Protecting and Restoring the Upper Looking Glass River:

A Watershed Management Plan

February 2008

Prepared for
Clinton County Conservation District

Prepared by
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With assistance from
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Dedication

This watershed plan is dedicated to Gloria Miller—a true friend of the Looking Glass River, whose passion for protecting the natural world and tireless efforts made this plan possible. She is a founder of the Friends of the Looking Glass and she's a pretty darn good paddler, too.

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PROJECT HISTORY

In April 2005, the Clinton Conservation District embarked on the development of a watershed management plan for the watershed of the upper Looking Glass River in order to assess and inventory existing water resources, determine current water uses, project future demands for those resources, prioritize water quality concerns, and explore and recommend feasible solutions to protect and restore the region's wildlife, habitat, and environmental quality. This plan provides a framework to direct future activities within the watershed.

THE UPPER LOOKING GLASS WATERSHED

The upper Looking Glass watershed comprises 13 sub-basins within four counties (which are ranked by area situated within the watershed): Shiawassee, Clinton, Ingham, and Livingston.

This upper Looking Glass River watershed management plan was designed to focus on the 12 sub-basins above the Remy-Chandler drain in order to avoid duplicating the storm water planning efforts in the Remy-Chandler sub-basin. This plan includes limited information on the Remy-Chandler and generally lists the sub-basin as an area that requires further watershed protection measures.

The dominant land use in the upper Looking Glass watershed is agriculture; however, much of the upper watershed exists in a relatively natural state providing forest land, open fields, wetlands, and long segments of abundant tree canopies that shade the river. Low-density residential is the second most prominent land use in the watershed.

FINDINGS OF THE WATERSHED PLAN

Under the direction of the Clinton Conservation District, and in cooperation with Public Sector Consultants Inc. (PSC) and Wetland and Coastal Resources Inc. (WCR), a steering committee, technical committee, and information and education committee representing local residents, government agencies, and academic institutions were assembled to guide the preparation of this watershed management plan.

Data Gathering and Analysis

In order to identify threats to water quality in the watershed, various data was gathered and analyzed. These efforts included the following:

- Literature research (pages 6-31)
- A stream bank erosion assessment over 25 miles of river and selected tributaries (page 35)
- An assessment of the biological and physical habitat at ten sites in the river and selected tributaries (page 39)
- Long-Term Hydrologic Impact Assessment (L-THIA) run-off modeling (page 42)
- Collection and analysis of 11 local land use plans or maps (page 63)

- Build-out analysis based on local land use plans (page 65)
- A survey of public perceptions about the watershed (page 77)

Results

Synthesis of all the information provided by these efforts provided an understanding of the threats to the water quality in the watershed. Many of these threats are due to nonpoint source pollution (that is, pollution from runoff). This pollution originates from a variety of sources, including agriculture, residential development, poor road crossings, and historical alterations to the natural shape and flow of the river. Eroded sediments, nutrients from fertilizers from residential and agricultural uses, bacteria from animal and human waste, and alterations to the river banks and stream are the most common problems in the upper watershed.

Critical areas, or areas that need special attention to protect the water quality of the river, were identified based on the known pollutant threats. The following were developed based on those critical areas:

- Management measures were proposed to address threats at the critical areas and protect water quality (Exhibit 35).
- Water quality criteria were listed to benchmark progress toward protection (Exhibit 48).
- Monitoring sites were selected and a monitoring plan was created (Exhibit 50).

SUMMARY AND CONCLUSIONS

Through an active stakeholder process, this project identified and prioritized sources of pollution entering the river and their causes; established clear links and specific targets for enhancing the watershed; and facilitated interagency and intergovernmental cooperation in addressing land use issues and public investments to restore and protect the river. A key objective of the plan is to inform and educate both the general public and local officials about the need to protect the Looking Glass River from both future residential and commercial development and increased runoff and pollution that lead to degradation of water quality. That information and education plan is detailed in Exhibit 47.

Project Goals

It may truthfully be said, "As go the headwaters, so goes the watershed." If pollutants or physical changes are introduced at the source waters of a watershed, the entire watershed will be affected. Changes to water may be of two basic types—qualitative changes that affect the chemical or biological quality, and quantitative changes that affect flow patterns and/or volume. While natural occurrences such as wind and flood may be responsible for changes in water quality and quantity, by far the most common cause is interference by humans. It is therefore very important to identify and understand the types of human activities—and their possible consequences—that may affect the upper Looking Glass River, if we desire to protect the river for the future. The primary goals of this project were as follows:

- Delineate upper watershed boundaries and surface waters
- Identify existing and desired uses of the watershed and what must be done for its protection
- Provide new tools to local governments and residents to encourage better land use decisions
- Encourage and facilitate interagency and intergovernmental cooperation in addressing land use issues and public investments of more than local concern
- Establish clear links and specific targets for enhancing/protecting the watershed
- Enhance land and habitat protection
- Identify and document current sources of water quality impairments and all sites that contribute to the source
- Identify future water quality impacts based on a build-out analysis of local townships
- Prioritize pollution sources and identification of remedies, including model ordinances
- Inventory wetlands
- Inventory the stream corridor to prioritize restoration of areas of eroding stream banks and excessive sedimentation
- Use findings of the inventory to adopt county and/or local ordinances to support protection and development standards
- Identify structural and managerial best practices targeting control of pollution sources
- Develop guidelines and recommendations for implementation of remedies
- Develop a process for evaluation efforts

Partners

The development of this plan would not have been possible without the contributions of a variety of organizations and individuals. The committees and the organizations that participated are described below and the project organization is described in Exhibit 1.

FRIENDS OF THE LOOKING GLASS (FLG)

The FLG is a 501(c)(3), local nonprofit river action group that formed in October 1990 to carry out watershed protection activities and promote the enjoyment of and responsibility for the river and to maintain and improve its quality. FLG members are a diverse group with expertise in a variety of areas including teaching, writing, environmental and natural resources management, government, and research. The FLG serves as a forum to convene partners, identify priorities, and implement monitoring and restoration activities. It played a pivotal role in obtaining grant funds to carry out this project and to ensure its success.

COMMITTEES

Three committees provided guidance and oversight in the development of this watershed plan.

Steering Committee

A steering committee, organized to coordinate and help direct project activities, met quarterly over approximately 18 months to develop the plan. The following organizations participated on the committee:

- Bennington Township Supervisor
- Clinton County Conservation District
- Clinton County Drain Commissioner
- The Friends of the Looking Glass River
- Michigan Department of Environmental Quality
- City of Perry via the Perry City Council
- Public Sector Consultants Inc.
- Sciota Township Supervisor
- Shiawassee County Conservation District
- Shiawassee County Drain Commissioner
- Timberland Resource Conservation & Development
- Victor Township Supervisor
- Wetland and Coastal Resources Inc.
- Williamstown Township Supervisor

Technical Committee

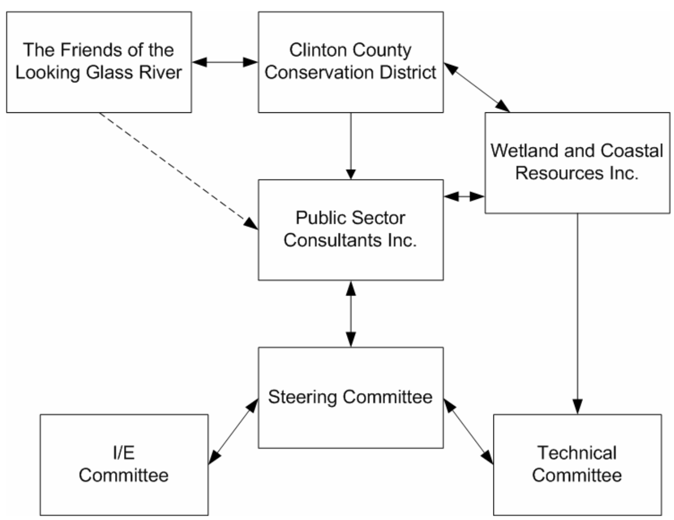
A technical committee was initially formed to coordinate and review scientific data; review zoning practices; identify best practices for implementation at prioritized sites; and advise the steering committee. But in most instances the steering and technical committees met jointly due to the overlap in membership. In addition to the organizations identified above, representatives from Michigan State University's Institute of Water Research participated in the committee meetings.

Information and Education Committee

The Information and Education Committee worked with stakeholders to develop an information/education (I/E) plan for the watershed and initiate outreach activities. The I/E Committee was also responsible for assisting in developing the stakeholder survey. The following organizations participated on the committee:

- Clinton County Conservation District
- The Friends of the Looking Glass
- Institute of Water Research, Michigan State University
- Public Sector Consultants Inc.
- Shiawassee County Conservation District
- Township representatives
- Tri-County Regional Planning Commission
- Wetland and Coastal Resources Inc.

EXHIBIT 1
Project Organization



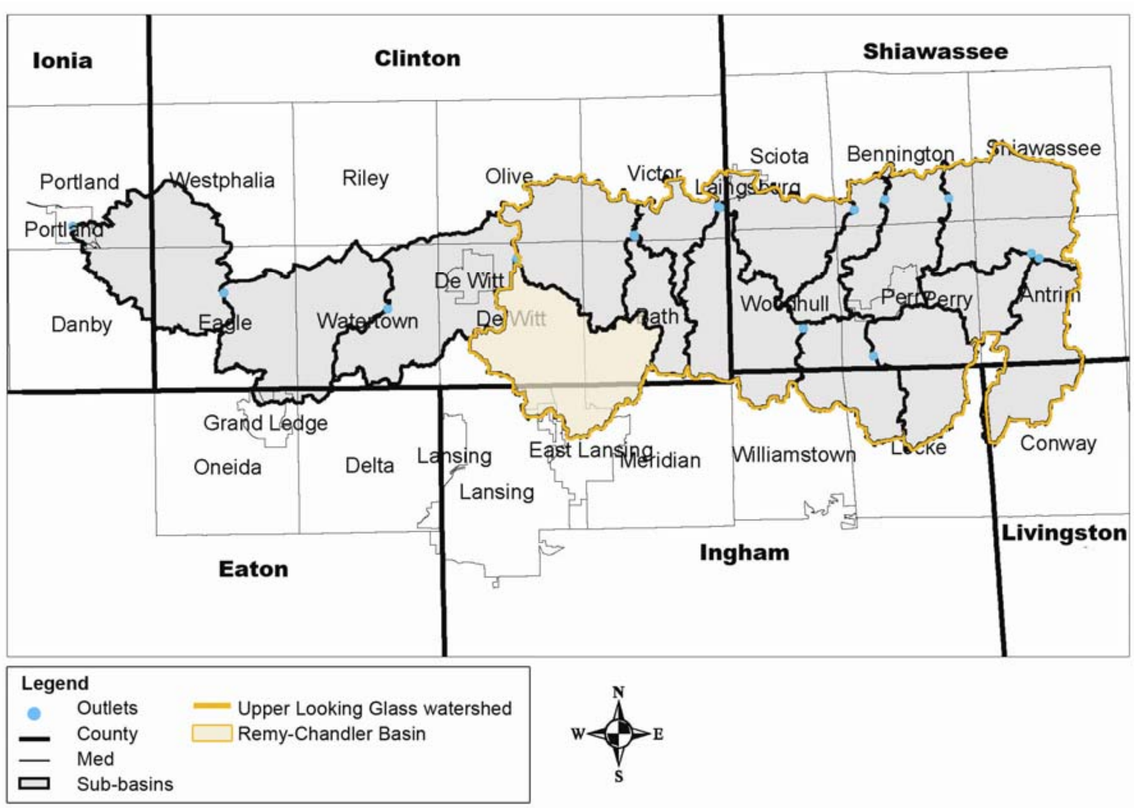
SOURCE: Public Sector Consultants Inc., 2007.

The Upper Looking Glass Watershed

BACKGROUND

The Looking Glass River flows over gentle, sloping land, its tributaries and surrounding watershed extending from headwaters in Livingston County to the confluence with the Grand River in Portland. The watershed encompasses 23 townships and numerous villages and cities over six counties on the river's 65-mile journey through mid-Michigan. The Looking Glass River basin occupies an area of 309 square miles (197,760 acres) and includes 16 sub-basins (see Exhibit 2). Most of the watershed is in Clinton and Shiawassee Counties, with small areas in the counties of Ingham, Ionia, Livingston, and Eaton. It is part of the Grand River watershed, whose waters ultimately flow into the Lake Michigan watershed.

EXHIBIT 2
Greater Looking Glass Watershed and Sub-basins



SOURCE: John Esch, 2005.

The upper Looking Glass watershed, the focus of this watershed management plan, comprises 13 sub-basins within four counties: Shiawassee, Clinton, Ingham and Livingston (see Exhibit 3). The dominant land use in the upper watershed is agriculture; however, much of the upper watershed exists in a relatively natural state providing forest land, open fields, wetlands, and long stretches of abundant tree canopies that shade the river (see Exhibit 4).

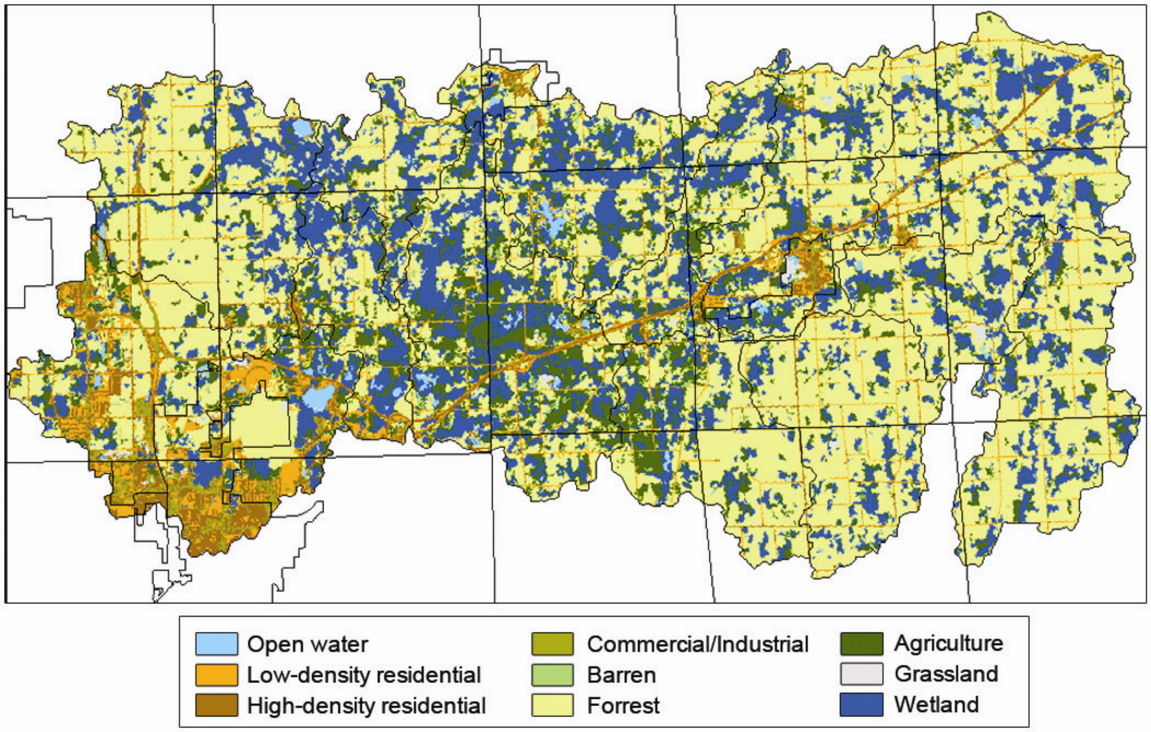
EXHIBIT 3
Upper Looking Glass Subwatershed

SOURCE: Public Sector Consultants Inc., 2007.

The entire watershed is under pressure from residential and commercial development spreading outward from cities including Lansing, DeWitt, Perry, and Bath. Many of the threats to the watershed are due to nonpoint source pollution (that is, pollution from runoff) discharged to the river via a system of drainage ditches. This pollution originates from a variety of sources, including urban runoff, agriculture, poorly maintained road crossings, and land use practices related to residential and light commercial development. Nutrients from fertilizers and eroded sediments from agriculture and residential land uses are some of the most common contaminants that cause problems in the upper watershed.

Given the watershed's proximity to Lansing and opportunities for research and education, a significant amount of biological data over many years has been collected covering the upper and lower watersheds. This data covers communities of fish and macroinvertebrates (aquatic invertebrates including insects, crustaceans, mollusks, and worms), physical habitat, road crossings, and several water quality parameters. The ability to implement corrective measures, however, has been significantly limited by several factors, including the lack of an organized and systematic approach to compiling this data, the lack of a comprehensive inventory of pollution sources and impacts, and the fact that these water quality concerns have not been prioritized. Moreover, the current patchwork quilt of policies, jurisdictional authorities, and regulations natural to a home-rule system of local government impedes progress at the local level. Balancing the inevitable development of the watershed with the protection of forest cover, wetlands, and other natural features, especially in the upper watershed, is critical to the future health of the Looking Glass River and is the goal of this watershed management plan.

EXHIBIT 4
Land Cover in the Upper Looking Glass Watershed, 2001



Land use	Acres	% ofgreater Looking Glass watershed
Agricultural land	72,477	50%
Wetlands	30,840	21
Forest land	19,058	13
Low-intensity residential	8,943	6
High-intensity residential	7,441	5
Commercial/industrial	1,833	1
Rangeland	1,558	1
Water	1,183	<1
Barren land	624	<1
Total upper Looking Glass	**143,957**	**100.0%**

SOURCE: Land Policy Institute, Michigan State University, 2001.
NOTE: Percentages do not total 100% due to rounding.

A portion of the upper Looking Glass River watershed, the Remy-Chandler sub-basin, is the most densely urbanized and urbanizing area of the watershed. It is shown in Exhibit 4 as the most southwesterly corner of the watershed. As a result of urbanization, the sub-basin is one that significantly impacts the quality of the Looking Glass River. For that reason, it is one of three geographic areas near the City of Lansing that were included in the formation of the Greater Lansing Regional Committee (GLRC) that focuses on the National Pollutant Discharge Elimination System (NPDES) Phase II Storm Water Permit under Section 402 of the Clean Water Act.[1] The GLRC comprises 22 government agencies (i.e., local governments, drain commission offices, and road commissions) that chose to fulfill the Phase II requirements by developing a storm water control watershed management plan. The Remy-Chandler is included in that storm water plan.

This upper Looking Glass River watershed management plan was designed to focus on the 12 sub-basins above the Remy-Chandler drain in order to avoid duplicating the GLRC's efforts in the Remy-Chandler sub-basin. This plan includes limited information on the Remy-Chandler and generally lists the sub-basin as an area that requires further watershed protection measures. In order to complement and bridge activities currently being implemented by the GLRC, any implementation efforts under this plan, especially information and education efforts, should be coordinated to the fullest extent possible with the GLRC in the Remy-Chandler.

DESCRIPTION OF THE UPPER LOOKING GLASS WATERSHED

Location and Size

The upper Looking Glass watershed comprises 12 sub-basins (excluding the Remy-Chandler Drain) within 16 municipalities (see Exhibit 5) and four counties and covers 130,532 acres or 204 square miles. It includes the river's headwaters in Livingston County and extends to the Route 27 business highway east of the City of Dewitt.

EXHIBIT 5

Communities in the Looking Glass River Watershed

Clinton County	Ingham County	Livingston County	Shiawassee County
Bath	Locke	Conway	Antrim
DeWitt	Williamstown		Bennington
Olive			City of Laingsburg
Victor			Village of Morrice
			City of Perry
			Perry
			Sciota
			Shiawassee
			Woodhull

SOURCE: Public Sector Consultants Inc., 2007.

DEMOGRAPHICS AND COMMUNITY PROFILE

As shown in Exhibit 6, the upper Looking Glass watershed is primarily rural in composition. According to official U.S. Census Bureau definitions, rural areas comprise open country and settlements with fewer than 2,500 residents. While some communities in the watershed have populations larger than 2,500 residents, only a small proportion of that population actually resides within the watershed. Exhibit 7 provides current

[1] 33 U.S.C. 1251 et seq.

population figures and 10- and 20-year projections for the four counties in the watershed. (see also Appendix A).

EXHIBIT 6
Residential Density in the Upper Looking Glass Watershed

County	Township	Total population 2000 Census	Population density (persons/sq mile)	Housing unit density (units/ sq mile)	Percentage of township's land area within the watershed
Clinton		**64,753**	**113.4**		
	Bath	7,541	208.6	81.1	78.6%
	Dewitt	12,143	383.5	161.7	15.6%
	Olive	2,322	65.1	23.7	18.6%
	Victor	3,275	94.8	33.7	32.8%
Ingham		**279,320**	**499.7**		
	Locke	1,671	46.4	16.3	38.5%
	Williamstown	4,834	164.3	58.9	19.9%
Livingston		**156,951**	**276.3**		
	Conway	2,732	72.3	24.3	21.1%
Shiawassee		**71,687**	**133.0**		
	Atrim	2,050	56.1	20.1	65.8%
	Bennington	3,017	82.7	30.4	32%
	Perry	4,438	139.4	25.3	100%
	Sciota	1,801	67.4	23.7	23.1%
	Shiawassee	2,907	79.2	28.7	29.1%
	Woodhull	3,850	142	53.1	100%

SOURCE: Population Data: 2000 US Census Information—Census Data by municipality; population and housing density data from Michigan Township Association (online: *www.michigantownships.org*, accessed July 19, 2007); percentage of municipality in watershed provided by Rowe Engineering Inc.

EXHIBIT 7
Population Projections for Counties in the Watershed

County	U.S. Census (2000)	Projection (2010)	Projection (2020)
Clinton	64,753	65,600	66,300
Ingham	279,320	280,200	280,000
Livingston	156,951	178,800	212,500
Shiawassee	71,687	73,300	72,200

SOURCE: 2000 Population Data from U.S. Census. 2010 and 2020 Projection by County Source: Office of the State Demographer, Michigan Information Center, January 1996.

Waterbodies

There are approximately 539 acres of lakes and ponds in the upper Looking Glass watershed. Acres of land covered by lakes and ponds within each municipality are indicated in Exhibit 8; the largest lakes are listed in Exhibit 9.

EXHIBIT 8

Upper Looking Glass Watershed, Acres of Land Covered by Lakes and Ponds

Municipality	Acres
Woodhull	191
Victor	106
Bath	73
Locke	37
Shiawassee	28
Williamstown	27
Bennington	21
Perry Twp	21
Antrim	15
Sciota	9
Olive	4
Conway	3
City of Perry	2
City of Laingsburg	2
Dewitt	0
Village of Morrice	0
Total	**539**

SOURCE: Rowe Engineering Inc., 2007.

EXHIBIT 9

Prominent Lakes within the Upper Looking Glass Watershed

Antrim Township	Bath Township	Perry Township	Sciota Township	Woodhull Township
Rose Lake	Lake Geneva	Bacon Lake	Loon Lake	Bullhead Lake
Round Lake	Park Lake	Perch Lake	Wolf Lake	Colby Lake
Woods Lake		Pickerel Lake		Dunn Lake
		Twin Lakes		Marsh Lake
		Ward Lake		Moon Lake
				North Graham Lake
				South Graham Lake

SOURCE: Public Sector Consultants Inc., 2007.

Land Ownership

Most of the land within the upper watershed is owned privately. Nevertheless, public land is a valuable component of the landscape and includes schools, libraries, and recreational land such as parks. The Rose Lake Wildlife Research Area, which covers approximately 4,000 acres, is owned and managed by the Michigan Department of Natural Resources. In addition, many small lots within each municipality are publicly owned and used for parks and other public infrastructure.

Current Land Uses

The dominant land use in the upper watershed is agriculture, with some natural forest land, open fields, and wetlands (see Exhibit 10).

EXHIBIT 10

Land Use Classifications within the Upper Looking Glass Watershed, in Acres, 2007

Land use classification	Bath	DeWitt	Olive	Victor	Locke	Williamstown	Conway	Shiawassee	Antrim	Bennington	Perry Twp.	Perry City	Morrice	Sciota	Woodhull	Laingsburg	Total
Multi-family												10.4					10.4
Single-family*	2,232.8	375.8	521.9	707.0	536.3	543.8	418.8	533.6	1,150.0	844.0	1,297.7	388.3	237.3	511.2	2,144.2	229.0	1,2671.7
Mobile home park	43.4										69.6				23.5		136.5
Commercial	252.7	27.7								14.0	100.5	92.3	55.8		19.3	25.2	587.5
Industrial																	0.0
Transportation	88.8				3.1	2.3					24.6	25.5	5.9			31.1	181.3
Extraction	37.9	38.0						2.6	19.4	38.5	5.4	162.8		28.5	102.8		435.9
Wells					24.4										3.1		27.5
Outdoor recreation	78.0			2.8						27.7	15.6	12.6	15.9	23.8	16.9	14.1	207.4
Cemetery	8.6		2.2					15.6			10.4			12.2		3.0	52.0
Lakes	73.2		3.8	105.6	36.7	27.1	3.3	27.9	15.1	21.2	20.9	1.7		9.0	191.2	2.2	538.9
Forested wetland	2,256.4	2.6	103.3	1,186.1	128.1	260.2	590.9	1,155.5	312.1	241.0	360.2	129.8	4.0	520.4	1,704.4	21.2	8,976.2
Nonforested wetland	1,238.2	26.4	13.6	151.4	101.9	218.2	18.3		31.4	8.2	16.9	3.8		58.6	76.8	80.0	2,043.7

SOURCE: Rowe Engineering Inc., 2007
* Can include land currently in agricultural use.

Changes in Land Use

Rowe Engineering Inc. developed a summary of housing projections in 2007 for the upper Looking Glass watershed. Ten- and 20-year land use projections were based on population and housing projections provided in land use plans when available. When land use plans were not available, projections were made based on straight line housing growth over the 1980–2000 time period projected over the period 2000–2030. Because most of the communities are not completely situated within the watershed, a factor based on the percentage of area within the watershed was used to weight the projection (see Exhibit 11).

EXHIBIT 11

Housing Units Projections Summary, Upper Looking Glass River Watershed

Municipality	Housing units 2000*	Average annual increase in housing units 2000–2010	Projected housing units 2010	Average annual increase in housing units 2010–2020	Projected housing units 2020	Average annual increase in housing units 2020–2030	Projected housing units 2030	% of Community in watershed	Increase in housing units in upper watershed 2010–2020	Increase in housing units in upper watershed 2020–2030	Total additional housing units in upper watershed
Antrim	734	13	864	13	994	13	1,124	65.8%	86	86	**172**
Bennington	1,108	16	1,268	16	1,428	16	1,588	32.0	51	51	**102**
Perry	1,285	49	1,772	23	2,002	26	2,262	100.0	307	251	**558**
Sciota	633	9	725	11	830	12	950	23.1	23	27	**50**
Shiawassee	1,008	25	1,256	31	1,565	39	1,950	29.1	85	105	**190**
Woodhull	1,441	42	1,860	29	2,154	34	2,494	100.0	332	326	**658**
City of Perry	784	8	861	8	945	9	1,038	100.0	82	90	**172**
City of Laingsburg	468	4	506	4	547	5	592	69.5	28	30	**58**
Village of Morrice	348	8	428	10	527	12	649	100.0	93	115	**208**
Bath	2,931	70	3,629	86	4,492	107	5,561	78.6	639	792	**1,431**
DeWitt	4,839	122	6,058	208	8,141	234	10,481	15.6	285	353	**638**
Olive	844	10	947	12	1,063	13	1,193	18.6	21	23	**44**
Victor	1,139	29	1,429	36	1,793	40	2,196	32.8	112	128	**240**
Locke	571	5	617	4	658	3	692	38.5	16	14	**30**
Williamstown	1,726	3	1,752	3	1,780	2	1,796	19.9	5	4	**9**
Conway	887	44	1,327	66	1,985	67	2,653	21.1	125	140	**265**
TOTAL	**20,746**	**457**	**25,299**	**560**	**30,904**	**632**	**37,219**		**2,290**	**2,536**	**4,826**

SOURCE: Rowe Engineering Inc., 2007.
* The number of housing units is for the entire municipality, not just the portion of the municipality within the watershed.

GEOLOGY, TOPOGRAPHY, AND SOILS

Bedrock Geology

As shown in Exhibit 12, the main underlying bedrock of the upper Looking Glass basin consists primarily of the Saginaw Formation, a sheet of bedrock that extends across much of mid-Michigan. Because of differences in sedimentation, the bedrock may consist of sandstone, shaley sandstone, sandy shale, sandy limestone, and limey shale.

Quaternary (Recent Glacial) Geology

Michigan has been subjected to four glacial periods: Kansian, Nebraskan, Illinoian, and Wisconsian. The last of these continental glaciers, the Wisconsian, existed approximately 11,000 years ago and is responsible for much of Michigan's surficial geology, soils, topography, and lake formation (see Exhibit 13).

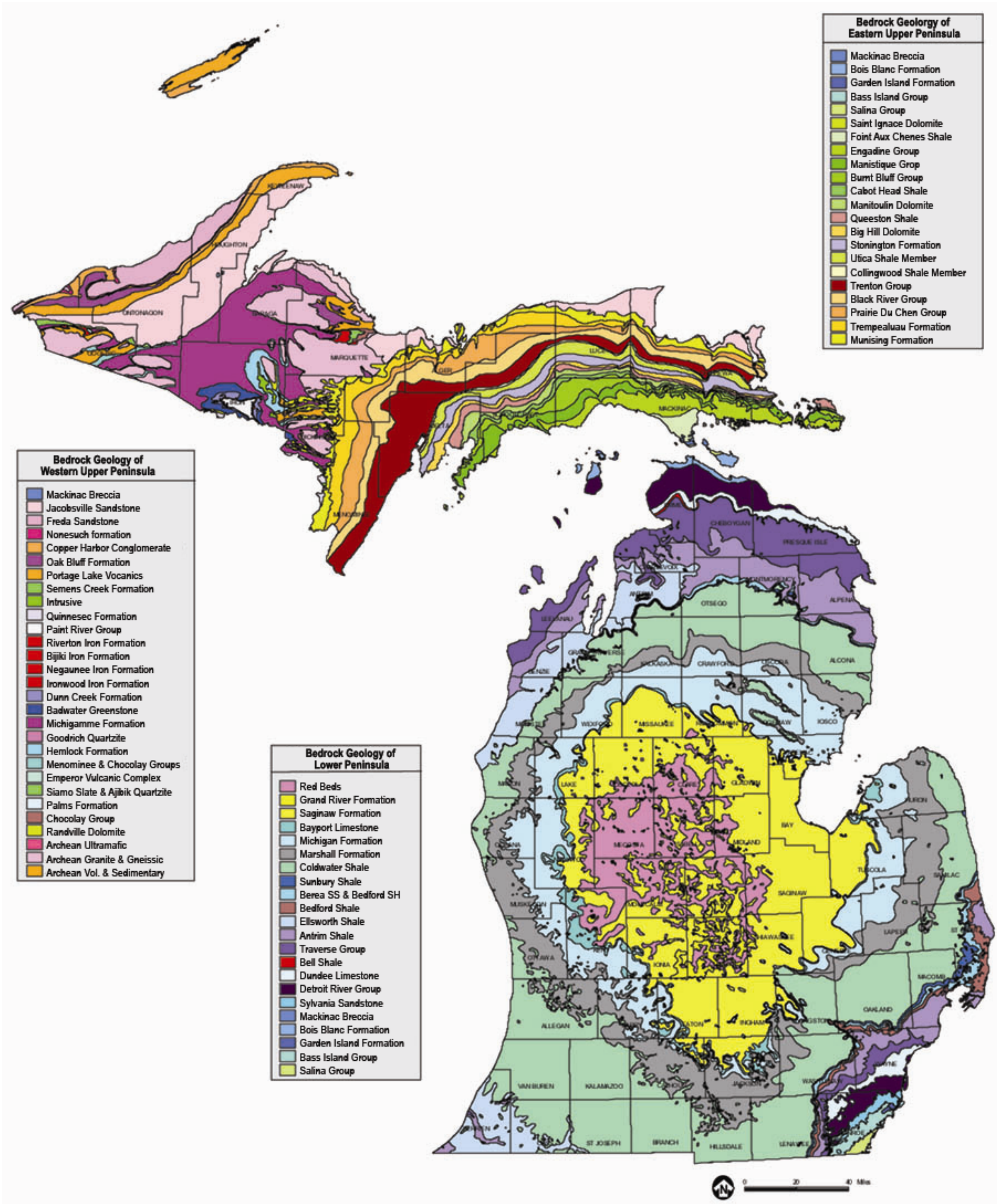
Soil Types

Generally, the watershed contains primarily clay loam soils with some muck soils, and loamy and sandy soils. Soils are classified by the Natural Resource Conservation Service into four hydrologic soil groups, Group A through Group D, based on the soil's runoff potential. Soils in the upper watershed are commonly classified as hydrologic soil groups A and B. Group A is sand, loamy sand, or sandy loam types of soils. It has low runoff potential and high infiltration rates (the rate at which water sinks into the earth) even when thoroughly wetted. It consists chiefly of deep, well to excessively drained sands or gravels, and has a high rate of water transmission. Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Soil Associations in the Greater Looking Glass Watershed

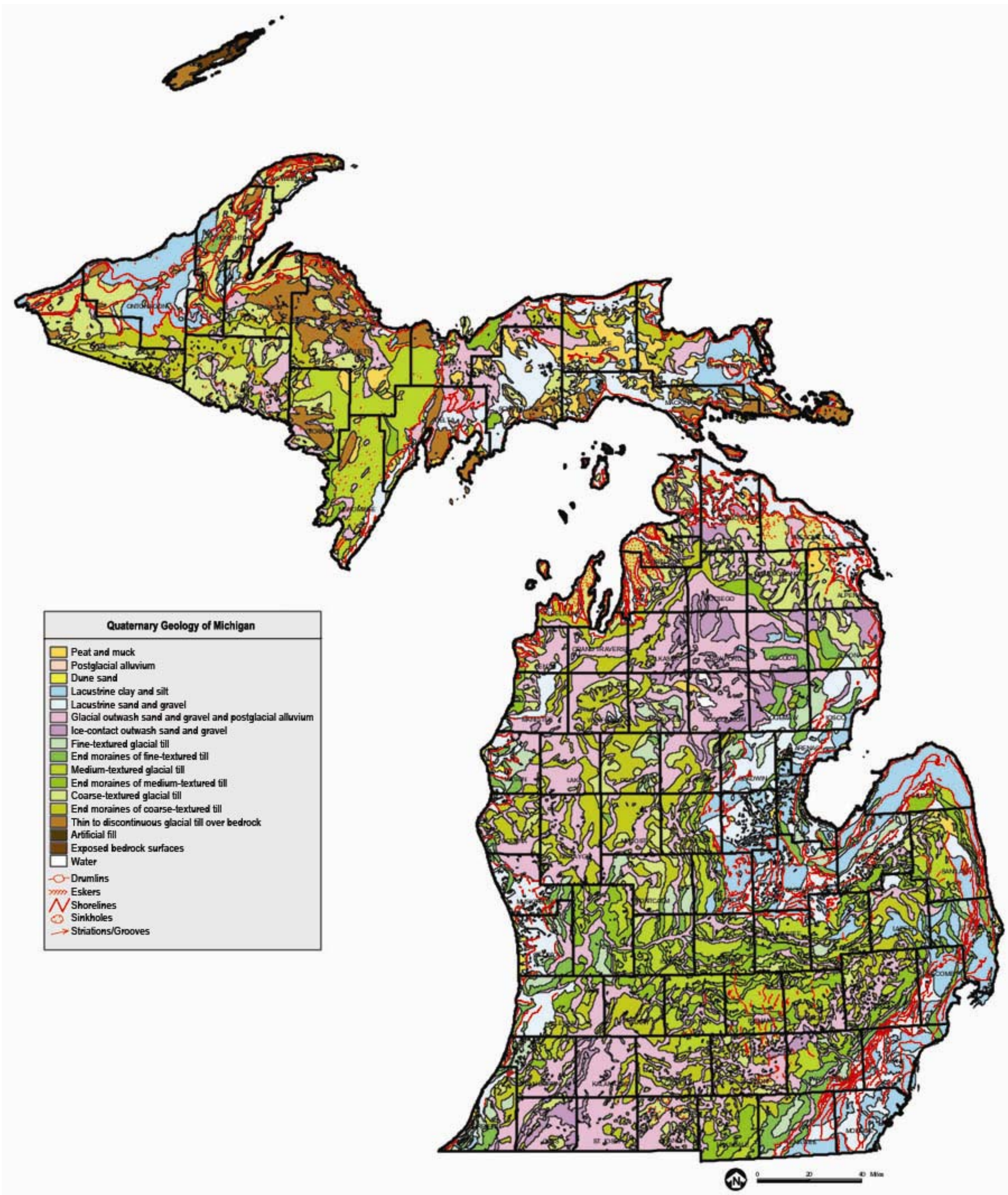
The term "soil association" refers to a group of soils that has been defined and that occurs in a characteristic pattern in particular geographic areas. Soil associations commonly include the three most prevalent soils by name. Individual soils are usually named for a location where they were first defined. A soil's name provides a concise way to refer to its unique characteristics, such as particle size and makeup, color, pH, water content, mineral composition, percentage organic matter, and dozens of other characteristics.

EXHIBIT 12
Bedrock Geology



SOURCE: Michigan Department of Natural Resources, 2001.

EXHIBIT 13
Glacial Geology



SOURCE: Michigan Department of Natural Resources, Land and Minerals Services Division, 1999.

Following are the soil associations present in the watershed:

- Urban land[2]/Marlette/Capac
- Marlette/Capac/Owosso
- Oshtema/Houghton/Riddles
- Marlette/Capac/Parkhill
- Boyer/Marlette/Houghton
- Houghton/Gilford/Adrian
- Miami/Conover/Brookston
- Boyer/Wasepi/Spinks
- Carlisle/Gilford/Tawas

Topography

The topography in the watershed ranges from 800 to 1,000 feet above sea level. Hills are rolling; slopes are generally between 0 and 30 percent.

Drainage

Drainage in the watershed results from a combination of the geology, soils, topography, and water table and varies from poorly to very well drained landscape. There are areas within the watershed that exhibit saturated soils due to poor drainage, low elevation, and a high water table. Other areas are well drained as a result of their natural attributes and engineered drainage channels.

HYDROLOGY

Hydrology is the study of water and the circulation of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere. Understanding how hydrologic components respond to land use changes and site development is the basis for developing successful watershed and storm water management programs. Traditional development practices tend to cause a sharp increase in the total volume, peak flow rate, and frequency of rainwater reaching the rivers and lakes. In addition, channels experience more flood events each year and are exposed to critical erosive velocities for longer intervals. Since impervious cover associated with development prevents rainfall from infiltrating into the soil, less flow is available to recharge groundwater. Consequently, during extended periods without rainfall, baseflow levels are often reduced in urban streams (Tetra Tech 2006).

Groundwater Interface

The Saginaw aquifer underlies much of the Looking Glass watershed. The upper Looking Glass watershed contains both the river's headwaters and associated wetlands. The deep

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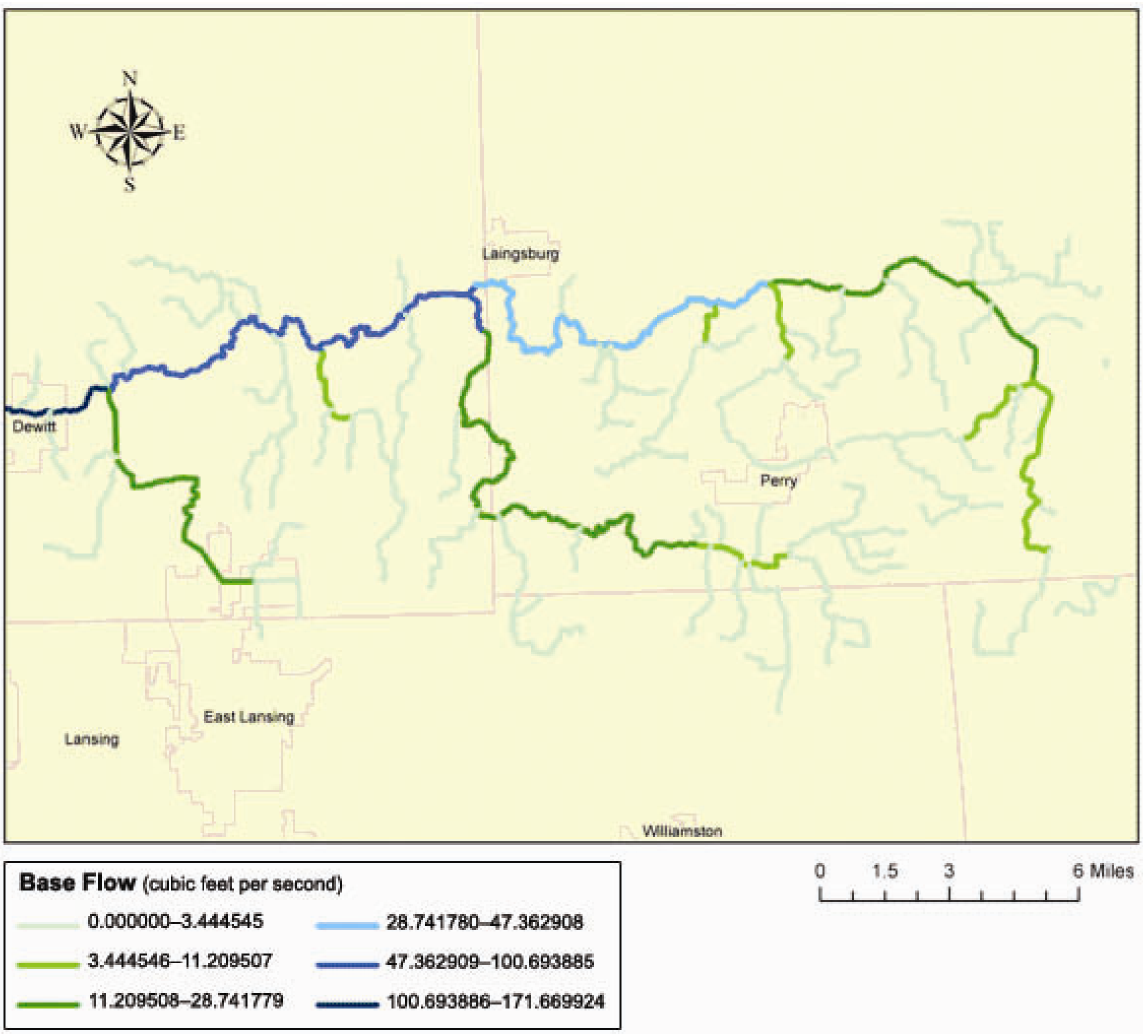
[2] The term "urban land" in a soil association indicates the high degree to which human-induced change affected the natural system. Urban land consists of areas with cut and graded soils that are covered by more than 80 percent with structures and works.

or bedrock aquifer underlying the watershed is the source of groundwater the human population uses for direct consumption, and for agricultural and industrial needs.

In addition, where the shallow, glacial drift aquifer intersects the stream bed, groundwater plays an integral role in the generation of streamflow in a river's headwaters, also known as a river's base flow. In the upper Looking Glass watershed the water table is shallow. The average water table depth in the upper watershed ranges from zero to 15 feet. Due to the shallow water table, there is an active exchange of water between the surface and the aquifer. Exhibit 14 demonstrates the base flow, or that proportion of the river's flow attributable to ground water. Groundwater makes a significant contribution to the flow of the upper Looking Glass River. Flows measured at DeWitt in October 2001 ranged between a base of 90 and a peak of 270 cubic feet per second (MDEQ 2002).

EXHIBIT 14
Looking Glass River Base Flow, 2007



SOURCE: Michigan Department of Environmental Quality and United States Geological Survey.

Surface Water

The Looking Glass River varies from a third-order warmwater stream to a fourth-order warmwater stream. Streams are designated based on their position within a greater stream/river system. A stream of the first order is a stream that does not have any other stream feeding into it. A stream of the second order is formed by the joining of two or more first-order streams. A third-order stream is one below the confluence of two or more second-order streams; a fourth-order stream is formed by the confluence of at least two third-order streams, and so forth. "Warmwater" refers to stream and lake waters that support fish with a maximum summer water temperature tolerance of about 80 degrees Fahrenheit.

Lakes in the upper Looking Glass cover 539 acres; the largest are Park Lake (182 acres), Round Lake (87 acres), Lake Geneva (58 acres), and Perch Lake (35 acres). (See Exhibits 8 and 9 above.)

Climate

The climate of the upper Looking Glass watershed can generally be described as one having a warm summer and a cool-to-cold winter. The average temperature in the region is highly seasonal. For the month of January (the coldest month) the average temperature is 22.7° F, while August (the warmest month) has an average temperature of 71.2° F—a difference of 48.5° F. The upper Looking Glass watershed receives between 30.1 and 35 inches of precipitation annually; the average annual precipitation is 32.8 inches. Like the temperature, precipitation is seasonally variable, with February (the driest month) receiving 1.6 inches on average while June (the wettest month) receives 3.7 inches on average—a difference of approximately 2.2 inches. In the months of October through April, a portion of precipitation typically occurs as snowfall. The greatest amount of snowfall occurs in January (13.4 inches on average—approximately equivalent to 1.3 inches of rainfall) and accounts for 75 percent of the precipitation for the month. The months of June through August average no snowfall, while May and September may receive trace amounts. The wind in the region generally comes from the west/southwest at nine miles per hour (mph) during the summer and 12 mph during the winter. The peak gusts generally occur in the spring/early summer.

Morphology and Physical Description

From its headwaters to its mouth, the Looking Glass River falls about 210 feet in elevation and travels for 65 miles.

The upper Looking Glass watershed still contains large tracts of wetland and forested floodplain; however, a large part of the morphology of the river and its tributaries (stream banks and stream beds) has been altered from its natural design. Commonly, channels have been straightened and/or dredged to improve drainage from nearby low-lying farm fields and housing developments. Of the 25 miles of river surveyed by Wetland and Coastal Resources, 22.5 miles had been dredged and straightened. This alteration of the river's natural meander creates some negative impacts in the watershed.

Wetlands

In general terms, wetlands are lands dominated by the saturation of water, which determines the nature of soil development and the types of plants and animals living in and above ground (Cowardin et al. 1979). Wetlands in the watershed are another location where the groundwater interfaces with surface water. As a result, wetland function is integrally tied to the function of nearby rivers. Wetlands allow water to seep into the ground and recharge the groundwater. Wetlands also may be places where the groundwater actually seeps into the surface water and contributes to a stream's flow. Wetlands serve different functions in the watershed as a result of their position in the landscape and their dominant water source. Wetlands facilitate groundwater recharge, headwater formation, and flood control in the form of surface water dispersion.

The Looking Glass watershed, like most watersheds, contains three types of wetlands: precipitation-dominated, surface water–dominated, and groundwater–dominated. Although all wetlands receive precipitation, precipitation events serve as the sole source of water for some wetlands. These precipitation-dominated wetlands may supply water to headwater streams and groundwater by infiltration. Riparian wetlands, which are dominated by surface flow, may remove, store, or release water, nutrients, and sediments. Other wetlands that occur where the water table meets the surface are maintained primarily by groundwater seeping to the surface.

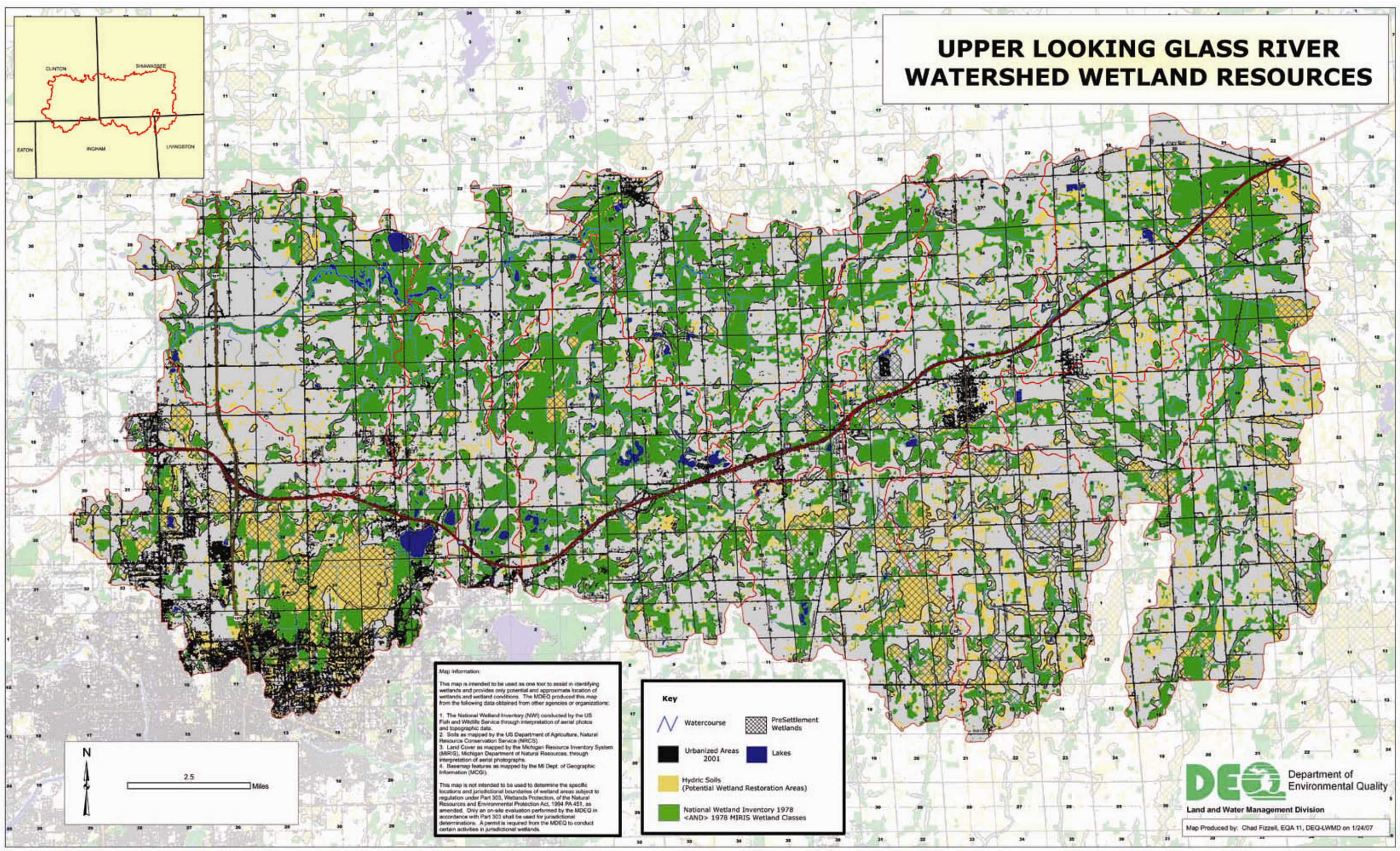
As part of a healthy watershed they may also mitigate the negative effects of impervious cover within the watershed. Important wetland functions and values include the following:

- Flood prevention and temporary storage of water, allowing it to be slowly released, evaporate, or percolate into the ground recharging groundwater
- Sediment capture and storage
- Habitat for a wide diversity of plants, amphibians, reptiles, fish, birds, and mammals, as well as for recreational uses
- Water quality improvement by filtering pollutants out of water
- Support for approximately 50 percent of Michigan's endangered or threatened species (Cwikiel, 2003)

Wetland Losses

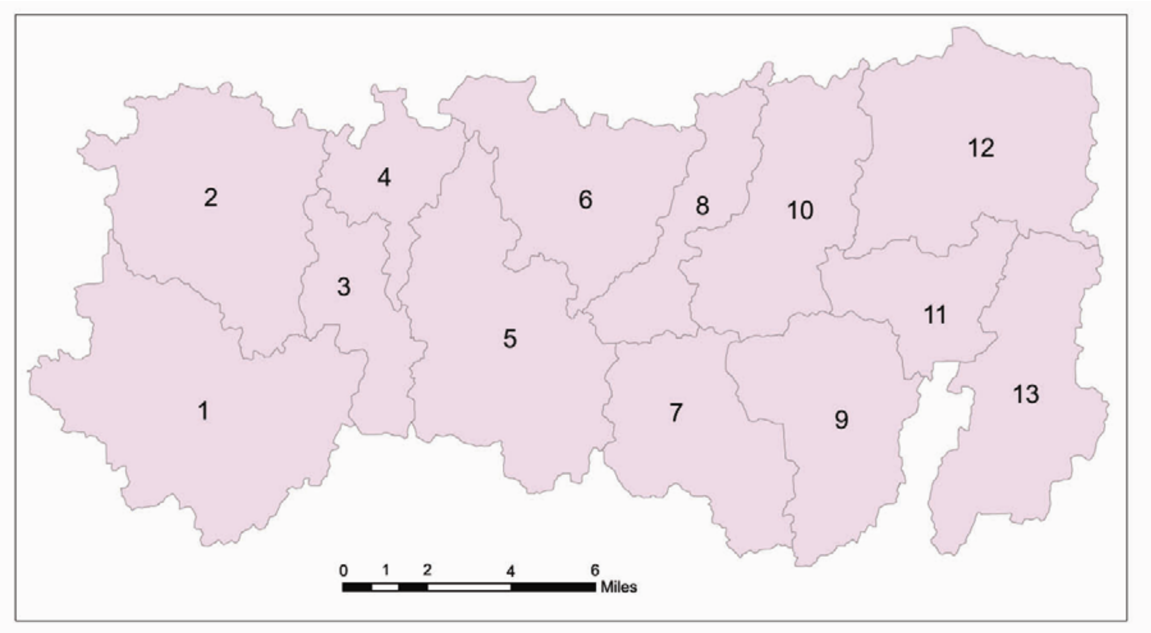
Exhibit 15 highlights the location of wetlands in the watershed. Currently, wetland coverage in the watershed is approximately 8.1 percent of land area. Exhibit 16 shows subwatershed boundaries and Exhibit 17 presents the wetland coverage and loss for each subwatershed. Generally speaking, those subwatersheds that have expansive contiguous areas of residential development or agricultural land, such as Faiver Drain and Looking Glass C, have the lowest percentage of land mass existing as wetlands (7 percent and 6 percent, respectively).

EXHIBIT 15
Location of Wetlands in the Upper Looking Glass Watershed, 1978



SOURCE: Michigan Department of Environmental Quality, Land and Water Management Division, 2007.

EXHIBIT 16
Subwatershed Boundaries



Watershed number	Hydrologic unit code	Watershed name
1	4050004060120	Upper Remy-Chandler
2	4050004060130	Looking Glass River at Remy-Chandler Drain
3	4050004060110	Mud Creek
4	4050004060100	Above Mud Creek
5	4050004060080	Vermillion Creek at Mouth
6	4050004060090	Vermillion Creek
7	4050004060070	Vermillion Creek at Gravel Pit
8	4050004060050	Osborne Creek Drain
9	4050004060060	Buck Branch
10	4050004060040	Kellogg Drain
11	4050004060020	Grub Creek
12	4050004060030	Howard Drain
13	4050004060010	Unnamed Tributary

SOURCE: Wetland and Coastal Resources Inc., 2006.

EXHIBIT 17
Wetland Loss between Settlement and 1978, by Subwatershed

Subwatershed	Acres presettlement wetlands	Average size of presettlement wetlands (acres)	1978 Acres of wetland	Average size of 1978 wetlands (acres)	% of Original wetlands remaining	% Loss of original wetlands
1	10,146.8	10.3	2,715.7	5.3	26.8%	73.2%
2	5,063.9	8.8	3,058.1	6.7	60.4	39.6
3	2,474.3	8.0	1,846.2	6.6	74.6	25.4
4	2,030.9	7.3	1,604.0	5.2	79.0	21.0
5	7,160.7	6.6	4,558.8	6.1	63.7	36.3
6	4,458.9	8.3	3,085.4	6.1	69.2	30.8
7	4,772.5	11.2	1,427.7	4.1	29.9	70.1
8	2,300.6	8.3	1,542.2	6.0	67.0	33.0
9	5,491.9	16.5	1,314.7	3.7	23.9	76.1
10	3,703.8	8.3	2,153.6	4.8	58.1	41.9
11	2,313.2	9.7	1,256.8	5.4	54.3	45.7
12	6,460.1	12.0	3,589.8	7.2	55.6	44.4
13	4,439.3	10.7	2,019.4	5.0	45.5	54.5
Total	**60,816.9**	**9.7**	**30,172.4**	**5.7**	**49.6%**	**50.4%**

SOURCE: Michigan Department of Environmental Quality, Land and Water Management Division, 2007.

The majority of wetlands in the watershed exist in the subwatersheds of Upper Remy Chandler, Middle Vermillion Creek, and Mud Creek (each with 12 percent of the total).

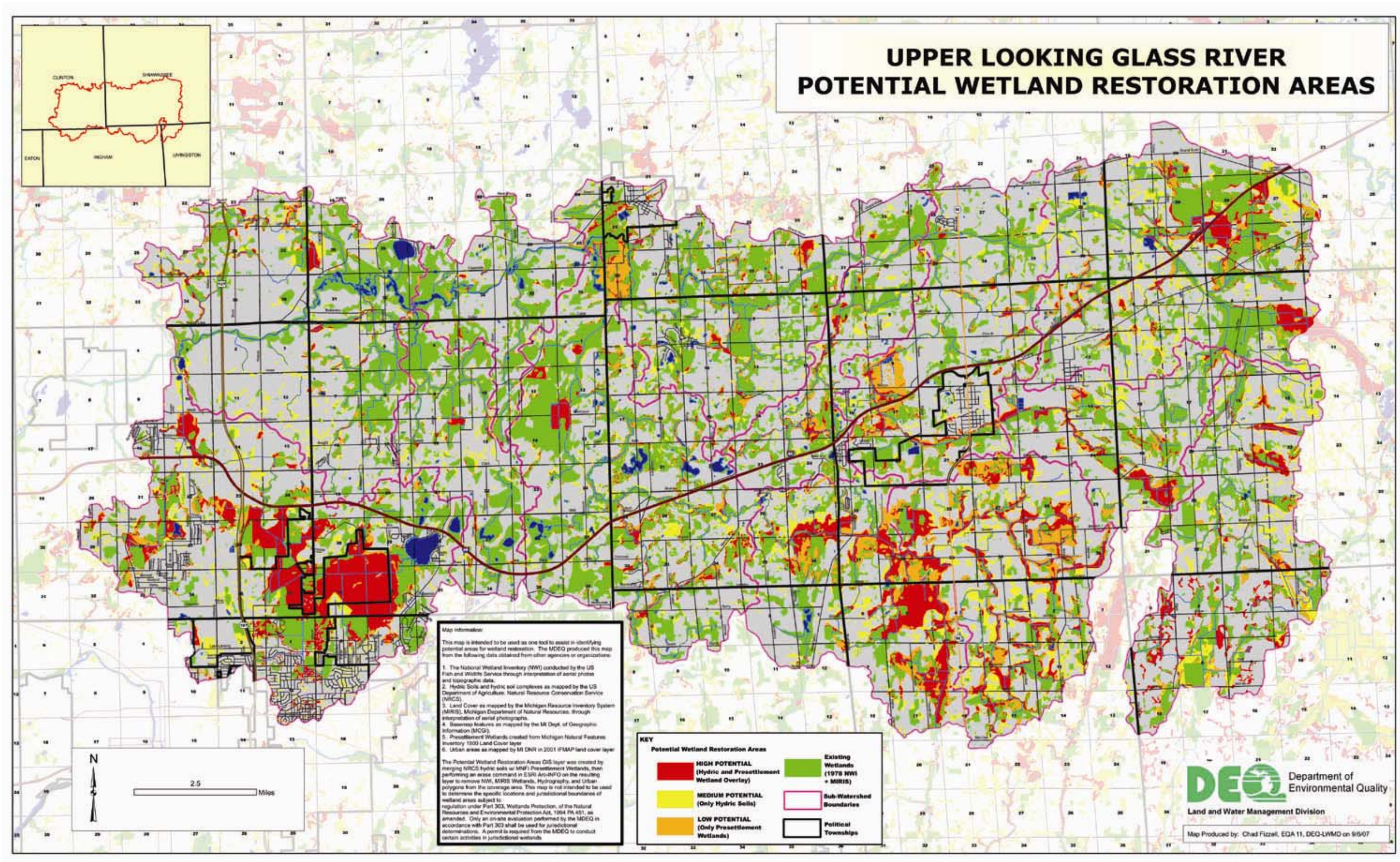
Since the 1978 data was collected, nearly 20,000 more acres of wetlands have been lost in the watershed. Currently, according to Rowe Engineering Inc., the upper Looking Glass watershed contains 8,421 acres of forested wetlands and 2,043 acres of nonforested wetlands. In total, there are 10,464 acres of wetlands in the watershed. This presents an opportunity to maintain the existing wetlands and also to continue to restore any wetlands that would benefit the river system. Wetland acres by municipality are illustrated in Exhibit 18. Potential wetland areas for restoration are highlighted in Exhibit 19.

EXHIBIT 18
Existing Wetland Acres, by Municipality

Municipality	Forested	Nonforested	Total
Bath	2,256	1,238	3,494
Victor	1,186	151	1,337
Woodhull	1,149	77	1,226
Shiawassee	1,156	0	1,156
Sciota	521	59	580
Conway	591	18	609
Williamstown	260	218	478
Perry Township	360	17	377
Antrim	312	31	343
Bennington	241	8	249
Dewitt	3	26	29
Locke	128	102	230
City of Perry	130	4	134
Olive	103	14	117
Laingsburg	21	80	101
Morrice	4	0	4
Total	**8,421**	**2,043**	**10,464**

SOURCE: Rowe Engineering Inc., 2007.

EXHIBIT 19
Potential Wetlands for Restoration



SOURCE: Michigan Department of Environmental Quality, Land and Water Management Division, 2007.

WILDLIFE

The upper Looking Glass Watershed is home to a diversity of wildlife such as ducks, geese, heron, sandhill crane, songbirds, raptors, raccoon, muskrat, and mink. Wildlife and wildlife habitat play a vital role in the ecological and biological processes that are essential to life itself. Some of the biological processes in which wild species play a key role are pollenization, germination, seed dispersal, soil generation, nutrient cycling, predation, habitat maintenance, waste breakdown, and pest control. Birds, for example, can be important in controlling insect pests.

Recreation pursuits such as hunting, bird watching, and other wildlife-related activities are also beneficial to local economies. In fact, the sheer scale of the benefits provided by wildlife to individuals and the economy is one more compelling reason for maintaining wildlife populations and habitats in a productive, healthy state. Currently, bird watching, wildlife viewing, and nature photography represent the fastest growing segment of all wildlife-related recreation. Surveys conducted in 1980 and 1990 indicated a 63 percent growth in trips related to these activities (Duda and Young 1994). Recent estimates place the annual value of these non-consumptive activities in Michigan at $692,757,000 (USFWS 2001 and U.S. Department of Commerce 2001).

One of the primary goals of this watershed management plan is to protect wildlife and wildlife habitats. This is evident in the current goal to protect existing wetlands within the upper Looking Glass watershed. These wetlands provide sustainable habitat for many of the wildlife species found in the watershed.

State Wildlife Areas and Parks

Rose Lake Wildlife Area

Rose Lake Wildlife Area is located within Woodhull and Bath townships and covers approximately 4,000 acres. Once part of a working farm, this site now contains a diverse mixture of habitats including lakes, wetlands, old fields, and forest. Work roads that double as hiking/biking trails traverse the area. The topography is flat to gently rolling. Because of the diversity of habitats found at Rose Lake, it supports many different kinds of wildlife. It has a great variety and abundance of songbirds, and sandhill cranes are known to nest in this area and may be seen flying to and from nesting marshes from May through August. Great blue herons are commonly seen in the lakes and wetland areas, and American bitterns also may be spotted by the careful observer.

Threatened and Endangered Species and Species of Concern

Michigan has a number of significant natural features located across the state. These natural features can provide public benefits that may include recreation, bird watching, hunting, fishing, camping, hiking, off-roading, and water sports. These areas also include critical habitat for different species of plants, mammals, amphibians, reptiles, birds, fish, and macroinvertebrates.

The Michigan Department of Natural Resources (MDNR) provides information on threatened and endangered plants and animals in Michigan by watershed. This work is coordinated by the Michigan Natural Features Inventory (MNFI). The categories used to describe these species are outlined in Exhibit 20.

EXHIBIT 20
Species Descriptions

Status	Definition
Endangered	A species is near extinction throughout all or a significant portion of its range in Michigan.
Threatened	A species is likely to become classified as endangered within the foreseeable future throughout all or a significant portion of its range in Michigan.
Special concern	A species is extremely uncommon in Michigan or it has a unique or highly specific habitat requirement and deserves careful monitoring of its status. A species on the edge or periphery of its range that is not listed as threatened may be included in this category along with any species that was once threatened or endangered but now has an increasing or protected, stable population.
Extinct	A species can no longer be found anywhere in the world.
Extirpated	A species that does not exist in Michigan, but can be found elsewhere in the world.
Stable	A species is not included in the above categories and the population is not declining drastically. A stable species is breeding and reproducing well enough to maintain current population in a given area.

SOURCE: Michigan Natural Features Inventory, Michigan State University Extension, 1995.

The State of Michigan has designated two endangered species in the upper Looking Glass watershed: the regal fritillary and the king rail. Seven Michigan threatened species are found in the upper watershed, along with 19 Michigan species of special concern. Exhibit 21 includes the species of plants and animals found in the watershed that are listed as endangered (E), threatened (T), or of special concern (SC).

EXHIBIT 21
Notable Species in the Upper Looking Glass Watershed

Scientific name	Common name	State status
Rallus elegans	King rail	E
Speyeria idalia	Regal fritillary	E
Carex lupuliformis	False hop sedge	T
Clemmys guttata	Spotted turtle	T
Cryptotis parva	Least shrew	T
Diarrhena americana	Beak grass	T
Galearis spectabilis	Showy orchis	T
Juncus vaseyi	Vasey's rush	T
Lycopus virginicus	Virginia water-horehound	T
Acris crepitans blanchardi	Blanchard's cricket frog	SC
Alasmidonta marginata	Elktoe	SC
Angelica venenosa	Hairy angelica	SC
Asclepias purpurascens	Purple milkweed	SC
Astragalus neglectus	Cooper's milk-vetch	SC

Scientific name	Common name	State status
Baptisia lactea	White or prairie false indigo	SC
Calephelis mutica	Swamp metalmark	SC
Dendroica cerulea	Cerulean warbler	SC
Emys blandingii	Blanding's turtle	SC
Microtus pinetorum	Woodland vole	SC
Oecanthus laricis	Tamarack tree cricket	SC
Oecanthus pini	Pinetree cricket	SC
Papaipema sciata	Culvers root borer	SC
Papaipema speciosissima	Regal fern borer	SC
Pleurobema coccineum	Round pigtoe	SC
Scirpus clintonii	Clinton's bulrush	SC
Scirpus torreyi	Torrey's bulrush	SC
Sistrurus catenatus catenatus	Eastern massasauga	SC
Tradescantia virginiana	Virginia spiderwort	SC

SOURCE: Michigan Natural Features Inventory, Michigan State University Extension, 1995.

FISHERY

Fish Populations and Management

One of the designated uses for the Looking Glass watershed is a warmwater fishery; the watershed is in attainment of all state requirements to support that designated use.[3] Warmwater fisheries support fish able to tolerate water temperatures above 80° F. Warmwater fish include such species as crappies, small and largemouth bass, sunfish, yellow perch, and catfish.

Based on results of the 2006 Wetland and Coastal Resources assessment and review of existing literature, at least 24 species of fish are known to inhabit the Looking Glass River and its tributaries. These fish occur naturally, since the MDNR does not stock fish in the Looking Glass. The fish are allowed to move freely throughout the watershed, as there are no dams along the length of the Looking Glass River or its tributaries.

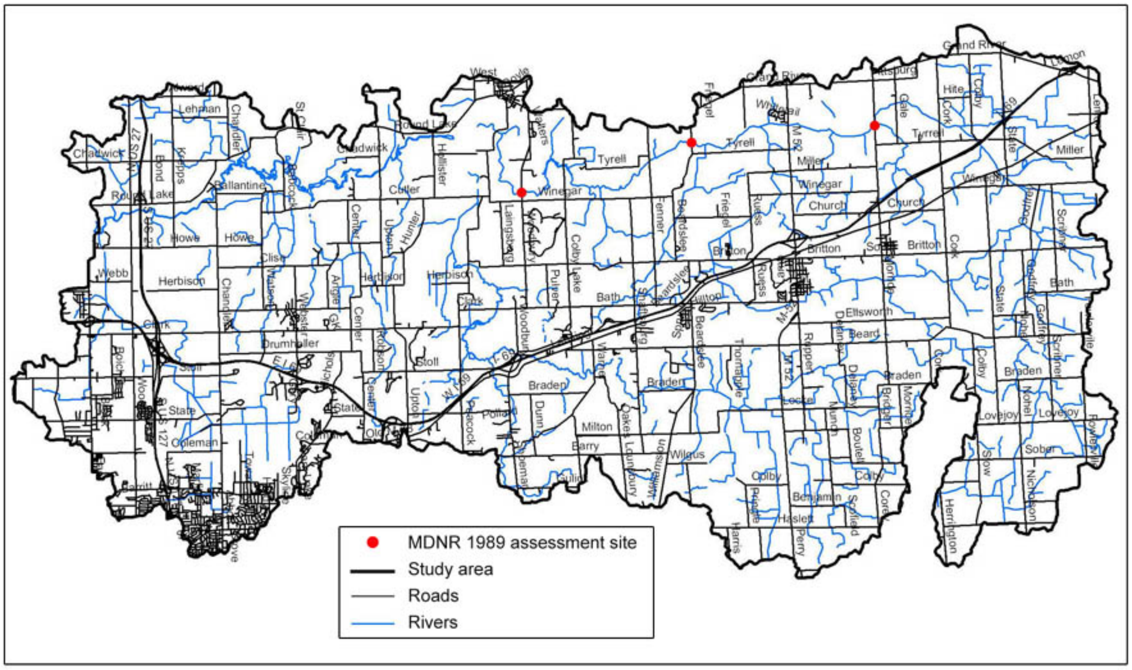
Fisheries Literature Review

The MDNR, Fisheries Division, conducted fish sampling surveys in 1989. The surveys were intended to capture all fish present for completion of a general inventory. The sites that were sampled in the Looking Glass watershed are shown in Exhibit 22.

[3] Designated uses are the standards applied by the state to ensure that specific water quality is attained to allow use of the water resource. Further explanation of designated uses can be found on page 32.

EXHIBIT 22

MDNR Fish Sampling, 1989



SOURCE: Wetland and Coastal Resources Inc., 2006.

Looking Glass River at Beardsley Road

The average width of the stream in the sample reach was 31 feet, the average depth was 1.5 feet, and maximum depth was 3.5 feet. The bottom substrate consisted of 55 percent silt, 40 percent sand, and 5 percent gravel. Instream cover was present in limited amounts at the time of the survey. A total of 548 fish, representing 13 species, were collected and more than 53 percent of the sample consisted of Johnny darters and white suckers.

Looking Glass River at Morrice Road

The river averaged 18.9 feet in width and 1 foot in depth at this station. Depth ranged from 0.5 to 2.5 feet and substrate consisted of 20 percent silt, 40 percent sand, 35 percent gravel, and 5 percent cobble. Instream habitat was present in limited amounts. A total of 1,318 fish were collected at this station. Twenty species were collected; rainbow darters, blacknose dace, Johnny darters, and creek chubs were collected in the largest numbers.

Vermillion Creek at Woodbury Road

Vermillion Creek averaged 20.1 feet in width and 1 foot in depth at this site. Water depth ranged from 0.5 to 2 feet. The stream bottom consisted of 40 percent silt, 35 percent sand, and 25 percent gravel. Instream cover was considered moderate and included pools, fallen debris, overhanging banks, and logjams. A total of 223 fish, representing 12 species, were collected at this station.

DESIGNATED USES

Designated uses for surface water bodies are specified by the state to ensure that specific water quality is attained and that water resources can be used for a variety of purposes. In designating uses for a water body, states examine the suitability of a water body for various uses based on the physical, chemical, and biological characteristics of the water body; its geographic setting and scenic qualities; and economic considerations. Characteristics necessary to support a use can be identified so that water bodies having those characteristics can be grouped together as supporting particular uses. When a water body is "in attainment" or "supporting" these designated uses, conditions in the water body satisfy the designated level for that use.

Under Michigan water pollution control statute (Natural Resources and Environmental Protection Act, Public Act 451 of 1994) discharges to surface waters are unlawful if they are or may become injurious to:

- Public health, safety, or welfare
- Domestic, commercial, industrial, agricultural, recreational, or other uses that are being made or may be made of such waters
- Value or utility of riparian lands
- Livestock, wild animals, birds, fish, aquatic life, or plants or to their growth or propagation

Promulgated Michigan water quality rules based on this state law and the federal Clean Water Act establish as a minimum that all waters of the state are designated and protected for the following uses:

- Agriculture
- Fish consumption
- Fishery health, coldwater
- Fishery health, warmwater
- Industrial water supply
- Navigation
- Other indigenous aquatic life and wildlife
- Partial body contact for recreation
- Total body contact for recreation from May 1 to October 31

Under state rules, both numerical and narrative water quality standards are established for designated and protected uses. In all cases where waters are designated for more than one of these protected uses, the most restrictive water quality standards apply.

Of the nine listed above, two do not apply to the watershed. There are no surface water public water supply intakes in the watershed and the coldwater fishery designation does not apply to the Looking Glass River. The Looking Glass River is classified as "in attainment" and considered fully supportive of all of seven of its designated uses (USEPA 2002). Exhibit 23 describes designated uses and related water quality standards in the watershed organized by activities that currently occur in the watershed.

EXHIBIT 23

Uses and Related Water Quality Standards

Existing activities and uses	Designated, protected uses (Part 31 of Act 451, §324.3109)	Water quality standards (MDEQ 2006)
Swimming and related full body contact activities	Total body recreational contact	Counts of 130 or less for *Escherichia coli (E. coli*) per 100 ml monthly average and 300 or less for *E. coli* per 100 ml at any time
Canoeing, fishing, kayaking, and related boating activities	Partial body recreational contact	Counts of 1,000 or less for *E. coli* per 100 ml
Fishing	Fish consumption	Fish consumption advisory trigger levels for toxic heavy metals and organic compounds
	Resident warmwater fish populations and seasonal migratory pathways for anadromous fish	Dissolved oxygen not less than 5.0 mg/l.
Agricultural, residential, recreational/ tourism-based and other businesses adjacent to river	Value and utility of riparian properties	Narrative statutory standard—no discharge that causes injury
Hunting, wildlife observation, ecosystem protection, plant and animal diversity	Protection of wild animals, birds, fish, aquatic life, or plants, and of their growth or propagation	Numerous numeric chemical limits such as pH, ammonia, toxic metals, and organic compounds, as well as narrative limits such as for nutrients (nuisance algal growths) and physical properties (color, temperature, clarity, etc.)
Small boat traffic	Navigation	No interference or increased cost to navigation

SOURCE: Public Sector Consultants 2007.

DESIRED USES

Desired uses of the watershed are those values identified by the community for protection. These uses fall under main headings such as water resource protection, recreation, river-sensitive land development, and habitat protection or improvement. Within these general categories, the community has identified the following desired uses.

Water Resource Protection

- Protection of priority areas from degradation
- Local protection of existing wetlands in watershed from development
- Wetland and floodplain restoration in subbasins that have already lost high percentages of these lands
- Protection of groundwater within the watershed

Recreation

- Protection and enhancement of paddling opportunities in the Looking Glass through maintained and improved public access points
- Development of a water trail

River-sensitive Low Impact Land Development

- Restored connectivity to riparian corridors where possible
- Protection of prime agricultural land
- Implementation of ecologically sustainable farm practices
- Increased use of buffer zones along riparian corridors

Habitat Protection or Improvement

Many programs exist to protect and enhance desired uses. One example is the Natural Rivers Program administered by the MDNR. Designation under the Natural Rivers program may allow local units of government to become program administrators over the public and private land along the river through the use of zoning and permitting. Partnerships with local groups that are active in the watershed can also be valuable to obtaining designation.

The designation process begins by development of a comprehensive river management plan that contains the background and baseline data for the river being studied and proposes reaches to be designated, as well as recommendations for public and private land development standards. In order for the upper Looking Glass to be considered for a Natural Rivers designation in the future, a Natural Rivers Plan must be developed and the following five concepts must be in place on private lands in the watershed:

- On both sides of the river, 300 to 400 feet from the ordinary high water mark must be designated a Natural Rivers Zoning District by local governments.
- Buildings along the river corridor must be set back 100 to 200 feet from the ordinary high water mark on both sides of the river.
- A minimum lot size and frontage must be established that is not less than one acre or narrower than 100 feet.
- A natural vegetated buffer must be established on both sides of the river corridor that must be at least 25 feet wide, but may be much wider, depending on the conditions.
- Septic systems must be set back from the river at least 100 feet, and sometimes 200 feet, depending on the river.

Standards for designated tributaries are often less restrictive than the mainstream standards listed above. Also, new industrial and most new commercial development is prohibited in the Natural Rivers District. Alteration of the stream channel or building in floodplains is also prohibited.

EROSION ASSESSMENT

Method

Erosion sites in the upper Looking Glass watershed were evaluated using a modified bank erosion hazard index (BEHI) model (Rosgen 2001). The BEHI model incorporates measurable field parameters into a relative predictive index. The BEHI values were modified for this study through the addition of a factor accounting for bank length. The resulting relative values can be used to ascertain which sites are likely to produce the most sediment on an annual basis, and also to prioritize subsequent bank stabilization efforts. Parameters measured for the modified BEHI model are as follows:

- **Bank Height:** In feet, total height of the apparent eroding bank, regardless of being above or below the water surface at the time of measurement.
- **Bankfull Height:** In feet, total height of *bankfull stage*, measured from the bottom of the eroding bank, regardless of the elevation of the water surface at the time of measurement.
- **Root Depth:** In feet, the maximum length of manifest plant root growth as measured from the top of the eroding bank
- **Root Density:** As a percentage, the volumetric space occupied by plant roots within the entire bank soil face, including areas above and below the root depth elevation, and excluding roots that are too small to be seen with the naked eye.
- **Bank Length:** In feet, the total length of the eroding bank.
- **Bank Angle:** In degrees, the average slope of the eroding bank, as referenced from a horizontal plane.
- **Surface Protection:** As a percentage, the amount of eroding bank surface area that is covered by non-soil objects, such as rocks, plants, roots, dense moss beds, or logs.
- **Bank Material:** Unitless adjustment ranging from –10 for pure cobble, to 0 for a moderately structured clay loam, to +10 for pure sand.
- **Stratification:** Unitless adjustment ranging from +5 for a substrate layering that promotes moderate additional erosion (such as a narrow sand and gravel layer within loamy soils) to +10 for a substrate layering that promotes maximum additional erosion (such as a thick sand layer beneath a heavy cobble layer).
- **Accessibility:** Factored in only for best management practice (BMP) prioritization; unitless, according to whether trucks and heavy equipment could access the location without encumbrance from rough topography, wetlands, forests, fences, etc.: +3 for “easy” access, 0 for “medium” access, and –5 for “difficult” access.

Results

In the summer of 2006, Wetland and Coastal Resources staff visited the river using the results from the Friends of the Looking Glass sampling as a guide. The Friends of the

Looking Glass volunteers traversed approximately 25 miles of the upper Looking Glass River and tributaries by foot (or 264,000 feet including both left and right banks). They conducted a qualitative assessment of the river banks and noted instances of erosion. Using this qualitative assessment as a basis, WCR staff visited all sites identified by the volunteers and quantitatively evaluated one hundred fifteen erosion sites, representing a total bank length of approximately 7,721 feet, or 3 percent of the total length assessed (see Exhibit 24).

Of the 115 sites evaluated, three were attributed to a log or debris jam; three were attributed to large livestock in the watercourse (cattle or horses); one was the result of a side channel outfall; one was attributed to a man-made bridge; and 107 were the result of altered morphology in the watercourse.

Erosion sites did not appear to be distributed randomly. Rather, they were generally found clustered in groups along particular reaches. Similarly, some reaches appeared to be relatively stable, with few or no significant erosion sites. For example, 21 of the erosion sites were within 3,500 feet of M-52 and there were ten erosion sites on the reach between Britton Road and Godfrey Road (3,130 feet); however, only five erosion sites were identified on the longer adjacent reach between Godfrey Road and Winegar Road (6,550 feet). Three of the ten highest scoring erosion sites were on the east side of M-52, within 3,300 feet of the M-52 bridge.

According to the BEHI model, the erosion sites were categorized as follows:

- Low: 2 sites, 130 feet of stream, contributing 180 pounds (.09 tons) of sediment annually to the river[4]
- Moderate: 18 sites, 890 feet of stream, contributing 8.07 tons of sediment annually to the river
- High: 90 sites, 6,036 feet of stream, contributing 187.58 tons of sediment annually to the river
- Very high: 5 sites, 665 feet of stream, contributing 28.37 tons of sediment annually to the river
- Extreme: 0 sites

Together these sites are contributing 224.11 tons of sediment to the watershed annually. They are also contributing 257.73 pounds of associated phosphorus annually, and 515.45 pounds of associated nitrogen annually.[5] Implementing BMPs at these erosion sites would eliminate 16 percent of the sediment discharged in the watershed.[6]

The erosion sites are prioritized in Appendix B, including an estimate of load reductions if best management practices are implemented at each site.

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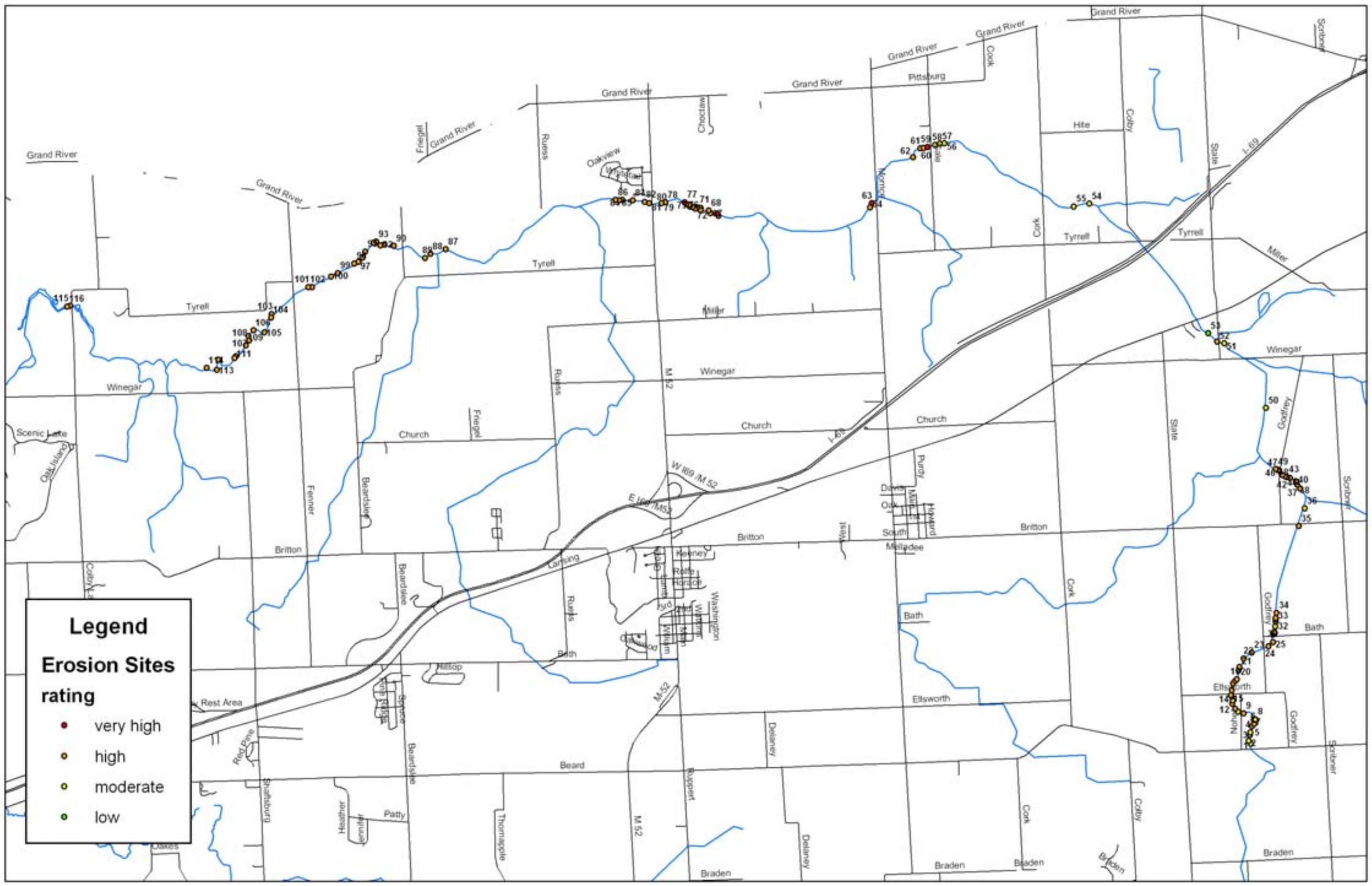
[4] Estimated loads were calculated using MDEQ's Channel Erosion Equation (CEE).

[5] Calculated using MDEQ formula: Nutrient reduced (lb/yr) = Sediment reduced (T/yr) x Nutrient conc. (lb/lb soil) x 2000 lb/T x correction factor. Calculations assume a nutrient concentration of .0005 lbP/lb of soil, and .001 lbN/lb of soil, and a correction factor of 1.15.

[6] Calculated proportion of the total suspended sediment in the watershed based on L-THIA modeling.

EXHIBIT 24
WCR Erosion Site Map



SOURCE: Wetland and Coastal Resources, 2006.

The majority of the erosion problems were located along previously channelized (deepened and straightened) stretches of the river. In general, these channelized areas have high, over-steepened banks that rise above the bankfull elevation. These banks are composed mainly of small gravel, fine sands, silt, clay, organic matter, and plant roots. Where the banks consist of dredged materials, they tend to rise higher above the bankfull elevation and contain fewer plant roots. Within the channelized areas, elevated bank erosion is fairly ubiquitous; in other words, erosion is greater than background erosion levels that would be expected in an unchannelized river. In some cases, natural tree fall events have created logjams in channelized stream areas. The flowing stream water has caused significant erosion in these areas as it flows past high, steep, weakly vegetated stream banks. Current velocities in the channelized sections were slow during assessments (averaging less than 1 foot. per second during summer and fall baseflow periods).

Areas of acute erosion occur in conjunction with manmade structures or contemporary land uses. For example, some erosion appears to have been initiated by private bridge crossings, cattle trampling, and direct discharge pipes. The situations involving livestock have particular potential to cause additional erosion, as the erosion would shift in response to animal numbers, behavior, and fencing.

Along the more natural river stretches, erosion levels are much lower, and are generally limited to natural bank erosion, tree falls near the river bank, and outside bends of meanders. Current speeds in unchannelized sections were also higher (averaging 2 feet. per second in fall season with water levels approximately 0.4 feet below bankfull).

WATER CHEMISTRY

Water chemistry sampling has been very limited within the upper Looking Glass watershed. Nutrient studies that have been conducted have focused specifically on discharge of the wastewater sewage lagoons into the Perry No. 2 Drain.

Water chemistry sampling was conducted by the MDEQ in 2001. Results are shown in Exhibit 25.

EXHIBIT 25
Water Chemistry Sampling, 2001

Parameter (mg/L)	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Ammonia	< 0.01	0.03	0.03	0.05	0.03	0.03
Nitrate + Nitrite	0.03	0.04	0.05	0.16	0.47	0.37
Nitrite	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Kjeldahl (N)	0.43	0.47	0.48	0.62	0.51	0.49
Phosphorus (SRP)	< 0.01	0.03	0.05	0.05	0.03	0.04
Phosphorus (T)	0.02	0.04	0.06	0.08	0.06	0.06
TSS	4.00	4.00	5.00	7.00	6.00	4.00
TDS	660.00	620.00	620.00	570.00	510.00	500.00

SOURCE: Michigan Department of Environmental Quality, 2001.

In the 1970s, the Tri-County Regional Planning Commission called the Looking Glass River dead, and a health hazard. Since then, municipal wastewater and other projects have resulted in improvements in water quality. Biological surveys conducted in 1992 by the MDNR identified the physical habitat at several monitoring stations along the Looking Glass River as “slightly to severely impaired.” A primary cause is the shifting sediment from flowing water that fluctuates as a result of weather, agriculture, increased urbanization, and nonpoint source pollution. Moreover, the results indicated that severely impaired physical habitat was due primarily to reduced natural vegetative buffers caused by increased development in the watershed. Ratings for the fish community, insect community, and water chemistry varied from poor (severely impaired) to good (slightly impaired).

BIOLOGICAL AND AQUATIC HABITAT ASSESSMENTS

Assessment of the biological and physical habitat of the Looking Glass River and selected tributaries was completed to characterize the quality of the watercourse and its contributing water sources, and to provide information necessary for identifying potential critical areas and making recommendations for improvements. In addition to collecting physical and biological data, previous studies performed by state agencies and others were reviewed and their findings evaluated.

Friends of the Looking Glass Activities

Between the spring of 2002 and the fall of 2003, volunteers from the Friends of the Looking Glass River conducted assessments of physical habitat and macroinvertebrates at several sites on the Looking Glass River and its tributaries.

Volunteers were trained by the Michigan Department of Environmental Quality (MDEQ) to conduct surveys and complete data forms. The information provided in this section represents summaries of the volunteer data collection; since not all data reviewed were considered to be complete, some sites that were sampled were left out of this report. Results of physical habitat and macroinvertebrate monitoring are provided in Exhibit 26.

EXHIBIT 26
Friends of the Looking Glass River 2002–2003 Sampling Results

	Score			
	2002		2003	
Station	Spring	Fall	Spring	Fall
Clise Drain at Ballantine Rd	55.0	40.4	NA	NA
Grub Creek at State Rd	47.1	52.1	56.7	57.9
Kellogg Drain at Tyrell Rd	34.7	NA	NA	NA
Looking Glass River at Ballantine Rd	24.9	NA	NA	NA
Looking Glass River at Beardslee Rd	NA	NA	NA	26.2
Looking Glass River at Britton Rd	49.4	34.2	44.0	33.3
Looking Glass River at Laingsburg Rd	43.8	34.3	NA	NA
Looking Glass River at Morrice Rd	30.5	44.4	37.8	29.9
Looking Glass River at State Rd	41.2	43.1	NA	NA
McRea Drain at Ruppert Rd	37.9	28.8	NA	NA
Remy-Chandler at Howe Rd	22.0	31.7	27.4	26.5
Remy-Chandler at State Rd	20.3	25.9	30.0	17.3
Vermillion Creek at Loche Rd	NA	NA	NA	20.6
Vermillion Creek at Peacock Rd	38.1	35.5	37.1	26.2
Vermillion Creek at Warner Rd	39.0	49.1	36.8	31.8

SOURCE: Friends of the Looking Glass River, 2003.
Adjective Scores: Excellent (>48); Good (34–48); Fair (19–33); Poor (<19). NA = not available.

Macroinvertebrate and Aquatic Sampling by WCR

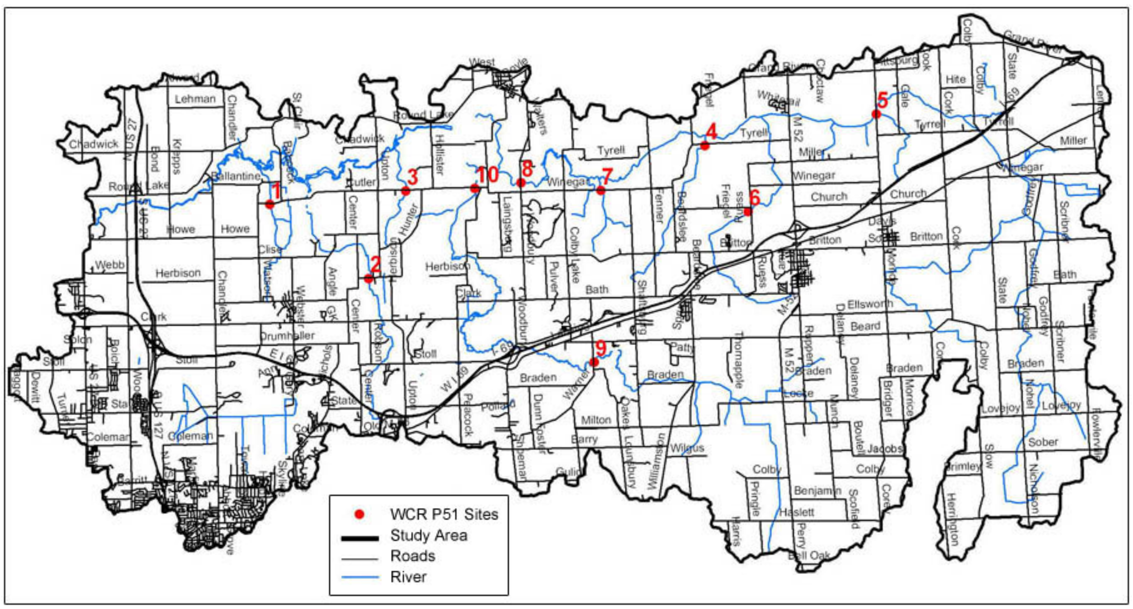
WCR conducted sampling of macroinvertebrates, fish, and physical habitat in fall 2006 to supplement existing data. Ten sites were selected based upon review of existing data and previous sampling sites. An effort was made to fill data gaps that had been left by previous studies, as well as to duplicate effort at a minimum of one site to validate sampling results. Macroinvertebrates and physical habitat were sampled at all ten sites, while fish were sampled at five sites. The sites were sampled in September 2006 using protocols set forth in *The Great Lakes Environmental Assessment Section, Procedure 51* (MDEQ, 2002).

Based on the results of the September 2006 sampling conducted by WCR, the instream aquatic habitat in the Looking Glass River and its tributaries appears to fall short of its potential. While most of the stations sampled received “good” ratings for physical habitat, many of the watercourses sampled have been dredged at some point, with a negative impact on aquatic habitat. Altered morphology and excessive sediment are the primary impacts to water quality. Of the ten stations sampled, all showed signs of historic alteration and sediment-related effects. While instream habitat is degraded, the overall scores for physical habitat were positively influenced by metrics associated with riparian and bank structure. Stream banks are very stable at the sampling stations and riparian vegetation is healthy, even in heavily modified stream reaches. Flow status appeared to be stable based on observed site conditions.

Scores for macroinvertebrate health ranged from "poor" to "acceptable." Stations that received "acceptable" scores were generally at the lower end of the range, tending toward poor. Only one station, the Looking Glass River at Morrice Road, received a positive macroinvertebrate score. In large part, the low macroinvertebrate scores correspond to the accumulation of sediment at many of the stations. Three of the highest scoring stations for macroinvertebrates were those that were least impacted by sediment: the Mud Creek, Looking Glass at Morrice Road, and Vermillion Creek stations. The lowest macroinvertebrate scores correspond to stations with the highest sediment loads.

All fish sampling conducted in accordance with Procedure 51 protocols resulted in station ratings of "acceptable," with the exception of the station on the Clise Drain, which had a poor rating. Exhibit 27 shows a map of the fish sampling stations.

EXHIBIT 27
Wetland and Coastal Resources Fish Sampling Map, 2006



SOURCE: Wetland and Coastal Resources Inc., 2006.

The highest scoring station was located in the Graneer Drain. Based on results of the 2006 assessment and review of literature referenced in this document, at least 24 species of fish are known to inhabit the Looking Glass River and its tributaries. Of the 24 species documented, ten are considered to be tolerant to degraded conditions. Tolerant species have been collected at every fish sampling station. Four of the 24 species are considered to be intolerant. A total of four individual intolerant specimens were collected during fish sampling in 2006: one rock bass in the Looking Glass River at Woodbury Road, two rock bass in the Graneer Drain, and one Iowa darter in the Perry No. 2 Drain. In addition, one rainbow darter, which is also intolerant, was captured and several more were observed during macroinvertebrate sampling in the Looking Glass River at Morrice Road. In 1989, the MDNR collected a total of 384 rainbow darters at the Morrice Road site, along with two Iowa darters. The MDNR also collected two stonecats in 1989, in the Looking Glass River at Beardsley Road.

The results of the WCR sampling for macroinvertebrates, physical habitat, and fish are summarized in Exhibit 28.

EXHIBIT 28
Wetland and Coastal Resources Sampling Results, September 2006

Station	Macroinvertebrate (–9 to 9)	Physical habitat (0–200)	Fish (–10 to 10)	Adjective rating
Clise Drain at Cutler Rd	–4	85	–10	Acceptable
Mud Creek at Herbison Rd	0	136		Acceptable
Graneer Drain at Cutler Rd	–6	134	3	Poor
Osborn Creek Drain at Tyrell Rd	–4	116	–4	Acceptable
Looking Glass River at Morrice	2	130		Acceptable
Perry No. 2 Drain at Reuss Rd	–6	92	–1	Poor
Outlet of Dunn Lakes at Winegar	–5	104		Poor
Looking Glass River at Woodbury	–1	111	–2	Acceptable
Vermillion Creek at Warner Rd	–3	137		Acceptable
Potters Lake Outlet at Cutler Rd	–7	111		Poor

SOURCE: Wetland and Coastal Resources Inc., 2006

LONG-TERM HYDROLOGIC IMPACT ASSESSMENT (L-THIA) MODELING ANALYSIS

Land use changes can significantly impact groundwater recharge, storm water drainage, and water pollution. The Long-Term Hydrologic Impact Assessment (L-THIA) model was utilized as part of this planning process to assess the water quality impacts of land use change. Based on community-specific climate data, the L-THIA estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development. The L-THIA analysis results can be used to generate community awareness of potential long-term problems and to support planning aimed at minimizing disturbance of critical areas. The L-THIA is a tool to assist in the evaluation of potential effects of land use change and to identify the best location for a particular land use for minimum impact on a community's natural environment.

Methods

The L-THIA model was used to identify areas in the upper Looking Glass River watershed that are critical to maintaining or improving water quality. The L-THIA uses existing climate and soil data, along with current or future land use scenarios, to predict changes in the quantity and quality of water in the watershed. Ideally, the L-THIA will be used by local governments prior to site development to predict water quality changes and to help local planners identify development alternatives that will have the least impact.

Several analyses were conducted specific to the upper Looking Glass watershed: the 12 subwatersheds[7] were analyzed based upon existing land use, and 10- and 20-year build-out scenarios were produced. The analysis of existing land use resulted in a side-by-side comparison of each subwatershed and allowed the subwatersheds to be prioritized according to impact on existing water quality. The build-out analyses were completed to illustrate what water quality changes can be expected if lands in the watershed are developed to the extent allowed by current zoning plans. These analyses were ultimately used to aid in identification of critical and priority areas in the upper Looking Glass watershed.

Data used for the L-THIA analyses included existing and predicted land use (10- and 20-year) files created by Rowe Engineering Inc., watershed boundaries obtained from the Michigan Center for Geographic Information, and soil and precipitation data derived from the model. Input data were prepared using a Geographic Information System (GIS) (ArcView 9.2 by ESRI). The Internet-based, basic input version of the L-THIA was used to analyze the data (outputs are provided in Appendix C). It was determined that this version of the model had the greatest likelihood of continued use by local officials due to its cost savings, online availability, and ease of use.

Model outputs were summarized in Microsoft Excel worksheets. Due to the difference in size among subwatersheds, all of the output results are standardized to annual output per acre. Future land use results are expressed as change over time or departure from existing conditions.

Results

Existing Land Use. Existing land use is having the greatest impact on water quality in the Buck Branch watershed (HUC 4050004060060). This watershed is contributing the largest average annual runoff and the most fecal coliform, nitrogen, phosphorus, and suspended solids of all of the subwatersheds analyzed. This is largely a result of the dominance of agricultural use in this watershed. The greatest concentration of heavy metals, including lead, copper, zinc, cadmium, chromium, and nickel, is coming from the Kellogg Drain watershed (HUC 4050004060040), apparently as a result of industrial land uses, including mining. The Mud Creek watershed (HUC 4050004060110) contributes the largest quantities of nickel, oxygen demand, oil and grease, and fecal strep. The watersheds having the least impact, based on existing land use, are the Looking Glass above Mud Creek (HUC 4050004060100) and Vermillion Creek (HUC 4050004060080).

Ten- and 20-year Build-out. Results of the L-THIA modeling for the future land use scenarios are encouraging in terms of impacts to the quantity and quality of water entering the Looking Glass River. The dominant change expected in land use is from agriculture to residential and, therefore, levels of nitrogen, phosphorus, fecal coliform and suspended solids are all expected to decrease. The model indicates that little to no change will occur in the average annual volume of runoff. While concentrations of heavy

[7] The Remy-Chandler sub-basin was not included as part of the build-out analysis because it is covered by the Greater Lansing Regional Committee (GLRC) that focuses on the National Pollutant Discharge Elimination System (NPDES) Phase II Storm Water Permit.

metals will increase, the change appears to be insignificant. The largest change in water quality will be in the volume of biochemical oxygen demand, chemical oxygen demand, oil and grease, and fecal strep. The watershed expected to experience the most significant change in water quality is the Unnamed Tributary (HUC 4050004060010). The least change is expected in Grub Creek (HUC 4050004060020) and Kellogg Drain (HUC 4050004060040).

Discussion

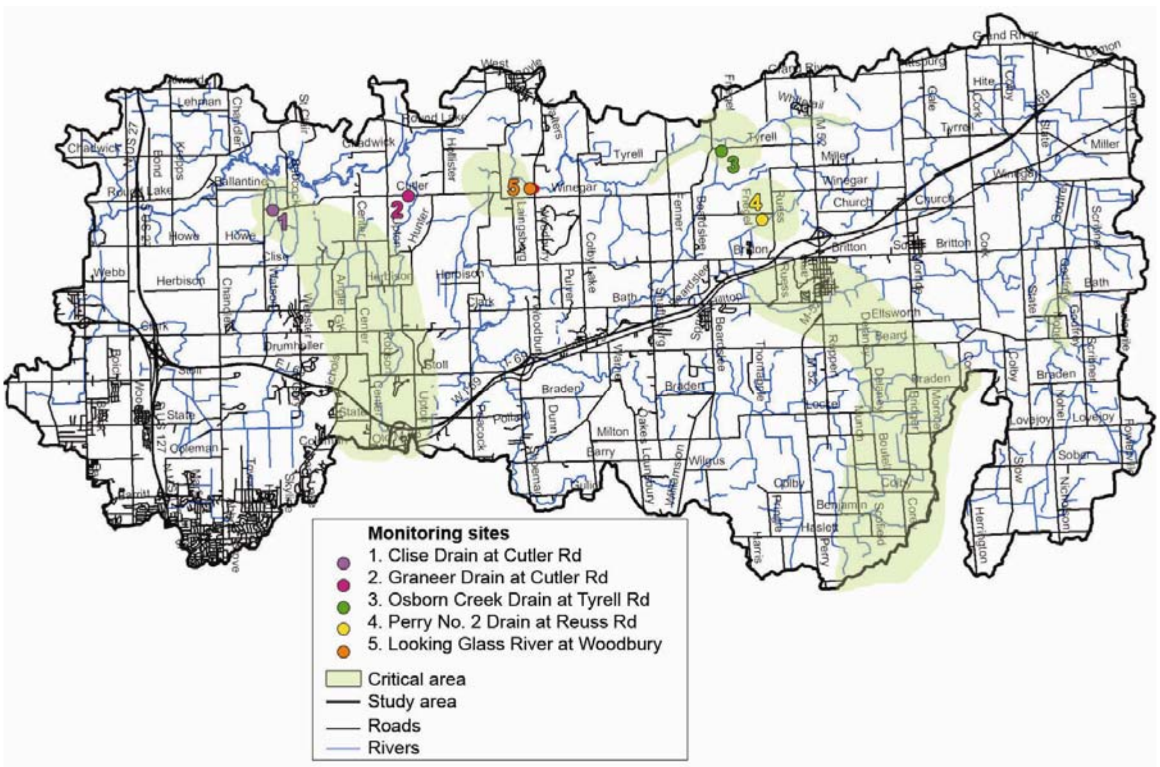
While the model does not show increased volume of water for the 10- or 20-year build-outs, it is anticipated that a change in land use from agriculture to residential will increase the runoff volume, at least on a local scale. It is likely that the model does not indicate these changes in volume because the land use change is very small compared to the overall watershed area.

CRITICAL AREAS

Critical areas in the upper Looking Glass watershed were selected after review of the erosion assessments, biological assessments, build-out assessment, wetlands assessment, and the L-THIA modeling exercise.

Critical areas include locations within the watershed that have been most damaged by human activities and pollution sources; or are most vulnerable to damage in the near future; or where restoration or changed use is proposed in order to prevent degradation of water quality. Exhibit 29 shows the critical areas on a map. Exhibit 30 provides details about each critical area.

EXHIBIT 29
Critical Areas



SOURCE: Public Sector Consultants 2007

EXHIBIT 30
Critical Area Details

Critical area	Method of selection and rationale	Designated or desired use threatened	Magnitude of threat	Suspected cause
From Beard Road downstream to approximately 1,000 feet to Godfrey Road	Erosion Assessment: This section includes 47 of the 115 erosion sites (30% of total), but only 6% of the total assessment area.	Agriculture, Warm-water Fishery Health, Indigenous Aquatic Life and Wildlife, Partial Body Contact Recreation, Total Body Contact Recreation, Riparian Property Values	Approximately 67.23 tons/year of sediment, 77.32 lbs/year of associated phosphorus, and 154.64 lbs/year of associated nitrogen	Road crossings and altered hydrology (channelization, severance from the floodplain and associated wetlands)
3,300 feet upstream of M-52 to 1,700 feet downstream of M-52	Erosion Assessment: 21 erosion sites in only one mile of stream (14% of the total assessed sites)	Agriculture, Warm-water Fishery Health, Indigenous Aquatic Life and Wildlife, Partial Body Contact Recreation, Total Body Contact Recreation, Riparian Property Values	31.38 tons/year of sediment, 36.08 lbs/year of associated phosphorus, and 72.16 lbs/year of associated nitrogen	Road crossings and altered hydrology (channelization, severance from the floodplain and associated wetlands)

Critical area	Method of selection and rationale	Designated or desired use threatened	Magnitude of threat	Suspected cause
One mile upstream and one mile downstream of Fenner Road	Erosion Assessment: 25 “high” erosion sites in two miles (17% of the total assessed sites)	Warmwater Fishery Health, Indigenous Aquatic Life and Wildlife,	According to the BEHI erosion model, this site is contributing an estimated 76,180 lbs (38.09 tons) of sediment, 43.80 lbs of associated phosphorus, and 87.61 lbs of associated nitrogen to the river annually	Road crossings and altered hydrology (channelization, severance from the floodplain and associated wetlands)
Osborn Creek Drain at Tyrell Road	Biological Assessment: degraded instream habitat	Warmwater Fishery Health, Indigenous Aquatic Life and Wildlife,	According to the L-THIA model, Osborn Creek sub-basin is contributing 101,359 pounds of sediment, 1,231 lbs of phosphorus, and 4,356 lbs (2.18 tons) of nitrogen to the river annually.	Historical alteration of morphology (channelization) and excessive sediment from surrounding land uses in the Osborn Creek sub-basin
Perry No. 2 Drain	Biological Assessment: degraded instream habitat	Warmwater Fishery Health, Indigenous Aquatic Life and Wildlife	According to the L-THIA model, Kellogg Drain sub-basin is contributing 282,493 lbs (141.25 tons) of sediment, 3,162 lbs (1.58 tons) of phosphorus, and 11,142 lbs (5.57 tons) of nitrogen to the river annually.	Historical alteration of morphology (channelization) and excessive sediment from surrounding land uses in the Kellogg Drain sub-basin
Clise Drain at Cutler Road	Biological Assessment: degraded instream habitat	Warmwater Fishery Health, Indigenous Aquatic Life and Wildlife	According to the L-THIA model, Mud Creek sub-basin is contributing 94,958 lbs (47.48 tons) of sediment, 1,077 lbs of phosphorus, and 3,833 lbs (1.94 tons) of nitrogen to the river annually.	historical alteration of morphology (channelization) and excessive sediment from surrounding land uses in the Mud Creek sub-basin
Buck Branch sub-basin	L-THIA anaylsis: This sub-basin is contributing the largest average annual runoff and the most fecal coliform, nitrogen, phosphorus, and sediment of all of the subwater-sheds analyzed.	Agriculture, Warmwater Fishery Health, Indigenous Aquatic Life and Wildlife, Partial Body Contact Recreation, Total Body Contact Recreation, Riparian Property Values	According to the L-THIA model, agricul-tural land use in the Buck Branch sub-basin contributes 354,912 lbs (177.46 tons) of sediment, 4,312 lbs (2.16 tons) of phosphorus, and 14,594 lbs (7.30 tons) of nitrogen to the river annually.	Based on the model, these pollutants are a result of the predominance of agricultural land use

Critical area	Method of selection and rationale	Designated or desired use threatened	Magnitude of threat	Suspected cause
Mud Creek sub-basin	L-THIA analysis: This sub-basin contributes the largest quantity of bacteria to the watershed.	Partial Body Contact Recreation, Full Body Contact Recreation, Warmwater Fishery Health, Indigenous Aquatic Life and Wildlife	According to the L-THIA model, residential land use in this sub-basin contributes 94,968 million colonies bacteria annually.	Based on the model, these pollutants are primarily the result of high- and low-density residential land uses in the sub-basin.

SOURCE: Public Sector Consultants 2007.

PRIORITY AREAS

Priority areas are those in which actions are recommended to protect current conditions or enhance the stream, but the activity will not be focused on reducing pollutants.

Priority Area Based on Erosion Assessments

The area extending from Colby Lake Road approximately 1.5 miles upstream is relatively natural, unaltered channel that exhibits minimal to no erosion. This site should be protected as a demonstration site. Increased sediment and nutrients resulting from any further alteration of hydrology would negatively impact the watershed.

Priority Areas Based on Biological Assessment and Literature Review

The following three sites exhibited high-quality instream habitat:

- Mud Creek at Herbison Road
- Looking Glass at Morrice Road
- Grub Creek at State Road

Priority Areas Based on Wetlands and Floodplain Assessment

While a significant portion of wetlands in the upper Looking Glass watershed has been converted to agriculture and commercial and residential development, the watershed contains approximately 10,000 acres of forested and nonforested wetlands, both within and outside the floodplain of the Looking Glass River. One of the unique components of the upper Looking Glass River is its forested floodplain, which remains intact and is an important element to maintain and protect the water quality and hydrology of the river, as well as to provide wildlife corridors, which are all designated uses.

The sub-basins that have lost more than 70 percent of their respective presettlement wetlands and should be the focus of wetland restoration activity are:

- Remy-Chandler Drain
- Vermillion Creek above the Gravel Pit
- Buck Branch

The Vermillion Creek and Mud Creek sub-basins are considered priority areas because the existing high-quality contiguous wetlands there are valuable to maintaining the quality of the watershed. Protection of existing wetlands is a high priority. Each of these sub-basins contains 12 percent of the total wetlands in the watershed.

Pollutants:
Impairments and Threats

Based on the U.S. Environmental Protection Agency (USEPA) definition, the upper Looking Glass watershed is not currently "impaired." In the USEPA's National Assessment Database, however, the listed potential threats to the river mirror the impairments highlighted by the erosion and biological assessments. They include nutrients, flow alterations, sedimentation/siltation, and suspended sediment concentration. The probable sources contributing to the threats listed in the USEPA's database are agriculture, channelization, non-irrigated crop production, dredging, pasture grazing (riparian and/or upland), and site clearance for construction.

Potential threats to surface water quality were identified by the assessments conducted during development of this plan in conjunction with a review of existing information available about the watershed. The potential sources and causes of these threats were identified and are listed below.

Specific Pollutants Known or Suspected to Threaten the Watershed

This plan focuses on the most prominent pollutants observed in the watershed:

- Sedimentation, resulting from both land use–created erosion and instream erosion
- Nutrients, including nitrogen and phosphorous
- Altered hydrology, including both hydrologic flow from adjacent land use and instream impacts resulting from the historically altered shape of the river
- Bacteria

Reducing pollutants in order to protect and maintain the designated and desired uses in the watershed is the key to this watershed plan. These pollutants threaten the designated and desired uses in many ways. In order to avert those threats, this plan combines information on the threats and identification of critical areas to develop goals for the watershed.

Origin of Potential Pollutants in the Watershed

Point Source Discharges

- A wastewater stabilization lagoon at Laingsburg

Nonpoint Source Discharges

- Runoff from impermeable surfaces within the watershed (e.g., roads, parking lots, roofs)
- Runoff from gravel roads and gravel roadsides
- Residential runoff from lawns and driveways
- Agricultural runoff, from both crop and animal operations
- Golf course runoff

- Altered morphology leading to flow alterations and increased instream erosion and sedimentation
- Log/debris jam
- Side-channel or drain runoff contributions from agriculture, lawn maintenance, road crossings—both nutrients and sediment
- Erosion from pastured livestock (horses, cattle) allowed to access the riparian zone

MDEQ 303(d) List of Impairments

The Clean Water Act requires Michigan to prepare a biennial report, called the Section 303(d) list, on the quality of its water resources. This report constitutes the principal means of conveying water quality protection/monitoring information to the USEPA and the U.S. Congress. The Section 303(d) list includes Michigan waterbodies that are not attaining one or more designated use and require the establishment of Total Maximum Daily Loads (TMDLs) to meet and maintain water quality standards. The upper Looking Glass watershed is attaining its designated uses currently. However, there are potential threats that have been identified for monitoring purposes; these are:

- **Mobile Home Park Sewage Lagoon on Perry No. 2 Drain:** During sampling for the aquatic habitat assessment in September 2006, a riparian landowner indicated that periodic discharges from an upstream sewage lagoon at the mobile home park create undesirable conditions in the stream. In addition to the unpleasant odor, the water reportedly appears extremely turbid during these discharge events. The MDEQ monitored the area in late summer 2007; results are currently being formalized in a report. This site has not yet been added to the MDEQ’s 303(d) list of impairments to the watershed.
- **Vermillion Creek:** A site on Vermillion Creek is listed on the MDEQ’s 303(d) list of impairments to the watershed. The problem creating the impairment was a septic discharge pipe, also known as a cheater pipe. The pipe has been removed and the impairment has been documented as corrected by the local health department. The MDEQ monitored in that area in late summer 2007, and found no indication of a cheater pipe. The department plans to remove the site from the 303(d) list during the next 303(d) list update process.
- **Wolf Creek:** A site on Wolf Creek in Locke Township is also listed on the MDEQ’s 303(d) list of impairments to the watershed. This site was originally included because of its straightened and channelized characteristics. Under the original listing scheme, waterways that were straightened and channelized were automatically classed as impairments. Under a more recent classification, the actual water quality at the site is assessed. Recent MDEQ monitoring will reveal whether there is water quality impairment at this site. At this time the MDEQ expects this site will also be removed from the 303(d) list during the next list update process.

PRIORITIZATION

The following pollutants and their associated sources and causes were selected based on the frequency of observation in the watershed, and are prioritized by the potential for the source to degrade the water quality and by the analysis of relative benefits and costs of addressing these sources (see Exhibit 31).

EXHIBIT 31
Watershed Prioritization of Pollutants

Pollutant	Priority ranking	Sources in order of priority	Causes	Designated use threatened
Sediment	1	In-stream bank and bed erosion	• Altered morphology (channelization, severance from floodplain, increased runoff volume from impervious surfaces, reduction in wetland acreage) • Road-stream crossings	Agriculture, Riparian Property Values, Navigation, Warmwater Fishery Health, Indigenous Aquatic Life and Wildlife
		Agricultural land	• Unbuffered surface runoff from fields • Unimpeded livestock access to stream	
		Residential and commercial land	• Development/construction sites without sufficient buffering or sediment management • Increased volume of runoff from impermeable surfaces	
Nutrients	2	Agricultural land	• Excessive fertilizer use • Unbuffered surface runoff from pastures and confined animal shelters • Unimpeded livestock access to stream	Agriculture, Warmwater Fishery Health, Indigenous Aquatic Life and Wildlife, Partial Body Contact Recreation, Total Body Contact Recreation
		Residential land	• Improper fertilizer Use • Organic debris deposited in stream • Failing septic systems resulting from improper design and/or maintenance	
		Golf courses	• Improper fertilizer use	
		In-stream bank and bed erosion	• Altered morphology (channelization, severance from floodplain, increased runoff volume from impervious surfaces, reduction in wetland acreage)	
Altered hydrology	3	Drainage practices	• Altered morphology (channelization, severance from floodplain)	Agriculture, Riparian Property Values, Navigation, Recreation, Warmwater Fishery Health, Indigenous Aquatic Life and Wildlife
		Residential and commercial land	• Increased volume of runoff from impermeable surfaces resulting from lack of river sensitive land use • Loss of wetlands due to development decisions at the local level	

Pollutant	Priority ranking	Sources in order of priority	Causes	Designated use threatened
Bacteria	4	Agricultural Lands	• Unimpeded livestock access to stream • Unbuffered surface runoff from pastures and confined animal shelters	Partial Body Contact Recreation, Total Body Contact Recreation
		Sewage treatment	• Failing septic systems resulting from improper design and/or maintenance • Overflow at sewage treatment facilities due to lack of treatment capacity and/or retention ponds	

SOURCE: Public Sector Consultants Inc., 2007.

POLLUTANT LOADING

Based on the L-THIA model results, estimated annual non-point source pollutant loads in the watershed are shown in Exhibit 32.

EXHIBIT 32
Watershed Pollutant Loads, 2007

Sub-basin	Nitrogen (lbs/year)	Phosphorous (lbs/year)	Suspended sediment (lbs/year)	Fecal coliform (millions of coliform)	Fecal strep (millions of coliform)
Buck Branch	15,083	4,425	364,554	409,776	47,046
Grub Creek	7,458	2,172	180,440	203,772	45,638
Howard Drain	17,182	4,969	425,893	476,546	130,034
Kellogg Drain	11,142	3,162	282,493	307,890	118,558
Looking Glass River above Remy-Chandler	16,540	4,827	401,085	459,720	132,242
Above Mud Creek Sub-basin	2,978	861	70,493	82,394	25,406
Mud Creek Sub-basin	3,833	1,077	94,958	109,962	89,424
Osborn Creek	4,356	1,231	101,359	119,921	53,961
Vermillion Creek	6,202	1,714	147,335	177,078	135,202
Vermillion Creek at Gravel Pit	9,969	2,877	237,455	272,193	63,628
Vermillion Creek at Mouth	7,074	1,898	164,284	194,670	145,339
Above Unnamed Tributary	14,334	4,191	344,330	391,628	66,101
Watershed total	**116,151**	**33,404**	**2,814,679**	**3,205,550**	**1,052,579**

SOURCE: Wetland and Coastal Resources, Inc. 2007. Data taken from L-THIA analysis (See Appendix C for more detail.)

Estimated pollutant loads resulting from high- and low-density residential land use are summarized below in Exhibit 33.

EXHIBIT 33
Residential Pollutant Loads, 2007

Sub-basin	Nitrogen (lbs/year)	Phosphorous (lbs/year)	Suspended sediment (lbs/year)	Fecal coliform (millions of colonies)	Fecal strep (millions of colonies)
Buck Branch	323	101	7,286	16,156	45,238
Grub Creek	278	87	6,280	13,924	38,989
Howard Drain	773	242	17,428	38,645	108,206
Kellogg Drain	578	181	13,030	28,892	80,900
Looking Glass River above Remy-Chandler	869	272	19,595	43,448	121,655
Above Mud Creek Sub-basin	181	56	4,091	9,073	25,406
Mud Creek Sub-basin	500	155	11,270	24,991	69,977
Osborn Creek	364	114	8,205	18,194	50,944
Vermillion Creek	859	269	19,354	42,914	120,161
Vermillion Creek at Gravel Pit	442	137	9,968	22,103	61,891
Vermillion Creek at Mouth	890	278	20,081	44,525	124,674
Above Unnamed Tributary	469	146	10,568	23,434	65,616
Watershed total	**6,526**	**2,038**	**147,156**	**326,299**	**913,657**

SOURCE: Wetland and Coastal Resources, Inc. 2007. Data taken from L-THIA analysis (See Appendix C for more detail.)

Estimated pollutant loads from agricultural land use are summarized below in Exhibit 34.

EXHIBIT 34
Agricultural Pollutant Loads, 2007

Sub-basin	Nitrogen (lbs/year)	Phosphorous (lbs/year)	Suspended sediment (lbs/year)	Fecal coliform (millions of colonies)	Fecal strep (millions of colonies)
Buck Branch	14,594	4,312	354,912	392,006	0
Grub Creek	6,963	2,057	169,332	187,028	0
Howard Drain	15,465	4,569	376,099	415,402	0
Kellogg Drain	9,364	2,766	227,729	251,527	0
Looking Glass River above Remy-Chandler	15,223	4,497	370,198	408,884	0
Above Mud Creek Sub-basin	2,725	804	66,299	73,228	0
Mud Creek Sub-basin	2,848	841	69,274	76,513	0
Osborn Creek	3,734	1,103	90,809	100,299	0
Vermillion Creek	4,605	1,360	111,993	123,696	0
Vermillion Creek at Gravel Pit	9,221	2,724	224,250	247,685	0
Vermillion Creek at Mouth	5,126	1,514	124,676	137,705	0
Above Unnamed Tributary	13,671	4,039	332,456	367,198	0
Watershed Total	**103,539**	**30,586**	**2,518,027**	**2,781,171**	**0**

SOURCE: Wetland and Coastal Resources, Inc. 2007. Data taken from L-THIA analysis (See Appendix C for more detail.)

Goals and Objectives

PRIORITY METHOD

The goals presented in Exhibit 35 were developed based on the assessments that were conducted in the watershed as part of this plan and a review of the existing literature about watershed management. The order of these goals was confirmed by a survey of watershed residents' priorities, and supported by the Steering and Technical Committees.

MANAGEMENT MEASURES

Management measures are proposed to address threats at the critical areas and protect water quality. They are described in Exhibit 35. Best management practices referenced in Exhibit 35 are described in Exhibit 36.

EXHIBIT 35
Management Measures and Load Reductions

Objectives (uses addressed)	Tasks (priority ranking in parentheses)	Partners	Technical assistance	10-year timeline	Estimated load reduction	Estimated costs and potential funding sources
Goal 1: Protect and enhance surface water quality in order to continue attainment of supporting designated uses by focusing on nonpoint source pollution.						
Decrease sediment load in the surface waters Designated uses: agriculture, riparian property values, navigation, warmwater fishery health, indigenous aquatic life and wildlife Desired uses: paddling enjoyment, habitat protection and improvement	Fence livestock out of the stream (High)	Landowners, conservation districts	Construction firms, conservation districts	Within 6 months	1.81 tons of sediment per year See Appendix B, Sites 26, 52 and 53. Estimated reductions were calculated using MDEQ's Channel Erosion Equation (CEE).	$5000 MDEQ, MDA, NRCS, local conservation district, private funds
	Implement buffer/filter strips on agricultural land in the watershed (High)	LUGs, county road commissions, MDOT, Friends of the Looking Glass	Engineering and construction firms, planting equipment	Years 1–5	818.36 tons of sediment per year from agricultural land 65% reduction of sediment delivery from agricultural land in the watershed See Appendix C	$36,500 $500/acre on 73 agricultural acres converted to buffer strip[8] CRP, WRP, NRCS, Land Conservancy, private funds
	Reduce upland erosion at three road stream crossings (Beard Rd, M-52, Fenner Rd) to limit sediment discharge into the watershed (Medium)	Landowners, MDOT, county road commissions, LUGs, Friends of the Looking Glass	Engineering and construction firms, planting equipment	Years 3–5	Together these tasks will remove 136.70 tons of sediment per year See Appendix B and erosion map; these three crossings contribute 61% of the total erosion sediment identified in that	$5,000 $500/acre on 10 acres of land adjacent to crossings treated with buffer/ filter strip and other vegetative plantings MDOT, CRP, WRP, NRCS, Land Conservancy, private

[8] The Upper Looking Glass is 40 river miles or 211,200 feet long. Agriculture occurs on 50 percent of the land in the watershed. The amount of buffer strip required was estimated by multiplying 50% against the river feet, which equals 105,600 feet. This figure was then multiplied by 30 feet (the width of a buffer strip) equaling 3,168,000 square feet. This number was divided by 43,560 square feet (the number of square feet equivalent to an acre) equaling 73 acres.

Objectives (uses addressed)	Tasks (priority ranking in parentheses)	Partners	Technical assistance	10-year timeline	Estimated load reduction	Estimated costs and potential funding sources
					analysis. Estimated reductions were calculated using MDEQ's Channel Erosion Equation (CEE).	funds
	Implement floodplain restoration; riprap; instream structures; vegetative plantings to address instream erosion at the three critical areas identified by the erosion assessment (High)	Landowners, LUGs, conservation districts	Planting equipment, engineering and construction firms, MDEQ, MDNR	Years 5–10		$155,000 (7,721 feet of river identified in BEHI assessment restored at $20/ft) LUGs, MDEQ, MDNR, private funds
Decrease nutrient load in the surface waters Designated uses: agriculture, warmwater fishery health, indigenous aquatic life and wildlife, partial body contact recreation, total body contact recreation	Proper fertilizer application and filter strips on agricultural land in the watershed (High)	Farmers, conservation districts	Conservation districts, MDEQ	Years 1–5	36.24 tons N 11.47 tons P[9]	$36,500 $500/acre on 73 agricultural acres converted to buffer strip[10]
	Proper fertilizer application and filter strips on residential land in the watershed (High)	Residents	LUGs, conservation districts, MDEQ	Years 1–3	2.45 tons N 1,529 lbs P	$8,000 $500/acre on 16 residential acres treated with buffer/ filter strip[11]
	MDEQ Turf Management BMPs for golf courses (Medium)	Golf course managers	MDEQ	Years 1–3	Unquantified reduction in N and P	Unknown

[9] The relative gross effectiveness of filter strips for sediment reduction is 65%; for phosphorus it is 75%; and for nitrogen it is 70%. Source: **Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual.** Revised June 1999. Michigan Department of Environmental Quality Water Division Nonpoint Source Unit. Lansing, Mich.

[10] The Upper Looking Glass is 40 river miles or 211,200 feet long. Agriculture occurs on 50 percent of the land in the watershed. The amount of buffer strip required was estimated by multiplying 50% against the river feet, which equals 105,600 feet. This figure was then multiplied by 30 feet (the width of a buffer strip) equaling 3,168,000 square feet. This number was divided by 43,560 square feet (the number of square feet equivalent to an acre) equaling 73 acres.

Objectives (uses addressed)	Tasks (priority ranking in parentheses)	Partners	Technical assistance	10-year timeline	Estimated load reduction	Estimated costs and potential funding sources
Desired uses: habitat protection and improvement	Fence livestock out of stream (Medium)	Landowners, conservation districts	Construction firms, conservation districts	Within 6 months	4.16 lbs N 2.08 lbs P Nutrients associated with removal of sediment by fencing[12]	$5,000 MDEQ, MDA, NRCS, local conservation district, private funds
	MDEQ Organic debris BMP on public land (Medium)	Grounds-keepers, landscapers, local public officials	MDEQ	Years 1–3	Unquantified reduction in N and P	$1,000/year for debris disposal watershed-wide
	Failing septic systems (Medium)	Residents, local officials, LUGs	County inspection officials, MDCH, local health departments, septic service companies	Years 1–5	Some portion of 3.26 tons/year of N, and 1.04 tons/year of P Residential land nutrients from L-THIA; See Appendix C	$834,300 Inspection for 8343 systems at $100/septic system Private funds
Address current state of altered morphology in the watershed; where feasible, return the surface waters to a natural flow regime Designated uses:	Alter and stabilize the overly high bank structure of the river to reduce instream erosion (High)	MDOT, county road commissions, conservation districts, landowners	Engineering firms	Years 1–3	Together these tasks will remove 136.70 tons of sediment per year See Appendix B and erosion map; these areas contribute 61% of the total erosion sediment	$155,000 (7,721 feet of river identified in BEHI assessment restored at $20/ft) LUGs, MDEQ, MDNR, private funds

[11] The Upper Looking Glass is 40 river miles or 211,200 feet long. Residential land use occurs on 11 percent of the land in the watershed. The amount of buffer strip required was estimated by multiplying 11% against the river feet, which equals 23,232 feet. This figure was then multiplied by 30 feet (the width of a buffer strip) equaling 696,960 square feet. This number was divided by 43,560 square feet (the number of square feet equivalent to an acre) equaling 16 acres.

[12] Calculated using MDEQ formula: Nutrient reduced (lb/yr) = Sediment reduced (T/yr) x Nutrient conc. (lb/lb soil) x 2000 lb/T x correction factor. Calculations assume a nutrient concentration of .0005 lbP/lb of soil, and .001 lbN/lb of soil, and a correction factor of 1.15.

Objectives (uses addressed)	Tasks (priority ranking in parentheses)	Partners	Technical assistance	10-year timeline	Estimated load reduction	Estimated costs and potential funding sources
agriculture, riparian property values, navigation, recreation, warmwater fishery health, indigenous aquatic life and wildlife	Restore access to the floodplain where the stream has been channelized (High)	Landowners, county road commissions, local officials, Friends of the Looking Glass	Engineering firms, construction firms, MDEQ, MDNR	Years 5–10	identified in that analysis. Estimated reductions were calculated using MDEQ's Channel Erosion Equation (CEE).	$18,000 (6 cuts into channelized banks at $3,000 each) LUGs, MDEQ, MDNR, private funds
Desired uses: habitat protection and improvement	Evaluate debris and log jams (Medium) Retain log jams where necessary to re-establish meander, and remove others to allow recreational access (Medium)	Friends of the Looking Glass	Tree and debris removal service, MDEQ, MDNR	Years 1–3	6.75 tons/year of sediment, 15.52 lbs/year N, 7.76 lbs/year P See Appendix B, Sites 31, 73 and 94. Estimated reductions were calculated using MDEQ's Channel Erosion Equation (CEE).	$3,000 ($1000 each for three log jams identified in BEHI) LUGs, MDNR, MDEQ, FLG volunteer labor, private funds
	Employ stormwater runoff detention ponds and filter strips to reduce impacts of runoff from impervious surfaces (Medium)	Local officials, general public	Developers, engineering firms, construction firms, MDEQ, MDNR	Years 3–5	Avoid increase in runoff volume and associated sediment and nutrients projected by L-THIA model, varies by sub-basin See Appendix C	Unknown, dependent on development, land availability, and proactive decision-making at the local level

Objectives (uses addressed)	Tasks (priority ranking in parentheses)	Partners	Technical assistance	10-year timeline	Estimated load reduction	Estimated costs and potential funding sources
Address potential bacterial contamination in waterbodies Designated uses: partial body contact recreation, total body contact recreation Desired uses: paddling enjoyment	Pasture livestock waste management using buffer/filter strips (Medium)	Farmers, landowners	MDEQ, conservation districts	Years 3–5	2,781,171 millions of fecal coliform colonies Agricultural L-THIA fecal coliform load; See Appendix C	$36,500 $500/acre on 73 agricultural acres converted to buffer strip[13] CRP, WRP, NRCS, Land Conservancy, private funds
	Septic system maintenance (Medium)	Landowners	County inspection officials, MDCH, local health departments, septic service companies	Years 1–3	326,299 millions of fecal coliform colonies Residential L-THIA fecal coliform load See Appendix C	$834,300 Inspection for 8343 systems at $100/septic system Private funds
Goal 2: Protect existing wetlands within the watershed.						
Develop and implement uniform and consistent wetland ordinances across townships in the watershed Designated uses: agriculture, riparian property values, navigation, recreation, warmwater fishery health, indigenous	Adopt uniform local wetland protection ordinance in every jurisdiction in the watershed (High)	Local units of government	Planning consultants, engineering firms, MDEQ	Years 3–5	Avoid wetland loads in L-THIA increasing to residential loads, varies by sub-basin See Appendix C	$150,000 for watershed-wide plan updates in conjunction with Goal 5 below. LUGs, MDEQ, private funds

[13] The Upper Looking Glass is 40 river miles or 211,200 feet long. Agriculture occurs on 50 percent of the land in the watershed. The amount of buffer strip required was estimated by multiplying 50% against the river feet, which equals 105,600 feet. This figure was then multiplied by 30 feet (the width of a buffer strip) equaling 3,168,000 square feet. This number was divided by 43,560 square feet (the number of square feet equivalent to an acre) equaling 73 acres.

Objectives (uses addressed)	Tasks (priority ranking in parentheses)	Partners	Technical assistance	10-year timeline	Estimated load reduction	Estimated costs and potential funding sources
aquatic life and wildlife Desired uses: habitat, wetland protection						
Goal 3: Protect groundwater in the watershed.						
Assess and protect groundwater in the watershed Desired use: groundwater protection	Develop wellhead–protection program for community water supplies (Medium)	LUGs, landowners, Friends of the Looking Glass	MDEQ, university research staff, engineering firms, planning consultants	Years 3–5	N/A	$60,000 $20,000 per community (3) with a well- reliant public water supply LUGs, private funds, MDEQ
Goal 4: Improve recreation opportunities in the watershed while ensuring that the watershed's integrity is not degraded.						
Improve existing and create new opportunities in the watershed for recreation to maintain and improve local quality of life Desired uses: paddling, fish and wildlife habitat protection and improvement	Evaluate log and debris jams in the watershed that impede paddling, removing those necessary for paddling while leaving in place those that provide benefits to the river ecology (High)	Riparian landowners, LUGs, Friends of the Looking Glass	Tree and debris removal services, MDEQ, MDNR	Years 2–5	6.75 tons/year of sediment and associated nutrients	$3,000 ($1,000 each for three log jams identified in BEHI) LUGs, MDNR, MDEQ, FLG volunteer labor, private funds
	Improve existing and create new fishing access points (Medium)	Local government, general public, Friends of the Looking Glass	Engineering and construction firms, fishing-oriented organizations (i.e., angler's clubs)	Years 3–5	Unknown quantity of bank erosion prevented by protecting riparian banks from erosion by river access	$100,000 for land acquisition and dock construction at 2 sites Michigan Natural Resources Trust Fund, MDNR, LUGs, private funds
	Maintain existing and create new riparian habitat for birds, wildlife (Low)	Riparian landowners, Friends of the Looking Glass, wildlife organizations	Fish and wildlife organizations, MDNR, Audubon Society, The Nature Conservancy, Mid-Michigan Land Conservancy	Years 3–5	N/A	$50,000 for land acquisition and habitat restoration Nonprofit bird and wildlife organizations, private foundations, MDNR, Natural Resources Trust Fund

Objectives (uses addressed)	Tasks (priority ranking in parentheses)	Partners	Technical assistance	10-year timeline	Estimated load reduction	Estimated costs and potential funding sources
Goal 5: Institute responsible land use planning in the watershed.						
Enact protective land use zoning to ensure the integrity of existing wetlands and riparian zones in the watershed Designated uses: all Desired uses: wetland protection, groundwater protection, river-sensitive low- impact development	Adopt uniform protective land use plans and zoning overlays (Medium)	Local units of government, Friends of the Looking Glass, Shiawassee and Clinton Counties, engineering firms	Planning consultants, engineering firms	Years 3–5	Avoid wetland loads in L-THIA increasing to residential loads, varies by sub-basin See Appendix C	$150,000 for watershed-wide plan updates in conjunction with Goal 2 above LUGs, MDEQ, private funds

SOURCE: Public Sector Consultants Inc., 2008.

Best Management Practices

DEFINITION OF A BEST MANAGEMENT PRACTICE

In the context of watershed management, a best management practice (BMP) is any method that has been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources. Specifically, the MDEQ defines a BMP as a structural, vegetative, or managerial practice used to protect and improve surface waters and groundwater.

ROLE OF BMPS IN WATERSHED MANAGEMENT PLANNING

Stream bank erosion and eutrophication (an abundant accumulation of nutrients that support dense growth of algae and other organisms, the decay of which depletes waters of oxygen) are slow, natural processes that are accelerated by human activity within the watershed. This human-created acceleration has a negative impact on the surface water quality and the river's biological health.

Accelerated erosion occurs in a river when stream banks are altered from the shape that they naturally acquire. This can occur when rivers are channelized for drainage, or when the stream banks are destabilized by machinery, people, or livestock.

Accelerated eutrophication occurs when plant nutrients, such as phosphorus and nitrogen, are applied to the land, through chemical fertilization, composting, or deposition of livestock waste. These nutrients then enter the runoff within the watershed and enter the stream. Once in the water, the nutrients enable algae growth. The increased growth in algae, called a bloom, negatively impacts the stream, both in terms of its aesthetics and its biological health. Not only do algae degrade the appearance of the stream, but more importantly, decaying algae use up oxygen in the water and can starve aquatic organisms of the oxygen they need to survive and reproduce.

BMPs selected in the management measures above (Exhibit 35) are described in Exhibit 36.

EXHIBIT 36
Best Management Practices for this Watershed

Best management practice	Description	Impairment addressed
Conservation cover, vegetative plantings	Establishment and maintenance of perennial vegetative cover to protect soil and water resources and land retired from agricultural production. This can be done by installing plants or by spreading seeds.	Erosion/ sedimentation Associated nutrients
Extended detention basin (stormwater runoff storage)	Basins designed to receive and detain storm water runoff for a prolonged period of time, typically up to 48 hours. Extended detention is achieved by use of an outlet device regulating the flow from the basin at a rate that minimizes downstream erosion, reduces flooding, and provides for enhanced pollutant removal.	Erosion/ sedimentation Associated nutrients Hydrologic flow

Best management practice	Description	Impairment addressed
Floodplain restoration	Where the stream has been channelized, lower the stream banks to the bankfull level to allow overflow and redeposition of sediment in the adjacent floodplain. Ensure that bank vegetation is restored after any earthmoving activities.	Erosion/ sedimentation Associated nutrients Hydrologic Flow
Wetland restoration	A rehabilitation of a drained or degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to the natural conditions to the greatest extent possible.	Erosion/ sedimentation Associated nutrients Hydrologic Flow
Filter strip	A strip or area of vegetation established to remove sediment, organic matter, and other pollutants from runoff water and wastewater.	Erosion/ sedimentation Excess nutrients
Livestock exclusion (including rotational grazing & alternate water source)	Excluding all types of livestock from a particular area in order to reduce stream bank erosion, nutrient runoff, or wind-induced erosion due to overgrazing.	Erosion/ sedimentation Excess nutrients
Natural channel restoration	Creating a more natural meander in the river where it has been previously channelized	Erosion/sedimentation Hydrologic flow
Organic debris disposal	For the purposes of this BMP, organic debris includes grass, leaves, pruned branches, and any other vegetative material. This material should not be deposited in the river.	Excess nutrients
Proper Fertilizer Application	Managing the amount, form, placement, and timing of applications of plant nutrients.	Excess nutrients
Snags and drifts	Evaluation of snags, drifts, and other obstructions in a channel for removal or use in the stream for habitat or stabilization.	Erosion/ sedimentation Associated nutrients
Stabilized outlets for runoff at sidechannels	Outlets are areas that receive discharge water. Stabilized outlets reduce the velocity of discharge water to non-erosive velocities.	Erosion/ sedimentation Associated nutrients
Stream bank stabilization	Stabilizing and protecting banks of streams, lakes, estuaries, or excavated channels against erosion by vegetative plantings or structural means such as riprap.	Erosion/ sedimentation Associated nutrients
Waste management system	A planned system in which all necessary components are installed for managing animal liquid and solid waste, including runoff from concentrated waste areas.	Excess nutrients
Watercourse crossing repair or establishment	A practice that repairs, replaces, or constructs a crossing to limit the sediment discharge into a watercourse.	Erosion/ sedimentation/associated nutrients

SOURCE: Michigan Department of Environmental Quality.

Local Government and Planning

HOME RULE

The upper Looking Glass watershed spans 16 local governments across four counties. While there is a strong tradition in Michigan of autonomy in private property rights, zoning, land use planning, and other elements of local governance, there is a recognized need for local units of government to coordinate on issues that transcend their political boundaries. Watershed management is one such issue that requires cooperation in order to achieve a successful outcome throughout the watershed.

MULTIJURISDICTIONAL PLANNING IN THE WATERSHED

Multijurisdictional or regional planning is a form of intergovernmental cooperation. This type of cooperation is allowed, but not required, by a series of Michigan constitutional provisions and statutes (see Exhibit 37).

EXHIBIT 37

Michigan Laws Allowing Intergovernmental Cooperation

Legislation	Description
The Intergovernmental Contracts between Municipal Corporations Act (P.A. 35 of 1951)	Authorizes intergovernmental contracts between municipal corporations; authorizes any municipal corporation to contract with any person or any municipal corporation to furnish any lawful municipal service to property outside the corporate limits of the first municipal corporation for a consideration; prescribes certain penalties; authorizes contracts between municipal corporations and with certain nonprofit public transportation corporations to form group self-insurance pools; and prescribes conditions for the performance of those contracts.
The Urban Cooperation Act (P.A. 7 of 1967, ex. sess.)	Provides for interlocal public agency agreements; provides standards for those agreements and for the filing and status of those agreements; permits the allocation of certain taxes or money received from tax increment financing plans as revenues; permits tax sharing; provides for the imposition of certain surcharges; provides for additional approval for those agreements; and prescribes penalties and provide remedies.
Intergovernmental Transfers of Functions and Responsibilities Act (P.A. 8 of 1967, ex. sess.)	Provides for intergovernmental transfers of functions and responsibilities.
The Intergovernmental Transfer of Property by Contract Act (P.A. 425 of 1984)	Permits the conditional transfer of property by contract between certain local units of government; provides for permissive and mandatory provisions in the contract; provides for certain conditions upon termination, expiration, or nonrenewal of the contract; and prescribes penalties and provides remedies.

Legislation	Description
The Municipal Sewage Disposal, Water Supply, and Solid Waste Management Systems Act (P.A. 233 of 1955)	Provides for the incorporation of certain municipal authorities to acquire, own, extend, improve, and operate sewage disposal systems, water supply systems, and solid waste management systems; prescribes the rights, powers, and duties thereof; authorizes contracts between such authorities and public corporations; provides for the issuance of bonds to acquire, construct, extend, or improve the systems; and prescribes penalties and provides remedies.
Natural Resources and Environmental Protection Act (P.A. 451 of 1994, excerpt)	P.A. 517 of 2004 amended this law to allow two or more municipalities to establish a watershed alliance for the purpose of studying problems and planning and implementing activities designed to address surface water quality or water flow issues of mutual concern.
The Inter-County Committees Act (P.A. 217 of 1957) and the Inter-Municipality Committees Act (P.A. 200 of 1957)	Provides for the creation by two or more counties of an intercounty committee for the purpose of studying area problems; and provides authority for the committee to receive gifts and grants. Provides for the creation by two or more municipalities of an intermunicipality committee for the purpose of studying area problems; and provides authority for the committee to receive gifts and grants.
The Joint Planning Commission Act (P.A. 226 of 2003)	Provides for joint land use planning and the joint exercise of certain zoning powers and duties by local units of government; and provides for the establishment, powers, and duties of joint planning commissions. PA 405 of 2004—Adds a provision to joint municipal planning agreements that explicitly clarifies that participants are not required to provide for all land uses so long as the cooperative planning entity provides for all land uses. PA 115 of 2005—Allows jurisdictions with a joint planning agreement to operate with a single downtown development authority (DDA) where the jurisdictions share a boundary and at least one is eligible to establish a DDA.
The Regional Planning Commission Act (P.A. 281 of 1945)	Enables the creation of a regional planning commission. These entities may be created by resolution of two or more legislative bodies of "any local governmental units desiring to create a regional planning commission."

SOURCE: Public Sector Consultants Inc., 2007.

Some of the communities in the watershed already participate in some form of intergovernmental cooperation for planning across boundaries. These organizations represent examples of successful coordination across municipal boundaries for the benefit of member communities.

- **Genesee-Lapeer-Shiawassee Planning and Development Commission.** Shiawassee County participates in the Genesee-Lapeer-Shiawassee Planning and Development Commission, also referred to as the GLS PDD, Region V. This regional planning commission was established in the 1970s as a state planning and development district (SPDD) to facilitate regional coordination of planning and programming undertaken by local governments.

- **Southeast Michigan Council of Governments (SEMCOG).** Livingston County participates in this organization, which provides support for local units of government and creates a forum for intergovernmental cooperation.
- **Tri-County Regional Planning Commission.** Clinton and Ingham Counties participate with Eaton County in this intergovernmental body, which seeks to coordinate growth and related public service expansion.

LOCAL LAND USE AND BUILD-OUT ANALYSIS

Township and County Land Use Plans

Because of the tradition of local control over local land use issues, there is no state mandate directing municipalities' management of their natural resources in the planning process or zoning. This leads to a variety of approaches to future development within the watershed.

An analysis of the municipalities in the watershed shows that seven of the municipalities had Farmland Preservation land use designations, but only two of them had land currently zoned to an equivalent density (one unit per 40 acres). Several communities also had land use designations that promoted open space development, but again, two had not zoned any land in conformance with that classification. The most common density in the watershed is one unit per acre, with one unit per two acres covering most of the remaining area. There is land designated outside the two cities and village for low-density, single-family residential usage, but the potential development in these areas will be constrained by the lack of municipal sewer service. There are three mobile home developments in the watershed, two of which have room for additional development.

An assessment of the land use plans in the watershed reveals some efforts to develop protection for the water resources in the watershed:

- A general goal of protecting natural resources, including surface and groundwater, was included in the great majority of land use plans.
- Explicit recognition of wetlands as a sensitive environmental feature to be considered when making development decisions was included in only five plans.
- A demonstrated understanding that development should not occur in the floodplain was shown in only four plans.
- Storm water drainage was listed in a minority of plans (four) as a direct contributor to surface water quality in the watershed that should be addressed through future planning.
- A few plans (three) recognized the environmental risk posed by septic systems and the need for sound septic management and/or public sewer services.

Elements of land use plans in the watershed that relate to wetland, floodplain, or river protection are outlined in Exhibit 38.

EXHIBIT 38

Existing Local Planning Provisions Related to Watershed Management

Government body	Plan preparers and date	Zoning authority	Planning provisions that relate to the watershed
Antrim Township	Antrim Township Planning Commission, Township Board and Rowe Engineering Inc. 2000	Shiawassee County	• Plan recognizes that much of the township is, and will, remain agricultural. • Wetlands cover the second largest area of land (after agriculture) in the township (p. 16); much of the wetlands in the township are wooded. These areas are designated for only limited development. • The Looking Glass and its associated wetlands are mentioned in the plan (p. 28). • Development is directed away from wetlands (p. 29).
Bath Township	Bath Township Planning Committee 1996	Clinton County	• The plan recognizes that much of the north quarter of the township is part of the Looking Glass floodplain (p. 18). • Part of the mission statement is to create environmentally responsible pattern of low-density residential land use (p. 27). • The policy on growth stated in the plan is to recognize, through policy and regulation, the environmental limitations to development (p. 29). • The stated goal in the plan is to strive to preserve and enhance environmentally sensitive natural resources from the impacts of development (p.33). • The township planning commission is currently in process of updating this plan.
Bennington Township	Rowe Engineering Inc. 2000	Shiawassee County	• Sensitive Lands and Natural Resource Policies: provide regional coordination to protect valuable & irreplaceable natural resources in the township including rivers, wooded land, and lakes (p.77). • Land Use Area Needs: Wetlands are valuable as their own highest and best use (p.82). • Wetland Conservation: classification of land as “conservation/floodplain/ wetland” in order to identify sensitive environmental features. Such areas should not be used for high-intensity uses. Significant area along Looking Glass with this designation (p. 85).

Government body	Plan preparers and date	Zoning authority	Planning provisions that relate to the watershed
Conway Township	Livingston County Planning Department 2002	Conway Township	• Wetlands have been mapped (p.11). • A substantial portion of township is wetland: 14.4 % of township's land is wetlands and waterways, most are in large contiguous areas (p. 15). • Natural Resource Goals (p. 21): Preserve natural resources of the township and prevent environmental damage or harm to these resources.
Dewitt, City of	Associated Government Services Inc. 1994, revised 1996 and 2002	Clinton County and City	• Located along the Looking Glass; there is sparse development in the floodplain; further floodplain development is curbed by subdivision controls (p. 25). • The mission statement includes reference to growth within environmentally responsible land use patterns (p. 4). • Portions of the downtown area are still served by combined sewer; heavy rains flush the sewer directly into the Looking Glass (p.21). • Only 50% of the city has storm drainage; open ditches and natural flow patterns are used in the remainder (p. 21). • Water resource profile: Looking Glass and its tributaries are listed as surface water resources; storm water runoff flows directly into the river (p. 25). • Goal: Intergovernmental coordination to address related land use planning issues (p. 39). • Objective: encourage the development of access points to the Looking Glass (p.39). • Future land use planning guiding principle: #3 of 4—preserve and enhance natural features (p. 42). • Future Land Use strategy: require responsible storm water management practices to minimize development impacts in the watershed; use of buffer strips, native plant materials, regulating water temperature, and other similar techniques.

Government body	Plan preparers and date	Zoning authority	Planning provisions that relate to the watershed
Dewitt Township	Planning & Zoning Center Inc., 2005	Clinton County	• Most of the township is within the Looking Glass watershed (sec.2-11). • Wastewater Treatment (sec.2-37): Southern Clinton County Municipal Utilities Authority, processes 1 million gallons per day and discharges under current NPDES permit directly into the Looking Glass. • The township maintains 5.2 acre Looking Glass Riverfront Park. • Environmental Protection and Conservation (sec.4-3): the Future Land Use Map includes a conservancy for lands that are environmentally sensitive, i.e., wetlands, floodplains. This is an "overlay" designation, and serves to focus priority for future public acquisitions for parks and preserves. • Greenways (sec.4-24): the plan includes a policy to develop network of natural open space for wildlife and environmental protection. • Dewitt Township is one of the most rapidly growing communities in mid-Michigan; the goal of the plan is to retain the rural character of the township while allowing for residential and commercial growth.
Locke Township	Landplan Inc. Mark Eidelson, AICP 2004	Locke Township	• Conservation of Natural Resources: where a parcel is characterized by environmentally sensitive areas, development should be directed elsewhere (sec.3-5). • Lack of public sewer poses threat to water sources (sec.4-1). • Storm water management to ensure discharge does not undermine environmental integrity of water resources (sec.4-2).
Laingsburg, City of	Capital Consultants 1997	Shiawassee County	• The Looking Glass River flows through the SW area of the city (sec.3-4). • Significant undevelopable wetland and floodplain areas exist along the river (sec.4-2). • City streets are paved but not curbed; drainage is adequate in most areas, drainage through settling ponds, into Laingsburg Drain, into Looking Glass (sec.7-8). • In 1995, residents did not consider storm drainage a concern (sec.9-1). • Under 1994 Parks and Recreation Plan (p. 51), natural resource areas are to be protected and developed. The plan includes a recommendation that the lowland south of the sewage lagoons be designated a natural area and developed as an interpretive trail.

Government body	Plan preparers and date	Zoning authority	Planning provisions that relate to the watershed
Olive Township	None	Clinton County	• Planning done by Clinton County, no local master plan available. County plan currently under revision, old Clinton county CDP is available online.
Perry, City of	None	City of Perry and Shiawassee County	• The city of Perry provided its zoning maps instead of a plan. • The zoning maps show traditional growth patterns are expected in Perry.
Perry Township	Rowe, Inc. 1998, revised 2006	Shiawassee County	• Environment Goals and Policies: the environment should be protected through development patter which respects natural features such as floodplains and soil characteristics (p.12). • Sensitive Lands and Natural Resource Policies: Floodplains & Lakes and Streams among other categories to be protected (p. 18). • Sanitary Sewer currently available in some parts of the township as extension from village of Morrice (p. 52).
Sciota Township	Brenda Moore AICP, PCP 2001	Shiawassee County	• Objective of plan is to protect and preserve natural resources, unique character, and environmental quality of the area (p.3). • Segment of Looking Glass River runs through the southern portion of the township (Fig. 4-1). • Portion of township suffers water erosion resulting in sediment pollution of surface water resources (Fig. 4-2). • (p.30) Surface water quality in the township is negatively impacted by high fecal coliform counts, nonpoint nutrient loading, sedimentation. • Plan includes 10 environmental strategies (pp. 61–62); emphasis on septic system management.
Shiawassee Township	None	Shiawassee County	• Planning done by Shiawassee County, no local master plan available
Victor Township	None	Clinton County	• Planning done by Clinton County, no local master plan available. County plan currently under revision, old Clinton county CDP is available online.

Government body	Plan preparers and date	Zoning authority	Planning provisions that relate to the watershed
Woodhull Township	Rowe Engineering Inc. 1998, revised 2004	Shiawassee County	• Plan contains Sensitive Lands and Natural Resource Policies (p. 42), includes floodplain areas, lakes, and streams. • Township Goal (p.38): pursue working relationship with surrounding communities. • Township Goal (p. 38): recognize relationship between environmental factors and planning activities. • Township Goal (p. 39): Planning Commission to promote development pattern with respect to natural features such as the Looking Glass, wetlands & floodplains. • Significant areas along Looking Glass are designated "Conservation/Floodplain/Wetland" in the Future Land Use Map (map 6).

SOURCE: Public Sector Consultants Inc., 2007.

Build-out Analysis

A build-out analysis utilizing current, 10-year, and 20-year land use projections was conducted to determine the near-term and long-term potential impacts in the upper watershed based on designated land uses.

Land use classifications from each planning jurisdiction were compared with current zoning classifications in that community. Where a future land use classification was proposed but no equivalent zoning district had been adopted, the existing zoning classification for that area was used. A few municipalities had a future land use classification identifying environmentally sensitive lands, but since there was no zoning classification for this designation these areas were designated based on the adjacent area's future land use designation.

A summary of the future land use designations for the build-out analysis is provided in Exhibit 39.

EXHIBIT 39
Land Use Designation Summary

Land use designation	Definition
Agricultural preservation	Agriculture is primary use; single-family homes allowed at a density of one unit per 40 acres
Agriculture	Agriculture is primary use; single-family homes allowed at a density of not less than one unit per two acres. Includes open space land use classifications
Agricultural/rural residential	Agriculture is permitted, as are single-family residences at a density of one unit per acre
Low-density residential	Single-family residences are primary use with densities of not more than 2.5 units per acre
Medium-density residential	Single-family residences are primary use with densities of greater than 2.5 units per acre
High-density residential	Multi-family uses
Mobile home	Mobile home parks
Commercial	Uses include commercial, office, and institutional uses
Industrial	Primarily light industrial uses
Public/institutional/other	Public and institutional uses that are expected to be more or less permanent and land is not available for development
Permanent open space	State land, sewage lagoons, land with conservation easements
Mixed use	A Clinton County classification that allows a mix of uses, which was calculated assuming the principal use will be low-density residential

SOURCE: Rowe Engineering Inc. 2007.

The total potential build-out in 2030 for the upper watershed will include 4,826 new dwelling units based on current future land use plans. This includes development on currently undeveloped land and existing units and new increases in density of dwellings in those areas. Build-out (a hypothetical condition used by planning and zoning officials) is derived from the legally allowed density of people per acre per zone and the total number of acres found in the township. The standardized land use classifications listed in Exhibit 38 could be used in future multijurisdictional planning activities along with the development of consistent and complementary local ordinances. Since the bulk of the watershed lies in Clinton and Shiawassee Counties, cooperative effort should first be focused there.

Protective Zoning Ordinances

County Ordinances

Shiawassee County has floodplain regulations for all districts (Section 5.7 Zoning Ordinance of Shiawassee County, February 23, 2003), which provides a good example of a protective zoning ordinance that would positively impact the health of the watershed if adopted by the rest of the local governments and followed closely by decision makers. Key attributes of the ordinance are as follows:

- Permitted principal uses are specified (and are required for any district within the floodplain): open space, off-street parking, public utility facilities, yard, and setback areas.
- Building is allowed in the floodplain only subsequent to obtaining permits under Part 31 and Part 91 of Public Act 451 of 1994.
- The stated intent of the ordinance is to permit existing uses to continue in the floodplain until they are removed, but not to encourage their survival.

Ingham County also has a local wetlands ordinance that covers floodplains and wetlands.

Wetland Regulation

As described above, the upper Looking Glass watershed has already lost a great deal of its original wetland coverage. Protection of the remaining wetlands is important for the health of the ecosystem; it will also prevent flooding, allow groundwater recharge, and maintain valuable wildlife habitat. In recognition of the valuable roles fulfilled by wetlands, state, federal, and local regulations have been developed to ensure their protection.

Michigan's wetland statute, Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, defines a wetland as "land characterized by the presence of water at a frequency and duration sufficient to support, and that under normal circumstances does support, wetland vegetation or aquatic life, and is commonly referred to as a bog, swamp, or marsh." The definition applies to public and private lands regardless of zoning or ownership.

Wetlands in Michigan are regulated at varying levels depending on their location, size, and relative importance to protection of natural resources.

Federal Wetland Regulation

In 1984, Michigan received authorization from the federal government to administer Section 404 of the federal Clean Water Act in most areas of the state. The state-administered 404 program must be consistent with the requirements of the federal Clean Water Act and associated regulations set forth in the Section 404(b)(1) guidelines. While an applicant for a wetland permit in other states must apply to the U.S. Army Corps of Engineers (USACE) and a state agency, applicants in Michigan generally submit only one wetland permit application to the MDEQ.

In accordance with the Clean Water Act, Section 404(g), the USACE retains federal jurisdiction over traditionally navigable waters including the Great Lakes, connecting channels, other waters connected to the Great Lakes where navigational conditions are maintained, and wetlands directly adjacent to these waters.

Federal oversight of state-administered 404 programs is primarily the responsibility of the USEPA. Federal review of the vast majority of permit applications in areas under Michigan's 404 jurisdiction is waived. However, federal agencies must review projects that impact critical environmental areas, or that involve large quantities of fill. At the present time, the USEPA reviews about 1 percent of all Michigan applications received.

If the MDEQ determines that an application under Michigan's 404 program is subject to federal review, federal agencies are notified. The USEPA is responsible for compiling all federal comments, and submitting comments on the federal position to the MDEQ.

The MDEQ may not issue a permit that carries Section 404 authority if the USEPA objects to the project. This is true even if the applicant successfully appeals the state's denial of a permit at the administrative level or through a state court. Section 404 provides for a reversion to USACE processing if a state and the USEPA reach an impasse on a project (that is, if the state is prepared to issue a permit, but the USEPA continues to object).

State Wetland Regulation

In 1979, the Michigan legislature passed the Geomare-Anderson Wetlands Protection Act, 1979 PA 203, which is now Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. In accordance with Part 303, wetlands are regulated if they are any of the following:

- Connected to one of the Great Lakes or Lake St. Clair
- Located within 1,000 feet of one of the Great Lakes or Lake St. Clair
- Connected to an inland lake, pond, river, or stream
- Located within 500 feet of an inland lake, pond, river or stream
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, river, or stream, but are more than five acres in size
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, river, or stream, and less than five acres in size, but the MDEQ has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner

The law requires that persons planning to conduct certain activities in regulated wetlands apply for and receive a permit from the state before beginning the activity. A permit is required from the state to

- deposit or permit the placing of fill material in a wetland;
- dredge, remove, or permit the removal of soil or minerals from a wetland;
- construct, operate, or maintain any use or development in a wetland; or
- drain surface water from a wetland.

Before a permit can be issued, the MDEQ must determine that all of the following conditions are met:

- The permit would be in the public interest.
- The permit would be otherwise lawful.
- The permit is necessary to realize the benefits from the activity.
- No unacceptable disruption to aquatic resources would occur.
- The proposed activity is wetland dependent **or** no feasible and prudent alternatives exist.

(For more information on permit application review and the criteria for determining public interest, please refer to Section 30311 of Part 303.)

Local Wetland Regulation

In accordance with Part 303, a local unit of government can regulate wetlands by ordinance, in addition to state regulation, if the following criteria are met:

- A wetland ordinance cannot require a permit for activities exempted from regulation under Part 303.
- A wetland ordinance must use the same wetland definition as in Part 303.
- Local units of government must publish a wetland inventory before adopting a wetland ordinance.
- Local units of government that adopt wetland ordinances must notify the MDEQ.

Wetlands less than five acres in area can be regulated by local governments. If a local government wishes to regulate a wetland less than two acres in size, the local government must grant a permit to the applicant unless it is determined that the wetland is essential to the preservation of the community's natural resources. In areas where a local wetland permit is required, a permit must also be received from the State of Michigan before beginning an activity.

Local Wetland Ordinances

Currently, Williamstown Township in Ingham County is the only community in the watershed to locally regulate wetlands under these provisions. Williamstown Township is the only municipality in the upper Looking Glass watershed that has a wetland ordinance on file with the MDEQ. The Township adopted the ordinance in March 2002. The wetlands ordinance can be viewed at *http://www.williamstowntownship.com/ ordinances.html* (accessed September 6, 2007).

Wetland Protection Tools

The MDEQ website (*http://www.michigan.gov/deq/0,1607,7-135-3313_3687-10801--,00.html*, accessed July 18, 2007) has the following tools available for local governments:

- Preserving Michigan's Wetlands: Options for Local Governments
- Filling the Gaps: Environmental Protections Options for Local Governments

The Tip of the Mitt Watershed Council produced a guide designed to assist local governments with wetlands management, *Protecting Michigan's Wetlands: A Guide for Local Governments.* This guide is available on the Watershed Council's website (*http://www.watershedcouncil.org/pub.html*, accessed September 6, 2007).

Use of Conservation Easements

Williamstown Township was identified by Rowe Engineering Inc. as a municipality that has land zoned "undevelopable" due to a conservation easement in place on the property. A conservation easement is another tool local governments can use to ensure that riparian land is protected from future development pressure and that the natural resource value of the land is maintained. Creating a conservation easement involves adding a restriction to the property deed that effectively severs the development rights of the property.

Michigan's Wetlands Reserve Program

The voluntary Wetlands Reserve Program (WRP) offers landowners the opportunity to protect, restore, and enhance wetlands on their property through fixed-term or perpetual conservation easements,[14] in return for a payment. The U. S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program.

The spirit and focus of WRP in Michigan is to provide a wide diversity of high-quality wetland and associated upland as habitat for migratory birds and other wildlife. A diversity of wetland types such as emergent marshes, shrub-scrub, and wet prairies, to name a few, is the key to the WRP success in Michigan. The importance of the need for high-quality, diverse wetland habitat is substantiated by the fact that fully 50 percent of Michigan's threatened or endangered species require healthy, fully functional wetlands to complete their life cycle.

Currently, Michigan has over 125 easements and more than 16,000 acres enrolled in the WRP. Two parcels within the upper Looking Glass watershed are enrolled in the program: a 120-acre easement in Clinton County and a 99-acre easement in Shiawassee County.

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[14] U. S. Department of Agriculture, Natural Resource Conservation Service, 2007. [Online, accessed 10/17/07.] Available: *http://www.nrcs.usda.gov/programs/wrp/states/mi.html*.

Due to the high proportion of agricultural land in the watershed there may be more opportunities to use the WRP to accomplish this plan's goals of wetland protection and restoration. It is important, however, to note that Michigan currently has a backlog of unfunded offers and many more applications are submitted each month.

The Mid-Michigan Land Conservancy

The Mid-Michigan Land Conservancy (MMLC) operates in seven counties including Ingham, Clinton, and Shiawassee Counties in the upper Looking Glass watershed area.

The MMLC was formed in 2002 as an expansion of the Natural Areas Association, which was founded in 1976 to support conservation of natural heritage in the greater Lansing area by protecting open space and increasing public awareness of the economic, social, and environmental impact of urban sprawl. The MMLC accepts conservation easements on farmland as well as natural open space lands in order to protect forestland, wetlands, riparian areas, and open space.

The MMLC currently holds three conservation easements in the upper Looking Glass watershed, covering 466 acres. One of the properties includes considerable frontage on the Looking Glass River. One of the MMLC's goals is to protect all of the riparian area of the river.

Survey of Residents

INTRODUCTION

Development of a watershed management plan for the upper Looking Glass River watershed included a survey of watershed residents to assess their knowledge and attitudes related to the protection and use of the Looking Glass River and its surrounding natural resources. The survey sought to help determine what residents believe to be the most urgent priorities and to establish a baseline of information that can be used to evaluate the success of future watershed management activities and target outreach and education efforts. This survey will also help local governments, concerned citizens, and other interested parties learn about the kinds of problems and activities that may be affecting the river, as well as inform decisions about what to do to protect or improve water quality.

METHODOLOGY

The survey instrument was developed collaboratively between PSC and representatives from the MDEQ (see Appendix D). A random sample of adult residents of the upper Looking Glass watershed were interviewed between May 5 and May 14, 2007. The sampling frame was developed by identifying Census tracts that are contained within the boundaries of the upper Looking Glass watershed and matching these to telephone records. The resulting list was cleaned for business numbers and non-working numbers. The final sample comprised 365 completed interviews with residents of the upper Looking Glass watershed. The margin of error for this survey is ±-5.1 percent within a 95 percent confidence interval.

MAJOR FINDINGS

Perception of Water Quality and Levels

A plurality of residents of the upper Looking Glass watershed (42 percent) think that the water quality has remained “about the same” in the time that they have lived there, and another 36 percent say that they “don’t know” about the water quality of the upper Looking Glass watershed. Equal proportions (approximately 12 percent each) think that water quality has gotten better or worse in the time that they have lived in their current location.

When asked about water levels of the Looking Glass River, 38 percent of residents say that the waters levels have stayed about the same; 28 percent say that, except after storms, the water levels are lower than they used to be; 22 percent say they “don’t know enough” to assess the changes in water levels; and 13 percent say that the water levels are higher than they used to be and flooding seems to be a more frequent occurrence.

Watershed Priorities of the Public

Respondents were next asked to rate the importance of problems facing the upper Looking Glass watershed. Items were grouped into a series of potential problems or threats to the water quality of the watershed related to four categories of concern: water quality criteria, physical structure of the watershed, regulated activities, and consequences of land use and residential development. For each group, respondents were asked to pick the most important problem facing the watershed. The most frequent responses are summarized in Exhibits 40–43.

EXHIBIT 40
Most Important Problem for Water Quality Criteria

Bacteria, such as *E. coli*	35%
Soil loss/sediment runoff into the Looking Glass River	23
Excess of nutrients in the water, which causes algae blooms	20
Bank erosion of Looking Glass River	13

SOURCE: Public Sector Consultants, 2007 Survey of Residents of the Upper Looking Glass Watershed.

EXHIBIT 41
Most Important Problem for the Physical Structure of the Watershed

Herbicides/pesticides	55%
Wildlife habitat loss	26
Logjams	12
Dams	3

SOURCE: Public Sector Consultants, 2007 Survey of Residents of the Upper Looking Glass Watershed.

EXHIBIT 42
Most Important Problem for Regulated Activities

Pollution discharges and spills (industry, farms, etc.)	51%
Storm water runoff from cities and villages	23
Debris and other litter	20

SOURCE: Public Sector Consultants, 2007 Survey of Residents of the Upper Looking Glass Watershed.

EXHIBIT 43
Most Important Problem for Land Use and Residential Development

Rapid housing development	31%
Loss of wetlands	26
Sediment building up in ditches and streams	19
Failing septic systems	17

SOURCE: Public Sector Consultants, 2007 Survey of Residents of the Upper Looking Glass Watershed.

Additional Priorities

In addition to the sets of priorities that respondents were asked to rate, respondents were asked to name any other priorities that had not been listed. While most respondents could not name an additional priority, many who did simply emphasized some of the items that had been previously mentioned. For example, many reiterated that they felt that litter, debris, logjams/damming, and rapid development are potential threats to the quality of the watershed. A few respondents specifically mentioned gravel pits as a negative impact on water levels in the area.

Priorities for Action

Respondents were next asked to rate how much of a priority various watershed management activities should be given using a scale of 1 to 5, where 1 means that something is not a priority and 5 means that it is a high priority. The activities were grouped into three categories—surface water and groundwater, wetlands, and land use management. Of all priorities, the most highly rated items (those that were rated between 4 and 5 points on the rating scale) are as follows:

- Education for county/township/village planning officials or commissioners (4.26)
- Protection of existing wetlands (4.25)
- Groundwater monitoring for pollution (4.10)
- Public education/outreach regarding the potential impacts of housing development (4.04)
- Surface water monitoring for pollution (4.03)

Ground and Surface Waters

Respondents were asked to prioritize possible actions—increased education about the effect of human activities on ground and surface waters and increased groundwater and surface water monitoring for pollution. Although all activities were rated as relatively high priorities (no item averaged less than 3.8 on a 5-point scale), clearly monitoring for pollution was viewed as a higher priority for surface water and groundwater than was education (see Exhibit 44).

EXHIBIT 44

Priority Activities for Surface Water and Groundwater Management

	Average rating
Groundwater monitoring for pollution	4.10
Surface water monitoring for pollution	4.03
Increasing knowledge about types of human activities on the land that affect groundwater	3.89
Increasing knowledge about types of human activities on the land that affect surface waters	3.83

SOURCE: Public Sector Consultants, 2007 Survey of Residents of the Upper Looking Glass Watershed.

Wetlands

Respondents prioritized four activities aimed at wetlands protection and management. Of the four items, the one rated most highly by residents of the watershed is protection of existing wetlands (see Exhibit 45).

EXHIBIT 45
Priority Activities for Wetlands Management

	Average rating
Protection of existing wetlands	4.25
Education/outreach regarding the role of wetlands and their function	3.99
Setting wetland restoration objectives	3.68
Wetland inventories including drained wetlands	3.62

SOURCE: Public Sector Consultants, 2007 Survey of Residents of the Upper Looking Glass Watershed.

Land Use Management

For land use management activities, respondents rated the education of planning officials or commissioners and public education more highly than policy change as a means to improve land use management in the watershed (see Exhibit 46).

EXHIBIT 46
Priority Activities for Land Use Management

	Average rating
Education for county/township/village planning officials or commissioners	4.26
Public education/outreach regarding the potential impacts of housing development	4.04
Public education about the role of buffer and filter strips, building setbacks, native grass plantings, and woodlot development	3.94
Development of consistent land use ordinances across townships	3.84
State land use policies	3.79

SOURCE: Public Sector Consultants, 2007 Survey of Residents of the Upper Looking Glass Watershed.

When asked if they felt there are additional actions that should be viewed as a priority, respondents mostly reiterated actions that had been previously mentioned. In their comments, respondents did tend to underscore the fact that improved enforcement of existing regulations and education about the regulations would be the most useful actions. Respondents also emphasized continued and regular monitoring of the water (both surface and ground).

Land Use

Finally, respondents were asked a series of questions about how they use the land in the upper Looking Glass watershed:

- Almost two-thirds of respondents use the local lakes and streams. The most common outdoor activities include fishing (37 percent), boating/canoeing (18 percent), hunting (14 percent), gardening and landscaping (14 percent), and hiking (12 percent). Just 3 percent of residents engage in bird watching. Other uses including painting, collecting aquatic insects, and "off-roading."
- Twelve percent of respondents receive all or part of their income from farming, and of those, 7 percent use water from local lakes and streams for irrigation.
- Respondents are evenly split in terms of residence—nearly half (49 percent) describe where they live as "rural" and another 49 percent say they live in a city, township, or village.
- Seventeen percent of respondents live on property that adjoins a lake, stream, or some other body of water. These include the Looking Glass River (4.4 percent of respondents), Vermillon Creek (3 percent), and Scenic Lake (3.8 percent). Respondents mentioned a variety of other bodies of water including county drains (2 percent), Mudd Creek (1 percent), and miscellaneous wetlands and waterbodies (3 percent).

Description of the Sample

- A plurality of respondents (42 percent) has lived in the watershed for 20 years or more.
- One in four (25 percent) live on parcels or lots that are less than one acre in size and 37 percent live on parcels that are between one and five acres in size. Another 25 percent live on parcels that are 11 acres or larger.
- Fifty-one percent of respondents are male and 49 percent are female.
- The sample is well-educated—46 percent of respondents have a college degree or advanced degree.
- The average age of respondents is 53 years.

SURVEY CONCLUSIONS AND RECOMMENDATIONS

The survey reveals that while a plurality of residents (42 percent) believe that water quality has remained "about the same," more than one in three persons (36 percent) don't know about the water quality status of the upper Looking Glass River.

Regarding what residents believe to be the most important problems from a set of four impairments (bacteria, soil loss, excess nutrients, bank erosion) related to water quality, nearly 35 percent indicated that bacteria such as *E. coli* are of most concern, with bank erosion ranking lowest. Interestingly, data collection efforts as part of the watershed planning process indicate that bank erosion is a considerably more important problem than is reflected in the 13 percent of respondents who ranked it as such.

When it comes to problems related to the physical structure of the watershed, nearly 55 percent believe that herbicides and pesticides are the most important threat, compared to 25.8 percent for the loss of wildlife habitat. When asked to select the most important problem related to regulated activities (i.e., pollution discharges and spills, storm water runoff from cities and villages, and debris and other litter), 51 percent of the respondents identified pollution discharges and spills as the most important problem. Storm water runoff was cited by only 22.5 percent of the respondents as the most important problem. Based on historical monitoring data available for the Looking Glass River, storm water runoff and the sediment carried into the river are a much more severe problem than the survey results indicate.

When asked about the most important problem related to land use and residential development, nearly 31 percent of respondents believe that rapid housing development is the most important problem, followed by the loss of wetlands, which was selected as most important in 26 percent of responses. In addition, when asked to rank four actions related to wetland management (protection of existing wetlands, education/outreach, setting restoration objectives, and developing wetland inventories) on a scale from 1 to 5, respondents considered protection of existing wetlands the most important action (4.25). The other three actions were also considered fairly high priorities (ranked between 3.62 and 3.99) and collectively, all three actions would likely lead to the protection of existing wetlands.

When asked to prioritize future actions to help protect the watershed, respondents far and away selected education for county/township/village planning officials or commissioners.

The survey results reveal the need for an education and outreach program targeted at residents to help develop a greater awareness about the river and the problems that currently impair water quality. In addition, there is a need to target education efforts related to residential housing, wetland protection, and cooperation at local township officials and county officials across township boundaries.

Information and Education

PUBLIC PARTICIPATION

Plan Development

Letters were sent to every township in the upper Looking Glass watershed inviting participation in the planning process. Township representatives participated in meetings of the steering and technical committees.

A survey of residents in the watershed was conducted to solicit input about areas of concern or information gaps. Results of the survey identified issues that residents perceived to be problems in the watershed. The results of the survey also established a baseline of knowledge about water-related issues in the watershed that will be useful in future evaluation and monitoring efforts.

Public Comment

A public meeting was held on September 18, 2007, to build awareness of the plan's development and solicit public comment on the content of the plan. Comments were welcomed at the meeting, and in writing for 30 days after the meeting.

POTENTIAL PARTNERS FOR THE COMMUNITY OUTREACH AND EDUCATIONAL PLAN

Continued community involvement is essential to the successful implementation of this plan. The Clinton County Conservation District, Natural Resource Conservation Service, Friends of the Looking Glass, and state and local agencies, among others, will be valuable contributors to the continued efforts.

Letters of support (see Appendix E) for the plan were received from each local government unit in the watershed. That support will be important to continued education and information efforts as well.

The following partners participated in the development of the plan:

- Clinton County Conservation District
- Clinton County Drain Commissioner
- The Friends of the Looking Glass River
- The Greater Lansing Regional Committee for Stormwater Management
- Michigan Department of Environmental Quality
- City of Perry via the Perry City Council
- Public Sector Consultants Inc.
- Shiawassee County Conservation District
- Shiawassee County Drain Commissioner
- Timberland Resource Conservation & Development
- Township supervisors
- Wetland and Coastal Resources Inc.

The involvement of the following organizations, in addition to those listed above, will be critical to the successful implementation of the plan:

- Local health departments
- Looking Glass Rod and Gun Club
- Michigan State University Extension
- Shiawassee Master Gardeners Club
- Shiawassee Pheasants Forever
- Tri-County Groundwater Management Board

EXISTING WATERSHED EDUCATION EFFORTS

Any information and education outreach should build on the efforts already under way by the following organizations:

- Clinton County Conservation District and other conservation districts
- Friends of the Looking Glass River
- Tri-County Regional Planning Commission—Greater Lansing Phase II Group

INFORMATION AND EDUCATION PLAN

The information/education goals, objectives, and actions necessary to implement the watershed management plan are summarized in Exhibit 47.

EXHIBIT 47
Information/Education Plan

Education goal	Critical area	Pollutant	Source	Cause	Target audience	Message	Methods
Educate local officials about this watershed plan	Watershed-wide	Sediment, nutrients, hydrology, bacteria	All land use in the watershed	Human activity	Local officials, general public	Awareness of watershed planning efforts and goals at the local decision making level	Present the watershed plan to local government meetings
Encourage local officials to enroll in MSU Extension's watershed management short course	Watershed-wide	Sediment, nutrients, hydrology, bacteria	All land use in the watershed	Changes in land use	Local officials	Availability of education opportunity to learn how to make smart watershed management choices	Send a letter to all local units of government with information on the course
Foster responsible, river-sensitive land use planning at the local level.	Watershed-wide	Sediment, nutrients, hydrology, bacteria	All land use in the watershed	Changes in land use	Local officials, general public	Local land use decisions are critical to maintaining the quality of the watershed.	Hold a workshop for local government officials and decision-makers on how to use the L-THIA model when considering land use decisions
Continue efforts on the Michigan Heritage water trail	Watershed-wide	Sediment, nutrients, hydrology, bacteria	All land use in the watershed	Changes in land use	General public, paddlers and other recreational users, watershed residents, riparian landowners	Water trail signs tell the history of the river and educate target audiences about changes to the watershed due to human activity	Signs posted throughout the watershed, printed water trail guide
Educate watershed residential landowners about their impacts on the watershed	Watershed-wide	Sediment, nutrients, hydrology	Residential land use	Residential fertilizer use	Residential landowners	Excessive fertilizer use negatively impacts the watershed	Flyers, information packets, door-to-door campaign
				Lack of riparian buffer strips	Residential landowners	Buffer strips prevent runoff from entering the river at a higher rate and carrying more sediment and nutrients	Flyers, information packets, door-to-door campaign
				Increased impervious surfaces	Residential landowners	Redirecting runoff away from storm sewers and onto natural areas for infiltration protects the watershed	Flyers, information packets, door-to-door campaign
		Bacteria	failing septic systems	Improper design and maintenance of septic system	Residential landowners	Proper design and maintenance of septic systems protects the watershed	Flyers, information packets, door-to-door campaign
Educate agricultural operators in watershed about their impacts.	Watershed-wide	Sediments, nutrients, hydrology, bacteria	Agricultural land use	Excessive fertilizer use, unimpeded livestock access to stream, unbuffered surface runoff from pastures and confined animal shelters	Agricultural landowners	Changes to farm operation can positively impact and protect the health of the watershed	Provide Farm*A*Syst, Home*A*Syst, or Crop*A*Syst counseling to agricultural operations in the watershed
Create a website that demonstrates monitoring activity and provides more information about how residents impact the health of the watershed.	Watershed-wide	Sediments, nutrients, hydrology, bacteria	All land uses in the watershed	Changes in land use and implementation of this plan's goals.	General public, regulatory agencies, local government officials, landowners, recreational river users	Promote understanding of current monitoring efforts and provide additional information about how residents' actions impact the numbers.	Develop and publicize a page on the FLG website and the CCCD website. Keep it updated with the latest monitoring information in the watershed.

Education goal	Partner	Timeline[15]	Milestones	Costs	Evaluation criteria	Follow-up
Educate local officials about this watershed plan	CCCD, FLG	Within 6 months	Plan presented to all 16 local units of government (LUGs)	$480 (16 one-hour presentations at $30/hour)	Number of local governments receiving presentation	Note local official feedback at presentations
Encourage local officials to enroll in MSU Extension's watershed management short course	FLG	Within 6 months	Letter sent to all LUGs	$50 (mailing expenses plus one person's time to prepare and mail the notice)	Number of local officials that completed the course	Within one year, repeat the mailing to ensure that any new local officials receive the information
Foster responsible, river-sensitive land use planning at the local level.	CCCD, FLG, Local governments	Within 6 months	Workshop held	$2,800 (4-hour workshop plus 10 hours of consulting staff preparation at $100/hour)	Number of local decision makers that attend the workshop.	Provide a feedback questionnaire at the end of the workshop. Follow up with attendees one year later to determine usefulness
Continue efforts on the Michigan Heritage water trail	FLG	Within 1 year	Signs posted in the watershed and trail guides printed and distributed.	$4,000 for sign and brochure design, printing, and hanging and/or distribution and FLG staff time to manage.	Water trail signs completely posted on trail. Number of trail guides distributed	Include e-mail address in trail guide where users can send their feedback
Educate watershed residential landowners about their impacts on the watershed	CCCD, FLG	Within 1 year	Majority of residential landowners in the watershed contacted by at least one form of communication	$1,000 (printing cost and 40 hours at $15/hour for distribution)	Number of residential landowners contacted, number of residential landowners requesting more information, number of residential landowners changing fertilizer habits	Include contact information so recipients can request more information and provide feedback
	CCCD, FLG	Within 1 year	Majority of residential landowners in the watershed contacted by at least one form of communication	$1,000 (printing cost and 40 hours at $15/hour for distribution)	Number of residential landowners contacted, number of residential landowners requesting more information, number of new buffer strips observed on the river	Include contact information so recipients can request more information and provide feedback.
	CCCD, FLG	Within 1 year	Majority of residential landowners in the watershed contacted by at least one form of communication	$1,000 (printing cost and 40 hours at $15/hour for distribution)	Number of residential landowners contacted, number of residential landowners requesting more information	Include contact information so recipients can request more information and provide feedback.
	CCCD, FLG, county health departments	Within 1 year	Majority of residential landowners in the watershed contacted by at least one form of communication	$1,000 (printing cost and 40 hours at $15/hour for distribution)	Number of residential landowners contacted, number of residential landowners requesting more information, number of residential landowners requesting septic inspection	Include contact information so recipients can request more information and provide feedback.
Educate agricultural operators in watershed about their impacts.	Local conservation district staff	Within 1 year	10 additional farms in the watershed have had an environmental impact assessment under the Farm*A*Syst, Home*A*Syst, or Crop*A*Syst programs	Unknown, cost determined by local conservation district staff	Number of agricultural landowners participating in these programs in the watershed	Provide contact information for more information and/ or feedback
Create a website that demonstrates monitoring activity and provides more information about how residents the watershed.	FLG, CCCD, volunteer Web designer, SCCD, local media	Within 2 years	Web page is designed, updated, and functional	$200 startup, $50 annually for maintenance, based on volunteer contributions of expertise.	Number of hits on the webpage, number of requests for more information	Include an e-mail account on the webpage that interested parties may use to request more information and provide feedback

SOURCE: Public Sector Consultants Inc., 2007.

[15] All schedules indicated in this section begin upon approval of the watershed plan by MDEQ. Activities are prioritized from high (top of the table) to low (bottom of the table).

CURRENT LOCAL ORGANIZATION ACTIVITIES

The Friends of the Looking Glass have been working on a Michigan Heritage water trail designation for the Looking Glass River. Heritage water trails are routes on navigable waterways such as rivers, lakes, and canals; they are designed and implemented to foster an interactive historical education experience. Historical markers posted on bridge crossings highlight historic events or themes related to the waterway. A companion guide provides a more detailed presentation of the historic material in addition to acting as a conventional water trail guide with maps, put-in points, take-out points, rest stop locations, paddling conditions, etc. To date, the Friends have collected information for use in the historical markers. The group is now pursuing local funding support to print the companion guide and create and install the historical markers.

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Evaluation and Monitoring

The true test of the efficacy of the watershed management plan will be the implementation of the plan goals and objectives. Implementation of watershed plan goals and objectives for site-specific activities will require an evaluation to determine the progress and effectiveness of the proposed activities. Because the tasks are varied, a wide variety of evaluation methods will be necessary.

A long-term monitoring program should be established so that progress can be measured over time that includes the following components:

- Increase watershed monitoring to track preservation and restoration activities in the watershed. Include as indicators: stream bank erosion monitoring and physical habitat monitoring.
- Continue biological data monitoring (fish, macroinvertebrates) and use these as indicators of the potential quality and health of the stream ecosystem. Include as biological indicators: fish assemblage; macroinvertebrate assemblage; single species indicator; composite indicator; and other biological indicators.
- Identify significant riparian corridors and other natural areas in order to plan for recreational opportunities, restoration, and linkages.
- Review and revise currently established benchmarks and dates based on new data.
- Increase the use of volunteers where possible for monitoring program (habitat, macroinvertebrates) to encourage involvement and stewardship.

Based on the goals of the watershed, the monitoring plan measures sediment (as suspended sediment concentration or as a function of stream embeddedness), nutrients (phosphorus and nitrogen), stream flow, bacteria (*E. coli*), fisheries and aquatic macroinvertebrates, and physical habitat. Targets for improving the watershed are established in order to measure success. Initial targets are set to ensure no further degradation of the watershed from current conditions and to prevent the degradation associated with the projected land use changes in the watershed. Exhibit 48 outlines water quality criteria under this plan.

EXHIBIT 48
Water Quality Criteria for the Watershed

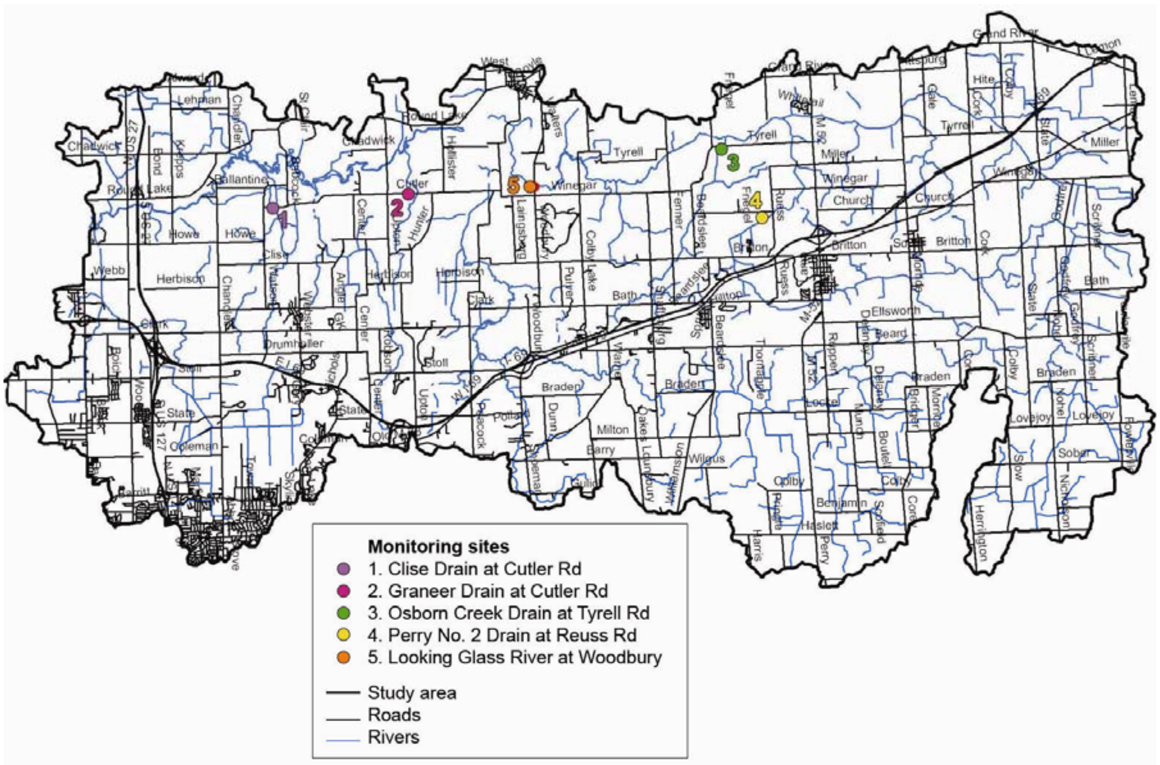
Parameter	Current conditions	Water quality standards	Watershed goal
Sediment	Suspended sediment in the watershed does not currently exceed the standard. There may be localized suspended sediment concentrations in excess of the standard. Projected land use changes may threaten current status.	Suspended sediment concentration does not exceed 80 mg/L. Additionally, satisfactory conditions are observed using the GLEAS Procedure 51 habitat assessment, metrics 1,2a, and 2b.	Maintain suspended sediment concentrations below standard throughout land use changes in the watershed.

Parameter	Current conditions	Water quality standards	Watershed goal
Nutrients	Currently, the river does not exceed nutrient standards. Total P measurements in 2001 were at or below .08 mg/L. Projected land use changes may threaten that status.	Total phosphorous does not exceed narrative standard for nuisance algal growth or degraded conditions for fish and wildlife.	Maintain phosphorus levels below standard and at or below current conditions throughout land use changes in the watershed.
Bacteria	The river does not currently exceed bacterial standards. Projected land use changes may threaten that status.	Counts of 130 or less for *E. coli* per 100 ml monthly average and 300 or less for *E. Coli* per 100ml at any time (full body contact standard)	Maintain *E. coli* counts below standard throughout land use changes in the watershed.
Stream Flow	The Looking Glass currently has a high retention rate resulting in low "flashiness" after rain events. The river has been channelized and disconnected from its floodplain in many places. The watershed still retains 17% of its presettlement wetlands.	Narrative standards that cause no damage to riparian property.	Restoration and maintenance of the stream maintains and improves the current hydrology of the river, including connectivity to wetlands and flood-plains, and no measurable increase in volume of run-off resulting from land use changes.
Fisheries	P51 fish scores in September 2006 were mostly below zero on a scale that ranges from –10 to 10. This resulted in a rating of Poor	Positive P51 scores, correlating to an adjective rating of "Acceptable."	P51 fish scores at monitoring sites are above zero, correlating to an adjective rating of "Acceptable."
Aquatic Macroin-vertebrates	Scores for macroinverte-brate health ranged from poor to acceptable in September 2006, corres-ponding to the accumula-tion of sediment at the sample sites. These scores were mostly below zero on a scale that ranges from –9 to 9.	Positive P51 scores, correlating to an adjective rating of "Acceptable."	P51 aquatic macroinvertebrate scores at monitoring sites are above zero, correlating to an adjective rating of "Acceptable."
Physical Habitat	Scores for physical habitat were primarily "Good," rating between 85 and 137 on a scale that ranges from zero to 200. The score was positively influenced by intact riparian habitat. Instream habitat was degraded.	P51 scores above 130, correlating to an adjective rating of "Good."	P51 physical habitat scores at monitoring sites are above 130, correlating to an adjective rating of "Good."

SOURCE: Public Sector Consultants Inc., 2007

Monitoring sites were selected from the sites used to gather information for this plan. They are shown in Exhibit 49.

EXHIBIT 49
Map of Monitoring Sites



SOURCE: Public Sector Consultants 2007.

The monitoring plan is described in Exhibit 50.

EXHIBIT 50
Monitoring Plan

Monitoring Site	Type of analysis	Method	Frequency	Responsible party
Sediment and nutrients				
Clise Drain at Cutler Road	Benthic Macro-invertebrates	Procedure 51, Great Lakes Environmental Assessment Section,	2 year interval	FLG Volunteer Monitoring Team in cooperation with the CCCD
Graneer Drain at Cutler Road	In-stream physical habitat assessment	Procedure 51, Great Lakes Environmental Assessment Section	2 year interval	FLG Volunteer Monitoring Team in cooperation with the CCCD

Monitoring Site	Type of analysis	Method	Frequency	Responsible party
Osborn Creek Drain at Tyrell Road	Fish assessment	Procedure 51, Great Lakes Environmental Assessment Section	2 year interval	FLG Volunteer Monitoring Team in cooperation with the CCCD
Perry No. 2 Drain at Reuss Road	Suspended Sediment Concentration	Cooperative Lakes Monitoring Program (CLMP) Methods	2 year interval	FLG Volunteer Monitoring Team in cooperation with the CCCD
Looking Glass River at Woodbury	Total Phosphorous	Procedure 51, Great Lakes Environmental Assessment Section	2 year interval	FLG Volunteer Monitoring Team in cooperation with the CCCD
Bacteria				
Sites in the watershed selected by MDEQ Water Bureau	*E. coli* MPN/100 ml	Heterotrophic Plate Count	5 year interval	MDEQ Water Bureau staff*

SOURCE: Public Sector Consultants, 2007.
*Specific sites will be included as part of the MDEQ Water Bureau's rotational water quality monitoring program.

Exhibit 51 outlines methods of evaluating progress on non-environmental goals, such as recreation, and lists interim milestones. In all cases, hydrology shall be addressed before in-stream sediment issues are remediated.

EXHIBIT 51
Non-Environmental Monitoring Parameters:
Evaluating Progress and Interim Milestones

Management activity	Interim milestone	Method of evaluating progress
Address causes of in-stream erosion first. Then implement BMP systems that address in-stream erosion sources at the 5 critical areas identified by the erosion assessment.	Improve 2 sites within 2 years.	Track number of sediment reduction BMPs implemented. Revisit sites and conduct BEHI analysis to document improvements.
Work with conservation districts and landowners to fence livestock out of the stream.	Contact landowners where livestock were documented in the stream within 6 months. Pursue funding and fencing at all identified sites within 1 year.	Track contact with landowners, funding secured, fencing actions taken.
Reduce erosion at road stream crossings to limit sediment discharge into the watershed.	Begin work on improving 1 road stream crossing within 2 years.	Track activity at road stream crossings. Revisit sites and conduct BEHI analysis to document improvements or remaining needs for

Management activity	Interim milestone	Method of evaluating progress
		improvement.

Management activity	Interim milestone	Method of evaluating progress
Implement nutrient management programs in the watershed.	Contact watershed residents, farmers, golf course managers, groundskeepers, landscape companies to provide information on nutrient management within 1 year.	Conduct a watershed survey to measure understanding and current use of nutrient management practices. Track nutrient management activities by each of these groups. Track number of requests for nutrient management information. Track number of nutrient management BMPs implemented.
Restore floodplain where the stream has been channelized.	Engineer plans to reestablish floodplain at the 2 most channelized sites in within 3 years.	Track activities in floodplain. Track feet of riverbank with restored access to floodplain.
Develop and implement uniform and consistent land use, floodplain, and wetland ordinances across townships in the watershed.	Adopt uniform ordinances in 2 townships in the first 2 years.	Track number of ordinances adopted. Track number of acres impacted/protected by the ordinances.
Assess and manage ground-water in the watershed.	Adopt wellhead protection program in 2 communities within the first 3 years.	Track number of communities with a well head protection program. Track research about and understanding of the groundwater in the watershed through public surveys and expert interviews.
Improve existing and create new recreational opportunities in the watershed.	Remove 2 log and debris jams where necessary for padding within the first year. Site a new fishing access point within the first year.	Track river miles opened from logjam removals. Track number of new fishing access sites in the watershed.
Enable local government decision makers to use L-THIA runoff modeling in land use decisions.	Hold a workshop for local government decision makers on the Web-based L-THIA model within 2 years.	Track number of local governments using watershed modeling to influence land use decision making. Track number of workshop attendees.

SOURCE: Public Sector Consultants Inc., 2007.

Plan Review

This watershed plan will be revisited every five years in order to assess changing conditions, review progress, and determine whether revision to the plan is necessary. Currently the upper Looking Glass watershed does not have any total maximum daily load (TMDL) restrictions in place. If TMDLs are implemented in the future, goals of this watershed plan should be amended to coincide with the TMDL watershed goals.

Cost of Plan Implementation

The cost of implementing the management goals laid out in this plan is estimated at $1,275,800. The cost of implementing the information and education component of this plan is estimated to be $11,580.

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Appendices

Appendix A: Build-out by Township

Appendix B: Prioritization of Erosion Sites

Appendix C: L-THIA reports

Appendix D: Survey and Results

Appendix E: Letters of Support