d. Improve the management of urban and agricultural runoff to reduce sediment introduction to Critical Area stream segments
    e. Improve the management of "drains" to support designated uses

2. Sufficiently protect/manage conservation critical areas that pose potential threats to designated uses if unmanaged/mismanaged
    a. Assist communities to plan for and implement policies that improve storm water management in high infiltration areas of the watershed
    b. Assist communities to plan for and improve policies that address soils posing moderate to severe septic system limitations
    c. Assist communities and individuals to appropriately manage soils that are considered highly erodable or potentially highly erodable
    d. Integrate private land conservation and progressive planning strategies into community planning activities

3. Promote and establish educational programs that support watershed planning goals, objectives and tasks, and increase stewardship.
    See Education Implementation Strategy Appendix 6 for details of education plan

See attached Excel file for Implementation Workplan, BMPs and Midterm Milestones

Public Involvement and Education Plan
Public Engagement

Public participation is a vital part of the watershed implementation process. Continuous public input and dialogue is needed to ensure the watershed plan is up to date and representative of all needs in the watershed. Throughout the watershed planning process CAER worked to gather public participation. CAER contracted with the Flint River Watershed Coalition (FRWC) to conduct the public input portion of the South Branch Watershed Management Plan. The public input program was conducted in three stages:

Stage 1 – Grass Roots Outreach

CAER and FRWC staff made several early visits to the FRWC's Lapeer Committee to explain the watershed planning process. Through these meetings the planning process was explained to residents, county parks staff, conservation district staff, local educators and members of the business community. Initial water quality concerns and opportunities for the watershed planning process were identified. Simple education materials highlighting the South Branch Project were prepared by the committee. This material was distributed at local events and festivals in an effort to spread the word and elicit feedback about the condition of the river from local citizens.

Stage 2 – Governmental Outreach

FRWC and CAER staff set up a series of meetings with local township boards, planning commissions, city planners, and other elected officials, to explain the watershed planning process. Through these visits, the team established a dialog with local community leaders and determine potential areas of concern and provide valuable information on local planning efforts. Over the course of the project, all planning agencies in the watershed were contacted and visited.

Stage 3 – Community Visioning Meetings

To gain a better understanding of the short and long range goals of the South Branch Community, a public visioning session was held in July 2007. The result of this meeting was the establishment of both five year and twenty five year planning goals for the South Branch communities. Additionally, the group looked at potential obstacles to those goals that could be addressed through appropriate planning.

Statements made in the visioning session were grouped into categories and correspond with those in the policy review (Appendix 2) and desired uses (Implementation Section).

Stage 4- Plan findings presentation and implementation assistance
The final state of the public input process will take place during the implementation of the watershed plan. FRWC and CAER staff will be working to begin the implemention process by conducting a number of visits to local planning boards and township officers.

These series of presentation will take place to present the findings of the watershed plan and work with communities to take those first steps towards implementation portions of the plan.

An effective community education plan is important to implementing the watershed plan. A successful education plan is important because reducing the pollutants affecting water quality in South Branch Flint River will require increases in knowledge by the community and voluntary behavior changes by residents and decision makers. A successful education plan must recognize the learning process and current stakeholder knowledge.

The learning process involves four basic steps: experiencing/awareness phase, building knowledge, processing of information, and application of knowledge (NVPDC, 1996). This education plan will be structured around theses processes by providing:

- Public education to increase **Experiences / Awareness** of issues that stakeholders are familiar with
- **Building knowledge** base of stakeholders
- Allowing stakeholders to **Process Information** through community dialogue and interactive learning
- Encourage stakeholders to **Apply** their knowledge

Specific tasks have been assembled in Appendix 6 based upon topic area and audiences in order to avoid a "one size fits all approach". In appendix 6 we have also identified education tasks, partners and estimated costs for implementing the programs**.**

Evaluation Plan

Program Process and Goals

The primary goal of the South Branch Flint River Watershed Planning Project was to develop a watershed plan that when implemented could protect and restore the designated uses of South Branch Watershed. A comprehensive watershed management process involves working though a number of phases that ultimately leads to water quality protection. Watershed management can be generally divided into three phases including watershed planning, plan implementation, and effectiveness assessment (evaluation). Figure 10 illustrates the relationship between the three phases of watershed management.

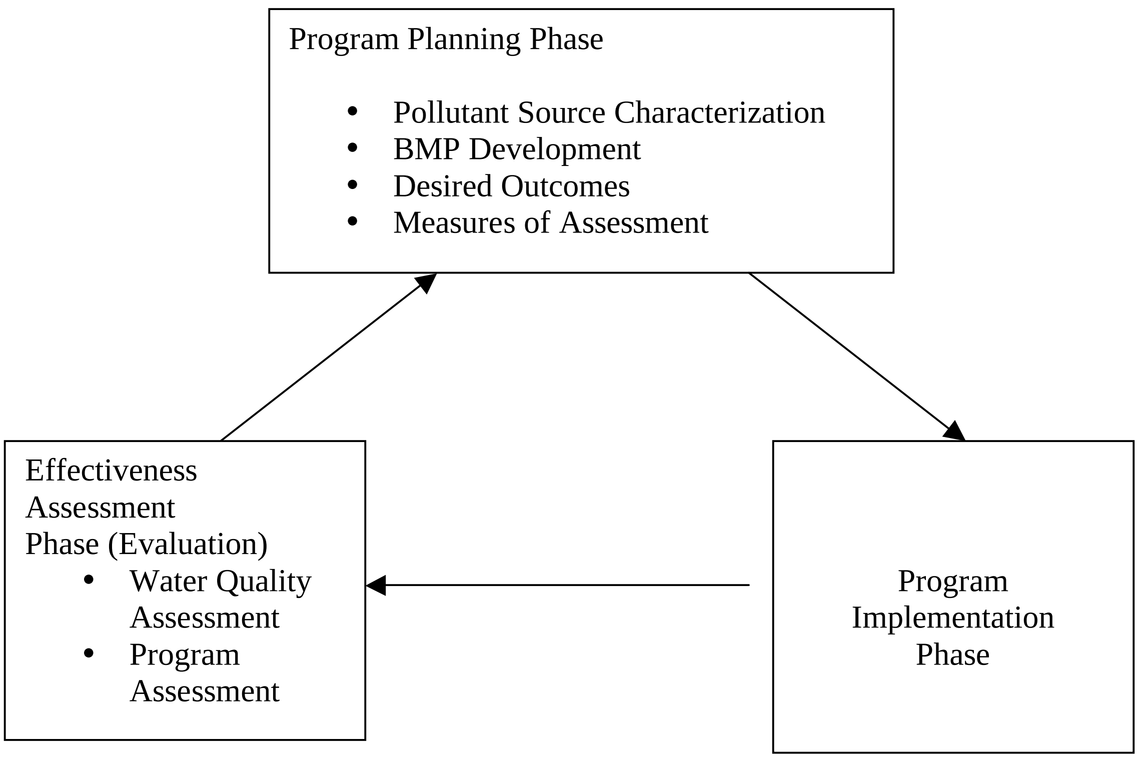


Figure 10. Watershed Management Cycle

Currently the South Branch Flint River Watershed Planning team has completed the steps associated with the program planning phase of the watershed management process including:

1. The identification of pollutants, source areas and causes of non-point source pollution in the watershed
2. The identification of Best Management Practices (BMPs) that need to be implemented to protect water quality
3. The identification of specific desired outcomes related to water quality
4. The identification of evaluation tools

With the South Branch Flint River Planning process complete the next step in watershed management involves implementing the watershed plan. As the program implementation is started activities will need to begin that provide information to evaluate the watershed plan.

Similar to the way that achieving objectives can lead to goal achievement, answering several questions will assist us in evaluating the effectiveness of the SBWMP. These questions are directly related to what are described as levels of success in the watershed management process. These include:

- Is the watershed plan in compliance with EPA requirements of watershed plans?
- Are changes in knowledge taking place because of the watershed plan?
- Are behavioral changes taking place as a result of the watershed plan?
- Are the reductions in the amount of pollution delivered to the stream because of the watershed plan?
- Are changes in the water quality of the South Branch Flint River being achieved because of the watershed plan?

Because watersheds are extremely dynamic systems that are influenced by nearly everything that happens in them, controlling all variables in a watershed plan is likely impossible. Similarly, measuring all outcomes of the plan is improbable. Instead what is intended by watershed management is that continual steps are made towards protecting water quality in a number of ways. These "levels of success" are intended to build upon one another in a hierarchy with the highest level resulting in water quality protection. Figure 11 is a graphic representation of the relationship between the six levels of success within watershed planning. The plan evaluation is set up to measure changes in these six levels/questions using a variety of tools and methods.

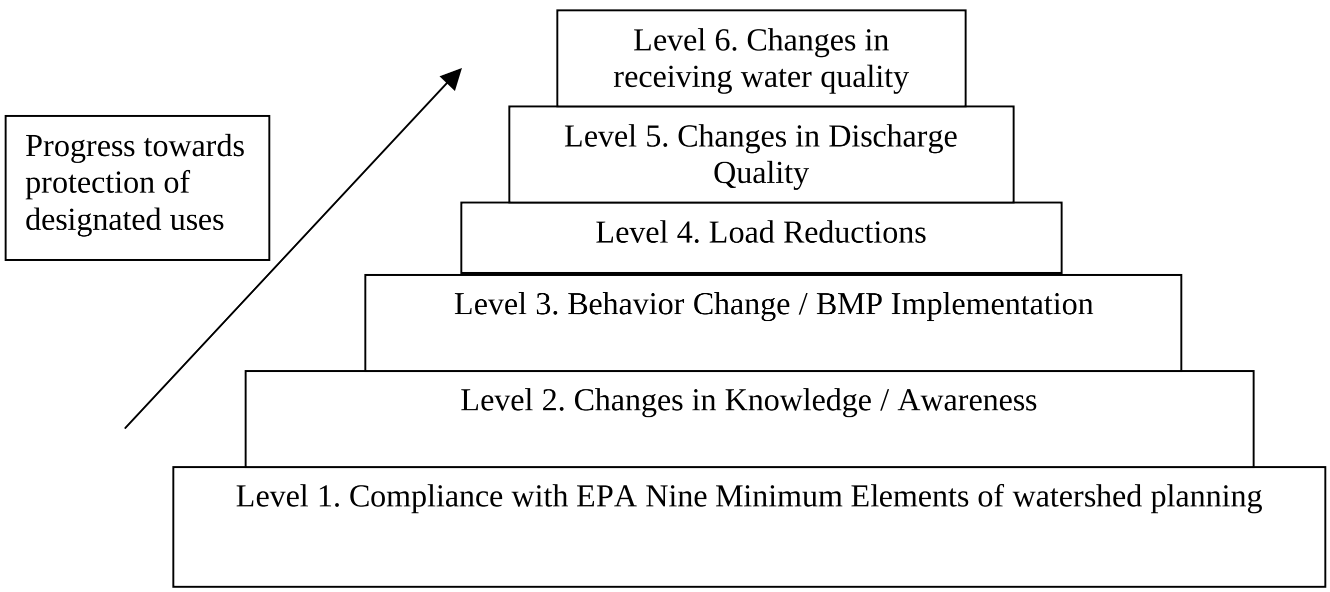


Figure 11: Levels of success necessary to protect the designated uses of the South Branch Flint River Watershed

easures of success are critical to assessing of the effectiveness of the South Branch Flint River Watershed planning effort. Identification of quantifiable measures provides measurability and accountability throughout the six levels of the program. Because of the hierarchical nature of the protection of water resources standards, data collection and analysis will be developed for each of the levels of success necessary to protect the water quality of the watershed. In the next section standards, measures and data gathering methods will be developed and detailed for each level of success.

Level 1: Compliance with EPA nine minimum elements of watershed planning
Evaluation Tool: Review of watershed plan for needed revisions should EPA requirements change.

Compliance with the EPAs minimum standards to watershed planning is a requirement of all watershed plans funded using federal dollars. This is achieved by including several key elements in all watershed plans.

Level 2: Changes in Knowledge / Awareness
Evaluation Tool: Surveys before and during implementation, increased involvement in local watershed organization and plan implementation.

Measures and data collection for this level of success can take place in two ways including a social survey and pre- and post-testing targeted individuals involved in education activities. Measures of knowledge change should be conducted on individuals who are specific targets of education efforts (elected officials, drain office, farmers, etc).

Data collection methods with these target individuals will primarily include pre- and post-tests at conferences or workshops focused on specific water quality issues in the South Branch Flint River Watershed.

Involvement in local watershed groups may also increase as a result of outreach conducted during plan implementation. This may be tracked by the Flint River Watershed Coalition and other local implementation partners.

Level 3: Behavior changes / BMP Implementation
Evaluation Tool: Tracking of BMP adoption and implementation with and without funding incentives.

The intended outcome of this level of success is a change in behaviors as a result of changes in knowledge. Behavior change should be monitored through action change (Levels 5 and 6), e.g. water quality is improving. Improved water quality is a result of changing behaviors. Therefore, activities performed must be documented to demonstrate successful implementation.

This portion of the evaluation will focus on identifying and tracking individuals who are known to be involved in the planning process and instrumental in implementing BMPs. Data about the implementation of BMP can be gathered simply through tracking the number of BMPs installed as a result of the plan's implementation. Data gathering should be done by project implementers with specific individuals as behavior changes and BMP installations are identified. An example of this may include documenting behavior changes of a local planning commission with regards to a particular policy after an educational seminar (managerial BMP) or by mapping the location of structural and vegetative BMPs. Standards for evaluating the success of these efforts are based on the specific measurable objectives outlined in the plan including the number of sites identified for BMPS or the number of policy changes recommended.

Level 4: Reduction in pollutant loadings to the South Branch Flint River
Evaluation Tool: Reduction of pollutant loading estimates due to reduced pollutant sources and causes.

A pollutant loading is a quantifiable amount of pollution that is being deposited in a river. Pollutant loads are based on an amount of pollutant that enters a stream in a given unit of time. An example could include a statement such as 500 pounds of nitrogen enter the stream per day from a specific site. Pollutant loads can be calculated based on the ability of an installed BMP to reduce the targeted pollutant. Loadings are best used at specific sites where detailed data about the reduction of pollutants can be gathered. Pollutant load reductions should be calculated for each installed BMP. Standards for pollutant loads are generally calculated on a cost-effectiveness basis. These are expressed in terms of the dollars spent to reduce a particular unit of pollution. MDEQ has specific standards that are established for BMPs and pollutants. These standards should be tied to the specific measurable milestones identified in the implementation work plan.

<u>Level 5 and 6:</u> <u>Changes in water quality</u>
Evaluation Tool: Benthic monitoring, habitat surveys, thermal monitoring

The evaluation of achievements in Levels 5 and 6 include activities that directly measure the water quality of the South Branch Flint River. The monitoring of water quality in these systems is an extremely complex task that involves gathering data from a number of sources. Periodic assessments of the water quality of the South Branch Flint River are conducted as part of several federal and state water quality monitoring programs. Combining data gathered under these programs, with periodic water quality assessments conducted as part of the watershed planning, will provide the best picture of existing water quality in the watersheds.

Benthic Monitoring – consistent and improved quality of biannual monitoring of two sites along the South Branch by the Flint River Watershed Coalition(FRWC) and continued monitoring of sites by the MDNR every 5 years will serve to evaluate changes in water quality aquatic life.

Habitat Surveys – conducted as part of benthic monitoring, expand habitat surveys to focus on natural areas identified in the Greenlinks Vision. Potential surveyors are the FRWC, students from the University of Michigan – Flint, Mott Community College, and public schools.

Thermal monitoring – is of special importance in the South Branch due to cold water fish species existing in portions of Pine Creek. Routine monitoring of temperature regimes will allow watershed managers to prescribe appropriate BMPs for cold water fish species protection and to evaluate changes in the riparian corridor.

Institutional integration

A key to successful implementation of a watershed is the use of the document by a wide variety of watershed stakeholders. It is the goal of the SBWMP to have the plan play an active role in decision making by a number of organizations and local government partners. Figure 12 includes a list of those partners, how they may use the document and how we intended to monitor its use.

User	Use	Measure
Drain Office	Guide drain maintenance practices and schedules	Measured reduction in drainage costs and linear drains cleaned
Conservation District	Guide annual resource assessment, strategic plan, and work plan	Review annual documents for reference and annual reports for activities directly related to plan implementation
Flint River Watershed Coalition	Guide strategic planning document, integration into public education work , used by committees including policy and watershed plan committee	Review strategic plan, review annual report, regular meeting notes of committee work
NRCS	Guide implementation of Farm bill programs in critical areas	Identification in annual business plan, monitoring of annual status reviews of contracts in priority areas
Local governments	Guide local master plans, parks and recreation plans, zoning and construction ordinances	Period review of planning document for citation, identification of planning decisions made using the document
Local Green Infrastructure planning partnerships	Integration into green infrastructure vision	Increase use in publication and focus in education programming

Figure 12 User, use and measure of institutional use of watershed plan.

Sources

Cooper, J. 2004. A Biological Survey of the Flint River and Selected Tributaries in Lapeer, Genesee, Oakland, and Saginaw Counties, Michigan, June 30-August 8, 2003. Michigan Department of Environmental Quality, Water Division, MI/DEQ/WD-03/114.

Dimond, W.F. 2003. Chronic Toxicity Assessment of Lapeer Wastewater Treatment Plant Outfall 001 Effluent. Michigan Department of Environmental Quality, Water Division. MI/DEQ/WD-03/042.

Frere, M.H., Ross, J.D., and Lane, L.J. (1980). The Nutrient Submodel. In: *Knisel, W.G. (ed.)1980. CREAMS: A Field Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems*, USDA, Cons. Research Report No. 26, pp. 65-86.

Leonardi, J.M. and W.J. Gruhn. 2001. Flint River Assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report.27, Ann Arbor, Michigan.

Leonardi, J.M. and W.J. Gruhn. 2001. Flint River Assessment Appendix. Michigan Department of Natural Resources, Fisheries Division, Special Report.27, Ann Arbor, Michigan.

Michigan DEQ, Pollutant Controlled Calculation and Documentation for 319 Watersheds Manual, 1999.

Norton, Richard and Christina Kelly. Smart Growth Audit results for local units of government in Genesee County, Michigan from May, 2004 - September, 2004. Unpublished research completed under the direction of Prof. Richard Norton at the University of Michigan, Department of Urban and Regional Planning, Ann Arbor, MI.

Scott, A.M. 1993. A Biological Survey of the Upper South Branch of the Flint River, Lapeer County, September 9, 1990. Michigan Department of Natural Resources, Surface Water Quality Division, MI/DNR/SWQ-93/004.

Walterhouse, M. 2001. A Biological Survey of the North and South Branch Flint River and its Tributaries. Michigan Department of Environmental Quality, Surface Water Quality Division, MI/DEQ/SWQ-01/033.

Wiley, Mike PhD. 2006 Presentation to Flint River Watershed Coalition Annual Meeting
Michigan Rivers Inventory, Institute for Fisheries Research
School of Natural Resources & Environment, University of Michigan

Wuycheck, J. and G. Jackson. 1979. A Biological Investigation of the South Branch Flint River and the Farmer's Creek Tributary. Michigan Department of Natural Resources, Water Quality Division, 003330.

Kubic, Sue 2005 Middle Flint River Watershed Management Plan

Appendix 1
Local Land Use Analysis

Historic Land Use
The following history of land use in the Flint River Watershed was described by Joe Leonardi in 2001:

> Prior to European settlement vegetation consisted of open forests and savannas of black and white oak on the sandy loam moraines and beech-sugar maple forests with some white oak on the clay-rich soils (Albert 1994). Depressions supported alder and conifer swamps with white pine, white cedar, tamarack, black ash, and eastern hemlock. (Leonardi)
>
> When the first European explorers arrived in the Saginaw Valley, they found it populated by Chippewa and Ottawa Indians, with the Chippewas being more numerous (Ellis 1879). However, Chippewa history tells that when they came into the area the Sauks and Onottoways inhabited the valley.
>
> When early French fur traders moved into the Flint River Valley, they established an encampment at a natural river crossing used by Native Americans. The Indian name for this river was Pewonigowink meaning "river of fire stone" or river of flint. The crossing was located on the "southern bend" of the Flint River on the “Saginaw Trail” that ran between villages at the outlet of Lake St. Clair (Detroit) and encampments at the mouth of the Saginaw River. It was located very near the mouth of the Swartz Creek. This crossing became known as the “Grand Traverse” or great crossing place. A permanent trading post was established when Jacob Smith arrived in 1819 (Crowe 1945).
>
> The City of Flint grew up at the site of the “Grand Traverse” and European settlers concentrated along the banks of the Flint River, taking up farming, lumbering, and manufacturing. Permanent human settlement brought great change to the landscape as the land began to be altered for human benefit. Although Michigan was primarily an agricultural state before the Civil War, lumbering became the principal economic activity in the new state during the second half of the 19th century (Fitting 1975). Muskegon, Menominee, and Saginaw were lumbering centers and “lumbering altered much of the landscape, as all of the timber of the northern lower peninsula and much of the upper peninsula was removed between 1860 and 1910” (Fitting 1975). Truman Fox (1858) described the Flint River…Pine is found in abundance upon the banks of this stream… many rich bottomlands are also found along this river. The river also affords a number of excellent mill sites, and is already being applied to a variety of manufacturing purposes.” With a good supply of high quality lumber and a need to move supplies from town to lumbering camps, it is not surprising that Flint became a center for transportation producing horses, horse harnesses, horse drawn vehicles and ox carts. By 1900, Flint was building 150000 vehicles per year, both wagons and carts. As the pine forests were exhausted, Flint’s attention turned to other industries, and the transition to automobile manufacturing was natural (Crowe 1945). In 1903, Buick Motor Company began production of the Buick automobile. Under the business genius of Will Durant, formerly of Durant-Dort Carriage Company, Buick Motor Company convinced suppliers such as Champion Spark Plug Company, Weston-Mott (Axle) Company, and Fisher Body

> Company to relocate in Flint. Flint became the birthplace of General Motors and the United Auto Workers (UAW) union. Even today, Flint is often referred to as Buick City and its prosperity centered on the manufacture of automobiles.
>
> After World War II, prosperity fostered population increase and diversifying communities. Gasoline was inexpensive, new highways were built, and General Motors, the UAW, and Flint Flourished. Outlying communities of Lapeer, Davison and Grand Blanc experienced growth and were desirable locations to live and work. Advancements in the gasoline engine allowed for increased agriculture and farming dominated watershed land use.

Currently the Flint River Watershed is changing. A community, whose economic welfare traditionally was tied to the prosperity of General Motors, has had to seek economic stability through diversification. New businesses have become important and redevelopment of underused industrial properties to attract new business has been a challenge. More recently, the increased demand for new residential and small commercial development is replacing agriculture. (Kubic 2006)

Current Land Uses

The National Oceanic and Atmospheric Administration's (NOAA) Coastal Change Analysis Program (CCAP) 1995 and 2000 data sets were used to determine land cover in the Flint River South Branch watershed using the ESRI ArcView ATtILA extension. Area specific data was extracted using the boundaries for the South Branch watershed and its nine sub-watersheds. The 22-category CCAP land use classification was collapsed into the best approximation of the Anderson Level I classification system permitted by the ATtILA landscape characteristics function, making the final number of ATtILA generated fields smaller and easier to work with. The two data sets were subsequently exported to Microsoft Excel for post-processing re-calculating area, arranging fields, and calculating percentages. This final output can be seen in Table A1.1 and Table A1.2. Both tables present the same ATtILA data summary for 1995 and 2000 respectively. *Watershed* gives the name of the sub-watersheds in the South Branch. *Area* provides the area of each sub-watershed in acres. *%Watershed* is the percent of the South Branch watershed made up by each sub-watershed. *%Water and Water Area* give the percent and area of that land in the sub-watershed designated as open water. *%Natural* and *Natural Area* are both metrics that give the percent and total area of natural land cover in each sub-watershed. Conversely, *%Human* and *Human Area* are metrics that give the percent and total area of human influenced land cover in each sub-watershed. Table A1.3 shows differences between the 1995 and 2000 CCAP land cover dataset for each sub-watershed with the exception of *Area* and *%Watershed* since there is no change in these metrics. Table A1.3 shows less than 1% change between the two data sets. The small, negative, changes in *Percent Water* can probably be attributed to the filling of unregulated wetlands or wetland drying due to insufficient precipitation. The increase in *Percent Natural* land and corresponding decrease in *Percent Human* can be attributed to seral succession of agricultural fields. This is borne out by the decrease observed in the *Percent Ag* and *Ag Area* fields added to this table.

Table A1.1

2000 CCAP ATtILA Landscape Characteristics								
Watershed	Acres	Percent Watershed	Percent Water	Water Area	Percent Natural	Natural Area	Percent Human	Human Area
Flint River Main Branch	11,395.3180	17.8	0.26	165.71	49.60	5569.9	50.40	5,659.7260
Hunters Creek	8,297.3430	12.96	0.19	122.55	59.40	4856.2	40.60	3,318.5760
Mirror Creek	3,880.4440	6.06	0.14	87.72	47.87	1815.6	52.13	1,977.0900
Pine Creek	8,479.7620	13.25	0.13	82.80	40.05	3362.8	59.95	5,034.1300
Pine Creek Headwaters	3,515.4370	5.49	0.06	37.85	61.68	2145.0	38.32	1,332.5900
South Branch Headwaters	18,300.2840	28.59	0.56	355.91	57.06	10238.8	42.94	7,705.5370
Unknown Creek	2,758.8260	4.31	0.06	37.16	62.77	1708.4	37.23	1,013.2310
Whigville Creek	4,703.0280	7.35	0.19	122.58	67.48	3090.8	32.52	1,489.6010
Whigville Lakeshead	2,674.0720	4.18	0.17	108.08	70.46	1808.1	29.54	757.9216
Flint River Watershed	64,004.5140	100.0	1.75	1120.37	55.02	34595.7	44.99	28,288.4000

Table A1.2

1995 CCAP ATtILA Landscape Characteristics								
Watershed	Acres	Percent Watershed	Percent Water	Water Area	Percent Natural	Natural Area	Percent Human	Human Area
Flint River Main Branch	11,395.3180	17.80	0.27	172.8294	49.37	5540.10	50.63	5,682.4106
Hunters Creek	8,297.3430	12.96	0.2	125.6669	59.49	4861.60	40.51	3,310.1248
Mirror Creek	3,880.4440	6.06	0.15	95.5062	47.86	1811.40	52.14	1,973.5318
Pine Creek	8,479.7620	13.25	0.17	109.2649	39.86	3336.60	60.14	5,033.9073
Pine Creek Headwaters	3,515.4370	5.49	0.07	43.8535	61.71	2142.30	38.29	1,329.2540
South Branch Headwaters	18,300.2840	28.59	0.57	362.1384	56.85	10198.6	43.15	7,739.5629
Unknown Creek	2,758.8260	4.31	0.06	37.1579	62.77	1708.40	37.23	1,013.2309
Whigville Creek	4,703.0280	7.35	0.22	141.9322	67.53	3079.90	32.47	1,481.1497
Whigville Lakeshead	2,674.0720	4.18	0.18	113.1954	70.33	1801.20	29.67	759.7008
Flint River Watershed	64,004.5140	100.00	1.88	1,201.5447	54.90	34480.1	45.10	28,322.8728

Table A1.3

CCAP Land Use Change (2000-1995)								
Watershed	Percent Ag	Ag Area	Percent Water	Water Area	Percent Natural	Natural Area	Percent Human	Human Area
Flint River Main Branch	-0.36	-36.9175	-0.01	-7.1166	0.23	29.8	-0.23	-22.6846
Hunters Creek	-0.72	-57.6003	-0.01	-3.1135	-0.09	-5.4	0.09	8.4512
Mirror Creek	-0.03	2.446343	-0.01	-7.7838	0.01	4.2	-0.01	3.5582
Pine Creek	-0.21	-2.44634	-0.04	-26.4650	0.19	26.2	-0.19	0.2227
Pine Creek Headwaters	0.03	3.335923	-0.01	-6.0047	-0.03	2.7	0.03	3.3360
South Branch Headwaters	-0.69	-122.317	-0.01	-6.2271	0.20	40.2	-0.20	-34.0259
Whigville Creek	0.00	0	0.00	0.0000	0.00	0.0	0.00	0.0001
Unknown Creek	0.05	8.228609	-0.03	-19.3484	-0.05	10.9	0.05	8.4514
Whigville Lakeshead	-0.19	-3.33592	-0.01	-5.1151	0.13	6.9	-0.13	-1.7792
Flint River Watershed	-0.39	-208.606	-0.13	-81.1741	0.11	115.6	-0.11	-34.4728

The categories of *Percent Natural* and *Percent Human* show the total percentages of natural and human land cover for each watershed. This distinction offers a quick but valuable insight into the land cover divisions of the sub-watersheds and their relationships within the South Branch. This data - from the 2000 CCAP dataset - has been graphed in figures A1.01 - A1.10. From this preliminary breakdown, two things are quickly evident. First, figures A1.01, A1.03, and A1.04 show that only three of the sub-watersheds in the South Branch have human land covers equal to or greater than 50%. The rest of the sub-watersheds all have natural land covers greater than 50%, and four have natural land covers greater than 60%. See figures A1.05, A1.07, A1.08, and A1.09.

The land cover figures also demonstrate the increase in human impact on a stream from its headwaters to its main stream. In figures A1.01 and A1.06, the Main Branch experiences a 7% drop in natural land cover from its headwaters to its main stream. In figures A1.08 and A1.09, Whigville Creek loses 3% of its natural land cover. However, it is in figures A1.04 and A1.05 that this relationship shows the starkest contrast. The Pine Creek watershed loses 22% of its natural land cover from its headwaters to its main channel. There is added significance to the loss of natural land cover from the upper to lower reaches of this watershed because the headwaters of Pine Creek provide the habitat for one of Southeast Michigan's few trout populations. The main channel can't support these trout due to the increase in human land cover and its associated thermal and sedimentation impacts on the river.

Figure A1.01

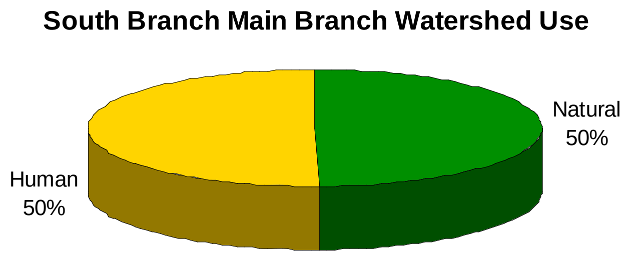


Figure A1.02

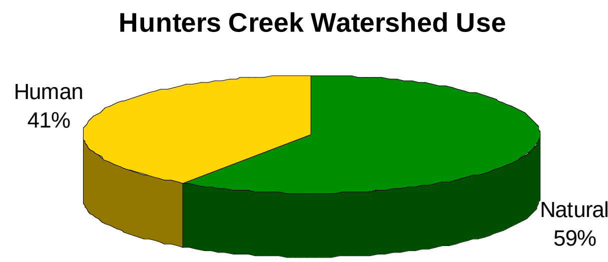


Figure A1.03

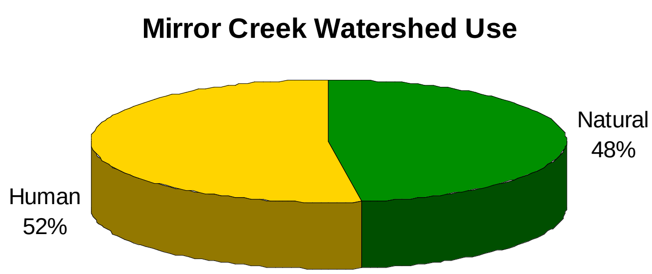


Figure A1.04

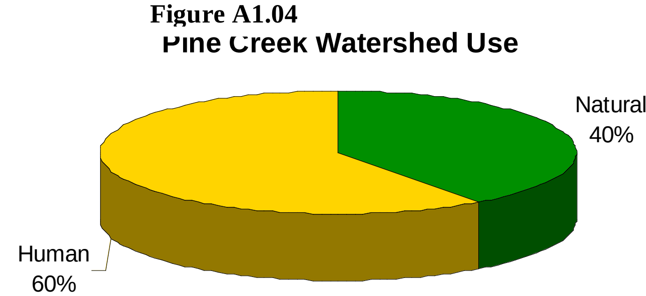


Figure A1.05

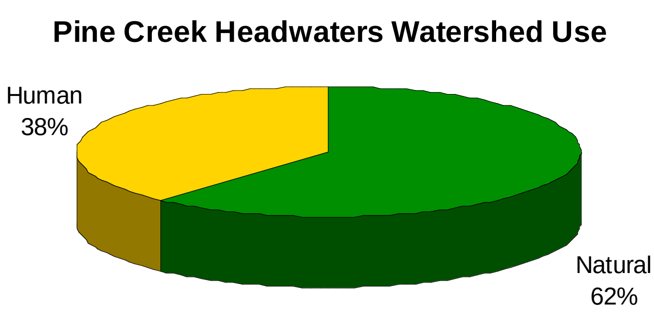


Figure A1.06

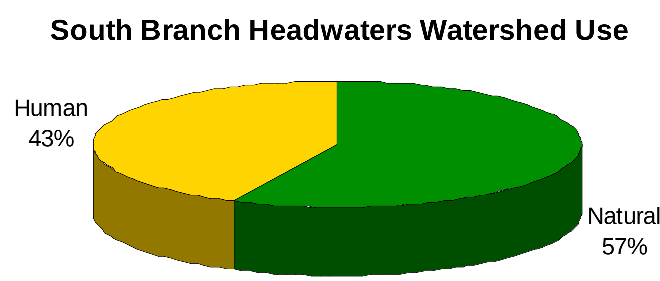


Figure A1.07

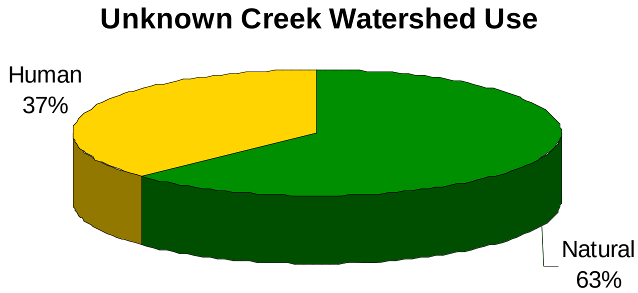


Figure A1.08

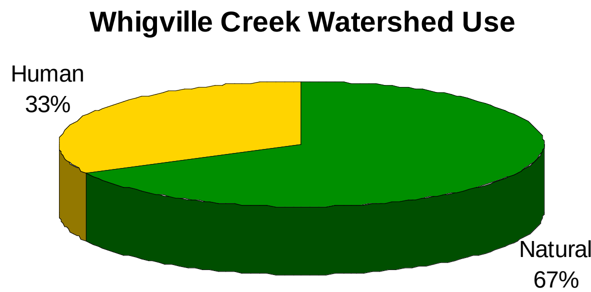


Figure A1.09

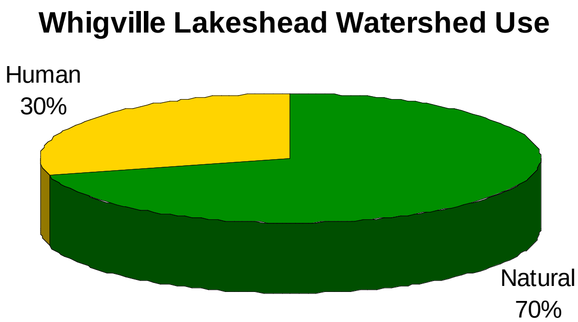
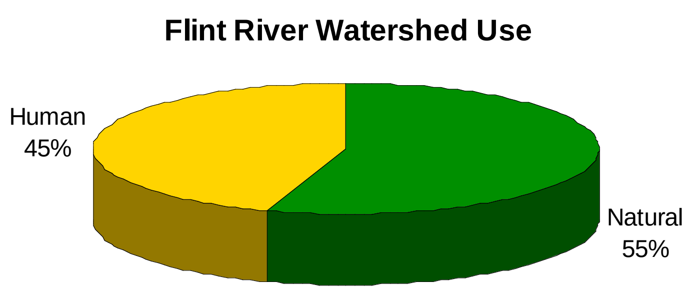


Figure A1.10



Figures 1.11 through 1.20 break the human and natural land cover groups down into more discrete classes. Human land cover is broken into crop, man made barren, and urban land covers while natural land cover is broken down into forest, wetland, natural grassland, and natural barren land covers. Barren land does not show up above 1% in any of the watersheds, and when it does, it is invariably man-made (see figures A1.12, A1.16, and A1.20). Urban land is also low, with the majority of human land cover in all sub-watersheds showing up as crop land. This meshes nicely with visual impressions of the South Branch made during field trips. With the exception of those areas immediately adjacent to urbanized areas such as the Village of Metamora or the City of Lapeer, the watershed is remarkably undeveloped with agriculture clearly making up the largest human use. Pine Creek is notable among all of the watersheds, however, for having the largest amount of cropland at 57% (see figure A1.14) while its upper reaches have 20% less (see figure A1.15). This shows the marked distinction in watershed habitat between the upper and lower reaches of this river and indicates why trout are not found in the main channel north of I-69.

Figure A1.11

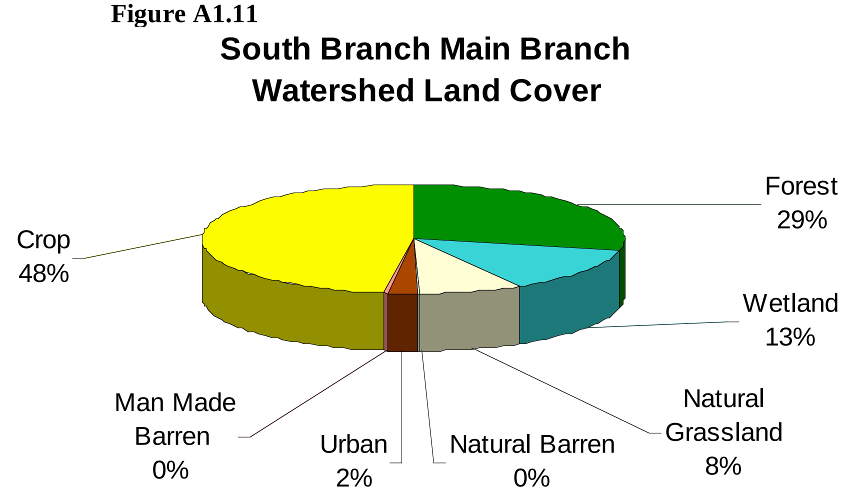


Figure A1.12

Hunters Creek Watershed Land Cover

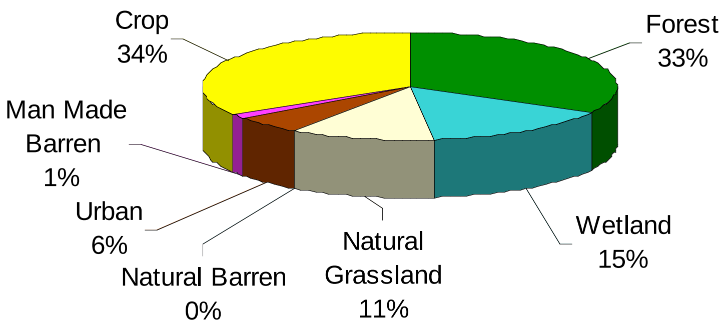


Figure A1.13

Mirror Creek Watershed Land Cover

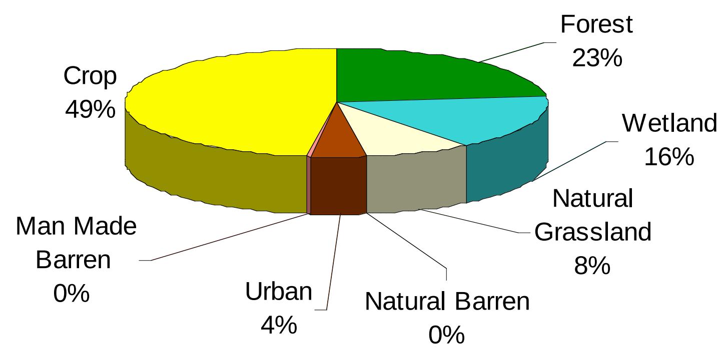


Figure A1.14

Pine Creek Watershed Land Cover

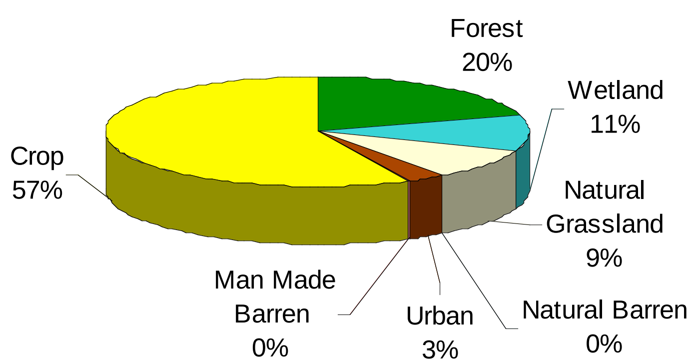


Figure A1.15

Pine Creek Headwaters Watershed Land Cover

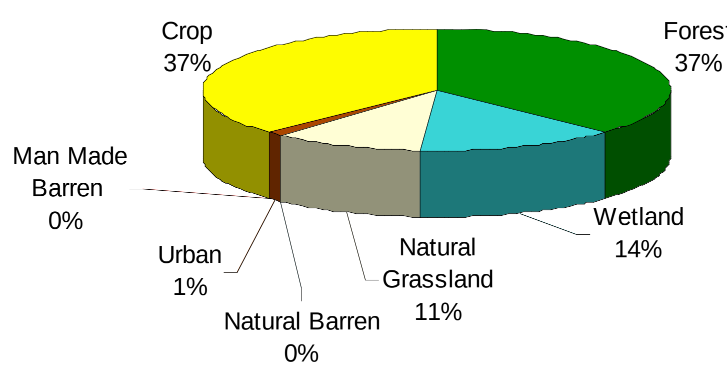


Figure A1.16

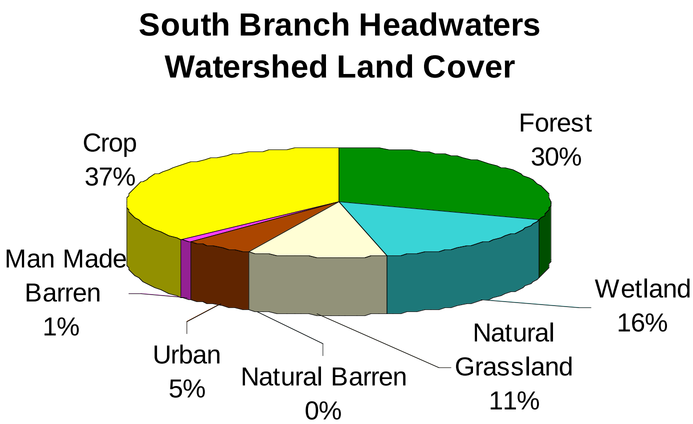


Figure A1.17

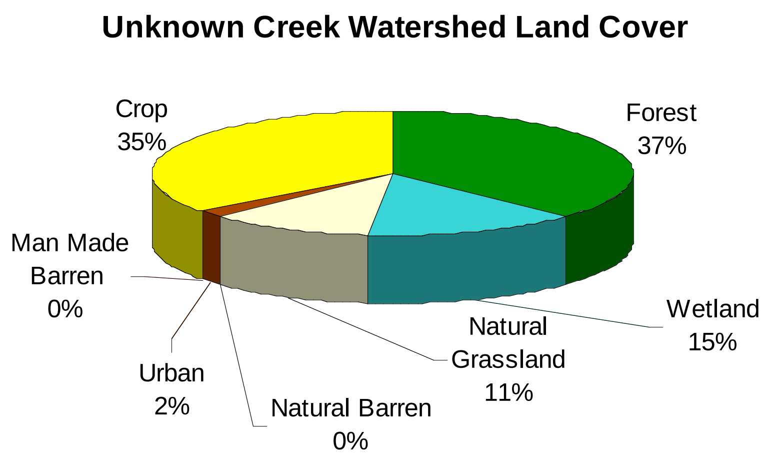


Figure A1.18

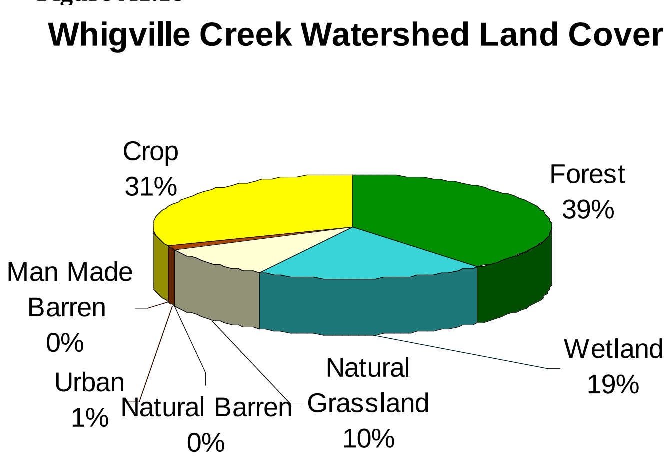
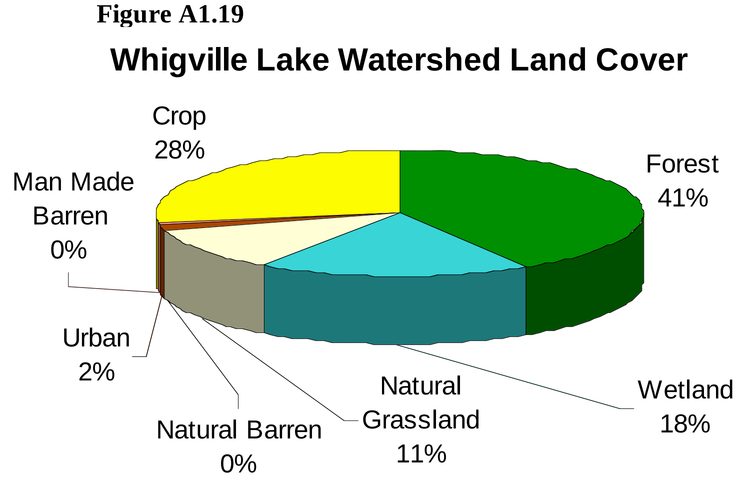


Figure A1.19



The land cover of a watershed is extremely important to the health of a river system. Increases in human land uses can intensify runoff to rivers, increase peak flows and lead to flooding problems, while simultaneously decreasing precipitation infiltration and contributing to low flows during dry periods. The riparian area adjacent to a river is extremely important to the health of a river and can have an immediate impact on the health of a river. If differences in riparian land cover are present, they may not show up in a landscape analysis of the entire watershed due to riparian lands making up a proportionally smaller part of the landscape.

ATtILA's riparian characteristics function is identical to its watershed-wide landscape analysis function discussed earlier, but on a narrower, user-defined buffer of the river. This riparian characteristics calculation was run using a 60 meter (197 foot) buffer. The desired buffer was 150 feet since that is the maximum width the NRCS considers when undertaking stream-bank stabilization projects, but the cell size of the 2000 CCAP data is 30 meter (98 feet) on a side. The 60 meter buffer is larger than desired, but it captures the desired range plus an extra 47 feet on each side of a river.

The results of the ATtILA riparian characteristics calculations on the 1995 and 2000 CCAP data can be seen in table 1.4 and 1.5. Table 1.6 is the difference table between 2000 and 1995. Field headings are the same as those in the landscape characteristics tables, all area metrics are in acres, and the last record in each table contains the calculation for the South Branch watershed. The relationship between natural and human land cover is graphed in figures A1.20-A1.28. These graphs show that the 60 meter riparian corridor analyzed in the sub-watersheds has less human and more natural land cover than their counterparts in figures A1.01-A1.10. This is an encouraging sign that the riparian corridor is in better condition than the rest of the watershed. The next group of graphs, figures A1.29-A1.37, presents the breakdown of all land covers for each sub-watershed. By comparing these figures to the land cover graphs of the sub-watersheds (figures A1.11-A1.19) similar trends can be seen in each set. They both show an increase in human land uses from the upper to lower watersheds of a stream, and the major human land use is cropland. Also, a large increase in wetlands can be seen in the riparian corridor. This increase is not unusual; the natural locations of wetlands are the topographic depressions near rivers and ponds. Most sub-watersheds show a corresponding drop in the percentage of cropland in the riparian corridor, which also would be expected given the technical difficulties and expense of draining the wetlands directly adjacent to open water. Pine Creek is an exception to this trend, showing only a 4% decrease in cropland in the riparian corridor. This is especially notable given that this watershed has the highest percentage of cropland. The fact that it also has the highest amount in the riparian corridor of any stream is a probable factor in the absence of trout from the main stream section. The proximity of agricultural land to the river can cause many problems for a stream, as mentioned earlier. This data matches well with the DEQ Thermal Habitat Classification map shown in figure A1.38, which shows the increasing temperature of Pine Creek from its headwaters to its confluence with the Main Branch of the Flint River.

Table A1.4

1995 CCAP ATtILA Riparian Characteristics - 60 meter buffer					
Watershed	*Acres*	*Percent Natural*	*Natural Area*	*Percent Human*	*Human Area*
South Branch Headwaters	18,300.3568	76.05	2,209.4928	23.95	695.8735
Unknown Creek	2,758.8367	74.86	460.3573	25.14	154.5644
Whigville Creek	4,703.0466	82.85	673.6340	17.15	139.4416
Whigville Lakeshead	2,674.0830	78.08	446.1241	21.92	125.2083
Pine Creek Headwaters	3,515.4511	78.59	324.9189	21.41	88.5131
Flint River Main Branch	11,395.3635	72.24	1,480.9273	27.76	569.1084
Hunters Creek	8,297.3758	77.37	1,210.2727	22.63	354.0526
Mirror Creek	3,880.4600	70.01	480.1505	29.99	205.7152
Pine Creek	8,479.7957	44.86	625.8191	55.14	769.2638
Flint River South Branch	64,004.7693	71.86	7,939.9407	28.14	3,109.3023

Table A1.5

2000 CCAP ATtILA Riparian Characteristics - 60 meter buffer					
Watershed	*Acres*	*Percent Natural*	*Natural Area*	*Percent Human*	*Human Area*
Flint River Main Branch	11,395.3636	72.26	1,483.1512	27.74	569.3308
Hunters Creek	8,297.3758	77.33	1,210.2727	22.67	354.7198
Mirror Creek	3,880.4600	70.10	481.2624	29.90	205.2704
Pine Creek	8,479.7957	45.13	630.0446	54.87	765.9278
Pine Creek Headwaters	3,515.4511	78.38	323.3621	21.62	89.1803
South Branch Headwaters	18,300.3569	76.04	2,209.0480	23.96	696.0959
Unknown Creek	2,758.8368	74.86	460.3573	25.14	154.5644
Whigville Creek	4,703.0467	82.85	673.6340	17.15	139.4416
Whigville Lakeshead	2,674.0830	78.40	448.7928	21.60	123.6515
Flint River South Branch	64,004.7695	71.90	7,948.1693	28.10	3,105.7440

Table A1.6

CCAP Riparian Characteristics Change (200-1995)					
Watershed	*Acres*	*Percent Natural*	*Natural Area*	*Percent Human*	*Human Area*
South Branch Headwaters	0.0001	-3.79	-0.4448	3.79	0.2224
Unknown Creek	0.0000	2.47	0.0000	-2.47	0.0000
Whigville Creek	0.0000	-12.75	0.0000	12.75	0.0000
Whigville Lakeshead	0.0000	-32.95	2.6687	32.95	-1.5568
Pine Creek Headwaters	0.0000	-0.21	-1.5568	0.21	0.6672
Flint River Main Branch	0.0001	3.80	2.2239	-3.80	0.2224
Hunters Creek	0.0000	-2.50	0.0000	2.50	0.6672
Mirror Creek	0.0000	12.84	1.1120	-12.84	-0.4448
Pine Creek	0.0000	33.54	4.2255	-33.54	-3.3359
Flint River South Branch	0.0003	0.04	8.2286	-0.04	-3.5583

Figure A1.20

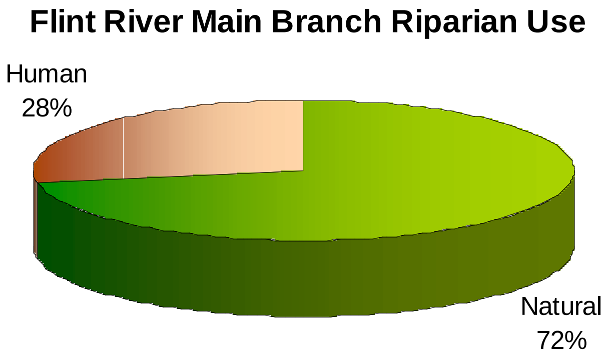


Figure A1.21

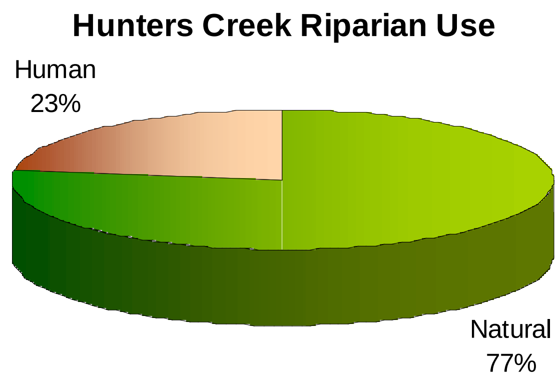


Figure A1.22

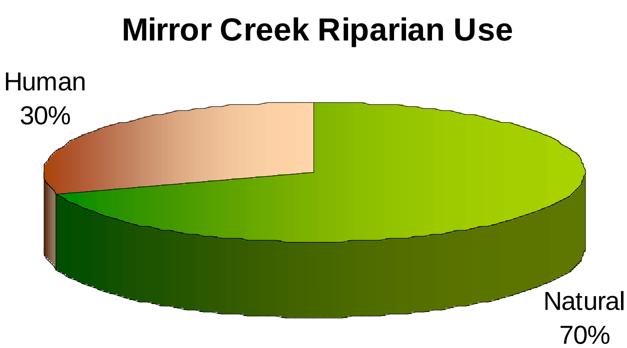


Figure A1.23

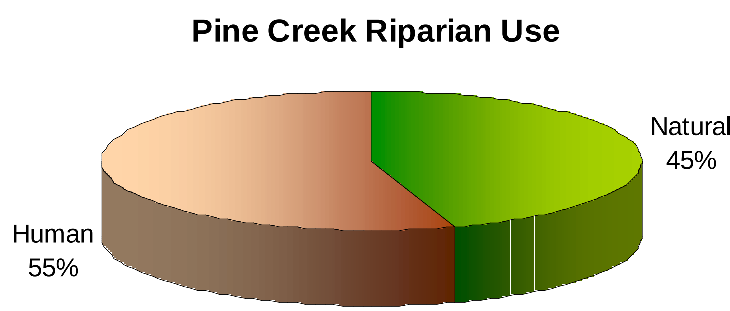


Figure A1.24

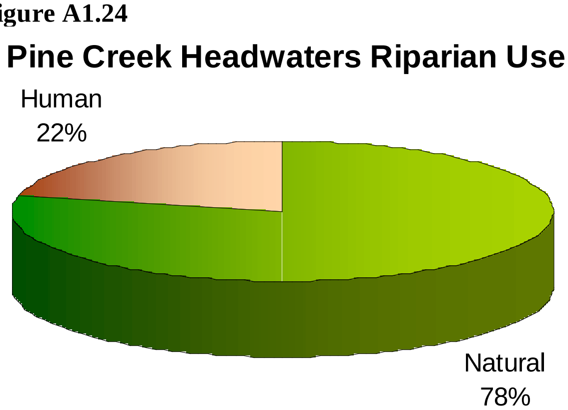


Figure A1.25

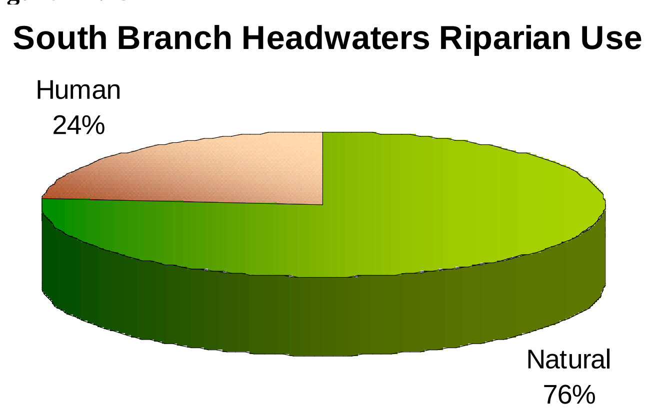


Figure A1.26

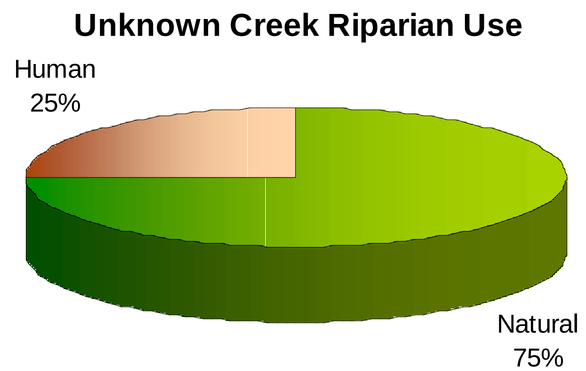


Figure A1.27

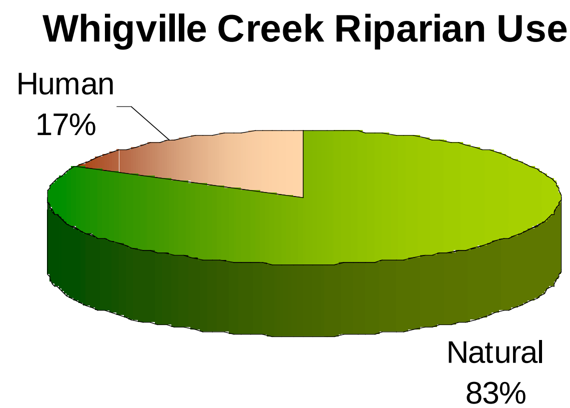


Figure A1.28

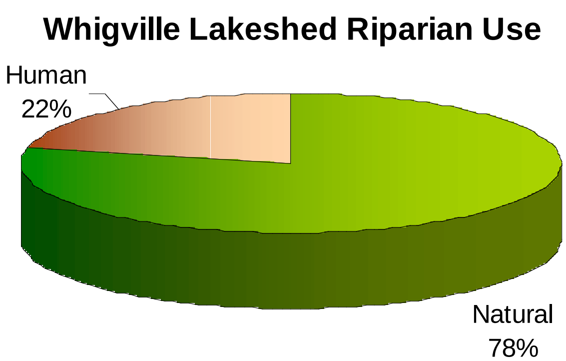


Figure A1.29

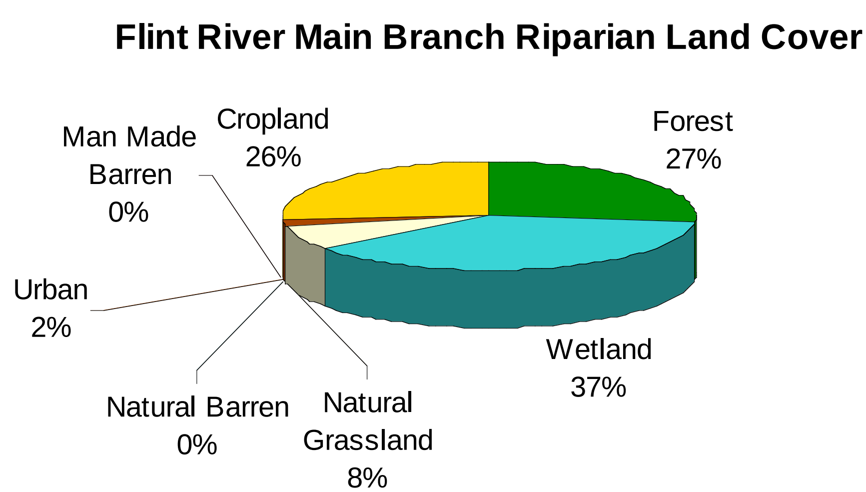


Figure A1.30

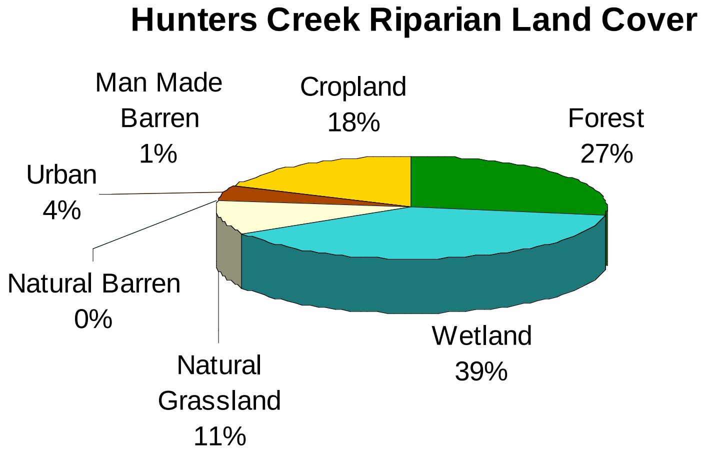


Figure A1.31

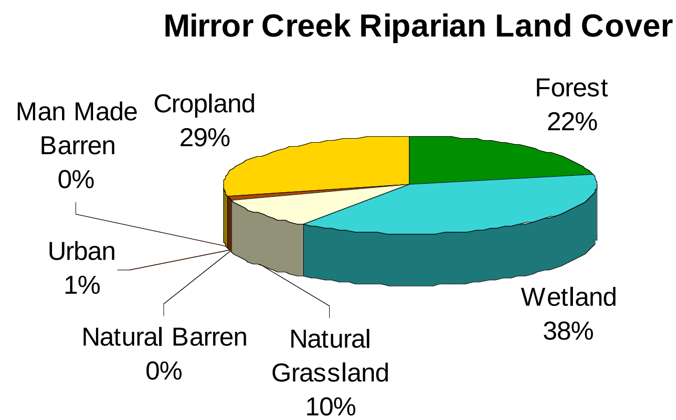


Figure A1.32

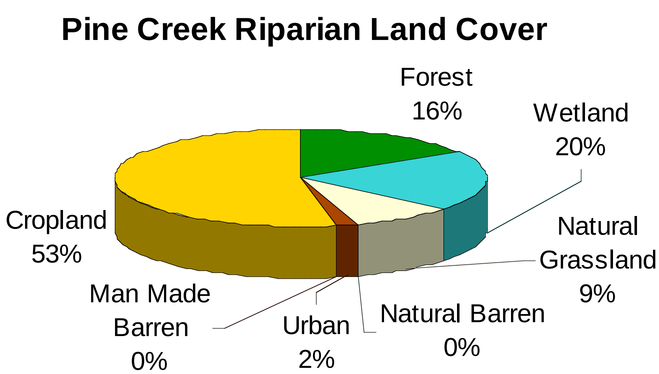


Figure A1.33

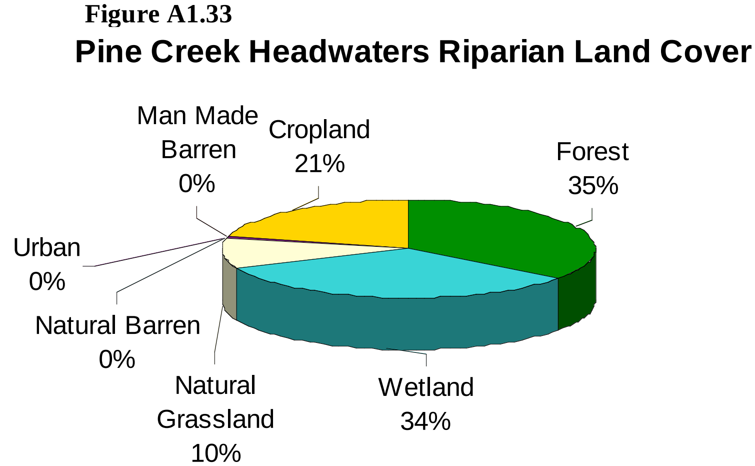


Figure A1.34

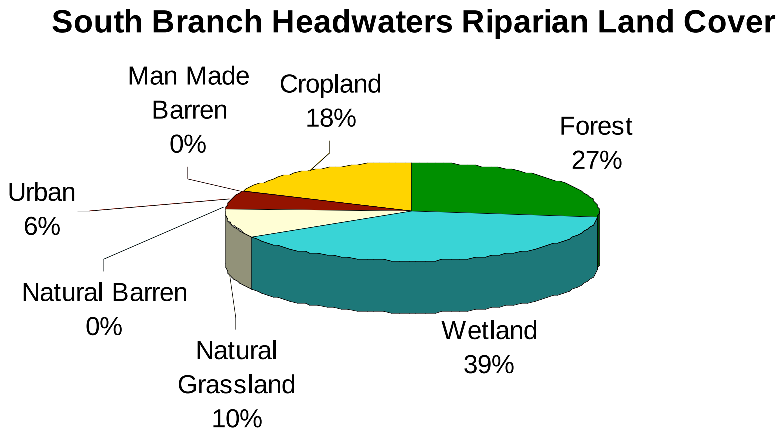


Figure A1.35

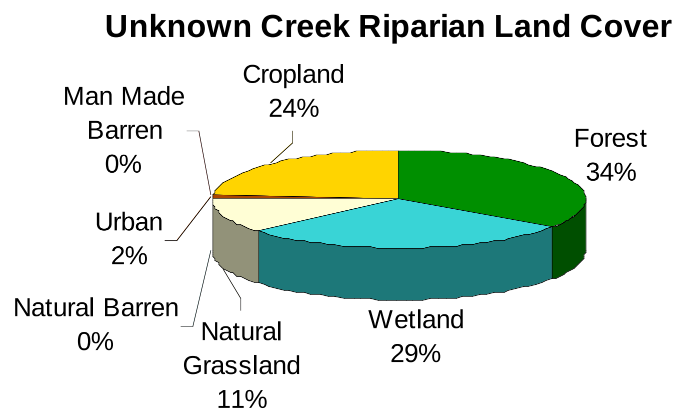


Figure A1.36

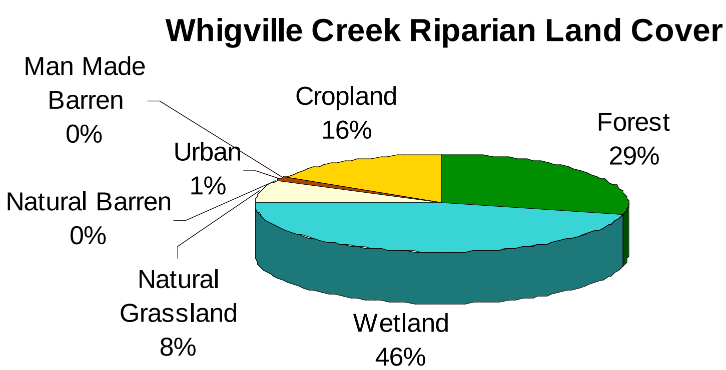
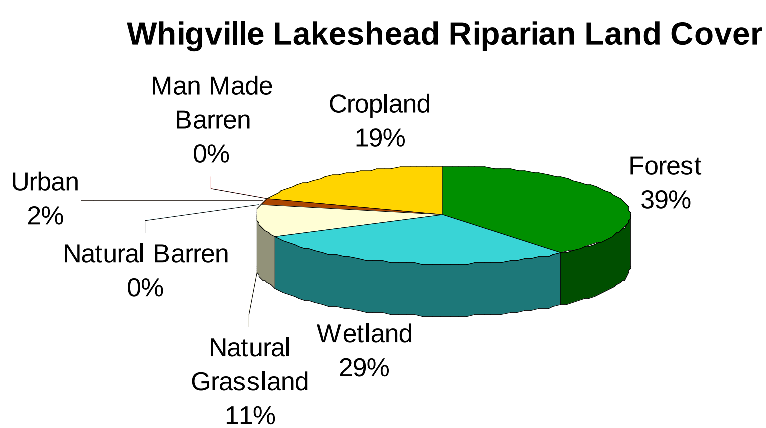


Figure A1.37



Land Cover, Growth Trends and Population Density

Our observations revealed that the South Branch watershed has managed to avoid many of the negative water quality impacts that have been associated with rapid urban expansion in the southeast Michigan region (Figures A1.37 & A1.38). The largely rural area has maintained relatively stable land uses over the past decade but continues to face threats from urban expansion (Wiley 2006). However, the existing land covers have had some impacts on the water quality. Our observations revealed the most significant impacts are from agricultural land uses in the lower portion of the watershed. Based upon our experience we assert the largest future threat to the watershed is urban expansion from the southern portions of the watershed and along the M-24 corridor.

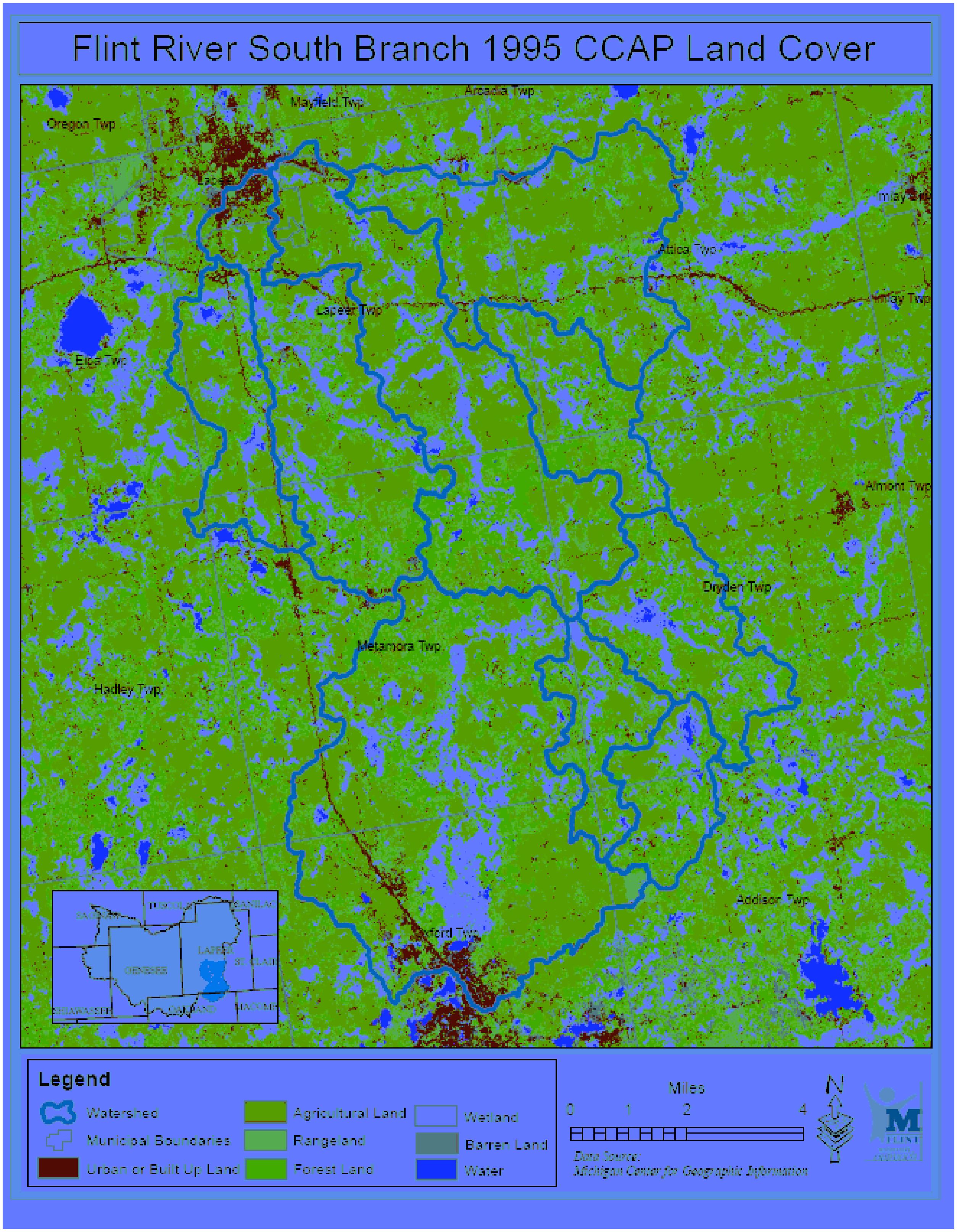


Figure A1.37 1995 Land Cover in South Branch Watershed

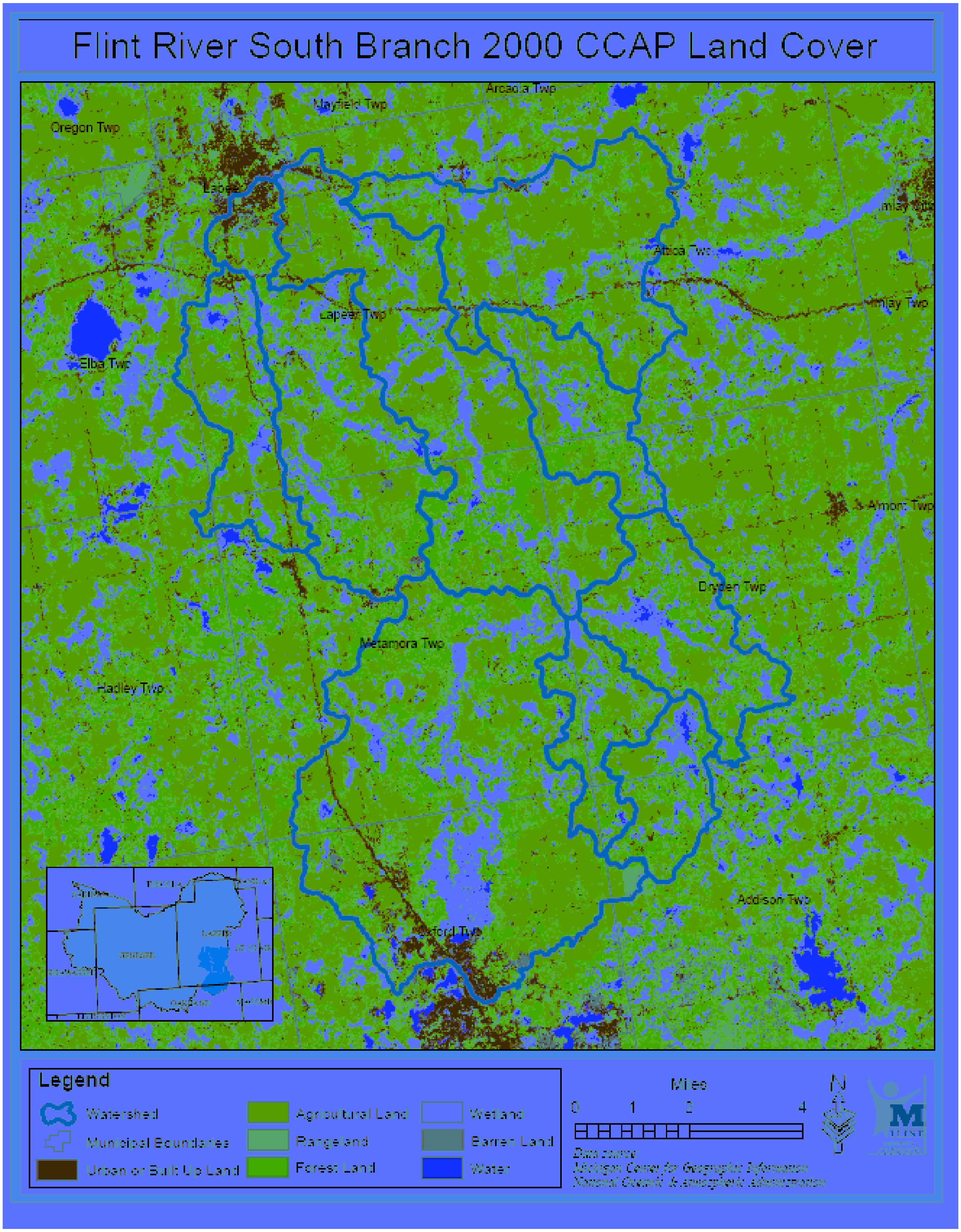


Figure A1.38 2000 Land Cover in South Branch Watershed

Agricultural Land Cover

- Agricultural land dominates the sub-watersheds of the SBW. This land use makes up approximately 50% of the land area within the watershed. The Pine Creek sub-watershed contains the highest percentage of agricultural land use at 57%. This is followed by Mirror Creek (49%), Flint River Main Branch (48%), Pine Creek Headwaters (37%), South Branch Headwaters (37%), Unnamed (35%), Whigville Creek (31%) and Whigville Lake (28%) respectively. The high percentage of agricultural land uses in the Pine Creek and Mirror Creek Watersheds are also coupled with the two lowest percentages of forested land uses in the watershed. Pine Creek's forest lands account for approximately 20% of the sub-watershed, and Mirror Creek's forested land is 22%.

- Key Point:
  The combination of high percentages of agricultural lands and reduced forest lands in the Pine Creek and Mirror Creek Watersheds are negatively impacting water quality.
  The land use combined with the drainage and ditching practices in the area appear to be increasing sediment delivery and hydrologic perturbations resulting in reduced water quality in these portions of the watershed. Figure A1.38 exemplifies these conditions. Specific recommendations for mitigating these impacts are presented in the implementation portion of the watershed plan including education, buffer strips and reforestation activities.

Figure A1.39: Pine Creek flowing through agricultural land (note lack of buffer on left bank)

Urban Land Uses

Urban land uses within the SBW land use has remained relatively stable from 1995 to 2000 with little to no significant increases in urban land use. The highest percentage of urban land uses are located within the Hunters Creek (6%), South Branch Headwaters (5%) and Mirror Creek (4%). These relatively higher percentages are associated with the Oxford urban center and the M-24 corridor.

- Key Point:

Continued increases in urban lands use poses a significant threat to future water quality within the SBW and are a major focus of the BMPs and education activities of this plans implementation section.

Riparian Corridor

The total amount of a particular land use impacts water quality in a watershed. Similarly, the location of that land use class will influence its impact on the health of the watershed. Research has shown that riparian lands, areas directly adjacent to the creek, are important in regulating flow, trapping sediment and providing critical habitat. These riparian areas often extend beyond the boundaries of the floodplain and act as a transition between aquatic and terrestrial environments (Forman and Wilson, 1995). As part of the land use analysis of the South Branch Watershed, the planning team analyzed the land use within a 150 foot buffer from the center of a river or stream. The results of that analysis are located in Appendix 1. The analysis points to Pine Creek having the most significantly impacted riparian corridor with 53% of the riparian corridor in agricultural land covers. This is almost double that of Mirror Creek, which has 29%.

- Key Point:

The riparian corridor of Pine Creek and Mirror Creek, and to a lesser extent Hunter's Creek, are negatively impacting water quality through the introduction of agricultural sediments and increased solar radiation. Significant effort should be placed in management of the riparian corridor in order to restore the impacted and threatened cold water fishery and protect other designated uses in the Pine Creek Watershed. In addition, efforts should be taken in the remainder of the watershed to protect the existing riparian corridors.

Appendix 2. Local Policy and Ordinances

Table of Contents

Introduction

It is commonly understood by watershed planners that "Communities find that their development codes and standards give developers little or no incentives to conserve natural areas and, in some cases, actually work against watershed protection" (frc&h, 2005). In order to address this reality the South Branch Watershed planning team conducted an analysis of the community's natural assets and the policies that impact them. This process involved identifying the land vital for maintaining high water quality, evaluating current policies, and offering recommendations on implementation steps necessary for resource protection that complement community goals (frc&h, 2005).

The identification of lands vital for resource protection was done done in this watershed plan and in the Greenlinks Potential Conservation Areas Assessment (see figure CD). The South Branch Flint River Watershed Management Plan elevates the relationship between land use and water quality by identifying specific changes in policy that will work to protect water quality within the watershed. The following policy review examines existing community goals, ordinances, development guidelines, and construction codes that impact water quality. The review also offers specific recommendations about policies that communities may want to adopt to protect water quality. Provided with this appendix is a CD that contains information about specific ordinances, natural features and other planning tools available to communities.

In Michigan land use and water quality decisions are made at the local level. Each unit of government plays a critical role in protecting natural resources. The following evaluation focuses on the role that county and township governments have on the water quality of the South Branch Watershed.

The Role of Township Government

Township governments in the state of Michigan utilize several mechanisms to protect the health, safety and welfare of their community's residents. These include:

- Master Plan and Future Land Use Map – establishes community goals and vision for the future of the Local Township or city. These documents serve as a guide for development of zoning ordinances
- Zoning Ordinances – provide rules to guide development in the local government that preserve the health, safety and welfare of residents.
- Development Guidelines and Construction Code – outline required procedures when altering land for development

Role of county government in protecting natural resources

County Governments also play a significant role in protecting the water resources of a community in a variety of ways. These specifically include:

- Soil Erosion & Sediment Control – regulated under Part 91 of the Natural Resources and Environmental Protection Act (1994 PA 451), the counties of Lapeer and Oakland administer soil erosion and sediment control permits for the respective communities of the South Branch. Permits are required for any activities that disturb more than an acre of land or that are within 500 feet of water in both counties.

- Drain Code – several water bodies in the South Branch watershed are regulated under the Michigan Drain Code of 1956 and administered by the Lapeer and Oakland County offices of the Drain Commissioner. The Drain Code gives authority to the Drain Commissions to construct, operate and maintain a system of county and inter-county storm drains.
- Road Commission – has jurisdiction over numerous roads in the watershed. The Road Commission is able to protect water quality by using Best Management Practices for road construction and stormwater runoff.

Overview of findings

Preserving the rich water resources of the South Branch requires watershed based land use decisions that protect natural resources. The communities of the South Branch have established goals that vary from protecting their beloved rural horse country and working farmlands, retaining small-town village character, to protecting unique natural features (woodlands, wetlands, scenic vistas). Alongside these goals are the realities of development pressure and the need to address infrastructure and service demands while maintaining the high quality of life enjoyed by residents of the South Branch watershed.

Several gaps have been identified between community goals and ordinances
CAERs recommendations are based on two levels:

1. What changes in local ordinances and codes are needed to meet current community goals (master plan, future land use plan)
2. What changes in local policy are needed to maintain the quality of life and clean water in the South Branch Watershed

Methods

Review Framework

Several documents and public input guided CAER in developing the methods for the ordinance review. CAER followed the methods of the Fishbeck, Thompson, Carr & Huber, Inc. for the Gun River Watershed Plan in looking at three layers of policy that regulate land use. These documents are: community master plans, local zoning ordinances, and construction regulations. A matrix developed by the Oakland County Planning and Economic Development, Environmental Stewardship Services titled "Oakland County Community Planning Inventory for Natural and Water Resource Protection" was used to compare the policies of the seven South Branch communities.

- **Addison Township** Contains portions of the Whigville Lakeshed, Unknown Creek and the South Branch Headwaters sub-watersheds.
- **Attica Township** Contains portions of the Pine Creek and Pine Creek Headwaters subwatersheds.
- **City of Lapeer** Contains the lower portions of the Hunters Creek and Flint River Main Branch sub-watersheds.
- **Dryden Township** Contains all of the Whigville Creek sub-watershed, and portions of the Pine Creek Headwaters, Flint River Main Branch, Unknown Creek, and the Whigville Lakeshed sub-watersheds.
- **Lapeer Township** Contains portions of the Mirror Creek, Hunters Creek, Flint River Main Branch, Pine Creek and Pine Creek Headwaters sub-watersheds.
- **Metamora Township** Contains portions of Hunter Creek, Flint River Main Branch, South Branch Headwaters, and Unknow Creek sub-watersheds.
- **Oxford Township** Contains the upper portions of the South Branch Headwaters

At the watershed scale, CAER looked at natural areas and processes occurring in the watershed and their role in protecting and preserving water quality. Potential Conservation Areas were identified by Michigan Natural Features Inventory for Oakland and Lapeer Counties.

Results & Recommendations

Utilizing the framework developed by Oakland County Planning and Economic Development, Environmental Stewardship Services, CAER focused on eight topics relating to water quality and quality of life when reviewing local policy. Each topic is described below followed by each community's policy relating to that topic. These topics are:

1. **Green Infrastructure**
2. **Trails**
3. **Ecosystem Health and Wildlife**
4. **Wetland and Woodland Preservation**
5. **Stormwater Management**
6. **Water and Sewer Planning**
7. **Land Development**
8. **Funding and Outreach**

This analysis outlines where communities rank in water and natural resource protection and what steps they can take to improve and maintain their way of life and natural assets.

1. Green Infrastructure

Green infrastructure is best described as a "interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife" (Benedict & McMahon, 2006). Communities in the South Branch watershed benefit from having several characteristics of green infrastructure including clean water, good fishing and abundant wildlife.

Input from the residents of the watershed indicated further that the ideal community in five years would maintain open space, create greenways, preserve existing greenbelts, have parks, develop natural corridors, control development to protect the watershed, and stop building in areas that would affect water quality. The 25 year community vision includes: inventory all natural areas for protection, coordinated effort to protect natural resources, canoeing and fishing access to promote coldwater trout stream, and a nature and recreation corridor across all of Lapeer County. All of these community aspects are achievable through successful green infrastructure planning and implementation.

Communities were assessed by asking several questions about local policy in regards to natural areas and open space, Michigan Natural Features Inventory, and Greenway Corridors.

Two existing efforts are underway that provide local communities with access to natural resource information and tools to incorporate green infrastructure planning into local policy. Oakland County Planning and Economic Development, Environmental Stewardship Services provides communities with services including green infrastructure visioning. The Greenlinks (green infrastructure) program covers Lapeer, Genesee and Shiawassee Counties and is administered through CAER. CAER is able to provide local conservation organizations and governments with natural resource information and capacity building support.

A watershed approach to land use planning dictates looking at larger networks of streams, rivers, lakes, natural areas, and green space to protect water quality. It is strongly recommended that each community of the South Branch incorporate natural resource information available through Greenlinks and Oakland County into local policy. The integrated approach of implementing green-infrastructure allows for development and economic growth while preserving the natural assets that make the South Branch a great place to live.

It should also be noted that several communities that provide open space development options to developers have created a complicated process (more so than for traditional developments) for site plan approval. By utilizing natural resource information available and allowing for more flexibility in site plan review, developers may be more apt to pursue non-traditional development options.

EXISTING GREEN INFRASTRUCTURE POLICY

Addison Township has incorporated goals and objectives on the conservation of natural resources in its master plan. The township recognizes that maintaining areas is "essential to maintaining the Township's unique heritage and character" (Bowman, 2002). In support of these goals, Addison Township has adopted zoning ordinances that require 25 foot natural feature setbacks in all districts. The township also provides density bonuses to developers that preserve 50% of their site as open space.

Attica Township allows cluster development to preserve open space, working lands and natural features. Density bonuses are given to sites where 50% of total area is preserved in perpetuity.

City of Lapeer has adopted an ordinance that allows lot areas to be reduced by 20% if 3 acres or more are preserved as open space. Cluster development is permitted when recreation is permitted on said open space.

Dryden Township recognizes the importance of natural areas in maintaining ecologic health and socio-economic status in the township. They have adopted goals that encourage long term stewardship and management of preserved natural areas and advocate working with conservation partners (ex. Land conservancy). Dryden Township has yet to adopt adequate policy in support of these goals but does allow cluster development when 50% of PUD developments are dedicated to open space. This incentive applies only to parcels of 40 acres or more.

Lapeer Township has stated goals and objectives tied to natural features and open space. Township zoning ordinances allow 10% density increases for sites that preserve 80% of existing trees and 100% of wetlands; 50% of the total site must be preserved as open space.

Lapeer County has incorporated natural areas identified by the Michigan Department of Natural Resources (MDNR) and the MNFI into their comprehensive plan, and states ensuring their protection by complying with State and Federal guidelines. Lapeer County has no regulatory authority at this time in regards to natural resource protection.

Metamora Township permits cluster development when 30-40% of site is preserved in open space. The open space must contain the site's most significant natural and cultural features. Sites that preserve 50% as open space are given density bonuses.

Oxford Township has included in the master plan goals, objectives and strategies that recognize the importance of a green infrastructure network. They have incorporated MNFI natural areas provided by Oakland County, an Open Space and Greenway Plan, have identified funding strategies, and developed a Greenways Implementation Matrix. Their zoning ordinances encourage open space development through their Open Space Option and PUD for new developments.

GREEN INFRASTRUCTURE RECOMMENDATIONS

Recommendations for all the communities are bulleted followed by community-specific recommendations.

- Require or encourage the linking of natural areas with adjacent natural areas or open space in site planning
- Discourage the fragmentation of natural areas and greenway corridors in site planning
- Encourage TDR or PDR programs to shift development from ecologically sensitive areas to higher density growth areas

<u>Oxford Township</u>

- Recognize the importance of long-term stewardship and management of preserved natural areas and greenway corridors

<u>Townships of Addison, Attica, Dryden, Lapeer and Metamora; City of Lapeer; Lapeer County</u>

- Include a map that identifies the location of natural areas and other ecologically sensitive features to promote preservation of natural systems while allowing development that complies with the natural capacity of the land
- Provide a green infrastructure vision for creating a linked network of key natural areas and connecting greenways
- Recognize the importance of long-term stewardship and management of preserved natural areas and greenway corridors
- Have a regulatory mechanism in place that requires or encourages the linking of natural areas with adjacent natural areas or open space in site planning
- Provide a green infrastructure map to guide the placement of open space during the site planning process for new developments
- Provide incentives to developers and landowners to conserve natural areas and greenway corridors

Tools

1. *Resource Protection Overlay District, see examples from Hillsdale County and Macomb County (Attached)*

2. *Michigan Natural Features Inventory courtesy of Greenlinks for Lapeer County and Oakland County Environmental Stewardship Services (Attached)*

3. *Greenlinks Vision for Lapeer, Genesee, and Shiawassee Counties (Attached)*

Online Resources

Oakland County Planning and Economic Development, Environmental Stewardship Services (for Addison and Oxford Townships)
http://www.oakgov.com/peds/program_service/es_prgm/green_infras/gi_project.html

Greenlinks (for Lapeer City, Attica, Dryden, Lapeer, and Metamora Townships)
http://www.flintriver.org/greenlinks/

Green Infrastructure (the Conservation Fund)
http://www.greeninfrastructure.net/

2. Trails & Recreation

Trails come in many forms and serve multiple benefits. Trails on land or water serve as a connector between communities and natural areas providing vital corridors for wildlife health and social interaction. Trails have been shown to increase economic value of homes, spur economic activity, and preserve open space, and link wildlife and natural areas. Trails may also serve to provide education to community residents about water quality, ecosystems, etc through the use of signage. The lack of public access to the South Branch prohibits development of a water trail where education activities could occur to increase river stewardship. The existing Polly Ann Trail runs through the eastern part of the watershed and is perceived as a community asset by local governments and residents. To date, 14 miles of the Polly Ann trail exist in Oakland County and 20 miles in Lapeer.

With the exception of Lapeer County and Dryden and Oxford townships, the remaining communities of the South Branch do not have any policy relating to trails or greenways. Development of trails linking communities of the South Branch will only benefit its residents and enhance their quality of life. Communities of the South Branch may also consider a water trail for locals to enjoy and appreciate the nature of the area. Trails are a great opportunity to educate citizens about the natural world, historic features, cultural assets, etc.

Public input also supports trails and recreation. Some of the comments mentioned at the input session included: develop trails, keep developing our trail, fishing access to river, more public access to river in Lapeer County, family outdoor outings, and a county that is easy to move around by bike and public transit.

TRAILS & RECREATION FINDINGS

Dryden Township identifies the need for a township recreation plan and promotes the continued use and maintenance of the Polly Ann Trail in their master plan. They have also identified a potential rail-trail through the township.

Lapeer County recognizes the benefits of a county wide trail system and has set a long term goal to develop a Recreational Plan. Lapeer County would serve as the coordinating entity for trail development.

Oxford Township has included trails in the Transportation section of their master plan and has developed a Parks and Recreation Plan for improving non-motorized transportation in their community.

TRAILS & RECREATION RECOMMENDATIONS
Recommendations for specific communities are below.

<u>Townships of Attica, Addison, Lapeer and Metamora; City of Lapeer</u>

- Include goals, objectives, and policies that recognize the health, fitness, non-motorized transportation, economic, and recreational benefits of developing and maintaining a community trail system
- Outline a proactive approach to identifying and prioritizing the development of key trail connections and linkages
- Coordinate community trail planning with adjacent community, County, and regional green infrastructure planning
- Provide a map of the community's green infrastructure vision to guide the placement of trails during the development planning process
- Promote and/ or require long-term stewardship and management of designated trailways systems
- Have a mechanism for assessing and addressing trail maintenace needs
- Require or encourage trail infrastructure to include educational sinage that informs community members of ecological, cultural, and/ or historical landmarks located along the trail

<u>Dryden Township, Oxford Township, and Lapeer County</u>

- Require or encourage developers to incorporate connections to the existing linked trails network where applicable
- Require or encourage all trail development to respect the natural characterisitcs of the land and its capacity to support recreational use

Tools

1. See green-infrastructure tools
2. Park and Recreation Plan

Online Resources

Polly Ann Trail
http://www.pollyanntrailway.org/

Oakland County Parks & Recreation
http://www.oakgov.com/parksrec/program_service/trails_intro.html

Lapeer County Parks
http://www.lapeercountyparks.org/

Michigan Trails & Greenways Alliance
http://www.michigantrails.org/

3. Ecosystem Health & Wildlife

As land use impacts water quality, communities were assessed on their understanding on the importance of ecosystems and the role they play in protecting the health, safety and welfare of residents. Specific topics covered in this area include: habitat protection, identification of high priority natural areas, natural capacity of land for development, and importance of native vegetation.

Lapeer County, and Dryden, Addison and Oxford Townships have policies that support ecosystem health and wildlife. The remaining communities of the South Branch have no policy addressing ecosystem health (habitat protection, native vegetation, invasive species management). Though a few communities have goals for protecting ecosystem health, ordinances or regulations are weak or absent. A simple first step is to incorporate existing natural resource information into local policy available from Oakland County and CAER. Practices that protect and improve ecosystem health mimic those for establishing a healthy green infrastructure.

Likewise, public input supports the protection of ecosystem health and wildlife based on the following comments from the visioning session:

- Develop natural corridors
- More trout streams
- Control development to protect the watershed

FINDINGS OF ECOSYSTEM HEALTH AND WILDLIFE POLICY

Addison Township includes goals and objectives in their master plan stating not to develop lakes that would result in environmental degradation, maintain and promote corridors for wildlife habitat, protect declining habitat and manage habitat for wildlife, promote land uses which preserve wildlife habitat and review site plans for compliance. Addison Township includes Development Guidelines in their master plan that site the natural capacity of land for development and native vegetation.

Dryden Township includes an Open Space Concept into their Land Use Plan, objectives to preserve existing nature sanctuaries and surrounding natural areas and cites soil limitations and natural features.

Lapeer County recognizes the importance of having a healthy ecosystem to have healthy residents and includes a map of natural areas identified by the MDNR and MNFI.

Oxford Township includes a comprehensive strategy for maintaining ecosystem health in their master plan. Their master plan outlines goals, objectives and strategies for maintaining ecosystems, identifies priority conservation areas, funding strategies, and a land suitability analysis. The township also promotes habitat protection during site development.

ECOSYSTEM HEALTH AND WILDLIFE RECOMMENDATIONS

Recommendations for all the communities are bulleted followed by community-specific recommendations.

- Recognize the importance of native vegetation in protecting vital air, land, and water resource quality.
- Provide model development principles that can be applied to site designs to reduce the impact of development on a site's natural resources or ecosystem functions
- Require and encourage the retention of native vegetation during site development
- Prevent the spread of soils containing invasive species during site development
- Outline a proactive approach for long-term invasive species monitoring and eradication throughout the community
- Adopt and enforce an ordinance that prohibits the use of invasive plants and encourages the use of native plants in all landscaping
- Require or encourage the relocation of at-risk plants and animals to suitable habitat prior to site development
- Advocate public education regarding the negative impacts invasive species have on native ecosystems
- Include goals, objectives and policies to address removal and management of invasive species on public and private lands

<u>Attica Township, City of Lapeer, Lapeer Township, Metamora Township</u>

- Recognize the interdependence of natural resources and the critical role functioning ecosystems play in protecting the health, safety, and welfare of residents
- Include a map of MNFI or other natural features inventory that recognizes these areas as critical for ecosystem health
- Include goals, policies, and objectives for preserving/ and or restoring ecosytems
- Outline a proactive approach to protecting high-priority natural areas and/ or high-quality wildlife habitat areas
- Recognize the natural capacity and limitation of land to support development
- Include goals, objectives, and policies that promote the retention and restoration of native vegetation
- Require developers to obtain an opinion from the MDEQ regarding the occurrences of threatened or endangered plant or animal species on a property prior to construction.
- Promote habitat protection and/ or enhancement as part of site development.
- Prevent the spread of soils containing invasive species during site development

Tools

1. Priority Conservation Areas identified by Michigan Natural Features Inventory (under green infrastructure section)
2. Native Vegetation Ordinance and Guidelines (Attached)
3. Sensitive Areas Protection (Attached)

Online Resources

Oakland Land Conservancy
http://www.oaklandlandconservancy.org/

Flint River Watershed Coalition
http://www.flintriver.org/

4. Wetland & Woodland Preservation

Wetlands and woodlands serve key functions in maintaining water quality by providing groundwater recharge, and filtering out pollutants. Wetland and woodland preservation further complements community goals to minimize flooding, maintain scenic vistas, and preserve rural character. Policies were evaluated based on woodland and wetland preservation practices, management of riparian (stream side) land, and floodplain management.

Attica Township and the City of Lapeer do not have policies relating to woodland and wetland preservation. Ideal policies would prohibit development within 50 feet or more from natural features. Management of stream corridors and riparian lands are especially important for maintaining water quality. With the exception of Addison Township, communities are further recommended to protect wetlands less than 5 acres, particularly those that provide high groundwater recharge (see Wetland Functionality Assessment, Appendix 4).

The public input received from CAER indicates that residents desire no wetland loss, want to protect water quality and the watershed by restricting development, and want sustainable privately owned forests.

EXISTING WETLAND AND WOODLAND PRESERVATION POLICY

Addison Township includes goals, objectives and development guidelines that support wetland and woodland preservation in their master plan. These include preserving wetlands regardless of size, maps of existing wetlands and woodlands, limiting lakeshore and stream bank development to recreation, limiting development in upland areas that would disturb wetland hydrology, and maximizing stream side buffers. In support of these goals, Addison Township has adopted ordinances that establish a 25 foot natural feature setbacks in all districts, protects wetlands of 2 acres or larger, and provides a fragile water course map for preservation.

Dryden Township includes a map of existing wetlands and woodlands and objectives to establish floodplain protection in its master plan. The township currently has no ordinances or regulations that protect wetlands and woodlands.

Lapeer Township recognizes the importance of wetland and woodlands in protecting the health, safety and welfare of its residents but provides no clear goals or objectives in support of protection. A wetlands map and woodlands map are provided in the master plan but no regulations exist to protect existing resources.

Metamora Township has a zoning ordinance restricting development in floodplains. Development must be 30 feet above 100 year flood plain or 30 feet from waters edge where 100 year flood level hasn't been established.

Oxford Township includes a map of existing woodland, wetland and tree rows and an Open Space & Greenway Plan in its master plan. In support of this, they have required 25 foot natural feature setback in all districts through zoning regulations.

WETLAND AND WOODLAND PRESERVATION RECOMMENDATIONS
Recommendations for all the communities are bulleted followed by community-specific recommendations.

- Protect wetland in an ecosystem context by protecting adjacent buffers, uplands and transitional areas.
- Discourage upland activities that have a negative impact on the natural hydrology of wetlands or streams
- Restore degraded buffer zones with native vegetation
- Include goals, policies, and objectives that discourage the channelization, rerouting, or any other topographical disturbance to a stream corridor to accommodate site development
- Include a 'Functionality Clause' within the wetland ordinance requiring a hydrological assessment of the property (preferably by a hydrological engineer) prior to development to ensure that the proposed development will not alter or disturb the natural hydrology of wetlands found on site or any existing hydrological connections to other water features within the watershed.
- Provide developers and community residents with a list of desirable, native riparian plant species to use in buffer restoration initiatives
- Replace trees that are removed during site development with comparable (native) species

<u>Addison Township</u>

- Adopt a woodland protection ordinance that includes special provisions for landmark trees and prohibits clearcutting of trees on development sites
- Coordinate riparian buffer regulations that are applied to community streams and rivers with regulations protecting county drains
- Restrict clearing and construction within the floodplain

<u>Attica Township, City of Lapeer, Dryden Township, Lapeer Township, Metamora Township</u>

- Inventory and map wetland, woodland, and riparian buffer resources within the community (except Dryden and Lapeer Townships)
- Include goals, policies, and objectives that advocate maximizing the width of riparian and wetland buffers
- Include goals and objectives to identify and preserve key riparian corridors that link the community's open spaces and natural areas
- Describe desirable and undesirable uses of floodplains and buffer zones (except Dryden Township)
- Include goals, policies, and objectives to prohibit or discourage construction with the 100-year floodplain (except Metamora Township)
- Adopt a natural feature setback ordinance to preserve wetland and riparian buffers, and floodplains (Recommended setback width of >50 ft)
- Adopt a wetland ordinance that protects wetlands below state protection criteria (< 5 acres in size)
- Adopt a woodland protection ordinance that includes special provisions for landmark trees and prohibits clear cutting of trees on development sites

- Coordinate riparian buffer regulations that are applied to community streams and rivers with regulations protecting county drains
- Provide developers with a Water Resources Overlay District designed to protect wetlands, woodlands, stream corridors and floodplain and related buffers
- Require the retention or restoration of naturally vegetated buffers along drainage corridors, wetlands, and floodplain boundaries
- Restrict clearing and construction within the floodplain

Oxford Township

- Include goals, policies, and objectives that advocate maximizing the width of riparian and wetland buffers
- Include goals, policies, and objectives to prohibit or discourage construction with the 100-year floodplain
- Adopt a wetland ordinance that protects wetlands below state protection criteria (< 5 acres in size)
- Adopt a woodland protection ordinance that includes special provisions for landmark trees and prohibits clear cutting of trees on development sites
- Coordinate riparian buffer regulations that are applied to community streams and rivers with regulations protecting county drains
- Provide developers with a Water Resources Overlay District designed to protect wetlands, woodlands, stream corridors and floodplain and related buffers

Tools

1. Woodlands Protection and Preservation Ordinance – example from Green Oak Township, Livingston County (attached)

2. Sample DEQ Wetland Ordinance (attached)

3. Natural Feature Setback Ordinance – example from Ann Arbor Township, Washtenaw County (attached)

4. Wetland Functionality Map (Appendix 4)

5. Stormwater Management

Due to the effects stormwater has on water quality (see Watershed Description of SWFRWMP); community policies were reviewed for effective stormwater management. Review of stormwater management policy includes regulating quality and quantity of flow, impervious surface reduction, use of porous pavement and vegetated swales, preserving natural pathways, and erosion and sediment control. Stormwater management is an issue that should be addressed by local communities in partnership with their respective Drain Commission and Road Commission. Stormwater management should be focused on areas that are developing, particularly the M-24 corridor. Together, comprehensive actions varied from education to best management practices are necessary for the South Branch to remain fishable, swimmable, and drinkable. Public input also indicates that development should be restricted in areas that would harm water quality.

Soil erosion and sedimentation is regulated by Oakland County Drain Commission in Oxford and Addison Townships, and by Lapeer County Drain Commission in the remaining communities of the South Branch. Both drain offices require a permit is obtained for any activities occurring within 500 feet of water or when an acre or more of land is to be disturbed. The Oakland County Drain Commission provides new homeowners with a brochure on “New Homeowner’s Guide to Soil Erosion Control”. As a result, local communities do not enforce soil and sediment permits, but may regulate the removal of topsoil and require landscaping immediately after project completion.

EXISTING STORMWATER MANAGEMENT POLICY

Addison Township addresses stormwater management in its master plan by minimizing stormwater runoff through proper land use locations and development practices, preserving natural infiltration and drainage pathways, and discouraging development in areas of significant slope. Regulations supporting some of these policy goals are part of the site plan review process. Shared parking is allowed when business hours are not in conflict. Township landscaping regulations require landscaping is completed within 6 months of project completion.

City of Lapeer has no stated goals on stormwater management but does require soil erosion control measures to be in place 15 days after final grading, prohibits the removal of topsoil except where buildings, roads, and parking lots will go, and allows shared parking when business hours are not in conflict.

Dryden Township requires landscaping be in place 180 days after project completion.

Lapeer County has set a goal to educate local units of government about stormwater management and recommends local zoning ordinances require developers to provide appropriate stormwater management.

Lapeer Township requires a development impact statement show that the proposed development will not cause soil erosion or sedimentation problems.

Oxford Township identifies impervious surface reduction as an important community goal and allows for reduced road and sidewalk widths in Planned Unit Developments. Natural features and drainage may also be preserved when developers utilize the Open Space Option.

STORMWATER MANAGEMENT RECOMMENDATIONS

Recommendations for all communities are below followed by community specific recommendations.

- Include goals, policies, and objectives that advocate the use of porous pavement and naturally vegetated swales to enhance infiltration and slow runoff velocity
- Outline goals or objectives to protect the value and function of wetlands that have been incorporated into the stormwater management system
- Outline a goal or policy to incorporate innovative stormwater management BMP's or low-impact design techniques where feasible
- Encourage site design plans to include effective criteria for stormwater BMPs.
- Require performance standards for stormwater management (e.g. maintain pre-development runoff rates or volumes, pollutant removal standards, etc.).
- Require maintenance and monitoring agreements for all stormwater management systems or other BMPs
- Promote the use of porous pavement in site development guidelines
- Encourage developers to protect steep slopes and cuts and to stabilize disturbed areas within 2 weeks (except City of Lapeer)

<u>Attica, City of Lapeer, Dryden, Lapeer, Metamora, Oxford</u>

- Identify the management of stormwater quality and quantity as an important community goal or policy relating to the the protection of health, safety, and welfare of your community's residents
- Include goals, policies, and objectives that advocate preserving natural drainage pathways and existing vegetation to the greatest extent possible
- Include goals, policies, and objectives that recognize the importance of controlling erosion and sedimentation as they relate to water and habitat quality, and to the health, safety, and welfare of the community
- Discourage discharge of untreated stormwater and effluent into natural water bodies (wetland, stream, river, lake) or sensitive terrestrial areas
- Provide developers with guidelines to make drainage systems and retention ponds visually attrative while enhancing the system's functionality (for example, avoiding traditional turf grass, use native species and contoured ponds)
- Encourage the developer to use native vegetation swales, buffers, and infiltration areas to manage stormwater
- Have a mechanism in place to responding to public complaints regarding construction site erosion control

<u>Attica, City of Lapeer, Dryden, Lapeer, Metamora</u>

- Identify impervious surface minimization and preservation of natural infiltration to the greatest extent possible as important community goals
- Encourage the developer to design sidewalks, roads, and driveways to minimize impervious surfaces
- Encourage developers to preserve natural contours, vegetation, and drainage patterns by incorporate the existing landform into development designs, and keeping grading and site preparation to a minimum (except City of Lapeer)

Tools

1. Stormwater Management / Impervious Surface Mitigation Sample Ordinance (attached)

2. Steep Slope Development Standards – example from Hillsdale County (attached)

3. Off Street Parking Regulations – example from Ann Arbor Township, Washtenaw County (attached)

4. Oakland County Drain Commissioner, New Homeowner's Guide to Soil Erosion Control (attached)

Online Resources

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

National Stormwater Center
http://www.npdes.com/

Center for Watershed Protection
http://www.cwp.org/

DEQ – Soil Erosion and Sedimentation Control
http://www.michigan.gov/deq/0,1607,7-135-3311_4113---,00.html

Oakland County Drain Office, Soil Erosion Control Permits
http://www.oakgov.com/drain/permit_license/erosion_apps.html

6. Water & Sewer Planning

Communities that plan for water and sewer service are taking a proactive approach in how and where their community develops. Setting service boundaries, assessing land suitability for septic and implementing wellhead and groundwater protection ensures that vital water resources and public health will be protected as the community grows.

The public input received on this topic included: intergovernmental cooperation on sewers and drainage, demand clean drinking water, paying a more realistic price for fresh water, keep out Detroit and Flint city water, and sensible sewer system for our townships' area.

The SBWMP provides several resources to guide planning at the regional and site scale. Included are maps of geology and soils (Maps ??) to give general guidelines where areas of high infiltration and runoff are located and a septic suitability map (Map?). Site investigation is still required to determine the capacity of soils for stormwater retention and detention. The Wetland Functionality Assessment provides detail at the site scale for incorporating wetlands into stormwater management schemes. Further analysis is needed to determine groundwater recharge areas in the South Branch to guide local development.

WATER AND SEWER POLICY FINDINGS

Addison Township has no intention of providing its residents with sanitary sewer services. The master plan encourages residential development to avoid areas of soils with poor suitability for septic and protect sensitive groundwater recharge areas. Maps are included, based on soils, detailing which areas are suitable for septic disposal and where fragile watercourses are located. Local regulations require septic be 100' from waters edge and require a 25' vegetated setback from the high water line.

Attica Township states in the master plan that wastewater treatment is important but has no regulations or schedule for implementation.

City of Lapeer provides sewer and water services to its residents.

Dryden Township relies solely on groundwater for water supply and refers to the wetlands and woodlands map as areas of groundwater recharge. Sewer expansion is only permitted near the village of Dryden. A map is consulted during site plan review outlining soils with severe limitations for septic tanks. The township has no regulations in support of their stated goals.

Lapeer County summarized the surface water resources in the county and summarized the studies initiated by the communities of the county in the comprehensive plan. There are no county owned or operated wastewater or water districts at this time.

Lapeer Township identifies the need for sewer and water planning, provides a map of service boundaries and areas suitable for septic systems in their master plan.

Metamora Township currently has no sanitary sewer but may offer it along the M-24 corridor in the future. The township has included a septic suitability map in their master plan.

Oxford Township established a sewer service district with the Oakland County Drain Commission in 1997. The master plan includes a Land Capability Analysis for development based on soils and goals for identifying need infrastructure.

WATER AND SEWER POLICY RECOMMENDATIONS
Recommendations for all communities are below followed by community specific recommendations.

- Identify and map the groundwater recharge area(s) that contributes to your community's groundwater supply. Advocate eliminating potential sources of pollution and retaining as much permeable surface as possible in identified recharge area(s).
- Require septic systems to be located atleast 100 feet from wetlands, streams, lakes, or other water features
- Encourage developers to address preserving the balance and integrity of the hydrogeological system in site development plans.
- Prohibit the connection of downspouts to the stormwater system
- Require regular maintenance and inspection of septic systems
- Outline an approach for identifying and correcting failing septic systems
- Advocate that the majority of the surface in groundwater recharge areas remains open space, or is limited to low density development.
- Discourage or prohibit land grading in groundwater recharge areas to maintain the water-holding characteristics of the land
- Require site development plans to include an assessment of, and preventative measures for, potential sources of contamination to the recharge area during the construction process
- Outline an approach for identifying, mapping, and eliminating illicit discharges to the drainage system
- Outline proper application and storage proceedures to prevent sand and salt from entering the stormwater system

<u>Attica Township</u>

- Identify groundwater as a natural resource important to the health, safety, and welfare of community residents, and outline the importance of groundwater recharge to maintaining the integrity of aquatic resources such as streams and wetlands
- Advocate the use of maps and discussion relating to current and planned wastewater infrastructure and soil cabability in land use, zoning, and site plan decisions
- Identify the sanitary sewer infrastructure needed (location and capacity of service) based on projected population growth, and outline a construction, maintenance, and replacement schedule for future and current sewer infrastructure
- Identify areas within the community that are suitable and unsuitable for septic systems, and include a map and discussion of soils and their capabilities for handling septic systems

<u>Dryden Township</u>

- Outline goals, policies, and objectives that address wastewater planning and relate adequate wastewater treatment to the protection of the health, safety, and welfare of residents

- Advocate the use of maps and discussion relating to current and planned wastewater infrastructure and soil cabability in land use, zoning, and site plan decisions

Lapeer Township

- Identify groundwater as a natural resource important to the health, safety, and welfare of community residents, and outline the importance of groundwater recharge to maintaining the integrity of aquatic resources such as streams and wetlands
- Advocate the use of maps and discussion relating to current and planned wastewater infrastructure and soil cabability in land use, zoning, and site plan decisions

Metamora Township

- Identify groundwater as a natural resource important to the health, safety, and welfare of community residents, and outline the importance of groundwater recharge to maintaining the integrity of aquatic resources such as streams and wetlands
- Advocate the use of maps and discussion relating to current and planned wastewater infrastructure and soil cabability in land use, zoning, and site plan decisions

Oxford Township

- Identify groundwater as a natural resource important to the health, safety, and welfare of community residents, and outline the importance of groundwater recharge to maintaining the integrity of aquatic resources such as streams and wetlands

Water and Sewer Planning Tools
1. Groundwater Protection, by Planning & Zoning Center, Inc. from Filling in the Gaps by DEQ
2. Septic Suitability Map
3. Point of Sale Septic Program (Shiawassee County Health Department)
4. Wetland Functionality Assessment (see Appendix 4)

7. Land Development

Local and county ordinances are consulted during the site plan approval process. This part of the review assessed the criteria developers must meet and provide as part of the site plan approval process. Communities were compared on the development review process they use, and the principles they advocate during site plan and development approval. Special notice was given to communities that advocate for principles that support green infrastructure, trails, ecosystem health and wildlife needs, wetland and woodland preservation, and stormwater management.

The communities of the South Branch can take a proactive approach in protecting water quality by streamlining the site plan review process and incorporating a comprehensive checklist for use by developers and review boards and commissions. All communities have required information to be included with site plans but it is unclear how this information encourages developers to preserve natural features, natural drainage, and protect water quality.

Public input also supported the following:

- Planned “green” development
- Better public transport coverage
- A trend toward smaller rather than larger homes
- Limited private road development
- Smart Growth to preserve the landscape
- No additional gravel mining
- Slow land division
- Control growth / slow development
- Land capability base planning

LAND DEVELOPMENT POLICY FINDINGS

Addison Township's criteria for site plan approval include preserving natural landscape by minimizing tree and soil removal and by topographic modifications. Drainage design shall recognize natural drainage patterns if practical.

Attica Township has standards for site plan approval. A Community Impact Statement (CIS) is required for intensive development projects and special land uses. The CIS must include impacts to community facilities and services, economy, environment, noise and traffic.

Dryden Township has standards for site plan approval.

The City of Lapeer has developed a Development Review Procedures Handbook to familiarize developers with the process and requirements for rezoning and master plan amendment, special conditional use permit, zoning variances, site plan review, subdivision and condominium review, and permits and inspections.

Lapeer Township requires a Development Impact Statement be submitted along for site plan approval. The intention is to provide the township with anticipated impacts to public infrastructure, adjacent properties, and the environment.

Metamora Township has standards for site plan approval. A Community Impact Statement (CIS) is required for intensive development projects and special land uses. The CIS must include impacts to community facilities and services, economy, environment, noise and traffic.

Oxford Township has standards for site plan approval. An Impact Assessment is required for developments that meet one of the following criteria: more than 100 residential units, square footage of non-residential building exceeds 100,000, anticipated vehicle traffic exceeds 1,000 trips per day, or hazardous material will be generated, stored or disposed of on-site.

LAND DEVELOPMENT POLICY RECOMMENDATIONS
Recommendations for all communities of the South Branch are below.

- Encourage developers to preserve natural features to the fullest extent possible
- Require a pre-application meeting or site analysis before engineered drawings are submitted
- Require site plan proposals to include a map of all natural features such as surface water, floodplains, wetlands, woodlands, steep slopes, and natural drainage pattern
- Strongly encourage or require developers to incorporate green development design into site plans
- Encourage developers to minimize impervious surface by using minimum widths for streets, ROWs, sidewalks, driveways, parking spaces and cul-de-sacs, and efficient street layouts and parking ratios
- Require a portion of all parking facilities to be dediated to enhancing filtration (plant vegetation within the parking area, provide pervious spillover areas using porous pavement, and use islands as detention areas)
- Relax side yard setbacks and narrow frontages to reduce total road length, driveway length, and overall site imperviousness
- Offer developers incentives to meet regulatory restrictions (density compensation, buffer averaging, transferable development rights, etc.)
- Provide developers with incentives and flexibility in the form of density compensation, buffer averaging, property tax reduction, stormwater credits, to conserve (unregulated) areas of environmental value

Tools

1. Example of Environmentally Sensitive Future Land Use Plan, Filling in the Gaps

2. Integrating Water and Natural Resource Protection into the Planning Process: Guidelines for Site Plan Review, Oakland County Planning Website

3. Lot Averaging, example from Hillsdale County

4. Growing Greener, Putting Conservation into Local Codes

8. Funding and Outreach

A strategy for accomplishing community goals traditionally consists of a Capital Improvement Plan, assessing funding options, and providing outreach and education on community goals. The evaluation of funding and outreach strategies is focused on environmental goals and objectives of individual communities. Communities that do not have strong policies for water and natural resource protection were not evaluated.

Funding and outreach strategies for water and natural resource protection are varied and available at multiple scales. It is recommended that all communities prioritize what projects are important and assess potential funding options.

FUNDING AND OUTREACH POLICY FINDINGS

Addison Township recommends a PDR or TDR program and/or working with a land conservancy to achieve goals of the master plan. Specific goal are not tied to specific funding strategies.

Attica Township lists several options for funding in the Implementation section of thei r master plan. The master plan does not tie specific goals and actions to specific funding options but does describe state and federal grants as well as TDR and PDR programs as options for achieving township goals.

Dryden Township includes in its master plan to promote the activities of local, state and national land conservancies as a strategy to protect natural resources without using tax dollars.

City of Lapeer has adopted a Tax Increment Financing (TIF) ordinance to spur economic growth which may conserve open space by encouraging infill development near the city center.

Lapeer County administers a Purchase of Development Rights (PDR) program for the county. The PDR program is focused on preserving farmland but may be used to conserve other natural features and open space.

Lapeer Township has included an Implementation section in their master plan that outlines several strategies to fund conservation of natural resources and open space. These strategies include partnering with local land conservancies, conservation easements, and bonds.

Metamora Township lists several options for funding in the Implementation section of their master plan. The master plan does not tie specific goals and actions to specific funding options but does describe state and federal grants as well as TDR and PDR programs as options for achieving township goals.

Oxford Township has included a prioritized list of conservation projects in the township and options for funding in their master plan.

FUNDING AND OUTREACH POLICY RECOMMENDATIONS

- Include guidance on how future infrastructure, repairs, and maintenance of the community's sanitary sewer system will be financed
- Outline goals, policies, and objectives for educating residents about the health, safety, and economic benefits associated with conserving the community's natural resources
- Use community millages as a funding mechanism for environmental, ecological, or conservation-related projects
- Apply for the M-DNR's Natural Resources Trust Fund Grant to fund the protection of natural resources and open space, and/ or purchase lands for outdoor recreation
- Produce and distribute educational materials discussing the health, safety, and economic benefits of preserving the community's natural resources
- Produce and distribute educational materials for residents that describe household/ residential conservation practices (for example, limiting water use outside their homes, such as on lawns and gardens, capturing storm runoff through features such as rain barrels or rain gardens, preserving riparian buffers, using native plants in landscaping, proper car-washing and waste-disposal practices etc.)
- Provide a mechanism for educating the community's commercial and industrial business owners/ managers about natural resource conservation practices (stormwater management, use of native vegetation, etc.)
- Support signage in local parks, natural areas, riparian corridors and/ or watershed boundaries to educate residents about natural features and their role in protecting vital air, land, and water resources

<u>City of Lapeer, Addison, Attica, Metamora, Dryden and Lapeer Townships</u>

- Outline a prioritized list of conservation projects/ areas to receive funding in the Master Plan Implementation Schedule
- Include a line item in the Capital Improvement Plan for funding community trails or greenways
- Include a line item in the Capital Improvement Plan for funding the community's natural area/ green infrastructure program
- Advocate the use of donation/ tax incentives, conservation easements, millages, bond referendums, and/ or utility fees to fund the conservation and management of natural areas, open space, and water resources within the community
- Identify environmental education and outreach as an important community goal or policy
- Advocate coordinating environmental education efforts with other organizations, such as local watershed councils, land conservancies, or the county

Tools and Resources

1. *Fish and Wildlife Service Grants available to local governments*
http://www.fws.gov/grants/local.html

2. *Michigan Natural Resources Trust Fund*
http://www.michigan.gov/dnr/0,1607,7-153-10366_37984_37985-124961--,00.html

3. *Oakland Land Conservancy*
http://www.oaklandlandconservancy.org/

4. *Flint River Watershed Coalition*
http://www.flintriver.org

5. *Field Guide to Transfer of Development Rights*
http://www.realtor.org/libweb.nsf/pages/fg804

6. *More on Transfer of Development Rights*
http://www.beyondtakingsandgivings.com/tdr.htm

Appendix 3
Hydrology and Impervious Surface Analysis

Introduction to Hydrology

Streams receive water in two general ways including overland flow (runoff) from the earth's surface and from base flow (infiltration that seeps directly into the stream channel). Land use changes in a watershed redistribute the amount of water that is delivered to the stream by these two processes. In most cases human interactions tend to increase the amount of water entering the stream from direct runoff while reducing the water available for base flow. This change in the hydrology (how much and how fast water moves through a watershed) is measured by two variables: the coefficient of runoff (amount) and the concentration time (speed). Landscape changes including land clearing, deforestation and the introduction of impervious surfaces increase the coefficient of runoff. Concentration time is shortened by activities such as installing ditches, constructing storm sewers and removing wetlands. (Figure A3.1) is a graphic representation of how natural and urban river systems react to rainfall events. This figure contains two hydrographs representing hypothetical urban and natural streams. Time is plotted along the horizontal axis while the amount of water (discharge) is plotted along the vertical axis. A review of this figure demonstrates drastic differences between natural and urbanized watersheds. Most important to notice are the increases in peak flow and reduction of base flow associated with the urban watershed.

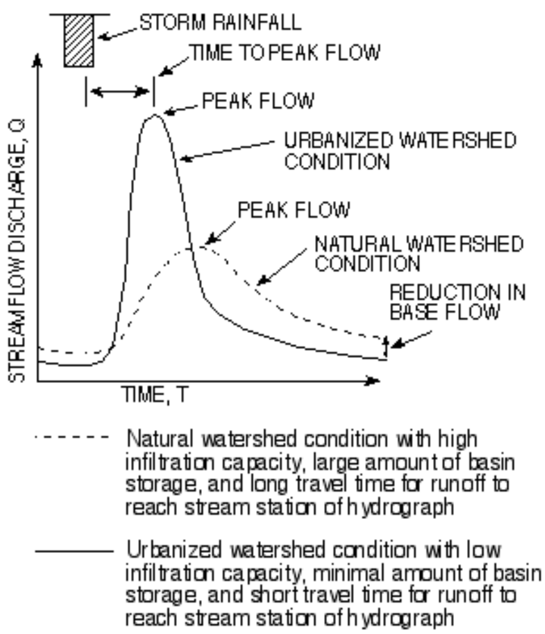


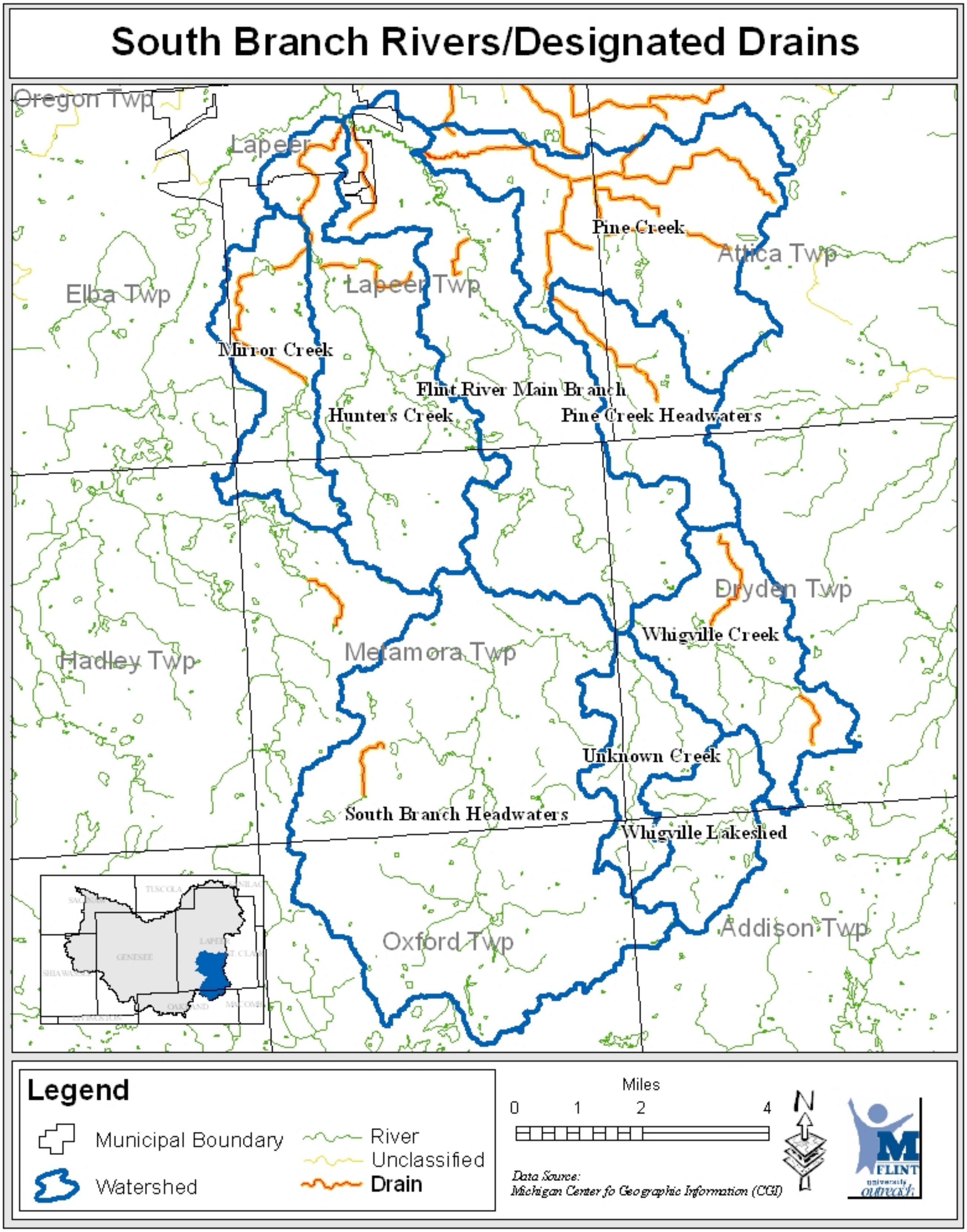
Figure A3.1. Hypothetical urban and natural hydrographs

The increases of runoff and concentration times (time it takes rainwater to reach the stream channel) associated with land use changes and channel alterations results in significant impacts on water quality. Changes in these two variables directly impact the aquatic habitats of the stream system. In addition they affect the magnitude and frequency of flooding events, increase erosion and the delivery of non-point source pollutants to the stream. The reduction in base flow negatively impacts the stream by reducing the water available for human and animal uses.

Hydrologic analysis methods
The planning team conducted several activities in an effort to characterize the hydrology of the South Branch Watershed. The basis for the analysis is the interpretation of hydrologic cues. Hydrologic cues are physical indicators within a watershed that offer information about the hydrologic condition of the watershed. For this analysis the cues consist of observations for extensive stream bank erosion, channel form (instability), high water mark and land use (impervious cover analysis).

Channel form & stream bank erosion
Significant portions of the South Branch watershed's stream channels are identified as designated drains (A3.2). However a majority of the watershed exhibits natural channel forms and stable stream banks. Field observation of stream bank erosion in the watershed was almost nonexistent with the exception of a few isolated locations within the watershed where erosion appears to be a result of local scale hydrologic factors. Most areas where these factors were noted, the channel exhibited forms that suggested the channel was adjusting and recovering naturally. These locations were infrequent and did not attract the attention of the planning team as a critical threat to designated uses. Table A.3.3 identifies the condition of the stream channels at the road/stream crossings inventoried. Included below are two photographs of the representative section of each sub watershed.

Figure A3.2 South Branch Rivers



Designated Drains

Table A3.3 Stream Channel Condition

	Upstream			Downstream		
River Morphology	**%Natural**	**%Recovering**	**%Maintained**	**%Natural**	**%Recovering**	**%Maintained**
Channel	64	11	16	63	13	14

High Water Marks

The high water mark of a stream is defined as the elevation of water in the stream channel during a flood event. Streams with stable hydrology tend to have low fluctuations between normal water mark and flood water mark. Large differences between the current water level and high watermarks are indicators of hydrologic instability. As Table A3.4 shows, most sub-watersheds have a high water mark of less than 1 foot, followed by 1-3 feet.

Table A3.4

	Highest Water Mark				
Watershed	**?**	**<1**	**1-3**	**3-5**	**Total**
Hunters Creek	0	4	5	1	10
Main Branch	2	6	4	0	12
Mirror Creek	0	3	1	0	4
Pine Creek	3	7	1	0	11
Pine Creek Headwaters	0	1	2	0	3
South Branch Headwaters	3	4	2	1	10
Unknown Creek	1	2	1	0	4
Whigville Creek	2	5	0	0	7
Whigville Creek Headwaters	2	1	0	0	3
Total	13	33	16	2	64

Land use and hydrology

Land use within a watershed is a major determining factor of the hydrologic stability of the watershed. Changes in the natural land cover can have tremendous effects upon the hydrologic functioning of the river system. One major change that takes place in the alteration of natural land covers is an increase in impervious surfaces (the area covered by rooftops, streets, parking facilities, and other hard surfaces). The physical, chemical, and biological integrity of a given stream system has been shown to be strongly correlated to the amount of impervious cover in the sub-basin or watershed (Schueler, 1994). Even small increases in impervious surface will change stream morphology and degrade aquatic habitat. The amount of impervious cover in a watershed can be used as an indicator to predict how severe differences are in the character of urban and natural watersheds.

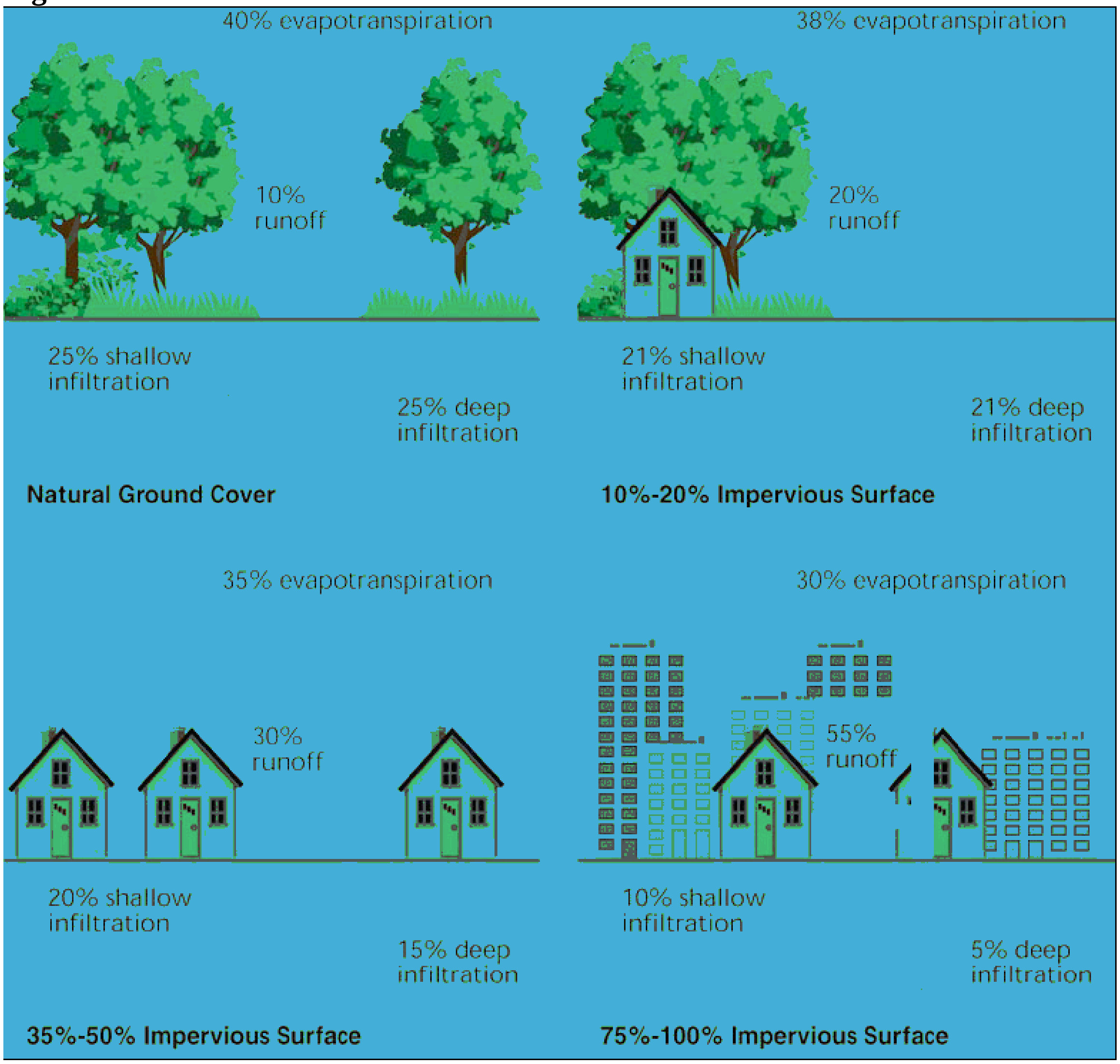
Analysis of stream systems across the country indicates there are thresholds at which watershed imperviousness results in degradation of water quality and physical stream processes. Research indicates that zones of stream quality exist, most noticeably beginning around 10 percent impervious cover, with a second threshold appearing at around 25-30 percent impervious cover. These thresholds are powerfully modeled in The Impervious Cover Model, classifying streams into three categories, sensitive, impacted, and non-supporting. Watersheds with less than 10 percent imperviousness appear to exhibit natural chemical, physical, and biological integrity. Between 10 and 25 percent imperviousness river systems show signs of degradation. Beyond 25 percent imperviousness, the damage to physical, chemical, and biological integrity may be irreversible. However it is important to understand the Impervious Cover Model, predicting quality of streams based on impervious cover change, is not without its limitations. (Schueler, 1994).

<u>Impervious Surface Assessment</u>

Impervious land cover consists of any surface that prevents the free movement of precipitation into soil pore spaces and then into interflow or a groundwater aquifer. It instead prevents infiltration and promotes storm water runoff into nearby wetlands or river networks. While certain clay soils, rocky outcroppings, and land with steep slopes can have these same effects and exist naturally, human created impervious land cover is more common in southeast Michigan and of greater concern. Man-made impervious surfaces can be anything from paved roads and parking lots, to the roofs of buildings and hard-packed soil.

Analysis of changes in impervious cover in the watershed over time will help evaluate the success of watershed planning efforts in the South Branch. The amount of impervious surface in a watershed is directly related to water quality. As impervious land cover increases, infiltration to groundwater and plant evapotranspiration are decreased while storm water runoff to storm drains, and subsequently to river systems, is increased (Figure A3.5). The results of this increased input to rivers includes increased risk of flooding, widely fluctuating stream levels, increased sedimentation of the stream bed, and increased erosion of the stream bank. Impervious cover in the South Branch must remain below 10% for water quality to remain in its current condition (CWP, 2005?).

Figure A3.5



Effects of Urbanization on Runoff
Source: FISRWG

Assessment Methods

Impervious surface reduction can be regulated through local policy and assessed by using simple GIS modeling. The National Oceanic Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) provides national land cover and change information based on satellite imagery for coastal regions of the U.S. One objective of C-CAP is to provide baseline for which coastal changes can be assessed over time. Data sets for the state of Michigan are available for 1995 and 2000. The C-CAP data can also be used to assess impervious cover through the use of the Impervious Surface Analysis Tool (ISAT), developed by NOAA Coastal Services Center and the University of Connecticut Non-point Education for Municipal Officials (NEMO) Program for coastal and natural resource managers. The ISAT is used to calculate the percentage of impervious surface area of user-selected geographic areas (e.g., watersheds, municipalities, subdivisions).

ArcGIS is software developed by Environmental Solutions for Resource Integration (ESRI) for aerial and satellite imagery interpretation, and spatial data management. CCAP data can be manipulated using a combination of ArcGIS and an extension available from NOAA. ISAT can then be added to ArcGIS as an extension in order to analyze the land cover data for a desired geographic area to determine the runoff for that area. The CCAP and ISAT extension and help files are available for download from NOAAs website. Users must have access to ArcGIS or ArcView software to perform the analysis.

Impervious surface data for the South Branch and its sub-watersheds were developed through the combined use of ESRI's ArcView and ArcInfo software with NOAA's C-CAP data and ISAT in a two-step process. The ISAT applies impervious surface coefficients to the CCAP land cover data within a user defined boundary to determine the amount of impervious surface in that area. The 1995 and 2000 C-CAP data were analyzed using the sub-watersheds of the South Branch as boundaries and low (rural) coefficient defined by the extension. ISAT gives the user the choice of three predefined impervious surface coefficients: high, medium, and low, which correspond to urban, suburban, and rural land use. Since the majority land use identified for all watersheds was land that would fall into the rural category, the lowest coefficient was used. As can be seen in Figure A3.6 and Table A3.7, the results of the extension show that all watersheds have less than 10 percent impervious land cover.

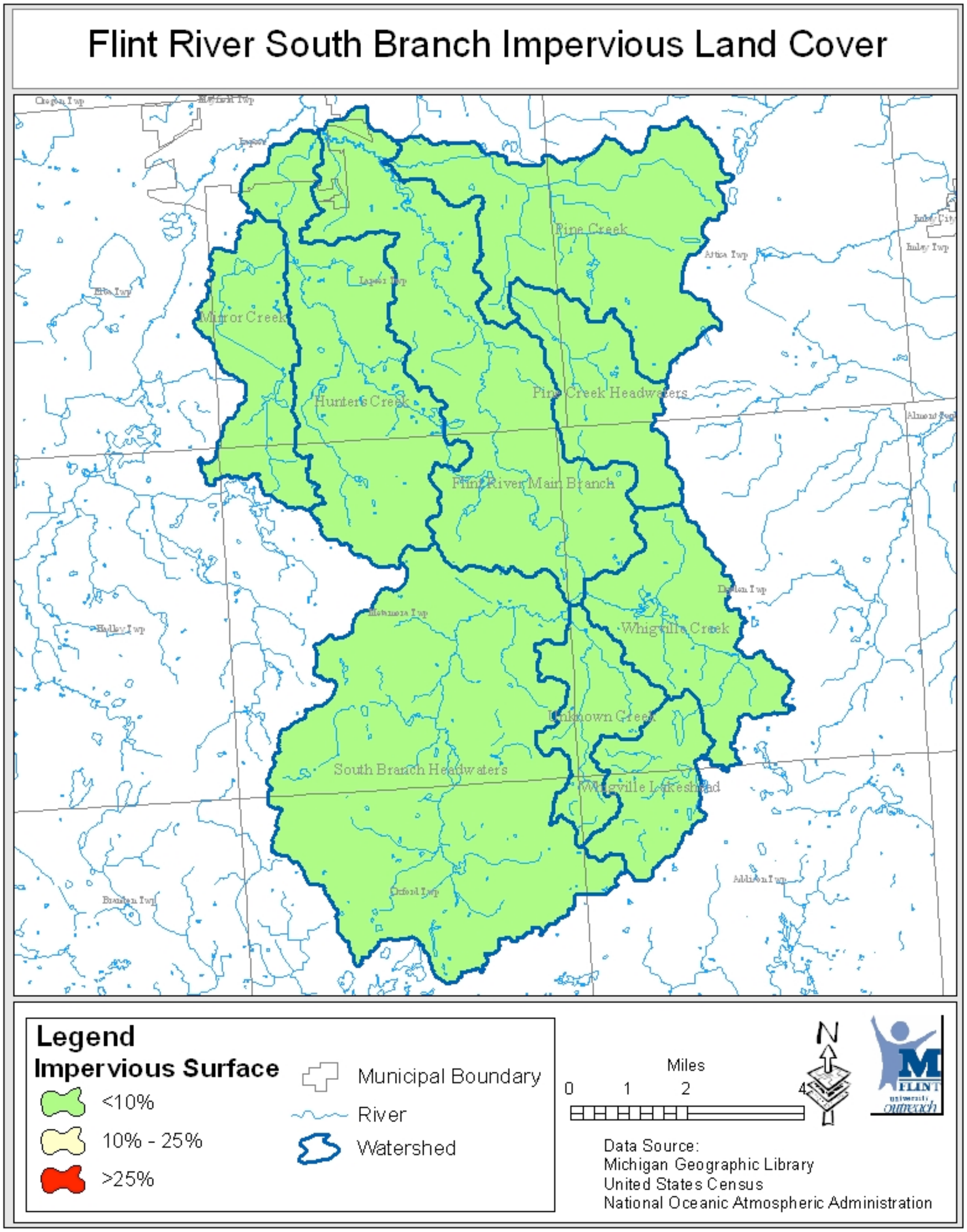


Figure A3.6 Flint River South Branch Impervious Land Cover

Table A3.7 Percent Impervious Land Cover

Watershed	%Impervious Surface
Flint River Main Branch	4
Hunters Creek	4
Mirror Creek	4
Pine Creek	4
Pine Creek Headwaters	3
South Branch Headwaters	4
Unknown Creek	3
Whigville Creek	3
Whigville Lakeshead	3

Future Research

As previously mentioned, changes in impervious land cover will have to be monitored in order to evaluate the success of watershed planning efforts in the South Branch. The available census data may be used as they have been here, but they will fail to pick up on changes at the local level unless population densities approach those of the City of Lapeer. There is a need, therefore, for the development of land cover data and impervious surface coefficients on the municipality level to adequately capture changes in impervious cover over time. Also it is anticipated that the 2005 CCAP data will soon be available, at which time it should be evaluated using ISAT to look for more recent changes in impervious land cover.

Ponds and Lakes

The stable hydrology of the South Branch Watershed is contributed to by the stable land use and the undulating landscape. The abundance of lakes and ponds in the watershed aid in the regulation of stream flow and is critical to maintaining high water quality in the South Branch. In addition to identifying rivers and streams, ponds and lakes also were inventoried as part of the Wetland Functionality Assessment (Appendix 4). Ponds and lakes were identified in each sub-watershed by origin and classified by flow path.

Origin is defined as:

Natural – naturally occurring lake or pond due to historic glacial activity
Dammed – lake or pond occurs as a result of a dammed stream or river
Excavated – lake or pond has been created by removal of soil and vegetation

Flow path is defined as:

Isolated – surface water does not enter pond or lake via a channel
Outflow – surface water flows out of lake or pond
Inflow – surface water flows into lake or pond
Through flow – surface water flows through lake or pond (ex. Impoundment)

Table A3.9 lists ponds and lakes in the South Branch watershed.

Table A3.9

South Branch Headwaters Watershed Ponds/Lakes			
Waterbody	**Origin**	**Flow Path**	**Count**
Lake	Natural	Isolated	1
Lake	Natural	Outflow	1
Lake	Other Dammed	Isolated	1
Pond	Natural	Isolated	27
Pond	Natural	Outflow	2
Pond	Natural	Throughflow	3
Pond	Excavated	Isolated	68
Pond	Excavated	Outflow	2
Pond	Excavated	Throughflow	7
Pond		Isolated	4
Pond		Outflow	1

Unknown Watershed Ponds/Lakes			
Waterbody	**Origin**	**Flow Path**	**Count**
Pond	Natural		1
Pond	Natural	Isolated	4
Pond	Natural	Outflow	1
Pond	Natural	Throughflow	2
Pond	Excavated	Isolated	9
Pond	Excavated	Outflow	1
Pond	Excavated	Throughflow	5
Pond		Isolated	2

Hunters Creek Watershed Ponds/Lakes			
Waterbody	**Origin**	**Flow Path**	**Count**
Lake	Natural	Throughflow	1
Pond	Natural	Inflow	2
Pond	Natural	Isolated	30
Pond	Natural	Outflow	4
Pond	Natural	Throughflow	5
Pond	Excavated		1
Pond	Excavated	Isolated	33
Pond	Excavated	Outflow	2
Pond	Excavated	Throughflow	4
Pond		Isolated	4

Main Branch Watershed Ponds/Lakes			
Waterbody	**Origin**	**Flow Path**	**Count**
Lake	Natural	Outflow	1
Lake	Other Dammed	Throughflow	2
Pond	Natural	Isolated	25
Pond	Natural	Outflow	2
Pond	Natural	Throughflow	5
Pond	Dammed/impounded		1
Pond	Dammed/impounded	Throughflow	1
Pond	Excavated	Isolated	44
Pond	Excavated	Outflow	1
Pond		Isolated	5

Mirror Creek Watershed Ponds/Lakes			
Waterbody	**Origin**	**Flow Path**	**Count**
Lake	Natural	Throughflow	1
Lake	Other Dammed	Throughflow	1
Pond	Natural	Isolated	6
Pond	Natural	Outflow	1
Pond	Excavated	Isolated	12
Pond	Excavated	Outflow	1
Pond	Excavated	Throughflow	1
Pond		Isolated	4

Pine Creek Watershed Ponds/Lakes			
Waterbody	**Origin**	**Flow Path**	**Count**
Lake	Dammed River Valley	Isolated	1
Pond	Natural	Isolated	23
Pond	Natural	Outflow	1
Pond	Natural	Throughflow	3
Pond	Excavated		2
Pond	Excavated	Isolated	36
Pond	Excavated	Outflow	3
Pond	Excavated	Throughflow	2
Pond		Isolated	17

Pine Creek Headwaters Watershed Ponds/Lakes			
Waterbody	**Origin**	**Flow Path**	**Count**
Pond	Natural	Isolated	16
Pond	Natural	Outflow	1
Pond	Natural	Throughflow	3
Pond	Excavated	Isolated	20
Pond	Excavated	Outflow	1
Pond	Excavated	Throughflow	1
Pond		Isolated	1

Whigville Creek Watershed Ponds/Lakes			
Waterbody	**Origin**	**Flow Path**	**Count**
Lake	Natural	Throughflow	1
Pond	Natural	Isolated	19
Pond	Natural	Throughflow	2
Pond	Excavated	Isolated	35
Pond	Excavated	Outflow	3
Pond	Excavated	Throughflow	1
		Isolated	2

Whigville Headwaters Watershed Ponds/Lakes			
Waterbody	**Origin**	**Flow Path**	**Count**
Lake	Natural	Throughflow	1
Pond	Natural	Isolated	6
Pond	Natural	Outflow	2
Pond	Natural	Throughflow	1
Pond	Dammed/impounded	Isolated	2
Pond	Dammed/impounded	Throughflow	1
Pond	Excavated	Isolated	8
Pond	Excavated	Outflow	1

Summary of the Hydrology of the South Branch Watershed

The hydrology of the South Branch Watershed appears to be relatively stable. The low percentages of urban land uses and historic stable land use has protected the watershed's hydrology from significant degradation. The watershed is most hydrologically stable in the headwater reaches including the South Branch Headwaters, Unnamed, Whigville Creek, Pine Creek Headwaters and Flint River Main Branch. The hydrology of these areas is regulated by significant groundwater inflow (Figure A3.10). The high ground water inflow is a direct result of the high percentage of permeable soils (hydrologic soil groups A and B) and the undulating landscape of this region of the watershed (Figure A3.11). The lower section of the watershed including Mirror Creek, Hunters Creek and Pine Creek exhibit less stable hydrology due to significant draining and ditching practices and higher percentages of agricultural land.

- Key Point:
  The stable hydrology of the upper reaches of the South Branch Watershed should be a priority for preservation. Preserving this hydrology can be done through the combination of private land preservation, natural feature setback and increases in the use of storm water management techniques that encourage infiltration. Communities may want to adopt local ordinances that require construction sites to not increase offsite runoff beyond pre-development states.

- Key Point:
  The hydrology of the Pine Creek Watershed and Mirror Creek are impacting and/or threatening designated uses. Efforts should be made to mitigate historic alterations to the hydrology. This can be achieved through a combination of BMPs that include wetland restoration, alternative drain and ditch design, and improvements in riparian corridor management.

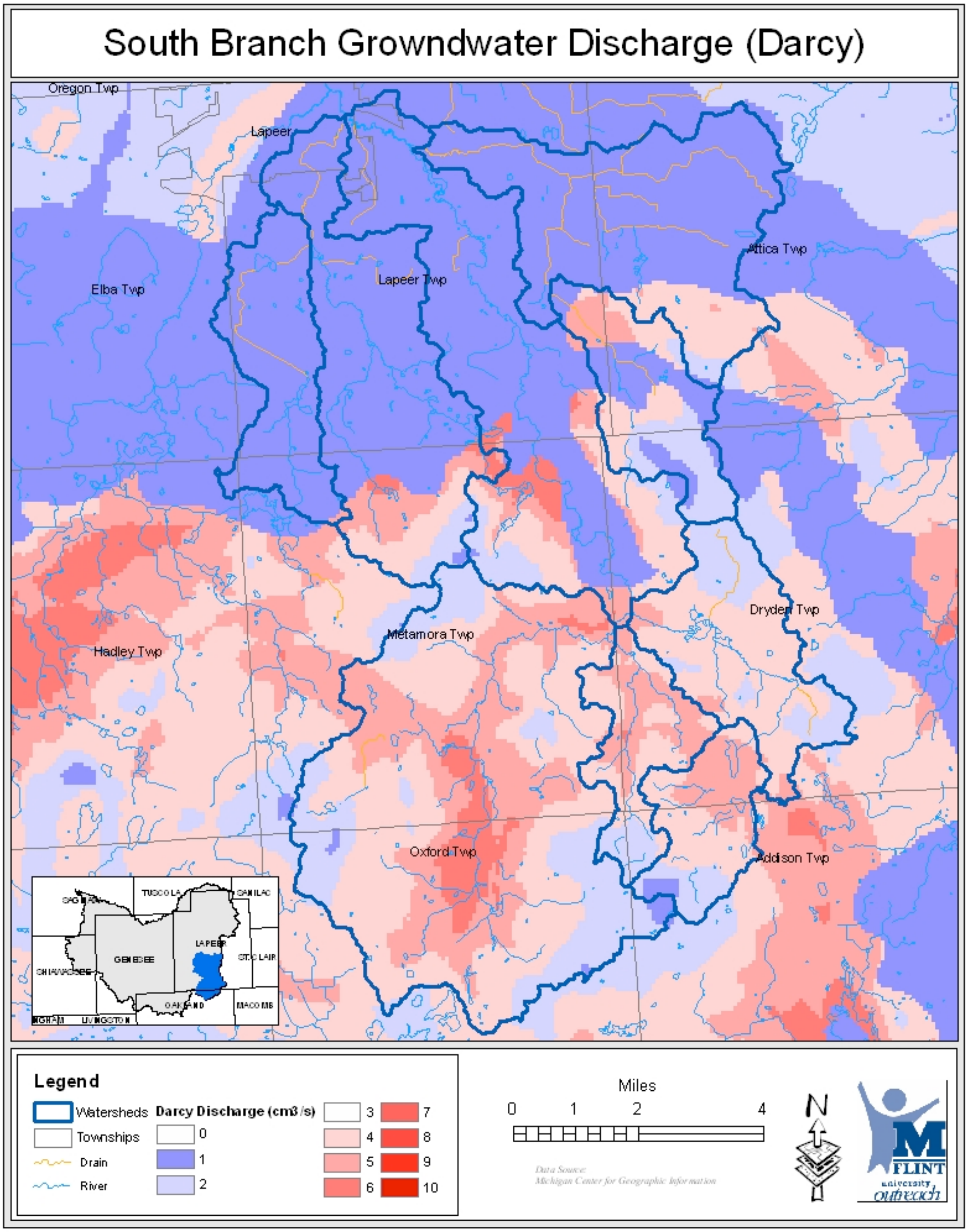


Figure A3.10 Ground Water Inflow to South Branch Watershed

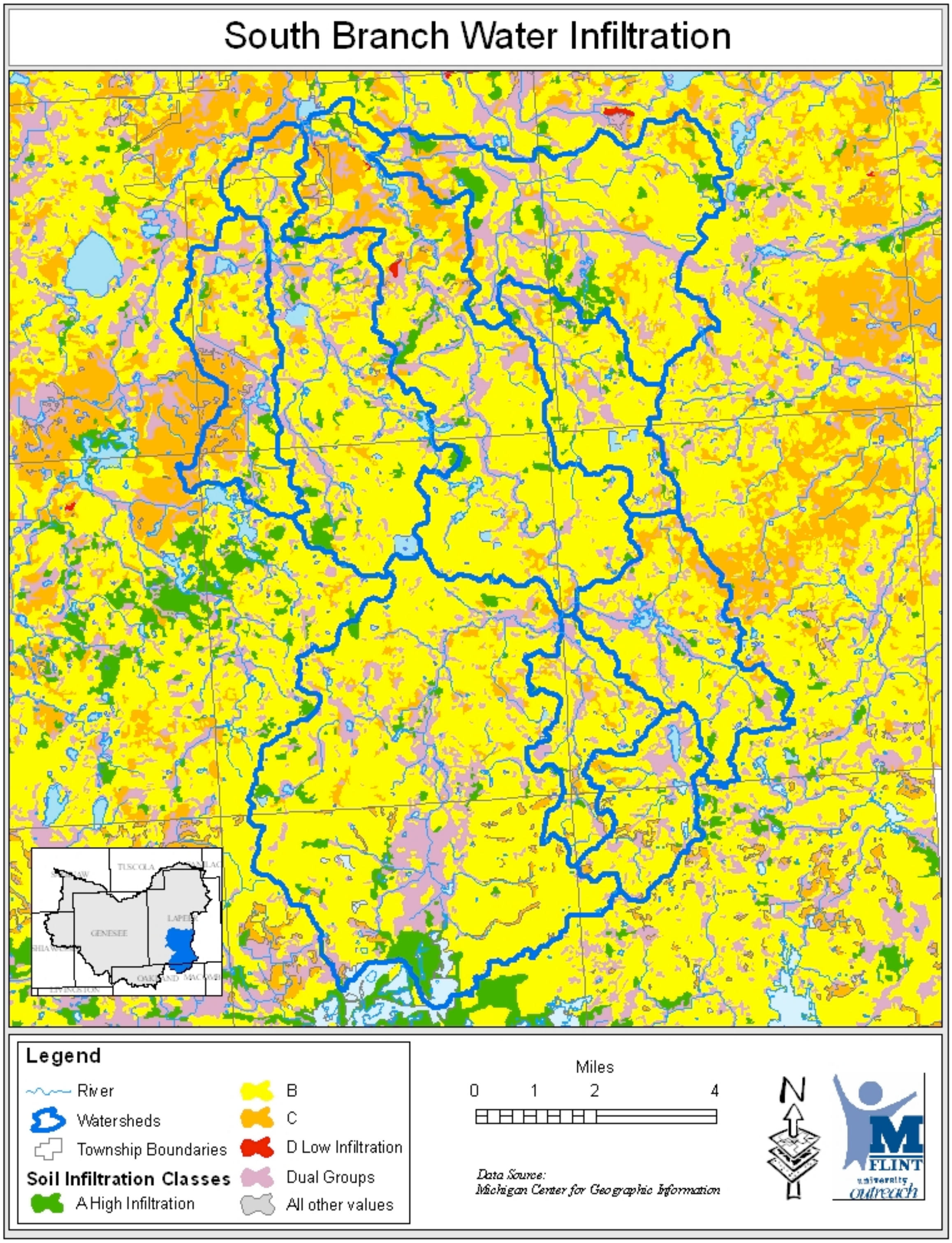


Figure A3.11 Water Infiltration Based on Hydrologic Soil Units

2007

The Flint River South Branch Headwaters Watershed Functional Wetland Assessment

Eric M Clark

This assessment was developed to serve as a watershed-level analysis of wetland function in the Flint River South Branch Watershed (FRSBW). Previous assessments of wetlands in the FRSBW relied on simple calculation of area gained and lost over time. This assessment seeks a detailed understanding of the functional changes in the wetland communities of the FRSBW from 1800 to 1998. Watershed scale assessments of wetland functions rely on geospatial data and geographic information systems (GIS). The analysis was based on landscape and watershed-level functional wetland assessment methods developed by the United States Fish and Wildlife Service (USFWS) in the Northeastern US. These methods involved enhancing the National Wetland Inventory (NWI) by adding descriptors for landscape position, landform, and waterbody type (LLWW) and then applying correlations between wetland characteristics and functions (Tiner, Assessing cumulative Loss of Wetland Functions in the Nanticoke River Watershed Using Enhanced National Wetlands Inventory Data, 2005). Wetlands of potential significance were identified for five different functions: surface water detention, streamflow maintenance, nutrient transformation, sediment and other particulate reduction, and shoreline stabilization. Wetland data from 1800 and 1998 were compared to quantify the functional changes in the FRSBW wetland community.

Methods

1800 Wetlands

Historic wetland data was reconstructed by integrating two data sources to derive the extent, distribution, and vegetation characteristics of wetlands in the FRSBW. These data sources were: 1) soil survey data from the United States Department of Agriculture Natural Resource Conservation Service (NRCS), and 2) Landcover Circa 1800 developed by the Michigan Natural Features Inventory. Hydric soil map units were obtained from the Michigan Department of Environmental Quality (MDEQ). These hydric soil units were assumed consistent with the extent and distribution of wetlands in the FRSBW, except in the case of natural waterbodies (ponds and lakes). Natural waterbodies were delineated based on 1998 wetland data.

The NWI database contains codes for wetland type, vegetation type, and water regime. The wetland and vegetation type codes were derived by assigning wetland type and vegetation codes to the landcover circa 1800 data and then spatially joining those codes with the hydric soil polygons. The water regime codes were derived from the NRCS soil surveys for Lapeer and Oakland Counties. The end dataset was 95% forested. The wetland types in 1800 were likely more varied than this data suggests; the implications of this simplification is discussed below.

1998 Wetlands

The 1998 wetland data was obtained from the Ducks Unlimited (DU) Great Lakes Regional Office. This dataset was updated based on 1998 color-infrared digital orthoquadrangles from the Michigan Center for Geographic Information (MCGI). The wetlands were coded according to the USFWS official wetland classification system (Cowardin et. al., 1979).

Enhanced Wetland Classification

The NWI data was expanded to include descriptors for landscape position, landform, waterflow path, and waterbody type (LLWW descriptors). This enhanced attribution was performed in ArcGIS 9 using dichotomous keys for LLWW classification (Tiner, 2003) along with consultation of USDA digital-aerial photography and US Geological Survey digital topographic maps (digital raster graphics). The LLWW descriptors are presented in Figure 1.

Assessment of Wetland functions

This study follows Tiner's (2005) methods for "Watershed-Based Preliminary Assessment of Wetland Functions". This method involved adding LLWW descriptors to NWI data and correlating wetland functions with wetland characteristics. Potential significance was assigned to each wetland for five wetland functions: surface water detention, streamflow maintenance, nutrient transformation, sediment and other particulate reduction, and shoreline stabilization. Tiner (2005) evaluated 10 wetland functions. This project focused on only five for two reasons:1) some wetland functions were specific to the northwest 2.) data used to reconstruct 1800 wetlands lacked the detail need to evaluate some wetland functions (i.e. conservation of biodiversity, fish and shellfish habitat.). This process was completed for both the 1800 and 1998 wetland datasets. Wetland polygons were then weighted based on their potential significance. Those with high significance were given a weight of 2, and those with moderate significance were given a weight of 1. The area (in hectares) was then multiplied by the weight to calculate the number of functional units for each wetland polygon. Maps were developed for each of the five functions evaluated for 1800 and 1998. The can be found in appendix 1. (Cowardin, Carter, Golet, & LaRose, 1979)

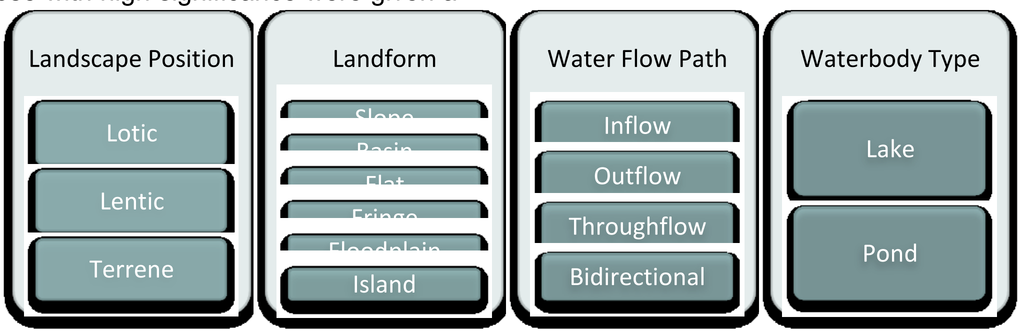


Figure 1. Landscape Position, Landform, Water Flow Path, and Waterbody Type descriptors used in the enhanced wetland classification for the Flint River South Branch Watershed.

Results

LLWW Wetland Comparison

According to the 1800 wetlands data, 1,350 wetlands occupied 20% (5,097 ha) of the FRSBW. Wetland area distributions by landscape position were: approximately 52% lotic, 42% terrene, and seven percent lentic. Wetland area distributions by landforms were: 60% basin type, 28% flat, and seven percent fringe. Less than 6% of the total wetland area were slope, floodplain and island wetlands (floodplain = 4%, slope = 1.0%, and island = <0.1%). With regard to water flow path, 59% of the wetland area was classified as throughflow and 21% as outflow. Approximately 20%, of the total wetland area was geographically isolated and completely surrounded by upland.

By 1998, the total land area occupied by wetlands in the FRSBW had decreased to 16% (4,203 ha). The number of wetlands increased to 2,151. Other than waterbodies, the distribution of wetlands in 1998 was nearly identical to that found in 1800. Approximately 52% percent of the 1998 wetlands were lotic, 42% terrene, and six percent lentic. Over 75% of the total wetland area in 1998 was basin type, 17% was flat, and five percent was fridge. The remaining five percent was composed of slope, floodplain, and island types (slope = <0.1, island = <0.1, and floodplain = 3.5%).

From 1800 to 1998, there was a total wetland area loss of 17% in the FRSBW. This loss was conservative when compared to more urbanized watersheds. Lentic wetlands in the FRSBW experienced the greatest loss since 1800: a decrease of over 29% in area. Lentic fridge wetlands were most critically affected. Lotic and terrene wetlands both exhibited a 23% decrease in total area. The effects of fragmentation were apparent for both lotic and terrene wetlands. The mean size of terrene and lotic wetlands decreased by 50% (from 2 to 1 ha) and 32% (from 14 to 9 ha), respectively. Terrene and lotic wetland types also increased in number by 475 and 23, respectively. The proportion of wetland area classified by landform and water flow type was altered considerably from 1800 to 1998. Basin wetland area increased from 60 to 74%.

Table 1. Historic trends in the Flint River South Branch's wetland area (hectares) by landscape position, landform, and water flow path: 1800 vs. 1998. Codes for water flow path: BI = bidirectional; TH = throughflow; OU = outflow; IS = isolated. Number of wetlands is approximate due to GIS processing

Landscape Position	Landform	Water Flow Path	# 1800	Area 1800	# 1998	Area 1998	% Change in Area
Lentic	Basin	BI			1	6.5	++
Lentic	Basin	TH	1	1.2	2	24.7	1959.5
Lentic	Basin	OU			1	0.5	++
Lentic	Basin	IS			1	2.9	++
Lentic	Flat	BI			1	4.2	++
Lentic	Flat	TH			2	10.9	++
Lentic	Fringe	BI	26	34.4	6	19.3	-43.8
Lentic	Fringe	OU			1	0.4	++
Lentic	Fringe	TH	12	288.1	7	158.6	-44.9
Lentic	Island	BI	3	.8	3	1.0	22.7
Lentic	Total		42	324.6	25	229.1	-29.4
Lotic	Basin	BI			2	1.9	++
Lotic	Basin	OU			4	39.0	++
Lotic	Basin	TH	78	1662.8	139	1542.6	-7.2
Lotic	Flat	TH	88	676.5	28	221.4	-67.3
Lotic	Floodplain	TH	11	179.8	25	120.9	-32.7
Lotic	Floodplain	BI			1	9.3	++
Lotic	Fringe	TH	1	0.8	5	1.8	125.2
Lotic	Slope	TH	3	2.3			-100.0
Lotic	Total		181	2522.1	204	1937.0	-23.2
Terrene	Basin	TH	10	43.5	11	170.5	291.9
Terrene	Basin	IN			1	3.7	++
Terrene	Basin	OU	147	565.7	60	155.7	-72.5
Terrene	Basin	IS	385	658.6	1031	803.3	22.0
Terrene	Flat	TH			2	53.3	++
Terrene	Flat	OU	127	422.0	22	132.2	-68.7
Terrene	Flat	IS	151	262.6	221	223.8	-14.8
Terrene	Flat	IN			1	1.4	++
Terrene	Slope	IS	42	44.2	1	1.0	-97.6
Terrene	Slope	OU	10	18.9			-100.0
Terrene	Fringe	BI	4	5.5	1	1.2	-77.8
Terrene	Total		876	2021.0	1351	1546.3	-23.5
	Grand Total		1099	4867.8	1580	3712.4	-23.7

.

Flat wetland areas decreased from 28 to 17%. Slope wetlands only accounted for one percent of wetland area in 1800; they were almost totally eliminated by 1998 (< 0.01%). The percentage of outflow wetlands decreased from 21 to 9%. The percentage of isolated and throughflow wetlands increased from 20 to 28% and 59 to 62%, respectively

Causes of Wetland Change

The majority of wetland change in the FRSBW can be attributed to human alteration of the landscape. In areas that have favorable conditions for agriculture, much of the wetland loss was due to draining and clearing associated with agricultural use. Fragmentation has occurred as a result of transportation and suburban development in the FRSBW. An examination of the waterbodies in the FRSBW revealed that human alterations in the watershed do not necessarily result in loss of wetland area.

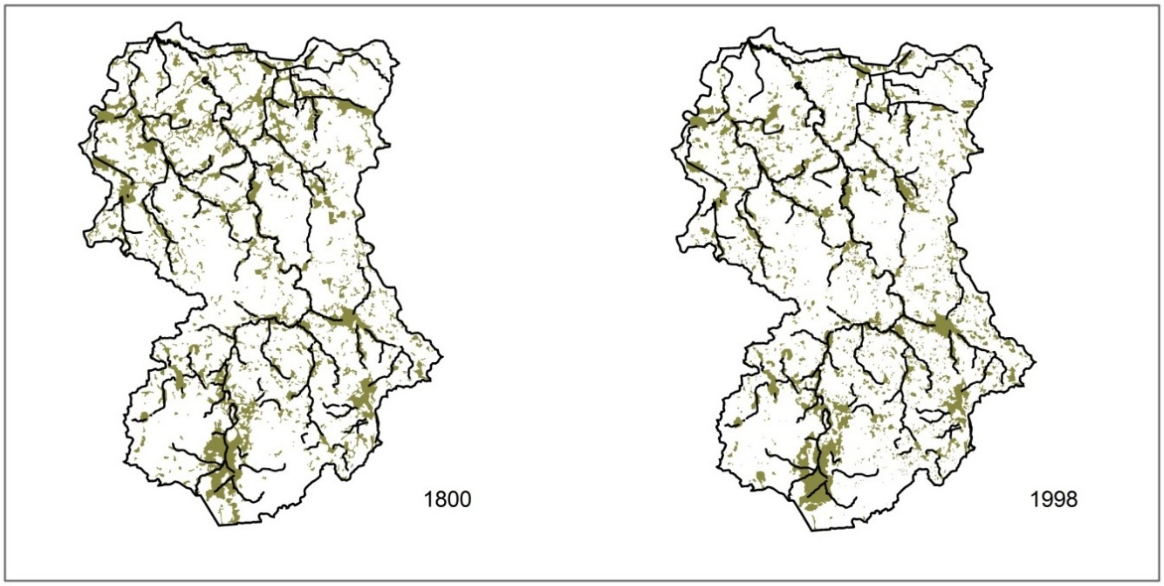


Figure 2. The Flint River South Branch's wetlands and streams at 1800 and 1998. Black areas are streams and green are wetlands

According to the 1800 wetland data there were 20 lakes and 65 ponds in the watershed totaling an area of 55 hectares or one percent of the total wetland area. By 1998 the wetland data indicated there were 11 lakes and 553 ponds in the watershed totaling over 480 hectares or 11% of the total wetland area. While some of the changes can be attributed to altered hydrology in the FRSBW, the fact that 313 of the ponds in the 1998 data were classified as excavated or impounded suggests that the majority of the increase in the number of waterbodies was due to human activities.

Trends by Wetland Function

Two comparisons of functional changes in the wetland communities of the FRSBW were made, one showing changes in wetland area providing significant level of functions (table 2) and the other estimating changes in functional units (table 3). From an area standpoint, losses in the total area of wetlands performing all five functions ranged from 22 to 36% decreases. Wetlands performing sediment and other particulate reduction exhibited the greatest decrease at 36% while the other four functions ranged between 22 and 24% losses in total area.

Table 2. Comparison of preliminary functional assessment results for the Flint River South Branch's wetlands at 1800 versus 1998. Area (in hectares) and percentage of the wetland area total are given for each function.

Function	Significance	1800 Area (ha)	1800 Percent	1998 Area (ha)	1998 Percent	Percent Change
Surface Water Detention	High	2082.2	40.9	2105.4	50.1	1.1
	Moderate	2093.1	41.1	1069.1	25.4	-48.9
	Total	4175.3	82.0	3174.5	75.5	-24.0
Streamflow Maintenance	High	1328.9	26.1	1968.5	46.8	48.1
	Moderate	2131.5	41.8	721.8	17.2	-66.1
	Total	3460.5	67.9	2690.3	64.0	-22.3
Nutrient Transformation	High	3259.5	64.0	3715.1	88.4	14.0
	Moderate	1601.4	31.4	0.2	0.0	-100.0
	Total	4860.8	95.4	3715.2	88.4	-23.6
Sediment and Other Particulate Reduction	High	2312.5	45.4	2256.9	53.7	-2.4
	Moderate	1992.3	39.1	494.0	11.8	-75.2
	Total	4304.8	84.5	2750.9	65.5	-36.1
Shoreline Stabilization	High	2845.9	55.9	2165.1	51.5	-23.9
	Moderate	226.5	4.4	155.7	3.7	-31.2
	Total	3072.4	60.3	2320.9	55.2	-24.5

Table 3. Predicted change in the Flint River South Branch's capacity to perform five wetland functions from 1800 to 1998. Functional units were derived from predictive values for each time period by applying a weighting scheme (2 for high; 1 for moderate).

Wetland Function	Functional Units 1800	Functional Units 1998	Percent Change
Surface Water Detention	6257.4	6083.3	-2.8
Streamflow maintenance	4789.4	3412.1	-28.8
Nutrient Transformation	8134.3	7430.3	-8.7
Sediment and Other Particulate Reduction	6635.0	5735.0	-13.6
Shoreline Stabilization	5918.43	4486.0	-24.2

The evaluation of functional units showed that potential functional capacity of the FRSBW had been reduced for all five wetland functions. The capacity for stream flow maintenance and shoreline stabilization had been impacted the most with reductions of 29 and 24% respectively. The watershed capacity to reduce sediment and other particulates had been reduced by 14%. Less substantial reductions in the wetland community's capacity to transform nutrients and detain surface water were seen at 9 and 3% respectively. There were no increases in functional capacity.

Uses of this study

Of all sub-watersheds in the Flint River Basin, the FRSBW is potentially the healthiest. This is due, in part, to successful retention of wetlands. In 1800, there were approximately 5,100 hectares of wetlands. In 1998, 4,200 hectares of wetlands remained—a loss of 900 hectares.

While this loss is significant, the rate of wetland retention is more important. Approximately 80% of wetland area was retained from 1800 to 1998.

The need for watershed management in the FRSBW was not compelled water quality problems; rather, it was based on the perceived threat of urban development and the potential for successful conservation. This study provides direction for preservation efforts by identifying areas where wetland losses have occurred and wetland areas with high functional capacity. This information may contribute to land management decision-making within the watershed. Wetlands with high functional capacity may be targeted for efficient conservation and preservation efforts.

Analyses of this type can provide deeper insight into the physical characteristics than are observed during typical inventory and management planning processes. Functional capacity analysis elucidates wetland function at a watershed scale to provide direction in management. For instance, sediment is a priority pollutant in the FRSBW. From 1800 to 1998, there was a 14% decrease in sediment reduction capacity, 24% decrease in shoreline stabilization, and a 29% decrease in stream flow maintenance capacity. Future wetland restoration and conservation efforts may target wetlands with high capacity to reduce sediment, stabilize shorelines and stream flow. Appendix 1, contains maps that highlight wetland function.

In 1998, these three wetland functions were potentially operating at 71 to 86% capacity. This suggests that factors other than wetland loss were significant contributors to sedimentation in the watershed. Wetland restoration efforts can be an effective component of a larger management strategy mitigating sediment pollution within the FRSBW.

This study also identified situations where water quality improvement should be focused in areas other than wetland management. For example, the FRSBW has over 96% of its nutrient transforming capacity. This would suggest that a situation where nutrient loadings are an issue could not be mitigated by restoring wetland function. By coupling a deeper understanding of wetland functions with knowledge of land use change in the watershed this helps land managers identify situations where wetland management can be used to improve water quality.

This study can be used as tool for management and education by land managers in the FRSBW. It provides watershed scale information about the function of wetlands in the FRSBW. By doing so, this study takes a step toward the use wetlands analysis as an important component of watershed assessment and management.

Acknowledgements

The author would like to thank Chad Fizzell at the Michigan Department of Environmental Quality Division of Land and Water Management for his guidance and the allotment of his time and resources.

Works Cited

Cowardin, L. M., Carter, V., Golet, F. C., & LaRose, a. E. (1979). *Classifacation of wetlands and deepwater habitats of the United States.* Washington D.C.: United States Fish and Wildlife Service.

Tiner, R. W. (2005). Assessing cumulative Loss of Wetland Functions in the Nanticoke River Watershed Using Enhanced National Wetlands Inventory Data. *Wetlands* , 405-419.

Tiner, R. W. (2003). *Dichotomous Keys and Mapping codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors.* Hadely, MA: United State Fish and Wildlife Service, National Wetlands Inventory Program.