2.7 History of the Upper Maumee River Watershed

The Upper Maumee watershed has a very rich cultural history. Because of the vast natural resources and travel provided by the Maumee River, the Maumee Valley has been a hub for human settlement. Throughout history, the area has been inhabited by many different groups and continues to be developed with the Maumee River as a central feature.

The area has been inhabited by humans for 12,000 years. Many Native American Tribes have called the area home including the Miami, Wyandot, Delaware, Shawnee, Ottawa, Potawatomi, Kickapoo, and Chippewa Tribes. In the 1770's, Kiihkayonki (Kekionga), located at the headwaters of the Maumee River in what is now Fort Wayne, was one of North Americas largest Native American villages.

As European traders began to enter the area around 1680, the rich lands surrounding the river were repeatedly contested. For the next 150 years, France, Britain, colonial militias, Native American tribes, and eventually the United States army fought for control of this area. The two major cities within the Upper Maumee watershed, Fort Wayne and Defiance, were both once strategic military outposts on the Maumee River. The land fell under control by the United States after the Indian Confederacy was defeated by General Anthony Wayne at the Battle of Fallen Timbers in 1794. Then again in the War of 1812, the British, and allied Native Americans led by Tecumseh, battled the American forces of William Henry Harrison. Ultimately, the land fell to the United States which opened up the Northwest Territory for permanent settlement.

As the area was more widely settled by early Americans and European immigrants, the Great Black Swamp was largely drained and converted to productive agricultural lands. The Maumee River served as key means of transportation to the interior lands and enabled the construction of the second largest canal in the world in the 1840s; the Erie Canal. The Erie Canal aided in the growth of the region making goods more readily available and brought thousands of workers to the valley. There was a short lived oil and gas boom in the early 19th century which created major industries such as glass and auto manufacturing. Today, the major industries with the Upper Maumee watershed remain largely agriculture with some auto related industries and glass production. The small villages within the watershed were typically developed around the need for a local grain elevator which grew small agricultural communities.

As settlement of the United States grew west, the railroad became the major means of transportation of people and goods from the East to the West. The rail system in the Upper Maumee River Watershed began in the late 1800's and even continues today. Many of the historical sites of importance listed on the National Register of Historic Places are in connection with the railroad system.

Currently, the Upper Maumee watershed sits within the Maumee Valley Heritage Corridor, which is a designated heritage area including the entire Maumee River watershed. Heritage areas must have distinctive features unified by a significant large resource or feature. The Maumee River is the centerpiece of this designation. The Maumee Valley Heritage Corridor, an

organization based out of Ft. Wayne, IN seeks to create partnerships to improve the quality of life while advocating for the preservation of cultural and natural resources of the area.

There are several places of significance that are located in the UMRW that are designated as a historic site either by the U.S. Parks Department, IN DNR Historic Preservation and Archeology Division, or the Ohio Historical Society. The states run their historic preservation program differently; those listed by Ohio are eligible for, and will apply for designation as a historic site on the National Registry, those listed in Indiana have several levels of historical significance. After discussions with the IN DNR, it was decided that those sites listed as "outstanding" are likely the most similar to the sites listed by Ohio as being eligible for federal designation. Table 2.14 lists the sites that are designated as historical on the National Registry, Table 2.15 are the sites listed by Ohio that are eligible for historical designation, and Table 2.16 are the sites listed by Indiana as "outstanding". Figure 2.20 is a map showing the location of each of the historic sites listed on the National Registry.

Table 2.14: National Registry of Historic Sites

Resource Name	Address	State	County	City/Town	Watershed
St. Paul's Episcopal Church	High St.	OH	Defiance	Hicksville	Gordon Creek
Antwerp Norfolk and Western Depot	W. Water St.	OH	Paulding	Antwerp	North Chaney Ditch
Forest Park Boulevard Historic District	Roughly bounded by Dodge Ave., the alley bet. Forest Park Blvd. and Anthony Blvd, Lake Ave. and the alley	IN	Allen	Fort Wayne	Bullerman Ditch
Fort Wayne Park and Boulevard System Historic District	Roughly the following parks and adjacent right-of-way: Franke, McCormick, McCulloch, McMillen, Memorial	IN	Allen	Fort Wayne	Bullerman Ditch
Craigville Depot	Ryan and Edgerton Rds.	IN	Allen	New Haven	Sixmile Creek
New York Chicago and St. Louis Railroad Steam Locomotive No. 765	15808 Edgerton Rd.	IN	Allen	New Haven	Sixmile Creek
St. Louis, Besancon, Historic District	15529--15535 E. Lincoln Hmy.	IN	Allen	New Haven	Bullerman Ditch
Wabash Railroad Depot	530 State St.	IN	Allen	New Haven	Trier Ditch

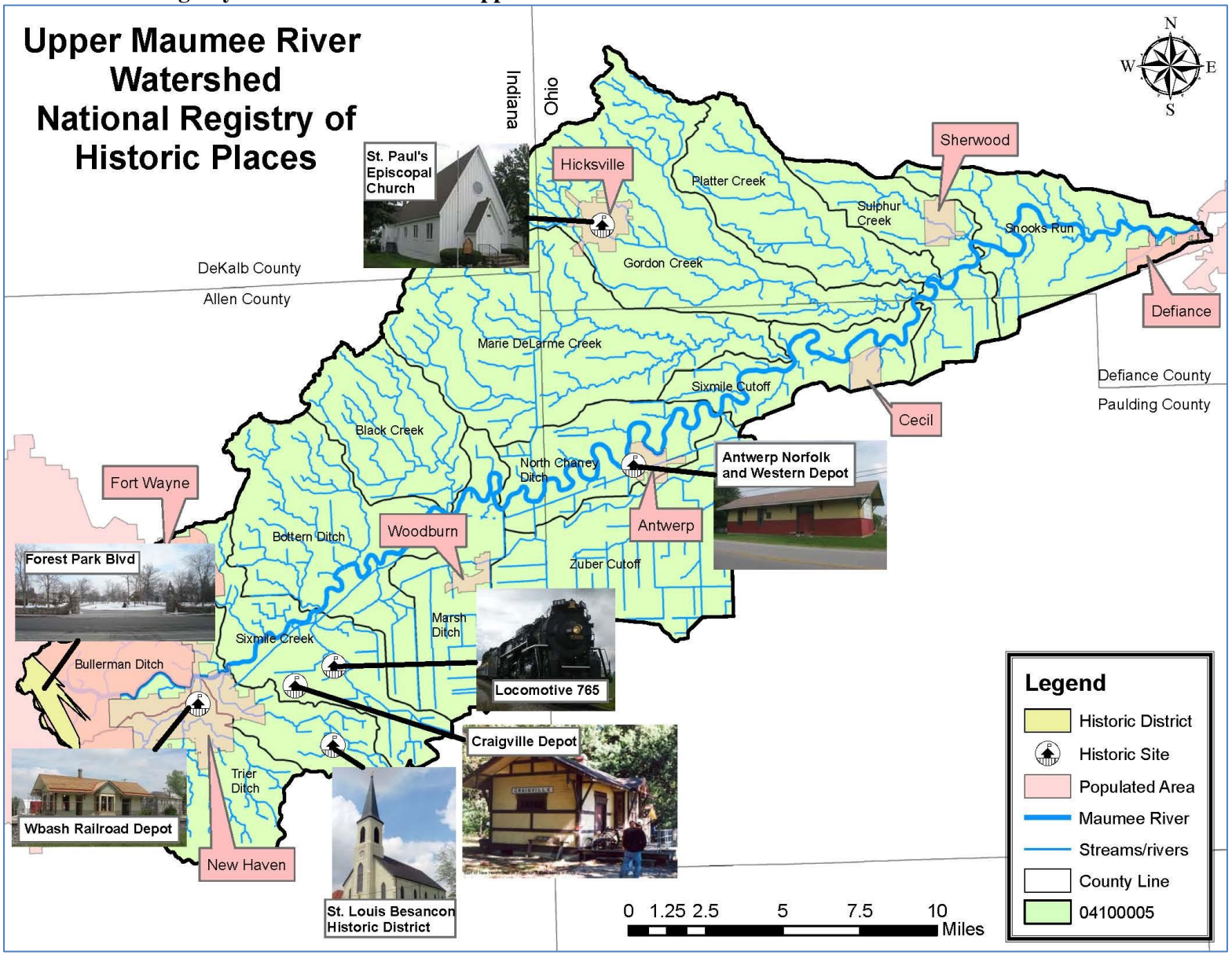
Table 2.15: State of Ohio Listed Historic Sites

Project Name	Address	State	County	City/Town	Watershed
BRIDGE #2031264	The Bend Rd, Over Maumee River	OH	Defiance	Delaware Twp.	Snooks Run
Crystal Fountain	100 Spiritualist Dr	OH	Defiance	Sherwood	Sulphur Creek
PAU - New Rochester Roadside Rest Area	CR 424	OH	Paulding	Cecil	Sixmile Cutoff
Historic Downtown Building	210 S Main	OH	Paulding	Antwerp	North Chaney Ditch
Historic Downtown Building	208 S Main	OH	Paulding	Antwerp	North Chaney Ditch
Historic Downtown Building	204 S Main	OH	Paulding	Antwerp	North Chaney Ditch
Historic Downtown Building	205 S Main	OH	Paulding	Antwerp	North Chaney Ditch

Table 2.16: State of Indiana Historic Sites Rated as "Outstanding"

Name	Address	State	County	City/Town	Watershed
Farm	11231 Linden	IN	Allen	New Haven	Bullerman Ditch
Milan Center School	Doty Rd @ Milan Center	IN	Allen	Milan Center	Sixmile Creek
George W. Warner Farm	23502 Hurshtown Road	IN	Allen	Scipio Twp	Marie DeLarme Creek
Thomas Hood House	17314 State Rd 37	IN	Allen	Harlan	Black Creek
Bridge	River Rd	IN	Allen	Maumee Twp.	North Chaney Ditch
G.A. Reeder House/Home Hotel	11928 Water St.	IN	Allen	Harlan	Black Creek
Scipio Township District Number 2 Schoolhouse	Corner of 14900 North Allen Rd and 24800 Spring	IN	Allen	Harlan	Marie DeLarme Creek
Maumee Township School Number 1	2588 River Rd	IN	Allen	Woodburn	North Chaney Ditch
Bridge	River Rd W of IN/OH line over Hamm Inceptor Ditch	IN	Allen	Maumee Twp.	North Chaney Ditch

Figure 2.20: National Registry of Historic Sites in the Upper Maumee River Watershed



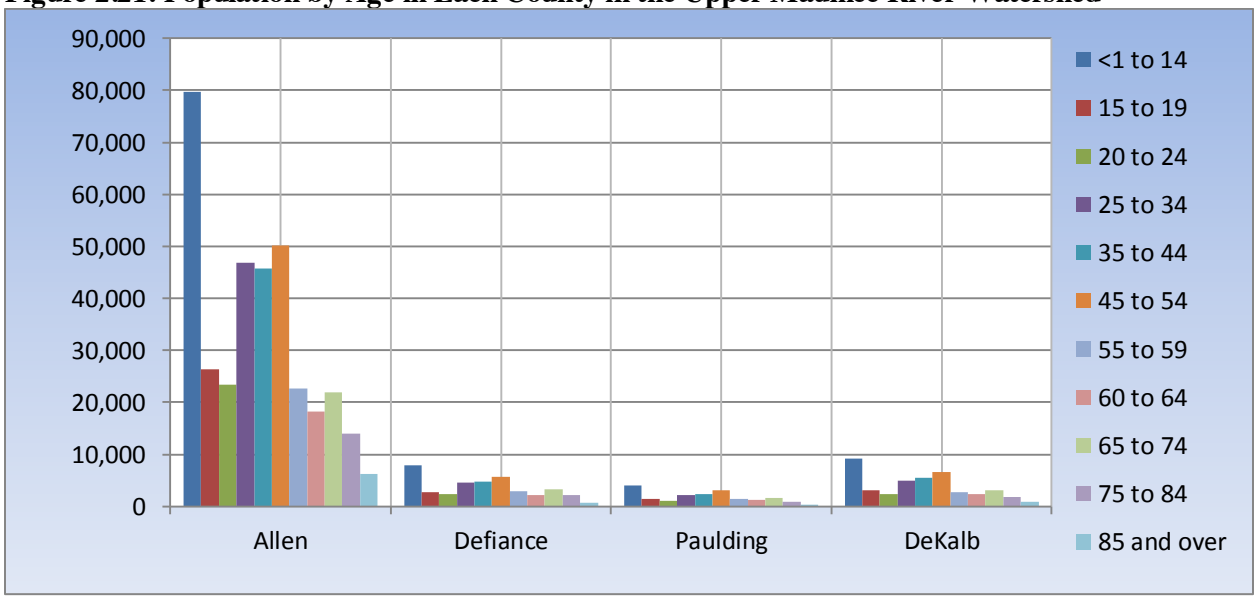
2.8 Demographics

Understanding the demographics of the project area will help to focus the implementation efforts of the WMP to the areas where the suggested management measures will be accepted both scientifically and financially. Below is a description of the demographics of the UMRW and the growth patterns observed in the past decade. All demographic information was obtained from the 2010 Census unless otherwise noted.

2.8.1 Population Trends

The population in Allen and DeKalb County, IN has increased by 29,260 between 2000 and 2010, which is a 7% growth rate in a decade. The population of Defiance and Paulding County, OH on the other hand has decreased by 1142, which is a 1% decrease in population between 2000 and 2010. According to the US Census Bureau, these trends are estimated to continue with the population to continue to increase in Allen and DeKalb County and decrease in Defiance and Paulding County. These trends may be due to the fact that the population in the bigger cities in Allen County (Fort Wayne) and DeKalb County (Auburn; not in the project area) continues to rise as more opportunities for jobs become available in these areas and Defiance and Paulding Counties are mostly rural. Figure 2.21 below shows the population by age in 2010.

Figure 2.21: Population by Age in Each County in the Upper Maumee River Watershed



2.8.2 Education and Income Level

The increase in population in Indiana Counties may be because there are more opportunities for individuals with a higher level of education to acquire a higher paying job. 23% of the population in Allen County has a bachelors, graduate or professional degree, where only 11% of the population in Defiance County, 5% of the population in Paulding County and 12% of the population in DeKalb County have degrees at the bachelor level or beyond. The graphs below illustrate the education level and household income for the counties located within the UMRW.

Figure 2.22: Education Level in Each County in the Upper Maumee River Watershed

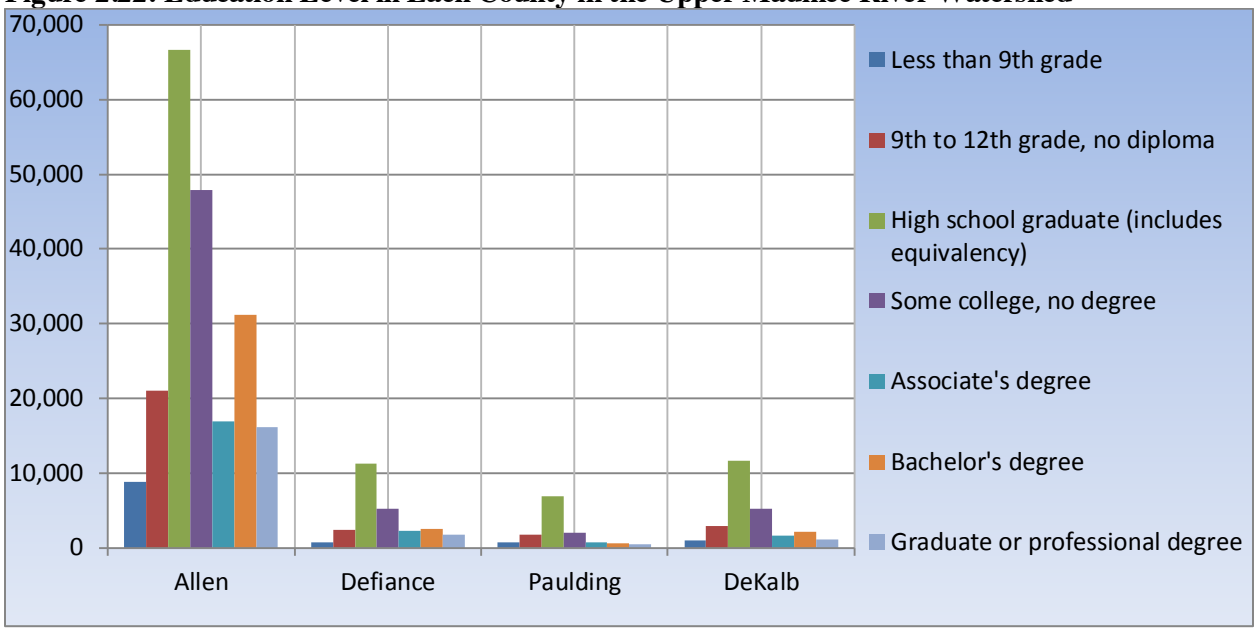
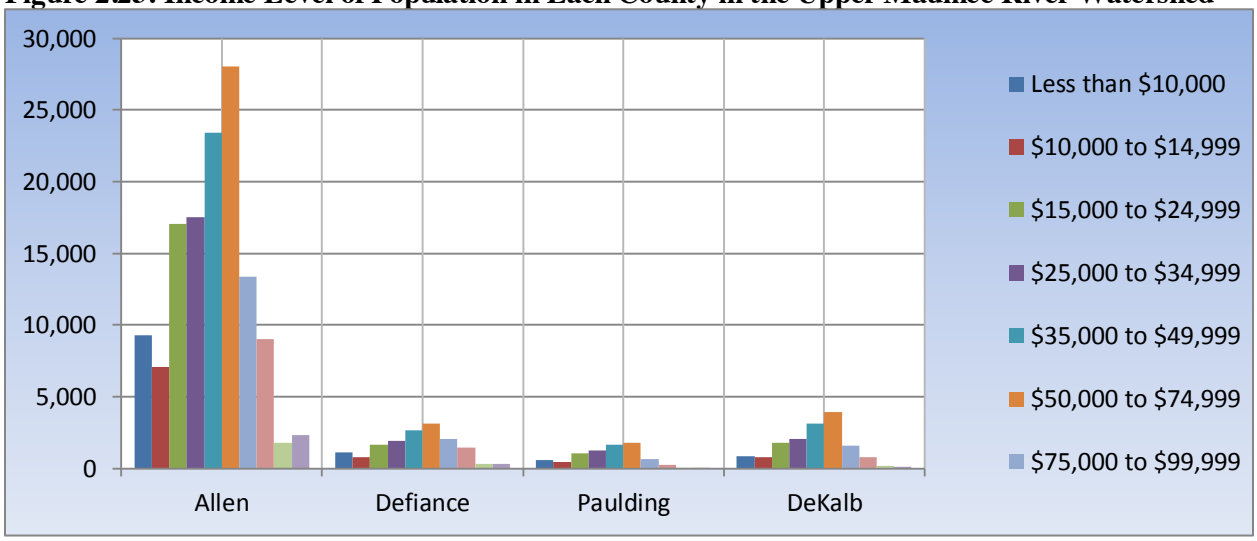


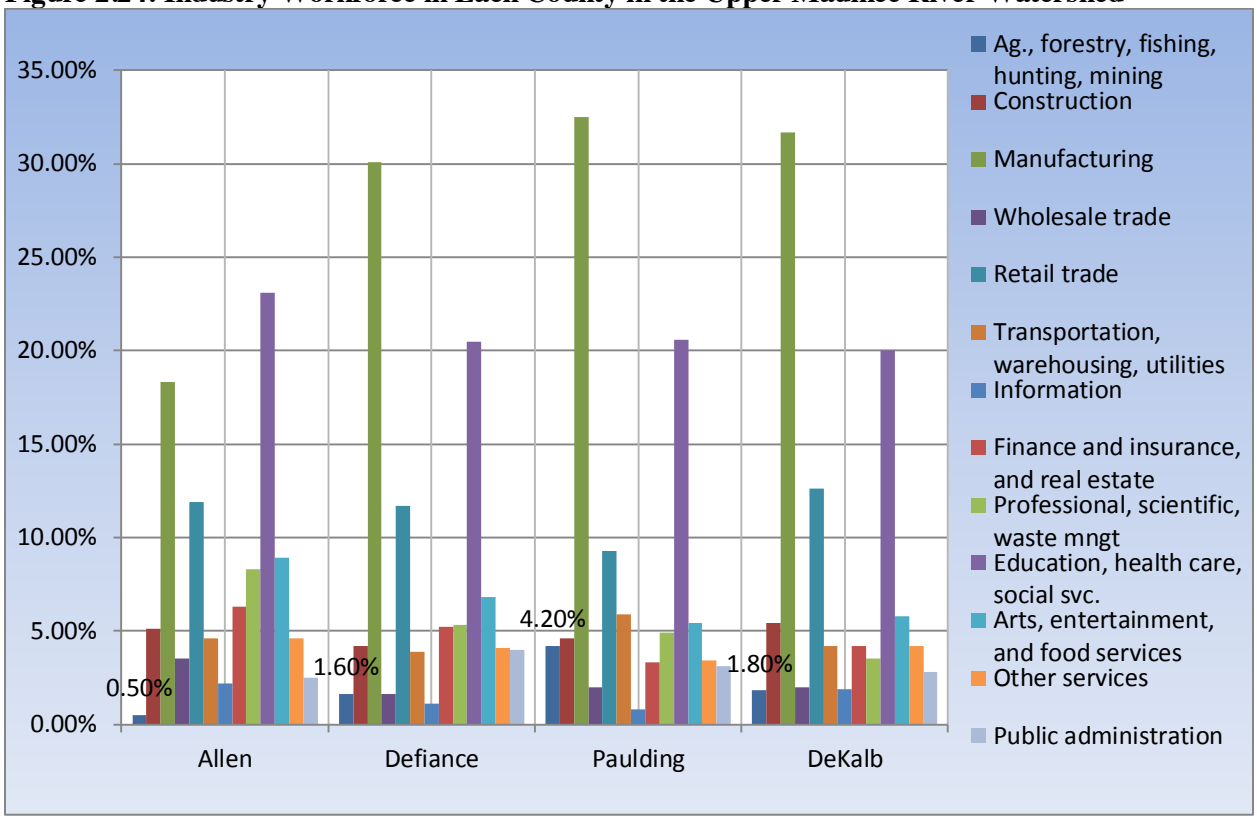
Figure 2.23: Income Level of Population in Each County in the Upper Maumee River Watershed



2.8.3 Workforce

Developed areas comprise 14% of the watershed and management measures will need to be implemented in those urbanized areas to decrease NPS pollution. However, the majority of the land use within the UMRW is agriculture, therefore producers will likely be the largest demographic targeted for the implementation of management measures in the watershed. According to Community Facts of the US Census Bureau, over 7% of the population within the four counties located in the UMRW work in agriculture, forestry, fishing, hunting and mining. The graph below illustrates the percentage of the population that works in each type of industry in each county. The percentages for agriculture, forestry, fishing, hunting, and mining are labeled on the graph.

Figure 2.24: Industry Workforce in Each County in the Upper Maumee River Watershed



2.8.4 Development

The increase in population may indicate that more construction of residential property and businesses is occurring. However due to the economic depression that began in 2008, development is on the decline. However, in the past year, development has picked up again in Fort Wayne particularly for business and commercial complexes and road construction to accommodate for the increased traffic to those areas, as well as residential homes. The Allen, Defiance, and Paulding County planning departments were contacted to learn the number of permits that were acquired for various construction projects in 2000 and 2012. DeKalb County was not contacted due to the small area of the county in the watershed which is mostly rural farmland. Table 2.17 shows the number of permits, and what type of permit, was acquired in 2000 and 2012 in each county. Note that the level of detail that was able to be acquired from each county is different and reflected in the following table.

Table 2.17: County Building Permits in the Upper Maumee River Watershed (2000-2012)

Type of Permit	Allen		Defiance		Paulding	
	2000	2012	2000	2012	2000	2012
Single Family Buildings	N/A	N/A	134	29	78	6
Two Family Buildings	N/A	N/A	4	3	2	0
3-4 Famiyl Buildings	N/A	N/A	0	0	1	0
5+ Family Buildings	N/A	N/A	0	0	7	0
Commercial	28	11	1	11	0	5
Residential	1649	612	N/A	N/A	N/A	N/A

2.9 Urban Areas

Urban landuses pose a unique, yet very prevalent threat to water quality. The balance between living, working, and recreating in an urban setting without adversely affecting the natural environment is a tenuous one. Urban areas typically have the highest concentration of point sources of pollution, as well as the most likelihood of having a direct effect on the surrounding water's quality through NPDES permit holder discharges to open water, road runoff carrying sediment, salt, oil and gas, and heavy metals, turf grass fertilizer runoff (residential, commercial and golf courses), Canada Geese, pet waste, and excess amounts of stormwater due to the high percentage of land cover that is impervious. The threat of these pollutants is exacerbated by CSO discharges which carry not only over land runoff to storm sewers, but also human waste and household chemicals and cleaners during heavy rain events. According to the National Land Cover database, administered by the USGS, over 14% of the UMRW is considered to be urban including the nine incorporated cities, towns, and villages that lie wholly, or partly, within the UMRW.

The City of Fort Wayne, IN is located at the headwaters of the Maumee River with nearly 90% of its 70,164 acres lying within the Western Lake Erie Basin, the remaining portion of the city drains to the Wabash River, however all combined sewers drain to the WLEB. The portion of Fort Wayne that drains to Lake Erie is located in the UMRW, Lower St. Joseph River Watershed (LSJRW), or the St. Marys River Watershed (SMRW). Watershed Management Plans were completed and approved by IDEM, for the LSJRW and SMRW in 2008 and 2009, respectively. The land within the city limits is predominately used for housing developments, and commercial and industrial uses. Table 2.18 is a breakdown of landuse within Fort Wayne's boundaries according to the 2006 National Land Use Database. Below the table is a definition of each of the "developed" land uses.

Table 2.18: Land Uses within Fort Wayne City Limits

Open Water	Dev. Open Space	Dev. Low Intensity	Dev. Medium Intensity	Dev. High Intensity	Cultivated Crops	Wetland	Forest/ Scrub	Total	Unit
948.2	20,984.3	26,919	7,942.7	4,245.3	4,059.7	708.9	4,233.2	70041.3	Acres
1.35%	29.96%	38.43%	11.34%	6.06%	5.80%	1.01%	6.04%	100.00%	%

- Developed; Open Space – < 20% impervious. Large lot single-family housing units, parks, golf courses.
- Developed; Low Intensity – 20% – 49% impervious. Mostly single-family housing units.
- Developed; Medium Intensity – 50% - 79% impervious. Mostly single-family housing units.
- Developed; High Intensity – 80% - 100% impervious. Apartment complexes, row houses, and commercial and industrial complexes.

Fort Wayne has several potential point sources of pollution located within its boundaries including 662 USTs, 302 of which are considered to be leaking (LUSTs), one superfund site (located wholly in the UMRW), 24 Brownfield locations, and 7 NPDES permitted facilities with 84 pipe outlets to the WLEB (43 of which are CSO discharge points). Fort Wayne is also growing with new construction of roads, and commercial and residential properties, mostly along the north side of the city. Fort Wayne also has over 80 parks and 19 golf courses located within its boundaries, both of which have regular lawn maintenance performed to keep the properties well-manicured, including the use of pesticides and fertilizer, and they are regularly irrigated.

Many other common urban practices are observed throughout Fort Wayne as well, including the lack of vegetated riparian buffers along ditches and streams, and homes and businesses with their gutter downspouts connected directly to the sewer system which may contribute to the amount of water needing processed by the WWTP during rain events in CSO areas and thus, can increase the number of CSO events. Due to the increase in imperviousness, more properties get flooded from smaller ditches and streams during moderate rain events. Therefore, the county surveyor's office has begun to dredge the waterways to straighten and deepen them to move water downstream faster. However, that practice involves removing vegetation from the riparian area, thus decreasing the amount of water that will be absorbed prior to entering the ditches, destabilizing the stream banks, and destroying wildlife habitat.

The LSJRW and SMRW WMPs were written and approved at a time when urban issues were not a focus of nonpoint source pollution remediation, and urban pollution was largely overlooked. Each of the WMPs, now outdated, mentioned very little about the urban landscape contributing to water quality issues in the WLEB. Below is a list of critical areas, according to the LSJRW and SMRW Management Plans, to focus implementation and remediation efforts within the boundaries of Fort Wayne.

Lower St. Joseph River Watershed Management Plan

- Northside Neighborhood for CSOs, pet waste, residential lawn fertilizer, construction and road runoff.
- North Anthony Corridor for Road runoff, high % of imperviousness, sediment
- Indiana University-Purdue University Campus for high traffic and % imperviousness, nuisance geese, lawn fertilizer, construction

- I69 at Beckett's Run for highway construction on bridge, bank erosion and increased runoff velocity
- Commercial construction at Dupont and Lima Roads for construction, increased traffic, increased solid waste and % imperviousness
- Dupont Rd and Union Chapel Rd for increased traffic and construction
- Parks and Green space for nuisance geese
- Ely Run and Martin Ditch for bank erosion

St. Mary River Watershed Management Plan

- Regulatory flood hazard area
- Industry under Rule 6 permitting requirements (none located within the City boundaries)

As can be seen in the above list, very little was identified as a critical area within the city limits in either of the WMPs. However, that is not because urban pollutants were not an issue at the time, it is due to the fact that urban best management practices were an emerging idea, but not readily viewed as obtainable. However, as technology expands, and new ideas emerge regarding ways to lessen the impact of urban pollutants and increase stormwater infiltration rates, urban best management practices are becoming more attainable and even sought after by developers and individuals. Figure 2.25, below, identifies the potential sources of pollution to the UMRW from the City of Fort Wayne and Figure 2.26 shows the landuse and impervious cover within the City of Fort Wayne.

Figure 2.25: Potential Point Sources of Pollution in Fort Wayne

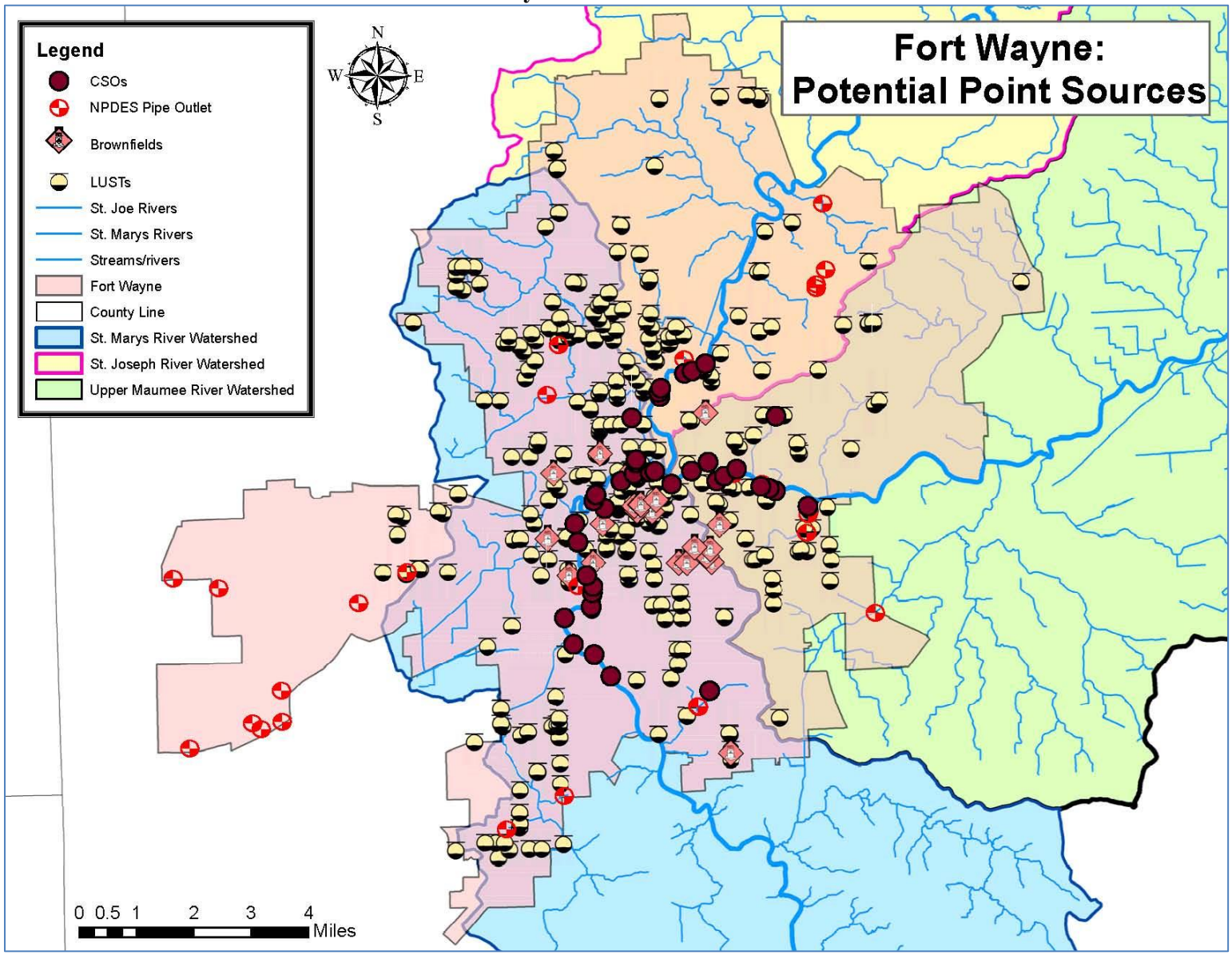
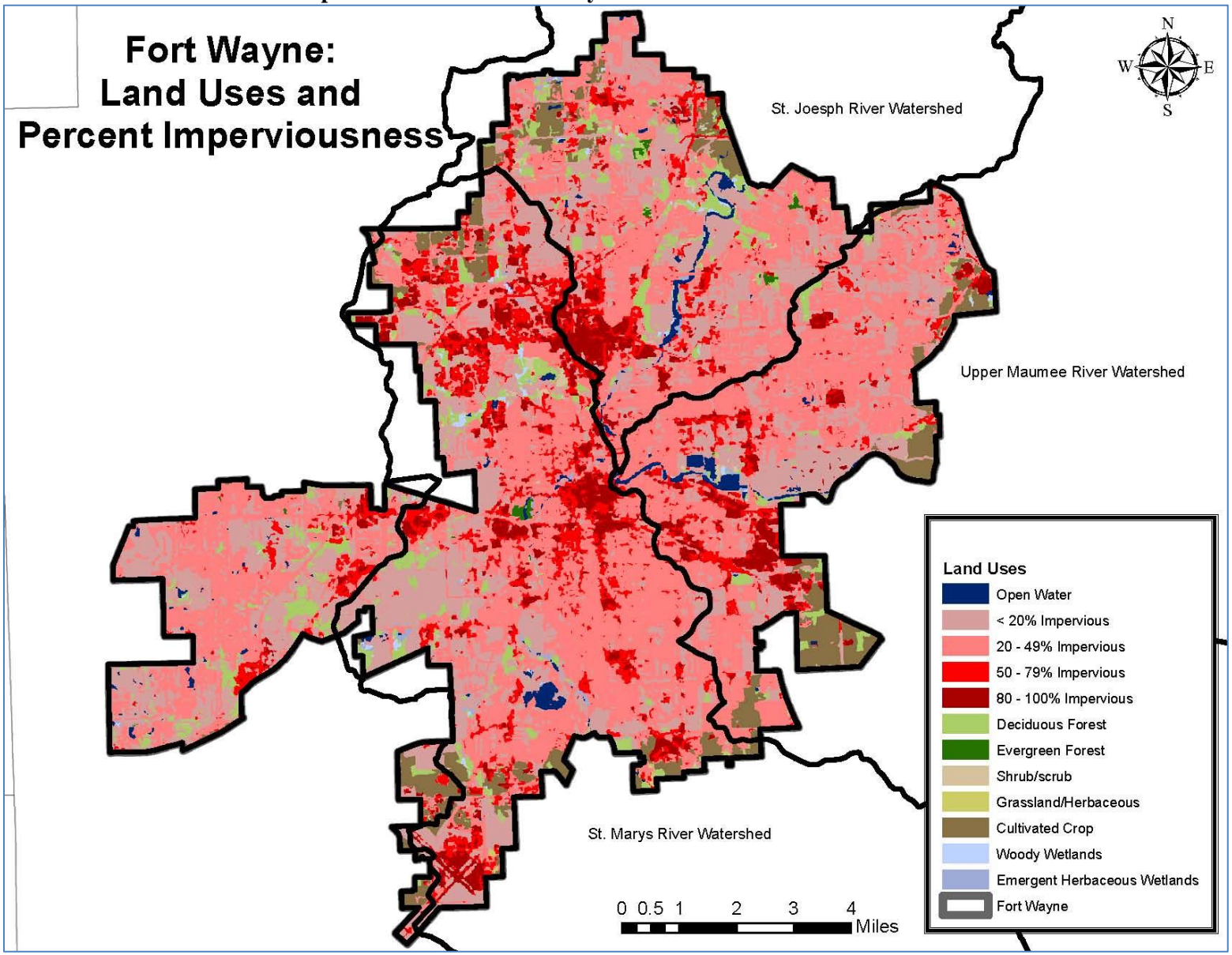


Figure 2.26: Land Uses and Percent Impervious Cover in Fort Wayne



2.10 Endangered Species

The UMRW is home to many federally and state listed endangered and threatened species. The US Fish and Wildlife Service (USFWS) maintains a database of those species that are either endangered or candidates to become endangered on the federal level which can be seen in Table 2.19. There are several species of significance located within the UMRW which rely on streams, wetlands, or upland forested areas for habitat, including the White Cat's Paw Pearly Mussel which currently can only be found in Fish Creek in the St. Joseph River watershed and the Indiana Bat.

According to the USFWS, the Indiana Bat population has decreased by over half since it was originally listed as endangered in 1967. This decrease in population can be attributed to human activities disturbing the Indiana Bat's habitat. Indiana Bats are very vulnerable to disturbances in their hibernation grounds as they hibernate in mass numbers (20,000 to 50,000) in caves in southern Indiana. The reason the bats population has declined in northern Indiana is mainly due to their breeding and feeding grounds, riparian and upland forests, being cleared for agricultural land and expanding urban areas. The Eastern Massasauga Rattlesnake lives in wetland areas, many of which have been drained to be used for agriculture. The ancestral Black Swamp which has all, but the northeast corner of the swamp near Toledo, been drained and converted to farm land is one such wetland area in which the Eastern Massasauga would use as prime habitat. With much of the Eastern Massasauga's habitat being converted for other uses, the snakes numbers have declined dramatically. Finally, the last known population of White Cat's Paw Pearly Mussel is located in the St. Joseph River though the mussel is still considered to be endangered in the Upper Maumee River watershed as it used to be home to the mussel. These mussels live in streams that have a coarse sand or gravel bottom. With the increase in intensive agriculture throughout the Upper Maumee River watershed, the amount of sediment entering surface water has also increased, thus smothering the mussels in the streambed. According to the United States Fish and Wildlife Service (USFWS), pesticides and fertilizers that runoff agricultural fields have also contributed to the demise of the White Cat's Paw Pearly Mussel, as well as other mussels as they are filter feeders and take in contaminated water each time they eat. The protection of the habitat in which all the species listed in Table 2.19 live is essential to their survival.

Table 2.19: Federally Listed Endangered Species

COUNTY	SPECIES	COMMON NAME	STATUS	HABITAT
MAMMALS				
Defiance and Paulding (OH) Allen and DeKalb (IN)	*Myotis sodalis*	Indiana Bat	Endangered	Hard wood forest and hardwood pine forest
MUSSELS				
Defiance (OH) Allen and DeKalb (IN)	*Pleurobema clava*	Clubshell	Endangered	Fresh water
Defiance (OH) Allen and DeKalb (IN)	*Epioblasma torulosa rangiana*	Northern Riffleshell	Endangered	Well graveled river beds with swift flow
Defiance and Paulding (OH) Allen and DeKalb (IN)	*Epioblasma obliquata peroblique*	White Cat's Paw Pearly Mussel	Endangered	Fresh water
Defiance and Paulding (OH)	*Villosa fabalis*	Rayed Bean	Endangered	Fresh water
Allen and DeKalb (IN)	*Villosa fabalis*	Rayed Bean	Candidate	Fresh water
Allen and DeKalb (IN)	*Quadrula cylindrica cylindrica*	Rabbitsfoot	Candidate	Fresh water
REPTILES				
Defiance (OH)	*Nerodia erythogaster neglecta*	Copperbelly Water Snake	Threatened	Lowland Swamps
Allen (IN)	*Sistrurus catenatus catenatus*	Eastern Massasauga	Candidate	Wooded and permanently wet areas such as oxbows, sloughs, brushy ditches and floodplain woods
BIRDS				
Defiance and Paulding (OH) Allen (IN)	*Haliaeetus Leucocephalus*	Bald Eagle	Species of Concern	Near Rivers with old trees

2.11 Invasive Species

Invasive species are those organisms that do not naturally occur in a specific area and when introduced will cause deleterious effects on the ecology of the area. Invasive species pose a significant threat to the natural areas within the UMRW. Due to the fact that the newly introduced organism does not have natural predators, the organism can spread through an area quickly and can outcompete native organisms that make an ecosystem thrive. Table 2.20 is a list of invasive species that are located within one or more of the four counties that are located in the UMRW.

Table 2.20: Invasive Species in the Upper Maumee River Watershed

COUNTY	SPECIES	COMMON NAME	HABITAT
Vegetation			
DeKalb and Allen (IN)	*Robinia pseudoacacia*	Black Locust	Openland
	Sicyos angulatus	Burcucumber	Openland
	Cirsium arvense	Canada Thistle	Openland
	Sorghum almum	Columbus Grass	Openland
	Lysimachia nummularia	Creeping Jenny	Forest, Wetland
	Securigera varia	Crown Vetch	Openland
	Potamogeton crispus	Curly-Leaf Pondweed	Lake
	Hesperis matronalis	Dame's Rocket	Forest, Openland
	Myriophyllum spicatum	Eurasian Watermilfoil	Lake
	Sorghum halepense	Johnsongrass	Openland
	Acer platanoides	Norway Maple	Forest
	Littorina littorea	Periwinkle	Forest
	Ligustrum obtusifolium	Privet	Forest
	Euonymus fortunei	Purple Winter Creeper	Forest
	Sorghum bicolor	Shattercane	Openland
	Ulmus pumila	Siberian Elm	Forest
	Bromus inermis	Smooth Brome	Forest, Openland
	Melilotus officinalis	Sweet Clover	Openland
	Festuca arundinacea	Tall Fescue	Openland
	Ailanthus altissima	Tree of Heaven	Forest
	Morus alba	White Mulberry	Openland
Defiance and Paulding (OH)	*Senecio glabellus*	Cressleaf Groundsel	Openland
	Vitis L.	Grapevines	Forest
	Ploygonum perforliatum	Mile-a-Minute Weed	Openland
	Carduus nutans	Musk Thistle	Openland
	Chrysanthemum leucanthemum	Ox-Eye Daisy	Openland
	Conium maculatum	Poison Hemlock	Wetland
	Salsola kali	Russian Thistle	Openland
	Daucus carota	Wild Carrot	Openland
	Brassica kaber	Wild Mustard	Openland

COUNTY	SPECIES	COMMON NAME	HABITAT
	Pastinaca sativa	Wild Parship	Openland
DeKalb and Allen (IN) and Defiance and Paulding (OH)	*Elaeagnus umbellata*	Autumn Olive	Openland
	Rhamnus cathartica	Buckthorn, Common	Wetland, Openland
	Rhamnus frangula	Buckthorn, Glossy	Wetland, Openland
	Phargmites australis	Common Reed Grass	Wetland
	Alliaria petiolata	Garlic Mustard	Forest
	Lonicera japonica	Japanese Honeysuckle	Forest
	Polygonum cuspidatum	Japanese Knotweed	Forest
	rosa multiflora	Multiflora Rose	Forest, Openland
	Lythrum salicaria	Purple Loosestrife	Wetland
	Phalaris arundinacea	Reed Canary Grass	Wetland
Fish			
Paulding (OH)	*Sander canadensis x vitreus*	Saugeye	Lake
Allen (IN)	*Micropterus*	Black Bass	Lake
	Dorosoma cepedianum	Gizzard Shad	Lake
	Cyprinus carpio	Common Carp	Lake
Mussels			
Allen & Defiance	*Dreissena polymorpha*	Zebra Mussel	Lake, River

Of specific interest to the Maumee River and Lake Erie is the Asian Carp (Common Carp is one species of Asian Carp). There is currently no evidence supporting the fact that Asian Carp are in the Maumee River, however there is potential for the Carp to infiltrate the Maumee River Watershed from Eagle Marsh, a 705 acre nature preserve in south west Fort Wayne which is susceptible to flood waters from the Wabash River Watershed, in which Asian Carp currently inhabit. Several plans have been drawn up to prevent Asian Carp from reaching the Maumee River watershed via the Eagle Marsh, but no final decisions have been made at the time of this document being written. More information on the plan to prevent Asian Carp from invading the Great Lakes Region can be found at http://glmris.anl.gov/.

2.12 Summary of Watershed Inventory

All of the elements described above, when combined, can provide a larger picture of how the watershed functions and what activities may pose a greater threat to our water resources. This section will summarize the characteristics of the project area and describe how they relate to each other. This will be examined more closely in subsequent sections.

The predominant land use in the UMRW is agriculture due to the fertile soils, much of which used to be wetlands as can be seen by the amount of hydric soil present within the watershed (Figure 2.5, page 21). Hydric soils are not ideal for agricultural use due to the frequency of ponding and/or flooding. When soils are over saturated, excess nutrients and animal waste often wash off the field and may discharge directly into surface waters. Many landowners

install field tiles or petition to convert open water to legal drains to be maintained by the county surveyor or engineer to prevent crop land from becoming over saturated. As can be seen in Figure 2.9 on page 27 many streams and ditches have been converted to be on regular maintenance by the County. However, this practice provides a direct means for nutrients, sediment, and bacteria to enter surface water, or depending on the depth to the water table, to groundwater resources used for irrigation or drinking water. For these reasons best management practices should be implemented on agricultural land with hydric soils, especially those using field tiles to drain the crop land.

Although only a little more than 14% of the watershed is considered developed, it is important to focus water quality improvement efforts in the urban areas. The city of Fort Wayne, population 255,824 (2010), is located at the headwaters of the Maumee River at the confluence of St. Marys and St. Joseph Rivers. Due to the high amount of impervious surfaces in Fort Wayne (refer to pages 70 and 74) and the neighboring city of New Haven, stormwater flow, carrying many urban and suburban pollutants, is on the rise and causing a problem for local water quality. The high amount of imperviousness is also the cause of the many CSO events in the watershed; 43 total outfalls into the St. Marys and St. Joseph, which flow into the Maumee River, or the Maumee River directly from Fort Wayne, three outfalls in New Haven and five outfalls in Hicksville. The City of Fort Wayne has an urban stormwater outreach program in place, along with partners including the Allen County Partnership for Water Quality and the Allen County SWCD. The City of Fort Wayne also offers Rain Garden installation classes and has a gutter-downspout disconnect program. However, more education and outreach events that reach further than the City of Fort Wayne and New Haven are essential for preventing polluted stormwater runoff from urban areas. There are also a multitude of urban best management practices that can be installed that will help to prevent urban pollution from running off the land in excessive stormwater flow and Low Impact Design should have a greater focus in the urban areas with intense development to help prevent an increase in stormwater from reaching combined sewers and decrease the number of CSO events.

There are few soils in the UMRW that are considered HEL or PHEL, as can be seen in Figure 2.4 on page 19. Even though less than 10% of the soils in the watershed are considered to be erodible, special precautions should be taken by those producers working HEL and PHEL land to limit the amount of soil erosion. As soil erodes, it can increase stream and lake sedimentation. The eroding soil particles often carry nutrients that bind to the particles to open water sources as well. This may cause an increase in phosphorus and nitrogen levels within the water system, leading to unsuitable water quality.

Since the majority of the land use in the UMRW is agriculture, specifically row crops (greater than 73% of the watershed), sedimentation can have a major effect on water quality and biota. Tillage data collected by each county in the watershed indicates a relatively fair adoption of conservation tillage practices. It is also clear from Table 2.6 on page 39 that the number of acres that qualify as no-till has declined 5% for beans, though has increased 11% for corn between 2006 and 2012. It appears that many of those fields have been switched to mulch or strip till, which is still a form of conservation tillage. Conservation tillage requires a minimum of

30% residue cover on the land. This decreases the potential for soil erosion, decreases soil compaction, and can save the producer time and money by minimizing the number of passes made on each field while preparing for the next planting season.

There are seven populated areas that are wholly within the UMRW, as well as the eastern half of the City of Fort Wayne and the most western edge of Defiance, OH. All of the above mentioned towns are served by a centralized sewer system, as well as some smaller populated areas such as neighborhoods and trailer parks. However, much of the watershed, approximately 85% is rural and therefore, many homes utilize on-site sewage treatment for their household effluent. While accurate estimates of the number of failing or failed septic systems could not be obtained for much of the project area, the estimates that were provided clearly identifies failing septic systems are a true issue in the watershed. The USDA soil survey for Allen, DeKalb, Defiance and Paulding counties lists less than 3% of the soil in the project area as being suitable for on-site sewage treatment as can be seen in Figure 2.6 on page 22. These two facts may lead one to believe that bacteria contamination, and excessive nutrients found within the water samples may be partly due to improperly sited septic systems and/or failing systems.

The majority of the major population centers obtain their drinking water from surface waters; Fort Wayne and New Haven from the St. Joseph River, and Antwerp, Cecil and Defiance from the Maumee River. However, Woodburn, Hicksville, and Sherwood obtain their drinking water from wells. Hicksville and Sherwood obtain their drinking water from the MICHINDOH aquifer which lies under the portion of the UMRW in DeKalb and Defiance Counties, and a small portion of Allen County, as can be seen in Figure 2.14 on page 36. Field tiles and improperly placed or faulty septic systems can seriously affect the integrity of the aquifer to be used for drinking water as the contaminated effluent may not be entirely filtered as it percolates through the soil. Leaking underground storage tanks can also pollute groundwater contaminating drinking water with various harmful chemicals. For this reason, special precautions must be taken to ensure that the watershed's drinking water source is not polluted.

As stated earlier, the majority of the land within the project area is used for agriculture and many of the wetlands that were once present have been drained for pasture land or row crops such as the Great Black Swamp as can be seen in Figure 2.10 on page 28. Wetlands play an important role in our ecosystem, not only as flood water traps and pollution sinks, but also as prime habitat for many of the species listed as endangered or threatened. For instance, the Indiana Bat, Copperbelly Water Snake, and Massasauga Rattlesnake all prefer the habitat provided by wetlands. Forest land, much of which has been cleared for agriculture, is also a vital habitat for endangered species, such as the Indiana Bat. Leaving some agricultural land fallow and replanting the fields with native vegetation to allow the landscape to return to forest or wetland will provide more vital habitat for those endangered and threatened species. Many of the strategic and comprehensive planning efforts by local governments and interest groups have made goals for conserving and protecting natural areas including *Plan-It Allen, City of Defiance Strategic Plan, Defiance Comprehensive Plan, and the WLEB Partnership Strategic Plan*.

Table 2.21, below, links those concerns that stakeholders from the public meetings had regarding the project area and water resources, to evidence found during the initial project area inventory. More evidence will be provided in subsequent sections at the 12 digit HUC level.

Table 2.21: Stakeholder Concerns and Evidence found for Concerns

Concerns	Evidence	Potential Problems
Flooding	All riparian areas of the Maumee River are considered to be high risk for flooding in IN and are considered to be located within the 100 year floodplain in OH. All incorporated areas within the watershed are located partially within a floodplain. Several log jams, which often contribute to flooding were observed during the windshield survey. Three major floods have taken place within the watershed over the past decade.	Sedimentation, impaired biotic community, heavy metals and other toxic chemicals, and nutrients
Log Jams	Six log jams were observed during the windshield survey.	Sedimentation and flooding
Stream Bank Erosion	Many population centers including Fort Wayne, New Haven, Antwerp, Cecil, and Defiance are located along the banks of the Maumee which can contribute to streambank erosion due to the increase in stormflow resulting from the high amount of impervious surfaces in those areas. Nearly 10% of the watershed, specifically farm land in the northern portion of the watershed is considered PHEL or HEL which when conventionally farmed can increase streambank erosion.	Sedimentation, turbidity, and impaired biotic community
Lack of Riparian Buffer	Nearly 535 miles of stream/ditches are under regular maintenance by the county surveyors. These legal drains are typically cleared of woody vegetation to allow easy access for heavy equipment to the ditch. The Indiana Bat, Copperbelly Watersnake, Eastern Massasauga, and Bald Eagle, all listed on the endangered species list; rely on habitat often associated with riparian areas, indicating a possible loss of habitat.	Sedimentation, turbidity, temperature, and impaired biotic community
Recreational Opportunities and Safety	There are only three boat launches managed by the DNR located within the Upper Maumee River Watershed. There is one canoe launch at Moser Park managed by New Haven. There are a total of six parks in the watershed that are located near the river, however there is limited access for fishing, boating and general recreating on the river.	Lack of action to conserve and preserve the river.

Concerns	Evidence	Potential Problems
Segmented/Lack of Forested Areas	Only 4.92% of the watershed is classified as forested. The land use map on page 38 shows how segmented the forested areas are. There are three species on the endangered species list for the four counties of the UMRW that rely on forested areas for their habitat and the continued segmentation of their habitat may have contributed to them being listed.	Impaired Biotic Community, and decreased wildlife habitat, including endangered and threatened species
Lack of Water Education/Outreach	There was not an organization focused solely on the Upper Maumee River Watershed until the Upper Maumee Watershed Partnership was formed in 2009. As per State law each CSO community must develop a plan to educate the public on water quality and stormwater management. Those communities include Fort Wayne, New Haven, Hicksville, and Defiance. The Allen County Partnership for Water Quality provides education and outreach on water quality issues throughout Allen County. It is not clear how much of the water quality education reaches the public.	Increase in nonpoint source pollution
Rural legal drains	There are 534.35 miles of ditches managed by the county regulating agency. Several streams and ditches have been dredged and straightened.	Nutrients, pesticides, sediment, turbidity, impaired biotic community
Combined Sewer Overflows	Fort Wayne has 43 CSOs discharging to the St. Joesph, St. Marys, and Maumee Rivers, all of which eventually flow to the Maumee River. 13 of those 43 CSOs discharge into the Maumee River. New Haven has three CSOs and Hicksville has five CSOs.	Sedimentation, *E. coli*, impaired biotic community, turbidity, nutrients
Need for Wetland Protection / Restoration	59% of the soils in the watershed are classified as hydric by the NRCS which is likely due to a large portion of the Great Black Swamp that was located within the Ohio portion of the watershed. The Ohio DNR estimates that 90% of the wetlands in Ohio have been drained and converted to farm land as currently only 3% of the watershed is classified as wetland.	Sedimentation, impaired biotic community, turbidity, nutrients, flooding

Concerns	Evidence	Potential Problems
Increase in Impervious Surfaces	Plan-It Allen, City of Defiance Strategic Plan, Defiance County Comprehensive Plan, Woodburn Strategic Plan, DeKalb County UDO and Comprehensive Plan all have increasing business and industry as a goal, as well as increasing navigability of the towns and counties. Due to the depressed economy, construction has been on the decline over the past decade, however current housing and building trends indicate construction may be on the rise again soon which will increase impervious surfaces.	Oil and grease, sediment, nutrients, increase in combined sewer overflows
Urban Contamination Sites	There are 19 NPDES permitted facilities, six brownfields, one superfund site, and 131 leaking underground storage tanks located within the UMRW.	Oil and grease, heavy metals, and other toxic chemicals, impaired biotic community
Need for More Water Quality Studies/Planning Efforts	There was only one previously written watershed plan which included the Upper Maumee River Watershed, however none have been written specific to the Upper Maumee Watershed alone. The US Army Corp of Engineers wrote a management plan to provide watershed, city, and county planners with a tool to help restore, protect, and promote sustainable uses of water resources and the surrounding land within the Western Lake Erie Basin.	Lack of action to conserve and preserve the river.
Increasing Hypoxic Zone in WLEB	Federal interest in the Great Lakes has begun to move toward Lake Erie due to the growing algal bloom along the Western Lake Erie coast.	DRP, sedimentation, impaired biotic community, blue green algal blooms
Increase in Dissolved Reactive Phosphorus	DRP from the Maumee River is known to be a contributing factor to the increasing hypoxic zone in the WLEB.	Increase in WLEB hypoxic zone and algal blooms, and impaired biotic community

Concerns	Evidence	Potential Problems
Fish and Wildlife Habitat	There are nine species of fish, wildlife, and birds on the federal endangered species list. There are 46 invasive species of fish, mussels, and vegetation found within the four counties of the UMRW which can use up resources and take over prime habitat that indigenous species rely on.	Lack of vegetative stream buffers and riparian corridors, fragmented landscape, and an increase in pollution entering the water
Soil Erosion and Sedimentation	Nearly 10% of the project area has soil considered to be PHEL or HEL and most of it is located on the northern portion of the watershed which is predominantly farm land. There are six species of mussel listed on the endangered species list. It is common for sediment to cover the stream floor thus suffocating mussel habitat.	Sedimentation, turbidity, and impaired biotic community
Unbuffered Tile Inlets	A specific inventory of tile inlets was not conducted.	Sediment, nutrients, pesticides
Structures within Floodplain	The entire UMRW is at some risk of flooding, though the area directly adjacent to the Maumee River in Indiana is considered to be at high risk of flooding which includes Fort Wayne and New Haven. Woodburn is surrounded by streams that are at a high risk of flooding. The land directly adjacent to the Maumee River, and many of its tributaries in Ohio are considered to be within the 100 year flood plain. Antwerp, Hicksville, Sherwood, and Defiance are all located within the 100 year floodplain.	*E. coli*, heavy metals, other toxic chemicals, sediment

Concerns	Evidence	Potential Problems
Failing or Straight pipe Septic Systems	The Allen County Health Department estimates that nearly 9,000 (50%) of the septic systems in Allen County are, or are at risk of failing. It is estimated that 25%-30% of the septic systems in Ohio are failing. 96% of the watershed soils are considered to be very limited, and 1% of the soils are considered somewhat limited for the placement of septic systems, leaving less than 3% of the watershed suitable for the placement of on-site waste disposal.	*E. coli*, nutrients, sediment, turbidity
Storm Water Control	There have been three major floods in the Maumee River Watershed within the past decade. There are Long Term Control Plans (LTCPs) in place in Fort Wayne, New Haven, Hicksville, and Defiance to separate sewers and to educate the public on storm water control methods. The number of CSO events have not decreased within the CSO communities since the development of the LTCPs	Sediment, turbidity, nutrients, *E. coli*, flooding
Decrease in Desirable Fish Species	There are no fish on the Federal endangered species list within the UMRW (Table 2.19), though there are 21 species of fish listed on the Indiana and/or Ohio State Endangered Species list. There are four species of invasive fish that can be found within the four counties of the UMRW.	Impaired Biotic Community
Rivers / Streams / Watershed Listed as "impaired" by Regulating State Agency	The list of waters deemed impaired by OEPA and IDEM are outlined in Tables 3.2 and 3.3.	*E. coli,* nutrients, sediment, impaired biotic community
Barnyard Runoff into Surface Water	There are 13 CFOs (CAFFs) with the potential to produce barnyard runoff. Nearly 4.2% of the watershed land use is considered to be pasture/hayland which would indicate the presence of livestock in those areas which could potentially result in barnyard runoff into surface waters.	*E. coli*, nutrients, sediment
Livestock Access to Open Water	Nearly 4.2% of the watershed land use is considered to be pasture/hayland which would indicate the presence of livestock in those areas which could potentially result in manure runoff into surface waters.	*E. coli,* nutrients, sedimentation, turbidity, impaired biotic community

3.0 Watershed Inventory by Sub-watershed

3.1 Water Quality Data

An important aspect of the watershed planning process is to examine current water quality data, as well as historic data to understand the issues present in the watershed. The historic data, some of which has been collected for decades, though only data collected since 2003 will be presented in this WMP, will provide a baseline in which to compare the data collected by the UMRW project in 2012. The historical data of consequence (collected since 2003) was combined with the watershed assessment that was done as part of this project to characterize water quality problems and their sources and tie them to stakeholder concerns. The following sections will provide a detailed description of all water quality data that has been collected in the watershed to date.

3.1.1 Water Quality Parameters

Many organizations, including IDEM, the City of Fort Wayne, Defiance College, Ohio EPA, Heidelberg University, and the USGS, have collected water quality information in the UMRW over the past decade for a myriad of different parameters including heavy metals, herbicides, nutrients, and bacteria. The UMRW project is most interested in sediment, herbicides, nutrients, and bacteria as those parameters are often released into the water system via non-point sources. The effects of various parameters on water quality are presented below.

Ammonia - Ammonia is common in the water system as it is released in the waste of living mammals. It is also released into the water system via farmland runoff as ammonium hydroxide is used as a fertilizer for row crops. Ammonia is important to measure for two reasons: the free form of ammonia, NH3, is toxic to fish and can lower reproduction and growth of aquatic organism, or even result in death, and the nitrification of ammonia removes dissolved oxygen from the water. Measuring the amount of ammonia in the water is also a good indicator for other pollutants that may be reaching the water as well. Due to the toxic nature of too much ammonia in the water, the state of Indiana has set a standard of between 0 and 0.21 mg/L, dependent on temperature.

Atrazine - Atrazine is one of the world's most used pesticides by row crop producers to control weeds. Atrazine is a highly soluble chemical that is not easily broken down in water. It has been shown that high levels of atrazine can cause some aquatic animals to become sterile, hermaphroditic, or even convert males to females. There is still debate in the scientific world as to whether or not atrazine can cause cancer in humans. But people who consume water containing high levels of atrazine over an extended period of time have been noted as presenting with cardio vascular problems. For these reasons the US EPA has set the Maximum Contaminant Level (MCL) for atrazine at 3 parts per billion (ppb).

Alachlor - Alachlor is an herbicide used predominantly on corn, sorghum, and soybeans to control annual grasses and broadleaf weeds. Alachlor is used regularly by producers within the Upper Maumee River watershed. It has been shown that people drinking water containing excessive amount of alachlor may present with eye, liver, kidney, or spleen problems. They may also experience anemia and an increased risk of getting cancer. For these reasons the US EPA has set the MCL for alachlor to be 2 ppb.

Metolachlor - Metolachlor is a pre-emergent grass weed herbicide that is effective on corn, soybeans, sorghum, peanuts, and cotton fields. While the product is very effective, its use is on the decline due to the deleterious effects it may have on organisms. Metolachlor has been shown to be a cytotoxin (toxic to cells) and a genotoxin (a toxic substance that damages DNA). The US EPA gave metolachlor a category C rating meaning that there is limited evidence showing it to be a carcinogen. However, the US EPA has given metolachlor a health advisory level of 52.5 ppb in drinking water. The UMRW steering committee decided to use the target of 50 ppb which is the Canadian drinking water standard for Metolachlor.

Dissolved Oxygen - Dissolved oxygen (DO) is the measure of oxygen in the water available for uptake by aquatic life. Typically, streams with a DO level greater than 8 mg/L are considered very healthy and streams with DO levels less than 2 mg/L are very unhealthy as there is not enough oxygen to sustain aquatic life. DO is affected by many factors including; temperature - the warmer the water the harder it is for oxygen to dissolve, flow –more oxygen can enter a stream where the water is moving faster and turning more, and aquatic plants – an influx of plant growth will use more oxygen than normal which does not leave enough available DO for other aquatic life, however photosynthesis will add oxygen to the water during the day. Thus, DO levels may change frequently when there is excessive aquatic plant growth. Excessive amounts of suspended or dissolved solids will decrease the amount of DO in the water. The state of Indiana has set a standard of at least an average of 5 mg/L per calendar day, but not less than 4 mg/L of DO for warm water streams. The US EPA recommends that DO not exceed 9 mg/L so as to avoid super-saturation of DO in the water system.

Temperature - As mentioned above, temperature can affect many aspects of the health of the water system. Water temperature is a controlling factor for aquatic organisms. If there are too many swings in water temperature, metabolic activities of aquatic organisms may slow, speed up, or even stop. Many things can affect water temperature including stream canopy, dams, and industrial discharges. The state of Indiana has set a standard for water temperature (which may be found in 327 IAC 2-1-6) depending on if the waterbody is a cold or warm water system.

Escherichia coli - *E. coli* is a bacteria found in all animal and human waste. *E. coli* testing is used as an indicator of fecal contamination in the water. While not all *E. coli* is harmful, there are certain strains that can cause serious illness in humans. *E. coli* may be present in the water system due to faulty septic systems, CSO overflows, wildlife; particularly geese, and from contaminated stormwater runoff from animal feeding operations. Due to the serious health risks from certain forms of *E. coli*, and other bacteria that may be present in water, the state of Indiana has developed the full body contact standard of less than 235 CFU/100 ml of *E. coli* in

any one water sample and less than 125 CFU/100 ml for the geometric mean of five equally spaced samples over a 30 day period.

Total Kjeldahl Nitrogen - TKN is the sum of organic nitrogen, ammonia, and ammonium. High levels of TKN found in water is typically indicative of manure runoff from farmland or sludge discharging to the water from failing or inadequate septic systems. The level of TKN in the water is a good indicator of other pollutants that may be reaching the water. The US EPA recommends a target level not to exceed 0.076 mg/L.

Turbidity -Turbidity is the measure of the cloudiness of the water which may be caused by sediment or an overgrowth of aquatic plants or animals. High levels of turbidity can block out essential sunlight for submerged plants and animals and may raise water temperatures, which then can decrease DO. Sediment in the water causing it to be turbid can clog fish gills and smother nests when it settles, thus affecting the overall health of the aquatic biota. Turbid water may be caused from farm field erosion, feedlot or urban stormwater runoff, eroding stream banks, and excessive aquatic plant growth. The US EPA recommends that the turbidity in the water measure less than 10.4 NTUs.

pH - pH is the measure of a substance's acidity or alkalinity and is an important factor in the health of a water system because if a stream is too acidic or basic it will affect the aquatic organisms' biological functions. A healthy stream typically has a pH between 6 and 9, depending on soil type and substances that come from dissolved bedrock. pH can also change the water's chemistry. For example, a higher pH means that a smaller amount of ammonia in the water may make it harmful to aquatic organisms and a lower pH may increase the amount of metal present in the water as it will not dissolve as easily. For these reasons, the state of Indiana has set a standard for pH of between 6 and 9.

Total Suspended Solids - Total suspended solids (TSS) is a measure of particulate matter in a water sample. TSS is measured by passing a water sample through a series of sieves of differing sizes, drying the particulate, and weighing the dried matter. The amount of Total Suspended Solids (TSS) in the water system will have the same type of deleterious effect on water quality as mentioned above under turbidity including, debilitating aquatic habitat and life, and carrying other pollutants to the water such as fertilizers and pathogens. The Michigan state code has set a standard for TSS to be equal to or lesser than 20 mg/L, and the Indiana state code standard for TSS is equal to or lesser than 30 mg/L. Based on this knowledge and other available studies on TSS concentrations, a target of 25 mg/L has been set for this project.

Total Dissolved Solids - Total dissolved solids are all dissolved organic or inorganic molecules that are found in the water. The difference between TDS and TSS is that TSS cannot pass through a sieve of 2 micrometers or smaller. So, the lower the TDS measurement in the water sample the purer the water is. TDS is a measurement of any pollutant in the water including salt, metal, and other minerals. The IN state code has a standard of <750 mg/L to maintain a healthy aquatic ecosystem.

Phosphorus - Phosphorus is an essential nutrient for aquatic plants however, too much phosphorus can create an over growth of plants which can lower the DO in a water system and decrease the amount of light that penetrates the surface thus killing other aquatic life that depends on these for survival. Some types of aquatic plants that thrive when phosphorus levels are high, such as blue-green algae, are toxic when consumed by humans and wildlife. Excessive amounts of phosphorus have also been found in ground water thus increasing the bacteria growth in underground water systems. Phosphorus can reach surface and ground water through contaminated runoff from row crop fields, and urban lawns where fertilizer has been applied, animal feeding operations, faulty septic tanks, and the disposal of cleaning supplies containing phosphorus in landfills or down the drain. The state of Indiana has set a target of 0.3 mg/L of total phosphorus (under certain conditions) in a water sample to list a waterbody as impaired on the state's impaired water list as required by the CWA § 303(d), often referred to as the 303(d) list. Though, the OEPA has set a standard of 0.08 mg/L in warm water headwater streams and a standard of 0.3 mg/L for large rivers. The UMRW steering committee decided to use OEPA's target of 0.08 mg/L for all tributaries and 0.3 mg/L for samples taken from the mainstem.

Dissolved Reactive Phosphorus (DRP)/Ortho-Phosphate – DRP is another form of phosphorus that is readily available for plant uptake once it reaches open water as it does not bind to soil particles. It is often considered the limiting factor to algae growth, which is a major concern throughout the natural resources world for the Upper Maumee River Watershed and the Western Lake Erie Basin. There has been an increase in algal blooms in Lake Erie, as well as an increase in DRP found throughout the WLEB. DRP can come from a variety of sources including point source dischargers and non-point sources. The North Carolina State University recommends concentrations of DRP be less than 0.05 mg/L in water samples to maintain a viable aquatic ecosystem.

Nitrite - Nitrites are highly toxic to aquatic life and also toxic to humans, especially babies, if consumed in excessive amounts. Nitrites can cause shortness of breath and blue baby syndrome, which can lead to death in babies which is of great concern to those individuals who acquire their drinking water from wells. Nitrites are commonly found in the water system in trace amounts because nitrite is quickly oxidized to nitrate. However nitrites can be introduced in excessive amounts from sewage treatment plants if the oxidation process is interrupted, from farm field runoff, animal feeding lot runoff, and faulty septic systems. For the harmful health effects mentioned above, the state of Indiana adopted the US EPA MCL standard of less than 1 mg/L of nitrite in drinking water which can be found in 327 IAC 2-1-6.

Nitrate - Nitrates can have the same effect on the water system as phosphorus, only to a much lesser degree. Nitrates can be found at levels up to 30mg/L in some waters before detrimental effects on aquatic life occur. However, due to the fact that infants who consume water with nitrate levels exceeding the US EPA MCL of 10 mg/L can become ill, nitrates in drinking water should be of particular concern to people who use wells as their drinking water source. The most common sources of nitrates are from fertilizer runoff from row crop fields, faulty septic

systems, and sewage. The UMRW steering committee has decided to use the US EPA reference level for nitrates in the water system, which is set at 1.6 mg/L.

Macroinvertebrate Index of Biotic Integrity - The Macroinvertebrate Index of Biotic Integrity (mIBI) is used as an indicator of water quality. Macroinvertebrates are collected from the water system and classified down to the genus level. The number and type of macroinverbrates found show the overall health of the water as some macroinvertebrates can only survive when little to no contaminants are present. The UMRW steering committee set a target of the index ranking to be greater than 23 based on the Hoosier Riverwatch method of collecting and ranking samples. Hoosier Riverwatch ranks macroinvertebrates as follows; >23 = excellent, 17-22 = good, 11-16 = fair, <10 = poor.

Citizens Qualitative Habitat Evaluation Index - The Qualitative Habitat Evaluation Index is another method used to determine the quality of a waterway. Various aspects of aquatic habitat are evaluated including in-stream habitat and the surrounding land use, to determine the waterways ability to support aquatic life such as fish and macroinvertebrates. A score greater than 61 is considered to be a stream that fully supports aquatic life, and a score between 51 and 61 is considered a stream that partially supports aquatic life.

3.1.2 Water Quality Targets

When the above parameters are combined a greater picture of the overall quality of the waterway can be gleaned. For the purpose of interpreting inventory data and defining problems, target values were identified for water quality parameters of concern by the UMRW steering committee (Table 3.1). It is important to note that the same parameters were not analyzed by each entity that collected water quality samples.

Table 3.1: Water Quality Targets

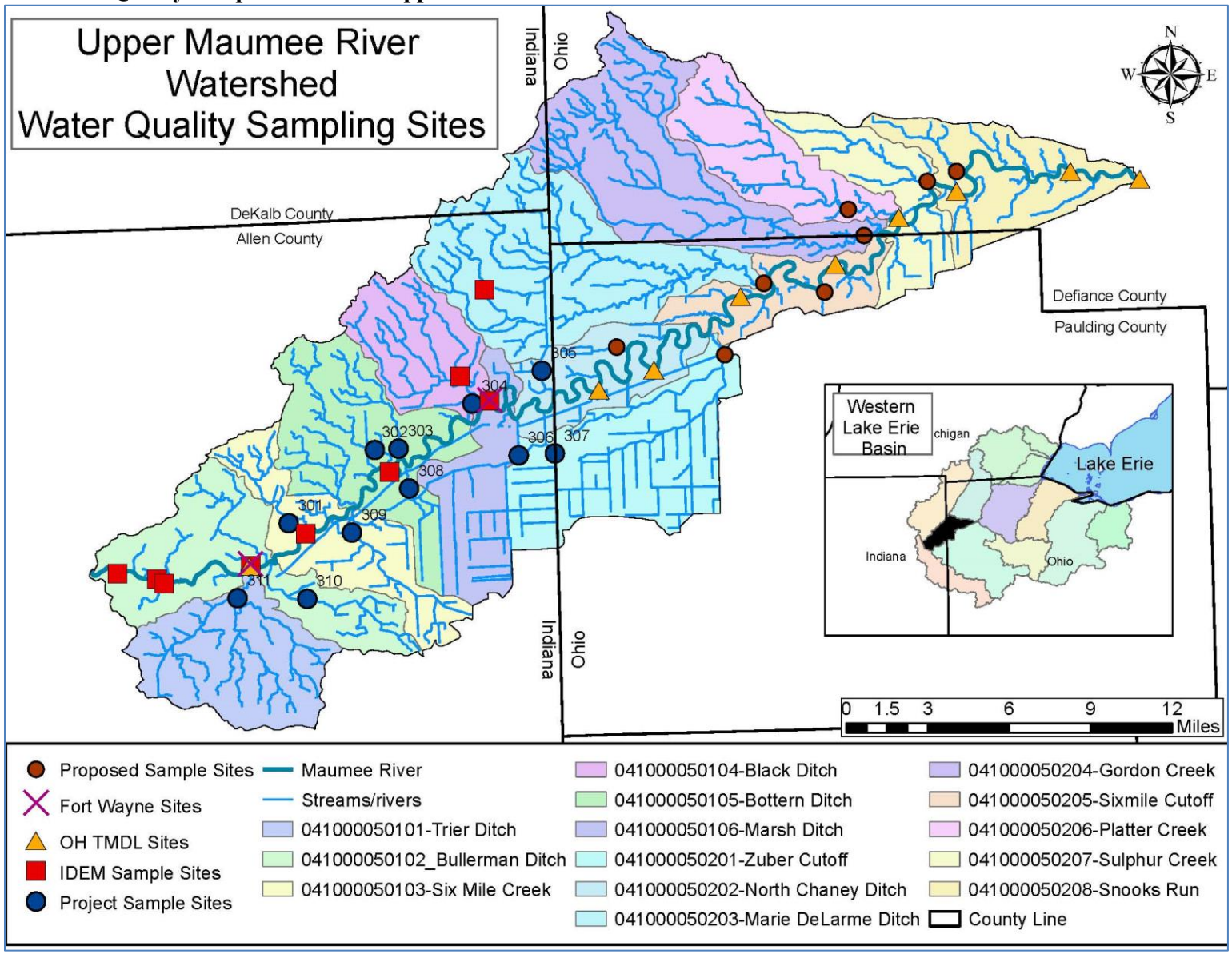
Parameter	Target	Source
Atrazine	< 3.0 ppb	US EPA drinking water MCL
Alachlor	< 2 ppb	US EPA drinking water MCL
Metolachlor	< 50 ppb	Canadian drinking water std
Dissolved Oxygen	>5mg/L but not < 4 mg/L and not > 9 mg/L (EPA recommendation)	327 IAC 2-1-6
Temperature	4.44 - 29.44 degrees C	327 IAC 2-1-6
Escherichia Coli	235 CFU/100 ml (single sample) or 125 CFU/100 ml (geo mean-5 equally spaced samples over a 30 day period)	327 IAC 2-1.5-8
Turbidity	< 10.4 NTU	US EPA recommendation (2000)
pH	> 6 and < 9	327 IAC 2-1-6
Total Suspended Solids	< 25 mg/L	Based on Rule 50 of MI water quality standards and 327 IAC 2-1-6
Total Dissolved Solids	< 750 mg/L	327 IAC 2-1-6
Total Phosphorus	< 0.08 mg/L – Tributaries < 0.30 mg/L - Mainstem	Ohio State Standard 327 IAC 2-1.5-8
Dissolved Reactive Phosphorus	< 0.05 mg/L	North Carolina State University Recommendation
Total Ammonia	< 0.21 mg/L depending on temperature	327 IAC 2-1-6
Nitrite	< 1 mg/L	327 IAC 2-1-6
Nitrate + Nitrite	< 1.6 mg/L	US EPA reference level (2000)
Total Kjeldahl Nitrogen (TKN)	< 0.591 mg/L	US EPA recommendation (2000)
Macroinvertebrate index of biotic Integrity	>23 points = Excellent 17-22 points = Good 11-16 points = Fair <10 points = Poor	Hoosier Riverwatch (2011)
Citizen's Qualitative Habitat Evaluation index	100-114 points = Exceptional > 60 points = Adequate	Hoosier Riverwatch (2011)

3.2 Water Quality Sampling Efforts

A variety of water quality assessment projects have been completed within the UMRW. These include the Indiana and Ohio Integrated Report monitoring, the IDEM Watershed Assessment and Planning Branch studies, the OEPA Total Maximum Daily Load (TMDL) project, the City of Fort Wayne monitoring program, and the Allen County SWCD's assessment performed as a part of this project. A summary of each study's methodology and general results are discussed below. Subsequent sections detail specific study information as it relates to each sub-watershed. Figure 3.1 displays all the historic sampling locations in the project area, the project sampling locations and the proposed sites that the Defiance County SWCD has selected as ideal locations to do water quality testing once funding is made available. Note that the sample sites with numbers associated with them are sample locations of the Allen County SWCD's and the only sites that have assigned labels.

The OEPA TMDL study sample sites are along the main stem of the Maumee River only. Therefore, we will extrapolate data from those sites to better understand the impact of NPS from a group of sub-watersheds rather than presenting each sub-watershed on its own. This process will be described in more detail in Section 3.3.

Figure 3.1: Water Quality Sample Sites in the Upper Maumee River Watershed



3.2.1 IDEM and OH EPA Integrated Reports

Each state is required to perform water quality analysis of its surface waters and report their findings to EPA in a report called the "Integrated Report" (IR) on a biannual basis, as mandated by the CWA§305(b). Prior to compiling the IR, a list of water bodies that do not meet state standards is developed as mandated by the Clean Water Act section 303(d). This has become commonly known as the 303(d) list. Many stream segments located within the UMRW are listed on the 2012 IDEM 303(d) list of impaired waters for *E. coli,* impaired biotic community, and PCBs in fish tissue. IDEM's 2012 IR can be found at http://www.in.gov/idem/nps/2639.htm. Ohio's 2012 IR has also been approved by the US EPA and shows that the entire portion of the UMRW project area located within Ohio is impaired for Aquatic Life use. The OEPA's Integrated Report can be found at http://www.epa.ohio.gov/dsw/tmdl/ohiointegratedreport.aspx. A full list of those waters impaired within the UMRW, as designated by each State, can be found in Table 3.2 and Table 3.3, and a map of those listed waters can be seen in Figure 3.2.

As part of the IDEM monitoring process, water samples are analyzed for numerous substances. Those relative to this WMP include: nitrogen as ammonia, nitrate+nitrite, total phosphorus, TKN, pH, TDS, TSS, DO, turbidity, temperature, and *E. coli*. Data collected by IDEM since 2003 was analyzed and sorted for the purpose of this project.

Ohio EPA has not collected water quality data for the 303(d) list of impaired waters within the Upper Maumee Watershed since 1993. However, the OEPA has begun the process of developing a TMDL for the Western Lake Erie Basin in Ohio including the Upper and Lower Maumee River Watersheds, the Auglaize River Watershed, and the Tiffin River Watershed. The OEPA collected water quality samples in the Ohio portion of these watersheds, as well as the New Haven, IN Landin Rd. City of Fort Wayne sample site, during the spring of 2012. The parameters analyzed in the Upper Maumee River watershed that are relevant to this WMP include: TDS, TSS, nitrogen as ammonia, nitrate+nitrite, nitrite, TKN, total phosphorus, temperature, DO, pH, and *E. coli*.

The list of waters deemed impaired by OEPA and IDEM are outlined in the following Tables 3.2 and 3.3, respectively.

Table 3.2: OEPA 303(d) List for the Upper Maumee River Watershed

Assessment Unit	Assessment Unit Name	Assessment Unit Size (Sq. Mi.)	Aquatic Life	Aquatic Life Uses	Recreation	Drinking Water Supply	Human Health/ Fish Tissue	Next Field Monitoring	Projected TMDL
41000050201	Zuber Cutoff	36.9	5hx	WWH/MWH-C	3	N/A	3	2016	2019
41000050202	North Chaney Ditch	18.4	5hx	WWH/MWH-C	3	N/A	3i	2016	2019
41000050203	Marie DeLarme Creek	49	5hx	WWH/MWH-C	3	N/A	3	2016	2019
41000050204	Gordon Creek	44.2	5hx	WWH/MWH-C	3	N/A	3	2016	2019
2008 Data Merritt Ditch at Hicksville - Industrial Park, River Mile 2.3, Non-attainment for Warm Water Habitat									
2008 Data Merritt Ditch at Hicksville - near Hospital, River Mile 1.9, Non-attainment for Warm Water Habitat									
41000050205	Sixmile Cutoff	15.7	5hx	WWH/MWH-C	3	N/A	3	2016	2019
41000050206	Platter Creek	21.7	5hx	WWH/MWH-C	3	N/A	3	2016	2019
41000050207	Sulphur Creek	18.2	5hx	WWH/MWH-C	3	N/A	3	2016	2019
41000050208	Snooks Run	25	5hx	WWH/MWH-C	3	N/A	3i	2016	2019

Category Description		Sub-Category	
Category 0	No waters currently utilized for water supply		
Category 1	Use attaining	h	Historical data
		x	Retained from 2010 IR
Category 2	Not applicable in new (2010) Ohio system		
Category3	Use attainment unknown	h	Historical data
		i	Insufficient data
		x	Retained from 2010 IR
Category 4	Impaired; TMDL not needed	A	TMDL complete
		B	Other required control measures will result in attainment of use
		C	Not a pollutant
		h	Historical data
		n	Natural causes and sources
		t	Category 4A may not tell the "whole story"
		x	Retained from 2010 IR
Category 5	Impaired; TMDL needed	M	Mercury
		h	Historical data
		x	Retained from 2010 IR

WWH = Warm water Habitat; MWH-C=Modified Warm water Habitat-Channelized

Table 3.3: IDEM Consolidated List of Impaired Waters for the Upper Maumee River Watershed

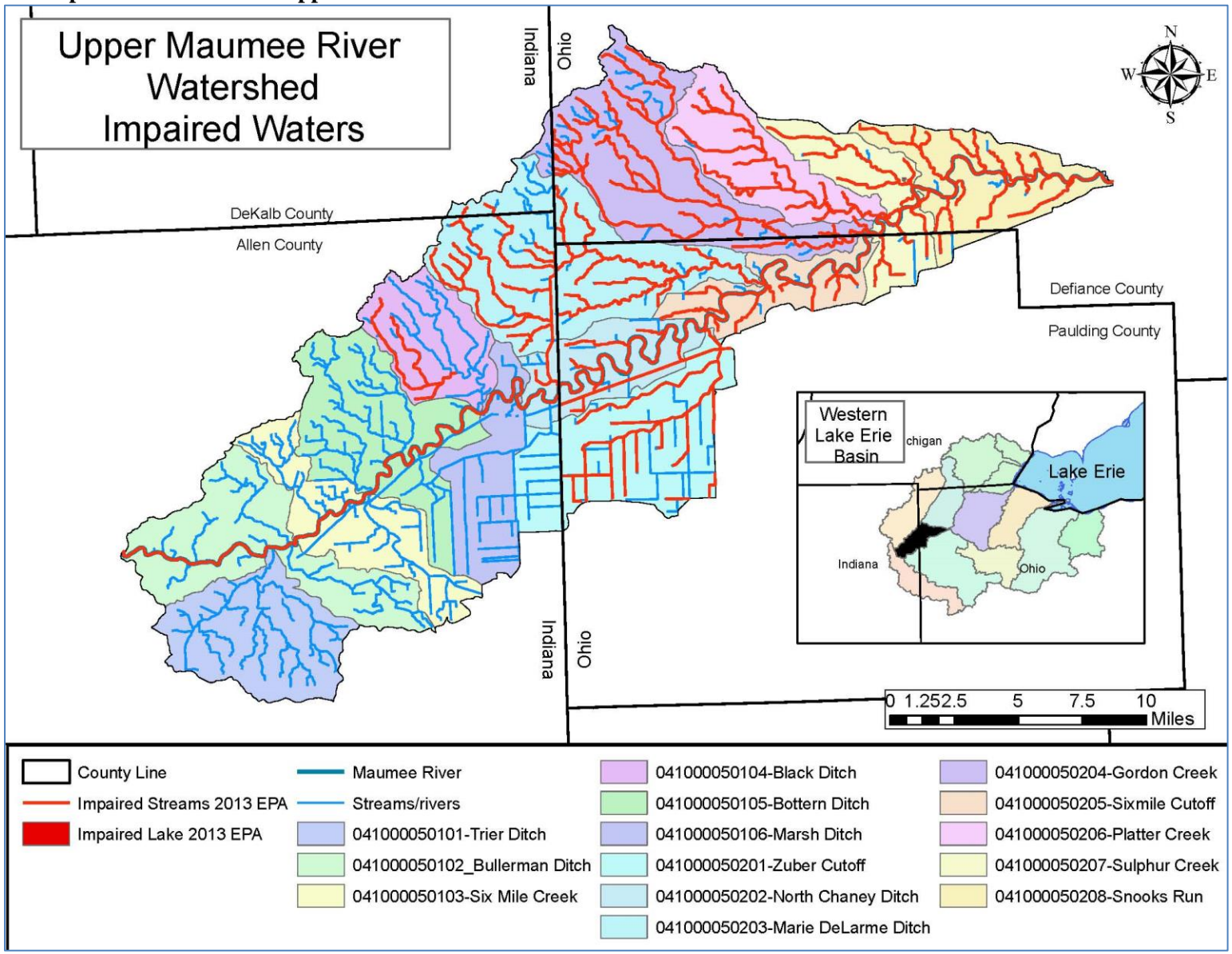
Assessment Unit	Assessment HUC	Assessment Unit Name	Aquatic Life	Recreation	Drinking Water Supply	Human Health /Fish Tissue	E. coli	Fish Tissue (PCBs)	Algae	IBC	Nutrients
INA0512_00	41000050101	SCHMIDT DITCH-COCHOIT DITCH	3	3		3					
INA0513_00	41000050101	TRIER DITCH	3	3		3					
INA0511_00	41000050102	RIVER HAVEN AND OTHER TRIBUTARYS	3	3		3					
INA0511_M1007	41000050102	MAUMEE RIVER	5A	4A		5B	4A	5B			
INA0514_00	41000050102	BULLERMAN DITCH AND OTHER TRIBUTARIES	2	3		3					
INA0514_M1006	41000050102	MAUMEE RIVER	5A	4A		5B	4A	5B			
INA0515_00	41000050102	MARTIN DITCH	3	3		3					
INA0516_00	41000050103	SIXMILE CREEK AND OTHER TRIBUTARYS	3	3		3					
INA0516_M1005	41000050103	MAUMEE RIVER	2	4A		5B	4A	5B			
INA0517_00	41000050103	GAR DITCH	3	3		3					
INA051B_01	41000050104	BLACK CREEK (HARLAN, IN)	5A	5A	5A	3	5A		5A	5A	5A
INA051B_02	41000050104	BLACK CREEK	2	3		3					
INA051B_T1001	41000050104	OBERHALTZER DITCH	3	5A		3	5A				
INA051B_T1002	41000050104	REICHELDERFER DITCH	3	5A		3	5A				
INA051B_T1003	41000050104	WARD LAKE DITCH	3	5A		3	5A				

Assessment Unit	Assessment HUC	Assessment Unit Name	Aquatic Life	Recreation	Drinking Water Supply	Human Health /Fish Tissue	E. coli	Fish Tissue (PCBs)	Algae	IBC	Nutrients
INA051B_T1004	41000050104	BLACK CREEK - UNNAMED TRIBUTARIES	3	3		3					
INA051B_T1005	41000050104	WERTZ DITCH	3	3		3					
INA051B_T1006	41000050104	SMITH-FRY DITCH	3	3		3					
INA051B_T1007	41000050104	KILLEN DITCH	3	3		3					
INA051B_T1008	41000050104	BLACK CREEK - UNNAMED TRIBUTARY	3	3		3					
INA0518_00	41000050105	SPINDLER DITCH AND OTHER TRIBUTARYS	3	3		3					
INA0518_M1004	41000050105	MAUMEE RIVER	2	4A		5B	4A	5B			
INA0519_00	41000050105	WILBUR DITCH AND TRIBUTARIES	3	3		3					
INA0519_T1008	41000050105	BOTERN DITCH AND TRIBUTARIES	2	3		3					
INA051A_00	41000050105	GROVER DITCH AND OTHER TRIBUTARYS	3	3		3					
INA051A_M1003	41000050105	MAUMEE RIVER	2	4A		5B	4A	5B			
INA051C_00	41000050106	MARSH DITCH AND OTHER TRIBS	3	3		3					
INA051C_M1002	41000050106	MAUMEE RIVER	5A	4A		5B	4A	5B			5A

Assessment Unit	Assessment HUC	Assessment Unit Name	Aquatic Life	Recreation	Drinking Water Supply	Human Health /Fish Tissue	E. coli	Fish Tissue (PCBs)	Algae	IBC	Nutrients
INA051D_00	41000050201	VILAND DITCH AND OTHER TRIBS	3	3		3					
INA051D_M1001	41000050202	MAUMEE RIVER	5A	4A		5B	4A	5B			5A
INA051E_00	41000050203	HAM INTERCEPTOR DITCH	5A	3		3				5A	5A
INA0524_00	41000050203	MARIE DELARME CREEK-TUSTISON CREEK	3	3		3					
INA05P1008_00	41000050203	RICH LAKE	3	3		3					

Category Description		Sub-Category
Category 1	Water Quality attainment for all designated uses and no use is threatened.	
Category 2	Water Quality attainment for some designated uses and no use is threatened; and insufficient data and information is available to determine if the remaining uses are attained or threatened.	
Category 3	Insufficient data and information are available to determine if any designated use is attained.	
Category 4	Waterway is impaired or threatened for one or more designated uses but does not require the development of a TMDL.	
	A TMDL has been completed that will result in the attainment of all applicable water quality standards.	A
	Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard.	B
	Impairment is not caused by a pollutant for which a TMDL can be calculated.	C
Category 5	The Water quality standard in not attained. Waters may be listed in both 5A and 5B depending on the parameters causing the impairment.	
	The waters are impaired or threatened for one or more designated uses by a pollutant(s) and require a TMDL(s).	A
	The waterbody Assessment Unit are impaired due to the presence of mercury or PCBs, or both in the edible tissue of fish collected from them at levels exceeding Indiana's human health criteria for these contaminants. The state believes that a conventional TMDL is not the appropriate approach to address these pollutants.	B

Figure 3.2: Impaired Waters in the Upper Maumee River Watershed



3.2.2 Fish Consumption Advisory (FCA)

The Indiana Department of Environmental Management, the Indiana Department of Natural Resources and the Indiana Department of Health have worked together since 1972 on a collaborative effort to compile the Indiana Fish consumption advisory. The Ohio Department of Health works in cooperation with Ohio EPA and the Ohio Department of Natural Resources to issue sport fish consumption advisories annually. It is important to note that a fish advisory on a body of water does not necessarily mean that the water is unsafe for other recreational activities.

Carp greater than 20 inches and Walleye greater than 26 inches are on the Do Not Consume list for all counties and water bodies located within Indiana. There are FCAs for several species of fish that can be found in the UMRW. The main stem of the Maumee River has a FCA advising sensitive populations to avoid eating any fish from the river and the general population should not eat fish from the river more than once every other month. Go to the Indiana State Department of Health's website for more information on Indiana's FCA. (http://www.in.gov/isdh/23650.htm). The Ohio Fish Consumption Advisory for the UMRW has the Maumee River in Defiance and Paulding counties listed for several different species of fish as well. Go to http://www.epa.state.oh.us/dsw/fishadvisory/index.aspx, for more information. Table 3.4 lists all species of fish that are on the Indiana and Ohio's FCA for the Maumee River.

Table 3.4: Fish Consumption Advisory for the Maumee River

State	Fish Species	Size Limit	Frequency for Safe Consumption	Contaminant
Ohio	Freshwater Drum	-	1X Month	PCBs
	Smallmouth Bass	-	1X Month	PCBs
	Smallmouth Buffalo	-	1X Month	Mercury and PCBs
	Common Carp	-	1X Month	Mercury
	Flathead Catfish	-	1X Month	Mercury
Indiana	All Fish in Maumee*	-	1X Month	PCBS
	All Fish in Maumee**	-	0	PCBs
	Common Carp	>20"	1X / 2 Months	PCBs
	River Redhorse	> 14"	1X / 2 Months	PCBs
	Rock Bass	>8"	1X / 2 Months	PCBs
	Shorthead Redhorse	>16"	1X / 2 Months	PCBs
	Walleye	≤21"	1X / 2 Months	PCBs
	Walleye	>21"	0	PCBs

* Advisory for the General Population unless more restrictive advisory is listed.

**Sensitive Population which includes pregnant or nursing women, women that will become pregnant, and children under 6 years old.

3.2.3 IDEM TMDL Report Monitoring

Many waters within the Upper Maumee River Watershed have been listed as impaired by IDEM for over a decade. In 2006, IDEM wrote, and was granted approval by the US EPA, a TMDL for E. coli in the Upper Maumee River Watershed. IDEM sampled two sites in the Upper Maumee Watershed at Anthony Blvd. and Landin Rd. monthly during the recreational season between the years of 2001 and 2003 and wrote the TMDL based off of the data that was gathered during that time frame. That data was excluded from this report as there is ample data available that has been collected over the past decade which will provide a better picture of what the condition of the watershed is today.

3.2.4: City of Fort Wayne Monitoring Sites

The City of Fort Wayne measures water quality at two sites within the Upper Maumee River Watershed because the City holds an NPDES permit which permits the discharge of effluent from combined sewers to the river during wet weather events. Thirteen of Fort Wayne's CSOs are upstream of the Landin Rd. sampling site in New Haven. While New Haven does not do any water testing of their own, their CSO outfalls are upstream of the City of Fort Wayne's St. Rd. 101 sampling site. Samples are collected and analyzed once monthly by the City of Fort Wayne Utilities staff at the city's laboratory. The city provided this project with results of their water quality analysis from January 2002 through December 2012. Samples are analyzed for the following parameters which are of interest to this project; *E. coli*, dissolved oxygen, ammonia, pH, total phosphorus, total dissolved solids, total suspended solids, and temperature.

3.2.5: Allen County SWCD Sampling

The IDEM CWA§319 grant provided to the Allen County SWCD has funds in it that are specifically allocated to sampling water within the UMRW. Specifically, the SWCD was to collect samples at 11 sites located in the UMRW, all of which are located in Indiana only, weekly during the recreational season in 2012 and 2013. Due to time constraints of the UMRW project, only 2012 data has been analyzed for this project. Indiana University-Purdue University, Fort Wayne (IPFW) was contracted to collect water samples for analysis of nitrate+nitrite, phosphorus, TDS, turbidity, DO, *E. coli*, temperature, pH, alachlor, atrazine, and metolachlor. IPFW performed the analysis for *E. coli* and pesticide samples in their lab located on the IPFW campus, and used the Hydrolab MS5 to collect data for D.O., temperature, turbidity, and pH. Nitrate+nitrite was analyzed by Sherry Labs in Fort Wayne, IN and the City of Fort Wayne's water treatment facility performed the analysis for total phosphorus. SNRT, Inc. was contracted by the SWCD to collect flow rates twice during high flow, and twice during low flow, as well as to analyze macroinvertebrates and perform an aquatic habitat assessment using the volunteer monitoring protocol designated by the IN DNR Hoosier Riverwatch program once during the first year of the grant.