WMP
MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER

Watershed Management Plan

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER

The White River Watershed Project has received funding from the Indiana Department of Environmental Management (Office of Water Quality, Watershed Planning and Restoration Section) for developing a Watershed Management Plan for the Muncie Creek-Hamilton Ditch (HUC 12-Digit Number: 051202010111) and Truitt Ditch-White River (HUC 12-Digit Number: 051202010110) Subwatersheds. Each HUC12 watershed is located at the headwaters of the HUC10 Muncie Creek Watershed, which forms the headwaters of the Upper White River Watershed.

The Muncie Creek-Hamilton Ditch and Truitt Ditch-White River Watershed Management Plan (WMP) is intended to guide the protection and enhancement of the environment while balancing the different land uses and demands of the community on the landscape.

The Plan will address items such as:

- Education and Outreach;
- Increasing preservation, restoration, and protection;
- Increasing cooperation, coordination, and collaboration with stakeholders;
- Maintaining a solid organization to implement the guidelines of the plan.

The WMP follows the Indiana Department of Environmental Management (IDEM) requirements for watershed management plans, including sections on:

- Watershed Inventory
- Problems and Causes
- Sources and Loads
- Setting Goals and Identifying Critical Areas
- Action Register and Schedule
- Tracking Effectiveness

The WMP is intended to be comprehensive, identifying problem areas and suggesting improvement measures for water quality concerns. The Subwatersheds have various issues and concerns that need to be addressed. In order to comprehensively address some of these issues, the group will work with local stakeholders, organized as a steering committee (See Section: Organization of the WRWP) to pursue Best Management Practices that will result in the improvement of water quality within the Subwatersheds. Because of the size of the task at hand, this plan will also be used as a platform to pursue additional grants and funding for implementation of the many different measures recommended in the plan.

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WATERSHED COMMUNITY INITIATIVE

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP
CHAPTER 1

Mission and Vision of the WRWP

WMP - CHAPTER 1 - PART 1 - SECTION 1 - SUBSECTION 1

A watershed is the area of land where water drains to a single point. All precipitation that enters a watershed will move across the landscape via overland flow, eventually making its way into a variety of detention basins or river systems (e.g. lakes, rivers, groundwater, wetlands or other water bodies). We all live, work, and play in a watershed. Watersheds provide water for drinking, irrigation, agriculture, industry, boating, fishing, and swimming, and is home to a vast array of plants and animals. A healthy watershed is vital for a healthy environment, a healthy economy, and overall high quality of life. However, all the behavior and technologies we use (new buildings, land care maintenance, agriculture) have externalities that can have a negative impact on water quality.

Understanding watershed dynamics is important because they aid in tracking sources of Nonpoint Source Pollution. Storm water runoff is the major medium of these types of pollutants and storm water drainage occurs within watershed boundaries. Once we begin to understand individual watershed dynamics, we can begin to understand sources of Nonpoint Source Pollution (NPS) and recommend alternative practices commonly referred to as Best Management Practices (BMPs).

BMPs are classified into structural and non-structural (behavioral) categories. This document primarily focuses on structural BMPs as methods for mitigating land-based water quality issues. While non-structural BMP education is a crucial element in the WRWP education program, this plan serves as a guidance document in selecting and implementing structural BMPs in the Delaware County community. A list of recommended BMPs (to be funded through the WRWP cost share program) can be found in subsequent chapters.

Mission and Vision Statements

The purpose of the White River Watershed Project is to advocate Best Management Practices (BMPs) through education, demonstration and financial incentive. It is important that we implement both structural and non-structural BMPs when feasible in order to reduce negative environmental impacts, which can inhibit nature's ability to produce natural goods by endangering the health of ecosystems. By managing and improving the portion of the White River Watershed (in Delaware County), we can do our part to improve water quality in the entire White River Basin.

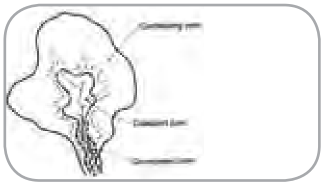
It is the mission of the WRWP to create a better awareness of water quality issues in Delaware County and to work with local landowners to develop BMPs for their properties and landholdings. The WRWP is able to exist because of its wide range of community partners and numerous volunteers and participants that share their time and expertise.

Mission: The White River Watershed Project is a citizen partnership dedicated to developing watershed management plans to improve water quality.

Vision: Our vision is that the White River will improve the quality of life of our community by safely serving its various needs, while supporting wildlife diversity.

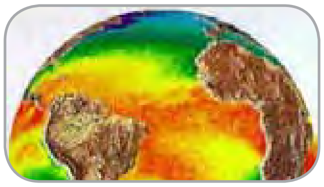
STATEMENT OF VALUES

The driving force behind the WRWP is its steering committee, which assists in identifying public concerns and Best Management Practices that are fit to solve those concerns. How these problems are identified and solved are based on the values which are held by the committee and watershed user groups. Our process of site analysis, selecting performance goals, and BMPs usually begins with the definition of these values, attitudes, and policies while understanding that people have different values in each Subwatershed or WMP area. The following values are present in our analysis of Watershed Data and subsequent recommendations.



Img. 1.1

Collection Zones
Collection Zones are the most critical areas for restoration, on site infiltration, and filtering of NPS pollutants.



Img. 1.2

Climate Change
Climate Change may lead to temperature extremes (droughts and floods) and increases in peak flow and shrink-swell dynamics.

Img. 1.3

Sediment Loss
Sediment loss is the most critical contributor to pollution, according to the Muncie Bureau of Water Quality and Hoosier River Watch.

Img. 1.4

Natural Hydrology
Stream bioengineering and biomimicry should influence design when selecting appropriate BMPs.

Img. 1.5

Creation of Habitat
Habitat is the most effective and self-sustaining water quality Best Management Practice.

Img. 1.6

Chemical Testing
Chemical Testing is important especially when combined with biological studies.

Img. 1.7

Basin planning
Basin level planning is crucial to understanding true site scale NPS pollutant sources.

Img. 1.8

Preservation
Preservation of natural resources, e.g. forests and riparian habitat (QHEI), enables functioning ecosystem services.

Values Summary

The consistent parallel in each of our values is the trust that natural systems hold the key to most of our water quality problems. Underlining this connection is a philosophy that ecosystems are capable of processing pollutants if managed properly. If we can seek to preserve existing habitat, recreate it when possible, utilize its ability to treat water, and confirm its success through biological testing we can begin to set in place the long range vision for this project.

A Public Process

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This plan was created by members of the White River Watershed Project (WRWP), a group of Delaware County stakeholders overseen by the Delaware County Soil and Water Conservation District (DCSWCD). The White River Watershed Project is a community-driven, voluntary effort to cleanup and reduce non-point source water pollution for a better quality of life in Delaware County.

The plan was created based on the premise that Watershed Planning is a critical and needed service to Delaware County. The process began with initial information gathered on the current conditions of Delaware County Subwatersheds and the eventual selection of Truitt Ditch-White River and Hamilton Ditch-Muncie Creek for the Watershed Management Planning process.

This plan outlines the initial local water quality issues and concerns gathered through public meetings, provides step-by-step methods for addressing each concern, and steers the reader toward sources that can help them implement the listed BMP suggestions. This management plan shall serve as a guide for local citizens from all sectors of the community in pursuit of Water Quality improvement.

Public Input Process

Public participation is crucial for a legitimate WMP planning process and sets the foundation for sustained community engagement. The committee consisted of representatives of over twenty different groups. Most importantly, the Muncie Bureau of Water Quality (responsible for water quality data collection and biological data analysis), Ball State University (assisted with data collection and interpretation of findings), and the Delaware County GIS Department and the Delaware-Muncie Metropolitan Plan Commission (responsible for Land Use Data creation and analysis). Other contributors range from Muncie citizens, experts, organizations, and community leaders organized through committees. These committees function as the primary method of ascertaining public concern.

The Watershed Coordinator crafted the plan with assistance from members of the general public organized through committees; therefore, this plan can be considered a product and result of a combined effort between the White River Watershed Project advisory board, subcommittees, and ultimately - Delaware County Citizens.

The Steering and Watershed Committees worked together to confirm local water quality issues and recommend strategies for voluntary action, while the DCSWCD Board reviewed all recommendations and granted final plan approval for submission to IDEM. The Technical Committees made the final plan possible by providing detailed baseline information needed to make appropriate watershed management recommendations.

The steering committee was directly involved in all aspects of the development of the plan, including input at public meetings, steering committee meetings, and completion of windshield surveys.

Initial concerns raised by the group will be explored throughout this WMP planning process. These concerns must by quantified using science and prioritized based on need and the values of the organization.

Public Meetings

There are many different methods of gaining public input – many of which have been outlined as a function of the WRWP Education and Outreach committee. The foundation of this plan was public meetings. These meetings are effective due to the presence of many participants focused on the process/strategy of Watershed Planning. Public input is essential for the sustainability and success of the watershed improvement effort. Stakeholder and public input was sought and included during all aspects of the planning process. This local input was essential for developing a plan that would have broad appeal throughout the watershed and be supported by the many different stakeholders.

Therefore, development of the White River Watershed Project Management Plan was achieved through the use of public meetings held throughout the life of the project. These included single committee sessions to large multi-committee and general public participation meetings. Each of the committees played a key role in the development of this plan.

Public meetings orchestrated by the WRWP follow a typical pattern of (1) presentation on the history and context of the WRWP (2) explanation of the watershed boundaries to be studied (3) brief discussion of the water quality issues in the community (4) discussion of concerns (5) overview of behavioral BMPs and how to get involved in future volunteer efforts.

The core public meeting for plan development was held on Monday April 27, 2009 at 6:30 pm at Minnetrista Cultural Center. A press release was printed in the Star Press on the Sunday before the meeting. Eleven people attended, the majority of which were members or former members of the WRWP steering committee. During the meeting, the public was invited to examine aerial maps and mark down areas where there are known or suspected nonpoint-source water quality issues.

The White River Watershed Project maintains a comprehensive list of water quality concerns. Most of these concerns are not specific to any particular Subwatershed. This comprehensive list can be found in Chapter 2 - Part 3 - Section 2. During the April 27, 2009 meeting, participants affirmed the existing (general) concerns and discussed issues specific to the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds. A overview of these specific concerns can be found on the following pages.

Public Input Meeting(s)

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Below is a list of concerns raised by the public for the Truitt Ditch-White River and the Hamilton Ditch-Muncie Creek watersheds during primary input meetings. Public Input Participants affirmed the existing (general) concerns held commonly by the White River Watershed Project. A comprehensive list of all concerns considered can be found in Chapter 2 Section 3 Subsection 3.

Runoff from Urban Areas
The participants noted that excessive urban runoff is present in all urbanized areas. This is often transferred through the storm water system to outfalls in the river. While there is concern over the runoff from all urbanized areas, concern over specific locations was raised by some of the participants. These locations are:

Nutrient rich runoff from Sports Complex,
Nutrient rich runoff from fertilizers used by the Delaware Country Club,
Memorial Drive ramps to IN-67, located adjacent to Truitt Ditch,
Runoff from the former Indiana Steel and Wire Company buildings,
Runoff from various parking lots sitting adjacent to Muncie Creek,
Storm water issues in Whitely area (high gradient, impermeable surfaces, etc.).

Runoff from urban areas was identified as one of the major concerns to the public. In these watersheds, additional concern over the direct runoff from recreation areas was brought up, specifically the Delaware Country Club. The main stem of Truitt Ditch runs through the Club and there are few to no filter strips present. This provides nutrients applied to the turf grass direct access to the stream.

Agricultural Conservation
Small or nonexistent buffer strips on Truitt Ditch and feeder ditches,
Lack of no-till/grassed waterways throughout both watersheds.

The lack of agricultural Best Management Practices in the Truitt Ditch watershed was brought up in the public meeting. The NRCS will be involved in identifying the areas where these practices are needed.

Ditch/Stream Erosion
General erosion of the streams and ditches was brought up as a major concern by the participants. They then identified areas in the two watersheds where this is a known problem. The following locations were identified:

Erosion of main stem of Truitt Ditch through Delaware Country Club,
Erosion on Smith Ditch, very visible from Inlow Springs Road,
Erosion of White River behind houses on Burlington drive,
Ditch erosion on Elwood Reese Ditch west of Burlington drive,
Erosion of White River banks near SR 32.

Channelized Ditches Eroding in Muncie Creek Watershed
The erosion of waterways was also identified by the public as an issue of major concern. There are two types of erosion; natural and human induced. In areas with little topography, such as Delaware County, erosion is usually the result of straightening, channelization, log jams, or other changes to the hydrology of the water body. Many of these concerns can be addressed in this plan.

Failed or Failing Septic Systems/E. coli Concerns
A concern over failing or failed septic systems in the watershed was brought up during the public meeting. It is suspected that failed or illegally hooked up septic systems are polluting the water bodies in this watershed.

Illegal Dumping Areas
Illegal and legal dumping areas, both past and present, were a concern to the public. These activities denote a general lack of education and awareness over pollution issues. There is a dumping area south of Delaware Country Club with unknown contents.

Various Illicit Dumping Areas
Former buried landfill in headwaters of Muncie Creek,
Auto salvage yards directly adjacent to Muncie Creek.

Areas where dumping has occurred, especially those directly adjacent to ditches and streams, were identified as concerns by the public. Runoff from these areas can carry pollution directly into the water bodies. This is especially true of auto salvage yards and other places where hydrocarbons can leak out of junked cars.

Partners

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Red-tail Conservancy
The Red-tail Conservancy preserves, protects, and restores natural areas and farm land in East Central Indiana while increasing awareness of our natural heritage. This not-for-profit land trust focuses on five counties to provide land conservation options to individual landowners. They also partner with local governments in restoration projects while providing land stewardship activities and education for these communities. Since 1999, the Red-tail Conservancy has protected nearly 2000 acres of natural areas and farm land and is committed to greater conservation efforts in the future.

Delaware County Office of Geographic Information
The Delaware County Office of Geographic Information manages the county's Geographic Information System (GIS). Their goals are to: maintain and update the county's GIS information databases; deliver this data to the public, private sectors, and government agencies; and provide consulting and application development for projects in the area. This data and assistance aids in making informed decisions and creating effective developments.

Upper White River Watershed Alliance
The Upper White River Watershed Alliance (UWRWA) is a 16-county organization of local governments, industries, utilities, universities, and agricultural and regional communities that improve and protect the water quality of watershed basins in the larger Upper White River Region. This organization works to better understand regional water quality patterns and target areas for restoration or protection. The UWRWA synthesizes existing data to better understand some of the social drivers affecting large-scale land use change. This alliance works together to protect vital water resources and pool their financial and technical resources.

The Muncie Sanitary District: (Bureau of Water Quality)
The Muncie Sanitary District: Bureau of Water Quality's vision is to become the principal regional watershed leader by creating resources and educational partnerships that promote, protect, and enhance the biological, chemical, and physical integrity of the White River ecosystem.

Delaware County Department of Storm water Management
The Delaware County Department of Storm water Management's vision is to create resources and educational programs that promote, protect, and enhance the biological, chemical, and physical integrity of the White River ecosystem by maintaining and promoting proper storm water techniques.

Ball Brothers Foundation
The Ball Brothers Foundation is an independent, private, philanthropic organization that is dedicated to improving the quality of life by building communities. This organization funds and supports these efforts through thorough examination and action. The Foundation applauds efforts to educate and participate in sound conservation practices, data gathering, and supporting of agricultural processes and other land usages that work in balance with a healthy economy and environment.

Cardinal Greenways
Cardinal Greenways is a private, not-for-profit organization that encompasses the Cardinal Greenway, White River Greenway, Historic Wysor Street Depot and Cardinal Equestrian Trail. The Cardinal Greenway portion is the longest rail-trail in Indiana and spans almost 60 miles from Marion through Muncie to Richmond in East Central Indiana.

The Delaware County Health Department
The Delaware County Health Department is organized for the purpose of health promotion and communicable disease prevention for the entire Delaware County community. Risk reduction and public health awareness are directed toward individuals, of all ages, to achieve optimal health. The department will facilitate programs that educate, enforce and provide services for the promotion and maintenance of a healthy environment in Delaware County.

Delaware County Soil and Water Conservation District
The Delaware County Soil & Water Conservation District provides information about soil, water, and related natural resource conservation; identifies and prioritizes local soil and water resource concerns; and connects land users to sources of educational, technical and financial assistance to implement conservation practices and technologies.

Prairie Creek: Reservoir & Park
Prairie Creek Reservoir is a man-made reservoir that provides resources for Delaware County through water, recreation, habitat, and education. The reservoir is owned by the Indiana-American Water Company, and the lands around it are managed by the City of Muncie Parks and Recreation Department. The reservoir is a secondary drinking water supply for the City of Muncie; during periods of low-flow, water is released from the reservoir into the White River, Muncie's primary water supply.

Ball State Natural Resources Club
The Natural Resources Club participates in activities to improve the environment. Their efforts in the past have included: reservoir clean-up and water quality improvement, streambed restoration and stabilization, wetland restoration and delineation, rain barrel workshop, educational programs, and much more.

Ball State Department of Natural Resources and Environmental Management
The Department of Natural Resources and Environmental Management at Ball State University promotes the educational, professional, and social interest of being stewards of the land.

Ball State Department of Biology
The Department of Biology at Ball State University promotes exploration, research, and study of nature and life.

Ball State Landscape Architecture Department
The Department of Landscape Architecture at Ball State University promotes the creation, design, and maintenance of the natural and built environment by creating safe, functional, and sustainable places for everyday life.

Ball State Geological Sciences Department
The Geological Sciences Department at Ball State University promotes the study of the composition of earth, and how best to find, use, and protect its mineral, energy, and water resources.

Delaware-Muncie Metropolitan Plan Commission (DMMPC)
The Delaware-Muncie Metropolitan Plan Commission (DMMPC) plans and approves the structure and infrastructure of the City of Muncie and the unincorporated Delaware County. This organization is responsible for all transportation planning activities.

Partners (cont.)

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Minnetrista Cultural Center
Minnetrista Cultural Center is a 40-acre, regional museum campus located along the White River in Delaware County. Their mission is to create awareness, understanding and appreciation of the natural and cultural heritage of East Central Indiana. Minnetrista serves the eight counties of East Central Indiana and beyond. Annual admissions and program participation averages 40,000 visitors, including 11,000 secondary school students. Minnetrista's wide reach into the regional community, their expertise in educational outreach, and strategic focus on eco-friendly initiatives makes them an organization focused on land and water management and stewardship, history, art, and education.

Randolph County Soil & Water Conservation District
The Randolph County Soil & Water Conservation District provides information about soil, water, and related natural resource conservation; identifies and prioritizes local soil and water resource concerns; and connects land users to sources of educational, technical and financial assistance to implement conservation practices and technologies.

Area Planning Commission of Randolph County
The Area Planning Commission oversees planning and zoning for the county and issuing Improvement Location Permits for new construction.

Purdue University Cooperative Extension Service: Randolph County
The Cooperative Extension Service is one of the nation's largest providers of scientific research-based information and education. It provides a network of colleges, universities, and the U.S. Department of Agriculture, serving communities and counties across America. Local Extension Services provide information about agriculture and natural resources, consumer and family sciences, economic and community development, and 4-H Youth programs for their particular county.

NRCS- Conservation Implementation Team and District Conservationist
The Natural Resources Conservation Service (NRCS) is dedicated to conserving natural resources on private lands. It was originally established by Congress in 1935 as the Soil Conservation Service and has expanded to become a conservation leader for all natural resources; ensuring private lands are conserved, restored, and more resilient to environmental challenges. NRCS works with private landowners through conservation planning and assistance designed to benefit the soil, water, air, plants, and animals that result in productive lands and healthy ecosystems.

Winchester Wastewater Treatment Plant
The Winchester Wastewater Treatment Plant promotes clean and efficient sanitary and storm sewers. The WWTP maintains 10 lift stations and is a 100% separate sanitary sewer system. The Plant uses a Class III conventional activated sludge treatment process.

Farmland Conservation Club
The Farmland Conservation Club participates and promotes activities that will improve the environment. The Club's mission is to promote healthy environments through preservation, conservation, and educational efforts. They seek to raise environmental awareness and concern about the local environment.

TABLE 1.1: WRWP Partners and their presence on sub-committees	
Organization(s) Represented	Sub-Committee
Red-tail Conservancy	Cost Share Sub-committee
Delaware County Office of Geographic Information	Watershed Management Planning Sub-committee
Upper White River Watershed Alliance	Outreach/Education Sub-committee
The Muncie Sanitary District: (Bureau of Water Quality)	Watershed Management Planning Sub-committee
Delaware County Department of Storm water Management	Outreach/Education Sub-committee
Ball Brothers Foundation	Cost Share Sub-committee
Cardinal Greenways	Cost Share Sub-committee
The Delaware County Health Department	Watershed Management Planning Sub-committee
Delaware County Soil and Water Conservation District	Watershed Management Planning Sub-committee
Prairie Creek: Reservoir & Park	Outreach/Education Sub-committee
Ball State Natural Resources Club	Outreach/Education Sub-committee
Ball State Department of Natural Resources and Environmental Management	Watershed Management Planning Sub-committee
Ball State Department of Biology	Outreach/Education Sub-committee
Ball State Landscape Architecture Department	Watershed Management Planning Sub-committee
Ball State Geological Sciences Department	Watershed Management Planning Sub-committee
Delaware-Muncie Metropolitan Plan Commission (DMMPC)	Watershed Management Planning Sub-committee
Minnetrista Cultural Center	Outreach/Education Sub-committee
Randolph County Soil & Water Conservation District	Watershed Management Planning Sub-committee
Area Planning Commission of Randolph County	Watershed Management Planning Sub-committee
Purdue University Cooperative Extension Service: Randolph County	Watershed Management Planning Sub-committee
NRCS- Conservation Implementation Team and District Conservationist	Watershed Management Planning Sub-committee
Winchester Wastewater Treatment Plant	Watershed Management Planning Sub-committee
Farmland Conservation Club	Outreach/Education Sub-committee

History of the WRWP

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Context

The Clean Water Act was a landmark piece of legislation that triggered a Nation-wide effort to address water pollution issues in the United States. Early application of the legislation was directed at point source pollution. Point source pollutants enter a stream directly from a pipe – most commonly from industrial processes. Amendments to the legislation added means and methods to address nonpoint water pollution, which is more diffuse and thus harder to track. Nonpoint water pollutions enter streams from storm water runoff. Out of these amendments came the 319 program, which funds states to solve nonpoint water pollution issues at the local level.

One way the State of Indiana has chosen to approach the nonpoint problem is by creating a grant program to cost-share on best management practices (The 319 Program). The WRWP administers this grant money to Delaware County. In order to most effectively distribute grant monies, WRWP has developed a management plan that identifies critical areas in the county that are in the greatest need for grant funding.

History

Impetus for the White River Watershed Project came from combined community concerns regarding local water quality, identified through a series of public meetings held in 2000 and 2001 by the Delaware County Soil and Water Conservation District. Representatives from Ball State University, local, state, and federal government, local community foundations, the agricultural community, and other local citizens met over a one year period to discuss options for addressing those concerns. Their final recommendation was to conduct a study of local watersheds and develop a community-driven, voluntary plan for protecting and improving local water quality.

From this, the White River Watershed Project (WRWP) was formed. The lead organization became the Delaware County Soil and Water Conservation District (DCSWCD) following the acquisition of an EPA Section 319 Grant in 2001. This initial three-year grant was awarded for the purpose of creating a watershed management plan that addresses local non-point source water pollution issues in the original three priority Subwatersheds. Those Subwatersheds, chosen by the community, are: Killbuck/Mud Creek, Buck Creek, and Prairie Creek Subwatersheds.

The original White River Watershed Project (WRWP) Watershed Management Plan (WMP) (developed in the first phase of the WRWP), covered three 12-digit HUC watersheds within the Upper West Fork White River Watershed in Delaware County, Indiana. The initial effort in creating this plan happened from 2001-2004. The second phase began in 2005 and was focused on implementing the recommendations from the WMP. Currently the WRWP is in its third phase of implementation, focused upon (1) updating the existing Watershed Management Plans, (2) continued implementation of the WMP, and (3) expansion into more urban locations. This management plan is a product of efforts to expand Watershed Planning into urban locations.

Updating the existing Watershed Management Plan affects the White River Watershed Project's efforts to reduce non-point source pollution. These include: updates to the 303 (d) List of Impaired Waters, the change of the EPA's use of 14 digit HUC watershed boundaries to 12 digit HUC watershed boundaries (of which only the Macedonia Creek-Buck Creek Watershed had any changes), and modifications to critical areas based on the results of the monitoring that took place during Phase Two of the WRWP.

The WRWP/Ball State Partnership

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The White River Watershed Project (WRWP) continues its ten year history in reducing non-point source pollution in Delaware County because we believe in the foundational principals of our cause: that a healthy environment is the true foundation of any healthy economic system and that proper stewardship of the natural world is the first step in the proper stewardship of our economic order.

Our objectives are to continue supplying the community with solid water quality science and land use impact analysis, provide future generations the ability to make objective land use decisions, and continuing the great environmental accomplishments we have made as a society in the past 40 years (since the Clean Water Act) - in industry, agronomy, and our household economies.

Watershed Planning, nation-wide and locally, has lead to many positive outcomes. None of the local discoveries could have been found without partnerships with various citizen groups, local foundations, and community partners in water quality including the Bureau of Water Quality, Delaware-Muncie Metropolitan Plan Commission (DMMPC), Ball Brothers Foundation, Community Foundation, and the Minnetrista Cultural Center.

Among our largest collaborators, Ball State University has consistently played a crucial role in helping us accomplish our goals by assisting in numerous and diverse ways. Faculty and students in the university's Department of Natural Resources and Environmental Management have aided our education outreach activities over the years, while also developing water quality studies in partnership with the Muncie Bureau of Water Quality.

That research, under the guidance of Dr. Hugh Brown and Dr. Jarka Popovicova, has led to a host of ecologically sound planning and environmental management strategies at Prairie Creek Reservoir. It has been a force in initiating the formulation of a long-term management plan and zoning for the reservoir, currently being implemented by Superintendant Bob Patterson.

Additional Ball State water quality research has demonstrated a reduction of E. coli contamination in the Killbuck-Mud Creek sub-watershed as the result of the 2001 Royerton Sewer project in northern Delaware County. Although there were many residential and commercial hardships in completing that project, the E. coli reduction is one positive outcome that will yield benefits to residents of the area for generations to come.

Innovative regional planning/land use classes in the Department of Landscape Architecture and Department of Geography, meanwhile, continue to use watersheds as the basis for developing theoretical land use plans that are mindful of ecological issues and concerns. The students in these projects have helped to clarify and identify key ecological resources in our community and their fresh eyes and energy have repeatedly confirmed and strengthened the values for which the WRWP and many Delaware County citizens have long stood.

Ball State Partnership (cont.)

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GIS students in the Department of Geography, under the guidance of Dr. Matt Wilson (and Kyle Johnson of the Delaware county GIS), have aided the WRWP in the development of this WMP by discovering primary sources of sediment contribution in our stream and rivers. Their research has helped to dispel commonly held notions that farm fields are the number one contributor of sediment to our rivers, and have quantified that key “hotspots” along de-vegetated stream banks can contribute up to 400 times more sediment than farm fields that are managed with contemporary conservation methods such as no-till, filter strips, grass waterways, and cover crops. Together with land use planners at the WRWP, students will be able to use this data to illustrate the historical decrease of sediment discharge of farm fields over the past 30 years as a result of these changes in land management practices.

The University has helped to offset costs through partnership and capacity building. The new techniques and technologies developed by Ball State students and faculty aid in making watershed planning ever more efficient and cost-effective. They keep our project young, relevant, and able to respond to a rapidly changing technical world. At the same time, the partnership provides students with Immersive Learning experiences, which is core to the Ball State mission.

Community partnerships such as these demonstrate the value of community groups coming together, and are celebrated state-wide as a precedent for other communities to follow. We are grateful for a vibrant volunteer community that is willing to work together on important issues that otherwise may remain unsolved or unaddressed. There is much work to be done to protect and enhance the lands on which we live, work, and play. Initiatives to learn more about human impact on the environment -- good or bad -- are not likely to cease in the foreseeable future, and great broad-based partners, like Ball State University, provide the WWRP a positive town-grown relationship.

Organization of the WRWP
WMP - CHAPTER 1 - PART 1 - SECTION 1 - SUBSECTION 9

The DCSWCD Board of Supervisors (grant holders) understood early on the importance of having broad community involvement in all aspects of the WRWP. An effective WMP is dependent on legitimate and quantifiable concerns from a wide range of citizens and professionals. The primary method of gaining this input is through public meetings (see below), but the sustained method of reporting data is through the committee structure of the organization. Without community involvement, chances of gaining broad-based community support would be slim and the successful implementation of the management plan would be in jeopardy. The following detailed description of the WRWP's organization reflects this deep commitment.

WRWP Structure
Below is the WRWP structure, listing each committee, their responsibilities, and their community representation. Some members have changed throughout the process, therefore this list represents all current and former participants.

Delaware County Soil and Water Conservation District Board of Supervisors
The DCSWCD is the legal grant holder and provides funding for the full-time Watershed Coordinator. The board is responsible for final approval on financial transactions, contracts, grant requests, and the final plan. The DCSWCD Board is represented by the agricultural community and local businesses (associate supervisors: Ball State University, Indiana Farm Bureau, agricultural community). This group provides invaluable insight and vision for the long-term success of the WRWP.

WRWP Steering Committee
The steering committee represents core individuals and organizations interested in County-Wide water quality issues. The Committee's responsibilities include overall project direction, major financial and contractual transaction recommendations to DCSWCD Board of Supervisors, and co-development of the management plan. The committee meets quarterly with monthly sub-committee meetings. Individuals involved represent the city of Muncie and other towns in Delaware County, and when possible include: neighborhood associations, environmental groups, natural resource and engineering professionals, industrial and educational entities, agricultural community, rural residential community, and the urban community.

Role of the Watershed Coordinator
The central role of the Watershed Coordinator is to bring together the vast community representation, which serve as the backbone of the White River Watershed Project, as represented above. The Coordinator provides the primary project management, working as translator of ideas and information into a common language for all to work with. Responsibilities include daily and overall project management, committee and general volunteer coordination, public outreach and education, financial management (including invoicing and bookkeeping), and writing of grants, reports, public relations documents and the Watershed Management Plan(s).

TABLE 1.2: Primary Responsibilities of WRWP sub-committees

Sub-committee(s)	Responsibilities
Watershed Planning Sub-committee	Public Input, Monitoring Analysis, GIS
Outreach/Education Sub-committee	Education/promotional Activities
Cost Share Sub-committee	Cost-share Assistance

Watershed Planning Sub-committee

WMP - CHAPTER 1 - PART 1 - SECTION 1 - SUBSECTION 10

The Watershed Planning Committee: ensures that local issues and concerns are addressed throughout the project; solicits interest and support for the project in their communities; assists with local land use identification; co-organizes local events and outreach activities; co-developes the management plan; and provides a representative to serve on the steering committee. The Watershed Committee includes: watershed citizens; the urban, rural residential and agricultural community, business owners, local governments, and educators and school administrators (primary, secondary and university).

Monitoring Analysis

Water quality monitoring is a crucial part of the watershed planning effort, providing quantitative studies to confirm public concerns about pollutants present in water resources. This quantitative data aids in the delineation of critical areas. The monitoring assists in sample site identification, historic water quality data identification, and data review and recommendation development. In Phase III, the Bureau of Water Quality has been responsible for identifying sites and monitoring on behalf of the organization. The committee has the responsibilities of continued implementation of the monitoring program, creation of the QAPP (quality assurance project plan for WRWP monitoring program), coordination of GIS based land use analysis, and the study and interpretation of monitoring program results.

GIS (Geographic Information System)Analysis

Responsibilities: creation and analysis of land use information using GIS technology; co development of GIS based land use analysis; development and maintenance of project web site; and outline development for GIS interactive web site. The GIS Committee is represented by: The Delaware County GIS Department, Muncie-Delaware Metropolitan Planning Commission, Ball State University (Geography), and the Bureau of Water Quality (city government).

TABLE 1.3: WMP Committee Chairperson

Sub-committee	Sub-committee Chairperson
Watershed Management Planning Sub-committee	Amanda Arnold

Outreach/ Education Sub-committee

WMP - CHAPTER 1 - PART 1 - SECTION 1 - SUBSECTION 11

The Education and Outreach Sub-committee is tasked with the execution of education programs that seek to: make citizens more aware of the WRWP's impacts in the community, engage the community for greater input into the WMP planning process, educate about the importance of non-structural BMPs (3) educate and demonstrate the implementation of structural BMPs, and promote the local cost-share programs available to the community. Responsibilities: co-creation of quarterly newsletter; creation and/or acquisition of outreach and education materials; development of outreach and education strategy; identification of target audiences; assist watershed committees with their outreach and education efforts.

Presentations on the Context and History of the WRWP
Sub-committee Members will work to develop a speaking engagement schedule for the calendar year. Engagements involve regional organizations and groups that have an interest in public service – especially those related to soil and water conservation. It should be emphasized that we do not limit our presentation to conservation groups. We speak with any community organization that is willing (within reason). The committee develops a list of WRWP steering committee members that are willing to speak at these events and provides them with materials and training to speak effectively.

Presence at Local "Trade show" Events
Sub-committee Members will work to develop a trade show event schedule for the calendar year. These events are primarily in Delaware County – and other opportunities are considered when they arise. The committee develops a "traveling display booth" that can easily be setup and broken down with minimal physical demands. The committee makes arrangements for the WRWP to be present at these events and arranges for these events to be staffed by WRWP steering committee members.

Public Input Meetings
Public input meetings are an important part of the Watershed Planning Process. Ascertaining the concerns of the community gives us leads for pursuing formal scientific studies of these issues and helps to broaden our understanding of larger watershed dynamics.

Educational Presentations
The core of the WRWP educational program is the Earth Team Service learning curriculum that spans 12 months and features storm water education. Each month, participants learn about a best management practice related to storm water management and tour structural BMPs. These individual presentations can also be given to local groups and at community events when desired.

Demonstration Project Tours (and Other Relevant Tours)
The Sub-committee develops a tour schedule for the calendar year. The purpose of these tours is to get interested Community Members into the field to observe previously installed Demonstration Projects and other cost-share BMPs (those that have landowner permissions).

Cost Share Promotion
We will meet with small groups of people interested in how our cost-share program can financially aid in the implementation of best management practices.

The WRWP Website

The WRWP Website aims to: channel public input into the WMP planning process, communicate elements of the WMP in accessible format, improve education and awareness of watershed issues and behavioral best management practices, and provide information for the various cost-share programs in the county. Event calendars also communicate happenings in the WMP process. The web site can be found at http://www.whiteriverwatershedproject.org

Quarterly E-mail Newsletters / Reports / Presentations

At each quarter, monthly project reports are sent to IDEM. These reports are presented to community stakeholders primarily through quarterly meetings (Power Point presentations), web site content development, and when appropriate, newsletters.

Promotional Materials

Promotional materials are created as needed to supplement all other educational efforts. Some of these materials include: cut-sheets for context and history presentation, methods to input community concerns, supplements to educational presentations, and descriptions of

TABLE 1.4: Education and Outreach Committee Chairperson	
Sub-committee	Sub-committee Chairperson
Education and Outreach Sub-committee	Colby Gray

Cost-share Sub-committee

WMP - CHAPTER 1 - PART 1 - SECTION 1 - SUBSECTION 12

Cost Share Sub-committee

The WRWP assists community members in learning more about local cost-share options – either through the WRWP or through other local programs. Landowners in Delaware County are eligible to participate in many different cost-share programs. The most commonly awarded programs are CRP, CREP, EQIP, WHIP, and CFWP. While the WRWP cost-share program is separate from these sources of funding, there are opportunities for partnership and pooling of resources. Before the WRWP awards grants out of the 319 funding, we often check to see if some of these other programs might be available for higher amounts of funding and for longer time periods. The cost-share sub-committee is primarily responsible for the implementation of cost-share promotion and strategic cost-share planning.

TABLE 1.5: Cost-share Implementation Committee Chairperson	
Sub-committee	Sub-committee Chairperson
Cost Share Sub-committee	Lorey Stinton

WATERSHED INVENTORY

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP

CHAPTER 2

WATERSHED INVENTORY PART ONE

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP
CHAPTER 2

Nonpoint Source Control Program

WMP - CHAPTER 2 - PART 1 - SECTION 0 - SUBSECTION 1

This watershed management plan is a product of the IDEM Clean Water Act Section 319 nonpoint source control program and is made possible by the various assistance given to the WRWP in collaboration with the program. The NPS program conducts training and provides technical assistance on watershed management planning and implementation and has produced valuable resources for watershed planning, such as the Indiana Watershed Planning Guide, the Indiana Water Quality Atlas (IWQA), and a community of Indiana Water Quality Groups engaged in the Watershed Management process. IDEM also employs five Watershed Specialists (WSS) who assist the NPS/TMDL Section in promoting the watershed approach by working with local watershed groups. [1]

Environmental problems often cut across political jurisdictions. Consequently, environmental mitigation and protection require a comprehensive and collaborative approach that works with a multitude of programs and agencies. IDEM is at the center of this collaborative effort. The watershed approach provides a framework for coordinating between multiple programs and leveraging limited resources. This approach focuses on water quality in a geographic area delineated by a watershed.[2]

Nonpoint source (NPS) pollution in Indiana is addressed in many ways by a number of agencies and organizations statewide. In partnership with other agencies, the IDEM Nonpoint Source Control Program leads efforts to restore waters of the state that do not meet Indiana Water Quality Standards and, consequently, are on Indiana's 303(d) List of Impaired Waters. [3]

In addition to providing tools to assist watershed management efforts, the NPS program has adopted a targeted approach to improving water quality in the state by focusing IDEM's Section 319 funds on impaired waters.

Thus, the White River Watershed Project is funded for the purposes of alleviating nonpoint source pollutant pressures on streams that do not meet current Water Quality Standards. In turn, the White River Watershed Project conducts its own water quality monitoring program which aids IDEM to a refined understanding of water quality at the watershed level. (The WRWP monitoring program is conducted by the Muncie Bureau of Water Quality). Under grant agreements, projects funded by IDEM routinely submit this data to the NPS program.

In many ways the White River Watershed Project is a local catalyst for IDEM statewide goals and objectives and concurrently, (data collected by the White River Watershed) informs IDEM's strategic water quality improvement prgram. In this way, the White River Watershed Project and IDEM are a partnership in state-wide water quality improvement.

1 Indiana's 2008 Integrated Water Monitoring and Assessment Report
2 Indiana Nonpoint Source Management Plan
3 Indiana's 2008 Integrated Water Monitoring and Assessment Report

TABLE 2.1: IDEM Assessment of Indiana Streams by Designated Usage: 305B Report, 2008				
Designated Use	Support	Non Support	Assessed	Not Assessed
Rivers (miles)				
Aquatic Life Use	13, 913	3,622	17,535	14,606
Fishable Uses	1,044	3,402	4,435	27,705
Drinking Water Supply	--	1	1	101
Recreational Use (Human Health)	3,700	8,374	12,073	20,100
Lakes and Reservoirs (acres)				
Aquatic Life Use	3,690	6,625	10,315	21,826
Fishable Uses	7,820	63,663	71,483	5,084
Drinking Water Supply	230	16,385	22,905	12,926
Recreational Use (Human Health)	21,922	983	22,905	104,662
Recreational Use (Aesthetics)	29,035	8,006	37,041	90,526
SOURCE: Indiana's 2008 Integrated Water Monitoring and Assessment Report				

The state mandated beneficial uses of water is one of the primary legislative methods for ensuring stream health above water quality standards.

Beneficial Uses at Core of Approach

Indiana's water quality standards (WQS) provide the basis for IDEM's CWA Section 305(b) water quality assessments which functions to designate the beneficial uses that Indiana waters must support. [1] Of the beneficial uses designated in the State's WQS, IDEM assesses aquatic life use support, recreational use support, and support of "fishable" uses. IDEM also assesses drinking water use support on surface waters that serve as a public water supply. [2]

Although there are additional uses designated in Indiana's WQS, IDEM limits its assessments to these four uses because the criteria in place to protect them are more stringent than those necessary to protect other uses. Thus, by protecting for these four uses, other uses such as agricultural and industrial uses are supported.[3]

The beneficial uses metric is used as a framework for this Watershed Plan Development. It provides a method for classifying concerns in the community and for creating an action plan for project implementation.

Therefore, this plan should be considered an effort to improve our streams and rivers for the purposes of human recreation and aquatic life.

1 Indiana's 2008 Integrated Water Monitoring and Assessment Report
2 Indiana's 2008 Integrated Water Monitoring and Assessment Report
3 Indiana's 2008 Integrated Water Monitoring and Assessment Report

Watersheds[1]

WMP - CHAPTER 2 - PART 1 - SECTION 0 - SUBSECTION 2

The watershed is the total area of land that drains into a particular water body (wetland, stream, river, lake, or sea). Land uses and runoff in a watershed determine the quality of surface water in smaller streams and waterways. They can then influence the water quality of larger streams. For example, point source discharges, urban runoff, runoff from landfills and runoff from agricultural areas may contain sediments, organic material, nutrients, toxic substances, bacteria or other contaminants. When these substances are present in significant concentrations, they may interfere with some stream uses.

Approximately one percent of a watershed is stream channels. The smallest channels in a watershed have no tributaries and are called first-order streams. When two first-order streams join, they form a second-order stream. When two second-order streams join, a third order stream is formed, and so on. First and second order channels are often small, steep or intermittent. Stream orders that are six or greater constitute large rivers.

The stream channel is formed by runoff from the watershed as it flows across the surface of the ground following the path of least resistance. The shape of the channel and velocity of flow are determined by the terrain, unless changes have been made by man. When the terrain is steep, the swiftly moving water may cut a deep stream channel and keep the streambed free of sediments. In flatter areas, the stream may be shallow and meandering, with a substrate comprised largely of fine sediments.

Hydrologic Unit Code (HUC) Areas are "watershed address". Delineated by the U.S. Geological Survey, hydrologic units represent the geographic boundaries of water as it flows across the landscape.

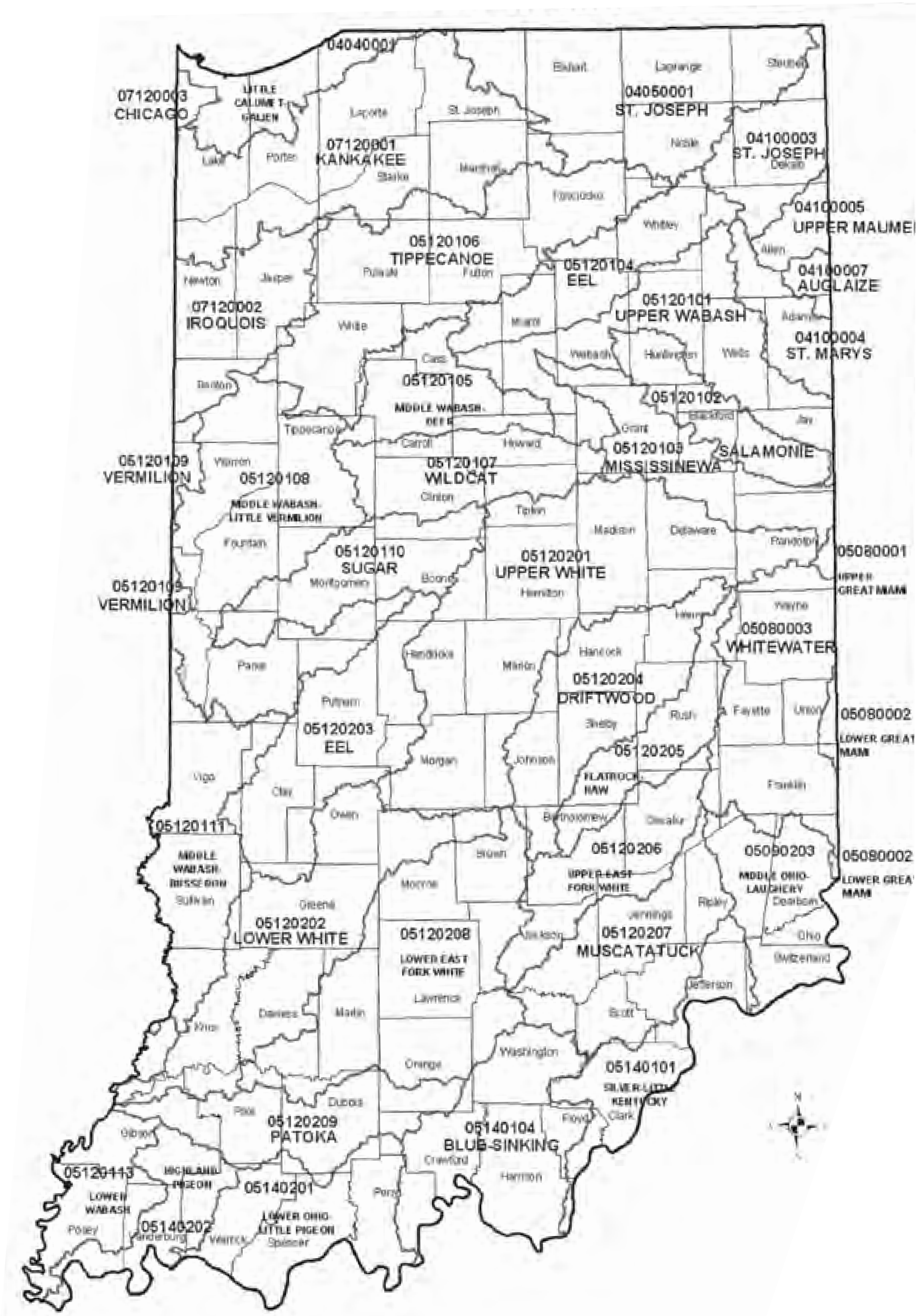
Not every HUC is a "watershed" in the pure sense, since longer streams are divided along their length. Each HUC has an associated 8-digit number or code. This number is representative of the size of the basin. Larger basins are represented by smaller numbers. The first six numbers of two or more watersheds near each other will be equal if they are in the same larger watershed.

Water within watersheds beginning with "04" flow into Lake Michigan or Lake Erie and are part of the Great Lakes Watershed. The "07"s flow west into the Illinois River before entering the Mississippi River. Water from the "05" watersheds flows into the Wabash or Ohio Rivers before also joining the Mississippi River and discharging into the Gulf of Mexico. The Mississippi River watershed is the largest in the USA .

Indiana is divided into 39 watersheds at the 8-digit level. Each of these watersheds can also be divided into smaller sub-watersheds which are represented by 11-digit numbers, and even smaller units with 14-digit numbers.

The State of Indiana has a surface area of approximately 36,532 square miles. There are about 90,000 miles of rivers, streams, ditches and drainage ways in Indiana. In addition, there are approximately 35,673 miles of surface waterways in Indiana greater than one mile in length.

1 Hoosier Riverwatch - Volunteer Stream Monitoring Training Manual



MAP 2.1: HUC8 Watersheds of Indiana, Hoosier Riverwatch - Volunteer Stream Monitoring Training Manual

SECTION ONE - LOCATION

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP
CHAPTER 2

Watershed Location

WMP - CHAPTER 2 - PART 1 - SECTION 1 - SUBSECTION 1

Indiana is located on the eastern edge of the North American great interior plains. The North - South continental divide traverses through northern Indiana, draining watersheds into the Great Lakes basin and the Mississippi River and Ohio River systems. Surface water in the northern one-quarter of the state flows north into the Great Lakes and then through the St. Lawrence River to the Atlantic Ocean. The southern three-quarters of the state drains into the Ohio River or Illinois River and flows into the Mississippi River then south to the Gulf of Mexico.[1] There are 35,673 miles of Indiana rivers, streams, ditches and drainage ways listed at the 1:100,000 scale in USEPA River Reach File 3 (RF3).[2]

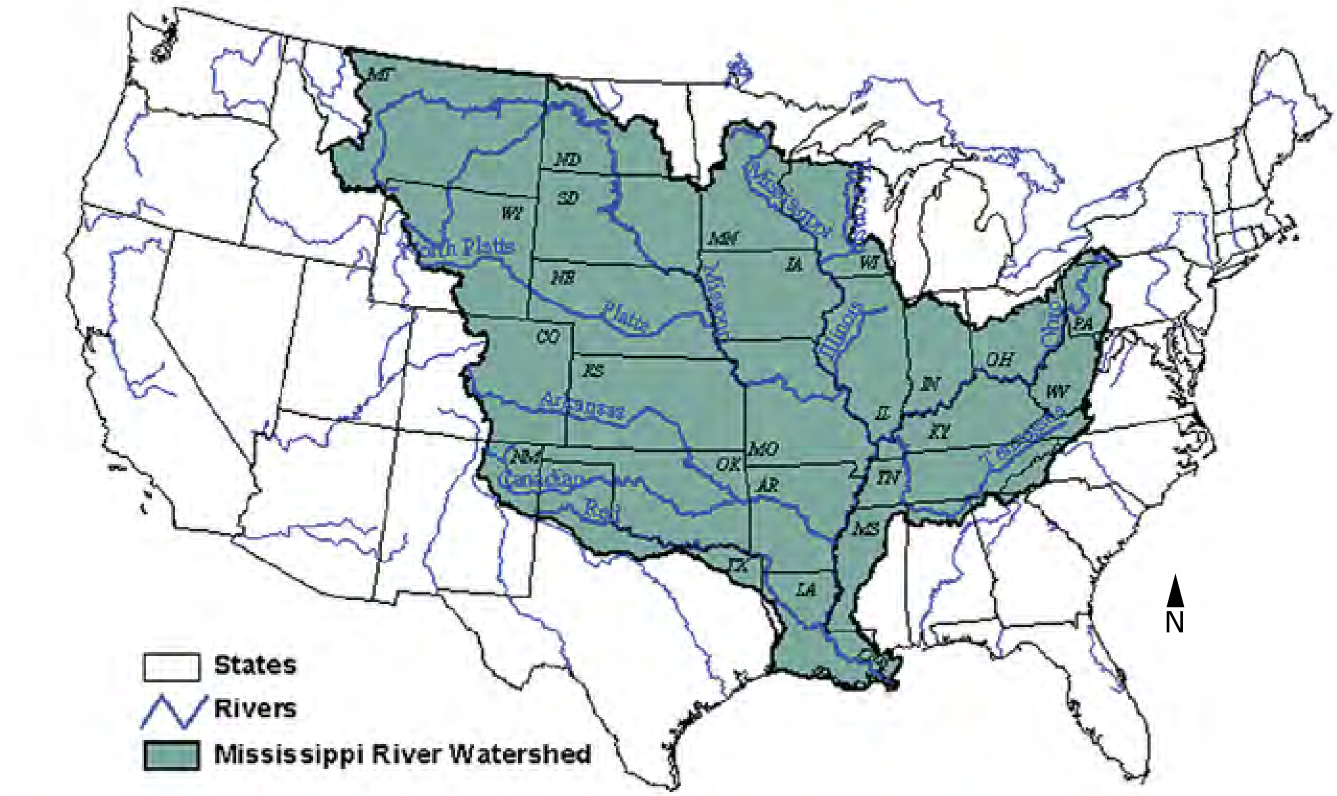
TABLE 2.2: Characteristics of Water bodies in Indiana

Description	Value	Units
Indiana population	6,080,485	
Indiana surface area	36,291	sq. mi.
Total miles of rivers and streams	35,673	miles
Number of publicly-owned lakes/ reservoirs/ ponds	575+	
Publicly-owned lakes/ reservoirs/ ponds	106,205	acres
Great Lakes	154,240	acres
Great Lakes shoreline	59	miles
Fresh water wetlands	813,000	acres

SOURCE: Indiana's 2008 Integrated Water Monitoring and Assessment Report

The White River flows in two forks across most of Central and Southern Indiana, creating the largest watershed contained entirely within the state, draining all or part of nearly half the counties. The White River Basin encompasses 11,350 square miles, starting in Randolph County (where the West Fork of the White River begins in an agricultural field), and ending in Gibson County (where the White River drains into the Wabash River). [3] There is approximately 1.6 million people living in the Upper White River Watershed and 1.8 million acres (approximately 1 acre per person).

1 Indiana Nonpoint Source Management Plan
2 Indiana's 2008 Integrated Water Monitoring and Assessment Report
3 U.S. Geological Survey



MAP 2.2: Mississippi River Watershed Basin, Hoosier Riverwatch - Volunteer Stream Monitoring Training Manual

MAP. 2.3: White River Basin, Indiana, wikipedia

Watershed Location

WMP - CHAPTER 2 - PART 1 - SECTION 1 - SUBSECTION 2

West Fork of the White River Basin (051202)
"The West Fork of the White River begins near Winchester in Randolph county, Indiana and flows through 11 counties where it is joined by the East Fork of the White River near Petersburg. It drains portions of Randolph, Henry, Delaware, Madison, Hancock, Brown, Monroe, Owen, Greene, Martin, Daviess, Knox, Clay, Pike, Gibson, Clinton, Vigo, Tipton, Boone, Hendricks, Putnam, Morgan, Johnson, Hamilton, Marion, and Sullivan counties. The main stem of the White River then flows about 48 miles and joins the Wabash River. In total, the West Fork flows about 356 river miles and drains 5,600 square miles of land in Indiana. Land use in the watershed is predominately agriculture (primarily corn and soybean production), which represents approximately 76 percent of the total land cover." [1]

The West Fork of the White River, from Farmland, IN to its confluence with the Wabash River, is on the Outstanding Rivers List for Indiana, as having outstanding ecological, recreational, or scenic importance. [2]Indianapolis is the state capital and largest city in this watershed (largest population area), with Muncie and Anderson following as the next largest cities.

1 Hoosier Riverwatch - Volunteer Stream Monitoring Training Manual
2 Indiana Nonpoint Source Management Plan

MAP. 2.4 Upper White River Watershed, West Fork White River

INVENTORY

Watershed Location

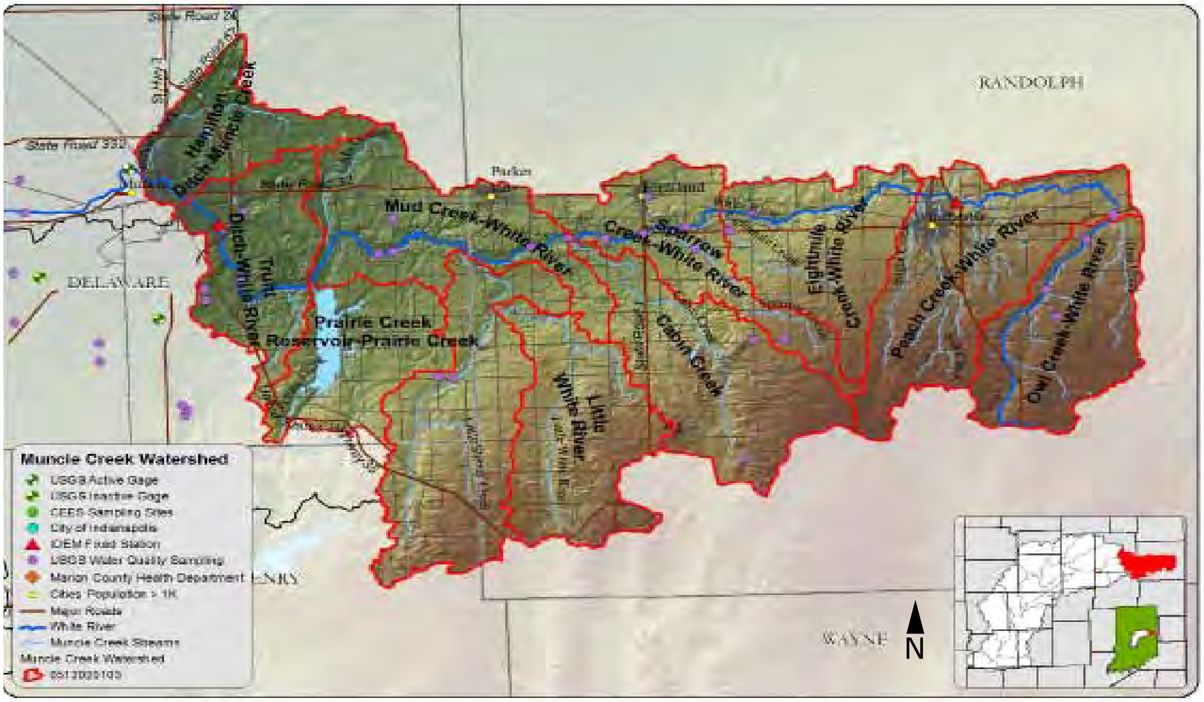
WMP - CHAPTER 2 - PART 1 - SECTION 1 - SUBSECTION 3

The Upper White River Watershed (Muncie Creek) (05120201)
"The headwaters of the West Fork White River (WFWR) can be found near Winchester, Indiana, moving westward through Muncie, draining approximately 384 square miles at the Madison County/Delaware County line (Hoggat 1975). The land along the river in Delaware County is primarily used for agriculture (corn, soybeans, and livestock), but also includes the urban area of Muncie."[1]

"Muncie is a heavily industrialized community that has included electroplating firms, a secondary lead smelter, foundries, heat treatment operations, galvanizing operations, and tool and die shops (although there has been a reduction of industry in the last 20 years)."[2] It is the first industrial city in the White River Watershed drainage basin. The HUC 10 watershed cover parts of Delaware County and Randolph county.

This management plan analyzes two Subwatersheds in the Muncie Creek HUC12 Watershed; Hamilton Ditch - Muncie Creek and Truitt-Ditch White River. For a list of all Subwatersheds in the Muncie Creek HUC10 Watershed see Table 2.3.

1 BWQ Macroinvertebrate (Aquatic Insect) And Mussel Community Report 2010
2 BWQ Macroinvertebrate (Aquatic Insect) And Mussel Community Report 2010



MAP. 2.5 Muncie Creek HUC10 Basin, http://www.cees.iupui.edu/

TABLE 2.3: Subwatersheds in Muncie Creek HUC10 Basin, indianamap.org

HU_12_NAME	HUC_12	ACRES	Sq Mi.	Counties
Peach Creek-White River	51202010102	19001	30	Henry
Eightmile Creek-White River	51202010103	13117	20	Henry
Cabin Creek	51202010104	16573	26	Henry
Sparrow Creek-White River	51202010105	11385	18	Henry
Little White River	51202010106	14609	23	Henry
Little Stoney Creek-Stoney Creek	51202010107	18771	29	Delaware, Randolph, Henry
Prairie Creek Reservoir-Prairie Creek	51202010108	10853	17	Delaware
Mud Creek-White River	51202010109	15745	25	Delaware, Randolph
Truitt Ditch-White River	51202010110	11781	18	Delaware
Hamilton Ditch-Muncie Creek	51202010111	8602	13	Delaware
Owl Creek-White River	51202010101	13456	21	Henry

SOURCE: ArcGIS, Indianamap.org

Watershed Location

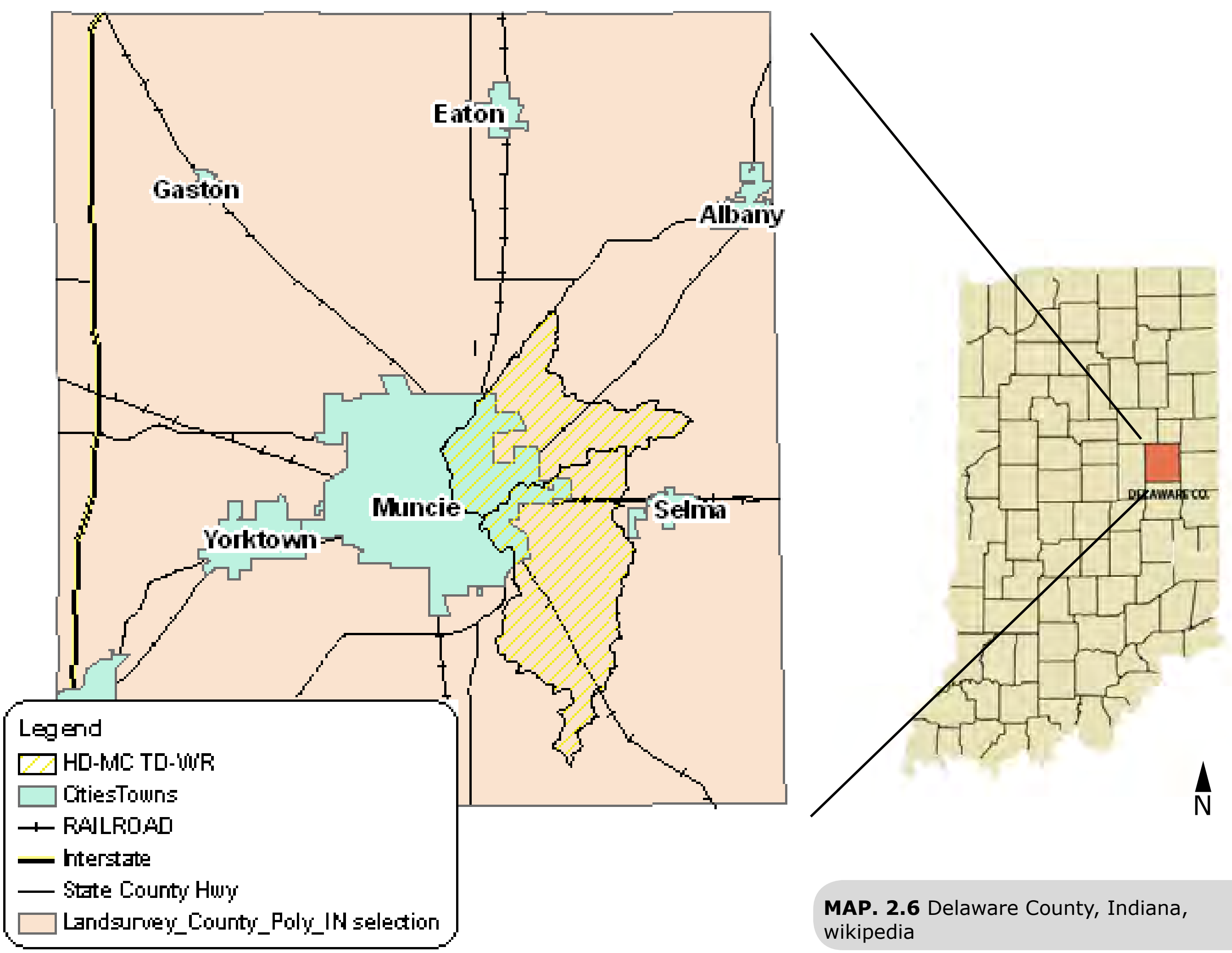
WMP - CHAPTER 2 - PART 1 - SECTION 1 - SUBSECTION 4

Hamilton Ditch- Muncie Creek (051202010111) and Truitt Ditch- White River (051202010110) are at the confluence of the Muncie Creek HUC10 Watershed. Both are located in Delaware County, Indiana (MAP 2.6).

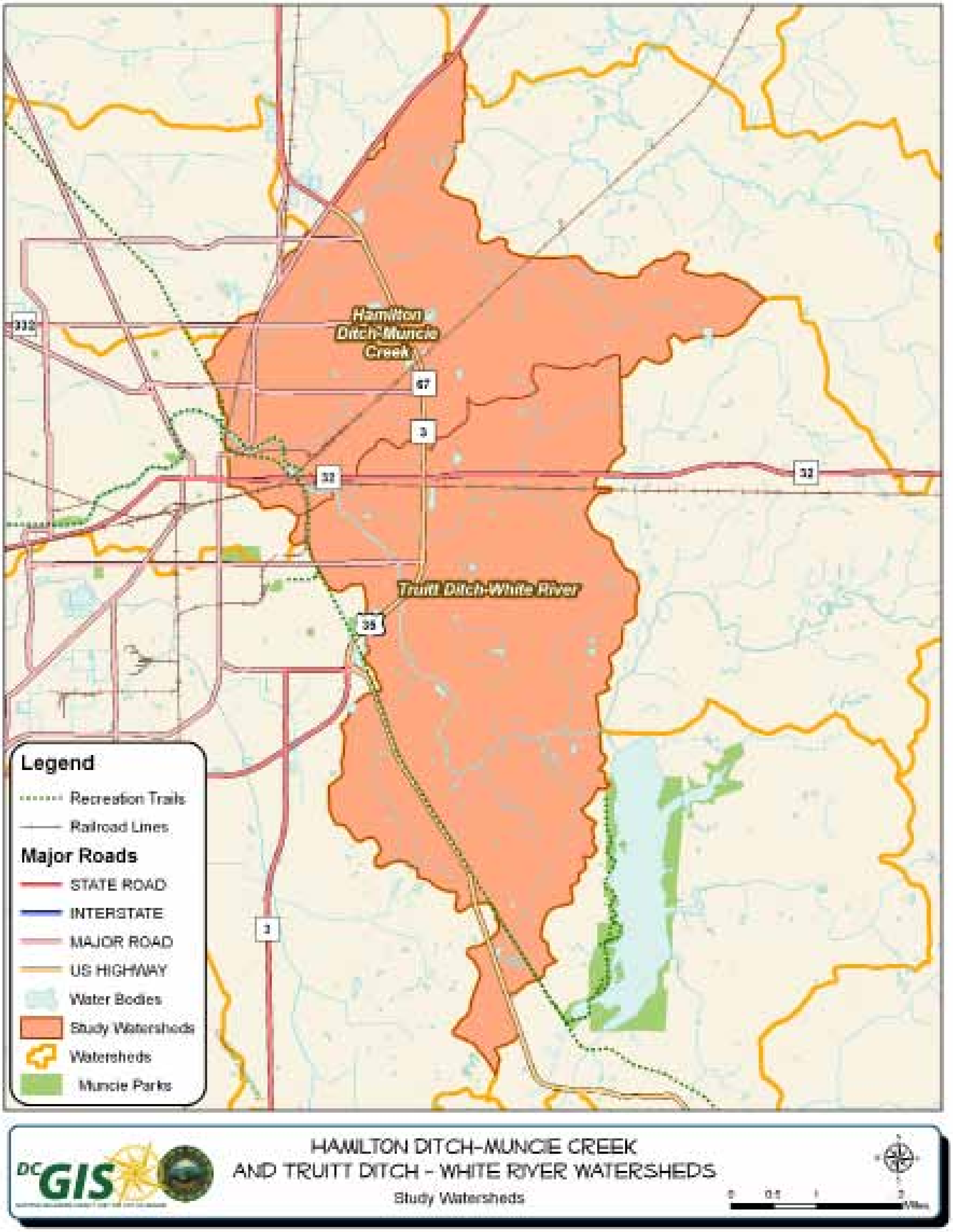
Delaware County is located in East Central Indiana. The Counties primary river, the White River, serves as the spine for the County's major city, Muncie. The main stem of the West Fork of the White River flows through both watersheds. The White River has approximately seven miles of its length in these two Subwatersheds. The second largest stream is Muncie Creek which extends six miles.

The Truitt Ditch-White River Subwatershed begins directly to the east of Muncie, and continues to the south (MAP 2.7, 2.9). It is 11,781 acres in size. The Hamilton Ditch-Muncie Creek Subwatershed is located to the northeast of the city of Muncie (MAP 2.7, 2.8). It is 8,602 acres in size. Both contain a mixture of urban, suburban, and rural areas.

CITIES AND TOWNS IN DELAWARE COUNTY INDIANA



MAP. 2.6 Delaware County, Indiana, wikipedia



MAP. 2.7 Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Watersheds

MAP. 2.8 Hamilton Ditch - Muncie Creek Subwatershed

MAP. 2.9 Truitt Ditch - White River Subwatershed

Watershed Location

WMP - CHAPTER 2 - PART 1 - SECTION 1 - SUBSECTION 5

Primary Subwatershed Drainage Basins

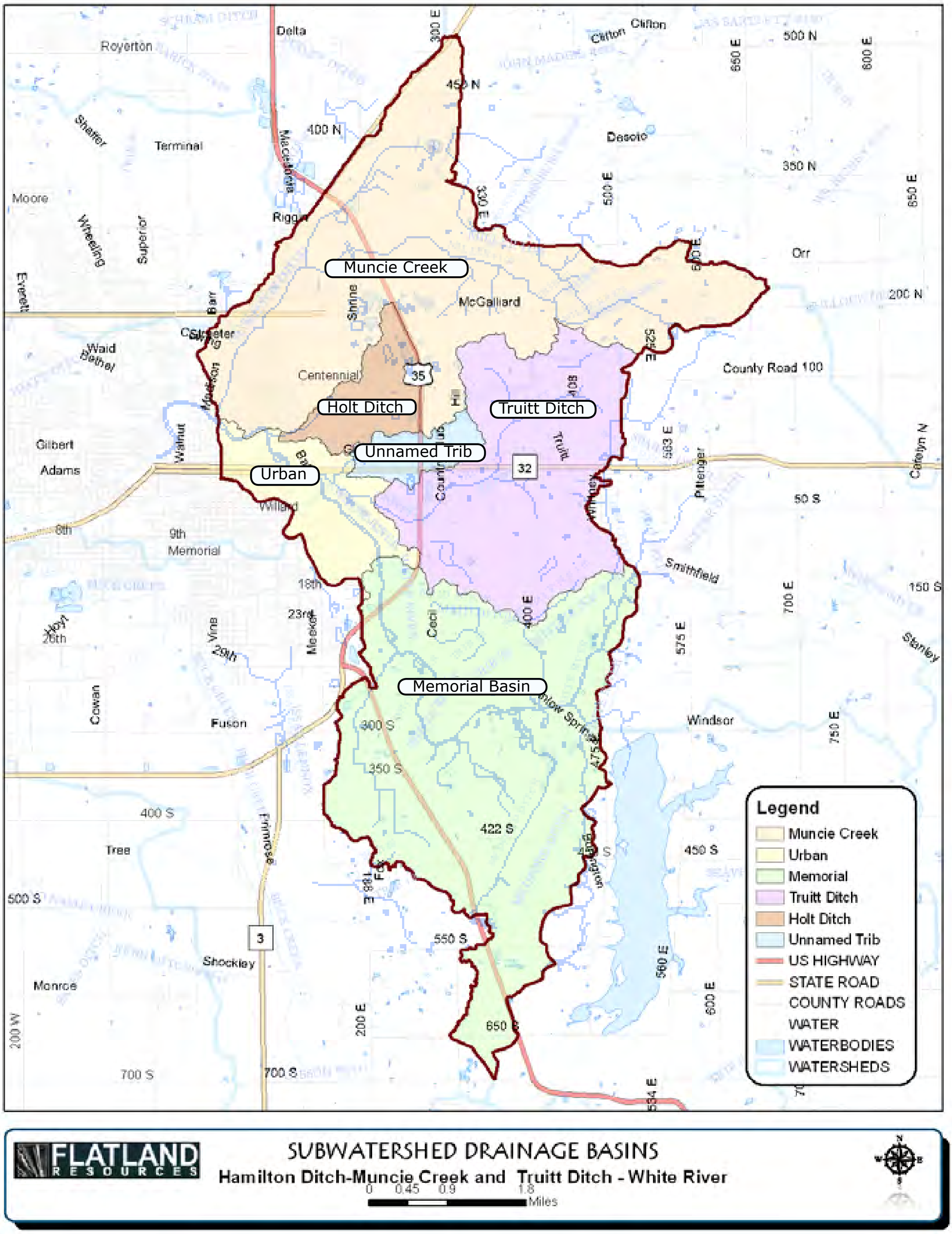
Table 2.4 outlines the drainage basins that will be studied in response to water quality sampling point locations and data generated by the Muncie Bureau of Water Quality. These drainage basin delineations will serve as study areas for critical area determinations. Each of the following sub basins are described in greater details in section 2[1]

TABLE 2.4: Primary Drainage Basins in Hamilton Ditch-Muncie Creek and Truitt Ditch-White River Subwatersheds

	Acres	Stream Mi.
Total Combined Subwatersheds	19654	31
Walnut Basin	12470	19
Walnut Basin: Secondary Basin - Muncie Creek	6468	10
Walnut Basin: Secondary Basin - Holt Ditch	724	1
Walnut Basin: Secondary Basin - Unnamed Trib	414	1
Walnut Basin: Secondary Basin - Truitt Ditch	3646	6
Walnut Basin: Secondary Basin - Urban (non monitored)	1218	2
Memorial Basin	7184	11

SOURCE: ArcGIS, Indianamap.org

1 Data Generated by ArcGIS



MAP. 2.10 Primary Drainage Basins in studied Subwatersheds

SECTION TWO - NATURAL FEATURES

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP
CHAPTER 2

Natural History

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 1

The Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds are located in the Central Till Plain Natural Region. The Tipton till plain (a sub unit of the Central Till Plain) is characterized by (1) a mix of poorly drained soils which support a variety of oaks, maples, ash, elm, and sycamore and (2) better drained soils home to hickory, tulip tree, white ash, sugar maple, and beech. Within the till plain, depressions are often wet and mesic forests, which contain highly diverse communities.

Sediments borne by ice sheets were deposited as till (an unsorted mixture of sand, silt, clay and boulders) when the glaciers advanced into Indiana and as outwash sand and gravel when the ice melted . Thick accumulations of till and outwash filled the bedrock valleys and covered the bedrock hills of northern Indiana to produce the flat to gently rolling landscape thought of by many as monotonous.[1]

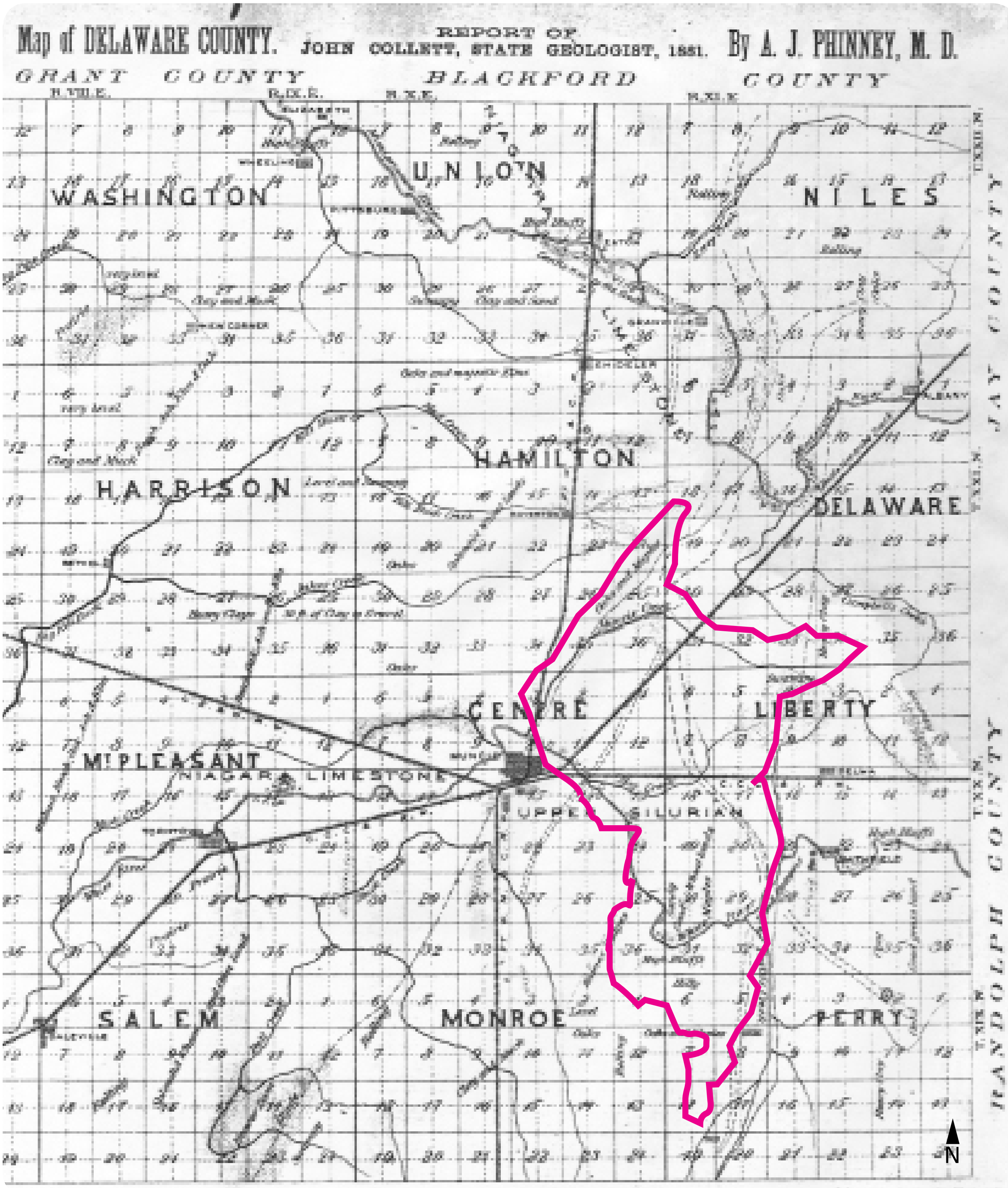
The surface of this region is flat to gently rolling and was shaped by the Wisconsinan Glaciers. The moraines that were left behind after glaciation are of two types: ground moraines and recessional moraines. The ground moraines are generally flatter and less sloped. The recessional moraines are more convexly shaped and have steep slopes.[2]

Pre-settlement, the area was predominately forest, with beech forests and oak sugar maple forests being the major type on the drier areas and beech and elm-ash swamp forests dominating the wetter areas. Small sections of prairie were located throughout the area, where conditions allowed. Typically, wetland areas would have been located in the headwaters of streams, as is apparent from the color of the soils as seen through contemporary aerial photography. [3]

Most of the early settlers in Delaware County came from Virginia, Pennsylvania, and Kentucky. The Delaware and Miami Indians, who were living in the area when the settlers arrived, remained until 1818. Muncie, the county seat, was named for the chief of the Delaware tribe. The first permanent settlement in Delaware County was established in 1820. The earliest settlers located along the West Fork of the White River near the present sites of Muncie, New Burlington, and Smithfield. [4]

By 1909 a tremendous landscape transformation had occurred. DeHart (1909) lamented the loss of forests throughout the region as more settlers arrived. He described Indiana as becoming a “treeless state” where native timber stands were removed for farming purposes. He wrote “with more timber our streams would again flow with more water; our climate would be better, crops would be better and prosperity would be insured to those that come after us.”[5]

1 Landscapes of Indiana, Indiana Geological Survey.
2 Soil Survey of Delaware County Indiana. US Department of Agriculture
3 Wabash River (Region of the Great Bend) WMP
4 Wabash River (Region of the Great Bend) WMP
5 Past and Present of Tippecanoe County Indiana



MAP. 2.11 Historic Map of Delaware County

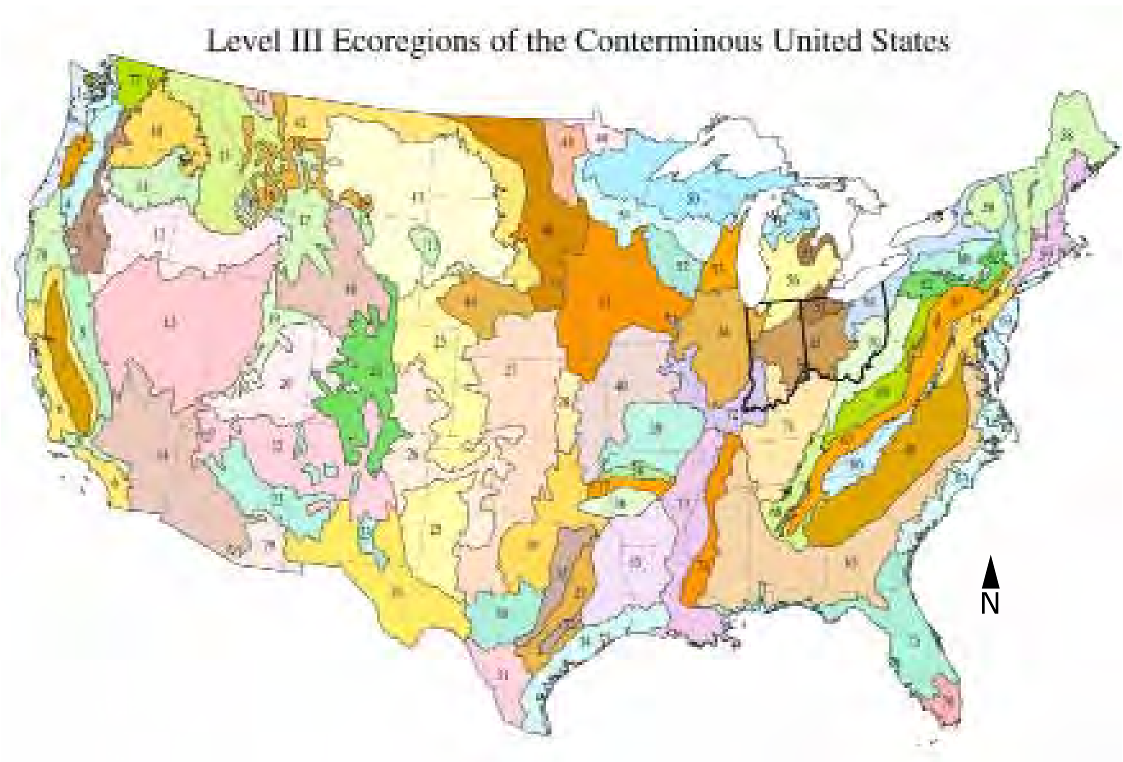
Ecoregions

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 2

Ecoregions
Underlying site-specific habitat variability is the broader effect of ecoregion differences. Geology, climate, geographic location, and soils all factor into shaping the native flora and fauna which occurs in a particular area.[1] Categorization of these floral and faunal communities has been completed by a number of ecologists since the earliest efforts by Coulter in 1886. Since this time, Petty and Jackson (1966) identified regional communities; Homoya et al. (1985) classified Indiana into natural regions, while Omernik and Gallant (1988) categorized Indiana into Ecoregions.[2]

Ecoregions are those areas with generally similar ecosystems. Ecoregions have four levels of classification, from Level I to Level IV, with Level I encompassing the broadest description and Level IV being the most specific.

Delaware County and all of the Upper West Fork White River lie within the Eastern Corn Belt Plains, a Level III ecoregion delineation (MAP 2.12). This ecoregion is characterized by rolling hills and end moraines. Extensive glacial deposits left over from the Wisconsonian age cover the area. Within the Level IV delineation, three separate Ecoregions can be found in Delaware County (MAP 2.14) and the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds (MAP 2.13).



MAP. 2.12 Level III Ecoregions, USA, epa.gov

1 Soil Survey of Delaware County Indiana. US Department of Agriculture
2 Wabash River (Region of the Great Bend) WMP

MAP. 2.13 Subwatershed Ecoregions

INVENTORY

Ecoregions

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 3

Clayey High Lime Till Plains (CHLTP)

North of White River is the Clayey High Lime Till Plains (CHLTP), distinguished by turbid, low gradient streams that cross less productive, poorly-drained soils. Within Delaware and Randolph County, this ecoregion includes the Mississinewa River watershed and many smaller tributaries of White River. (55a), The Clayey Lime Till Plains ecoregion is transitional between the Loamy High lime Till Plains (55b) and the Maumee Lake Plains (57a); soils are less productive and more artificially drained than Ecoregion 55b and supported fewer swampy areas than Ecoregion 57a. Corn, soybean, wheat, and livestock farming are dominant and have replaced the original beech forests and scattered elm-ash swamp forest. No exceptional fish communities exist in the turbid, low gradient streams of Ecoregion 55a."[1]

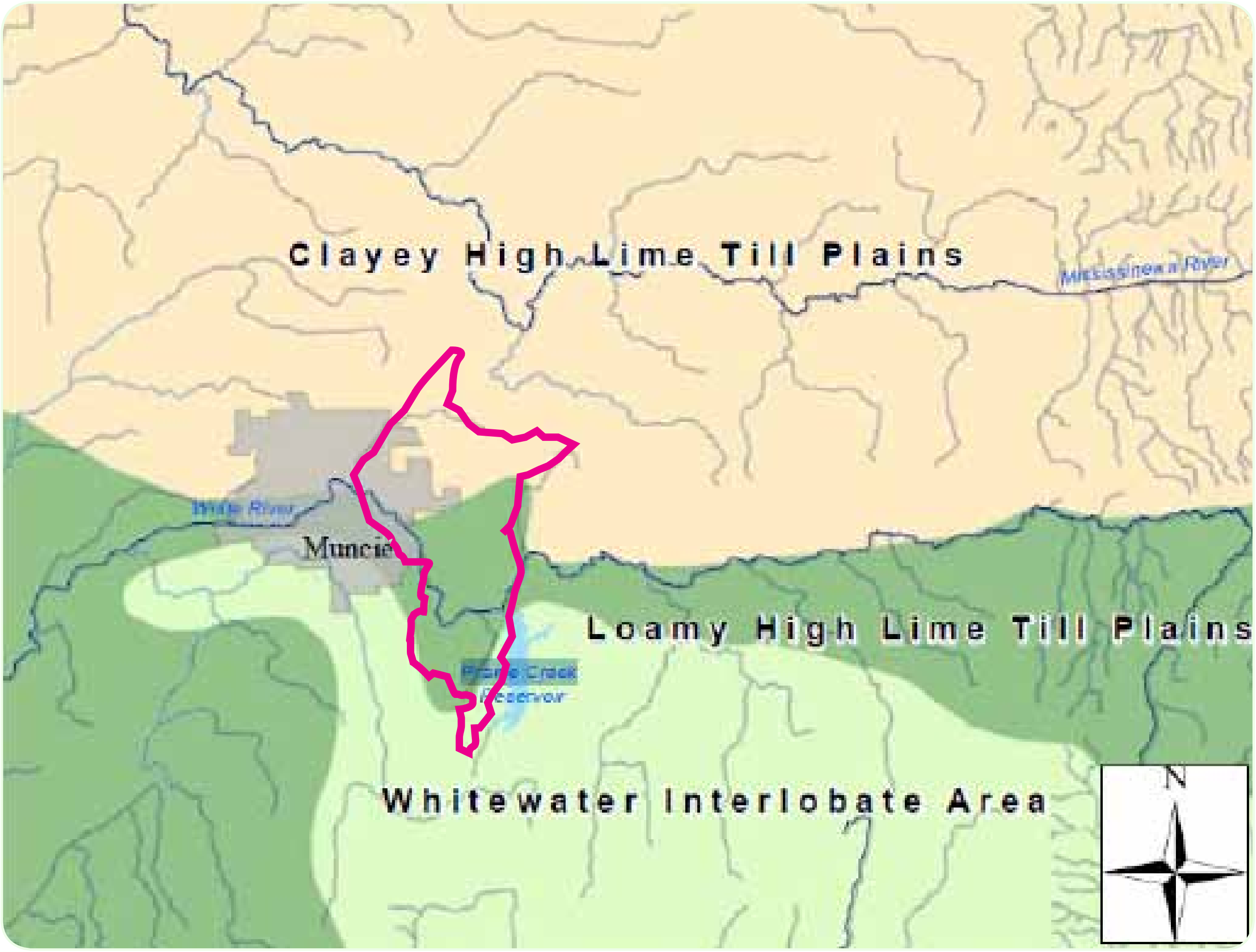
Loamy High Lime Till Plains (LHLTP)

Through the middle of the county and bordering nearly the entire length of White River is the Loamy High Lime Till Plains (LHLTP). Soils here are typically better drained than those of the previous ecoregion and have slightly higher gradients. 55b, "The Loamy, High Lime Till Plains ecoregion contains soils that developed from loamy, limy, glacial deposits of Wisconsinan age; these soils typically have better natural drainage than those of Ecoregion 55a and have more natural fertility than those of Ecoregion 55d. Beech forests, oak-sugar maple forest, and elm-ash swamp forests grew on the nearly level terrain; today, corn, soybean, and livestock production is widespread."[2]

Whitewater Interlobate Area (WIA)

Further south encompassing most of Buck Creek and the Prairie Creek Subwatershed is the Whitewater Interlobate Area (WIA). The coarse bottomed streams in this region have moderate gradients and are supported by abundant ground water supplies leading to noticeably cooler water temperatures. The cooler temperatures have a discernable effect on the composition of fish communities in this ecoregion and on IBI scores. 55f, The redside dace, northern stud fish, and banded sculpin occur; they are absent or uncommon in Ecoregion 55b. Unique Ozarkian invertebrates also occur in Ecoregion 55f. Dolomitic drift and meltwater deposits are characteristic and overlie limestone, calcareous shale, and dolomitic mudstone."[3]

1 Ecoregions of Indiana and Ohio
2 Ecoregions of Indiana and Ohio
3 Ecoregions of Indiana and Ohio



MAP. 2.14 Ecoregions of Delaware County. BWQ

INVENTORY

Ecoregions & World Biomes

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 4

"Underlying ecoregion characteristics have led to a differentiation in habitat and fish communities. The CHLTP is described as having less productive soil with turbid, low gradient streams. These characteristics have led to more artificial drainage and clear cutting of the stream riparian zone to increase drainage efficiency, compounding anthropocentric influences on the fish communities. In contrast, the LHLTP are inherently more efficient in natural drainage reducing the amount of channelization and clear cutting that has been necessary to increase drainage. The unique thermal regime of the WIA has led to a fish community that includes mottled sculpin, two species of dace, and native lampreys." [1]

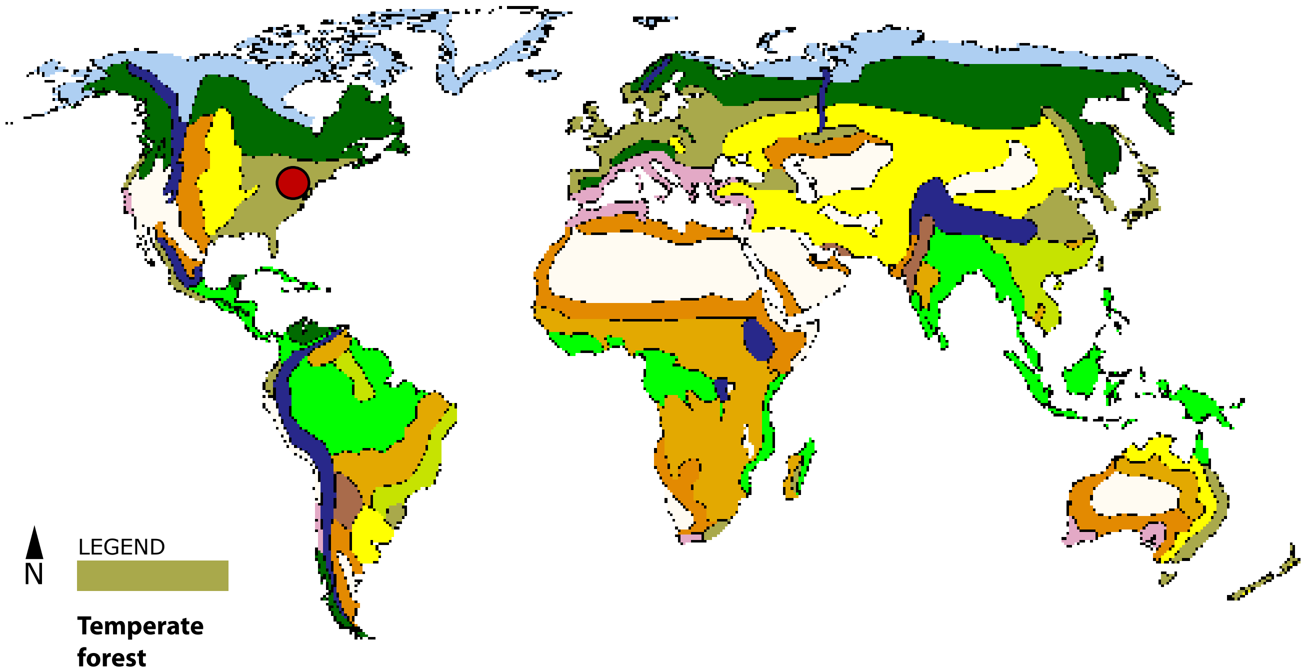
"When attempting to compare fish communities from these three Ecoregions it is important to take into consideration the unique characteristics that are beyond the control of managers and inherently promote different fish communities."[2]

Biomes are large geographical areas that are distinguished by different plant and animal groups within the area. The plants and animals have developed certain characteristics based on the climate and geography of the biome. In order for biomes to survive, a healthy relationship must exist between the living and its environment. [3]

The biome that describes the location of the White River Watershed is the temperate deciduous forest. (MAP 2.16) This biome is also found in the eastern half of North America, southwest Russia, Japan, Eastern China, New Zealand, southeast Australia, and the southern tip of South America. (MAP 2.15) The average temperature of the biome is 60 degrees Fahrenheit and it typically receives 30 – 60 inches of rain per year. [4]

The temperate deciduous forest has four distinct seasons – spring, summer, autumn and winter. The biome is considered deciduous because the plant leaves turn colors in the autumn, fall off in the winter and grow back in the spring. The common trees that are found in the biome are: beech, oak, ash, lime, and northern arrowhead. Five planting zones with distinct plants are found within the biome. They are: Tree stratum zone, small tree and sapling zone, shrub zone, herb zone and ground zone.[5]

1 Muncie Sanitary District's Fish Community Report
2 Muncie Sanitary District's Fish Community Report
3 Blue Planet Biomes
4 Natureworks
5 Blue Planet Biomes



MAP. 2.15 Site Location in Relationship to World Biome, BSU

MAP. 2.16 Site Location in Relationship to Temperate Forest, BSU

The Temperate Deciduous Biome in the United States is one of the largest biomes.

This project recommendations have potential application to sites in the eastern part of the country.

N
LEGEND

Temperate forest

Climate

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 5

Normatively, the State of Indiana has a temperate climate with warm summers and cool or cold winters. The dynamic of this climate affects many aspects of natural system history, land use, and water resources planning.

Temperature
Delaware County has average temperatures ranging from 34°F to 72°F, with an average temperature of 51.4°F (Table 2.5). This averaging is a result of the climatic forces that result in distinct seasons Spring, Summer, Fall and Winter. Table 2.6 shows probable dates of the first freeze in fall and the last freeze in spring, which are the most significant periods of transition during these climatic extremes. High temperatures measure approximately 85°F in July and August, while low temperatures measure near freezing (31°F) in January. In winter, the average temperature is 27.7 °F and the average daily minimum temperature is 20.0 °F. In summer, the average temperature is 72.8°F and the average daily maximum temperature is 83.1 °F. [1]

Precipitation
Average annual rainfall is 40 inches. According to the US Department of Agriculture, "Thunderstorms occur on about 43 days each year, and most occur between May and August." The average seasonal snowfall is 26.7 inches. On an average, 31 days per year have at least 1 inch of snow on the ground. The heaviest 1-day snowfall on record was 12.5 inches recorded on December 20, 1973. [2] (Table 2.7)

Humidity, Sun, Wind
"The average relative humidity in mid-afternoon is about 61°F. Humidity is higher at night, and the average at dawn is about 83°F. The sun shines 67 percent during daylight hours in summer and 43 percent in winter. The prevailing wind is from the southwest, except from January to March, when it is from the northwest. Average wind speed is highest, between 11 and 12 miles per hour, from January to April". [3]

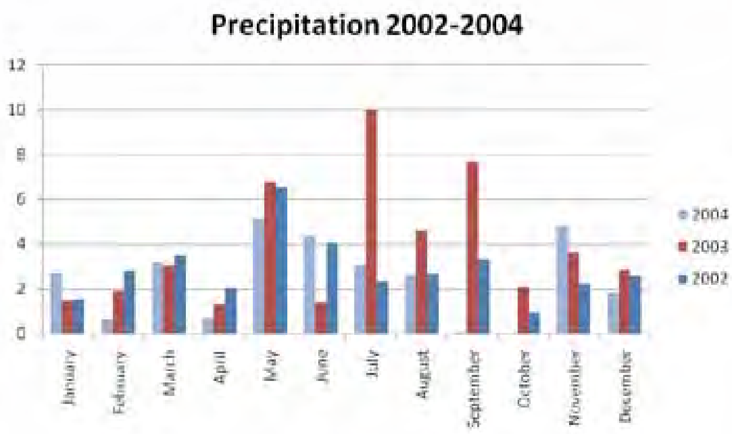
1 Soil Survey of Delaware County Indiana. US Department of Agriculture
2 Soil Survey of Delaware County Indiana. US Department of Agriculture
3 Soil Survey of Delaware County Indiana. US Department of Agriculture

TABLE 2.5: Temperature Recorded in the period 1961 to 1990 at Muncie Ball State University							
				2 year in 10 will have:			
	Average Daily Maxi-mum	Aver-age Daily Minimum	Aver-age	Max temp higher than	Minimum temp higher than	Average number of growing de-gree days	Average
Month							
January	32.2	16.8	24.5	61	-14	14	2.01
February	36.1	19.8	28	64	-8	25	2.1
March	48.4	30.5	39.4	77	5	132	3.33
April	61.6	40.7	51.2	84	20	345	3.5
May	72.1	51.1	61.6	90	30	669	3.86
June	81.3	60.8	71	95	43	926	3.62
July	85.1	64.6	74.8	97	40	1070	3.24
August	83	62.2	72.6	94	45	1003	3.49
September	76.9	55.3	66.1	92	35	779	3.19
October	64.7	43.5	54.1	85	24	432	2.68
November	50.6	34.3	42.5	74	13	160	3.18
December	37.9	23.3	30.6	64	-7	35	3.47
Yearly							
Average	60.8	41.9	51.4				
Extreme	102	-24		100	-16		
Total						5,590	37.67

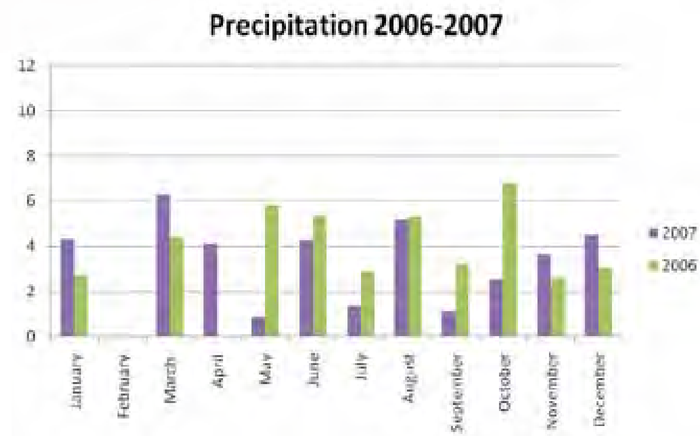
SOURCE: Soil Survey of Delaware County Indiana. US Department of Agriculture

TABLE 2.6: Freeze Dates in the Spring and Fall Recorded in the period 1961 to 1990 at Muncie Ball State University			
Probability	Temperature		
	24 F or lower	28 F or lower	32 F or lower
Last freezing temperature in spring:			
1 year in 10 later than	Apr. 15	Apr. 24	May 9
2 year in 10 later than	Apr. 9	Apr. 19	May 5
5 year in 10 later than	Mar 30	Apr. 9	Apr. 26
First freezing temperature in the fall:			
1 year in 10 earlier than	Oct. 24	Oct. 12	Sept. 26
2 year in 10 earlier than	Oct. 29	Oct. 17	Oct. 2
5 year in 10 earlier than	Nov. 9	Oct. 27	Oct. 12

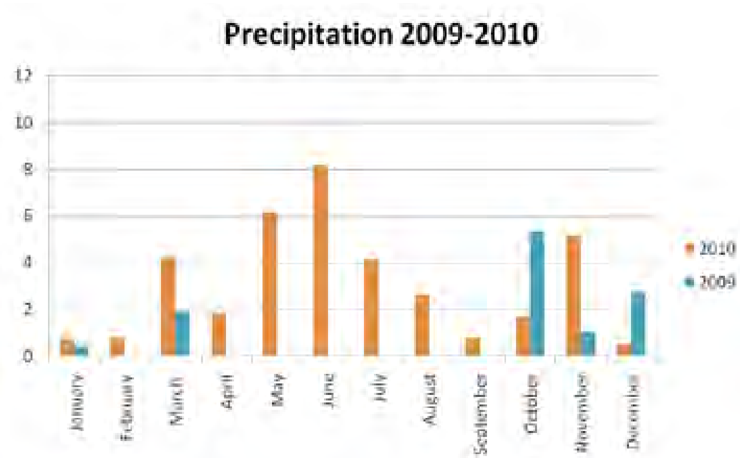
SOURCE: Soil Survey of Delaware County Indiana. US Department of Agriculture



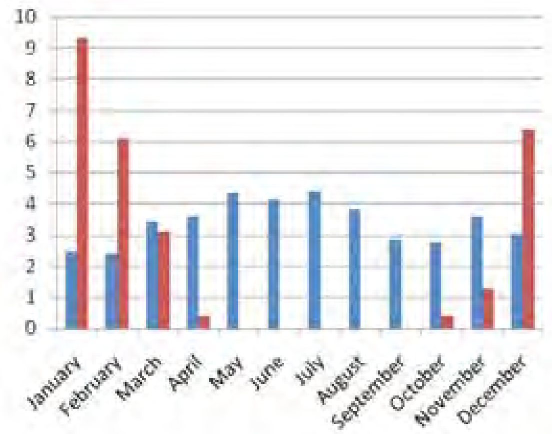
CHA. 2.1 Delaware County Precipitation 2002-2004



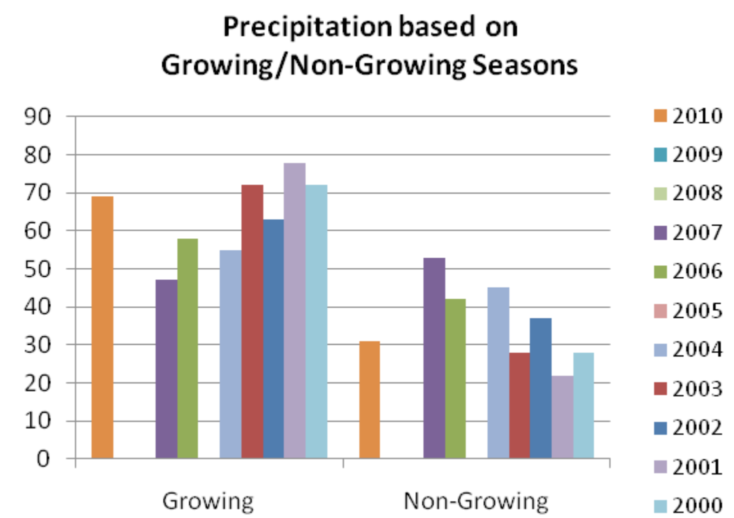
CHA. 2.4 Delaware County Precipitation 2006-2007



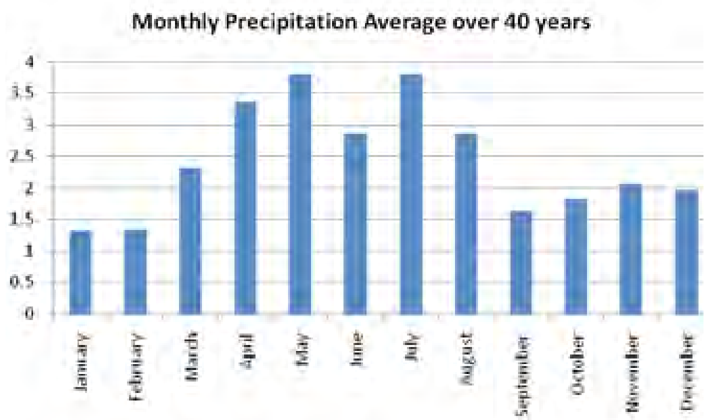
CHA. 2.2 Delaware County Precipitation 2009-2010



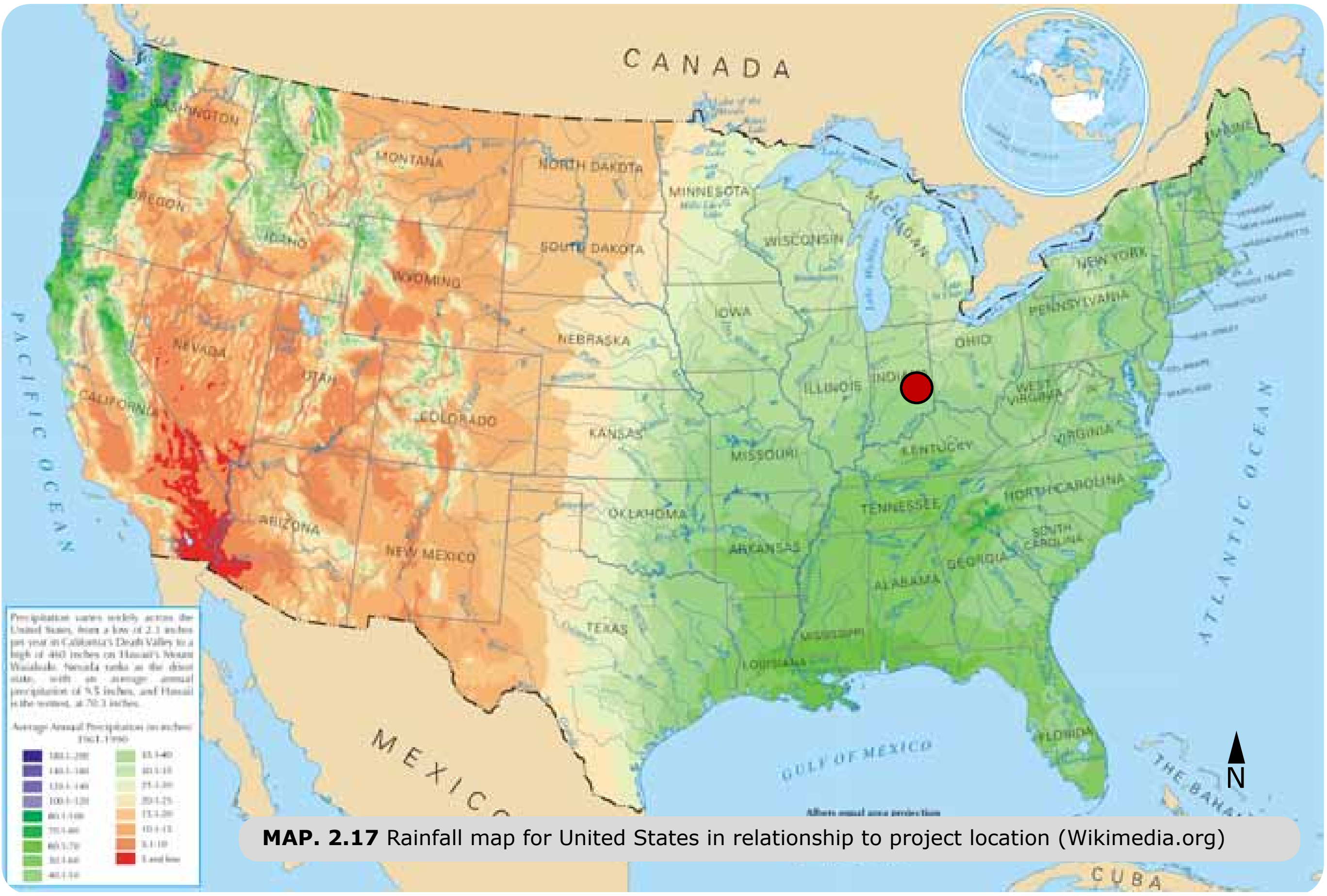
CHA. 2.5 Delaware County, Snowfall (red) Rain (blue)



CHA. 2.3 Delaware County Precipitation 2000-2010



CHA. 2.6 Delaware County Precipitation 40 year Monthly Avg.



MAP. 2.17 Rainfall map for United States in relationship to project location (Wikimedia.org)

TABLE 2.7: Snowfall precipitation Recorded in the period 1961 to 1990 at Muncie Ball State University, Soil Survey of Delaware County Indiana. US Department of Agriculture

	2 years in 10 will have			
	Less than	More than	Average number of days with 0.10 in or more	Average snowfall
Month				
January	0.96	2.92	5	7.1
February	0.85	3.15	5	6.9
March	2	4.53	7	3.7
April	2.32	4.57	7	0.4
May	2.36	5.2	7	0
June	1.9	5.12	6	0
July	1.89	4.45	6	0
August	1.74	5.02	5	0
September	1.02	4.97	5	0
October	1.58	3.84	6	0.3
November	1.38	4.71	6	1.9
December	2.06	4.73	7	6.4
Total	25.57	45.48	72	26.7

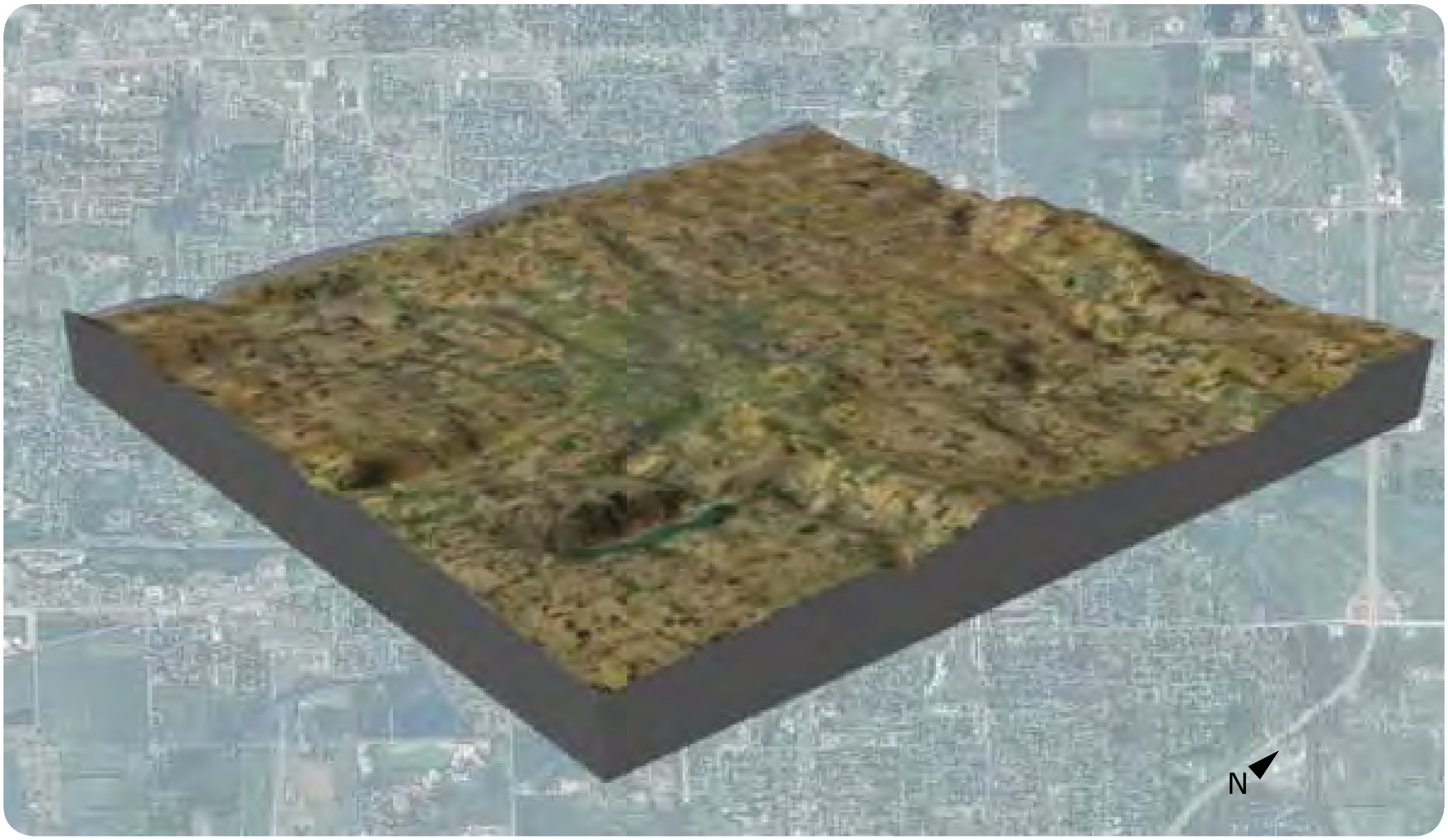
SOURCE: Soil Survey of Delaware County Indiana. US Department of Agriculture

Topography

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 6

The topography, surface geology, soil development, and bedrock geology in Muncie Creek- Hamilton Ditch and Truitt Ditch-White River Subwatersheds were directly influenced by the advance and retreat of the Saginaw-Huron, Michigan, and Erie lobes of ice during the Wisconsinan Glaciation. The two watersheds are located within the boundaries of the Wisconsinan glacial deposits. [1]

The lowest elevation in the county is 830 feet along the Mississinewa River on the northern edge of the county. The highest elevation in the county is 1,100 feet in the southeast corner of the county on the Knightstown Moraine. The relatively flat topography is interrupted both by a series of parallel end moraines or hills and by the White River.[2]



DIA. 2.1 Axonometric diagram of Delaware County landform (Kevin Henn)

1 Soil Survey of Delaware County Indiana. US Department of Agriculture
2 Soil Survey of Delaware County Indiana. US Department of Agriculture

MAP. 2.18 Digital Elevation Model

INVENTORY

Geological Bedrock

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 7

The bedrock of both watersheds was formed during the Silurian Period (~440-410 mya). This bedrock consists of limestones and dolostones with fossils throughout.[1] Bedrock deposits are from the Devonian and Mississippian ages and generally consist of shale, siltstone, and limestone (Rosenshein, 1958). There are many sand and gravel resources located in this watershed. The distance to the bedrock varies from 0 to 250 feet.[2]

Landforms

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 8

The till plain in Delaware County is divided into two distinct landforms, ground moraines and recessional moraines. The ground moraines have rather broad, flat surfaces with swell-and-swale topography and scattered closed depressions. The largest ground moraine in the county lies in the watershed between the West Fork of the White River and the Mississinewa River.

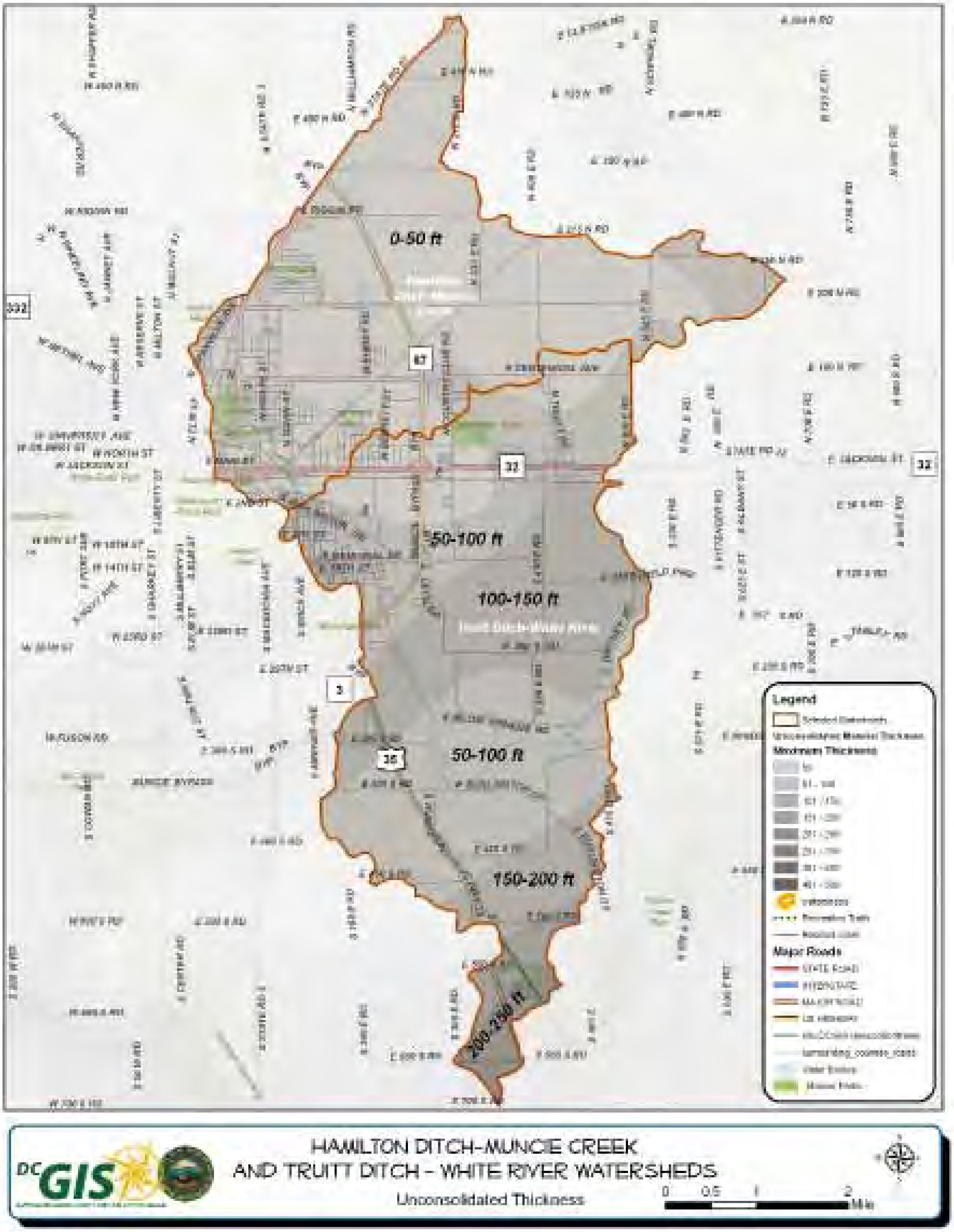
The recessional moraines are a series of rolling, mostly convex ridges that are narrower and more sloping than the ground moraines. The rolling slopes in the southeastern part of the county are part of the Knightstown Moraine (Wayne, 1965). Several kames in the county rise above the till plain like an inverted bowl. These eskers and kames are underlain by sand and gravel and are commonly mined.[3]

In the Hamilton Ditch - Muncie Creek watershed, there are numerous eskers present as a result of the glacial period. The depth of unconsolidated material ranges from 0 to 100 feet. [4]

The Truitt Ditch-White River watershed is located on the boundary between the Tipton Till Plain and the Bluffton till Plain section of the Central Till Plain. Its shrink-swell characteristics are moderate throughout, with an unconsolidated thickness of 0 to 250 feet.

An abrupt ridge system rising above the till plain northeast of Muncie is known as the Muncie Esker, a portion of the Muncie Esker runs through the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds. This esker was also left by the retreating glaciers of the Wisconsinan Ice Age. [5]

1 Indiana Geological Survey
2 Indiana Geologic Survey, ARCIMS Downloader
3 Soil Survey of Delaware County Indiana. US Department of Agriculture
4 Soil Survey of Delaware County Indiana. US Department of Agriculture
5 Soil Survey of Delaware County Indiana. US Department of Agriculture



MAP. 2.19 Unconsolidated Thickness

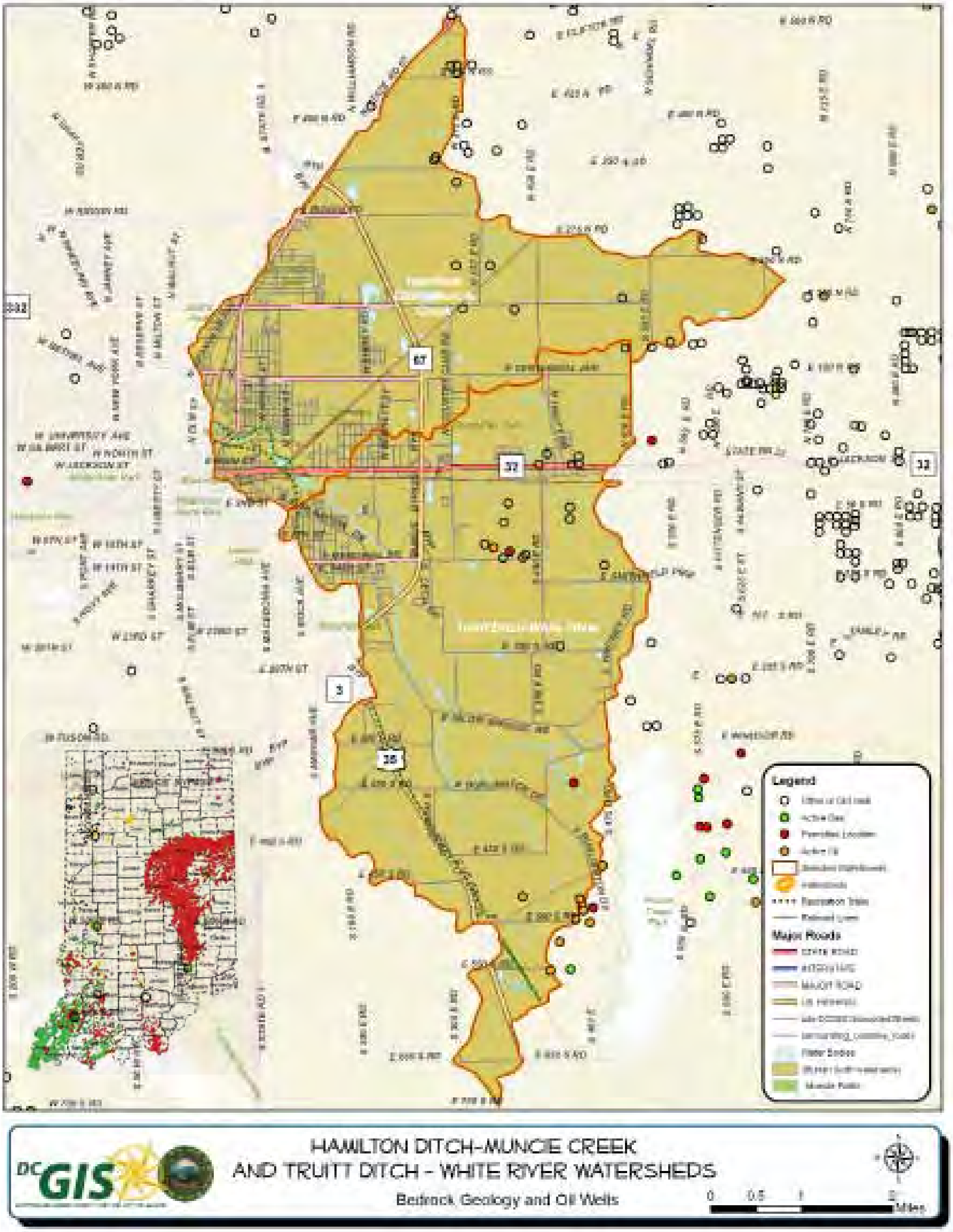
Petroleum

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 9

Trenton Field:
In 1876, natural gas was found near Eaton, Delaware County, Indiana. The gas was not used until the 1880s. Trenton Field was the first giant oil field in the United States. It produced 100 million total barrels. By 1910, 90% of the gas was used; mostly due to the wastefulness and unregulated drilling practices of the field. The oil boom in Delaware Co. is the reason why the county became industrious attracting people like the Ball Brothers. [1]

Hamilton Ditch - Muncie Creek and Truitt - Ditch White River are both located within the Trenton Petroleum Field and there are numerous oil and gas wells present. New and recent drilling has started in the Prairie Creek - Perry Township area. The status of both old (retired) and new wells and their inherent risks and unknown at this time.

1 Indiana Geological Survey



MAP. 2.20 Bedrock Geology and Oil Wells

INVENTORY

Biological Indicators

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 10

"Biological indicators provide many benefits to a water quality program. Biological communities reflect the cumulative impacts of the watershed condition. The most obvious biological indicator related to water quality is stream biology. Fish are long lived and disturbances in their environment can be reflected at the community or individual level (e.g. DELT anomalies, % tolerant species and age and growth). Fish represent a variety of trophic levels: omnivores, herbivores, insectivores, planktivores, and piscivores. Fish are ubiquitous and found in even the smallest of streams. Biological sampling is also relatively inexpensive compared to chemical analysis. In addition, descriptors of the fish community are more easily related to the public." [1]

The Muncie Bureau of Water Quality assists the White River Watershed Project by assessing the fish and macroinvertabrate communities within the WFWR and its tributaries within Delaware County for the purposes of: evaluating the health of these aquatic communities, supplementing chemical assessments by evaluating overall water quality, and reporting the results to the WRWP in a manner that is useful to both the public and professionals.

"While the benefits of biological criteria are widely known, they are not intended to replace chemical sampling. Implementation of the two in concert provides the most holistic representation of water quality. It has been found that 40% of impaired streams in Ohio were detected by biological assessments and missed by chemical sampling (OEPA 1994), while 7% were found only with chemical sampling. In addition, chemical testing is sometimes necessary as a follow-up to pinpoint the exact cause of disturbances found by biological testing. A single approach or a single statistical framework (e.g. Shannon Diversity Index) is insufficient at describing every variable that affects water quality. Multiple sampling approaches coupled with multiple analyses, which take into account the nuances of the relationship at hand, is necessary to formulate a holistic conclusion on water quality." [2]

Aside from instream biology, individuals are concerned about lack of knowledge of local wildlife populations and the impact that changing land uses could have on these populations. Additionally, pathogen inputs from wildlife are also a concern.

The Indiana Department of Natural Resources (IDNR) is tasked with managing wildlife populations throughout the state. The most recent survey of wildlife populations occurred in 2005. Deer and squirrels are the most common wildlife present within the region.

According to IDNR, many wild animals in Indiana have become displaced as the result of urban growth and removal of their habitat. While some species may move to other areas where natural habitat exists, some species actually thrive in urban settings. Species such as raccoons, opossums, Canadian geese and even red foxes are becoming more common in urban areas and are frequently seen by people. However, these animals can also cause problems when they use a person's attic for shelter, destroy shingles and soffits, utilize lawns as homes, and eat their garbage. [3]

Wildlife is an indicator of a healthy and 'complete ecosystem.' At the core of any thriving ecosystem is a water system that is supportive of all dimensions of the wildlife food chain. Therefore, the hope of the White River Watershed Project is that water quality improvement at the in stream level will concurrently work to help improve the presence of historic wildlife in the area.

1 Muncie Sanitary District's Fish Community Report
2 Muncie Sanitary District's Fish Community Report
3 Geist Reservoir/Upper Fall Creek WMP

Endangered Species

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 11

According to the Indiana Department of Natural Resources, Division of Nature Preserves, there are 31 species that are endangered, threatened, or rare in Delaware County (Table 2.8). The state of Indiana uses the following definitions for classification of species:

Endangered: Any species whose prospects for survival or recruitment with the state are in immediate jeopardy and are in danger of disappearing from the state. This includes all species classified as endangered by the federal government which occur in Indiana. Plants currently known to occur on five or fewer sites in the state are considered endangered.[1]

Threatened: Any species likely to become endangered within the foreseeable future. This includes all species classified as threatened by the federal government which occur in Indiana. Plants currently known to occur on six to ten sites in the state are considered threatened.[2]

Rare: Plants and insects currently known to occur on from eleven to twenty sites.[3]

This includes 9 species of mollusks, 5 reptiles, 6 birds, 3 mammals, and 8 plants. Of these, four are federally listed as endangered: the Indiana Bat (Myotis sodalist), the Northern Riffleshell Rangiana (Epioblasma torulosa), the Clubshell (Pleurobema clava), and the Running Buffalo Clover (Trifolium stoloniferum).

1 Indiana County Endangered, Threatened and Rare Species List
2 Indiana County Endangered, Threatened and Rare Species List
3 Indiana County Endangered, Threatened and Rare Species List

TABLE 2.8: Delaware County Endangered Species

Species Name	Common Name	Federal	State	GRANK	SRANK
Mollusk: Bivalvia (Mussels)					
Alasmidonta viridis	Slippershell Mussel			G4G5	S2
Epioblasma turulosa rangiana	Northern Riffleshell	LE	SE	G2T2	S1
Lampsilis fasciola	Wavyrayed Lampmussel		SSC	G4	S2
Pleurobema clava	Clubshell	LE	SE	G2	S1
Pleurobema cordatum	Ohio Pigtoe		SSC	G3	S2
Ptychobranchus fasciolaris	Kidneyshell		SSC	G4G5	S2
Toxolasma lividus	Purple Lilliput		SSC	G2	S2
Toxolasma parvum	Lilliput			G5	S2
Villosa fabalis	Rayed Bean	C	SSC	G1G2	S1
Reptile					
Clemmys guttata	Spotted Turtle		SE	G5	S2
Clonophis kirtlandii	Kirtland's Snake		SE	G2	S2
Emydoidea blandingii	Blanding's Turtle		SE	G4	S2
Sistrurus catenatus catenatus	Eastern Massasauga	C	SE	G3G4	S2
Thamnophis butleri	Butler's Gartner Snake		SE	G4	S1
Bird					
Ardea herodias	Great Blue Heron			G5	S4B
Botaurus lentiginosus	American Bittern		SE	G4	S2B
Lanius ludovicianus	Loggerhead Shrike	NS	SE	G4	S3B
Nyctanassa violacea	Yellow-crowned Night-heron		SE	G5	S2B
Nycticorax nycticorax	Black-crowned Night-heron		SE	G5	S1B
Rallus eleganus	King Rail		SE	G4	S1B
Mammal					
Lynx rufus	Bobcat	NS		G5	S1
Myotis sodalis	Indiana Bat or Social Myotis	LE	SE	G2	S1
Taxidea taxus	American Badger			G5	S2
Vascular Plant					
Carex alopecoidea	Foxtail Sedge		SE	G5	S1
Glyceria borealis	Small Floating Manna-grass		SE	G5	S1
Matteuccia struthiopteris	Ostrich Fern		S	G5	S2
Silene regia	Royal Catchfly		ST	G3	S2
Trichostema dichotomum	Forked Bluecurl		SR	G5	S2
Trifolium stoloniferum	Running Buffalo Clover	LE	SE	G3	S1
Valerianella chenopodiifolia	Goose-foot Corn-salad		SE	G5	S1
Wisteria macrostachya	Kentucky Wisteria		SR	G5	S2
Forest - flatwoods central till plain	Central Till Plain Flatwoods		SG	G3	S2

SOURCE: Indiana County Endangered, Threatened and Rare Species List

INVENTORY

Exotic and Invasive Species

WMP - CHAPTER 2 - PART 1 - SECTION 2 - SUBSECTION 12

Exotic and invasive species are prevalent throughout the state of Indiana. Their presence throughout the watershed and their potential impacts on high quality natural communities and regional species are of concern to stakeholders.

Individuals are especially concerned about the prevalence of garlic mustard, Norway Maple, honeysuckle species, and invasive fish species such as carp on the White River. Honeysuckle, in particular, have been documented to increase surface erosion due to shade suppression of understory species.

Exotic species are defined as non-native species, while invasive species are those species whose introduction can cause environmental or economic harm and/or harm to human health. Thousands of dollars are spent annually controlling exotic and/or invasive species populations within both publicly-owned natural areas and on privately-owned land. The threat of exotic and invasive species is continuously evolving. [1]

Invasive plant species are a threat to natural areas. They displace native plants, eliminate food and cover for wildlife, and threaten rare plant and animal species. Many agencies and organizations have joined together to form the Invasive Plant Species Assessment Working Group (IPSAWG) to assess which plant species threaten natural areas in Indiana and develop recommendations regarding the use of that specific plant species. The IPSAWG's goal is for all partner agencies and organizations to utilize the species assessment when recommending or selling plants. [2]

In 2007, the State of Indiana established a task force to (1) study the economic and environmental impacts of invasive species in Indiana and (2) provide findings and recommendations on strategies for prevention, early detection, control and management of invasive species to minimize these impacts. [3]

1 Wabash River (Region of the Great Bend) WMP
2 Wabash River (Region of the Great Bend) WMP
3 Indiana DNR (http://www.in.gov/dnr/files/is_Task_force_list.pdf)

Nuisance Wildlife

WMP - CHAPTER 2 - PART 1 - SECTION 1 - SUBSECTION 13

Canada geese are a particular problem within the watershed, specifically for areas along the White River Liner Park System. As stated by the DNR, many people enjoy seeing Canada geese, but problems can occur when too many geese concentrate in one area. [1]

The Starpress, the local Muncie newspaper, has recently written op-ed pieces questioning the impacts that nuisance wildlife has on the community and overall health of streams. Canada geese can contribute to excessive fecal matter to streams (three geese equal the daily waste equivalent of one human) and their presence is an indicator of mismanaged stream habitat.

Typically, developers and landowners unknowingly cause the problem by creating ideal goose habitat. Geese are grazers and feed extensively on fresh, short, green grass. A permanent body of water adjacent to their feeding area will create the ideal stable environment for geese to set up residence, multiply and concentrate. Geese, including their young, also have a strong tendency to return to the same area year after year.[2]

The problem is further exacerbated when well-intentioned people purposefully feed geese. Artificial feeding of geese tends to concentrate larger numbers of geese in areas that under normal conditions would only support a few geese. Artificial feeding can also disrupt normal migration patterns and hold geese in areas longer than what would be normal. With an abundant source of artificial food available, geese can devote more time to locating nesting sites and mating. Artificial feeding can also concentrate geese on adjacent properties where their presence may not be welcomed, resulting in neighbor/neighborhood conflicts. [3]

Congregating geese can cause a number of problems. Damage to landscaping can be significant and expensive to repair or replace, while large amounts of excrement can render swimming areas, parks, golf courses, lawns, docks, and patios unfit for human use. Since geese are active grazers, they are particularly attracted to lawns and ponds located near apartment complexes, houses, office areas and golf courses. Geese can rapidly denude lawns, turning them into barren, dirt areas. Most of the problems in metropolitan areas occur from March through June during the nesting season. Breeding pairs begin nesting in late February and March. Egg-laying begins soon after nest construction is complete. [4]

1 Geist Reservoir/Upper Fall Creek WMP
2 Geist Reservoir/Upper Fall Creek WMP
3 Geist Reservoir/Upper Fall Creek WMP
4 Geist Reservoir/Upper Fall Creek WMP

SECTION THREE - SOIL CHARACTERISTICS

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP CHAPTER 2

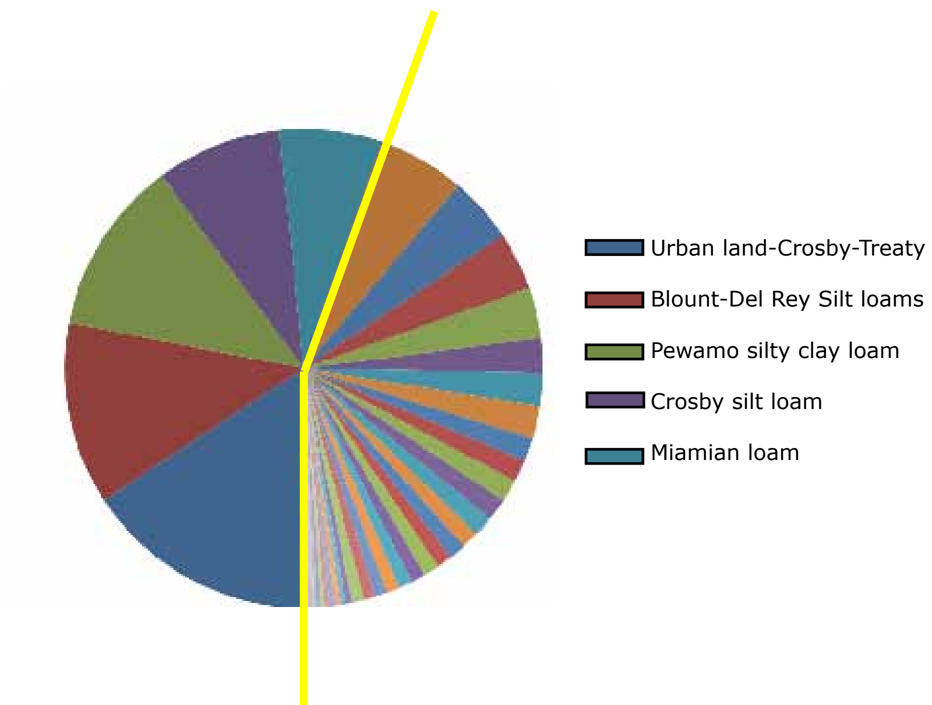
Soil Characteristics

WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 1

There are hundreds of different soil types located within the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds. These soil types are delineated into soil associations by their unique characteristics such as slope, drainage, and water. A soil association is a geographic area consisting of landscapes on which soils are formed. Soil associations are groups of soil types that generally share one or more common characteristics, such as parent material or drainage capability. The watershed is covered by 44 core soil types with six associations individually accounting for 55% of the total watershed area. The Urban-Crosby, Blount, Pewamo, Crosby, and Miamian soils associations make up the largest percentage of the watersheds. These soil types will be referenced as the Dominant Soil Associations. These main soil types have limited use for septic systems, due to a higher percentage of septic failure in areas with these soil types. The Treaty soil type is the only soil that is considered hydric (see hydric). Some specific soil characteristics of interest, including hydric soils, highly erodible soils, and septic limitations are detailed in later sections.[1]

These soil associations provide general characteristics for the specific soil association, and can be used for conceptual locations of best management practices. Information pertaining to the clay content, permeability and even groundwater characteristics are helpful when identifying locations that are feasible for infiltration practices or other best management practices to improve the water quality within the watershed. It should be noted that soil tests in these specific areas should be performed for more project specific detailed information.

The data source for the Soil Association Map is from the Department of Agriculture Soil Associations in Indiana GIS shape file with a published date of December 2002.



CHA. 2.7 Dominant Soil Associations

1 Web Soil Survey

Dominant Soil Associations
WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 2

Urban land-Crosby-Treaty complex
These soils accompany 3205.919 acres, with 16% predominantly urban. Urban soil types are those that have undergone major alterations from human activity. They are typically covered with parking lots and buildings. These soils take on the characteristics of their parent soil, but modification from humans has a major affect on their characteristics, which varies from site to site (USDA, 2004). Urban soils are somewhat poorly drained, but may be prime farmland if drained.[1]

Blount-Del Rey silt loams
Both of these soils are prime farmland if drained, and both are very limited in their septic use. The Blount types are somewhat poorly drained, non hydric, and are subject to slight erosion. Similar soils: Soils that have less than 35 percent clay in the subsoil, Soils in which the depth to dense till is more than 48 inches and in areas of the Blount soil; soils that have stratified outwash deposits in the profile. Dissimilar soils: the poorly drained Pewamo soils in open depressions; the very poorly drained Milford-till substratum-soils in closed depressions; the moderately well drained, moderately eroded glynwood soils on microhighs which are somewhat poorly drained and prime farmland if drained.[2]

Pewamo silty clay loam
Pewamo soils are good as farmland if drained, and are very limited in their septic use. The Pewamo types are poorly drained, hydric, and also suffer from slight erosion. Similar soils: soils that have a surface layer that is less than 10 inches thick and soils that have 8 to 15 inches of lighter colored overwash. Dissimilar soils: the somewhat poorly drained Blount and Del Rey soils on summits); the very poorly drained Millgrove soils in microlows of open depressions; the poorly drained Pella soils in closed depressions, The very poorly drained Milford, till substratum, soils in closed depressions; the very poorly drained Muskego-undrained- soils in closed depressions; and areas of undrained mineral soils in closed depressions, mostly in woodlands.[3]

Crosby silt loam
Similar soils: soils that have less than 35 percent clay in the argillic horizon; soils in which the depth to dense till is more than 40 inches; and soils that have layers of outwash or lacustrine, deposits overlying the till. Dissimilar soils: the moderately well drained Williamstown soils on microhighs on summits; the somewhat poorly drained Del Rey soils in microlows on summits; the poorly drained Treaty soils in open depressions; and the moderately well drained Miamian soils on gently sloping shoulders (Soil Survey of Delaware County Indiana. US Department of Agriculture).[4]

Miamian loam
Similar soils: soils that have less than 35 percent clay in the subsoil; soils that have 12 to 36 inches of outwash overlying the till; soils in which the depth to dense till is more than 40 inches. Dissimilar soils: the well drained Belmore soils on gently sloping shoulders; the well drained Mount Pleasant soils on gently sloping shoulders; the somewhat poorly drained Crosby soils on nearly level summits; and the moderately well drained, severely eroded Losantville soils on backslopes. (USGS)

1 Web Soil Survey
2 Web Soil Survey
3 Web Soil Survey
4 Web Soil Survey

Dominant Soil Associations

WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 4

According to the USGS soil survey, there are over forty-four soils types in the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds. Of these types, eight constitute 69% of the Subwatersheds. These eight types are represented in Table 2.9 and represented collectively as yellow in MAP 2.21. All other soils types are represented collectively as purple and presented on the following page in Table 2.10.

Soils are also represented in MAP 2.22 according to their NRCS Hydrologic Soil Groups Classification. These classifications are based on the soil's runoff potential and are grouped as A, B, C and D. A's generally have the smallest runoff potential and Ds the greatest.

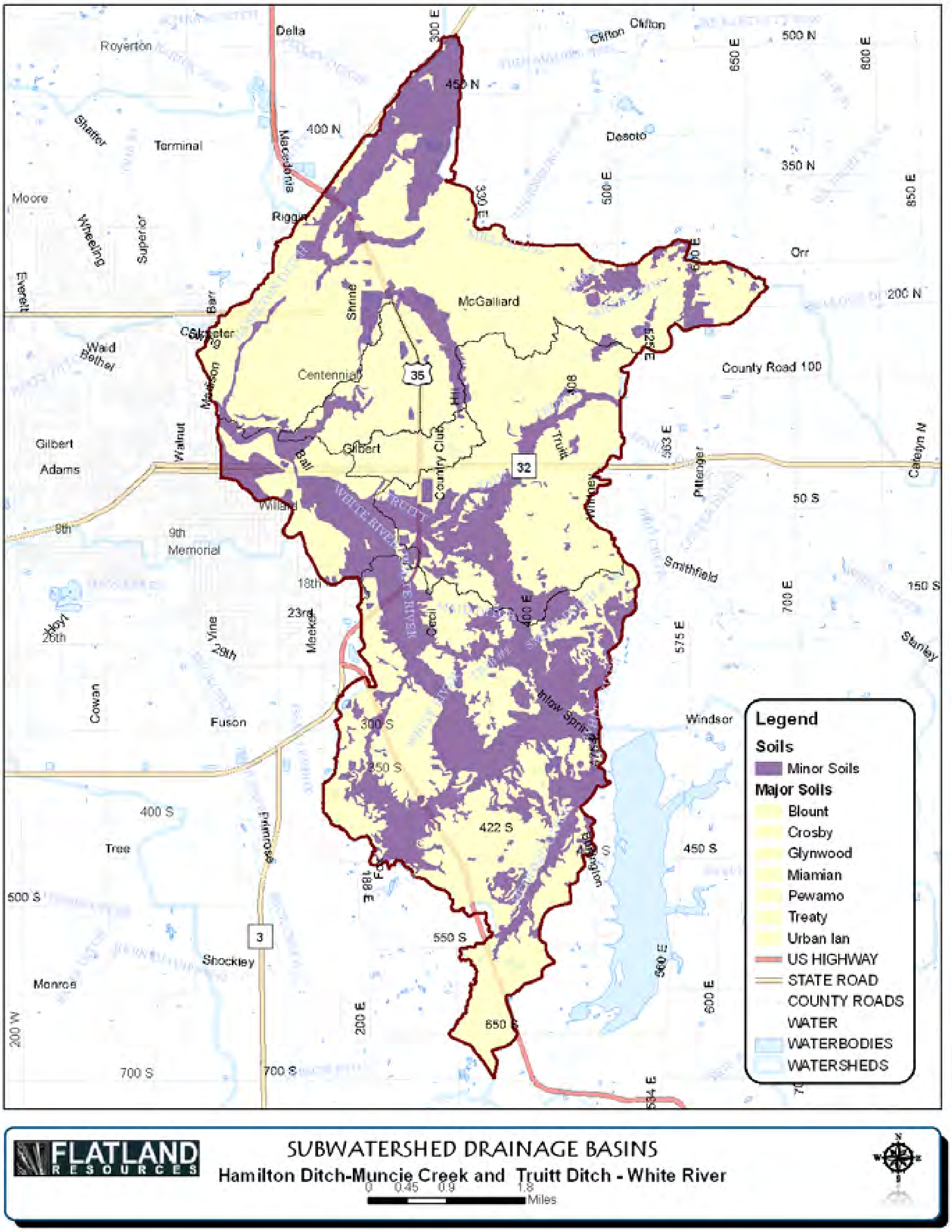
> "Group A is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
>
> Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
>
> Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
>
> Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material."[1]

TABLE 2.9: Dominant Soil Associations

Abbrv.	Soil Name	Acres	%
UccA	Urban land-Crosby-Treaty complex, 0 to 2 percent slopes	3205.919	16%
BmlA	Blount-Del Rey silt loams, 0 to 1 percent slopes	2509.408	12%
PkkA	Pewamo silty clay loam, 0 to 1 percent slopes	2410.159	12%
CudA	Crosby silt loam, 0 to 2 percent slopes	1728.012	8%
MoeB2	Miamian loam, 1 to 5 percent slopes, eroded	1424.959	7%
GlrB2	Glynwood silt loam, 1 to 4 percent slopes, eroded	1185.787	6%
ThrA	Treaty silty clay loam, 0 to 1 percent slopes	910.9704	4%
BltA	Blount silt loam, 0 to 2 percent slopes	801.3442	4%

SOURCE: Web Soil Survey

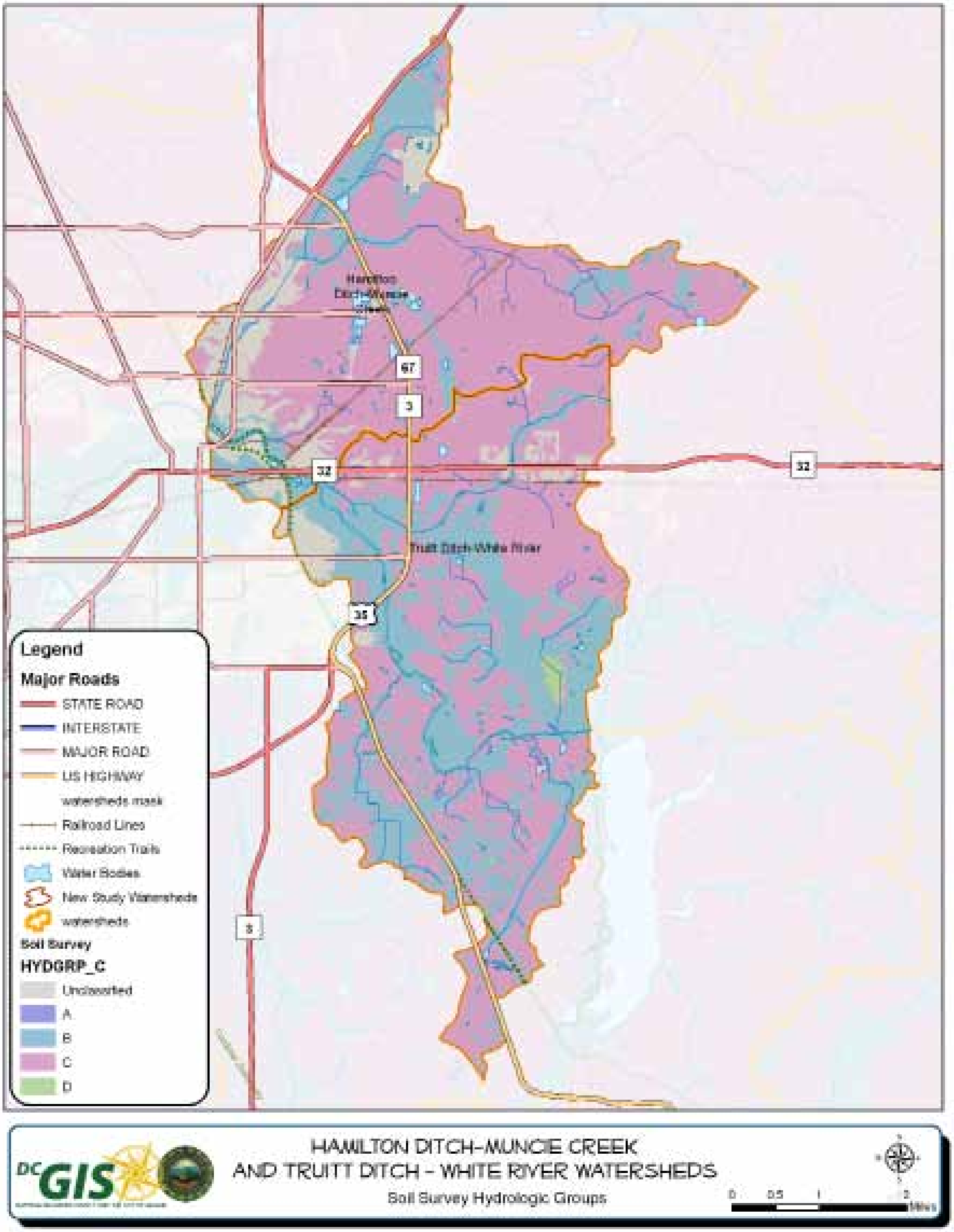
1 Natural Resource Conservation Service, United States Department of Agriculture, Technical Release–55.



MAP. 2.21 Dominant Soil Associations

TABLE 2.10: Inventory of Minor Soil Groups			
Abbrv.	Soil Name	Acres	%
MryA	Millgrove silty clay loam, 0 to 1 percent slopes	693.0557	3%
ReyA	Rensselaer loam, 0 to 1 percent slopes	471.4656	2%
FgoB2	Fox-Muncie complex, 2 to 6 percent slopes, eroded	455.7407	2%
MecA	Martinsville loam, 0 to 2 percent slopes	452.2533	2%
BdlC2	Belmore loam, 6 to 12 percent slopes, eroded	317.5489	2%
MphA	Milford silty clay loam, stratified sandy substratum, 0 to 1 percent slopes	310.0925	2%
Uam	Udorthents, loamy	303.6377	1%
DdxA	Digby-Haney silt loams, 0 to 1 percent slopes	302.8224	1%
MvxA	Mountpleasant silt loam, 0 to 2 percent slopes	275.7508	1%
FexB2	Fox loam, 2 to 6 percent slopes, eroded	243.4605	1%
PgaA	Pella silty clay loam, 0 to 1 percent slopes	227.1152	1%
ObxA	Ockley silt loam, 0 to 2 percent slopes	215.8506	1%
SnlA	Southwest silt loam, 0 to 1 percent slopes	215.5479	1%
W	Water	196.5221	1%
GlnAH	Gessie-Eel silt loams, 0 to 1 percent slopes, frequently flooded, brief duration	184.3782	1%
LshC3	Losantville clay loam, 5 to 10 percent slopes, severely eroded	183.6972	1%
RrwB	Rawson loam, 1 to 5 percent slopes	165.4414	1%
SmsAH	Sloan silt loam, 0 to 1 percent slopes, frequently flooded, brief duration	162.7757	1%
Pmg	Pits, gravel	157.6533	1%
RroAH	Ross-Lash loams, 0 to 1 percent slopes, frequently flooded, brief duration	91.00208	0%
HtbAu	Houghton muck, undrained, 0 to 1 percent slopes	75.23479	0%
MvbC3	Morley-Mississinewa clay loams, 5 to 10 percent slopes, severely eroded	74.22328	0%
CdgC3	Casco sandy clay loam, 6 to 15 percent slopes, severely eroded	71.00009	0%
SgmAH	Shoals silt loam, 0 to 1 percent slopes, frequently flooded, brief duration	68.21214	0%
LneAW	Lickcreek silt loam, 0 to 3 percent slopes, occasionally flooded, very brief duration	58.80764	0%
LdfAH	Lash loam, 0 to 1 percent slopes, frequently flooded, brief duration	55.29421	0%
SvsE2	Strawn-Belmore loams, 15 to 30 percent slopes, eroded	36.78916	0%
EdxB2	Eldean silt loam, 2 to 6- percent slopes, eroded	27.59103	0%
BdsAN	Benadum silt loam, drained, 0 to 1 percent slopes	23.01658	0%
Pml	Pml—Pits, quarry	21.04004	0%
MorA	Milford mucky silty clay, pothole, 0 to 1 percent slopes	14.92274	0%
LshD3	LshD3—Losantville clay loam, 10 to 15 percent slopes, severely eroded	14.15701	0%
MumC2	Morley silt loam, 5 to 10 percent slopes, eroded	13.2358	0%
GlyB3	Glynwood-Mississinewa clay loams, 2 to 6 percent slopes, severely eroded	12.93883	0%
BdhAH	Bellcreek silty clay loam, 0 to 1 percent slopes, frequently flooded, brief duration	6.123329	0%
MwzAU	Muskego muck, undrained, 0 to 1 percent slopes	1.919829	0%

SOURCE: Web Soil Survey



MAP. 2.22 Hydric Soil Groups

INVENTORY

Highly Erodible Soils

WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 5

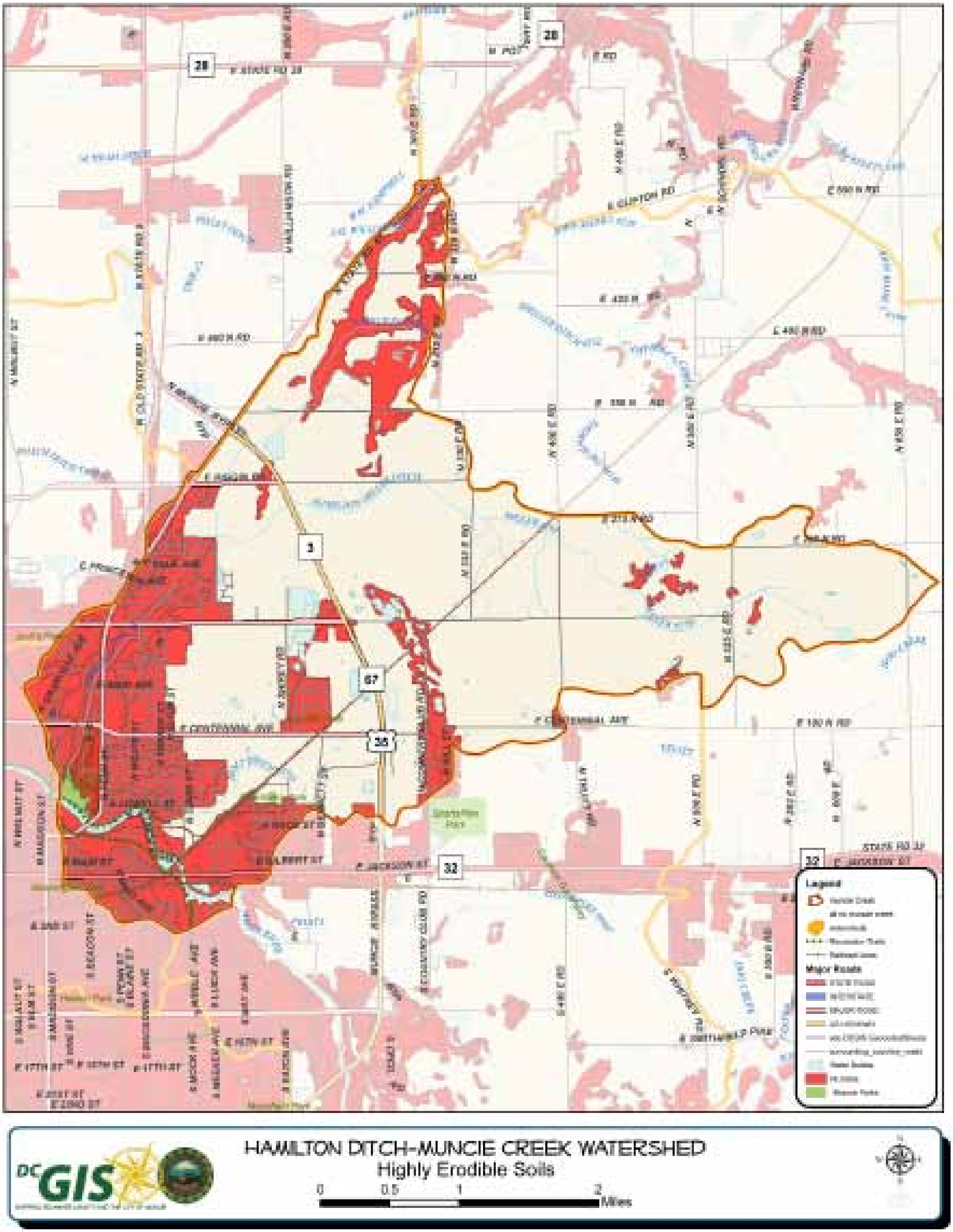
Soils that are transported through storm water runoff across the landscape have negative impacts on ecosystems and result in degraded water quality, limited recreational use, and impaired aquatic habitat and health. Soils carry attached nutrients, pesticides, and herbicides. These can result in impaired water quality by increasing plant and algae growth, killing aquatic life, or damaging water quality. [1]

The NRCS uses soil texture and slope to classify soils into those that are considered highly erodible, potentially highly eroded, and non-erodible. The classification is based on an erodibility index which is determined by dividing the potential average annual rate of erosion by the soil unit's soil loss or tolerance value (T value). The T value is the maximum annual rate of erosion that occurs for a particular soil type without causing a decline in long-term productivity. Potentially highly erodible soil determinations are based on the slope steepness and length in addition to the erodibility index value.[2]

The actual potential for these soils to erode is based on the slope steepness and length of slope; erodibility can only be determined through field investigations.

The United States Department of Agriculture (USDA) and the National Resources Conservation Service (NRCS) have begun to update the 1985 survey of soil types. However, due to a policy decision, the Highly Erodible Soils data has not been updated. This has led WRWP planners to incorporate the old HES data into the new soil units through the GIS data. As such, these do not constitute official HEL (HES) determinations for Farm Bill Programs.

1 Tom Reeve, White River Watershed Project, White River Watershed Project
2 Tom Reeve, White River Watershed Project, White River Watershed Project



MAP. 2.23 Highly Erodible Soils

Highly Erodible Soils (cont.)

WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 6

Erosion is a natural process within stream ecosystems; however, excessive erosion negatively impacts the health of the watershed. Erosion throughout the watershed increases sedimentation of the streambeds, which impacts the quality of habitat for fish and other organisms. As water flows over land and enters the stream it carries pollutants and other nutrients that are attached to the sediment. Sediment suspended in the water blocks light needed by plants for photosynthesis and clogs respiratory surfaces of aquatic organisms. [1]

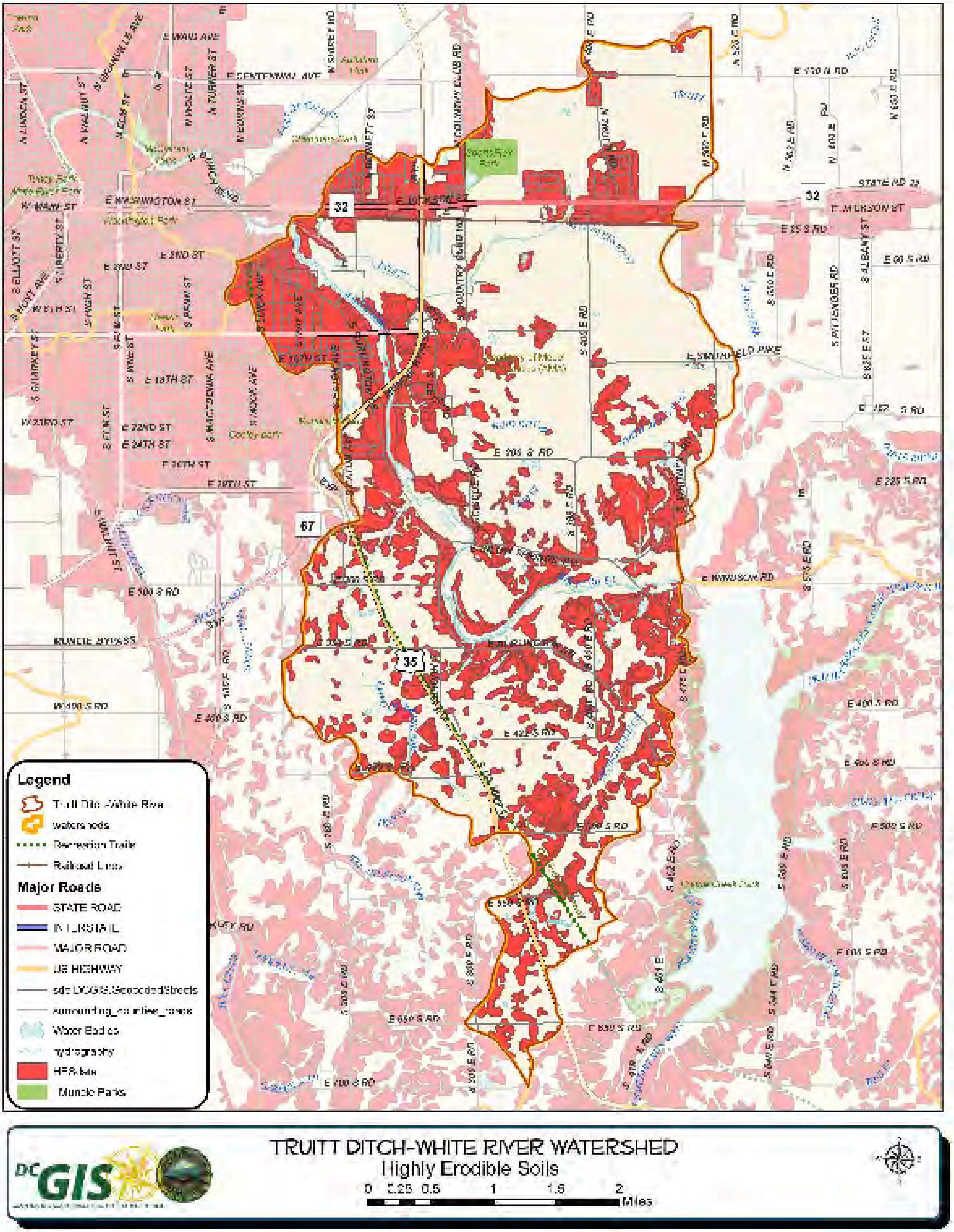
Therefore, erosion also impacts water quality as it increases nutrients and decreases water clarity. Highly erodible land (HEL) and potentially highly erodible soils in the Subwatersheds are mapped in MAP 2.23 and MAP 2.24. [2]

Highly erodible soils are also especially susceptible to the eroding forces of wind and water. Wind erosion is common in flat areas where vegetation is sparse or where soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing productive top soil from one place and depositing it in another. [3]

In areas with highly erodible soils, special care must be taken to insure that land use practices do not result in severe wind or water erosion. Although natural erosion cannot be prevented, the effects of runoff can be moderated so that it does not diminish the health of the watershed. There are no specific requirements for developments within highly erodible soils. However, IDEM's Rule 5 regulates storm water discharges during construction where temporary best management practices are required (until construction activities are completed and the site has been stabilized) as to not impact receiving waters with sediment.[4] Additionally, no-till practices (and other BMPs) in the agricultural community has been documented to reduce sheetflow and rill erosion.

Of a total of 8,602 acres in the Hamilton Ditch-Muncie Creek watershed, 2,393 of them (27.8%) have highly erodible soils (MAP 2.23). Of a total of 11,781 acres in the Truitt Ditch-White River watershed, 3,662 of them (31.0%) have highly erodible soils (MAP 2.24). Depending on the type of land use associated with these areas, varying NPS water pollution issues can become issues of concern.

1 Geist Reservoir/Upper Fall Creek WMP
2 Geist Reservoir/Upper Fall Creek WMP
3 Geist Reservoir/Upper Fall Creek WMP
4 Geist Reservoir/Upper Fall Creek WMP



MAP. 2.24 Highly Erodible Soils

Hydric Soils

WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 7

Hydric soils are soils that, due to prolonged hydration, change on a chemical-biological level through natural processes. Once a soil takes on hydric characteristics, it retains those characteristics even after the soil is drained. [1] The changes in the soils are not easily reversed when drained and therefore typically can be identified as hydric soils post drained. A majority of hydric soils found in the watershed are located along river corridors in the non urban areas. Because these soils are considered to have developed under wetland conditions, they are a good indicator of historic wetland locations.[2]

Legal drains (controlled by the County drainage board), agricultural tilling (controlled by Producers) and urban stormwater systems have drained wetlands and continue to keep wetlands drained.

Hydric soils that have been converted to other uses should be capable of being restored to wetlands. However, a large majority of the soils in the watershed have been drained for either agricultural production or urban development. Removing the subsurface drainage systems would allow for restoration of these wetland areas. [3]

The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology. Criteria for each of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. [4]

Of the 8,602 acres in Muncie Creek Watershed, 2,512 acres are considered to contain hydric soils (29.0%). In general, hydric soils in the Muncie Creek Watershed surround the waterways (MAP 2.25). Aerial orthophotographs show large areas of hydric soils in the upper reaches of the watershed as evidenced by the presence of darker than normal soils. These findings are typical of the area; Delaware County has a large number of agricultural areas that have high water tables, and shows evidence of being a wetland in the past.[5]

Out of the 11,781 acres in Truitt Ditch Watershed, 3,011 acres are considered to have hydric soils (25.6%). In general, hydric soils in the Truitt Ditch watershed follow the paths of the existing waterways (MAP 2.26). Additionally, there is a major section of hydric soils in the northern part of the watershed that appears to follow the original path of what is now called Truitt Ditch. Aerial views of the area show soils in a drained agricultural field that is dark in color. Additional areas of hydric soils are located in the southern portion of the watershed.[6]

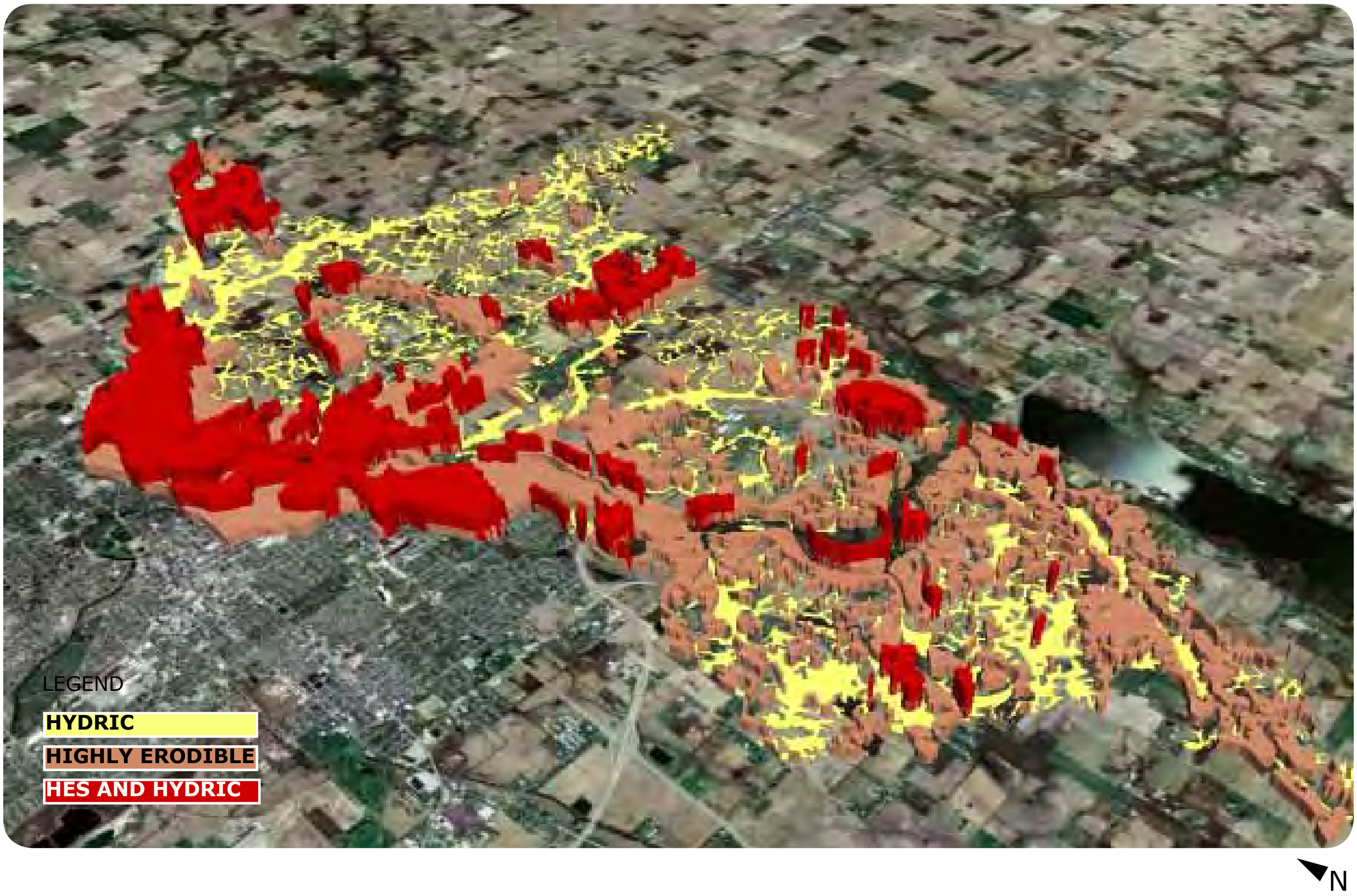
1 Geist Reservoir/Upper Fall Creek WMP
2 Tom Reeve, White River Watershed Project
3 Geist Reservoir/Upper Fall Creek WMP
4 Geist Reservoir/Upper Fall Creek WMP
5 Tom Reeve, White River Watershed Project
6 Tom Reeve, White River Watershed Project

MAP. 2.25 Hydric Soils

INVENTORY

HES and Hydric Soils

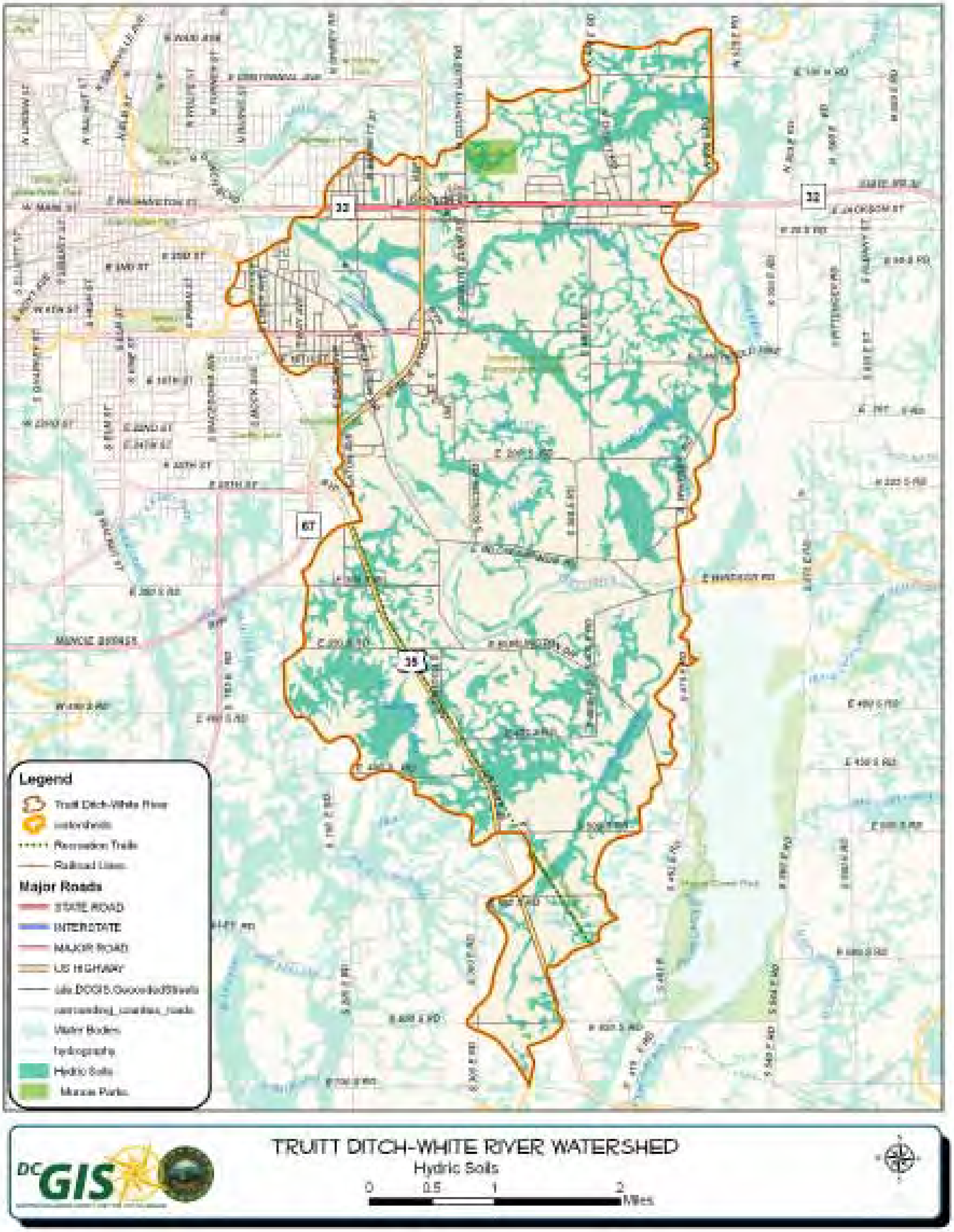
WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 8



DIA. 2.2 HES and Hydric Soil Relationship (see description below)

The White River Watershed Project stakeholders are concerned about both Hydric and Highly Erodible Soils. The above diagram compares the location of Highly Erodible Soils (salmon) and Hydric soils (yellow). The red areas designate soils that are considered both hydric and highly erodible. These types of comparisons aid the WRWP in determining critical areas for sediment.

Since hydric soils are typically soil types that were once wetlands (and sometimes also riparian zones) they are important to preserve and restore when feasible (i.e. when both environmental and agronomy needs are met). Restored wetlands along riparian zones help prevent the flow of HES soil from agricultural and urban land into river systems.



MAP. 2.26 Hydric Soils

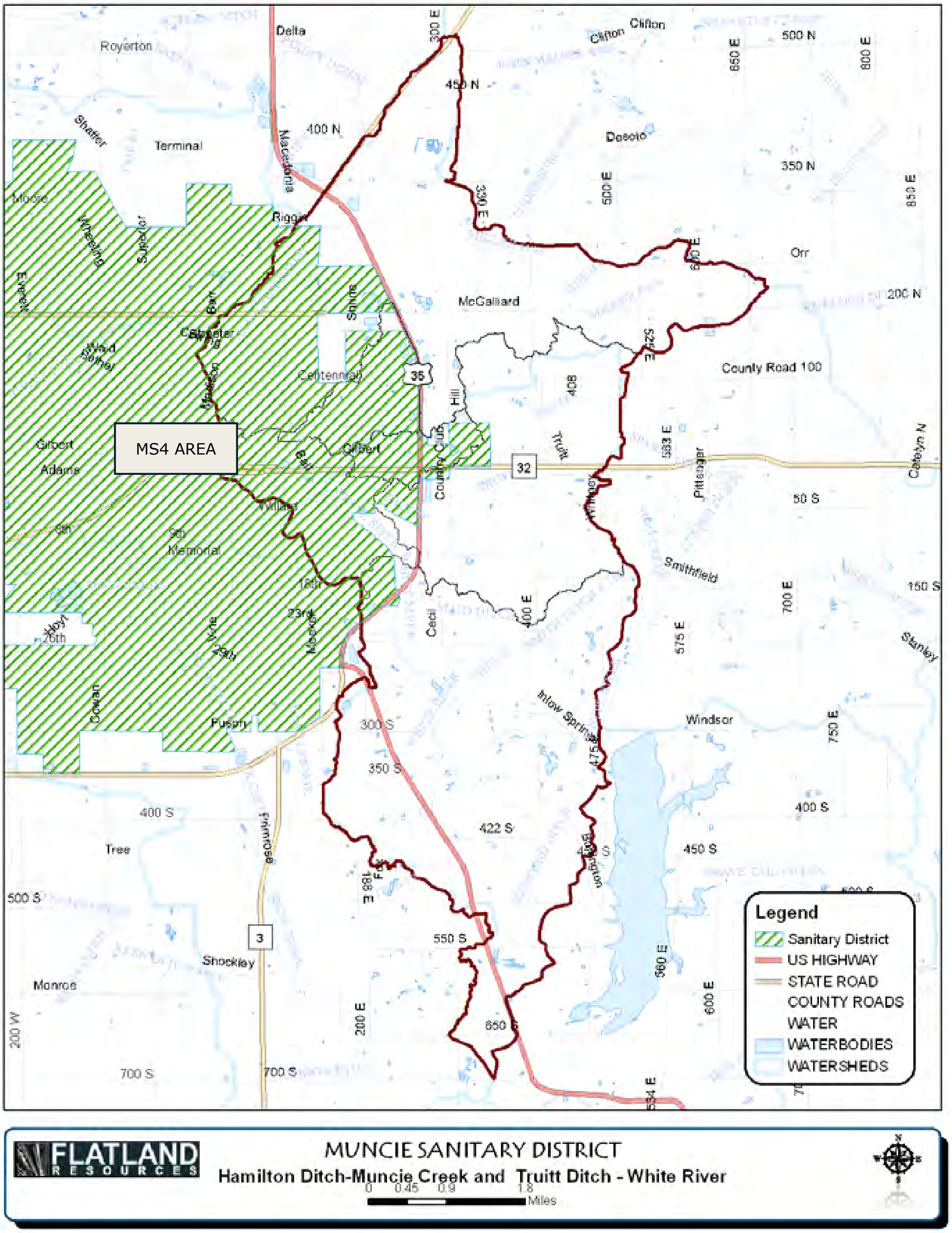
Waste Water Treatment
WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 9

"The Muncie Sanitary District owns and operates a 24 MGD activated sludge water pollution control facility. The facility treats domestic, commercial & industrial wastewater to reduce biochemical oxygen demand (BOD), total suspended solids (TSS), nitrogen ammonia and E. coli prior to discharge into the receiving stream, the West Fork of the White River." [1]

"The main discharge outfall to the receiving stream is designated as outfall #21A. A secondary outfall used during excessive river levels or during maintenance to the tertiary facility is designated as outfall #30A. Treatment includes screening, grit removal, primary settling, aerobic activated sludge nitrification, final clarification/settling, & final tertiary filtration through mono media filters. Disinfection with gaseous chlorine and dechlorination with sulphur dioxide follows final filtration from April to November. In addition to the processes described above, sludge dewatering takes place with belt presses following anaerobic digestion/sludge stabilization. Ultimate sludge disposal is completed by transporting the dewatered sludge to a sanitary landfill." [2]

IMG. 2.1 Muncie Water Pollution Control Facility, MWPCF

1 Muncie Water Pollution Control Facility
2 Muncie Water Pollution Control Facility



MAP. 2.27 MS4 Relationship to Subwatersheds

INVENTORY

Unsewered Areas

WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 10

Throughout Indiana, households depend upon septic tank absorption fields to treat wastewater. Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. The only part that is evaluated is soil depths between 24 and 60 inches.

Septic waste treatment systems require soil characteristics and geology that allow gradual seepage of wastewater into the surrounding soils. (The key chemical processes governing the movement of particles from the effluent through the soil are ion exchange, adsorption, and chemical precipitation.[1]) Seasonal high water tables, shallow compact till and coarse soils present limitations for septic systems. While system design (i.e. perimeter drains, mound systems or pressure distribution) can often overcome these limitations sometimes, the soil characteristics prove to be unsuitable for any type of traditional septic system. Heavy clay soils require larger (and therefore more expensive) absorption fields; sandier, well-drained soils are often suitable for smaller, more affordable gravity-flow trench systems. [2]

Several unsewered areas were identified within the watershed. These areas generally consist of relatively concentrated housing units outside of the sanitary district boundaries. School buildings should be particularly observed, due to a high density of usage at these facilities throughout the year. There are many pollutants that enter the water system as the result of failed septic systems:

Nitrogen: The organic form of nitrogen is converted to the ammonium form due to anaerobic conditions in the septic tank.

Chlorides: Chlorides are very common and are naturally present in surface and groundwater, and are also found in wastewaters.

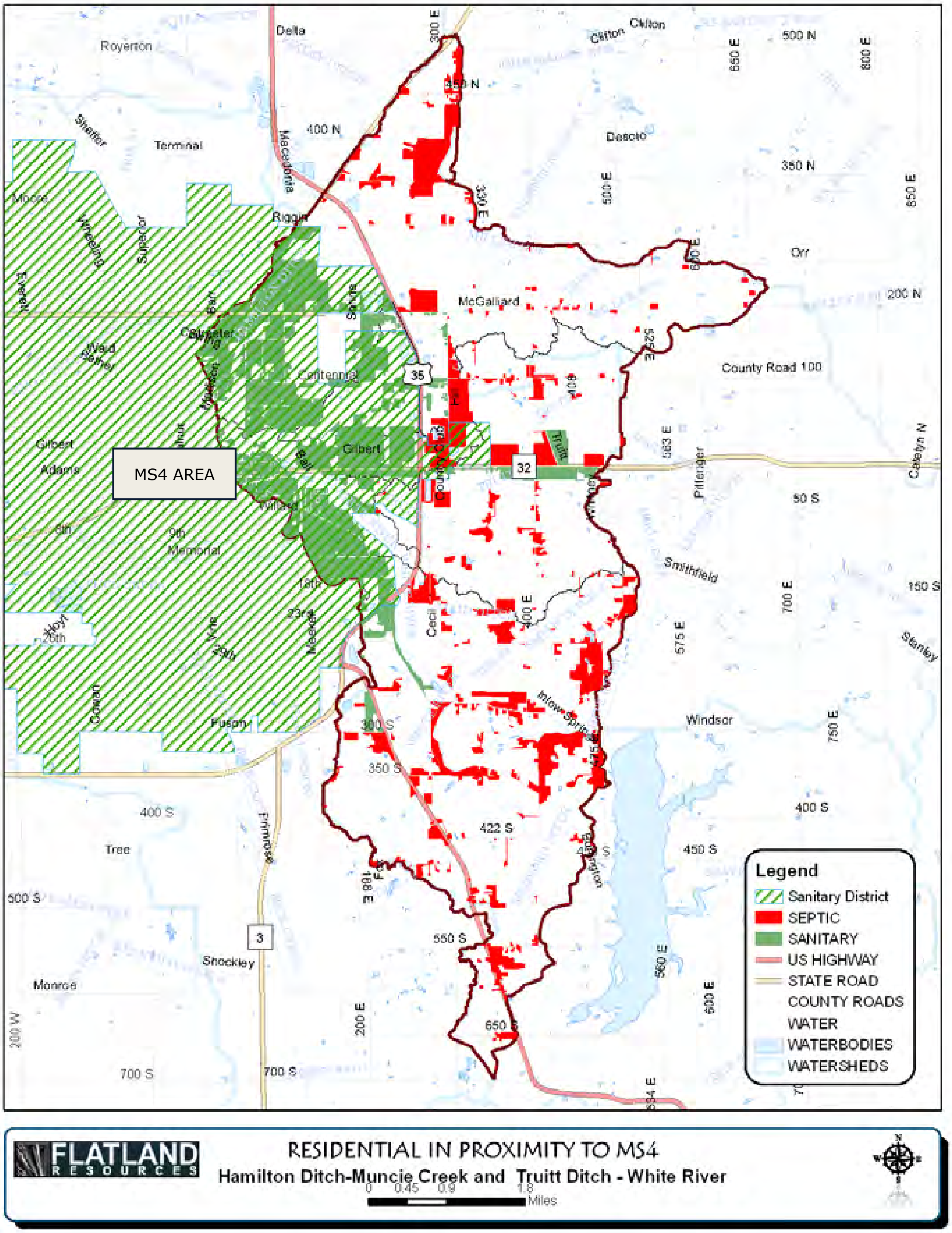
Phosphorus: Most of the influent phosphorus in the organic and phosphate forms are converted to soluble orthophosphate by the anaerobic process occurring in the septic tank. Usually phosphorus does not reach the groundwater because it is strongly retained in soils.

Metals: Metals in the effluents from septic tank systems may be responsible for the contamination of shallow water supply sources, especially where there is a high groundwater table.

Microorganisms: Microorganisms do not usually contaminate groundwater sources. The main limitation to movement of microbes through the soil is the physical filtration of bacteria and other microbes. This factor usually limits the travel distances. Soil conditions with limited nutrients and antagonistic organisms' secretions also determine the travel distances.

Septage: Septage is the mixture of sludge, fatty materials, and wastewater present in septic tanks. The septage is periodically pumped out by licensed companies. The concentrations of possible pollutants is high in septage. Septage has also been found to harbor disease-causing organisms. [3]

1 The Elkhart River Watershed Management Plan
2 Tom Reeve, White River Watershed Project,
3 Virginia Tech Department of Enviornmental Engineering



MAP. 2.28 Residential (red) not on Sanitary

Septic Tank Suitability

WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 11

Seven soil characteristics are utilized to determine suitability for on-site septic treatment including: position in the landscape, soil texture, slope, soil structure, soil consistency, depth to limiting layers, and depth to seasonal high water table. Septic tanks require soil characteristics that allow for gradual movement of wastewater from the surface into the groundwater. High water tables, shallow soils, compact till, and coarse soils all limit soil's abilities in their use as septic tank absorption fields. Specific system modifications are necessary to adequately address soil limitation. However, in some cases, soils are too poor for treatment and therefore prove inadequate for use in septic tank absorption fields. [1]

Soil ratings are determined by the NRCS. The ratings are both verbal and numerical. Each soil series is placed in one of three categories: severely limited, moderately limited, and slightly limited.

Severe limitations delineate areas whose soil properties present serious restrictions to the successful operation of a septic tank tile disposal field. Using soils with a severe limitation increases the probability of the system's failure and increases the costs of installation and maintenance.

Areas designated as having moderate limitations have soil qualities which present some drawbacks to the successful operation of a septic system. Correcting these restrictions will increase the system's installation and maintenance costs[2].

Slight limitations delineate locations whose soil properties present no known complications to the successful operation of a septic tank tile disposal field. Use of soils that are rated moderately or severely limited generally require special design, planning, and/or maintenance to overcome limitations and ensure proper function. [3]

Severely limited soils cover a majority of the watershed. In total, nearly 19,500 acres (of 20,000 acres) of the watershed is covered by soils that are considered severely limited for use in septic tank absorption fields. 500 acres are moderately to slightly limited (Chart 2.8).

CHA. 2.8 Percent of suitable soils

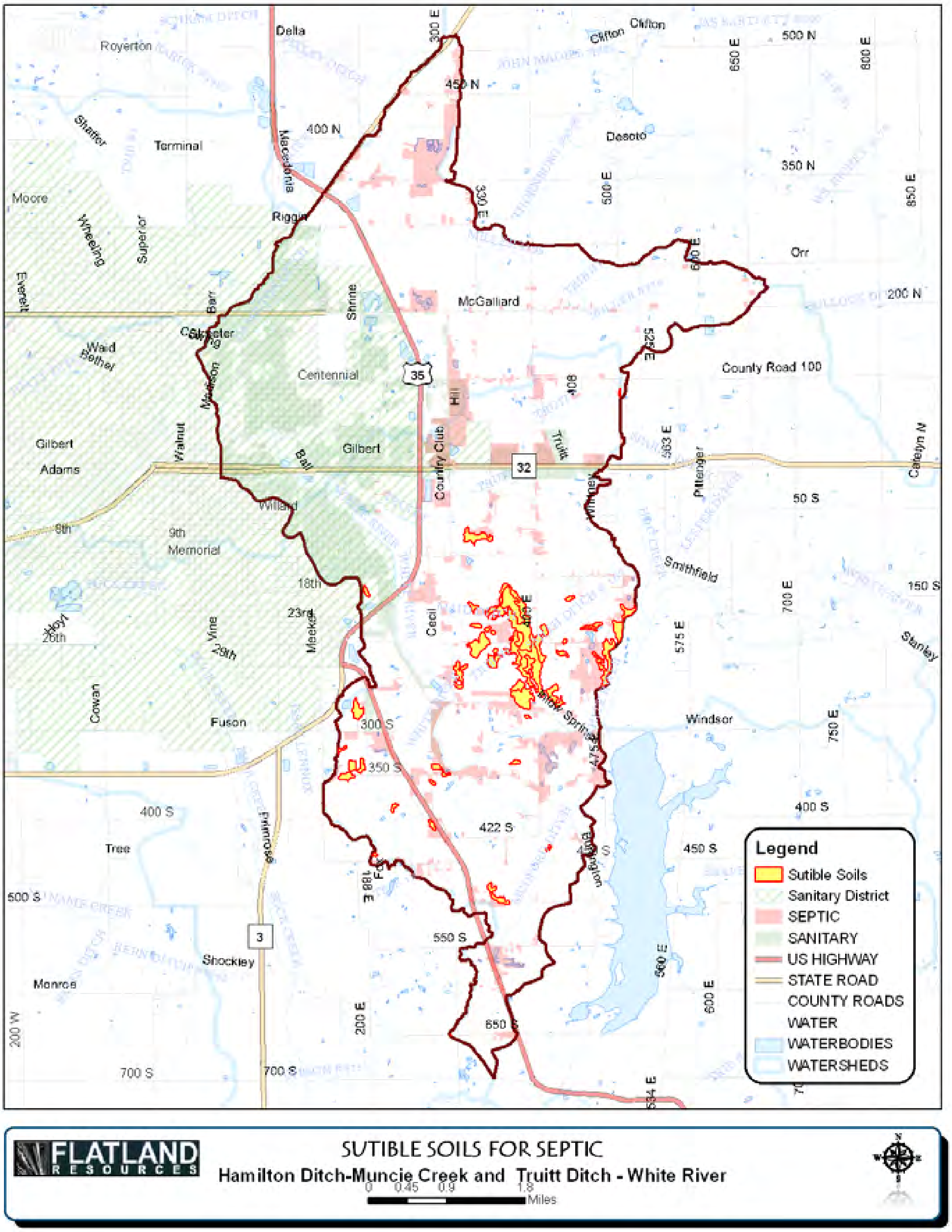
CHA. 2.9 <5% of Septic tanks on Suitable soils

TABLE 2.11: Acres of Soils Suitable for septic system (MecA only soils suitable according to USGS soil mapper)

Soil Type	Name	Acres
All Soil Types	Varies	19,924
MecA	Martinsville loam, 0 to 2 percent slopes	452

SOURCE: ArcGIS Indianamap.org

1 Wabash River (Region of the Great Bend) WMP
2 The valleys of the East Branch of LeBoeuf Creek
3 Wabash River (Region of the Great Bend) WMP



MAP. 2.29 Soils suitable for septic absorption fields

Septic Tank Failure

WMP - CHAPTER 2 - PART 1 - SECTION 3 - SUBSECTION 12

Because so little of the Subwatersheds are suitable for septic systems, watershed stakeholders are concerned. They are especially concerned about the perceived lack of maintenance associated with septic tanks, the use of soils that are not suited for septic treatment, and the presence of straight pipe systems within the watershed.

"The septic disposal system is considered failing when the system exhibits one or more of the following: the system refuses to accept sewage at the rate of design application thereby interfering with the normal use of plumbing fixtures; effluent discharge exceeds the absorptive capacity of the soil, resulting in ponding, seepage, or other discharge of the effluent to the ground surface or to surface waters; effluent is discharged from the system causing contamination of a potable water supply, ground water, or surface water." [1]

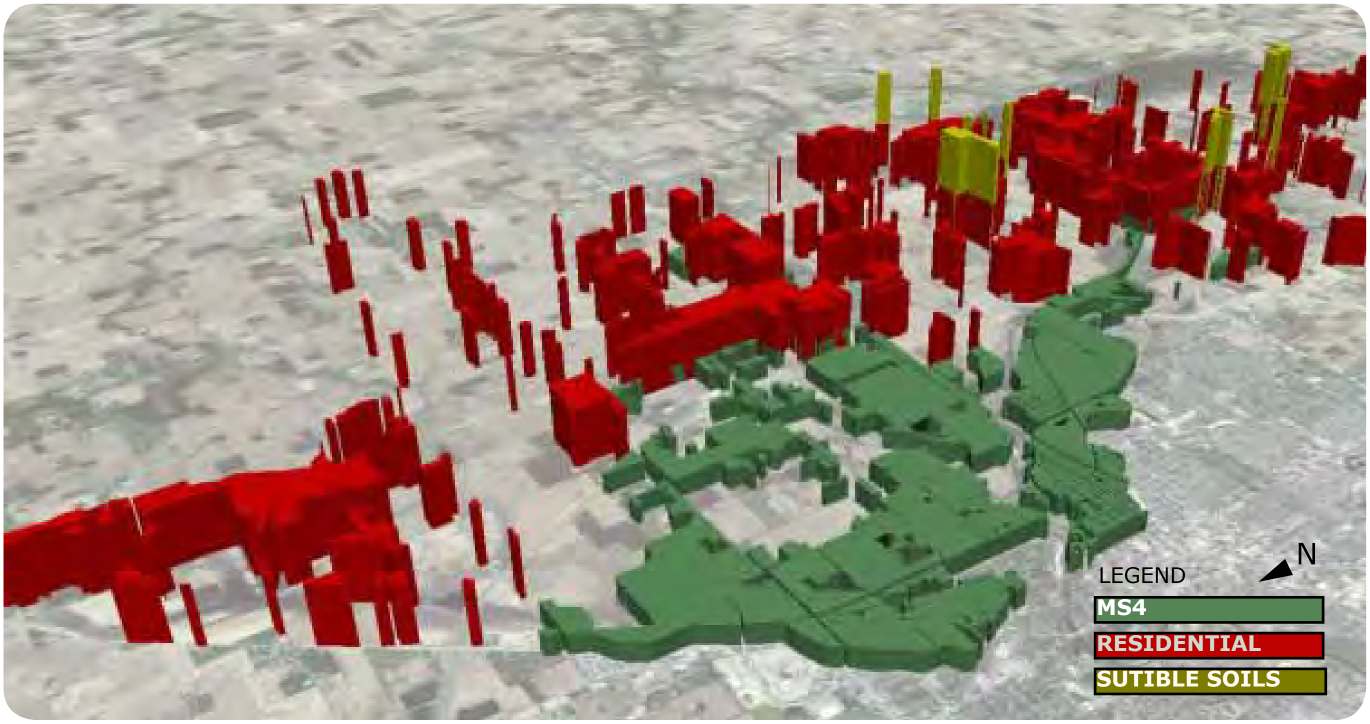
"Prior to 1990, residential homes on 10 acres or more of land --and at least 1,000 feet from a neighboring residence --did not have to comply with any septic system regulations. A new septic code in 1990 fixed this loophole but many of these homes still do not have functioning septic systems. The septic effluent from many of these older homes discharges into field tiles and eventually flows to open ditches. Unfortunately, the high cost of septic repair (typically from $5,000 to $15,000) has been an impediment to modernization." [2]

Current regulations address these issues and require that individual septic systems be examined for functionality. It is estimated that 76,650 gallons of untreated wastewater is expelled in the state of Indiana annually. The true impact of these systems on the water quality in the Subwatersheds cannot be determined without a complete survey of systems [3] as individual septic sites must be evaluated on a case-by-case basis to determine septic system suitability.

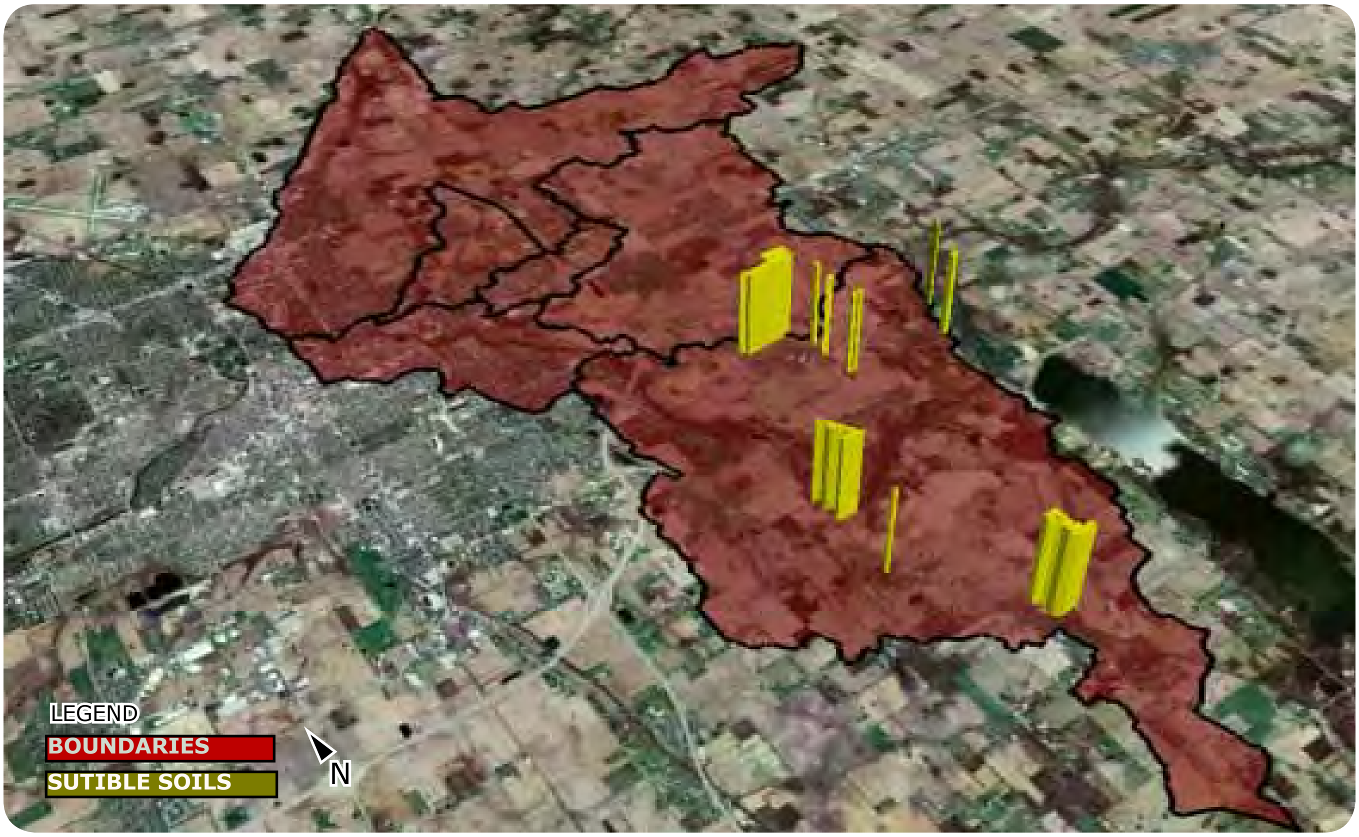
Additionally, newly constructed systems cannot be placed within the 100-year floodplain and systems installed at existing homes must be placed above the 100-year flood elevation. However, many residences grandfathered into this code throughout the state have not upgraded or installed fully functioning systems (Krenz and Lee, 2005). In these cases, septic effluent discharges into field tiles or open ditches and waterways and will likely continue to do so due to the high cost of repairing or modernizing systems.

Diagram (DIA) 2.3 shows the location of urban/residential areas (red) in proximity to suitable soils (yellow) and the Muncie Sanitary System (green) in the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds. Diagram 2.4 shows the location of suitable soils relative to the entire subwatershed(s) area.

1 Residential Onsite Swwage Systems, RULE 410 IAC 6-8
2 Geist Reservoir/Upper Fall Creek WMP
3 Kangen Water



DIA. 2.3 Septic Suitability Diagram (Red - on septic; Green - on sanitary - Yellow - suitable soils for septic)



DIA. 2.4 Diagram of Suitable Soil Types (yellow)

SECTION FOUR - HYDROLOGY

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP
CHAPTER 2

Hydrology and Drainage

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 1

The Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds contain more than 30 miles of streams, legal drains, and tile drains. The White River and major tributaries are used for boating, fishing, and full-body contact recreation.

The West Fork of the White River, and its largest tributaries—Prairie, Buck, Mud, and Bell Creeks—drain two-thirds of the county. Glaciation formed a number of eskers, kames, outwash plains, and glacial drainage channels within the till plain. Outwash plains and glacial drainage channels commonly bracket the rivers and their tributaries or, in places, are associated with eskers. In places, relief from the flood plain to the crest of the adjacent moraine is 40 to 50 feet. Some of the eskers are 30 to 40 feet above the adjacent till plain.[1]

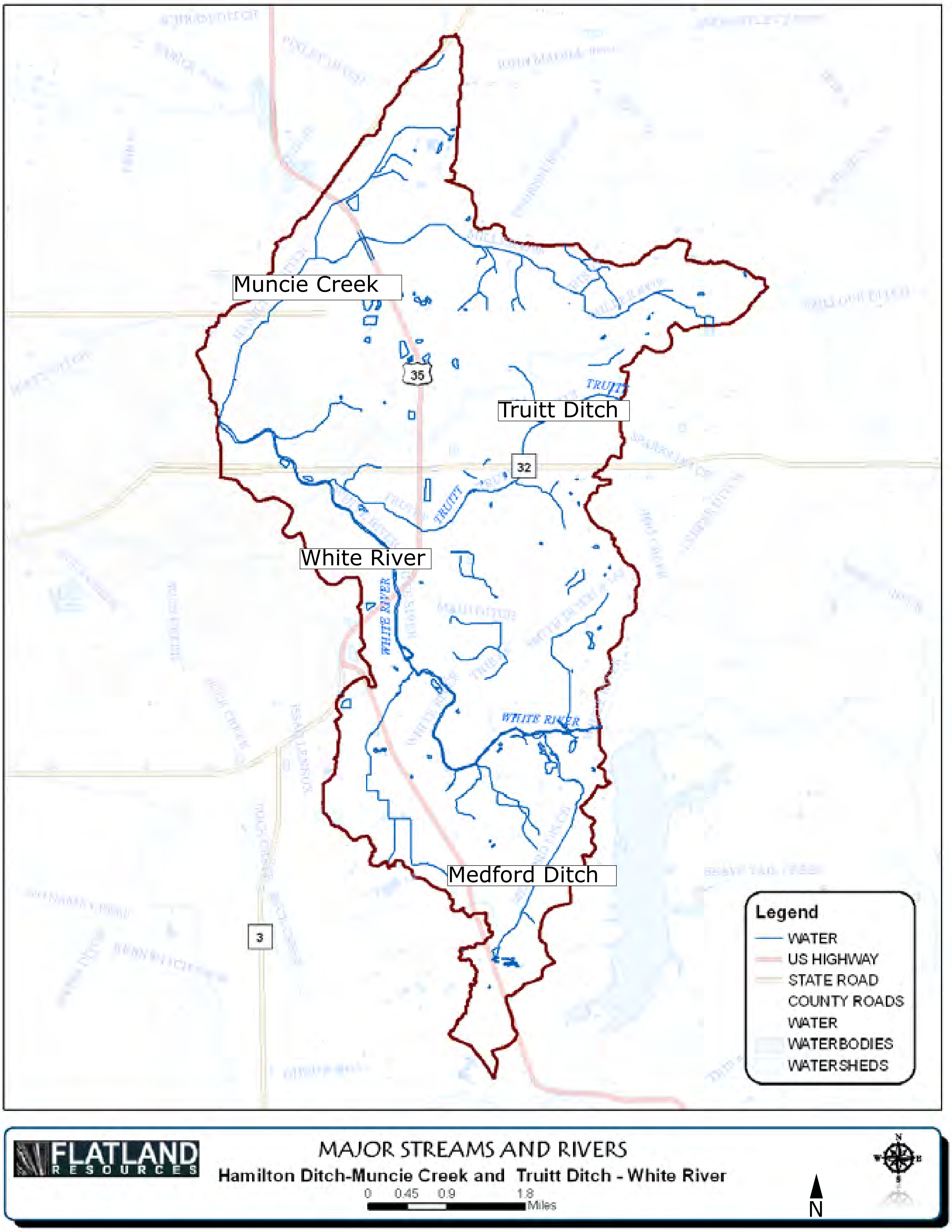
The main waterbodies in the Truitt Ditch-White River Watershed are the White River in the center, Truitt Ditch to the north (joining the White River at the mouth of the watershed), and Medford Ditch in the south. Both Truitt Ditch and the White River are naturally occurring channels. Both of their natural courses have been modified by human activity to either increase drainage or allow for development. The modifications to the White River have been less severe than those of Truitt Ditch, mostly occurring in the areas around Burlington Drive and the southeast end of Muncie. These changes have altered the floodplain, causing areas of erosion. Truitt Ditch has been highly modified to allow for drainage. The channel flow has been straightened and the cross section of the channel has been modified to such a degree that erosion occurs frequently. [2]

The modified (incised) cross-sectional area of most ditches and waterways has eliminated the streams access to the floodplain and the point of incipient flooding (anything above bankful, i.e. ordinary high water mark.) As a result, any flood-stage activity increases the velocity of water because the volume of water is confined or trapped. Velocity is also increased by straightening the stream meander outside of natural meander wave-length patterns. This increases the stream gradient and velocity. Increased velocity, plus high volumes in confined spaces, increases flood frequencies (without floodplain access) and the collective result is a high frequency of localized bank failures. White River Watershed Project research on Buck Creek (neighboring stream) shows that the sediment source is greater from in-channel sources (e.g. streambanks) than sheet flow from farm fields.

The main bodies of the Hamilton Ditch-Muncie Creek Watershed are the White River in the southern portion and Muncie Creek that flows from the north east and joins with the White River at the mouth of the watershed (MAP 2.30). Both Muncie Creek and the White River are naturally occurring channels. Both of their natural courses have also been modified by human activity to either increase drainage, allow for development, or as flood control measures. Muncie Creek has also undergone major channelization and straightening to allow for human activities such as agriculture and housing development. As a result, degradation and aggradation occurs as the channel tries to re-engineer itself to the appropriate sinuosity and grade.

Watershed streams, legal drains, floodplains, wetlands, storm drains, groundwater, subsurface conveyances, and manmade drainage channels all contribute to the watershed's hydrology. Each component moves water into, out of, or through the system.

1 Soil Survey of Delaware County Indiana. US Department of Agriculture
2 Tom Reeve, White River Watershed Project



MAP. 2.30 Major Subwatershed Hydrology

Mainstem

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 2

The most significant water feature in the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds is the White River, which flows from east to west across the southern third of the County, thereby draining most of the County. The River bisects the City of Muncie, then continues along the north side of Yorktown, then curves south to form the north boundary of Daleville before exiting the County. Buck Creek, Bell Creek, Muncie Creek, and York-Priaire Creek are major tributaries that flow into the White River in Delaware County. The amount of floodplain surrounding the river is fairly limited within the City of Muncie, with the exception of the River's eastern entrance. [1]

"As a whole, Delaware County encompasses nearly 250 miles of streams which provide habitat for 65 species of fish, 13 species of mussels, and numerous birds and mammals. These public waterways offer recreational opportunities such as fishing, canoeing, and swimming to Delaware County residents. Additionally, the White River provides a source of drinking water for Muncie residents as well as residents of downstream cities such as Anderson and Indianapolis." [2]

"Prior to passage of the Clean Water Act (CWA) and its amendments in the early 1970s, the White River was the receiving stream for several point source stressors such as: wastewater treatment facilities, combined sewer overflows (CSOs), battery and transmission plants, and tool and die shops. These point sources were unregulated and led to massive amounts of pollutants entering the river, severely degrading water quality. Toxic pollutants that hindered all but the most tolerant species included ammonia, cyanide, lead, zinc, and chromium (Craddock 1975). In addition to these point source pollutants, nonpoint source pollutants were also contributing to the degraded water quality. Originating from agriculture and urbanization, runoff including sediment, fertilizers, insecticides, and herbicides were some of the top sources of impairments. Currently agriculture and hydromodification such as dredging, channelization, and impoundments by dams are listed as the source for over 60% of the reported impaired rivers and streams in the U.S. (U.S. EPA 2009)."[3] Due to a large amount of bedrock in Muncie streams, dredging for flood control is a common practice.

Outstanding Rivers

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 3

"The state of Indiana determines "outstanding rivers". The West Fork White River is considered an Outstanding River. Outstanding rivers or streams are those that are of particular environmental or aesthetic interest and qualify under one or more of 22 categories (NRC, 2007). The three categories upon which the West Fork White River qualifies are as follows: Category 5) Nationwide Rivers Inventory Rivers: The 1,524 river segments identified by the National Park Service in its 1982 "Nationwide Rivers Inventory" as qualified for consideration for inclusion in the National Wild and Scenic Rivers System. Category 11) State Heritage Program Sites: Rivers identified by state natural heritage programs or similar state programs as having outstanding ecological importance. Category 13) Canoe Trails: State-designated canoe/boating routes."[4]

1 Tom Reeve, White River Watershed Project
2 BWQ Annual Fish Community Report
3 BWQ Annual Fish Community Report
4 Outstanding Rivers List for Indiana

IMG. 2.2 Historic White River at West Side Park, Thomas Keesling.

TABLE 2.12: White River as Outstanding River Metric			
River	Location	Significance	Counties
West Fork White River	Farmland to confluence with Wabash River	5, 11, 13	Daviess, Delaware, Gibson, Knox, Greene, Hamilton, Madison, Marion, Morgan, Owen, Randolph
SOURCE: Outstanding Rivers List for Indiana			

INVENTORY

Tributaries

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 4

Importance of Tributary Development

"Over the last thirty-five years, fish communities within White River in Muncie have dramatically improved. However, future improvements may depend on our ability to affect change in the tributaries which supply its water. In addition to efficiently conveying water, tributaries simultaneously transport myriad nonpoint pollutants such as silt, fertilizers, pesticides, etc. which are discharged directly into White River.

In Delaware County, these small streams account for more than 80% of the county's stream miles and are capable of having a significant impact on the water quality of White River. For example, effects of agricultural related run-off and stream bank erosion were found in the number of sucker species metric of the IBI. Often, the use of streams as drainage ditches is viewed as directly cimpacting the ability to support ecological integrity. However, simple methods exist that can cause dramatic improvements on water quality while still preserving the primary function of the stream.[1]

County-wide, headwater sites that typically receive good ratings, such as those along Stoney Creek, are bordered by wooded riparian zones, while those that typically receive poor ratings, such as those on Killbuck Creek and Mud Creek, are not.

Streams bordered by a woody buffer strip 10 m wide may reduce the phosphorous load by 95% (Vought et al. 1995). Simpler vegetated borders such as filter strips and grassed waterways also provide significant benefits to water quality. These BMPs trap soil that would otherwise suffocate aquatic life and protect the natural structure and function of fish habitats. In addition to benefiting water quality, they can also increase farming profits by diverting efforts away from the naturally low-yield areas of buffer zones. Filter strips also supply increased access to fields, more forage for cattle, and improved aesthetics." [2]

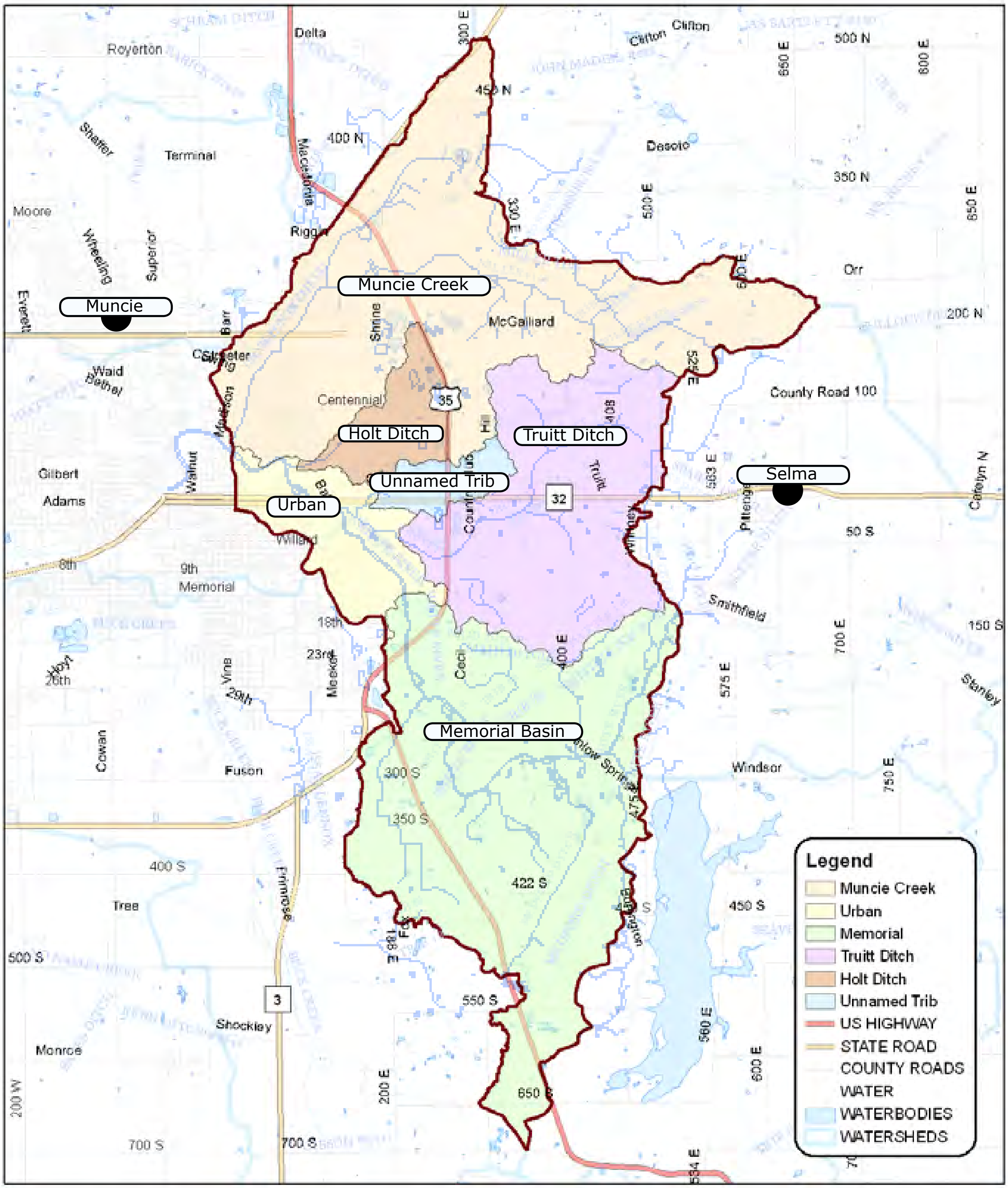
There are five major tributaries in the Subwatershed Management Areas

TABLE 2.13: Major tributaries in the Subwatershed Management Areas	
GIS ID NUMBER	NAME
435642	Hamilton Ditch
438961	Medford Drain
439879	Muncie Creek
441546	Prairie Creek
444933	Truitt Ditch
SOURCE: ArcGIS Indianamap.org	

Tributary to White River Comparison

"In contrast to White River, tributaries within Delaware County have consistently poor biological integrity ratings. Often, small streams and creeks are not maintained with consideration to water quality and aquatic life. Channelized, dredged, and denuded of riparian vegetation, they have been engineered for the sole purpose of rapidly draining water. Fish communities within these types of streams are dominated by pollution tolerant species. Under these conditions, biological integrity is often irretrievable (Yoder et al. 2000)."[3]

1 BWQ Annual Fish Community Report
2 BWQ Annual Fish Community Report
3 BWQ Annual Fish Community Report



FLATLAND RESOURCES

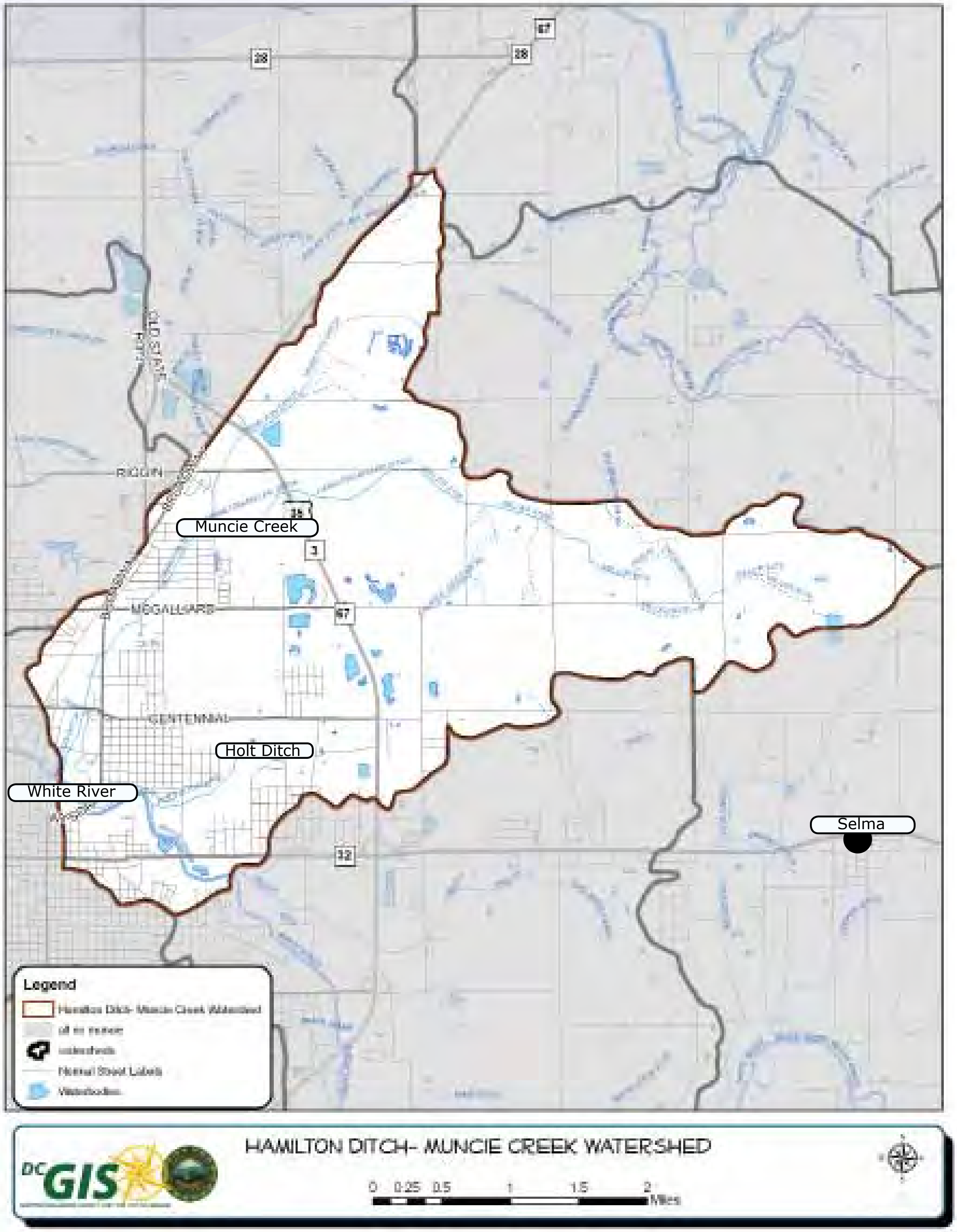
SUBWATERSHED DRAINAGE BASINS

Hamilton Ditch-Muncie Creek and Truitt Ditch - White River

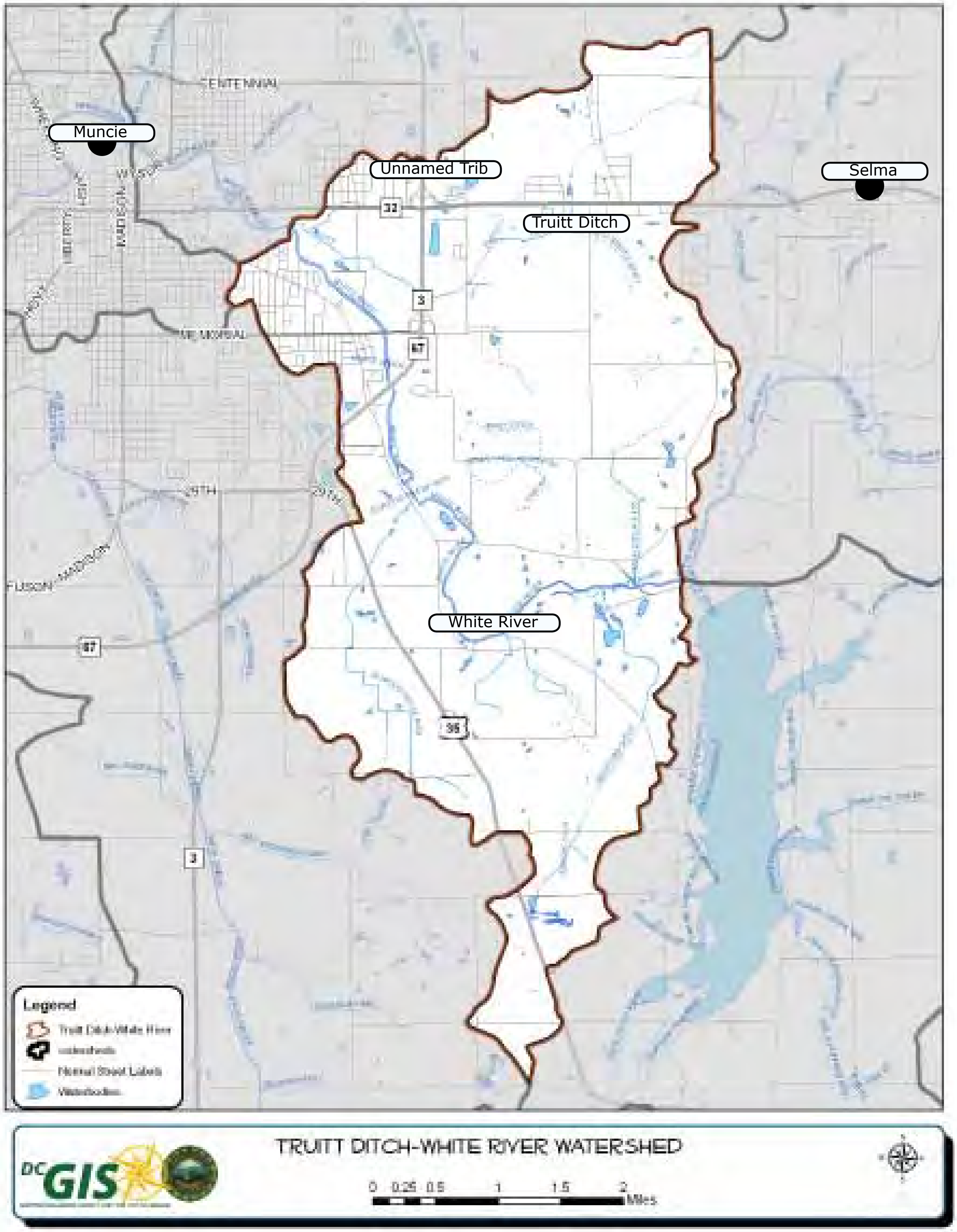
0 0.45 0.9 1.8 Miles

MAP. 2.31 Major Rivers in Subwatersheds

INVENTORY



MAP. 2.32 Hamilton Ditch - Muncie Creek Hydrology



MAP. 2.33 Truitt Ditch - White River Hydrology

INVENTORY

Floodplains

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 5

Flooding is a common hazard that can affect a local area or an entire river basin. Increased imperviousness, encroachment on the floodplain, deforestation, stream obstruction, tiling, or failure of a flood control structure are all mechanisms by which flooding occurs. Impacts of flooding include property and inventory damage, utility damage and service disruption, bridge or road impasses, stream bank erosion and riparian vegetation loss, water quality degradation, and channel or riparian area modification. [1]

In addition to storm water runoff, flooding can negatively affect water quality as large volumes of water transport contaminants into water bodies and also overload storm and wastewater systems. Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground and ultimately increases during periods of flooding. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, and streams.[2]

Floodplains are lands adjacent to streams, rivers, and other waterbodies that provide temporary storage for water. These systems act as nurseries for wildlife, offer green space for humans and wildlife, improve water quality, and buffer the waterbody from adjacent land uses. [3]

Approximately 6.8% (1295 acres) is cultivated and 890 acres is of urban land use within Subwatershed 100-year floodplains. In some cases, the rivers and streams have steep escarpments along their edges. Relatively small flood plains and terraces commonly alternate on opposite sides of the rivers.

These natural features pose the largest single constraint upon land use in the County. Development in waterways is generally impossible. Floodplain development should be carefully limited and controlled, due to the risk of property damage to the development itself, as well as the potential changes to the floodplain that may result in injury to properties downstream. Upon visual observation, much of the undeveloped acreage in the County is located in floodplain areas.[4]

Waterways and associative floodplains should also be viewed as assets. They perform an important function by draining areas of storm water and runoff. Floodplains attenuate energy resulting in sediment “drops” at the flood stage. Channeled systems can’t properly deposit sediment at flood stage forcing sediment to be flushed downstream until it finds floodplain (or if the channel creates new floodplains). Additionally, these waterway and floodplains serve as habitats for wildlife and need to be maintained as such.

Significant floodplain access occurs near Selma and between Yorktown and Daleville.

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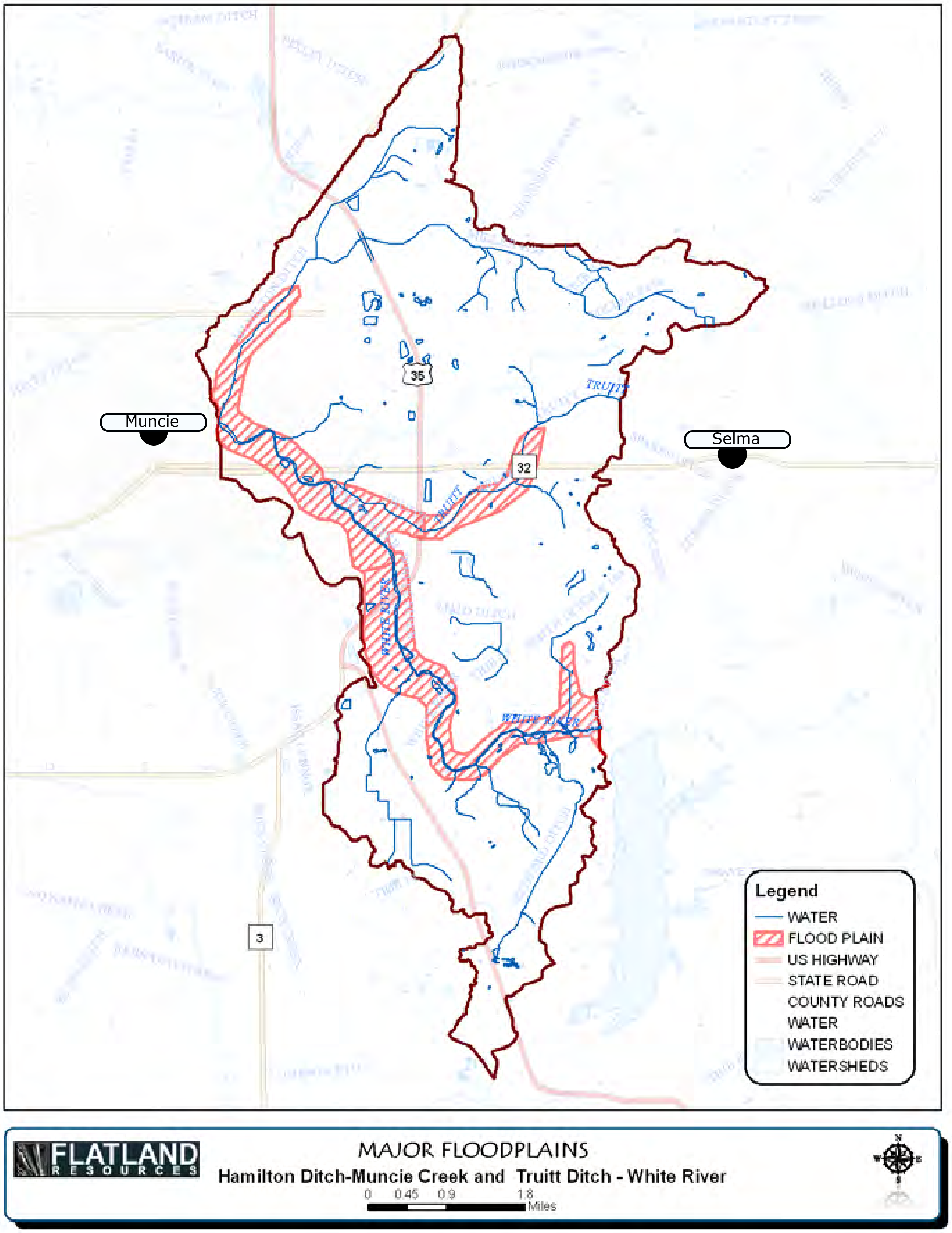
1 Tom Reeve, White River Watershed Project
2 Geist Reservoir/Upper Fall Creek WMP
3 Tom Reeve, White River Watershed Project
4 Wabash River (Region of the Great Bend) WMP



MAP. 2.34 GIS Based Subwatershed Floodplains (GIS)

Floodplains

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 6

The Federal Emergency Management Agency (FEMA) has developed Flood Insurance Rate Maps (FIRMs) for many parts of the country in order for individuals and governments to assess the risk of flooding in specific areas. These maps also indicate what insurance rates property owners may need to pay to develop property in these areas.

Identifying the location of floodplain areas within the Subwatersheds allows for targeted areas for floodplain management and/or restoration. Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage. These measures take a variety of forms and generally include requirements for zoning and special-purpose floodplain ordinances. [1]

Developments within flood prone areas (regulated by local, state and federal agencies) is dependant on permitting. The probability of permit approval further depends on the floodplain boundaries depicted on the FEMA FIRM and its corresponding floodplain designation (Zone A, AE, X).

Zone A (MAP 2.35) is defined as an area inundated by 100-year flooding for which no base flood elevation (BFE) has been determined. In this zone there is a 1% chance of annual flooding, and a 26% chance that the area will be inundated at sometime during the life of a 30-year mortgage.

Zone AE (MAP 2.35) is defined as an area inundated by 100-year flooding for which a BFE has been determined. Chance of flooding in Zone AE is the same as in Zone A. However, Zone A floodplain boundaries are based off of approximate methods, and Zone AE floodplain boundaries are based off of detailed hydrologic and hydraulic analyses (thus establishing BFEs), making the delineation more accurate.

Zone X (MAP 2.35) is defined as an area that is either determined to be outside the 100-year floodplain but within the 500-year floodplain (0.2% chance of annual flooding), or to have a 1% chance of sheet flow flooding where the average depths are less then 1 foot. These areas are considered to have a moderate or minimal risk of flooding, and the purchase of flood insurance is available but not required. [2]

Rainfall data is used to create these maps based on National Weather Service cooperative network. Teams of Soil Survey of Delaware County Indiana. US Department of Agriculture hydrographers have traveled to 40 streamflow-gaging stations to keep station instruments operating and to verify streamflow data needed for National Weather Service (NWS) flood forecasts. Soil Survey of Delaware County Indiana. US Department of Agriculture personnel have worked closely with Federal, state, and local agencies during the flood to provide flood information for emergency managers, the media, and the public. [3]

1 Geist Reservoir/Upper Fall Creek WMP
2 Geist Reservoir/Upper Fall Creek WMP
3 Geist Reservoir/Upper Fall Creek WMP

LEGEND
BOUNDARIES
PHOTOS
FLOODPLAIN AE
FLOODPLAIN X

N

MAP. 2.35 Subwatershed Floodplains, note levee system in city limits; See photos of red dots on next page, DCGIS

INVENTORY

Riparian Zones / Floodplains

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 7

Riparian zones are responsible for trapping sediment, filtering water, maintaining banks and shorelines, reducing impacts of flooding, recharging local groundwater reserves, and enhancing biodiversity and habitat. Eighty percent of terrestrial species within the western US depend on riparian vegetation for food, habitat or mitigation. Riparian zones slow the flow of the water down affecting the sedimentation rates. Human manipulation can accelerate the sedimentation rate from 500 years to 20-30 year periods.

TABLE 2.14: Type of Land Use in Subwatershed Floodways

Watershed Name	Truitt Ditch - White River		Hamilton Ditch - Muncie Creek	
GAP Land Use	Area (Ha.)	30 meter Buffer	Area (Ha.)	30 meter Buffer
Ag: Pasture	6	7%	12	17%
Ag: Row Crop	25	29%	30	43%
Ag: Wet Areas	0	0%	0	0%
Deciduous Forest	17	20%	2	3%
Evergreen Forest	13	14%	0	0%
Open Water	0	0%	0	0%
Palustrine Forest	11	13%	3	5%
Palustrine Herbaceous	9	11%	6	9%
Palustrine Sparsely Veg.	1	1%	0	0%
Palustrine Deciduous	0	0%	0	0%
Shrubland	1	1%	0	0%
Urban: High Density	0	0%	4	6%
Urban: Low Density	0	0%	11	16%
Woodland	3	4%	0	1%
Total Riparian Area	88		70	
Total Watershed Area	4,769		3,480	

SOURCE: ArcGIS Indianamap.org

GIS Derived Statistics
Table contains information derived from GIS maps created in ArcView. Summary statistics are listed by storm water watersheds and include land use information from Indiana's GAP data program.

Levee System
WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 8

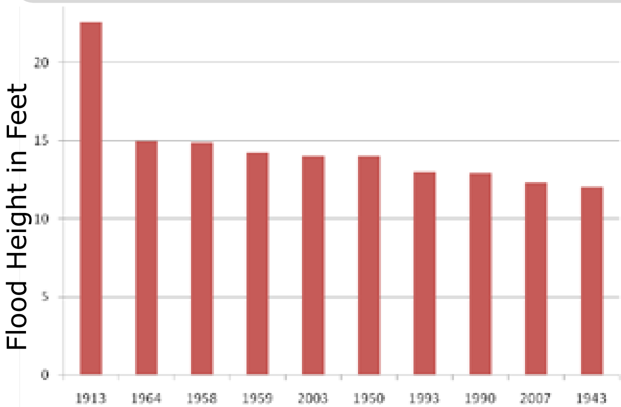
A Section of the Muncie Creek-Hamilton Ditch Subwatershed includes portion of the Muncie Levee System. The flood control levees were created by the United State Army Corps of Engineers over a period of time spanning from 1913-1960. The Levee System was created in response to catastrophic flooding during the turn of the century and built in conjunction with WPA and CCC programs with pressures from the local Business Community.

IMG. 2.3 Photo 1 Levee System at McKinnley Neighborhood

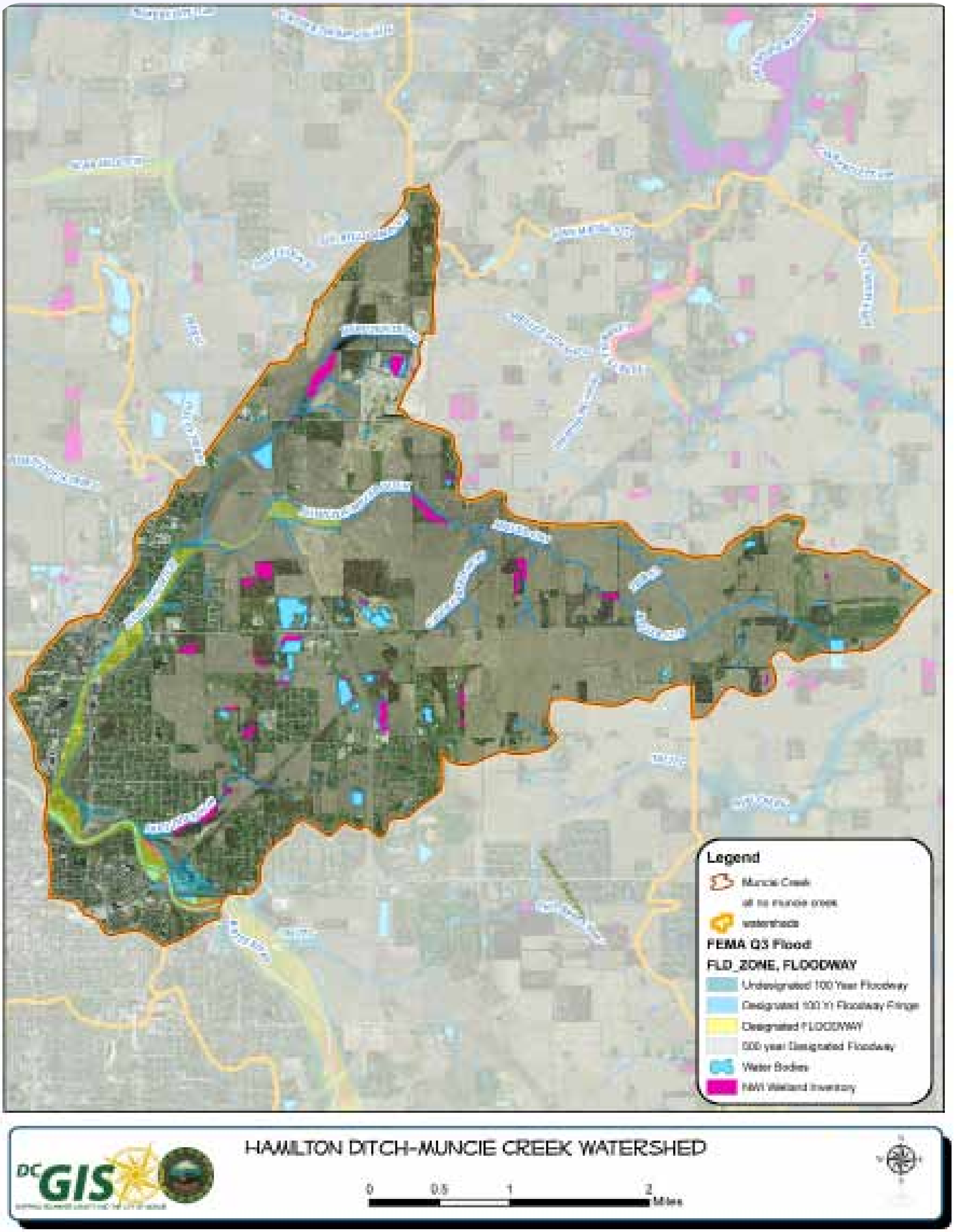
IMG. 2.5 Photo 4 Levee System at Daily Apartments

IMG. 2.4 Photo 3 Levee System at Cardinal Greenways

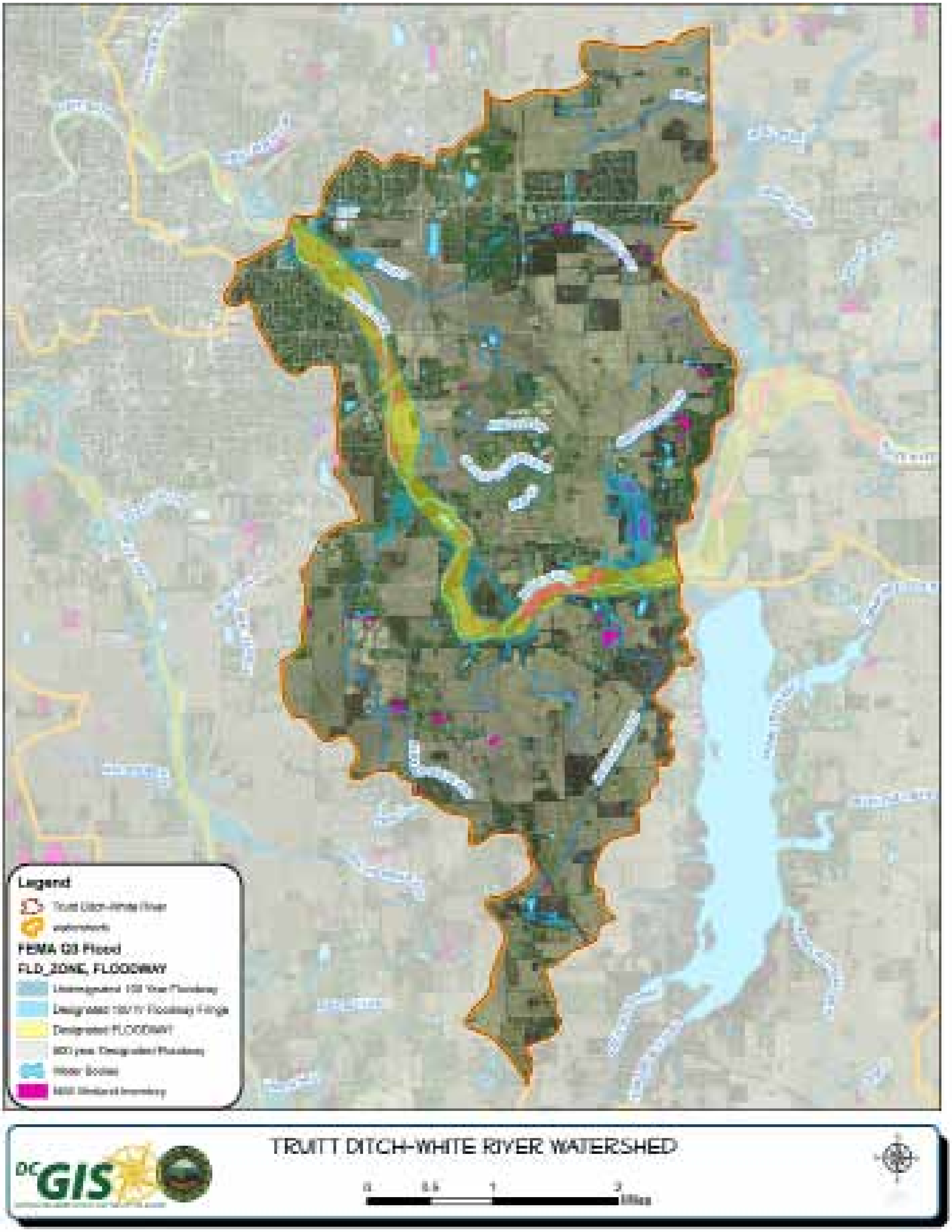
IMG. 2.6 Photo 4 Levee System at Craddock Wetlands



CHA. 2.10 Major Floods in the City of Muncie



MAP. 2.36 Hamilton Ditch - Muncie Creek Floodway



MAP. 2.37 Truitt Ditch - White River Floodway

INVENTORY

Waterbodies

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 9

Several small ponds and reservoirs are located in the Muncie Creek - Hamilton Ditch and Truitt Ditch - White River Subwatersheds. However, none of these waterbodies are significant in either size or usability and are therefore not discussed in further detail. Ponds and reservoirs located within Delaware County are typically used for shoreline and small boat fishing, full-body contact recreation, and aesthetic enjoyment. [1] They are concerns as they are potential nutrients sinks, but we do not have quantifiable data to support those concerns that this time.

One prominent water feature in Delaware County is the Prairie Creek Reservoir, a man-made lake located in the southeast corner of the County. The outlet for this Reservoir drains into the Truitt Ditch-White River Subwatershed. In addition to serving as a drinking water resource, the Reservoir also has recreational value. Although floodplain is evident in the White River, which runs near the Reservoir, little floodplain is evident at the Reservoir itself. [2]

Individuals are concerned about consuming fish from regional waterbodies and the possible health risks associated with full-body contact with many of the regional waterbodies. No beaches are located within the watershed. However, access to the waterbodies is possible via public access or public parks located adjacent to waterbodies. Informal swimming areas may be located in the watershed, but these sites were not identified by stakeholders.[3]

DIA. 2.5 Diagram of Waterbodies in Subwatersheds

1 Tom Reeve, White River Watershed Project
2 Tom Reeve, White River Watershed Project
3 Tom Reeve, White River Watershed Project

Wetland Importance

WMP - CHAPTER 1 - PART 1 - SECTION 4 - SUBSECTION 10

Wetlands provide numerous valuable functions that are necessary for the health of a watershed and waterbodies. Wetlands play critical roles in protecting water quality, moderating water quantity, and providing habitats. Wetland vegetation adjacent to waterways stabilize shorelines and stream banks, prevents erosion, and limits sediment transport to waterbodies.[1]

In addition, wetlands have the ability to increase storm water detention capacity, increase storm water attenuation, and moderate low flows. These benefits help to reduce flooding and reduce erosion. Wetlands also facilitate groundwater recharge by allowing water to seep slowly into the ground, thus replenishing underlying aquifers. This groundwater recharge is also valuable to wildlife during the summer months when precipitation is low and the base flow of the river draws on the surrounding groundwater table. [2]

Although wetlands occupy a small percentage of the surrounding landscape, these areas typically contain large percentages of wildlife and produce more flora and fauna per acre than any other ecosystem. As a result of this high diversity, wetlands provide many recreational opportunities, such as fishing, hunting, boating, hiking and bird watching.

However, wetlands within the Subwatersheds have experienced degradation as a result of urbanization and development (as has most Indiana Wetlands). Development projects that have wetlands present or adjacent to the property must apply for and receive Section 404 (of the Clean Water Act) permits to fill and develop wetlands. This practice permits the reduction of wetland acreage in the watershed. [3]

Isolated and adjacent wetlands are regulated through IDEM and the Army Corps of Engineers (ACOE), respectively. Although wetlands are typically avoided during the development phase, permits have been given to fill wetlands that cannot be avoided. Some isolated wetlands are being converted to detention/retention basins in new residential developments. Regulatory agencies may require on-site mitigation, including the creation of wetlands and natural areas on the same piece of land where wetland impacts occur. Some development projects that impact wetlands are allowed to mitigate for wetland impacts at an approved off-site wetland mitigation bank facility. In this case, the wetland impacts are offset through the purchase of wetland mitigation credits at an approved wetland mitigation bank.

For Indiana Department of Transportation (INDOT) projects in general, the Federal and State requirement is to mitigate for impacts to wetlands associated with roadway improvements within the same watershed. Stream enhancement and stream mitigation are some of the options that INDOT utilizes to offset wetland/stream impacts.[4]

1 Geist Reservoir/Upper Fall Creek WMP
2 Geist Reservoir/Upper Fall Creek WMP
3 Geist Reservoir/Upper Fall Creek WMP
4 Geist Reservoir/Upper Fall Creek WMP

Wetlands

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 11

Approximately 25% of Indiana was covered by wetlands prior to European settlement (IDEM, 2007). Overall, 85% of wetlands have been lost resulting in Indiana ranking fourth in the nation in terms of percentage of wetland loss. Wetland classifications are based on attributes which can be measured and when combined, help to define the nature of a specific wetland and distinguish it from others. According to the National Wetland Inventory, there are three wetland classifications within the Subwatersheds including lacustrine, palustrine, and riverine.[1]

Lacustrine Wetlands: As defined by the U.S Fish and Wildlife Service, lacustrine wetlands are associated with lakes and are characterized by a lack of trees and a dominance of emergent and submersed aquatic vegetation. Lacustrine wetlands typically extend from the shoreline to depths of 6.5 feet or until emergent vegetation no longer persists. Lacustrine wetlands are important in removing sediment and nutrients as well as providing habitat for fish and macroinvertebrates which are a vital food source within a lake ecosystem. The Lacustrine System includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; and (3) total area exceeds 20 acres.[2]

Palustrine Wetlands: Palustrine wetlands are related to marshes, swamps and bogs. Palustrine habitats are wetlands dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens. Palustrine habitats have structural features that provide feeding, breeding, nesting, over wintering and migration habitat for Wildlife in addition to their natural filtration properties. [34]

Riverine Wetlands: Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Riverine wetlands are directly affected by streamflow including overbank and backwater conditions. Riverine wetlands are very important in sediment retention as well as pollutant removal. [5]

Currently, Hamilton Ditch - Muncie Creek and Truitt Ditch - White River contain approximately 400 acres of wetlands. In total, wetlands cover approximately 9% of the Subwatersheds. There are 5,525 acres of hydric soils and when hydric soil coverage is used as an estimate of historic wetland coverage, it becomes apparent that the Subwatersheds were once 36% wetland. This theoretically represents nearly 5,125 acres of wetland loss within the Subwatershed(s) area.

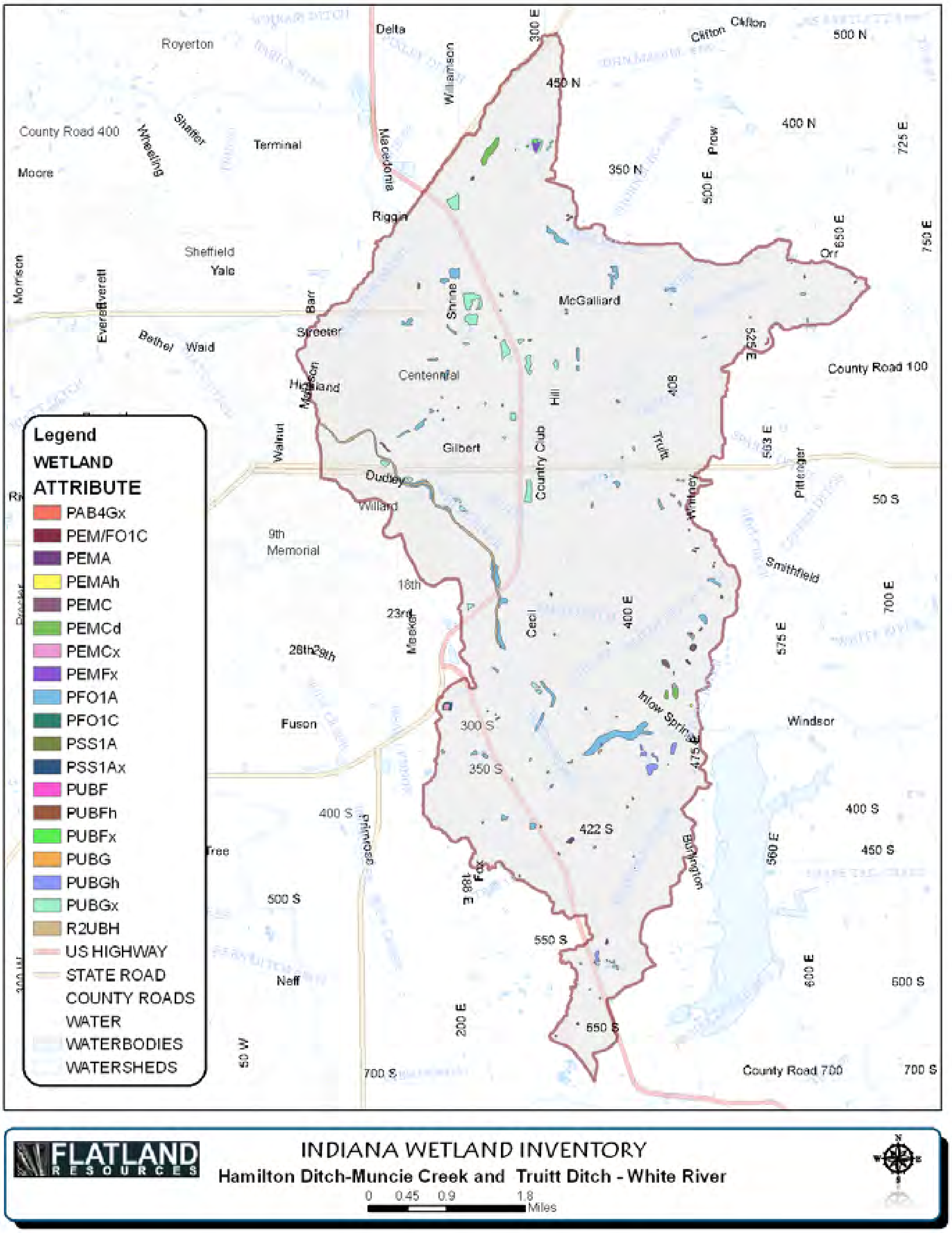
MAP. 2.38 Major Wetland Destruction by State

TABLE 2.15: State Ranking by Percentage of Wetland Destruction

Arkansas	72%	Maryland	73%
California	91%	Mississippi	59%
Connecticut	74%	Missouri	87%
Delaware	54%	Nevada	52%
Idaho	56%	New York	60%
Illinois	85%	Ohio	90%
Indiana	87%	Oklahoma	67%
Iowa	89%	Pennsylvania	56%
Kentucky	81%	Tennessee	59%

SOURCE: EPA

1 Tom Reeve, White River Watershed Project
2 U.S Fish and Wildlife Service
3 U.S Fish and Wildlife Service
4 U.S Fish and Wildlife Service
5 U.S Fish and Wildlife Service



MAP. 2.39 FWS Wetland Mapper (pink watershed boundary)

Wetlands Assessment

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 12

IDEM administers the Clean Water Act (CWA) Section 401 Water Quality Certification (WQC) Program. IDEM regulates the placement of fill materials, excavation (in certain cases), and mechanical clearing of wetlands and other waterbodies. IDEM draws its authority from the federal CWA, state law and rules for state regulated wetlands, and from Indiana's Water Quality Standards. IDEM regulates some activities in wetlands in conjunction with the ACOE. Any person who wishes to place fill materials, excavate or dredge, or mechanically clear (use heavy equipment) within a jurisdictional wetland, lake, river, or stream must first apply to the ACOE for a CWA Section 404 permit. If the ACOE decides a permit is needed, then the person must also obtain a CWA Section 401 water quality certification from IDEM. Placement of fill into nonjurisdictional wetlands is regulated by Indiana's Wetlands Activity Permits rule and by state law. Under CWA Section 401, IDEM reviews the proposed activity to determine if it will comply with Indiana's WQS. The applicant may be required to avoid impacts, minimize impacts, or mitigate for impacts to wetlands and other waters. IDEM will deny water quality certification if the activity will cause adverse impacts to water quality. No project may proceed until it has received a certification from IDEM. A key goal of the program is to ensure that all activities regulated by IDEM meet the no net loss of wetlands policy. Table 2.16 provides information regarding historical and present estimates of wetland resources in Indiana.[1]

TABLE 2.16: Percentage of Existing Wetlands in Indiana compared to 1700 estimate

Statistic	Amount
Total surface area of the state of Indiana	23,310,000 acres
Estimate of wetland acreage in Indiana circa 1700	5,600,000 acres
Wetland acreage in Indiana circa 1986 (National Wetland Inventory)	813,000 acres
Percent of surface area of Indiana covered by wetlands circa 1700	24.1%
Percent of surface area of Indiana covered by wetlands circa 1986	3.5%
Percent of total area of wetlands that are wholly or partially contained within managed lands (state, local, federal and private areas)	14%
Percent of Indiana's total wetlands that are 0.25 acres or less in size	11.6%
Percent of Indiana's total wetlands that are 0.50 acres or less in size	29.5%
Percent of Indiana's total wetlands that are 1.00 acres or less in size	46.9%
Percent of Indiana's total wetlands that are 5.00 acres or less in size	80.2%

SOURCE: IDEM: Indiana's Wetland Resources

1 IDEM: Indiana's Wetland Resources

Integrity and Extent of Wetland Resources

Wetlands occur in and provide benefits to every county in Indiana. The lack of quantitative information on some aspects of Indiana's wetland resources is a major obstacle to improving wetland conservation efforts. The most extensive database of wetland resources in Indiana is the National Wetlands Inventory developed by the USFWS. Indiana's National Wetlands Inventory maps were produced primarily from interpretation of high-altitude color infrared aerial photographs (scale of 1:58,000) taken of Indiana during spring and fall 1980-87. The maps indicate wetlands type, using the Cowardin et al. classification scheme. Very narrow wetlands in river corridors and wetlands under cultivation at the time of mapping are generally not depicted. Forested wetlands are poorly described. IDEM entered into a partnership with Ducks Unlimited to update the palustrine wetlands mapped in Indiana. This effort was scheduled for completion in 2009 and will become an update to the National Wetland Inventory.[2]

The IDNR conducted the most recent and complete analysis of this database in 1991. According to the report, Indiana had approximately 813,000 acres of wetland habitat in the mid-1980s when the data were collected (Table 2.17). Wetland loss or gain since then is not known at this time (Rolley 1991). [3]

TABLE 2.17: Historic Wetland Resources in Indiana

Wetland Type (Cowardin Classification)	Extent as of mid-1980s (acres)
Palustrine scrub/shrub (PSS)	42,000
Palustrine forested (PFO)	504,000
Palustrine emergent (PEMB)	55,000
Palustrine emergent seasonally flooded (PEMC)	68,000
Palustrine emergent semi-permanently flooded (PEMF)	21,000
Palustrine open water (POW)	99,000
Lacustrine limnetic open water (L10W)	141,000
Riverine (R)	53,000
Total wetland resources	813,000 (Historic: 5,600,000)

SOURCE: IDEM: Indiana's Wetland Resources

2 IDEM: Indiana's Wetland Resources
3 IDEM: Indiana's Wetland Resources

INVENTORY

Hydromodification - Dams

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 13

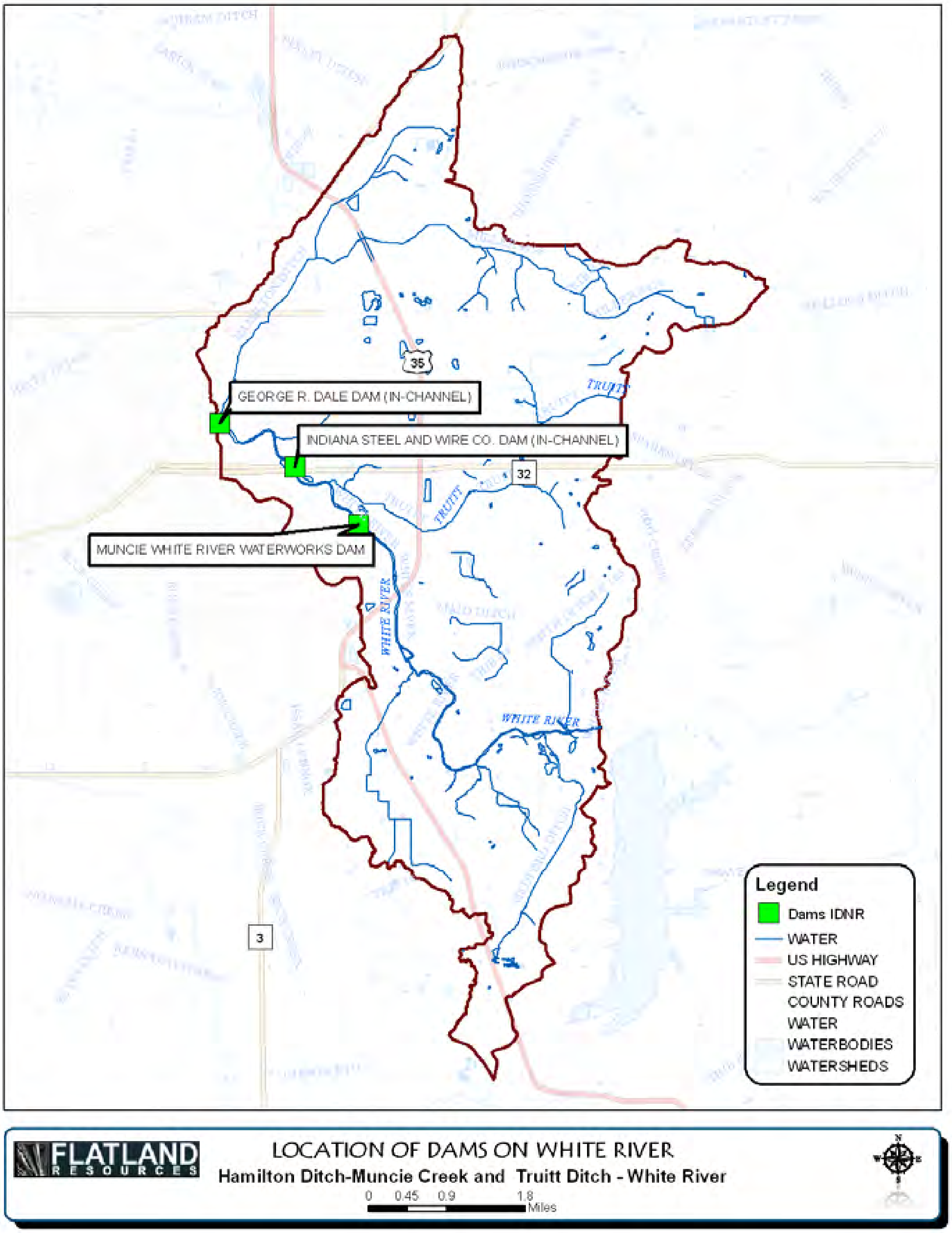
Dams are an ecological impairment because they create long pools of water that are low in dissolved oxygen (DO), high in nutrients such as nitrogen (and can inhibit breakdown of background pollutants such as ammonia (Baxter 1977)), and very monotonous in terms of habitat conditions for fish and other aquatic organisms. They are also a safety hazard because of the turbulent flow conditions at the base of the dams.[1] Their presence blocks fish passage and creates lentic habitats unsuitable for rheophilic (river dependent) species (Beasley & Hightower 2000).[2]

"Fish need cold, clean water rich in oxygen, but the shallow reservoirs behind the dams can potentially warm to temperatures lethal to organisms and are low in oxygen. Overheated and oxygen deficient waters provide prime conditions for toxic algae to bloom in the reservoirs behind the dams at levels thousands of times higher than what the World Health Organization says is safe for recreation. The algae secrets a toxin that is known to can cause liver damage and promote tumor growth."[3]

There are three dams in the Muncie Creek- Hamilton Ditch and Truitt Ditch-White River Subwatersheds.[4] Although the presence of dams or impoundments typically have noticeable negative effects on water quality (Santucci et al. 2005); all dams located along White River maintain uncommonly high IBI scores. In spite of the chemical and physical challenges, integrity of fish communities above Muncie's dams currently remain strong.

TABLE 2.18: Name and Location of Dams in Subwatersheds				
DAM NAME	STATE_ID	COUNTY_NAM	EASTING	NORTHING
MUNCIE WHITE RIVER WATERWORKS DAM	18-3	Delaware	640503	4449462
INDIANA STEEL AND WIRE CO. DAM (IN-CHANNEL)	18-6	Delaware	639311	4450519
GEORGE R. DALE DAM (IN-CHANNEL)	18-5	Delaware	637903	4451296
SOURCE: ArcGIS Indianamap.org				

1 Friends of Alum Creek and Tributaries
2 BWQ Annual Fish Community Report
3 Klamath Restoration Agreements
4 Data Generated by ArcGIS



MAP. 2.40 Location of Dams in Subwatersheds

INVENTORY

Hydromodification - Drains

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 14

Regulated drains consist of creeks, ditches, tiles (underground pipe systems), and other structures intended to move run-off water. Regulated drains are under the jurisdiction of the local county drainage board and/or the County Surveyor's office . Regulated drains are common throughout the watershed and are mainly tiles and open ditches.[1] Regulated drains are typically maintained by the County Surveyors office. This maintenance includes dredging with large construction equipment, removal of debris, and management of vegetation both within the regulated drains and within the riparian zone associated with the drains. As these waterbodies are subject to periodic cleaning, it is important to work with the county surveyor to establish priorities for these waterbodies in terms of water quality improvement and erosion control. [2]

Muncie has approximately 389,700 ft of ditches within the MS4 boundary. The precise footage is unavailable, but it is continually updated by the Muncie Sanitary District and maps are available at the Engineering Department. It should be noted that legal drains are maintained by the county surveyor's office. However, some of the legal drains within the watershed have neither a maintenance fund nor a maintenance schedule.

There has been extensive underground tiling and above ground ditching within the watershed. This reduces the amount of water that infiltrates the ground and causes a flush of water during rain events. Many of the above ground ditches have structural problems, such as abutments and impoundments. These problems cause erosion and deposition throughout the channels.

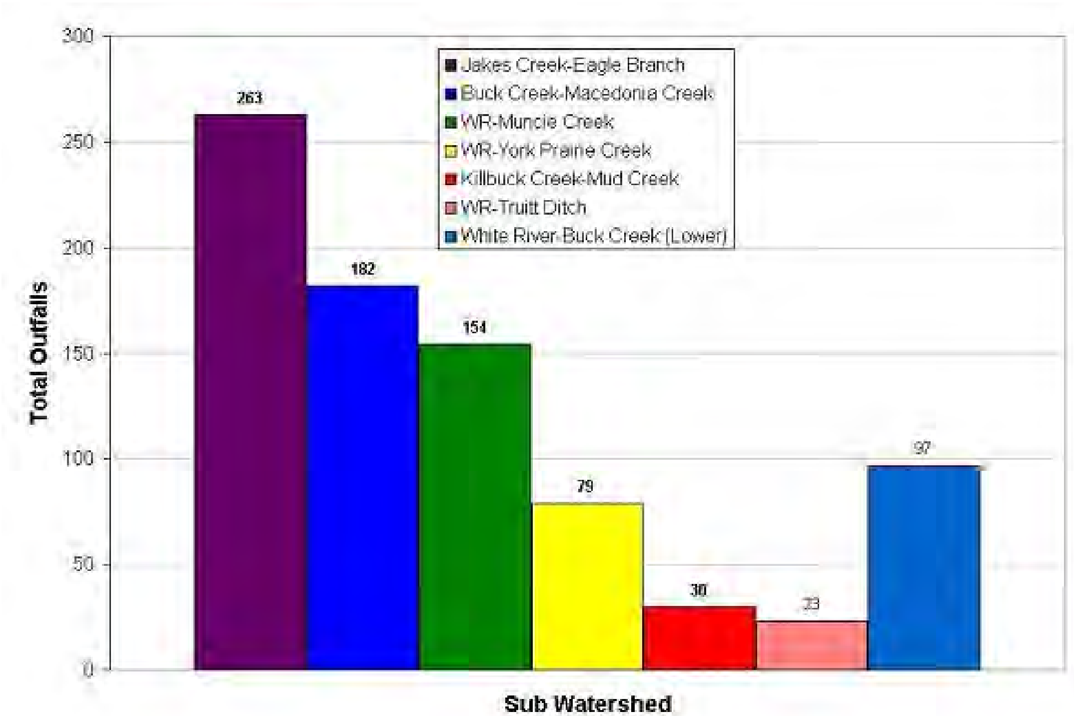
Due to the nature of the drainage systems in the county that do not fall under the jurisdiction of the County Surveyor (and Drainage Board) or INDOT, identification has proven to be difficult. The County is diligently working to gather 100% of the information, however, some of the surveyor's maps are on linen from the late 1800's and determining the age of developments or ownership has been difficult. [3]

Based on the unpredictable maintenance schedule of regulated drains within the watershed, it is difficult to assign a priority rating to these areas for potential improvement of wildlife habitat, water quality improvement measures, and erosion control measures within the Subwatersheds. However, the selected BMPs and Action Registers include measures and implementation projects that may be applicable to regulated drains. Coordination with the County Surveyors Office will be necessary during the implementation project evaluation phase. [4]

Potential limitations were considered by the steering committee with regard to prioritizing specific projects and priorities for Subwatersheds that contain high densities of legal drains. The remaining waters are streams that are not maintained and remain in their natural state.[5] BMPs within regulated drains in the watershed should be evaluated prior to implementation. If regulated drains are considered for BMP measures (Le. two-stage ditches, stabilization, etc), the Steering Committee should coordinate with the local County Surveyor's office. [6]

1 Geist Reservoir/Upper Fall Creek WMP
2 Wabash River (Region of the Great Bend) WMP
3 Tom Reeve, White River Watershed Project
4 Wabash River (Region of the Great Bend) WMP
5 Tom Reeve, White River Watershed Project
6 Geist Reservoir/Upper Fall Creek WMP

Many outfall pipes, in Muncie city limits, have been identified by the Muncie Bureau of Water Quality surveillance team. Common types of pipe materials identified are: corrugated metal pipe, corrugated plastic pipe, polyvinyl chloride, reinforced concrete pipe, and steel pipe. Table 2.19 shows the number of outfalls located in Muncie Creek - Hamilton Ditch and Truitt Ditch - White River Subwatersheds and Chart 2.11 compares these subwatersheds to others in the county. The location of these outfalls can be found on Map 2.41 on the following pages.



CHA. 2.11 Relation of out falls between major Subwatersheds in City Limits, BWQ

TABLE 2.19: Total Outfalls in Hamilton Ditch-Muncie Creek and Truitt Ditch-White River Subwatersheds (Muncie)

Subwatershed	Stream	Total Outfalls	Stream Miles	Density (out-falls/mile)
WR-Muncie Creek		154	5.95	25.88
	White River	33	1.7	19.41
	Holt Ditch	14	1.6	8.75
	Muncie Creek	93	2.28	40.79
	Hamilton Ditch	14	0.37	37.84
WR-Truitt Ditch		23	3.08	7.47
	White River	20	1.8	11.11
	Truitt Ditch	2	1.24	1.61
	32 Ditch	1	0.04	25.00
Total		835	32.44	25.73982737

SOURCE: Muncie Bureau of Water Quality Website

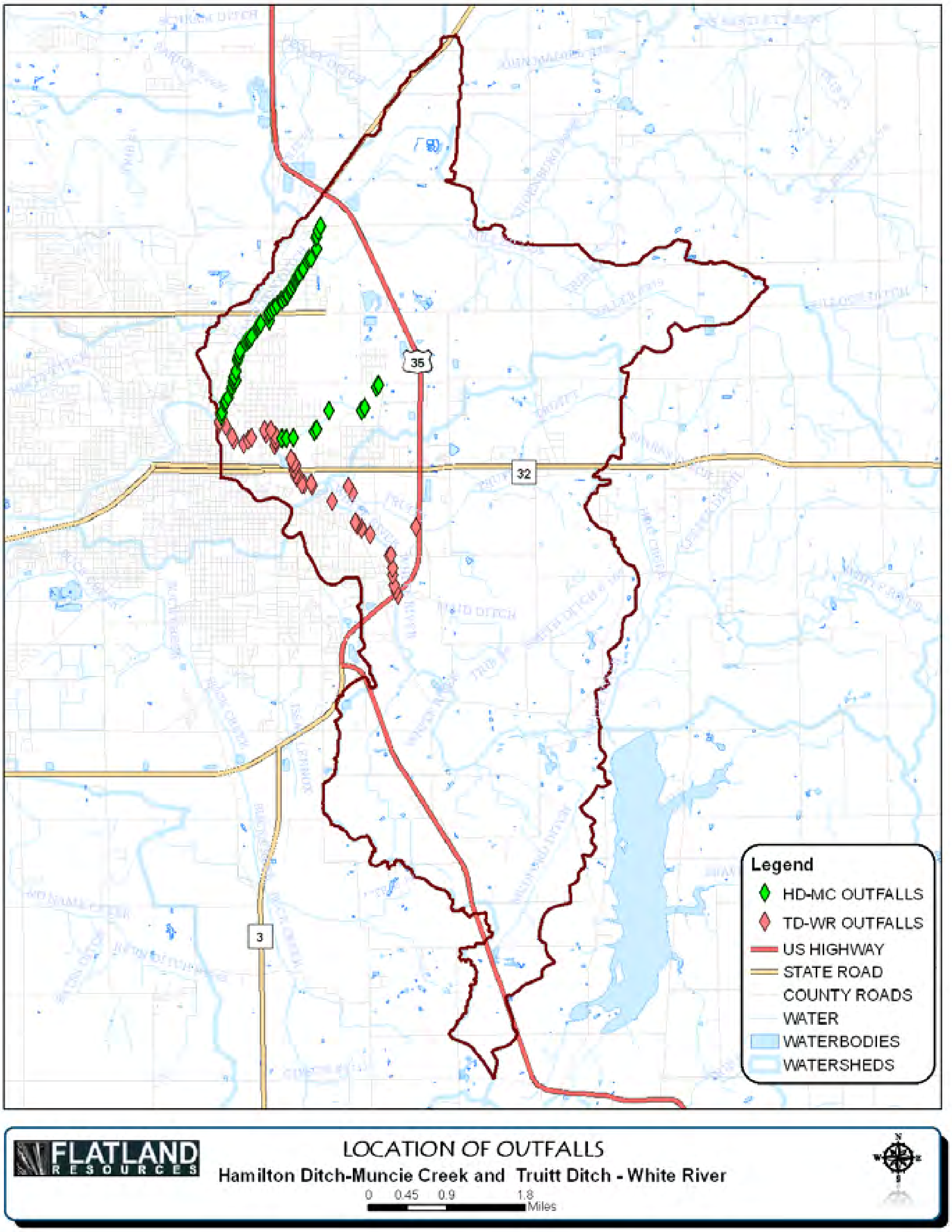
INVENTORY

Hydromodification - Logjams

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 15

A major log jam over one acre in size was removed in 2008 from the White River in the Truitt Ditch - White River Subwatershed. This log jam had been building in size for over 5 years. The backup of water and alteration in the flow of the river had caused the river to alter its course during high water events. This led to an increase in erosion in the area surrounding the jam. After removal, the eroded channel was restored to proper sinuosity and width using natural channel design to reduce the possibility of future erosion. Channel obstructions are a significant cause of erosion but not the sole source source of sediment.

IMG. 2.7 Burlington Log Jam



MAP. 2.41 Location of Outfalls in Subwatersheds

Hydromodification - Stormsewers

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 16

Under natural conditions, the majority of precipitation is allowed to infiltrate the soil and recharge groundwater resources. The volume of infiltration and groundwater recharge diminishes as development increases. To handle the large volume of precipitation falling in urban areas, storm water systems have been constructed. Storm drain systems are present in most urban areas throughout the watershed. In total, more than 800 miles of storm drain pipe are present within the watershed. The MS4 boundary is the service area of the Muncie Sanitary District, which includes most of the corporate boundary of the City of Muncie. The Muncie MS4 has approximately 617,800 ft of storm sewers.[1]

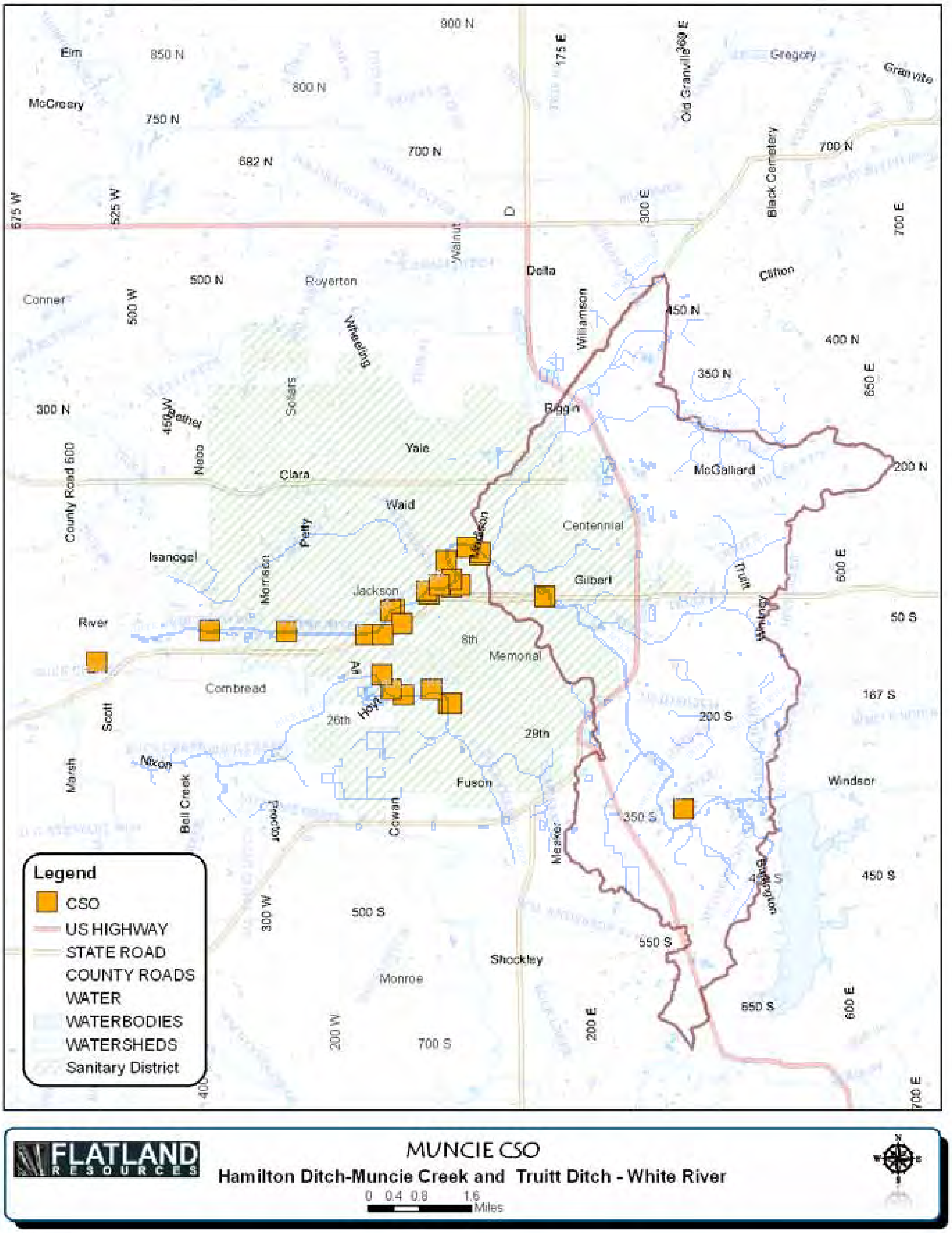
The Muncie Sanitary District has 100% of its storm sewer system and outfalls mapped in GIS and AutoCAD (MAP 2.41). Delaware County has 100% of its outfalls mapped in GIS and approximately 95% of its storm sewer system mapped. [2] Once systems that do fall under the jurisdiction of the County Surveyor and private have been identified, the county mapping will be complete.[3]

Evidence for Muncie's vast combined storm water/sewage system is the spike of Phosphorus that discharges from the WPCF. Although the WPCF estimates reducing Phosphorus by 10%, the WPCF is not designed to remove Phosphorus. The fact that there is such a high amount of Phosphorus discharging from the WPCF makes shareholders assume that the storm water runoff entering the combined system is high in Phosphorus from urban lawn care practices (and other sources).

Combined Sewer Overflows

When it rains, the sewer system can't handle the large volume of sewage and storm water. Instead of allowing water to back up into people's basements during a rainstorm, the combined sewer system allows the polluted water to be discharged directly into the White River. This discharge into the river is known as a combined sewer overflow or CSO.[4]

1 Tom Reeve, White River Watershed Project
2 Tom Reeve, White River Watershed Project
3 Tom Reeve, White River Watershed Project
4 The Rouge River Project



MAP. 2.42 Location of CSOs in Muncie City Limits, MSD

TABLE 2.20: MUNCIE SANITARY DISTRICT SUMMARY OF CSO DISCHARGE MONITORING REPORTS (2002 - 2004)						
	2002		2003		2004	
	37.2-in. Rainfall		45.1-in. Rainfall		30.0-in. Rainfall	
	Discharge Days	Discharge Duration (HRS)	Discharge Days	Discharge Duration (HRS)	Discharge Days	Discharge Duration (HRS)
CSO 026	9	133	34	454	24	349
CSO 025	No Data	No Data	No Data	No Data	No Data	No Data
CSO 024	1	11	6	66	6	80
CSO 023	No Data	No Data	No Data	No Data	No Data	No Data
CSO 022	No Data	No Data	4	44	4	51
CSO 018	13	195	55	940	50	693
CSO 262	No Data	No Data	No Data	No Data	No Data	No Data
CSO 027	4	47	14	197	5	66
CSO 015	20	283	52	834	42	645
CSO 013	1	16	7	98	10	126
CSO 012	1	15	10	142	4	51
CSO 031	No Data	No Data	5	67	2	24
CSO 009	9	143	9	143	12	146
CSO 028	2	18	12	161	13	152
CSO 034	No Data	No Data	No Data	No Data	No Data	No Data
CSO 007	No Data	No Data	6	69	4	46
CSO 004	3	28	3	28	4	46
CSO 033	No Data	No Data	5	72	2	24
CSO 002	2	23	2	23	2	24
CSO 001	7	102	7	102	4	40

SOURCE: MUNCIE SANITARY DISTRICT SUMMARY OF CSO DISCHARGE MONITORING REPORTS

Long Range Control Plan

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 17

Muncie's Long Term Control Plan (LTCP) specifies a 96% reduction in CSO discharge and the eventual elimination of combined sewers.[1] There is no CSO data for the two CSOs in the Hamilton Ditch - Muncie Creek Subwatershed or the singular CSO in the Truitt-Ditch White River Subwatershed (See MAP 2.42). The remaining CSO locations discharge to the White River and Buck Creek. This data is included to demonstrate the tremendous impact CSOs have on water quality in Delaware County. The relationship between CSOs and E. coli levels will be discussed in later sections of the WMP.

1 Data from the Muncie Water Pollution Control Facility

MUNCIE SANITARY DISTRICT SUMMARY OF CSO DISCHARGE MONITORING REPORTS (2005 - 2008)							
2005		2006		2007		2008	
39.7-in. Rainfall		44.7-in. Rainfall		38-in. Rainfall		39.31-in. Rainfall	
Discharge Days	Discharge Duration (HRS)	Discharge Days	Discharge Duration (HRS)	Discharge Days	Discharge Duration (HRS)	Discharge Days	Discharge Duration (HRS)
33	519	37	508	13	206	19	542
9	141	4	43	0	0	1	23
11	197	7	93	4	48	5	107
11	199	3	44	0	0	1	23
9	167	7	91	11	236	42	391
37	649	71	1099	74	1743	33	2119
No Data	No Data	10	151	14	232	13	266
11	170	10	142	15	174	26	136
42	657	34	481	38	424	55	861
15	207	6	71	2	26	0	0
8	116	No Data	No Data	6	73	1	24
2	26	2	25	0	0	0	0
9	117	8	90	2	24	3	71
13	168	7	90	8	168	2	52
No Data	No Data	No Data	No Data	0	0	0	0
4	46	No Data	No Data	0	0	1	28
6	106	8	112	5	68	4	93
No Data	No Data	No Data	No Data	2	24	0	0
6	94	4	52	0	0	1	23
8	114	15	209	6	128	3	76

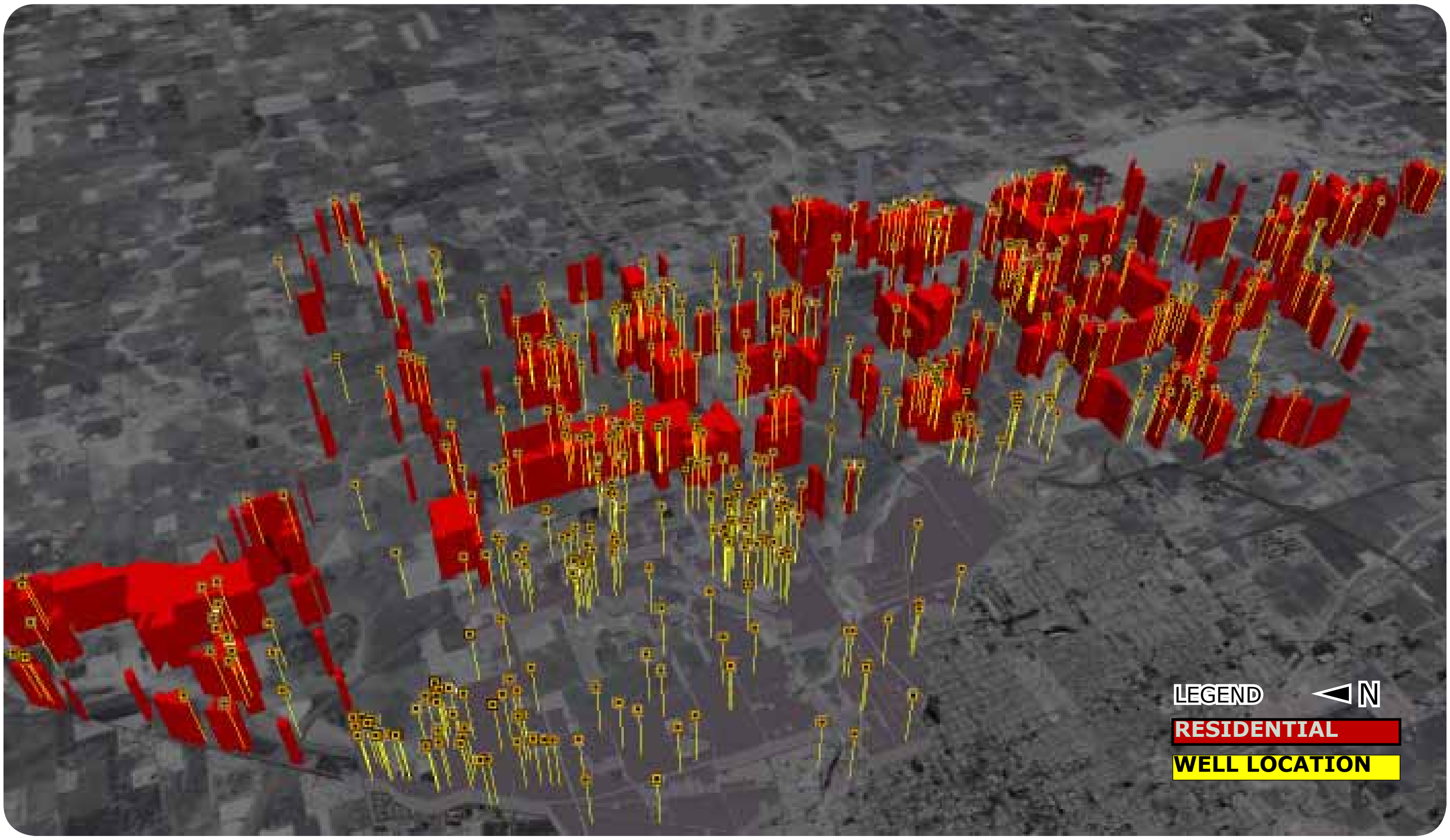
SOURCE: MUNCIE SANITARY DISTRICT SUMMARY OF CSO DISCHARGE MONITORING REPORTS

Water Supply

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 18

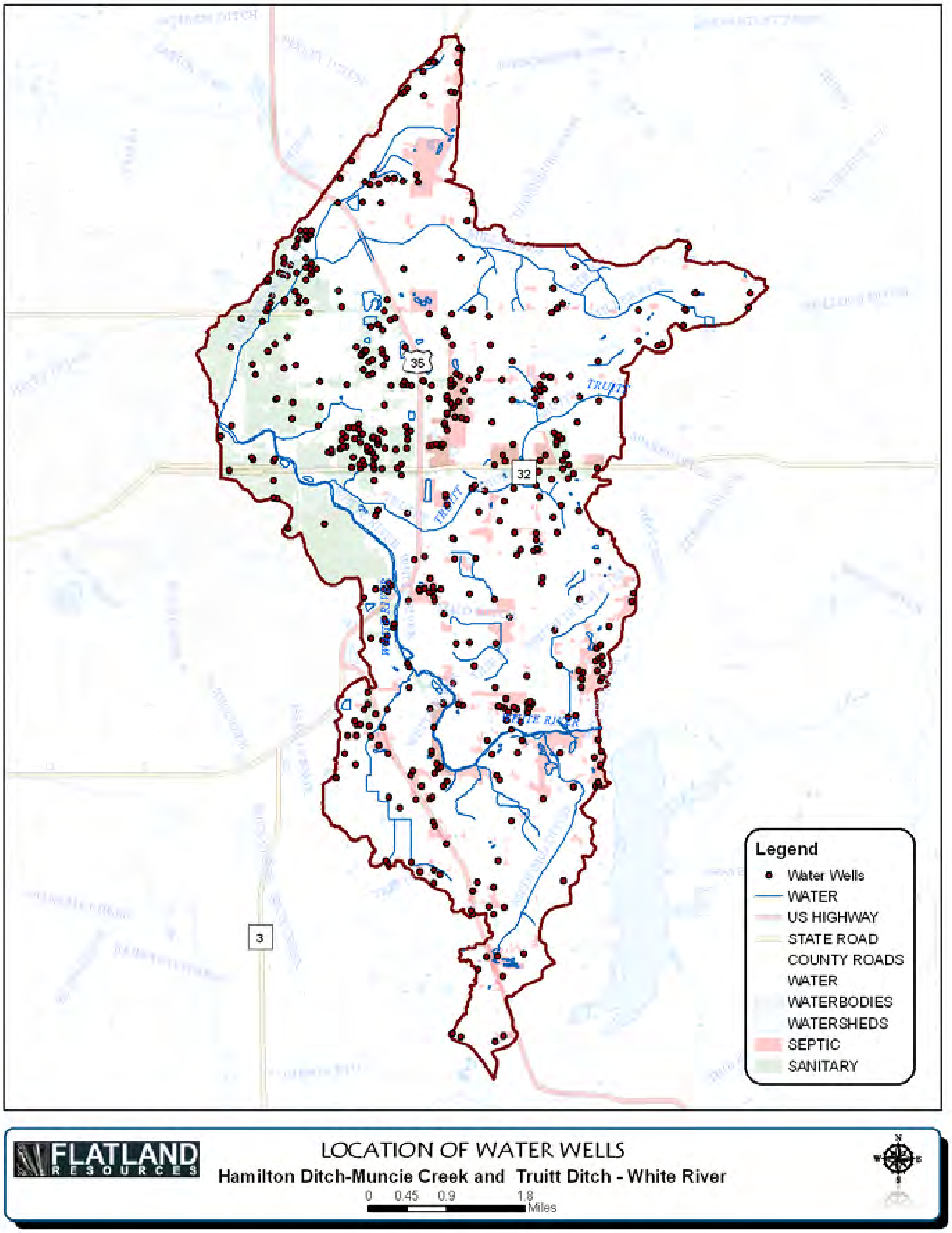
The primary supply for the city is derived from the White River, supplemented by discharge from Prairie Creek Reservoir during periods of low flow. The City of Muncie utilizes ground water as an auxiliary water supply. Delaware County does not have any rural water systems, thus wells are used in much of the rural community. There are 610 wells in Muncie Creek - Hamilton Ditch and Truitt Ditch-White River Subwatersheds (See Map 2.43 and Diagram 2.6). [1] The quality of the ground water is strongly affected by the glacial deposits and the underlying bedrock. The availability of ground water is generally good in Delaware County, and wells produce as much as 200 to 400 gallons per minute. For the most part, the primary aquifers are seams of sand and gravel within the glacial till and glacial outwash deposits of sand and gravel.[2]

Recharge of local aquifers occurs in the same manner as do many of the other aquifers in the state, namely by the downward percolation of local rainfall through the soil horizon and underlying formations. However, localized significant rainstorms can produce relatively quick response to recharge, especially if adjacent areas did not receive the rainfall. Care must be taken to ensure the quality of the water from alluvial and surficial aquifer source waters. Potential pollution from construction, sewage outfall, illegal dumping, agriculture, and storm water runoff must be avoided or controlled due to the recharge of these aquifers from runoff and river water.[3]



DIA. 2.6 Location of Water Wells adjacent to residential septic tanks on unsuitable soils.

1 Soil Survey of Delaware County Indiana. US Department of Agriculture
2 Soil Survey of Delaware County Indiana. US Department of Agriculture
3 Soil Survey of Delaware County Indiana. US Department of Agriculture



MAP. 2.43 Location of Waterwells in Subwatersheds

Wellhead Protection Areas

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 19

The IDEM Ground Water Section administers the Wellhead Protection Program, a strategy to protect ground water drinking supplies from pollution. The Safe Drinking Water Act and the Indiana Wellhead Protection Rule (327 IAC 8.4-1) mandates a wellhead program for all Community Public Water Systems. The Wellhead Protection Programs consist of two phases. Phase I involves the delineation of a Wellhead Protection Area (WHPA), identifying potential sources of contamination, and creating management and contingency plans for the WHPA. Phase II involves the implementation of the plan created in Phase I, and communities are required to report to IDEM how they have protected ground water resources. [1]

Information pertaining to wellhead protection and its delineations/restrictions will be important during the implementation phases of the plan. Approved Wellhead Protection Areas are no longer available on-line due to recent legislation classifying this type of information as confidential. [2]

Indiana America Water Company Inc. is the utility providing water to Muncie. As a community water source, they are required by IDEM to have a plan in order to protect the groundwater supply from pollution. The plan is regularly reviewed and updated with input from a local Wellhead Protection Plan committee. Committee members include personnel from the Indiana-American Water Co., the Delaware County Health Department, the East-Central Indiana Soil Waste District, Storm water Management, the Delaware-Muncie Metropolitan Plan Commission, and local emergency service providers.[3]

The plan includes identifying potential contaminant sources within the wellhead protection areas. The Wellhead Protection Areas are the delineated areas where a spill would take one year to reach the wellheads and the areas in where a spill would take five years to reach the wellheads (MAP 2.44). If a spill occurs in these areas, procedures have been established to minimize the spill's impact upon the local water supply. Another important component to the plan is educating the public about what groundwater is and practices to protect it from pollution. Recently the plan has helped identify Indiana American Water in Muncie's community as a Hoosier Water Guardian.[4]

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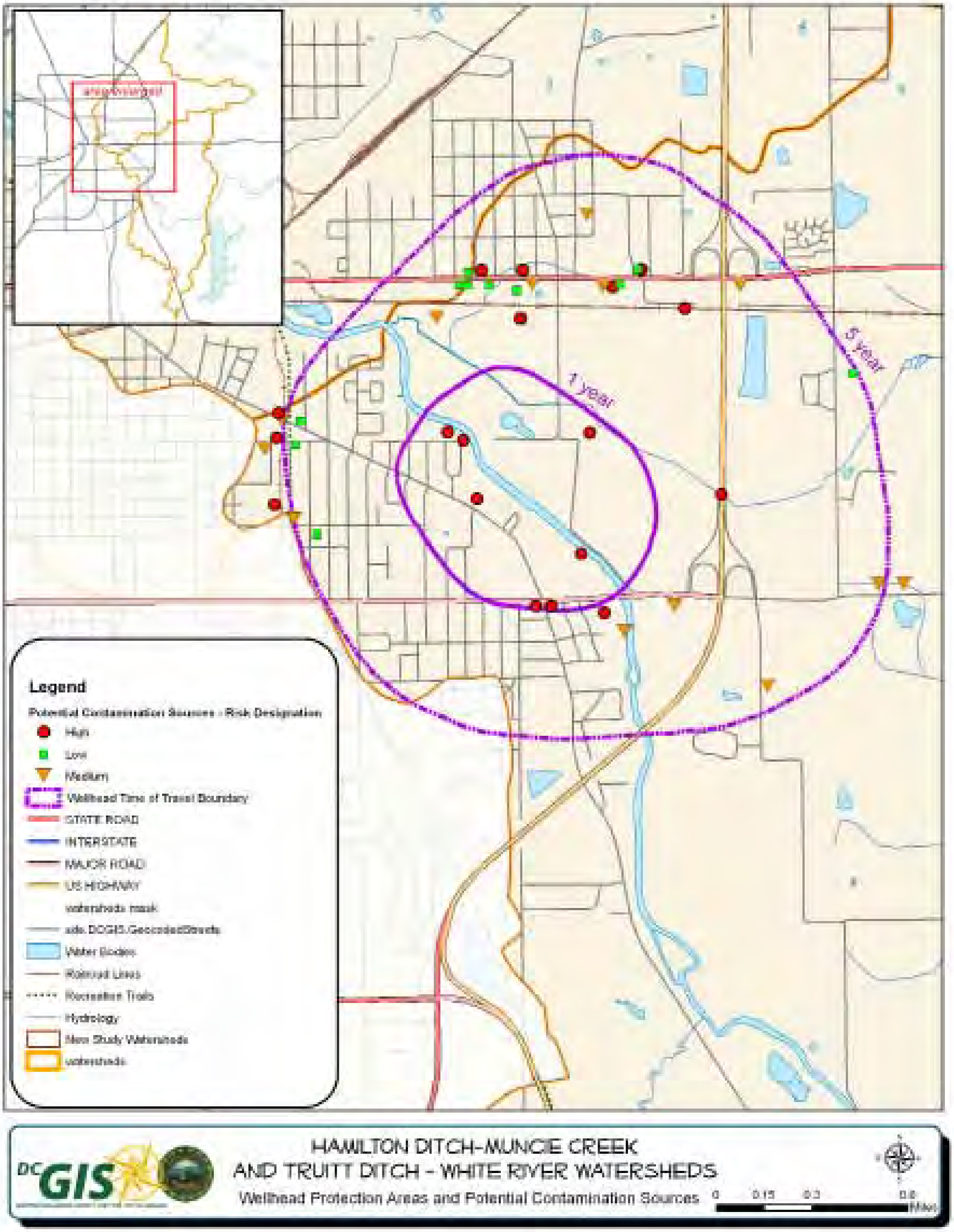
1 Tom Reeve, White River Watershed Project
2 Tom Reeve, White River Watershed Project
3 Tom Reeve, White River Watershed Project
4 Tom Reeve, White River Watershed Project



MAP. 2.44 Wellhead Protection Zone in Subwatersheds

INVENTORY

Ground Water Assessment

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 20

Ground water is an important resource for Indiana citizens, agriculture, and industry. The majority of the state's population use ground water for drinking water and other household uses.

During the growing season, ground water is withdrawn at an average rate of 282.9 million gallons per day (mgd) for crop and turf irrigation (based on a 90-day season). Industry withdraws an average 98.6 mgd of ground water, and 31.3 mgd is used for energy production (Ralph Spaeth, Indiana Department of Natural Resources, written communication, 2000). Since December 2000, no statewide ground water monitoring studies have been conducted due to budgetary and staffing constraints. However, a statewide ground water monitoring network is scheduled to begin spring of 2008.[1]

Some of the major contaminant sources impacting Indiana ground water as of 1998 are listed below and in Table 2.21 and 2.22. All pollutant sources are a potential threat to ground water. However, the degree to which the source is a threat to ground water depends on several factors, the most significant being hydrogeologic sensitivity. Other major risk factors include location of the contaminant source relative to drinking water sources, toxicity of the contaminant, and the size of the population at risk.[2]

1 Indiana Integrated Water Monitoring and Assessment Report
2 Indiana Integrated Water Monitoring and Assessment Report

Nitrate

Nitrate is a potential contaminant from the following high priority sources: commercial fertilizer applications, concentrated animal feeding operations (CAFOs), and septic systems. Nitrate, a highly mobile and soluble contaminant, is the most frequently detected ground water contaminant in rural areas. However, determining the source of nitrates detected in ground water can be difficult and costly. For the 1999 and 2000 crop production season, 537 million tons and 970 million tons, respectively, of commercial fertilizer containing nitrogen were sold in Indiana for application on some 12 million acres of cropland, most of which was applied to nearly 6 million acres of corn (Indiana Agricultural Statistics Service 1999-2000). Unlike pesticides, the purchase and application of commercial fertilizer is not regulated by the Office of the Indiana State Chemist. When applied at the proper rate and time, commercial fertilizer poses little threat of contamination to ground water. Purdue University Cooperative Extension Service staff, United States U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) staff and private consultants assist crop producers in developing nutrient management plans that focus on meeting crop nutrient needs based on realistic goals.[3]

Confined feeding operations

Confined feeding operations and larger concentrated animal feeding operations exist throughout Indiana as an integral component of Indiana's agricultural economy. In 2001, the Indiana WPCB adopted new confined feeding operation (CFO) regulations (327 IAC 16), as required by IC 13-18-10, that provides design, construction and operational performance standards for all state-regulated CFOs. This is not to be confused with the NPDES permit program that regulates CAFOs. The WPCB adopted new NPDES regulations for CAFOs in January of 2004. These regulations mirror the federal regulations for animal feeding operations and include the recent amendments to the federal regulations. The NPDES regulations for the issuance of individual NPDES permits for CAFOs are found at 327 IAC 5-4-3 and the regulations for the issuance of NPDES general permits for CAFOs are found at 327 AIC 15-15-5. Additionally, the USDA-NRCS also works closely with livestock producers who request financial and technical assistance for building livestock waste storage facilities and to install or implement conservation practices that serve to reduce soil erosion and nutrient loss. The primary concerns associated with CAFOs are the proper storage and land application of the large volumes of ammonia-containing manure produced by these operations. The ammonia form of nitrogen is converted to nitrate through biological processes in the soil. Consequently, the rate of manure application to farmland is a major concern when the application provides more nitrogen than a crop will use, allowing excess nitrogen to move into underlying aquifers. The new regulations also address the need to consider the phosphorous content of manure in determining the agronomic rates for land application.[4]

Septic Systems

Properly constructed and maintained septic systems provide satisfactory on-site treatment of domestic wastewater in rural and unsewered suburban areas of Indiana. However, improperly constructed or poorly maintained septic systems, as well as systems operating in areas of high seasonal water tables or other ground water sensitive areas, are also of concern as a source of nitrate contamination to ground water.[5]

Landfills

3 Indiana Integrated Water Monitoring and Assessment Report
4 Indiana Integrated Water Monitoring and Assessment Report
5 Indiana Integrated Water Monitoring and Assessment Report

INVENTORY

Landfills and underground storage tanks are a high priority ground water contamination concern, largely due to practices or activities that occurred prior to construction standards and legislation established for the protection of ground water. Landfills constructed after 1988 have been required to adhere to stringent construction standards. Since 1988, underground storage tank registration, upgrading, closure activity and site assessment have been closely reviewed by the IDEM Underground Storage Tank (UST) Section. In accordance with federal and state mandates, underground storage tanks installed prior to December 22, 1988, were to be either properly protected against spills, overflows and corrosion, or properly closed. Class V underground injection wells (UIWs) are widespread throughout the state and occur in high concentration in several areas, including some where ground water is highly sensitive to contamination. Class V wells release a wide variety of contaminants into or above aquifers supplying drinking water. The large number and diversity of Class V wells combined with lack of information regarding effects of these wells on ground water pose a significant potential threat to ground water. Indiana Class V wells are regulated by the USEPA. The USEPA targeted those Class V wells that pose the greatest environmental risk and in 2000 implemented more intensive regulations and enforcement for large capacity cesspools and motor vehicle waste disposal wells. [6]

Industrial facilities

Several cases of ground water contamination due to industrial facilities or their ancillary operations have been documented in Indiana. Although many contamination events occurred prior to the development of regulations for the storage and handling of industrial materials, ground water contamination still occurs as a result of either accidents or intentional dumping of waste. In 1998, Indiana's Secondary Containment of Above Ground Storage Tanks Containing Hazardous Materials Rule (327 IAC 2-10) was adopted. This rule requires that new facilities provide secondary containment for storage of 660 gallons or more of hazardous wastes if the facility is located outside an approved delineated wellhead protection area. The rule is more protective if the facility is located within an approved delineated wellhead protection and requires secondary containment if 275 gallons or more of hazardous materials are stored there. The secondary containment rule, along with outreach and education programs, have alleviated a number of problems. However, these activities continue to be a potential source of contamination to ground water in Indiana.[7]

Salt

The storage and extensive use of salt as a deicing agent during the winter months has an impact on ground water. Ground water contamination from road salt has been documented in Indiana. Efforts are being made by the Indiana Department of Transportation (INDOT) to build salt storage facilities in areas where ground water is not sensitive to contamination and to upgrade existing facilities to protect ground water. Currently all INDOT salt storage facilities are covered by domes or canopies, and several new facilities were built to contain all surface runoff on-site to reduce ground water contamination. In addition, road salt usage and application rates have been significantly reduced from past years through computerized weather forecasting and roadway temperature sensors. [8]

Spills

Ground water contamination as a result of spills can be avoided or minimized if spills are properly handled and cleaned up. Unreported spills may contribute to ground water contamination. Spill handling and clean up, when not properly executed, create a concern for ground water contamination. Indiana's Spills; Reporting, Containment and Response Rule (327 IAC 2-6.1) ensures that spills are reported, properly handled and cleaned up.[9]

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6 Indiana Integrated Water Monitoring and Assessment Report
7 Indiana Integrated Water Monitoring and Assessment Report
8 Indiana Integrated Water Monitoring and Assessment Report
9 Indiana Integrated Water Monitoring and Assessment Report

TABLE 2.21: Contaminant Priority Rankings for Muncie Creek - Hamilton Ditch and Truitt Ditch-White River (adopted from USEPA)			
	Highest Priority	Risk Factors	Type of Contaminant
Agricultural chemical facilities		A,C,H,I	5
Commercial fertilizer applications	X	A, C, D, E	5
Confined animal feeding operations	X	A, D, E	5, 9
Irrigation practices		A,C,H,I	1,2,5,8,9
Manure applications	X	A,C,H,I	5, 9
Pesticide applications		A,C,H,I	1,2
Land application		A,C,H,I	5,9
Domestic and industrial residual applications		A,C,H,I	5,9
Material stockpiles		A,C,H,I	5,9
Storage tanks (above ground)		A,C,H,I	
Storage tanks (underground)	X	A, B, C, D, E, F	2, 3, 4
Surface impoundments	X	A, C, D, E, F	1, 2, 3, 4, 5, 6, 7, 9
Waste piles		A,C,H,I	5,9
Landfills (constructed prior to 1989)	X	A, B, C, D, E, F	1, 2, 3, 4, 5, 6, 7, 8, 9
Septic systems	X	A, C, D, E, F, G	1, 2, 3, 4, 5, 7, 9
Shallow (Class V) injection wells	X	A, B, C, D, E, I	1, 2, 3, 4, 5,7,9
Hazardous waste generators		A	
Hazardous waste sites		A	
Industrial facilities	X	A, B, C, D, E, F	1, 2, 3, 4, 5, 7, 8, 9
Liquid transport pipelines (including sewer)		A	8
Materials spills (including during transport)	X	A, B, C, D, E, F	1, 2, 3, 4, 5, 7, 8, 9
Material transfer operations		A	
Small-scale manufacturing and repair shops		A, I	8
Mining and mine drainage		A	7,8
Salt storage (state and nonstate facilities) and road salting	X	A, C, D, E, F	6
Urban runoff		A, C, H, I	1, 2, 4, 5, 7, 8, 9

SOURCE: USEPA

Factors considered in selecting the contaminant source: (A) human health and/or environmental risk (toxicity); (B) size of the population at risk; (C) location of source relative to drinking water source; (D) number and/or size of contaminant sources; (E) hydrogeologic sensitivity; (F) documented state findings, other findings; (G) high to very high priority in localized areas, but not over majority of Indiana; (H) geographic distribution/occurrence; (I) lack of information

Classes of contaminants associated with contamination source: (1) Inorganic pesticides; (2) Organic pesticides; (3) Halogenated solvents; (4) Petroleum compounds; (5) Nitrate; (6) Salinity/ brine; (7) Metals; (8) Radionuclides; (9) Bacteria, Protozoa and Viruses[1]

1 Indiana Integrated Water Monitoring and Assessment Report

Hazardous Waste and Superfund

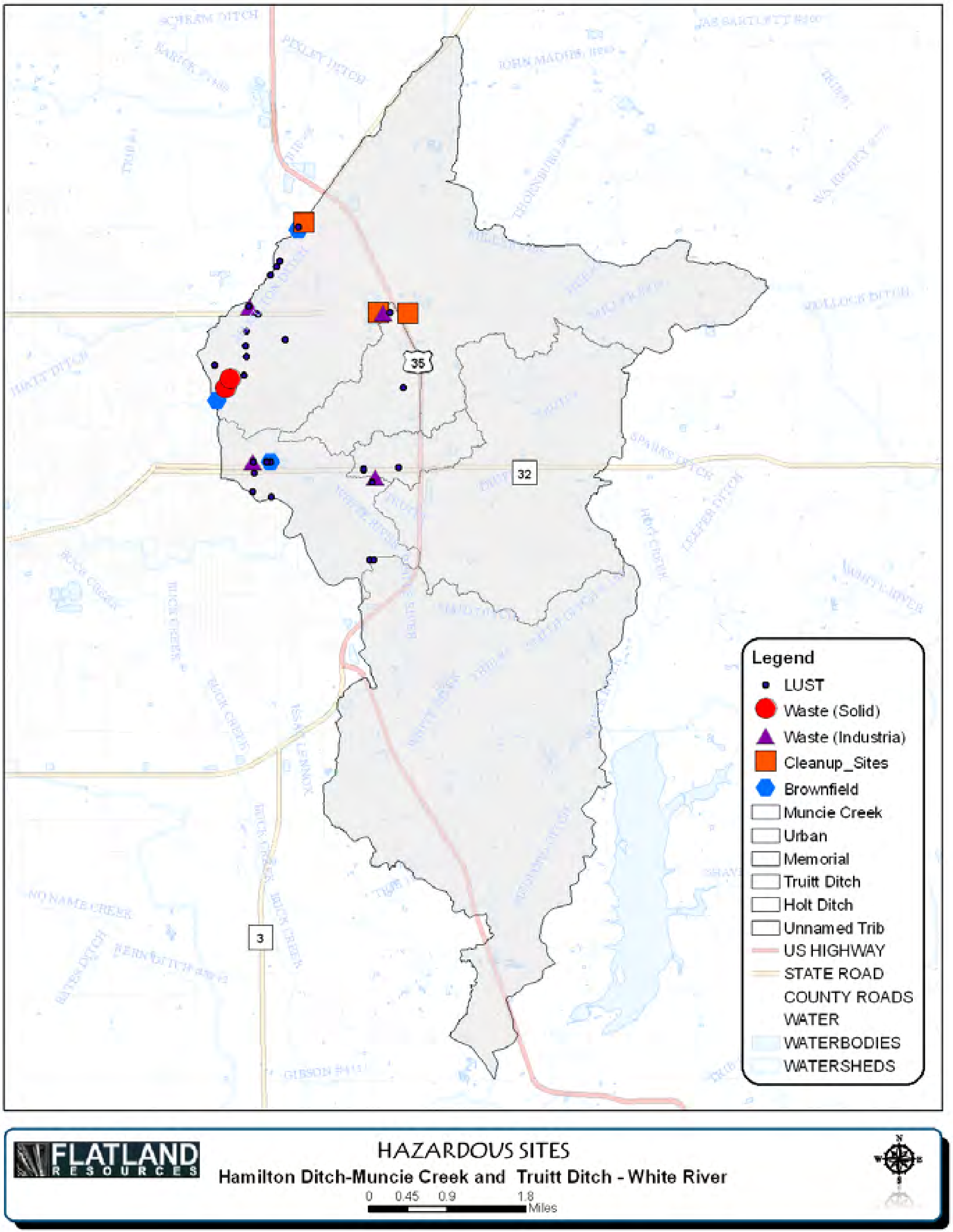
WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 23

There are about 4000 Leaking Underground Storage Tanks (LUST) sites in the state of these over eighty require attention in Delaware County. A list of Active LUST Sites in Delaware County was extracted from the state database.[1]

Underground storage tanks are typically found at gas or service stations, dry cleaners, airport or truck refueling facilities, and in homes or businesses where heating oil was stored. Gasoline, diesel fuel, hydraulic fuel, jet fuel, oil, and perchloroethylene (dry cleaning), are some of the contaminants that leak from older tanks.

A fuel additive called MTBE, methyl tertiary-butyl ether, is also a source of concern. "In December 1997, EPA issued a drinking water advisory that states concentrations of MTBE, in the range of 20 to 40 ppb of water or below will probably not cause unpleasant taste and odor for most people, recognizing that human sensitivity to taste and odor varies widely. The advisory is a guidance document that recommends keeping concentrations below that range." The EPA recommends but does not require drinking water be tested for MTBE.[2]

1 Data Generated by ArcGIS
2 Data Generated by ArcGIS



MAP. 2.45 Location of Hazardous, Waste, Lust and Superfund Sites

Hazardous Waste and Superfund

WMP - CHAPTER 2 - PART 1 - SECTION 4 - SUBSECTION 24

There are two permitted solid waste sites in the Muncie Creek - Hamilton Ditch Subwatershed: Muncie Sanitation District (811 East Centennial Avenue) and the East Central Recycling Transfer Station (701 East Centennial Avenue). There are currently no permitted hazardous waste disposal facilities in the county.[1]

However, at least two hazardous waste sites have been formally identified in Delaware County by IDEM and are described in the 2002 Commissioners Bulletin: The Albany Sludge Pit (located on Hwy 67SW in Albany) and Stout Storage Battery (located at 2505 W 8th Street in Muncie). The sludge pit served as an uncontrolled dumpsite and sewage release site. Lead, PCBs and solvents have been detected in the soil and groundwater. Action has begun to contain the problem and a three-year study ending in 2003 has been implemented to monitor progress. The old lead battery site has been cleaned and is considered safe for residential or commercial use. [2]

The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) tracks EPA's hazardous waste sites that have the potential for releasing hazardous substances into the environment. They list the following current hazardous waste sites in Delaware County.[3]

The Agency for Toxic Substances and Disease Registry identifies incidences at the following hazardous sites: Baker Garage, 1996, the Battery Case Dump, in 1991, Franks Foundry Corp. in 1996 and 2000; the Lennington and Thornburgh Sludge Dumps, 1990 and 1991; the Memorial Drive Dump in 1997. The Lennington Area Dump is located at Eaton Avenue and SR 35S in Muncie. The CDC toxic substances report for this site in 1990, indicated private groundwater contamination: 35mg lead (MCL 0.05mg); iron 7mg, sodium 180mg. The Thornburgh Sludge Dump located at SR and CR 700N in Albany has been cleaned after the EPA found lead contamination in 1991. The site continues to be monitored. [4]

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1 BioMuncie.org
2 IDEM, 2002
3 EPA CERCLIS Database
4 Agency for Toxic Substances and Disease Registry

TABLE 2.22: Location of Waste, Cleanup and Brownfeild sites		
Waste_Solid_Active_Permitted		
Name	Location	Zip
East Central Recycling Transfer Station	701 East Centennial Avenue	47303
MUNCIE-TRANSFER-ST	300 North High Street	47305
Waste_Industrial_IDEM		
Name	Location	Zip
JEFFERSON SMURFIT CORP (U.S.)	301 S BUTTERFIELD RD	47303
CITY MACHINE TOOL & DIE CO	1302 E WASHINGTON ST	47305
PRECISION TRANSMISSION	3700 E MCGALLIARD RD	47303
SEARS SVC	3501 GRANVILLE AVE	47303
Cleanup_Sites_IDEM		
Name	Location	Zip
Norrick Petroleum	NA	NA
Fred Ginther Property	NA	NA
Union Chapel Ministries	NA	NA
Brownfields		
Name	Location	Zip
CARDINAL GREENWAY	NA	NA
Muncie Recycling Center	NA	NA
Feeney Farm	4500 N. Broadway	47303
Munsyana Homes Pub. Hse. Copl	NA	NA

SOURCE: ArcGIS Indianamap.org

INVENTORY

SECTION FIVE - LAND USE

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP
CHAPTER 2

Historic Land Use

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 1

Prior to pioneer settlement, the county was covered primarily in natural forests, beech and oak-sugar maple complexes on more well drained soils and elm-ash complexes in swampy areas of the county (Ecoregions of Indiana, USEPA). According to the 1849 Delaware County Retrospect, "The face of the county is mostly level or gently undulating, even the rivers and creeks not having any considerable bluffs or hills in their vicinity. In the southwest, southeast, and northwest parts of the county and near the center, there are prairies mostly small and not exceeding one-twelfth of the county. They are usually called wet prairies. The principal growth of timber is oak, hickory, poplar, beech, walnut, sugar, linn, etc., with undergrowth of hazel, dogwood, spice, and prickly ash; but the oak land is more extensive than the beech.". [1]

Delaware County was organized in 1826, named after the largest division of the Delaware Native American tribe that made its home here. That tribe was the Delaware Indians, an Eastern tribe that settled in east central Indiana during the 1770's. The Delaware Indians established several towns along the White River, among these Munseytown, near present day Muncie. In 1818, under the Treaty of St. Mary's Ohio, the Delawares ceded their holdings in Indiana to the United States government and moved westward. In 1820, Delaware County was opened for settlement. [2]

Munseytown became the county seat in 1827 (over Granville and Smithfield, both on like waterways). Muncie was incorporated in 1854 and became a city in 1865. "Most of the County's small towns were laid out along railroad lines. These included Desoto, Cowan, Oakville, and Royerton. Delaware County's population almost doubled to 23,000 between the years 1860-1880. During these years, Muncie began to evolve into an industrial city. By 1880, Muncie had forty factories, manufacturing products ranging from washing machines to roller skates. During the next few years, more than a dozen new industries opened. In 1888, five brothers from Buffalo, New York moved to Muncie after their glass factory had burned. Ball Brothers became one of the largest employers in Muncie and their Ball jars and other glass products were shipped throughout the country." [3]

"During the 1890's, additional businesses located in Muncie including Midland Steel, Indiana Iron Works, and the Muncie Wheel Company. By 1900 the Union Traction Company had opened an interurban line between Muncie and Anderson. The interurban passed through many of the smaller towns and cities. The opportunity to easily and inexpensively travel to a larger city to make purchases and conduct business decreased the economic importance of smaller towns. This became more evident when the interurban extended its service to Indianapolis early in the century. In 1917, the Ball Brothers bought what had previously been the Eastern Indiana Normal University and offered the property to the State. The school opened as a teachers college in 1918". [4]

The college is now known as Ball State University." Waterways and wagon paths were supplemented with railroads (8 lines laid between 1901 and 1948) and public roads. Enhanced connections between cities and towns were developed through a system of county roads, turnpikes and, eventually, a state highway system. The final connectors came with the completion of I-69 and the expansion of Johnson Field into the Delaware County airport, which ties the Delaware-Muncie area into a nationwide arena and a global economy. [5]

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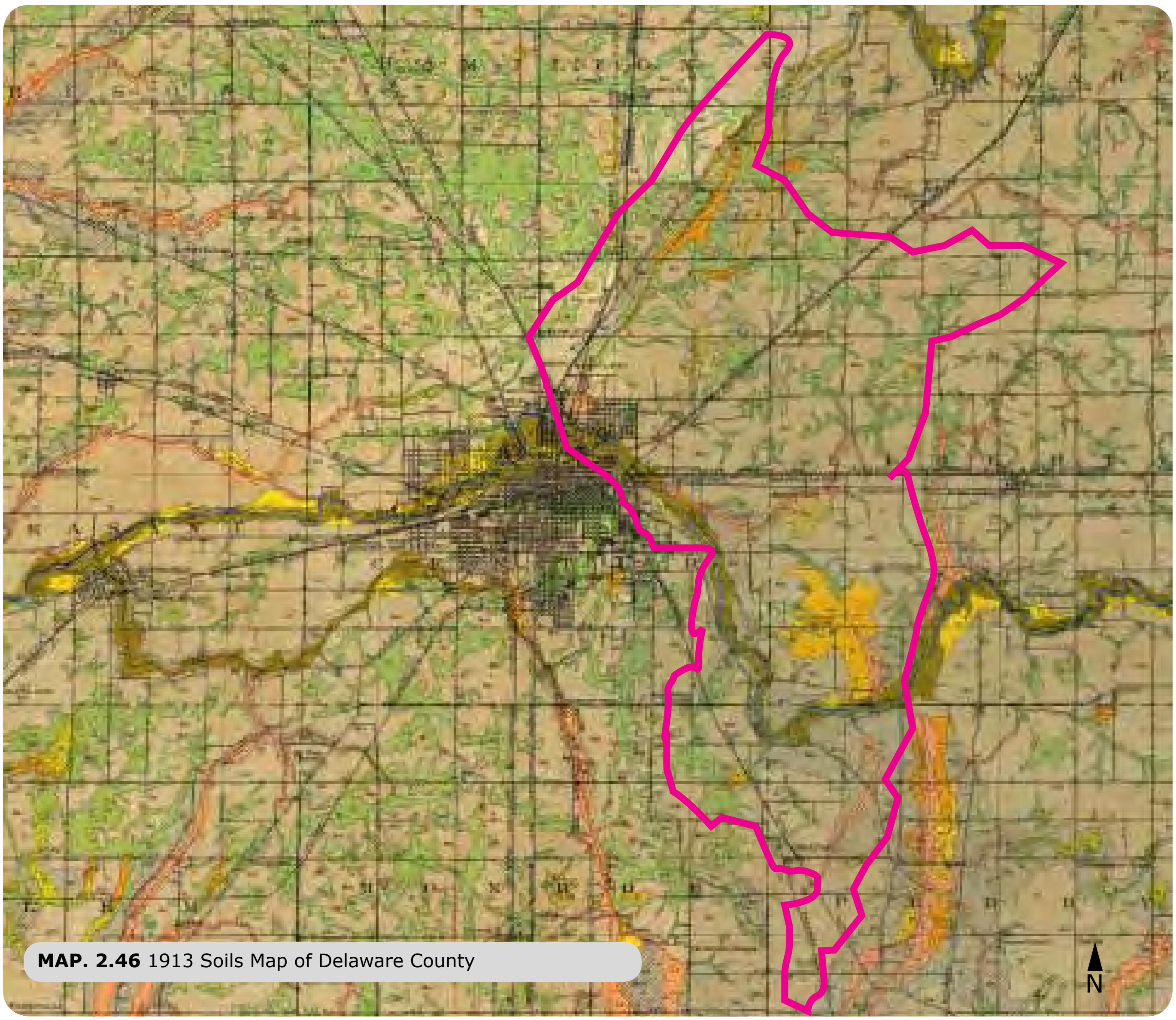
1 Indiana County History Preservation Society
2 Delaware County INGenWeb Project
3 2030 Delaware-Muncie Transportation Plan Update
4 Center Township Trustee's Office
5 2030 Delaware-Muncie Transportation Plan Update

Muncie was transformed from an agricultural trading center into an industrial community (glass, rubber, metals) with the discovery of natural gas in 1886. Depletion of the gas supply was followed by a growing automobile industry. The glass industry, via the Ball family, fostered a small community college, Normal City, which grew into Ball State Teachers College (with a 1944 enrollment of 1,346) and became Ball State University in 1965 with enrollment steadily increasing until the mid 1990's to a current range of some 19,000 students, which has risen and fallen near that level for ten years. [6]



MAP. 2.46 1913 Soils Map of Delaware County

6 2030 Delaware-Muncie Transportation Plan Update.pdf

INVENTORY

Current Land Use

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 2

The Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds consist of approximately 20,383 acres of mixed land use, according to the 2001 National Land Cover Data (NLCD) published by the Soil Survey of Delaware County Indiana US Department of Agriculture (MAP 2.47, 2.48). The NLCD 2001 includes nineteen land classifications ranging from cultivated crops to high intensity developed land. These aerial images were compared to the NLCD 2001 in order to determine if any changes in land use had occurred. Based on the 2008 aerial, minor changes in land use when looking at the overall watershed (less than .1%) were seen in comparison to the 2001 information. [1]

The watershed has historically been dominated by agricultural land that comprises approximately 60% of its area. Additionally, forests and wetlands comprise only 30% (open water, forest, shrub/scrub, grassland herbaceous, woody wetlands and emergent herbaceous), and urban and residential lands comprise 10% of the watershed.

As urban areas continue to develop within the watershed, the agencies with regulatory authority should pay careful attention to the characteristics of the existing areas and require (as much as the law allows) that developments incorporate best management practices (including avoidance of significant natural areas, buffers, etc.) within their projects. [2]

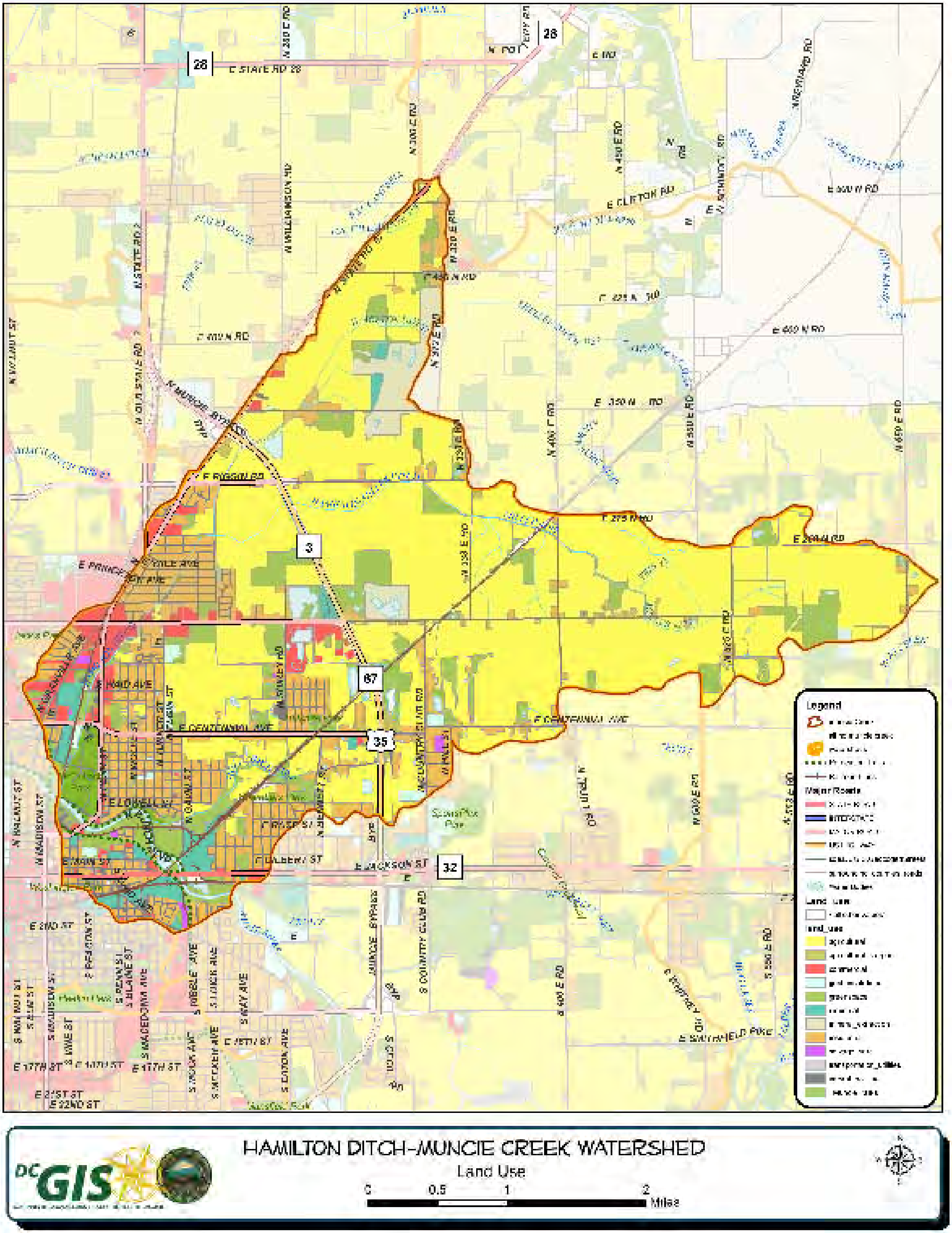
Of the total 11,781 acres in the Truitt Ditch-White River watershed, a large section of the watershed, over 1000 acres, is owned by the Academy of Model Aeronautics and is the site of their National Model Aviation Museum. The museum includes a large cool-season grass field that is surrounded by agriculture fields. Other large landowners include the County Commissioners of Delaware County, Cardinal Greenways Inc., and the Delaware Country Club Golf Course. In total 2.24% of the land is owned by public entities, and the rest, 97.76% is privately held.

Of the total 8,602 acres in the Hamilton Ditch-Muncie Creek watershed, the major landowners in this watershed include the City of Muncie, Irving Materials, Inc., and Muncie Community Schools. Three parks are located in this watershed: McCullough Park, the John M. Craddock Wetland Nature Preserve, and the Hughes Nature Preserve. A portion of the White River Greenway is also located in this watershed. In total, 2.17% of the land is owned by public entities, and the rest, 97.83% is privately held.[3]

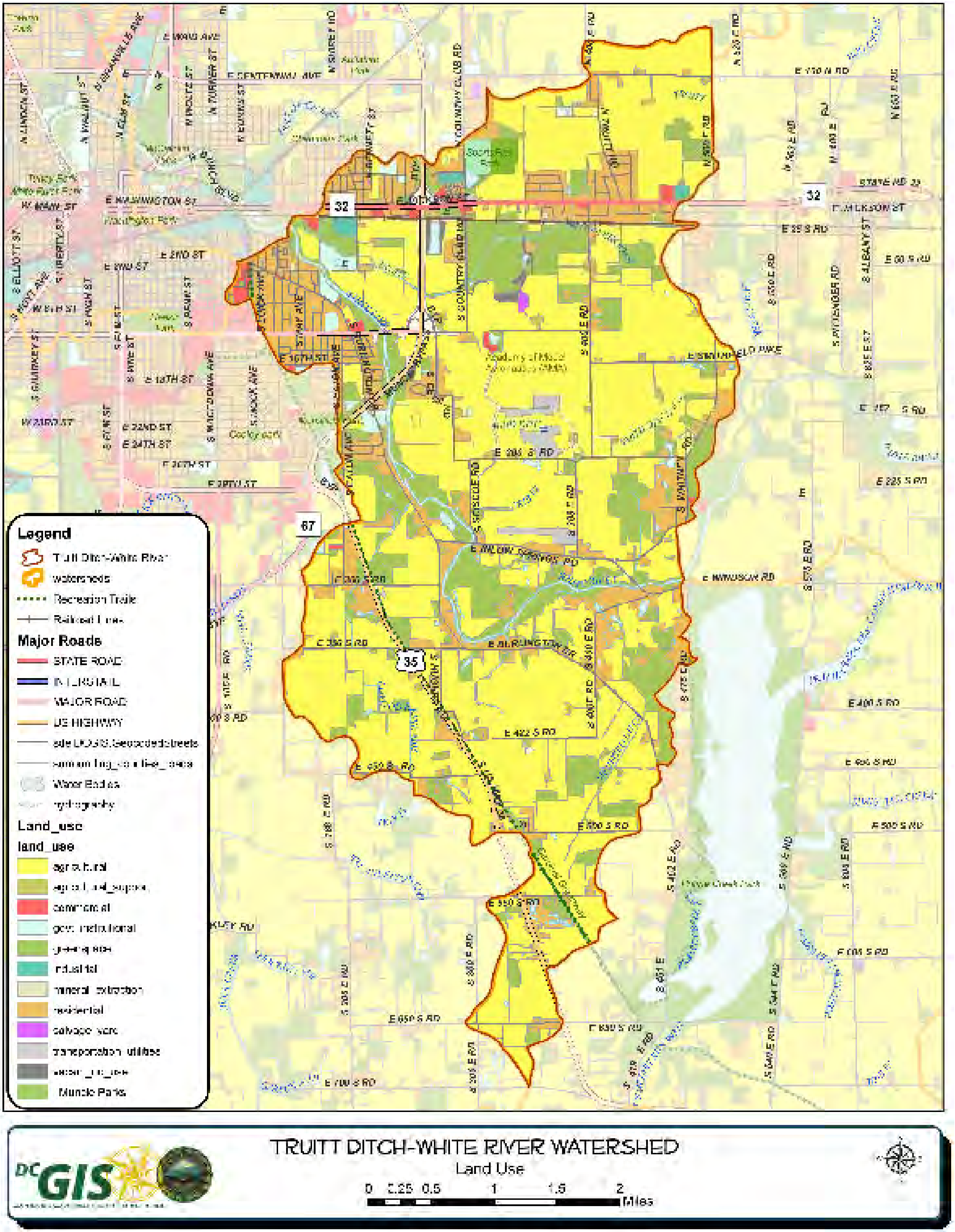
Water quality is greatly influenced by land use both past and present. Different land uses contribute different contaminants to surface waters. As water flows across agricultural lands it can pick up pesticides, fertilizers, nutrients, sediment, pathogens, and manure. However, when water flows across parking lots or from roof tops it not only picks up motor oil, grease, transmission fluid, sediment, and nutrients, but it reaches a waterbody faster than water flowing over natural or agricultural land. This is due to the inability of surface water to reach groundwater where hard surfaces exist. A review of the land types present in the watershed will provide an idea of the types of restoration that could occur within the watershed and also a basis for the past uses of the land. [4]

1 Tom Reeve, White River Watershed Project
2 Tom Reeve, White River Watershed Project
3 Tom Reeve, White River Watershed Project
4 Tom Reeve, White River Watershed Project

INVENTORY



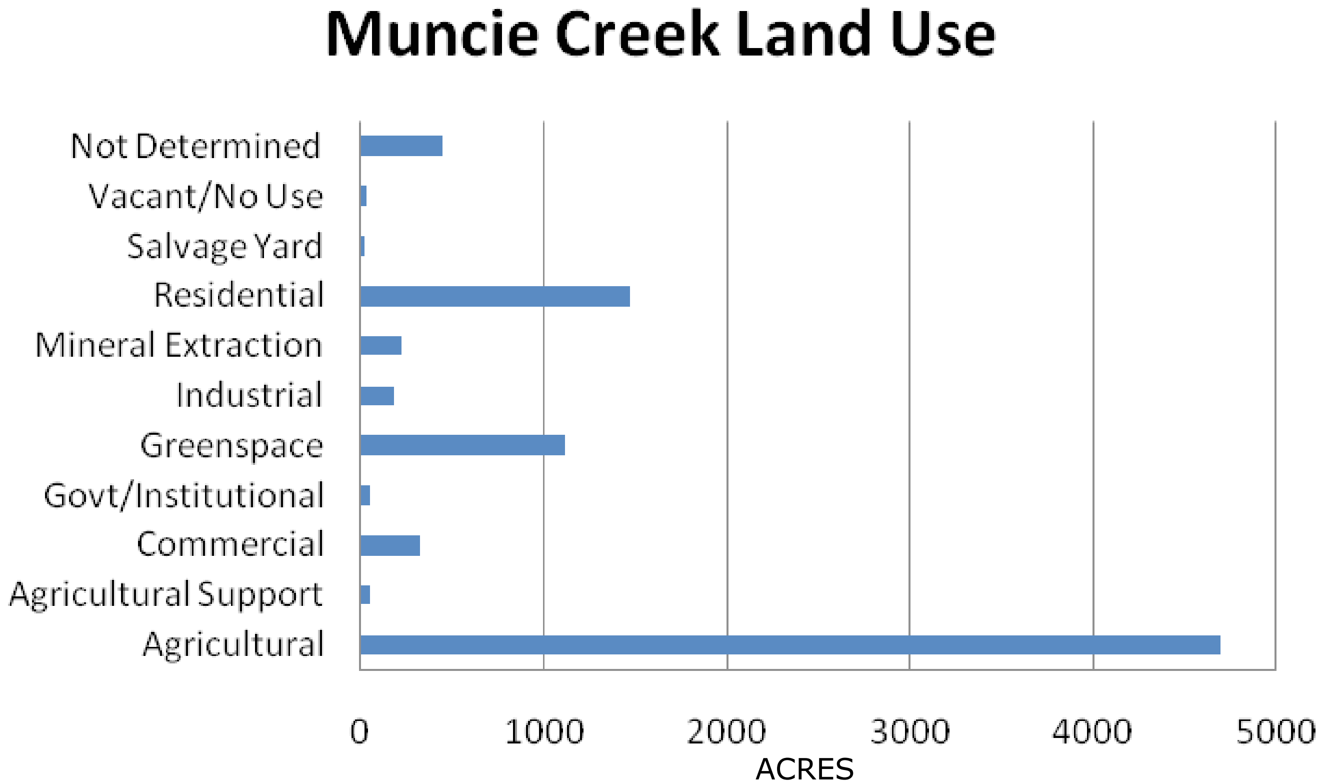
MAP. 2.47 Hamilton Ditch - Muncie Creek Land Use



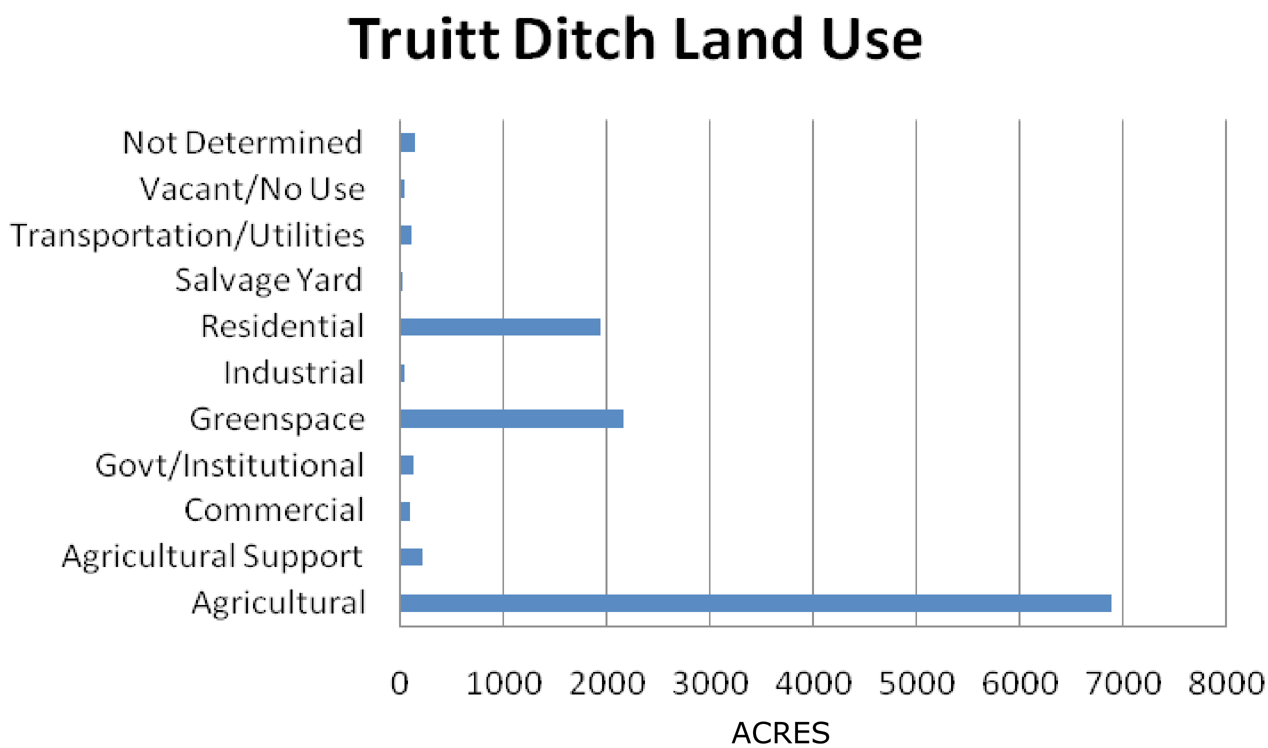
MAP. 2.48 Truitt Ditch-White River Land Use

Current Land Use

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 3



CHA. 2.12 Hamilton Ditch-Muncie Creek Land Use



CHA. 2.13 Truitt Ditch-White River Land Use

Below is a summary of the types of land use for the Muncie Creek Watershed according to a 2008 aerial orthophotograph (Table 2.23) and a map of the land use data (MAP 2.47). The specific data about land use and its relationship to water quality will be discussed later in this management plan.

TABLE 2.23: Hamilton Ditch-Muncie Creek Land Use

Land Use	Acres	Percentage
Agricultural	4697.19	54.61
Agricultural Support	49.14	0.57
Commercial	321.77	3.74
Govt/Institutional	52.5	0.61
Greenspace	1113.07	12.94
Industrial	180.98	2.10
Mineral Extraction	219.7	2.55
Residential	1470.91	17.10
Salvage Yard	19.66	0.23
Vacant/No Use	30.99	0.36
Not Determined	446.09	5.19
Total	8155.91	100.00

SOURCE: ArcGIS Indianamap.org

Below is a summary of the types of land use for the Truitt Ditch Watershed according to a 2008 aerial orthophotograph (Table 2.24) and a map of the land use data (MAP 2.48). The specific data about land use and its relationship to water quality will be discussed later in this management plan.

TABLE 2.24: Truitt Ditch-White River Land Use

Land Use	Acres	Percentage
Agricultural	6884.39	58.44
Agricultural Support	217.06	1.84
Commercial	101.39	0.86
Govt/Institutional	121.4	1.03
Greenspace	2152.03	18.27
Industrial	47.74	0.41
Residential	1937.91	16.45
Salvage Yard	8.82	0.07
Transportation/Utilities	116.94	0.99
Vacant/No Use	39.76	0.34
Not Determined	153.56	1.30
Total	11627.44	100.00

SOURCE: ArcGIS Indianamap.org

Urban Land Use

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 4

Urban land uses cover an additional 10% of the watersheds. These land uses include low, medium, and high density residential and commercial development and urban grass lands. Many urban land use issues are of concern to stakeholders including: the prevalence of impervious surfaces, which contribute to both the increasingly flashy nature of the White River and sediment transportation to watershed waterbodies; continued urban development and conversion of lands from agricultural to urban uses without restoration of forested and wetland land uses; use of septic systems in areas which are unsuited for high-density residential development and where sewer systems are not yet present; and the presence of chemical inputs from previous industrial development and uses.

A majority of the urban land is located within the citiy of Muncie and this is the boundary for the municipal separate storm sewer system (MS4). The MS4 boundary is designated by IDEM.

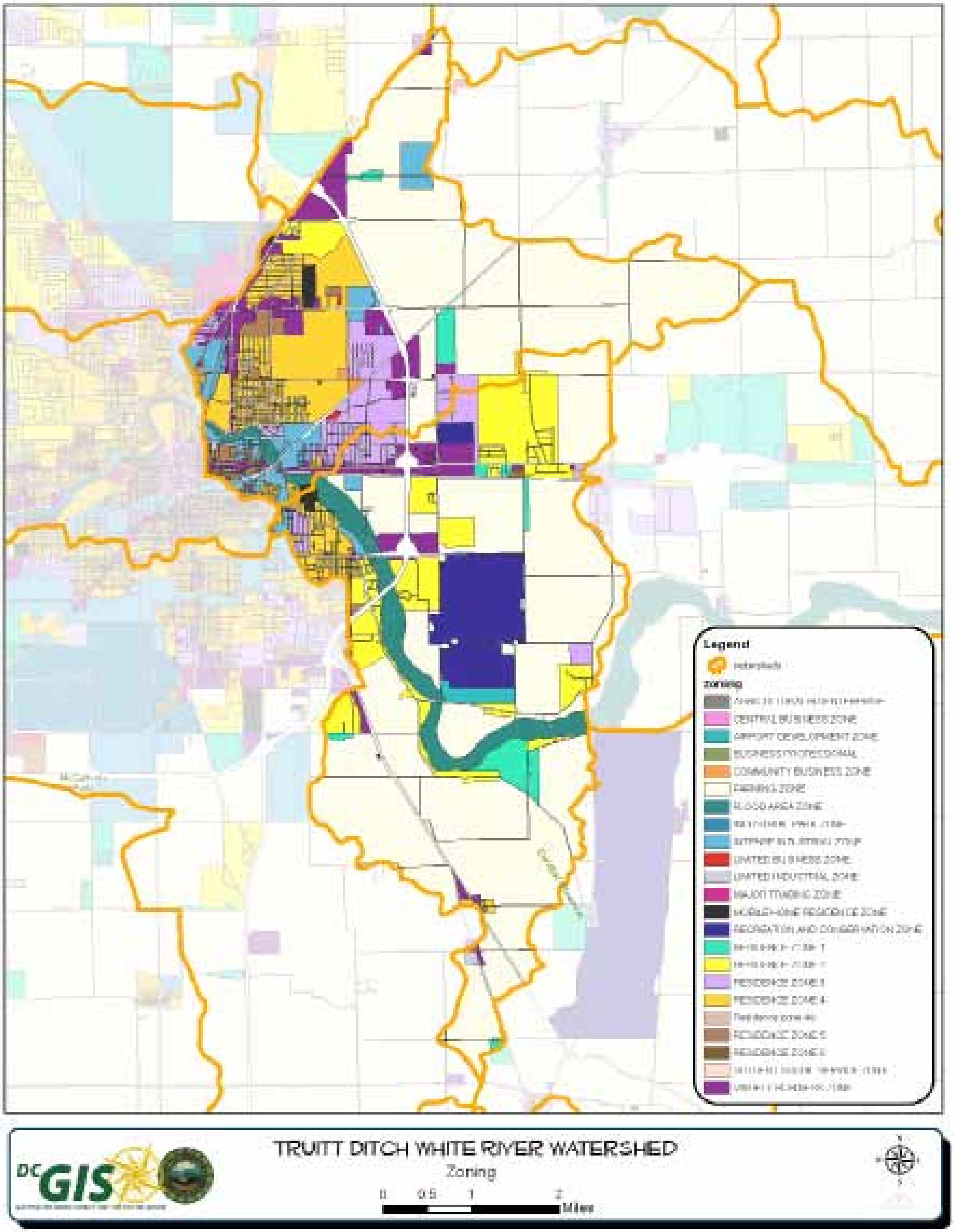
Muncie, the county seat of Delaware County, has many different industries. Some of the smaller companies produce component parts or provide services to the larger industries. The main industries are plants that treat metal, produce alloys, and provide metal products, factories that manufacture automotive equipment and tool-and-die equipment, and firms that provide a variety of goods and services, including trucking, foods, and other retail products.[1]

Delaware County is served by several State highways, U.S. Highway 35, and Interstate Highway 69. Muncie is located about 50 miles northeast of Indianapolis, Indiana, and is within 5 to 10 miles of Interstate 69. Delaware County is served by three railroad lines. Small airlines provide commuter service to the Muncie airport. Grain markets consist mainly of local elevators in the county and surrounding counties. From these elevators, grain is shipped by truck or railroad to larger terminals. Glacial outwash deposits provide a good source of sand and gravel.[2]

Several commercial gravel pits are in operation. Quarries produce crushed and agricultural limestone used in concrete, farming, road construction, and building construction. Organic soils provide a source of muck and peat. The larger deposits are found in the northwest quadrant of the county. A few commercial operations mine muck and peat in the county.[3]

IMG. 2.8 Aerial View of the City of Muncie

1 Soil Survey of Delaware County Indiana. US Department of Agriculture soil survey
2 Soil Survey of Delaware County Indiana. US Department of Agriculture soil survey
3 Soil Survey of Delaware County Indiana. US Department of Agriculture soil survey



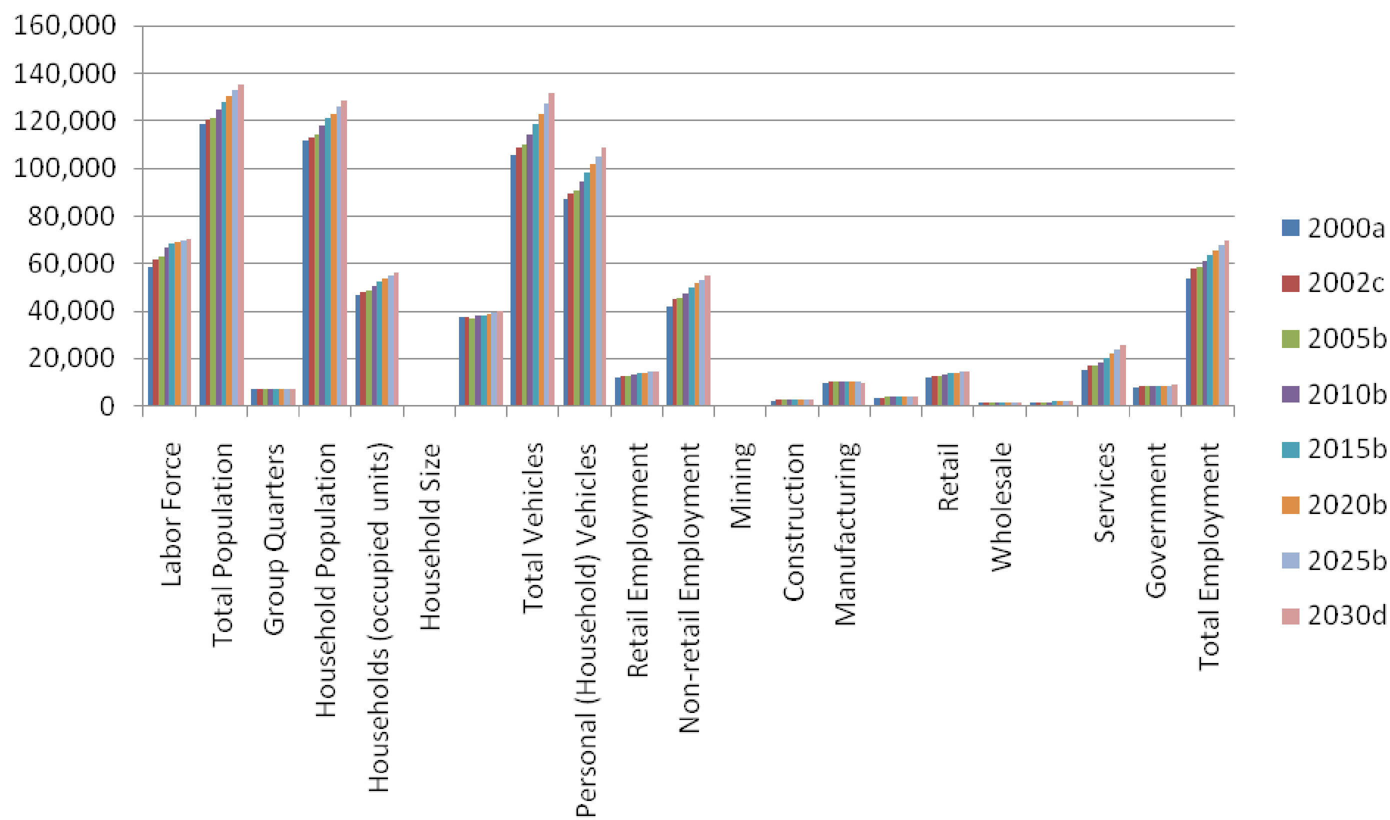
MAP. 2.49 Hamilton Ditch - Muncie Creek Zoning

INVENTORY

Economy

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 5

As with many communities, the economic base of the Delaware-Muncie area used to be characterized by a small number of large manufacturing firms and the provision of professional services. The manufacturing base included Ball Brothers, Borg-Warner, Westinghouse, Owens-Illinois, General Motors, and Dayton-Walther - all of which have are now gone. Ball State University and Ball Memorial Hospital continue to represent a majority of the professional services industry. Diversification and new recruitment, including manufacturing concerns, and retention/ growth of the service industry have helped to maintain some stability for the local economy. Employment trends have continued along patterns established over the last few decades in line with national trends toward a tertiary economy. East Central Indiana has shown more job and population loss than most areas of the state; however, the IU Business Research Center does show projections that, over the next 20 years, Delaware County will maintain stability and some growth. [1]



CHA. 2.14 Delaware County Employment Characteristics and Projections

1 2030 Delaware-Muncie Transportation Plan Update

TABLE 2.25: Delaware County Employment Characteristics and Projections								
	2000a	2002c	2005b	2010b	2015b	2020b	2025b	2030d
Labor Force	58,710	61,540	62,990	66,530	68,379	69,110	69,745	70,390
Total Population	118,749	120,227	120,984	124,691	128,161	130,237	132,855	135,525
Group Quarters	6,933	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Household Population	111,836	113,227	113,984	117,691	121,161	123,237	125,855	128,523
Households (occupied units)	47,131	47,978	48,504	50,511	52,451	53,581	54,959	56,371
Household Size	2.37	2.36	2.35	2.33	2.31	2.30	2.29	2.28
Median Household Income (Yr 2000 dollars)	$37,401	$37,328	$37,218	$37,884	$38,042	$38,765	$39,344	$39,930
Total Vehicles	105,436	108,645	109,684	114,031	118,378	122,724	127,071	131,569
Personal (Household) Vehicles	87,286	89,818	90,803	94,401	98,000	101,598	105,197	108,921
Retail Employment	11,943	12,751	12,890	13,444	13,907	14,136	14,360	14,587
Non-retail Employment	41,789	45,161	45,656	47,611	49,702	51,472	53,231	55,128
Mining	34	29	26	22	21	20	19	18
Construction	2,375	2,616	2,638	2,725	2,778	2,795	2,811	2,827
Manufacturing	9,569	10,142	10,170	10,284	10,298	10,194	10,081	9,969
Transportation /Communications Public Utilities	3,279	3,781	3,827	4,009	4,136	4,191	4,244	4,297
Retail	11,943	12,751	12,890	13,444	13,907	14,136	14,360	14,587
Wholesale	1,507	1,507	1,507	1,507	1,507	1,507	1,507	1,507
Finance / Insurance /Real Estate	1,846	1,903	1,913	1,954	1,991	2,007	2,024	2,041
Services	15,073	16,818	17,167	18,562	20,307	22,052	23,796	25,678
Government	8,126	8,373	8,408	8,548	8,665	8,707	8,749	8,791
Total Employment	53,732	57,920	58,546	61,055	63,610	65,609	67,591	69,715

SOURCE: 2030 Delaware-Muncie Transportation Plan Update

Population Forecast Control Totals
Sources: (a) Indiana Department of Workforce Development for labor force and "wage and salary" employment; U.S. Bureau of the Census for 1990-2000 population and housing; and Indiana Business Research Center for median household income and motor vehicle registration with the State of Indiana Bureau of Motor Vehicles. (b) Bernardin-Lochmueller & Associates for Projections (c) DMMPC projections using March 2002 Indiana employment figures and BLA figures. (d) DMMPC projections using BLA figures. 1

1 2030 Delaware-Muncie Transportation Plan Update

Population

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 6

Population trends can be monitored per watershed, though watershed boundaries do not align with townships or census tracts. Despite these challenges, it is important to understand overall population trends within the watershed or the vicinity.

Delaware County has shown a slow decline in population since 1980, as seen below. The population in 2009 was 115,192 with 77% located in the urban areas and 23% in rural areas. The population density of Delaware County is 293 people per square mile (395.6 sq miles in the county). [1]

Muncie-Delaware County area is currently experiencing declines from the nationwide recession. For the most part, the rate of growth has slowed significantly. County planners project that population decline in the Muncie-Delaware County area will slowly begin to reverse over the next 20 years. [2]

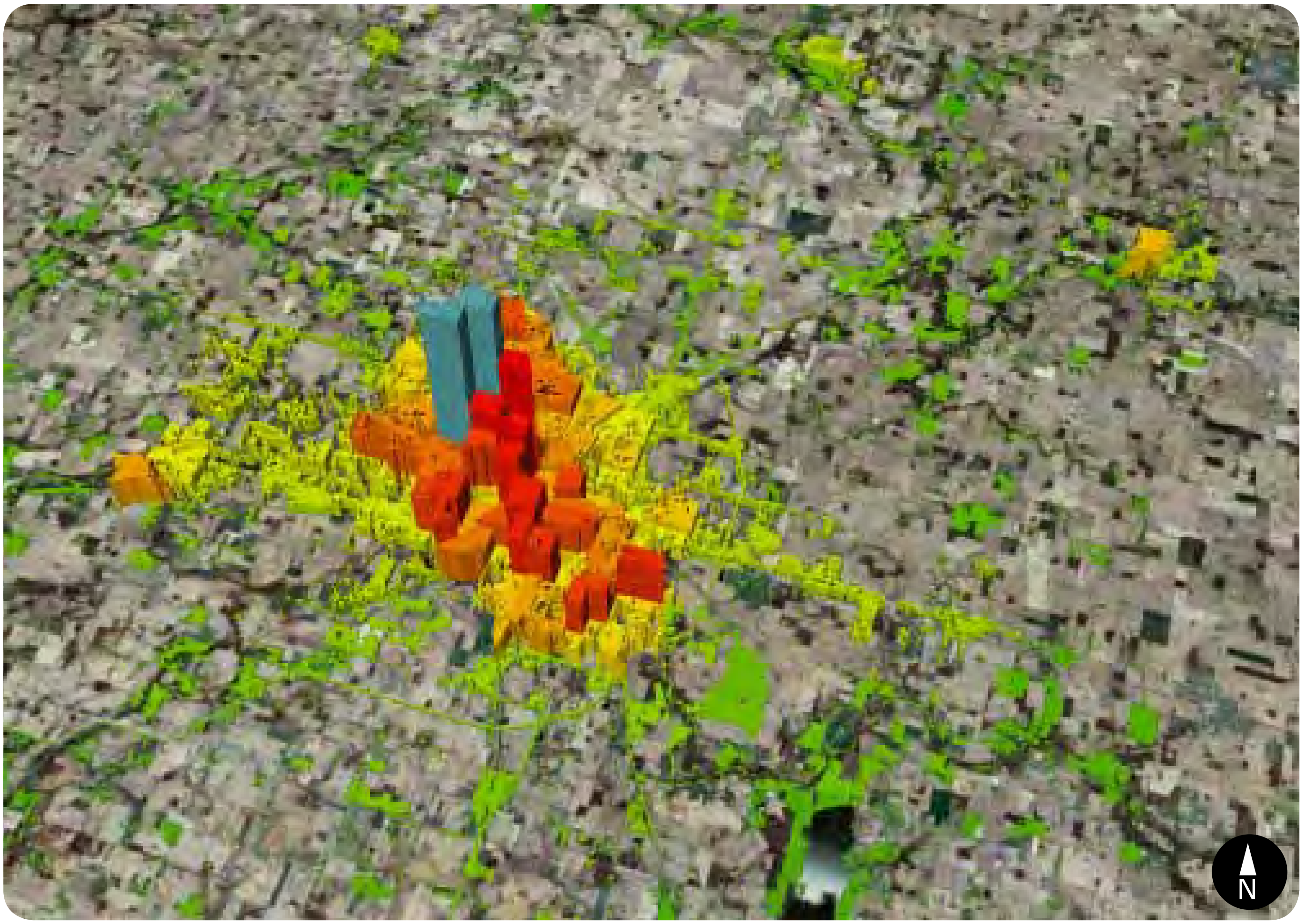
According to a data collected by the Muncie Parks and Recreation Department and the US Census Bureau, the population outside of Muncie has increased at a larger rate as the city has decreased in population. [3]

TABLE 2.26: Census QuickFacts

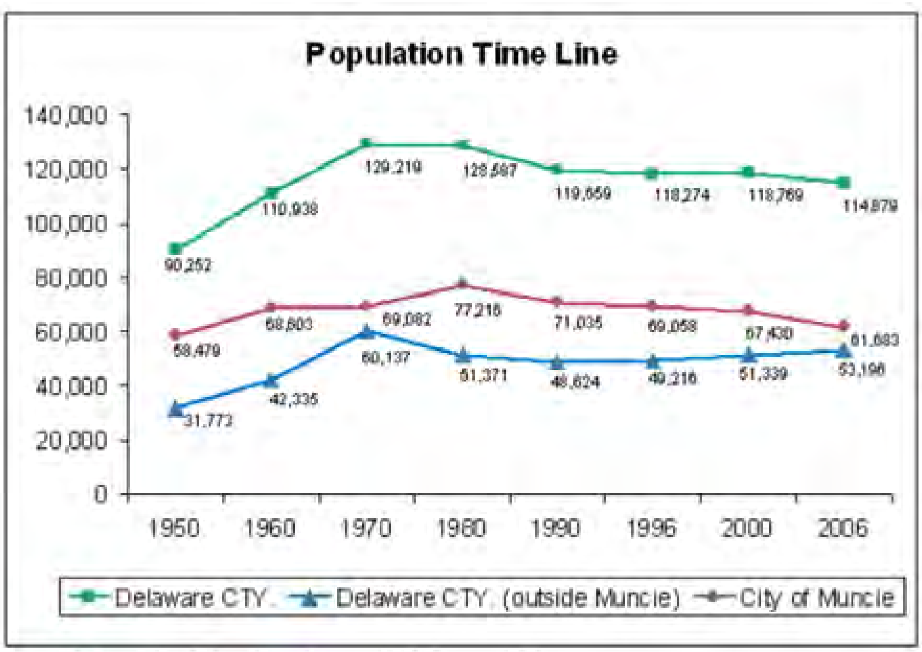
Population, 2009 estimate	115,192
Population, percent change, April 1, 2000 to July 1, 2009	-3.0%
Population estimates base (April 1) 2000	118,769

SOURCE: Census QuickFacts

1 CityData.com
2 2030 Delaware-Muncie Transportation Plan Update
3 U.S. Census Bureau



DIA. 2.7 Diagram of Population Concentration



CHA. 2.15 Muncie-Delaware County Population Timeline, US Bureau of Censu

INVENTORY

Pop. /Economic Projections

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 7

Population projections for Delaware County in 2035 show a low of 109,081, a medium of 119,497 and a high of 132,754. The high range is reflected in the 2005-2030 Model used in the Regional Planning department. However, with the slowing of permits by more than half and the state of the recovering economy, the medium population projections were used in other regional planning documents. [1]

Therefore, using this estimate, the 2030 population will have recovered to approximate the 2000 population.[2] As the growth in jobs exceeds the growth in population and labor force over the same twenty-five year period, Delaware County will become an even greater net importer of labor with the number of jobs (including farms and proprietorships) exceeding the available labor force in the county.[3]

For the year 2020, the Delaware County forecast of 130,237 persons was considerably higher than most recent forecast of 117,344 persons by the Indiana State Data Center and the Woods & Poole Economics forecast of 118,430 persons, but comparable to the 1970 Census count of 129,129 persons and the 1980 Census count of 128,597 persons.[4]

Using the population projection and assuming a stable population in group quarters, 54,959 households were projected for the year 2025 for Delaware County resulting in a net increase of 7,828 households over the year 2000 count of 47,131 households. [5]

This reflects a future reduction in the gap between the household size in the United States and Indiana versus Delaware County. In the year 2000, the household size was 2.37 persons per household for Delaware County compared to 2.59 persons per household in the United States and 2.53 persons per household in Indiana. [6]

1 2030 Delaware-Muncie Transportation Plan Update
2 2030 Delaware-Muncie Transportation Plan Update
3 2030 Delaware-Muncie Transportation Plan Update
4 2030 Delaware-Muncie Transportation Plan Update
5 2030 Delaware-Muncie Transportation Plan Update
6 2030 Delaware-Muncie Transportation Plan Update

TABLE 2.27: Population and Employment Forecast for Delaware County			
Component	Year 2000	Change from 2000 to 2025	Year 2025
Population	118,769	14,080	132,849
Group Quarters Population	6,933	67	7,000
Household Population	111,836	14,013	125,849
Households	47,131	7,828	54,959
Grades K to 12 School Enrollment	18,615	1,396	20,011
College & University Enrollment	20,346	0	20,346
Total Enrollment	38,961	1,396	40,357
Farm Employment	307	0	307
Mining Employment	9	0	9
Construction Employment	2,586	475	3,061
Manufacturing Employment	10,281	573	10,854
Transportation, Communication & Public Utilities Employment	1,739	512	2,251
Wholesale Employment	1,891	0	1,891
Retail Employment	13,841	2,801	16,642
Finance, Insurance & Real Estate Employment	2,794	269	3,063
Services Employment	27,991	11,411	39,402
Government Employment	1,068	82	1,150
Total Employment in Year 2025	62,507	16,123	78,630

SOURCE: 2030 Delaware-Muncie Transportation Plan Update

Land Use Demand Model

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 8

As emphasized by the regional planning office, there is an undeniable interrelationship between transportation, land use, demographics and socioeconomic factors. Policies, decisions and actions undertaken within one arena will affect the others. With a strong economy, existing businesses will expand and new business will locate in an area (after consideration of feasibility factors such as capacity of transportation facilities, utilities, labor force, etc.). This, in turn, provides new employment opportunities and these new employees will create a demand for housing and other urban amenities and services.

Increased amenities (social, recreational, environmental) and services (roads, transit, utilities) increase the attractiveness of an area and its potential for obtaining more new business, and the cycle continues.

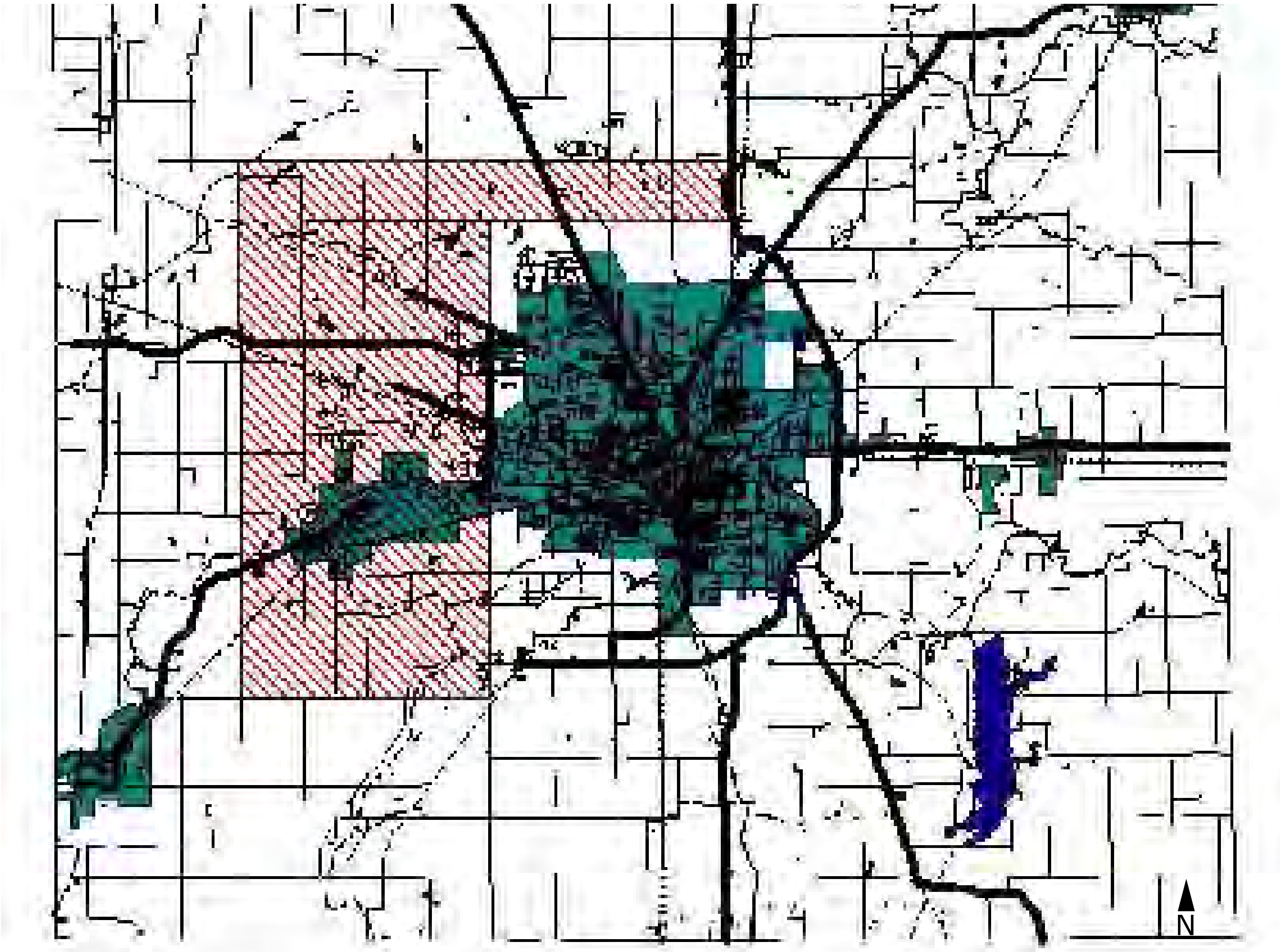
Therefore it is important to document the projections used in other regional planning documents to prepare for development pressures that are projected to occur and have watershed management strategies for these developments. (MAP 2.50)

County wide control totals of socioeconomic variables were forecasted in five-year increments from 2000 to the year 2025 in order to serve as a basis for developing projections for the individual 514 Travel Analysis Zones (TAZs), which represented all general locations connected by traffic. BLA developed a base year traffic model for 2000 and a future year traffic model for 2025. [1]

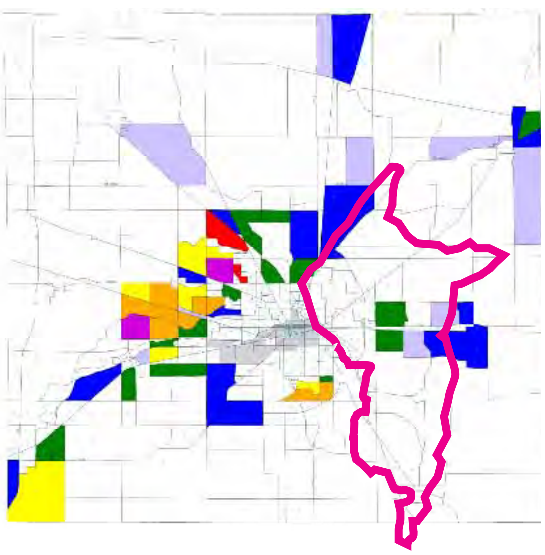
The forecasts used in developing the Delaware County Travel Model were cross-checked by utilizing building permit data. Permit location patterns were consistent with the Travel Model forecasts which emphasize growth to the west and northwest of the City of Muncie. Business loss has occurred within the City of Muncie. However, new business attraction in the last 5 years has occurred in the 3 industrial park areas –the Airpark on the north side, the Industrial Centre on the southwest side and the Park One center at I-69 and SR 332. [2]

The cross-checked building permit data forecasts indicated an increase of 1,373 new dwelling units from 2000-2005 (MAP 2.53). With approximately 20 permits per year for the small towns, a five year period would add 100 new units. Also, a fourplex development in the county was undercounted by 60 units and a city apartment project for 52 units was counted as one commercial permit. The 5 year total of 1323 is within 4% of the forecast.[3]

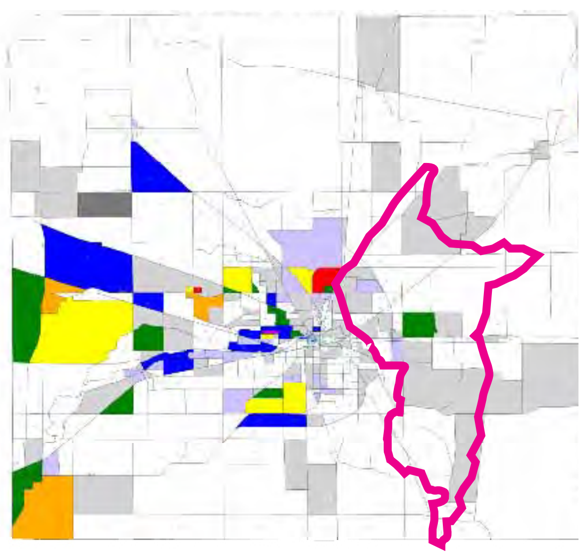
1 2030 Delaware-Muncie Transportation Plan Update
2 2030 Delaware-Muncie Transportation Plan Update
3 2030 Delaware-Muncie Transportation Plan Update



MAP. 2.50 Forecasted Land Use Development (hashed)



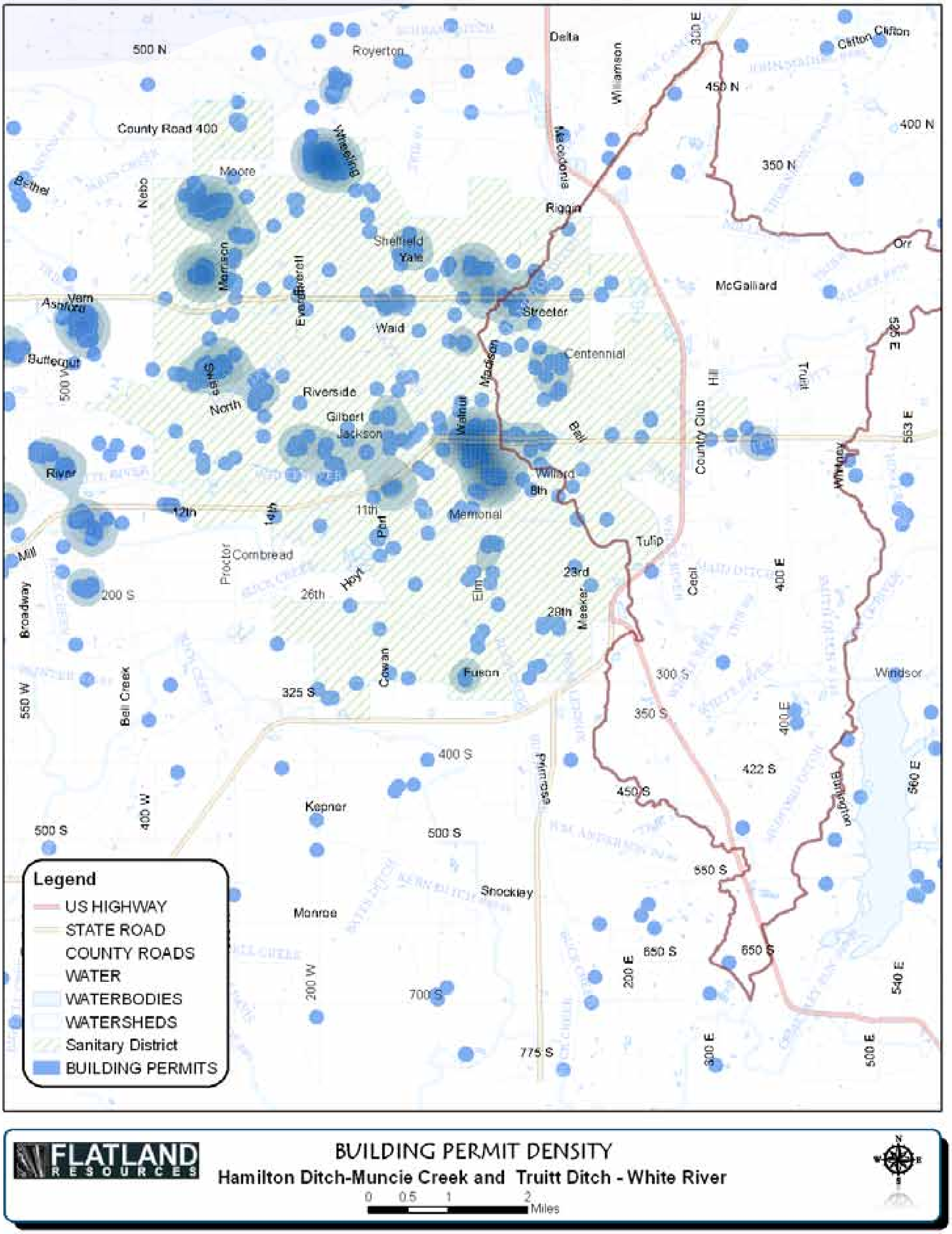
MAP. 2.51 Forecasted Residential Changes



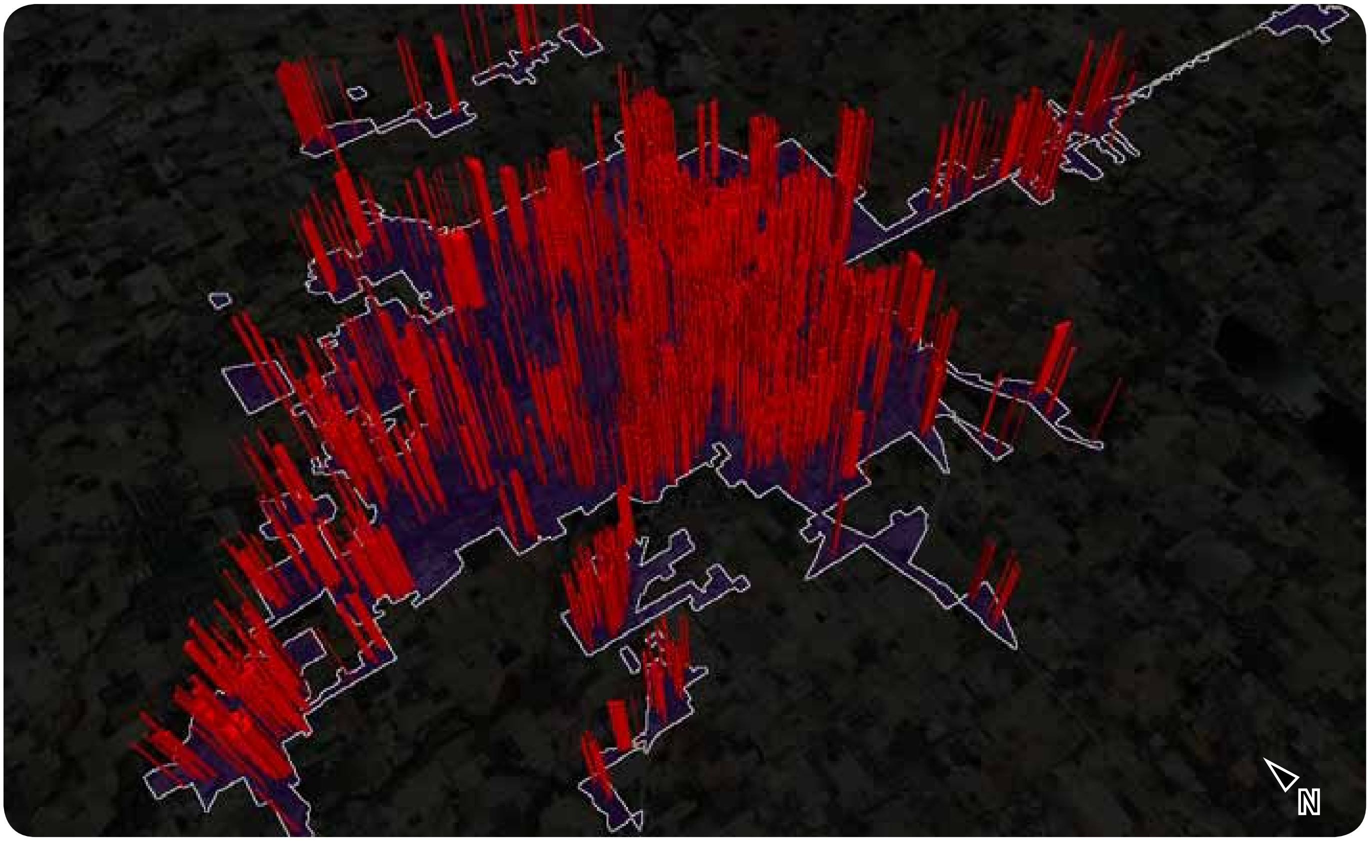
MAP. 2.52 Forecasted Commercial Changes

SOURCE: 2030 Delaware-Muncie Transportation Plan Update

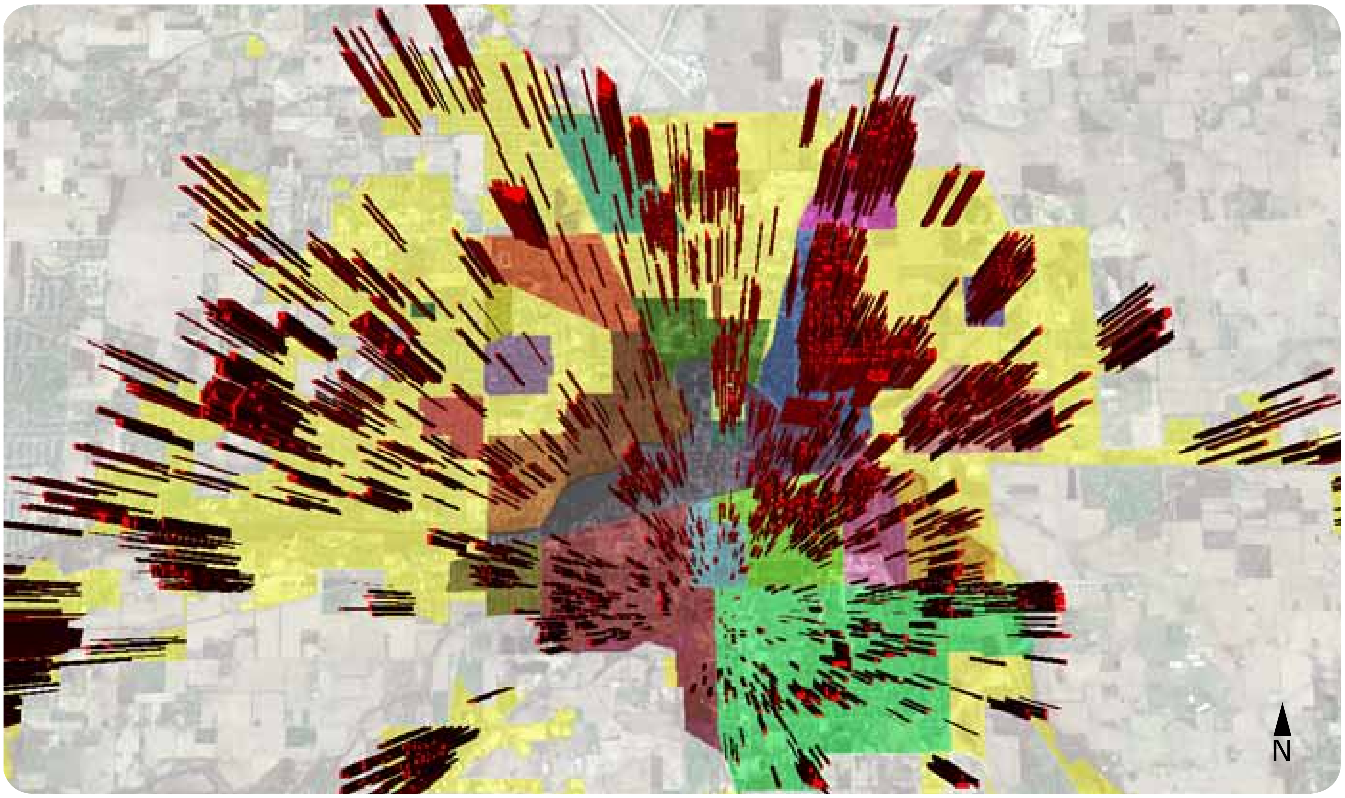
INVENTORY



MAP. 2.53 Concentration of Building Permits in Delaware County



DIA.2.8 Location of Vacancy in City of Muncie



DIA.2.9 Location of Vacancy in City of Muncie Relative to Historic Neighborhoods

INVENTORY

Impervious Surface

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 9

Impervious surfaces are hard surfaces which limit surface water from infiltrating into the land surface to become groundwater, thereby creating high overland flow rates. Hard surfaces include concrete, asphalt, compacted soils, rooftops, and buildings or structures. In developed areas like the City of Muncie, land which was once permeable has been covered by hard, impervious surfaces. This causes rain that once absorbed into the surface to runoff of rooftops and over pavement entering the White River with not only higher velocity but also higher quantities of pollutants. [1]

Overall, much of the watershed is covered by low levels of impervious surfaces; however, high impervious densities are present in Muncie with lower densities occurring within smaller towns and along roads throughout the watershed.

Studies indicate that stream ecology degradation begins with only 10% impervious cover in a watershed. Higher impervious surface coverage results in further impairments including water quality problems, increased bacteria concentrations, higher levels of toxic chemicals, high temperatures, and lower dissolved oxygen concentrations. Areas of high impervious surface density (>10%) within the watershed should be considered as a factor during implementation.[2]

The impervious cover in the Truitt Ditch - White River Subwatershed is 1022.4 acres or 11.89 % of the watershed area under the current conditions.[3]

The impervious cover in the Muncie Creek - Hamilton Ditch Subwatershed is 806.4 acres or 6.84 % of the watershed area under the current conditions.[4]

1 Tom Reeve, White River Watershed Project
2 Wabash River (Region of the Great Bend) WMP
3 Data Generated by ArcGIS
4 Data Generated by ArcGIS

DIA. 2.10 Normative Urban Core in City of Muncie

DIA. 2.11 Dominant Peri-urban land use configuration in city of Muncie

INVENTORY

Impervious Surface (cont.)

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 9

TABLE 2.28: Impervious Surface per Land Use Type Muncie Creek - Hamilton Ditch and Truitt Ditch-White River	
Acres	Landuse
219	Agriculture
316.5	Commercial
33.1	Forest
28.2	Grass/pasture
1,136.3	Residential
95.7	Industrial
1,828.8	Total impervious acres
20,367.5	Total acres

SOURCE: ArcGIS Indianamap.org

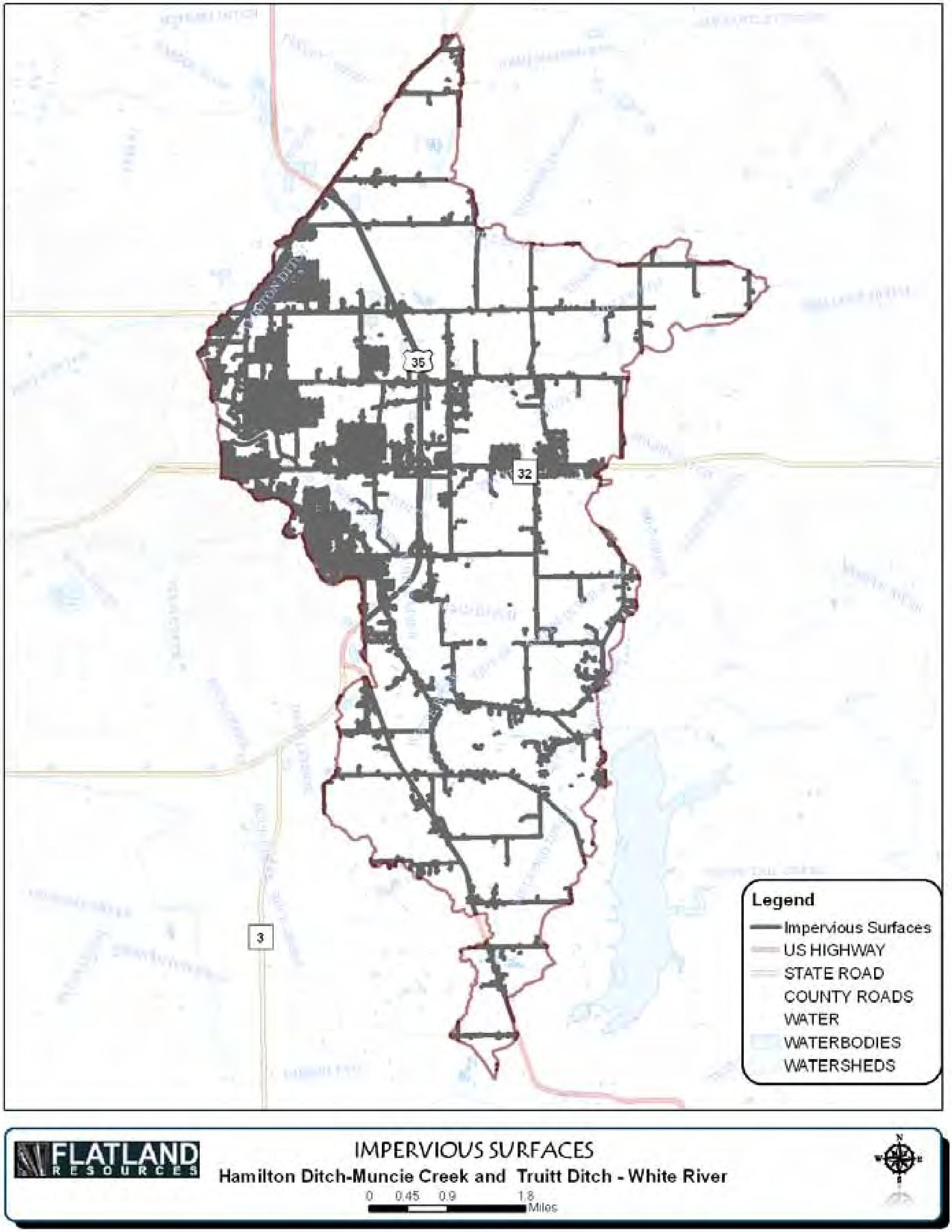
TABLE 2.29: Comparison of Impervious Surface to Wetlands					
	Truitt Ditch-White River			Muncie Creek - Hamilton Ditch	
Total Impervious Cover	1022.4	11.89%		806.4	6.84%
Total Wetland	96	2.02%		98	2.81%

SOURCE: ArcGIS Indianamap.org

GIS Derived Statistics

Tables contain information derived from GIS maps created in ArcView. Summary statistics are listed by storm water watersheds and include land use information from Indiana's GAP data program.[1]

1 Data Generated by ArcGIS



MAP. 2.54 Impervious Surfaces in Subwatershed Areas

Natural Land Uses

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 10

Natural land uses including forest, wetlands, and open water cover 30% of the watershed. Individuals are concerned that too much forested land is being lost within the watershed and would like to see reforestation prioritized. Forest cover occurs adjacent to waterbodies throughout the watershed in non-contiguous tracts. However, large lengths of the watershed streams no longer contain intact riparian buffers. Specific areas of concern will be discussed in further detail in subsequent sections.

A number of recreational opportunities are present throughout the Subwatershed areas. Recreational facilities and parks serve as an opportunity for the public to enjoy the natural landscape within their community as well as learn about valuable natural resources.

Recreational opportunities in the watersheds include city parks, nature preserves, and recreational facilities including: McCulloch Park, Buley Center Park, Riverview Park, Aultshire Park, and the John M Craddock Wetland Nature Preserve. The Muncie Parks and Recreation Department oversees the management of these parks with the exception of The John M Craddock Wetland Nature Preserve.

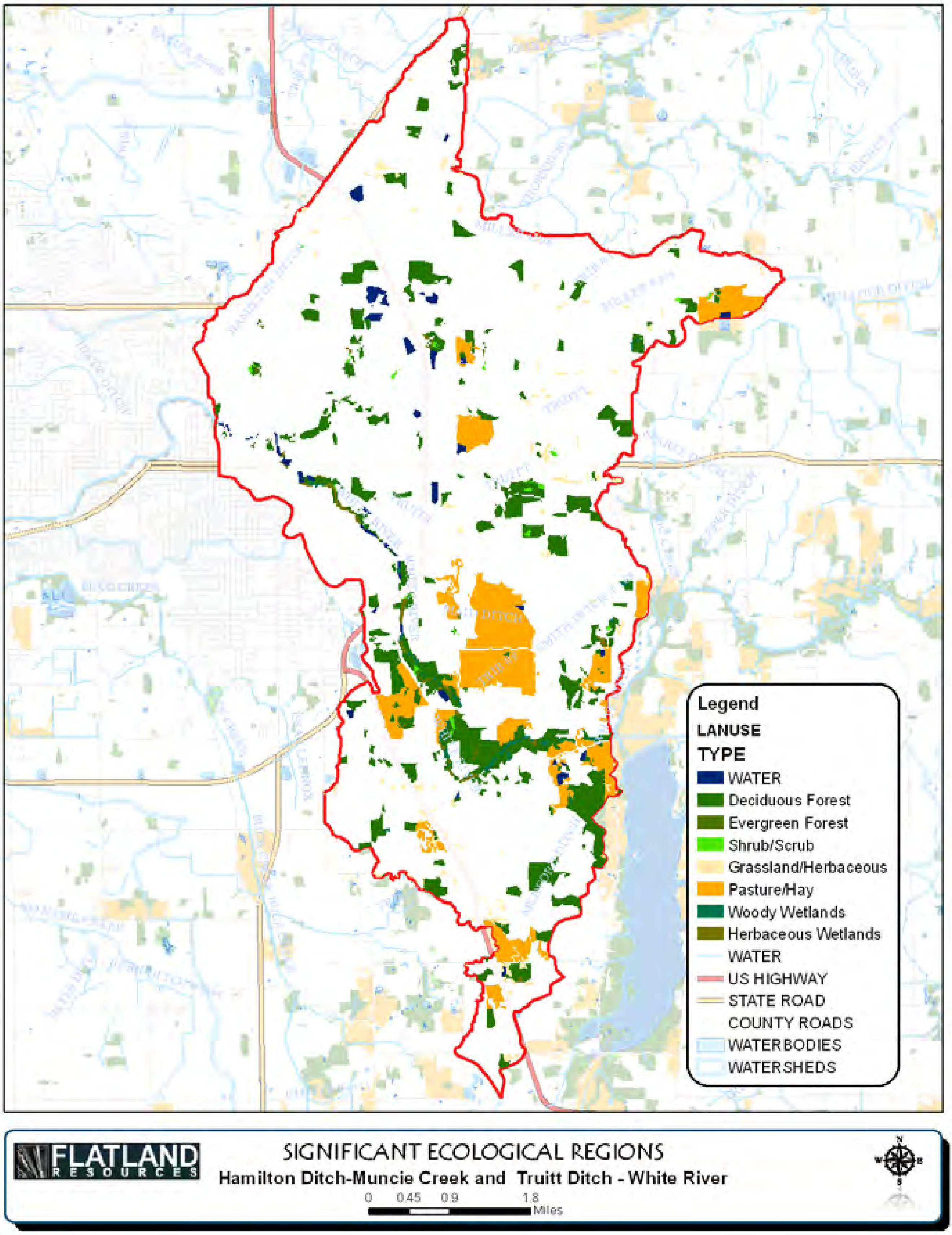
County-wide Park System and Public Space Deficiency
Couty-wide, the Muncie Park System includes 23 parks including the largest natural resource in Delaware County, Prairie Creek Park and Reservoir.

Parks are classified by the National Recreation and Park Association (NRPA) to understand level of service (LOS), recreational opportunities, and local population. Below are the classifications of Muncie Parks: Prairie Creek Reservoir, 750 acres, is considered Delaware County's only regional park. [1]

(a) Two parks met the NRPA's standard for Large Urban Parks (McCullough and Heekin Parks).
(b) Two parks were classified as large neighborhood parks (Thomas and Ball Corporation Parks).
(c) One recreational facility, the 750- acre Prairie Creek Reservoir, meets the NRPA's definition of a regional park. The LOS for this park The NRPA LOS standard for this type of park is 5.0 to 10.0 acres per 1,000 persons. Accounting for Delaware County's population, the LOS for regional parks comes out to 6.3 acres per 1,000 population, which is within the LOS range set by NRPA.
(d) Three parks (Heekin, McCulloch, and White River Parks) meet the NRPA's definition of community parks. Another two parks (Tuhey and Westside) are on the margin between neighborhood-level and community-level parks. These five parks have a combined area of about 245 acres. If we define "community" as Adequate park and recreation facilities are critical quality of life features in any community. Delaware County, then the LOS is about 2.1 acres per 1,000 population. This LOS does not measure up to NRPA's recommended LOS of 5.0 to 8.0 acres per 1,000 population. It is also noteworthy that the existing community park space is concentrated in the City of Muncie, with no community parks space immediately available to County residents.[2]

The remaining 18 parks qualify as either mini- or neighborhood-level parks, with a total area of 59.2 acres. Since all of these parks are located within the City of Muncie, and are oriented to Muncie neighborhoods, we can assume that the serviced population is constituted entirely of Muncie residents. The combined LOS for these parks is 1.33 acres per 1,000 residents, which is within the

1 Muncie-Delaware County Comprehensive Plan
2 Muncie-Delaware County Comprehensive Plan



MAP. 2.55 Significant Ecological Regions

Natural Land Uses (cont.)

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 11

NRPA recommended LOS of 1.25 to 2.5 acres per 1,000 residents. No formal recreation space is tallied within the County, although this analysis does not include informal passive recreation space that may be available in such places as schoolyards.[3] Overall, the total amount of "close-to-home" recreational space (consisting of community-, neighborhood-, and mini-park facilities) available to Muncie citizens is about 3.4 acres per 1,000 persons, which is well below the NRPA's recommended LOS of 6.25 to 10.5 acres per 1,000 persons. This is primarily due to a lack of community park space. [4]

In the County, which does not have the benefit of neighborhood- or mini-parks, the total "close-to-home" recreational space consists entirely of community parks, at a LOS of 2.1 acres per 1,000 population (While Delaware County Townships do manage some park space there is no county-wide parks system). Again, this is well below the NRPA's total recommended LOS of 6.25 to 10.5 acres per 1,000 persons. More community park space and substantial implementation of neighborhood- or minipark space may be required to rectify these deficiencies.[5]

Due to this county wide deficiency in public space, the steering committee expressed an interest in exploring opportunities to develop park space in conjunction with environmental restoration activities. The John M Craddock Wetland Nature Preserve serves as a case study for this type of development. MAP 2.55 provides a framework for restoration efforts/locations.

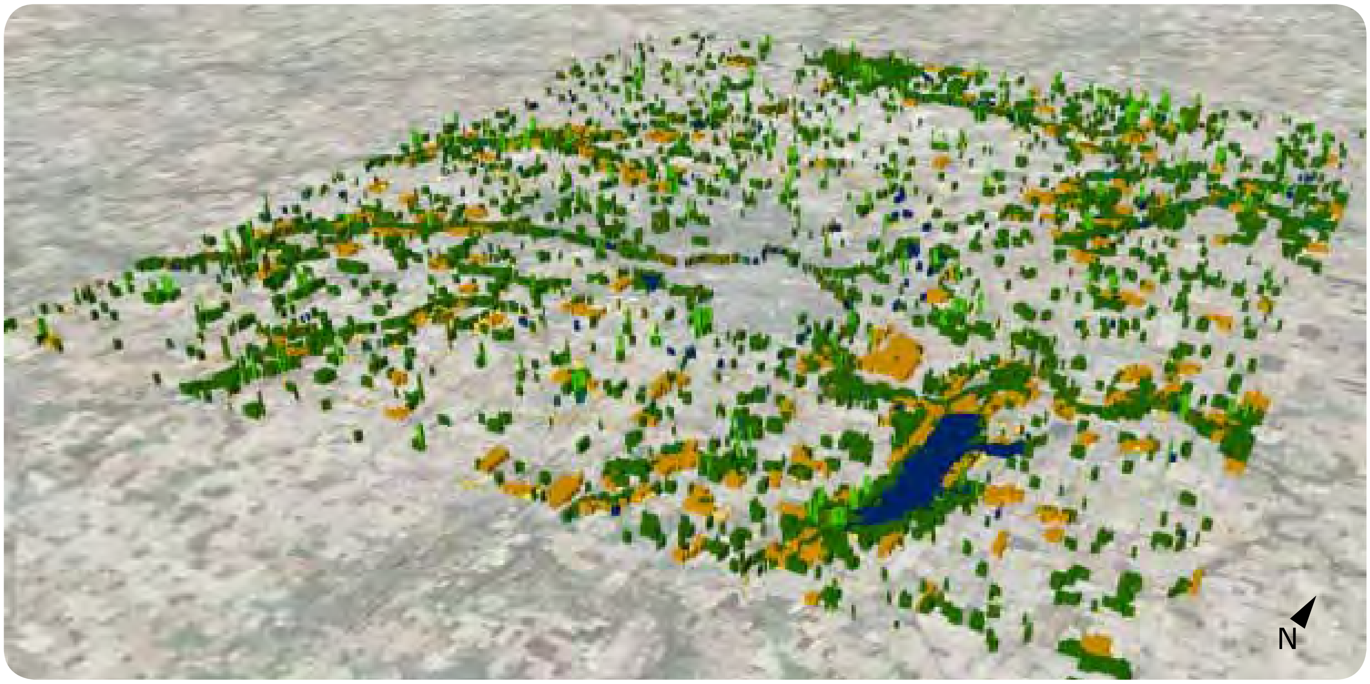
Cardinal Greenway / White River Greenway

The Cardinal Greenway is part of the organized Rails-to-Trails movement and Indiana's longest rail trail on a former CSX (railroad)line. Both the Cardinal and White River Greenway trails have asphalt surfaces and can accommodate multiple users. All rest areas and trail heads are handicapped accessible. In addition to Muncie's park system, a major portion of the Cardinal Greenway is in the watershed. This 60-plus mile trail extends continuously from Gaston to Richmond in the south and sees over 250,000 visitors annually. It provides an important link for the community providing access to recreation throughout the area.[6]

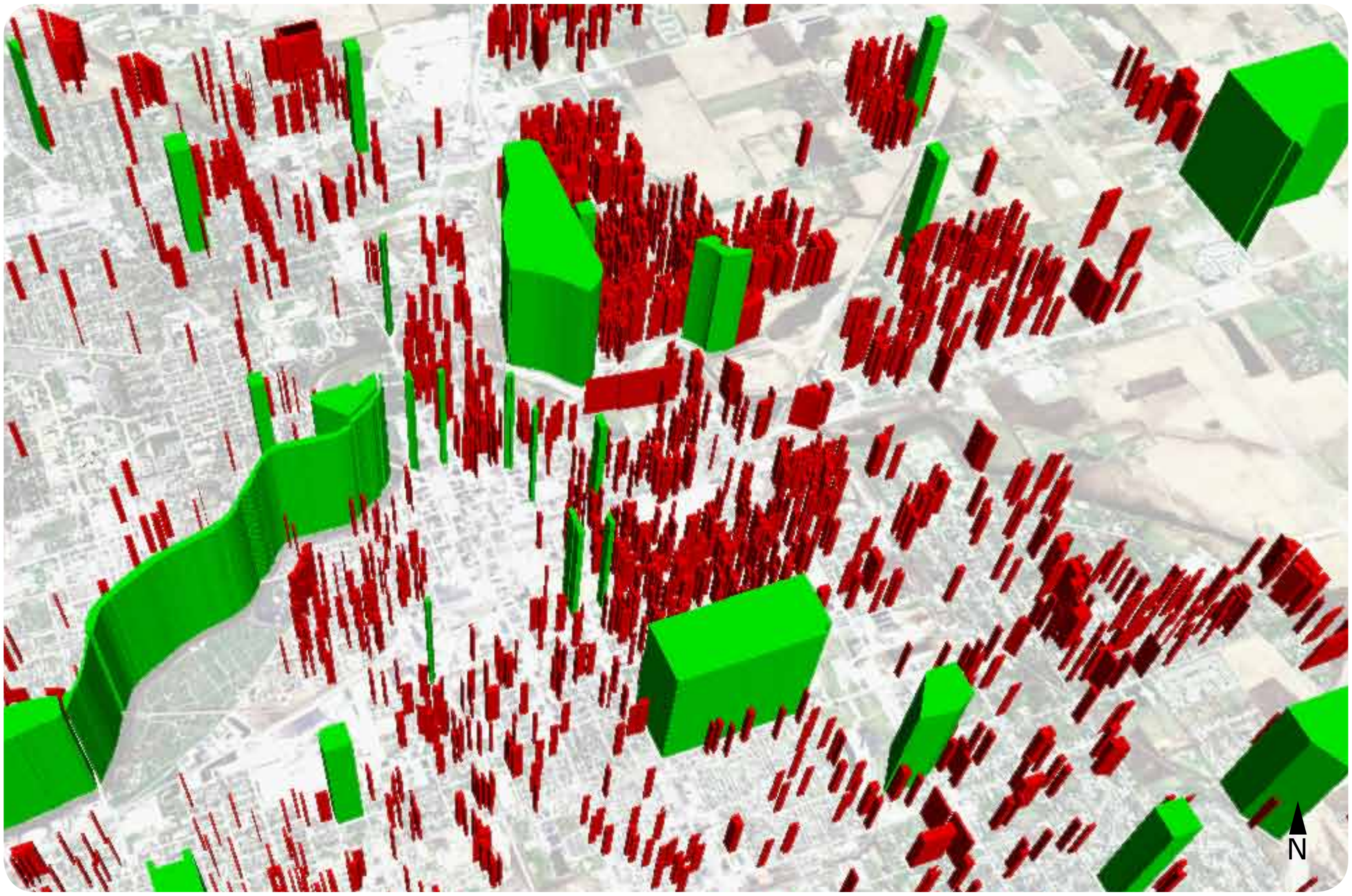
Prairie Creek Park and Reservoir

Although Prairie Creek Reservoir is not in the studied subwatershed, it discharges directly into the headwaters of the Truitt Ditch-White River Subwatershed. The reservoir is currently being used as an environmental education site by the Muncie Stormwater Department and the White River Watershed Project Education and Outreach Sub-committee. As a regional destination, it will undoubtedly have a crucial role to play in Muncie Creek - Hamilton Ditch and Truitt Ditch-White River community based education. The future of Prairie Creek Park and Reservoir is of great importance to WRWP steering committee. It is also a serious responsibility. To ensure that this unique community resource continues to be available for human enjoyment and use by future generations it is important to plan ahead. The Prairie Creek Master Plan has been a joint effort between the Delaware-Muncie Metropolitan Plan commission and the Delaware County Soil and Water Conservation District with input from multiple government and private stakeholders, along with the public. The plan elaborates upon key elements set forth in the Comprehensive Plan and has been mindful of the need to protect private property rights.[7]

3 Muncie-Delaware County Comprehensive Plan
4 Muncie-Delaware County Comprehensive Plan
5 Muncie's 5 Year Parks and Recreation Master Plan 2009
6 Muncie's 5 Year Parks and Recreation Master Plan 2009
7 Muncie's 5 Year Parks and Recreation Master Plan 2009

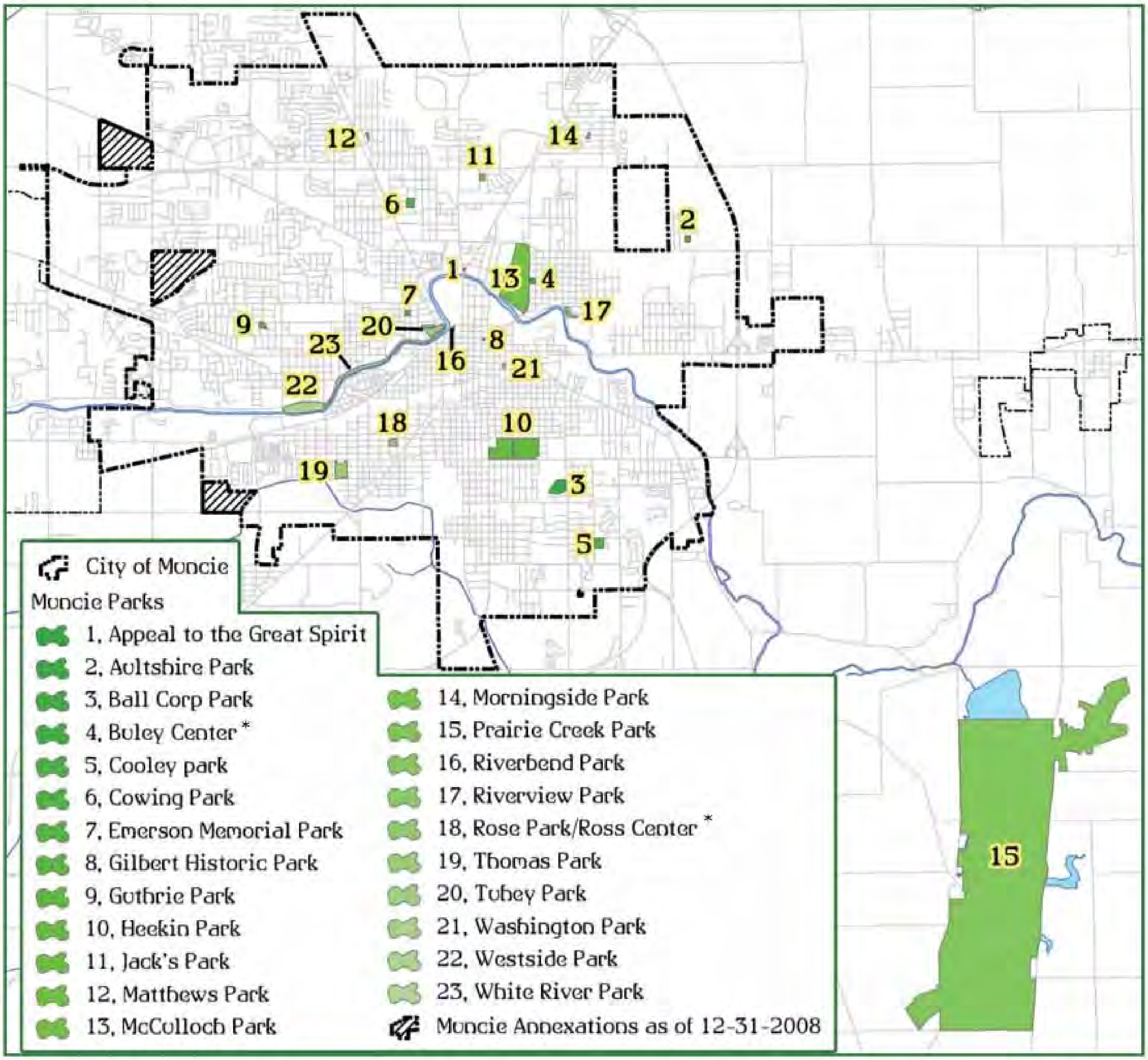


DIA. 2.12 Diagram of Forest (green) and Openspace (yellow) land use in Delaware County



DIA. 2.13 Relationship of Muncie Parks System (green) to Vacancy (red)

INVENTORY



MAP. 2.56 Locations of Muncie Parks

SOURCE: Muncie's 5 Year Parks and Recreation Master Plan 2009

Park Classifications

Muncie Parks, Owned Properties

Park Type	NRPA Size Criteria	Local Classifications	# of parks
Mini Park	up to 1 acre		5
Small Neighborhood Parks		1 - 5 acres	7
Neighborhood Parks	5 - 10 acres		2
Large Neighborhood Parks		10 - 20 acres	1
Linear Parks			1
Small Community Parks		20 - 30 acres	1
Community Parks	30 - 50 acres		0
Large Urban Parks	50 - 75+ acres		2
			19

Muncie Parks, Leased Properties

Small Neighborhood Parks		1 - 5 acres	2
Large Neighobrhood Parks		10-20 acres	1
Regional Parks	200+ acres*		1
			23

* - defined by the NRPA in 1983 but not updated in the 1996 guidelines

TABLE. 2.30 Muncie Parks Classifications

INVENTORY

Agricultural Land Uses
WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 12

According to the 2007 Census of Agriculture, 635 farms were in Delaware County in 1997 (USDA). They incorporated 173,443 acres of land. About 5,307 acres was used for hay and pasture, and a total of 5,587 acres was forested. Cash grain is the major farming enterprise in the county. Corn and soybeans are the main grains grown as cash crops. About 61,100 and 96,500 acres, respectively, were planted.[1]

These concerns are especially important as according to the 2001 land classification effort, nearly 60% of the watershed is used for agricultural purposes. According to USDA data from 2004, cultivated areas cover approximately 55% of the watershed with a majority of cultivation occurring in densities of 75% or greater. Of the areas that are cultivated, corn and soybeans dominate crop production (MAP 2.57). [2]

Delaware County ranks in the top 20 statewide for corn and soybean production. Most farms within the watershed undergo a corn-soybean rotation with some including a corn-soybean-wheat rotation. According to the 2009 survey, conservation tillage practices within the county are on par or a little below the median for the state of Indiana.[3]

Small grains made up about 2,100 of the acres. In 2002, specialized crops, such as tomatoes for processing, peppers, pumpkins, apples, turf grass, and nursery crops, were raised on small acreages. Hogs and beef cattle are the main livestock raised in Delaware County (Table 2.31). A few dairy operations are in the county, and some sheep and chickens are raised. Also, a significant number of horses and other equines are raised in the county.[4] Due to the difficulty in estimating animal farms from aerial photography, the amount of farm animals in the individual Subwatersheds is undetermined at this time.

Individuals are concerned about the impact of agricultural practices on water quality. Specifically, the volume of exposed soil entering adjacent waterbodies, the prevalence of tiled fields and thus the transport of chemicals into waterbodies, the use of agricultural chemicals, and the volume of manure applied via small animal farms and through confined animal feeding operations are concerning to local residents. Each of these issues will be discussed in further detail below. In total, corn production accounted for 32% of land cover in 2006, while soybeans accounted for 28% of land cover. Non-agricultural uses, such as woodland and urban areas, covered an additional 28% of the watershed. Grasses and clover, small grains, alfalfa, winter wheat, and other crops covered the remaining crop production lands.[5]

1 USDA data from 2004
2 USDA data from 2004
3 USDA data from 2004
4 USDA data from 2004
5 USDA data from 2004

TABLE 2.31: Agricultural Land Use in Delaware County and Subwatershed Estimates based on farm acreage.

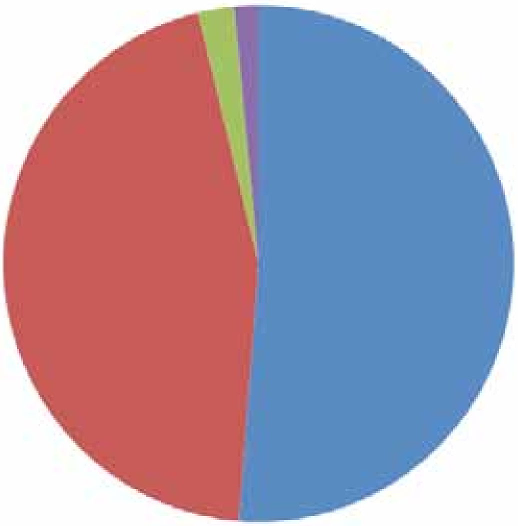
	Delaware Co.	Munce Creek - Hamilton Ditch	Truitt Ditch-White River
Number of Farms	659	20	30
Land in Farms (acres)	154,470	4,742	6,974
Total Acres	253,382	8,602	11,781
Average Size of Farm (acres)	234	234	234
Market Value of Products Sold	68,608,000	2,109,770	3,102,812
Crop Sales	60,539,000	1,793,304	2,637,390
Livestock Sales	8,069,000	316,465	465,422
Average Total Sales Per Farm	104,109	104,109	104,109
Government Payments	2,670,000	82,105	120,751
Average Per Farm Receiving Payments	6,934	4,052	4,052

SOURCE: USDA data from 2004 (grey columns interpolated from GIS acreage)

TABLE 2.32: Dominant Agricultural Land use in Delaware County and Subwatershed Estimates

Category	Delaware Co.	Munce Creek - Hamilton Ditch	Truitt Ditch-White River
Total Acres	253,382	8,602	11,781
Soybeans	81,087	2,753	3,770
Corn	70,673	2,399	3,286
Pasture/Hay	28,270	960	1,314
Deciduous Forest	23,815	808	1,107
Developed/Open Space	22,025	748	1,024
Developed/Low Intensity	11,724	398	545
Grassland Herbaceous	4,337	147	202
Developed/Medium Intensity	3,025	103	141
Open Water	2,660	90	124
Developed/High Intensity	1,428	48	66
Winter Wheat	1,426	48	66
Grass/Pasture/Non-Ag	981	33	46
Alfalfa	455	15	21
Other Hays	366	12	17
Tomatoes	208	7	10
Popcorn or Ornamental Corn	204	7	9
Herbaceous Wetlands	202	7	9
Winter Wheat/Soybeans	120	4	6
Barren	107	4	5
Dry Beans	90	3	4
Woody Wetlands	76	3	4
Oats	41	1	2
Shrubland	36	1	2
Evergreen Forest	15	1	1
Fallow/Idle Cropland	6	0	0
Seed/Sod Grass	6	0	0

SOURCE: ArcGIS

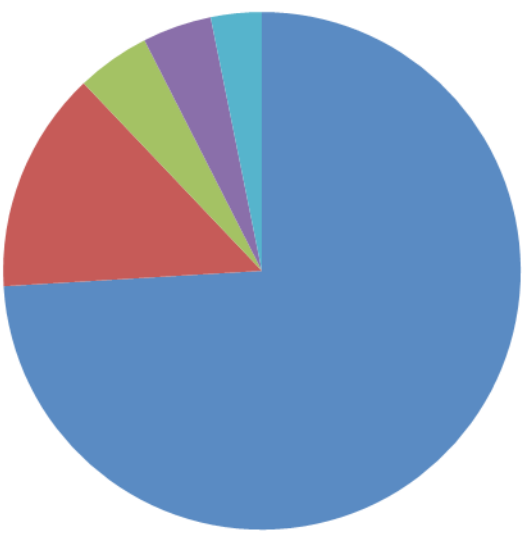


CHA. 2.16 Corn and Soybean Dominant

TABLE 2.33: Crop Items

	Delaware Co.	Munce Creek - Hamilton Ditch	Truitt Ditch-White River
Total Acerage	253,382	8,602	11,781
Corn for grain	70,502	2,393	3,278
Soybeans for beans	61,828	2,099	2,875
Forage	3,158	107	147
Wheat for grain, all	2,097	71	98
Total	137,585	4,671	6,397

SOURCE: USDA data from 2004

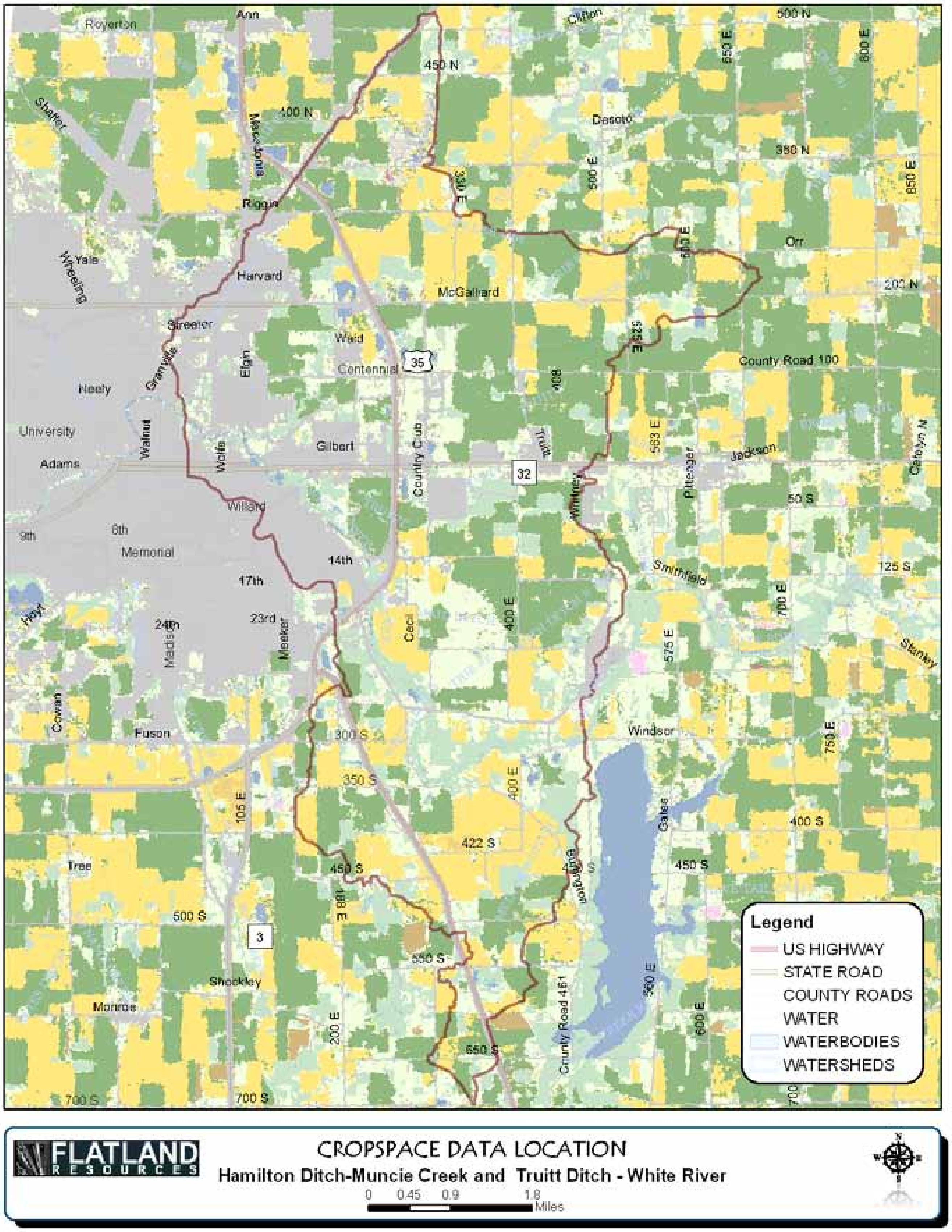


CHA. 2.17 Hogs and pigs Dominant

TABLE 2.34: Delaware County Livestock Inventory (Estimation)

	Delaware Co.	Munce Creek - Hamilton Ditch	Truitt Ditch-White River
Total Acerage	253,382	8,602	11,781
Hogs and pigs	15,453	525	718
Cattle and calves	2,891	98	134
Layers	959	33	45
Horses and ponies	901	31	42
Sheep and lambs	664	23	31

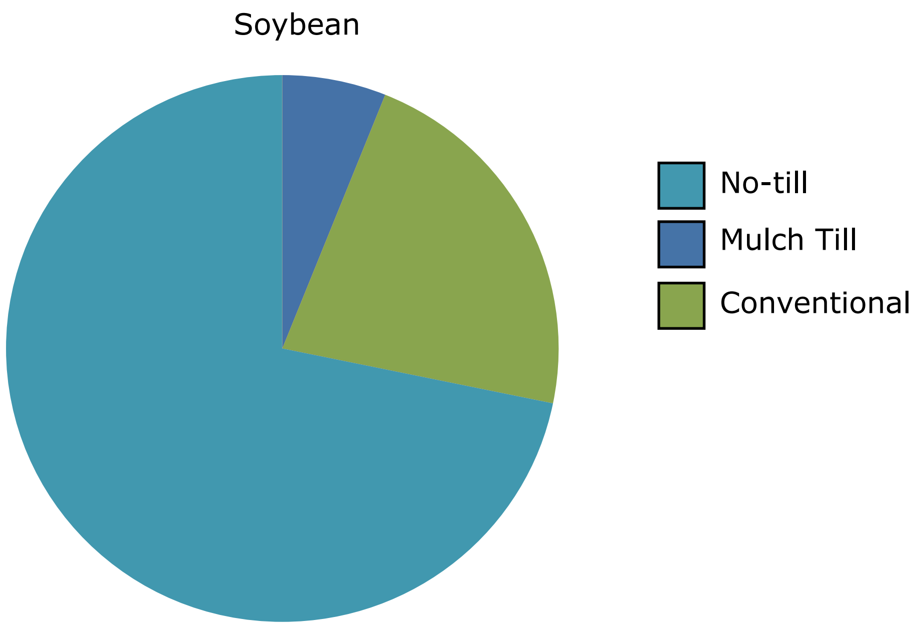
SOURCE: USDA data from 2004

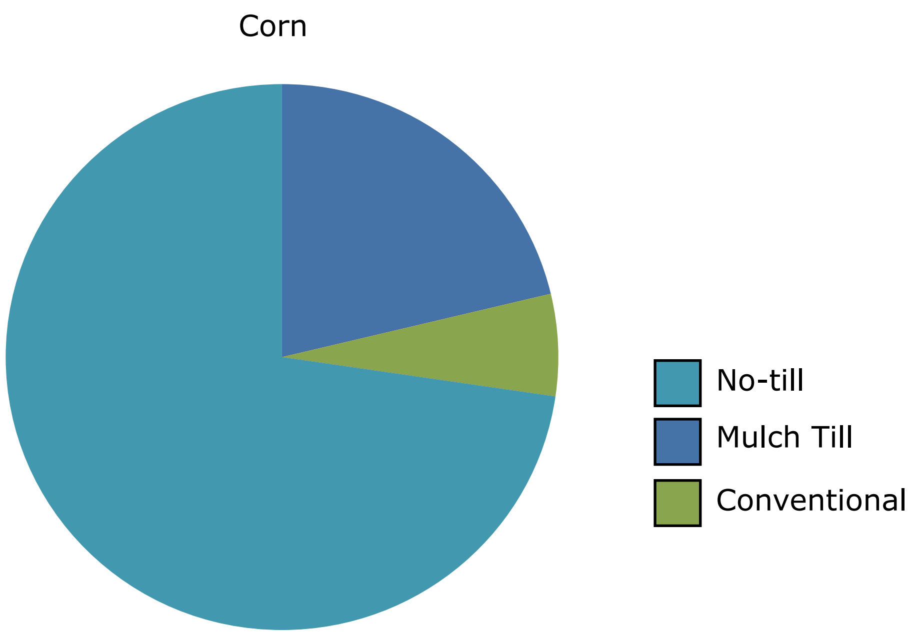


MAP. 2.57 Typical Soybean (green) and Corn (yellow) Field Locations in Subwatershds

SOURCE: USDA, NASS

Agricultural No-till
WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 13





CHA. 2.18 Delaware Corn and Soybean Tillage Practices

SOURCE: USDA

TABLE 2.35: Soybean and Corn Ranked by No-till Percentage								
		total	conventional till		mulch till		no-till	
		acres	Acres	%	Acres	%	Acres	%
Bean	Delaware County	84,000	5,100	6%	18,600	22%	60,300	72%
	Muncie Creek - Hamilton Ditch	2,099	126	6%	462	22%	1,511	72%
	Truitt Ditch- White River	2,875	173	6%	633	22%	2,070	72%
Corn	Delaware County	66,300	14,100	21%	4,000	6%	48,200	72%
	Muncie Creek - Hamilton Ditch	2,393	502.53	21%	143.58	6%	1722.96	72%
	Truitt Ditch- White River	3,278	688.38	21%	196.68	6%	2360.16	72%

SOURCE: USDA data from 2004

TABLE 2.36: Total Diesel Fuel Cost Estimate (in dollars per year) based on $4.00/gallon					
Delaware County					
Crop	Acres	Conventional	Mulch-Till	Ridge-Till	No-Till
Corn	70,502	$1,598,985	$950,367	$865,765	$486,464
Soybeans	61,828	$1,402,259	$833,441	$759,248	$426,613
Muncie Creek - Hamilton Ditch					
Crop	Acres	Conventional	Mulch-Till	Ridge-Till	No-Till
Corn	2,393	$54,273	$32,258	$29,386	$16,512
Soybeans	2,099	$47,605	$28,294	$25,776	$14,483
Truitt Ditch- White River					
Crop	Acres	Conventional	Mulch-Till	Ridge-Till	No-Till
Corn	3,278	$74,345	$44,187	$40,254	$22,618
Soybeans	2,875	$65,198	$38,751	$35,301	$19,835
Total Fuel Cost (Subwatersheds)		$241,421	$143,490	$130,717	$73,448
Potential Cost Savings vs Conventional			$97,931	$110,705	$167,973

SOURCE: USDA data from 2004

INVENTORY

Agricultural Chemical Usage

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 14

Agricultural herbicides, pesticides, and fertilizers are commonly applied to row crops in Indiana. These chemicals can be carried into adjacent waterbodies through surface runoff and through tile drainage. This is especially an issue if a storm occurs prior to the chemicals being broken down and used by the crops.

Data for chemical usage on an individual county or watershed level is not currently collected. Rather, data is collected for the state as a whole in two forms. First, the National Agricultural Statistics Survey (NASS) collects information on chemical usage, number of applications per year, type of chemical applied, number of applications per year, and the application rate. These data were last collected in 2006 (NASS, 2006). Additionally, NASS collects farmland data for the number of acres in agricultural production by type (i.e. corn, soybeans, grains) every five years. This data was last collected in 2007 (NASS, 2007). The acreage of cropland in the watershed was estimated above using 2005 cropland cover data. [1]

Purposes of Herbicides:
Alachlor – Annual grasses and broadleaf weeds in corn and soybean fields.
Atrazine – Pre and post emergent broadleaf weeds and grass.
Metolachlor – Broadleaf weed control in corn.
Glysophate – Non-selective herbicide; commonly known as Round-up.
Potash – Potassium carbonate. Used in fertilizers. Improves water retention, yield, nutrient value, color, texture, taste and disease resistance in crops.

TABLE 2.37: Soybean: Fertilizer Primary Nutrient Applications

Nutrient	lbs/acre/yr
Nitrogen	16
Phosphate	44
Potash	96

SOURCE: USDA data from 2004

TABLE 2.38: Corn: Fertilizer Primary Nutrient Applications

Nutrient	lbs/acre/yr
Nitrogen	67
Phosphate	56
Potash	111
Sulfur	10

SOURCE: USDA data from 2004

1 National Agricultural Statistics Service

TABLE 2.39: Soybean: Agricultural Chemical Applications	
Herbicides	lbs/acre/yr
2,4-D, 2-EHE	0.585
2,4-D, dimeth. salt	0.525
Chlorimuron-ethyl	0.017
Glyphosate	1.374
Glyphosate iso. salt	1.3974
Imazaquin	0.072
Imazethapyr	0.061
Metribuzin	0.253

SOURCE: USDA data from 2004

TABLE 2.40: Corn: Agricultural Chemical Applications *	
Herbicides	lbs/acre/application
2,4-D, 2-EHE	0.428
Acetochlor	1.823
Atrazine	1.094
Clopyralid	0.136
Dicamba, Dimet. salt	0.121
Dicamba, Sodium salt	0.106
Diflufenzopyr-sodium	0.042
Flufenacet	0.463
Flumetsulam	0.044
Foramsulfuron	0.028
Glyphosate iso. salt	0.867
Imazapyr	0.014
Imazethapyr	0.042
Isoxaflutole	0.049
Mesotrione	0.128
Nicosulfuron	0.02
Primisulfuron	0.027
Prosulfuron	0.009
Rimsulfuron	0.017
S-Metolachlor	1.234
Simazine	1.236
Insecticides	
Chlorpyrifos	1.336
Cyfluthrin	0.006
Tebupirimphos	0.113
Tefluthrin	0.107

Indiana - Soybeans: Fertilizer Primary Nutrient Applications, Program States and Total, 2006

SOURCE: USDA data from 2004

INVENTORY

Growing Season

WMP - CHAPTER 1 - PART 1 - SECTION 5 - SUBSECTION 15

The average annual total precipitation is about 37.67 inches. Of this, 20.1 inches, or about 53 percent, usually falls in May through October. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 4.74 inches at Muncie on June 18, 1992.[1]

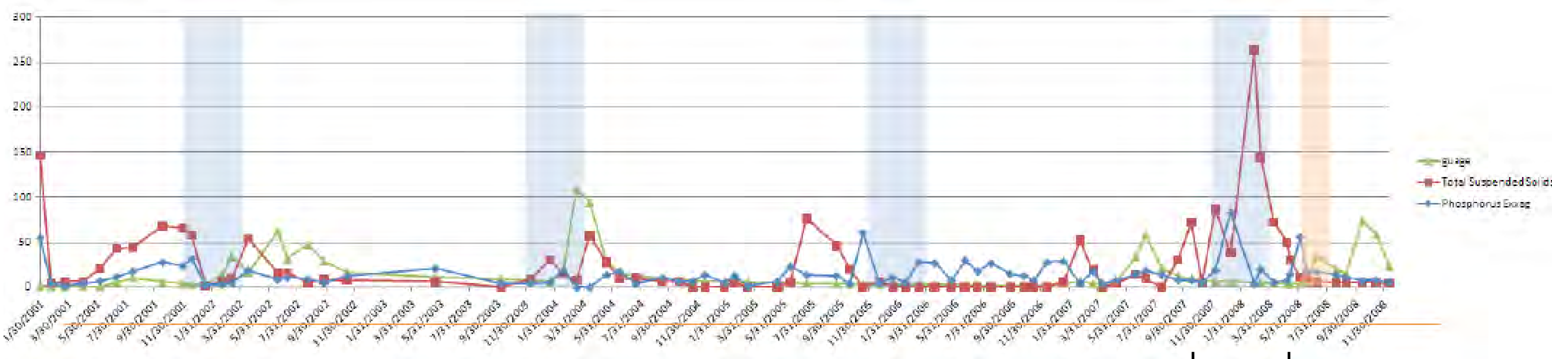
Growing degree days are shown in Table 2.41. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive planting of a crop between the last freeze in spring and the first freeze in fall.[2]

TABLE 2.41: Daily Minimum Temperature During Growing Season

Probability	Higher than 24 F	Higher than 28 F	Higher than 32 F
	Days	Days	Days
9 years in 10	203	177	149
8 years in 10	210	185	156
5 years in 10	224	200	169
2 years in 10	238	215	181
1 years in 10	245	223	188

SOURCE: Soil Survey of Delaware County Indiana. US Department of Agriculture

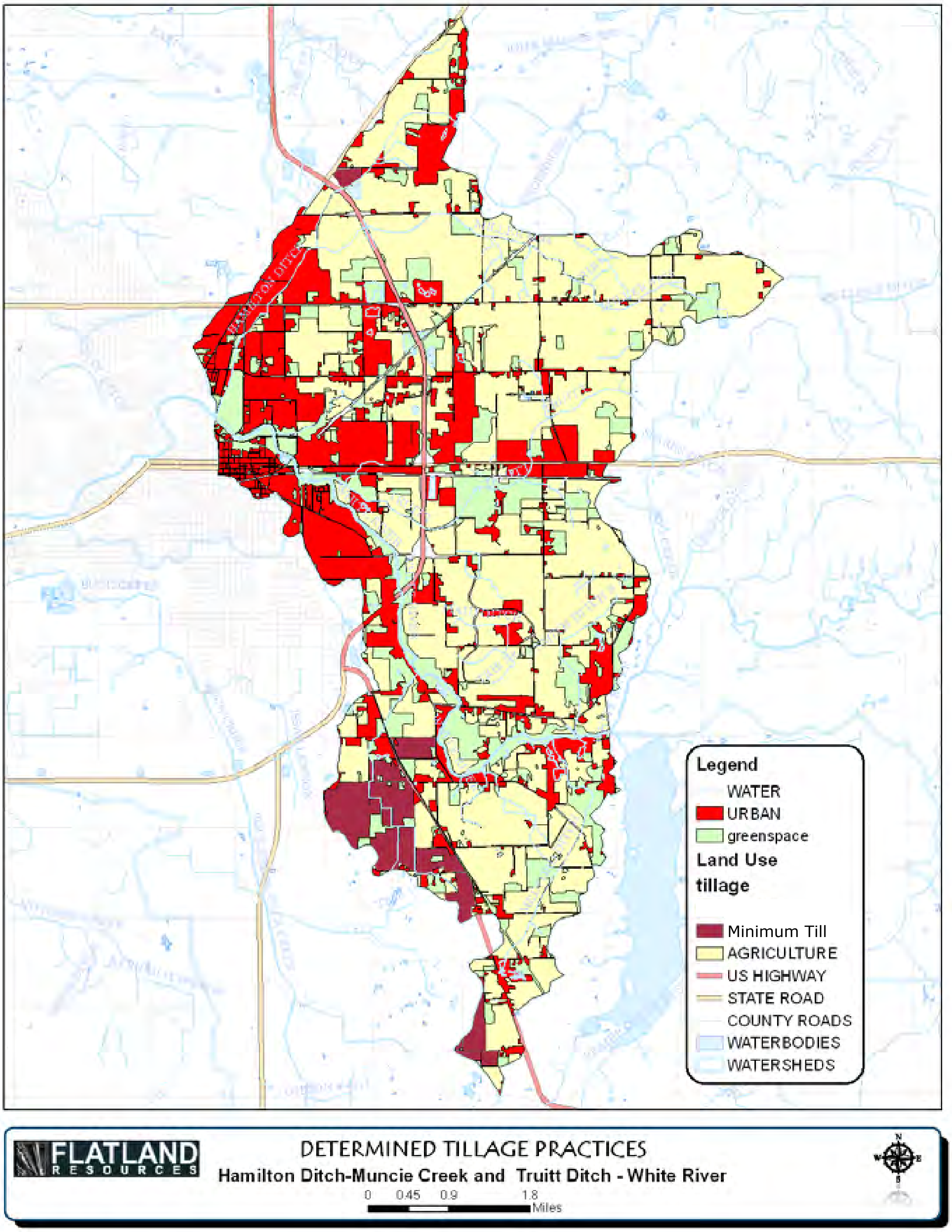
Spikes in TSS and Phosphorus can be observed in WQ sampling data (over 10 year monitoring period) during non growing seasons. Chart 2.19 highlights winter months in light blue. A sediment spike is observed in 2008 as a result in a significant logjam.



CHA. 2.19 TSS and Phosphorus Spikes During Nongrowing Seasons

Sediment Spike in 2008 occurred as a result of a logjam

1 Soil Survey of Delaware County Indiana. US Department of Agriculture
2 Soil Survey of Delaware County Indiana. US Department of Agriculture



MAP. 2.58 No-till locations.

CAFOS

WMP - CHAPTER 2 - PART 1 - SECTION 5 - SUBSECTION 16

Confined Feeding Operations and Hobby Farms

A mixture of small, unregulated (hobby farms) and larger, regulated livestock operations (confined feeding operations) are located within Delaware and Randolph Counties (feeding into the Subwatersheds). Small farms are referred to as hobby farms and are unregulated, while larger farms that house animals for longer than 45 days per year are regulated by the IDEM. These regulations are based on the number and type of animals present. IDEM requires permit applications which document animal housing, manure storage and disposal, and nutrient management plans for farms that maintain 300 or more cows, 600 or more hogs, or 30,000 or more fowl. These facilities are considered confined feeding operations (CFO). There are 19 active confined feeding operations and 420 hobby farms located in the watershed. None of the CFOs are large enough to be classified as a concentrated animal feeding operation (CAFO). [1]

CAFOs are defined by the number of animals housed on-site as follows:
1,000 beef cattle; 1,000 veal calves; 700 mature dairy cattle; 2,500 swine if >55 pounds; 10,000 swine if <55 pounds; 500 horses; 10,000 sheep; 55,000 turkeys; 125,000 chickens (dry system); 30,000 chickens (liquid system); 82,000 layers (dry system); 30,000 ducks (dry)[2]

Confined Feeding Operation (CFO):

Confined feeding operation for purposes of the Delaware County Ordinance means:
1) any confined feeding of: a. at least three hundred (300) cattle; b. at least six hundred (600) swine or sheep; or c. at least thirty thousand (30,000) fowl.
2) any animal feeding operation electing to be subject to state law; or
3) any animal feeding operation that is causing a violation of: a. water pollution control laws; b. any rules of the water pollution control board; or c. state statute (IC 13-18-10).

The term CFO is intended to include all of the production area involved in the operation. Two or more operations under common ownership are considered to be a single operation for purposes of determining the number of animals at an operation if they adjoin each other or if they use a common area or system for the disposal of waste. [State definition 327 IAC 16-2-5][3]

Concentrated Animal Feeding Operation (CAFO):

An AFO that is one of the following: a large CAFO, a medium CAFO, or designated as a CAFO by the Indiana Department of Environmental Management. Two or more AFOs under common ownership are considered to be a single AFO for the purposes of determining the number of animals at an operation, if the AFOs adjoin each other or if the AFOs use a common area or system for land application of manure, litter or process wastewater. [State definition 327 IAC 5-4-3][4]

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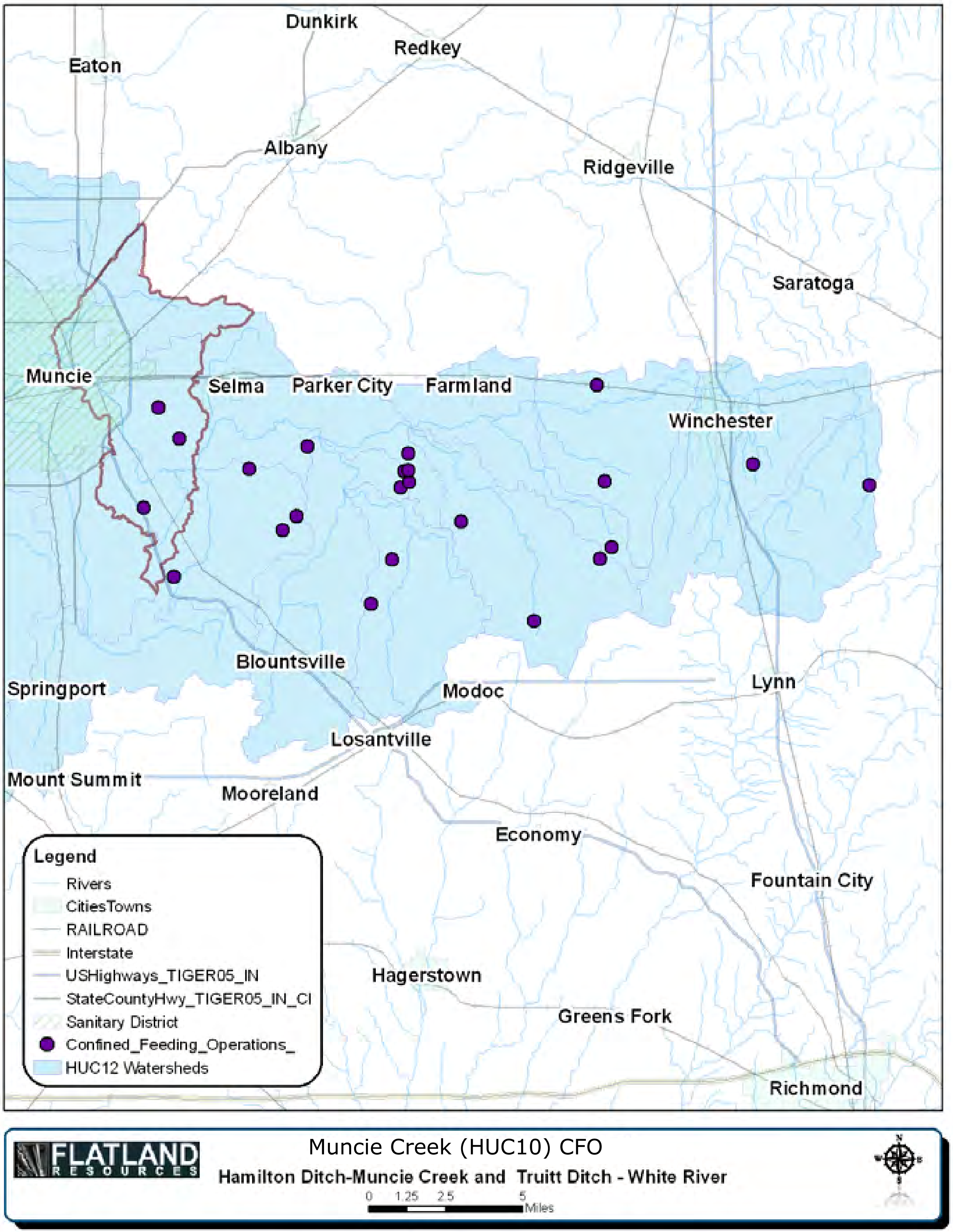
1 Muncie Free Press
2 Muncie Free Press
3 Muncie Free Press
4 Muncie Free Press



MAP. 2.59 CFOs in Subwatersheds and Muncie Creek HUC10 Drainage basin

SECTION SIX - OTHER PLANNING EFFORTS IN WATERSHEDS

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP
CHAPTER 2

Planning Efforts in Watersheds
WMP - CHAPTER 2 - PART 1 - SECTION 6 - SUBSECTION 1

Planning efforts have occurred at a variety of scales in Delaware County since 2000. These efforts have been focused on developing, maintaining, and improving local resources, stimulating the economy, improving quality of life, and planning for the future. Various groups have been involved in this process and there has been public participation with every project, at all levels. Large scale planning has occurred within the City and the County with the development of the Muncie-Delaware Comprehensive, Muncie Action, Transportation, Muncie-Delaware Public Transit-Human Services Coordination, Delaware-Muncie Transportation Improvement, and Muncie Delaware County Economic Development Alliance Vision Plans. These have been a wide scale effort to understand development and create a cohesive vision. As these county/citywide plans have developed there has been an intense focus on parks, recreation, and natural resources through the White River Watershed Project, The City of Muncie 5 Year Parks and Recreation, and Prairie Creek Master Plans. All of these plans have created a centered focused vision for Muncie and Delaware County for the next 5-20 years.

TABLE 2.42: Inventory of Muncie-Delaware County Planning
Muncie-Delaware County Comprehensive Plan: 2000
White River Watershed Project: 2001
Prairie Creek Master Plan 2007
The City of Muncie 5 Year Parks and Recreation Master Plan 2009
Muncie Action Plan 2010
Muncie Delaware County Economic Development Alliance Vision 2011
2005-2030 Transportation Plan
Muncie Delaware County Public Transit - Human Services Coordination Plan
Delaware-Muncie Transportation Improvement Plan

Muncie-Delaware County Comprehensive Plan: 2000[1]

Communities plan so that they can better manage their future and provide a high quality of life to their residents. By carefully planning land uses and public investments, public services can be more efficiently provided, scarce land resources can be put to their highest uses, and public resources can be effectively targeted to pervasive problems. This Comprehensive Plan Update focuses on seven key plan elements. These plan elements are equal in importance to one another, and include:

- Alleviating and preventing problems created by urban sprawl, through several means. These means may include focusing new developing around the existing "service area villages" of Eaton, Gaston, Albany, Selma, Yorktown and Daleville, as well as encouraging infill development and defining an effective growth boundary for the City of Muncie.

- Preserving agricultural land, by focusing new development around existing development. An investigation of the feasibility of changing lot size for residential uses in agricultural areas should be conducted. The agricultural land committee that was formed during the Comprehensive Planning process should be retained, and continue to discuss and implement agricultural preservation items.

- Redevelopment and revitalization of existing urban areas and neighborhoods within the City of Muncie, including the Central Business District.

- Implementing key thoroughfare improvements, including the completion of the western portion of the Muncie Bypass loop.

- Encouraging economic development through the provision of new Class A industrial and office space, and taking advantage of the proximity of the community to the Indianapolis metropolitan area via I-69.

- Preserving and protecting the natural environment, and maximizing the recreational value of natural areas for all citizens, through constraining development to non-environmentally sensitive areas, expanding the greenway system, and encouraging, where feasible, clustered development that preserves open space. Such techniques to preserve and protect the natural environment shall also be cognizant of the importance of private property rights.

- Enhancing the attractiveness of the community through enhanced design standards for major gateway corridors, and implementing improvements to major gateways, such as SR 332 and the Muncie Bypass. Such activities will reinforce a positive city/county image, promote better quality design, and serve as a guide for the enhancement of existing properties.

1 Muncie-Delaware County Comprehensive Plan: 2000

White River Watershed Project: 2001[2]

The purpose of the White River Watershed Project is to advocate Best Management Practices (BMPs) through education, demonstration and financial incentive. BMPs are both behavioral and structural. Behavioral BMPs include day to day decision making such as conserving water, proper disposal of waste, and other conservation methods - while structural BMPs include modifications to the landscape or machinery. It is important that we implement both types of BMPs when feasible in order to reduce negative environmental impacts, which inhibits nature's ability to produce natural goods, and endangers the health of entire ecosystems.

The Clean Water Act was a landmark piece of legislation that initiated a Nation-wide effort to address water pollution issues in the United States. Early application of the legislation was directed at point source pollution. Point source pollutants enter a stream directly from a pipe – most commonly from industrial processes. Amendments to the legislation added means and methods to address nonpoint water pollution which is harder to track as it is more diffuse. Nonpoint water pollutants enter streams from storm water runoff. Out of these amendments came the 319 program which funds states to solve nonpoint water pollution issues at the local level.

One way the State of Indiana has chosen to approach the nonpoint problem is creating a grant program to cost-share on best management practices. The WRWP administers this grant money for Delaware County. In order to most effectively distribute grant monies, WRWP has developed a management plan that identifies critical areas in the county that are in the greatest need for grant funding. It is the mission of the WRWP to create a better awareness of water quality issues in Delaware County and to work with local landowners to develop best management practices for their properties and landholdings.The WRWP is able to exist because of its wide range of community partners and numerous volunteers and participants that share their time and expertise.

2 White River Watershed Project: 2001

Prairie Creek Master Plan 2007[3]
Although Prairie Creek Reservoir is not in the studied subwatershed, it discharges directly into the headwaters of the Truitt Ditch-White River Subwatershed. The reservoir is currently being used as an environmental education site by the Muncie Stormwater Department and the White River Watershed Project Education and Outreach Sub-committee. As a regional destination, it will undoubtedly have a crucial role to play in Muncie Creek - Hamilton Ditch and Truitt Ditch-White River community based education.

The future of Prairie Creek Park and Reservoir is of great importance to the citizens of Muncie and Delaware County. It is also a serious responsibility. To ensure that this unique community resource continues to be available for human enjoyment and use by future generations, it is important to plan ahead. This plan is a guide for public policy, actions, and investments. The plan is not limited in scope to government, but includes many suggestions that can only be implemented by other organizations, private individuals, and community groups including those not-for-profits.

The Prairie Creek Master Plan has been a joint effort between the Delaware-Muncie Metropolitan Plan commission and the Delaware County Soil and Water Conservation District with input from multiple government and private stakeholders, and the public. The plan elaborates upon key elements set forth in the Comprehensive Plan and has been mindful of the need to protect private property rights. It should be interpreted as a dynamic document frequently updated to incorporate the ongoing changes both at Prairie Creek and in the community at large.

Key elements in the Prairie Creek Master Plan:

- Protecting the future of the park and reservoir as community assets entails extending the city's lease with IAWC beyond 2010 termination of the current lease and purchasing the land if it becomes available for sale. These measures are essential to ensure that both public access to the area and its ecological health continues.

- Water quality in the watershed is a fundamental concern. Conservation measures must be extended to limit pollution. The impact of development must be mitigated through regulations and creative design. On-site wastewater disposal systems are one source of pollution that needs to be addressed immediately. Measures to reduce sedimentation and accompanying nutrient and pesticide loading in the reservoir should continue and expand.

- Enhance the value of the park and reservoir as an economic, aesthetic (quality of life) and recreational asset for our community. The reservoir and park have regional appeal that should be capitalized on through planning and marketing of special events. The park facilities are in need of an upgrade and should receive priority funding.

- Implementation of this plan should involve public education, amending, ordinances, the forming of public and private partnerships and the cooperation of all involved entities.

The citizens of Muncie and Delaware County enjoy the benefits of Prairie Creek Reservoir and have acknowledged it as one of the important factors contributing to the quality of life in our community. The success of this plan will depend on the support it receives from a coordinated effort between all stakeholders and the greater community.

3 Prairie Creek Master Plan 2007

The City of Muncie 5 Year Parks and Recreation Master Plan 2009[4]

Parks, Open Space, Trails, Greenways and Recreational Programming offer many beneficial amenities to a community. These amenities include:

Quality of Life Benefits

- Makes neighborhoods more attractive places to live
- Strengthens community pride
- Improves physical health – opportunities for exercise and recreation
- Improves mental health
- Can reduce violence and crime Economic Benefits
- Attracts and retains businesses
- Attracts home buyers (when parks are within 2000 feet of the home)
- Attracts retirees
- Reduced costs for public services
- Provides "free" natural services like flood control & filtration of pollutants
- Higher assessments, thus higher property tax revenue for local government (when parks are within 2000 feet of the home)
- Increased tourism

Environmental Benefits

- Offer natural environmental protection
- Improved water quality – absorbs storm runoff, reduces runoff and filters out sediment, nutrients, pathogens, pesticides, metals and other contaminants
- Reduce air pollution – natural air filters
- Moderates temperatures – reduces heat island effects
- Energy conservation (within the parks these are applicable for cabins and offices)
- Tree cover can reduce building energy use in the summer by providing shade
- Trees also contribute to reduced winter energy use by providing a wind block
- Habitat
- Increased natural areas provides for habitat diversity
- Contributes to connecting natural areas which provide for healthier wildlife

According to the 2007 U.S. Census population estimates, Muncie is the 8th largest second class city in Indiana. Muncie spends less on its park system and employs one of the lowest amount of full time employees than all other second class cities benchmarked. While Muncie provides an average number of parks, the amount of acres dedicated to parkland in the City is the least amount offered per resident. For decades, Muncie's park system has not offered any recreational programming, aged park equipment has needed updating, and no new parks of significant size have been established. One of the best ways for Muncie to improve its overall character is to enhance its park system. A preeminent park system will set Muncie apart from other cities in the State. This would enhance the livability of the community for residents and the marketability of Muncie for prospective businesses.

4 The City of Muncie 5 Year Parks and Recreation Master Plan 2009

Muncie Action Plan 2010[5]

The Muncie Action Plan provides a pathway to the future of the city of Muncie. The plan utilizes the ideas and input of more than 2,000 residents- an unprecedented coming together of the community. The Plan includes long-term goals and measurable action steps that will accomplish a realistic vision and uphold the values identified by our community.

Recommendations from the community, accompanied by extensive factual analysis of trends and conditions, form the basis of the Plan. The Plan is divided into five initiative areas, each with specific action steps designed to realize the vision of a stronger, better Muncie. The Plan will be used by the community as public and private decisions are made concerning development, redevelopment, capital improvements, and other matters affecting the well being of the community. The Plan will be used as the Delaware-Muncie Metropolitan Plan Commission begins working on a Comprehensive Plan update. It will be used by Community Development as it prioritizes projects and funding.

Five Initiatives:

1. Linking Learning, Health, and Prosperity
2. Fostering Collaboration
3. Strengthening Pride and Image
4. Creating Attractive and Desirable Places
5. Managing Community Resources

The Plan encourages cooperation and neighborhood development. It recognizes that the whole community is responsible for education, community image and identity, economic development and for the effective use of community resources. To our knowledge it is the first city-wide strategic plan and has had unprecedented success in involving the whole community.

The Plan strongly recommends an integrated approach to land use and reuse so that decisions are not made in isolation; rather, each decision should consider its impact on other areas (neighborhoods, pedestrian movement, educating the public) and be examined through the lens of the Plan's goals, principles, and action steps.

The effectiveness of the Plan will be measured in the success of its implementation. 47 actions were recommended within the five initiatives, and implementation and planning structures were developed.

5 Muncie Action Plan 2010

Muncie Delaware County Economic Development Alliance Vision 2011[6]

Vision 2011 is an updated master plan for the Muncie Delaware County Economic Development Alliance vision 2006. A new five-year economic development effort was formed after careful analysis of the results, failures, and outcomes of the 2006 Plan. The 2011 goals were focused around seeking to improve wages, increasing the number of high skill, high pay and advancement jobs, and work to develop a community that is attractive to knowledge based businesses, which in turn will enhance the overall quality of life for the city. Vision 2011 is the most aggressive and comprehensive program that the community has undertaken.

The overarching goals are the following with these initiatives:

• By working with existing businesses to improve the performance of mainstay industries.

- Expansion and Retention of Existing Businesses
- Downtown Development
- Strengthen Workforce Education

•By accelerating the attraction and/or development of frontier industries and high growth, high pay companies.

- New Business Attraction and Tax Base Expansion
- Marketing and Recruitment of Tech/Knowledge-based Businesses and Retention of Tech/Knowledge Based Workers
- Promote Agri-business as a Method to Help Diversify the Local Economic Base and Provide New Opportunities for the Region's Farming Industry

• By forming strong alliances with our business, government, labor, medical and education partners, we will surpass the competition by executing seamless, collaborative initiatives in economic development.

- Marketing and Recruitment of Tech/Knowledge-based Businesses and Retention of Tech/Knowledge Based Workers
- Marketing and Promotion of the Medical Community as the Destination Point for Healthcare in East Central Indiana

• By encouraging everyone involved to stay the course even when the economy slows down over the short term.

- Coordinate Community and Regional Resources to Generate Economic Growth
- Promote a Positive "Quality of Life" Image of Muncie-Delaware both Internally and Externally

This new long-term vision calls for Muncie and Delaware County to be one of the best small cities in the Midwest while achieving national recognition in four areas of excellence: free enterprise, smart government, superior education, and quality of life.

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6 Muncie Delaware County Economic Development Alliance Vision 2011

Delaware-Muncie Transportation Improvement Plan
This project is a transportation study and network analysis for future transportation improvements designed to enhance travel movements in the development growth areas of Delaware County (including Muncie and Yorktown). The main purpose of the study is to determine the best combination of improvements to deal with congested traffic resulting from growth toward the north and the west edges of Muncie, Indiana. A second purpose of the study is to compare the impact of extending the Muncie Bypass around the north and west side of Muncie to the impact of a variety of alternative improvements.

To ensure that the annual development of the DMTIP is consistent with the ends to which the Delaware-Muncie area aspires, a set of transportation goals and objectives was adopted by the DMTIP Coordinating Committee. The goals and objectives are intended to help establish policy guidelines for planning implementation and identify specific community needs as a focal point for project selection.

The goals and objectives adopted by the committee were developed and approved as a part of the 2009-2030 Delaware-Muncie Transportation Plan:

- Ensure the continued provision of bus service throughout the City of Muncie including purchase of replacement transit vehicles.

-Provide a safe, well-maintained, functional multi-modal transportation system that is compatible with planned community growth and minimizes traffic congestion.

-Develop cost-effective, environmentally sound plans, programs, standards, and enforcement procedures for the maintenance and extension of public and private facilities.

-Promote the development of land, parking facilities and effective movement of people and goods within the Central Business District (also known as City Center), while improving the aesthetic character and environmental quality of downtown Muncie.

-Promote the community’s ability to improve the surface transportation system by means of an improved economic base resulting from orderly economic development encompassing all industries (ousing, retail, manufacturing and tourism)

SECTION SEVEN - SUMMARY

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP
CHAPTER 2

Inventory Summary
WMP - CHAPTER 2 - PART 1 - SECTION 7 - SUBSECTION 1

By Amy Latomme, White River Watershed Project

A healthy environment is the foundation of any healthy economic system; the proper stewardship of the natural world is the first step in the proper stewardship of the economic order. This foundational belief is the driving force behind the continuation and adaptation of the White River Watershed Management Plan.

The White River Watershed Project started in 2000 because of concerns for local water quality. The project acquired a three year grant that enabled the committee to form the White River Watershed Management Plan for three sub-watersheds. By updating the existing plan to include two more sub-watersheds, the plan will be comprehensive and will result in the finding of more point and non-point source pollutants of the White River and its tributaries.

The objectives for the White River Watershed Management Plan are to 1) supply the community with water quality science and land use impact analysis, 2) provide future generations the ability to make objective land use decisions, and 3) foster the ability to continue the great environmental accomplishments made by the society in industry, agronomy and household economies that have occurred in the last forty years.

The mission for the White River Watershed Management Plan is to advocate Best Management Practices (BMPs) through education, demonstration and financial incentive. It is important for all types of BMPs to be implemented when feasible. BMPs reduce the negative environmental impacts that inhibit nature's ability to produce natural goods and that endanger the health of the entire ecosystem. BMPs will ultimately improve the quality of the White River which will in turn improve the quality of life surrounding the White River whether that is human, plant or animal life.

The plan has been created by members of the White River Watershed Project, a group of stakeholders from Delaware County who oversee the Delaware County Soil and Water Conservation District. The project is a community-driven, voluntary effort to clean-up and reduce non-point source water pollution within the county. The Red-tail Conservatory, the Delaware County Office of Geographic Information, the Muncie Sanitary District, the Ball Brothers Foundation, Ball State University and Minnetrista Cultural Center are just a few of the partners that aided in the development of the plan because of their concern for the White River Watershed.

During its development, the plan received public input at several meetings. At these meetings, the public raised concerns about the quality of the White River. Some of these concerns included: run-off from urban areas and from the sports complex; ditch and stream erosion; channelized ditches within the watershed; failed or failing septic systems; and illegal and legal dumping. The public was also informed about the project through educational outreach, newsletters and promotional material.

The White River Watershed Natural History

A watershed is the total area of land that drains into a particular body of what whether that be a wetland, stream, river, lake or sea. Each watershed is assigned an address referred to as a Hydrologic Unit Code Area (HUC). Each HUC has an 8-digit code; that represents its location in the United States. Indiana is divided into 39 watersheds at the 8-digit code level. Watersheds can be divided even further into 11, 12 and 14 digit codes. The Muncie Creek-Hamilton ditch and the Truitt Ditch-

White River are 12 digit sub-watersheds and are the specific watersheds being used for this update of the White River Watershed Management Plan.

The White River Watershed is located in the Tipton Till plain in East Central Indiana. This plain was formed from glacial deposits of sand and gravel that filled in bedrock valleys. The result of the deposits is the flat monotonous landscape that is central Indiana. The watershed, geologically, is made up of moraines and eskers, as well as bedrock. The landforms dictate the natural flow of the streams and rivers within the watershed.

Within the Tipton Till plain, the soils are generally classified by poorly drained or better draining soils. Using the USDA classification of soils, most of the soils within the sub-watersheds are silt loam. Also, almost 30% of the soils within the sub-watersheds are classified as highly erodible. The soil eroded by wind and storm water carries with it nutrients, herbicides and pesticides. The soil travels directly into the streams affecting the water quality. The poor water quality increases plant and algae growth, kills aquatic life and increases the sedimentation of the streambeds.

Another general soil classification is a hydric soil. Hydric soils are typically found along river corridors and are good indications of historic wetland conditions. Around 27% of the soils in the sub-watersheds are considered hydric.

Floodplains are the land adjacent to streams, rivers and other water bodies that provide temporary storage of water. Approximately 6.8% of the urban and cultivated land of the sub-watershed lies within the 100-year floodplain. Flooding occurs when there is encroachment on the floodplain, deforestation, stream obstruction, tiling, or the failure of the flood control structure. Flooding can cause property and inventory damage, utility damage and service disruption, bridge or road impasses, stream bank erosion, vegetation loss, and water quality degradation. To avoid the damages and impacts of flooding, floodplains should not be built in or disturbed. The majority of undeveloped land in Delaware County is within the floodplain of the White River.

To help alleviate the impact of potential flooding of the White River and other rivers across the country, the Army Corps of Engineers designed and developed the flood control levee system that was built during 1913-1960. The Muncie Levee System within the Muncie Creek –Hamilton Ditch sub-watershed is part of the Army Corps of Engineers' efforts.

Pre-settlement vegetation within the sub-watersheds was mostly forest consisting of oak, maple, ash, elm, sycamore, hickory, and beech trees. There were also a few prairies and wetlands.

White River Watershed Cultural History

Most of the early settlers to Delaware County came from Virginia, Pennsylvania and Kentucky. The Delaware and Miami Indians lived in the area and remained until 1818. Muncie was named after the chief of the Delaware Indian tribe. The first permanent settlement in Delaware County was established in 1820 located along the West Fork of the White River near present day Muncie, New Burlington and Smithfield.

Most of the county's towns were laid out along railroad lines making it convenient for trade. Muncie, then Munseytown, became the county seat in 1827. Between 1860 and 1880, the population of Muncie nearly doubled. In 1876, natural gas was discovered near Eaton in Delaware County, this area would become known as Trenton Field. The natural gas was almost forgotten about until it was discovered in neighboring Ohio around the 1880s.

The availability of the gas attracted many businessmen and industries to the region, including the Ball Brothers. By 1880, Muncie had forty factories manufacturing products ranging from washing machines to roller skates. Unfortunately, by 1910, 90% of the gas had been used due to wastefulness and unregulated drilling practices.

As the glass industry continued to grow, the Ball Brothers and their families became a respected and influential part of Delaware County. In 1917, the Ball Brothers purchased what would become Ball State University. The university attracts around 19,000 students from around the world.

With the globalization of the manufacturing business, many of manufacturers have moved away from Muncie, leaving the economy of the town depleted. Ball State University and Ball Memorial Hospital are the leading employers of the county. Projections for the next twenty years show that Delaware County will maintain stability and steady growth.

White River

The White River is the primary supply of water for Muncie and Delaware County. During periods of low flow the water supply is supplemented by Prairie Creek Reservoir. In the rural parts of the county, wells are used. Due to the glacial deposits and bedrock, the availability of ground water is good, producing 200 to 400 gallons per minute.

The White River is used for boating, fishing and full-body contact recreation. The West Fork of the White River and its major tributaries drains two-thirds of the county. The Truitt Ditch, a main tributary to the White River, joins the White River at the mouth of the Truitt-Ditch White River watershed. Both are naturally occurring channels, although both have been modified by humans to either increase drainage or allow development. Because of the modifications, both have frequent cases of erosion.

Muncie Creek, within the Muncie Creek –Hamilton Ditch Subwatershed, is also a naturally occurring channel that has also undergone channelization and straightening to allow for agriculture and housing development. As a result the channel tries to reengineer itself back to a more natural and appropriate grade and flow.

Before the Clean Water Act was implemented in the 1970s, the White River received several point source pollutants from sources such as, waste water treatment facilities, combined sewer outflows, battery and transmission plants, and tool and die shops. Non-point source pollutants also contributed to the degradation of the water quality of the White River. Some of these include urbanism, agriculture, runoff, fertilizers, insecticides, and herbicides. Most of these non-point sources still exist.

Pitfalls within the Watershed

Impervious surfaces limit surface water from infiltrating the land to become groundwater. Studies show that stream ecology degradation begins with only 10% impervious cover within a watershed. This results in water quality problems, increased bacteria concentrations, higher levels of toxic chemicals, and higher temperatures. The combined impervious surface total for both sub-watersheds is 18% coverage.

Although there are great recreational amenities within the county including the Cardinal and White River Greenways and Prairie Creek Reservoir, the amount of recreational space per person that is recommended by the National Recreation and Park Association is half the amount it should be. This number needs to be increased and can be increased by community involvement.

Most of the soil erosion and the stream sedimentation problems are blamed on agricultural fields not using BMPs. Some sedimentation comes from agriculture surface erosion, however most comes from the erosion of stream banks due to human manipulation (straightening and channelization) of the channel's natural course. Farmers should be more concerned about containing the herbicide and pesticide chemicals as well as manure applications that get washed into the river during storm events.

Unfortunately, over 85% of the wetlands in Indiana have been lost due to land development. In the Muncie Creek - Hamilton Ditch and Truitt Ditch - White River Subwatersheds an estimated 25% has been removed. There are now laws that require the replacement of a wetland within the same watershed if the wetland was drained for development. Although not the ideal solution, the obligation to replace beneficial wetland ecosystems will benefit the watershed. Restoring these areas back to their historic condition would prevent the further flow of highly erodible soils into the river systems.

Conclusion

Since 2000, many efforts have been made to improve the quality of the White River and its associated Watersheds. Because of the White River Watershed Management Plan, planning efforts involving Muncie and Delaware County have focused on the improvement of parks, recreation and natural resources. These plans need to be implemented to ensure the protection of the White River and its surroundings.

The White River Watershed Project exists because of the wide range of community partners and the numerous volunteers who share their time and expertise improving the quality of the White River for themselves and for future generations.

WATERSHED INVENTORY PART TWO

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP
CHAPTER 2

SECTION ONE - HISTORICAL WATER QUALITY DATA

MUNCIE CREEK - HAMILTON DITCH AND TRUITT DITCH-WHITE RIVER WMP

CHAPTER 2

IDEM Integrated Water Monitoring

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 1

Integrated Water Monitoring Assessment

The Indiana Department of Environmental Management (IDEM) is the primary agency tasked with monitoring surface water quality within the state of Indiana.

Every two years, the Indiana Department of Environmental Management submits an Integrated Monitoring report to the Environmental Protection Agency on the state of Indiana's waters. The most recent report was delivered to the United States Environmental Protection Agency (USEPA) in 2008 (IDEM, 2008).

USEPA emphasizes a probabilistic monitoring approach in order to help states meet the Clean Water Act section 305(b) goal of comprehensively monitoring all waters of the state. IDEM's probabilistic monitoring program provides IDEM with the ability to make statistical inferences regarding the extent to which waters of the state, as a whole, support or do not support designated uses based on data collected randomly throughout the state. [1]

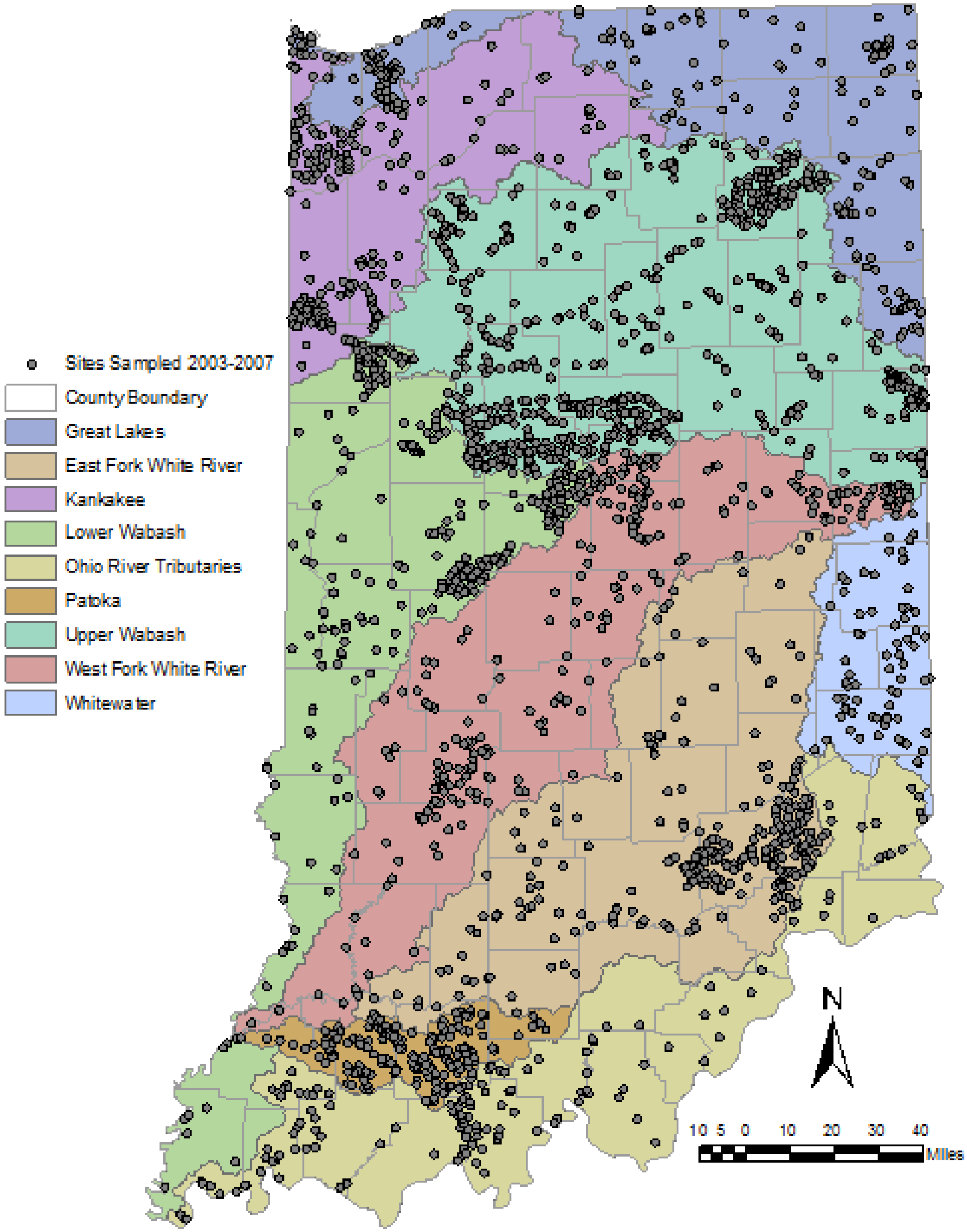
Sources of Data Include:[2]

- Fixed Station Monitoring Program, which provides chemistry data;
- Watershed Monitoring Program, which provides fish and benthic aquatic macroinvertebrate community data (IBI and mIBI) along with habitat evaluations, water chemistry data including information on nutrients, Chlorophyll a data, and E. coli data;
- Source ID Program, which provides chemistry data;
- Stressor ID Program, which provides fish community (IBI) data and habitat evaluations along with chemistry data collected at the same sites;
- Fish Tissue Contaminant Program, which provides fish tissue data;
- Special Studies Program which provides a variety of information for selected locations.

Indiana's list of impaired streams continues to grow as a function of probabilistic monitoring required to meet Clean Water Act monitoring goals. IDEM seeks to continue probabilistic monitoring in order to determine overall trends in water quality throughout the state and over time and to provide additional data with which to assess previously unassessed waters.[3]

IDEM's water quality monitoring also employs a watershed approach. The statewide rotating basin approach to watershed monitoring was adopted in 1996. The rotating basin plan makes it possible to update water quality assessments on a five-year cycle for monitored watersheds throughout the state and ensures that the information available for planning and watershed management activities is no more than five years old. MAP 2.60 shows the monitoring locations for all of IDEM's sampling programs and illustrates the sampling density achieved through IDEM's water quality monitoring strategy over the past five years (2003-2007).[4]

1 SWQMS and fact sheets with detailed descriptions of the monitoring programs are available on the IDEM Web site.
2 Indiana Integrated Water Monitoring and Assessment Report
3 Indiana Integrated Water Monitoring and Assessment Report
4 Indiana Integrated Water Monitoring and Assessment Report



MAP. 2.60 Location of IDEM Sampling Sites

SOURCE: Indiana Integrated Water Monitoring and Assessment Report

Integrated Water Monitoring

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 2

The data collected in IDEM's WQ program enables the state to assess and report on how well the waters of Indiana support the "beneficial uses" designated in Indiana's water quality standards. This assessment is called the 305(b) report which uses the data from the waterbodies sampled for water quality and determines where "beneficial uses" are adversely effected.

Indiana's beneficial uses are defined in Indiana Code 14-25-7-2 as "The use of water for any useful and productive purpose." The term includes the following uses:[1] (1) Domestic (2) Agricultural, including irrigation (3) Industrial (4) Commercial (5) Power generation (6) Energy conversion (7) Public water supply (8) Waste assimilation (9) Navigation (10) Fish and wildlife (11) Recreational

To complete this report, the 305(b) coordinator reviews all data collected by IDEM and selected high-quality data collected by other organizations on a waterbody basis. Each assessed waterbody is then assigned a water quality rating based on its ability to meet Indiana's water quality standards (WQS). WQS are set at a level to protect Indiana waters' designated uses of swimmable, fishable, and drinkable. Waterbodies that do not meet their designated uses are proposed for listing on the impaired waterbodies list (303(d)), which is discussed in more detail below.[2]

IDEM completed its first comprehensive aquatic life use support assessments for the entire state in 2002 and will report similar information for recreational uses in 2010. The 2002 report was the state's first baseline report on water quality, which was revised in 2004 and 2006. The 2008 report provides the most recent comprehensive report on Indiana water quality to date.[3] MAP 2.61 Designates the location of IDEM Sampling points in the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds as part of the 2002 and 2008 305(b) reports.

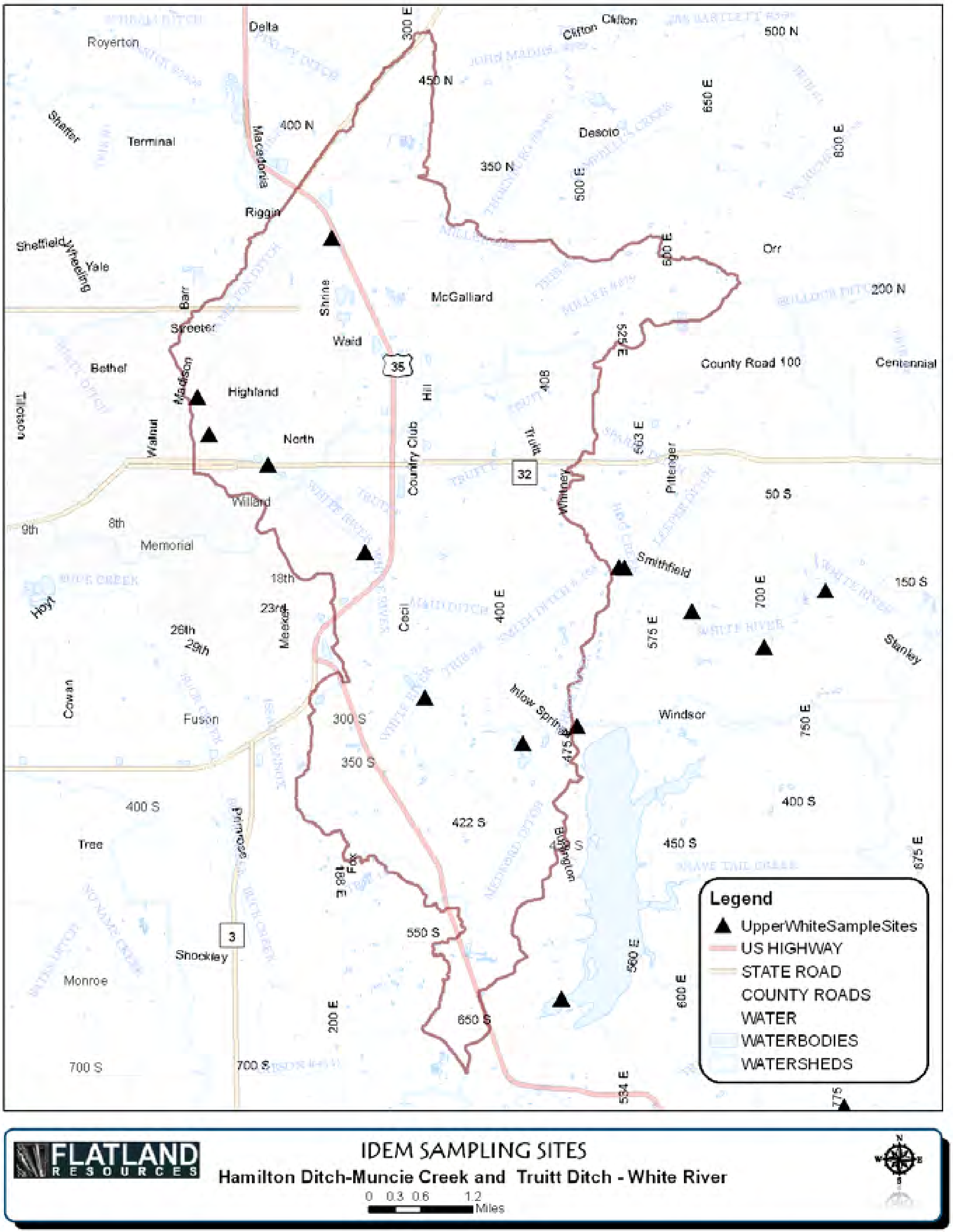
Approximately 79 percent of the 17,535 stream miles assessed Statewide for aquatic life use were found to be fully supporting. Approximately 30 percent of the 12,073 stream miles assessed Statewide support full body contact recreational use. [4] During the analysis, it was determined that pathogens are the top cause of stream impairments, affecting over 8,000 miles of streams. Polychlorinated biphenyl (PCB) found in fish tissue impacts over 3,000 miles while mercury impairments impact nearly 2,000 miles of streams. [5] Over 2,000 stream miles also have biological communities with measurable adverse response to pollutants. [6]

TABLE 2.43: Designated Beneficial Use of Water State of Indiana

Designated Beneficial Use	Total Miles Designated	Miles Assessed	Percent Assessed	Miles Fully Supporting	Miles Not Supporting
Aquatic Life Use	32,141	17,535	54.6	13,913	3,622
Fishable Uses	32,170	4,465	13.9	1,044	3,420
Drinking Water Supply	102	1	1.0	0	1
Rec / Human Health	32,173	12,073	37.5	3,700	8,374

SOURCE: Indiana Integrated Water Monitoring and Assessment Report

1 IC-14-25-7-2 2009
2 Indiana Integrated Water Monitoring and Assessment Report
3 Indiana Integrated Water Monitoring and Assessment Report
4 Indiana Integrated Water Monitoring and Assessment Report
5 Indiana Integrated Water Monitoring and Assessment Report
6 Indiana Integrated Water Monitoring and Assessment Report



MAP. 2.61 IDEM Sampling Sites Points

Integrated Water Monitoring

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 3

Two water bodies in the Truitt Ditch-White River watershed were examined during the 2008 305(b) monitoring: the main stem of Truitt Ditch, along with some tributaries, and the White River. For three categories; recreation use, fishing use, and aquatic life use, there was insufficient data available to make a use support determination (Category 3).

The main stem of the White River was impaired for recreation use by the presence of E. coli (Category 5A), and a Total Maximum Daily Load determination is needed. It was also impaired for fishable use by the presence of PCBs found in fish tissue (Category 5B) and a TMDL is needed. Aquatic life use was placed in Category 2, which means that there is insufficient data to determine if all the uses are being met and further data would be required.

Two waterbodies in the Hamilton Ditch-Muncie Creek watershed were examined during the 2008 305(b) monitoring: the main stem of Muncie Creek and some of its tributaries, as well as the White River. Muncie Creek is impaired for recreational use due to E. coli levels and a TMDL has been approved in 2004 (Category 5A).

There was insufficient data to determine whether Muncie Creek was impaired for fishing (Category 3), and the data indicates that some, but not all designated uses are supported for aquatic life (Category 2).

The main stem of the White River was impaired for all use categories. Recreation use was threatened, but it was determined that a TMDL is not needed (Category 4A). Additionally fishable use was threatened by the presence of PCBs in fish tissue and a TMDL is needed (Category 5B). Finally, aquatic life use is impaired in this stretch of the White River due to impaired biotic communities. It was determined that a TMDL is needed for this parameter (Category 5A).[1]

TABLE 2.44: Designated Use Categories

Category 1	Attaining the water quality standard and other applicable criteria for all designated uses and no use is threatened.
Category 2	Attaining some of the designated uses; no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.
Category 3	Insufficient data and information is available to determine if any designated use is attained.
Category 4	Impaired or threatened for one or more designated uses, but does not require the development of a total maximum daily load (TMDL).
Category 5	The water quality standards or other applicable criteria are not attained. The waters are impaired or threatened for one or more designated uses by a pollutant(s), and require a TMDL.

SOURCE: Indiana Integrated Water Monitoring and Assessment Report

1 Indiana Integrated Water Monitoring and Assessment Report

TABLE 2.45: Indiana Integrated Water Monitoring

ASSESSMENT UNIT NAME	RECREATIONAL USE	FISHABLE USE	DRINKING WATER USE	AQUATIC LIFE USE	ECOLI	IBC	PCBs in FISH TISSUE	NUMBER OF IMPAIRMENTS
STONEY CREEK AND OTHER TRIBUTARYS	5A	3		3	X			1
WHITE RIVER	5A	5B		2	X		X	2
MUD CREEK AND OTHER TRIBUTARIES	5A	3		2	X			1
WHITE RIVER	5A	5B		2	X		X	2
ARBOGAST DITCH	3	3		5A				
PRAIRIE CREEK-CUNNINGHAM/CARMICHAEL DITCHES	2	3		2				
TRUITT DITCH AND OTHER TRIBUTARYS	3	3		3				
WHITE RIVER	5A	5B		2	X		X	2
MUNCIE CREEK - OTHER TRIBUTARIES	5A	3		2	X			1
WHITE RIVER	4A	5B		5A		X	X	2
Buck Creek	5A	3		5A	X	X		2
BELL CREEK-BETHEL BROOK	5A	3		2	X			1
BELL CREEK-WILLIAMS DITCH	5A	3		2	X			1
BELL CREEK-NO NAME CREEK	5A	3		2	X			1
WHITE RIVER	4A	5B		5A			X	1
BUCK CREEK	5A	5B		5A	X		X	2
YORK PRAIRIE CREEK AND OTHER TRIBUTARYS	5A	3		3	X			1
WHITE RIVER	4A	5B		5A			X	1
KILLBUCK CREEK	5A	3		2	X			1
MUD CREEK	2	3		3				
KILLBUCK CREEK-THRUSTON DITCH	5A	3		2	X			1
JAKES CREEK-EAGLE BRANCH	5A	2		2	X			1
KILLBUCK CREEK-PLEASANT RUN CREEK	5A	2		2	X			1
KILLBUCK CREEK	5A	5B		2	X		X	2
PIPE CREEK-YEAGER FINLEY MENARD DITCH	5A	3		2	X			1
BURLINGTON LAKE	3	3		3				
EMERALD LAKE	3	3		3				
JIM LAKE	3	3		3				
PHILLIPS QUARRY LAKE	3	3		3				
PRAIRIE CREEK RESERVOIR	3	3	3	3				

INVENTORY

Impaired Waterbodies 303(d)

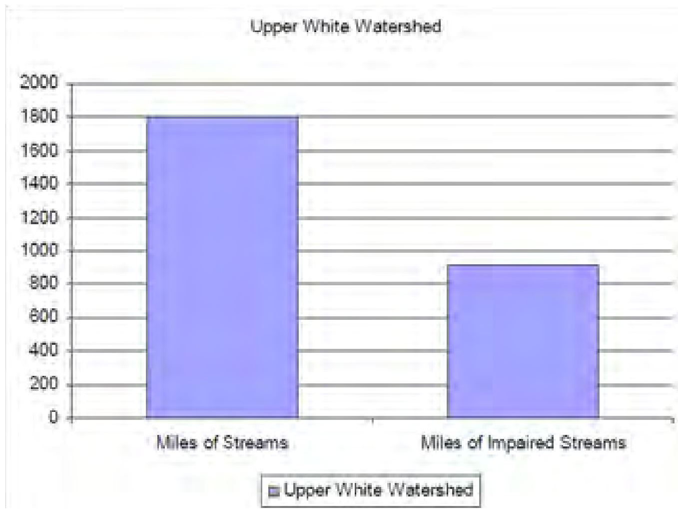
WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 4

A part of the 305(b) report is the 303(d) list. This list is used to identify impairments in waterbodies for which a total maximum daily load (TMDL) is needed.[1]

The impaired waterbodies list is prepared biannually (as a component of the IR) by the Indiana Department of Environmental Management. Waterbodies are included on the list if they do not meet the state's water quality standards. Waterbodies are relisted on the impaired waterbodies list once a Total Maximum Daily Load (TMDL) has been written or the waterbody or the waterbody again meets the state standards.[2]

There are currently 28 stream segments listed as not meeting the state water quality standards within the West Fork Drainage Basin Delaware County (Table 2.46). 10 of these listings are on streams present in the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds. These segments are part of the United State Environmental Protection Agency's approved list of water quality limited segments still requiring Total Maximum Daily Load calculations (Approved May 21, 2008). The segments that are a part of this management plan are listed in bold. In Delaware County, the waters are impaired due to the presence of mercury or PCBs, or both in the edible tissue of fish collected at levels exceeding Indiana's human health criteria for these contaminants." [3]

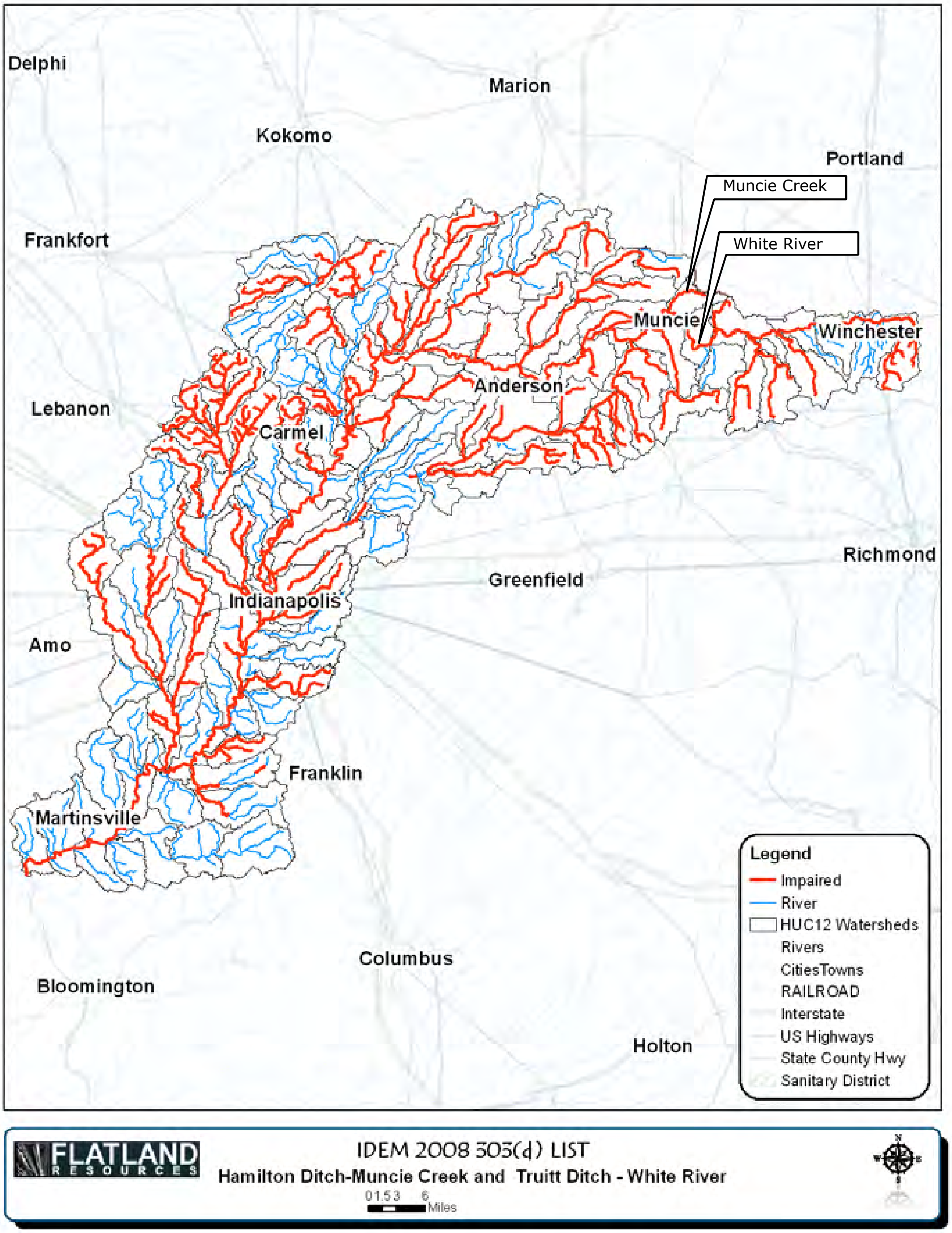
State wide, leading problems in Indiana's waters include E. coli impaired biotic communities, and fish consumption advisories.



CHA. 2.20 Miles of Impaired Stream in Upper White River Watershed

SOURCE: Rapid Watershed Assessment Upper White Watershed

1 Indiana Integrated Water Monitoring and Assessment Report
2 DNR Division of Forestry
3 IDEM, 2009



MAP. 2.62 2008 IDEM Impaired Streams in Upper White River Watershed

INVENTORY

Impaired Waterbodies 303(d) List For W

TABLE 2.46: 303 (d) List for West Form White River

MAJOR BASIN	14-DIGIT HUC	COUNTY	ASSESSMENT UNIT ID
WEST FORK WHITE	5120201020030	DELAWARE CO	INW0123_00
WEST FORK WHITE	5120201020050	DELAWARE CO	INW0125_00
WEST FORK WHITE	5120201020040	DELAWARE CO	INW0124_00
WEST FORK WHITE	5120201020020	DELAWARE CO	INW0122_T1011
WEST FORK WHITE	5120201020020	DELAWARE CO	INW0122_T1011
WEST FORK WHITE	5120201020060	DELAWARE CO	INW0126_T1012
WEST FORK WHITE	5120201020060	DELAWARE CO	INW0126_T1012
WEST FORK WHITE	5120201040030	DELAWARE CO	INW0143_00
WEST FORK WHITE	5120201040010	DELAWARE CO	INW0141_00
WEST FORK WHITE	5120201040050	DELAWARE CO	INW0145_00
WEST FORK WHITE	5120201040050	DELAWARE CO	INW0145_00
WEST FORK WHITE	5120201040040	DELAWARE CO	INW0144_00
WEST FORK WHITE	5120201040020	DELAWARE CO	INW0142_00
WEST FORK WHITE	5120201010100	DELAWARE CO	INW011A_00
WEST FORK WHITE	5120201010130	DELAWARE CO	INW011D_00
WEST FORK WHITE	5120201050010	DELAWARE CO	INW0151_00
WEST FORK WHITE	5120201010090	DELAWARE CO	INW0119_00
WEST FORK WHITE	5120201010090	DELAWARE CO	INW0119_T1006
WEST FORK WHITE	5120201010090	DELAWARE CO	INW0119_T1006
WEST FORK WHITE	5120201010100	DELAWARE CO	INW011A_T1007
WEST FORK WHITE	5120201010100	DELAWARE CO	INW011A_T1007
WEST FORK WHITE	5120201010120	DELAWARE CO	INW011C_T1008
WEST FORK WHITE	5120201010120	DELAWARE CO	INW011C_T1008
WEST FORK WHITE	5120201010130	DELAWARE CO	INW011D_T1009
WEST FORK WHITE	5120201010130	DELAWARE CO	INW011D_T1009
WEST FORK WHITE	5120201020060	DELAWARE CO	INW0126_T1010
WEST FORK WHITE	5120201030010	DELAWARE CO	INW0131_T1013
WEST FORK WHITE	5120201030010	DELAWARE CO	INW0131_00

SOURCE: Indiana Integrated Water Monitoring and Assessment Report

West Fork White River

ASSESSMENT UNIT NAME	CAUSE OF IMPAIRMENT	IRCAT
BELL CREEK-BETHEL BROOK	E. COLI	5A
BELL CREEK-NO NAME CREEK	E. COLI	5A
BELL CREEK-WILLIAMS DITCH	E. COLI	5A
BUCK CREEK	E. COLI	5A
BUCK CREEK	Impaired Biotic Communities	5A
BUCK CREEK	E. COLI	5A
BUCK CREEK	PCBs in Fish Tissue	5B
JAKES CREEK-EAGLE BRANCH	E. COLI	5A
KILLBUCK CREEK	E. COLI	5A
KILLBUCK CREEK	E. COLI	5A
KILLBUCK CREEK	PCBs in Fish Tissue	5B
KILLBUCK CREEK-PLEASANT RUN CREEK	E. COLI	5A
KILLBUCK CREEK-THRUSTON DITCH	E. COLI	5A
MUD CREEK AND OTHER TRIBUTARIES	E. COLI	5A
MUNCIE CREEK - OTHER TRIBUTARIES	E. COLI	5A
PIPE CREEK-YEAGER FINLEY MENARD DITCH	E. COLI	5A
STONEY CREEK AND OTHER TRIBUTARIES	E. COLI	5A
WHITE RIVER	E. COLI	5A
WHITE RIVER	PCBs in Fish Tissue	5B
WHITE RIVER	E. COLI	5A
WHITE RIVER	PCBs in Fish Tissue	5B
WHITE RIVER	E. COLI	5A
WHITE RIVER	PCBs in Fish Tissue	5B
WHITE RIVER	Impaired Biotic Communities	5A
WHITE RIVER	PCBs in Fish Tissue	5B
WHITE RIVER	PCBs in Fish Tissue	5B
WHITE RIVER	PCBs in Fish Tissue	5B
YORK PRAIRIE CREEK AND OTHER TRIBUTARIES	E. COLI	5A

INVENTORY

TMDL Studies

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 6

Total Maximum Daily Load is the amount of a pollutant that a water body can receive and still meet water quality standards. It is calculated by combining a sum of allowable loads from point sources and nonpoint sources plus a margin of safety. The TMDL study seeks to identify sources of water quality impairments and estimate needed reductions.

TMDLs aid watershed groups in the determination of sources for the purposes of effective watershed planning. TMDLs provide an overview of the watershed condition and provide guidance on how to correct problems. TMDLs are also required by the Clean Water Act.

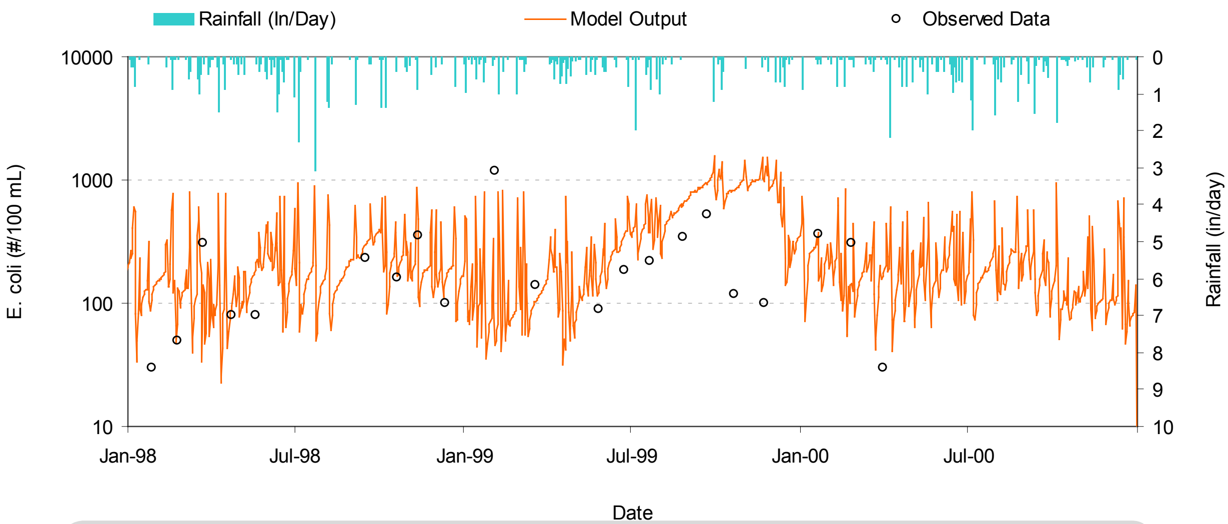
IDEM's TMDL program focuses almost exclusively on nonpoint source related impairments and has developed 559 TMDLs to date. There are another 548 TMDLs either in progress or planned for 2008. Indiana's early TMDLs were developed primarily through the use of third party contractors. IDEM's TMDL program now develops most of its TMDLs in-house. In addition to being more cost-effective, agency development of TMDLs provides the opportunity for more effective coordination with IDEM's NPS program and other relevant water quality programs. IDEM is continuing to develop TMDLs focused on E. coli impairments as well as TMDLs for other NPS related issues such as impaired biotic communities and nutrient impairments. [1]

IDEM's TMDL program has been awarded considerable funding from USEPA through contractor support grants to develop additional TMDLs. IDEM's TMDL program has collaborated with both Illinois and Michigan on TMDL development for interstate waters and leads the nation in the development of TMDLs for impairments in waters that cross state lines.[2]

IDEM's TMDL Program works closely with the NPS program and IDEM's Watershed Specialists to develop TMDL reports that can be effectively used by local watershed groups and stakeholders to facilitate the restoration of impaired waters. The TMDL program also coordinates with local governmental agencies and stakeholders within the TMDL area. This coordination provides numerous opportunities for local participation in the TMDL process, which leads to positive changes in the watershed. Since 2004, the coordinated efforts of the NPS/TMDL Section and IDEM's WSS have resulted in the formation of ten new watershed groups and new grant -funded projects for planning and restoration activities in impaired watersheds. [3]

There have been no TMDL studies completed in the Hamilton Ditch-Muncie Creek or Truitt Ditch-White River Subwatersheds at the time of this plan development, although there is currently being one developed by IDEM.

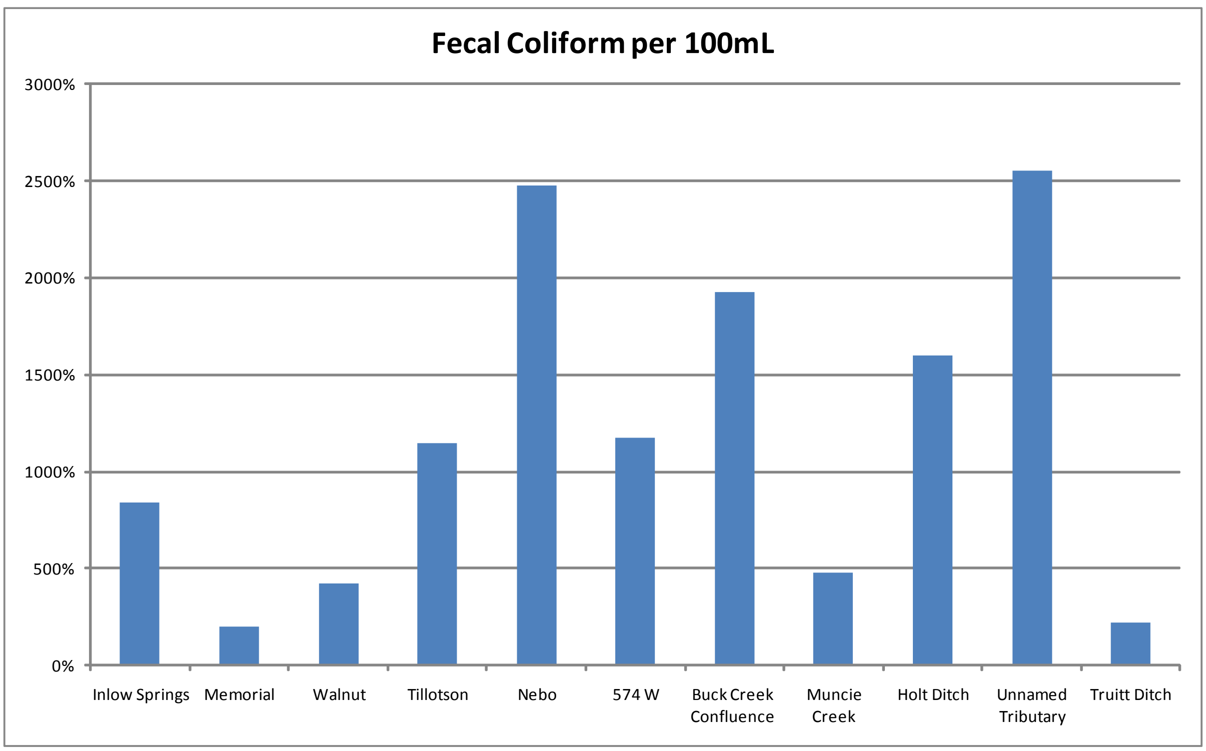
1 Indiana Integrated Water Monitoring and Assessment Report
2 Indiana Integrated Water Monitoring and Assessment Report
3 Indiana Integrated Water Monitoring and Assessment Report



CHA. 2.21 TMDL E. coli East Edge of Muncie

SOURCE: IDEM TMDL West Fork White River

Comparison of modeled to observed predicted E. coli at station WWU010-0001 (east edge of Muncie) for the period January 1, 1998, to December 31, 2000.



CHA. 2.22 Comparison of E. coli readings at 319 Water sampling Points

INVENTORY

Chemistry | IDEM Data
WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 7

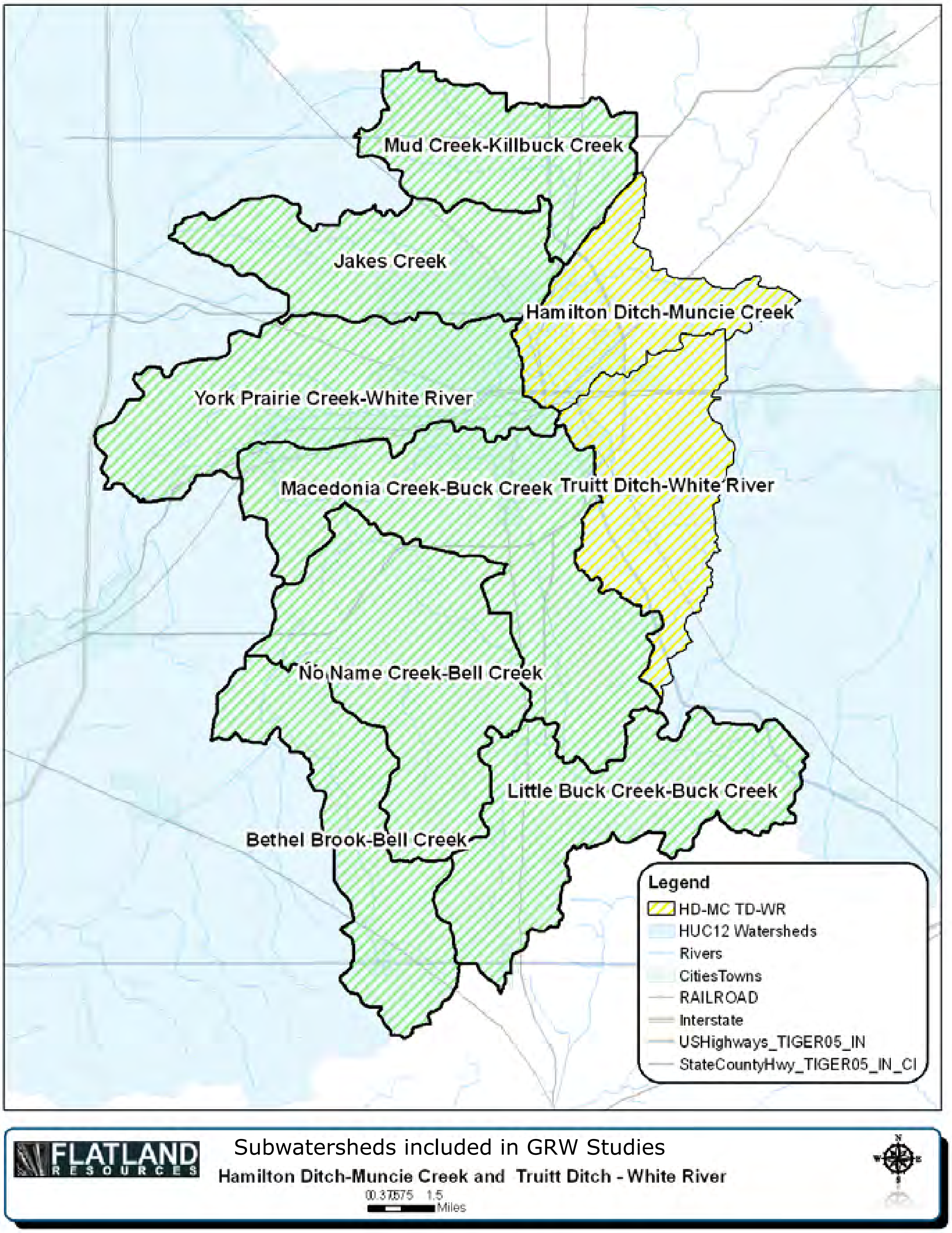
Although the leading metric for the 303(D) and subsequent TMDL listing (in the West Fork White River) is limited to Mercury, E. coli., Impaired Biotic Communities, PCBs found in fish Tissue, Cyanide, Algae, Dissolved Oxygen, and Taste and Odor, IDEM collects data on over 50 other contaminates. This data, despite the inherent limits of probabilistic monitoring, is available for analysis through IDEM data resources website.

In 2010, GRW Engineers did an analysis of IDEM water quality sampling on behalf of the Muncie Storm Water Utility (MS4) as part of the submission requirements for the NPDES (National Pollutant Discharge Elimination System) Phase II. This research included data for six HUC 12 Subwatersheds located in Muncie MS4 jurisdiction: Buck Creek-Macedonia Creek watershed, the Jakes Creek-Eagle Branch watershed, the White River-Truitt Ditch watershed, the White River-Buck Creek (lower) watershed, the White River-Muncie Creek watershed and the White River-York Prairie Creek watershed in the Muncie area. (MAP 2.63)

Because the data analysis included the Truitt Ditch-White River watershed and the Hamilton Ditch - Muncie Creek watershed, it is included in this WMP. The complete report can be found on the Muncie Sanitary District Website. Raw data for the studied Subwatersheds is available from the Indiana Department of Environmental Management upon request.

GRW looked at close to 40 water quality metrics in the broader Muncie area and provided an overview of what their inherent risks are, rated/analyzed them based on how much they exceeded their state limits, indicated how consistently they were above the state standards (per sample), and indicated whether they are issues to be concerned about (i.e. require mitigation). GRW's analysis of water quality parameters is included in the following pages. Table 2.48 provides a summary and indicates where data suggested issues of concern for the Truitt Ditch-White River watershed and the Hamilton Ditch - Muncie Creek watersheds.

Description of IDEM Water Quality Data Sets (GRW)
Muncie, Yorktown, Ivy Tech - Muncie & Delaware County, Indiana
October 2010
http://www.munciesanitary.org/clientuploads/Appendix%20B.pdf



MAP. 2.63 Location of GRW Subwatershed Studies

INVENTORY

Dissolved Oxygen (DO)

"This is one of the most important measures of water quality. For recreational purposes, it has significant effects on odor and color of the body of water. DO helps to reduce certain contaminants in the water. Bacteria uses oxygen to decompose organic material in addition to converting some more toxic chemicals to more stable less toxic forms. IDEM has set a minimum five-day level of 5 mg/L and no less than 4 mg/L at any one time in a freshwater stream for healthy organism life.
The data displayed acceptable values for DO over the 11-year period. However, three sampling points were below the minimum acceptable limit in that period. In the White River-Truitt Ditch watershed the level declined to 2.0 mg/L. The level also declined twice in the White River-Buck Creek (lower) watershed. These levels were 0.7 and 3.8 mg/L. While all three points are significantly low levels of DO, they did not remain low. The reading of 0.7 mg/L may be a monitor malfunction. There is no reason to be concerned with these results."

pH

"The pH is a measure on a logarithmic scale ranging from 0 to 14 where the lower range numbers are associated with acidic solutions and the higher range numbers with basic solutions. Consequently the closer to the number 7 the results are, the more neutral the solution. For natural waters the pH value should be between 6 and 9, according to IDEM, however, daily fluctuations can occur. Daily fluctuations in pH are acceptable and can result in a daily reading exceeding 9.
These increases in pH readings rarely remain high and are likely to be associated with photosynthetic activity. The values for the watersheds were well within the acceptable range."

Saturation Percent

"The saturation percent is the calculation of the DO concentration relative to the capacity in a body of water. The main factors affecting it are the water temperature, salinity, and partial pressure. There are no set standards for this parameter, but it should stay as close to 100% as possible. If the percent saturation falls to a detrimental level, the result would show up in the DO available.
Muncie's data showed reasonable values for this parameter. The saturation percent ranged from 57 % to 117 % with the majority of the data points falling in the 90th percentile."

Specific Conductance

"Specific conductance is the ability of water to conduct electricity. The IDEM standard for specific conductance for water to be used for agricultural, domestic and industrial uses is 1200 micromhos per centimeter. However, when used as a water quality parameter for surface water for recreational purposes, it is most often used in estimating total dissolved solids. The majority of the watersheds were within the threshold for this parameter. However, both the White River-Buck Creek (lower) watershed and the White River-York Prairie Creek watershed had some falling values. 13% of the data retrieved from the Buck Creek (lower) watershed was higher than the standard. This is a relatively small percentage and is not large enough to cause concern. The York Prairie Creek watershed however, was significantly failing. 42% of the data was above the standard. The value for total dissolved solids is within range for this watershed, so wheather or not this parameter needs further attention depends on whether or not there is an intake near the failing area."

Description of IDEM Water Quality Data Sets (GRW)
Muncie, Yorktown, Ivy Tech - Muncie & Delaware County, Indiana
October 2010
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Turbidity
"Turbidity is the measure of the clarity of water. An increase in turbidity is due to suspended impurities such as clay, silts, and soil particles. An increase can hinder the microorganisms from acting as disinfectants in surface waters. The acceptable range for turbidity varies between a "clear" lake at 25 units to a muddy unaesthetic body of water at 100 units. The Muncie watersheds only had 5% of its data point in the 100 units or above range. All the fixed monitoring stations reported relatively low numbers throughout the data with a few spikes. If these spikes were associated with a large rain event, then the waterways in the Muncie watershed would be considered "flashing water" (the data was not compared to major rain events during this study). "Flashing water" is a waterway that, due to a rain event and the terrain, has more soil particles released from the streambed. There are no significant problems with this situation. It should be noted that one of Muncie's meters in each watershed had significant malfunctions throughout the data retrieval period."

Temperature
"An increase in temperature of a body of water can increase the oxygen required for life while at the same time decrease the DO available. If changed at a rapid rate this could have detrimental effects on the aquatic life, however, since the levels of DO are within the required limits it is safe to extrapolate that the temperature is within a safe zone. The main factor related to temperature is the rate of change. For every 10 degrees Celsius increase the metabolic rate increases by a factor of two. The IDEM standard states that the water temperature should not exceed 32.2 degrees Celsius at any given time, and that the maximum rate of temperature increase should be no more rapid than 2.8 degrees Celsius at any given time. This statement is from the IDEM standards and is incomplete. There is not a reference as to the unit of time. This parameter should not be a concern."

Alkalinity
"Alkalinity is the ability of water to absorb hydrogen ions without having a change in pH. It is what helps to keep the pH stable when water conditions change. In surface water, the alkalinity is mainly affected by the presence of bicarbonates. There is not a standard alkalinity value. The value is a result of the geological formations of the area. This value can vary drastically from city to city. Areas of Indiana and Kentucky are prone to having high values of alkalinity; this is due to the large quantity of limestone in the area. Even taking this into consideration, the average values for the area studied are relatively average for the nation. The data for this parameter revealed relatively low levels of alkalinity.
This parameter should not be a concern."

Chlorides
"Chlorides in large quantities contribute highly to the hardness of water. They also reduce the quality of taste in the drinking water supply. The IDEM standard for chlorides is less than 250 mg/L. Muncie's watershed data for this parameter was significantly under the standard. The highest reading was 134 mg/L in the White River-Buck-Creek (lower) watershed.
This parameter should not be a concern."

Biochemical Oxygen Demand (BOD5)
"The BOD5 is the measure of the amount of oxygen consumed in five days by microorganisms during biodegradation. According to NPDES, the standard for effluent from a sanitary sewer treatment facility is 20-50 mg/L with the average below 30 mg/L. The data from Muncie's water quality study is not at an effluent point, but instead at some point downstream of the mixing station. Therefore, the measured values should be considerably lower than expected values near the effluent. For the two watersheds monitored, White River-Truitt Ditch and White River-Buck Creek (lower), values were between 1.0-6.7 mg/L. The measured values were below the effluent standard, however, there is no standard for the values downstream of the mixing zone. Therefore, the results are inconclusive."

Chemical Oxygen Demand (COD)
"COD is the measure of the oxygen needed to oxidize chemical waste. There is not a standard set for this parameter; however, the values should be higher than the biochemical oxygen demand (BOD5). The measured values for COD are higher than those identified for BOD5, and they are also in a reasonable range. This parameter should not be a concern."

Fluoride
"Fluoride is not to exceed 2.0 mg/L according to IDEM in any waterway in Indiana. Fluoride is added to many cities water supply for the benefit of protecting the consumer's teeth. This is only being done to an amount of 1.0 mg/L. In large quantities if ingested fluoride can cause brittleness of bones. The measured values in the watersheds in Muncie stayed within the standard. This parameter should not be a concern."

Coliforms
"The number of coliform bacteria found in a sample of water can be significant. This number indicates the potential for disease causing species being in the sample. The lower the number of coliform bacteria, the lower the potential for pathogenic organisms. The IDEM standard limit for the coliform bacteria group is 5,000 MPN or MF per 100 mL on a monthly average and no more than 20% of the data samples can be above 5,000, and there has to be less than 20,000 MPN or MF per 100mL in 5% of the data collected. The data reading for the Muncie watershed read greater than 2,419 per 100 mL. This data are inconclusive."

Hardness
"Hardness is a measure of the concentration of ions of calcium and magnesium, and is a major cause of staining plumbing fixtures. These properties should not be present in significant quantities in natural waters. Four additional elements contribute to the hardness of water. They are iron, manganese, strontium, and aluminum. It is considered to be excessive if the value is greater than 500 mg/L as Calcium carbonate ($CaCO_3$) and is preferred to be around 150 mg/L as $CaCO_3$. In excessive amounts, hardness can cause skin irritation. These can vary and depend highly on the type of soil that is in the area. The highest measured value for $CaCO_3$ in Muncie's watersheds was 470 mg/L as $CaCO_3$ in the White River-Buck Creek (lower). This is not an issue for storm water discharge."

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Nitrogen
"Nitrate-N + Nitrite-N has an IDEM standard of 10 mg/L. Nitrate and nitrite are harmful if consumed in large quantities. They can function as a hemoglobin inhibitor. The measured values for the watershed do stay significantly low for all data points. In fact, there was not a single data point that crossed the maximum acceptable level. Ammonia nitrogen has been known to have adverse affects on aquatic life at chronic levels as low as 0.1 mg/L, however the EPA standard is 3.5 mg/L. Again, all the data points were significantly lower than the standard. This parameter should not be a concern."

Sulfates
"Sulfates in large quantities contribute highly to the hardness of water. They may have a laxative effect if found in high concentrations in a drinking water supply. The IDEM standard is 250 mg/L. Muncie's sulfate reading displayed several incidences where sulfates were considerably above the standard. 11% of the readings were above the threshold, and the highest reading was 723 mg/L. All of the points that were outside of the standard were in the White River-Buck Creek (lower) watershed. Some of the readings were significantly elevated. The reason for this could need to be investigated."

Phosphorus
"Nutrients are considered pollutants when the concentrations reach a level that is conducive for excessive algal growth. Excessive algae are undesirable for surface water for three main reasons. It adds to the turbidity of water, causes a foul smell, and reduces the DO levels in water. Nitrogen, carbon, and phosphorus are the three most contributing nutrients for algae growth. In the Muncie watersheds, phosphorus is the limiting nutrient. Most state regulations require phosphorus-limiting streams to have a maximum of 1.0 mg/L of phosphorus. Common contributors of phosphorus are detergents, clay type soils, human waste and agricultural runoff. 8% of the data points from the White River-Buck Creek (lower) measured outside of the threshold and the highest value was 2.0 mg/L. Such as small percentage is insignificant, and the rest of the watershed in this area are within the threshold."

Surfactants
"Surfactants are man made synthetic organic chemicals often used in large quantities in detergents or result from the natural decay of organic substances found in a stream. These substances can cause a foamy layer on the surface of water. For the most part, this foam layer is not hazardous, but rather unattractive for recreational uses. There is no set standard for the concentration of surfactants for surface water."

Total Organic Carbon (TOC)
"TOC is the measure of the total organic material in a water supply source from natural and human activities. According to the EPA, in surface water the number should be no higher than 5 mg/L. All of the watersheds in this area had a few points that were slightly high, however, no one watershed had a significant amount of points above the threshold. This parameter should not be a concern."

Total Dissolved Solids and Suspended Solids

"Total dissolved solids (TDS) are the amount of solids that pass through a 1.2-micrometer filter, while the term suspended solids refers to the amount of substance retained on said filter. In high concentrations, dissolved solids can reduce the serviceable water for agriculture, domestic, and industrial uses. The TDS threshold for drinking water is 500 mg/L and the majority of data points fell around this range. However, the IDEM requirement for fresh water streams is 750 mg/L assuming that the water will be used for more than just recreation. For water used solely for recreational purposes, there is no existing standard. 11% of the TDS measured values were above the standard of 750 mg/L, with the highest value being 1450 mg/L. All of the failing data points were retrieved from the White River-Buck Creek (lower) watershed. Some of the suspended solids data were rather high as well, and there appeared to be a correlation between suspended solids and the TDS level. . 21% of the tests for suspended solids were above the allowable 30 mg/L as stated in the NPDES for effluents. These points were taken from the White River-Buck Creek watershed and the White River-Truitt Ditch watershed. The samples were taken from a location downstream from the mixing point. Therefore, they should have significantly lower values than the NPDES requirements for effluent discharge."

Total Kjeldahl Nitrogen (TKN)

"TKN consists of ammonia plus organic nitrogen. According to NPDES, the standard for effluent from a sanitary sewer treatment facility is 20-50 mg/L with the average less than 30 mg/L. The data that is contained in Muncie's water quality study is not at an effluent point, but instead at some point downstream from the mixing station. Therefore, the measured values should be considerably lower than the actual values at the effluent. The measured values for the Muncie watersheds' were between 0.2-5.4 mg/L. Yorktown's watersheds measured between 0.3-5.4 mg/L. The values were below the effluent standard, however, there is no standard for the values downstream of the mixing zone. Therefore, the results are inconclusive."

Phenolics

"Phenol is an aromatic organic compound commonly used in disinfectants. The EPA standard limit for this material is 5 micrograms per liter. The majority of the results resulted in less than 5 micrograms per liter detected, however, three measurments were slightly above that. They ranged from 6-8 micrograms per liter. These points were located in the White River-Truitt Ditch and the White River-Buck Creek (lower) watersheds. If this chemical is found in excessive quantities, it can cause fish flesh tainting in the streams. There is no reason to be concerned with the concentration of this chemical."

Pyrene

"Pyrene and its derivatives are used commercially to make dyes and dye precursors. The EPA standard limit for this material is 0.21 mg/L. The majority of the results resulted in less than 0.00001 mg/L detected, however, one reading was above that. That result read 0.0002 mg/L in the White River-Buck Creek (lower) watershed. This is still significantly below the standard. There is no reason to be concerned with the concentration of this chemical."

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Cyanide

"The IDEM standard for cyanide is 0.0052 mg/L for human health and 0.022 mg/L for aquatic life. Muncie's fixed monitoring stations reported more than 90% to be below the detectable value of 0.005 mg/L. And Yorktown reported more than 85% of their fixed monitoring stations to be below this value also. The White River-Truitt Ditch watershed had 4% of its measured values above the human health standard, but no points above the aquatic life standard. The only other watershed that had a significant data was the White River-Buck Creek (lower) watershed. This watershed had 12% of the measured values above the IDEM standard for human health and one value above the standard for aquatic life. However, none of the failing values were significantly above the standard and they did not remain elevated either. This parameter should not be a concern."

E. Coli

"E. coli is used as an indicator organism that suggests the presence of sewage and other pathogenic organisms. Most strains of E. coli are harmless, only one in hundred strains is harmful to humans. E. coli will not survive as long as coliforms will; therefore, if the coliform bacteria level is low it is probably not necessary to test for E. coli. The IDEM standard for full body contact with E. coli is no more than 235 MF per 100 mL in any one sample over a 30-day sampling period. Muncie's watersheds had consistent reading of E. coli that are significantly higher than the standard. The Buck Creek-Macedonia Creek watershed and the Jakes Creek-Eagle Branch watershed had 100% of their data points above the threshold. The White River-Muncie Creek watershed and the White River-Buck Creek (lower) watershed were both in the range of 65% failing readings. The remaining two watersheds, White River-Truitt Ditch and White River-York Prairie Creek had approximately 35% of the values above the threshold. The E. coli reading in this area should be considered as a significant sign of contamination."

Organics

"In the data tables for the types of organic material tested, very few had measured values above the detectable limits. The only chemicals addressed are those that had results above the detectable value."

Metals | IDEM Data

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Antimony
"The IDEM standard is 0.146 mg/L for surface waters. 50% of the measured values were below the detectable value. The highest reading from the fixed monitoring station was 0.011 mg/L in the White River-Buck Creek (lower) watershed. The highest measured value is still below the standard. There is no reason to be concerned with the concentration of this metal."

Arsenic
"Arsenic can cause a variety of problems for human health. It is a known carcinogen and a mutagen. In milder forms it can cause fatigue and dermatitis. The EPA standard is 0.05 mg/L for surface waters. The measured values for Muncie's watersheds are very low for this parameter. The highest value was 0.014 mg/L in Jakes Creek-Eagle Branch watershed. There is no reason to be concerned with the concentration of this metal."

Beryllium
"The EPA standard for domestic water supply is 0.004 mg/L. 93% of the measured values for Muncie's watersheds were less than the detectable value of 0.002mg/L. Therefore, this parameter is insignificant. There is no reason to be concerned with the concentration of this metal."

Cadmium
"Cadmium will concentrate long-term in the liver, kidneys, pancreas, and thyroid. It has also been suspected of causing hypertension. The IDEM standard is 0.01 mg/L for surface waters. 93% of the measured values for Muncie's watersheds were less than the detectable value. There is no reason to be concerned with the concentration of this metal."

Calcium
"Calcium can contribute to blue-green algae growth. There are currently no standards fro calcium from the EPA or IDEM."

Chromium
"Long-term excessive exposure to chromium can cause skin irritation and kidney damage. The IDEM standard is 0.47 mg/L for surface waters. More than 93% of the measured values were below detectable values. There is no reason to be concerned with the concentration of this metal."

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Copper
"Copper in surface water will act as a corrosive agent. The EPA standard is 0.028 mg/L for surface waters. In the Muncie area, 63% of the data points were below the detectable value, yet there were 3 out of the 296 results that were above the threshold. Two points were in the White River-Truitt Ditch watershed and one was in the White River-Buck Creek (lower) watershed. A few points above the threshold over an eleven-year period are not detrimental. For Yorktown, 30% of the data points were below the detectable value, yet there was 1 out of the 144 results that was above the threshold. That point was in the White River-Buck Creek (lower) watershed. One point above the threshold over an eleven-year period is not detrimental. There is no reason to be concerned with the concentration of this metal."

Iron
"Iron in large quantities can cause staining of clothes, boats, etc. It may also contribute to the growth of Crenothrix, autotrophic bacteria. The EPA standard is 0.3 mg/L for surface waters. The data in this watershed were significantly higher than the threshold for the material. Only two watersheds had significant data on this parameter and some of the points were extremely high. The White River-Truitt Ditch watershed had 48% of the data above the threshold and the White River-Buck Creek (lower) watershed had 36% of the data above the threshold value. This metal is found in too high of concentrations and should be investigated. The extreme levels found in this area could be due to a high clay or inorganic content in the soil."

Lead
"Lead can cause long-term brain and kidney damage as well as birth defects if consumed in large quantities. The EPA standard is 0.011 mg/L for surface waters. 83% of Muncie's data was below a detectable value of 0.006 mg/L. However, there were still seven points above the threshold. Five of the points were in the White River-Buck Creek (lower) watershed and the remaining points were in the White River-Truitt Ditch watershed. Over an eleven-year period, seven measured values above the threshold is not detrimental, but should be watched. The concentration of this material is not a major concern, however, it should be closely monitored."

Magnesium
"There are currently no standards fro Magnesium from the EPA or IDEM."

Thallium
"The IDEM standard is 0.048 mg/L for surface waters. Muncie's watershed data was under detectable values. There is no reason to be concerned with the concentration of this metal."

Pesticides | IDEM Data

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 9

The following has been compiled by GRW Engineers as an explanation of the water quality report assembled for the NPDES (National Pollutant Discharge Elimination System) Phase II as it pertains to storm water quality for the Buck Creek-Macedonia Creek watershed, the Jakes Creek-Eagle Branch watershed, the White River-Truitt Ditch watershed, the White River-Buck Creek (lower) watershed, the White River-Muncie Creek watershed and the White River-York Prairie Creek watershed in the Muncie area. The following will describe characteristic of the sampling data as it related to pesticides. It will also provide a comparison of the data versus the standard limits.

Pesticides
The only chemicals addressed are those that had results above the detectable value:

Acetochlor
"Acetochlor has been classified as a probable human carcinogen. It is a herbicide developed by Monsanto Company and Zeneca. There is not a standard for this material. The majority of the data were below the detectable value. Only 19% were above the detectable value, and those values ranged from 0.1-0.8 micrograms per liter. There is no reason to be concerned with the concentration of this chemical."

Alachlor
"The United States Environmental Protection Agency classifies the herbicide as toxicity class III - slightly toxic. It is commonly used for annual grasses and broadleaf weeds in corn and soybean fields. The EPA standard limit for this material is 2 micrograms per liter. The majority of the results stated less than the detectable value, and all the reading were below the standard. If this chemical is found in excessive quantities, it can cause skin and eye irritation and some long-term kidney problems. There is no reason to be concerned with the concentration of this chemical."

Atrazine
"Its use is controversial due to widespread contamination in drinking water and its associations with birth defects and menstrual problems when consumed by humans at concentrations below government standards. Atrazine is used to stop pre- and post-emergence broadleaf and grassy weeds in major crops. The EPA standard for this material is 3.0 micrograms per liter. The majority of the data were below the detectable value. Only 8% of the test results were above the standard, and those values ranged from 3.1-10.0 micrograms per liter. These points were taken from the data in the Buck Creek-Macedonia Creek watershed and the White River Buck Creek (lower) watershed. There is no reason to be concerned with the concentration of this chemical."

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Bromacil
"Bromacil is a commercially available herbicide that is also used as rat poison. The EPA standard limit for this material is 5 mg/L. The majority of the results were less than the detectable value, and all the readings were below the standard. If this chemical is found in excessive quantities, it can cause skin and eye irritation. There is no reason to be concerned with the concentration of this chemical."

Metolachlor
"Evidence of the bioaccumulation of metolachlor in edible species of fish as well as its adverse effect on the growth and development raise concerns on its effects on human health. It is an herbicide commonly used for broadleaf weed control in corn. There is not a standard for this material. The majority of the data were below the detectable value. Only a few were above that, and those values ranged from 0.1-2.7 micrograms per liter. This data is inconclusive."

Metribuzin
"Metribuzin is slightly to moderately toxic to humans by oral, skin or inhalation routes of exposure. It is an herbicide which inhibits photosynthesis. There is not a standard for this material. The majority of the data were below the detectable value. Only a few were above that, and those values ranged from 0.1-0.5 micrograms per liter. This data is inconclusive."

Simazine
"If simazine is found in excessive quantities, it can harmful to the livestock that use the stream for nourishment. The EPA standard limit for this material is 4 micrograms per liter. The majority of the results were less than the detectable value, and all the readings were below the standard. There is no reason to be concerned with the concentration of this chemical."

TABLE 2.47: Chemical Applications for Corn and Soybeans in Delaware County

Corn: Agricultural Chemical Applications *	
	lbs/acre/application
Acetochlor	1.823
Atrazine	1.094
S-Metolachlor	1.234
Simazine	1.236
Soybean: Agricultural Chemical Applications,	
Metribuzin	0.253

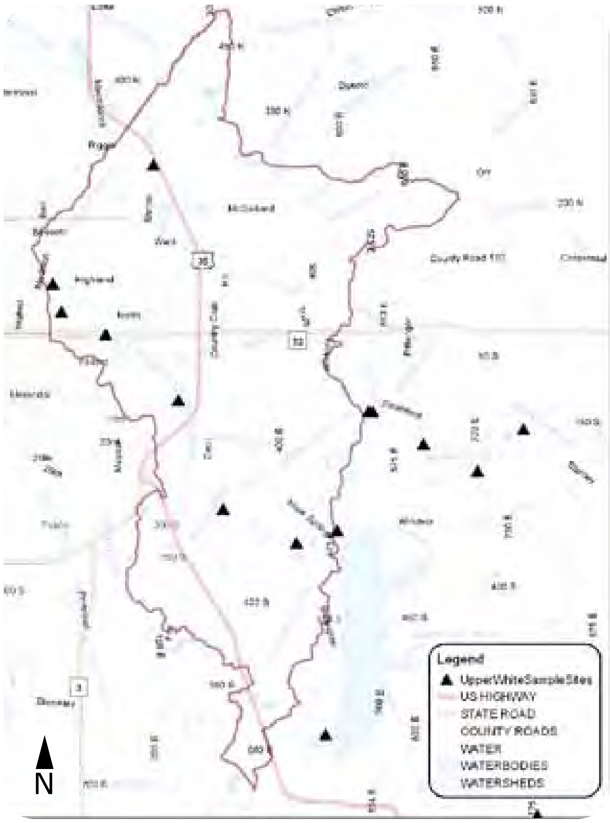
SOURCE: USDA 2004

INVENTORY

GRW Engineers Study | IDEM Data

The GRW Study was consistent with IDEM conclusions that E. Coli is the leading cause of water quality impairment in the Truitt Ditch-White River watershed and the Hamilton Ditch - Muncie Creek watershed.

The report also determined that Dissolved Oxygen, BODs, Cyanide, TSS, Pheonilics, Copper, Lead, and Iron were contaminates that exceeded water quality standards at various sampling times but did not indicate that they were issues of concern when averaged.



MAP. 2.64 IDEM Sampling Sites

TABLE 2.48: Summary of GRW Study	Dissolved Oxygen	pH	Saturation Percent	Specific Conductance	Turbidity	Temperature	Alkalinity	Chlorides	Biochemical Oxygen Demand	Fluoride	Coliforms	Cyanide	E. Coli	Hardness	Nitrogen	Sufates	
Hamilton Ditch - Muncie Creek													X				
Truitt Ditch - White River	X								X			X	X				

MAP 2.64 designates the locations of IDEM sampling sites in Truitt Ditch-White River watershed and the Hamilton Ditch - Muncie Creek watershed. Table 2.48 Notes impairments exceeding state Water Quality Standards.

	Phosphorus	Surfactants	Total Organic Carbon	Total Suspended Solids	Total Organic Carbon	Organics	Phenolics	Pyrene	Antimony	Arsenic	Beryllium	Cadmium	Calcium	Chromium	Copper	Iron	Lead	Magnesum	Thallium	Acetochlor	Alachlor	Atrazine	Bromacil	Metolachlor	Metribuzin	Simazine
				X			X								X	X	X									

Point Sources Overview
WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 11

Point source pollution is contamination that enters the environment through any discernible, confined, and discrete conveyance, such as a smokestack, pipe, ditch, tunnel, or conduit. Point source pollution remains a major cause of pollution to both air and water. Point sources are differentiated from non-point sources, which are those that spread out over a large area and have no specific outlet or discharge point. Point source pollution in the United States is regulated by the Environmental Protection Agency (EPA).[1]

"Point source pollution in Indiana is controlled primarily through permits issued by IDEM for discharges to surface water under the NPDES program. Locally, the Muncie Sanitary and Bureau of Water Quality enforces discharge permits as well as additional regulations such as storm water permits and pre-treatment permits. Additional sources of reports/information used to determine our water quality program/ overview include Muncie's Long Term Control Plan for separation of storm water and sewage systems, and contaminants of emerging concern report.

Discharge Permits

The NPDES is a state program issuing permits to regulate industrial waste and discharge into our water bodies. Certain scales of industry are given permits to discharge, but have to conform to state standards and often times have to pretreated the discharge before it enters into our water bodies. All facilities which discharge to waters of the State must apply for and receive a NPDES permit. Unpermitted dischargers and permittees out of compliance with their permit conditions are referred to IDEM's Office of Enforcement for corrective actions, which can include fines."[2] One industrial permit was issued in the studied Subwatersheds and it is located in Hamilton Ditch- Muncie Creek. This site has had zero noncompliance issues during the WMP development period.

Pre-treatment Permits

"n order to reduce untreated discharges to Indiana's surface waters, industrial wastewater pretreatment permits are issued to industries that discharge to municipal wastewater treatment plants and industries that were delegated to operate their own pretreatment programs. NPDES staff oversees and audits municipal pretreatment programs in 45 municipalities with industrial dischargers.

Point Sources of Emerging Concern

"The Muncie Bureau of Water Quality included a study of contaminants of emerging concerns, in their 2010 annual report. Medications, pharmaceuticals, etc. that are improperly disposed make their way to the WPCF or into our rivers during CSO events. Muncie Bureau of Water Quality sampling at the WPCF and White River indicate that while these contaminants are detectable, they are currently not a levels that are to be of concern. There are no formal studies planned by the Muncie Bureau of Water Quality on these contaminates due to their low level in out waters. The public at large can often times misperceive the data and can become more concerned about the presence of these contaminants than the scientists at the Muncie Bureau of Water Quality."[3]

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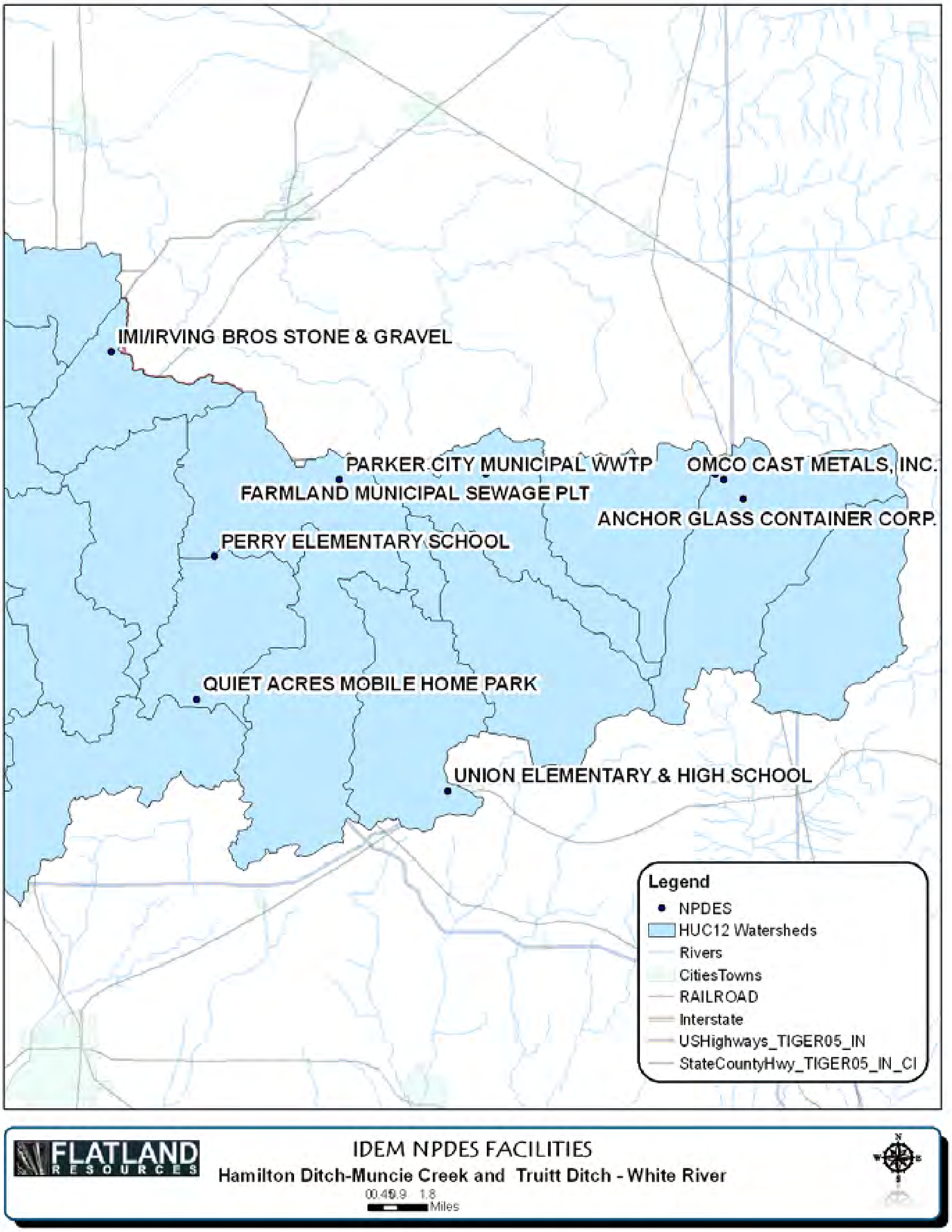
1 Pollutionissues.com
2 BWQ Annual Pretreatment Report
3 BWQ Annual Pretreatment Report



MAP.2.65 Point Source Discharge Permits in Muncie Creek HUC10 Watershed

INVENTORY

Point Source: Discharge Permits

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 12

The stability of White River is due in large part to the strict permitting efforts of point source outfalls through the National Pollutant Discharge Elimination Systems. Discharges of toxic pollutants is controlled through permit limits for specific chemicals and by whole effluent toxicity limits.

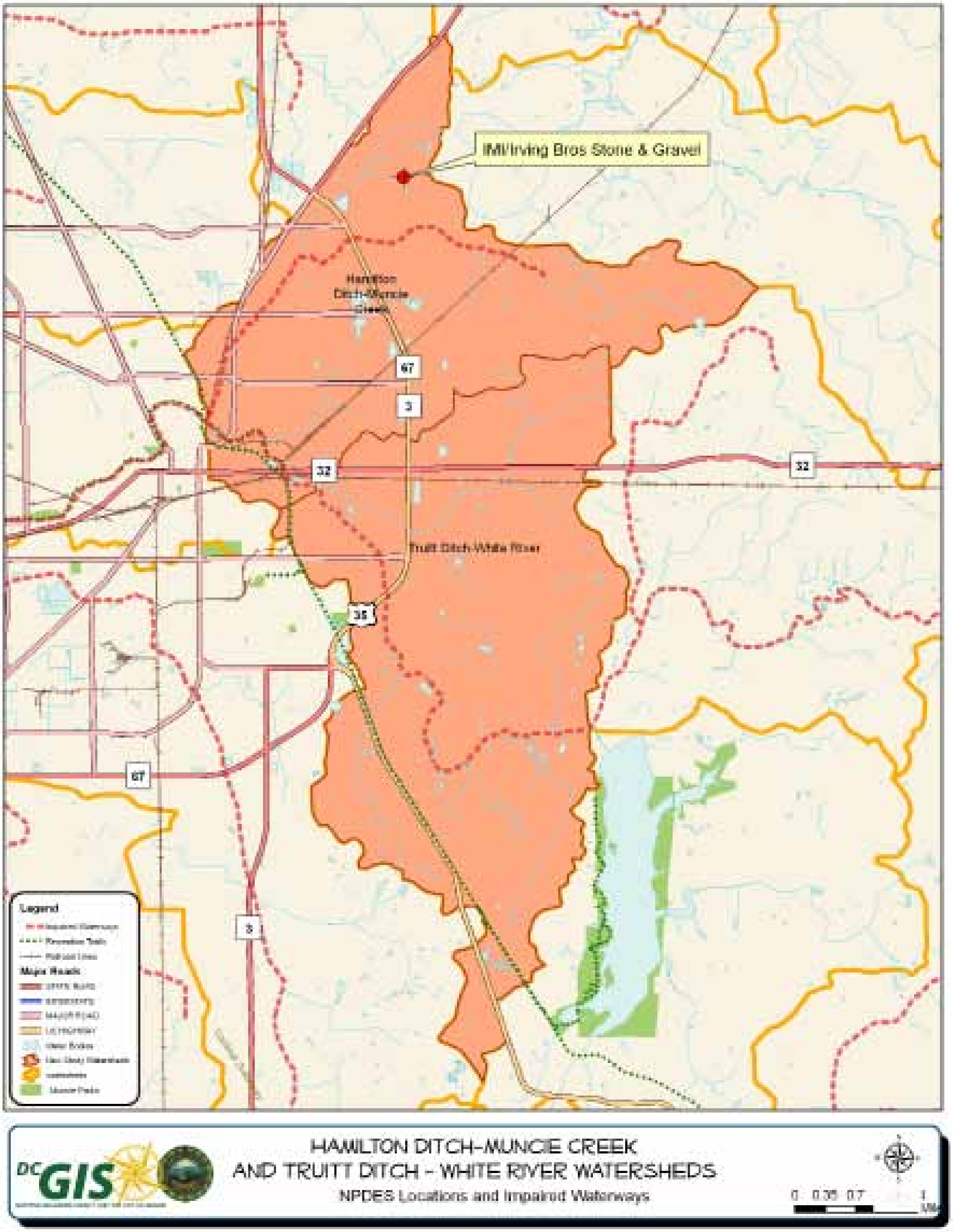
Several facilities which treat wastewater and are permitted to discharge the treated effluent are located within the Muncie Creek HUC 10 watershed and have impacts on the incoming water quality to Hamilton Ditch - Muncie Creek and Truitt Ditch - White River. However, there are no NPDES facilities in the Truitt Ditch-White River watershed and only one facility within the Hamilton Ditch-Muncie Creek watershed (MAP 2.66). The site is a quarry that discharges waste water polluted with the leavings from mining limestone. These pollutants can affect sediment levels and pH. Below is information submitted to the USEPA about the facility and its discharge.[1]

Facility Name: Irving Stone and Gravel Division of IMI
Address: 4312 East County Road 350 North, Muncie, IN 47303
County: Delaware
NPDES: ING490028
Permit Issued Date: JUL-15-2005
Permit Expired Date: JAN-31-2011
SIC Code: 1422 Crushed and Broken Limestone
List of Permitted Discharges

IDEM's NPDES permits are the cornerstone of the point source control program. IDEM actively works to stay in contact with permittees through the inspection program and the permit renewal process. The various permits issued through IDEM's NPDES program are intended to reduce untreated discharges to Indiana surface waters and to ensure that treated discharges do not cause or contribute to impairment of Indiana's surface water resources. [2]

TABLE 2.49: Location of Permitted Point Source Discharge Facility			
IND016541096	IMI/MUNCIE	DELAWARE	W FK WHITE R VIA MUNCIE CR VIA DR.
SOURCE: ArcGIS Indianamap.org			

1 Tom Reeve, White River Watershed Project
2 Indiana Integrated Water Monitoring and Assessment Report



MAP.2.66 Point Source Discharge Permits in Muncie Creek /Truitt Ditch Subwatershed

INVENTORY

Point Source: Pre-treatment Program

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 13

"The BWQ's pretreatment program has been federally mandated through the United States Environmental Protection Agency (EPA) and the Indiana Department of Environmental Management (IDEM) to ensure the safe and effective operation of the Muncie Water Pollution Control Facility (MWPCF) and to protect the quality of the facility's receiving stream. Publicly owned treatment works are designed to remove contaminants and harmful organisms commonly associated with residential wastewater; however, many facilities including the MWPCF also service local industries whose wastewaters may contain uniquely toxic compounds capable of interfering with, passing through, or accumulating in the sewage sludge of the treatment facility. Through the pretreatment program, the Muncie Bureau of Water Quality serves as the Control Authority responsible for ensuring that local industries comply with the regulatory requirements of the EPA, IDEM, and Muncie's local Pretreatment Ordinance." [3]

Major responsibilities of the program include:
"(1) permitting industries (2) sampling and analyzing industrial wastewater (3) requiring industries to self-monitor their wastewaters (4) requiring industries to implement spill response plans and pollution prevention (P2) management plans (5) sampling and analyzing the MWPCF's influent, effluent, and biosolids (6) sampling and analyzing the MWPCF's receiving stream (7) Industrial compliance is maintained nearly entirely through cooperation; however, the Bureau has the authority to issue enforcement actions including administrative orders, fines."[4]

"Before the Clean Water Act gave municipalities the legal authority to require pretreatment standards, the Muncie Bureau of Water Quality was already working with local industries to maintain voluntary compliance with its pretreatment standards. Both the City of Muncie and its industries have invested greatly in their pretreatment programs. The industrial community has spent approximately $14.5 million dollars within the Muncie Sanitary District for pretreatment equipment from the time the Muncie Bureau of Water Quality was established in 1972 through 2010. Of the BWQ's $1 million annual budget, approximately 80% is allocated specifically for the industrial pretreatment program. The Muncie Bureau of Water Quality maintains a Pretreatment Coordinator, a Chemistry Section for laboratory analyses, a surveillance Section for collection of water samples, and a Biological Section for assessing the health of aquatic life, each with specific roles related to the pretreatment program."

"Even as early in its history as 1982, when many cities were just beginning to establish their own pretreatment programs, the Muncie Bureau of Water Quality was already seeing measurable improvements in the quality of wastewater being collected and discharged by the MWPCF. Some of the changes could only be seen through chemical analyses; the reduction in metal concentrations reaching the MWPCF equates to removing as much as 63 tons of metal every year."[5]

"Some of the changes could be seen in the biology. Since the BWQ's first biological assessments over thirty years ago, the number of fish in White River downstream of the MWPCF has doubled, and sensitive species like the smallmouth bass, longear sunfish, and many freshwater mussels have returned. Some of the changes were easily visible to the naked eye; the White River, which once ran orange and whose stream bottom was once nothing but sludge, is now clear and its substrate once again contains a healthy mixture of gravel and cobble."[6]

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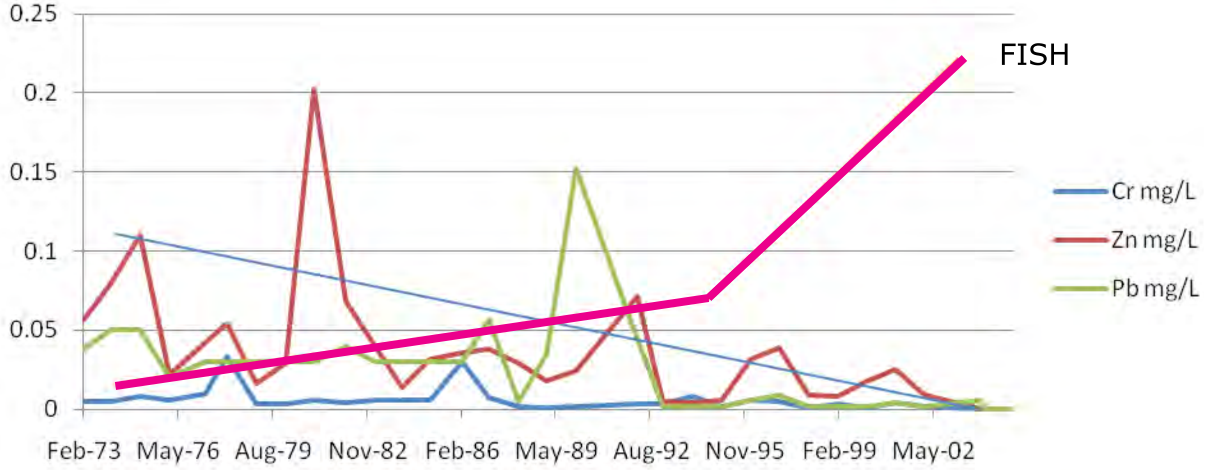
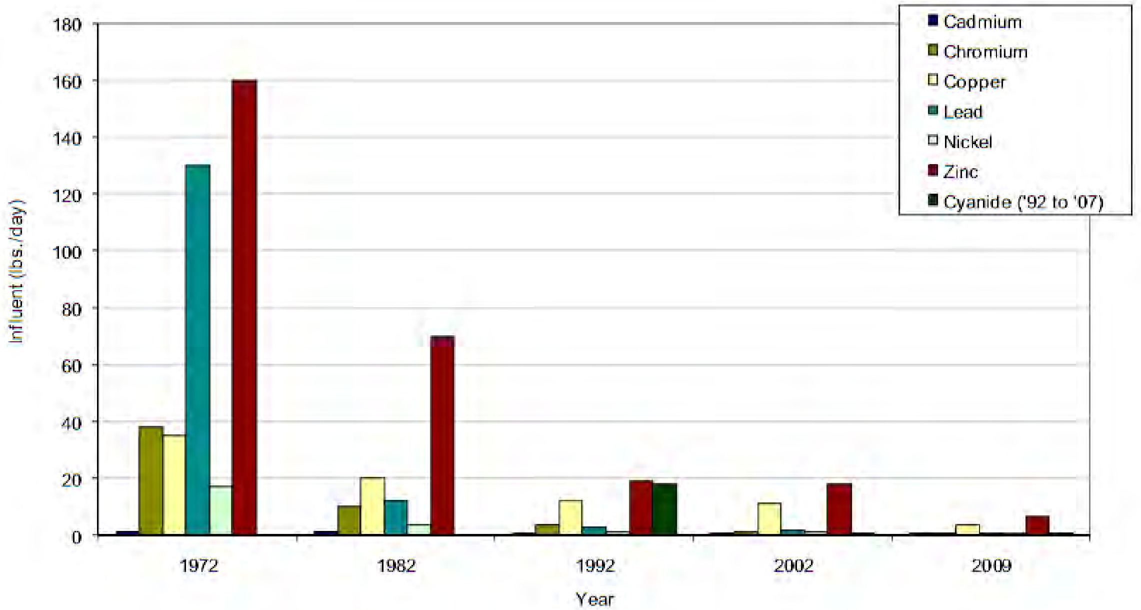
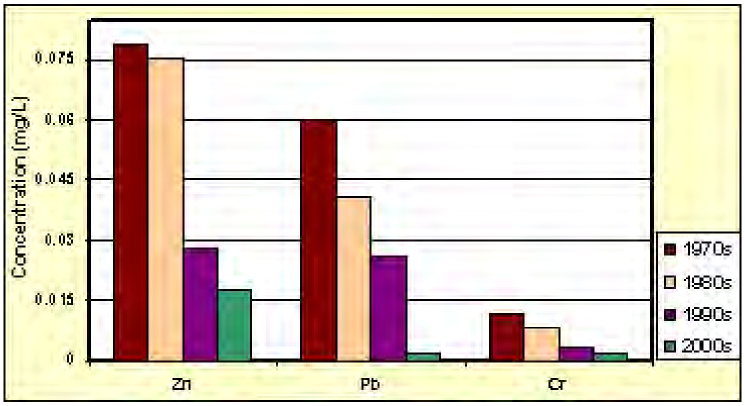
3 BWQ Annual Pretreatment Report
4 BWQ Annual Pretreatment Report
5 BWQ Annual Pretreatment Report
6 BWQ Annual Pretreatment Report



CHA. 2.23 Response of Fish to metals reduction (pink trendline_



CHA. 2.24 Historic Heavy Metals data



CHA. 2.25 Historic Heavy Metals data

Through Industrial Pre-treatment Program the White River has shown extensive reductions in pollutants. Chart 2.23 and 2.24 display changes that have taken place as measured just downstream from Muncie. Zinc (Zn) concentrations have been reduced 77% from the 1970s , while lead (Pb) and chromium (Cr) have seen a 97% and 83% reduction, respectively.

INVENTORY

Point Source: Metals
WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 14

"One means of demonstrating the overall effectiveness of Muncie's Pretreatment Program is to graphically present data associated with industrially related parameters in the Muncie Water Pollution Control Facility's (MWPCF) Influent, Effluent and Biosolids. A major portion of the wastewater entering the MWPCF from our industrial base is from metal finishing processes. Muncie has plating firms, zinc coaters, phosphate coaters, automotive transmission plants, a secondary lead smelter, heat treat operations, hammer shops, tool and die operations and others. For the purposes of comparison, the Bureau uses the Method Detection Limit or Level of Detection (MDL or LOD) as the basis for reporting results at the low end of the analytical curve."[1]

"An example of this would be requiring industries to replace chromium as an anticorrosive agent in cooling towers with a less toxic chemical. The overall effectiveness of a Pretreatment Program can be evaluated by determining the reduction in the regulated parameters from year to year. (Chart 2.26, 2.27) One can see substantial reductions have taken place in the MWPCF Influent, Effluent and Biosolids." [2] (Chart 2.28)

"The graphs for the Influent and Effluent have units of pounds per day. Being directly related to flow measurements, pounds per day allows for a direct yearly comparison even though the flow at the MWPCF fluctuates from year to year. Using pounds per day, the BWQ can document the actual decrease in loadings to the MWPCF and West Fork White River. Biosolids concentrations are graphed using mg/Kg dry weight. Graphing dry weight concentrations for the Biosolids eliminates the percent moisture variable in the biosolid samples."[3]

"Following the creation of the Bureau of Water Quality in 1972, the amount of toxic metals entering the MWPCF has been reduced as a result of the Pretreatment Program by an average of approximately 133,000 pounds (66.5 tons) annually."[4]

1 BWQ Annual Pretreatment Report
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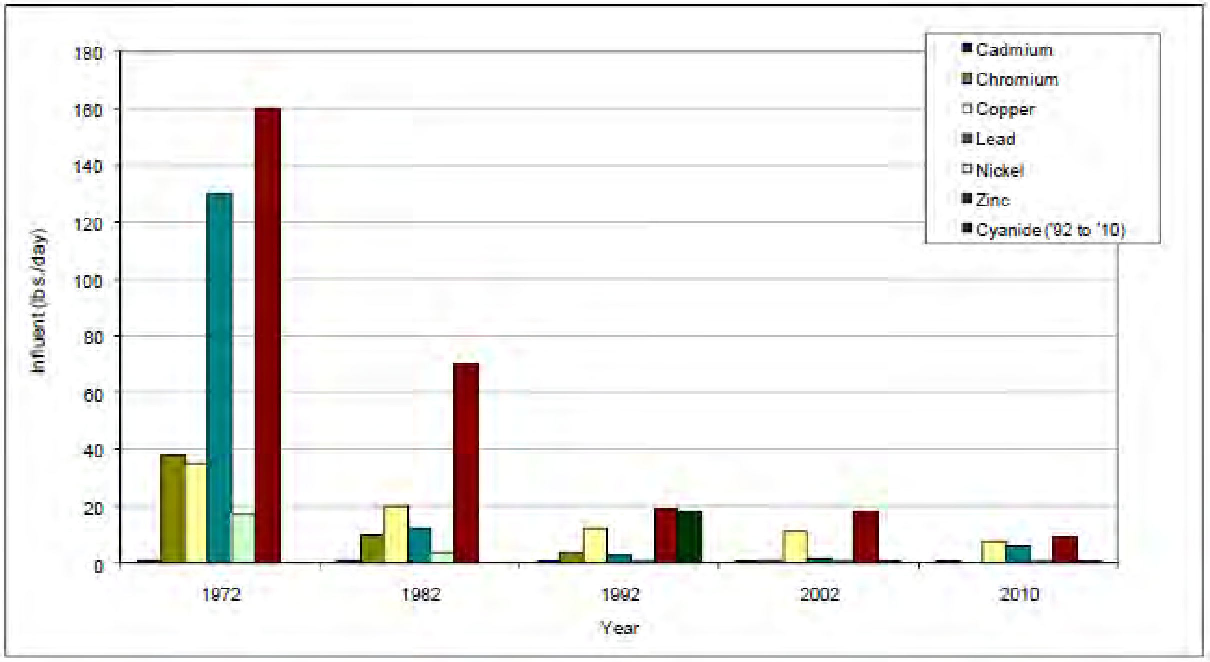
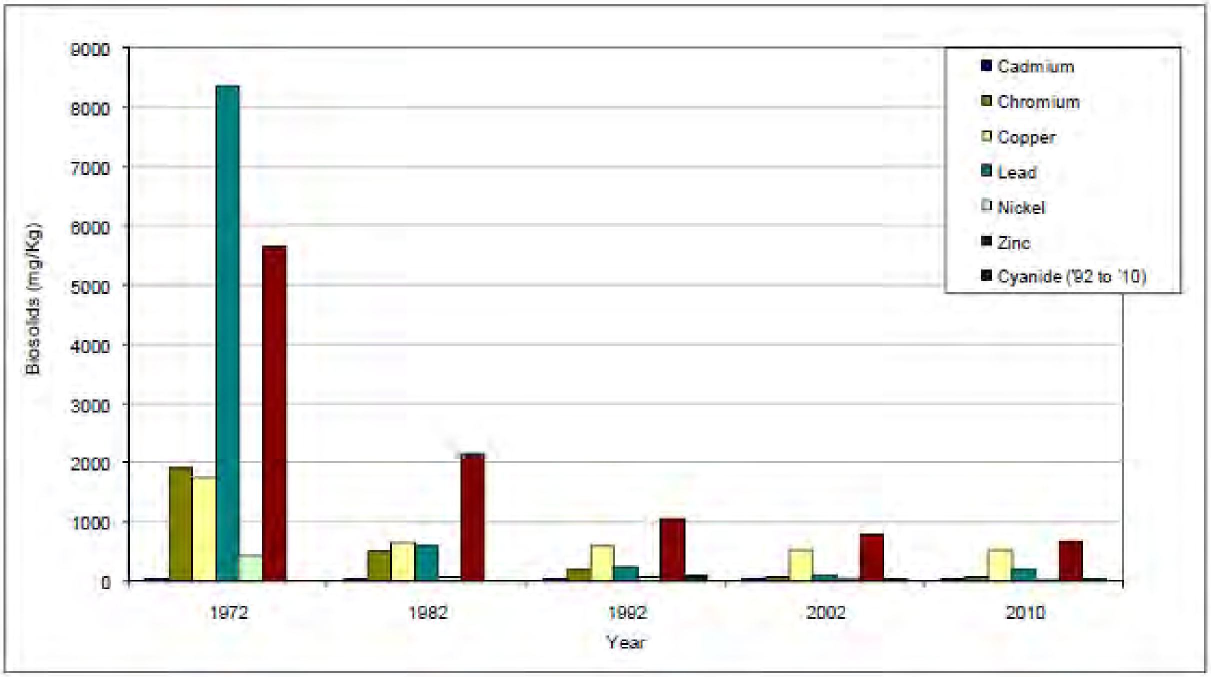


CHA. 2.26 Heavy Metals in Influent



CHA. 2.27 Heavy Metals in Biosoilds

Point Source: Toxic Organics

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 15

Toxic Organic Pollutant Monitoring

As part of the monitoring requirements detailed by the BWQs NPDES permit, the BWQ conducts an annual scan for organic pollutants in the influent, effluent, and biosolids of the pollution control facility.

Though the pollution control facility is not specifically designed to remove organic compounds, removal efficiencies appear to be relatively high as most of the compounds found in the influent are absent from the effluent.

The BWQ has long recognized the potential threat posed by organic pollutants and has continued to surpass the minimum monitoring required by law. This includes annual monitoring of a handful of industries, selected on a rotating basis, to ensure they are effectively prohibiting the discharge of these toxic organics into wastestreams. Periodic sampling of storm water run-off, including run-off from large parking lots, are also included as these are each sources of organic compounds found in the wastewater treatment plant.[1]

"Finally, samples from the White River are also included in annual organic compound scans to estimate the influence on the receiving stream and to help locate potential sources."[2]

"Commonly detected compounds include chloroform and bromodichloromethane, which are byproducts of the chlorination of tap water. In most cases, the concentrations of compounds were below detection limits, but those few that were detected were extremely low in concentration (in the microgram per Liter range)."[3]

1 BWQ Annual Pretreatment Report
2 BWQ Annual Pretreatment Report
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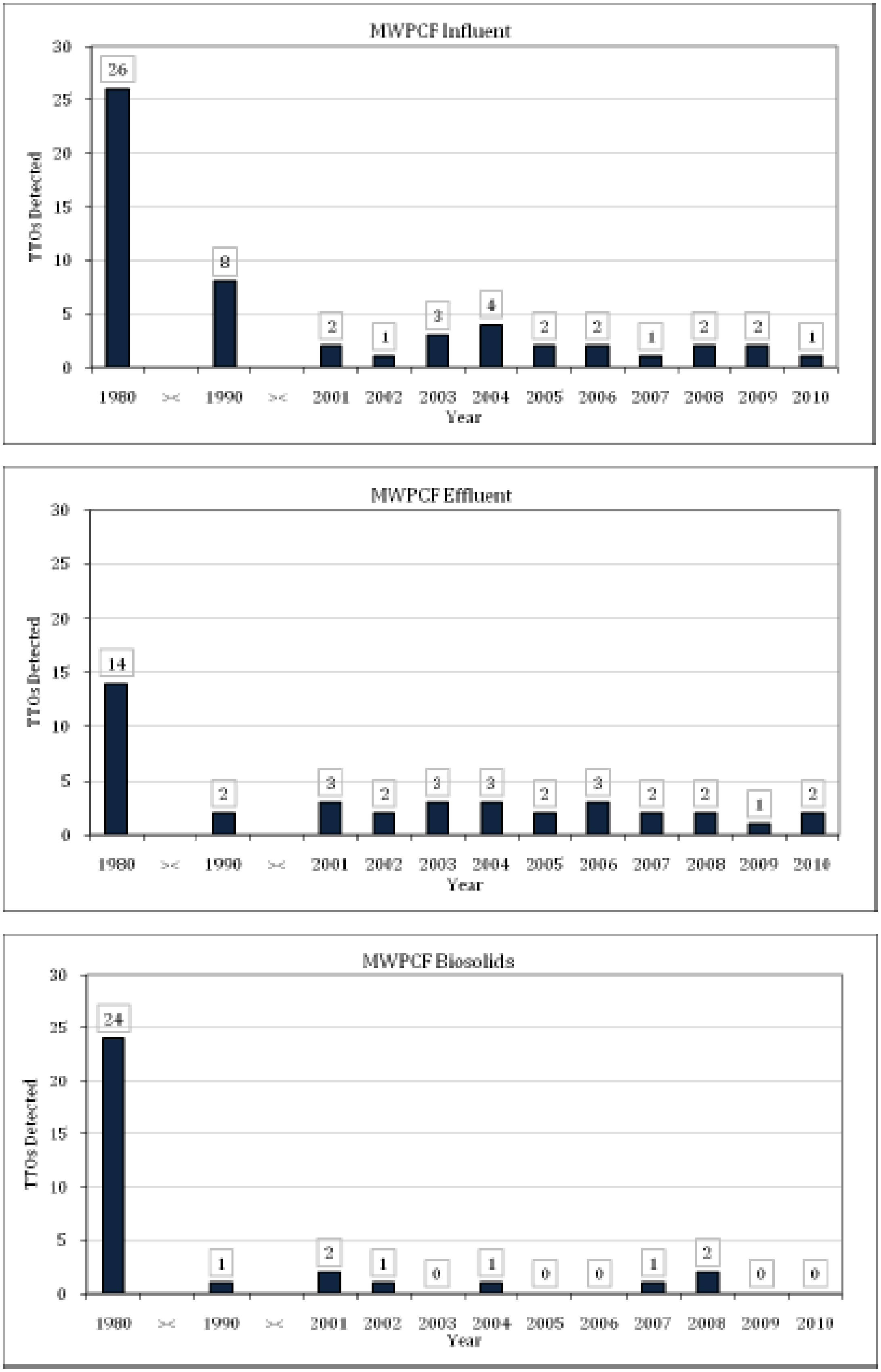

CHA. 2.28 Toxic Organic Pollutants in Influent, Effulent and Biosolids at WPCF

Point Source: Contaminants of Emerging Concern

WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 16

"Public concern regarding endocrine disrupting compounds, specifically those related to pharmaceutical and personal care products, has piqued in recent years. In response, the BWQ has implemented a limited monitoring program aimed at identifying the presence of these substances in local wastewaters and waterways. Table 2.50 lists the compounds which were investigated as well as their concentrations in Muncie's wastewater treatment plant and in the White River throughout Muncie."[1]

"Relatively high concentrations of acetaminophen, caffeine, and ibuprofen were detected in the wastewater influent. However, in spite of the fact that the treatment plant is not specifically designed to remove these types of wastes, the removal efficiency appears remarkably high for those compounds which were more concentrated in the wastewater than they were in the river."[2]

"The small number of samples taken prevents any detailed statistical analysis of loading or removal efficiencies; however, more rigorous sampling seems unwarranted at this time for three main reasons.[3]

(1) These tests are extremely expensive. Analysis of pharmaceuticals requires specialized equipment to detect such small concentrations, and it quickly becomes cost prohibitive to conduct as many samples as would be necessary to illustrate the nuanced variability that we are frequently able to describe with the more conventional pollutants such as ammonia and metals.

(2) The BWQ can already reasonably estimate the presence and concentrations of pharmaceuticals in and around Muncie based on research conducted elsewhere in the country simply based on Muncie's population.

(3) The demonstrated threat from exposure to pharmaceuticals appears to be extremely low. As an example, for someone to consume the equivalent of a one-time dose of Tylenol, he or she would have to drink 300 gallons of water directly from the river every day for the rest of his or her life. Some of the communities in this area do rely upon the White River as a drinking water source, but only following additional treatment. Additional treatment has been shown to further reduce the concentrations of these chemicals.[4]

To be clear, it is not the BWQ's contention that this subject is not important. With so much left unknown about these compounds and their possible interactions in the environment, the BWQ is merely suggesting that efforts be focused less on re-reporting numbers which have very little meaning to the public other than to incite worry.

With this in mind, the Muncie Sanitary District has decided to focus its efforts in two general directions.

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(1) Investigating the possible responses of aquatic organisms in the environment.[5] Specifically, the BWQ is working to develop a more practical detection method that is sensitive to a wider array of endocrine disrupting compounds, and one that will simultaneously demonstrate an impact on the environment (as opposed to simply demonstrating presence). The preliminary results of this work are promising. [6] Morphological measurements of a sentinel species of fish have shown small but detectable effects that have been correlated to the presence of estrogenic compounds.

(2) An acknowledgment that the concentrations of these compounds could be reduced, and that there was no reason to wait and see if any of these compounds is someday proven to be harmful to humans or the environment before taking action to reduce their presence in waterways. To this end, the Muncie Sanitary District has been sponsoring "drug drops" where residents can safely dispose of their unused medicines. The district has also developed educational programs directed at the public and local pharmacies to discourage flushing of unwanted medicines; the most controllable means of contamination of waterways."[7]

The White River Watershed Projects intends to follow the BWQ's lead and therefore will not investigate or implement strategies to reduce endocrine disrupting compounds independent of BWQ efforts.

all values in ng/L

Drug Name	Plant Influent	Plant Effluent	Percent Removal	White River Upstream of Muncie	White River Within Muncie	White River Downstream of Muncie	Buck Cr. Upstream of CSOs	Buck Cr. Downstream of CSOs
Acetominophen	39000	5.8	99.99%	4.2	5.4	6.5	41	26
Caffeine	26000	14	99.95%	29	48	54	52	78
Carbamazepine	110	150	0%	1.4	1.6	9.3	1.7	1.7
Cotinine	1300	13	99.00%	4.3	5.1	8.3	5.9	6.5
DEET	1400	150	89.29%	*24	24	33	*24	*24
Ibuprofen	3400	2.7	99.92%	3.1	*1.1	*1.1	13	6.3
Lincomycin	*1.0	*1.0	-	1.1	1.2	1	*1.0	*1.0
Sulfadimethoxine	*1.1	*1.1	-	*1.1	*1.1	*1.1	*1.1	*1.1
Sulfamethazine	*1.1	*1.1	-	*1.1	*1.1	*1.1	*1.1	*1.1
Sulfamethoxazole	810	9.8	98.79%	4.7	5.7	7.1	2.1	2.3
Sulfathiazole	*1.0	*1.0	-	*1.0	*1.0	*1.0	*1.0	*1.0
Triclosan	*4.8	*4.8	-	*4.8	*4.8	*4.8	*4.8	9.2
Trimethoprim	170	*6.6	-	*1.0	*1.1	*1.2	*1.0	1.7
Tylosin	1.8	1.3	27.78%	*1.1	*1.0	*1.0	*1.0	*1.0
Gemfibrozil	650	5.9	99.09%	2	*1.1	1.5	2.5	2.2
Diclofenac	42	*1.0	-	*1.0	*1.0	*1.0	*1.0	*1.0

** below detection limit*

SOURCE: Muncie Bureau of Water Quality

Summary of results of pharmaceutical sampling in the MWPCF and local streams via LCMSMS.

TABLE 2.50: Contaminates of Emerging Concern

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6 BWQ Annual Pretreatment Report
7 BWQ Annual Pretreatment Report

INVENTORY

Summary of Existing Data
WMP - CHAPTER 2 - PART 2 - SECTION 1 - SUBSECTION 17

While probabilistic monitoring has value at the macro scale (for determining the overall status of Indiana's waters), at the site specific scale it is incapable for determining site/reach impairments, or in quantifying necessary or needed reductions. The sporadic, inconsistent, and age of this data makes site scale WQ planning with IDEM data problematic.

Despite the wide number of sampling sites in the state of Indiana, and even for Delaware County, there is a inability for IDEM to sufficiently rate the sites based on the four primary desired use characteristics: recreational use, fishable uses, drinking water uses, and aquatic life uses. This is evidenced in the fact most of the streams in the WMP areas cannot be assessed with WQ metric to determine 305(b) ranking due to insufficient data (Category 3).

GRW Engineering looked at all IDEM WQ data collected from 2001-2006. Despite reporting on the conclusions from this data analysis, the incomplete data sets prohibits a sufficient comparative analysis of all streams and tributaries in the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds. GRW conclusions are therefore used with caution considering the difficulty of making definitive critical area decisions with the data (due to a lack of Subbasin information). Nonetheless, there are points of note for Dissolved Oxygen, Cynaide, E. Coli, TSS, Phenolics, and Copper.

E. coli is the only WQ impairment that is discovered to be a significant source of contamination in both sets of non point analysis. It is used as a metric for impaired recreational usage on the 305 (b) report, most of the streams on the 303(d) list (West Fork White River) are impaired for E. coli, and these same streams have been designated for the TMDL list. A TMDL is currently being developed for the West Fork White River East of the City of Muncie. WRWP 319 WQ studies (explained in subsequent sections) also confirmed that E. coli is the most pressing water quality impairment in Delaware County rivers and tributaries. The water quality parameters exceeding state water quality standards (according to IDEM data) is indicated in Table 2.51 in relationship to the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds.

Most of the point source studies done in conjunction with treatment identification/treatment programs are at the Muncie Water Pollution Control Facility. The WPCF is located downstream of Hamilton Ditch - Muncie Creek and Truitt Ditch-White River and there are over six Subwatersheds that have urban areas discharging to this system.

Combined sewer/storm water systems are prevalent in the sanitary district. Because both point and non-point sources are entering this sanitary line, it is difficult to discern which contaminants are coming from which source: residential, urban, storm water, etc. Furthermore, because there are no sampling points on the actual storm water network (for the purposes of isolating Hamilton Ditch - Muncie Creek and Truitt Ditch- White River) there is no capacity for separating out all of the Subwatersheds and discerning their relative contribution.

The BWQ's studies have shown a significant decrease in point source WQ pollutants over the last forty years in organic toxins, metals etc. The WRWP is confident that point source reductions will continue under the guidance of the BWQ because of these effective programs despite a lack of data specific to the Hamilton Ditch - Muncie Creek and Truitt Ditch - White River Subwatersheds. Therefore, point sources of pollution will not be addressed going forward in our WMP.

		Dissolved Oxygen	Biochemical Oxygen Demand	Flouride	Coliforms	Cyanide	E. Coli	Total Suspended Solids	Phenolics	Copper	Iron	Lead
Table 2.51 IDEM Impairment Summary												
Hamilton Ditch - Muncie Creek					X		X					
Truitt Ditch - White River		X	X		X	X	X	X	X	X	X	X

INVENTORY