Paw Paw River Watershed Management Plan

"A Guide for the Protection and Improvement of Water Quality"

August 2008

Paw Paw River Watershed Management Plan

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1 Introduction

The Paw Paw River Watershed (PPRW) is all of the land that drains into the Paw Paw River. Wetlands, lakes, streams, other surface water bodies on this land and groundwater are also part of the watershed. Water is a critical resource for recreation, irrigation, and increasing the value of adjacent real estate. These uses depend on good water quality, but they can also be a threat to it.

A watershed is all of the land that drains into a common body of water. Watersheds surpass political boundaries and connect communities with a common resource.

The PPRW is a priority for protection and preservation among southern Michigan watersheds because a relatively high percentage of its natural land cover remains in spite of increasing development pressure throughout the region. The PPRW Management Plan is intended to guide individuals, businesses, organizations and governmental units working cooperatively to ensure the water and natural resources necessary for future growth and prosperity are improved and protected. It can be used to educate watershed residents on how they can improve and protect water quality, encourage and direct natural resource protection and preservation, and develop land use planning and zoning that will protect water quality in the future. Implementation of the plan will require stakeholders to work across township, county, and other political boundaries.

Watershed management involves identifying and prioritizing problems, promoting involvement by stakeholders, developing solutions and measuring success through monitoring and data collection.

Chapters 2 and 3 of the management plan provide an overview of the watershed. Chapter 4 outlines the role governmental units play in protecting water quality. Chapter 5 describes the natural features of the watershed. The process used to develop the plan is reviewed in Chapter 6. Chapter 7 summarizes water quality throughout the watershed and Chapter 8 prioritizes the areas, pollutants and sources impacting it. Chapter 9 offers goals for the watershed and Chapter 10 provides strategies for achieving them. Lastly, Chapter 11 suggests a strategy for evaluating the progress toward the goals of the plan.

The State of Michigan protects all water bodies for designated uses such as water supply, fisheries and for partial and total body contact for recreation. This management plan was created as part of the PPRW planning project, which was funded with a Clean Water Act Section 319 grant administered by the Michigan Department of Environmental Quality (MDEQ), Nonpoint Source Program. The Southwest Michigan Planning Commission in collaboration with several partners was awarded the grant in January of 2006. Development of the PPRW Management Plan relied heavily on stakeholder input and agency support, as well as professional services and other partnerships. The overall health of a river system can be difficult to determine. Characterizations and recommendations in this plan are based on the best available data.

2 Watershed Description

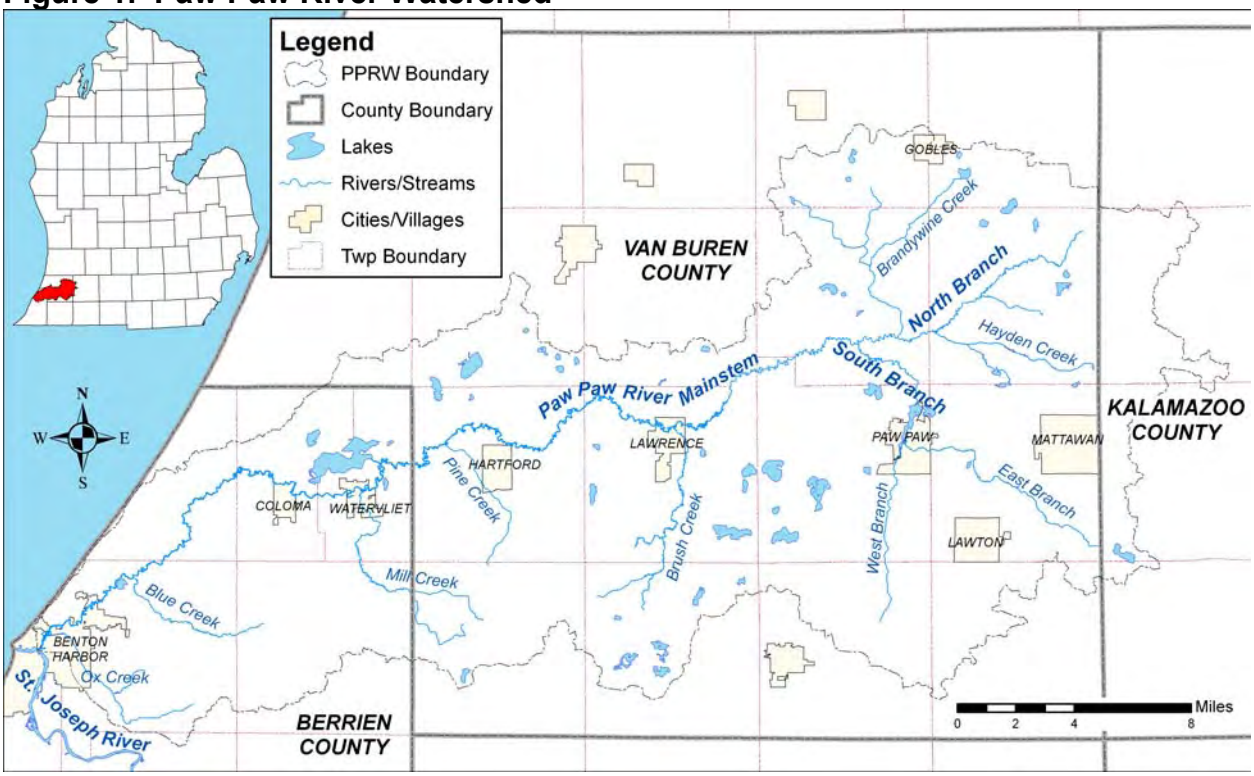
2.1 Geography

The term watershed describes an area of land that drains down slope to the lowest point. It includes all of the land, in which any drop of water falling within it, will leave in the same stream or river. Watersheds can be large or small and can traverse county, state or national boundaries. Every stream, tributary or river has an associated watershed; and small watersheds join to become larger watersheds. For example, within the Great Lakes watershed, the PPRW is part of the St. Joseph River watershed, which is part of the larger Lake Michigan watershed.

Pennsylvania Department of Environmental Protection

The Paw Paw River flows westward through southwestern Lower Michigan before joining the St. Joseph River and emptying into Lake Michigan near the City of Benton Harbor. The PPRW encompasses approximately 285,557 acres (446 square miles) in Kalamazoo, Van Buren and Berrien Counties with the largest portion in Van Buren County (203,720 acres). In the eastern portion of the watershed, the North Branch joins the South Branch to become the mainstem of the Paw Paw River. Other significant tributaries include Brandywine Creek, Hayden Creek, the East Branch, the West Branch, Brush Creek, Pine Creek, Mill Creek, Blue Creek and Ox Creek. The total length of the Paw Paw River and these significant tributaries is approximately 145 miles. The PPRW includes 5,818 acres of lakes and ponds.

Figure 1. Paw Paw River Watershed



Watersheds are typically identified by Hydrologic Unit Codes (HUCs). HUCs were developed by the United States Geologic Society to provide official boundaries for watersheds. HUCs identify a geographic area, which includes part or all of a surface drainage basin. The United States is divided into successively smaller hydrologic units. The units are classified into six levels starting with large areas such as the Great Lakes Region (2-digit) down to small areas like the Brandywine Creek subwatershed (14-digit). Often for management purposes, agencies focus on the smaller 14-digit HUC subwatershed level.

Each subwatershed has slopes, soils and other conditions, which direct runoff to the Paw Paw River or one of its tributaries. Figure 2 identifies the 17 subwatersheds (14-digit HUCs) of the PPRW. Table 1 lists the acreage and 14-digit HUC for each subwatershed, as well as, the percentage of each governmental unit included in the subwatershed. Throughout the plan, the HUCs are labeled as subwatersheds 1-17 and the HUCs are not referenced except for in Table 1. The specific water bodies located in each subwatershed can be found in Table 8 (major streams) and Table 9 (lakes).

Figure 2. Subwatersheds of the Paw Paw River

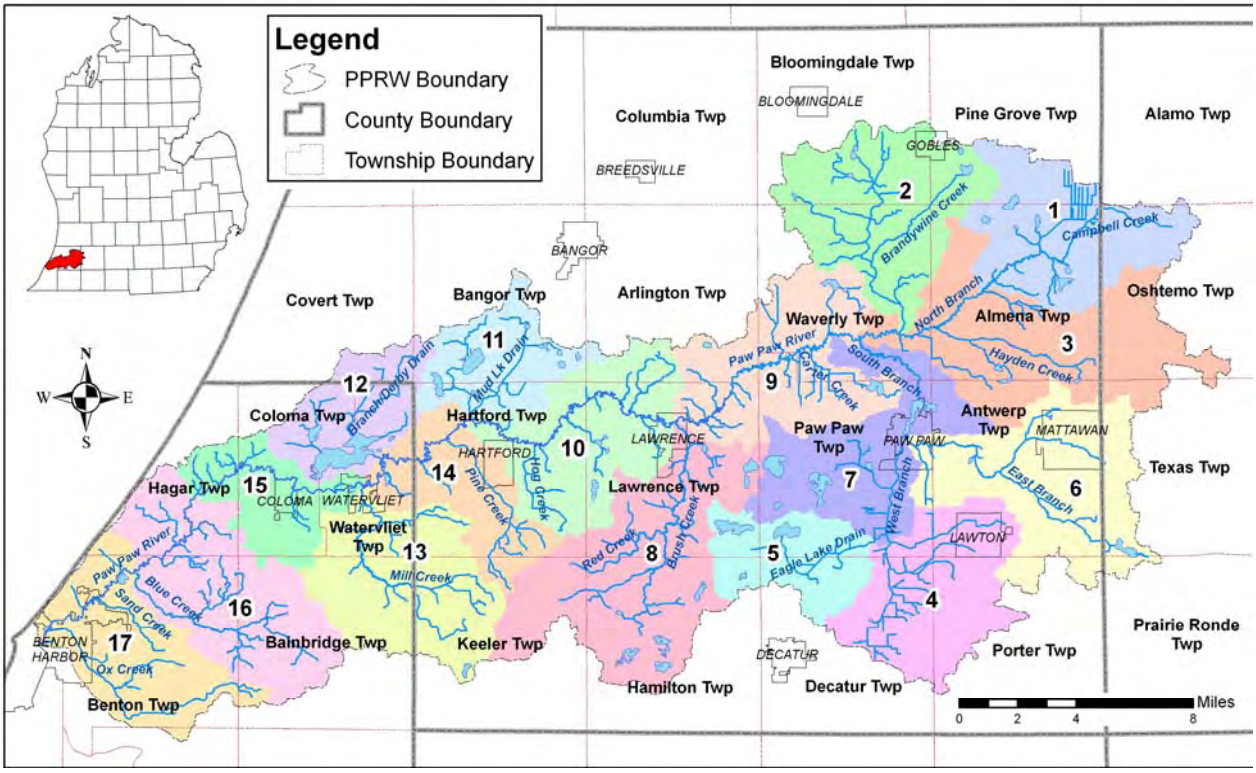


Table 1. Paw Paw River Subwatersheds

Map ID #	14-Digit HUC* (subwatershed name)	Total Area (Acres)	Governmental Units (% of Subwatershed)
1	04050001260010 (Campbell Creek and North Branch)	17,204	Almena Twp (53.45%), Oshtemo Twp (24.68%), Pine Grove Twp (21.53%), Alamo Twp (.34%)
2	04050001260020 (Brandywine Creek)	19,718	Waverly Twp (43.54%), Bloomingdale Twp (37.03%), Pine Grove Twp (12.09%), Almena Twp (4.83%), Gobles (2.51%)
3	04050001260030 (Hayden Creek and North Branch)	23,844	Almena Twp (50.30%), Oshtemo Twp (25.13%), Antwerp Twp (11.73%), Waverly Twp (7.65%), Texas Twp (5.19%)
4	04050001260040 (Lawton Drain and West Branch)	16,767	Decatur Twp (40.21%), Porter Twp (31.76%), Antwerp Twp (11.29%), Lawton Village (9.11%), Paw Paw Twp (7.63%)
5	04050001260050 (Eagle Lake Drain)	9,733	Decatur Twp (36.86%), Paw Paw Twp (31.98%), Lawrence Twp (18.32%), Hamilton Twp (12.85%)
6	04050001260060 (East Branch)	21,636	Antwerp Twp (54.54%), Texas Twp (18.02%), Mattawan Village (12.17%), Porter Twp (7.68%), Prairie Ronde Twp (2.66%), Paw Paw Twp (2.44%), Paw Paw Village (2.41%), Almena Twp (.07%)
7	04050001260070 (Maple Lake and South Branch)	16,875	Paw Paw Twp (67.57%), Waverly Twp (12.40%), Antwerp Twp (9.93%), Paw Paw Village (7.63%), Lawrence Twp (1.55%), Almena Twp (.91%)
8	04050001270010 (Brush Creek)	26,322	Hamilton Twp (40.23%), Lawrence Twp (36.55%), Keeler Twp (19.28%), Hartford Twp (1.92%), Lawrence Village (1.50%), Paw Paw Twp (.51%)
9	04050001260080 (Carter Creek and Mainstem)	18,907	Waverly Twp (38.20%), Paw Paw Twp (28.39%), Lawrence Twp (19.23%), Arlington Twp (13.63%), Lawrence Village (.54%)
10	04050001270020 (Hog Creek and Mainstem)	17,908	Hartford Twp (44.52%), Lawrence Twp (36.05%), Arlington Twp (12.83%), Lawrence Village (3.69%), Hartford City (1.73%), Bangor Twp (1.18%)
11	04050001270030 (Mud Lake Drain)	10,044	Bangor Twp (66.2 %), Hartford Twp (24.79 %), Pokagon Band of Potawatomi Indians (6.65 %), Arlington Twp (2.36 %)
12	04050001270040 (Paw Paw Lake)	10,280	Coloma Twp (41.70%), Watervliet Twp (33.87%), Covert Twp (18.59%), Bangor Twp (4.58%), Hartford Twp (1.25%), Watervliet City (.01%)
13	04050001270050 (Mill Creek)	18,499	Bainbridge Twp (35.11%), Keeler Twp (34.54%), Watervliet Twp (16.63%), Hartford Twp (10.83%), Watervliet City (1.98%), Coloma Twp (.91%)
14	04050001270060 (Pine Creek and Mainstem)	11,958	Hartford Twp (64.13 %), Watervliet Twp (16.38 %), Keeler Twp (8.18 %), Hartford City (5.67 %), Pokagon Band of Potawatomi Indians (4.55 %), Watervliet City (1.09 %)
15	04050001270070 (Ryno Drain and Mainstem)	9,732	Coloma Twp (55.39%), Hagar Twp (24.08%), Watervliet Twp (7.76%), Coloma City (5.85%), Bainbridge Twp (4.00%), Watervliet City (2.93%)
16	04050001270080 (Blue Creek and Mainstem)	20,720	Bainbridge Twp (40.42%), Benton Twp (30.97%), Hagar Twp (27.63%), Coloma Twp (.98%)
17	04050001270090 (Ox Creek and Mainstem)	15,421	Benton Twp (77.03%), Benton Harbor (14.12%), Hagar Twp (3.90%), Bainbridge Twp (3.04%), Sodus Twp (1.23%), St. Joseph City (.67%)

*HUC – Hydrologic Unit Code (Also see Tables 8 and 9 for water bodies in each subwatershed.)

2.2 Climate

The proximity of the PPRW to Lake Michigan and prevailing westerly winds moderate the climate and produce lake effect precipitation during the fall and winter months. The climate is also influenced by the Maritime Tropical air mass, which tends to be a relatively warm and humid air mass. The average growing season (consecutive days with low temperatures greater than or equal to 32 degrees) is 148 days. Total annual precipitation is approximately 38.3 inches including approximately 81 inches of snowfall. (Berrien & Van Buren Soil Surveys) According to the National Climatic Data Center, the average winter temperature in Benton Harbor was 26.56 degrees F and the average summer temperature was 68.93 degrees F from 1971 to 2000.

The PPRW lies within the Southern Michigan, Northern Indiana Till Plains (SMNITP) ecoregion. Ecoregions are delineated by their climates, soils, vegetation, land slope and land use. The Paw Paw River is typical of rivers in the SMNITP ecoregion in that it: 1.) has good quality headwaters, 2.) is generally slow flowing, and 3.) is often bordered by extensive wetlands. Ditching and channelizing has been used throughout this ecoregion to drain areas that are too wet for settlement and agriculture. The PPRW is a priority for conservation because it contains more wetland and natural stream channel than many other rivers in the SMNITP ecoregion. (Chapter 6, MDEQ Integrated Report 2006)

2.3 Geology, Hydrology and Soils

The geological features, hydrology and soils of the PPRW combined with the current lack of impervious surface and abundance of intact natural land cover make the Paw Paw River one of the most hydrologically stable river systems in southern lower Michigan.

<u>Geology and Hydrology</u>

Virtually all of Michigan's topography and hydrology has been influenced by glacial action. Repeated advances of continental ice sheets eroded the pre-existing rock and soils and then re-deposited these materials as sediments as the ice advanced, melted and retreated during several cycles. These glacial materials were deposited as sands, gravels, silts and clays, as well as various mixtures, and vary in thickness within the watershed area from approximately 130 feet to over 400 feet. Ice movement and its meltwater influenced the patterns and distributions of various landforms, such as moraines and stream valleys. The meltwater created large rivers, which deposited glacial materials throughout the region. These glacial deposits and their associated landforms provide a foundation for the hydrology, soil types and land cover that exist today.

<u>Soils</u>

The National Cooperative Soil Survey publishes soil surveys for each county within the U.S. These soil surveys contain predictions of soil behavior for selected land uses, and also highlight limitations and hazards inherent in the soil, general improvements needed to overcome the limitations, and the impact of selected land uses on the environment. The soil surveys are designed for many different users. Planners, community officials,

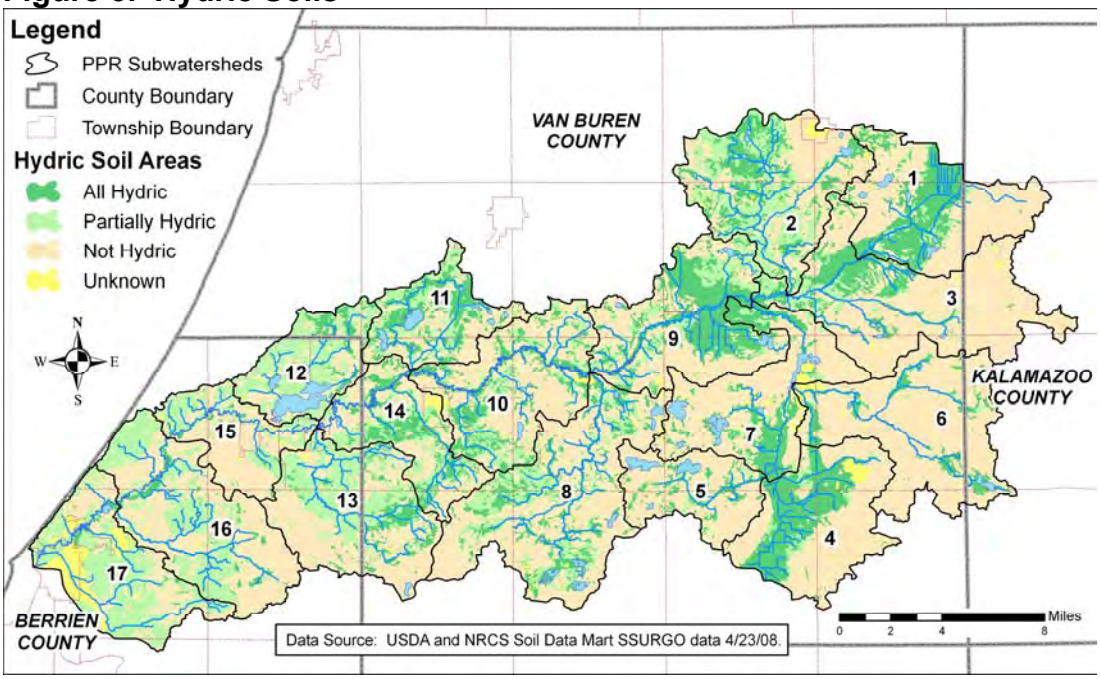
engineers, developers, builders, etc., use the surveys to help plan land use, select sites for construction, and identify special practices needed to ensure proper performance.

Protection of areas with high infiltration capacity (Group A soils) is important for maintaining hydrology and temperature regimes.

Hydrologic soil groups can help determine, which portions of the watershed are more important for groundwater recharge. The upper and middle sections of the PPRW are mostly made up of Group A soils. Group A soils are mostly sandy and loamy types of soils with a low runoff potential and high infiltration rate even when thoroughly wetted. These coarse soil types allow water to infiltrate and recharge the groundwater supply. As a result of these soils and a relative lack of impervious surface, the Paw Paw River system receives moderate groundwater inputs. Groundwater inputs are important for maintaining stream temperatures and flow throughout the system. The lower sections of the watershed mostly consist of Group C soils. Group C soils are sandy clay loam with a low infiltration rate when thoroughly wetted. (St. Joseph River Assessment, 1999) Protection of areas with high infiltration capacity (Group A soils) is important for maintaining hydrology and temperature regimes within the watershed.

Another important characteristic of soils is whether they are considered hydric. Hydric soils are defined as poorly or somewhat poorly drained soils. These soils are one of the indicators of wetlands, but many have been drained for building or agricultural purposes. Although wetland regulations do not apply to all hydric soil areas, they are poorly suited for development, especially for septic fields. Septic systems installed in areas with unsuitable soils are prone to failure, which can lead to nutrient and bacteria pollution of groundwater and surface water. Figure 3 shows the hydric and partially hydric soils in the PPRW, which are mostly found in the eastern part of the watershed in low-lying areas and along river and stream segments.

Figure 3. Hydric Soils



2.4 Land Cover

Prior to European settlement in the early-to-mid-1800's, much of the PPRW was forested. Beech-sugar maple forests were dominant, and oak-hickory forests, mixed hardwood swamps, mixed conifer swamps, white pine-mixed hardwood forests, and black ash swamps were all represented. There were openings in the forest as well, consisting primarily of mixed oak savanna and open wetlands.

Today, natural land cover in the PPRW has become fragmented by agricultural practices, as well as residential and commercial development. However, despite the increasing pressure from these competing land uses, significant portions of natural land cover remain. The forested floodplain corridor along the main stem of the Paw Paw River from Benton Harbor to the Village of Paw Paw in particular remains largely intact.

As seen in Figures 4 and 5 and Table 2, the watershed contains mostly agricultural (47%) and natural (45%) land cover. In Table 3, the amount of land cover (urban, agricultural, natural and other) is listed for each subwatershed. Subwatersheds 15 and 17 have the highest percentage of urban land. Subwatersheds 5 and 13 have the highest percentage of agriculture. Subwatersheds 1, 3 and 6 (the headwaters) have the highest percentage of natural land cover. Detailed land cover by subwatershed can be found in Appendix 1.

> Preservation and restoration of natural land cover, as well as proper management of agricultural lands, will be critical to protecting and improving water quality in the PPRW.

The relatively high percentage of natural land cover in the PPRW is threatened by increasing development pressure. An estimated 50% of wetlands have been lost in the PPRW in the last 200 years. Preservation and restoration of natural land cover, as well as proper management of agricultural lands will be critical to protecting and improving water quality in the PPRW.

Table 2. Paw Paw River Watershed Land Cover (2000)

Land Cover Category	% of Watershed	Area (acres)
Low Intensity Urban	1.91%	5,468
High Intensity Urban	0.87%	2,488
Airports	0.08%	234
Roads/Paved	4.12%	11,775
Total Urban	**6.99%**	**19,965**
Non-vegetated Farmland	0.24%	680
Row Crops	15.14%	43,241
Forage Crops	21.99%	62,789
Orchards/Vineyards/Nursery	10.22%	29,179
Total Agriculture	**47.59%**	**135,889**
Upland Open Land	9.75%	27,848
Upland Forest	20.02%	57,184
Lowland Forest	8.23%	23,501
Wetland	6.09%	17,383
Water	1.02%	2,912
Total Natural	**45.11%**	**128,828**
Other/Unknown	**0.31%**	**886**
Total Watershed		**285,568**

Figure 4. Land Cover in the Paw Paw River Watershed (percent)

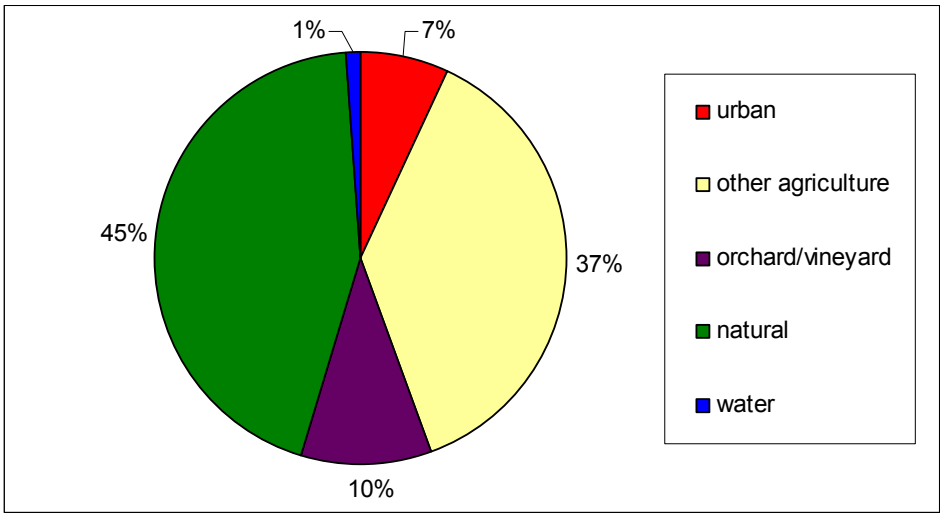


Figure 5. Paw Paw River Watershed Land Cover (2000)

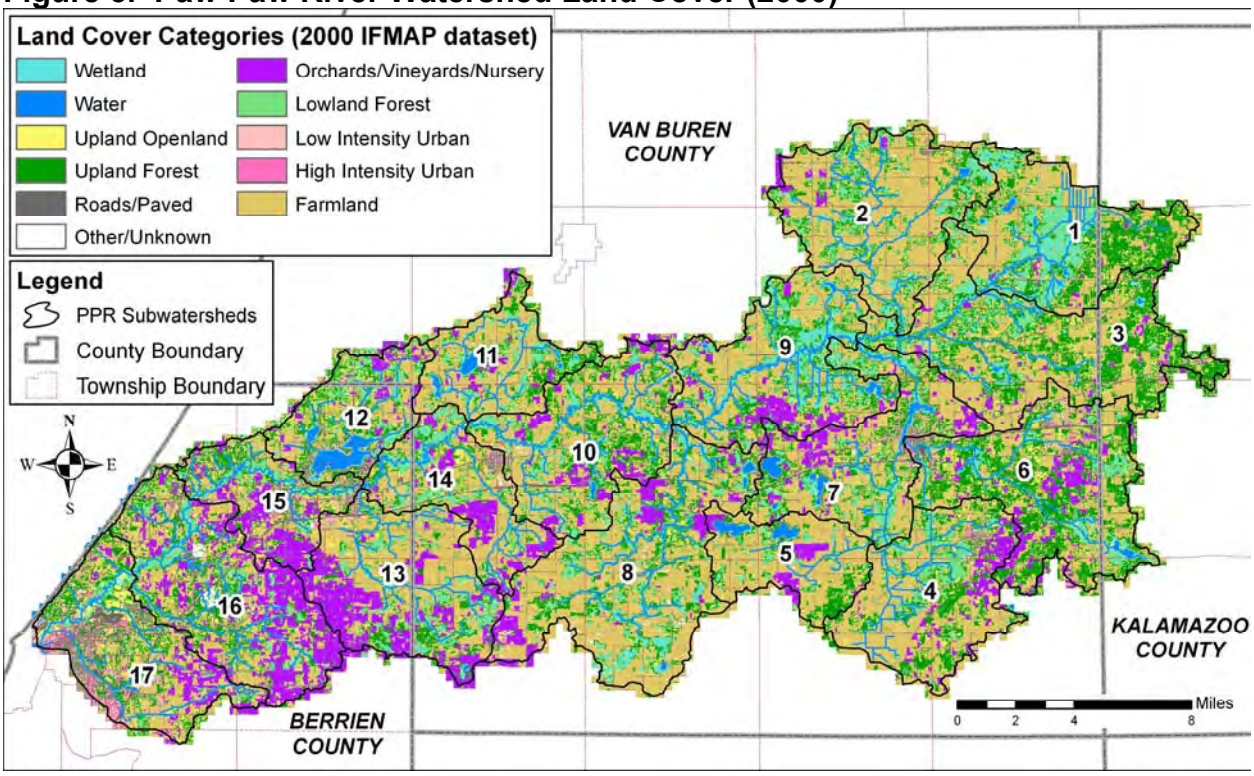


Table 3. Generalized Land Cover by Subwatershed (2000)

Sub watershed ID#	Urban		Agricultural		Natural		Other/Unknown	
	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres
1	3.42%	589	31.13%	5,355	65.43%	11,257	0.02%	3
2	4.48%	883	55.62%	10,968	39.79%	7,845	0.11%	22
3	4.87%	1,162	38.04%	9,070	57.05%	13,603	0.04%	9
4	4.92%	825	54.40%	9,121	40.59%	6,806	0.09%	15
5	3.64%	354	65.18%	6,344	31.08%	3,025	0.10%	10
6	7.65%	1,656	34.87%	7,544	57.37%	12,412	0.11%	24
7	8.69%	1,467	45.13%	7,615	45.99%	7,761	0.19%	32
8	4.50%	1,184	56.68%	14,918	38.12%	10,035	0.70%	185
9	3.05%	577	45.99%	8,696	50.94%	9,631	0.02%	3
10	5.48%	982	47.86%	8,570	46.42%	8,312	0.25%	44
11	3.89%	391	53.51%	5,375	42.49%	4,268	0.10%	10
12	9.70%	997	36.16%	3,717	54.03%	5,554	0.12%	12
13	5.12%	947	65.80%	12,172	28.94%	5,354	0.14%	26
14	7.38%	883	54.99%	6,576	37.30%	4,460	0.33%	39
15	13.67%	1,330	44.28%	4,309	41.63%	4,051	0.43%	42
16	7.85%	1,627	52.36%	10,848	38.49%	7,976	1.30%	269
17	26.66%	4,111	30.42%	4,691	42.01%	6,478	0.91%	141
Total	6.99%	19,965	47.59%	135,889	45.11%	128,828	0.31%	886

2.5 Dams and Barriers

Dams and barriers in the watershed pose issues with recreational use and also with the fragmentation of habitat. Dams can restrict the movement of fish in river systems. There are 22 registered dams in the PPRW. Many of these dams are obsolete (not serving any function) and they are generally low head and found in remote areas. Low head dams are artificial structures, which are less than 15 feet in height and extend across the river channel. There are no active hydroelectric dams; many of the dams are being used for recreational lake level control structures. (St. Joseph River Assessment, 1999) The Michigan Department of Natural Resources, U.S. Fish and Wildlife Service, Berrien County, Watervliet City, The Nature Conservancy and the Southwest Michigan Planning Commission have been partners on an effort to remove a dam on the Paw Paw River east of Watervliet City. This project will eliminate the only major barrier on the Paw Paw River mainstem.

3 Community Profile

3.1 History of Region

Throughout history, water resources have been important for the culture and economy of southwest Michigan. The Hopewell inhabited the area from 500 BC to 900 AD, followed by the Algonquin groups and the Miami tribe. By the early 1700's the Potawatomi tribe was the predominant Native American people in this area. The French were the first European explorers to come to southwest Michigan. They were interested in the fur trade in this area. The French explorer, LaSalle, is known to have wintered near the City of St Joseph in 1680-81. A 1999 Michigan History magazine article indicates La Salle proceeded up the Paw Paw River and entered western Kalamazoo County at Prairie Ronde. British traders came here during the second half of the eighteenth century. Artifacts suggest that a trading post existed on the banks overlooking the Paw Paw River near Coloma.

The Erie canal was opened in 1825 and settlers poured into southwest Michigan from the east. Most settlements were located on streams or rivers and soon major water and steam driven mills were erected in every settlement. Until railroads were installed, flour and other products were transported by water to Lake Michigan. The Paw Paw River was, in the days of early settlement, an important highway for the transportation of freight from the Paw Paw Valley to St. Joseph, and many people were engaged in the business of boating flour on flatboats. The traffic on the Paw Paw continued with more or less regularity until the completion of the Michigan Central Railroad.

In 1893, an old sawmill in Watervliet was replaced with a paper mill. For the next hundred years the paper mill grew into the town's main industry, employing 400 people. Today Watervliet is reclaiming its waterfront from industrial uses and there is a nice stormwater demonstration project at Veterans Park with a porous parking lot, a rain garden and a riparian buffer along the Paw Paw River.

In the late 1800's tourism abounded at Paw Paw Lake (the largest lake in the watershed at 920 acres). Its eleven miles of shoreline, proximity to Benton Harbor/St. Joseph, and accessibility to railroads made it the perfect place for a resort destination. Double-decked steamboats 90 feet in length were circling the lake on a regular schedule. Vacationers came to town by the electric interurban train or by regular passenger trains. Train records from the early part of the 1900's show 40,000 people coming to Paw Paw Lake every summer. At one time, fifty hotels and four dance pavilions lined the lake. The area's popularity continued through the 1950's.

In April 1947 torrential rains caused a dam to break in Lawrence creating a domino effect of flooding downstream on the Paw Paw River. The record flooding of Paw Paw Lake resulted in hundreds of homes being damaged and many being pushed off their foundations. The cost of cleanup and repair was a staggering dollar amount for that time.

The Wolf Lake State Fish Hatchery was established in 1927 with land donated to the State by the Izaak Walton League who bought 78 acres for $5,000. This facility produces a wide range of fish species for both inland and Great Lakes waters. The hatchery has both indoor and outdoor rearing facilities.

Southwest Michigan is known for its fruit and vegetable production. The PPRW is the home to several wineries. The rural character, the Paw Paw River and area lakes continue to attract tourists and residents to southwest Michigan.

(History section is courtesy of Barb Cook)

Water resources are important to our economy, history and culture. These priceless treasures must be protected.

3.2 Governmental Units

In the PPRW, there are 39 governmental units including 25 townships, four (4) villages, six (6) cities, three (3) counties (Berrien, Van Buren and Kalamazoo counties), and one (1) tribe (Pokagon Band of Potawatomi Indians). Out of the 35 townships, cities and villages, only 22 have at least 75% of their land in the PPRW. The Pokagon Band of Potawatomi Indians own 1,212 acres within the watershed (Hartford and Bangor Townships). Approximately 775 acres of these lands are held in federal trust for the benefit of the Pokagon Band, and as a result, the Band possesses the jurisdiction to develop and implement its own land use plan, as well as regulate the resources and other activities within these lands. The majority of these lands are along the Paw Paw River. See Figure 6 for a map of governmental units in the PPRW.

Table 4 lists all of the governmental units located in the PPRW along with the approximate: 1.) number of acres of that governmental unit in the PPRW, 2.) percent of that governmental unit in the PPRW, 3.) number of miles of PPRW streams and rivers in that governmental unit, and 4.) number of acres of lakes and ponds in that governmental unit and within the PPRW. Almena, Waverly and Hartford Townships have the most river length in the PPRW. Paw Paw, Lawrence and Coloma Townships have the most surface water acreage in the PPRW.

Figure 6. Governmental Units in Paw Paw River Watershed

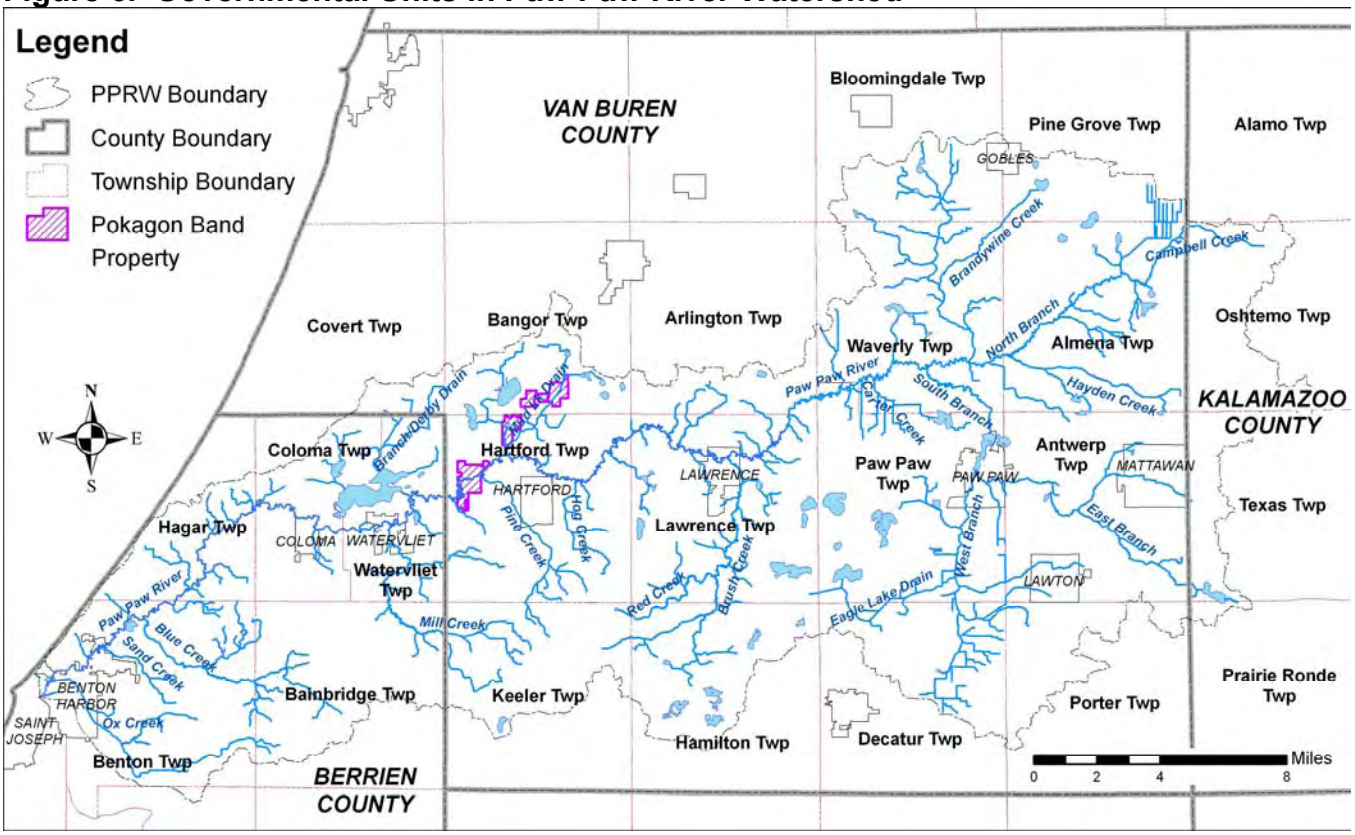


Table 4. Watershed Area, River Length and Water Acreage by Governmental Unit

Governmental Unit	County	Watershed Area (Acres)	% in Watershed	River Length (Miles)	Surface Water Area* (Acres)
Alamo Twp.	Kalamazoo	59	0.25	0	0
Almena Twp.	Van Buren	22,310	100	36.5	345
Antwerp Twp.	Van Buren	18,168	99.87	15	145
Arlington Twp.	Van Buren	5,112	22.86	1.9	79
Bainbridge Twp.	Berrien	15,729	69.54	5.1	87
Bangor Twp.	Van Buren	7,773	32.18	2.55	442.7
Benton Harbor, City of	Berrien	2,177	76.81	9.1	28
Benton Twp.	Berrien	18,292	86.94	19.8	165
Bloomingdale Twp.	Van Buren	7,301	33.66	4.3	109
Coloma, City of	Berrien	569	100	1.6	1
Coloma Twp.	Berrien	10,047	82.31	5.5	602
Covert Twp.	Van Buren	1,910	8.53	0.8	2
Decatur Twp.	Van Buren	10,326	47.15	9.8	16
Gobles, City of	Van Buren	495	74.88	0	0

Governmental Unit	County	Watershed Area (Acres)	% in Watershed	River Length (Miles)	Surface Water Area* (Acres)
Hagar Twp.	Berrien	8,672	72.5	6.7	57
Hamilton Twp.	Van Buren	11,840	52.04	12.5	536
Hartford, City of	Van Buren	988	100	0.4	4
Hartford Twp.	Van Buren	21,545	100	28.7	151
Keeler Twp.	Van Buren	12,442	55.55	11.2	122
Lawrence Twp.	Van Buren	21,753	100	27.1	644
Lawrence, Village of	Van Buren	1,158	100	3.9	6
Lawton, Village of	Van Buren	1,527	100	0	23
Mattawan, Village of	Van Buren	2,633	100	2.8	15
Oshtemo Twp.	Kalamazoo	1,0237	44.42	0	24
Paw Paw Twp.	Van Buren	21,832	100	9.1	1131
Paw Paw, Village of	Van Buren	1,811	100	2.1	140
Pine Grove Twp.	Van Buren	6,088	27.13	2.6	193
Pokagon Band of Potawatomi Indians	Van Buren	1,212	100	3.73	17.3
Porter Twp.	Van Buren	6,985	30.84	1.3	17
Prairie Ronde Twp.	Kalamazoo	575	2.47	0	6
Sodus Twp.	Berrien	190	1.48	0	0
St. Joseph, City of	Berrien	103	4.4	0.75	1
Texas Twp.	Kalamazoo	5,137	22.12	1.6	127
Watervliet, City of	Berrien	782	100	2.6	0
Watervliet Twp.	Berrien	9270	100	16.5	573
Waverly Twp.	Van Buren	19,723	89.3	32.3	174

*Surface Water Area does not include rivers and streams. Source: Michigan Center for Geographic Information

3.3 Demographics

The PPRW is an important resource for its human population, including parts of the metropolitan areas of Kalamazoo at the headwaters and Benton Harbor-St. Joseph at the mouth. It is important to understand the characteristics of the population in the watershed. By having a better understanding of the people, water quality related management and outreach efforts can be tailored to be more effective for the intended audience(s).

All of the demographic information presented here is from the US Census. It was not possible to report numbers specifically for the watershed area. The Census information was available at two different levels, the block and block group level.

At the block level, 2,505 blocks were selected to best represent the PPRW area. The 2,505 blocks encompass about 452.32 square miles compared to the PPRW, which is 446 square miles. Figure 7 illustrates the extent of the selected blocks with population density. Only population, population density, number of households and race were available at the block level. The remaining census information is presented at the block group level.

At the block group level, 95 block groups were selected to best represent the PPRW area. The 95 block groups encompass 677 square miles compared to the PPRW area of 446 square miles. Figure 8 illustrates the extent of the selected block groups with median household income.

According to the block level 2000 US Census data, there were about 80,851 people living in the PPRW. The average population density in the watershed was 179 people per square mile. In 2000, the watershed contained about 29,733 households with 22,043 (74%) of these being owner occupied. The average household contained 2.7 persons. Figure 7 illustrates that the most densely populated areas of the watershed are located in the headwaters and near the mouth (Benton Harbor and Coloma/Watervliet areas). Table 5 lists the race breakdown of the population living in the watershed. About 80% were white only, about 15% were black or African American and about 5% were Hispanic or Latino.

Figure 7. Population Density (2000)

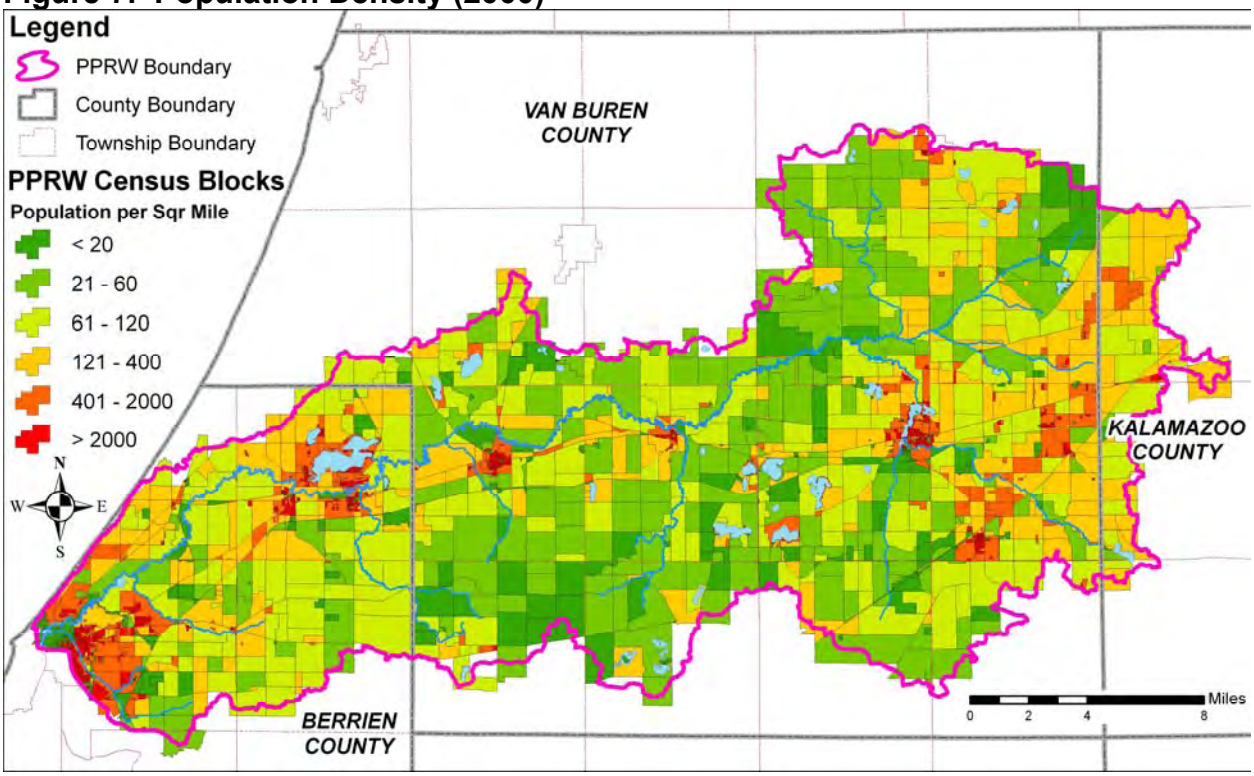


Table 5. Race by Census Block (2000)

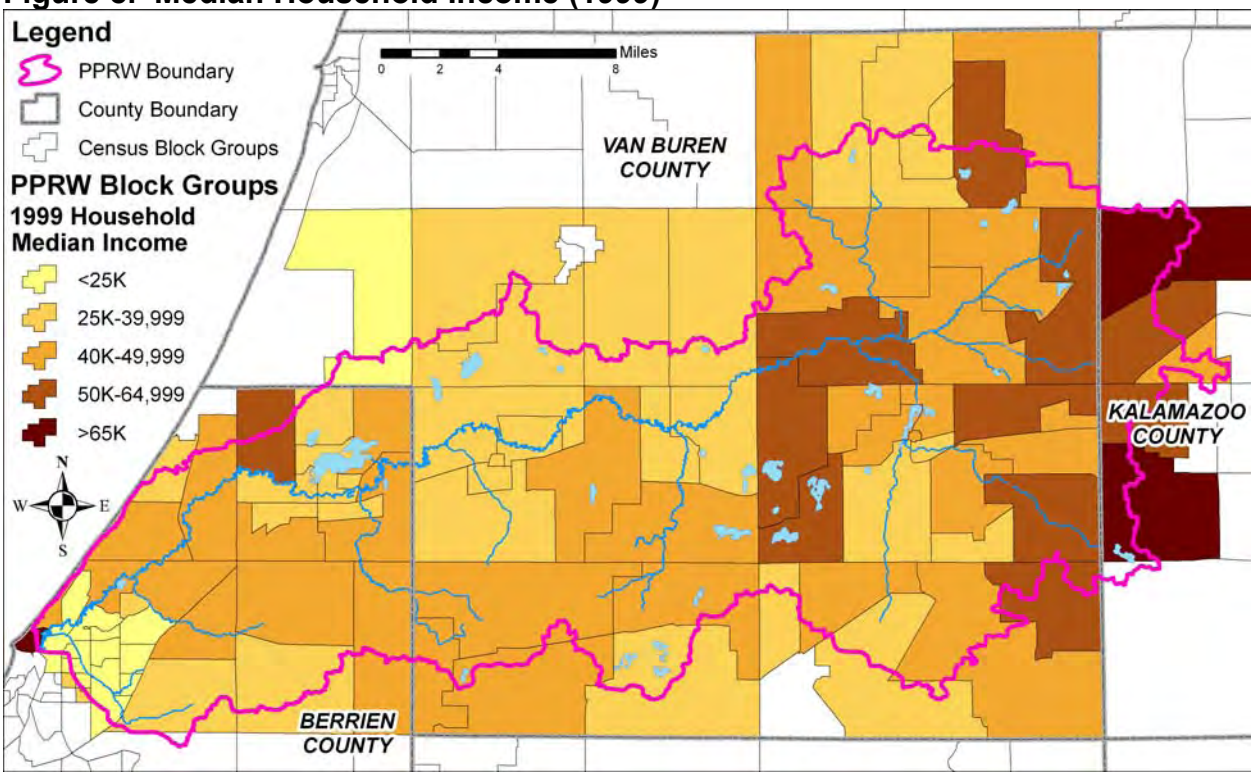
Race	Number	Percentage
White Only	64,004	79.16%
Black or African American Only	12,850	15.89%
American Indian or Alaska Native Only	504	0.62%
Asian Only	293	0.36%
Hawaiian or Other Pacific Islander Only	16	0.02%
Some Other Race Only	1,758	2.17%
Two or more races	1,426	1.76%
Hispanic or Latino (of any race)	4,246	5.25%

The following statistics are presented at the census block group level from the 2000 US Census. The total population for the 677 square miles was 109,882 with a population density of 162 persons per square mile. The number of individuals below the 1999 poverty level was 16,092 or 14.8% of the population. The median household income was $39,412 in 1999. Figure 8 illustrates a higher median household income in the headwaters area of the PPRW. In 2000, the unemployment rate was 6.29%. About 80% of the population age 25 and over had at least a high school diploma. Only about 3% of the population age 5 and over spoke English less than very well.

Table 6. Poverty, Employment, Education and Language by Block Group (2000)

Poverty Status in 1999	Number	Percent
Individuals below Poverty Level	16,092	14.87%
Individuals At or Above Poverty Level	92,140	85.13%
Employment Status (Age 16 and over)		
Total Civilian Workforce	53,188	
# of workforce unemployed	3,348	6.29%
# of workforce employed	49,840	93.71%
Educational Attainment (Age 25 and over)		
Total Population 25 and over	67,327	
Less than 9th Grade	3,005	4.46%
9th to12th grade, no diploma	10,136	15.05%
High School Graduate (includes equivalency)	23,672	35.16%
Some College, no degree	15,328	22.77%
Associate degree	4,482	6.66%
Bachelor's degree	6,906	10.26%
Graduate or Professional degree	3,798	5.64%
No High School diploma	13,141	19.52%
High School Graduate or higher	54,186	80.48%
Bachelor's degree or higher	10,704	15.90%
Language Spoken At Home (Age 5 and older)		
Total Population 5 and over	101,915	
English Only	96,537	94.72%
Language other than English	5,378	5.28%
Speak English less than “very well”	3,030	2.97%

Figure 8. Median Household Income (1999)



3.4 Future Growth and Development

The PPRW has abundant natural and water resources that attract businesses, residents and tourists. Over the next few decades, the PPRW is expected to see population growth and land use change, especially in the eastern part of the watershed and along the I-94 corridor. In 2008, MPI Inc. announced the expansion of its facilities in Mattawan and the creation of 3,000 jobs. In 2007, Harbor Shores began a 530 acre development in Benton Harbor City, Benton Township and St. Joseph City. This development is expected to spur further economic and population growth in the Benton Harbor area. The cities and townships along Red Arrow Highway are working cooperatively to attract industrial, commercial and residential growth to the area. With these projects, population growth and major land use changes are expected to occur rapidly throughout the watershed.

For the long-term prosperity and health of these communities, the water quality and natural resources need to be recognized for their important role in the current and future economic development of the region. It will be imperative to have thoughtful and sensitive planning of these and other developments to ensure that the water quality and natural resources and the services they provide are protected. For more information on economic development and natural resources visit www.swmpc.org/growgreen.asp.

4 Resource Management

Federal, state, county and local governmental units and their agencies have exclusive, or share, responsibility for the management and protection of water, land and other natural resources. Local entities are obligated to comply with federal and state environmental statutes, county level ordinances and local ordinances. In the case of surface water protection, the federal and state laws generally provide a nation or statewide strategy for water quality protection. Because of their broad-scale nature there are often gaps in protection efforts. This presents opportunities for county and local governmental units to enact ordinances or standards that will support a more comprehensive water quality protection strategy.

For more information on opportunities for local government to protect water and other natural resources consult the "Filling the Gaps" documents at www.swmpc.org/gaps.asp.

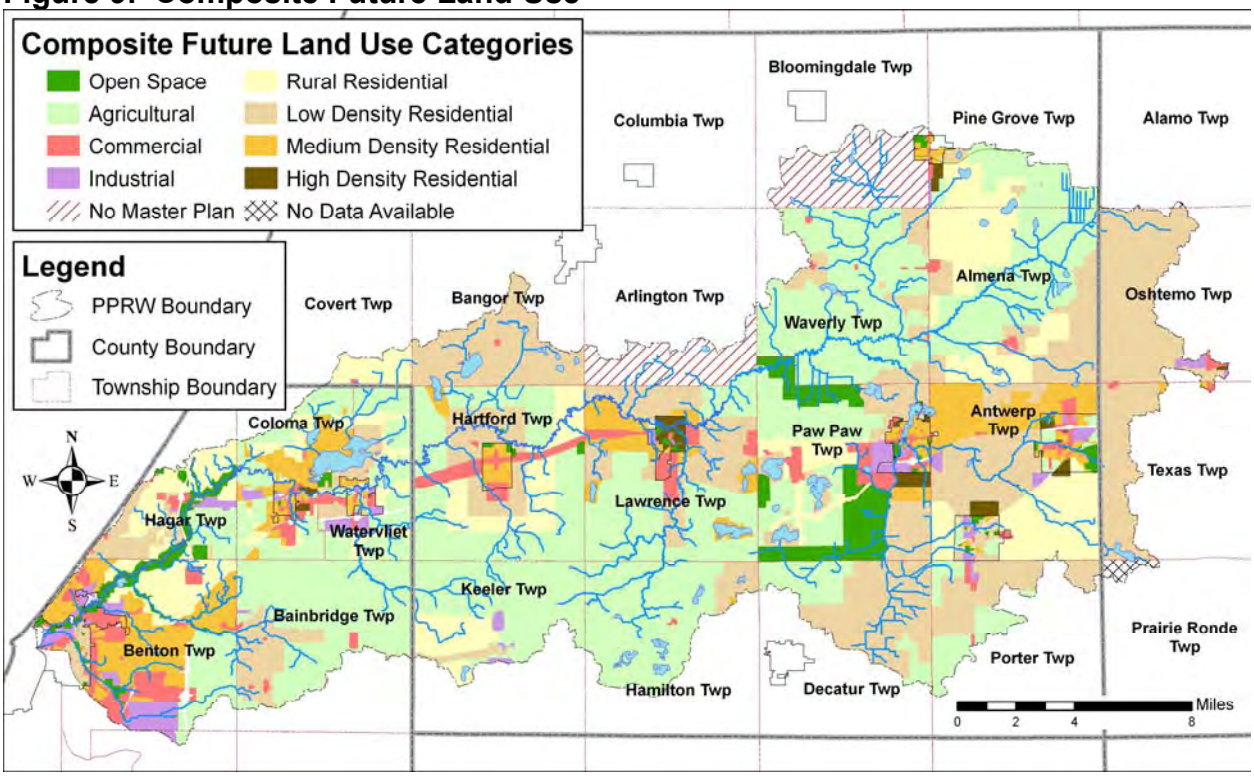
4.1 Land Use and Water Quality

The way land is managed, patterns of land use in relation to natural resources, and especially the way water is managed on a site to support the land use, has a large impact on the quality of water and the ecology of lakes, rivers, streams and shorelands. The authority to regulate land use rests primarily with local governments, largely through master plans and zoning ordinances. In addition, counties have the authority to enact ordinances that could affect the management of land. For example, several counties in Michigan have adopted phosphorus bans for fertilizer use. As a result, city, village, township and tribal governments have a significant role to play in protecting water resources. This role presents itself where federal and state statutes and county ordinances leave off.

The authority to regulate land use rests primarily with local governments. This gives cities, villages and townships a significant role in protecting water resources.

It is essential to plan for land uses with respect to existing natural features, soils and drainage patterns to lessen the impacts to water quality. Certain uses and activities should be located in areas where their impacts to water will be minimized. From a watershed perspective, land use will not only affect the immediate area, but also downstream areas and water bodies. Figure 9 is a composite map of future land use in the watershed. The future land use map was created from each governmental unit's master plan. The future land use map is a vision that is supposed to guide future development. Most of the land in the PPRW is planned for agriculture and rural or low - density residential use.

Figure 9. Composite Future Land Use



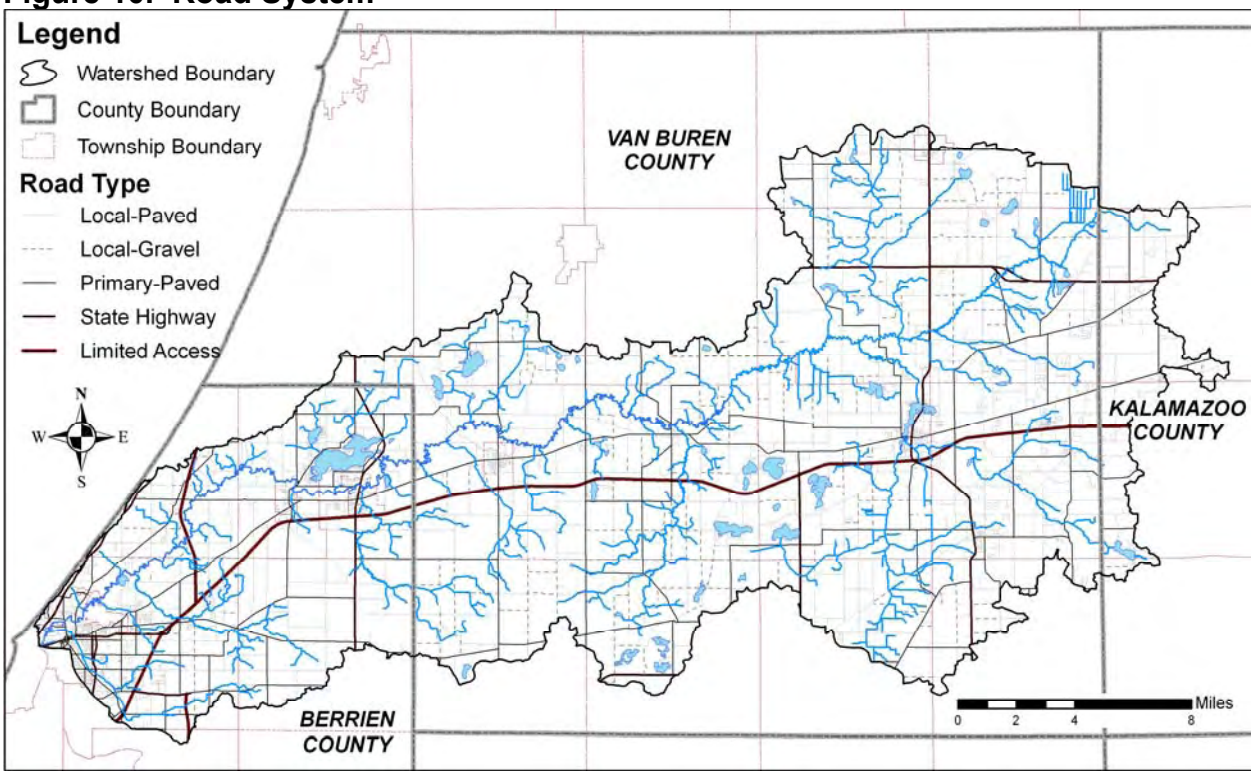
Once the placement of different future land uses (high density residential, low density residential, commercial, industrial, etc) are located with respect to soils, natural features, water bodies and drainage patterns, there should be great attention to how the land is developed. Land development can have a significant impact on water quality. The impacts to water quality that commonly result directly from development activity and increased drainage to support land development can be minimized through the use of smart growth and low impact development techniques. For more information on low impact development techniques visit www.swmpc.org/lid.asp.

Roads are a land use that can have substantial impacts on water quality. Controlling roadway-related pollution during project planning, construction and ongoing maintenance is important.

Roads and Water Quality

Roads are a land use that can have substantial impacts on water quality. Controlling roadway-related pollution during project planning, construction and ongoing maintenance is important. For example, the salting and sanding of roads during the winter can be a major pollution concern. Figure 10 shows the extent of the road system in the PPRW. MDOT and County Road Commissions are responsible for the construction and maintenance of most roads in the PPRW. However, the management of local roads is often shared with townships, cities and villages. In addition, many cities and villages have their own road systems, which they maintain. The Southeast Michigan Council of Governments (SEMCOG) published a guidance document designed to promote good planning practices and endorse consideration and integration of environmental issues into transportation projects. This guidance document is available on-line at www.swmpc.org/downloads/enviro_transpo_guidance.pdf.

Figure 10. Road System



4.2 Regulatory Authority and Water Resources

Water Bodies (rivers, drains, streams, lakes)

At the federal level, the Army Corps of Engineers exercises jurisdiction for navigation on the Paw Paw River from the mouth up to Paw Paw Avenue in Benton Harbor (about 2 miles). The Michigan Department of Environmental Quality (MDEQ) regulates water bodies in the watershed based on the Natural Resources and Environmental Protection Act, PA 451, part 301 Inland Lakes and Streams. This statute regulates the dredging, filling, construction and any structural interference with the natural flow of a lake or stream. This act also regulates marina operations. Permits are needed for activities such as construction of docks or placing fill or structures in lakes and streams. The Michigan Department of Natural Resources (MDNR) has the authority to regulate the number of boats and size of engines at MDNR access sites if human health or protected species are being impacted. Cities, villages and townships should enact ordinances that further protect the water quality of lakes and streams. Model ordinances to protect water quality can be found at www.swmpc.org/ordinances.asp.

MDEQ also regulates any discharges to lakes or streams such as those from industrial operations or municipal wastewater treatment plants through the National Pollutant Discharge Elimination System (NPDES) program. For a listing of NPDES permits in the watershed see Appendix 2. Further the MDEQ administers the Phase II stormwater program, which requires owners or operators of municipal separate storm sewer systems (MS4s) in urbanized areas to implement programs and practices to control polluted stormwater runoff. Benton Harbor City, Benton Charter Township, St. Joseph City, Berrien County Road Commission and Berrien County Drain Commissioner and

Administration participate in the Phase II stormwater program. More information on this program is available at www.swmpc.org/lsjr.asp.

The County Drain Commissioner is responsible for the administration of the Drain Code of 1956, as amended. The duties of the Drain Commissioner include the construction and maintenance of drains, determining drainage districts, apportioning costs of drains among property owners, and receiving bids and awarding contracts for drain construction. The Drain Commissioner also approves drainage in new developments and subdivisions and maintains lake levels. The soil erosion and sedimentation program is housed in the Drain Commissioner's office. The County Enforcement Agent for the soil erosion program has the responsibility of ensuring earth change activities that are one or more acres in area and/or within 500 feet of a watercourse or lake do not contribute soil to water bodies.

Wetlands

Michigan is one of two states that has the authority to administer section 404 of the Clean Water Act dealing with wetland protection. The Michigan Department of Environmental Quality regulates wetlands and shares this responsibility with the Army Corps of Engineers for the wetlands connecting to the Paw Paw River from the mouth to Paw Paw Avenue in Benton Harbor. However, MDEQ does not regulate all wetlands. Wetlands are regulated by MDEQ if they meet any of the following criteria:

- Connected to one of the Great Lakes.
- Located within 1,000 feet of one of the Great Lakes.
- 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 an inland lake, pond, stream, or river, but are more than 5 acres in size.
- Not connected to one of the Great Lakes, or an inland lake, pond, stream, or river, and less than 5 acres in size, but the DEQ has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner.

Since there are gaps in state protection of wetlands, a local unit of government (city, township, village, county) has the authority to create wetland regulations. A local wetland ordinance must be at least as restrictive as state regulations and the MDEQ must be notified if there is a local wetland ordinance in effect. Approximately 50 communities in Michigan have adopted local wetland ordinances. Although, none of these are in the PPRW, some jurisdictions within the watershed require building setbacks and a no-disturb zone around wetlands, which can be just as effective as a wetland ordinance.

> Local governmental units can enact building setbacks and a no disturb zone around wetlands to help protect water quality.

Floodplains

The Michigan Department of Environmental Quality requires that a permit be obtained prior to any alteration or occupation of the 100-year floodplain of a river, stream or drain to ensure that development is reasonably safe from flooding and does not increase flood damage potential. Local ordinances restricting development in floodplains can be more restrictive than MDEQ regulations.

Some communities in the PPRW participate in FEMA's National Flood Insurance Program (NFIP) (see Table 7). The NFIP is a Federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. The program is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods. The overall intent of NFIP is to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

Groundwater

Locally, the health department plays a role in groundwater protection with the regulation of the installation and design of septic systems. Local units of government have the authority to require the maintenance of septic systems through a septic system maintenance district ordinance. Another local groundwater protection option is a point of sale inspection ordinance for septic systems. With this ordinance, when property is sold there is a requirement to inspect the septic system. In Van Buren County, Columbia Township has recently adopted a point of sale septic inspection ordinance.

At the state level, the Department of Environmental Quality and the Department of Agriculture monitor groundwater use. All large quantity withdrawals, defined as having the capacity to withdraw more than 100,000 gallons of water per day average over any 30-day period, equivalent to 70 gallons per minute pumping, must be registered and water use must be reported annually. The Comprehensive State Groundwater Protection Program is a statewide program that looks at groundwater uses, including drinking water, and its role in sustaining the health of surface water bodies (rivers, streams, wetlands, marshes). The Wellhead Protection Program is intended to protect the drinking water supply. The program minimizes the potential for contamination by identifying and protecting the area that contributes water to municipal water supply wells and avoids costly groundwater clean-ups. The following cities and villages in the PPRW participate in a local Wellhead Protection Program:

Gobles Hartford Lawrence Lawton Mattawan Watervliet

4.3 Local Water Quality Protection Policies

Local governments regulate land use mostly through master plans and zoning ordinances. Table 7 presents a list of governmental units in the PPRW that possess master plans and zoning ordinances as well as participation in the Federal Emergency Management Agency (FEMA) National Floodplain Insurance Program (NFIP). Community participation in the NFIP is voluntary and based on an agreement between local governmental units and the Federal Government that states if a governmental unit will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas, the Federal Government will make flood insurance available within the community as a financial protection against flood losses.

As part of the PRRW Planning Project, several communities agreed to have their master plans and zoning ordinances reviewed by the Southwest Michigan Planning Commission (SWMPC). The goal of these evaluations was to assist with the identification of strengths and limitations in the master plan and zoning ordinances that support the protection of water quality and natural resources. The communities volunteering to have their plans and ordinances reviewed by SWMPC included:

Almena Township
Antwerp Township
Decatur Village
Decatur Township
Hamilton Township
Hartford Township
Hartford City
Paw Paw Village
Waverly Township

In addition to the municipalities listed above, the Pokagon Band of Potawatomi Indians provided a copy of their draft master land use plan to SWMPC for evaluation of its content. The plan does an excellent job of addressing natural resources and utilizes the information to influence growth and development decisions. Subsequent to the finalization of the Land Use Plan, a Tribal Land Use and Conservation Code will be developed to support the land use plan vision and may include any other form of land use requirement, restriction, or management practice considered necessary for the protection, sound use and development of the property and resources of the Band.

The full reviews of the plans and zoning ordinances are available on the SWMPC website at www.swmpc.org/pprw_pz_review.asp. In summary, the master plans generally did not relate water quality and natural resource protection to the safety and welfare of the residents and community. Most of the master plans did not address the connection between land use and water quality. Further, the plans generally did not discuss the negative impacts of increased impervious surfaces and the need for stormwater management and low impact development techniques to protect water quality. Lastly, most plans did not include much language on natural resources (lakes, wetlands, streams, riparian buffers, woodlands, open space etc.) and their value to the community and their role in protecting water quality. The following provisions were generally missing from most zoning ordinances reviewed:

1. Waterbody Protection

- require adequate building setbacks along rivers/drains and wetlands
- require naturally vegetated buffers along streams, rivers, lakes and wetlands
- floodplain protection regulations

2. Site Plan Review Process

- show the location of natural features, such as lakes, ponds, streams, floodplains, floodways, wetlands, woodlands, steep slopes, and natural drainage patterns on site plans
- show and label all stormwater best management practices on the site plan (rain gardens, swales, etc)
- site plan review criteria - require the preservation of natural features, such as lakes, ponds, streams, floodplains, floodways, wetlands, woodlands, steep slopes, and natural drainage patterns to the fullest extent possible and minimize site disturbance as much as possible

- require drain commissioner review of stormwater management during the site plan review process
- require the use of native plants in all landscaping plans and vegetative stormwater bmps (to help reduce storm water velocities, filter runoff and provide additional opportunities for wildlife habitat)
- require the use of Low Impact Development techniques whenever feasible (see Low Impact Development for Michigan: A Design Guide for Implementers and Reviewers at www.swmpc.org/downloads/lidmanual.pdf

3. Open Space and Agricultural Land Preservation

- use bonus densities or other incentives to encourage open space developments
- require all Planned Unit Developments to provide 25-50% open space
- require open space areas to be contiguous and restrict uses of open space area to low impact uses
- in agricultural zoning districts, utilize methods, such as sliding-scale, to limit fragmentation of farmland and to lessen conflicts between farming and residential uses
- require buffers between agricultural operations and residential uses
- allow for clustering/open space developments in agricultural districts to protect natural features

4. Parking Lots and Roads – Reducing Impervious Surfaces

- allow for more flexibility in parking standards and encourage shared parking
- require a portion of large paved parking lots to be planted with trees/vegetation
- require treatment of stormwater parking lot runoff in landscaped areas
- require 30% of the parking area to have compact car spaces (9 x18 ft or less)
- allow driveways and overflow parking to be pervious or porous pavement
- use maximum spaces instead of minimums for parking space numbers
- require landscaped areas in cul-de-sacs and allow hammerheads
- allow swales instead of curb and gutter (if curbs are used require perforated or invisible curbs, which allow for water to flow into swales

5. Stormwater BMPs (refer to Low Impact Development for Michigan: A Design Guide for Implementers and Reviewers at www.swmpc.org/downloads/lidmanual.pdf or see model stormwater ordinance at www.swmpc.org/ordinances.asp)

- allow the location of bioretention areas (rain gardens, filter strips, swales) in required setback areas and common areas
- encourage the use of best management practices (BMPs) that improve a site's infiltration and have BMPs labeled and shown on site plans
- require use of native plants for landscaping plans and for runoff/stormwater controls (prohibit invasive and exotics species)
- require use of BMPs and encourage use of above ground BMPs instead of below ground stormwater conveyance systems
- prohibit direct discharge of stormwater into wetlands, streams, or other surface waters without pre-treatment
- require periodic monitoring of BMPs to ensure they are working properly and require that all stormwater BMPs be maintained

Table 7. Zoning, Master Plans and NFIP Participation by Governmental Unit

Governmental Unit	County	Zoning?	Master Plan Date*	FEMA NFIP Participation
Alamo Twp.	Kalamazoo	Yes	Unknown	No
Almena Twp.	Van Buren	Yes	2006	Yes
Antwerp Twp.	Van Buren	Yes	2002	No
Arlington Twp.	Van Buren	Yes	Draft in progress	Yes
Bainbridge Twp.	Berrien	Yes	2003	Yes
Bangor Twp.	Van Buren	No	2001	No
Benton Harbor, City of	Berrien	Yes	1998	Yes
Benton Twp.	Berrien	Yes	2002	Yes
Bloomingdale Twp.	Van Buren	No	None	No
Coloma, City of	Berrien	Yes	1991	Suspended
Coloma Twp.	Berrien	Yes	2001	Yes
Covert Twp.	Van Buren	Yes	2004	Yes
Decatur Twp.	Van Buren	Yes	2001	No
Gobles, City of	Van Buren	Yes	2006	No
Hagar Twp.	Berrien	Yes	2001	Yes
Hamilton Twp.	Van Buren	Yes	2001	No
Hartford, City of	Van Buren	Yes	1999	No
Hartford Twp.	Van Buren	Yes	1999	No
Keeler Twp.	Van Buren	Yes	2002	No
Lawrence Twp.	Van Buren	Yes	2002	No
Lawrence, Village of	Van Buren	Yes	2002 – Draft	No
Lawton, Village of	Van Buren	Yes	2004	No
Mattawan, Village of	Van Buren	Yes	1998	No
Oshtemo Twp.	Kalamazoo	Yes	1993	Yes
Paw Paw Twp.	Van Buren	Yes	2003	No
Paw Paw, Village of	Van Buren	Yes	1999	Yes
Pine Grove Twp.	Van Buren	Yes	2006	No
Pokagon Band of Potawatomi	Van Buren	In Progress	2008 - Draft	No
Porter Twp.	Van Buren	Yes	2005 – Draft	No
Prairie Ronde Twp.	Kalamazoo	Yes	Unknown	No
Sodus Twp.	Berrien	Yes	2004	Yes
St. Joseph, City of	Berrien	Yes	2008	Yes
Texas Twp.	Kalamazoo	Yes	1999	No
Watervliet, City of	Berrien	Yes	Unknown	Yes
Watervliet Twp.	Berrien	Yes	1998	Yes
Waverly Twp.	Van Buren	Yes	2006 -Draft	Yes

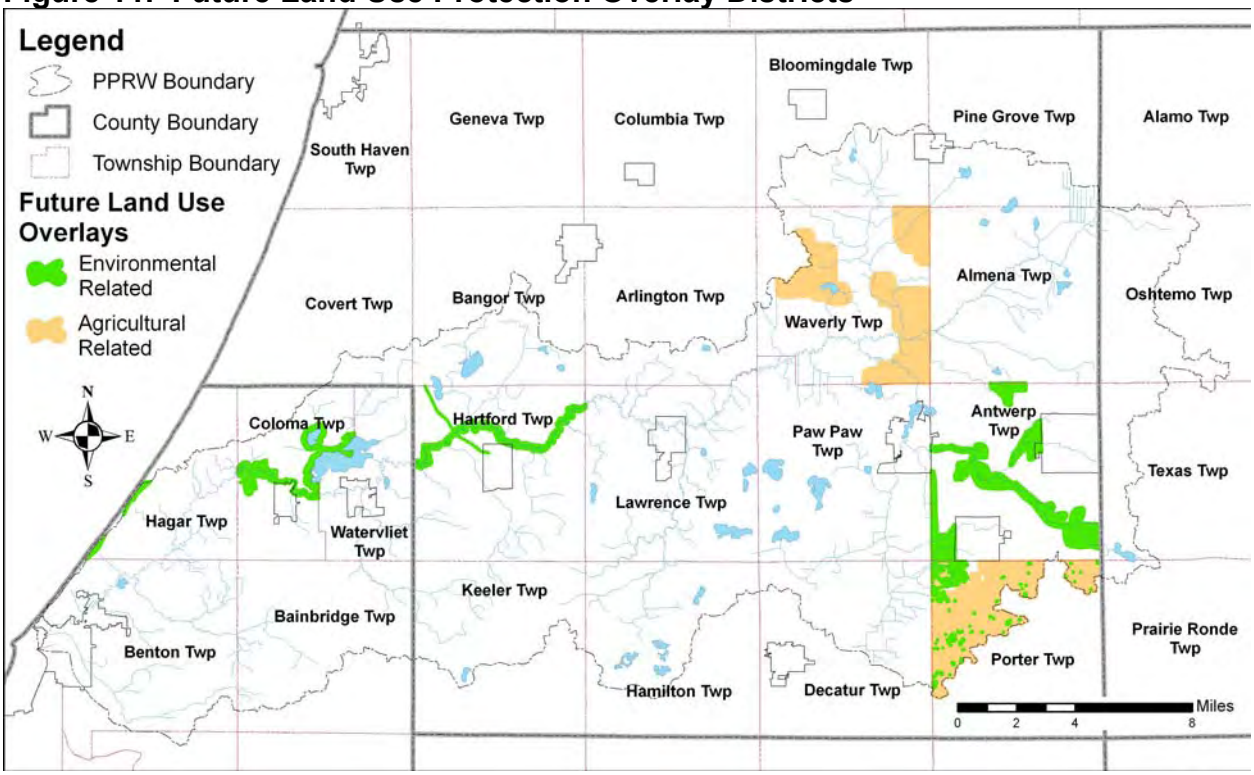
*on file at Southwest Michigan Planning Commission

A few municipalities have implemented specific protection regulations for the Paw Paw River and its tributaries. Figure 11 illustrates local protection initiatives for agricultural lands and natural and water resources through the use of overlay districts.

- Waverly and Porter Townships have agricultural related overlays to encourage farmland preservation.
- Hagar Township has an environmental overlay district along the Lake Michigan shoreline; much of this area is critical dune.
- Antwerp, Porter, Coloma and Hartford Townships have environmental overlay districts protecting water resources.
- Hartford Township has an overlay district along the Van Buren Trail.

It is evident from Figure 11 environmental overlay districts do not protect most of the Paw Paw River and its tributaries. However, several jurisdictions have ordinances that mandate building setbacks along water bodies and wetlands, which provide protection of water quality. These setbacks also provide room for a stream to meander and change its course over time. A building setback of at least 100-150 feet is ideal (this width may need to be increased if the floodplain is wider or if it is a coldwater stream).

Figure 11. Future Land Use Protection Overlay Districts



4.4 Private Land Management

Beyond, federal, state and local laws protecting water quality, the greatest opportunity to protect and preserve water quality and natural resources rests with the landowner in how they manage their lands. Most of the land in the watershed is in private ownership. Many organizations are willing to provide technical assistance to landowners on how to better manage their lands to protect natural resources and water quality. These

organizations include MSU County Extension Offices, Conservation Districts, Natural Resources Conservation Service, Southwest Michigan Land Conservancy, The Nature Conservancy, Sarett Nature Center, Department of Natural Resources and United States Fish and Wildlife Service (Partners for Wildlife Program). See Appendix 3 for more detailed information on protection and management options available for private lands.

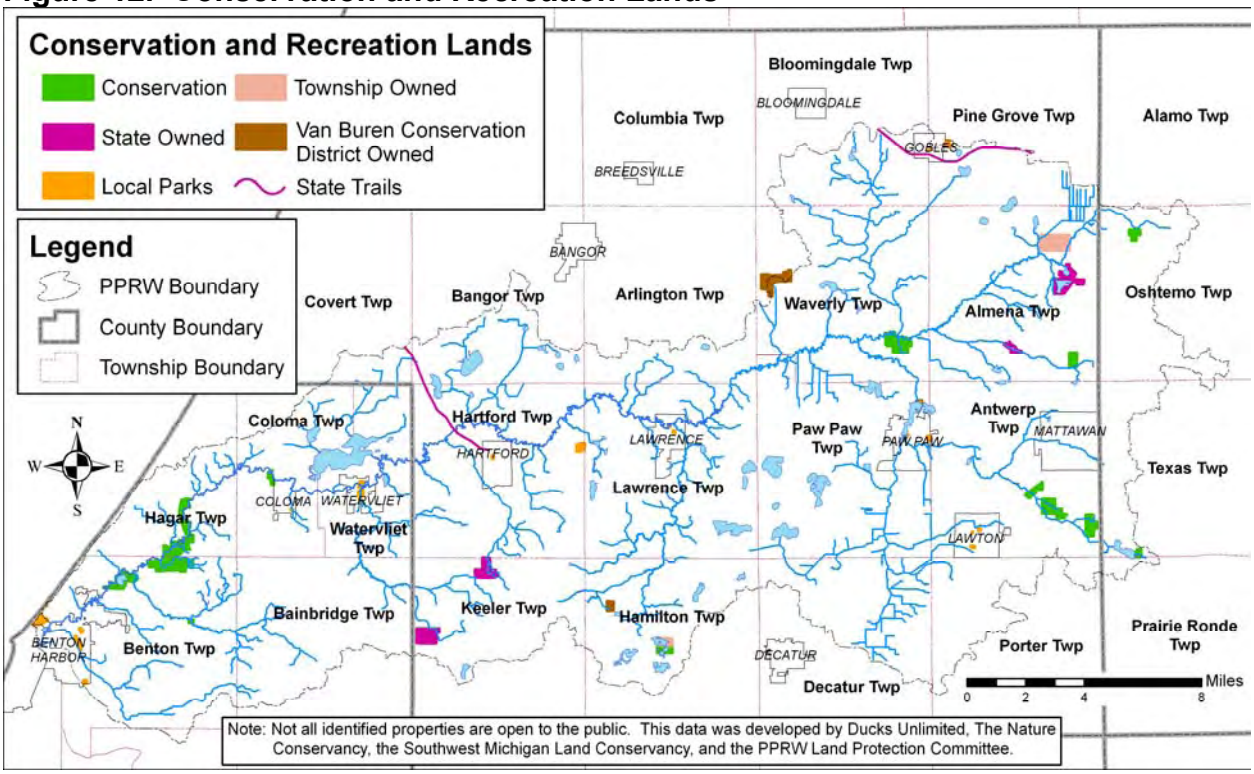
5 Natural Features

The natural features of the PPRW provide ecosystem services that benefit humans, such as recharging groundwater, cleansing air and filtering water. These natural features also provide recreational opportunities including fishing, hunting and boating. The Nature Conservancy has identified the Paw Paw River mainstem and certain tributaries as high-quality representative aquatic systems important for conserving freshwater biodiversity in the Great Lakes Basin.

5.1 Protected Lands

Figure 12 shows that over 2,000 acres in the watershed are under some form of protection. These lands include those owned by Sarett Nature Center, Michigan Department of Natural Resources, The Nature Conservancy (TNC), Southwest Michigan Land Conservancy (SWMLC), Michigan Nature Association and cities, villages and townships. The map also includes privately owned lands with conservation easements held by either TNC or SWMLC.

Figure 12. Conservation and Recreation Lands



5.2 Generalized Hydrologic Cycle

The earth's water is one large, continuous feature that exists within a complex and dynamic cycle, and is commonly categorized as distinct features such as surface water, groundwater and wetlands. Although the cycle has no beginning or end, it is convenient to describe the generalized cycle with a starting point of surface water. Water evaporates from oceans, lakes and other surface waters to the atmosphere and is carried over land surfaces, where it condenses and is precipitated onto the land surfaces as rain, snow, etc. Some water will drain across the land as runoff into a water body. The land cover will affect how this water moves across the land. If the surface soil is permeable, some water will infiltrate to the subsurface under the influence of gravity and will saturate the soil and/or rock. This zone of saturation is recognized as groundwater. Due to gravity, groundwater generally moves from areas of higher elevations to lower elevations to locations where it discharges to wetlands and/or surface water (lakes, streams, rivers). Wetlands may be viewed as a transition of groundwater to surface water, and visa-versa.

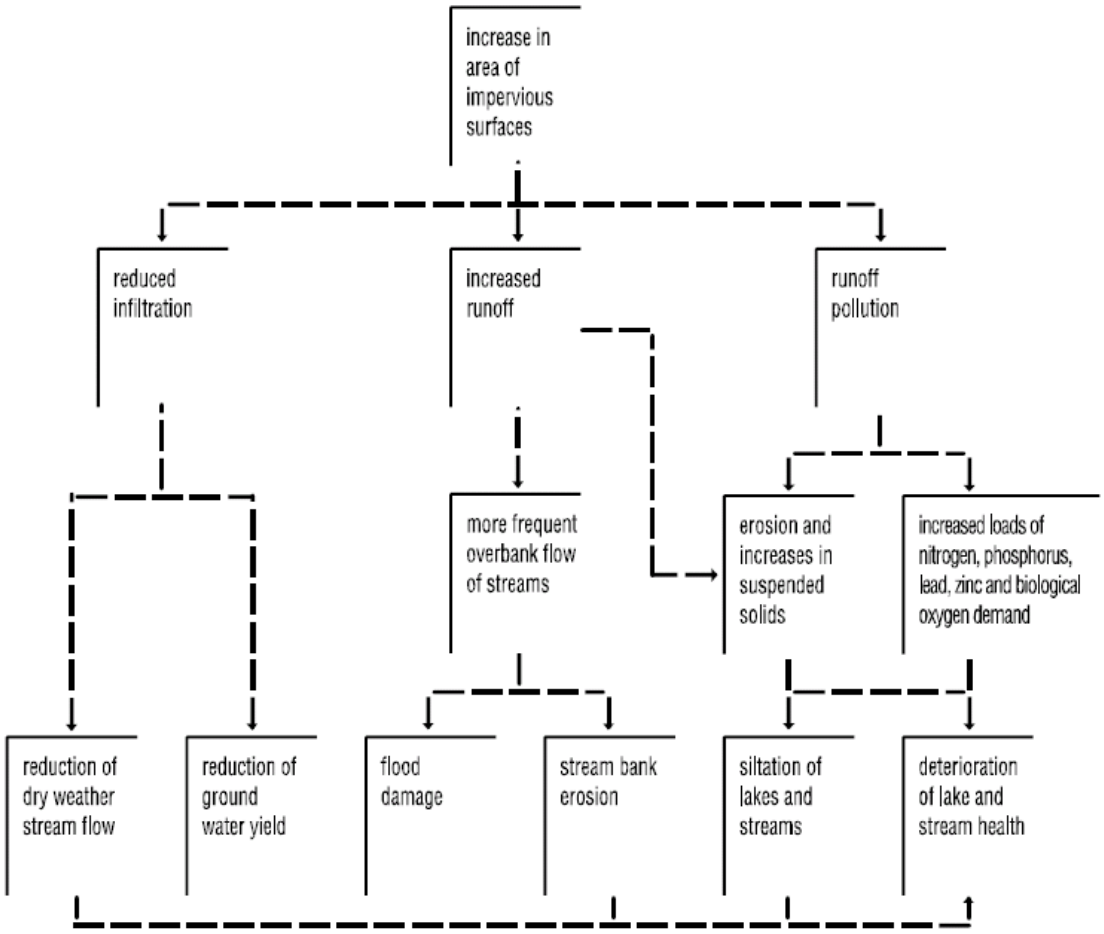
Pennsylvania Department of Environmental Protection

A properly functioning hydrologic cycle is greatly dependant upon the land cover and natural features in the watershed. Natural vegetation, such as forested land cover, usually has high infiltration capacity and low runoff rates. Whereas urbanized land cover has impervious areas (buildings, parking lots and roads) and networks of ditches, pipes and storm sewers, which augment natural stream channels. Impervious surfaces in urban areas reduce infiltration and the recharge of groundwater while increasing the amount of runoff. This runoff carries pollutants contributing to poor water quality. Agricultural lands, including row crops, orchards, vineyards, rangelands and animal farms can also have a significant impact on runoff and groundwater resources. Agricultural lands are often heavily compacted by farm equipment, which lessens their ability to infiltrate water. In addition, many agricultural lands are extensively ditched to move water off of the land as quickly as possible. Further, irrigation can alter the groundwater resources. These activities disrupt the natural hydrologic cycle and negatively impact the functioning of the remaining natural features in the watershed.

Figure 13 illustrates the many impacts of the loss of natural lands and an increase in impervious surfaces on water quality and quantity. The impacts resulting from land use change also negatively impact the fragmented natural areas left in the watershed. Following is a discussion of the different natural communities found in the PPRW and the major threats to their existence and quality. The interdependent natural systems

and communities discussed in this chapter include rivers, lakes, wetlands, groundwater, floodplain forests, upland forests, oak savanna and prairie remnants and rare species.

Figure 13. Impacts of Impervious Surfaces



5.3 Rivers/Streams

The Paw Paw River is a coolwater system containing warmwater and coldwater tributaries. Approximately 159,728 acres (56%) of the PPRW drain into designated coldwater streams. The remaining 125,829 acres (44%) drain to warmwater or coolwater water bodies. Figures 14 and 15 show the streams and rivers in the PPRW. These figures also show the watershed area contributing to coldwater streams. Coldwater streams are a unique natural feature providing important spawning habitat and thermal refuge for coldwater aquatic species such as trout.

Coldwater streams contribute to the hydrologic stability of the PPRW because they have large groundwater inputs. Coldwater streams with a July monthly average of 70 degrees Fahrenheit or lower comprise 69% (100 miles) of the river distance within the watershed. Designated trout streams (MDNR Fisheries Division regulations) found in the watershed are characterized by having fish communities dominated by mottled sculpin, brown trout, and coldwater minnows. Sand Creek, Blue Creek, Mill Creek, Pine

Creek, Brush Creek, North Branch Paw Paw River and tributaries above M-40, West Branch and East Branch above M-40 are designated coldwater trout streams within the watershed.

Warmwater streams typically have higher surface water inputs than groundwater inputs and as a result these streams have higher flow variability. Species richness is typically higher in southern Michigan streams, like the Paw Paw River, as a result of the overlap of regions supporting coldwater and warmwater species. The major tributaries in the PPRW that are considered warmwater are Ox Creek, Mud Lake Drain, Hog Creek, Branch Derby Drain and the Brandywine Creek. Table 8 lists primary streams and drains by subwatershed.

Figure 14. Water Bodies in the Paw Paw River Watershed (West)

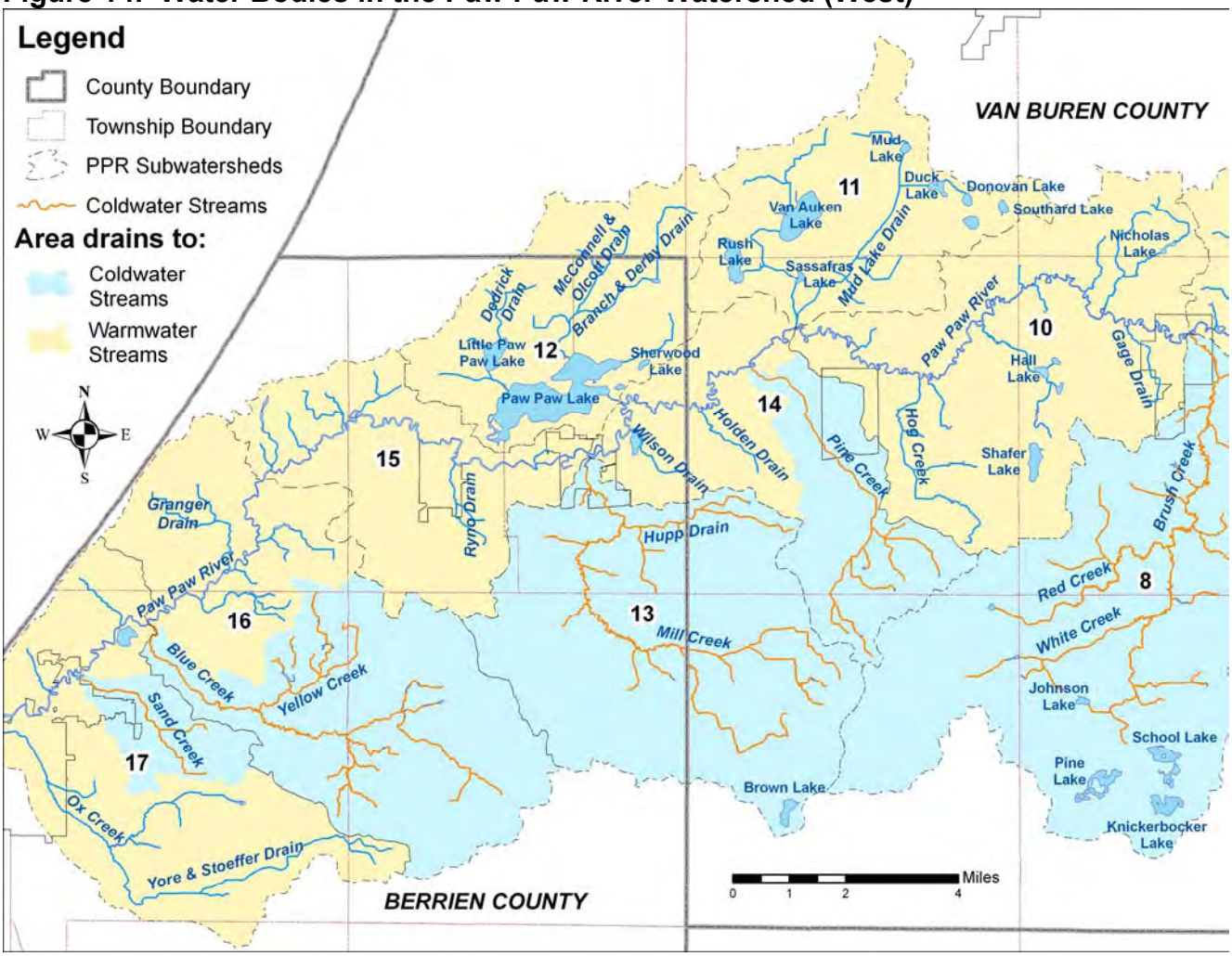
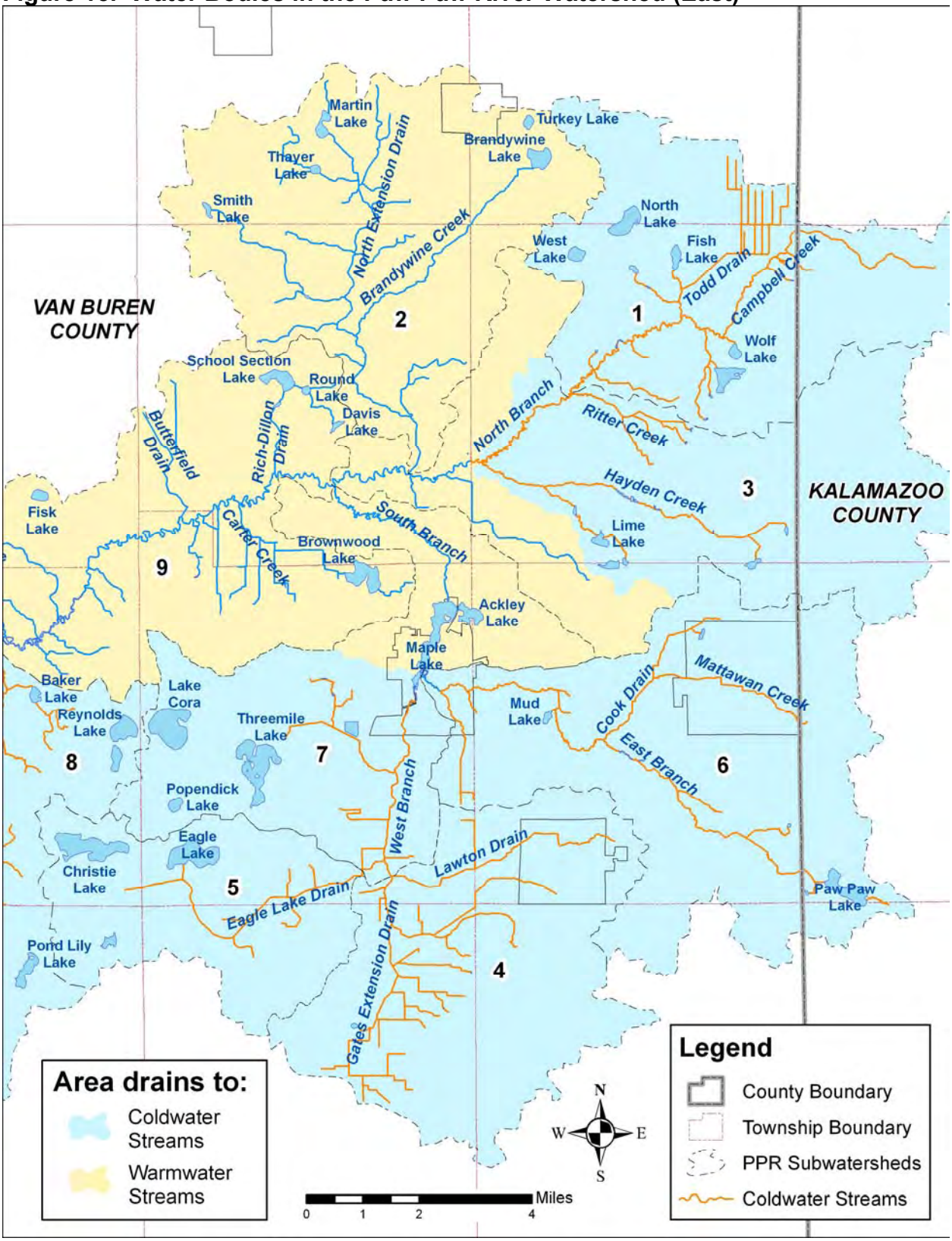


Figure 15. Water Bodies in the Paw Paw River Watershed (East)



The Paw Paw River and its tributaries can be characterized in terms of ecologically similar subwatersheds. Similarities within each subwatershed include soil types, surface geology and landscape patterns that relate to groundwater inflow and fish species composition. An MDNR report classifying the Paw Paw River subwatersheds on the basis of ecologically similar conditions is available online at www.swmpc.org/downloads/pprw_dnr_report.pdf.

Table 8. Streams in the Paw Paw River Watershed

Subwatershed ID #	Primary Streams & Drains
1	North Branch*, Campbell Creek*, Todd Drain
2	Brandywine Creek*, North Extension Drain, Martin Lake Drain
3	North Branch*, Hayden Creek*, Ritter Creek
4	West Branch*, Lawton Drain, Gates Extension Drain
5	Eagle Lake Drain*
6	East Branch*, Cook Drain, Mattawan Creek
7	West Branch*, South Branch*, Three Mile Lake Drain
8	Brush Creek*, Red Creek*, White Creek
9	Paw Paw Mainstem*, Carter Creek*, Butterfield Drain, Rich-Dillon Drain
10	Paw Paw Mainstem*, Hog Creek*, Gage Drain
11	Mud Lake Drain*, Van Auken Lake Drain, Rush Lake Outlet
12	Branch & Derby Drain*, McConnell & Olcott Drain, Dedrick Drain
13	Mill Creek*, Hupp Intercounty Drain
14	Paw Paw Mainstem*, Pine Creek*, Wilson Intercounty Drain, Holden Drain
15	Paw Paw Mainstem*, Ryno Drain
16	Paw Paw Mainstem*, Blue Creek*, Yellow Creek, Granger Drain
17	Paw Paw Mainstem*, Ox Creek*, Sand Creek*, Yore & Stoeffer Drain

*Additional information can be found in Appendix 4.

Threats

As discussed at the beginning of this chapter, water pollution and hydrologic alterations from changes in land use are a major threat to rivers and streams. This management plan is intended to address the major threats to surface water. Detailed information on water pollutants, their sources and causes can be found in Appendices 4 and 9.

Water pollution comes from all land uses in the watershed including residential, commercial, industrial and agricultural.

Invasive species such as zebra mussels also threaten aquatic communities in the Paw Paw River. Although zebra mussels need lakes or impoundments to persist long-term, they can colonize river and stream segments downstream from these water bodies indefinitely. Other invasive species threatening the Paw Paw River include round gobies and sea lampreys. The US Fish and Wildlife Service treats the lower Paw Paw River for sea lampreys every three years with lampricide TFM (3-trifluoromethyl-4-nitrophenol). The chemical treatment itself, however, may be a significant threat because it can cause indirect mortality of native reptiles, amphibians, fish and mollusks.

5.4 Lakes

The PPRW includes approximately 5,818 acres of lakes and ponds. There are 78 lakes greater than 10 acres in size that comprise 4,659 acres within the watershed. Paw Paw Lake in Berrien County is the largest lake in the watershed covering 920 acres. The only lakes in the PPRW with municipal sewer service are Paw Paw (Berrien County), Little Paw Paw, Brownwood, Maple and Ackley Lakes. Table 9 contains information on lakes greater than 5 acres in the PPRW. The maps of PPRW water bodies (Figures 14 and 15) display the name of all lakes greater than 10 acres.

Bluegill-largemouth bass communities dominate fish assemblages in lake environments in southern Michigan watersheds including the PPRW. Largemouth bass are found in most lakes in the watershed and are the primary predator on bluegill, which is the most abundant fish in these lakes. Fish communities in the watershed are comprised of a diverse number of other fish, averaging 20 species in each lake. In the PPRW, there are two rare fish species, lake herring (listed as state threatened) and spotted gar (a species of special concern) commonly found in lake environments. Two-story fisheries that support both coldwater fish (trout and lake herring) and coolwater fish (black bass and northern pike) are rare resources in southwest Michigan. They occur in Little Paw Paw Lake (Kalamazoo County) and Shafer Lake (Van Buren County). (Kregg Smith, MDNR, 2007)

A "two-story" fishery is a lake capable of providing two different types of fisheries. In the PPRW, the two-story fishery lakes contain coolwater and coldwater fish populations.

Table 9. Lakes in the Paw Paw River Watershed

Name	Sub watershed ID	County	Area (Acres)	Elevation	**Surface Water Connection	Maximum Depth (Approx.)	Public Access	Sewer System?
Ackley Lake	7	Van Buren	63	715	Outflow	15	Yes	Yes
Baker Lake	8	Van Buren	25	678	Throughflow	50		
Brandywine Lake*	2	Van Buren	73	771	Throughflow	25	Yes	
Brown Lake	13	Van Buren	50	768	Isolated	60		
Brownwood Lake	9	Van Buren	124	696	Throughflow	44	Yes	Yes
Carroll Lake	10	Van Buren	9	710	Outflow			
Christie Lake	5	Van Buren	238	756	Bidirectional		Yes	
Cornwall Lake	10	Van Buren	10		Outflow			
Davis Lake	9	Van Buren	12		Outflow	20		
Donovan Lake	11	Van Buren	18	669	Outflow	80		
Duck Lake	11	Van Buren	31		Bidirectional	40	Yes	
Dustin Lake	3	Kalamazoo	10	845	Isolated			
Eagle Lake*	5	Van Buren	196	755	Outflow		Yes	
East Lake	1	Van Buren	8		Outflow	22		
Fish Lake*	1	Van Buren	34	718	Throughflow		Yes	
Fisk Lake	9	Van Buren	30		Bidirectional			
Hall Lake*	10	Van Buren	21	695	Throughflow		Yes	
Hawk Lake	1	Van Buren	11		Outflow			
Hemlock Lake	1	Van Buren	12	774	Throughflow			
Hillocher Lake	10	Van Buren	7		Outflow			

Name	Sub watershed ID	County	Area (Acres)	Elevation	**Surface Water Connection	Maximum Depth (Approx.)	Public Access	Sewer System?
Johnson Lake	8	Van Buren	16		Outflow	20		
Kibler Lake	16	Berrien	11		Isolated			
Knickerbocker Lake	8	Van Buren	82	770	Bidirectional			
Lake Cora*	7	Van Buren	234	751	Bidirectional	60	Yes	
Lime Lake	3	Van Buren	28		Throughflow	40		
Little Paw Paw Lake	12	Berrien	101	624	Throughflow	29		Yes
Lower Reynolds Lake	8	Van Buren	40	756	Bidirectional			
Lyle Lake	2	Van Buren	6		Isolated			
Maple Lake*	7	Van Buren	166		Throughflow	15		Yes
Martin Lake*	2	Van Buren	44	747	Throughflow	35	Yes	
Mud Lake	11	Van Buren	15	656	Bidirectional	20		
Mud Lake	6	Van Buren	15		Outflow	50	Yes	
Mud Lake	4	Van Buren	5		Outflow			
Nelson Lake	9	Van Buren	7		Throughflow			
Nicholas Lake	10	Van Buren	11		Throughflow			
Paw Paw Lake*	12	Berrien	920	621	Throughflow	90	Yes	Yes
Paw Paw Lake*	6	Kalamazoo	123	871	Throughflow	56	Yes	
Pine Lake	8	Van Buren	96		Bidirectional			
Pond Lily Lake	8	Van Buren	66		Bidirectional			
Popendick Lake	7	Van Buren	29	757	Bidirectional	35	Yes	
Red Lake	8	Van Buren	6		Outflow			
Round Lake	9	Van Buren	12	685	Throughflow	40	Yes	
Rush Lake*	11	Van Buren	121	645	Bidirectional	56	Yes	
Sand Lake	6	Van Buren	19	754	Bidirectional	25	Yes	
Sassafras Lake	11	Van Buren	14		Throughflow			
School Lake	8	Van Buren	63		Bidirectional			
School Section Lake*	9	Van Buren	79	685	Throughflow	45	Yes	
Shafer Lake*	10	Van Buren	72	739	Throughflow	67	Yes	
Shaw Lake	9	Van Buren	10	683	Bidirectional	45		
Sherwood Lake	12	Berrien	12		Bidirectional			
Simmons Lake	2	Van Buren	13		Outflow	40		
Smith Lake	2	Van Buren	15		Throughflow	12		
Southard Lake	11	Van Buren	20	690	Bidirectional	40		
Tamarack Lake	1	Van Buren	12		Throughflow	30		
Thayer Lake	2	Van Buren	15	742	Throughflow	50		
Threemile Lake*	7	Van Buren	258	754	Bidirectional	40	Yes	
Turkey Lake	2	Van Buren	20	771	Bidirectional			
Upper Reynolds Lake*	8	Van Buren	96	756	Bidirectional	40	Yes	
Van Auken Lake*	11	Van Buren	252	650	Bidirectional	60	Yes	

Name	Sub watershed ID	County	Area (Acres)	Elevation	**Surface Water Connection	Maximum Depth (Approx.)	Public Access	Sewer System?
West Lake	1	Van Buren	37	748	Bidirectional	45		
Wolf Lake	1	Van Buren	25	718	Outflow	40	Yes	

*Additional water quality information in Appendix 4.

**Surface water connections were identified as part of the MDEQ Wetland Functional Assessment; groundwater linkages and hydrological relationships to wetlands and other water bodies are more complex than what could be determined by the simple visual assessment of surface water conditions performed by MDEQ.

Isolated – receives precipitation and runoff from adjacent areas with no apparent outflow

Outflow – water flows out of the water body, but does not flow in from another water body

Throughflow – water flows through water body, often coming from a stream or uphill sources

Bidirectional – inflow and outflow patterns are subject to the rise and fall of lake or reservoir levels

Threats

Threats to lake environments within the watershed are primarily related to shoreline development and land uses. Residential development around lakes with no connection to municipal wastewater treatment facilities can increase nutrient levels and bacteria counts in the lake. The only lakes within the PPRW that have municipal sewer systems are Paw Paw (Berrien County), Little Paw Paw, Brownwood, Maple and Ackley Lakes. With residential development, coarse woody material abundance and shoreline habitat diversity strongly declines while nutrient loading increases. Aquatic plant assemblages are also influenced by residential development, and interestingly, reproductive success of black bass nests declines almost two fold with increasing residential development. (Kregg Smith, MDNR Fisheries Division, 2007)

Human activities negatively affect inland lake ecosystems through alterations in water quality and physical habitat. For example, increased nutrient loadings from lawn fertilizers can increase algae and aquatic vegetation to nuisance levels and decrease concentrations of dissolved oxygen when excess algae and vegetation decompose. In addition, the quantity and quality of physical habitat available to fishes in the area between high and low water marks is altered by removal of coarse woody debris, by an increase or decrease (via chemical or mechanical removal) of aquatic plants, and by homogenization of the shoreline through erosion control efforts (e.g., rip-rap and sheet piling). Such changes in water quality and habitat features have been shown to negatively impact fish growth, limit natural reproduction of certain fish species, and reduce fish species richness while shifting assemblage structure towards more tolerant species. (Kregg Smith, MDNR Fisheries Division, 2007)

Invasive species are also a big concern in lakes. One nuisance aquatic invasive species is the zebra mussel. Through human activity such as boating, zebra mussels have the potential to spread. Zebra mussels attach to any hard surface and can clog water intake pipes. They can become a nuisance on docks and piers and they may compete with resident aquatic species that filter algae and zooplankton for food. Zebra mussels can improve water clarity, but they also kill native mussel species through

suffocation and starvation. Eurasian milfoil and curly leaf pondweed are two widespread nuisance plants in lakes. Boats and trailers can transfer these species to water bodies, so special care should be taken by boaters to limit the possibility.

5.5 Wetlands

Wetlands provide critical ecosystem services such as cleansing water, storing water and providing wildlife habitat. The wetland resource base in the PPRW has undergone significant disruption in the 200 years since Michigan was settled, losing approximately 50% of its total wetland area, and in some cases up to 62% of its wetland functionality. There is evidence to suggest that the result of these losses is reduced surface water quality and total loss of some fisheries. The watershed itself has been extensively ditched since pre-settlement, and this has resulted in the destruction, degradation, and vegetative conversion of many of the wetlands and waterways that originally existed. Forested wetlands have been the most affected, with silviculture and drainage for agriculture responsible for most of the impact. Because of ineffective drainage and/or forestry practices, there has been a sharp increase in the amount of emergent and scrub-shrub wetland acreage over time. According to the MDEQ Landscape Level Wetland Functional Assessment report for the PPRW, several wetland functions were reduced in capacity by 50% or more in the watershed as a whole; retention of sediment and other particulates lost 51% capacity, fish and shellfish habitat was reduced by 61%, and conservation of biodiversity by 62%. Other functions fell just below that mark, with streamflow maintenance, nutrient transformation, and other wildlife habitat all estimated to have lost 44-45% of their original capacity. No wetland functions have increased in the last 200 years.

A few large intact wetland complexes can be found in the watershed. One is located in the headwaters of the North Branch known as the Almena Swamp. Another is in Waverly Township north of the Paw Paw River. These wetlands perform functions that protect water quality and provide habitat for many species.

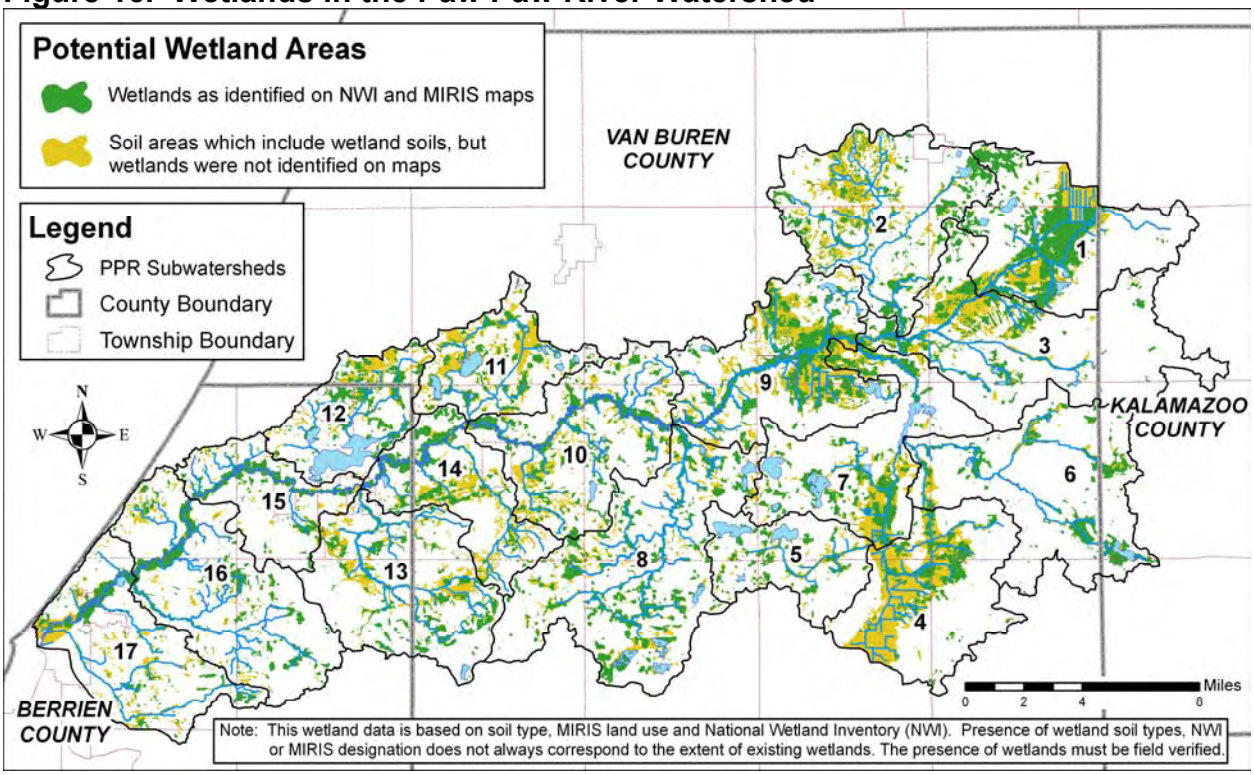
Still a few large intact wetland complexes can be found in the watershed. One is located in the headwaters of the North Branch known as the Almena Swamp. Another is in Waverly Township north of the Paw Paw River. (See Figure 16.) These wetlands perform functions that protect water quality and provide habitat for many species.

Wetlands of special interest in the PPRW include Great Lakes marsh and prairie fens. Great Lakes marsh is an herbaceous wetland community restricted to the shoreline of the Great Lakes and their major connecting rivers. Great Lakes Marsh exist from the City of Benton Harbor upstream to the Brown Sanctuary of Sarett Nature Center. Species of interest in these wetlands include the Swamp Rose Mallow (Hisbiscus moscheutos) and the Blanding's turtle (Emydoidea blandingii). For more information on Great Lakes Marsh visit www.swmpc.org/downloads/great_lakes_marsh.pdf.

Prairie fens are geologically and biologically unique wetlands found only in the glaciated Midwest. In Michigan, they occur in the southern three to four tiers of counties. The groundwater springs, which characterize prairie fens, are very rich in calcium and magnesium. Typical plants found in prairie fens are switchgrass, Indiangrass, big

bluestem, sedges, rushes, Indian-plantain, and prairie dropseed. The wettest part of a prairie fen, which is usually found near the water source, is called a "sedge flat" because members of the sedge family dominate the vegetation. The "fen meadow" is the largest part and is more diverse with many lowland prairie grasses and wildflowers. Slightly elevated areas, especially around the upland edge, also support tamarack, dogwood, bog birch and poison sumac. In the PPRW, prairie fens are found in the Blue Creek watershed, at Sarett Nature Center, near Lime Lake, in the Paw Paw Prairie Fen Preserve and around Paw Paw Lake in Kalamazoo County.

Figure 16. Wetlands in the Paw Paw River Watershed



Threats

Historically the PPRW contained 65,254 acres of vegetated wetland or 23% of the total watershed area. By 1998, the total wetland area had been reduced to 57% of its original extent. Conversion to farmland was the main reason for wetland loss. Conversion of forested wetland to emergent/scrub-shrub wetland due to logging practices and drainage also played a role in the cumulative impact of wetland functional loss. (Fizzell, 2007)

Current threats to wetlands include filling or draining to accommodate industrial, residential, agricultural or recreational land uses. Altered hydrology is a significant threat to most wetland types, whether it is due to a change in groundwater contributions to a fen or diversion of the water that feeds a swamp or marsh due to new road construction. Exotic species invasion, altered fire regime and polluted runoff with sediment, nutrients and chemicals also threaten wetlands.

5.6 Floodplains

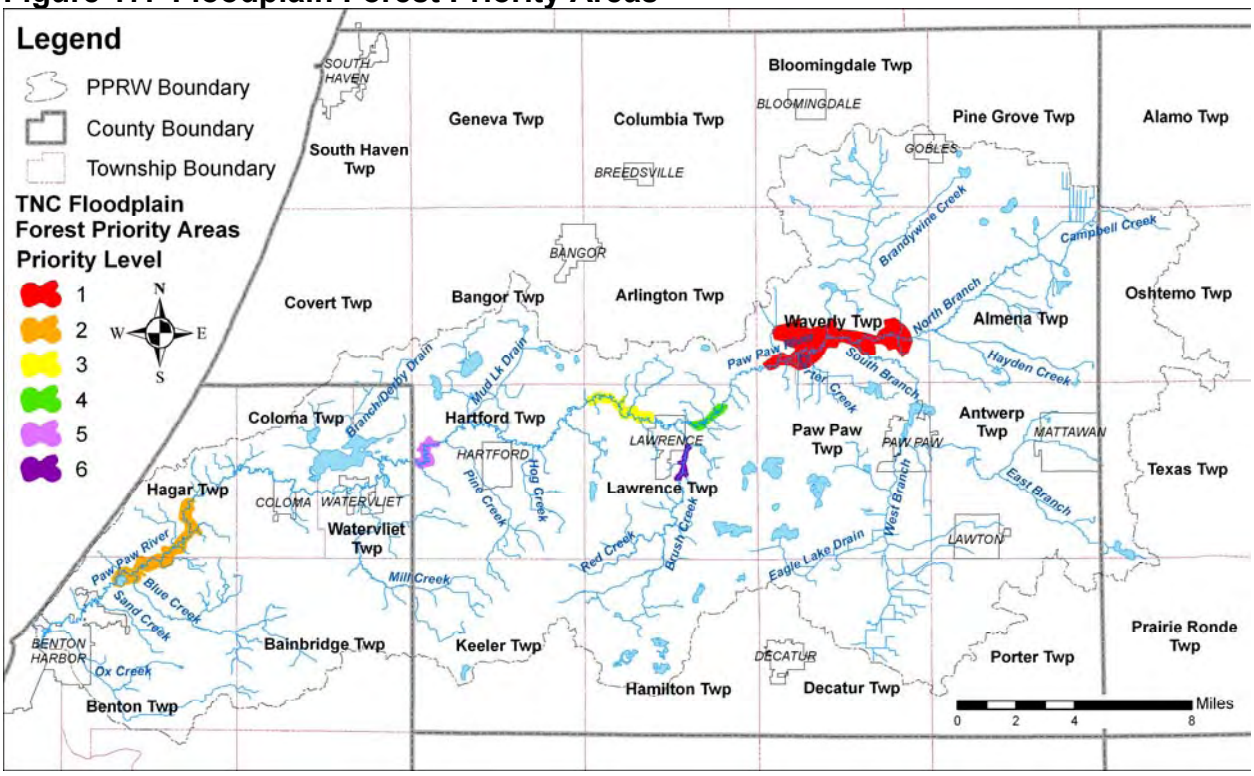
A river, stream, lake, or drain may on occasion overflow their banks and inundate adjacent land areas. The land that is inundated by water is defined as a floodplain. In Michigan, and nationally, the term floodplain has come to mean the land area that will be inundated by the overflow of water resulting from a 100-year flood (a flood which has a 1% chance of occurring any given year). Often, floodplains are forested with silver maple (Acer saccharinum) and red ash (Fraxinus pennsylvanica) being the major over-story dominant trees. These dynamic forested systems represent an interface between terrestrial and aquatic ecosystems and are extremely valuable for storing floodwaters, allowing areas for sediment to settle and providing wildlife habitat.

The forested floodplain along the Paw Paw River from Sarett Nature Center to the Paw Paw River Preserve in Waverly Township is largely intact.

The forested floodplain along the Paw Paw River from Sarett Nature Center to the Paw Paw River Preserve in Waverly Township is largely intact. This intact forest is important for migratory birds. Bird species of interest along the mainstem include the Prothonotary warbler (Protonotaria citrea), Wood thrush (Hylochichla mustelina) and the Cerulean warbler (Dendroica cerulea). For general information on floodplain forests visit www.swmpc.org/downloads/floodplain_forest.pdf.

For more specific information, a report on the prioritization of forested floodplain areas in the PPRW completed by The Nature Conservancy in 2006 is available online at www.swmpc.org/downloads/pprw_tnc_floodplain.pdf. Figure 17 is from the TNC report.

Figure 17. Floodplain Forest Priority Areas



Threats

Current threats to floodplains include conversion to industrial, residential, or recreational uses, wetland or floodplain fill or drainage, exotic species invasion, chemical pollution, sedimentation, and nutrient loading from agriculture and other land uses. Almost all rivers and their floodplains are subject to multiple hydrologic alterations, such as changes in land use, human-made levees, impoundments, channelization, and dams. The Nature Conservancy stated in the 2006 prioritization floodplain forest report, “even at the best floodplain forest sites, there is a serious threat from invasive species, because the forests here have extensive boundaries along agricultural lands offering numerous routes for invasion. Additional buffering of these core floodplain forest areas with more native upland forest would benefit them.”

5.7 Groundwater

Groundwater is the water that saturates the tiny spaces between soil and rock. Most groundwater is found in aquifers, which are underground layers of porous rock that are saturated from above or from structures sloping toward it. For water to reach the aquifer, it must be able to infiltrate through the soil.

Groundwater and surface water are fundamentally interconnected. In fact, it is often difficult to separate the two because they "feed" each other. Aquifers feed streams and provide a stream's baseflow. Those streams with a high baseflow are often coldwater streams. Often groundwater can be responsible for maintaining the hydrologic balance of streams, springs, lakes and wetlands.

Most of the PPRW is underlain with Coldwater Shale bedrock, which contains no aquifers. The only groundwater source is the water located in the coarse textured drift material left by the glaciers. These glacial sources typically yield high amounts of groundwater (20-1,400 gallons per minute) and are very vulnerable to groundwater pollution.

Overall, groundwater in southwest Michigan is very vulnerable to groundwater pollution.

Threats

Increased groundwater withdrawal to meet the demands of a growing population is a threat. Despite a general abundance of groundwater in the PPRW, there is growing concern about the availability of good quality groundwater for municipal, industrial, agricultural and domestic use, and for adequate baseflow to our lakes, streams and wetlands. Increased withdrawal can cause groundwater overdraft, which occurs when water removal rates exceed recharge rates. This depletes water supplies and may even cause land subsidence (the gradual settling or sudden sinking of the land surface from changes that take place underground).

In addition to groundwater withdrawals, increases in impervious surface and soil compaction limit infiltration and reduce groundwater recharge. These land use changes along with improvements in drainage efficiency (adding drain tiles, storm drains and ditches) further reduce groundwater recharge (see figure 18). The reduction in infiltration alters the hydrology of surface water causing increased flooding and streambank erosion.

Groundwater contamination can often be linked to land use. What goes on the ground can seep through the soil and turn up in drinking water, lakes, rivers, streams and wetlands. Activities in urban areas that pose significant threats to groundwater quality include industrial and municipal waste disposal, road salting, and the storage of petroleum products and other hazardous materials. In rural areas, different threats to groundwater quality exist such as animal waste, septic systems, fertilizers and pesticides. Table 10 lists common groundwater contaminant sources. Table 11 lists known areas of groundwater contamination in the PPRW.

Figure 18. Effects of Impervious Cover

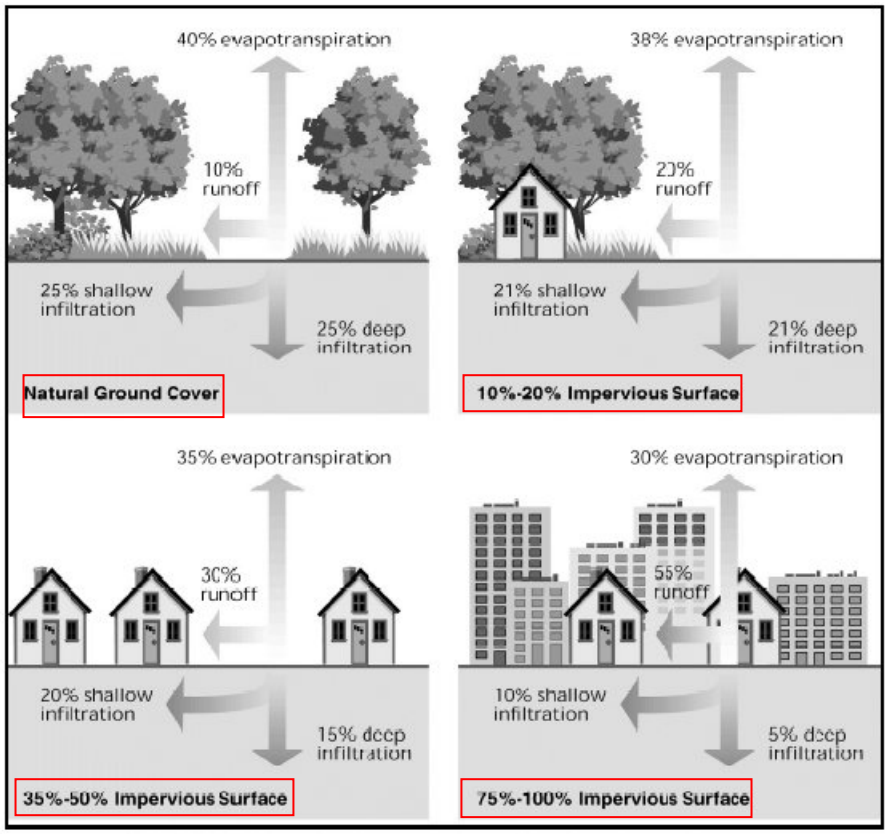


Table 10. Common Groundwater Contaminant Sources

Source	Contaminant	Source	Contaminant
Salting practices & storage	Chlorides	Solid waste landfills	Hazardous materials, Metals
Snow dumping	Chlorides	Industrial uses	Hazardous materials
Agricultural fertilizers	Nitrates	Households	Hazardous materials
Manure handling	Nitrates, pathogens	Gas stations	Hydrocarbons, Solvents
Home fertilizer	Nitrates	Auto repair shops	Hydrocarbons, Solvents
Septic systems	Nitrates, pathogens	Recycling facilities	Hydrocarbons, Solvents
Urban landscapes	Hydrocarbons, pesticides, pathogens	Auto salvage yards/junk yards	Hydrocarbons, Solvents
Agricultural dealers	Hydrocarbons, pesticides, nitrates	Underground storage tanks	Hydrocarbons
Agricultural feedlots	Nitrates, pathogens	Industrial floor drains	Hydrocarbons, Solvents

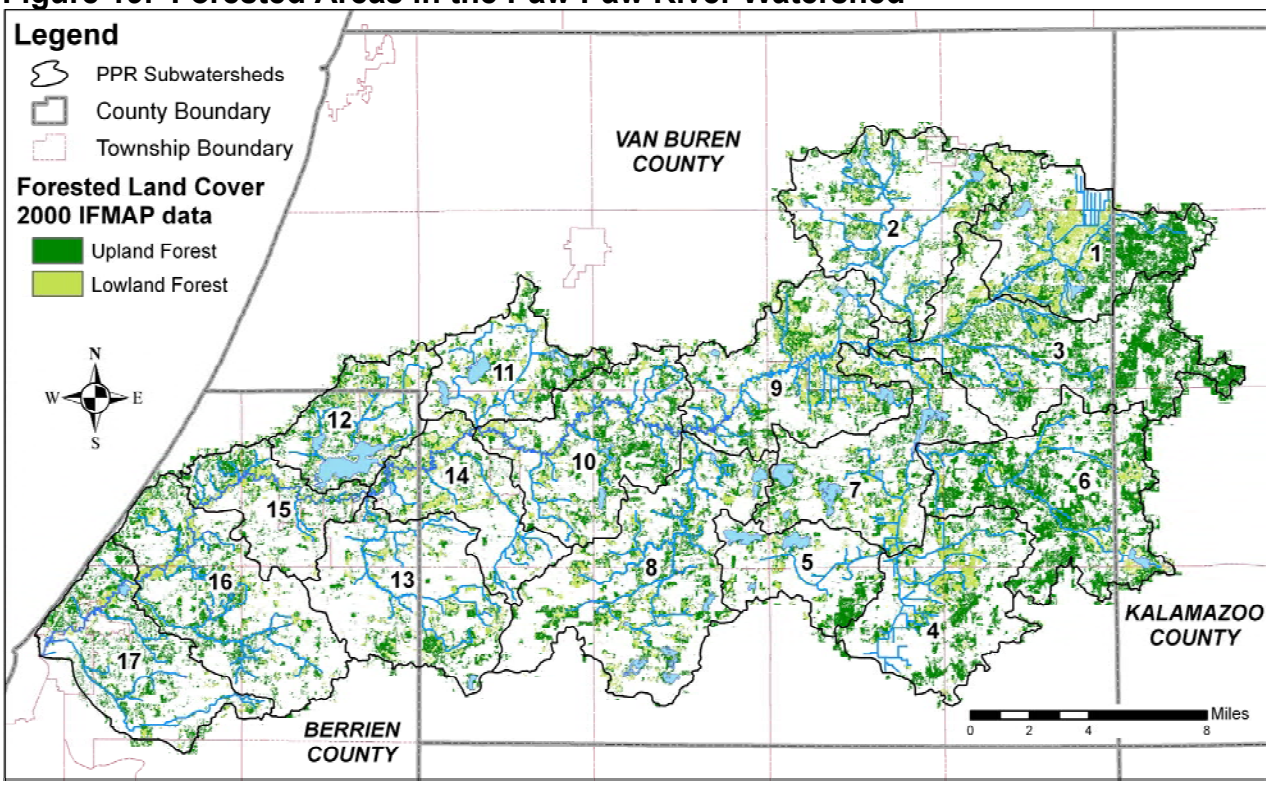
Table 11. Known Groundwater Contamination Areas

Area	Contaminant	Source
Coloma Township area	Dacthal®, a pre-emergent herbicide	Unknown
Ox Creek	trichloroethylene and hexavalent chromium	Harbor Plating, an abandoned chrome plating company
Oshtemo Township area	organic compounds, including chloroform, trichloroethylene, and perchloroethylene	West KL Avenue Landfill Superfund Site
Hartford	Heavy metals such as chromium, lead, and nickel	Burrows Sanitation Superfund Site
Benton Harbor	VOCs trichloroethene (TCE) and tetrachloroethene (PCE) and their breakdown products: 1,1-dichloroethene (1,1-DCE), vinyl chloride, and cis-1,2-dichloroethene (cis-1,2-DCE)	Aircraft Components Superfund Site

5.8 Forests

Forest lands protect rivers and streams and provide habitat for many species. Forest tress and the underlying organic humus layer intercept and help to infiltrate rainfall runoff contributing to the stability of the hydrologic cycle. According to Figure 19, the most intact forested areas are located along streams and rivers and in the PPRW headwaters area. Woodlands of southern Michigan that are dominated by beech and sugar maple also contain red oak, basswood, white ash, tulip tree, black cherry, black walnut and bitternut hickory. Upland forests on drier soils are generally an oak and hickory composition with black, red, white, and bur oaks, shagbark and pignut hickories, black cherry, black walnut and red maple.

Figure 19. Forested Areas in the Paw Paw River Watershed



Threats

The largest threats to natural forest communities in the PPRW are continued fragmentation and invasive species (e.g., garlic mustard). Fragmentation often results in nest predation and nest parasitism (mainly by cowbirds), which accounts for population declines of forest birds, especially neotropical migrants. Fragmentation also increases the ability of invasive species to penetrate forested areas. Invasive species can disrupt the forest's role in managing water and the hydrologic cycle. For more information on forests visit www.swmpc.org/downloads/mesic_southern_forest.pdf.

5.9 Savanna and Prairie Remnants

The PPRW has oak savanna and prairie remnants. Southwest Michigan is part of the tallgrass prairie region, which is dominated by grasses such as big bluestem and Indian grass. The tallgrass prairie vegetation sometimes reaches a height of 10 feet or more. Oak savannas, characterized by a grassy prairie-type ground cover underneath an open tree canopy, are common in areas that border the prairies. Prairies and oak savannas are fire-dependent systems.

Oak savanna and prairies support many species such as the Eastern box turtle and the Great Plains spittlebug. These systems in the PPRW also support plants that are rare in Michigan and indicative of high-quality savannas, including Rattlesnakemaster, prairie coreopsis, sand grass, and black haw. The savannas with their native plants play an integral part of the hydrologic cycle by providing areas where water can easily infiltrate the soil. For more information on oak savannas visit www.swmpc.org/downloads/oak_barrens.pdf.

Threats

The largest threat to savanna areas is the conversion to developed uses. Developing these natural areas can disrupt the natural water infiltration capacity of these areas. In addition, invasive alien plants have become extensively established in oak savanna and prairie remnants. These aggressive species are encouraged by the conversion of open lands to homes. Development creates large amounts of disturbed open ground and roadways that are new invasion routes for invasive species. Increased human recreational and other activities connected to development also tend to spread invasive plants' seeds further into natural areas. Suppression of natural fire regimes in developed areas further encourages the dominance of invasive over native plants, which are often adapted to recurring fire. Invasive plant species can actually result in reduced groundwater recharge, which disrupts the hydrologic cycle.

5.10 Rare Features

A variety of rare species and communities have been documented in the PPRW. The Michigan Natural Features Inventory (MNFI) maintains a list of threatened, endangered, and special concern species/communities in Michigan. Twenty-three species of animals, 46 species of plants, 7 communities, and one "other" element (Great Blue Heron Rookery) are listed as either federally endangered, a candidate for federal status under the Endangered Species Act of 1998, state special concern, state threatened, state endangered or probably extirpated for the PPRW. The list of species and communities can be found in Appendix 5.

Threats

The major threat to rare species and features is habitat loss and fragmentation. As natural habitats become more fragmented and disrupted, invasive species can be accidentally or deliberately introduced into high quality habitat areas. Invasive species can displace or eliminate native species, particularly rare species that have specific habitat requirements. Invasive species can substantially alter the structure and functioning of high quality natural communities including an alteration of the amount of water that is infiltrated. Further, new construction can affect groundwater infiltration rates and consequently reduce the amount of water discharging from a spring. An altered hydrologic cycle can change the conditions necessary for the continued health of rare species populations and some natural communities such as prairie fens.

6 Plan Development Process

This PPRW Management Plan was developed utilizing the best available data along with input from stakeholders. The planning process included

- soliciting public input
- reviewing previous studies and reports
- conducting a volunteer inventory to identify problem sites and areas
- conducting research on topics of concern such as wetland functions, floodplain forests, agricultural concerns and hydrology
- developing models to determine priority areas

6.1 Public Input

Public participation was relied upon heavily during the planning process to solicit input on all stages of plan development. The results from previous public forums and meetings were utilized to identify watershed concerns. Further, during the planning process, several methods were used to engage stakeholders and solicit input. These methods included steering committee meetings, sub-committee meetings, a website with feedback opportunities, and extensive email communications to interested citizens and groups.

Public participation methods included steering committee meetings, sub-committee meetings, a website with feedback opportunities, and extensive email communications to interested citizens and groups.

Steering committee and sub-committee participants were instrumental in identifying and commenting on designated uses, desired uses, pollutants, sources and causes of pollutants, priority or critical areas and in developing goals, objectives and an action plan. A list of steering committee participants can be found in Appendix 6. Many partners were instrumental in providing information, completing modeling efforts, organizing and implementing the volunteer inventory and providing feedback on early versions of the plan. The key governmental and non-profit partners included the Michigan Department of Environmental Quality, Michigan Department of Natural Resources, the Berrien and Van Buren Conservation Districts, Southwest Michigan Land Conservancy, Sarett Nature Center, The Nature Conservancy, Pokagon Band of Potawatomi Indians, the Paw Paw Lake Association, Van Buren County Drain Commissioner, Hamilton Township, Village of Paw Paw and Almena Township.

The Internet was used throughout the plan development process. An email communication list containing over 150 addresses was used to keep stakeholders informed and to offer the opportunity to comment on the information being presented. The PPRW website contained information relating to the development of the plan including all steering committee meeting summaries. An on-line forum allowed individuals to submit comments throughout the process.

The media assisted in alerting watershed stakeholders and residents about the PPRW Management Plan and encouraged them to comment on the draft plan either on-line, by phone or in person. In May 2008, SWMPC held an open house for stakeholders to

review and comment on the plan. Channel 3 News announced the open house and several concerned citizens came to the open house to learn about the watershed and the management plan.

Stakeholder Concerns

Paw Paw River Watershed Stakeholders have identified known or perceived impairments and problems within the PPRW at Steering Committee meetings from 2006 to 2008 and in a public watershed forum held in November of 2004. Stakeholders expressed concerns about several issues in the PPRW. One issue that united the stakeholders was preservation of the connected forested floodplain corridor along the Paw Paw mainstem. Including the Paw Paw River in the state's Natural Rivers Program was discussed as an option for protecting the floodplain corridor. Another issue was large-scale wetland filling or draining for proposed projects such as the Paw Paw Wal-Mart, Harbor Shores in Benton Harbor and the Hartford - Watervliet Area Development Corridor along Red Arrow Highway. Specific pollution concerns included discharge from the Coca-Cola/Minute Maid facility near Paw Paw, bacteria and pathogens from the Hartford Dairy CAFO and groundwater contamination in Coloma and Oshtemo Townships. Sedimentation was a concern for all water bodies, but is especially noticeable in Maple and Paw Paw Lakes. Stakeholders were also concerned about the potential negative impacts on natural resources from increased recreational use. A full list of stakeholder concerns have been compiled and organized by topic in Appendix 7.

Wetlands are often filled to create roads, driveways, and building sites.

6.2 Previous Studies/Reports

Several studies and reports pertaining to the PPRW were reviewed during the development of this management plan. The information contained in these reports provided much of the background information and also helped to prioritize protection and management areas. A list of known studies and reports pertaining to the PPRW are listed in the Appendix 8.

6.3 Volunteer Inventory

A volunteer inventory project was conducted in the PPRW throughout the summer of 2006. The purpose of the inventory project was to establish a baseline characterization of the watershed and identify potential or existing problem sites. Volunteers completed a riparian survey form at 217 road/stream crossing sites within the PPRW. The survey assessed stream bank erosion potential using Rosgen's Bank Erosion Hazard Index (BEHI) methodology. The survey also addressed other riparian criteria, such as stream width, canopy coverage and vegetation type. Volunteers took several photographs at each survey location. A database was used to store survey results, calculate erosion potential (based on BEHI criteria) and organize photographs taken during the survey.

The value of the survey results for characterizing erosion potential throughout the watershed was limited due to inconsistency between volunteers. However, data collected for other riparian conditions and the 941 photographs taken during the inventory project were useful for establishing a baseline characterization of the

watershed. Volunteers identified several problem sites during the inventory process. The types of problems included unrestricted livestock access to streams, soil erosion from new construction and soil erosion from road runoff. Some of these problems were corrected after the inventory was completed; the remaining problem sites are included in Figure 26. The volunteer inventory final report is available online at www.swmpc.org/downloads/pprw_volunteer_inventory.pdf.

6.4 Watershed Research and Modeling

MDEQ Landscape Level Wetland Functional Assessment

Wetlands are critical for providing diverse wildlife habitat, improving water quality and stabilizing stream flows throughout the watershed. In 2007, Michigan Department of Environmental Quality (MDEQ) completed a landscape level analysis to better understand the functions of existing and lost wetlands in the PPRW. The results from this analysis can be utilized to locate wetlands with important functions such as protecting water quality, providing habitat and reducing flood impacts in the watershed. The results can help pinpoint potential restoration, enhancement, and protection activities to appropriate areas of the watershed that are most in need of a particular wetland function. These functions include 1) surface-water detention 2) streamflow maintenance 3) nutrient transformation 4) sediment and other particulate retention 5) shoreline stabilization 6) provision of fish and shellfish habitat 7) provision of waterfowl and waterbird habitat 8) provision of other wildlife habitat, and 9) conservation of biodiversity (rare or imperiled wetland habitats in the local region with regional significance for biodiversity). The final report is available online at www.swmpc.org/downloads/pprw_WetlandFunctionAssmnt.pdf.

TNC Prioritization of Forested Floodplain

The largely intact floodplain forest corridor along the Paw Paw River mainstem from Benton Harbor to Paw Paw Village is one of the greatest assets of the PPRW. The forested floodplain not only provides habitat for several migratory birds and other species, but it also maintains water quality, stabilizes flows and reduces flooding in the Paw Paw River. In 2006, The Nature Conservancy (TNC) completed a report that prioritized six areas of forested floodplain along the Paw Paw River and identified threats to these areas. The results from this report will help to focus TNC's protection and management efforts. Further, the results assisted with the prioritization of protection areas in the PPRW management plan. The TNC report is available online at www.swmpc.org/downloads/pprw_tnc_floodplain.pdf.

TNC Agricultural Assessment

Based on soil types and lack of ground cover (using Google Earth), problem agricultural areas within the PPRW were identified in this assessment. The report recommends which best management practices should be implemented in each problem area. The TNC report is available online at www.swmpc.org/downloads/pprw_tnc_ag_assmnt.pdf.

SWAT Model

The Soil and Water Assessment Tool (SWAT) was used in the PPRW because of its ability to simulate agricultural best management practices (BMPs). It was also utilized

in the St. Joseph River Watershed Management Plan. The SWAT model was used to assess sediment and nutrient loads within the PPRW, and to predict load reductions from selected agricultural BMP scenarios. The report is available online at www.swmpc.org/downloads/pprw_swat_report.pdf.

Build Out Model

In 2008, Keiser & Associates completed a build out model for the PPRW. The purpose of this effort was to evaluate the impact of future land use changes on water quality, specifically runoff volume, total suspended solids, phosphorus and nitrogen. In the model, land use change was based on the future land use maps from local municipal master plans. This report will be instrumental in working with governmental units on master plan and zoning ordinance updates to improve and/or protect water quality. Further, the results from this effort helped identify areas where future development is expected to threaten water quality. The report is available online at www.swmpc.org/downloads/pprw_buildout_report.pdf.

SWMLC Conservation Priority Model

The PPRW Land Protection Committee assisted the Southwest Michigan Land Conservancy (SWMLC) in the development of a model used to map critical areas for preservation. These areas were identified in order to assist land conservancies, governmental units, and other groups in locating high priority sites for preservation. The model united local knowledge and human values with the best available scientific data. The model was refined throughout the planning process as more data was received. The final report from this modeling effort is available online at www.swmpc.org/downloads/pprw_cp_mdl_report.pdf.

SWMPC Models

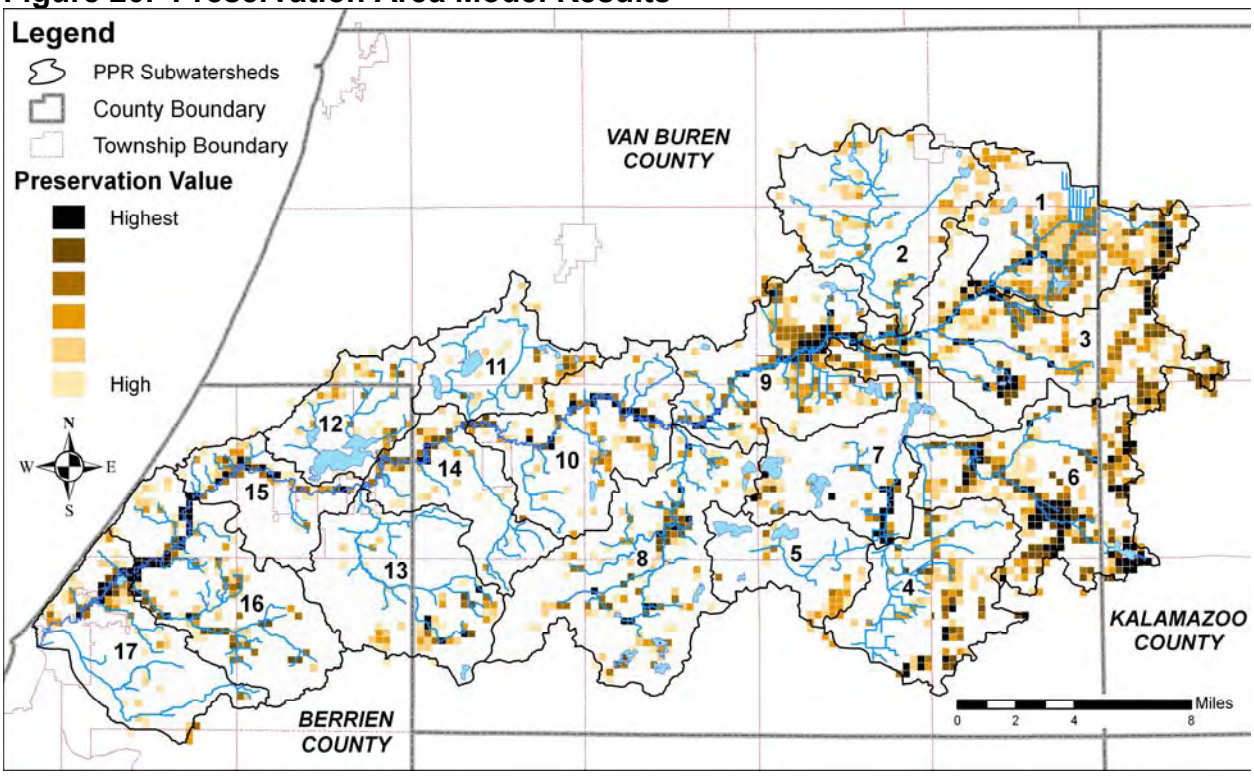
The Southwest Michigan Planning Commission (SWMPC) adapted the methodology used in the SWMLC Conservation Priority Model to create three new models. These models were developed to help understand the significance and geographical distribution of protection and management areas in the PPRW. The models divided the entire watershed into 7605 “squares” known as quarter-quarter sections (QQs). Each “square” or QQ is approximately 40 acres. GIS software was used to calculate a score for each QQ based on the presence, absence or significance of certain criteria. For each model, the PPRW Steering Committee helped determine which criteria were used, as well as how much “weight” or value each criterion was given. Combining the value of each criterion for each QQ allowed for ranking on the basis of preservation or management priority.

1. Preservation

The preservation area model was developed to help locate high quality natural areas. It can be utilized to influence planning and zoning decisions (such as water body setbacks and low impact development techniques) and also to target the private land protection efforts of land conservancies. The following criteria were considered when calculating the preservation value of each QQ: 1) land cover – percent of natural land cover, 2) hydrology – presence and/or quality of water features, 3) groundwater recharge

potential, 4) proximity to already protected areas, 5) presence of priority floodplain forest areas and 6) presence of wetlands with significant habitat related functions. Figure 20 illustrates the top 25% of all QQs for preservation value. More information on the SWMPC Preservation Area Model is available online at www.swmpc.org/downloads/pprw_pres_mdl.pdf.

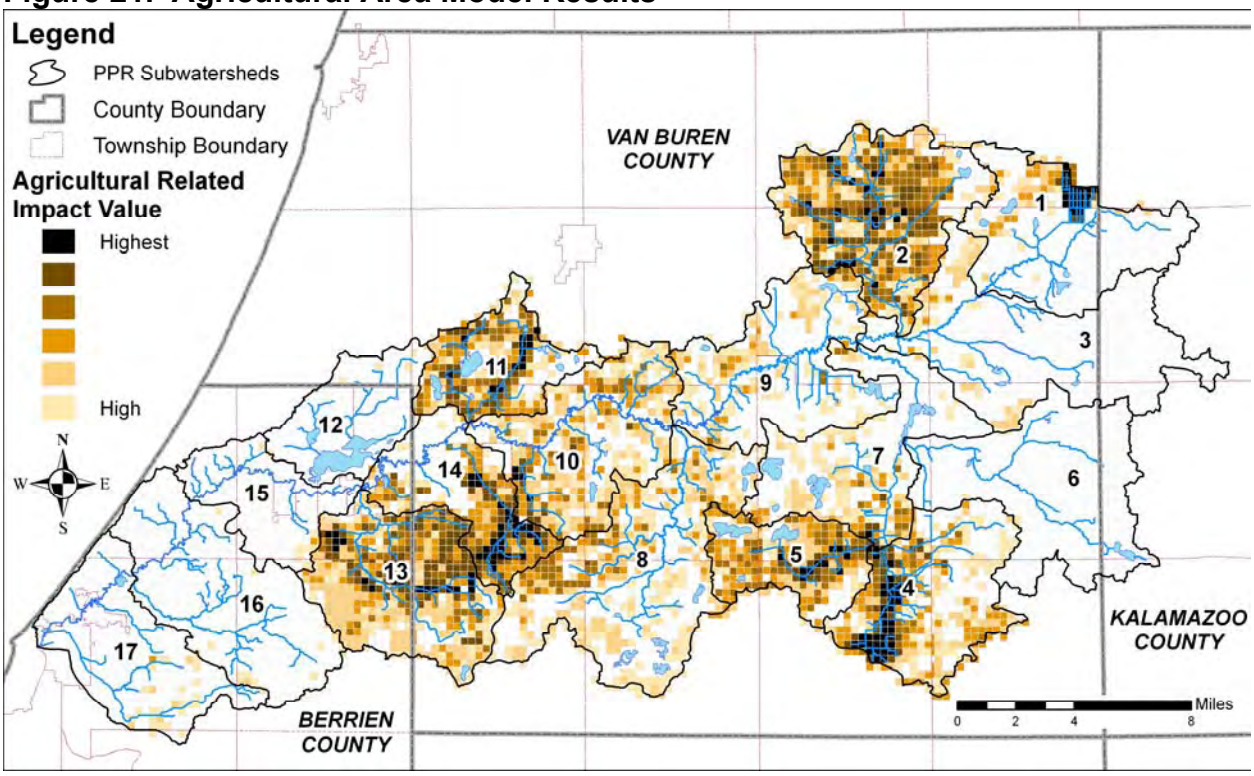
Figure 20. Preservation Area Model Results



2. Agricultural

The agricultural area model was developed to help locate agricultural areas that could have an impact on water quality. It can be used to target best management practices, restoration efforts and outreach to the agricultural community. The following criteria were considered when calculating the impact value of each QQ: 1) land cover – percent of agricultural land cover, 2) impaired water bodies – the presence and severity of water quality impairments, 3) pollutant loading – estimates from SWAT model and 4) lost wetland functionality – absence of historic wetlands with a high significance for nutrient transformation and/or sediment and other particulate retention. Figure 21 illustrates the top 40% of all QQs for agricultural related impact value. More information on the SWMPC Agricultural Area Model is available online at www.swmpc.org/downloads/pprw_ag_mdl.pdf.

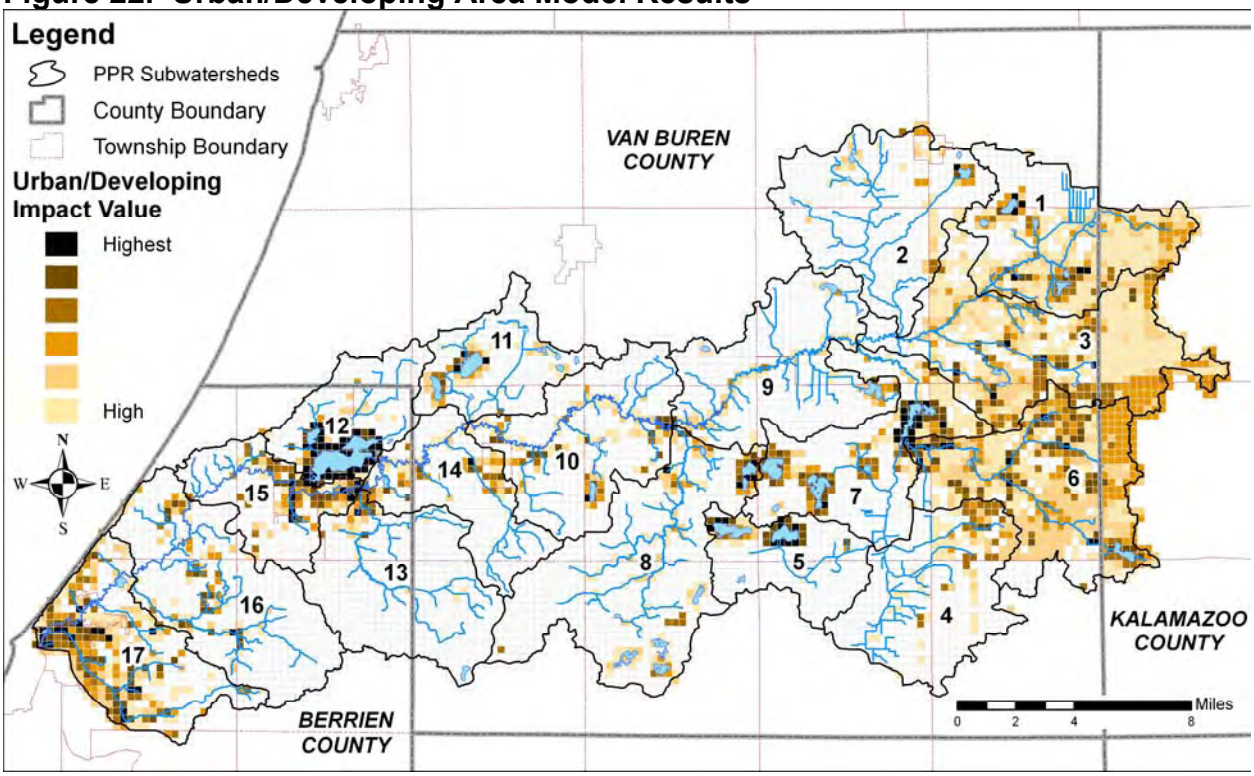
Figure 21. Agricultural Area Model Results



3. Urban/Developing

The urban/developing area model was created to help understand the extent of existing urbanized areas, as well as areas that are expected to develop rapidly in the near future. It can be utilized to influence planning and zoning decisions in developing areas (such as water body setbacks and low impact development techniques) and for targeting existing urban areas for improved stormwater management practices. The following criteria were considered when calculating the impact value of each QQ: 1) land cover – percent of urban land cover, 2) development potential – population trends and future land use plans, 3) hydrology – impaired water bodies and 4) accessibility – proximity to primary road networks. Figure 22 illustrates the top 34% of all QQs for urban/developing impact value. More information on the SWMPC Urban/Developing Area Model is available online at www.swmpc.org/downloads/pprw_urban_mdl.pdf.

Figure 22. Urban/Developing Area Model Results



7 Water Quality Summary

7.1 Designated Uses

According to the Michigan Department of Environmental Quality (MDEQ), the primary criterion for water quality is whether the water body meets designated uses. Designated uses are recognized uses of water established by state and federal water quality programs. All surface waters of the state of Michigan are designated for and shall be protected for the uses listed in Table 12. (Citation: R323.1100 of Part 4, Part 31 of PA 451, 1994, revised 4/2/99). A watershed management plan provides direction for protecting and restoring designated uses.

Table 12. Definitions of Designated Uses

Designated Use	General Definition
Agriculture	Water supply for cropland irrigation and livestock watering
Industrial Water Supply	Water utilized in industrial processes
Public Water Supply	Public drinking water source
Navigation	Waters capable of being used for shipping, travel, or other transport by private, military, or commercial vessels
Warmwater Fishery	Supports reproduction of warmwater fish
Coldwater Fishery	Supports reproduction of coldwater fish
Other Indigenous Aquatic Life and Wildlife	Supports reproduction of indigenous animals, plants, and insects
Partial Body Contact	Water quality standards are maintained for water skiing, canoeing, and wading
Total Body Contact	Water quality standards are maintained for swimming

Designated uses of many water bodies in the PPRW are threatened or impaired due to habitat loss or fragmentation, rather than any specific pollutant. For the designated use assessment, only pollutant based impairments and threats are considered. For detailed information on the most common pollutants (sediment, nutrients, temperature, flow, bacteria and chemicals) their sources and Michigan's water quality standards see Appendix 9.

7.2 General Water Quality Statement

Overall, the following designated uses are threatened in the PPRW: Partial and Total Body Contact, Coldwater and Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife. The Coldwater Fishery designated use only applies to MDNR designated coldwater streams. The following water bodies in the PPRW are designated as coldwater fisheries: Sand Creek, Blue Creek, Mill Creek, Brush Creek, North Branch and its tributaries above M-40, West Branch, East Branch above M-40 and Pine Creek.

The designated uses of Agriculture, Industrial Water Supply and Navigation are being met throughout the watershed. The Public Water Supply use is not applicable in the PPRW because no communities withdraw water directly from the Paw Paw River. Benton Harbor is the only community in the PPRW relying on surface water for its municipal water supply and their water intake is located offshore in Lake Michigan.

The State of Michigan also considers Fish Consumption a designated use for all water bodies. For all streams within the PPRW and Maple Lake, the Fish Consumption designated use is considered non-attaining due to elevated levels of PCB's found in several locations. There is a generic, statewide, mercury-based fish consumption advisory that applies to all of Michigan's inland lakes. In the PPRW, Van Auken and Rush were the only lakes sampled for mercury in fish tissue. In both lakes, elevated levels of mercury were found in fish tissue, as a result the Fish Consumption designated use is considered non-attaining in those lakes.

7.3 Individual Water Body Assessment

Within a watershed, water quality can vary greatly from one water body to the next. An assessment of individual water bodies was completed for the PPRW and can be found in Appendix 4. Table 13 provides a summary of the assessment. Not all water bodies within the watershed were evaluated. Only water bodies with enough information to make a water quality statement were included. The assessment includes: 1) which designated uses are threatened or impaired, 2) the reasons why the designated uses are being threatened or impaired, 3) the pollutants causing the threat or impairment, and 4) the sources of the pollutants and the causes related to those sources. Several sources of information were used in this assessment, such as the MDEQ 2006 and 2008 Integrated Reports; MDNR Fisheries Division staff input; MDNR Fisheries Reports; Spicer Study on Paw Paw Lake; TNC Agricultural Impact Study; TNC Floodplain Forest Study; Van Buren County Drain Commissioner input; MDEQ Biosurvey Reports; PPRW Volunteer Inventory; MDEQ Road Stream Crossing Inventory, MDEQ Wetland Functional Analysis and MDEQ Flashiness Report.

The Clean Water Act (CWA) requires Michigan to prepare a biennial Integrated Report on the quality of its water resources as the principal means of conveying water quality protection/monitoring information to the United States Environmental Protection Agency (USEPA) and the United States Congress. For each water body, the report classifies each designated use as: 1) fully supported, 2) not supported or 3) not assessed. Designated uses other than fish consumption, which were considered not supported by the MDEQ in 2008, are identified in Table 13. Designated uses not supported because of a specific pollutant often require the development of a Total Maximum Daily Load (TMDL). Table 14 lists the water bodies in the PPRW that require a TMDL and the year the TMDL is scheduled to be developed.

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant a water body can receive and still meet applicable water quality standards.

Table 13. Water Bodies at a Glance

Water Body	Sub Watershed ID+	Impaired Uses	Threatened Uses	Pollutants (known (k) or suspected (s))
Paw Paw Mainstem	9, 10, 14, 15, 16, 17		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s)
Coldwater Tributaries				
Blue Creek	16	Partial & Total Body Contact*	Coldwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Temperature (s), Bacteria/ Pathogens (k), Pesticides (s)
Brush Creek	8		Coldwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Temperature (s), Pesticides (s)
Campbell Creek	1		Coldwater Fishery Other Indigenous Wildlife	Sediment (s), Nutrients (s), Temperature (s), Pesticides (s)
Eagle Lake Drain	5	Coldwater Fishery Other Indigenous Wildlife*		Sediment (k), Nutrients (s), Temperature (s), Pesticides (s)
East Branch	6		Coldwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Temperature (s), Pesticides (s)
Hayden Creek	3		Coldwater Fishery Other Indigenous Wildlife	Sediment (s), Nutrients (s), Temperature (s), Pesticides (s)
Mill Creek	13	Partial & Total Body Contact*	Coldwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Temperature (s), Bacteria/ Pathogens (k), Pesticides (s)
North Branch	1, 3		Coldwater Fishery Other Indigenous Wildlife Partial & Total Body Contact	Sediment (k), Nutrients (s), Temperature(s), Bacteria/ Pathogens (s), Pesticides (s)
Pine Creek	14	Coldwater Fishery* Other Indigenous Wildlife* Partial & Total Body Contact*		Sediment (k), Nutrients (s), Temperature (s), Bacteria/ Pathogens (k), Pesticides (s)
Red Creek	8	Coldwater Fishery Other Indigenous Wildlife		Sediment (k), Nutrients (s), Temperature (s), Pesticides (s)

Water Body	Sub Watershed ID+	Impaired Uses	Threatened Uses	Pollutants (known (k) or suspected (s))
Sand Creek	17	Coldwater Fishery Other Indigenous Wildlife		Sediment (k), Nutrients (s), Temperature (s), Oils/Grease/Metals (s), Pesticides (s)
West Branch**	4, 7	Coldwater Fishery* Other Indigenous Wildlife	Partial & Total Body Contact	Sediment (k), Bacteria/Pathogens (s), Nutrients (s), Temperature (s), Pesticides (s)
Warmwater Tributaries				
Brandywine Creek	2	Warmwater Fishery	Other Indigenous Wildlife Partial & Total Body Contact	Sediment (k), Nutrients (s), Bacteria/Pathogens (s), Pesticides (s)
Branch & Derby Drain	12		Warmwater Fishery Other Indigenous Wildlife Partial & Total Body Contact	Sediment (k), Nutrients (s), Bacteria/ Pathogens (s), Pesticides (s)
Carter Creek	9		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s)
Hog Creek	10		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s)
Mud Lake Drain	11	Warmwater Fishery	Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s)
Ox Creek	17	Warmwater Fishery Other Indigenous Wildlife*		Sediment (k), Nutrients (s), Oils/Grease/Metals (k), (chromium, copper, lead PCBs, organic compounds; zinc, PAHs; BNAs), Pesticides (s)
South Branch	7		Warmwater Fishery Other Indigenous Wildlife	Sediment (k), Nutrients (s), Pesticides (s), Oils/Grease/Metals (s)
Lakes				
Paw Paw Lake	12	Warmwater Fishery	Other Indigenous Wildlife	Sediment (k), Nutrients (k), Oils/ Grease/ Metals (s), Pesticides (s)
Maple Lake	7	Warmwater Fishery	Other Indigenous Wildlife	Sediment (k), Nutrients (s), Oils/Grease/Metals (s), Pesticides (s)

+Refer to Figure 3 for subwatershed boundaries

*This designated use was listed as not supported by the MDEQ in the 2008 Integrated Report.

**Referred to in MDEQ Integrated Report as South Branch

Table 14. TMDLs Scheduled for Paw Paw River Watershed

Water Body	Pollutant	TMDL* Schedule
Ox Creek	Sedimentation/Siltation, Solids (Suspened/Bedload), Chromium (total), Copper, Lead, Oil and Grease	2009
Mill Creek	Escherichia coli (E. coli)	2009
Pine Creek	E. coli	2009
Blue Creek	E. coli	2017
West Branch**	Dissolved oxygen	2018
Rush Lake	Mercury in Fish Tissue	2011
Van Auken Lake	Mercury in Fish Tissue	2011
Maple Lake	PCB in Fish Tissue	2009
All PPRW Rivers/Streams	PCB in Fish Tissue and Water Column	2009/2010

*A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant a water body can receive and still meet applicable water quality standards.
**Referred to in MDEQ Integrated Report as South Branch

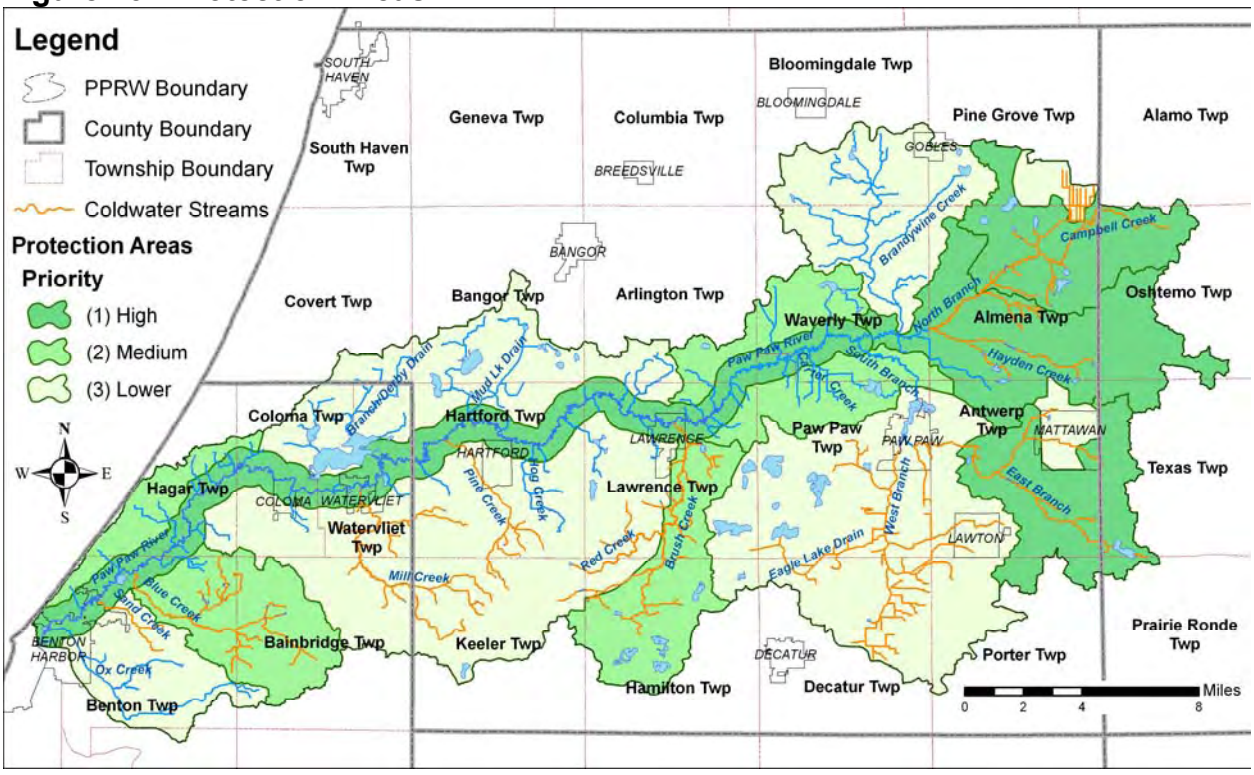
8 Prioritization - Areas, Pollutants, Sources

Priority areas were identified in the watershed based on lands that are contributing, or have the potential to contribute, a majority of the pollutants impacting water quality. By identifying priority areas, implementation can be targeted to the places where the most benefit can be achieved. Three different types of areas were prioritized in the PPRW – protection, agricultural management and urban management. Pollutants and sources of pollutants were also prioritized for each of the three areas.

8.1 Protection Areas

The prioritization of protection areas is based on the amount of natural land cover (habitat), groundwater recharge potential, intact wetland functions, the presence of high quality water bodies and development pressure. The PPRW is prioritized into three categories for protection as shown in Figure 23. High priority protection areas are generally the Paw Paw River mainstem and the PPRW headwaters (North Branch and East Branch subwatersheds). Medium priority protection areas include the Blue Creek and Brush Creek subwatersheds, the southwestern half of Waverly Township and the area near Lake Michigan. The high and medium priority areas, if not preserved or at least managed properly, have the potential to contribute large amounts of pollution, as well as disrupt hydrologic patterns in the watershed. The remainder of the watershed is lower in priority for protection efforts, but since this analysis is at a landscape level, specific sites in the lower priority area may need just as much attention as the high and medium priority areas for maintaining long-term water quality in the watershed.

Figure 23. Protection Areas



Protection Area Pollutants and Sources

In the protection areas the prioritization of pollutants and sources is based on their potential to threaten or impair water quality as development increases in these areas.

In the protection areas, the pollutants are prioritized as follows:

1. **Sediment** is a known pollutant causing impairments throughout the watershed. Construction sites in developing areas often contribute sediment to water bodies. Additional impervious surfaces alter hydrology leading to increased erosion and sedimentation.
2. **Nutrients** are currently a problem pollutant around lakes and urban areas. Nutrients are often attached to sediment. Stormwater runoff containing nutrients from lawns and golf courses is expected to increase with new development. Nutrients from additional septic systems could also be an issue with increased development in rural or suburban areas not served by municipal sewer.
3. **Temperature** is a concern because most coldwater streams are located in protection areas. With additional impervious surfaces and the removal of riparian buffers, the temperature of these streams could increase. Increased temperature could limit their ability to support coldwater fish.
4. **Bacteria and pathogens** are currently a suspected problem around lakes not served by municipal sewer systems. With increased development and additional septic systems in protection areas (especially in areas with soils not suitable for septic systems), bacteria and pathogens might become a more widespread problem.
5. **Pesticides** are suspected to become a problem with increased urbanization and the use of pesticides on lawns and golf courses.
6. **Oil, grease and metals** are not currently suspected to be a major problem in protection areas. The amount of oil, grease and metals is expected to increase with new development in these areas.

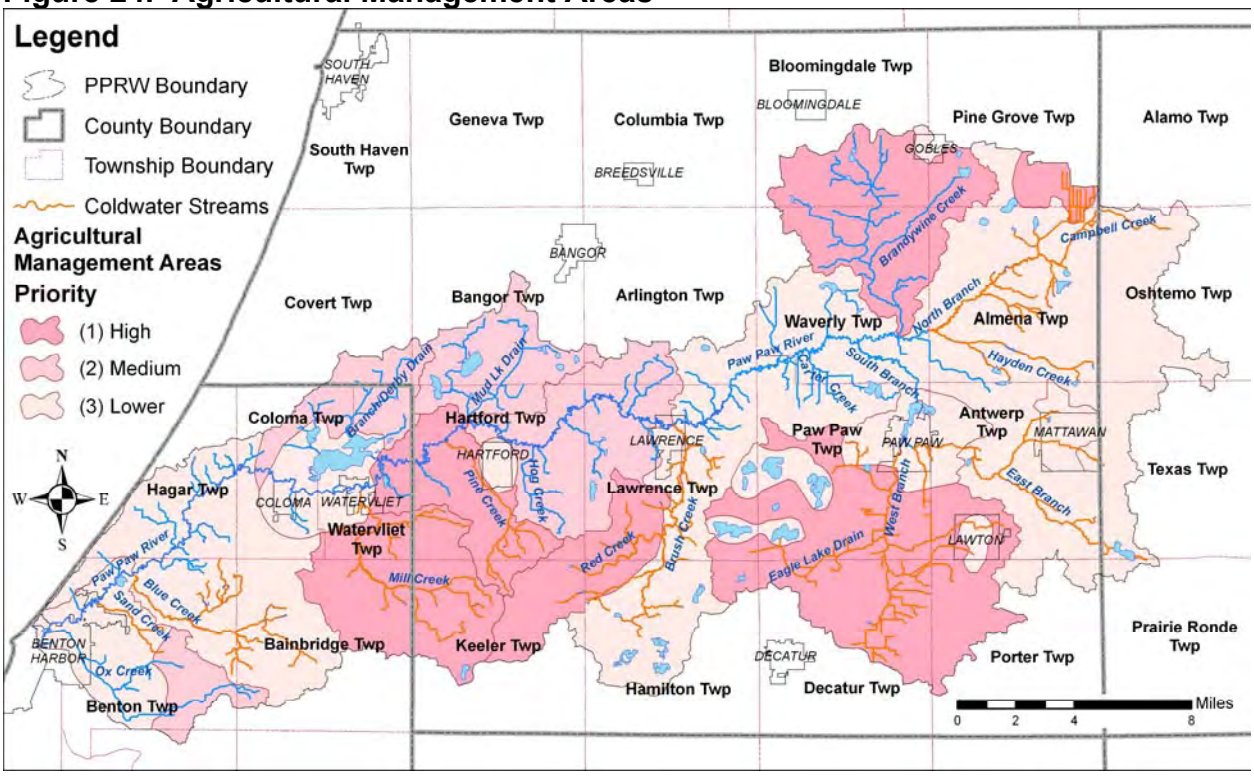
In the protection areas, the pollutant sources are prioritized as follows:

1. **Streambanks –** Increasing impervious surface in protection areas could alter hydrology and cause streambank erosion if runoff is not managed properly. Removal of the riparian corridor for waterfront development in protection areas could cause additional streambank erosion.
2. **Stormwater runoff –** Several priority pollutants could be delivered to protection area water bodies by stormwater runoff. With new development, stormwater runoff from construction sites and impervious surfaces is expected to increase in protection areas.
3. **Septage waste –** Failing septic systems are expected to become a problem with additional waterfront and suburban type development occurring in protection areas.
4. **Livestock –** There are several unrestricted livestock access sites within the protection areas; however, with increased residential development occurring in these areas, it is expected that livestock problems will become less of a concern.

8.2 Agricultural Management Areas

The prioritization of agricultural management areas is based on significant water body impairments, estimated pollutant loadings (SWAT model), amount of agriculture land cover and problems identified by MDEQ staff, MDNR Fisheries staff, Van Buren County Drain Commissioner or through the volunteer inventory process. The PPRW is prioritized into three categories for agricultural management as shown in Figure 24. The high priority agricultural management areas are the Mill Creek, Pine Creek, Red Creek, Brandywine Creek and West Branch subwatersheds and the Mentha Flats area in the southeast corner of Pine Grove Township. The medium priority agricultural management areas generally cover the Branch & Derby Drain, Mud Lake Drain and Hog Creek subwatersheds as well as the upstream portions of Ox and Sand Creek. The high and medium priority areas are suspected to contain a majority of the agricultural related pollutant sources impairing or threatening water quality in the PPRW. The remainder of the watershed is in a lower priority level for agricultural management efforts. However, since this analysis is at a landscape scale, there may be agricultural sites in the lower priority area that need attention to improve water quality in the watershed.

Figure 24. Agricultural Management Areas



Agricultural Management Area Pollutants and Sources

In the agricultural management areas the prioritization of pollutants and sources is based on their suspected significance to impaired water quality in these areas.

In the agricultural management areas, the pollutants are prioritized as follows:

1. **Sediment** is a known pollutant throughout the watershed, especially in the agricultural areas. Sediment from agricultural runoff also carries nutrients like phosphorus and nitrogen. Biosurveys found sediment impairment occurring in all of the impaired streams in agricultural management areas.
2. **Bacteria and pathogens** are a known pollutant in two of the highest priority agricultural management area waterbodies, Mill and Pine Creeks. TMDLs are scheduled for development in these watersheds due to extremely high Escherichia coli (E. coli) levels. Unrestricted livestock access sites have also been found in agricultural management areas.
3. **Nutrients** are a suspected pollutant in all of the agricultural management areas. In the West Branch, one of the highest priority agricultural management areas, a TMDL is scheduled for development due to low dissolved oxygen levels. Nutrients from agricultural runoff are suspected to be causing the impairment.
4. **Pesticides** are suspected to be a problem in agricultural areas; however, no data was found to document their significance in the PPRW.
5. **Temperature** is a concern in agricultural management areas because the removal of tree cover along coldwater streams and drains can lead to increased water temperature. Temperature is also impacted by altered hydrology from increased drainage efficiency and soil compaction, because groundwater recharge is reduced.
6. **Oil, grease and metals** are a concern in agricultural areas because of the use and maintenance of farm equipment (tractors, irrigation pumps, etc.).

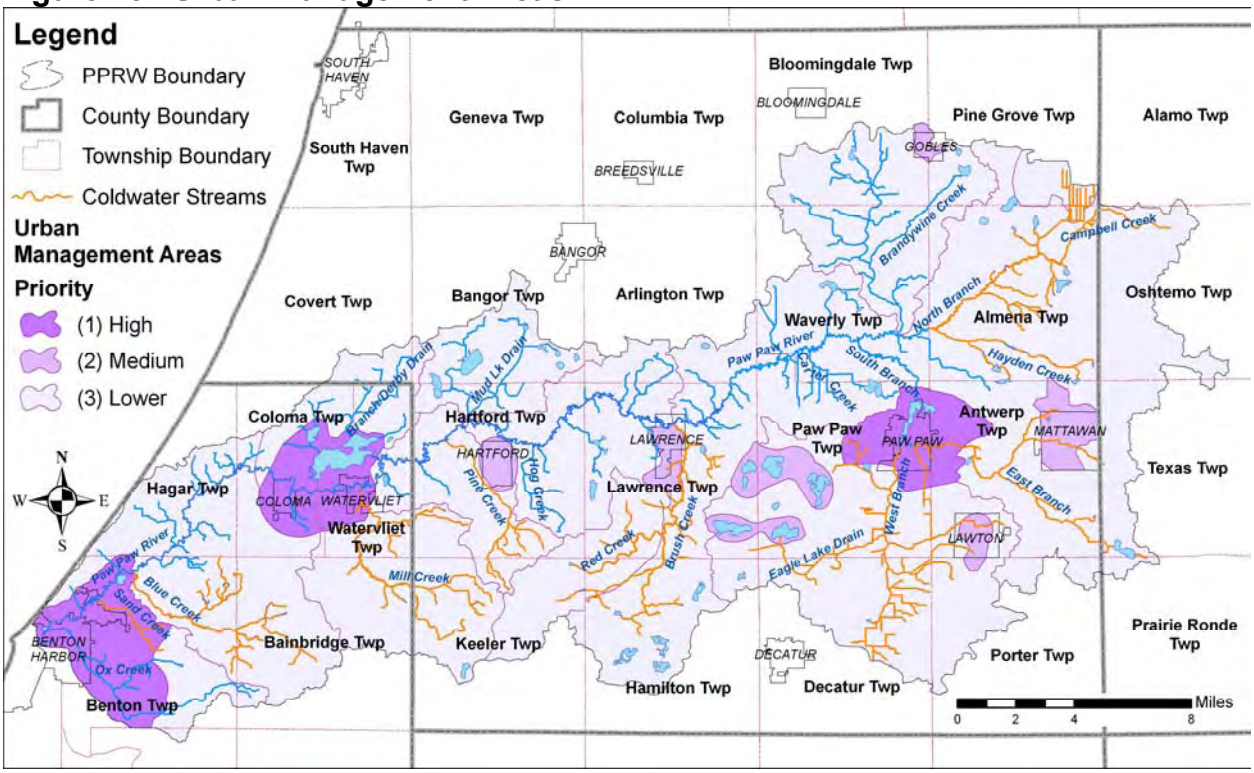
In the agricultural management areas, the pollutant sources are prioritized as follows:

1. **Streambanks –** Streambank erosion is a significant source of the highest priority pollutant (sediment). Streambank erosion was identified in biosurveys throughout the agricultural areas. In addition, recent fieldwork identified several streambank erosion sites on agricultural drains in the Paw Paw Lake (Berrien County) watershed.
2. **Livestock –** Two water bodies with scheduled TMDLs in agricultural management areas (Mill and Pine Creek) are being impacted by the application of livestock waste.
3. **Stormwater runoff –** Unmanaged runoff from agricultural lands can carry sediment, nutrients, bacteria and pathogens directly to surface water.
4. **Septage waste –** Failing septic systems and improper application or disposal of septage waste by septic haulers is a suspected source of nutrients, bacteria and pathogens in agricultural management areas.

8.3 Urban Management Areas

The prioritization of urban management areas is based on significant water body impairments, amount of urban land cover and problems identified by MDEQ staff, MDNR Fisheries staff, Van Buren County Drain Commissioner or through the volunteer inventory process. The PPRW is prioritized into three categories for urban management as shown in Figure 25. The high priority urban management areas are the downstream portions of the Ox and Sand Creek subwatersheds, the Paw Paw Lake area and the Village of Paw Paw. Medium priority areas include the Villages of Lawrence, Lawton and Mattawan, the Cities of Gobles and Hartford and the area around Eagle, Three Mile, Cora, Reynolds and Christie lakes (between Lawrence and Paw Paw Villages). The high and medium priority areas are suspected to contain a majority of the urban related pollutant sources impairing or threatening water quality in the PPRW. The remainder of the watershed is in a lower priority level for urban management efforts. However, since this analysis is at a landscape scale, there may be places in the lower priority area that need attention to improve water quality in the watershed.

Figure 25. Urban Management Areas



Urban Management Area Pollutants and Sources

In the urban management areas the prioritization of pollutants and sources is based on their suspected significance to impaired water quality in these areas.

In the urban management areas, the pollutants are prioritized as follows:

1. **Sediment** is a known pollutant causing impairments in urban areas, especially in Benton Harbor (Ox Creek) and the Village of Paw Paw (Maple Lake).

2. **Nutrients** are a known pollutant in urban stormwater runoff. A study of Paw Paw Lake attributed low dissolved oxygen levels to excess nutrients. Nutrients are also suspected to be a problem in other developed lakes in the watershed.
3. **Oil, grease and metals** are a known pollutant in Ox Creek and are suspected to be causing impairments.
4. **Bacteria and pathogens** are suspected to be a problem in highly developed lake areas without municipal sewer (Eagle, Three Mile, Cora, Reynolds and Christie lakes).
5. **Temperature** is a concern because impervious surfaces in urban areas can cause increases in temperature; however, most coldwater streams in the PPRW are not located in urban areas.
6. **Pesticides** are a pollutant of concern in urban areas because of improper application on lawns and golf courses in these areas; however no data was found documenting their significance in the PPRW.

In the urban management areas, the pollutant sources are prioritized as follows:

1. **Stormwater runoff –** A majority of pollutants impairing or threatening designated uses in urban areas are found in stormwater runoff, which largely results from impervious surfaces.
2. **Streambanks –** Impervious surfaces in urban areas can alter hydrology, which causes streambank erosion.
3. **Septage waste –** Septic systems are suspected to be a source of bacteria and pathogens in lake areas lacking municipal sewer services. In addition, the failure of sewer system infrastructure in urban areas has also led to releases of untreated wastewater.

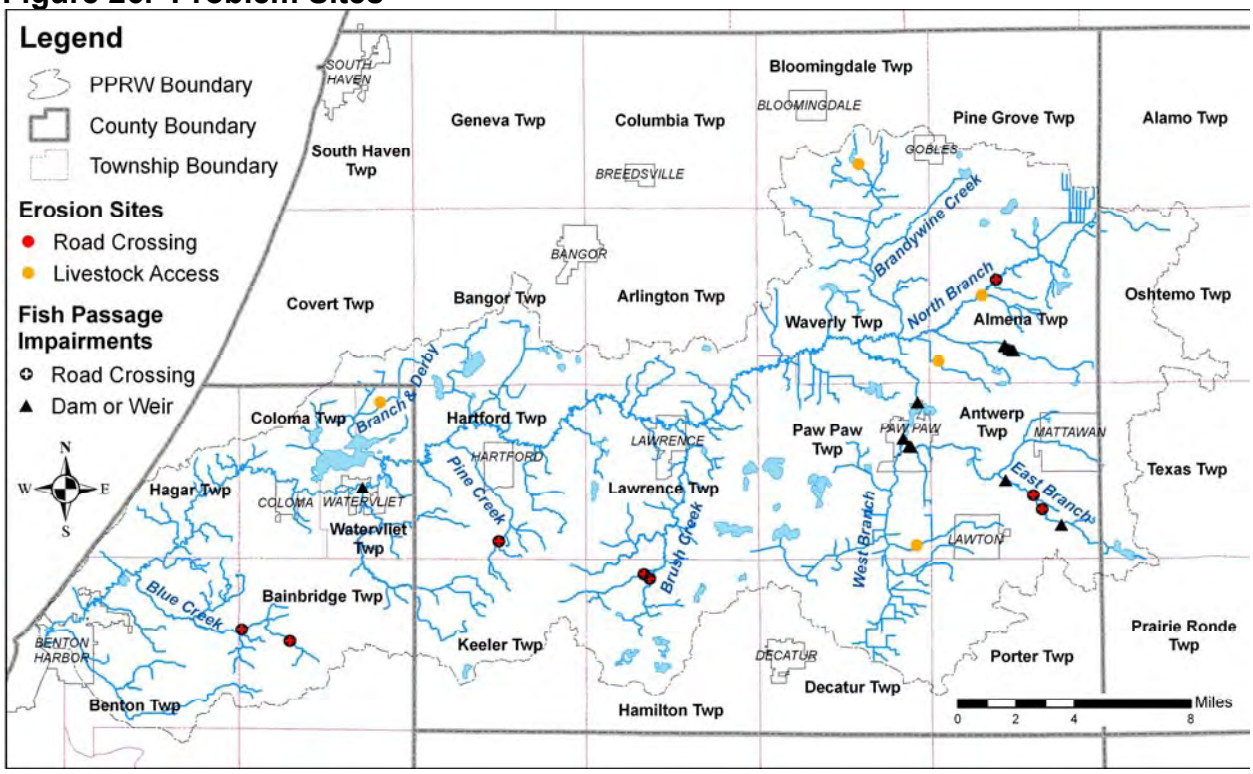
8.4 Problem Sites

Along with the priority areas, stakeholders identified several problem sites during the planning process that need attention. These sites included erosion sites, fish passage impairments and illegal wetland drainage or fill sites. A major problem site is located between Watervliet and Hartford along the Red Arrow Corridor, where a large wetland complex has been extensively ditched and drained altering the hydrology of the area.

Erosion and fish passage impairment sites are identified in Figure 26. Fish passage impairment sites result from a road crossing, dam or weir. An MDNR fisheries biologist identified the fish passage impairment sites. The fish passage sites may not be causing direct erosion problems, but may be disrupting the natural flow regime of several tributaries in the watershed. Further, the low head dams and weirs found in the watershed can impact the movement of fish and other organisms and limit their ability to reach headwater areas for spawning and nursery areas.

Following the map is a description of each erosion site, which is due to either a problematic road/stream crossing or unrestricted livestock access to a stream. Volunteers identified several of the livestock access problem sites during the Volunteer Inventory process. At the livestock access problem sites, the streambanks are eroding and most likely nutrients and bacteria/pathogens are entering the waterbodies.

Figure 26. Problem Sites



Blue Creek

There are two known impaired road/stream crossings along Blue Creek, both on Territorial Road. The first crossing has a failing culvert that is undersized causing erosion and a shifting sand bedload on top of the fine gravel streambed. Stormwater runoff at the second crossing is causing erosion and variable flow rates. The undersized culverts at this crossing are impacting fish passage, flow and sand/woody debris transport.

Branch and Derby Drain

There is one known pasture with unrestricted livestock access on Branch & Derby Drain between M-140 and North Watervliet Rd.

Pine Creek

There is one known impaired road/stream crossing along Pine Creek at 64th Street causing sedimentation. The bottom of this box culvert is elevated above the streambed resulting in a semi-perched condition affecting channel morphology.

Brush Creek

There are two known impaired road/stream crossings in the Brush Creek watershed. The CR 215 road crossing of White Creek is preventing fish passage and causing modifications to stream morphology. The CR 215 crossing of Brush Creek is preventing fish passage and causing streambank erosion.

West Branch
There is one known unrestricted livestock access site in the West Branch watershed. Sheep were reported to have unrestricted access to Lawton Drain near CR 665.

East Branch
There are two known impaired road/stream crossings along the East Branch. The crossing at 26th Street has a culvert that is poorly aligned with the stream dimensions and as a result is preventing fish passage upstream and causing scouring downstream. The crossing at 63rd Avenue is undersized and perched preventing fish passage, creating scouring downstream and impounding water upstream.

North Branch
There is one known impaired road/stream crossing north of Whiskey Run on CR 653 causing severe streambank erosion. The culverts are poorly aligned and undersized restricting flows and creating modifications to the stream dimensions. There are two known sites where livestock have unrestricted access to streams within the North Branch watershed. One site is located on Ritter Creek at 30th Street and the other is on the Paw Paw and Allegan Road Drain at 45th Street.

Brandywine Creek
There is one known unrestricted livestock access site in the Brandywine Creek watershed. The site was found during the volunteer inventory on Martin Lake Drain at 18th Ave.

9 Goals and Objectives

Successful implementation of a watershed management plan is more likely to occur when the objectives are based on clearly defined goals. Goals can represent a long-term vision and also serve as guideposts established to keep everyone moving in the same direction and assess progress. Objectives are more specific actions that need to occur to achieve the stated goal. The goals and objectives for the PPRW address both water quality concerns and desired uses.

Successful implementation of a watershed management plan is more likely to occur when the objectives are based on clearly defined goals.

9.1 Goals for Designated Uses

The following two goals are related to restoring and protecting the designated uses of water bodies in the PPRW. Objectives for these goals are listed in the Action Plan (Table 16) as tasks to be implemented.

1. Prevent or reduce pollutants threatening or impairing water quality by sufficiently preserving or managing protection areas to meet designated uses.

2. Reduce pollutants threatening or impairing water quality in agricultural and urban management areas to meet designated uses.

9.2 Goals for Desired Uses

In addition to the Designated Uses established by state and federal water quality programs, stakeholders identified several Desired Uses for the PPRW. Desired uses are based on factors important to the watershed community. Desired uses may or may not have a direct impact on water quality. Table 15 lists the Desired Uses identified through public meetings, surveys and discussions with watershed stakeholders. The desired uses listed in Table 15 all have a direct or indirect impact on water quality.

Table 15. Paw Paw River Watershed Desired Uses

PPRW Desired Use	General Definition
Coordinated development	Promote and achieve the environmental and economic benefits of planned communities through coordinated land use planning and low impact development
Intact habitat for native and aquatic and terrestrial wildlife	Protect and enhance the habitats on which indigenous, threatened, and endangered species depend
Open Space and Agricultural Land	Develop a green infrastructure network consisting of natural, open and working lands to maintain a viable farming economy, maintain the rural character of communities, and maintain the natural ecosystem functions provided by woodlands, wetlands, and other natural areas
Groundwater Resources Protection	Protect groundwater recharge and wellhead areas from contamination and overdrafting

PPRW Desired Use	General Definition
Appropriate recreational use and infrastructure	Establish water and non-motorized trails on or along appropriate sections of the Paw Paw River and its tributaries where desired and feasible while protecting natural features
Watershed monitoring efforts	Continue and increase monitoring efforts to better understand issues in the PPRW and to create baselines for future reference
Watershed Organization	Develop an organization to coordinate implementation of the watershed management plan

The following goals were developed to address the desired uses identified by stakeholders. Objectives for these goals are listed below.

1. Coordinated land use planning in the PPRW.

- Review local plans, ordinances and regulations addressing stormwater management, non-point source pollution and related water quality and natural resource issues
- Promote uniform set back requirements along lakes, streams, rivers and wetlands
- Develop model language for development standards and ordinances
- Develop resource maps for planning officials
- Gain local commitments to consider the watershed context in planning efforts and to recognize stormwater planning early in site planning and evaluation
- Conduct technical workshops and provide technical assistance throughout the watershed regarding the importance of coordinated watershed and land use planning
- Develop a communication plan targeting mayors, city managers, county administrators, governing bodies, planning commissioners, community development corporations, and neighborhoods about the importance of watershed and land use planning

2. Protected habitat for native aquatic and terrestrial wildlife

- Build support to include the Paw Paw River in Michigan's Natural Rivers Program
- Develop a community supported green infrastructure vision for the PPRW that includes natural and working lands
- Assist conservation organizations, local governments and landowners to preserve and manage wildlife habitat
- Minimize modification of sensitive habitat areas such as stream corridors
- Conduct on the ground habitat evaluations in high priority protection areas and in high quality water bodies

3. Protected groundwater resources

- Develop and implement community well head protection programs
- Continue to close abandoned wells

- Determine current and future amount of groundwater withdrawal and its potential impacts
- Develop strategies to prevent increased impervious surfaces in high recharge areas and to restore areas with high recharge potential, as appropriate

4. Improved recreation infrastructure along river while respecting natural features

- Encourage coordinated recreation planning that promotes sustainable uses of natural resources and protects the unique natural features of PPRW communities
- Incorporate bank stabilization efforts and BMPs at access sites to minimize the impact of foot traffic and erosion
- Educate private and commercial river users on the proper management of woody debris to improve navigability without impacting fish habitat or hydrology
- Build and maintain a trail/boardwalk system along appropriate sections of the river
- Remove litter and trash along banks
- Educate boaters about limiting the movement of invasive species

5. Continued/increased watershed monitoring efforts

- Partner with Drain Commissioners, MDEQ, MDNR, tribal and federal agencies to develop and implement a monitoring strategy to examine the current quality of the river as well as to monitor changes over time
- Coordinate volunteer road/stream crossing riparian surveys to assess current conditions and monitor changes over time as well identify problem sites
- Develop a program for testing of private drinking water wells
- Encourage monitoring and potential regulation of commercial groundwater withdrawals

6. A sustainable organization to coordinate and implement the watershed management plan and to instill a sense of stewardship

- Partner with the Black River Watershed to build an organization for coordinating and implementing watershed efforts
- Identify a funding strategy that includes membership, governmental units, foundations and business support
- Hire staff to secure funding and implement the watershed management plan
- Develop a work plan for the organization

10 Implementation Strategies

This chapter provides a management strategy to protect and improve water quality in the PPRW. The management strategy prioritizes tasks to be implemented, identifies specific problem sites and lays out a detailed action plan for implementation. The strategy also includes an information and education plan and describes current efforts.

10.1 Action Plan by Priority Area

Table 16 is a detailed action plan with structural, vegetative and managerial tasks, which address priority pollutants and their sources. This action plan should serve as a starting point for effective implementation. The items in the action plan should be reviewed annually and updated as conditions change in the watershed.

Table 16 is divided into three priority areas (protection, agricultural and urban) and specific sites, which are detailed later in this chapter and identified in Figure 26. For each priority area, specific tasks are listed. Each task addresses specific pollutants and sources as indicated. Since resources will probably not be available to implement all of the tasks at once, Table 16 provides a suggested timeframe for beginning implementation of each task. The implementation timeframe was based on the ranking of pollutants and sources for each priority area in Chapter 8. Prioritizing the tasks will allow resources to be allocated to the tasks that address the most important pollutants and sources first. The timeframe may be changed if resources or opportunities become available for earlier implementation. Table 16 also provides a cost estimate for each task and identifies the potential lead agency or individuals that need to take action. Potential partners, funding sources and programs are listed, which could assist with task implementation. Lastly, milestones and proposed evaluation methods are listed for each task.

Below is a list of structural, vegetative and managerial tasks to be implemented in the PPRW by priority area. The priority areas are meant to target implementation efforts where the most benefit can be achieved. However, implementing these tasks in other parts of the watershed may be necessary to achieve long-term water quality improvement and protection. The priority areas are based on the watershed protection and management area maps described in Chapter 8 (Figures 23-25).

<u>Protection Area Tasks</u>

The following tasks should be focused in the high and medium priority protection areas as indicated in Figure 23.

Tasks to begin within 1-5 years:

- Enact/improve water quality protection related ordinances (see Chapter 4.3 of this plan for recommendations on ordinances)
- Protect wetlands (see Landscape Level Wetland Functional Assessment report to determine priority sites for protection)
- Enact ordinances protecting riparian buffers
- Develop and enact design and maintenance standards for road stream crossings

- Enact a septic system time of sale inspection ordinance
- Identify and correct problem road/stream crossing sites (see Figure 26)

Tasks to begin within 6-10 years:

- Protect sensitive lands (see Figure 20 for further refinement of priority lands by quarter-quarter section)
- Improve soil erosion and sedimentation practices and regulations (building construction site practices and regulations)

Tasks to begin within 11-15 years:

- Improve zoning maps to locate high density or intensive uses in appropriate areas
- Identify and correct failing septic systems

Agricultural Area Tasks

The following tasks should be focused in the high and medium priority agricultural management areas as indicated in Figure 24.

Tasks to begin within 1-5 years:

- Utilize alternative drain maintenance/ construction techniques (such as two stage ditch design, natural river restoration techniques - j-hooks, cross vanes, etc)
- Restore riparian buffers and stabilize eroding streambanks
- Restore wetlands (see Landscape Level Wetland Functional Assessment to determine priority sites for restoration)
- Prevent/limit livestock access (fencing, crossings structures, alternative water sources) (see Figure 26)
- Install agricultural BMPs (filter strips, no-till, cover crops, grassed waterways, etc)
- Protect wetlands (see Landscape Level Wetland Functional Assessment report rto determine priority sites for protection)
- Expand disposal options for agricultural chemicals

Tasks to begin within 6-10 years:

- Develop and implement manure management plans

Tasks to begin within 11-15 years:

- Utilize soil testing to determine appropriate application rates for fertilizers and pesticides
- Utilize integrated pest management
- Construct secondary containment facilities for chemical/fuel handling areas
- Improve and/or enforce septage waste disposal regulations

Urban Area Tasks

The following tasks should be focused in the high and medium priority urban management areas as indicated in Figure 25.

Tasks to begin within 1-5 years:

- Utilize stormwater best management practices (road/parking lot sweeping, stormceptors, rain gardens, constructed wetlands, vegetated swales, etc)
- Enact stormwater and post construction control ordinances (see Low Impact Development for Michigan: A Design Guide for Implementers and Reviewers at

www.swmpc.org/downloads/lidmanual.pdf or see model stormwater ordinance at www.swmpc.org/ordinances.asp)

- Identify and correct illicit connections or discharges to stormwater system
- Utilize best management practices for road maintenance (such as alternative de-icing methods)
- Enact a phosphorus lawn fertilizer ban

Tasks to begin within 6-10 years:

- Increase or expand household hazardous waste disposal options
- Distribute spill kits

Tasks to begin within 11-15 years:

- Properly maintain and design municipal sewer system infrastructure

10.2 Information and Education

The structural, vegetative and managerial tasks listed in the action plan (Table 16) are voluntary. Therefore, individuals, before they are motivated to action, will need to understand the watershed concerns and how their actions can play a role in protecting water quality. An Information and Education (I&E) plan was developed to offer a strategy for informing and motivating responsible parties to implement the tasks listed Table 16. The I&E plan provides goals and outlines the relationship between target audiences, watershed issues and outreach activities. The I&E plan was developed in cooperation with the Black River Watershed Project because both watersheds have similar issues. The benefits of partnering and sharing resources are clear with outreach activities. The Black and Paw Paw River Watershed Information and Education Plan can be found in Appendix 10.

10.3 Planning and Studies

In some areas, further study and investigation, as well as subwatershed planning may be needed before more specific recommendations can be made. For example, hydro geomorphology studies in the Ox Creek, West Branch/Eagle Lake Drain and Branch/Derby Drain subwatersheds would provide specific direction as to which BMPs would be best suited to improve water quality and hydrology problems in these water bodies. In the North and East Branch subwatersheds, an on the ground habitat evaluation of the land and waterbodies would be beneficial for targeting protection efforts.

Wetland restoration and protection activities are listed for both protection and agricultural management areas, therefore the implementation of these tasks could have a substantial effect on the long-term improvement and protection of water quality in the watershed. A targeted wetland restoration and protection project based on the Landscape Level Wetland Functional Assessment in conjunction with an educational campaign to landowners and municipal officials would be extremely helpful in advancing the wetland related tasks in the action plan. A few demonstration projects would be beneficial even in lower priority areas, because there has not been much wetland restoration work in the watershed.

10.4 Current Efforts

There are several opportunities to coordinate with and build upon existing local programs and projects. Below is a description of some key local initiatives that have developed during the planning phase of the PPRW project. Information on several other organizations and agencies working to improve and protect water quality in the PPRW can be found in Appendix 11.

The Southwest Michigan Land Conservancy and The Nature Conservancy are coordinating protection efforts in the headwaters and along the mainstem. Sarett Nature Center is continuing to purchase lands along the mainstem and Blue Creek in the Benton Harbor area. After conducting a study to determine priority sources of sediment and nutrients, the Paw Paw Lake Foundation is working to develop implementation strategies. The Village of Paw Paw in partnership with the Van Buren County Drain Commissioner and the Maple Lake Association are coordinating efforts to better understand pollutant sources and causes in the Maple Lake Watershed.

The Black River and Paw Paw River Watershed steering committees hosted sustainability workshops in May and June of 2008. At these workshops, the participants explored options available to ensure the watershed management plans are being implemented by a sustainable watershed organization. As a result of these meetings, a transition team formed to develop a new watershed organization to protect and improve the Paw Paw and Black River Watersheds called the Two Rivers Coalition: An alliance of the Black and Paw Paw River Watersheds. Over the next year, the group hopes to incorporate as a 501(c)3. Meanwhile the group will focus on a few efforts to protect and improve water quality such as promoting a phosphorus ban for lawn fertilizer in Allegan, Van Buren and Berrien Counties and attending township board and planning commission meetings to talk about water quality issues. The next step will be for the Two Rivers Coalition to partner with another organization such as the Van Buren Conservation District or the Southwest Michigan Land Conservancy to assist with watershed plan implementation.

Table 16. Paw Paw River Watershed Action Plan

Protection Areas (See Figure 23)	High priority waterbodies – Paw Paw River mainstem, North Branch, East Branch, Hayden Creek, Campbell Creek Medium priority waterbodies - Blue Creek, Brush Creek, Carter Creek, South Branch								
Task	**Pollutant**	**Source**	**Cause**	**Begin Implementation**	**Potential Lead (Partners)**	**Estimated Cost**	**Potential Funding or Partner Programs**	**Milestones (after implementation begins)**	**Proposed Evaluation Method**
Enact/improve water quality protection related ordinances	Sediment	Streambanks	Increased flow fluctuations	2009-2013	Municipalities (SWMPC, MTA, MML)	$10,000/municipality	Municipalities, MDEQ 319	By 2015: 3 municipalities By 2018: 7 municipalities By 2023: 13 municipalities	Number of ordinances enacted; Number of municipalities with ordinances
	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Insufficient land use planning						
Protect wetlands	Sediment	Streambanks	Increased flow fluctuations	2009-2013	Landowners (SWMLC, TNC, Sarett Nature Center, DU)	$3,000-6,000/acre for purchase $3,000/conservation easement	MDEQ 319, NAWCA grant, Ducks Unlimited	By 2015: 120 acres By 2018: 320 acres By 2023: 720 acres	Number of acres protected; Number of landowners protecting wetlands; Estimate pollutant loading reduction
Enact ordinances protecting riparian buffers	Sediment	Streambanks	Lack of riparian buffers	2009-2013	Municipalities (SWMPC, MTA, MML)	$2,500/municipality	Municipalities, MDEQ 319	By 2015: 2 municipalities By 2018: 5 municipalities By 2023: 11 municipalities	Number of municipalities with ordinances
	Nutrients, pesticides	Stormwater runoff - lawns, parks, golf courses, agricultural lands							
Develop and enact design and maintenance standards for road stream crossings	Sediment	Streambanks	Lack of riparian buffers	2009-2013	Road Commission (Municipalities, SWMPC)	$5,000/agency	Road Commissions, Municipalities	By 2015: 2 road agencies By 2018: 5 road agencies By 2023: 8 road agencies	Number of road commissions and municipalities (road agencies) with improved standards enacted
Enact a septic inspection time of sale ordinance	Nutrients, bacteria/ pathogens	Septage waste	Improper design or maintenance of septic systems	2009-2013	Counties (Health Department, SWMPC)	$2,000/county	Counties	By 2015: 1 county By 2018: 3 counties	Number of counties with ordinance enacted
Improve soil erosion and sedimentation practices and regulations	Sediment	Stormwater runoff- road and building construction sites	Lack of soil erosion and sedimentation practices	2014-2018	Road Commission, Drain Commission	$5,000/agency	Road Commission, Drain Commissioner	By 2020: 1 agency By 2023: 3 agencies By 2028: 5 agencies	Number of agencies with improved practices and regulations adopted
Protect sensitive lands	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Insufficient land use planning	2014-2018	SWMLC, TNC, Sarett Nature Center	$3,000-6,000/acre for purchase $3,000/conservation easement	Land Trusts, MDEQ 319, private foundations	By 2020: 200 acres By 2023: 600 acres By 2028: 1400 acres	Number of acres protected; Estimate pollutant loading reduction
Improve zoning maps to locate high density or intensive uses in appropriate areas	Nutrients, bacteria/ pathogens	Septage waste	Insufficient site planning for locating septic systems	2014-2018	Municipalities (SWMPC)	$5,000/municipality	Municipalities	By 2020: 2 municipalities By 2023: 5 municipalities By 2028: 11 municipalities	Number of municipalities with improved zoning maps
Identify and correct failing septic systems	Nutrients, bacteria/ pathogens	Septage waste	Improper design or maintenance of septic systems	2019-2023	Landowners (Health Department)	$200-6,000/system	USDA Rural Development	By 2025: 5 systems By 2028: 13 systems By 2033: 28 systems	Number of systems identified and corrected; Estimate nutrient loading reduction

Agricultural Management Areas (See Figure 24)	High priority waterbodies- Eagle Lake Drain, Mill Creek, Pine Creek, Red Creek, Brandywine Creek, West Branch, North Branch headwaters Medium priority waterbodies - Branch & Derby Drain, Mud Lake Drain, Hog Creek, upstream portion of Ox Creek								
Task	**Pollutant**	**Source**	**Cause**	**Begin Implementation**	**Potential Lead (Partners)**	**Estimated Cost**	**Potential Funding or Partner Programs**	**Milestones (after implementation begins)**	**Proposed Evaluation Method**
Utilize alternative drain maintenance/ construction techniques	Sediment	Streambanks	Increased flow fluctuations	2009-2013	Drain Commissioner (TNC)	$20/linear foot for tree revetments $7/lineal foot for woody debris mgt. $20/linear foot for 2 stage ditch $100-500/linear foot for jhooks and cross vanes	Drain Assessments, MDEQ 319	By 2015: 2 projects By 2018: 3 projects By 2023: 5 projects	Number of miles of drain maintained or constructed with alternative techniques
Restore wetlands	Sediment	Streambanks	Increased flow fluctuations	2009-2013	Landowners (NRCS, USFWS)	$1,000 – 2,000/acre	WRP. Partners for Wildlife, NAWCA, DU, National Fish and Wildlife Foundation, MDEQ 319, Continuous CRP	By 2015: 80 acres By 2018: 180 acres By 2023: 240 acres	Number of acres restored; Number of landowners restoring wetlands; Estimate loading reduction
Install agricultural BMPs (filter strips, no-till, cover crops, grassed waterways, nutrient mgt, etc)	Sediment,	Streambanks	Increased flow fluctuations	2009-2013	Landowners (NRCS, Conservation Districts, TNC)	25% coverage in watershed with filter strips and conservation tillage $139,000	Farm Bill Programs, MDEQ 319, Carbon Credit Program	By 2015: 5 landowners By 2018: 10 landowners By 2023: 15 landowners	Number of acres; Estimate sediment/nutrient loading reduction; Number of landowners
	Sediment, nutrients, temperature	Stormwater runoff -agricultural lands	Lack of BMPs						
Restore riparian buffers and stabilize eroding streambanks	Sediment	Streambanks	Lack of riparian buffers	2009-2013	Landowners (Drain Comm., Conservation Districts, NRCS)	$200-500/acre for restoration $200/ft for stabilization	Drain Assessments, MDEQ 319, Farm Bill Programs, Carbon Credit Program	By 2015: 200 feet By 2018: 600 feet By 2023: 1400 feet	Linear feet of restoration/stabilization; Estimate pollutant loading reduction
	Nutrients, pesticides	Stormwater runoff - lawns, parks, golf courses, agricultural lands							
Protect wetlands	Sediment, nutrients, temperature	Stormwater runoff -agricultural lands	Loss of wetlands	2009-2013	Landowners (NRCS, USFWS, SWMLC, TNC, Sarett Nature Center)	$3,000-$6,000/acre for purchase $3,000 /conservation easement	MDEQ 319, NAWCA grant, Ducks Unlimited, Wetland Reserve Program. Partners for Wildlife, Continuous CRP	By 2015: 20 acres By 2018: 80 acres By 2023: 180 acres	Number of acres protected; Number of landowners protecting wetlands; Estimate pollutant loading reduction
Expand disposal options for agricultural chemicals	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper storage/disposal of fertilizers and pesticides	2009-2013	MSUE	$15,000/year	MSUE, Michigan Dept of Agriculture	By 2015: increase by 2 days/sites By 2018: increase by 3 days/sites By 2023: increase by 5 days/sites	Number of disposal sites/days; Amount of chemicals collected
Develop and implement manure management plans	Nutrients	Livestock waste	Improper manure management	2014-2018	Landowners (NRCS, Conservation Districts)	$4,000- $10,000/plan (depends on the number of livestock)	Farm Bill Programs, Michigan Environmental Assurance Program	By 2020: 2 plans By 2023: 5 plans By 2028: 8 plans	Number of plans developed E.coli monitoring program
Utilize soil testing to determine appropriate application rates for fertilizers and pesticides	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper application or overuse of fertilizers and pesticides	2019-2023	Landowners (MSUE)	$3.85/acre/year for field crops $13.30/acre/year for specialty crops	Unknown	By 2025: 20 tests By 2028: 30 tests By 2033: 50 tests	Number of soil tests performed
Utilize integrated pest management	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper application or overuse of fertilizers and pesticides	2019-2023	Landowners (MSUE, NRCS)	$30/acre/year for field crops $120/acre/year for orchards $80/acre/year for vegetables	Unknown	By 2025: 5 landowners By 2028: 7 landowners By 2033: 10 landowners	Number of landowners utilizing IPM
Improve and/or enforce septage waste disposal regulations	Nutrients, bacteria/ pathogens	Septage waste	Improper disposal by waste haulers/ wastewater treatment plants	2019-2023	MDEQ (MLSA, Tip of Mitt, MI Environmental Council)	N/A	MDEQ	Unknown	Improved regulations enacted and enforced
Construct secondary containment facilities	Oil, grease, fuel	Stormwater runoff	Spills and leaks	2019-2023	Landowners (NRCS, Conservation Districts)	$4,000-32,000/facility	Groundwater Program	By 2025: 1 facility By 2028: 3 facilities By 2033: 5 facilities	Number of secondary containment facilities installed

Urban Management Areas (See Figure 25)	High priority waterbodies –Sand Creek, Paw Paw Lake, Maple Lake, downstream portions of Paw Paw River mainstem, East Branch, Mill Creek, Ox Creek, West Branch Medium priority waterbodies –Eagle Lake, Three Mile Lake, Cora Lake, Reynolds Lake and Christie Lake, Mattawan Creek, Lawton Drain, downstream portion of Brush Creek								
Task	**Pollutant**	**Source**	**Cause**	**Begin Implementation**	**Potential Lead (Partners)**	**Estimated Cost**	**Potential Funding or Partner Programs**	**Milestones (after implementation begins)**	**Proposed Evaluation Method**
Utilize stormwater best management practices (road/parking lot sweeping, stormceptors, rain gardens, vegetated swales, constructed wetlands, wet/dry ponds, etc)	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Lack of stormwater management	2009-2013	Municipalities, Drain Commissioner, Road Commission (SWMPC, MTA, MML)	Depends on practice Rain Garden - $5-40/ft2 Rain Barrel - $75 each Green Roof - $12-24/ft2 Bioswales – $0.05-2.50/ft2 Permeable paving- $1-5/ft2	Municipalities, MDEQ 319	By 2015: 2 municipalities By 2018: 4 municipalities By 2023: 8 municipalities	Number of municipalities sweeping streets/parking lots and using other practices; Estimate pollutant loading reduction
	Sediment	Streambanks	Increased flow fluctuations						
Enact stormwater and post construction control ordinances	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Lack of stormwater management	2009-2013	Municipalities, Drain Commissioner, Road Commission (SWMPC, MTA, MML)	$5,000/municipality	Municipalities, MDEQ 319	By 2015 – 2 municipalities By 2018 – 4 municipalities By 2023 – 8 municiplalities	Number of municipalities with ordinances enacted
Identify and correct illicit discharges or connections	Sediment, nutrients, pesticides, oil, grease, metals, temperature	Stormwater runoff – impervious surfaces and storm drains	Illicit connections or discharges	2009-2013	Drain Commissioner, Municipalities, Road Commission	$500 - $5,000/site	Drain Commissioner, Municipalities, Road Commission	By 2015: 3 sites By 2018: 5 sites By 2023: 8 sites	Number of connections or discharges identified and corrected
Utilize best management practices for road maintenance	Sediment, salt	Stormwater runoff – roads and parking lots	Improper road salt/sand application and snow disposal	2009-2013	Road Commission, Municipalities	$50-$1,000/practice	Road Commission, Municipalities	By 2015: 2 road agencies By 2018: 3 road agencies By 2023: 5 road agencies	Number of road agencies adopting improved practices; Estimate sediment loading reduction
Enact county –wide phosphorus fertilizer ban	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper application or overuse of fertilizers and pesticides	2009-2013	Counties (SWMPC, Conservation Districts, Health Department, Drain Commissioner, Two Rivers Coalition)	$2,000/county	Unknown	By 2015: 2 counties By 2018: 3 counties	Number of counties with bans
Increase or expand household hazardous waste disposal options	Nutrients, pesticides	Stormwater runoff – lawns, parks, golf courses, agricultural lands	Improper storage/disposal of hazardous materials	2014-2018	VB MSUE, Berrien County Resource Recovery, Kalamazoo County	$10,000/year	Counties, Municipalities, Private Sector	By 2020: increase by 2 days/sites By 2023: increase by 3 days/sites By 2028: increase by 5 days/sites	Number of disposal sites/days; Amount of waste collected
	Oil, grease, fuel	Stormwater runoff – impervious surfaces and storm drains							
Distribute spill kits	Oil, grease, fuel	Stormwater runoff – impervious surfaces and storm drains	Spills and leaks	2014-2018	Businesses (MSUE, Conservation Districts)	$200/kit	Groundwater Program	By 2020: 8 kits By 2023: 16 kits By 2028: 30 kits	Number of spill kits distributed
Proper maintenance and design of sewer system infrastructure	Nutrients, bacteria/ pathogens	Septage waste	Sewer system/ infrastructure failure	2019-2023	Municipalities	Depends on system needs	Municipalities, MDEQ state revolving loans, USDA Rural Development	By 2025: 2 municipalities By 2028: 4 municipalities By 2033: 5 municipalities	Number of system improvements; Number of municipalities with regular system inspection
Specific Sites (See Figure 26)									
Prevent/limit livestock access (fencing, crossings structures, alternative water source)	Sediment	Streambanks	Lack of riparian buffers	2009-2013	Landowners (NRCS, Conservation Districts)	$2/ft for fencing $1,200 –3,600/crossing structure $500/water source	Farm Bill Programs, MDEQ 319	By 2015: 2 sites By 2018: 4 sites By 2023: 8 sites	Number of sites corrected; Estimate sediment and nutrient loading reduction
	Nutrients	Livestock waste	Unrestricted livestock access						
Identify and correct problem road/stream crossing sites	Sediment	Streambanks	Improper design or maintenance of road/stream crossings	2009-2013	Road Commission	$5,000 - $15,000/site	Road Commission, MDEQ 319, MDNR Inland Fisheries Grant	By 2015: 1 site By 2018: 3 sites By 2023: 6 sites	Number of sites corrected; Estimate sediment loading reduction

11 Evaluation

An evaluation process will determine if the plan implementation is effective and if improvements in water quality are being achieved. Measuring improvements and sharing results will increase community support for plan implementation. Since watersheds are extremely dynamic systems influenced by many factors, evaluation can be a difficult and expensive endeavor. As a result, different levels of evaluation are proposed to illustrate levels of success in the watershed. The level of evaluation and the methods utilized will largely be dependant on the formation of a sustainable watershed organization being able to carry out the proposed evaluation methods and on the amount of resources and funding available. Lastly, this Watershed Management Plan should be reviewed and updated periodically.

11.1 Knowledge and Awareness

The first level of evaluation is documenting a change in knowledge or increase in awareness. Measures and data collection for this level can take place in three specific ways:

1. A pre- and post-test of individuals at workshops focused on specific water quality issues in the PPRW. This should be an on-going activity.
2. The tracking of involvement in a local watershed group or increases in attendance at water quality workshops or other events. This should be an on-going activity.
3. A large-scale social survey effort of the PPRW population to understand individual watershed awareness and behaviors impacting water quality. Surveys are expensive, so this level of evaluation will not be able to happen until funding is secured.

Additional evaluation methods for measuring and tracking knowledge and awareness can be found in the Information and Education Plan for the Black and Paw Paw River Watersheds in Appendix 10.

11.2 Documenting Implementation

The second level of evaluation is BMP adoption or implementation. The measurement is mostly a documentation of successful implementation. The evaluation will involve identifying and tracking individuals, organizations and governmental units involved in implementing and adopting BMPs whether they be structural, vegetative or managerial. Data about the BMP implementation can be gathered simply through tracking the number of BMPs installed or adopted. This evaluation should be done annually.

Table 16 has milestones and specific evaluation methods proposed for measuring the progress of BMP implementation and improvements to water quality for each task in the PPRW action plan. The action plan should be reviewed at least annually to ensure progress is being made to meet the milestones. During the annual review, the action plan should be updated as tasks are completed and as new tasks are identified.

11.3 Monitoring Water Quality

Another level of evaluation is documenting changes in water quality through monitoring. The monitoring of water quality is a very complex task, which involves gathering data from a number of sources. Periodic assessments of the water quality in the PPRW are conducted as part of federal and state water quality monitoring programs. Local efforts to monitor water quality include those of lake associations, drain commissioners and the Pokagon Band of Potawatomi Indians. Combining data gathered under these programs, with other periodic water quality assessments will provide a picture of water quality in the watershed. Four types of monitoring are proposed for the PPRW:

1. The volunteer inventory that was conducted during the plan development process could be repeated at the 200 plus sites throughout the watershed. The results could be compared to see if any problem areas have been improved or if any areas are worsening. This activity should take place between 2011 and 2015.

2. Expanding Current Monitoring Efforts:

a. Benthic Monitoring can evaluate changes in the presence and type of aquatic life in the Paw Paw River and its tributaries to provide a general trend of water quality in the watershed. MDEQ performs benthic monitoring in the watershed.

b. Thermal monitoring is of special importance for the coldwater streams in the PPRW. Routine monitoring of temperature regimes will help to evaluate if these coldwater streams are being protected with the BMPs that are being implemented in these subwatersheds. MDNR Fisheries Division sometimes conducts thermal monitoring.

c. E.coli monitoring could be helpful in the Pine and Mill Creek subwatersheds. The levels of E.coli have been extremely high in these subwatersheds in the past several years. A specific monitoring effort in these subwatersheds could help to better understand the problem and to recommend appropriate BMPs for implementation. There is interest from stakeholders in the Hartford area to start this monitoring as soon as possible.

Both benthic and thermal monitoring efforts could be expanded with the development of a local volunteer monitoring program. Once a local watershed group is formed, this could be a task for that group to coordinate.

11.4 Estimating Pollutant Load Reductions

The last level of evaluation is to estimate a reduction in pollutant loadings. A pollutant loading is a quantifiable amount of pollution that is being delivered to a water body. Pollutant load reductions can be calculated based on the ability of an installed BMP to reduce the targeted pollutant. Pollutant loading calculations are best used at specific sites where structural BMPs are installed and detailed data about the reduction of pollutants can be gathered. Specific pollutant load reduction calculations should be completed for structural BMPs when they are proposed and installed.

The PPRW plan is mostly focused on the preservation of water quality and habitat. However, there are pollution problems throughout the watershed. Pollutants of concern include sediment, nutrients (nitrogen and phosphorus), bacteria/pathogens (E.coli), pesticides, oil, grease, metals and temperature.

In Table 16, under the last column (proposed evaluation methods), pollutant loading reduction calculations are suggested for evaluating several tasks in the action plan. Specifically these tasks include: protecting and restoring wetlands and sensitive lands, correcting failing septic systems, installing agricultural BMPs (filter strips, no-till, cover crops, grassed waterways, nutrient mgt, etc), restoring riparian buffers and stabilizing streambanks, utilizing urban stormwater BMPs (road/parking lot sweeping, stormceptors, rain gardens, vegetated swales, constructed wetlands, wet/dry ponds, etc), correcting livestock access problem sites and correcting road/stream crossing problem sites. The other items in the action plan (Table 16) either deal with hydrological modifications or they are proactive and preventative measures. Estimating pollutant loads and load reductions for these types of practices is not feasible.

Appendix 12 presents estimates for pollutant loading and loading reductions for specific agricultural and urban stormwater BMPs implemented in the PPRW. The estimates were derived from modeling efforts which included the Soil and Water Assessment Tool (SWAT) and an empirical build-out model using the Long-term Hydrologic Impact Assessment model (L-THIA).

(SWAT) was utilized to estimate pollutant-loading reductions for sediment and nutrients with the installation of agricultural BMPs (such as no-till, filter strips, cover crops, fertilizer reduction and a combination of filter strips and no-till). The largest load reductions were realized from the combination of no-till and filter strips. Alone, filter strips provided the most water quality benefits, but are the most expensive to implement. No-till is the most cost efficient BMP and large scale implementation of no-till would bring significant water quality benefits.

To address threatened and impaired designated uses, other than Partial and Total Body Contact (Coldwater Fishery, Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife), in the priority agricultural areas, BMPs should be implemented in at least 75% of those areas. At this level of implementation, an estimated reduction of sediment by 65.3%, total phosphorus by 62.1% and total nitrogen by 60.8% needs to be realized at the mouth of the Paw Paw River.

An empirical model utilizing the Long-term Hydrologic Impact Assessment model (L-THIA) was utilized to estimate load reductions in high priority urban areas for sediment and nutrients with the installation of urban stormwater BMPs (such as wet retention ponds, dry detention ponds, vegetated swales, rain gardens and constructed wetlands). Table 17 presents some general treatment efficiencies for urban stormwater BMPs which were used as a baseline in the PPRW build-out empirical model.

Table 17. General Urban BMP Treatment Efficiencies

	TP	TSS
Wet retention pond	90%	90%
Dry detention pond	30%	90%
Vegetated swale	40%	80%
Rain garden [1]	100%	100%
Constructed wetland [2]	90%	90%

[1] Assuming rain gardens absorb all pollutants contained in the runoff captured.
[2] Assuming to be the same as wet retention ponds (Rouge River National Wet Weather Demonstration Project, 2001).

Among the five urban BMPs examined (wet retention ponds, dry detention ponds, vegetated swales, rain gardens, and constructed wetlands), wet retention ponds and constructed wetlands provide the greatest load reductions for TP and TSS while vegetative swales are the most cost-effective (lowest per pound cost of load reduction).

To address threatened and impaired designated uses, other than Partial and Total Body Contact (Coldwater Fishery, Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife), in the priority urban areas, urban stormwater BMPs should be implemented on urban lands at a 50% treatment coverage for wet and dry retention ponds, vegetated swales and constructed wetlands and at a 15% treatment coverage for rain gardens. With those BMP implementation rates on urban lands, an estimated 1,500 pounds/year reduction in total phosphorus and a 60,000 pounds/year reduction in total suspended solids need to be realized in the PPRW. These reduction estimates were calculated by averaging the load reductions for each of the five urban stormwater BMPs modeled for the three urban subwatersheds of the PPRW. The three urban areas are 1) the Ox Creek Area (Benton Harbor/St Joseph); 2) the Paw Paw Lake Area (includes the townships of Coloma and Watervliet and the Cities of Watervliet and Coloma); and 3) the village of Paw Paw and Antwerp Township.

To address the threatened and impaired use of Partial and Total Body Contact, BMPs must be implemented in agricultural, protection and urban areas to ensure all water bodies meet water quality standards for Escherichia coli (E. coli). For Total Body Contact, E. coli levels need to be reduced to 130 E. coli per 100 milliliters (ml) water as a 30-day average and 300 E. coli per 100 ml water at any time during the time period of May 1 to October 1 to meet the water quality standard. For Partial Body Contact, E. coli levels need to be reduced to 1000 E. coli per 100 ml water to meet the water quality standard.

Currently, there are no loading estimates or reduction calculations for pesticides, oils, grease, metals and temperature for the PPRW.

11.5 Evaluating the Watershed Management Plan

The watershed management plan should be reviewed and updated as needed. The Two Rivers Coalition: An alliance for the Black and Paw Paw River Watersheds should take the lead in the management and action plan review process. As general guidance, the review should at a minimum include the following updates:

- Land Cover (Chapter 2.4) – at a minimum every 10 years
- Demographics (Chapter 3.3) – with every new US Census
- Future Growth and Development (Chapter 3.4) – every 5-10 years
- Local Water Quality Protection Policies (Chapter 4.3 and 4.4) – every 3 years
- Water Quality Summary (Chapter 7) – every two years with the release of MDEQ Integrated Reports
- Scheduled TMDLs (Table 14) – every two years with the release of MDEQ Integrated Reports or when a TMDL is completed
- Prioritization of areas, pollutants and sources (Chapter 8) – every 5-10 years
- Goals and Objectives (Chapter 9) – every 5-10 years
- Implementation Strategy (Chapter 10) – review annually and update as needed

Appendix 1. Land Cover by Subwatershed

Entire Watershed and Subwatersheds 1-5 (WS = subwatershed)

Paw Paw River Watershed 2000 Land Cover												
	Entire PPRW		Subwatershed 1		Subwatershed 2		Subwatershed 3		Subwatershed 4		Subwatershed 5	
	% of PPRW	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres
Land Cover Category												
Low Intensity Urban	1.91%	5468	0.92%	159	0.97%	192	1.51%	360	1.23%	206	0.79%	77
High Intensity Urban	0.87%	2488	0.18%	31	0.28%	56	0.41%	98	0.57%	95	0.28%	27
Airports	0.08%	234	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0
Roads/Paved	4.12%	11775	2.32%	399	3.22%	635	2.95%	704	3.13%	524	2.57%	250
Total Urban	**6.99%**	**19965**	**3.42%**	**589**	**4.48%**	**883**	**4.87%**	**1162**	**4.92%**	**825**	**3.64%**	**354**
Non-vegetated Farmland	0.24%	680	0.10%	18	0.37%	73	0.14%	33	0.31%	52	0.09%	9
Row Crops	15.14%	43241	17.91%	3081	32.72%	6451	9.17%	2187	19.63%	3291	26.60%	2589
Forage Crops	21.99%	62789	11.96%	2058	20.77%	4096	25.86%	6167	26.05%	4367	30.61%	2979
Orchards/Vineyards/ Nursery	10.22%	29179	1.15%	198	1.76%	348	2.86%	683	8.42%	1411	7.88%	767
Total Agriculture	**47.59%**	**135889**	**31.13%**	**5355**	**55.62%**	**10968**	**38.04%**	**9070**	**54.40%**	**9121**	**65.18%**	**6344**
Upland Openland	9.75%	27848	9.91%	1705	8.97%	1768	12.67%	3020	9.19%	1541	4.98%	485
Upland Forest	20.02%	57184	28.87%	4967	16.16%	3186	31.58%	7530	19.66%	3297	14.80%	1440
Lowland Forest	8.23%	23501	15.06%	2591	7.62%	1502	7.00%	1670	8.54%	1432	4.20%	409
Wetland	6.09%	17383	10.78%	1854	6.50%	1281	5.65%	1347	3.15%	528	3.03%	295
Water	1.02%	2912	0.81%	140	0.55%	108	0.15%	36	0.05%	8	4.07%	396
Total Natural	**45.11%**	**128828**	**65.43%**	**11257**	**39.79%**	**7845**	**57.05%**	**13603**	**40.59%**	**6806**	**31.08%**	**3025**
Other/Unknown	**0.31%**	**886**	**0.02%**	**3**	**0.11%**	**22**	**0.04%**	**9**	**0.09%**	**15**	**0.10%**	**10**
Total Acres	**100.00%**	**285568**	**100.00%**	**17204**	**100.00%**	**19718**	**100.00%**	**23844**	**100.00%**	**16767**	**100.00%**	**9733**

Subwatersheds 6-11 (WS=subwatershed)

Paw Paw River Watershed 2000 Land Cover												
	Subwatershed 6		Subwatershed 7		Subwatershed 8		Subwatershed 9		Subwatershed 10		Subwatershed 11	
	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres	% of WS	Acres
Land Cover Category												
Low Intensity Urban	1.96%	425	2.32%	392	1.16%	306	0.56%	105	1.52%	273	1.01%	101
High Intensity Urban	1.10%	237	1.16%	196	0.41%	107	0.09%	17	0.59%	105	0.19%	19
Airports	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0
Roads/Paved	4.59%	994	5.21%	879	2.93%	771	2.41%	455	3.37%	604	2.70%	271
Total Urban	**7.65%**	**1656**	**8.69%**	**1467**	**4.50%**	**1184**	**3.05%**	**577**	**5.48%**	**982**	**3.89%**	**391**
Non-vegetated Farmland	0.15%	33	0.73%	124	0.28%	75	0.14%	27	0.15%	26	0.16%	16
Row Crops	4.87%	1054	14.81%	2500	20.83%	5483	16.53%	3126	15.08%	2700	26.58%	2670
Forage Crops	21.03%	4550	20.54%	3466	28.46%	7491	20.70%	3913	23.35%	4182	21.38%	2147
Orchards/Vineyards/ Nursery	8.81%	1907	9.04%	1525	7.10%	1869	8.62%	1630	9.28%	1662	5.40%	542
Total Agriculture	**34.87%**	**7544**	**45.13%**	**7615**	**56.68%**	**14918**	**45.99%**	**8696**	**47.86%**	**8570**	**53.51%**	**5375**
Upland Openland	13.23%	2863	8.54%	1441	7.42%	1952	8.65%	1635	9.38%	1680	7.22%	725
Upland Forest	33.65%	7281	18.30%	3088	15.44%	4064	18.42%	3482	20.47%	3665	16.69%	1676
Lowland Forest	5.59%	1210	8.82%	1489	7.87%	2072	10.72%	2027	9.15%	1638	8.66%	870
Wetland	4.33%	936	7.04%	1188	6.88%	1810	12.38%	2340	7.06%	1264	6.77%	680
Water	0.56%	122	3.29%	555	0.52%	137	0.78%	147	0.36%	65	3.16%	317
Total Natural	**57.37%**	**12412**	**45.99%**	**7761**	**38.12%**	**10035**	**50.94%**	**9631**	**46.42%**	**8312**	**42.49%**	**4268**
Other/Unknown	**0.11%**	**24**	**0.19%**	**32**	**0.70%**	**185**	**0.02%**	**3**	**0.25%**	**44**	**0.10%**	**10**
Total Acres	**100.00%**	**21636**	**100.00%**	**16875**	**100.00%**	**26322**	**100.00%**	**18907**	**100.00%**	**17908**	**100.00%**	**10044**

Subwatersheds 12-17 (WS = subwatershed)

Paw Paw River Watershed 2000 Land Cover												
	Subwatershed 12		**Subwatershed 13**		**Subwatershed 14**		**Subwatershed 15**		**Subwatershed 16**		**Subwatershed 17**	
	% of WS	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**	**% of WS**	**Acres**
Land Cover Category												
Low Intensity Urban	3.54%	364	1.31%	242	2.17%	259	4.90%	477	2.26%	469	6.88%	1061
High Intensity Urban	0.62%	64	0.59%	109	0.74%	88	2.11%	205	0.60%	124	5.90%	910
Airports	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	1.52%	234
Roads/Paved	5.54%	569	3.22%	596	4.48%	536	6.66%	648	4.99%	1034	12.36%	1906
Total Urban	**9.70%**	**997**	**5.12%**	**947**	**7.38%**	**883**	**13.67%**	**1330**	**7.85%**	**1627**	**26.66%**	**4111**
Non-vegetated Farmland	0.09%	9	0.24%	44	0.18%	22	0.38%	37	0.13%	27	0.36%	55
Row Crops	8.98%	923	16.65%	3080	16.64%	1990	2.65%	258	5.25%	1087	5.00%	771
Forage Crops	19.31%	1985	24.79%	4586	21.44%	2564	18.08%	1760	19.23%	3984	16.17%	2494
Orchards/Vineyards/ Nursery	7.78%	800	24.12%	4462	16.73%	2000	23.16%	2254	27.75%	5750	8.89%	1371
Total Agriculture	**36.16%**	**3717**	**65.80%**	**12172**	**54.99%**	**6576**	**44.28%**	**4309**	**52.36%**	**10848**	**30.42%**	**4691**
Upland Openland	11.71%	1204	6.67%	1234	8.14%	973	10.73%	1044	11.06%	2291	14.83%	2287
Upland Forest	19.03%	1956	10.94%	2024	12.12%	1449	17.50%	1703	16.88%	3498	18.66%	2878
Lowland Forest	8.49%	873	6.60%	1221	10.79%	1290	9.09%	885	7.19%	1489	5.40%	833
Wetland	6.48%	666	4.64%	858	6.26%	748	4.25%	414	3.37%	698	3.09%	476
Water	8.32%	855	0.09%	17	0.00%	0	0.05%	5	0.00%	0	0.03%	4
Total Natural	**54.03%**	**5554**	**28.94%**	**5354**	**37.30%**	**4460**	**41.63%**	**4051**	**38.49%**	**7976**	**42.01%**	**6478**
Other/Unknown	**0.12%**	**12**	**0.14%**	**26**	**0.33%**	**39**	**0.43%**	**42**	**1.30%**	**269**	**0.91%**	**141**
Total Acres	**100.00%**	**10280**	**100.00%**	**18499**	**100.00%**	**11958**	**100.00%**	**9732**	**100.00%**	**20720**	**100.00%**	**15421**

Appendix 2. NPDES permits in the Paw Paw River Watershed

Current as of May 2007

FACILITY	PERMIT NUMBER	ISSUE DATE	EXPIRES	LOCATION	CITY
ABC Precision Machining	MIS310109	10/22/02	04/01/08	2077 Yore Avenue	Benton Harbor
Ace Companies, LLC	MIS310576	07/12/06	04/01/08	900 Alreco Road	Benton Harbor
Atlantic Automotive Components	MIS310119	10/21/02	04/01/08	359 Territorial Road	Benton Harbor
Atlantic Automotive Components	MIS310127	10/31/02	04/01/08	1285 North Crystal Avenue	Benton Harbor
August Pohl Auto Wreckers	MIS310266	02/03/03	04/01/08	2670 Territorial Road	Benton Harbor
Benton Harbor LLC	MIS210853	02/09/06	04/01/07	800 South Fair Avenue	Benton Harbor
Bowater NuWay Inc	MIG250285	04/16/03	04/01/08	1320 Paw Paw Avenue	Benton Harbor
Brutsche Concrete	MIS310009	09/24/02	04/01/08	1108 South Crystal	Benton Harbor
Certified Metal Finishing, Inc	MIS310329	02/27/03	04/01/08	424 West Main Street	Benton Harbor
Dawson Manufacturing Company	MIS310519	04/15/04	04/01/08	1042 North Crystal Avenue	Benton Harbor
GM Brass & Aluminum Foundry, Inc	MIS310106	10/22/02	04/01/08	200 West Wall Street	Benton Harbor
K-O Products Company	MIS310131	11/05/02	04/01/08	1225 Milton Street	Benton Harbor
Leco-Michigan Ceramics Division	MIS310062	10/08/02	04/01/08	1920 Yore Avenue	Benton Harbor
Max Casting Company, Inc	MIS310242	01/22/03	04/01/08	116 Paw Paw Avenue	Benton Harbor
Mordern Plastics Corporation	MIS310343	02/28/03	04/01/08	489 North Shore Drive	Benton Harbor
Nat Zinc Processors	MIG250393	12/26/02	04/01/08	1256 Milton Street	Benton Harbor
National Zinc Processors, Inc	MIS310069	10/08/02	04/01/08	1256 Milton Street	Benton Harbor
New Products Corp	MIG250368	12/26/02	04/01/08	448 North Shore Drive	Benton Harbor
New Products Corporation	MIS320001	11/05/02	04/01/08	448 North Shore Drive	Benton Harbor

FACILITY	PERMIT NUMBER	ISSUE DATE	EXPIRES	LOCATION	CITY
Old Europe Cheese, Inc	MIS310204	12/23/02	04/01/08	1330 Empire Avenue	Benton Harbor
Sandvik Materials Technology	MIS310255	02/03/03	04/01/08	2235 Dewey Avenue	Benton Harbor
SW MI Regional Airport Authority	MIS310078	10/09/02	04/01/08	1123 Territorial Road	Benton Harbor
Square Deal Auto Salvage	MIS310520	06/24/04	04/01/08	1091 Territorial Road	Benton Harbor
Sumitec Inc-Benton Harbor	MIG250362	02/27/03	04/01/08	470 Paw Paw Avenue	Benton Harbor
Sumitec Incorporated	MIS310396	05/08/03	04/01/08	470 Paw Paw Avenue	Benton Harbor
The Alloy Foundry Company	MIS310443	06/24/03	04/01/08	1617 Territorial Road	Benton Harbor
Whirlpool Corporation	MIS310150	11/26/02	04/01/08	151 North Riverview Drive	Benton Harbor
FACILITY	PERMIT NUMBER	ISSUE DATE	EXPIRES	LOCATION	CITY
Whirlpool-Benton Harbor Div	MIG250369	02/27/03	04/01/08	151 North Riverview Drive	Benton Harbor
Worthington Armstrong Venture	MIS310118	10/22/02	04/01/08	745 Enterprise Way	Benton Harbor
Coloma Frozen Foods	MIS310434	06/24/03	04/01/08	4145 Coloma Road	Coloma
Menasha Packaging Company LLC	MIS310237	01/09/03	04/01/08	333 West Center Street	Coloma
Norm & Sons Auto Salvage	MIS310349	03/06/03	04/01/08	46588 County Road 703	Coloma
Paw Paw Lake Area WWTP	MI0023779	07/10/03	10/01/07	4689 Defield Road	Coloma
Ravine View Estates MHC	MIG570105	12/20/04	04/01/10	5100 Little Paw Paw Lake Road	Coloma
Shawnee Specialties Inc	MIS310154	11/26/02	04/01/08	7100 3rd Street	Eau Claire
Hartford Dairy-CAFO	MI0057562	06/11/04	10/01/08	N. side 72nd Ave, btwn 76th & 64th Sts	Hartford
Hartford WWTP	MI0023094	04/02/03	10/01/07	66460 56th Avenue	Hartford
Kalamazoo Transit System	MIS110702	05/18/06	04/01/11	530 North Rose Street	Kalamazoo
Lawrence WWSL	MIG580107	10/08/03	04/01/09	County Road 653 & 51st Avenue	Lawrence
Dave's Concrete Products, Inc	MIS210824	11/09/04	04/01/07	79811 M-40	Lawton

FACILITY	PERMIT NUMBER	ISSUE DATE	EXPIRES	LOCATION	CITY
Lawton WWTP	MI0055514	12/06/02	10/01/07	625 West Union Street	Lawton
Welch Foods Inc	MIG250385	02/21/03	04/01/08	400 Walker Street	Lawton
Welch Foods, Incorporated	MIS310525	08/05/04	04/01/08	400 Walker Street	Lawton
MDNR-Wolf Lake Fish Hatchery	MI0035734	02/12/03	10/01/07	34270 County Road 652	Mattawan
Coca Cola-Paw Paw	MI0056367	06/20/02	10/01/06	38279 Red Arrow Highway	Paw Paw
Knouse Foods Coop Inc	MIS320016	06/24/03	04/01/08	815 South Kalamazoo Street	Paw Paw
Paw Paw WWTP	MI0021741	09/23/03	10/01/07	38360 Paw Paw Road	Paw Paw
St Julian Wine Company Inc	MIG250145	06/26/03	04/01/08	716 South Kalamazoo Street	Paw Paw
St. Julian Wine Company Inc	MIS310061	10/08/02	04/01/08	716 South Kalamazoo Street	Paw Paw
Orchard Hill Landfill	MIS310115	10/22/02	04/01/08	3290 Hennesey Road	Watervliet

Appendix 3. Protection and Management Options for Private Lands

Land Protection Options

Land Protection Option	Description	Results	Income Tax Deduction ?*	Estate Tax Reduction ?*
Conservation easement	Legal agreement between a landowner and a land conservancy or government agency permanently limiting a property's uses.	Important features of the property protected by organization. Owner continues to own, use, live on land.	Yes	Yes
Outright land donation	Land is donated to the land conservancy.	Organization owns, manages, and protects land.	Yes	Yes
Donation of land by will	Land is specifically designated for donation to the land conservancy.	Organization owns, manages, and protects land.	No	Yes
Donation of remainder interest in land with reserved life estate	Personal residence or farm is donated to the land conservancy, but owner (or others designated) continue to live there, usually until death.	Organization owns remainder interest in the land, but owners (others) continue to live on and manage land during their lifetime subject to a conservation restriction.	Yes	Yes
Bargain sale of land	Land is sold to the land conservancy below fair market value. It provides cash, but may also reduce capital gains tax, and entitle you to an income tax deduction.	Organization owns, manages, and protects land.	Yes	Yes

*The amount of income/estate tax reduction depends on a number of factors. Please consult a professional tax and/or legal advisor. (Adapted from Conservation Options: A Landowner's Guide, Land Trust Alliance.)

This table was created by the Southwest Michigan Land Conservancy call (269) 324-1600 for more information.

Land Management Programs**

Land Management Option	Description	Agreement	Landowner reimbursement
Wildlife Habitat Incentive Program (WHIP)	Provides technical and financial assistance to promote wildlife habitat including corridor, riparian buffer and rare species habitat development	Contracts run for a minimum of 5 years and a maximum of 10 years.	Up to 75% of cost of improvements.
Wetland Reserve Program (WRP)	Assists in restoring active agricultural land to natural wetland condition.	Agreements can be 10-year, 30-year or perpetual.	Up to 75% of cost of improvements or 100% for permanent agreements.
Environmental Quality Incentives Program (EQIP)	Assists in restoring agricultural land to wildlife habitat.	Agreements can last 2-10 years.	Up to 75% of cost of improvements.

**These are just a few of many examples. For more information contact Van Buren Conservation District office at 269-657-4030 x5 or the Berrien Conservation District at (269) 471-9111.

Appendix 4. Water Quality Statement by Water Body

Designated uses of many water bodies in the PPRW are threatened or impaired due to habitat loss or fragmentation, rather than any specific pollutant. For the purposes of this summary we will limit the discussion to pollutant based impairments and threats. From a pollutant standpoint, water quality in the PPRW varies greatly from one water body to the next. The connection between which designated uses are being threatened or impaired; the pollutants causing the threat or impairment; the sources of the pollutants; and the causes related to those sources will be examined for individual water bodies in order to provide a detailed description of water quality throughout the watershed. Several sources of information* were used to determine the status of each step in this connection. If a designated use is not mentioned, there was not sufficient information to determine if the use was being met, threatened or impaired. Not all water bodies within the watershed were evaluated. Only water bodies with enough information to make a water quality statement are included in this summary.

*Information used: MDEQ 2006 and 2008 Integrated Reports; MDNR Fisheries Division staff input; MDNR Fisheries Reports; Spicer Study on Paw Paw Lake; TNC Agricultural Impact Study; TNC Floodplain Forest Study; Van Buren County Drain Commissioner input; MDEQ Biosurvey Reports; PPRW Volunteer Inventory; MDEQ Road Stream Crossing Inventory, MDEQ Wetland Functional Analysis, MDEQ Flashiness Report

Paw Paw Mainstem

The Paw Paw Mainstem originates at the confluence of the North and South Branches and flows centrally through the watershed in a southwest direction to the St. Joseph River. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients and pesticides are also suspected to be threatening water quality. Streambanks are the only known source of sediment within the mainstem corridor. Agricultural lands, roads, building sites and impervious surfaces throughout the watershed are suspected to be contributing sediment, nutrients and pesticides.

Land cover along the Paw Paw Mainstem is predominantly natural. The floodplain forests, wetlands, and sand/gravel geology along the mainstem provide excellent habitat for a diverse assemblage of fish species. Land cover changes throughout the PPRW are the primary threat to the hydrology of the mainstem. Wetland loss, channel modification and increased runoff from urban and agricultural land without BMPs creates flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. The Paw Paw River has relatively stable flows, but a study of historic streamflow data by MDEQ suggests flashiness is increasing. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2008 Integrated Report, the Paw Paw Mainstem is meeting its designated use for Other Aquatic Life and Wildlife, but it was not assessed for its Warmwater Fishery designated use. The Paw Paw Mainstem was sampled at eight locations in a biological survey conducted by the MDEQ in 2006. According to the staff report, the riparian corridor was very complete with most stations having riparian zones that were more than 150 feet wide with a large amount and variety of vegetation. Although some bank erosion was evident at nearly every station, the river did not appear flashy and large woody debris was stable and extended into the active stream channel.

Coldwater Tributaries

Blue Creek

Blue Creek is a coldwater stream that joins the Paw Paw River in Benton Twp. Yellow Creek is the only significant tributary to Blue Creek. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. The designated uses of Total and Partial Body Contact are impaired due to known bacteria and pathogens, as evidenced by the presence of Escherichia coli (E. coli). Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Agricultural and developed lands are suspected sources of sediment, nutrients, pesticides and increased water temperature. Streambanks are a known source of sediment. Illicit discharges of wastewater are the primary suspected source of E. coli.

Land cover in the Blue Creek watershed is approximately 57% agricultural, 35% natural and 8% developed. Most of the natural riparian corridor along Blue Creek remains intact. According to the MDEQ Landscape Level Wetland Functional Assessment report, 82% of presettlement wetlands in the Blue Creek watershed remain intact. Many of these wetlands have a high significance for sediment and other particulate retention. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) increase runoff allowing sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Developed lands and associated impervious surfaces also increase runoff. Without sufficient stormwater management practices, runoff from developed lands within the watershed will carry sediment, nutrients, oils, metals and chemicals directly to Blue Creek.

Increased runoff creates flow fluctuations and reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There are two known impaired road/stream crossings along Blue Creek, both on Territorial Road. The first crossing has a failing culvert that is undersized causing erosion and a shifting sand bedload on top of the fine gravel streambed. Stormwater runoff at the second crossing

is causing erosion and variable flow rates. The undersized culverts at this crossing are impacting fish passage, flow and sand/woody debris transport.

According to the 2008 Integrated Report, Blue Creek was not assessed for its Coldwater Fishery designated use. It was found to be meeting its designated use for Other Aquatic Life and Wildlife. Blue Creek is not meeting its designated use for Total and Partial Body Contact due to E. coli. A TMDL is scheduled for development in 2017. A biological survey conducted by the MDEQ in 2006 at Park Road rated the macroinvertebrate community acceptable. Habitat was rated excellent due to epifaunal substrate consisting of undercut banks, leaf packs and abundant woody debris. However, the report noted that the deposition of sand was evident.

The biological survey conducted by the MDEQ in 2006 also includes information about elevated E. coli levels found in a strom drain discharging to Blue Creek downstream of Highland Avenue. According to the report, illicit discharges of wastewater from the community of Millburg in Benton Twp are the likely source of the E. coli. The MDEQ is working with the Berrien County Health Department to address this problem. In addition to the E. coli issue, a great deal of sedimentation has occurred in Blue Creek from a gully that formed along the streambank due to the stormwater discharges at this site.

Brush Creek

Brush Creek is a coldwater stream that joins the Paw Paw River in the Village of Lawrence. Its tributaries include Red Creek and White Creek. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Agricultural lands are the primary suspected source of sediment, nutrients, pesticides and increased water temperature. Streambanks are a known source of sediment.

Land cover in the Brush Creek watershed is approximately 57% agricultural, 38% natural and only 4% developed. Although a large portion of the natural riparian corridor along Brush Creek remains intact, there is a lack of riparian buffers on many of the small agricultural ditches in the watershed. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. According to the MDEQ Wetland Functional Assessment report, the Brush Creek watershed has only lost 28% of its presettlement wetlands. However, 45% of the wetlands with a high significance for streamflow maintenance and sediment and other particulate retention have been lost.

Wetland loss, channel modification and lack of BMPs cause increased runoff from agricultural lands. Increased runoff creates flow fluctuations and reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform

flow throughout the year typically have more stable channel morphology and fish assemblages.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There are two known impaired road/stream crossings in the Brush Creek watershed. The CR 215 crossing of White Creek is preventing fish passage and causing modifications to stream morphology. The CR 215 crossing of Brush Creek is preventing fish passage and causing streambank erosion.

According to the 2008 Integrated Report, Brush Creek was not assessed for its Coldwater Fishery designated use. It was found to be meeting its designated use for Other Aquatic Life and Wildlife. A biological survey conducted by the MDEQ in 2006 at 63rd Street rated the macroinvertebrate community as acceptable. The habitat was rated good due to large woody debris, undercut banks and a small amount of gravel. However, the report noted that the substrate was dominated by sand, the banks were somewhat scoured and the stream appeared to be somewhat flashy.

Campbell Creek

Campbell Creek is a coldwater tributary of the North Branch. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to suspected sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Suspected sources of sediment are agricultural lands and streambanks. Agricultural and developed lands are also a suspected source of nutrients, pesticides and increased water temperature.

The Campbell Creek watershed contains a tremendous amount of natural land cover including a very large wetland complex known as the Almena Swamp. According to the MDEQ Wetland Functional Assessment report, 66% of presettlement wetlands in the Campbell Creek watershed remain intact. Many of these wetlands have a high significance for streamflow maintenance and nutrient transformation. Small farms are scattered throughout this watershed and residential development is increasing. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) increase runoff allowing sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Developed lands and associated impervious surfaces also increase runoff. Without sufficient stormwater management practices, runoff from developed lands within the watershed will carry sediment, nutrients, oils, metals and chemicals directly to Campbell Creek.

Increased runoff creates flow fluctuations and reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2008 Integrated Report, Campbell Creek was not assessed for its Coldwater Fishery designated use. It was found to be meeting its designated use for Other Aquatic Life and Wildlife. A biological survey conducted by the MDEQ in 2006 at 28th Street rated the macroinvertebrate community at the high end of acceptable. Habitat was rated excellent, but a lack of cobble and gravel was evident. A biological survey conducted by the MDEQ in 1991 at Stevens Road reported that Campbell Creek demonstrated classic temperature and macroinvertebrate profiles of a cold headwater stream. The 1991 report stated that the water was well oxygenated with good instream habitat only modestly impacted by silt and sand deposition. Overall scores in 1991 indicated the stream was meeting its coldwater designated use.

Eagle Lake Drain

Eagle Lake Drain is a coldwater tributary of the West Branch. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Suspected sources of sediment are agricultural lands and streambanks. Agricultural lands are also a suspected source of nutrients, pesticides and increased water temperature.

Land use in the Eagle Lake Drain Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with wind and runoff from rain events. Increased runoff due to wetland loss, channel modification and lack of BMPs (buffer strips, no-till, cover crops, etc.) creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Eagle Lake Drain is listed as a Category 4c water body in MDEQ's 2006 Integrated Report and the 2008 Integrated Report. According to these reports, Eagle Lake Drain is not supporting its designated use for Other Indigenous Aquatic Life and Wildlife due to channel modifications and other flow regime alterations. According to the 2008 Integrated Report, it is meeting its designated use for Coldwater Fishery based on dissolved oxygen measurements. However, biological surveys conducted by the MDEQ in 1991 and 1996 found the Coldwater Fishery designated use not being supported. In addition, the biological survey conducted by the MDEQ in 2006 rated the macroinvertebrate community poor and the habitat marginal at 42nd Street. Habitat was rated as marginal because woody debris was absent from the stream channel and there was very little substrate available for colonization. Discussions with MDNR Fisheries Division staff suggest the coldwater fishery is being impaired by sediment laden agricultural runoff.

East Branch

The East Branch is a coldwater stream that joins the West Branch in the Village of Paw Paw. Its tributaries include Cook Drain, Mattawan Creek and Paw Paw Lake in Kalamazoo County. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Streambanks are the only known source of sediment. Agricultural and developed lands are suspected sources of nutrients, pesticides and increased water temperature.

The East Branch has the highest groundwater inflow in the PPRW and therefore is more stable and less affected by major precipitation events. The natural riparian corridor along the stream remains mostly intact and this watershed contains an extensive area with high potential for groundwater recharge. This watershed also contains several large prairie fens, which are unique wetlands rich in species diversity.

The Village of Mattawan and a portion of the Village of Paw Paw are found within the East Branch watershed. Commercial and residential development is increasing rapidly in this area. Agricultural land cover in the East Branch watershed is dominated by orchards, vineyards and non-tilled forage crops. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) increase runoff allowing sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Developed lands and associated impervious surfaces also increase runoff. Without sufficient stormwater management practices, runoff from developed lands within the watershed will carry sediment, nutrients, oils, metals and chemicals directly to the East Branch.

Flow fluctuations created by increased runoff reduce groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes also cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There are two known impaired road/stream crossings along the East Branch. The crossing at 26th Street has a culvert that is poorly aligned with the stream dimensions and as a result is preventing fish passage upstream and causing scouring downstream. The crossing at 63rd Avenue is undersized and perched preventing fish passage, creating scouring downstream and impounding water upstream.

According to the 2008 Integrated Report, the East Branch was not assessed for its Coldwater Fishery designated use. It was found to be meeting its designated use for Other Aquatic Life and Wildlife. A biological survey conducted by the MDEQ in 2006 at 32nd Street rated both the macroinvertebrate community and habitat as excellent. However, the report noted that woody debris within the stream channel was at least

50% embedded, and the bottom substrate was dominated by sand. Two stations near the Village of Paw Paw were also surveyed in 2006. The macroinvertebrate communities were rated as acceptable and the habitats were rated as good at these sites.

The biological survey conducted by the MDEQ in 2006 also includes information on the possible effects of contaminated venting groundwater on the East Branch. Thomas Drain has been enclosed and functions as a city storm drain for the Village of Paw Paw. The drain meets the East Branch just downstream of the Gremps Street crossing and just upstream of the confluence with the West Branch. The drain historically has been thought to carry venting groundwater contaminated with trichloroethene from the Paw Paw Plating facility on Commercial Street. Water samples were collected from the storm drain itself and sediment samples were collected downstream and upstream of its confluence with the East Branch. Water quality standards were being met for all parameters analyzed. Sediment sample results from the downstream site exceeded sediment quality guidelines for several parameters and were much higher than the results from the upstream site. The MDEQ will continue to investigate the Paw Paw Plating site.

Hayden Creek

Hayden Creek is a coldwater tributary of the North Branch. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to suspected sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Suspected sources of sediment are agricultural lands and streambanks. Agricultural and developed lands are also a suspected source of nutrients, pesticides and increased water temperature.

The natural riparian corridor along Hayden Creek remains mostly intact including a wide wetland zone in many areas. According to the MDEQ Wetland Functional Assessment report, the wetlands along Hayden Creek have a high significance for sediment and other particulate retention as well as fish, shellfish and other wildlife habitat. There is a considerable amount of agricultural land cover within the Hayden Creek watershed. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) increase runoff allowing sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Developed lands and associated impervious surfaces also increase runoff. Without sufficient stormwater management practices, runoff from developed lands within the watershed will carry sediment, nutrients, oils, metals and chemicals directly to Hayden Creek.

Increased runoff creates flow fluctuations and reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2008 Integrated Report, Hayden Creek was not assessed for its Coldwater Fishery designated use. It was found to be meeting its designated use for Other Aquatic Life and Wildlife. A biological survey conducted by the MDEQ in 2006 at 30th Street rated the macroinvertebrate community in the mid-range of excellent. Habitat was also rated excellent. The 2006 report notes that the banks appeared stable and although the substrate consisted entirely of sand, there was an excellent amount of pool variability and a mix of available cover including large woody debris and undercut banks. A biological survey conducted by the MDEQ in 1991 at 32nd Street found the stream to be somewhat limited by sand and silt deposition. It noted that insects commonly found in rocky or gravel riffle zones were absent. Although one trout was found during this survey, a number of warmwater fish were also found. The report noted that these warmwater species might be emigrants from Lime Lake or other small impoundments on Hayden Creek. Overall scores in 1991 indicated the stream was meeting its coldwater designated use.

Mill Creek

Mill Creek is a coldwater stream that meets the Paw Paw River in the City of Watervliet. The Total and Partial Body Contact designated uses are impaired due to known bacteria and pathogens (E. coli). The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Livestock and septic systems are the suspected sources of E. coli. Streambanks are a suspected source of sediment. Agricultural lands are a suspected source of sediment, nutrients, pesticides and increased water temperature.

Land use in the Mill Creek Watershed is primarily agricultural. Unrestricted livestock access to streams and improper management of manure causes bacteria and pathogens to enter surface water. There are no known unrestricted livestock access sites in the Mill Creek Watershed, but there are several farms with livestock. There is also a large amount of manure being applied to fields within the watershed. Improper management of manure is the primary suspected cause of E. coli in Mill Creek. Improperly designed or maintained septic systems are another suspected cause of E. coli.

Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. According to the MDEQ Wetland Functional Assessment report, 60% of the wetlands with a high significance for sediment and other particulate retention have been lost in the Mill Creek Watershed. Increased runoff due to wetland loss, channel modification and lack of BMPs creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Mill Creek is listed as a Category 5 water body in MDEQ's 2006 Integrated Report and the 2008 Integrated Report. According to these reports, Mill Creek is not meeting its designated use for Total and Partial Body Contact due to E. coli. A TMDL is scheduled for development in 2009. In the 2008 Integrated Report, Mill Creek was not assessed for its Coldwater Fishery designated use and its Other Aquatic Life and Wildlife designated use was found to be fully supported. A biological survey conducted by the MDEQ in 2006 at a site just upstream of Red Arrow Hwy rated the habitat as good due to a large amount of gravel and some woody debris, but also found evidence of flow fluctuations and sedimentation. A biological survey conducted by the MDEQ in 2005 rated the habitat at 67th Street as severely impaired. In addition to MDEQ reports, the SWAT model places the Mill Creek Watershed in the second highest category for sediment loading.

North Branch

The North Branch is designated as a coldwater stream above M-40. Coldwater tributaries of the North Branch include Campbell Creek, Hayden Creek, and Ritter Creek. The only significant warmwater tributary is Brandywine Creek and it joins the North Branch approximately 1.5 miles before the confluence of the North and South Branches. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. The designated uses of Total and Partial Body Contact are threatened due to suspected bacteria and pathogens (E. coli). Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. Agricultural lands are the primary suspected source of sediment, nutrients, pesticides and increased water temperature. Streambanks are a known source of sediment. Livestock are the only known source of suspected E. coli.

The North Branch watershed includes a large historic wetland area known as the Mentha Flats, which has been severely channelized to facilitate vegetable production. This area and Brandywine Creek are suspected to be contributing the largest amounts of sediment to the North Branch. Land cover in the Mentha Flats area is 71% agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with wind and runoff from rain events.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There is one known impaired road/stream crossing north of Whiskey Run on CR 653 causing severe streambank erosion. The culverts are poorly aligned and undersized restricting flows and creating modifications to the stream dimensions. Unrestricted livestock access to streams also causes streambank erosion and allows bacteria and pathogens to enter surface water. There are two known sites where livestock have unrestricted access to streams within the North Branch watershed. One site is located on Ritter Creek at 30th Street and the other is on the Paw Paw and Allegan Road Drain at 45th Street.

Below the Mentha Flats, the North Branch flows through approximately 1,500 acres of wetland known as the Almena Swamp. According to the MDEQ Wetland Functional

Assessment report, the coldwater portion of the North Branch Watershed has lost 40% of its presettlement wetlands. However, 94% of the wetlands with a high significance for sediment and other particulate retention still remain. Wetland loss, channel modification and lack of BMPs can increase runoff creating flow fluctuations and increased stream power. Increased runoff also reduces reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2008 Integrated Report, the North Branch was not assessed for its Coldwater Fishery designated use. It is meeting its designated use for Other Aquatic Life and Wildlife. However, a biological survey conducted by the MDEQ in 2006 at 35 ½ Street rated the macroinvertebrate community in the mid-range of acceptable. Habitat was rated as good, but the riparian zone was noted to be impacted by the road running parallel and very close to the stream for several yards. The survey noted a lack of epifaunal substrate due to sand embedding most of the large woody debris.

Pine Creek

Pine Creek is a coldwater stream that meets the Paw Paw River near the City of Hartford. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation. The Total and Partial Body Contact designated uses are impaired due to known bacteria and pathogens (E. coli). Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. The only known source of sediment is streambanks. Livestock and septic systems are the suspected sources of E. coli. Agricultural lands are a suspected source of sediment, nutrients, pesticides and increased water temperature.

Land use in the Pine Creek Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Increased runoff due to lack of BMPs, wetland loss and channel modification, creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Failing and improperly designed road/stream crossings can cause fish passage impairment, bank erosion and other changes to channel morphology. There is one known impaired road/stream crossing at 64th Street causing sedimentation. The bottom of this box culvert is elevated above the streambed resulting in a semi-perched condition affecting channel morphology.

Unrestricted livestock access to streams and improper management of manure causes bacteria and pathogens to enter surface water. There are no known unrestricted livestock access sites in the Pine Creek Watershed, but there are several farms with livestock. There is also large amount of manure being applied to fields within the watershed. Improper management of manure is the primary suspected cause of E. coli in Pine Creek. Improperly designed or maintained septic systems are another suspected cause of E. coli.

Pine Creek is listed as a Category 5 water body in MDEQ's 2006 Integrated Report and the 2008 Integrated Report. According to the 2008 Integrated Report, Pine Creek is not supporting its designated use for Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife due to channel modifications and other flow regime alterations. It is not meeting its designated use for Total and Partial Body Contact due to E. coli. A TMDL is scheduled for development in 2009. A biological survey conducted by the MDEQ in 2006 rated the macroinvertebrate community poor at Red Arrow Hwy. Habitat was rated as marginal because the substrate consisted entirely of sand with little pool variability. According to the staff report the stream appeared to experience severe flow fluctuations. In addition to MDEQ reports, the SWAT model places the Pine Creek Watershed in the second highest category for sediment loading.

Red Creek

Red Creek is a coldwater tributary of Brush Creek. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation. Nutrients, pesticides and increased water temperature are also suspected to be threatening water quality. The only known source of sediment is agricultural lands. Streambanks are a suspected source of sediment. Agricultural lands are a suspected source of nutrients, pesticides and increased water temperature.

Land use in the Red Creek Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) are the primary source of sedimentation. They allow sediment, nutrients and pesticides to be transported to surface water with runoff from rain events. Increased runoff due to lack of BMPs, creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2008 Integrated Report, Red Creek is meeting its designated use for Other Aquatic Life and Wildlife. However, a biological survey conducted by the MDEQ in 2006 rated the macroinvertebrate community as barely acceptable at 56th Street. The MDEQ staff report from biological surveys conducted in 1991 notes that habitat was significantly impacted by sediment deposition and poor stream bank vegetation producing unstable banks. Red Creek's designated use of Coldwater Fishery was not

assessed in the 2008 Integrated Report. Biological surveys conducted by the MDEQ in 1991 found the Coldwater Fishery designated use not being supported. In addition to MDEQ reports, the SWAT model places the Red Creek Watershed in the highest category for sediment loading. Discussions with MDNR Fisheries Division staff confirm that the coldwater fishery is being impaired by sediment laden agricultural runoff.

Sand Creek

Sand Creek is a coldwater stream that meets the Paw Paw River near Benton Harbor. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation. Streambank erosion is the primary suspected source of sediment. Increased water temperature, nutrients, pesticides, metals, oils and grease are also suspected to be impacting water quality. Developed lands are the only suspected source of these pollutants.

The Sand Creek Watershed contains a significant amount of urban land cover and associated impervious surfaces. Insufficient management of the stormwater runoff created by impervious surfaces leads to sedimentation, polluted runoff and altered hydrology. Increased runoff reduces groundwater infiltration causing decreased base flow and water depth during periods of low flow. Flow fluctuations, increased stream power and other hydrology changes cause stream bank erosion, habitat modification and adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages. Increased water temperature can be caused by impervious surfaces (such as parking lots and rooftops), which may increase the temperature of water moving over them, and reduced water depth during low flow periods due to decreased base flow. Suspected causes of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by landowners. Poor vehicle maintenance and improper oil disposal are suspected causes of oil and grease in urban stormwater runoff.

Sand Creek was not assessed for its Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife designated uses in MDEQ's 2008 Integrated Report. In the staff report of biological surveys conducted by the MDEQ in 2006, Sand Creek is considered a potential concern due to the possible addition of a large culvert to facilitate runway extension at the Southwest Michigan Regional Airport in Benton Harbor. The report notes that in 2004 the macroinvertebrate community was rated acceptable, but the fish community was rated poor. Discussions with MDNR Fisheries Division staff suggest the coldwater fishery is being impaired by sedimentation resulting from altered hydrology.

West Branch

The West Branch is a coldwater stream that joins the East Branch in the Village of Paw Paw. Its tributaries include Eagle Lake Drain, Lawton Drain, Gates Extension Drain and Three Mile Lake Drain. The designated uses of Coldwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation and low dissolved oxygen (DO) levels. The designated uses of Total and Partial Body Contact are threatened due to suspected bacteria and pathogens (E. coli). Nutrients, pesticides and increased water temperature are suspected to be threatening water quality. The

only known source of sediment is streambanks. Agricultural lands are a suspected source of sediment, nutrients, pesticides and increased water temperature. Livestock are the only known source of suspected E. coli.

Land use in the West Branch Watershed is primarily agricultural. Presettlement land cover in the watershed was dominated by wetlands. According to the MDEQ Wetland Functional Assessment report, 57% of presettlement wetlands in the West Branch Watershed have been drained and converted to agricultural lands. Of those lost wetlands, 81% had a high significance for streamflow maintenance and 47% had a high significance for sediment and other particulate retention. Increased runoff due to wetland loss, channel modification and lack of BMPs (buffer strips, no-till, cover crops, etc.) creates flow fluctuations and increased stream power. Increased runoff also reduces groundwater infiltration and decreases base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion, temperature fluctuations and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Unrestricted livestock access to streams causes streambank erosion and allows bacteria and pathogens to enter surface water. There is one known unrestricted sheep access site on Lawton Drain at CR 665. Agricultural lands without BMPs allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. There are no known causes of low DO levels in the West Branch, but nutrients are often related to the impairment.

The West Branch is listed as a Category 5 water body in MDEQ's 2008 Integrated Report. The West Branch is listed as not supporting its designated use for Coldwater Fishery due to low DO levels. A TMDL is scheduled for development in 2018. According to the report, it is fully supporting its designated use for Other Aquatic Life and Wildlife. However, a biological survey conducted by the MDEQ in 2006 rated the macroinvertebrate community at the low end of acceptable. Habitat was rated as marginal due to sedimentation and silt exceeding three feet in depth in some areas. In addition to MDEQ reports, the West Branch was identified in the TNC Agricultural Impact study as a problem area. The Van Buren County Drain Commissioner and the Village of Paw Paw have identified the West Branch as the primary source of sediment problems in Briggs Pond and Maple Lake.

Warmwater Tributaries

Brandywine Creek

Brandywine Creek is a warmwater tributary of the North Branch. Its tributaries include the North Extension Drain and Martin Lake Drain. The designated use of Warmwater Fishery is impaired and the designated use of Other Indigenous Aquatic Life and Wildlife is threatened due to known sedimentation. The designated uses of Total and Partial Body Contact are threatened due to suspected bacteria and pathogens (E. coli). Nutrients and pesticides are also suspected to be threatening water quality.

Streambanks are the only known source of sediment. Livestock are the only known source of suspected E. coli. Agricultural lands are a suspected source of sediment, nutrients and pesticides.

Land cover in the Brandywine Creek Watershed is approximately 56% agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Unrestricted livestock access to streams causes streambank erosion and allows bacteria and pathogens to enter surface water. There is one known unrestricted livestock access site on Martin Lake Drain at 18th Ave.

According to the MDEQ Wetland Functional Assessment report, the Brandywine Creek Watershed has lost 61% of its wetlands with a high significance for streamflow maintenance. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota.

Brandywine Creek is listed as a Category 4c water body in MDEQ's 2006 Integrated Report. According to the 2008 Integrated Report, Brandywine Creek is fully supporting its designated use for Other Aquatic Life and Wildlife. However, a biological survey conducted by the MDEQ in 2006 rated the habitat as marginal because existing woody debris was deeply embedded by sediment. The survey also noted that the stream appeared flashy as evidenced by eroded streambanks. Brandywine Creek's designated use of Warmwater Fishery was not assessed in the 2008 Integrated Report. Biological surveys conducted by the MDEQ in 1991 found the fish populations acceptable, but noted a significant lack of instream structure for fish cover.

In addition to MDEQ reports, Brandywine Creek was identified in the TNC Agricultural Impact study as a in-stream erosion problem area. Bank Erosion Hazard Index scores from the Volunteer Inventory were very high in this watershed. The Van Buren County Drain Commissioner identified Brandywine Creek and the North Extension Drain as high priorities for restoration due to sedimentation problems. Discussions with MDNR Fisheries Division staff suggest the warmwater fishery is being impaired by sedimentation.

Branch & Derby Drain

Branch & Derby Drain is a warmwater stream that is the largest tributary of Paw Paw Lake. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. The designated uses of Total and Partial Body Contact are threatened due to suspected bacteria and pathogens (E. coli). Nutrients and pesticides are also suspected to be threatening water quality. Agricultural lands are a suspected source of sediment, nutrients and pesticides. Streambanks are a suspected source of sediment. Livestock are the only known source of suspected E. coli.

Land use in the Branch & Derby Drain Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Unrestricted livestock access to streams causes streambank erosion and allows bacteria and pathogens to enter surface water. There is one known pasture with unrestricted livestock access on Branch & Derby Drain between M-140 and North Watervliet Rd. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

According to the 2008 Integrated Report, Branch & Derby Drain was not assessed for the designated uses of Other Indigenous Aquatic Life and Wildlife or Warmwater Fishery. The Spicer Group conducted an assessment of the Branch & Derby Drain as part of a study of the Paw Paw Lake Watershed in 2007. According to the study, Branch & Derby Drain is the largest contributor of sediment to Paw Paw Lake. The unrestricted livestock access site between M-140 and North Watervliet Rd was discovered during this assessment.

Carter Creek

Carter Creek is a warmwater stream that meets the Paw Paw River northwest of the Village of Paw Paw in Waverly Twp. Brownwood Lake and a few county drains are the only significant tributaries. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients and pesticides are also suspected to be threatening water quality. Agricultural lands are a suspected source of sediment, nutrients and pesticides. Discharges from the Coca-Cola Paw Paw facility are a suspected source of nutrients.

Land cover in the Carter Creek Watershed is 58% natural, 38% agricultural and 4% urban. According to the MDEQ Wetland Functional Assessment report, 57% of the presettlement wetlands have been lost. Wetland loss, channel modification and lack of agricultural BMPs (buffer strips, no-till, cover crops, etc.) create flow fluctuations and increased runoff. Increased runoff reduces groundwater infiltration, which affects base flow and water depth during periods of low flow. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. Agricultural lands without BMPs allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events.

According to the 2008 Integrated Report, Carter Creek was not assessed for its Warmwater Fishery designated use. It was found to be meeting its designated use for Other Aquatic Life and Wildlife. A biological survey conducted by the MDEQ in 2006 downstream of 47th Avenue rated the macroinvertebrate community as acceptable. However, the habitat was rated marginal and the report noted that historic channel alterations were evident. More than 50% of the stream bottom was affected by sediment deposition, but the banks appeared stable. Large amounts of aquatic

vegetation were present. The report notes that in July of 2001, MDEQ staff observed nuisance level algae conditions, but these conditions were not present in 2006. Increased flow was noticed compared to 2001. This increase may be attributed to the discharge from the Coca-Cola Paw Paw facility, which began in 2002.

Hog Creek

Hog Creek is a warmwater stream that meets the Paw Paw River just east of the City of Hartford. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients and pesticides are also suspected to be threatening water quality. Streambanks are the only known sources of sediment. Agricultural lands are a suspected source of sediment, nutrients and pesticides.

Land use in the Hog Creek Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. According to the MDEQ Wetland Functional Assessment report, the Hog Creek Watershed has lost 85% of its wetlands with a high significance for sediment and other particulate retention. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and fish assemblages.

Hog Creek is listed as a Category 4c water body in MDEQ's 2006 Integrated Report. According to the 2008 Integrated Report, Hog Creek is fully supporting its designated use for Other Indigenous Aquatic Life and Wildlife, but its designated use for Warmwater Fishery was not assessed. A biological survey conducted by the MDEQ in 2006 at Red Arrow Hwy rated the habitat marginal and the macroinvertebrate community as acceptable, but noted that the banks were scoured up to three feet above the water surface suggesting the stream is somewhat flashy.

Mud Lake Drain

Mud Lake Drain is a warmwater stream that meets the Paw Paw River north of the City of Hartford. The designated use of Warmwater Fishery is impaired and the designated use of Other Indigenous Aquatic Life and Wildlife is threatened due to known sedimentation. Nutrients are also suspected to be threatening water quality. Suspected sources of sediment are agricultural lands and streambanks. Agricultural lands are the suspected source of nutrients.

Land use in the Mud Lake Drain Watershed is primarily agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment and nutrients to be transported to surface water with runoff from rain events. Increased runoff, due to the lack of BMPs, wetland loss and channel modification, creates flow fluctuations and increased stream power. These hydrologic changes cause stream bank erosion and habitat modification resulting in adverse impacts to native biota. Streams with more

uniform flow throughout the year typically have more stable channel morphology and fish assemblages. According to the MDEQ Wetland Functional Assessment report, the Mud Lake Drain Watershed has lost 42% of its wetlands with a high significance for streamflow maintenance and 81% of its wetlands with a high significance for fish and shellfish habitat.

Mud Lake Drain is listed as a Category 4c water body in MDEQ's 2006 Integrated Report. According to the 2008 Integrated Report, Mud Lake Drain is fully supporting its designated use for Other Indigenous Aquatic Life and Wildlife, but its designated use of Warmwater Fishery was not assessed. A biological survey conducted by the MDEQ in 2006 at 52nd Street noted that 70% of the stream bottom was affected by sand deposition. MDNR Fisheries Division staff reported that Mud Lake Drain has recently lost two fish species.

Ox Creek

Ox Creek is a warmwater stream that joins the Paw Paw River in Benton Harbor. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are impaired due to known sedimentation, metals, oils and grease. Nutrients, pesticides and contaminated sediment are also suspected to be impacting water quality. Developed lands are a suspected source of these pollutants. Streambanks are a suspected source of sediment. Agricultural lands in the headwaters of the stream are another suspected source of sediment, as well as nutrients and pesticides. Heavy metals and organic compounds have been found in Ox Creek. Historic industrial practices are a known source of these pollutants.

The Ox Creek Watershed contains the most urbanized portion of the PPRW, with over 2000 acres of impervious surface. Insufficient management of the stormwater runoff created by impervious surfaces leads to sedimentation, polluted runoff and altered hydrology. Flow fluctuations, increased stream power and other hydrology changes cause stream bank erosion, habitat modification and adverse impacts to native biota. Streams with more uniform flow throughout the year typically have more stable channel morphology and more stable fish assemblages. Flow fluctuations can also affect environmental conditions, such as water temperature and chemistry. Suspected causes of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by landowners. Poor vehicle maintenance and improper oil disposal are suspected causes of oils and grease in urban stormwater runoff. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events.

Ox Creek is listed as a Category 5 water body in MDEQ's 2006 Integrated Report and a TMDL is scheduled for 2009. According to the 2008 Integrated Report, Ox Creek is not supporting its designated use for Other Indigenous Aquatic Life and Wildlife due to several pollutants including sediment, solids, chromium, copper, lead, oils and grease. Sediment samples taken in 2006 by MDEQ indicated that levels of lead, zinc and several polycyclic aromatic hydrocarbons exceeded sediment quality guidelines. The designated use of Warm Water Fishery was not assessed in the 2008 Integrated Report

due to insufficient information. Biological surveys conducted by the MDEQ in 2006 rated the macroinvertebrate community poor at 2 of 3 survey locations. Habitat was rated as marginal at one location due to a lack of epifaunal substrate and heavy deposits of sand. The fish community was rated at the low end of acceptable at Meadowbrook Rd., the only location sampled for fish and the most upstream survey station on Ox Creek. The fish community further downstream is more affected by high stormwater flows and altered hydrology.

South Branch

The South Branch is designated as a warmwater stream originating at the confluence of the East and West Branches in the Village of Paw. Approximately 5 miles downstream of Maple Lake, the South Branch joins the North Branch to become the Paw Paw River Mainstem. The designated uses of Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife are threatened due to known sedimentation. Nutrients, pesticides, metals, oils and grease are also suspected to be threatening water quality. Agricultural lands are a suspected source of sediment, nutrients and pesticides. Streambanks are the primary suspected source of sediment. Urban stormwater runoff from the Village of Paw Paw is a suspected source of nutrients, pesticides, metals, oils and grease.

Land cover in the South Branch Watershed below the confluence of the East and West branches is 49% natural, 40% agricultural and 11% urban. According to the MDEQ Wetland Functional Assessment report, 75% of the presettlement wetlands remain intact. The Village of Paw Paw contains most of the urban land cover and associated impervious surfaces in the South Branch Watershed. Insufficient management of stormwater runoff created by impervious surfaces leads to sedimentation and polluted runoff. Suspected causes of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by landowners. Poor vehicle maintenance and improper oil disposal are suspected causes of metals, oil and grease in urban stormwater runoff.

The West Branch is the largest tributary to the South Branch and its watershed is predominantly agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Wetland loss, channel modification and lack of BMPs create flow fluctuations in the West Branch and its tributaries. These hydrologic changes cause stream bank erosion and allow sediment and nutrients to be transported to Maple Lake in suspension.

Most of the sediment from urban stormwater runoff and the West Branch is trapped by Maple Lake, but nutrients, pesticides and other pollutants can move through the lake to the South Branch. Although Maple Lake serves as a sediment trap, the lack of suspended sediment in the water below the lake can actually lead to increased bank erosion along the South Branch. Water devoid of suspended sediment has an enhanced ability to cause streambank erosion.

According to the 2008 Integrated Report, the South Branch was not assessed for its Warmwater Fishery designated use. It was found to be meeting its designated use for Other Aquatic Life and Wildlife. A biological survey conducted by the MDEQ in 2006 at 3750th Avenue rated the macroinvertebrate community as acceptable. The habitat was rated good, but the report noted that very little substrate was available for colonization. The pool substrate was dominated by silt, and there were several deep deposits of silt.

Lakes

The following lakes were assessed by Michigan Department of Environmental Quality and were found to be supporting their designated use for Other Indigenous Aquatic Life and Wildlife: Paw Paw Lake (Kalamazoo County), Fish Lake, Brandywine Lake, Martin Lake (Little Brandywine Lake), Ackley Lake, Threemile Lake, Eagle Lake, Maple Lake, Lake Cora, Upper Reynolds Lake, School Section Lake, Rush Lake, Van Auken Lake, Shafer Lake, Hall Lake and Paw Paw Lake (Berrien County).

Maple Lake

Maple Lake is a man made impoundment of the East and West Branches of the Paw Paw River. The designated use of Warmwater Fishery is impaired due to known sedimentation. The designated use of Other Indigenous Aquatic Life and Wildlife is threatened by sediment and suspected nutrients. Pesticides, metals, oils and grease are also suspected to be impacting water quality. Suspected sources of sediment are streambanks and agricultural lands in the West Branch Watershed. Agricultural lands are a suspected source of nutrients and pesticides. Urban stormwater runoff from the Village of Paw Paw is a suspected source of nutrients, sediment, pesticides, metals, oils and grease.

The Village of Paw Paw contains the largest amount of urban land cover and associated impervious surfaces in the Maple Lake Watershed. Insufficient management of the stormwater runoff created by impervious surfaces leads to sedimentation and polluted runoff. Suspected causes of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by landowners. Poor vehicle maintenance and improper oil disposal are suspected causes of metals, oil and grease in urban stormwater runoff. Polluted runoff and increased nutrient levels lower dissolved oxygen (DO) in the water column.

The West Branch is the largest tributary to Maple Lake and its watershed is predominantly agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power in the West Branch and its tributaries. These hydrologic changes cause stream bank erosion and allow sediment and nutrients to be transported to Maple Lake in suspension. The sediment and nutrients accumulate in the lake resulting in lowered DO levels and habitat modification with adverse impacts to native biota.

According to the 2008 Integrated Report, Maple Lake is meeting its designated use for Other Aquatic Life and Wildlife. However, increasing sediment, nutrients and weed growth is altering the lake's habitat and chemistry. Maple Lake's designated use of Warmwater Fishery was not assessed in the 2008 Integrated Report. Lake levels were lowered during the fall of 2007 to facilitate repair of the dam. Lower water levels revealed the extent of sedimentation and weed growth. The Village of Paw Paw is working with the Van Buren County Drain Commissioner to determine how they can restore Maple Lake and protect it from further sedimentation and weed growth.

Paw Paw Lake

Paw Paw Lake is the largest lake in Berrien County and the largest lake in the PPRW. The designated use of Warmwater Fishery is impaired due to known low dissolved oxygen (DO) levels. The designated use of Other Indigenous Aquatic Life and Wildlife is threatened by known sediment and nutrients. Pesticides, metals, oils and grease are also suspected to be impacting water quality. Developed lands are a suspected source of nutrients, sediment, pesticides, metals, oils and grease. Agricultural lands in the headwaters of the lake are a suspected source of nutrients, sediment and pesticides. Tributary streambanks are another suspected source of sediment.

The area immediately adjacent to Paw Paw Lake contains a significant amount of urban land cover and associated impervious surfaces. Insufficient management of the stormwater runoff created by impervious surfaces leads to sedimentation and polluted runoff. Suspected causes of polluted runoff include improper application, storage, and disposal of fertilizers and pesticides by land owners. Polluted runoff and increased nutrient levels lower DO in the water column. Poor vehicle maintenance and improper oil disposal are suspected causes of metals, oil and grease in urban stormwater runoff.

Land cover in the headwaters of the Paw Paw Lake Watershed is predominantly agricultural. Agricultural lands without BMPs (buffer strips, no-till, cover crops, etc.) allow sediment, nutrients and pesticides to be transported directly to surface water with runoff from rain events. Wetland loss, channel modification and lack of BMPs create flow fluctuations and increased stream power in Paw Paw Lake tributaries. These hydrologic changes cause stream bank erosion and allow sediment and nutrients to be transported to the lake in suspension. The sediment and nutrients accumulate in the lake resulting in lowered DO levels and habitat modification with adverse impacts to native biota.

According to the 2008 Integrated Report, Paw Paw Lake is meeting its designated use for Other Aquatic Life and Wildlife. However, habitat has been severely impaired by increased armoring of the shoreline (sea walls, sheet piling and rip-rap). Paw Paw Lake's designated use of Warmwater Fishery was not assessed in the 2008 Integrated Report. The Spicer Group conducted a study of Paw Paw Lake and its watershed in 2007. According to the study, low DO levels are impairing the water quality of the lake. Accumulating nutrients (phosphorus & nitrogen) and organic material on the lake bottom is using up the available oxygen in the water column. Discussions with MDNR Fisheries Division staff confirm the fishery is impaired.

Appendix 5. Rare Species in the Paw Paw River Watershed

Scientific Name	Common Name	Federal Status	State Status	Type
Accipiter gentiles	Northern Goshawk		SC	Animal
Acris crepitans blanchardi	Blanchard's Cricket Frog		SC	Animal
Agrimonia rostellata	Beaked Agrimony		SC	Plant
Ambystoma opacum	Marbled Salamander		T	Animal
Ammodramus henslowii	Henslow's Sparrow		T	Animal
Ammodramus savannarum	Grasshopper Sparrow		SC	Animal
Amorpha canescens	Leadplant		SC	Plant
Aristida tuberculosa	Beach Three-awned Grass		T	Plant
Asclepias purpurascens	Purple Milkweed		SC	Plant
Astragalus canadensis	Canadian Milk-vetch		T	Plant
Baptisia lactea	White or Prairie False Indigo		SC	Plant
Bartonia paniculata	Panicled Screw-stem		T	Plant
Berula erecta	Cut-leaved Water-parsnip		T	Plant
Bog				Community
Cacalia plantaginea	Prairie Indian-plantain		SC	Plant
Calamagrostis stricta	Narrow-leaved Reedgrass		T	Plant
Carex seorsa	Sedge		T	Plant
Carex squarrosa	Sedge		SC	Plant
Cistothorus palustris	Marsh Wren		SC	Animal
Clemmys guttata	Spotted Turtle		T	Animal
Clonophis kirtlandii	Kirtland's Snake		E	Animal
Coastal plain marsh	Infertile Pond/marsh, Great Lakes Type			Community
Coreopsis palmata	Prairie Coreopsis		T	Plant
Cypripedium candidum	White Lady-slipper		T	Plant
Dalea purpurea	Purple Prairie-clover		X	Plant
Dendroica cerulea	Cerulean Warbler		SC	Animal
Dryopteris celsa	Log Fern		T	Plant
Elaphe obsoleta obsoleta	Black Rat Snake		SC	Animal
Emys blandingii	Blanding's Turtle		SC	Animal
Eryngium yuccifolium	Rattlesnake-master		T	Plant
Filipendula rubra	Queen-of-the-prairie		T	Plant
Fuirena squarrosa	Umbrella-grass		T	Plant
Galearis spectabilis	Showy Orchis		T	Plant
Great Blue Heron Rookery	Great Blue Heron Rookery			Other
Great lakes marsh				Community

Scientific Name	Common Name	Federal Status	State Status	Type
Gymnocladus dioicus	Kentucky Coffee-tree		SC	Plant
Hemicarpha micrantha	Dwarf-bulrush		SC	Plant
Hibiscus moscheutos	Swamp Rose-mallow		SC	Plant
Hydrastis canadensis	Goldenseal		T	Plant
Jeffersonia diphylla	Twinleaf		SC	Plant
Juncus scirpoides	Scirpus-like Rush		T	Plant
Kuhnia eupatorioides	False Boneset		SC	Plant
Lepisosteus oculatus	Spotted Gar		SC	Animal
Lepyronia angulifera	Angular Spittlebug		SC	Animal
Lepyronia gibbosa	Great Plains Spittlebug		T	Animal
Liparis liliifolia	Purple Twayblade		SC	Plant
Ludwigia alternifolia	Seedbox		SC	Plant
Mesic sand prairie	Moist Sand Prairie, Midwest Type			Community
Mesodon elevatus	Proud Globe		SC	Animal
Microtus ochrogaster	Prairie Vole		E	Animal
Neonympha mitchellii mitchellii	Mitchell's Satyr	LE	E	Animal
Nicrophorus americanus	American Burying Beetle	LE	E	Animal
Oak barrens	Barrens, Central Midwest Type			Community
Panax quinquefolius	Ginseng		T	Plant
Panicum leibergii	Leiberg's Panic-grass		T	Plant
Panicum verrucosum	Warty Panic-grass		T	Plant
Platanthera ciliaris	Orange or Yellow Fringed Orchid		T	Plant
Polygala cruciata	Cross-leaved Milkwort		SC	Plant
Pomatiopsis cincinnatiensis	Brown Walker		SC	Animal
Populus heterophylla	Swamp or Black Cottonwood		E	Plant
Potamogeton bicupulatus	Waterthread Pondweed		T	Plant
Prairie fen	Alkaline Shrub/herb Fen, Midwest Type			Community
Protonotaria citrea	Prothonotary Warbler		SC	Animal
Psilocarya scirpoides	Bald-rush		T	Plant
Pycnanthemum verticillatum	Whorled Mountain-mint		SC	Plant
Rallus elegans	King Rail		E	Animal
Rhexia virginica	Meadow-beauty		SC	Plant
Rhynchospora macrostachya	Tall Beak-rush		SC	Plant
Sabatia angularis	Rose-pink		T	Plant
Scleria pauciflora	Few-flowered Nut-rush		E	Plant

Scientific Name	Common Name	Federal Status	State Status	Type
Scleria reticularis	Netted Nut-rush		T	Plant
Silphium integrifolium	Rosinweed		T	Plant
Sistrurus catenatus	Eastern Massasauga	C	SC	Animal
Southern floodplain forest				Community
Sporobolus heterolepis	Prairie Dropseed		SC	Plant
Stellaria crassifolia	Fleshy Stitchwort		T	Plant
Terrapene carolina Carolina	Eastern Box Turtle		SC	Animal

LE: Listed Endangered SC: Special Concern T: Threatened
C: Candidate for federal status under the Endangered Species Act of 1998
E: Endangered X: Probably Extirpated
Source: Michigan Natural Features Inventory, 2006

Appendix 6. Steering Committee Participants

First Name	Last Name	Representing*	# of Steering Committee Meetings Attended
Chris	Bauer	Michigan Department of Environmental Quality	13
Bob	Becker	Paw Paw Lake	2
Calli	Berg	Coloma Watervliet Economic Development Corporation	1
Tricia	Bizoukas	Van Buren Conservation District	1
Jack	Bley	Landowner	2
Gaye	Blind	Berrien County Conservation District	10
Craig	Burns	The Nature Conservancy	2
Beth	Clawson	Van Buren MSU Extension	5
Marcy	Colclough	Southwest Michigan Planning Commission	16
Geoff	Cripe	Southwest Michigan Land Conservancy	4
Pete	DeBoer	Southwest Michigan Land Conservancy	10
Sue	DeVries	The Nature Conservancy	13
Dave	Diget	Landowner	5
Carl	Druskovich	Hamilton Twp	1
Chuck	Eckenstahler	Public Consulting Team	3
Nancy	Edwards	Landowner	9
Andrew	Fang	Kieser & Associates	1
Chad	Fizzel	Michigan Department of Environmental Quality	1
Dave	Foerster	Van Buren County Farmland Preservation Board	14
Dave	Fongers	Michigan Department of Environmental Quality	1
John	Fraser	Southwest Michigan Land Conservancy	1
Erin	Fuller	Black River Watershed Project	3
Kelly	Dissette	Van Buren MSU Extension	5
Lou	Gibson	Paw Paw Lake	5
Charles	Goodrich	Hamilton Twp	5
Cameron	Guenther	Kieser & Associates	1
Brian	Gunderman	Michigan Department of Natural Resources	1
Bob	Harvey	Village of Paw Paw	9
Anne	Hendrix	Berrien County Drain Commission	1
Matt	Herbert	The Nature Conservancy	1
Lawrence	Hummel	Van Buren County Road Commission	1
Val	Janowski	Pokagon Band of Potawatomi Indians	1
Frank	Jurenka	Paw Paw Lake	3
Linda	Kerr	Texas Twp	1
Jean	Ketchum	Landowner	1
Mark	Kieser	Kieser & Associates	2
Julia	Kirkwood	Michigan Department of Environmental Quality	10
John	Lauck	Van Buren County Planning Commission	3
William	Lawson Jr.	Hamilton Twp Planning Commission	2

First Name	Last Name	Representing*	# of Steering Committee Meetings Attended
Lohn	Legge	The Nature Conservancy	6
Tamara	Lipsey	Michigan Department of Environmental Quality	1
Amy	Lockhart	Van Buren Conservation District	9
Don	Main	Landowner	6
MaDonna	Martin	Hartford Twp	1
Kyle	Mead	Van Buren Conservation District	1
Matt	Meersman	Southwest Michigan Planning Commission	14
Jon	Mills	Van Buren Conservation District	1
Chuck	Nelson	Sarett Nature Center	8
Pat	Nelson	Little Paw Paw Lake	1
Larry	Nielsen	Village of Paw Paw	2
Jeff	Noel	Whirlpool Corporation	1
Joe	Parman	Van Buren County Drain Commission	9
Mark	Parrish	Pokagon Band of Potawatomi Indians	10
Steve	Petersen	Hamilton Twp Planning Commission	13
Lisa	Phillips	Porter Twp	1
Laurence	Picq	Kieser & Associates	12
Steven	Rigoni	Michigan Avenue Academy	1
Daniel	Ruzick	Antwerp Twp	2
Darrin	Schaer	Landowner	4
Ken	Schaut	Village of Lawrence	2
Sharon	Schmuhl	Michigan Agri-Women	1
Bonnie	Schultz	Michigan Agri-Women	1
Amy	Seitz	Southwest Michigan Planning Commission	1
Connie	Selles	Almena Twp	1
Del	Sipes	Paw Paw Lake	8
John	Small	Village of Paw Paw	2
Kregg	Smith	Michigan Department of Natural Resources	2
Gary	Soper	Benton Twp	4
Jeff	Spoelstra	Kieser & Associates	2
Joe	Stepich	Paw Paw Lake	3
Doug	Stiles	Almena Twp Supervisor	13
Gary	Stock	Landowner	13
Jo	Taylor	Landowner	1
Ted	Thar	Van Buren County	1
Jeannine	Totzke	Berrien County Drain Commission	1
Peter	Vincent	Michigan Department of Environmental Quality	8
Mindy	Walker	Sarett Nature Center	8
Emily	Wilke	Southwest Michigan Land Conservancy	1
Rob	Zbiciak	Michigan Department of Environmental Quality	10

*The representation of steering committee members is self declared and may have changed from when it was recorded in the meeting records.

Appendix 7. Stakeholder Concerns

Urban/Urbanizing Related

- Wetland Filling (Wal-Mart, Crystal Ave., Harbor Shores Project, etc.)
- Soil Erosion and Sedimentation from Urban Development
- Polluted Urban Stormwater Runoff (roads, parking lots, etc.)
- Fertilizer and Chemical Runoff from Lawns
- Faulty Sewer and Septic Systems
- Fragmentation/Urban Development
- Hartford - Watervliet Area Development Corridor
- Loss of Natural Lake Shoreline to Sea Walls and Rip Rap
- Fisheries Habitat Fragmentation from Road/Stream Crossings (especially in Blue Creek and East Branch)
- Head Cuts Starting to Form on Blue Creek from Undersized or Misaligned Culverts on Road/Stream Crossings
- Impact of Road Improvements and Possible Tree Removal Along Trout Stream on 38th Ave. in Almena Twp.

Agricultural Related

- Impact of Confined Animal Feeding Operation (CAFO) in Hartford Area
- Soil Erosion and Sedimentation from Cropland
- Lack of buffers on tributaries
- Chemical and Fertilizer Runoff from Cropland
- Livestock Waste and Livestock Access to Streams
- Historic Contributions of Sediment to Brush Creek from Agricultural Practices Along Red Creek (recovery is being monitored by MDNR)
- Groundwater Contamination in Coloma Township
- Vegetable production and soil erosion concerns (Cucumbers, tomatoes and jalapeño peppers are grown in unique ways, which make prevention of soil erosion difficult. Tomatoes and peppers are grown in mounds of soil. Cucumbers grow in short vines that spread across the ground with little root structure. After the cucumbers are harvested, the vines die leaving soils exposed. Winter cover crops are rarely planted to protect soils.)

Industrial Related

- Groundwater Contamination from KL Landfill in Kalamazoo County
- Hartford Superfund Site
- Coca Cola/Minute Maid Effluent Discharge
- Ox Creek Groundwater Venting
- Groundwater Withdrawals for Commercial Bottling
- Aircraft Components Superfund Site – Benton Harbor

Conservation Related

- Preserve the Connected Forested Floodplain Corridor
- Protection of Groundwater Recharge Areas
- Protection and Identification of Endangered Species Habitat
- Invasive or Non-native Species Competing with Natives
- MDNR Natural River Designation

Recreation Related

- Watercraft on Waterways (gas, oil, wave action, etc.)
- Lack of Public Access to River
- Negative Impact of Increased Recreation on Natural Resources

General Concerns

- Plant and Algae Growth in Area Lakes
- Canada Geese Population
- Sedimentation of Maple Lake and Paw Paw Lake
- In-Channel Erosion and Sediment Load
- Pesticide/Herbicide Use by Paw Paw Public Schools
- Ecoli Impairment of Pine/Mill Creeks

Appendix 8. Paw Paw River Watershed Related Studies

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
State of Michigan 1955 report on water resource conditions and uses in the Paw Paw River basin	1955	Michigan Water Resources Commission	MDEQ	MI/DEQ/SWQ-96/100
Bottom fauna survey, Paw Paw River, Watervliet to Benton Harbor, Berrien County, Michigan, July 10-11, 1958	1958	Fetterolf, C.M.	MDEQ	Report # 000550
Self purification study, Paw Paw River, Watervliet to Benton Harbor	1960		MDEQ	Report # 025430
Water resource conditions and uses in the Paw Paw River basin (revised 1964)	1964		MDEQ	Report # 025435
Water Resource Conditions and Uses in the Paw Paw River Basin	1964	Michigan Water Resources Commission		
Comments on Glaser, Crandall Company's proposed use of the East Branch Paw Paw River for waste disposal	1966	Fetterolf, C.M.	MDEQ	Report # 022571
Physical Characteristics of the Paw Paw Basin	1969		MDEQ	MI/DEQ/SWQ-99/026
Biological and Sediment Oil Survey of Ox Creek, Benton Harbor, MI	1976		MDEQ	Report # 002910
Water Quality at Selected Stations on Streams in the Kalamazoo, Paw Paw, Black and Macatawa River Basins in Southwestern Michigan	1976	Sylvester, S.	MDEQ	Report # 022850
A Water and Land Resource Plan for the Kalamazoo-Black-Macatawa-Paw Paw Rivers Basin	1977		USDA	
Report of toxicity evaluations conducted with well water from International Research and Development Corporation, VanBuren County, Mattawan, MI	1978	Bohan, J.E.	MDEQ	MI/DNR/SWQ-91/167
Report of a 48-hour acute toxicity screening test conducted on effluent, Duwel Metal Products, all outfall No. 800023, VanBuren County, Hartford, MI	1979	Lee, L	MDEQ	MI/DNR/SWQ-91/258
Report of a toxicity screening test conducted on wastewater of International Research and Development Corporation, Vanburen County, Mattawan, MI	1979	Bohan, J.E.	MDEQ	MI/DNR/SWQ-91/168
Report of toxicity evaluations conducted on process wastewater of Auto Specialties Company, Riverside Castings Division, Berrien County, Benton Harbor, MI	1979	Bohan, J.E.	MDEQ	MI/DNR/SWQ-92/095

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
Reports of a toxicity evaluation conducted on wastewaters discharged by Auto Specialties Manufacturing Company, St. Joseph, MI	1979	White, B.	MDEQ	MI/DNR/SWQ-92/096
Sediment and Water Survey to Determine influences by Michigan Standard Alloy - Aluminum Division's (Benton Harbor) Operations on the Paw Paw River	1979	Wuycheck, J.	MDEQ	Report # 065130
Stream Assessment of the Paw Paw River in the Vicinity of Automotive Specialties and Whirlpool Corporation	1979	Creal, W.	MDEQ	Report # 003490
Biological Assessment of Pine Creek, Vicinity of Hartford, Van Buren County	1980	Creal, W.	MDEQ	Report # 003710
Report of a toxicity evaluation conducted at the Duwel Products, Inc., outfall 800155 (000), VanBuren County, Hartford, MI	1980	Lee, L	MDEQ	MI/DNR/SWQ-91/261
Report of an invertebrate toxicity screening test conducted with effluent from International Research and Development Corporation, all outfalls No. 800030, Van Buren County, Mattawan, MI	1980	Swanson, J.	MDEQ	MI/DNR/SWQ-91/169
Chemical and biological Investigations of the East & West Branches of the Paw Paw River & Maple Ackley Lakes, Vicinity of Paw Paw, Van Buren County	1982	Creal, W.	MDEQ	Report # 004070
Macroinvertebrate Survey of the Paw Paw River, Vicinity of Watervliet Paper Company	1982	Creal, W.	MDEQ	Report # 004060
Report of an on-site toxicity evaluation at Watervliet Paper Company, facility No. 110091, NPDES permit No. MI0000817, Berrien County, Watervliet, MI, November 1981	1982	White, B.	MDEQ	MI/DNR/SWQ-92/180
Report of an on-site toxicity evaluation at Watervliet Paper Company,facility No. 110091, NPDES Permit No. MI0000817, Berrien County, Watervliet, MI, June-July 1982	1982	White, B.	MDEQ	MI/DNR/SWQ-92/181
Toxicity evaluation of effluent discharged by Auto Specialties Corporation, Hartford, MI	1984	Hull, C.	MDEQ	MI/DNR/SWQ-91/280
Hydrology and Land Use in Van Buren County, MI	1984	Cummings, T.R.; Twenter, F.R.; Holtschlag, D.J.	USGS, Van Buren County, MDNR, MDA	
Michigan Tributaries of the St. Joseph River Basin Report	1985		USDA, Soil Cons. Services	

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
Acute toxicity assessment of Duwell Products, Inc., dechlorinated effluent, Hartford, MI	1987	Hering, C.M.	MDEQ	MI/DNR/SWQ-91/260
Site Visit at Lawton Drain, Van Buren County	1987		MDEQ	Report # 025660
Southwestern Michigan Commission Water Quality Sampling of the St. Joseph River and Its Tributaries	1988	Fishbeck, Thompson, Carr & Huber, Inc.		
Aquatic toxicity assessment of Watervliet Paper Company 001 effluent, Watervliet, Michigan	1988	Dimond, W.F.	MDEQ	MI/DNR/SWQ-88/068
Biological Survey of Lawton Drain in the Vicinity of Welch Foods, Inc., Van Buren County, Michigan	1989	Hull, C.	MDEQ	MI/DNR/SWQ-89/038
Water Quality Investigation for St. Joseph River System	1989	Fishbeck, Thompson, Carr & Huber, Inc.		
Acute toxicity assessment of Paw Paw Lake area WWTP 001 effluent, Coloma, Michigan	1990	Dimond, W.F.	MDEQ	MI/DNR/SWQ-90/139
Acute toxicity assessment of Paw Paw WWTP 001 effluent, Paw Paw, Michigan	1990	Dimond, W.F.	MDEQ	MI/DNR/SWQ-90/138
Acute toxicity assessment of Hoffman Die Cast Corp. outfall 002 effluent, Benton Harbor, MI	1991	Dimond, W.F.	MDEQ	MI/DNR/SWQ-91/225
Fisheries Survey of the Paw Paw River Basin	1991	Dexter, J.L.	MDNR–Fisheries Division	Report # 91-2
MDNR Status of the Fishery Resource Report: East Branch Paw Paw River (and Mattawan Creek)	1991	Dexter, J.L.	MDNR–Fisheries Division	Report # 91-16
Biological Survey of Pine Creek, Van Buren County, Michigan	1992	Heaton, S.	MDEQ	MI/DNR/SWQ-92/272
MDNR Status of the Fishery Resource Report: Campbell Creek	1992	Dexter, J.L.	MDNR–Fisheries Division	Report # 92-3
Biological Survey of the Paw Paw River between Coloma and Paw Paw Roads	1992	Schaddlelee, L.	TNC	
Paw Paw River Trail – Preliminary Conceptual Plan	1993		CWAEDC	

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
MDNR Status of the Fishery Resource Report: Maple Lake	1993	Dexter, J.L.	MDNR–Fisheries Division	Report # 93-5
Acute toxicity assessment of Fletcher Paper Company, Watervliet, Michigan, Outfall 001 effluent, NPDES Permit No. MI0000817	1994	Butler, D.	MDEQ	MI/DNR/SWQ-94/069
Biological survey of Blue Creek, Yellow Creek and Pipestone Creek, Berrien County, MI	1995	Heaton, S.	MDEQ	MI/DNR/SWQ-95/032
Biological Survey of Sand Creek, Berrien County, MI	1995	Heaton, S.	MDEQ	MI/DNR/SWQ-95/030
Carrying capacity analysis of Paw Paw Lake	1995		Paw Paw Lake Assoc.	
Protecting the Groundwater of Van Buren County: A Blueprint for Action	1995	Houseman, L.; Kirby, M.J; Hughes, L.D.	Van Buren Cons. District, EPA, MDEQ	
Paw Paw Lake Chemical Monitoring Project Final Project Report	1998	Kirby, M.J.	Paw Paw Lake Assoc. & Foundation	
Biological Survey of the Paw Paw River and Selected Tributaries in Van Buren County	1999	Cooper, J.	MDEQ	MI/DEQ/SWQ-99/017
Biological Surveys of Selected Tributaries in the Paw Paw River Watershed in Van Buren County	1999	Cooper, J.	MDEQ	MI/DEQ/SWQ-99/158
St. Joseph River Assessment	1999	Wesley, J.; Duffy, J.	MDNR–Fisheries Division	
MDNR Status of the Fishery Resource Report: East Branch Paw Paw River	2000	Dexter, J.L.	MDNR–Fisheries Division	Report # 2000-4
MDNR Status of the Fishery Resource Report: Maple Lake	2000	Dexter, J.L.	MDNR–Fisheries Division	Report # 2000-10
The St. Joseph River Basin: Water-Related People, Activities, and Things that Influenced the History of the Region	2001	St. Joseph River Basin Commission		

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
Paw Paw River Development Corridor	2002	The Abonmarche Group	CWAEDC	
A Biological Survey of the North and South Branches of the Paw Paw River and Selected Tributaries	2002	Rockafellow, D.	MDEQ	MI/DEQ/SWQ-02/062
A Biological Survey of the Paw Paw River and Selected Tributaries	2002	Rockafellow, D.	MDEQ	MI/DEQ/SWQ-02/063
Site ecological summary for Lower Paw Paw River	2002	Hyde, D.A.; Padkus, J.J.	MNFI	
Paw Paw River Watershed Conservation Area Plan	2002		TNC	
Final Draft Souce Water Assessment Report for the City of Benton Harbor Water Supply	2002		USGS, MDEQ	MI Source Water Assmnt Report 18
The Brach-Derby Toll Gate Project “An in-depth feasibility study”	2003	Progressive AE	Paw Paw Lake Foundation	
NPL Fact sheets for Michigan: Burrows Sanitation	2003		EPA – Region 5	EPA ID# MID980410617
St. Joseph River Watershed Management Plan	2005	DeGraves, A.	Friends of the St. Joe River Assoc.	
Mill Creek Water Survey	2005	Wesley, J.; Markham, S.	MDNR– Fisheries Division	
St. Joseph River Sediment Transport Modeling Study	2005	W.F. Baird & Assoc.	U.S. Army Corps of Engineers	
A Biological and Water Chemistry Survey of Mill and Pine Creeks in the Vicinity of the Hartford Dairy Concentrated Animal Feeding Operation	2006	Walterhouse, M.	MDEQ	MI/DEQ/WB-06/035
Big Paw Paw Lake, Water Quality Studies 2004-2005	2006	Fusilier, W.E.; Fusilier, B.	Paw Paw Lake Foundation	

Title	Year of Pub.	Author	Agency Sponsor	Report ID/#
Little Paw Paw Lake, Water Quality Studies 1992-2005	2006	Fusilier, W.E.; Fusilier, B.	Paw Paw Lake Foundation	
Stream Power Analysis of the Paw Paw River Watershed	2007	Applied Ecological Services	Great Lakes Protection Fund	

The following studies and reports were completed for the Paw Paw River Watershed Planning Project and can be found at www.swmpc.org/pprw_studies.asp.

Title	Year of Pub.	Author	Agency Sponsor
Ecologically Similar Subwatersheds of the Paw Paw River	2008	Kregg Smith	Michigan Department of Natural Resources
Prioritization of Floodplain Forest Areas on the Paw Paw River	2007	John Legge	The Nature Conservancy
Volunteer Inventory of the Paw Paw River Watershed	2008	Matt Meersman	Southwest Michigan Planning Commission
Assessing Cumulative Loss of Wetland Functions in the Paw Paw River Watershed Using Enhanced National Wetlands Inventory Data	2007	Chad Fizzell	Michigan Department of Environmental Quality
Agricultural Insult Areas in the Paw Paw River Watershed	2008	Matt Meersman and Craig Burns	The Nature Conservancy and Southwest Michigan Planning Commission
Modeling of Agricultural BMP Scenarios in the Paw Paw River Watershed using the Soil and Water Assessment Tool (SWAT)	2008	Kieser & Associates	Kieser & Associates
Urban Build Out and Stormwater BMP Analysis in the Paw Paw River Watershed	2008	Kieser & Associates	Kieser & Associates
Critical Areas for Preservation in the Paw Paw River Watershed	2008	Southwest Michigan Land Conservancy	Southwest Michigan Land Conservancy
PPRW Preservation Area Model	2008	Matt Meersman	Southwest Michigan Planning Commission
PPRW Agricultural Area Model	2008	Matt Meersman	Southwest Michigan Planning Commission

Title	Year of Pub.	Author	Agency Sponsor
PPRW Urban/Developing Model	2008	Matt Meersman	Southwest Michigan Planning Commission
Information and Education Plan for the Black and Paw Paw River Watersheds	2008	Southwest Michigan Planning Commission and Van Burn Conservation District	Southwest Michigan Planning Commission and Van Burn Conservation District
Municipal Planning and Water Quality in the Paw Paw River Watershed – Local Plan Reviews	2008	Southwest Michigan Planning Commission	Southwest Michigan Planning Commission

Appendix 9. Common Pollutants, Sources and Water Quality Standards

Sources of water pollution are broken down into two categories: point source pollution and nonpoint source pollution. Point source pollution is the release of a discharge from a pipe, outfall or other direct input into a body of water. Common examples of point source pollution are factories and wastewater treatment facilities. Facilities with point source pollution discharges are required to obtain a National Pollutant Discharge Elimination System (NPDES) permit to ensure compliance with water quality standards under the Clean Water Act. They are also required to report to the Michigan Department of Environmental Quality on a regular basis. This process assists in the restoration of degraded water bodies and drinking water supplies.

Sixty percent of water pollution is from non-point source pollution. Polluted runoff is caused when rain, snowmelt, or wind carries pollutants off the land and into water bodies. Roads, parking lots, driveways, farms, home lawns, golf courses, storm sewers, and businesses collectively contribute to nonpoint source pollution.

Nonpoint source pollution, also known as polluted runoff, is not as easily identified. It is often overlooked because it can be a less visible form of pollution. Polluted runoff is caused when rain, snowmelt, or wind carries pollutants off the land and into water bodies. Roads, parking lots, driveways, farms, home lawns, golf courses, storm sewers, and businesses collectively contribute to nonpoint source pollution.

The State of Michigan's Part 4 Rules (of Part 31, Water Resources Protection, of Act 451 of 1994) specify water quality standards, which shall be met in all waters of the state. Common water pollutants and related water quality standards are described below. Note that not all water quality pollutants have water quality standards established.

Sediment

Sediment is soil, sand, and minerals that can take the form of bedload, suspended or dissolved material. Sediment harms aquatic wildlife by altering the natural streambed and increasing the turbidity of the water, making it "cloudy". Sedimentation may result in gill damage and suffocation of fish, as well as having a negative impact on spawning habitat. Increased turbidity from sediment affects light penetration resulting in changes in oxygen concentrations and water temperature that could affect aquatic wildlife. Sediment can also affect water levels by filling in the stream bottom, causing water levels to rise. Lakes, ponds and wetland areas can be greatly altered by sedimentation. Other pollutants, such as phosphorus and metals, can bind themselves to the finer sediment particles. Sedimentation provides a path for these pollutants to enter the waterway or water body.

Removing trees and building close to the river's edge can cause bank erosion.

Related water quality standards

Total Suspended Solids (TSS) - Rule 50 of the Michigan Water Quality Standards (Part 4 of Act 451) states that waters of the state shall not have any of the following unnatural physical properties in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foam, settleable solids, suspended solids, and deposits. This kind of rule, which does not establish a numeric level, is known as a "narrative standard." Most people consider water with a TSS concentration less than 20 mg/l to be clear. Water with TSS levels between 40 and 80 mg/l tends to appear cloudy, while water with concentrations over 150 mg/l usually appears dirty. The nature of the particles that comprise the suspended solids may cause these numbers to vary.

Nutrients

Although certain nutrients are required by aquatic plants in order to survive, an overabundance can be detrimental to the aquatic ecosystem. Nitrogen and phosphorus are generally available in limited supply in an unaltered watershed but can quickly become abundant in a watershed with agricultural and urban development. In abundance, nitrogen and phosphorus accelerate the natural aging process of a water body and allow exotic species to better compete with native plants. Wastewater treatment plants and combined sewer overflows are the most common point sources of nutrients. Nonpoint sources of nutrients include fertilizers and organic waste carried within water runoff. Excessive nutrients increase weed and algae growth impacting recreational use on the water body. Decomposition of the increased weeds and algae lowers dissolved oxygen levels resulting in a negative impact on aquatic wildlife and fish populations.

Nitrogen and phosphorus are generally available in limited supply in an unaltered watershed but can quickly become abundant in a watershed with agricultural and urban development.

Related water quality standards

Phosphorus - Rule 60 of the Michigan Water Quality Standards (Part 4 of Act 451) limits phosphorus concentrations in point source discharges to 1 mg/l of total phosphorus as a monthly average. The rule states that other limits may be placed in permits when deemed necessary. The rule also requires that nutrients be limited as necessary to prevent excessive growth of aquatic plants, fungi or bacteria, which could impair designated uses of the surface water.

Dissolved Oxygen - Rule 64 of the Michigan Water Quality Standards (Part 4 of Act 451) includes minimum concentrations of dissolved oxygen, which must be met in surface waters of the state. This rule states that surface waters designated as coldwater fisheries must meet a minimum dissolved oxygen standard of 7 mg/l, while surface waters protected for warmwater fish and aquatic life must meet a minimum dissolved oxygen standard of 5 mg/l.

Temperature/Flow

Removal of streambank vegetation decreases the shading of a water body, which can lead to an increase in temperature. Impounded areas can also have a higher water temperature relative to a free-flowing stream. Heated runoff from impervious surfaces

and cooling water from industrial processes can alter the normal temperature range of a waterway. Surges of heated water during rainstorms can shock and stress aquatic wildlife, which are adapted to "normal" temperature conditions. Increased areas of impervious surfaces, such as parking lots and driveways, and reduced infiltration from other land use types, such as lawns and bare ground, leads to an increase in runoff. Increased runoff reduces groundwater recharge and leads to highly variable flow patterns. These flow patterns can alter stream morphology and increase the possibility of flooding downstream.

Increased areas of impervious surfaces, such as parking lots and driveways, and reduced infiltration from other land use types, such as lawns and bare ground, leads to an increase in runoff. Increased runoff reduces groundwater recharge and leads to highly variable flow patterns.

Related water quality standards

Temperature - Rules 69 through 75 of the Michigan Water Quality Standards (Part 4 of Act 451) specify temperature standards which must be met in the Great Lakes and connecting waters, inland lakes, and rivers, streams and impoundments. The rules state that the Great Lakes and connecting waters and inland lakes shall not receive a heat load which increases the temperature of the receiving water more than 3 degrees Fahrenheit above the existing natural water temperature (after mixing with the receiving water). Rivers, streams and impoundments shall not receive a heat load, which increases the temperature of the receiving water more than 2 degrees Fahrenheit for coldwater fisheries, and 5 degrees Fahrenheit for warmwater fisheries. These waters shall not receive a heat load, which increases the temperature of the receiving water above monthly maximum temperatures (after mixing). Monthly maximum temperatures for each water body or grouping of water bodies are listed in the rules. The rules state that inland lakes shall not receive a heat load, which would increase the temperature of the hypolimnion (the dense, cooler layer of water at the bottom of a lake) or decrease its volume. Further provisions protect migrating salmon populations, stating that warmwater rivers and inland lakes serving as principal migratory routes shall not receive a heat load which may adversely affect salmonid migration.

<u>Bacteria/Pathogens</u>

Bacteria are among the simplest, smallest, and most abundant organisms on earth. While the vast majority of bacteria are not harmful, certain types of bacteria cause disease in humans and animals. Concerns about bacterial contamination of surface waters led to the development of analytical methods to measure the presence of waterborne bacteria. Since 1880, coliform bacteria have been used to assess the quality of water and the likelihood of pathogens being present. Combined sewer overflows in urban areas and failing septic systems in residential or rural areas can contribute large numbers of coliforms and other bacteria to surface water and groundwater. Agricultural sources of bacteria include livestock excrement from barnyards, pastures, rangelands, feedlots, and uncontrolled manure storage areas. Stormwater runoff from residential, rural and urban areas can transport waste material from domestic pets and wildlife into surface waters. Land application of manure and

Bacteria from both human and animal sources can cause disease in humans.

sewage sludge can also result in water contamination. Bacteria from both human and animal sources can cause disease in humans.

Related water quality standards

Bacteria - Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 451) limits the concentration of microorganisms in surface waters of the state and surface water discharges. Waters of the state, which are protected for total body contact recreation, must meet limits of 130 Escherichia coli (E. coli) per 100 milliliters (ml) water as a 30-day average and 300 E. coli per 100 ml water at any time. The total body contact recreation standard only applies from May 1 to October 1. The limit for waters of the state, which are protected for partial body contact recreation, is 1000 E. coli per 100 ml water. Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 ml water as a monthly average and 400 fecal coliform bacteria per 100 ml water as a 7-day average. For infectious organisms which are not addressed by Rule 62, The Department of Environmental Quality has the authority to set limits on a case-by-case basis to assure that designated uses are protected.

Chemical Pollutants

Chemical pollutants such as gasoline and oil can enter surface water through runoff from roads and parking lots, or from boating. Other sources can be approved processes such as permitted application of herbicides to inland lakes to prevent the growth of aquatic nuisance plants. Other chemical pollutants consist of pesticides and herbicide runoff from commercial, agricultural, municipal or residential uses. Impacts of chemical pollutants vary widely with the chemical.

Related water quality standards

pH - Rule 53 of the Michigan Water Quality Standards (Part 4 of Act 451) states that the hydrogen ion concentration expressed as pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state.

Appendix 10. Education Plan: Black & Paw Paw River Watersheds

Introduction

The Black River Watershed and Paw Paw River Watershed Information & Education (I&E) Plan was formulated through the efforts of the joint information & education sub-committee. This sub-committee consisted of members from both watershed Steering Committees. The purpose of the plan is to provide a framework to inform and motivate the various stakeholders, residents and other decision makers within the Black River and Paw Paw River watersheds to take appropriate actions to protect water quality. This working document will also provide a starting point for organizations within the watersheds looking to provide educational opportunities or outreach efforts.

The geography of the Black River and Paw Paw River watersheds lend themselves to a partnership approach, which has been a focal point for all information and education efforts to date within the watersheds. With both watersheds sharing multiple municipal boundaries as well as many similar water quality concerns, a partnership approach to education and outreach enables both watershed projects to maximize their resources and effectively reach a larger audience than could be accomplished alone.

Information & Education Goal

The I&E plan will help to achieve the watershed management goals by increasing the involvement of the community in watershed protection efforts through awareness, education and action. The watershed community can become involved only if they are informed of the issues and are provided information and opportunities to participate.

The I&E plan lists specific tasks to be completed. These tasks will increase the general awareness of watersheds and water quality issues for all audiences, educate target audiences on specific issues and motivate target audiences to implement practices to improve and protect water quality. These practices may include homeowner activities such as reducing fertilizer use, maintaining septic systems, installing a rain garden or maintaining stream buffers. Practices for governmental units or officials may include incorporating watershed protection language into master plans and zoning ordinances, reducing the amount of salt used for deicing and utilizing low impact development techniques on public property.

Target Audiences

The level of understanding of watershed concepts and management, the concerns, values and level of enthusiasm can all vary between different audience groups. Recognizing differences between groups of target audiences is critical to achieving success through education and outreach efforts. Educational messages may need to be tailored to effectively reach different audiences. It is important to understand key motivators of each target audience to establish messages that will persuade them to adopt behaviors or practices to protect and improve water quality. The table below lists

and describes the major target audiences for the Paw Paw and Black River Watersheds and specific messages and activities that could be used to reach each audience.

Target Audiences	Description of Audience	General Message Ideas	Potential Activities
Businesses	This audience includes businesses engaging in activities that can impact water quality such as lawn care companies, landscapers, car washes, etc.	Clean water helps to ensure a high quality of life that attracts workers and other businesses.	Workshops and presentations Brochures/flyers/fact sheets One-on-one contact
Developers / Builders / Engineers	This audience includes developers, builders and engineers.	Water quality impacts property values.	Newsletter articles Workshops and presentations Watershed tours Brochures/flyers/fact sheets Trainings
Farmers	This audience includes both agricultural landowners and those renting agricultural lands and farming them.	Protecting water quality is a long-term investment by saving money by decreasing inputs (fuel, fertilizer)	Workshops and presentations Brochures/flyers/fact sheets One-on-one contact Watershed tours Newsletter articles
Government Officials and Employees	This audience includes elected (board and council members) and appointed (planning commissions and zoning board of appeals) officials of cities, townships, villages and the county. This audience also includes the drain commission and road commission staff. It also includes state and federal elected officials.	Water quality impacts economic growth potential. Water quality impacts property values and the tax revenue generated in my community to support essential services. Clean drinking water protects public health.	One-on-one contact Trainings Workshops and presentations Brochures/flyers/fact sheets Watershed tours Educational videos Watershed Management Plan User Guide
Kids / Students	This audience includes any child living or going to school in the watershed.	Clean water is important for humans and wildlife. We all depend on water.	Student stream monitoring Teacher training workshops Curriculum Educational videos
Property Owners	This audience includes any property owner in the watershed.	Water quality impacts my property value and my health.	PSAs and press releases Display/materials at festivals Workshops and presentations Watershed Tours Tax/utility bill inserts Website/YouTube video Workshops and presentations Brochures/flyers/fact sheets One-on-one contact "Entering the watershed" signs
Riparian Property Owners	This audience includes those property owners that own land along a river, stream, drain or lake.	Water quality impacts my property value and my health.	Newsletter articles Door knob hangers One-on-one contact Videos Workshops and presentations
Recreational Users	This audience includes any person who engages in recreational activities.	Water quality is important for enjoying recreational activities.	Website/YouTube video Kiosks Newsletter articles Brochures/flyers/fact sheets

Watershed Issues

To begin formulating education and outreach strategies, it is important to identify the major issues, which need to be addressed to improve and protect water quality. The priority issues for the Black and Paw Paw River Watersheds are described below. Each of these issues relate back to the goals and actions in the Watershed Management Plans for the Black and Paw Paw Rivers.

Each issue is tied to pollutants of concern in the watersheds. For each issue, the audience(s) will need to not only understand the issue, but also the solutions or actions needed to protect or improve water quality. For each major issue, priority target audiences have been identified. The priority audiences were selected because of their influence or ability to take actions, which would improve or protect water quality.

1. Watershed Awareness

The Paw Paw and Black River Watersheds both have unique natural resources, but also have significant problems with water quality. Watershed residents need to understand that their every day activities affect the quality of those resources. All watershed audiences need to be made aware of the priority pollutants and their sources and causes in each of the watersheds. Lastly, education efforts should, whenever possible, offer audiences solutions to improve and protect water quality.

One effective way to increase general watershed awareness is through recreational activities. These activities can help instill a sense of stewardship of the resources needed to enjoy the activities. Rivers, lakes and streams can provide many enjoyable recreational activities such as fishing, paddling, boating and swimming. It is important for recreational users to understand and appreciate the natural resources within the watershed and to gain a level of knowledge about the protection of those natural resources. Water trails and public access to water bodies can ensure that the public is offered an opportunity to enjoy and recreate on the water resources within the watersheds.

Priority Target Audiences: All , with focus on kids/students

Major Pollutants of Concern: sediment, nutrients, bacteria and pathogens, temperature, oil, grease and metals, pesticides

Priority Area: Entire watershed

2. Land Use Change

Land use change can disrupt the natural hydrologic cycle in a watershed. Natural vegetation, such as forest cover, usually has high infiltration capacity and low runoff rates. Whereas, urbanized land cover has impervious areas (buildings, parking lots, roads) and networks of ditches, pipes and storm sewer, which augment natural drainage patterns. Impervious surfaces reduce infiltration and the recharge of groundwater while increasing the amount of runoff. Local governmental officials and builders/developers need to understand the water quality benefits of smart growth, low

impact development, open space and farmland preservation and protection of wetlands, floodplains and riparian areas.

Current and past wetland loss in both urban and agricultural areas is a major concern in both the Paw Paw and Black River Watersheds. The loss of wetlands result in disrupted hydrology and degraded water quality. Further, many agricultural areas have been drained with extensive ditching to move water off the land quickly. While this helps with food production in these areas, water quality suffers. The high flow amounts and velocity can cause increased streambank erosion and sediment delivery. Educational efforts should target drain commissioners and farmers to better understand the water quality benefits of ditch naturalization techniques and the need for wetland protection and restoration.

Priority Target Audiences: Farmers, Governmental Officials and Employees, Developers/Builders/Engineers

Major Pollutant of Concern: sediment

Priority Area: Paw Paw River Watershed High and Medium Priority Protection Areas

3. Stormwater Runoff

Stormwater runoff is caused when rain, snowmelt or wind carries pollutants off the land and into water bodies. Education efforts should increase awareness of stormwater pollutants, sources and causes, especially the impacts of impervious (paved or built) surfaces and their role in delivering water and pollutants to water bodies. Everyday homeowner and business actions are often the source and cause of stormwater pollution. These activities include lawn care practices, household hazardous waste and oil disposal, pet waste disposal and car and equipment care. Local government activities impacting stormwater runoff include land use planning, road and parking lot maintenance and construction, lawn care practices, oversight of construction sites and identification and correction of illicit discharges and connections.

Educational efforts should target property owners and businesses about the many best practices that can decrease the amount of water and pollutants coming from their property. In addition, local governmental units can be encouraged to implement low impact development and smart growth techniques in their plans and zoning ordinances. Local governments can also be encouraged to enact regulations such as a stormwater ordinance and a phosphorus ban for non-agricultural fertilizer use. Educational efforts can also promote municipal operations and maintenance best practices, which are important for reducing polluted runoff. These include best practices for road and parking lot construction and maintenance, lawn care and vehicle maintenance.

Priority Target Audiences: Property Owners, Builders/Developers/Engineers, Businesses, Governmental Officials and Employees

Major Pollutants of Concern: sediment, nutrients, bacteria and pathogens, temperature, oil, grease and metals, pesticides

Priority Area: Paw Paw River Watershed High and Medium Priority Urban Management Areas

4. Natural Resources Management and Preservation

Preserving land and managing natural resources is crucial for effective watershed management. Preservation and management of open space, wetlands, farmland and other natural features helps to reduce the amount of stormwater runoff entering water bodies, preserve natural ecosystems, endangered species as well as the services that the natural systems provide to us such as filtering drinking water and retaining storm water.

Invasive species, both aquatic and terrestrial; pose a threat to water quality and biodiversity in both watersheds. Education efforts should focus on identification and control techniques as well as the prevention of additional invasive species. Education efforts should also encourage the use of native Michigan plants for landscaping, wildlife habitat and other uses.

Recreational activities can often have a negative impact on sensitive areas. It may be necessary to understand carrying capacities for boats on lakes and rivers. In sensitive areas, there may be a need to limit recreational activities to ensure water quality and natural resources are protected. In addition, best management practices should be utilized to limit the impacts of recreational use on water and other natural resources. BMPs could include proper woody debris management for clearing rivers for navigation and installing and maintaining proper access sites to rivers and streams for fishing and canoeing.

Education efforts should instill a sense of understanding and appreciation for natural features. Property owners, developers and local governmental officials and employees need to be presented with options for preservation and management of natural resources. Educational efforts promoting smart growth, low impact and open space development and green infrastructure should target local government officials and employees and builders, developers and engineers.

Priority Target Audiences: Property Owners, Governmental Officials and Employees, Recreational Groups/Users, Developers/Builders/Engineers

Major Pollutants of Concern: sediment, temperature

Priority Area: Paw Paw River Watershed High and Medium Priority Protection Areas

5. Agricultural Runoff

Agricultural lands cover most of the area in the Black and Paw Paw River Watersheds, If not properly managed, runoff from agricultural lands can impact the watershed by delivering pollutants such as sediment and nutrients. Education efforts should seek to help audiences understand the impacts of agricultural runoff. A key concept is the need to reduce soil erosion from agricultural lands. It is also important to understand that soil particles also carry nutrients and chemicals to water bodies. There are many best management practices for addressing soil erosion from agricultural lands. Best management practices include conservation tillage, filter strips, cover crops, grassed waterways, ditch naturalization and wetland restoration.

> Erosion is an intrinsic natural process, but in many places it is increased by human land use. A certain amount of erosion is natural and, in fact, healthy. Excessive erosion, however, does cause problems, such as sedimentation of streams and lakes, ecosystem damage and outright loss of soil. Soil erosion on agricultural fields can be caused by water, wind and tillage practices. Soil loss, and its associated impacts, is of great concern to farmers.

Drain maintenance activities, which often remove vegetation from riparian areas, contribute to soil erosion problems in agricultural areas. Drain maintenance projects should ensure as much riparian vegetation is left intact as possible and replace the vegetation with native grasses, shrubs and trees if it needs to be removed. Another major concern is manure being applied to fields in the watershed especially fields with drain tiles, which connect to ditches and streams. For nutrients and bacteria and pathogens, agricultural best management practices include methane digesters, manure and/or nutrient management, restricting livestock access to water bodies, wetland restoration and soil testing. Lastly, for pesticide concerns, best management practices include organic production and integrated pest management techniques. Cost share and technical assistance programs are available to assist agricultural landowners in implementing many of these practices.

Priority Target Audiences: Farmers

Major Pollutants of Concern: sediment, nutrients, bacteria and pathogens, pesticides

Priority Area: Paw Paw River Watershed High and Medium Priority Agricultural Management Areas

6. Septage Waste

Septage waste is both an urban and rural issue. In more rural areas and around lakes, failing or incorrectly installed septic systems impact water quality by adding excess nutrients, bacteria or other pollutants to the system. Education activities should seek to educate audiences about the impacts of septic systems on water quality. Proper maintenance of septic systems is a key practice for homeowners. Educational efforts should also target governmental units to encourage them to enact point of sale septic system inspection ordinances and to plan and zone for higher density development only in areas served by municipal sewer systems.

For urban areas, the proper operation and maintenance of municipal sewer infrastructure is necessary for protecting water quality. There is a widespread problem with aging infrastructure in urban areas, with some sewer systems dating over 100 years. Municipalities must ensure that combined sewer overflow events and other untreated releases of septage waste do not impact water quality. Educational efforts should target municipal officials and employees to encourage planning for adequate capacity, management, operation, and maintenance of sewer collection and treatment systems.

Priority Target Audiences: Governmental Officials and Employees, Riparian Property Owners

Major Pollutants of Concern: bacteria and pathogens, nutrients

Priority Area: Paw Paw River Watershed High and Medium Priority Urban Management Areas and E.coli TMDL watersheds (Pine and Mill Creek watersheds)

Distribution Formats

Because of the differences between target audiences, it will sometimes be necessary to utilize multiple formats to successfully get the intended message across. Distribution methods include the media, newsletters and direct mailings, email lists and websites, and passive distribution of printed materials. Below is a brief description of each format with some suggestions on specific outlets or methods.

1. Media

Local media is a key tool for outreach to several audience groups. The more often an audience sees or hears information about watershed topics, the more familiar they will become and the more likely they will be to use the information in their daily lives. Keeping the message out in front through press releases and public service announcements is essential to the success of education and outreach efforts.

Newspapers include: the Herald Palladium, the Kalamazoo Gazette (including the Hometown Gazette), the Courier Leader, the Bangor Reminder, the South Haven Tribune, the South Bend Tribune, the Decatur Republican, the Tri-City Record, Michigan Farm News and the Farmer's Exchange.

Radio outlets include WMUK, WCSY, WKZO, WBCT, Michigan Farm Radio Network , WKMI – Kalamazoo, WDOW – Dowagiac

Television outlets include WWMT Channel 3, WOOD Channel 8, WZZM Channel 13, WGVU Channel 35 and WXMI FOX Channel 17.

2. Newsletters and other direct mailings

Several municipalities, governmental agencies, utilities, County offices and non-profit organizations send out newsletters or other mailings which may be coordinated with

various outreach efforts such as fact sheets or “Did you Know” messages. Currently identified mailings include Van Buren County Drain Office, Village and City utility bills, Van Buren, Allegan and Berrien County Farm Bureau newsletters, USDA Farm Service Agency newsletters, Van Buren, Allegan and Berrien Conservation District newsletters, Sarett Nature Center, The Southwest Michigan Land Conservancy newsletters, MSUE, Southwest Michigan Planning Commission newsletters and The Stewardship Network.

3. E-Mail lists and Websites:

The Van Buren Conservation District and the Southwest Michigan Planning Commission maintain active websites and email lists which can be used to reach residents of the watersheds as well as elected officials and businesses. As part of the Information and Education plan, other organizations should be encouraged to supply watershed related educational materials through their websites where appropriate. Enviro-mich provides an opportunity to advertise events and workshops to a large audience. Enviro-mich is a list serve for those in Michigan interested in environmental issues.

4. Passive Distribution:

This method relies on the target audience picking up a brochure, fact sheet, or other information. This can occur by placing materials at businesses, libraries, township/city/village halls and community festivals and events, An example would be to place information on reducing fertilizer use at a store that sells fertilizer.

Plan Administration and Implementation

An information and education implementation strategy is laid out for the Black and Paw Paw River Watersheds in the table found at the end of this report. This table lists specific tasks or activities, a potential lead agency and partners, timeframe, milestones and costs to educate target audiences for each watershed issue.

Roles and Responsibilities

The Southwest Michigan Planning Commission and the Van Buren Conservation District will continue to oversee the implementation of the Information and Education Plan as well as make adjustments to the plan when necessary. An Information & Education committee will meet as needed to advise on educational efforts.

There are efforts underway to establish a non-profit organization called the Two Rivers Coalition to implement the watershed plans for the Black and Paw Paw River Watersheds. Once this group is established, it may be most appropriate for this organization to oversee the implementation of the I&E Plan and convene the I&E committee.

Existing Efforts

It is important to understand current education efforts being offered or resources that are available for use or adaptation in the Paw Paw and Black River Watersheds. In some cases, existing efforts may need additional advertisement or updating to more effectively transmit their intended message. A few existing efforts that could be

supplemented or utilized in the Paw Paw and Black River Watersheds are described below.

MSU Extension sponsors a Citizen Planner Course each year in Southwest Michigan. The target audiences for this course are municipal and planning officials as well as citizens. Topics presented during each course include various land use planning topics and techniques.

The Stewardship Network, Sarett Nature Center, Conservation Districts, Southwest Michigan Planning Commission, MSUE and lake associations periodically host educational workshops related to watershed and water quality topics.

The Southwest Michigan Planning Commission provides educational resources about stormwater and water quality to Berrien and Cass County Phase II communities. These resources are available on the Internet at www.swmpc.org/pep_materials.asp and could easily be adapted for use in the Black and Paw Paw River Watersheds.

The St. Joseph River Basin has produced a DVD about septic systems that could be distributed in the Black and Paw Paw River Watersheds.

The Southeast Michigan Council of Governments is facilitating a committee to develop a Statewide Low Impact Development manual, which will be extremely useful for educating and implementing LID.

Priorities

Project priorities will be established to direct resources to the areas that will gain the most benefit from the designated outreach activity. These priorities should be re-evaluated over time by the Education & Outreach sub-committee and changed as necessary.

Highest priority activities include:

- Activities that promote or build on existing efforts and expand partnerships with neighboring watershed projects, municipalities, conservation organizations and other entities.
- Activities that promote general awareness and understanding of watershed concepts and project goals.
- Activities that leverage external funding from local, state or federal sources.
- Activities that lead to actions (especially those in the watershed management plan), which help to improve and/or protect water quality.

Evaluation

Ultimately, evaluation should show if water quality is being improved or protected in the watershed due to education efforts being implemented. Since watersheds are dynamic systems, this can be difficult to accomplish. For the education efforts, one level of evaluation is documenting a change in knowledge or increase in awareness and participation. Measures and data collection for this level can take place in three specific ways:

1. A large-scale social survey effort to understand individual watershed awareness and behaviors impacting water quality.
2. A pre- and post-test of individuals at workshops focused on specific water quality issues in the PPRW.
3. The tracking of involvement in a local watershed group or increases in attendance at water quality workshops or other events.

Additional levels of evaluation, which estimate pollutant loading reductions and measure water quality improvements through monitoring, are explained in the Paw Paw River Watershed Management Plan in Chapter 11 Evaluation.

Information and Education Strategy for the Black and Paw Paw River Watersheds

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Watershed awareness	All	Produce and distribute 3- 4 public service announcements/press releases per year	VBCD, BCD	SWMPC, MSUE, TRC	current - on-going (3-4 PSAs/year)	number of news articles	5 hours staff time/press release
		Maintain a website that makes watershed information easily available to the public	TRC	VBCD, SWMPC	current - on-going	website traffic - number of hits monthly	$20 per month hosting fees + 20 hours staff time/month
		Develop 4 videos for website (stories about watershed protection/management - Farmer, Landowner, Municipal Official, etc.)	TRC	SWMLC, TNC, VBCD, SWMPC	short-term (2 videos/ year)	website traffic - number of hits monthly	$600/video for production 100 hours staff time/video
		Create a display and participate in 2-3 community festivals/year	TRC	VBCD, SWMPC	current - on-going (2-3 festivals/ year)	number of participants	$200 per event + 30 hours staff time to develop
		Develop and install "Entering the watershed" signs at watershed boundaries	Road Commission	TRC	long-term (5 signs/ year)	number of installed signs	$200 per sign for printing and installation
	Kids/ Students	Develop a student stream monitoring program	VBISD	VBCD, Math & Science Center (Allegan ISD)	long-term (1 school/ year)	number of schools participating in program	$1500 for program materials (nets, waders, etc) + 20 hours/month staff time
		Plan and offer 1 teacher training workshop/year	VBCD	VBISD	long-term (1 training/ year)	attendance at workshop and incorporation of watershed topics into curriculum	$200/workshop + 40 hours staff time/year
		Distribute curriculum materials on watersheds and water quality to teachers (use materials from Great Lakes Alliance)	VBISD	VBCD, Math & Science Center	medium-term (4 schools/ year)	number of schools incorporating curriculum materials	$200/school + 60 hours staff time
Land Use Change	Drain Commission	Meet one-on-one with drain commissioners to discuss alternative drain maintenance methods and ditch naturalization techniques and stormwater standards/ordinance	VBCD, SWMPC	TRC, Drain Commissioner	medium-term (3 commissioners/year)	miles of County Drains converted and improvements in stormwater standards	80 hours staff time
		Promote trainings being offered that relate to drain maintenance and construction methods that protect water quality	TRC	Drain Commissioner, VBCD, SWMPC	short-term (1 training/ year)	improvements in drain maintenance and construction practices, reduced sediment	5 hours staff time/training

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Agricultural runoff and Land Use Change	Farmers	Produce and distribute brochures/flyers/fact sheets to farmers about best management practices, cost share programs, wetland protection/restoration opportunities	VBCD	MSUE, Drain Commissioner, VBCD, NRCS	short-term (2 printed pieces/year)	number of practices installed, amount of Farm Bill $ spent in the watershed, reduction in pollutants	$1500 per direct mailing + 30 hours staff time/distribution
		Plan and host at least 1 workshop per year and host a tour/field site visit at least every 2-3 years addressing agricultural runoff, best management practices, wetland protection and restoration	VBCD, BCD, ACD	MSUE, NRCS	current - on-going (1 workshop/ year and 1 tour/2-3 years)	number of attendees and evaluations completed	$200-$600/workshop + 80 hours/year
		Develop and provide 1 newsletter article per year to Farm Bureau or other agencies on agricultural BMPs and wetland restoration/protection	MSUE, VBCD	NRCS	short-term (1 article/ year)	number of readers (circulation of publication)	10 hours/year
		Contact farmers in TMDL areas on a one-on-one basis to discuss best management practices and wetland restoration and distribute printed materials	VBCD	NRCS, MSUE, Drain Commissioner	medium-term (15-20 farmers/ year)	number of practices installed, reduction of pollutants	$400 printing + 400 hours staff time
Land use change, stormwater runoff and natural resource management and preservation	Government units-officials	Promote trainings being offered on water quality, land use planning and LID	TRC	VBCD, MSUE, SWMPC	current - on-going (2 trainings/ year)	increase in use of LID techniques	5 hours staff time/training
		Promote the adoption of a county-wide phosphorus ban in Van Buren and Berrien Counties and assist with educational efforts in Berrien, Van Buren and Allegan counties	TRC	Lake Assoc, Drain Commissioner, VBCD, SWMPC, ACD	current - on-going (1 adoption/ year)	adoption of ordinance	$1000 (printing materials) + 120 hours staff time
		Plan and host at least 1 workshop or summit per year on land use and water quality related issues and to share successes in watershed protection efforts and host a watershed tour every 2-3 years focusing on low impact development.	SWMPC	MSUE, VBCD, Planning Commission	long-term (1 workshop/ year and 1 tour/2-3 years)	incorporation of watershed topics into land use planning	$600/year + 80 hours staff time
		Produce and distribute a Watershed Management Plan user guide	TRC	VBCD, SWMPC	short-term (1 user guide/ year)	number of guides distributed or requested	200 hours staff time +$800 printing
		Produce and distribute brochures/flyers/fact sheets on land use and water quality, low impact development, smart growth, green infrastructure etc.	SWMPC	VBCD, MSUE, TRC, SWMLC	current - on-going (2 printed pieces/year)	increased use of LID practices	$800/printing & postage 80 staff hours/item
		Work one-on-one with planning commissions to improve plans and zoning ordinances for water quality protection ordinances, smart growth and low impact development and green infrastructure	SWMPC	VBCD, TRC.	current - on-going (3 municipalities/year)	number of improvements to plans and ordinances	200 hours staff time/municipality

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Land use change, stormwater runoff and natural resource management and preservation	Developers/ builders/ engineers	Develop and distribute newsletter articles and brochures, flyers and fact sheets on low impact development to SW Michigan realtor and builders associations	SWMPC	SWMHBA, SWMAR	medium-term (1 printed piece/year)	increased use of LID practices	30 hours staff time/item
		Plan and host a watershed tour to showcase LID every 2-3 years	TRC	VBCD, MSUE, SWMPC	medium-term (1 tour/2-3 years)	tour attendance and evaluations	100 hours/event + $50/person
		Promote statewide LID manual and trainings offered	SWMPC	SWMHBA / SWMAR	short-term (1 training/ year)	attendance at trainings	80 hours staff time
Stormwater runoff and natural resource management and preservation	Property owners	Print and distribute fact sheets from SWMPC's stormwater campaign at www.swmpc.org/water.asp	TRC	SWMPC, VBCD	current - on-going (50 fact sheets/year)	number distributed	$300 printing/postage 20 hours staff time
		Install storm drain markers and place door knob hangers to educate residents about stormwater runoff	VBCD, BCD	Lake Associations, TRC	current - on-going (2 municipalities/year)	number installed	40 hours staff time to coordinate volunteers
		Produce a direct mailing on land protection options - focus on property owners in high priority protection areas and high priority wetland protection/restoration areas	SWMLC	Land Preservation Board, VBCD, BCD, SWMPC	short-term (1mailing/ 2-3 years)	increased landowner interest in land preservation options	$1000/printing and postage + 100 hours staff time
		Host workshops/tours for property owners in high priority protection areas	SWMLC	VBCD, BCD, TRC, SWMPC	short-term (1 tour/ 2-3 years)	attendance and evaluations completed	$100-$500/workshop + 80 staff hours
		Distribute printed materials on what can be done to protect water quality and on land protection options for private landowners in tax or utility bills	County and Townships	SWMLC, VBCD, BCD, SWMLC, TRC	long-term (1 mailing/ year)	number of mailings	$300 printing/postage 40 hours staff time
Stormwater runoff	Government units- employees	Promote trainings on municipal operations (including road maintenance and construction) and best management practices to protect water quality	Drain Commissioner Municipalities	Road Commission, VBCD, SWMPC	medium-term (1 training/ year)	number of governmental employees attending trainings	20 hours/training opportunity
		Distribute brochures/flyers/fact sheets about municipal operations and road construction and maintenance best practices for water quality	Road Commission, Municipalities	SWMPC	medium-term (1 printed piece/year)	number adopting watershed friendly practices	$150/item printing and postage + 20 hours staff time/item

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Stormwater runoff	Businesses	Give presentations at local business gatherings about what businesses can do to protect water quality	VBCD	MSUE, Drain Commissioner	medium-term (1 presentation/ year)	number of business adopting watershed friendly practices	40 hours staff time/presentation
		Distribute brochures/flyers/fact sheets about business operations best practices for water quality - focus on lawn care companies	MSUE	VBCD	medium-term (1 distribution/ year	number of business adopting watershed friendly practices	$200-$500 printing/postage 30 hours staff time/item
Natural resource management and preservation	Recreation groups/users	Develop and install kiosks at parks along the rivers about water quality and natural features	Municipalities	BSHWTA, VBCD, SWMPC, Sarett Nature Center, TRC	medium-term (1 kiosk/ 2 years)	number of kiosks installed	$1,000/kiosk + 120 hours staff time/kiosk
		Develop water trails, public access sites and walling trails along the river	Municipalities	BSHWTA, Sarett Nature Center, SWMPC, Road Commission	long-term (1access site/ 2-3 years)	number of access sites; use of trails	$100/mile for water trail $1,000-$8,000/access site
		Develop and distribute 1 newsletter article per year for recreation groups	VBCD	BSHWTA, Lake Associations SWMLC	medium-term (1 article/ year)	number of readers (circulation of publication)	10 hours staff time/article
Septage waste	Riparian property owners	Develop 1 newsletter article per year for lake associations to utilize in their newsletters	VBCD	Health Dept, MSUE, SWMPC	medium-term (1 article/ year)	number of readers (circulation of publication)	10 hours staff time/article
		Develop and work with lake associations to distribute door knob hangers about septic system maintenance	Lake Assoc.	VBCD, TRC	medium-term (2 lakes/year)	number of households in distribution area	$0.50each printing + 100 hours staff time/lake association
		Encourage lake association members to meet with lake owners on a one-on-one basis to discuss septic system maintenance	Lake Assoc.	VBCD, MSUE	medium-term (2 lakes/year)	improved septic maintenance and reduced pollutants	3 hours/household
		Obtain and distribute a video on septic systems and water quality to Lake Associations (video available from St. Joseph River Basin Commission)	Lake Assoc.	SWMPC, St Joe River Basin Commission	medium-term (3 lakes/year)	improved septic maintenance and reduced pollutants	100 hours staff time
	Government unit-employees	Promote trainings about municipal sewer infrastructure planning and management	TRC	VBCD, SWMPC, Health Dept.	medium-term (1 training/ year)	number of municipal officials and employees attending trainings	10 hours/training

Issue	Priority Target Audience*	Activity	Potential lead agency	Potential partners	Timeline** (milestone)	Evaluation	Costs
Septage waste	Government units-officials	Develop and distribute brochures/flyers/fact sheets about the impacts of failing septic systems and what local governments can do	VBCD	MSUE, Health Dept, TRC	medium-term (1distribution/ 4 years)	increased number of septic related ordinances	$400 printing/postage 80 hours staff time
		Obtain and distribute a video on septic systems and water quality to governmental units (video available from St. Joseph River Basin Commission)	SWMPC	St. Joe Basin Commission, VBCD, MSUE	medium-term (5 governmental units/year)	number of municipalities receiving video	100 hours staff time
		Work one-on-one with planning commissions to improve plans and zoning ordinances relating to septic systems	SWMPC	VBCD, MSUE	current - on-going (3 municipalities/year)	increased number of septic related ordinances	80 hours/municipality

*Note: Primary audiences are listed; there may be additional audiences that could benefit as well
** short-term - within one year; medium-term - within 2-3 years; long-term - within 4-6 years

Acronyms
ACD: Allegan Conservation District
BCD: Berrien Conservation District
BSHWTA" Bangor-South Haven Heritage Water Trail Association
MSUE: Michigan State University Extension
NRCS: Natural Resources Conservation Service
SWMAR: Southwest Michigan Association of Realtors
SWMHBA: Southwest Michigan Home Builder's Association
SWMLC: Southwest Michigan Land Conservancy
SWMPC: Southwest Michigan Planning Commission
TNC: The Nature Conservancy
TRC: Two Rivers Coalition: An Alliance for the Black and Paw Paw River Watersheds
VBCD: Van Buren Conservation District
VBISD: Van Buren Intermediate School District

Appendix 11. Existing Efforts

The Van Buren Conservation District worked with several teachers and opportunities exist with Gobles, Lawton, Lawrence, Hartford and Mattawan schools to do water quality/macro-invertebrate monitoring with schools.

The Village of Mattawan applied for a grant to install plantings along Mattawan Creek and to monitor water quality.

The VBISD owns 35 acres in Lawrence along Brush Creek, which is being developed as an outdoor education center. The VBISD is working on curriculum and plans to open this center up to all Van Buren County schools for learning opportunities.

The Red Arrow Corridor Group has conducted an economic development study. This group involves the municipalities along Red Arrow (and the Paw Paw River) from Coloma to Mattawan. The study indicated that the Paw Paw River is a under utilized asset to the local economies of these small towns. The study also recognized the need to protect the natural areas and small town atmospheres. Van Buren County Economic Development led this effort.

As a result of the Red Arrow economic study, the Paw Paw River sub-committee was formed. This group hosted a municipal summit on November 3, 2003. The summit was organized by SWMPC and TNC. The group is interested in increasing Protection, Education and Awareness of the Paw Paw River. (The PEA plan!)

Partners including the MDNR, TNC, SWMPC and Berrien County, are working to remove the Watervliet dam on the Paw Paw River. In 2008, a USFWS grant was secured and TNC has applied for an MDNR Inland Fisheries Grant.

In 2004, SWMPC helped Watervliet secure a grant from Great Lakes Basin to install an Urban Stormwater BMP Demonstration Site along the Paw Paw River off M-140. A porous pavement parking lot, rain garden, riparian buffer and interpretative signs have been installed.

In 2004, SWMPC worked with Watervliet and Coloma Cities on a Cool Cities grant application. The main focus of the grant was on the Paw Paw River (connecting the two cities with a water heritage trail and connecting the downtowns with the river). This grant was not awarded.

SWMPC organized a Watershed Short Course offered in Berrien County in the spring of 2005. The targeted audience included the Galien, St. Joseph and Paw Paw River Watersheds. (This course was partly funded by SWMPC, MSUE and the Galien River Watershed 319 grant.)

TNC has designated the Paw Paw River Watershed as a target area for preservation. TNC created a poster that showcases the different habitats in the Paw Paw River Watershed. It also recognizes the river corridor and headwaters as priority conservation areas.

Over 1,800 acres in the watershed are protected or managed by the Sarett Nature Center, SWMLC, TNC and Michigan DNR.

SWMLC owns a preserve along the river corridor.

SWMLC is partnering with TNC to plan for the preservation of ecologically diverse areas in the watershed.

SWMLC is partnering with Sarett Nature Center and fostering protection efforts in the western part of the watershed.

FOTSJR Assoc. has developed a watershed management plan for the entire St. Joseph River Watershed, which includes the Paw Paw River Watershed. The Plan has identified the Paw Paw River as a high priority preservation area.

In 1991, the Van Buren Conservation District completed a groundwater study in the Paw Paw River Watershed.

The VBCD worked with Partners for Fish and Wildlife to restore 300 acres of wetland in the watershed owned by the VBCD.

The Maple Lake Association and the Village of Paw Paw continually dredge Maple Lake and Briggs Pond. There is interest to better understand the source of sediment and implement BMPs upstream to address the problem.

In 2007, the Paw Paw Lake Foundation hired Spicer Group to study pollutants, causes and sources in Paw Paw Lake.

Benton Harbor area is included in Phase II for stormwater regulations. Because the Phase II program affects less than 1/3 of the Paw Paw River Watershed, the watershed is still eligible for 319 funding.

The Pokagon Band is doing water quality monitoring in the PPRW near Hartford and is developing a land use plan for its property.

Van Buren County Planning Commission is pursuing a ban on the use of phosphorus fertilizer. The Paw Paw Lake Association is pushing for a similar ban in Berrien County.

The Village of Paw Paw, and others, have supported the inclusion of the the west brancy between Michigan Avenue and 60th Street to the south as part of the Gates Drain. This would put the management of the total Gates Drain under one agency which

would work with all parties to implement best management practices. As of this date, a Board of Determiners had approved the extension of the Gates Drain but a group has filed circuit court action in opposition.

The Maple Lake Association and the Village of Paw Paw are interested in learning more about weed management and the re-establishment of a fishery in Maple Lake. Such is now primarily pan fish where other species had been found.

Appendix 12. Pollutant Load Estimates and Reductions

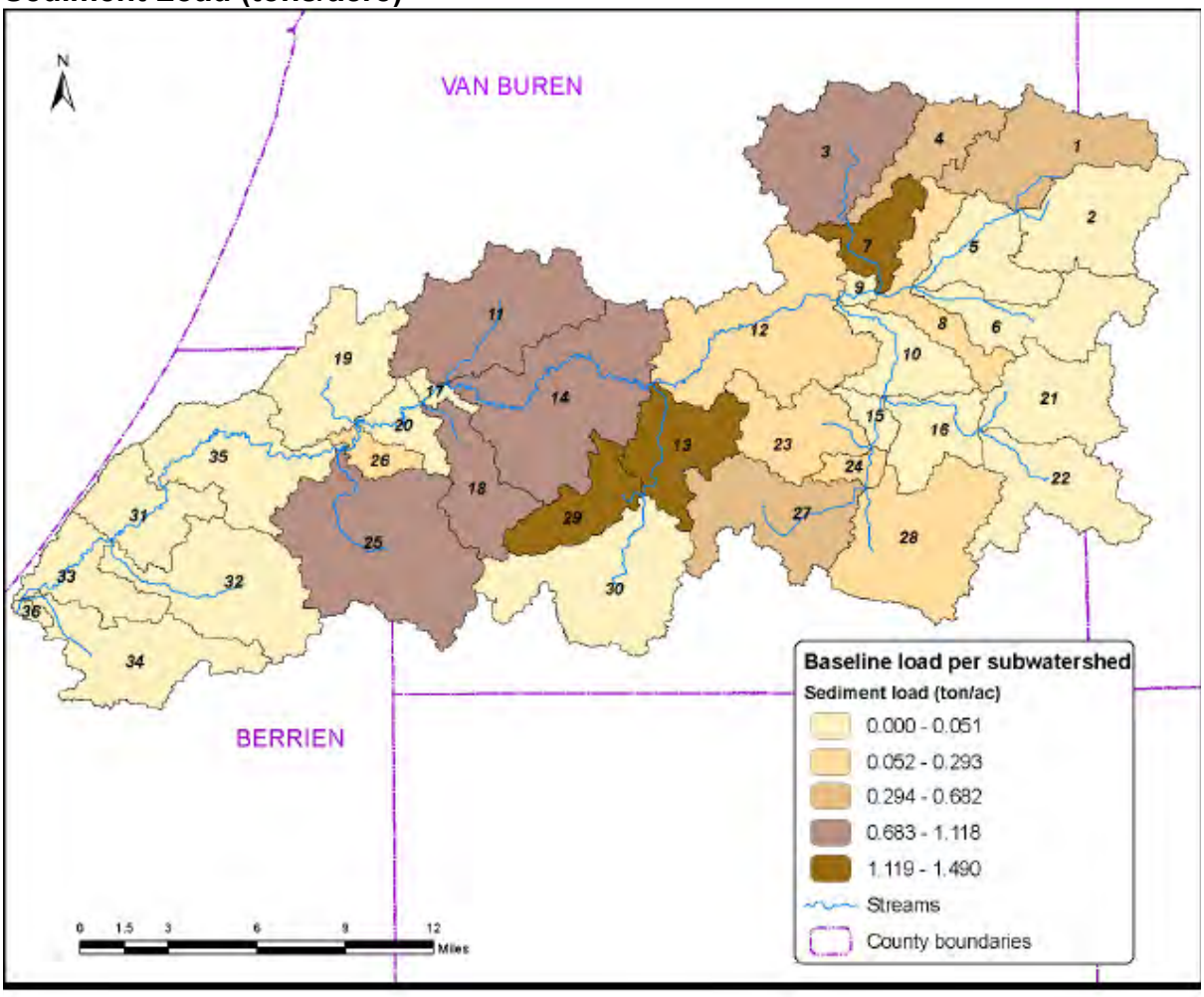
A pollutant loading is a quantifiable amount of pollution that is being delivered to a water body. Pollutant load reductions can be calculated based on the ability of an installed BMP to reduce the targeted pollutant. For this plan, the Soil and Water Assessment Tool (SWAT) was utilized to estimate pollutant-loading reductions for sediment and nutrients with the installation of agricultural BMPs (such as no-till, filter strips, cover crops, fertilizer reduction and a combination of filter strips and no-till). An empirical model utilizing the Long-term Hydrologic Impact Assessment model (L-THIA) was utilized to estimate load reductions in high priority urban areas for sediment and nutrients with the installation of urban stormwater BMPs (such as wet retention ponds, dry detention ponds, vegetated swales, rain gardens and constructed wetlands). Below is a summary of the results of these two modeling efforts. The full reports can be found online at:
www.swmpc.org/downloads/pprw_swat_report.pdf
www.swmpc.org/downloads/pprw_buildout_report.pdf.

SWAT Modeling

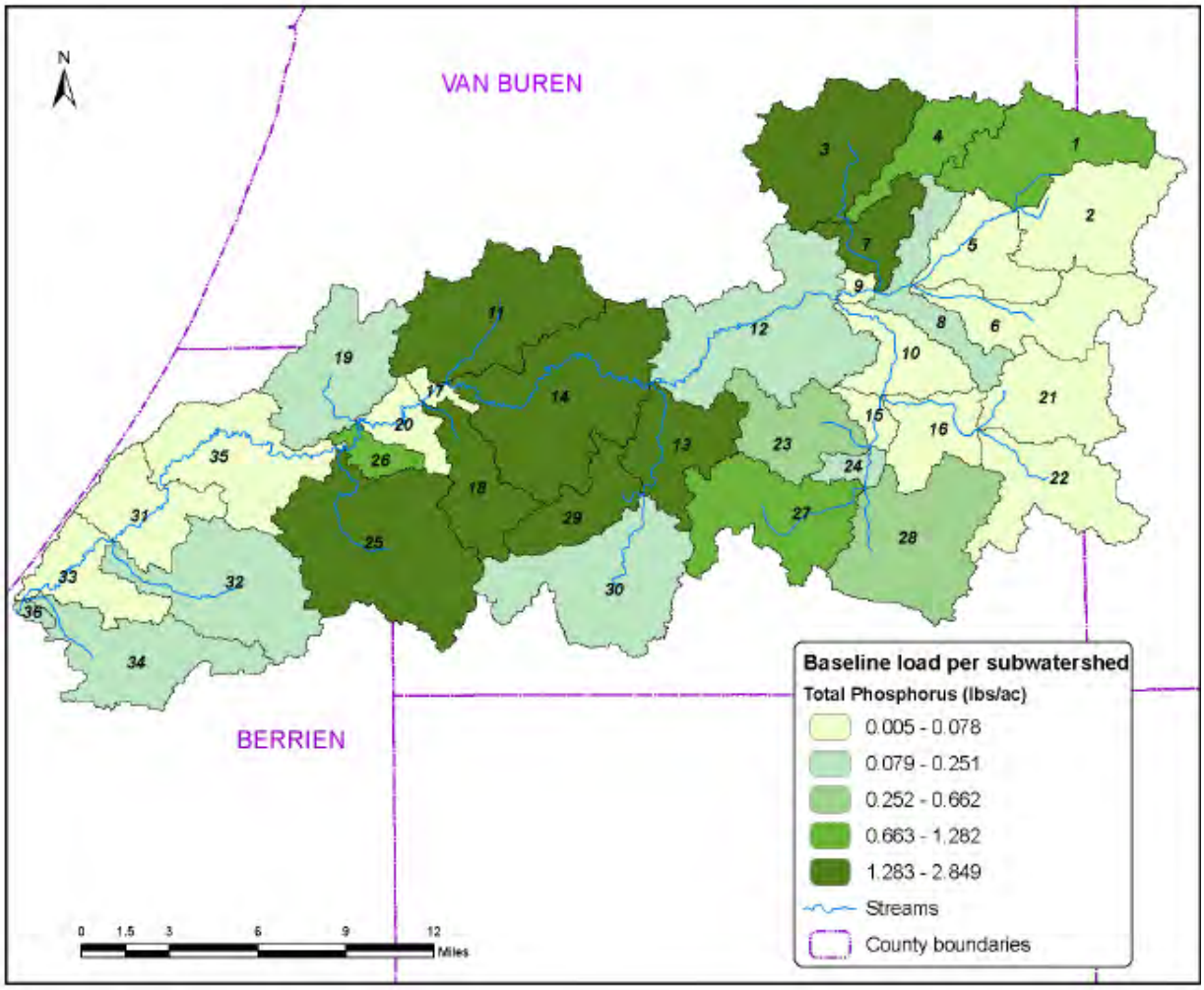
The US EPA supports the use of water quality models to satisfy the load quantification requirements in the development of a watershed management plan (US EPA, 2005). In part, the US EPA developed "BASINS" (Better Assessment Science Integrating point and Nonpoint Sources), a multipurpose analytical tool that integrates environmental databases and water quality models in a geographic information systems (GIS) framework. The Soil and Water Assessment Tool (SWAT), one of the models included in BASINS 3.1, was selected for this study due to its ability to simulate agricultural best management practices. Further, SWAT was chosen to build on existing efforts and to be consistent with the St. Joseph River Watershed Management Plan, which also utilized SWAT.

SWAT modeling was utilized to estimate the pollutant loads of total nitrogen, total phosphorus and sediment in 36 sub-basins of the PPRW. SWAT was also used to predict load reductions under selected agricultural best management practices (BMP) scenarios in selected sub-basins. The baseline average annual pollutant loadings were calculated for year 1997-2004 (excluding 2000 because of missing precipitation data) for 36 sub basins. The results for the pollutant loading are shown in the following figures.

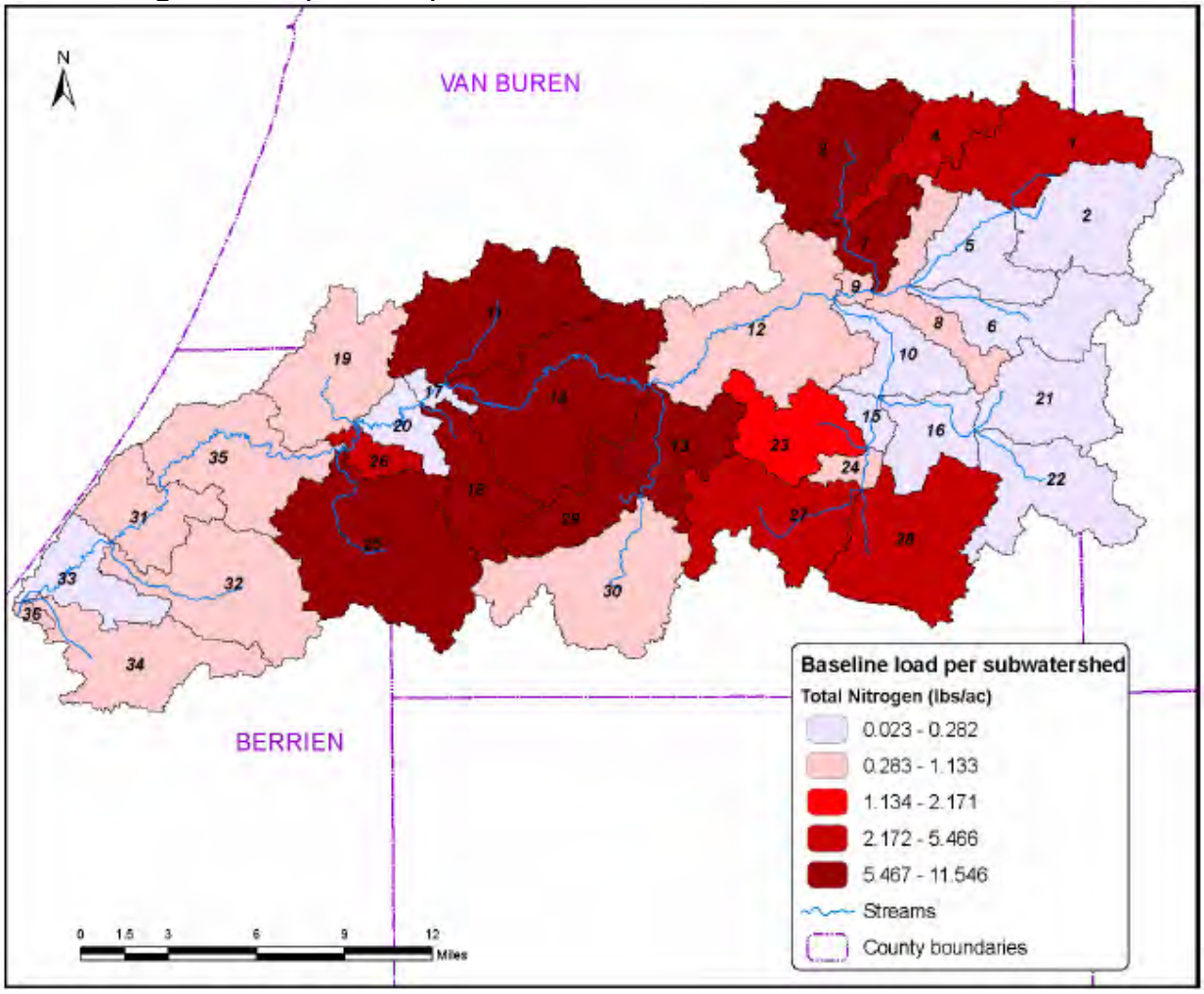
Sediment Load (tons/acre)



Total Phosphorus Load (lbs/acre)

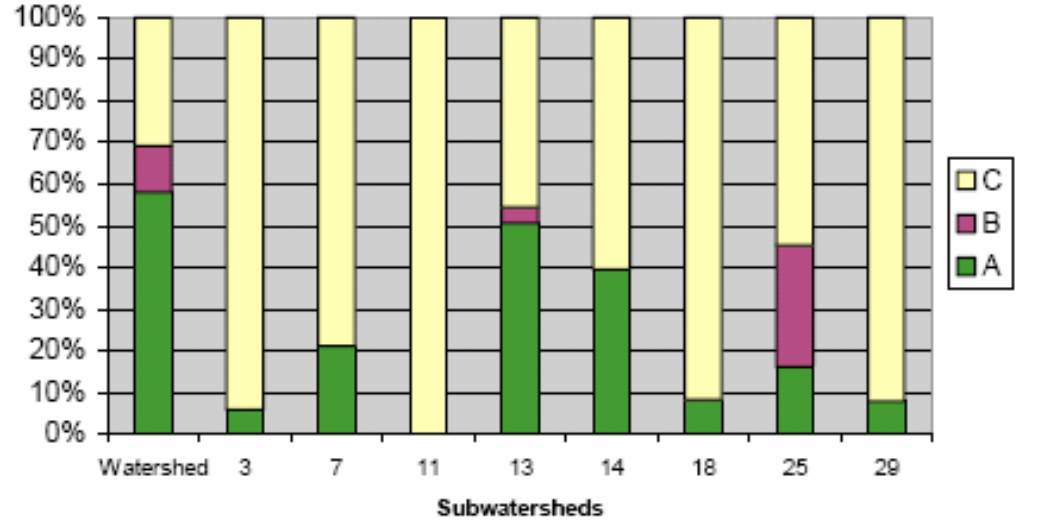


Total Nitrogen Load (lbs/acre)

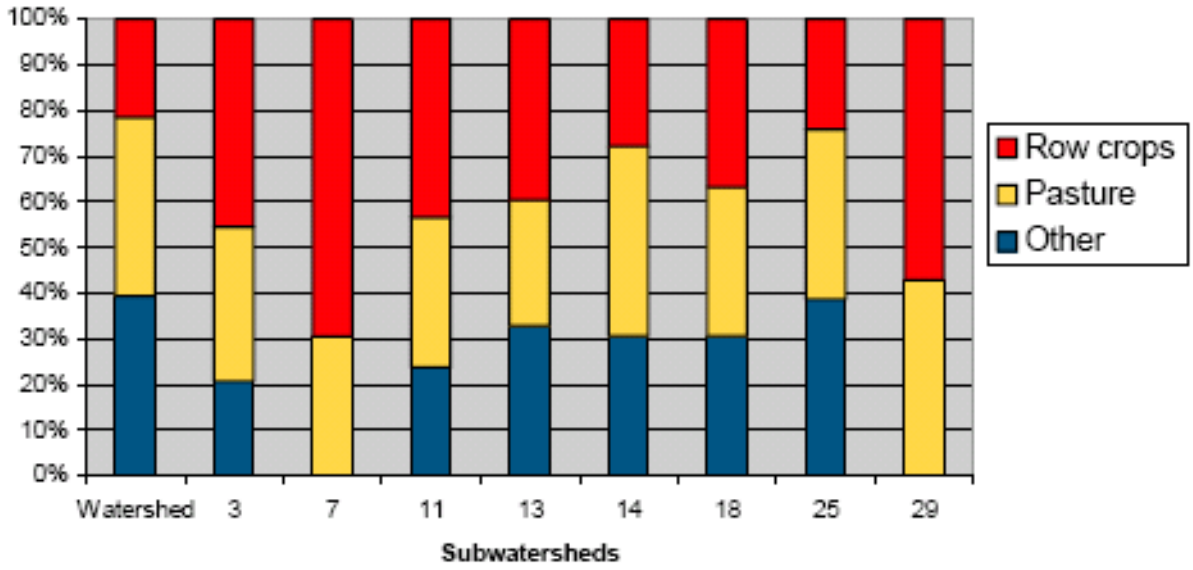


Model results indicate that the highest loading subwatersheds have a large proportion of silty clay loam soils, with a slow infiltration rate and higher runoff potential (hydrologic soil group C). These subwatersheds also have a higher proportion of agricultural land use, in particular row crops. See figures below.

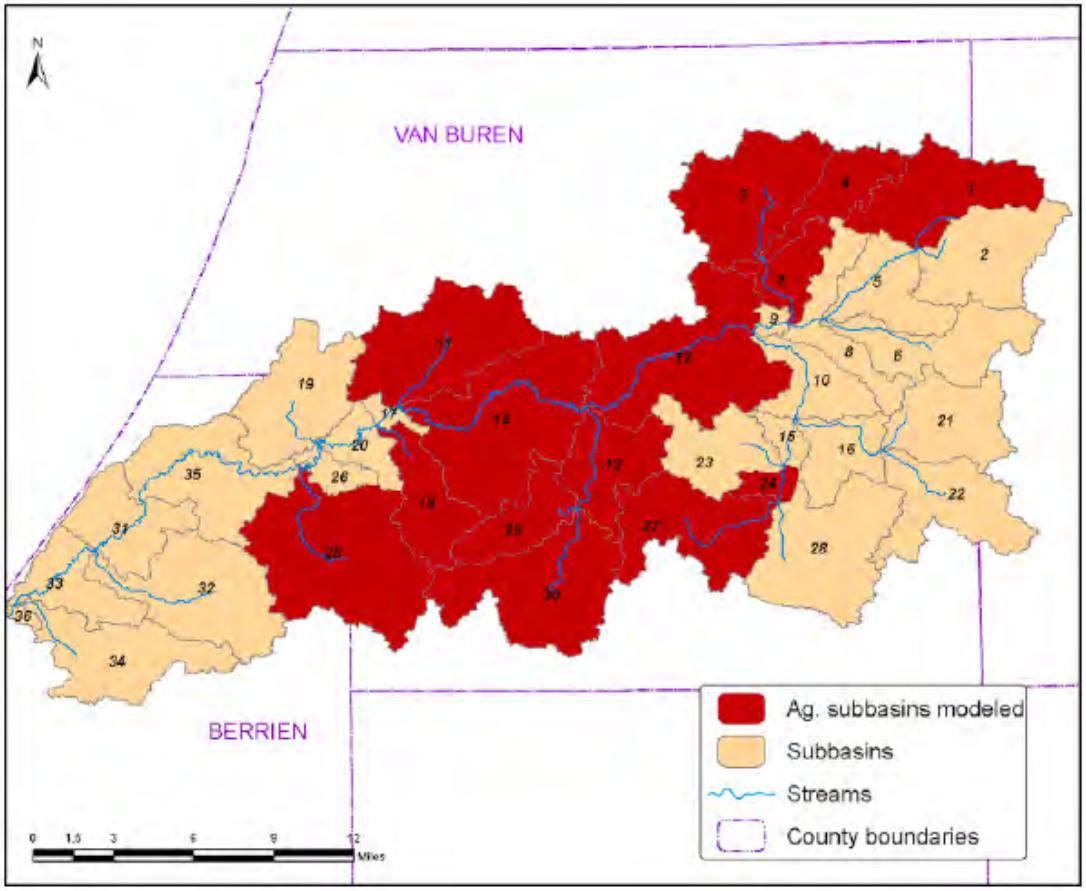
Proportion of hydrologic soil groups (A-C) in highest loading subwatersheds compared to the watershed average.



Proportion of land use in highest loading subwatersheds compared to the watershed average.



Agricultural Sub-basins Modeled in BMP Scenarios



The loading reductions from the implementation of agricultural best management practices were calculated as a percent reduction at the mouth of the Paw Paw River. The following table shows the loading reductions for agricultural practices being applied to 25%, 50% and 75% of the selected agricultural area respectively.

Percent Pollutant Loading Reduction for Selected Agricultural BMPs

	Implementation rate (% of selected agricultural area)		
	25%	***50%***	***75%***
Sediment			
No-till[a]	13	33.1	49.8
Filterstrip[b]	19.8	34.6	42.9
Cover crop[c]	7.8	18.5	23.9
Fertilizer reduction[d]	0	0.9	1.1
Combo[e]	22.5	39.5	65.3
Total Phosphorus			
No-till	11.1	25.1	41.7
Filterstrip	23.1	35.8	44.4
Cover crop	10.5	21.1	26.3
Fertilizer reduction	0.6	1.4	1.7
Combo	23.7	40.3	62.1
Total Nitrogen			
No-till	11	24.9	41.1
Filterstrip	21.7	34.4	43.2
Cover crop	10.1	21.4	27.2
Fertilizer reduction	0.7	1.5	1.9
Combo	22.9	39.2	60.8

[a] No-till for corn
[b] 30-ft edge-of-field filter strip
[c] Rye cover crop during winter
[d] Fertilizer application rate reduction of 25%
[e] Combination of filter strips and no-till

In conclusion, the SWAT modeling was coarsely calibrated for the Paw Paw River watershed given the limited availability of monitoring data. The model was used to simulate baseline-loading conditions for TP, TN, and sediments and analyzed the impact of five agricultural best management practices on water quality.

Among the four individual agricultural BMPs simulated, no-till emerged as the most cost-efficient BMP at all implementation rates due to its low per acre implementation cost ($3.23/ac/yr). Large-scale implementation for this BMP would bring significant water quality benefits. Filter strips may represent the most expensive BMP to install but they provide the largest sediment and nutrient load reductions, and are second to no-till

when considering cost-effectiveness. A small-scale implementation of filter strips would represent the best option given increasing cost with diminishing returns at higher application rates. This result suggests that **preservation of existing stream buffers should be a high priority for the watershed.** The combined BMP scenario (no-till and filter strips) provided the largest load reductions in all scenarios. However, it was shown that effectiveness gains will be diminished when more than one BMP is implemented on top of one another. Finally, it must be noted that filter strip and no-till BMPs (as modeled in the combination scenario) will not consistently improve water quality under all streamflow conditions as they do not have an impact on sediment loads under high flows, and they have minimal benefit on TP and TN loads under low flow conditions.

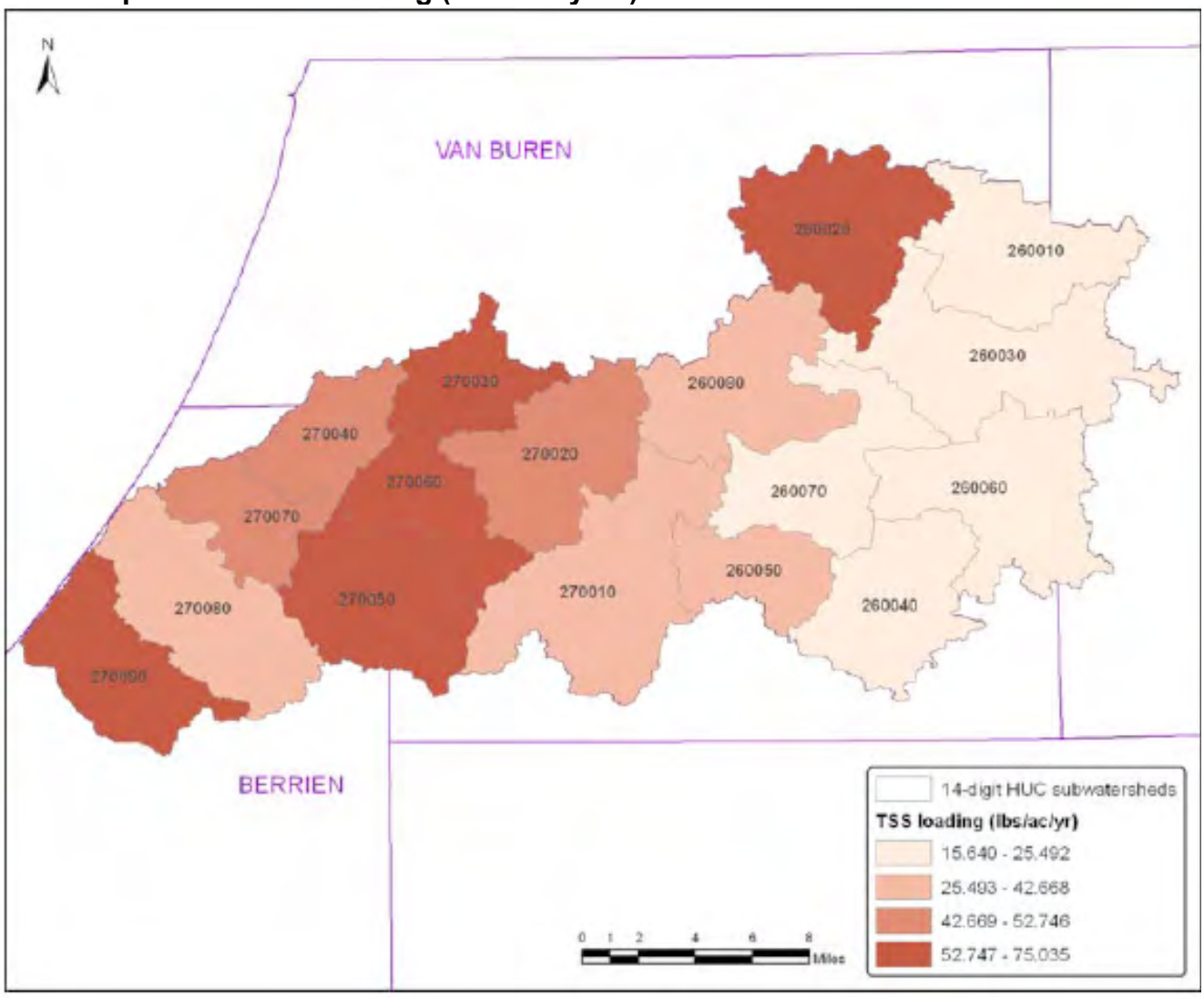
This study summarizes the impact of agricultural BMPs on pollutant and sediment loads at the mouth of the watershed. However, BMP load reductions could also be quantified for specific subwatersheds to identify the potential for local water quality improvement provided local monitoring data were available to support robust calibration.

Build-out Modeling

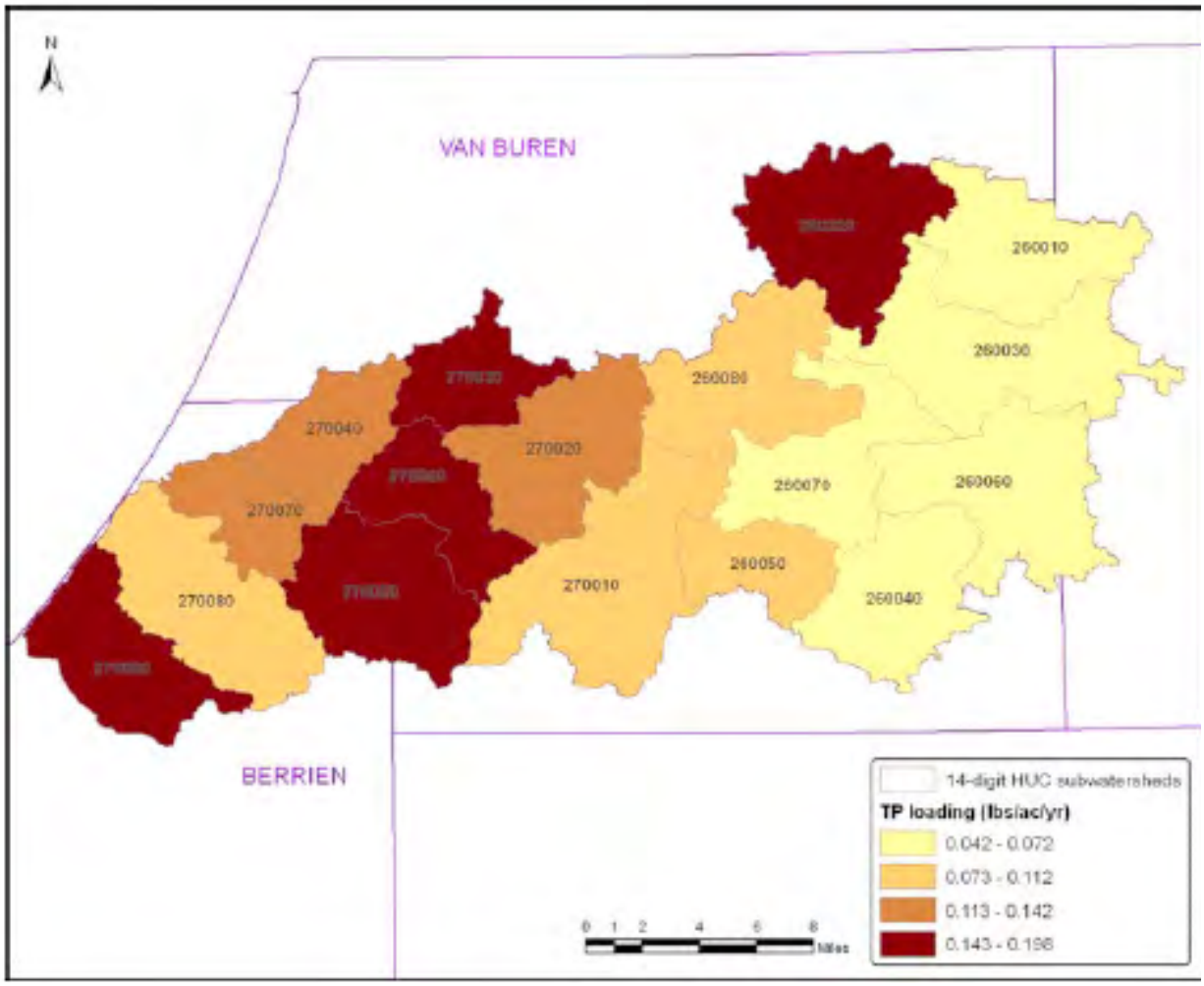
A simple empirical approach, similar to the one used in the St Joseph Watershed Management Plan was used to calculate nonpoint source pollutant loads and estimate the impact of stormwater BMPs. Pollutant loads and runoff volumes were calculated using average runoff depth values produced by the Long-term Hydrologic Impact Assessment model (L-THIA), and available pollutant event mean concentration values. Hypothetical build-out scenarios were based on local future land use plans to estimate the impact of urban development on water quality and quantity. The impact and cost-effectiveness of five common stormwater best management practices were also modeled to support land use planning in the Paw Paw River Watershed. The report is available online at www.swmpc.org/downloads/pprw_buildout_report.pdf. Below is a summary of the findings.

Pollutant loadings for sediment, total phosphorous, total nitrogen and runoff volume were calculated for current conditions and build-out scenarios. The following figures show the sediment, total phosphorous, total nitrogen and runoff volume for each of the seventeen 14-digit HUC subwatersheds at baseline conditions.

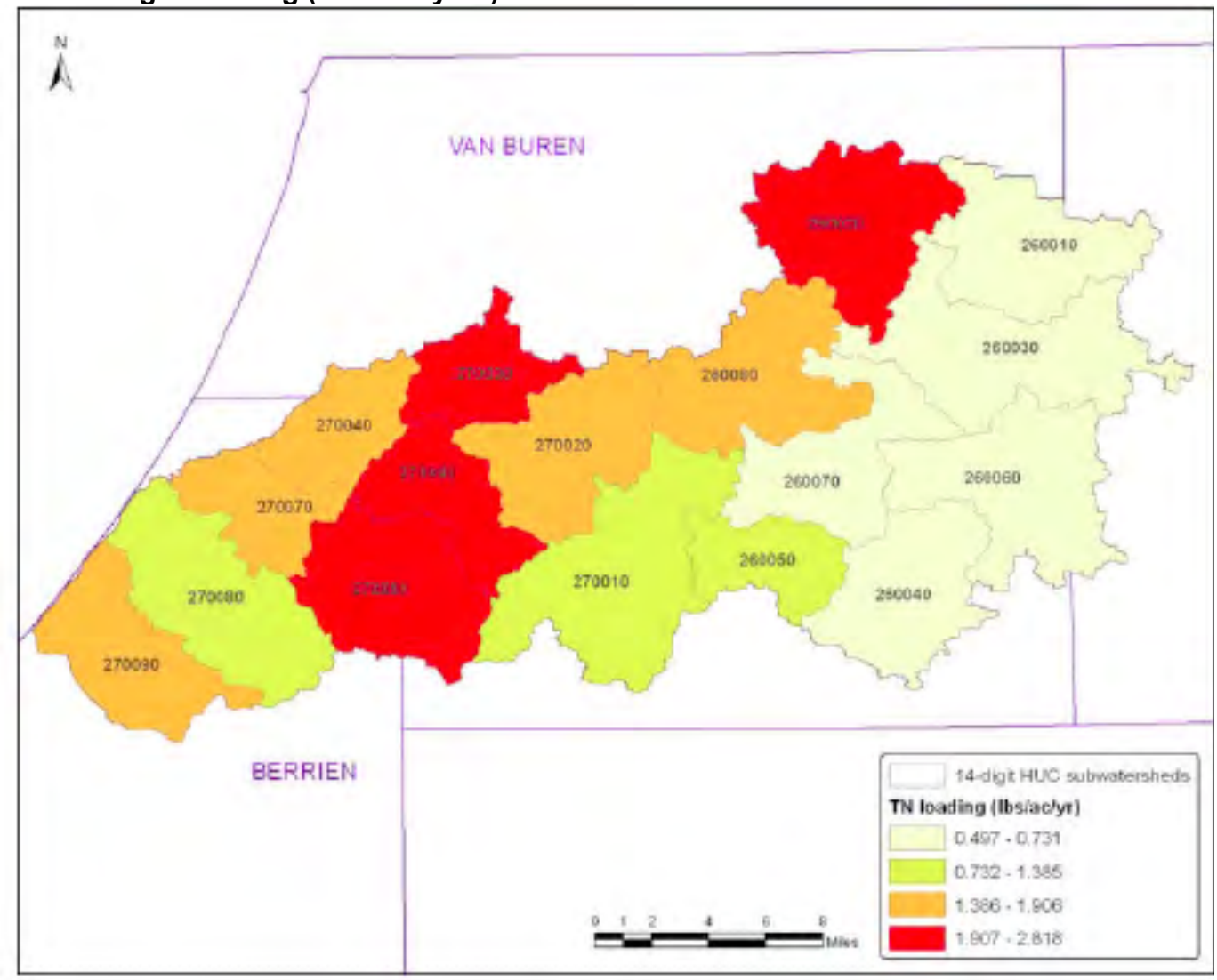
Total Suspended Solids loading (lbs/acre/year)



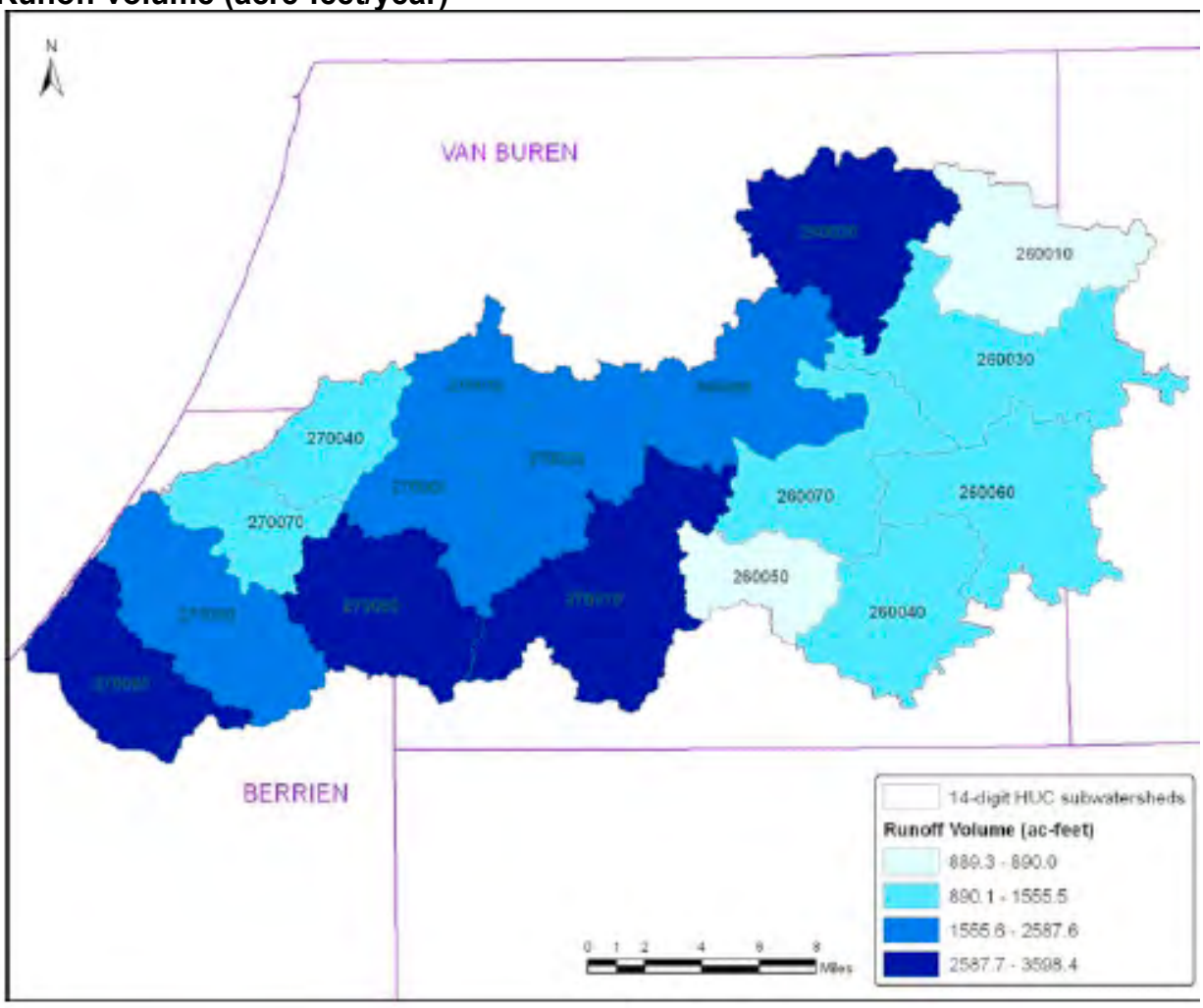
Total Phosphorus loading (lbs/acre/year)



Total nitrogen loading (lbs/acre/year)



Runoff volume (acre-feet/year)



To calculate pollutant-loading reductions, best management practices were applied to the highest priority urban areas in the watershed defined as follows:

- Ox Creek Area: corresponds to subwatershed 270090 (Benton Harbor/St Joseph).
- Paw Paw Lake Area (includes the townships of Coloma and Watervliet and the Cities of Watervliet and Coloma)
- The village of Paw Paw and Antwerp Township.

The following tables from the final report show the pollutant load reductions for total phosphorus and total suspended solids with the installation of five different BMPs in the high priority urban areas. The tables also show the costs to implement these BMPs in relation to the amount of pollutants reduced.

Table 9: Wet retention pond pollutant treatment costs with a 50% treatment coverage of urban lands.

	Pond Volume	Pond Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP Load Reduction Cost	TSS Load Reduction Cost
Urban Center	ft^3	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	749,559	3.4	1,086	358,988	730,820	64,147	59	0.18
Paw Paw Lake Area (Watervliet/Coloma)	432,260	2.0	827	260,349	421,454	36,992	45	0.14
Antwerp Twp/Village of Paw Paw	375,987	1.7	529	174,787	366,588	32,177	61	0.18
Total/Average	*1,557,807*	*7*	*2,441*	*794,124*	*1,518,862*	*133,316*	*55*	*0.17*

[1] Ponds are assumed to have an average depth of 5 feet.
[2] Construction cost + design and permits.
[3] Assuming a 5% interest rate and including a $4,152/acre/year maintenance cost.

Table 10: Dry detention pond pollutant treatment costs with a 50% treatment coverage of urban lands.

	Pond Volume	Pond Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP Load Reduction Cost	TSS Load Reduction Cost
Urban Center	ft^3	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	749,559	3.4	362	199,438	584,656	38,033	151	0.27
Paw Paw Lake Area (Watervliet/Coloma)	432,260	2.0	276	144,639	337,163	21,933	114	0.22
Antwerp Twp/Village of Paw Paw	375,987	1.7	176	97,104	293,270	19,078	156	0.28
Total/Average	*1,557,807*	*7*	*814*	*441,180*	*1,215,089*	*79,043*	*140*	*0.26*

[1] Ponds are assumed to have an average depth of 5 feet.
[2] Construction cost + design and permits.
[3] Assuming a 5% interest rate and including a $4,825/acre/year maintenance cost.

Table 11: Vegetated swale pollutant treatment costs with a 50% treatment coverage of urban lands.

	Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP load Reduction Cost	TSS Load Reduction Cost
Urban Center	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	15.0	483	319,101	196,498	25,882	54	0.08
Paw Paw Lake Area (Watervliet/Coloma)	9.7	367	231,422	126,293	16,635	45	0.07
Antwerp Twp/Village of Paw Paw	9.2	235	155,366	120,672	15,895	68	0.10
Total/Average	*34*	*1,085*	*705,888*	*443,462*	*58,412*	*56*	*0.09*

[1] Total area of vegetated swales in the subwatershed. Assuming for every 5 acre of drainage area, an 8×200 sq ft swale is needed.
[2] Construction cost
[3] Assuming a 5% interest rate and including a $0.02/sq ft/yr maintenance cost.

Table 12: Rain garden pollutant treatment costs with a 15% treatment coverage of urban lands

	Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP load Reduction Cost	TSS Load Reduction Cost
Urban Center	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	80.9	362	119,663	38,758,220	2,521,270	6,967	21.07
Paw Paw Lake Area (Watervliet/Coloma)	46.1	276	86,783	22,103,183	1,437,839	5,218	16.57
Antwerp Twp/Village of Paw Paw	48.8	176	58,262	23,360,056	1,519,600	8,624	26.08
Total/Average	*176*	*814*	*264,708*	*84,221,459*	*5,478,709*	*6,936*	*21.24*

[1] Total area of rain gardens in the subwatershed. Assuming rain garden area of 19% of the drainage area, which in turn is assumed to be 15% of impervious urban lands.
[2] Construction cost.
[3] Assuming a 5% interest rate

Table 13: Constructed wetland treatment costs with a 50% treatment coverage of urban lands.

	Area [1]	TP Load Reduction	TSS Load Reduction	Capital Cost [2]	30-year Annualized Cost [3]	TP load Reduction Cost	TSS Load Reduction Cost
Urban enter	acre	lbs/yr	lbs/yr	$	$/yr	$/lbs/yr	$/lbs/yr
Ox Creek Area (Benton Harbor)	141.9	1,086	358,988	7,237,334	591,420	545	1.65
Paw Paw Lake Area (Watervliet/Coloma)	80.9	827	260,349	4,127,334	337,277	408	1.30
Antwerp Twp/Village of Paw Paw	85.5	529	174,787	4,362,030	356,456	674	2.04
Total//Average	*308*	*2,441*	*794,124*	*15,726,697*	*1,285,153*	*542*	*1.66*

[1] Total area of constructed wetlands in the subwatershed. Assuming constructed wetlands to have 10% of the impervious drainage area.
[2] Construction cost + design and permits.
[3] Assuming a 5% interest rate and including a $850 /acre/year maintenance cost.

Among the five urban BMPs examined (wet retention ponds, dry detention ponds, vegetated swales, rain gardens, and constructed wetlands), wet retention ponds and constructed wetlands provide the greatest load reductions for TP and TSS while vegetative swales are the most cost-effective (lowest per pound cost of load reduction). Cautions should be taken, however, in interpreting these results due to the uncertainties in design parameters of vegetative swales and rain gardens. Other considerations should be evaluated, including limitations of vegetated swales and rain gardens for runoff flow reduction, and the feasibility of installing the required acreage in residential or high-density urban areas.

The modeling results clearly indicate that urban land uses (in particular transportation) contribute disproportionately high loads of TP, TN and TSS when compared to the fraction of the area they occupy. In fact, urban areas contribute greater than 50% of TP load in all three subwatersheds modeled for BMPs, but only occupy between 9 to 26% of the total acreage. Specifically in the St Joseph/Benton Harbor subwatershed (the most urban of the three), transportation uses account for 66% of the TP load and only 12% of the acreage. **It is clear that treatment of urban stormwater runoff is crucial for reducing TP and TSS loadings in these urbanized subwatersheds.**

Overall the model shows, under the current land use **urban stormwater runoff is the largest source of nutrient and sediment loads in urban subwatersheds**. In addition, the analysis of a hypothetical 25% build-out scenario showed that urban subwatersheds would experience the greatest increase in pollutant loads and runoff volume. Therefore, it is important to control this source of loading if water quality in the Paw Paw River Watershed is to be maintained or improved.