LOWER FALL CREEK WATERSHED MANAGEMENT PLAN

Prepared For:

Marion County Soil & Water Conservation District
Lower Fall Creek Watershed Alliance

May 2009

Prepared By:

Christopher B. Burke Engineering, Ltd.
National City Center, Suite 1368-South
115 W Washington Street
Indianapolis, IN 46204

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EXECUTIVE SUMMARY

Christopher B. Burke Engineering, Inc. (CBBEL) was retained by the Marion County Soil & Water Conservation District (SWCD) to help lead the investigation, development, and drafting of the Watershed Management Plan (WMP) for the Lower Fall Creek Watershed. Interest in developing this WMP stems from historical water quality problems associated with the watershed. It is hoped that, through the implementation of this WMP, improved water quality conditions will be realized that will benefit all residents of the Lower Fall Creek Watershed.

The Lower Fall Creek Watershed drains approximately 57,800 acres (90 square miles) of rural, suburban, and urban land in Central Indiana. This land includes portions of Madison County, Hamilton County (City of Noblesville, Town of Fishers), Hancock County (Town of McCordsville), and Marion County (City of Indianapolis, City of Lawrence). The Lower Fall Creek Watershed consists of 6 14-digit Hydrologic Unit Code (HUC) watersheds. These include: 05120201110-010, 020, 030, 040, 050, and 060.

Chapter 1: Introduction describes the planning objective, process, and participation that are pertinent to watershed planning and management. The watershed planning effort began with the organization of a Steering Committee and Work Groups that assessed conditions in the watershed, examined water quality issues important to the community, and made decisions as to the direction and content of the plan.

Chapter 2: Watershed Overview provides details on the watershed as a whole, the land use and land use change, the relationship of groundwater and surface water, as well as a discussion on the impacts of flooding in the watershed.

Chapter 3: Water Quality Problems, Causes, & Sources examines and discusses information that describes the current water quality conditions. To help facilitate this planning effort, CBBEL researched and compiled information on past studies and analyzed trends to provide the Steering Committee with a comprehensive picture of water quality conditions in Lower Fall Creek. The Steering Committee determined that sediment, nutrients, and pathogens were to be the focus of this planning effort. Sources identified include:

- Tillage Practices
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- Streambank Erosion
- Fertilizer Application
- Inadequately Functioning Septic Systems
- Combined Sewer Overflows
- Illicit Connections to the Storm Sewer
- Wildlife and Background Levels
- Stormwater Runoff
- Livestock and Manure Management

In **Chapter 4: Critical Areas** general locations where pollutant sources may be addressed to help preserve and improve water quality conditions in the Lower Fall Creek Watershed were identified. These areas include:

- HEL & PHEL Classified Soils
- Indian Lake Watershed
- Eroded Streambanks
- Golf Courses

- Residential Lakes
- Non-Sewered Developments
- Livestock and Manure Management Areas
- Wellfield Protection Areas

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Additional input was sought from the public. Two public meetings were held to provide a forum and conduit for review and comment on the development of the WMP. Individuals that are interested in learning more about the project or obtaining a copy of the WMP can contact:

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1.0 WATERSHED PLANNING

A watershed is an area of land that collects and drains water to a specific point. Similar to water poured into a bowl, a portion of the precipitation that falls on a watershed will move through the landscape, collecting and concentrating in low areas, creeks, and streams, until it exits through an outlet point. A watershed is a measurable and practical landscape feature that is based on how water moves, interacts with, and behaves on the landscape. Watershed planning is especially important to preserve watershed functions, help prevent future water resource problems and ensure future economic, political, and environmental health. This section provides information on the funding, purpose, and stakeholders involved in the development of the Lower Fall Creek Watershed Management Plan.

1.1 BACKGROUND

In the fall of 2006, the Marion County Soil and Water Conservation District (SWCD) submitted a Section 319 Non Point Source Program grant application to the Indiana Department of Environmental Management (IDEM) to develop a Watershed Management Plan (WMP) for the Lower Fall Creek Watershed. The grant application was approved, and the SWCD received a grant in March of 2007. The tasks, timeline, and checklist for this project are in **Appendix 1**. The SWCD retained the professional services of Christopher B. Burke Engineering, Ltd. (CBBEL) to serve as the Watershed Coordinator for the development of the WMP. CBBEL assisted in the development, coordination, and facilitation of stakeholder discussions, the collection and analysis of water quality data, and is the primary author of the WMP.

1.2 PURPOSE

The purpose of this WMP is to gain a greater understanding of the water quality impairments in the Lower Fall Creek Watershed and engage the diverse stakeholders to identify and implement sustainable and local solutions.

The Marion County SWCD believes that a WMP is a guiding document that examines the historical and existing water resource issues in a particular watershed and presents specific actions to address those water resource issues based on the values and needs of the community. The SWCD hopes that the successful completion of the Lower Fall Creek WMP will serve as a benchmark for all future urban watershed efforts in the State of Indiana. Fall Creek is a highly recognizable recreational and drinking water supply resource which traverses a varied landscape socially, economically, and geographically.

1.3 STAKEHOLDER INVOLVEMENT

A WMP represents the efforts of the stakeholders, including water resource professionals, local government leaders, and interested citizens, to understand, analyze, and become an integral part of the solution to improve impaired water quality. In recognition of the social, physical, and economic diversity present in the Lower Fall Creek Watershed, a Steering Committee, work groups, workshops, public meetings, and educational materials were used to engage stakeholders and develop the WMP.

<u>Steering Committee</u>

The Lower Fall Creek WMP Steering Committee was made up of individuals representing municipalities, counties, economic development organizations, neighborhood associations, universities, and environmental groups; and was the primary committee utilized to guide the overall direction of the WMP. The Steering Committee (**Figure 1-1**) met on a quarterly basis from May of 2007 through January of 2009. **Table 1-1** identifies the Steering Committee members. **Appendix 2** includes Steering Committee meeting agendas and summaries.

Figure 1-1: Steering Committee

Other individuals that served as Steering Committee members during the development of this WMP include Lori Kaplan while serving Director of the City of Lawrence DPW, Christ Blassaras formerly with the Madison County SWCD, Angie Dye while employed with Veolia Water, and Kelly Wood while serving as the Neighborhood Liaison for the City of Indianapolis.

Table 1-1: Steering Committee

Name	Representing
Chris Barnett	Near North Development Corporation
Robert Barr	IUPUI – CEES
Cindy Newkirk	Hancock County SWCD
Carl Clark	Indianapolis Mayor's Office
Victoria Cluck	Indianapolis DPW
Josh Goode	IACT
Tina Jones	Indy Parks
Joe King	Dirty Dozen Hunting & Fishing Club
Ron Lauster	Marion County SWCD
Bob Masbaum	Indianapolis DPW
Brad Newman	Madison County Surveyor's Office
Donna Price	Indianapolis DMD
John South	Hamilton County SWCD
Pam Thevenow	Marion County Health Department
Kenton Ward	Hamilton County Surveyor
Gwen White	IDNR – LARE Program
Paul Whitmore	Veolia Water
Jerry Wilkey	Lawrence MS4 Coordinator

In addition to guiding the development of the WMP, the Steering Committee discussed the larger issues of 1) land use and land use change, 2) source water protection, and 3) flooding in the Lower Fall Creek Watershed. A summary of these discussions are below, and a detailed discussion in Section 2.0 of this WMP.

The first topic of interest, Land Use and Land Use Change, was discussed at the February 12, 2008 Steering Committee meeting. Using US Census data and aerial photography, CBBEL staff illustrated the dramatic growth and development that has occurred within the Lower Fall Creek Watershed in the last 50 years. Research on land use and development practices as sources of sediment, nutrients, and pathogens as well as the direct relationship between imperviousness and water quality was presented to the Steering Committee. To further illustrate this point the Land Use Central Indiana (LUCI) and the Long-Term Hydrologic Impact Analysis (L-THIA) were used in different growth scenarios. Members of the Steering Committee engaged in a fruitful discussion regarding the opportunities and challenges of land use planners and stormwater managers working together to develop watershed solutions to improve water quality.

The second topic of interest, the Relationship of Surface Water and Groundwater Quality, was discussed at the May 13, 2008 Steering Committee meeting. CBBEL staff presented research on the connectivity of groundwater and surface water, gaining and losing streams, and potential pollutant sources from land uses in Wellfield Protection Areas (WFPAs). Approximately 25% of the land in the Lower Fall Creek Watershed is within a WFPA. The Steering Committee discussed the implications of implementing stormwater quality management measures designed for sediment removal and filtration of pollutants in WFPAs. Chris Barnett with the Marion County Wellfield Education Corporation (MCWEC) also provided valuable insight to the potential impacts of contaminated groundwater as he serves on the Board for MCWEC.

The third topic of interest, Flooding and Flooding Impacts was discussed at the August 12, 2008 Steering Committee meeting. CBBEL staff provided an overview of notable historic flood events in the Lower Fall Creek Watershed and flood-related losses. Maintenance practices of regulated and non-regulated drains were discussed. Throughout the Lower Fall Creek Watershed, there are very good examples of floodplain management. These include: adopting compensatory storage/No Adverse Impact (NAI) language, participation in the Community Rating System (CRS), reactivating stream gages for flood warning, implementation of a Flood Preparedness/Response Plan, delineate floodplain on unstudied streams, implement 2-stage ditch design on regulated drains, and implementation of Low Impact Development (LID) techniques.

<u>Work Groups</u>

Three work groups were formed to focus on Public Education & Outreach, Land Use & Economic Development, and Water Quality in the Lower Fall Creek Watershed. Participation in the work groups was open to stakeholders with expertise or interest. The work groups met 3 to 4 times to assist with collecting and interpreting data; identify and prioritize Critical Areas; recommend programs, policies, and projects to improve water quality; and review and comment on the Lower Fall Creek WMP. Summaries from work group meetings are in Appendix 2. **Table 1-2, Table 1-3,** and **Table 1-4** lists the individuals invited to participate in each of the work groups. Not all the individuals listed were able to physically attend the meetings but were able to assist in the development of the Lower Fall Creek WMP via email, phone, or one-on-one meetings with the Marion County SWCD and CBBEL staff.

Table 1-2: Public Education & Outreach Work Group

Name	Representing
Lou Ann Baker	Veolia Water Company
Eric Becker	Lake Maxinhall
Cindy Newkirk	Hancock County SWCD
Bonnie Chastain	Windridge Development
Carl Clark	Indianapolis DMD - Neighborhoods
Dean Farr	Watershed Resident

Name	Representing
Tina Jones	Indy Parks
Joe King	Dirty Dozen Hunting and Fishing Club
Ron Lauster	Marion County SWCD
Mark McCauley	Hamilton County SWCD
Linda Prokopy	Purdue University
Mark Rumreich	Indian Lake HOA
Shaena Smith	Hamilton County SWCD
Karen Terrel	Indianapolis DMD - Neighborhoods
John Ulmer	Central Indiana Watershed Group
Gwen White	IDNR – LARE

Table 1-3: Land Use & Economic Development Work Group

Name	Representing
Chris Barnett	Near North Development Corporation
Tammy Bowman	Madison County Economic Development
Jerry Bridges	Madison County of Governments
Tom Crouch	Lawrence Economic Development
Kathy Davidson	Indianapolis Economic Development
Michael Hershman	Madison County Planning
Jennifer Janke	Fishers Development Department
Anna Jetmore-Vargas	Indianapolis DPW
Roger Johnson	Noblesville Planning Department
Kevin Kelly	Noblesville Economic Development
Chuck Kiphart	Hamilton County Plan Commission
Ron Lauster	Marion County SWCD
Dennis Malloy	Hancock County Economic Development
Mark Rumreich	Indian Lake
Dennis Slaughter	Indianapolis Planning Department
John South	Hamilton County SWCD
Gwen White	INDR – LARE
Christi Wolfe	Fishers Economic Development

Table 1-4: Water Quality Work Group

Name	Representing
Robert Barr	IUPUI – CEES
Fred Beyne	Mallard Lake Association
Dean Farr	Watershed Resident
Bill Guertal	USGS
Jim Hoskins	Indian Lake HOA
Joe Ketterman	Marion County Health Department
Ron Lauster	Marion County SWCD
Gary Rosenberg	Windridge Development
Andy Van Treese	Indian Lake HOA
Paul Werdertich	Indianapolis DPW
Gwen White	IDNR - LARE

<u>Public Meetings</u>

Public participation is essential to the long-term success of any watershed planning effort. Education and outreach efforts can effectively change the public's behaviors and attitudes toward water quality, improve local awareness of the relationship between land use and water quality, and demonstrate how day-to-day activities impact the quality of rivers and streams in the Lower Fall Creek Watershed.

Two Public Meetings were conducted (**Figure 1-2**). The purpose of the Public Meetings was to introduce Lower Fall Creek Watershed stakeholders to the planning process, solicit stakeholder participation in work groups, identify critical areas, recommend programs, policies, and projects to improve water quality, and build support for the long-term implementation of the Lower Fall Creek WMP.

Figure 1-2: Public Meeting

Both public meetings were advertised through a targeted direct mailing campaign to Neighborhood Associations in the Lower Fall Creek Watershed, and press releases were sent to local media outlets, the SWCD, and the Lower Fall Creek Watershed website. **Appendix 3** includes the materials distributed.

The first Public Meeting was held on July 24, 2007 at the City of Lawrence Government Center and was attended by 30 Lower Fall Creek Watershed stakeholders representing citizens, neighborhood groups, environmental groups, state and local government agencies. CBBEL staff provided an overview of the 319 grant program describing the need for a WMP, the Steering Committee, and the anticipated outcomes of the planning effort. An open discussion regarding the current status of the entire watershed was facilitated by CBBEL staff. Comments from the audience were recorded, discussed, and were later provided to the Steering Committee for further comment and discussion. Information was disseminated, which described the 3 work groups (Education & Outreach, Land Use & Economic Development, and Water Quality) along with the dates and locations for the initial meetings of each work group. Opportunities for collaboration were also discussed and many attendees provided contact information and discussed the ability to include updates in neighborhood newsletters and websites.

The second Public Meeting was held on January 15, 2009 at the City of Lawrence Government Center. Approximately 25 Lower Fall Creek Watershed stakeholders were in attendance as highlights from the draft WMP were presented. Information included an overview of the planning process, the education and outreach efforts throughout the development of the WMP as well as the proposed management measures developed by the work groups and the Steering Committee. Representatives from the Indian Lake Watershed as well as Windridge Condominiums were present to discuss their recent actions (detailed in later sections) to protect and enhance water quality. Both groups were also very interested in the continuation of efforts within the Lower Fall Creek Watershed. A representative from Purdue University was also present to provide a summary of the next steps of the Social Indicator Survey completed within the watershed. Due to a low response rate, a series of small focus groups will be held to obtain better insight and similar information as was sought with the mailed survey.

Workshops

While it is critical to engage citizens and stakeholders as a component of developing a WMP, it is equally as important to provide stakeholders with educational opportunities that extend beyond the conceptual boundaries of watershed planning. In recognition of this concept, 3 workshops were conducted. Each of these workshops was designed to target specific stakeholders in urban, suburban, or rural communities in the Lower Fall Creek Watershed. Brochures were prepared and distributed to advertise each workshop (Appendix 3).

The first workshop focused on assisting suburban lake and stream shoreline residents to develop a Management Plan for their property to reduce water quality impacts (**Figure 1-3**). This workshop was held in two sessions, the first on June 12, 2008 and the second on August 21, 2008. Both sessions were held at the Garrison at the Fort Benjamin Harrison State Park.

The first session, with approximately 30 people in attendance, featured presentations from Mark Mongin, SePro Corporation and Heather Buck, CBBEL. Mark's presentation provided the background information on what a watershed is, the importance of working on a watershed level, and examples of projects that representative lake communities in Indiana have completed to protect their shoreline, their homes, and the quality of their lake or pond.

Figure 1-3: Shoreline Stewards Workshop

A representative case study of a shoreline assessment was presented to the participants indicating important information that their assessments should include. During the assessment discussion, participants were able to ask questions and provide information related to their specific location and situation. The evening ended with final guidance on completing the blank assessment sheets for each participant. It is expected that during the August session, the individual assessments will be reviewed, and any further questions will be addressed.

The focus of the second session of the Shoreline Stewards workshop was several topic related round table discussions. Approximately 10 participants returned with draft shoreline management plans in hand and several questions for the round table discussions. Topics and discussion leaders for this portion of the workshop included:

- Plant pests and invasive species – Mark Mongin, SePro Corp.
- Nutrient Management and Water Quality Concerns – Matt Johnson, Aquatic Control, Inc
- Nuisance animal control – Shannon Winks, IDNR
- Shoreline and streambank stabilization – Matthew Kerkhof, Hoosier Aquatic Management and Simon Davies, JF NEW
- Backyard conservation and naturescaping techniques – Shaena Smith, Hamilton County SWCD and Ben Reinhart, Indiana Wildlife Federation
- Resources and information for land management – Glenn Lange, Marion County SWCD
- Resources and information for lake and stream management – Angela Sturdevant, Indiana Lake Management Society

Participants were encouraged to visit each topic table to address specific questions related to their shoreline, or to learn more about each of the topics.

The second Workshop focused on establishing backyard conservation practices at existing residential, commercial, and institutional properties in the urbanized portions of the watershed (**Figure 1-4**). With the focus of assisting urban watershed residents utilize their own backyards to make a difference in the water quality of Lower Fall Creek, a Backyard Conservation workshop was held on November 12, 2008 at the Broadway United Methodist Church. Jackie Nytes, Executive Director of the Mapleton Fall Creek Community Development Corporation, welcomed nearly 30 people to the evening's workshop. Following the welcome, Ron Lauster, Marion County SWCD, discussed the basics of a rain barrel and the benefits of rain barrels to homeowners and Lower Fall Creek. With a brief overview of rain barrel construction, groups of 5 participants joined together to design and construct a functioning rain barrel that was awarded to one of the group members at the end of the workshop.

Figure 1-4: Backyard Conservation Workshop

After construction of the rain barrels, Michele Conyer or Indy Parks, Environmental Education, provided participants with tips for attracting wildlife to their backyards while also deterring unwanted species. Ben Reinhart of the Indiana Wildlife Federation described the certification process by which homeowners can have their backyards declared a Backyard Wildlife Habitat. Brooke Klejnot of the Mapleton Fall Creek Community Development Corporation and Danielle Fluhr of Eden in Indianapolis also helped to coordinate the evening's events. Several local businesses assisted with the success of the workshop through donations of refreshments and additional supplies for the installation of the rain barrels. At the conclusion of the workshop, participants were given all the necessary supplies and a barrel to construct their own rain barrels.

The third Workshop focused on the rural issues pertaining to regulated and non-regulated drains, buffers for water quality, and maintenance procedures (**Figure 1-5**). The "Regulated Drains and Natural Waterways" workshop was held at the Lapel Public Library in Lapel, Indiana. Presentations included an overview of regulated drains by Kent Ward, Hamilton County Surveyor; log jams and permitting issues by George Bowman, IDNR Division of Water and Brad Baldwin, IDEM; funding opportunities through USDA by Henry Wallis, NRCS, District Conservationist, Boone and Marion Counties; and 2-stage ditch design overview by John South of the Hamilton County SWCD.

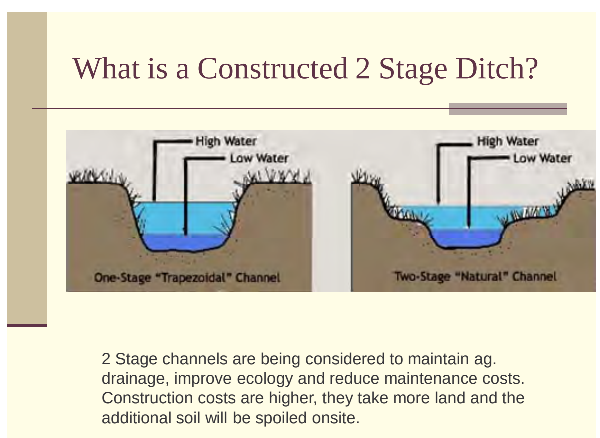


Figure 1-5: Regulated & Non-Regulated Drain Workshop

Figure 1-6: Lower Fall Creek Website

Website

The Lower Fall Creek Watershed website (**Figure 1-6**) was developed to ensure local stakeholders had up-to-date information regarding the status of the Lower Fall Creek WMP. The website also became a clearinghouse of information related to the Steering Committee, work groups, public meetings, and workshops. Educational materials developed as a part of the project were also made available. The website, www.lowerfallcreek.org was developed and maintained through a Clean Water Indiana grant and hosted by the Hoosier Heartland Resource Conservation & Development (HHRC&D) Council.

Figure 1-7: Lower Fall Creek Brochure

Brochure and Newsletters

In the summer of 2007, a Lower Fall Creek Watershed brochure was developed. The brochure included a map of the Lower Fall Creek Watershed, water quality information, facts and statistics regarding the land use. The brochure was distributed to stakeholders throughout the planning process via direct mailings to Neighborhood Associations in the Lower Fall Creek Watershed, Steering Committee meetings, work group meetings, public meetings, workshops, and other local events. A copy of the brochure is included in Appendix 3.

Three Lower Fall Creek Watershed Newsletters were developed and distributed to watershed stakeholders as part of the SWCD Newsletters. The Lower Fall Creek Newsletter kept stakeholders abreast of upcoming meeting dates and announced various project milestones and successes. Copies of newsletters are also available in Appendix 3 of this plan.

Social Indicators Survey

In the fall of 2008, the Lower Fall Creek Watershed participated in a US EPA Region 5 pilot program designed to evaluate the use of social indicators in non-point source pollution management. According to the Draft Social Indicators for NPS Management Handbook 2.0, Social Indicators are measures that describe the capacity, skills, awareness, knowledge, values, beliefs, and behaviors of individuals, households, organizations, and communities.

Dr. Linda Prokopy from Purdue University guided the Education & Outreach Work Group through the important process of developing a Social Indicators Survey which asks questions regarding attitudes toward water quality, types and sources of water pollution, the knowledge of practices that can improve water quality, as well as the willingness of the landowner to adopt those practices. In September 2008, the survey was directly mailed to over 1,000 residences within the Lower Fall Creek Watershed; however, only approximately 700 addresses were valid. Of the nearly 700 valid mailings, the survey achieved a 27% response rate receiving 187 completed surveys. Of the completed surveys, over half of the respondents indicated that they agree that local economic stability depends upon good water quality, that it is their personal responsibility to help protect water quality, and that their actions have a direct impact on water quality. When surveyed about which pollutants were present in the Lower Fall Creek Watershed, the majority of respondents indicated that they "don't know" how much of a problem pollutants such as sediments, nitrates, phosphorus, and ***E. coli*** posed.

Due to the lower response rate, Purdue University representatives plan to hold a series of small, neighborhood based focus groups to evaluate residents' awareness, attitudes, and practices related to water quality, similar to the survey. As of the development of this WMP, only one focus group has been conducted and data from that assessment has not been provided by Purdue University.

Appendix 3 includes a copy of the Social Indicator Survey and a summary of the results as provided by Purdue University. Results of this comprehensive survey will be utilized to develop future education and outreach campaigns in the Lower Fall Creek Watershed and it is intended to repeat this survey as a component of an IDEM Section 319 Implementation Project.

2.0 WATERSHED OVERVIEW

The Lower Fall Creek Watershed is a unique watershed. It drains land from the largest and fastest growing municipalities in Indiana and is rapidly converting from agriculture to urban land uses. This section provides an overview of the physical and social landscape of the Lower Fall Creek Watershed as well as the 3 topics of interest to the Lower Fall Creek Watershed Steering Committee: Land Use and Land Use Change, Groundwater and Surface Water, and Flooding and Flooding Impacts.

2.1 WATERSHED DESCRIPTION

The Lower Fall Creek Watershed drains approximately 57,800 acres (90 square miles) of rural, suburban, and urban land in Central Indiana (**Figure 2-1**). As shown in **Figure 2-2**, this land includes portions of Madison County, Hamilton County (City of Noblesville, Town of Fishers), Hancock County (Town of McCordsville), and Marion County (City of Indianapolis, City of Lawrence). The Lower Fall Creek Watershed consists of 6 14-digit Hydrologic Unit Code (HUC) watersheds. These include: 05120201110-010, 020, 030, 040, 050, and 060.

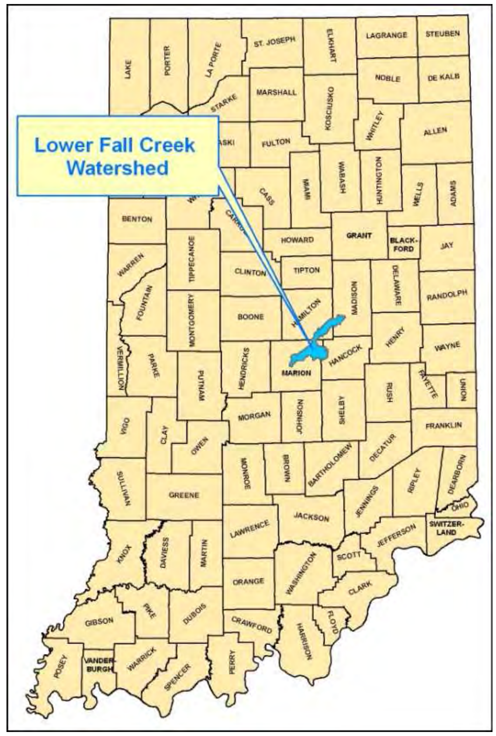


Figure 2-1: Lower Fall Creek Watershed

Physical Landscape

Based on current land use data, 38% of the Lower Fall Creek Watershed is in agriculture production followed by 32% low-density residential development, 20% commercial, industrial, and institutional land uses, 6% open space, 2% golf courses and 2% open water. With the exception of Madison County, the existing agricultural land has been zoned for residential, commercial, or industrial development.

There are 44 publicly-owned parks in the Lower Fall Creek Watershed. This accounts for 6% or 3,250 acres of the land use. The largest of these parks is the 1,700-acre Fort Harrison State Park managed by the Indiana Department of Natural Resources (IDNR). The remaining parklands are owned and operated by Indy Parks, Fishers Parks and Recreation Department, and the Lawrence Parks Department. The Fall Creek Watershed is unique in that much of the land along Fall Creek in Marion County is protected as parkland as was the design in the 1909 Indianapolis Park and Boulevard Plan. This area was added to the National Register of Historic Places in 2003. According to the 2004 Indianapolis-Marion County Parks, Recreation & Open Space Master Plan, the intent of the 1909 Park and Boulevard Plan was to "link the city in a network of transportation and recreation corridors that also function to guide urban growth, conserve the natural environment, limit water pollution, and provide flood control".

In addition to the park areas, natural features in the Lower Fall Creek Watershed provide a home for unique plant and animal species. As shown in **Appendix 4,** there are 78 endangered, threatened, or rare plants and animals that have been identified in Hamilton, Hancock, Madison,

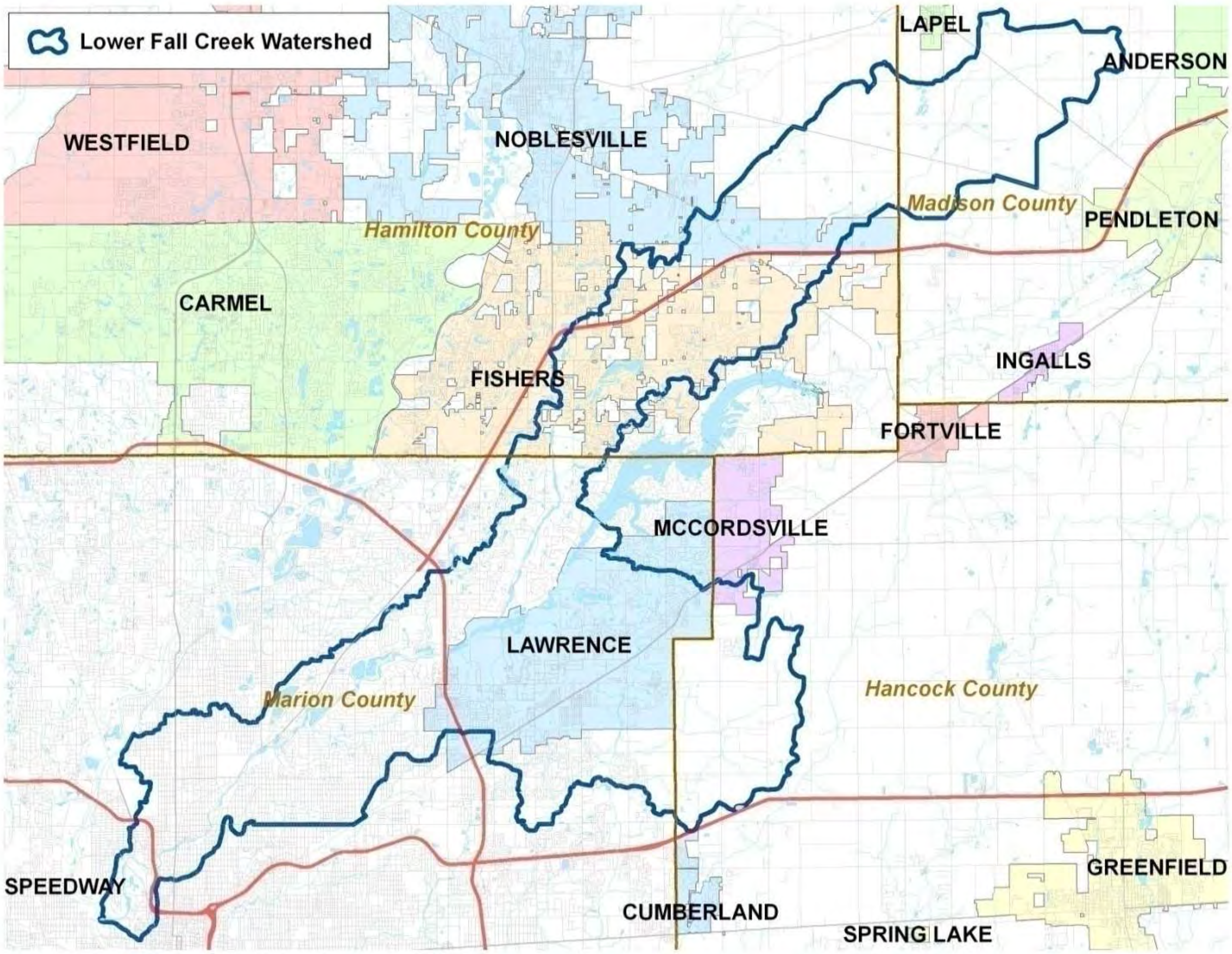


Figure 2-2: Lower Fall Creek Watershed

and Marion Counties. A detailed study to verify whether these plants and animals are located in the Lower Fall Creek Watershed has not been conducted.

The relief and soils of the Lower Fall Creek Watershed were influenced by three glacial periods. As the last of these glaciers retreated, the watershed was scoured to a relatively flat plain with a gently rolling surface, with elevations ranging from approximately 690 to 870 feet above sea level. The more distinctive slopes in the watershed have been formed by the actions of the rivers, streams, and tributaries in the watershed. Some of the greatest relief in the watershed occurs along Fall Creek and Mud Creek in and around the City of Lawrence.

The soils of the Lower Fall Creek Watershed formed from Wisconsin glacial till, glacial outwash, and recently deposited alluvium. According to the Soil Surveys for Hamilton, Hancock, Madison, and Marion Counties, there are 10 predominant soil associations in the Lower Fall Creek Watershed. In the low-lying, floodplain areas, the Genesee-Sloan and Shoals–Genesse associations dominate; whereas in the upland areas, the Crosby-Brookston associations are more prevalent.

There are approximately 126 miles of waterways in the Lower Fall Creek Watershed. These waterways are identified in **Table 2-1** and illustrated in **Exhibit 2-1**. In addition to these waterways there are numerous subsurface drains, storm sewer systems, and other man-made conveyance systems that drain the Lower Fall Creek Watershed.

Within the Lower Fall Creek Watershed there are several lakes and ponds that may also have impacts on the water quality and quantity in the area. These lakes and ponds can have a direct connection to Fall Creek or tributaries via inlets and outlets to and from these water systems. Further, some lakes and ponds were constructed through sand and gravel mining practices and are located in the recharge zones of wellfields utilized to provide drinking water to a high percentage of the population of central Indiana. These lakes and ponds are listed in Table 2-1 and located on Exhibit 2-1; however many are unnamed.

Table 2-1: List of Named Waterbodies

Alexander Hare Drain	George Burke Drain	Mud Creek
Atkinson Creek	Heinrich Ditch	Nancy Kimberlin Drain
Bartholomew Irwin Drain	Henry Ditch	Newton Teter Drain
Bells Run	Henry Ebbert Drain	O'Brien Ditch
Berkshire Creek	Hillcrest Creek	Osborn Ditch
Billings Creek	Hoss Creek	Pistol Run
Blue Creek	Hunter Mitthoefer Ditch	Russell Johnson Drain
Booth and Snead Drain	Indian Branch	Sand Creek
Brave Creek	Indian Creek	Sand Creek Tile Drain
Brian Ditch	Indian Lake	Sarah Morgan Drain
Camp Creek	Indianapolis Water Co. Canal	Schoen Creek
Chime Run	James D. McCarty Drain	Scout Branch
Daniel Heiney Drain	Jay Ditch	Squaw Run
Devon Creek	John Beaver Drain	Stanford Baughm Drain
Dunn Ditch	Kesslerwood Lake (East/West)	Steele Ditch
EE Bennett Drain	Kynett Ditch	Stonebridge Lake
Exit Ten Drain	Laurel Run	TJ Patterson Drain
Fall Creek	Lake Maxinhall	Trittipo Ditch
Field Creek	Margaret Goodwin Drain	Wesley Creek
Fort Branch	Meadows Brook	William McKinstray Drain
Frank Keiser Drain	Minnie Creek	Woollen Run
Garden Run	Mock Creek	

Social Landscape

The Lower Fall Creek Watershed is located in the most populated, and fastest growing, municipalities in Indiana – the City of Indianapolis, Town of Fishers, City of Lawrence, and City of Noblesville. A 2007 Indiana University Kelley School of Business report on the 20 largest cities in 2006, indicated that between 2000 and 2006, the Town of Fishers grew 62.6% (8.1% since 2005), the City of Lawrence grew 7.4% (2.2% since 2005), and the City of Noblesville grew 38.0% (3.3% since 2005). The 2010 growth projections for Hamilton County indicate the county will grow by another 19%, and reach a total population of 298,642. Correspondence with local planning departments confirms that a significant portion of this growth has, and will continue, in the Lower Fall Creek Watershed.

Race and ethnicity vary throughout the Lower Fall Creek Watershed. In the watershed portion of Marion County, 46% of the reporting population is African-American. In comparison, Hamilton, Hancock, and Madison Counties African-Americans account for 3.1%, 1.3%, and 8.1% of each county's respective population. Within the watershed, these populations represent less than 0.5% of the population. Between 1990 and 2000 the Hispanic population has increased between 100% and 200% throughout Marion County and by more than 300% in Hamilton County. However, within the Lower Fall Creek Watershed, the Hispanic population accounts for approximately 2.5% of the population.

As with population and ethnicity, median income and poverty varies throughout the Lower Fall Creek Watershed as well. According to Stats Indiana, Hamilton County had the highest median income ($79,927) and lowest poverty rate (3.9%) in the State followed by Hancock County with a median income of $60,343 (ranked 3rd) and poverty rate of 4.7% (ranked 90th) compared to Marion County's median income of $42,129 (ranked 54th) and poverty rate of 15.2% (ranked 12th) and Madison County's median income of $40,747 (ranked 63rd) and poverty rate of 11.9% (ranked 33rd). **Appendix 5** includes the most recent Stats Indiana profiles for Marion, Hamilton, Madison, and Hancock Counties.

2.2 LAND USE & LAND USE CHANGE

In 2005, the US EPA, with assistance from the American Planning Association (APA) published "Using Smart Growth Techniques as Stormwater Best Management Practices". This landmark publication discusses the nexus between land development patterns and water quality and quantity – especially as it relates to nonpoint source (NPS) pollution. NPS pollution originates when precipitation (rainfall or snowmelt) moves over and through the ground carrying pollutants and then depositing them into lakes, rivers, and aquifers.

Similar studies by the Center for Watershed Protection have illustrated how imperviousness related to land use and land use change can significantly impact water quality. Impervious areas (rooftops, roads, parking lots, driveways, sidewalks, etc.) decrease infiltration and increase the volume and velocity of stormwater runoff. The Center's studies have shown that a stream's ecology begins to degrade with only 10% imperviousness in the watershed. At 25% imperviousness, water quality problems include increases in bacteria concentrations, additions of toxic materials, increases in sediment loads, alterations of water temperature, and reductions in dissolved oxygen concentrations. **Table 2-2** summarizes some of the research completed by the Center for Watershed Protection.

Table 2-2: Impact of Imperviousness on Water Quality

Watershed Imperviousness	Stream Impact	Impact on Water Quality
0-10%	Minimal	Reduced macro invertebrate diversity.
10-15%	Low	Degraded habitat.
15-25%	Medium	Increased pollutant loads, toxic materials, and water temperatures.
25-50%	High	Higher peak flows. Impaired stream chemistry, biology
50%+	Severe	Severe changes in hydrology, hydraulics, morphology, water quality. Few natural attributes remaining.

<u>Specific to the Lower Fall Creek Watershed</u>

Within the Lower Fall Creek Watershed, the continued growth of the Indianapolis Metropolitan Area has greatly influenced land use and land use change. As recent as 50 years ago, the area outside of I-465 was primarily agricultural with some scattered, low-density residential development. However, these areas have, and continue to, rapidly urbanize. The most dramatic change has occurred in the Town of Fishers. As shown in **Figure 2-3** and **Figure 2-4**, almost the entire area in the Lower Fall Creek Watershed has been developed. Thirteen of the 20 fastest growing municipalities in Indiana are in the Indianapolis Metropolitan Area, including the Town of Fishers, the City of Lawrence, and the City of Noblesville in the Lower Fall Creek Watershed.

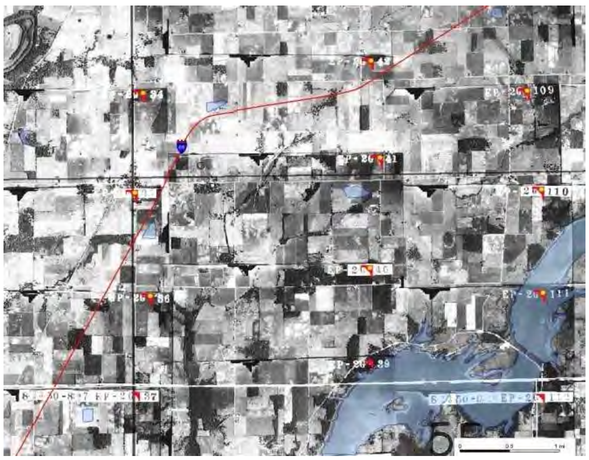


Figure 2-3: Fishers 1950

Figure 2-4: Fishers 2003

Recognizing the recent growth and anticipated continued growth in the Lower Fall Creek Watershed, the Land Use & Economic Development Work Group created a unique land use map that combines similar land uses based on their risk to water quality. Rather than displayiing generic land use classifications such as residential, commercial, industrial, etc., the Work Group combined the land uses in the Lower Fall Creek Watershed into 7 categories:

1. ***Agriculture***: Land used for cultivation of crops, pasturage, horticulture, animal husbandry with necessary buildings for housing and storage:
2. ***Low-density Residential***: Single family suburban development on ½ acre or larger lots; public water and sewer facilities may or may not be present; large mowed or wooded lots and paved streets connecting individual homes;
3. ***Commercial, Industrial, Educational, Medium-to-High Residential***: Subruban and urban development with greater than 75% imperviousness, no NPDES permit; typical of neighborhood commercial districts, general commercial districts, high intensity commercial districts, and commercial-industrial districts; public water and sewer facilities required; single family residential development on ¼ acre lots; multi-family townhouses, condomimiums, and high-rise apartments in proximity to schools and businesses; extensive network of streets, rooftops, parking lots, and on-street parking;
4. ***Commercial, Industrial***: development greater than 75% imperviousness, NPDES permit, listed on IDEM's Community Right to Know due to type and quantity of potentially harmful materials stored and handled on-site; includes light, medium, and heavy industry (based on amount of dirt, noise, glare, odor, etc.); large buildings, parking, and depending on use, outdoor storage;
5. ***Open Space***: active and passive recreational uses, nature preserves, greenway corridor; limited imperviousness (access road, parking, paths, and park facility); fertilizer application dependent on use;

6. ***Golf Courses***: public and private golf course facilities; limited imperviousness (access road, parking, paths, and club house); exentsive fertilizer application to maintain greens; and
7. ***Active Construction***: development in progress regulated under IDEM Rule 5 program requiring erosion and sediment control practices .

Exhibit 2-2 illustrates these land use categories in the Lower Fall Creek Watershed.

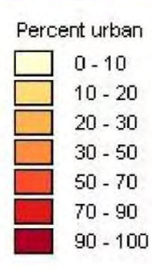
In an effort to address how the land uses in the Lower Fall Creek Watershed were changing, the Land Use & Economic Development Work Group created a Land Use Influences map. This map, shown in Exhibit 2-2, illustrates areas of anticipated growth and development, including the Town of Fishers, the City of Noblesville, and the Town of McCordsville. The Work Group identified 2 significant land use changes including the redevelopment of former commercial and industrial land into Bio Crossroads, at the confluence of Fall Creek and White River and the 700-acre Corporate Campus and Saxony Development at Exit 10 in the City of Novblesville (north of I-69) and Town of Fishers (south of I-69). Other areas of proposed or anticipated land use change include the proposed Technology Park Development at Exit 5 in the Town of Fishers, proposed residential and commercial development of Wayne Township in the City of Noblesville, the proposed airport south of Lapel, the Mt. Comfort Airport in Hancock County, the proposed McCord Square Develpoment in the Town of McCordsville, as well as the influence and proximity of I-69 and I-74 in the Lower Fall Creek Watershed.

<u>Central Indiana Growth Models</u>

In 2003, the Indiana University-Purdue University Indianapolis Center for Urban Policy and the Environment released the Land Use in Central Indiana model (LUCI) for planners, policymakers, and citizens to explore the implications of policy choices and alternative assumptions on future development patterns. According to literature from the Center, LUCI predicts the conversion of non-urban land to urban use, the general development pattern, and the resulting population density through 2040.

The Land Use & Economic Development Work Group used LUCI to predict 2040 land use for 3 growth scenarios:

1) Current Growth Model – maintain current density, limited restriction on sensitive lands, some restrictions on agricultural lands, no urban growth boundaries, current dispersal of development, proximity to existing utilities not required
2) Build-Out Growth Model – decrease density, no restriction on sensitive lands, no restrictions on agricultural lands, no urban growth boundaries, more dispersed development, proximity to existing utilities not required
3) Conservation Growth Model – minimum density, restriction on sensitive lands (wetlands, riparian buffers, steep slopes, forested areas), restrictions on agricultural lands,



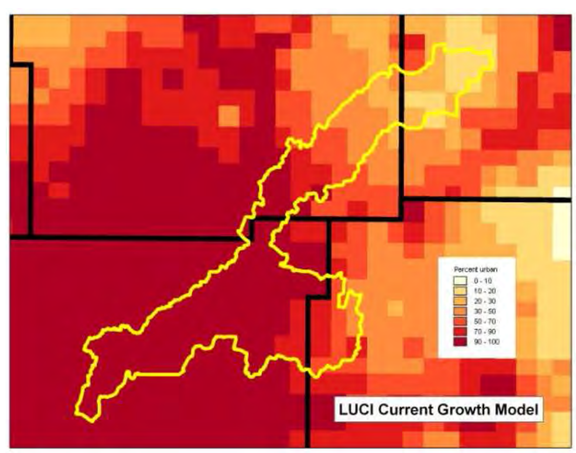


Figure 2-5: LUCI 2040 Current Growth Model

establish an urban growth boundary, less dispersed development, access to existing utilities required

Figure 2-5, **Figure 2-6** and **Figure 2-7** illustrate the result of these 3 growth models. As shown in **Table 2-3**, the percentage of each land use in the Current and the Conservation Growth Models are similar. However, as shown in Figure 2-3 and Figure 2-5, the distribution is very different. Not surprisingly, the Build-Out Growth Model shows an increase in residential, commercial, industrial, and educational development in lieu of agricultural land uses.

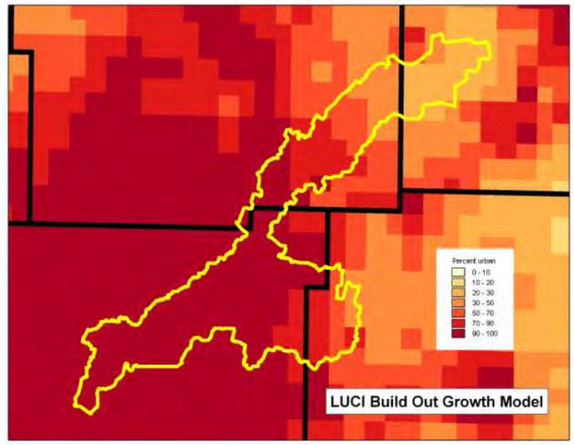


Figure 2-6: LUCI 2040 Build-Out Growth Model

The 2040 land uses from the LUCI growth models were entered into Purdue University's Long-Term Hydrologic Impact Assessment (L-THIA) tool to determine the impact of each scenario on water quality. L-THIA was designed to help community planners, developers, and citizens quantify the impact of land use change on the quantity and quality of water. The following summarizes the results from L-THIA:

- Average Annual Runoff Volume – increase (10%) in Build-Out Growth Model and 5% increase in urbanized portion of Conservation Growth Model
- Nutrient Loading – significant decrease (74%) in nitrogen and phosphorus in Build-Out Growth Model (eliminated agricultural land uses); slight decrease (2%) in Conservation Growth Model
- Sediment Loading – significant decrease (77%) in suspended solids in Build-Out Growth Model (eliminated agricultural land uses); minimal decrease (0.5%) from Conservation Growth Model
- Pathogen Loading – significant increase (194%) ***fecal streptococcus*** in Build-Out Growth Model (greatest increases associated with residential land uses); 15% increase in Conservation Growth Model

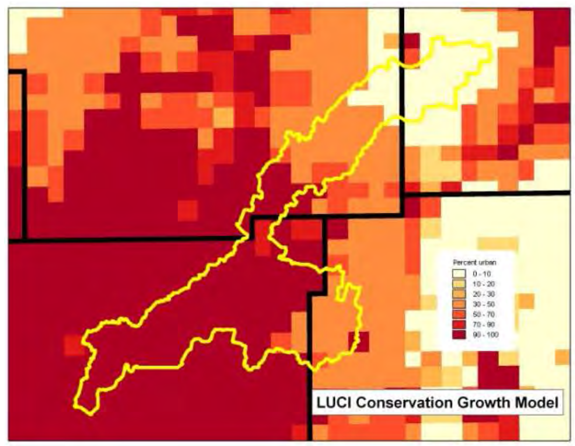


Figure 2-7: LUCI 2040 Conservation Growth Model

Table 2-3: Current and Projected Land Use

Land Use	Local Data & Aerials	LUCI GROWTH MODEL 2040		
		Current	Build-Out	Conservation
Agricultural	38.5%	37.7%	0.0%	31.6%
Low-Density Residential	32.4%	22.5%	49.0%	24.2%
Commercial, Industrial, Educational, Medium to High-Density Residential [1]	19.8%	30.8%	43.4%	35.3%
Commercial, Industrial [2]	0.5%			
Open Space	5.9%	8.9%	7.6%	8.8%
Golf Course	2.3%			
Rule 5	0.6%	NA	NA	NA

[1] greater than 75% imperviousness
[2] greater than 75% imperviousness; NPDES Permit, Community Right to Know

Recommendations & Discussion

The municipalities in the Lower Fall Creek Watershed have invested significant time and resources into developing a Comprehensive Plan and Ordinance(s) that are unique to how they wish to see their community grow and develop in the future. These documents are important in that they determine the location density, and design of development (and redevelopment). However, these documents do not always consider the impact of land use and land use change on water quality (and quantity), causing communities to work harder to meet regulatory requirements such as NPDES Phase II, TMDLs for impaired streams, drinking water standards, compensatory flood storage, and ultimately quality of life.

In 2008, the Center for Watershed Protection published “Managing Stormwater in Your Community”. Chapter 3 of this document is dedicated to the land use planning and water quality/quantity. **Table 2-4** highlights land use planning strategies that should be considered to protect and enhance water resources.

Table 2-4: Land Use Planning Strategies

Watershed Characteristics	Land Use Planning Strategy
Special receiving water	• Overlay zoning and performance standards • Conservation development • Special stormwater criteria • Low impact development
Existing flooding problem	• Overlay zoning and performance standards • Special stormwater criteria • Low impact development • Street design • Fee-in-lieu program
Impaired stream	• Special stormwater criteria • Special use permits for certain uses • Performance standards • Low impact development • Conservation development

(CWP, 2008)

There has been a growing interest of utilizing green infrastructure to filter sediments and pollutants from stormwater before it drains to receiving waters. Many local governments and groups associated with protecting surface water resources have begun to investigate and incorporate Low Impact Development (LID) techniques into their planning and development regulations. LID principles include:

- Minimizing stormwater impacts to the extent practicable through reducing imperviousness, conserving natural resources and ecosystems, maintaining natural drainage courses, reducing use of pipes, and minimizing clearing and grading;
- Providing runoff storage measures dispersed uniformly throughout a site's landscape with the use of a variety of detention, retention, and runoff practices;
- Maintain predevelopment time of concentration by strategically routing flows to maintain travel time and control the discharge; and
- Implementing effective public education programs to encourage property owners to use pollution prevention measures and maintain the on-lot hydrological functional landscape management practices.

2.3 RELATIONSHIP OF GROUNDWATER & SURFACE WATER

Groundwater Concerns

Groundwater resources and Wellfield Protection Areas (WFPAs) should be an important consideration during the development and implementation of the WMP. A WFPA is the land above and surrounding wells drilled into an aquifer where the water seeps into the ground and recharges the aquifers from which the wells extract water. Typically these WFPAs are divided into two areas of concern, the 1-year and 5-year times of travel. These areas are based on the amount of time needed for groundwater to reach the well.

Under natural hydrologic conditions, a large percentage of stormwater is allowed to infiltrate the soil and recharge the groundwater resources. As indicated in **Figure 2-8** the amount of infiltration and groundwater recharge is diminished as more development and more impervious surface is added to the watershed landscape.

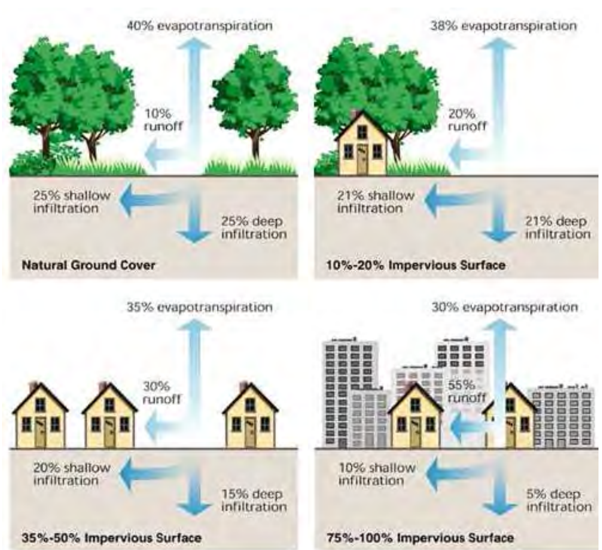


Figure 2-8: Infiltration and Imperviousness

Within central Indiana, some of the most productive aquifers follow the major river systems of White River, Eagle Creek, and Fall Creek. With this in mind, it is very important to know if a stream or river is a gaining stream or a losing stream. In **Figure 2-9**, the top illustration indicates how the gaining stream is fed by groundwater resources. This provides the base flow for this stream. In the bottom illustration, the losing stream provides groundwater recharge as water is lost from the stream into the water table.

If streams and rivers are losing streams, the potential for groundwater contamination is greater and planning efforts should account for this increased risk. Unfortunately, within the Lower Fall Creek Watershed, this information is not readily available. It is not known at this time if Fall Creek and its tributary streams are gaining or losing streams. Hydrologic information, especially as it pertains to drinking water sources, has become sensitive information and is not readily shared between agencies and offices.

Primary pollutants of concern regarding WFPAs include:

- Nutrients – especially nitrates in cool, wet weather due to reduced de-nitrification, volatilization, limited microbial action, and plant uptake
- Pesticides – can be in high concentrations in dry flows such as those related to landscape irrigation
- Pathogens – especially near CSO areas
- Metals – Aluminum, Copper, Iron, Lead, and Nickel can be present in stormwater runoff
- Salts – Ice prevention and removal treatments can cause high concentrations in snow melt and runoff
- Pharmaceutical & Personal Care Products – recent studies have shown that 93% of USGS Groundwater samples contained low levels of steroids, nonprescription drugs, and/or insect repellants.

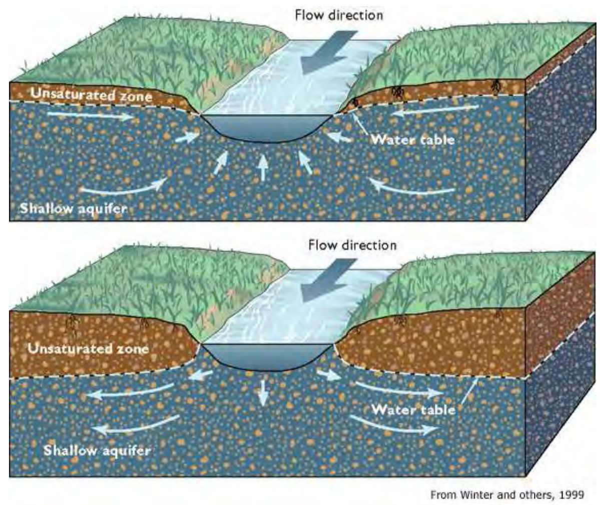


Figure 2-9: Gaining (top) and Losing (bottom) Streams

Specific to the Lower Fall Creek Watershed

In the Lower Fall Creek Watershed, approximately 25% of the watershed is designated as a WFPA. It is estimated that 20% of the Central Indiana population is serviced by the wells protected by the WFPAs. Rural residents within the Hancock and Madison County portions of the watershed are primarily serviced by private residential wells. The WFPAs within the Lower Fall Creek Watershed are indicated on **Figure 2-10**.

The City of Indianapolis has adopted a Wellfield Protection Zoning Ordinance with zoning classifications W-1 for the 1-year time of travel and W-5 for the 5-year time of travel areas. Within these areas, all new site development plans must be reviewed by a Technically Qualified Person (TQP) to ensure that groundwater resources will be protected and that the facility does not pose and unreasonable risk to the groundwater. Restrictions and requirements to ensure this risk is lowered include connections to sanitary sewers, covering of areas where maintenance will occur, and secondary containment for chemical storage areas.

The Marion County Wellfield Education Corporation (MCWEC) was developed as part of the Wellfield Protection Zoning Ordinance to prevent contamination of the groundwater resource through public awareness and education – targeting pre-existing commercial and industrial businesses in the WFPAs. MCWEC maintains a Potential Source Inventory (PSI) database for each wellfield (a list of existing and potential sources of contamination within the WFPAs which might represent a threat to the public water supply system), visits each facility to discuss groundwater issues, and conducts confidential detailed on-site assessments for interested business owners. Through the efforts of MCWEC, Marion County has been designated as a Groundwater Guardian Community by the National Groundwater Foundation since 1998.

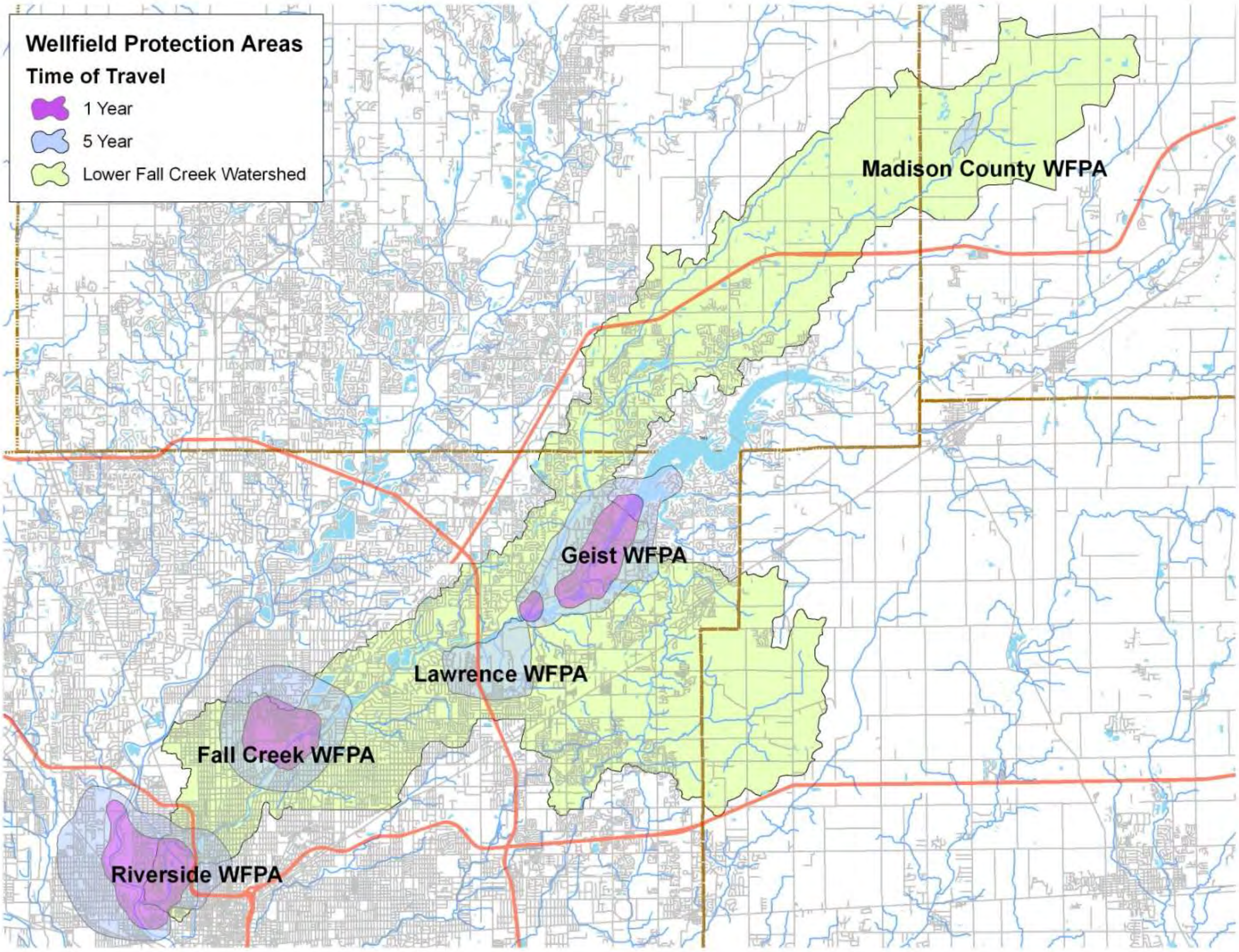


Figure 2-10: Wellfield Protection Areas

According to the PSI database, the Riverside WPFA has 175 facilities with chemicals stored or handled on-site that, if mishandled, could potentially contaminate the groundwater. More than half of these are within the W-1 or 1-year time of travel. MCWEC considers the Riverside WFPA as their highest priority because of the large number and age of the commercial and industrial facilities. The Fall Creek WFPA has 112 facilities (52 in the W-1). The land use of the Fall Creek WFPA has a mix of commercial, industrial, educational, and high-density residential land uses. Further upstream, in the Lawrence and Geist WFPAs, the land use transitions to residential, open space, and some commercial. Both of these wellfields have significantly fewer facilities of concern. Lawrence has 11 active facilities identified on the PSI (none in the W-1) and Geist has 4 facilities listed with 2 in the W-1. The Madison County WFPA is in currently in agriculture production. An ordinance to regulate land uses in this WFPA has not been adopted.

<u>Surface Water Concerns</u>

Veolia Water utilizes surface water from Fall Creek to provide Indianapolis residents with clean, safe drinking water. Real-time water quality sampling takes place near the surface water intake on Fall Creek. These samples are tested for over 90 parameters on a monthly basis. According to Veolia representatives, phosphorus reductions in the ambient surface water in Fall Creek would serve to reduce the treatment efforts and process required to treat the water.

Issues of debris, such as litter and uprooted trees are also a concern, as these can restrict flow and clog intake pipes creating a concern for both water quantity and water quality. Algal blooms, such as those occurring in Geist Reservoir in 2007 and 2008, create taste and odor problems that have affected the drinking water quality for years. To address the algal blooms, remote sensing technologies have been employed to better detect, map, and characterize the blooms which lead to a decrease in the number of taste and odor complaints. Further, by utilizing these technologies, chemicals used to treat algal blooms have decreased from 9,000 pounds to 900 pounds annually. In 2002, Veolia entered into a long-term partnership with the Center for Earth and Environmental Science at IUPUI to conduct applied research targeted at both protecting and improving water quality.

Recommendations and Discussion

LID techniques can be important to protecting surface water quality and may be utilized to protect groundwater quality as well. However, infiltration techniques such as vegetated swales, bio-retention areas, and porous pavements on commercial or industrial properties within the WFPAs may pose a threat to groundwater resources.

Therefore within the 1-year time of travel, it may be best to limit infiltration practices such as vegetated swales and small bio-retention areas to residential or other low intensity land uses. Demonstration BMPs such as these may be placed on individual residential lots, in common areas throughout neighborhoods, or in open areas on school properties. School properties may provide the best partnership opportunity as BMPs such as vegetated swales, rain gardens, or small bio-retention facilities can be utilized for educational purposes as well and these properties typically allow for high accessibility and visibility. Within the 5-year time of travel, infiltration practices may also be utilized on smaller commercial properties and higher intensity residential facilities, such as multi-family dwellings and apartment complexes.

2.4 FLOODING & FLOODING IMPACTS

Flooding is defined as an inundation of land by the rise and overflow of a body of water caused by heavy rainfall and/or melting ice and snow, increased imperviousness, floodplain encroachment, deforestation, stream obstruction, or failure of a flood control structure. Flooding can result in widespread impacts in both rural and urban areas. Impacts of flooding include: damage to property and inventory; damage to utilities/disruption of service; impassible roads and bridges; injuries, fatalities, mental/physical stress; degradation of water quality; and channel/riparian modification.

Floodplains are lands adjacent to streams, rivers, and creeks that combine to form a complex, dynamic physical and biological system. When portions of floodplains are preserved in (or restored to) their natural state, they provide many benefits to both human and natural systems. Floodplains can provide temporary storage for floodwaters, provide ideal settings for wetlands, improve water quality, offer green space that can be used as buffers, greenways or other functions, and provide important habitat for wildlife.

Flooding can be expected to occur in the floodplain or Special Flood Hazard Area (SFHA). **Figure 2-11** illustrates a plan view and cross section of a floodplain.

The terms are defined as:

- Floodway – essential part of stream conveyance system. It includes the stream channel plus adjacent floodplain area.
- Floodway Fringe – the area subject to flooding by the regulatory or base flood. The regulatory or base flood is defined as an area with a 1% or greater annual probability of flooding also known as the 100-year flood.

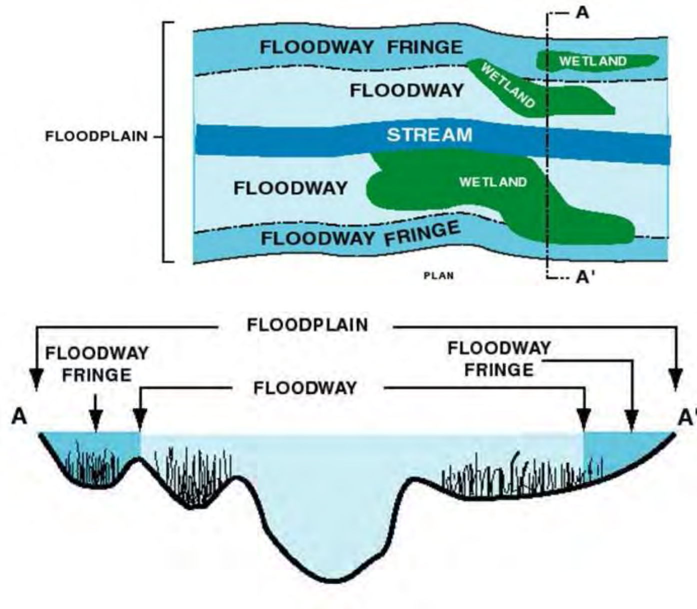


Figure 2-11: Floodplain Areas

Flooding may also occur outside of the floodplain area as a result of increased urbanization relying on antiquated or undersized drainage systems that are unable to deal with the increase volume and velocity of stormwater. The increased volume and velocity of water can be detrimental to receiving streams resulting in severe erosion, scouring, and undercutting of streambanks and ultimately loss of aquatic and terrestrial habitat. Runoff associated with floodwaters may carry extremely toxic substances such as gasoline, oil, and pesticides that results in downstream deterioration of water quality.

Specific to the Lower Fall Creek Watershed

According to FEMA's most recent Flood Insurance Rating Maps (FIRMs), Fall Creek, Grassy Creek, Mud Creek, and Sand Creek are the only waterways that have been studied in detail and base flood elevations have been determined (**Figure 2-12**). The remaining waterways are unstudied or classified as Unnumbered Zone a streams which means the base flood elevations have only been approximated.

In the Lower Fall Creek Watershed, development in the floodplain is regulated through local Floodplain Ordinances. Each local ordinance is based on the State of Indiana Model Floodplain Ordinance and states that 1) no development in the SFHA shall create a damaging or potentially damaging increase in flood heights or velocity or threat to public health and safety and 2) all buildings to be located in the SFHA shall be protected from flood damage below the flood protection grade (elevation of the regulatory flood plus 2 feet at any given location in the SFHA). The City of Indianapolis (includes City of Lawrence), City of Noblesville, Town of Fishers, Hamilton County, and Hancock County all participate in the Community Rating System (CRS) of the National Flood Insurance Program (NFIP). This program provides reduced flood insurance premiums to participating communities that go above and beyond the minimum NFIP requirements.

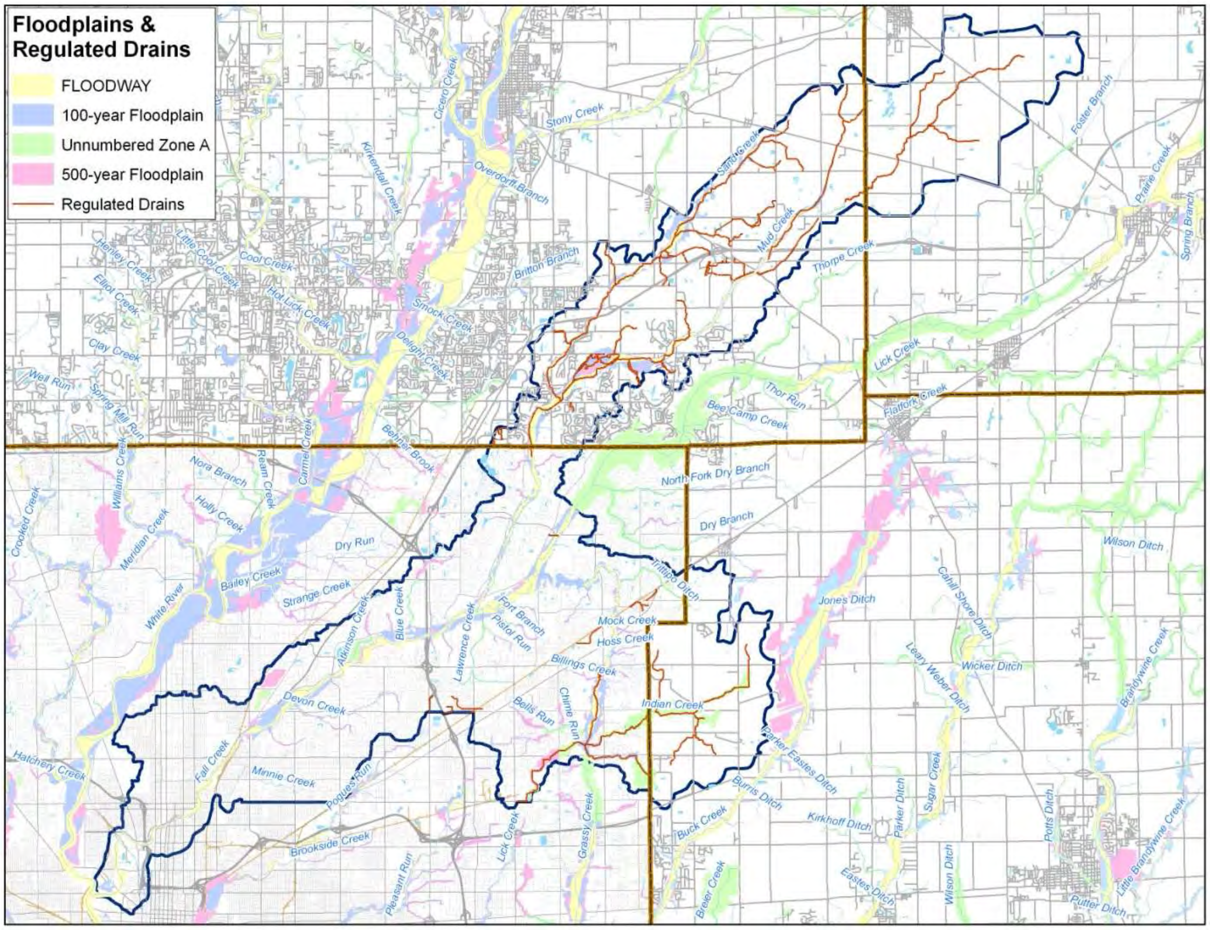


Figure 2-12: Floodplains and Regulated Drains

Hamilton County, Town of Fishers, City of Noblesville, Town of McCordsville, and Hancock County have each adopted Stormwater Management Ordinances that includes a No Net Loss Floodplain/Compensatory Storage Policy. This policy is above and beyond the minimum Floodplain Ordinance requirements. Compensatory storage is required when a portion of the floodplain is filled, occupied by a structure, or when as a result of a project a change in the channel hydraulics occurs that reduces the existing available floodplain storage. Compensatory storage should be located adjacent or opposite the placement of the fill and maintain an unimpeded connection to an adjoining floodplain area.

Maintenance of waterways, including clearing fallen trees, log jams, and debris is essential to maintaining stream flow during high water and reduce flooding. Approximately 60% of the waterways in the Lower Fall Creek Watershed are regulated drains. A regulated drain can be an agricultural drain, urban storm sewer, or open ditch. As shown in Figure 2-12, these are primarily located in Hamilton, Madison, and Hancock County and under the jurisdiction of the local Drainage Board. In Marion County, the City of Indianapolis DPW is responsible for regulated drains. Land owners within the drainage area of a regulated drain pay for maintenance and reconstruction based on an assessment process. Maintenance of non-regulated drains is the responsibility of adjacent landowners. The SWCD in each county and the IDNR Division of Water is able to provide some guidance on stream maintenance to individual landowners.

Flood complaints are tracked and addressed in each county by the Surveyor's Office, Indianapolis DPW, and SWCDs. In the Lower Fall Creek Watershed, there have been few flood complaints in the headwaters in Madison County and Hamilton County. In Hancock County, flood complaints have been documented by residents along the Trittipo Ditch. In Marion County, flood complaints are tracked through the Mayor's Action Center.

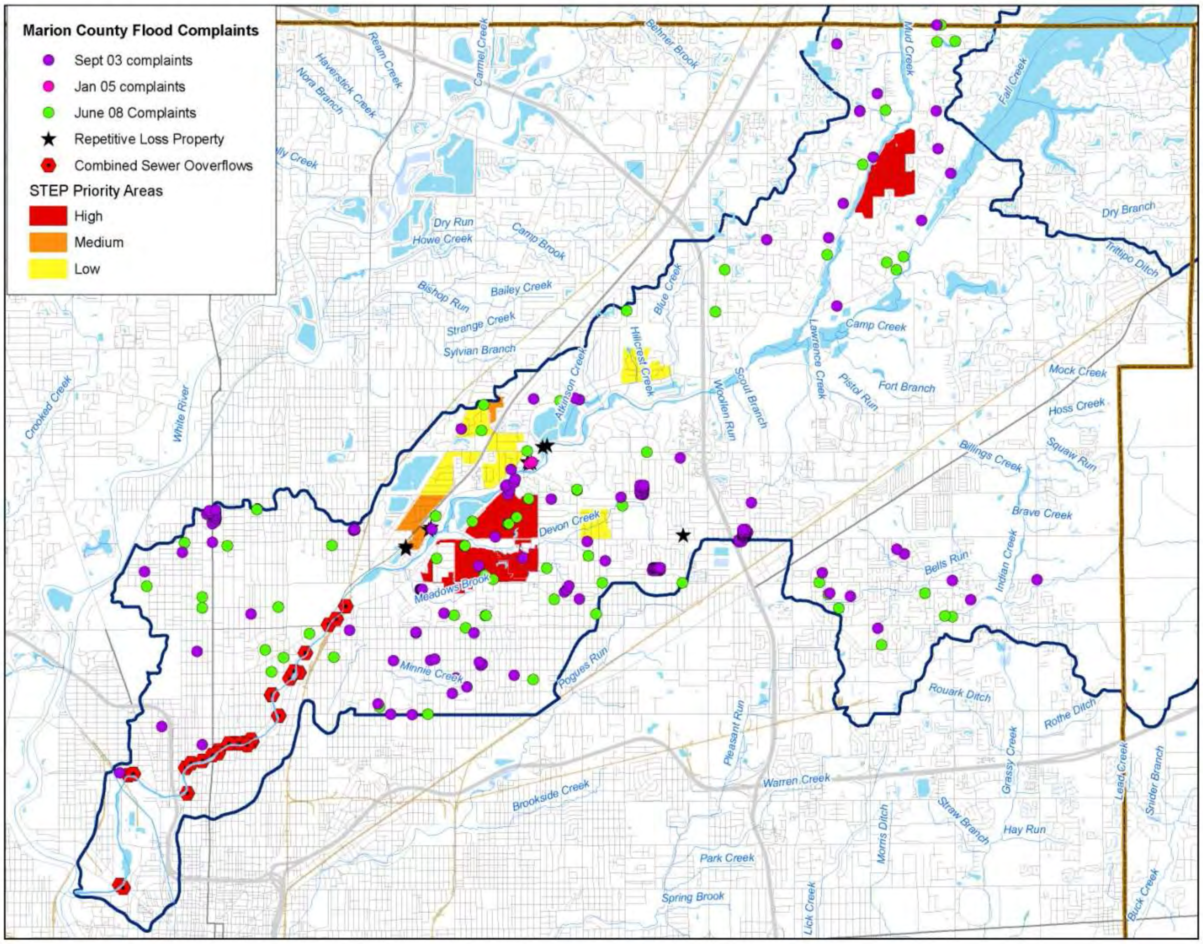


Figure 2-13: Flood Complaints

Figure 2-13 illustrates flood complaints in the Lower Fall Creek Watershed during the last 3 significant rain events: September 1, 2003, January 3, 2005, and June 7, 2008. A number of flood complaints were received outside of the regulatory floodplain and were attributed to the storm sewers, open ditches, and small tributaries. These systems were trying to convey larger volumes of water from more impervious area than they are typically designed for. Flood complaints were also documented in priority Septic Tank Elimination Program (STEP) areas of the Lower Fall Creek Watershed. During a flood or heavy rainstorm, excessive water can accumulate in the leach field and cause the septic system to become sluggish, back up, or stop functioning. Raw sewage may accumulate on the ground or get washed into receiving waters and result in long-term water quality problems.

Recommendations and Discussion

The impacts of flooding and flood-related losses can be greatly reduced through better design and planning. LID has been discussed as a method to improve water quality and reduce flood storage areas (for smaller rain events only). **Figure 2-14** (top) illustrates a typical stormwater management practice of draining the entire site to a single pond and a large volume of water leaving the site. The bottom of Figure 2-14 shows the LID technique that uses small stormwater infiltration and retention facilities distributed throughout the site to capture rainfall and reduce the volume of water leaving the site. This technique reduces the volume and velocity of water to conveyance systems (storm sewers, open ditches) as well as improving the water quality that does make its way to the receiving waters.

Figure 2-14: Low Impact Development

Although flooding complaints along the regulated drains have been minimal, these conveyance systems could be modified into 2-stage ditches to store and filter floodwater in the headwaters of the watershed and reduce the impact of flooding in the downstream urban areas.

Flood-related losses could be reduced by understanding actual flood depths along unstudied or unnumbered Zone A streams. This would ensure that new buildings are elevated above the regulatory floodplain and existing structures could be protected from flood damage. Flood-related losses could also be reduced through improved flood warning systems like additional stream gages on Mud Creek (Hamilton County) and Indian Creek (Hancock County). This will become increasingly important to the City of Indianapolis and the City of Lawrence as the upstream communities of the City of Noblesville, Town of Fishers, and Town of McCordsville continue to grow and less land is available to retain floodwaters.

Many of these issues are further detailed and potential mitigation measures are included in existing plans developed such as the Multi-Hazard Mitigation Plans developed for each of the 4 counties, the City of Indianapolis Flood Response Plan, and the Community Rating System (CRS) programs developed by Hamilton County, Hancock County, the City of Indianapolis, and the City of Noblesville.

3.0 WATER QUALITY PROBLEMS, CAUSES & SOURCES

As part of the watershed planning process, an inventory and assessment of the watershed and existing water quality studies relevant to the watershed was conducted. Examination of previous work showed that data already gathered is sufficient for determining the magnitude and extent of water quality conditions, or may indicate that additional studies are needed to characterize the water quality problems. Once analysis of these studies was completed, water quality problems and links to pollution sources in the watershed could be determined. The following section provides a summary of water quality assessments, identifies pollutants of concern, links pollutants with potential sources, estimates existing pollutant loads, and concludes by establishing problem statements for the Lower Fall Creek Watershed.

3.1 STAKEHOLDER CONCERNS

Individuals living and working in the Lower Fall Creek Watershed have proven to have a wealth of knowledge as it relates to water quality, water quantity, and other natural resource issues in the watershed. Listed in **Table 3-1** are water quality issues of concern that were identified by Lower Fall Creek Watershed stakeholders.

Table 3-1: Stakeholder Concerns

Pollutant	Concern
Sediment	Lack of erosion control on construction sites
	Streambank erosion (lack of buffers)
	Tillage practices
Nutrients	Commercial and residential fertilizer application
	Inadequately functioning septic systems
	Combined Sewer Overflow's
Pathogens	Inadequately functioning septic systems
	Illicit storm sewer connections
	Waterfowl near waterways and retention ponds (Wildlife)
	Stormwater Runoff
	Combined Sewer Overflow's
	Livestock and Manure Management
	Indiana State Fairgrounds
Other	Invasive species
	Herbicide and pesticide applications
	Localized drainage and flooding problems
	Growth and Development
	Groundwater/Drinking Water Sources

3.2 WATER QUALITY BASELINE STUDIES

In addition to stakeholder input, a wide variety of water quality information was evaluated in order to ensure that the planning process considered the best available water quality information relevant to the Lower Fall Creek Watershed. Within this section, a summary of baseline water quality studies completed within the Lower Fall Creek Watershed is provided. In order to better compare water quality data, a suite of parameters and parameter benchmarks were identified to conduct water quality evaluations. **Table 3-2** identifies the water quality parameters and benchmarks that were chosen for the Lower Fall Creek Watershed. In many cases, water quality data is presented by 14-digit subwatershed (**Figure 3-1**).

Table 3-2: Water Quality Benchmarks

Parameter	Benchmark	Source
Dissolved Oxygen (DO)	4.0 mg/L	State Water Quality Standard
E. coli	125 CFU/100ml (5-week Geometric Mean) or 235 CFU/100ml (single grab sample)	State Water Quality Standard
Fecal coliform	200 colonies/100ml	EPA Recommendation
Nitrogen	10 mg/L	Indiana TMDL Guideline
Total Phosphorus	0.076 mg/L	EPA Recommendation
Atrazine	3.0 ppb	Drinking Water Standard
TSS	80 mg/L	IDEM Correspondence
Turbidity	10.4 NTU	EPA Recommendation

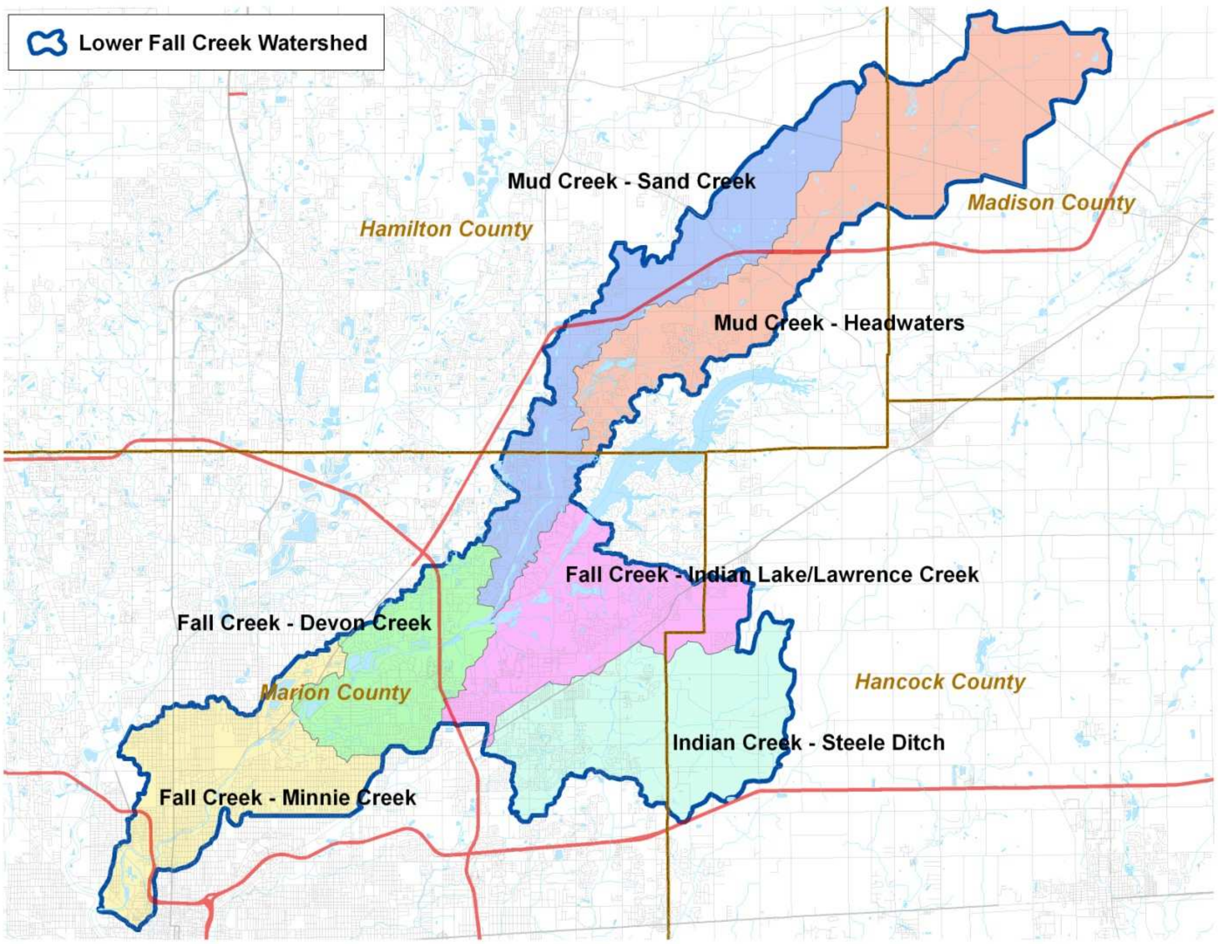


Figure 3-1: 14-digit Subwatersheds

Integrated Water Monitoring and Assessment

The Indiana Department of Environmental Management (IDEM) is the primary agency involved in surface water quality monitoring and assessment in the State of Indiana. In conjunction with the requirements of the Clean Water Act and the State's goals for protecting its natural and recreational resources, the IDEM operates several monitoring programs designed to monitor and assess the chemical, physical, and biological conditions of Indiana's rivers, streams, and lakes.

The IDEM's Office of Water Quality's Integrated Water Monitoring and Assessment strategy is designed to describe the overall environmental quality of each major river basin in the state and to identify monitored water bodies that do not fully support designated uses. All IDEM water quality data is evaluated by IDEM's 305(b) Coordinator and interpreted for each 14-digit HUC subwatershed. Each subwatershed is given a water quality rating relative to its streams status in meeting Indiana's Water Quality Standards (WQS). WQS are set at levels necessary for protecting a waterway's designated uses, such as swimmable, fishable, or drinkable. Each subwatershed is given a rating of its designated uses. **Table 3-3** below identifies known impairments of the Lower Fall Creek Watershed according to the 2008 Integrated Water Monitoring Assessment report.

Table 3-3: 2008 305(b) Report

Waterbody Name	Impairment
Fall Creek - Lawrence Creek (05120201110020)	PCBs in fish tissue
Fall Creek - Devon Creek (05120201110050)	PCBs in fish tissue
Fall Creek - Minnie Creek (05120201110060)	***E. coli*** Mercury in fish tissue PCBs in fish tissue

(IDEM, 2006)

Based on the Integrated Water Monitoring and Assessment Report the following conclusions have been drawn:

- The ***E. coli*** water quality standard is consistently exceeded along Fall Creek in the Fall Creek – Minnie Creek Subwatershed.
- PCBs and Mercury concentrations are elevated along Fall Creek from the Geist Reservoir Spillway to the confluence of the White River.
- Lead levels are elevated along Fall Creek in the Fall Creek - Minnie Creek Subwatershed.

2008 303(d) List of Impaired Waters

Chapter 303(d) of the Clean Water Act requires states to identify waters that do not or are not expected to meet applicable water quality standards. States are also required to develop a priority ranking for these waters, taking into account the severity of the pollution and the designated use of the waters. Once this listing and ranking of waters is completed, States are required to develop Total Maximum Daily Loads (TMDL) for these waters in order to achieve water quality standards. As shown in **Table 3-4,** 5 waterbodies within the Lower Fall Creek Watershed are listed on the 2008 303(d) List of Impaired Waters.

Table 3-4: 2008 303(d) Impaired Waters

Waterbody Name	Impairments
Fall Creek	PCBs
Minnie Creek Tributaries	***E. coli,*** Mercury, PCBs
Devon Creek	PCBs

(IDEM, 2008)

Based on the List of Impaired Waters the following conclusions have been drawn:

- The ***E. coli*** water quality standard is consistently exceeded along Fall Creek from the Geist Reservoir Spillway to the confluence of the White River.
- PCB and Mercury levels are elevated from the Geist Reservoir Spillway to the confluence of White River.

Fish Consumption Advisory (FCA)

Each year since 1972, three agencies have collaborated to create the Indiana Fish Consumption Advisory. These agencies include the Indiana Department of Environmental Management (IDEM), the Indiana Department of Natural Resources (IDNR), and the Indiana State Board of Health (ISBH). Each year, members from these agencies meet to discuss the findings of recent fish monitoring data and to develop the statewide fish consumption advisory.

The 2006 advisory is based on levels of PCBs and Mercury found in fish tissue. In each area, samples were taken of bottom-feeding fish, mid-water column feeding fish, and top-feeding fish. Fish tissue samples were analyzed for polychlorinated biphenyls (PCBs), pesticides, and heavy metals. Of those samples, the majority contained at least some Mercury. However, not all fish tissue samples had Mercury at levels considered harmful to human health. **Table 3-5** shows the fish consumption advisories within the Lower Fall Creek Watershed. A Level 3 advisory recommends limiting consumption to one meal per month (12 meals per year) for adults. Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 are under a zero consumption advisory. A Level 4 advisory limits consumption to one meal every 2 months (6 meals per year) for adults. Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 are under a zero consumption advisory. A Level 5 advisory is a zero consumption advisory (Do Not Eat).

Table 3-5: Fish Consumption Advisories

Waterway	Fish Species	Fish Size	Advisory
Fall Creek	Carp	<20 inches	3
		>20 inches	5
	Channel Catfish	<18 inches	3
		18 -20 inches	4
		>20 inches	5
	Large Mouth Bass	14 + inches	3

(ISDH, 2007)

Based on the Fish Consumption Advisory the following conclusions have been drawn:

- Fall Creek is under a fish consumption advisory from the Geist Reservoir Spillway to the confluence with the White River.

Fall Creek TMDL Study

Water quality data has been collected from Fall Creek by numerous state and local entities since 1991. In 1998, the IDEM determined that segments of Fall Creek do not consistently comply with the state's water quality standards for ***E. coli*** bacteria. As a result, segments of Fall Creek were listed on the 1998 303(d) list and required to have a TMDL evaluation for ***E. coli*** bacteria. This study was prepared for the City of Indianapolis and for IDEM pursuant to a contract with the State of Indiana. Data collected by several agencies was obtained for the water quality model development. For analysis purposes, Fall Creek was divided into segments. One segment consisted of areas up-stream of all of Indianapolis' Combined Sewer Overflow (CSO) outfalls, and another segment consisted of areas downstream of the most upstream CSO outfall. Fall Creek downstream of Keystone Avenue to the confluence with the White River is the stretch of river considered to be in the CSO area. CSO locations are indicated on **Exhibit 4-3**.

Based on the Fall Creek TMDL the following conclusions have been drawn:

- The ***E. coli*** water quality standard is consistently exceeded along Fall Creek from the Geist Reservoir Spillway to the confluence of the White River.
- A 52% reduction of ***E. coli*** loadings is needed upstream of the CSO area in order to meet water quality standards.
- A 99.5% reduction of ***E. coli*** bacteria loadings is needed in the CSO area in order to meet water quality standard.

Stream Reach Characterization and Evaluation Report

In 2002, the City of Indianapolis completed a Stream Reach Characterization Evaluation Report (SRCER) as a component of the CSO Long Term Control Plan. The purpose of the SRCER was to enable the City to undergo technically sound CSO planning by providing baseline water quality information within the City of Indianapolis.

Based on the SRCER the following conclusions have been drawn;

- Dissolved Oxygen (DO) levels are depressed within the Fall Creek Watershed.
- The ***E. coli*** water quality standard is consistently exceeded along Fall Creek from the Geist Reservoir Spillway to the confluence of the White River.
- Biological communities are impaired along Fall Creek from the Geist Reservoir Spillway to the confluence of the White River.

NPDES Permitted Facilities

Wastewater point source discharges include municipal (city, town, or county) and industrial wastewater treatment plants and small domestic wastewater treatment systems that may serve schools, commercial offices, residential subdivisions, and individual homes. Stormwater point source discharges include stormwater discharges associated with industrial activities and stormwater discharges from municipal separate storm sewer systems (MS4) operated by municipalities and counties.

Industrial point source dischargers in Indiana must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state. Discharge permits are issued under the NPDES program, which is delegated to DIEM by the US EPA. Within the boundaries of the Lower Fall Creek Watershed, there are 6 active NPDES permitted facilities. These facilities are:

- Indianapolis Water Company – White River
- Indianapolis Water Company – Fall Creek

- Mount Comfort Elementary School
- Peerless Pump
- Indianapolis Water Company – Geist Station
- IH Sewer Corporation (Exit 10)

Department of Public Works – Office of Environmental Services

The City of Indianapolis, Department of Public Works - Office of Environmental Services (DPW) has 3 primary surface water quality monitoring programs relevant to the Lower Fall Creek Watershed. The water quality monitoring programs are primarily used to monitor the success of the City's Stormwater Management and CSO strategies as they are implemented in accordance with State and Federal guidelines. However, this data is very broad based and is relevant and valuable to the Lower Fall Creek Watershed planning process.

DPW's Monthly White River Monitoring Program was implemented in January of 1991 to monitor the ambient quality of surface water passing through Marion County on a long-term basis, specifically in the West Fork of the White River and its tributaries. Currently, DPW is collecting water quality samples at 3 locations within the Lower Fall Creek Watershed as a component of their Monthly White River Monitoring Program: Fall Creek at 16th Street in the Fall Creek - Minnie Creek Subwatershed, Fall Creek at 71st Street in the Fall Creek – Devon Creek Subwatershed, and Fall Creek and Emerson Way in the Fall Creek – Lawrence Creek Subwatershed.

Based on monthly White River sampling data the following conclusions have been drawn:

- The ***E. coli*** water quality standard is consistently exceeded along Fall Creek from the Geist Reservoir Spillway to the confluence of the White River.
- Mean phosphorus concentrations along Fall Creek between Emerson Way and 16th Street are above EPA recommended thresholds.
- Mean nitrogen concentrations are below Indiana TMDL guidelines.
- Mean Total Suspended Solid (TSS) levels are typically below IDEM recommended thresholds.

DPW also conducts a continuous DO monitoring program, which monitors DO concentrations at strategic locations that have the potential for water quality impairment. Monitoring is typically conducted from mid-April/early-May through December. Continuous DO monitoring provides DPW the ability to observe diurnal and long-term patterns of DO changes at specific sites. Currently, Fall Creek at 16th Street in the Fall Creek-Minnie Creek Subwatershed is the only active site within the Lower Fall Creek Watershed

Based on Continuous DO sampling data the following conclusions have been drawn:

- Depressed DO levels and diurnal fluctuations are a concern in the Fall Creek- Minnie Creek Subwatershed.

Marion County Health Department (MCHD)

Historically, Marion County has conducted 4 Water Quality Sampling Programs throughout Marion County, an Ambient Water Quality Program, an Herbicides Program, a Public Access/Recreation Sampling Program, and a Macroinvertebrate Sampling Program.

In January of 1997, MCHD started an ambient sampling project for Fall Creek. This project consisted of 9 sites sampled 5 times per month, with geometric means calculated for each site's ***E. coli*** data. The purpose of the project was to find non-CSO influences of ***E. coli*** to Fall Creek. In 1999, the sampling points were adjusted to coincide with the City's CSO projects to help determine their overall impact to water quality, as well as to maintain data for historical comparison and continue working on non-CSO influences.

Presently, 6 sites on Fall Creek are sampled 5 times per month as a component of the ambient program, with geometric means calculated for each site's ***E. coli*** data. Active ambient sampling sites on Fall Creek are located on Fall Creek at Stadium Drive, Martin Luther King Jr. Street, Illinois Street, Central Avenue, 30th Street, and 39th Street in the Fall Creek–Minnie Creek Subwatershed.

Based on the ambient sampling data the following conclusions have been drawn:

- The ***E. coli*** water quality standard is consistently violated along Fall Creek within the Fall Creek - Minnie Creek Subwatershed.
- Phosphorus concentrations have typically been below detection limits of laboratory equipment utilized to analyze water quality samples. However, because the EPA recommended phosphorus threshold is lower than laboratory detection limits it is assumed that mean concentrations of phosphorus are at the existing detection limit of 0.19mg/L.
- Mean nitrogen concentrations are below Indiana TMDL guidelines.

In 1995, MCHD started an herbicide monitoring program for Eagle Creek, Fall Creek and White River to evaluate the level of herbicides in Marion County source water. Historically, samples have been collected at 7 sites in the Lower Fall Creek Watershed. Those sites consist of Fall Creek at 79th Street, Indian Creek at Indian Creek Road, Lawrence Creek at Shatner Rd, and Fall Creek at Emerson Way in the Fall Creek - Lawrence Creek Subwatershed, Mud Creek at Fall Creek Road in the Mud Creek - Sand Creek Subwatershed, and Fall Creek at Keystone Avenue in the Fall Creek - Minnie Creek Subwatershed. Currently, samples are only collected from Fall Creek at the Keystone Avenue site.

Based on the Herbicide sampling data the following conclusions have been drawn:

- Mean atrazine levels at Fall Creek and Keystone are above the state water quality standard.
- Phosphorus concentrations have typically been below detection limits of laboratory equipment utilized to analyze water quality samples. However, because the EPA recommended phosphorus threshold is lower than laboratory detection limits it is assumed that mean concentrations of phosphorus are at the existing detection limit of 0.19mg/L.
- Mean nitrogen levels are below Indiana TMDL guidelines.

For many years, the MCHD has collected monthly grab samples for ***E. coli*** from the major waterways in Marion County during the recreational season (April through October). The purpose of the Recreational sampling program, is to warn people of potentially elevated ***E. coli*** levels in areas frequented for recreation. Such places are in/or near parks, greenways, canoe launches, schools, and fishing areas. Currently the Health Department is not conducting any public recreation monitoring within the Lower Fall Creek Watershed.

Based on historic recreational season sampling data the following conclusions have been drawn:

- The ***E. coli*** water quality standard is consistently exceeded along Fall Creek and its tributaries.

In 1998, MCHD completed its first annual collection of benthic macroinvertebrates from streams throughout Marion County. There are many advantages of using benthic macroinvertebrates to assess the quality of a stream. First, monitoring of biological communities is relatively inexpensive in comparison to the cost of assessing chemical or bacterial parameters. It also has minimal detrimental effects on the resident biota. Benthic macroinvertebrates are also good indicators of localized conditions, as many of the animals have limited migration patterns. Sensitive life stages respond quickly to stress while the overall community will respond more slowly. Within the Lower Fall Creek Watershed, the MCHD is actively collecting macroinvertebrate samples on Fall Creek at 16th Street, Central Avenue, and 39th Street in the Fall Creek - Minnie Creek Subwatershed, Emerson Way in the Fall Creek-Devon Creek Subwatershed, and at 79th Street in the Fall Creek – Lawrence Creek Subwatershed.

Based on MCHD macroinvertebrate data the following conclusions have been drawn:

- Biological communities in Fall Creek at Emerson Way are considered to be good under the Hilsenhoff Biological Index (HBI). A score of good is indicative of some organic pollution.
- Biological communities in Fall Creek at 39th Street are considered to be good under the HBI.
- Biological communities in Fall Creek at 79th Street are considered fairly poor under the HBI. A score of fairly poor is indicative of significant organic pollution.
- Biological communities in Fall Creek at Central Avenue are considered fairly poor under the HBI.
- Biological communities in Fall Creek at 16th Street are considered poor under the HBI. A score of poor is indicative of very significant organic pollution.

Mud Creek Bioassessment 2003

During May, June, and October 2003, students from Indiana University Southeast used rapid bioassessment protocols to assess the status of Mud Creek. In particular, the study looked at eight sites located within the Mud Creek Headwaters Subwatershed and the Mud Creek - Sand Creek Subwatershed. Three of those sites, Mud Creek at Atlantic Road, Mud Creek at Olio Road, and Mud Creek at Brook School Avenue, were located in the Mud Creek Headwaters Subwatershed; and five of those sites, Sand Creek near Verizon Wireless Entertainment Complex, Sand Creek at Mud Creek near 106th Street, Mud Creek at 106th Street, Mud Creek at Cumberland Road, and Mud Creek at 96th Street were located in the Mud Creek - Sand Creek Subwatershed.

Based on the Mud Creek Bioassessment the following conclusions have been drawn:

- ***Fecal coli form*** concentrations in Mud Creek and Sand Creek are exceeding EPA recommended thresholds.
- Phosphorus concentrations in Mud Creek and Sand Creek are exceeding EPA recommended thresholds.
- Nitrogen concentrations in Mud Creek and Sand Creek are below Indiana TMDL guidelines.
- Turbidity levels (NTU) in Mud Creek and Sand Creek are exceeding EPA recommended reference conditions.
- Macroinvertebrate communities in Mud Creek and Sand Creek are classified as slightly impaired.
- Habitat in Mud Creek and Sand Creek is classified as slightly impaired.

1991 – 2005 Fixed Station Water Quality Results

Under IDEM's Fixed Station Water Quality Monitoring Program, IDEM scientists collect water samples and field analytical data every month from 160 sampling sites at selected rivers, streams, and lakes throughout the state. This program has been collecting water quality samples from two sites within the Lower Fall Creek Watershed since February of 1991. The first site is located on Fall Creek at Keystone Avenue in the Fall Creek - Minnie Creek Subwatershed; the second site is also located on Fall Creek in the Fall Creek - Minnie Creek Subwatershed, but further downstream at Stadium Drive.

Based on Fixed Station sampling data, the following conclusions have been drawn:

- The ***E. coli*** water quality standard is consistently exceeded along Fall Creek from the Geist Reservoir Spillway to the confluence of the White River.
- Mean phosphorus concentrations on Fall Creek at Stadium Drive area above EPA recommended thresholds.
- Mean nitrogen concentrations are below Indiana TMDL guidelines.
- Mean Total Suspended Solid (TSS) levels are typically below IDEM recommended thresholds.

Lower Fall Creek IUPUI Assessment 2007

In October of 2007 two IUPUI students completed Citizen Qualitative Habitat Evaluation Index (CQHEI) assessment sheets at 16 specified locations (**Figure 3-2**) within the upper reaches of the Lower Fall Creek Watershed.

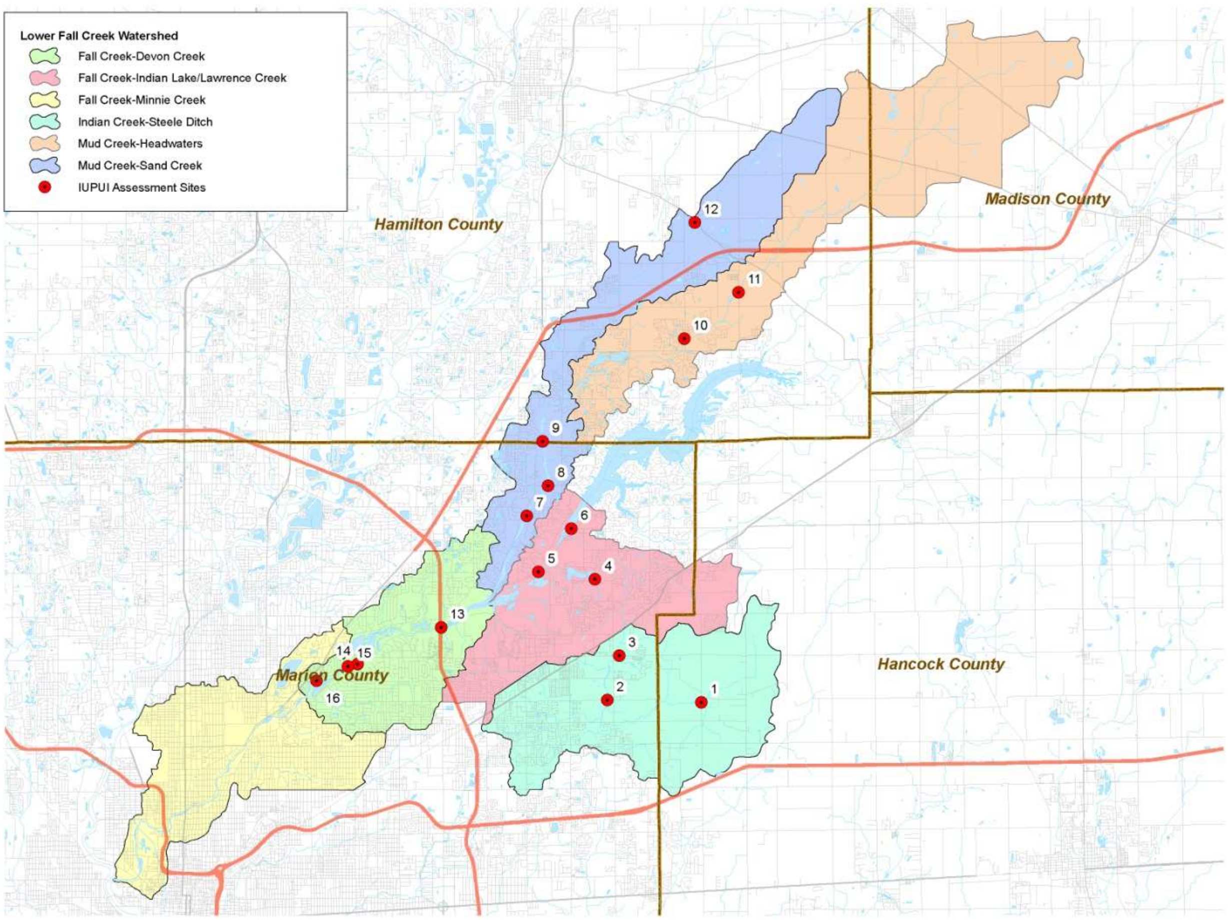


Figure 3-2: IUPUI Assessment Sites

The CQHEI was developed by the Ohio EPA to provide a measure of the stream habitat and riparian health that generally corresponds to physical factors affecting fish and other aquatic life. The CQHEI produces a total score, with a maximum of 114, which can be utilized to compare changes at one site over time or to compare 2 different sites. Further, Ohio EPA has determined that “CQHEI scores > 60 have been found to be generally conducive to the existence of warmwater fauna”.

Parameter sections are given an individual score and the total of those sections is the overall site score.

Parameters that are evaluated include:

- Substrate (bottom type)
- Fish Cover (hiding places)
- Stream Shape and Human Alterations
- Stream Forests & Wetlands (Riparian Area) & Erosion
- Depth and Velocity
- Riffles/Runs (areas where current is fast/turbulent, surface may be broken)

Based on CQHEI data the following conclusions have been drawn:

- Of 16 sites, 9 received scores >60 in part due to high scoring Substrate and Stream Forests & Wetlands sections.
- Of those 9 sites receiving > 60, 4 sites received scores >80 and all were along the main stem of Fall Creek.
- Sites 12 and 1, both in the upper reaches of the watershed, received the lower scores of 20 and 34 respectively. Both CQHEI scores indicate a very fine (silt) substrate, stream alterations, and no riffle/run sequences.
- CQHEI scores seemed to generally increase from upstream to downstream throughout the watershed.

<u>Lower Fall Creek Commonwealth Biomonitoring Assessment 2008</u>

As a part of the Lower Fall Creek WMP development, macro-invertebrate sampling and geomorphic assessments were completed by Commonwealth Biomonitoring, Inc. While there have been several studies measuring the chemical water quality throughout the watershed, there is very little data related to the biological water quality. The objectives of this bioassessment were to characterize the biological and physical integrity of Lower Fall Creek and its tributaries and to make recommendations to solve any identified problems. This was accomplished by utilizing the Index of Biotic Integrity (IBI) and the Qualitative Habitat Evaluation Index (QHEI) at 12 sites in the watershed. In addition, Rapid Stream Assessments were completed measuring river corridor encroachments, bank measurements, sinuosity, and bed substrate. **Figure 3-3** identifies the macroinvertebrate sampling locations.

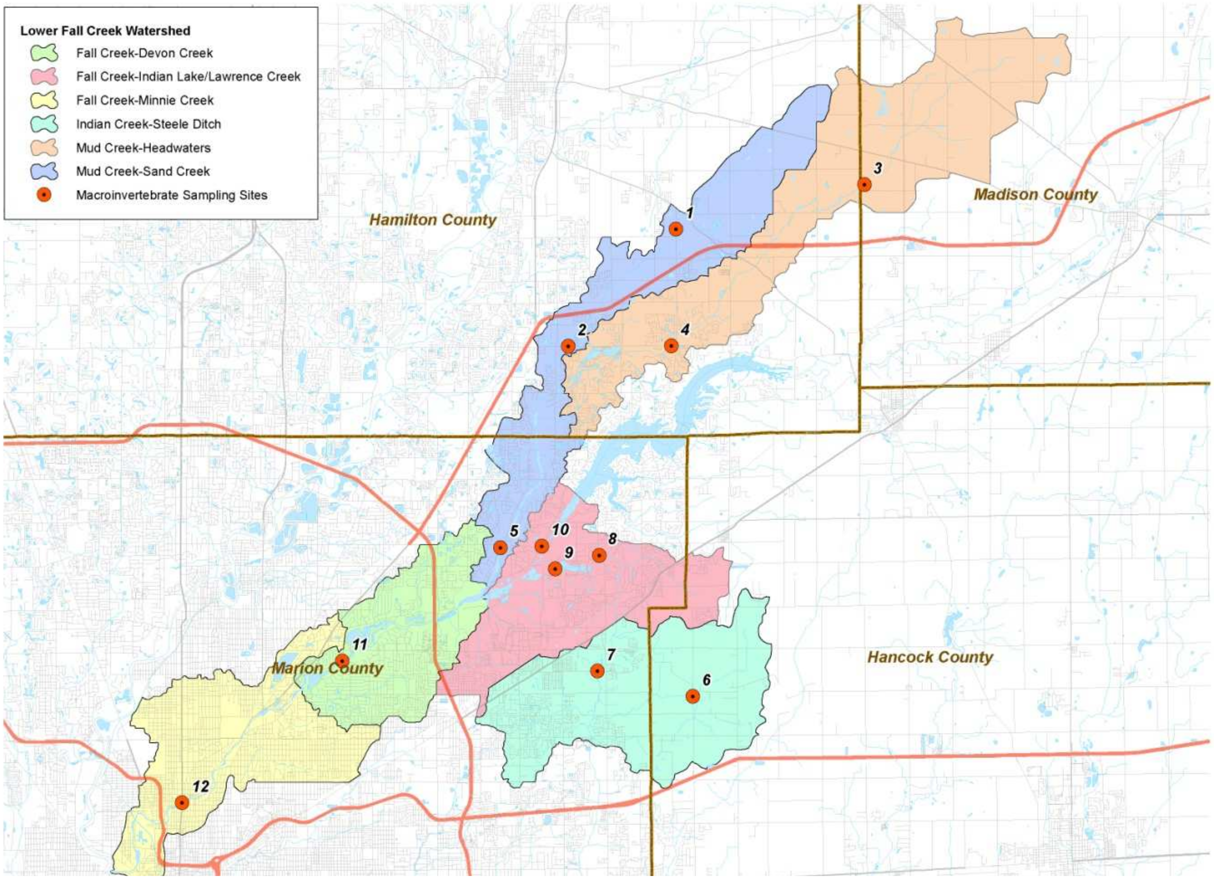


Figure 3-3: Macroinvertebrate Sampling Sites

Based on the findings of the Commonwealth Biomonitoring assessment, the following conclusions have been drawn:

- Heavy silt deposits were observed at all sites within the Indian Creek subwatershed.
- Habitat quality was limited by a lack of in-stream cover and riparian vegetation in the Fall Creek subwatershed.
- While habitat quality at the sites within the Mud Creek subwatershed were reduced by past channelization, it was overall good.
- Sand Creek subwatershed sites had the poorest habitat scores due to heavy silt deposits, unstable substrates, and evidence of recent channelization.

Commonwealth Biomonitoring also provided 4 recommendations as to enhance the overall water quality and macroinvertebrate assemblages within the Lower Fall Creek Watershed. These include:

1. Control inflow of sediment and silt into streams with special emphasis placed on the Indian Lake subwatershed.
2. Investigate status of water quality within Geist Reservoir as it may be impairing biotic integrity downstream in Fall Creek.
3. Enhance habitat by planting riparian vegetation especially upstream of site 6 and downstream of site 12.
4. Avoid future channelization of streams.

A report provided by Commonwealth Biomonitoring, as well as the data collected through the assessment, is located in **Appendix 7.**

Summary of Water Quality Conclusions

Based on the analysis of water quality studies and data, the following quality conclusions have been drawn:

- Bacteria concentrations exceed EPA recommended thresholds and Water Quality Standards throughout the Lower Fall Creek Watershed.
- Phosphorus levels are exceeding EPA recommended thresholds throughout the Lower Fall Creek Watershed.
- Depressed DO levels and diurnal fluctuations are a concern in the Fall Creek- Minnie Creek Subwatershed.
- Biological communities are stressed throughout the Lower Fall Creek Watershed.
- Habitat is degraded within the Mud Creek - Sand Creek and Mud Creek Headwaters Subwatersheds.
- Atrazine concentrations are exceeding the State Water Quality Standard in the Fall Creek – Minnie Creek Subwatershed.
- PCB and Mercury levels are elevated throughout the Lower Fall Creek Watershed.

For the purposes of this planning effort, the focus of the WMP will be placed on reducing sediment, nutrient, and pathogen loadings to the Lower Fall Creek Watershed. These 3 main pollutants were discussed and agreed upon by the Steering Committee and the 3 Working Groups. While TSS levels were typically below IDEM recommended thresholds, the Steering Committee and Working Groups felt that this issue was prevalent throughout the watershed and warranted focus in the WMP.

It was discussed that insufficient data and studies have been collected and completed regarding invasive species, herbicide and pesticide applications and associated water quality problems, as well as localized drainage and flooding problems. While it is known that these issues exist and impact water quality, there is currently not enough data to support water quality conclusions regarding the Lower Fall Creek Watershed.

While the baseline studies mentioned above do not specifically indicate water quality problems associated with sedimentation or elevated levels of TSS, several stakeholders have brought this issue to the discussion. Erosion and sedimentation especially as it relates to streambank destabilization and stormwater runoff were discussed and will therefore be included in this WMP.

It can be anticipated that some of the water quality impacts associated with depressed DO levels, stressed biological communities, and habitat degradation will also be reduced through the potential management measures identified in **Section 5.0** for the purpose of addressing sediment, nutrient, and pathogen loadings. Further, it was determined that while it is important to identify areas affected by, and the water quality impacts associated with, increased Atrazine, PCBs, Lead, and Mercury levels, it is not feasible for the WMP to address these issues. Much of the work associated with Atrazine, PCBs, Lead, and Mercury contamination in streams and rivers needs to be addressed and remediated at the State and Federal levels. In addition, much of the CSO issues and associated ***E. coli*** loadings will be addressed during the implementation of the City of Indianapolis' LTCP.

3.3 CAUSES AND SOURCES OF POLLUTION

For each pollutant to be addressed within this WMP (sediment, nutrients, and pathogens), potential sources of that pollutant within the Lower Fall Creek Watershed will be discussed in further detail. The Land Use & Economic Development Work Group, in working to create the land use categories for Lower Fall Creek, also developed **Table 3-6** Land Use Categories and Associated Pollutants. This table is designed to highlight land use categories and potential sources of pollutants that are associated with those land use categories.

Table 3-6: Land Use Categories and Associated Pollutants

Land Use Category	Associated Pollutant
1. **Agriculture**	Sediment – tillage practices, streambank erosion from encroachment Nutrients – fertilizer application, livestock and manure management Pathogens – failing septic systems, livestock, wildlife, and manure management
2. **Low-Density Residential**	Sediment – streambank erosion from encroachment and stormwater runoff Nutrients – fertilizer application and failing septic systems Pathogens – failing septic systems, stormwater runoff, domestic pet and wildlife waste
3. **Commercial, Industrial, Educational, Medium-to-High Residential** (without NPDES permit)	Sediment – streambank erosion from encroachment and stormwater runoff Nutrients – fertilizer application, combined sewer overflows Pathogens – stormwater runoff, domestic pet and wildlife waste, combined sewer overflows, illicit stormwater connections
4. Commercial, Industrial (with NPDES permit)	Sediment – streambank erosion from encroachment and stormwater runoff Nutrients – combined sewer overflows Pathogens – stormwater runoff, combined sewer overflows, illicit stormwater connections
5. **Open Space**	Sediment – streambank erosion from encroachment and stormwater runoff Nutrients – fertilizer application Pathogens – stormwater runoff, domestic pet and wildlife waste
6. **Golf Course**	Sediment – streambank erosion from encroachment and stormwater runoff Nutrients – fertilizer application Pathogens – stormwater runoff, wildlife waste
7. **Active Construction**	Sediment – failing erosion and sediment control practices

Sediment

By volume, sediment is the greatest pollutant entering our nation's surface waters. Erosion and sedimentation occur when wind or water runoff carries soil particles from an area, such as a farm field, stream bank, or construction site and transports them to a water body. Within Lower Fall Creek Watershed, sediment loads are anticipated to originate from conventional tillage practices where loosened soils remain exposed to weather, streambank erosion exacerbated by encroachment of activities such as tillage or development, and failing sediment and erosion control practices on active construction sites.

Like nutrients, sediment also impacts fisheries, drinking water supplies, and recreational uses of waterways. By reducing the amount of sunlight reaching aquatic plants, the availability of fish cover and food is greatly reduced, and mating practices are impacted. Sediment also impacts fish communities by covering and filling fish spawning areas and smothering benthic food supplies. Sediment loads also tend to increase drinking water treatment costs and can result in damage to pumps and other water treatment equipment. Finally, sediments impact recreational uses by reducing water clarity, aesthetic value, and sport fishing populations. There are three primary sources of sediment within the Lower Fall Creek Watershed, tillage practices, construction and development, and stream bank erosion.

Tillage Practices

One way to minimize sedimentation and erosion associated with agricultural activities is to implement conservation tillage practices. No-till refers to any direct seeding system, including strip preparation, with minimal soil disturbance. Mulch till refers to any tillage system leaving greater than 30% crop residue cover after planting, excluding no-till. No-till and mulch till are often grouped together into conservation tillage. **Table 3-7** compares various tillage methods utilized within the Lower Fall Creek Watershed.

During various water quality sampling and habitat assessment events it has been noted that turbidity and siltation levels are increased in areas where conventional tillage practices still occur. An increase in conservation tillage practices in the Lower Fall Creek Watershed will likely reduce the loading of fine clay particulates and surface erosion materials that are delivered to adjacent waterways. Water quality impacts associated with conventional tillage practices can be exacerbated when they occur on highly erodible lands (HEL). If not managed properly, HELs can erode at accelerated rates and may lead to excessive soil deposition in waterways. HELs are determined based on slope and other erodibility factors. According to the USDA, the soil of an entire crop field is considered erodible if at least one-third of the field has highly erodible soils. There are approximately 13,500 acres of highly erodible soils within the Lower Fall Creek Watershed (**Exhibit 4-1**). HELs are primarily a concern for erosion associated with agricultural practices.

Table 3-7: Percent of Crop Acres in Conservation Tillage

County	Crop	% No Till (2004)	% Mulch-Till	% Conventional Till	State Rank
Hamilton	Corn	25%	5%	61%	36 of 92 Counties
	Soybeans	74%	74%	8%	21 of 92 Counties
Hancock	Corn	2%	3%	70%	89 of 92 Counties
	Soybeans	47%	22%	10%	73 of 92 Counties
Madison	Corn	11%	2%	81%	63 of 92 Counties
	Soybeans	68%	5%	16%	31 of 92 Counties
Marion	Corn	***No Data***	***No Data***	***No Data***	***No Data***
	Soybeans	***No Data***	***No Data***	***No Data***	***No Data***

(ISDA, 2004)

It is also noted that within the middle reaches of the watershed (Hamilton County), rapid growth and development is converting agricultural lands to other land uses, such as residential and commercial. As this rate of development is one of the highest in Indiana, it is anticipated that agricultural land, and specifically tillage practices, will be of little concern in the near future. In the Madison County portions of the watershed, agriculture remains the primary land use. While growth and development are not occurring as rapidly as in Hamilton County, it is anticipated that eventually this area, especially as the Interstate 69 corridor is developed, will be converted from agricultural land use to commercial, industrial or residential land use. Throughout this time of land use conversion, efforts to reduce the erosion occurring from conventional tillage practices and HELs on agricultural lands will best be led by the individual county SWCDs by utilizing existing federal funding sources through USDA.

Construction and Development Practices

Construction and development practices can also result in excessive sediment loading to local waterways. As stormwater flows over a construction site, it picks up pollutants like sediment, debris, and other pollutants associated with land-disturbing activities. As was the case with tillage practices, when land disturbing activities occur on HELs, sediment loads to local waterways have the potential to increase substantially. Exhibit 4-1 identifies areas of known and potentially HEL classified soils. Exhibit 4-1 paired with Exhibit 2-2 can be used to further highlight areas where growth and development is being planned and where HEL or PHEL classified soils exist, especially in the Mud Creek and Sand Creek subwatersheds.

The NPDES Stormwater Phase I and Phase II programs require operators of construction sites greater than or equal to 1 acre (including smaller sites that are part of a larger common plan of development) to obtain authorization to discharge stormwater under an NPDES construction stormwater permit. Within the Lower Fall Creek Watershed there are several local and state agencies responsible for ensuring local compliance with stormwater requirements. Included among the agencies are the Hamilton, Hancock, Madison, and Marion County SWCDs, the City of Indianapolis DPW, the Hamilton and Hancock County Surveyor's Office, the Fishers Department of Engineering and Public Works, the Noblesville Wastewater Department, the

Lawrence Department of Public Works, the McCordsville Town Engineer, and the IDEM. Despite the number of agencies charged with monitoring erosion and sediment control practices on construction and development sites within the watershed, enforcement efforts tend to be inconsistent, and program resources tend to be underfunded.

Efforts to reduce stormwater runoff and related erosion from construction and development within the Lower Fall Creek Watershed could greatly reduce the sediment loadings to Fall Creek and tributary streams. As continued urbanization and re-development occurs throughout the Lower Fall Creek watershed, practices such as Low Impact Development (LID) and proper erosion control practices during construction could result in a significant reduction in sediment loadings.

Streambank Erosion

Overall streambank erosion is a natural phenomenon. When a stream is healthy, it balances water flow, sediment loads, and its overall shape and energy. However, excessive erosion tends to pollute water supplies, smother aquatic habitat, and threaten property and infrastructure.

Surrounding land use activities have a tremendous impact on the rate at which streambank erosion occurs within a watershed. As development and impervious surface increase in a watershed, so to do stream flow volumes and peak discharges, which accelerate erosion. As impervious areas and developed acres increase, the amount of pervious surfaces and open space uses, such as riparian buffers tend to decrease in the watershed. Riparian buffers are one of the most beneficial types of open space in any watershed. These areas consist of large overstory trees, smaller woody shrubs, and herbaceous groundcover that act as natural barriers against stream bank erosion. However, as riparian vegetation is changed from woody species to annual grasses and/or forbs, which is often the case on development sites, the internal strength of the stream bank is weakened and erosion rates are increased.

Areas where little to no riparian vegetation exists, as in the primarily agricultural areas of Hancock and Madison County portions of the watershed, are considered to be areas of concern regarding sedimentation and potential streambank erosion. This concern is validated by the findings of the 2007 IUPUI Assessment and the 2008 Bio assessment. In both assessments, the sites associated with the most marked erosion are located in the upper reaches of the watershed; in Hamilton and Hancock Counties. Of notable significance is the Hancock County sampling site within the 2008 Bioassessment. At this site, no trees were present and clumps of streambank were slumping into the channel.

Significant streambank erosion problems in more urban areas, such as the Windridge Condominiums site discussed in Chapter 4 have been identified through stakeholder input and the IUPUI Assessment. Several residents and neighbors of Windridge Condominiums expressed deep concern over the magnitude of the erosion and failing of the streambank in that area. Further, the IUPUI assessment indicated undercut banks, downed trees, and a combination of stable and eroding banks in Marion County (sites #14, 15, and 16).

Estimated Existing Sediment Loads

In order to estimate existing sediment loadings, EPA’s Spreadsheet Tool for Estimating Pollutant Loads (STEP-L) was utilized. STEP–L employs simple algorithms to calculate nutrient and sediment loads from different land uses and load reductions that would result from the implementation of various best management practices (BMPs). Based on STEP-L results, existing sediment loads within the Lower Fall Creek Watershed are estimated at 13,748 Tons/Year.

Efforts to reduce the sediment loads to the Lower Fall Creek Watershed focus on reducing the inputs from construction and development practices as well as streambank stabilization measures, both structural and non-structural. These are discussed further in **Section 5.0** of this WMP. Agricultural practices to reduce sediment loadings within the Lower Fall Creek watershed were considered but are not the focus of this planning effort. As urbanization and development occurs throughout the upper reaches of the watershed, agricultural sediment sources will be reduced. Due to the transitional nature of the watershed, the Steering Committee and Work Groups chose to focus on measures designed to prevent future loadings from developed lands.

<u>Nutrients (Phosphorus and Nitrogen)</u>

According to the EPA, nutrient pollution, especially from nitrogen and phosphorus, has consistently ranked as one of the top causes of degradation of waters of the US for more than a decade. Nutrients impact fisheries by promoting algal blooms that reduce plant growth and by reducing dissolved oxygen concentrations through increased productivity and decay of organic matter. Nutrients impact drinking water supplies by increasing treatment costs. Finally, nutrient concentrations, especially phosphorus, can limit recreational uses of waterways. Blue-Green algae, also known as cyanobacteria, which resulted in the use restrictions on Geist Reservoir in the summer of 2007, thrive in phosphorus rich waters. There are 3 primary sources of nutrients within the Lower Fall Creek Watershed, 1) fertilizer application, 2) inadequately functioning septic systems, and 3) combined sewer overflows. An additional source of nutrient loading is manure from agricultural and hobby operations in the more rural areas of the watershed. More detail on the agricultural impact will be provided later in this section as bacteria and pathogens are the primary pollutants of concern regarding manure.

Fertilizer Application

Nutrients such as phosphorus and nitrogen in the form of commercial fertilizers are often applied by agricultural users to enhance crop production. Similarly, residential and commercial property owners in the Lower Fall Creek Watershed routinely utilize fertilizers to promote the growth of turf grass and other landscaping.

The Office of Indiana State Chemist (OISC) annually publishes the total tonnages of commercial fertilizers sold in each Indiana County. The list includes single nutrient fertilizers, multi-nutrient fertilizers, as well as organic and micronutrient fertilizers. **Table 3-8** estimates the annual nutrient application based on the amount of nutrients sold in the Lower Fall Creek Watershed. Total countywide application rates were multiplied by the percent of the County's land area within the Lower Fall Creek Watershed in order to estimate watershed wide application.

Table 3-8: Estimate of Nutrient Applications

County	% of County in Watershed	x	Total Nutrients (tons)		X 2,000 lbs/ton	Nutrients in watershed (lbs)	
			N	P2O5		N	P2O5
Hamilton	5.97%	x	1,425	1,079	X 2000	170278	128,934
Hancock	3.40%	x	307	764	X 2000	20,889	51,986
Madison	2.72%	x	641	1,327	X 2000	34,882	72,213
Marion	10.75%	x	410	549	X 2000	88,174	118,067
Total						314,224	371,199

(OISC, 2007)

The table shown above describes an estimate of the amount of fertilizer applied in the Lower Fall Creek Watershed and is not intended to serve as an estimate of loadings to waterways. Based upon nutrient removal rates from crops and turf grasses, it is expected that only a portion of the applied fertilizer nutrients would be mobilized to local waterways, as a majority of the macronutrient would be utilized by the vegetation to which it was applied.

Lawn and garden practices associated with residential and commercial land uses are expected to be a substantial source of the excess nutrients in the watershed as these land uses are the most prevalent. Much of the estimated nutrients applied within the Lower Fall Creek Watershed are within Hamilton and Marion Counties, as indicated in Table 3-7. As land uses transition within the watershed (as identified on Exhibit 2-2) the anticipation is that an increase in fertilizers and nutrients applied to residential and commercial lawns will increase accordingly. The Hamilton County portion, and eventually the Hancock and Madison County areas, would be the area expected to see the largest rise in applications of these additives.

Professional lawn and garden chemical applicators receive training and are required to maintain application records, but the average citizen does not. Therefore, the typical resident and business owner may often over-apply lawn and garden chemicals, which are easily washed away and contribute significant nutrient loads to adjacent waterbodies. Applications of fertilizers from either a professional or an individual home or business owner need to be completed according to the product's instructions, but also in accordance with the needs of the soil. Many times, even in cases where professional services are utilized, soil nutrient levels are not analyzed.

Additionally, yard wastes such as grass clippings, leaves, and dead plants are high in organic matter, and when piled or dumped on nearby stream banks, they can potentially smother naturally stabilizing vegetation. This smothering can lead to increased bank erosion and decreased levels of dissolved oxygen. The long-term effects of yard waste dumping is increased levels of nutrients from the decomposition of the waste, as well as the increased nutrient levels associated with increased sedimentation and destabilization of streambanks. Yard wastes are considered a source of pollution in the Lower Fall Creek Watershed, however the relative extent of that pollution is not known at this time.

Based on decisions made by the Steering Committee and Work Groups, the focus of efforts to reduce nutrient loadings from fertilizer application and yard wastes will be directed to golf courses and residential lakes over 50 acres in size. There are 8 golf courses within the Lower Fall Creek Watershed; 1 located in a WFPA and 5 additional courses that are located directly adjacent to or spanning tributary streams. These public golf courses are highly visible and could be utilized as a demonstration area for practices reducing the application and potential runoff of excess nutrients.

Lakes larger than 50 acres and surrounded by residential land use were also selected as a focus area. These lakes are directly connected to either surface or ground water resources in the Lower Fall Creek Watershed and transferred water may carry with it increased levels of nutrients from fertilizers applied to the residential lawns surrounding these lakes. Specific details regarding these areas are provided in Chapter 4 in this WMP.

Inadequately Functioning Septic Systems

Inadequately functioning septic systems are a large source of nutrients in the watershed. According to the EPA, even fully functional septic systems reduce only 28% of nitrogen concentration and 57% of phosphorus concentration of household wastewater. As septic systems fall into disrepair, these removal capabilities are reduced even further. According to the Chesapeake Bay Journal, a properly operating septic system is releasing more than ten pounds of nitrogen per year to groundwater for each person using it, and approximately 26% of that is making its way to open waters.

Within the Lower Fall Creek Watershed, the Marion County Health Department and the Indianapolis DPW have identified areas serviced by residential septic systems and prioritized these areas for connection to sanitary sewer through the Septic Tank Elimination Program (STEP). These areas are illustrated on **Exhibit 4-3**.

While nutrients from inadequately functioning septic systems is a concern within the Lower Fall Creek watershed, the primary pollutant from these sources is pathogens. Therefore, more detailed information regarding the magnitude of the concern, location of unsewered areas will be found in the pathogens portion of this section.

Combined Sewer Overflows (CSOs)

Like septic systems, CSOs are also a source of nutrients to waterways within the lower portions of the Lower Fall Creek Watershed. The CSO locations within the watershed have been identified on Exhibit 4-3. Implementation of the Indianapolis CSO LTCP will greatly reduce the loadings of nutrients to Fall Creek. As mentioned above, the LTCP established a schedule of detailed actions that will be taken to reduce water quality problems associated with CSOs, and should be referenced for all CSO-related water quality improvements.

Estimated Existing Nutrient (Phosphorus and Nitrogen) Loads

Based on STEP-L results, existing phosphorus loads within the Lower Fall Creek Watershed are estimated at 85,590 lbs/year, and existing nitrogen loads are estimated at 405,439 lbs/year.

Efforts to reduce the nutrient loads to the Lower Fall Creek Watershed focus on reducing the inputs from fertilizer application to golf courses and residential properties surrounding lakes greater than 50 acres. These are discussed further in Section 5.0 of this WMP.

<u>Pathogens</u>

Bacteria concentrations within the Lower Fall Creek watershed have typically been measured via ***E. coli*** or fecal coliform concentrations. The presence of fecal coliform bacteria in aquatic environments indicates that water has been contaminated with the fecal material of humans or other animals. Similarly, ***E. coli*** bacteria is associated with the intestinal track of warm blooded animals and is widely used as an indicator of sewage pollution in surface waters. Where bacteria concentrations are elevated there is an increased likelihood that disease causing organisms may be present in surface waters. Bacteria have detrimental effects on fisheries, water supply, and recreational uses of water bodies. Bacteriological contamination exposes aquatic life to disease causing organisms, increases drinking water treatment costs and threatens public health by threatening the drinking water supply, and prevents recreational uses of waterbodies.

As discussed above, the 2003 Fall Creek TMDL Study quantified and established pollutant reduction targets for ***E. coli*** in the Lower Fall Creek Watershed. According to the TMDL, the primary sources contributing the greatest loadings of bacteria to surface waters in the Lower Fall Creek Watershed are 1) inadequately functioning septic systems, 2) illicit connections to the storm sewer, 3) wildlife and background levels, 4) urban stormwater, and 5) CSOs.

Inadequately Functioning Septic Systems

Failing and inadequately functioning septic systems are common sources of bacteria in waterbodies throughout Indiana. While septic systems can be a safe and effective method for treating wastewater if they are sized, sited, and maintained properly, they frequently fall into disrepair. Unfortunately, homeowners are often unaware of how septic systems function, where their system is located, or how they should maintain their system.

Within the Lower Fall Creek Watershed 92% of soils are considered to be moderately or severely limited for onsite wastewater treatment. These soil limitations are identified on Exhibit 4-1. **Table 3-9** identifies subdivisions within the Lower Fall Creek Watershed that have been prioritized under the City of Indianapolis' Septic Tank Elimination Program (STEP). These areas are also identified in Exhibit 4-3.

Table 3-9: STEP Priorities

Project Name	Primary Subwatershed	Priority Ranking
42nd and Sherman	Fall Creek – Devon Creek	High
42nd and Millersville	Fall Creek – Minnie Creek	High
46th and Millersville	Fall Creek – Devon Creek	High
82nd and Red Bud	Mud Creek – Sand Creek	High
46th and Emerson	Fall Creek – Devon Creek	High
48th and Allisonville	Fall Creek – Minnie Creek	Medium
61st and Allisonville	Fall Creek – Minnie Creek	Medium
Fall Creek and Johnson	Fall Creek – Devon Creek	Low
55th and Allisonville	Fall Creek – Minnie Creek	Low
56th and Fall Creek	Fall Creek – Devon Creek	Low
57th and Kessler	Fall Creek – Minnie Creek	Low
46th and Ritter	Fall Creek – Devon Creek	Low

Problems with inadequate septic systems are intensified when those systems are located in floodplain areas. Flooding leads septic systems to function improperly which can result in stormwater runoff that contains elevated concentrations of ***E. coli,*** nutrients, and other pollutants. None of the STEP subdivisions lie within a regulated floodplain area.

In the Lower Fall Creek Watershed, Hamilton County, the Town of Fishers, and the City of Noblesville are serviced by Hamilton Southeastern Utilities. Information regarding the sewer service area of Hamilton Southeastern Utilities was unavailable. It is assumed that areas outside of these sanitary service areas are served by on-site septic systems. As the Town of

Fishers and City of Noblesville grow, areas on septic are required to connect to sanitary sewer. As growth and development are planned throughout Hamilton County, especially in the portion of the watershed north of 146th Street and east to the Hamilton – Madison County line, existing residential septic systems will be replaced with sanitary sewer service, potentially reducing the pathogen loadings to Sand and Mud Creeks. Portions of Sand and Mud Creek in this area have delineated floodplains where few residential properties currently exist.

Development in the Madison County portion of the Lower Fall Creek is scattered, very low density, and serviced by septic systems. None of the streams in the Madison County portion of the watershed have delineated floodplains. In Hancock County, with the exception of some isolated septic systems, the developed areas are serviced by the Town of McCordsville Sewer District.

Illicit Connections to the Storm Sewer

In addition to falling into disrepair, septic systems are often tied directly into local drainage tiles, ditches, and storm sewer systems. While this connection may have been intentional at one time, often times current homeowners or tenants are unaware that their wastewater is tied directly into these conveyances. According to research completed by the Center for Watershed Protection, some of the most common types of illicit connections include broken sanitary lines, cross connections, sanitary sewer overflows, and direct connections from septic systems.

As part of NPDES Stormwater Phase I and Phase II requirements the City of Indianapolis, the City of Lawrence, the City of Noblesville, the Town of Fishers, and Hamilton, Hancock, and Madison Counties are required to screen their stormwater outfalls during periods of dry weather in an effort to identify illicit stormwater discharges. According to the Fall Creek TMDL, the City of Indianapolis has learned that approximately 8% of their 145 stormwater outfalls contain wet flows during periods of dry weather. As of the writing of this plan the City of Noblesville, the Town of Fishers, and Hamilton, Hancock, and Madison Counties have not begun their dry weather screening programs as regulatory schedules have not required this action.

Wildlife and Background Levels

Wildlife within the Lower Fall Creek Watershed is a source of bacteria loadings. It is difficult to determine the exact contribution that different animals have on ***E. coli*** loadings; however, in many central Indiana watersheds, waterfowl have been identified as a significant source of ***E. coli*** loading to local waterways. Many existing commercial and residential developments within the Lower Fall Creek Watershed have ponds or lakes with unrestricted access for Canada Geese to nest and raise their young. The number of these developments with ponds can be expected to increase in areas slated for future development, such as those highlighted on Exhibit 2-2.

Habitually, ducks and geese nest in colonies located in trees and bushes around rivers, streams, and lakes. ***Lake Access*** is a Minnesota based initiative that began in 1999 to deliver real-time water quality information on Minneapolis metropolitan lakes to the public using advanced sensor technology and the Internet. According to their research, the average goose dropping has a dry weight of 1.2 grams and each goose is responsible for approximately 82 grams of feces per day. Common management strategies for controlling Canada Geese and other waterfowl include reducing or eliminating all mowing activities within 50' – 75' of a waterbody, minimizing watering and fertilizing activities within 50' – 75' of a waterbody, planting less palatable species of grass and plants along the water's edge, prohibiting feeding, and utilizing auditory, visual, and physical scare tactics.

Additionally, recent water quality studies done by the Maryland Department of the Environment identified pet waste as the second most common source of bacteria in the Washington DC area. Pet wastes can be controlled through ordinances requiring collection and removal of the waste from curbsides, yards, parks, roadways, and other areas where the waste can be washed directly into receiving waters.

Stormwater Runoff

Differing land uses contribute different bacteria loadings to local waterways. Causes of bacteria in stormwater runoff include domestic pet waste, wildlife, and agricultural uses. According to the TMDL, "Average stormwater ***E. coli*** bacteria counts were estimated from literature values and based on Indianapolis Mapping and Geographic Infrastructure System (IMAGIS) land use and watershed coverages. These bacteria counts were applied to surface runoff flows from October 1991 to October 2001 as predicted using the city's watershed model". **Table 3-10** identifies estimated stormwater ***E. coli*** concentrations and percentages of land use types within the City of Indianapolis as identified in the Fall Creek TMDL study.

Table 3-10: *E. coli* Concentrations and Land Use Classes in the City of Indianapolis

	Com.	Res.	Historic & Hospital	Indust.	Parks	Highways	Spec. Uses	University
Assumed ***E. coli*** Concentration	2,500 CFU	2,000 CFU	2,500 CFU	5,000 CFU	2,000 CFU	5,000 CFU	3,000 CFU	3,000 CFU
Mud Creek	***Assumed to be the same as Fall Creek***							
Fall Creek upstream	3%	71%	0%	2%	4%	1%	19%	0%
Fall Creek CSO	9%	65%	1%	9%	4%	2%	9%	1%

(Fall Creek TMDL, 2003)

The TMDL also discusses the anticipated ***E. coli*** stormwater loads to Fall Creek that come from permitted, non-permitted, and out-of-county sources. It is anticipated that 45% of the ***E. coli*** loads originate from permitted (storm drain outfall) sources while the remaining 55% originate from outside of Marion County. The City of Indianapolis' stormwater programs are designed to address only the portion of the loads from within Marion County.

Combined Sewer Overflows

The City of Indianapolis built its first storm sewers hundreds of years ago in order to carry stormwater away from streets and homes and into rivers. However, when indoor plumbing became available, sewage lines from homes and business were tied directly into the existing storm sewer system, which discharged directly to local receiving waters. In recognition of the water quality and health problems that this system posed, the City eventually built wastewater treatment plants to treat and eliminate sewage before it entered local waterways.

During periods of dry weather, the capacity of the sewer system and wastewater treatment plants are sufficient, and nearly all stormwater and sewage in the combined sewer system is treated by the wastewater treatment plant. However, during rain events, the capacity of the combined sewer system is insufficient, and in order to prevent sewage from backing up into basements and onto streets, combined stormwater, sanitary and raw sewage overflows into local streams.

Within the Lower Fall Creek Watershed there are 28 CSO outfalls. These outfalls are identified on Exhibit 4-3. In order to correct problems associated with CSOs the City has developed the Raw Sewage Overflow Long Term Control Plan and Water Quality Improvement Plan (LTCP). In total, the City's LTCP will ultimately capture 95-97% of sewage entering streams during wet weather and is estimated to cost the City more than $1.73B. The LTCP has detailed actions that will be taken to reduce water quality problems associated with CSOs, and should be referenced for all CSO related water quality improvements.

Among the plans identified in the LTCP to reduce sewerage overflows in the Lower Fall Creek Watershed include:

- Digging underground tunnels that will store and carry sewage to the City's wastewater treatment plant.
- Building new, larger sewers to capture overflows and carry them to the tunnel.
- Installing inflatable dams and sluice gates at key point in the sewer system.
- Separating sewers in a neighborhood near 38th St.
- Removing the dam near Dr. Martin Luther King Junior Street and Fall Creek to improve stream flow and raise dissolved oxygen concentrations. This was completed in the fall of 2007.

Livestock and Manure Management

The Fall Creek TMDL focused on bacteria sources within Marion County, and considering the limited agricultural land uses within the county, the TMDL did not discuss agricultural sources of bacteria. However, within the Lower Fall Creek Watershed, more than 22,000 acres are currently in agricultural production. Further, the Indiana State Fairgrounds' has been discussed as a potential source of manure laden runoff leading to elevated levels of ***E. coli*** within Lower Fall Creek.

Manure, whether being stored, applied for crop nutrition, or simply the by-product of grazing is a water quality concern in the Lower Fall Creek Watershed. The best way to manage for and mitigate the potential water quality impacts of manure application and storage is to ensure that storage, application rates, and timing aspects are appropriately addressed through the implementation of nutrient management plans on agricultural lands.

A Confined Feeding Operation (CFO) is a livestock operation that has in excess of 600 hogs, 300 cattle, or 600 sheep. These facilities are required, by IAC 16-2-5, to obtain a permit from IDEM's Office of Land Quality. According to IDEM's records, there is only 1 active CFO located in the Lower Fall Creek Watershed. In addition to this CFO within the watershed, there are Animal Feeding Operations (AFOs) in the upper reaches of the Lower Fall Creek Watershed in Hamilton, Hancock, and Madison Counties. These operations continue to decline in number and in number of cattle, pigs, and sheep at each operation. Further, Hamilton County ranks among the top 10 counties in Indiana in regard to the number of horses. **Table 3-11** identifies the total number livestock and overall state rankings for Hamilton, Hancock, Marion, and Madison County.

Table 3-11: Livestock Statistics

	Cattle		Hogs		Sheep	
	Head	Rank	Head	Rank	Head	Rank
Hamilton	4,300	72	10,500	62	988	23
Hancock	2,900	80	37,082	29	1,941	6
Madison	4,500	70	26,875	42	655	39
Marion	1,000	92	N/A	N/A	252	66

(NASS, 2007)

Pasture management can be an effective management measure to reduce impacts that small livestock operations have on water quality. Pasture management leads to better weed control, better soil structure, increased productivity over longer periods of time, and healthier animals. It also helps the soil absorb excess water, manure, nutrients and other pollutants and ultimately protects water quality by reducing the amount and improving the quality of runoff. As discussed earlier within Section 3.3, related to tillage practices, the Steering Committee and Working Groups have agreed that agricultural related management efforts are best led by the individual county SWCDs. Local SWCD and NRCS staff have long-established relationships with agricultural landowners as well as an extensive knowledge of USDA programs designed to mitigate livestock and manure impacts as well as those designed to protect water quality in a livestock production area.

Estimated Existing Bacteria Loads

Bacteria load reductions identified within the 2003 Fall Creek TMDL were utilized to estimate bacteria loads for the Lower Fall Creek Watershed. Based on results from the TMDL existing bacteria loads within the Lower Fall Creek Watershed are estimated at 1.59E+14 CFU/recreational season (April to October). In order to meet the water quality standard identified in Table 3.2, the TMDL calls for a 1.57E+12 CFU reduction. This equates to a 52% reduction of ***E. coli*** loadings upstream of the CSO area and 99.5% reduction of ***E. coli*** loadings downstream of the CSO area.

Problem Statements

After analysis of Water Quality data, evaluation of pollutant causes and sources, and estimation of existing pollutant loads the following problem statements have been developed relevant to the Lower Fall Creek Watershed.

Problem Statement #1

Macroinvertebrate and habitat assessment scores at 17 of 28 (60%) of the sites assessed scored under 60 on the CQHEI or QHEI indices. The cause for this is assumed to be due to excessive siltation observed at these sites.

Problem Statement #2

Increased levels of nutrients throughout the Lower Fall Creek watershed have harmful impacts on drinking water, recreational use waters, and aquatic plant and animal life. The cause for this is Phosphorus concentrations that routinely exceed the EPA recommended threshold of 0.076 mg/L.

Problem Statement #3

Restrictions on primary contact recreation in Lower Fall Creek have been implemented and advertised in some areas while discouraged in others. The cause for this is due to ***E. coli*** concentrations routinely exceeding the State of Indiana's Water Quality Standard of (geometric mean) 125 CFU/100ml.

While sediment, excess nutrients, and the potential presence of pathogens seem to be the primary water quality problems in the Lower Fall Creek Watershed, other concerns such as invasive species, diurnal fluctuations of dissolved oxygen concentrations, poor habitat quality, and impaired biotic communities have also been identified. Problem statements have not been identified for these issues as it is expected that the implementation of mitigation measures intended to reduce loadings of pathogens, nutrients, and sediments will also serve to improve habitat and biological health, and reduce invasive species.

3.4 AREA OF CONCERN SUMMARY

As a method of better understanding the cumulative impacts of the areas of concern discussed within this section, a composite map was created and is shown as **Figure 3-4**. This map can be utilized to aid in the evaluation of areas and activities of concern, the development of Critical Areas, as well as a means to direct outreach efforts related to education or implementation of BMPs designed to reduce the water quality impacts within each subwatershed. For example, many areas of concern are located within the Fall Creek – Devon Creek subwatershed. Perhaps this would be a good subwatershed to begin when starting targeted education and outreach and implementation programs.

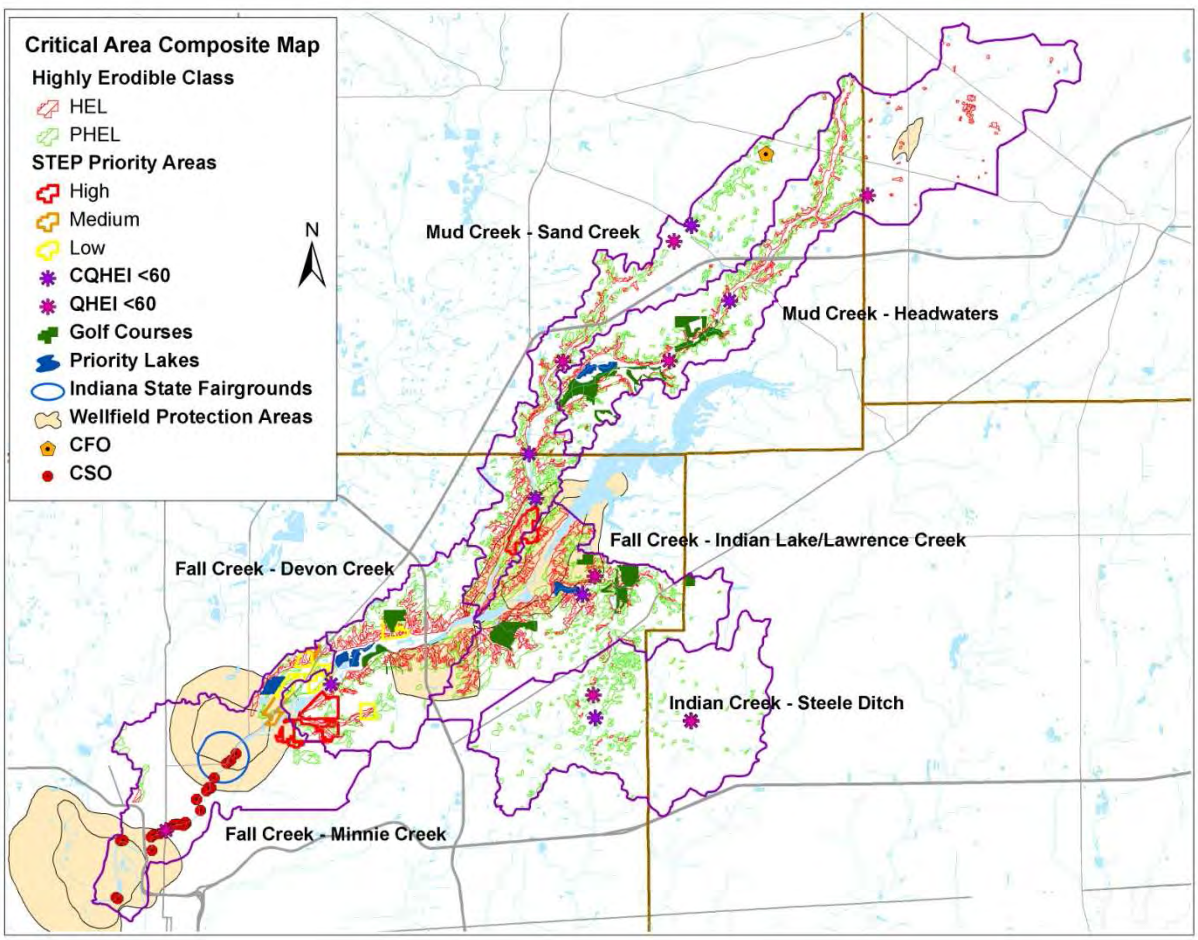


Figure 3-4: Critical Areas Composite Map

Figure 3-4 should be used in conjunction with Figure 2-2 highlighting existing land uses and areas where growth and development are expected or planned. As growth and development within the watershed is proposed, special considerations should be given to areas such as HEL or PHEL classified soils or WFPAs.

4.0 CRITICAL AREAS

Critical Areas are specific areas or activities in the watershed that are suspected of degrading water quality. Focusing on a few specific areas or activities should be more effective at improving water quality than a generalized watershed-based program. Implementation of management measures (programs, policies, or projects) for these specific areas or activities in the watershed should have the greatest impact on water quality. However, not all areas and activities identified as Critical Areas may be at a stage where management measures can be implemented. In this case, these are still valid Critical Areas because they provide an example of what is happening in the Lower Fall Creek Watershed and an opportunity to learn what, if anything could be done differently to improve water quality.

4.1 IDENTIFICATION OF CRITICAL AREAS

To identify Critical Areas in the Lower Fall Creek Watershed, each of the 3 work groups (Education & Outreach, Land Use & Economic Development, and Water Quality) met and reviewed the list of Stakeholder concerns from Table 3-1 and composite GIS maps showing wellfield protection areas, erodible lands, floodplains, sewer service areas, impaired streams, and land use.

Each work group discussed the impact of sediment, nutrients, and pathogens on aquatic life, recreation, and drinking water; the land use or land use practice associated with each pollutant; and then identified specific areas or activities in the Lower Fall Creek Watershed suspected of degrading water quality. **Table 4-1** is a copy of the exercise used to identify Critical Areas with each work group.

<u>Sediment Critical Areas</u>
As shown on **Exhibit 4-1**, the specific sediment Critical Areas include areas classified as HEL or PHEL, especially those areas lacking sediment and erosion controls and those with conservation tillage; the Indian Lake watershed, and streambanks identified as undergoing severe erosion.

HEL & PHEL Classified Soils
HEL determinations are made by the NRCS, are based on mathematical equations considering rainfall factors, erodibility of the soil type, allowable loss for that soil type, and the length and the slope of the area. Soil map units may be classified as Potentially Highly Erodible (PHEL) based on a varying range of length/slope values. In such instances, the final determination of erodibility must be made through an onsite investigation.

Approximately 20% of the soils within the watershed are classified as HEL or PHEL. Activities exposing HEL or PHEL soil types for periods of time, such as construction or conventional tillage, may exacerbate the erosion and sedimentation impact within the Lower Fall Creek Watershed.

- Lack of Erosion & Sediment Control

According to US EPA, the most environmentally dangerous period of development is the initial construction phase when land is cleared of vegetation and graded to create a proper surface for construction. The removal of natural vegetation and topsoil makes the exposed area particularly susceptible to erosion, causing transformation of existing drainage areas and disturbance of sensitive areas.

Erosion and sediment control is widely accepted as a necessary practice, but there are certain caveats to making it effective. First, communities need to have the staff and resources to adopt and enforce an Erosion & Sediment Control Ordinance. In addition, a Technical Standards or Manual (as part of the Erosion & Sediment Control Ordinance) needs to provide useful guidance on selecting erosion and sediment control measures. Finally, education of contractors, engineers, and designers regarding the importance and effective use of erosion and sediment controls is imperative to implementing effective erosion and sediment control. **Figure 4-1** shows an example of a poorly installed erosion and sediment control system.

Figure 4-1: Poorly installed silt fencing

Erosion and sediment control has been identified as a Critical Area (or critical activity) because of the current development and potential for development in the Lower Fall Creek Watershed. The City of Lawrence, City of Noblesville, Town of Fishers, Hamilton County, and Madison County are required to have a an Erosion & Sediment Control Ordinance in order to be in compliance with the NPDES Phase II Stormwater Program. The City of Indianapolis has an Erosion & Sediment Control Ordinance as a requirement of the NPDES Phase I Stormwater Program. As construction and development occur within the Lower Fall Creek Watershed, additional precaution should be taken in areas of HEL or PHEL soil classifications.

- Conventional Tillage Practices

Within the Lower Fall Creek Watershed approximately 22,000 acres are in agricultural production; while approximately 13,500 acres are classified as HEL. As identified in Table 3-7, much of those acres in Hamilton, Hancock, and Madison Counties associated with corn production are utilizing conventional tillage (no data is available for Marion County tillage types).

Conventional tillage systems disturb the entire soil surface, resulting in less than 15% residue cover after planting. Conventional tillage practices on HEL or PHEL classified soils allow those erodible soils to be exposed to the weather for periods of time, typically during the spring wet weather prior to planting, or after harvest in the fall, leaving the soil exposed during the spring thaw, or both.

Indian Lake Watershed

Indian Lake is located in the City of Lawrence. Approximately 16,000 acres drain to this 54 acre lake (**Figure 4-2**). This ratio of 300:1 far exceeds the current standard of 100:1. The Hancock County portion of the Indian Lake subwatershed remains primarily undeveloped with the

Figure 4-2: Indian Lake

exception of proposed growth in the Town of McCordsville. The Marion County portion is predominantly residential.

The Indian Lake Homeowners Association has been dredging approximately 3,000-5,000 tons of sediment from the lake on an annual basis. Due to this frequency and volume, the Association has found it to be more cost effective to purchase their own dredging equipment. In 2007, the Indian Lake Homeowners Association reached a settlement agreement with INDOT for damages due to negligence in erosion control during a 2005 Pendleton Pike road project. The settlement funds are to be put toward dredging cost.

Indian Lake was selected by the working groups and the Steering Committee based on the amount of sediment entering the lake necessitating dredging on a routine basis. Water quality, macroinvertebrate, and physical assessments completed within the Indian Lake watershed have attributed impaired waters or degraded habitats to the excessive amount of silt within the streams and tributaries leading to the lake.

Indian Lake can provide a good representation of the issues faced by many of the lakes within the Lower Fall Creek Watershed and is currently managed by an active Homeowners Association willing to put forth effort to protect the quality and aesthetic value of their lake.

Eroded Streambanks

During the assessments completed by IUPUI students in 2007 and by Commonwealth Biomonitoring in 2008 streambanks experiencing erosion were observed and noted. These areas, identified on Exhibit 4-1, and the upstream drainage areas should be further studied to determine the specific causes for the streambank erosion; lack of riparian vegetation, streambank encroachment by agricultural or development practices, or increases in conveyance volumes via surface runoff or direct piping to the receiving streams. In the more rural areas of the watershed, Commonwealth's Site 6, located in Hancock County is of significant interest. Clumps of streambank with vegetation attached, signifying recent erosion, and excess silt within the streambed were observed. While no areas of exceptional erosion were noted in the IUPUI assessment, only 5 of the 16 sites were noted as having stable banks.

Figure 4-3: Eroded Streambank at Windridge Condominiums

Several stakeholders present at the public meetings, Steering Committee meetings, and Work Group meetings discussed the effects of streambank erosion and how it can potentially have a direct effect on hundreds of property owners. One example of such significant damages caused by streambank erosion is located near the intersection of Emerson Way and 56th Street. Windridge Condominiums and the National Headquarters of Phi Kappa Psi experienced a significant loss of streambank in March 2007 requiring them to relocate approximately 400 linear feet of sanitary sewer along Fall Creek (**Figure 4-3**) and close to the main entrance to the Phi Kappa Psi house.

This area has been identified as a Critical Area within the Lower Fall Creek Watershed since it represents the magnitude of social, physical, and economic losses that result when streambank erosion is not addressed. Streambank erosion is usually a symptom of a larger problem in the watershed.

Further downstream, the accumulation of sediment and large woody debris from the eroded banks of Fall Creek have restricted flow and flooded commercial and residential developments. The Windridge Condominiums Homeowners Association have recently retained the services of a professional engineering firm to study the drainage area and determine the best solution to stabilize the banks of Fall Creek, reduce additional streambank erosion, and downstream flooding.

<u>Nutrient Critical Areas</u>

Nutrient Critical Areas or activities were identified as the over application of lawn fertilizers on residential lakes and golf courses. The Steering Committee and Work Groups worked to determine where to focus efforts on reducing nutrient loads with the anticipation of having the greatest overall watershed effect and a high visibility for implemented practices or BMPs. As a result, lakes greater than 50 acres in size and surrounded by residential land use and golf courses were identified. **Exhibit 4-2** illustrates the location of these 5 lakes and 8 golf courses in the Fall Creek Watershed.

Golf Courses

The maintenance practices of golf courses are often identified as a source of runoff polluted with excess nutrients and chemicals. Courses are also designed with several ponds or "water hazards" which may be attractive to water fowl such as Canada Geese, also commonly identified as a source of nutrient, and other pollutant, loadings. Without good course design and maintenance practices, golf courses can have a detrimental effect on riparian buffers, wetlands, and water quality. Further, groundwater may be impacted by heavily applied fertilizers and pesticides.

Of the 8 golf courses identified on Exhibit 4-2, only one, Indian Lake Country Club Golf Course, lies within a Wellfield Protection Area (Geist). In addition, there are 5 courses that are directly adjacent to or span across bodies of water: Brendonwood (Fall Creek); Fort Golf Course (Camp Creek); Gray Eagle (Mud Creek); Hawthorne (Mud Creek); and Ironwood (Mud Creek). The Fort Golf Course (**Figure 4-4**) is in the process of achieving certification through the Audubon International's Cooperative Sanctuary Program for Golf Courses. The Ironwood Golf Course, shown in **Figure 4-5**, highlights the proximity of the golf course to Stonebridge Lake, which is one of the prioritized residential lakes within the Lower Fall Creek watershed.

Golf courses within the Lower Fall Creek Watershed have been identified as Critical Areas due to the potential for elevated levels of fertilizers and pesticides in runoff to surface waters or the potential for leaching into groundwater systems. These public courses are highly visible, visited by thousands of stakeholders each year, and may also serve as sites for future projects related to reduced fertilizer application, stormwater pollutant filtration measures, riparian buffers, and education and outreach efforts.

Figure 4-4: Fort Golf Course

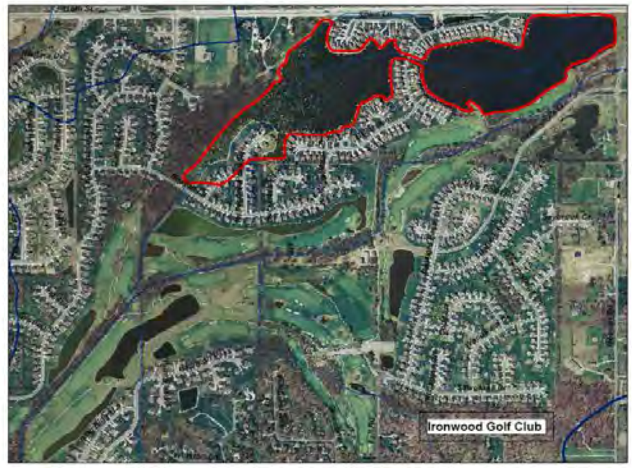


Figure 4-5: Ironwood Golf Club

Residential Lakes

Inland lakes surrounded by residential land use may be severely impacted due to excess lawn fertilizers, pet & wildlife waste, and even failing residential septic systems. As the lake systems are impacted by increased bacteria and nutrient loadings human health issues, aesthetic value, and property values may also be negatively impacted as a result. Residential lakes were selected based on the potential concentrations of homeowners reached through education and outreach efforts focused through the HOA, the visibility of BMPs installed or measures implemented, and the ability to involve individual homeowners or the HOA through long-term monitoring and measurement of the impacts of BMP installation.

Figure 4-6: Lake Maxinhall

Five residential lakes greater than 50 acres were selected as Critical Areas. These include: Lake Kesslerwood (East & West), Lake Maxinhall, Stonebridge, and Indian Lake. These were selected because there is opportunity to build the partnerships needed to implement management measures and observe or monitor water quality improvements. Two of the 5 lakes (Indian Lake and Lake Maxinhall) were created through sand and gravel mining operations several years ago. These lakes also lie within WFPAs, further creating the need for designation as a critical area as there is a direct connection between surface water and ground water within these areas. **Figure 4-6** is of Lake Maxinhall, one of the lakes located within a WFPA. This particular lake is of particular interest because it is within proximity to several non-sewered neighborhoods along its eastern border. Other lakes considered critical have a direct connection to Fall Creek or tributary streams as Indian Creek travels through Indian Lake (also located within a WFPA), tributaries to Sand Creek travel through Stonebridge Lake, and Atkinson Creek flows to Lake Kesslerwood and an outlet to Fall Creek has been constructed in

this area.

More details regarding other sources of nutrient loading to the watershed, non-sewered areas and CSOs, will be included within the pathogens discussion.

Pathogen Critical Areas

Specific Critical Areas or activities for pathogens were identified by the Fall Creek TMDL, Steering Committee, Work Groups, and watershed stakeholders as non-sewered developments, livestock and manure management, and Wellfield Protection Areas. **Exhibit 4-3** shows the overall location of these Critical Areas or activities. Other areas discussed by these groups, but not considered as a Critical Area (or activity) within this WMP, are CSOs, waterfowl, and stormwater runoff.

Non-Sewered Development

Septic systems can be a safe and effective method for treating wastewater if they are sized, sited, and maintained properly. However, as discussed in Section 3.0, failing and inadequately functioning systems are a common source of bacteria and pathogens in waterbodies. The NRCS has rated 92% of the soil in the Lower Fall Creek as moderate or severely limited for septic system use.

An additional concern within non-sewered developments is the potential for septic systems to be tied directly to local drainage tiles, ditches and storm sewer systems. These illicit discharges serve as a direct conduit for bacteria and pathogens (and excess nutrients) to travel to streams within the watershed. As a part of the NPDES Stormwater Phase I and Phase II requirements, communities within the Lower Fall Creek Watershed are required to screen outfalls during periods of dry weather to identify these illicit discharges. For many of the Lower Fall Creek Watershed Communities, this process has not yet began as regulatory schedules have not required this action.

Development in the Madison County portion of the Lower Fall Creek Watershed is scattered, very low in density, and on septic. If growth and development follows the guidance of the Comprehensive Plan, this area is expected to remain this way. Further downstream, the Hamilton Southeastern Sewer District provides sewer service to the portions of Hamilton County, City of Noblesville, and Town of Fishers in the Lower Fall Creek Watershed. Similar to Madison County, the development in this portion of Hamilton County is scattered, very low density, and on septic. However, as the City of Noblesville grows into this area, sewer lines will be extended and new (and existing) development will be connected to a wastewater treatment facility. The Town of Fishers has recently implemented a program to assist homeowners in their jurisdiction to connect to sanitary sewer. All new development is required to be sewered.

In 2005, the City of Indianapolis DPW Clean Stream Team initiated a Septic Tank Elimination Program (STEP) to convert entire neighborhoods on septic to sewer by 2025. This program replaces the Barrett Law conversion program and is estimated to save homeowners 50% of the cost to connect to sanitary sewer. In the Lower Fall Creek Watershed, there are 12 neighborhoods that have been identified and prioritized in STEP.

The STEP areas include:

- High Priority Neighborhoods – 82nd and Redbud, 46th and Millersville, 46th and Emerson, 42nd and Sherman, 42nd and Millersville
- Medium Priority Neighborhoods – 62st and Allisonville, 46th and Allisonville

- Low Priority Neighborhoods – 57th and Kessler, 55th and Allisonville, Fall Creek and Johnson, 46th and Ritter

In Hancock County, with the exception of some isolated septic systems, the developed areas are serviced by the Town of McCordsville Sewer District.

Livestock and Manure Management

Manure, whether being stored, applied for crop nutrition, or simply the by-product of grazing is a water quality concern within Lower Fall Creek Watershed. The Fall Creek TMDL did not discuss agricultural sources of bacteria or pathogens due to the limited amount of agricultural land use within Marion County. However, elsewhere in the watershed, livestock and manure are more of a contributing factor.

- Confined Feeding Operations

A Confined Feeding Operation (CFO) is a livestock operation that has in excess of 600 hogs, 300 cattle, or 600 sheep. These facilities are required, by IAC 16-2-5, to obtain a permit from IDEM's Office of Land Quality. According to IDEM's records, there is only 1 active CFO located in the Lower Fall Creek Watershed. In addition to this CFO within the watershed, there are Animal Feeding Operations (AFOs) in the upper reaches of the Lower Fall Creek Watershed in Hamilton, Hancock, and Madison Counties. These operations continue to decline in number and in number of cattle, pigs, and sheep at each operation. Further, Hamilton County ranks among the top 10 counties in Indiana in regard to the number of horses.

As discussed earlier within previous sections, the Steering Committee and Working Groups have agreed that agricultural related management efforts are best led by the individual county SWCDs. Local SWCD and NRCS staff have long-established relationships with agricultural landowners as well as an extensive knowledge of USDA programs designed to mitigate livestock and manure impacts as well as those designed to protect water quality in a livestock production area.

- Indiana State Fair Grounds

In urban areas, runoff from impervious surfaces, such as parking lots and roads are major contributors to stream pollution. The Indiana State Fair Grounds was identified as a Critical Area because it comprised of more than 250 acres (approximately 70 acres of imperviousness) in the Lower Fall Creek Watershed. The State Fair is home to more than 300 events each year, including the annual Indiana State Fair. During the State Fair, the fairgrounds are populated with thousands of livestock, including horses, cattle, hogs, sheep, poultry and numerous others (**Figure 4-7**). The livestock are usually available for display in one of the fairgrounds 7 livestock barns.

Figure 4-7: Horse event at State Fair

Water quality data collected to date indicates that the State Fair grounds are contributing ***E. coli*** loadings to Fall Creek. Since 1993, the Health Department has collected grab samples on Fall Creek during the State Fair. This sampling program has included the collection of ***E. coli*** samples at 39th Street, which is located upstream of the fairgrounds, at the fairgrounds stormwater outfall, and downstream of the fairgrounds at 30th Street. A similar sampling program conducted since 1994 has demonstrated parallel results.

There has long been recognition that animal waste from the fairgrounds contributes to pollution to Fall Creek. In 1999, the City of Indianapolis DPW completed a 104(b)(3) water quality cooperative grant to design a wetland-type wastewater treatment system for runoff leaving the fairground site. However, this project was never constructed.

Wellfield Protection Areas

There are 5 Wellfield Protection Areas (WFPA) in the Lower Fall Creek Watershed. These include the Riverside, Fall Creek, Lawrence, Geist, and Southern Madison County Utilities wellfields.

Figure 4-8: Wellfield Protection Area

WFPAs were identified as a Critical Area because of the potential contamination to groundwater and drinking water supply to approximately 20% of central Indiana population. Pollutants of particular concern in these areas are nutrients and pathogens. Land use and land use practices in the 4 WFPAs in Marion County that may impact groundwater are regulated through a Wellfield Protection Ordinance (City County General Ordinance # 91, 2003). As part of this Ordinance, new development and redevelopment plans are reviewed by a Technically Qualified Person (TQP).

The Ordinance also established a Marion County Wellfield Education Corporation (MCWEC) whose mission is to prevent contamination of groundwater through public awareness and education – like the "Entering Wellfield Protection Area" roadside sign illustrated in **Figure 4-8**. MCWEC targets it education and outreach efforts toward the businesses in the WFPAs that were grandfathered under the Ordinance. Although a Source Water Protection Plan has been prepared for the WFPA in Madison County, an Ordinance regulating land use has not been adopted.

Other

As mentioned, the Fall Creek TMDL, as well as the Steering Committee, Work Groups, and stakeholders also mentioned concerns over the pathogen loadings attributed to CSOs, waterfowl (and other wildlife), and stormwater runoff within the Lower Fall Creek Watershed. While these are important considerations throughout the watershed, and throughout Indiana, this WMP will not highlight specific areas as Critical Areas.

Regarding CSOs within the watershed, the City of Indianapolis has developed their LTCP which will ultimately capture 95-97% of sewage entering streams during wet weather and it is estimated that the implementation of this plan will cost more than $1.73B. The LTCP has detailed actions that will be taken to reduce water quality problems associated with CSOs, and should be referenced for all CSO related water quality improvements.

It is anticipated that actions taken to reduce pollutant loadings within the Critical Areas previously discussed will also reduce pollutant loadings associated with waterfowl (and wildlife) and pollutant laden stormwater runoff. For example, stabilization of streambanks will help reduce sediment loadings, but will also help to reduce pollutant loadings from waterfowl as bank and overhanging vegetation along streambanks and shorelines prohibit Canada Geese from staying in areas for prolonged periods of time. Further reducing applications of nutrients, implementing erosion control practices, and conversion from conventional to conservational tillage practices will also decrease the amount of pollutants within stormwater runoff.

Table 4-1: Identifying Critical Areas Work Group Exercise

DOCUMENTED WATER QUALITY POLLUTANT IN LOWER FALL CREEK	TYPICAL LAND USE/LAND USE PRACTICE ASSOCIATED WITH POLLUTANT		CRITICAL AREAS IN LOWER FALL CREEK WATERSHED
SEDIMENT impacts: Aquatic Life – ***reduces plant growth, smothers and covers spawning grounds and benthic habitats*** Recreational Impact – ***reduces water clarity, reduces aesthetic appeal, stresses sport fishing populations*** Drinking Water – ***increases drinking water treatment costs, damages pumps and infrastructure***	**BENEFIT** water quality: • Riparian Buffers • Filter Strips • Conservation Areas • Post-Construction Practices	**DEGRADE** water quality: • Tillage Practices • Construction Practices • Streambank Erosion • Stormwater Runoff	• ***Erosion and sediment control enforcement*** • ***HEL & PHEL Classified Soils*** • ***Indian Lake Watershed*** • ***Eroded Streambanks***
NUTRIENT (Phosphorus & Nitrogen) impacts: Aquatic Life – ***promotes algal blooms, reduces dissolved oxygen concentrations*** Recreational Impact – ***causes algal blooms, reduces aesthetic appeal, and causes unpleasant odors*** Drinking Water – ***increases drinking water treatment costs (taste and odor), resultant algae can clog water intakes and filters***	**BENEFIT** water quality: • Riparian Buffers • Filter Strips • Post-Construction Practices	**DEGRADE** water quality: • Fertilizer Application • Failing Septic Systems	• ***Over application of fertilizers (residential lakes and golf courses)*** • ***Wellfield Protection Areas***
PATHOGENS (Bacteria & Viruses) ***impacts:*** Aquatic Life – ***exposes aquatic life to disease causing organisms*** Recreational Impact – ***exposes recreational users to disease causing organisms*** Drinking Water – ***increases drinking water treatment costs***	**BENEFIT** water quality: • Sewer Service • Exclusionary Fencing	**DEGRADE** water quality: • Failing Septic Systems • Combined Sewer Overflows (CSO) • Illicit Connections to Storm Sewer • Wildlife • Stormwater Runoff • Livestock & Manure Management	• ***Indiana State Fair Grounds*** • ***Wellfield Protection Areas*** • ***Non-sewered development*** • ***Wellfield Protection Areas*** • ***Livestock and Manure Management Areas***

4.0 CRITICAL AREAS

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Figure 4-2: Indian Lake

Indian Lake Watershed

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Indian Lake can provide a good representation of the issues faced by many of the lakes within the Lower Fall Creek Watershed and is currently managed by an active Homeowners Association willing to put forth effort to protect the quality and aesthetic value of their lake.

Eroded Streambanks

During the assessments completed by IUPUI students in 2007 and by Commonwealth Biomonitoring in 2008 streambanks experiencing erosion were observed and noted. These areas, identified on Exhibit 4-1, and the upstream drainage areas should be further studied to determine the specific causes for the streambank erosion; lack of riparian vegetation, streambank encroachment by agricultural or development practices, or increases in conveyance volumes via surface runoff or direct piping to the receiving streams. In the more rural areas of the watershed, Commonwealth's Site 6, located in Hancock County is of significant interest. Clumps of streambank with vegetation attached, signifying recent erosion, and excess silt within the streambed were observed. While no areas of exceptional erosion were noted in the IUPUI assessment, only 5 of the 16 sites were noted as having stable banks.

Figure 4-3: Eroded Streambank at Windridge Condominiums

Several stakeholders present at the public meetings, Steering Committee meetings, and Work Group meetings discussed the effects of streambank erosion and how it can potentially have a direct effect on hundreds of property owners. One example of such significant damages caused by streambank erosion is located near the intersection of Emerson Way and 56th Street. Windridge Condominiums and the National Headquarters of Phi Kappa Psi experienced a significant loss of streambank in March 2007 requiring them to relocate approximately 400 linear feet of sanitary sewer along Fall Creek (**Figure 4-3**) and close to the main entrance to the Phi Kappa Psi house.

This area has been identified as a Critical Area within the Lower Fall Creek Watershed since it represents the magnitude of social, physical, and economic losses that result when streambank erosion is not addressed. Streambank erosion is usually a symptom of a larger problem in the watershed.

Further downstream, the accumulation of sediment and large woody debris from the eroded banks of Fall Creek have restricted flow and flooded commercial and residential developments. The Windridge Condominiums Homeowners Association have recently retained the services of a professional engineering firm to study the drainage area and determine the best solution to stabilize the banks of Fall Creek, reduce additional streambank erosion, and downstream flooding.

Nutrient Critical Areas

Nutrient Critical Areas or activities were identified as the over application of lawn fertilizers on residential lakes and golf courses. The Steering Committee and Work Groups worked to determine where to focus efforts on reducing nutrient loads with the anticipation of having the greatest overall watershed effect and a high visibility for implemented practices or BMPs. As a result, lakes greater than 50 acres in size and surrounded by residential land use and golf courses were identified. **Exhibit 4-2** illustrates the location of these 5 lakes and 8 golf courses in the Fall Creek Watershed.

Golf Courses

The maintenance practices of golf courses are often identified as a source of runoff polluted with excess nutrients and chemicals. Courses are also designed with several ponds or “water hazards” which may be attractive to water fowl such as Canada Geese, also commonly identified as a source of nutrient, and other pollutant, loadings. Without good course design and maintenance practices, golf courses can have a detrimental effect on riparian buffers, wetlands, and water quality. Further, groundwater may be impacted by heavily applied fertilizers and pesticides.

Of the 8 golf courses identified on Exhibit 4-2, only one, Indian Lake Country Club Golf Course, lies within a Wellfield Protection Area (Geist). In addition, there are 5 courses that are directly adjacent to or span across bodies of water: Brendonwood (Fall Creek); Fort Golf Course (Camp Creek); Gray Eagle (Mud Creek); Hawthorne (Mud Creek); and Ironwood (Mud Creek). The Fort Golf Course (**Figure 4-4**) is in the process of achieving certification through the Audubon International’s Cooperative Sanctuary Program for Golf Courses. The Ironwood Golf Course, shown in **Figure 4-5**, highlights the proximity of the golf course to Stonebridge Lake, which is one of the prioritized residential lakes within the Lower Fall Creek watershed.

Golf courses within the Lower Fall Creek Watershed have been identified as Critical Areas due to the potential for elevated levels of fertilizers and pesticides in runoff to surface waters or the potential for leaching into groundwater systems. These public courses are highly visible, visited by thousands of stakeholders each year, and may also serve as sites for future projects related to reduced fertilizer application, stormwater pollutant filtration measures, riparian buffers, and education and outreach efforts.

Figure 4-4: Fort Golf Course

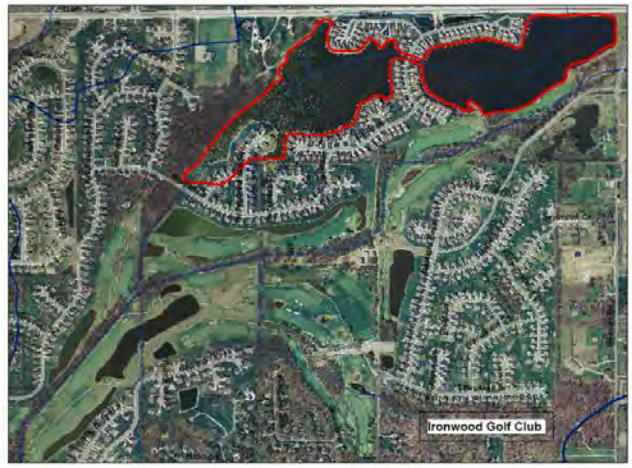

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Figure 4-6: Lake Maxinhall

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More details regarding other sources of nutrient loading to the watershed, non-sewered areas and CSOs, will be included within the pathogens discussion.

Pathogen Critical Areas

Specific Critical Areas or activities for pathogens were identified by the Fall Creek TMDL, Steering Committee, Work Groups, and watershed stakeholders as non-sewered developments, livestock and manure management, and Wellfield Protection Areas. **Exhibit 4-3** shows the overall location of these Critical Areas or activities. Other areas discussed by these groups, but not considered as a Critical Area (or activity) within this WMP, are CSOs, waterfowl, and stormwater runoff.

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Septic systems can be a safe and effective method for treating wastewater if they are sized, sited, and maintained properly. However, as discussed in Section 3.0, failing and inadequately functioning systems are a common source of bacteria and pathogens in waterbodies. The NRCS has rated 92% of the soil in the Lower Fall Creek as moderate or severely limited for septic system use.

An additional concern within non-sewered developments is the potential for septic systems to be tied directly to local drainage tiles, ditches and storm sewer systems. These illicit discharges serve as a direct conduit for bacteria and pathogens (and excess nutrients) to travel to streams within the watershed. As a part of the NPDES Stormwater Phase I and Phase II requirements, communities within the Lower Fall Creek Watershed are required to screen outfalls during periods of dry weather to identify these illicit discharges. For many of the Lower Fall Creek Watershed Communities, this process has not yet began as regulatory schedules have not required this action.

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- High Priority Neighborhoods – 82nd and Redbud, 46th and Millersville, 46th and Emerson, 42nd and Sherman, 42nd and Millersville
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- Low Priority Neighborhoods – 57th and Kessler, 55th and Allisonville, Fall Creek and Johnson, 46th and Ritter

In Hancock County, with the exception of some isolated septic systems, the developed areas are serviced by the Town of McCordsville Sewer District.

Livestock and Manure Management

Manure, whether being stored, applied for crop nutrition, or simply the by-product of grazing is a water quality concern within Lower Fall Creek Watershed. The Fall Creek TMDL did not discuss agricultural sources of bacteria or pathogens due to the limited amount of agricultural land use within Marion County. However, elsewhere in the watershed, livestock and manure are more of a contributing factor.

- Confined Feeding Operations

A Confined Feeding Operation (CFO) is a livestock operation that has in excess of 600 hogs, 300 cattle, or 600 sheep. These facilities are required, by IAC 16-2-5, to obtain a permit from IDEM's Office of Land Quality. According to IDEM's records, there is only 1 active CFO located in the Lower Fall Creek Watershed. In addition to this CFO within the watershed, there are Animal Feeding Operations (AFOs) in the upper reaches of the Lower Fall Creek Watershed in Hamilton, Hancock, and Madison Counties. These operations continue to decline in number and in number of cattle, pigs, and sheep at each operation. Further, Hamilton County ranks among the top 10 counties in Indiana in regard to the number of horses.

As discussed earlier within previous sections, the Steering Committee and Working Groups have agreed that agricultural related management efforts are best led by the individual county SWCDs. Local SWCD and NRCS staff have long-established relationships with agricultural landowners as well as an extensive knowledge of USDA programs designed to mitigate livestock and manure impacts as well as those designed to protect water quality in a livestock production area.

- Indiana State Fair Grounds

In urban areas, runoff from impervious surfaces, such as parking lots and roads are major contributors to stream pollution. The Indiana State Fair Grounds was identified as a Critical Area because it comprised of more than 250 acres (approximately 70 acres of imperviousness) in the Lower Fall Creek Watershed. The State Fair is home to more than 300 events each year, including the annual Indiana State Fair. During the State Fair, the fairgrounds are populated with thousands of livestock, including horses, cattle, hogs, sheep, poultry and numerous others (**Figure 4-7**). The livestock are usually available for display in one of the fairgrounds 7 livestock barns.

Figure 4-7: Horse event at State Fair

Water quality data collected to date indicates that the State Fair grounds are contributing ***E. coli*** loadings to Fall Creek. Since 1993, the Health Department has collected grab samples on Fall Creek during the State Fair. This sampling program has included the collection of ***E. coli*** samples at 39th Street, which is located upstream of the fairgrounds, at the fairgrounds stormwater outfall, and downstream of the fairgrounds at 30th Street. A similar sampling program conducted since 1994 has demonstrated parallel results.

There has long been recognition that animal waste from the fairgrounds contributes to pollution to Fall Creek. In 1999, the City of Indianapolis DPW completed a 104(b)(3) water quality cooperative grant to design a wetland-type wastewater treatment system for runoff leaving the fairground site. However, this project was never constructed.

Wellfield Protection Areas

There are 5 Wellfield Protection Areas (WFPA) in the Lower Fall Creek Watershed. These include the Riverside, Fall Creek, Lawrence, Geist, and Southern Madison County Utilities wellfields.

Figure 4-8: Wellfield Protection Area

WFPAs were identified as a Critical Area because of the potential contamination to groundwater and drinking water supply to approximately 20% of central Indiana population. Pollutants of particular concern in these areas are nutrients and pathogens. Land use and land use practices in the 4 WFPAs in Marion County that may impact groundwater are regulated through a Wellfield Protection Ordinance (City County General Ordinance # 91, 2003). As part of this Ordinance, new development and redevelopment plans are reviewed by a Technically Qualified Person (TQP).

The Ordinance also established a Marion County Wellfield Education Corporation (MCWEC) whose mission is to prevent contamination of groundwater through public awareness and education – like the “Entering Wellfield Protection Area” roadside sign illustrated in **Figure 4-8**. MCWEC targets it education and outreach efforts toward the businesses in the WFPAs that were grandfathered under the Ordinance. Although a Source Water Protection Plan has been prepared for the WFPA in Madison County, an Ordinance regulating land use has not been adopted.

Other

As mentioned, the Fall Creek TMDL, as well as the Steering Committee, Work Groups, and stakeholders also mentioned concerns over the pathogen loadings attributed to CSOs, waterfowl (and other wildlife), and stormwater runoff within the Lower Fall Creek Watershed. While these are important considerations throughout the watershed, and throughout Indiana, this WMP will not highlight specific areas as Critical Areas.

Regarding CSOs within the watershed, the City of Indianapolis has developed their LTCP which will ultimately capture 95-97% of sewage entering streams during wet weather and it is estimated that the implementation of this plan will cost more than $1.73B. The LTCP has detailed actions that will be taken to reduce water quality problems associated with CSOs, and should be referenced for all CSO related water quality improvements.

It is anticipated that actions taken to reduce pollutant loadings within the Critical Areas previously discussed will also reduce pollutant loadings associated with waterfowl (and wildlife) and pollutant laden stormwater runoff. For example, stabilization of streambanks will help reduce sediment loadings, but will also help to reduce pollutant loadings from waterfowl as bank and overhanging vegetation along streambanks and shorelines prohibit Canada Geese from staying in areas for prolonged periods of time. Further reducing applications of nutrients, implementing erosion control practices, and conversion from conventional to conservational tillage practices will also decrease the amount of pollutants within stormwater runoff.

Table 4-1: Identifying Critical Areas Work Group Exercise

DOCUMENTED WATER QUALITY POLLUTANT IN LOWER FALL CREEK	TYPICAL LAND USE/LAND USE PRACTICE ASSOCIATED WITH POLLUTANT		CRITICAL AREAS IN LOWER FALL CREEK WATERSHED
SEDIMENT impacts: Aquatic Life – ***reduces plant growth, smothers and covers spawning grounds and benthic habitats*** Recreational Impact – ***reduces water clarity, reduces aesthetic appeal, stresses sport fishing populations*** Drinking Water – ***increases drinking water treatment costs, damages pumps and infrastructure***	**BENEFIT** water quality: • Riparian Buffers • Filter Strips • Conservation Areas • Post-Construction Practices	**DEGRADE** water quality: • Tillage Practices • Construction Practices • Streambank Erosion • Stormwater Runoff	• ***Erosion and sediment control enforcement*** • ***HEL & PHEL Classified Soils*** • ***Indian Lake Watershed*** • ***Eroded Streambanks***
NUTRIENT (Phosphorus & Nitrogen) impacts: Aquatic Life – ***promotes algal blooms, reduces dissolved oxygen concentrations*** Recreational Impact – ***causes algal blooms, reduces aesthetic appeal, and causes unpleasant odors*** Drinking Water – ***increases drinking water treatment costs (taste and odor), resultant algae can clog water intakes and filters***	**BENEFIT** water quality: • Riparian Buffers • Filter Strips • Post-Construction Practices	**DEGRADE** water quality: • Fertilizer Application • Failing Septic Systems	• ***Over application of fertilizers (residential lakes and golf courses)*** • ***Wellfield Protection Areas***
PATHOGENS (Bacteria & Viruses) ***impacts:*** Aquatic Life – ***exposes aquatic life to disease causing organisms*** Recreational Impact – ***exposes recreational users to disease causing organisms*** Drinking Water – ***increases drinking water treatment costs***	**BENEFIT** water quality: • Sewer Service • Exclusionary Fencing	**DEGRADE** water quality: • Failing Septic Systems • Combined Sewer Overflows (CSO) • Illicit Connections to Storm Sewer • Wildlife • Stormwater Runoff • Livestock & Manure Management	• ***Indiana State Fair Grounds*** • ***Wellfield Protection Areas*** • ***Non-sewered development*** • ***Wellfield Protection Areas*** • ***Livestock and Manure Management Areas***

4.0 CRITICAL AREAS

Critical Areas are specific areas or activities in the watershed that are suspected of degrading water quality. Focusing on a few specific areas or activities should be more effective at improving water quality than a generalized watershed-based program. Implementation of management measures (programs, policies, or projects) for these specific areas or activities in the watershed should have the greatest impact on water quality. However, not all areas and activities identified as Critical Areas may be at a stage where management measures can be implemented. In this case, these are still valid Critical Areas because they provide an example of what is happening in the Lower Fall Creek Watershed and an opportunity to learn what, if anything could be done differently to improve water quality.

4.1 IDENTIFICATION OF CRITICAL AREAS

To identify Critical Areas in the Lower Fall Creek Watershed, each of the 3 work groups (Education & Outreach, Land Use & Economic Development, and Water Quality) met and reviewed the list of Stakeholder concerns from Table 3-1 and composite GIS maps showing wellfield protection areas, erodible lands, floodplains, sewer service areas, impaired streams, and land use.

Each work group discussed the impact of sediment, nutrients, and pathogens on aquatic life, recreation, and drinking water; the land use or land use practice associated with each pollutant; and then identified specific areas or activities in the Lower Fall Creek Watershed suspected of degrading water quality. **Table 4-1** is a copy of the exercise used to identify Critical Areas with each work group.

<u>Sediment Critical Areas</u>

As shown on **Exhibit 4-1**, the specific sediment Critical Areas include areas classified as HEL or PHEL, especially those areas lacking sediment and erosion controls and those with conservation tillage; the Indian Lake watershed, and streambanks identified as undergoing severe erosion.

HEL & PHEL Classified Soils

HEL determinations are made by the NRCS, are based on mathematical equations considering rainfall factors, erodibility of the soil type, allowable loss for that soil type, and the length and the slope of the area. Soil map units may be classified as Potentially Highly Erodible (PHEL) based on a varying range of length/slope values. In such instances, the final determination of erodibility must be made through an onsite investigation.

Approximately 20% of the soils within the watershed are classified as HEL or PHEL. Activities exposing HEL or PHEL soil types for periods of time, such as construction or conventional tillage, may exacerbate the erosion and sedimentation impact within the Lower Fall Creek Watershed.

- Lack of Erosion & Sediment Control

According to US EPA, the most environmentally dangerous period of development is the initial construction phase when land is cleared of vegetation and graded to create a proper surface for construction. The removal of natural vegetation and topsoil makes the exposed area particularly susceptible to erosion, causing transformation of existing drainage areas and disturbance of sensitive areas.

Erosion and sediment control is widely accepted as a necessary practice, but there are certain caveats to making it effective. First, communities need to have the staff and resources to adopt and enforce an Erosion & Sediment Control Ordinance. In addition, a Technical Standards or Manual (as part of the Erosion & Sediment Control Ordinance) needs to provide useful guidance on selecting erosion and sediment control measures. Finally, education of contractors, engineers, and designers regarding the importance and effective use of erosion and sediment controls is imperative to implementing effective erosion and sediment control. **Figure 4-1** shows an example of a poorly installed erosion and sediment control system.

Figure 4-1: Poorly installed silt fencing

Erosion and sediment control has been identified as a Critical Area (or critical activity) because of the current development and potential for development in the Lower Fall Creek Watershed. The City of Lawrence, City of Noblesville, Town of Fishers, Hamilton County, and Madison County are required to have a an Erosion & Sediment Control Ordinance in order to be in compliance with the NPDES Phase II Stormwater Program. The City of Indianapolis has an Erosion & Sediment Control Ordinance as a requirement of the NPDES Phase I Stormwater Program. As construction and development occur within the Lower Fall Creek Watershed, additional precaution should be taken in areas of HEL or PHEL soil classifications.

- Conventional Tillage Practices

Within the Lower Fall Creek Watershed approximately 22,000 acres are in agricultural production; while approximately 13,500 acres are classified as HEL. As identified in Table 3-7, much of those acres in Hamilton, Hancock, and Madison Counties associated with corn production are utilizing conventional tillage (no data is available for Marion County tillage types).

Conventional tillage systems disturb the entire soil surface, resulting in less than 15% residue cover after planting. Conventional tillage practices on HEL or PHEL classified soils allow those erodible soils to be exposed to the weather for periods of time, typically during the spring wet weather prior to planting, or after harvest in the fall, leaving the soil exposed during the spring thaw, or both.

Indian Lake Watershed

Indian Lake is located in the City of Lawrence. Approximately 16,000 acres drain to this 54 acre lake (**Figure 4-2**). This ratio of 300:1 far exceeds the current standard of 100:1. The Hancock County portion of the Indian Lake subwatershed remains primarily undeveloped with the

Figure 4-2: Indian Lake

exception of proposed growth in the Town of McCordsville. The Marion County portion is predominantly residential.

The Indian Lake Homeowners Association has been dredging approximately 3,000-5,000 tons of sediment from the lake on an annual basis. Due to this frequency and volume, the Association has found it to be more cost effective to purchase their own dredging equipment. In 2007, the Indian Lake Homeowners Association reached a settlement agreement with INDOT for damages due to negligence in erosion control during a 2005 Pendleton Pike road project. The settlement funds are to be put toward dredging cost.

Indian Lake was selected by the working groups and the Steering Committee based on the amount of sediment entering the lake necessitating dredging on a routine basis. Water quality, macroinvertebrate, and physical assessments completed within the Indian Lake watershed have attributed impaired waters or degraded habitats to the excessive amount of silt within the streams and tributaries leading to the lake.

Indian Lake can provide a good representation of the issues faced by many of the lakes within the Lower Fall Creek Watershed and is currently managed by an active Homeowners Association willing to put forth effort to protect the quality and aesthetic value of their lake.

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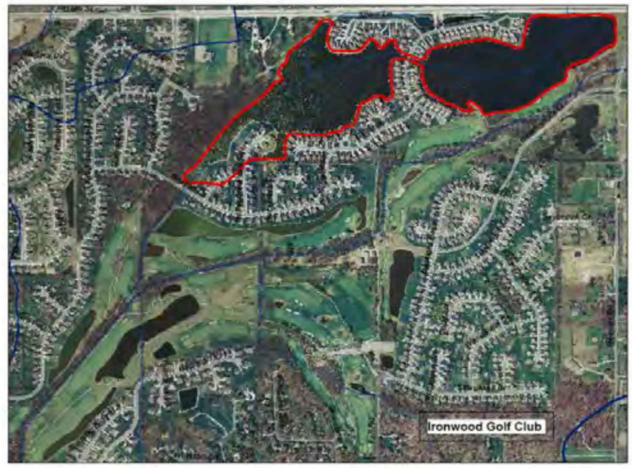

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As discussed earlier within previous sections, the Steering Committee and Working Groups have agreed that agricultural related management efforts are best led by the individual county SWCDs. Local SWCD and NRCS staff have long-established relationships with agricultural landowners as well as an extensive knowledge of USDA programs designed to mitigate livestock and manure impacts as well as those designed to protect water quality in a livestock production area.

- Indiana State Fair Grounds

In urban areas, runoff from impervious surfaces, such as parking lots and roads are major contributors to stream pollution. The Indiana State Fair Grounds was identified as a Critical Area because it comprised of more than 250 acres (approximately 70 acres of imperviousness) in the Lower Fall Creek Watershed. The State Fair is home to more than 300 events each year, including the annual Indiana State Fair. During the State Fair, the fairgrounds are populated with thousands of livestock, including horses, cattle, hogs, sheep, poultry and numerous others (**Figure 4-7**). The livestock are usually available for display in one of the fairgrounds 7 livestock barns.

Figure 4-7: Horse event at State Fair

Water quality data collected to date indicates that the State Fair grounds are contributing ***E. coli*** loadings to Fall Creek. Since 1993, the Health Department has collected grab samples on Fall Creek during the State Fair. This sampling program has included the collection of ***E. coli*** samples at 39th Street, which is located upstream of the fairgrounds, at the fairgrounds stormwater outfall, and downstream of the fairgrounds at 30th Street. A similar sampling program conducted since 1994 has demonstrated parallel results.

There has long been recognition that animal waste from the fairgrounds contributes to pollution to Fall Creek. In 1999, the City of Indianapolis DPW completed a 104(b)(3) water quality cooperative grant to design a wetland-type wastewater treatment system for runoff leaving the fairground site. However, this project was never constructed.

Wellfield Protection Areas

There are 5 Wellfield Protection Areas (WFPA) in the Lower Fall Creek Watershed. These include the Riverside, Fall Creek, Lawrence, Geist, and Southern Madison County Utilities wellfields.

Figure 4-8: Wellfield Protection Area

WFPAs were identified as a Critical Area because of the potential contamination to groundwater and drinking water supply to approximately 20% of central Indiana population. Pollutants of particular concern in these areas are nutrients and pathogens. Land use and land use practices in the 4 WFPAs in Marion County that may impact groundwater are regulated through a Wellfield Protection Ordinance (City County General Ordinance # 91, 2003). As part of this Ordinance, new development and redevelopment plans are reviewed by a Technically Qualified Person (TQP).

The Ordinance also established a Marion County Wellfield Education Corporation (MCWEC) whose mission is to prevent contamination of groundwater through public awareness and education – like the "Entering Wellfield Protection Area" roadside sign illustrated in **Figure 4-8**. MCWEC targets it education and outreach efforts toward the businesses in the WFPAs that were grandfathered under the Ordinance. Although a Source Water Protection Plan has been prepared for the WFPA in Madison County, an Ordinance regulating land use has not been adopted.

Other

As mentioned, the Fall Creek TMDL, as well as the Steering Committee, Work Groups, and stakeholders also mentioned concerns over the pathogen loadings attributed to CSOs, waterfowl (and other wildlife), and stormwater runoff within the Lower Fall Creek Watershed. While these are important considerations throughout the watershed, and throughout Indiana, this WMP will not highlight specific areas as Critical Areas.

Regarding CSOs within the watershed, the City of Indianapolis has developed their LTCP which will ultimately capture 95-97% of sewage entering streams during wet weather and it is estimated that the implementation of this plan will cost more than $1.73B. The LTCP has detailed actions that will be taken to reduce water quality problems associated with CSOs, and should be referenced for all CSO related water quality improvements.

It is anticipated that actions taken to reduce pollutant loadings within the Critical Areas previously discussed will also reduce pollutant loadings associated with waterfowl (and wildlife) and pollutant laden stormwater runoff. For example, stabilization of streambanks will help reduce sediment loadings, but will also help to reduce pollutant loadings from waterfowl as bank and overhanging vegetation along streambanks and shorelines prohibit Canada Geese from staying in areas for prolonged periods of time. Further reducing applications of nutrients, implementing erosion control practices, and conversion from conventional to conservational tillage practices will also decrease the amount of pollutants within stormwater runoff.

Table 4-1: Identifying Critical Areas Work Group Exercise

DOCUMENTED WATER QUALITY POLLUTANT IN LOWER FALL CREEK	TYPICAL LAND USE/LAND USE PRACTICE ASSOCIATED WITH POLLUTANT		CRITICAL AREAS IN LOWER FALL CREEK WATERSHED
SEDIMENT impacts: Aquatic Life – ***reduces plant growth, smothers and covers spawning grounds and benthic habitats*** Recreational Impact – ***reduces water clarity, reduces aesthetic appeal, stresses sport fishing populations*** Drinking Water – ***increases drinking water treatment costs, damages pumps and infrastructure***	**BENEFIT** water quality: • Riparian Buffers • Filter Strips • Conservation Areas • Post-Construction Practices	**DEGRADE** water quality: • Tillage Practices • Construction Practices • Streambank Erosion • Stormwater Runoff	• ***Erosion and sediment control enforcement*** • ***HEL & PHEL Classified Soils*** • ***Indian Lake Watershed*** • ***Eroded Streambanks***
NUTRIENT (Phosphorus & Nitrogen) impacts: Aquatic Life – ***promotes algal blooms, reduces dissolved oxygen concentrations*** Recreational Impact – ***causes algal blooms, reduces aesthetic appeal, and causes unpleasant odors*** Drinking Water – ***increases drinking water treatment costs (taste and odor), resultant algae can clog water intakes and filters***	**BENEFIT** water quality: • Riparian Buffers • Filter Strips • Post-Construction Practices	**DEGRADE** water quality: • Fertilizer Application • Failing Septic Systems	• ***Over application of fertilizers (residential lakes and golf courses)*** • ***Wellfield Protection Areas***
PATHOGENS (Bacteria & Viruses) ***impacts:*** Aquatic Life – ***exposes aquatic life to disease causing organisms*** Recreational Impact – ***exposes recreational users to disease causing organisms*** Drinking Water – ***increases drinking water treatment costs***	**BENEFIT** water quality: • Sewer Service • Exclusionary Fencing	**DEGRADE** water quality: • Failing Septic Systems • Combined Sewer Overflows (CSO) • Illicit Connections to Storm Sewer • Wildlife • Stormwater Runoff • Livestock & Manure Management	• ***Indiana State Fair Grounds*** • ***Wellfield Protection Areas*** • ***Non-sewered development*** • ***Wellfield Protection Areas*** • ***Livestock and Manure Management Areas***

5.0 GOALS AND DECISIONS

Setting realistic and measurable goals is key to the successful implementation of the WMP. A goal is the desired change or outcome as a result of the watershed planning effort. Depending on the magnitude of the problem, goals may be general, specific, long-term, or short-term. The goals in this WMP focus on improving water quality through the implementation of a variety of management measures.

5.1 GOALS

The Lower Fall Creek Watershed Steering Committee agreed to focus on three pollutants throughout the identification of Critical Areas, development of proposed management measures, and the development of goals and decisions to improve water quality. Those pollutants are sediment, excess nutrients, and pathogens. A goal for public education and outreach is also included as this is an important part of the planning or implementation of this WMP.

Sediment

- Problem: Macroinvertebrate and habitat assessment scores at 17 of 28 (60%) of the sites assessed scored under 60 on the CQHEI or QHEI indices.

- Goal: Reduce sediment delivery to waterbodies within the Lower Fall Creek Watershed.

- Target: To achieve CQHEI or QHEI scores above 60 and improved habitat assessments at all sampling locations throughout the watershed in 10 years.

Nutrients

- Problem: Phosphorus concentrations within the Lower Fall Creek Watershed routinely exceed the EPA recommended threshold of 0.076 mg/L.

- Goal: Reduce excess nutrient loadings to waterbodies within the Lower Fall Creek Watershed.

- Target: To reduce phosphorus concentrations to at or below the EPA recommended threshold of 0.076 mg/L within 25 years. Phosphorus concentrations in many of the water quality samples have been below the detection limits of laboratory equipment utilized to analyze water quality samples (0.19 mg/L). For this reason, a recommended threshold lower than Indiana's draft benchmark of 0.30 mg/L was selected.

Pathogens

- Problem: E. coli concentrations within the Lower Fall Creek Watershed routinely exceed the State of Indiana's Water Quality Standard for a single sample daily maximum of 235 CFU per 100 milliliters or the 5 day geometric mean of 125 CFU per 100 milliliters.

- Goal: Reduce pathogen loadings to waterbodies within the Lower Fall Creek Watershed.

- Target: To reduce E. coli loadings to levels indicated in the Fall Creek TMDL (52% reduction of E. coli loadings upstream of CSO area and 99.5% reduction of E. coli loadings downstream of CSO area) within 25 years.

Education and Outreach

- Problem: It is difficult to indicate the successes of public education and outreach efforts such as media releases, workshops, and brochures designed to raise awareness, change behaviors, and have a positive impact on water quality.

- Goal: Increase watershed related public education and outreach efforts within the Lower Fall Creek Watershed.

- Target: Utilize social indicator survey results to prepare future public education and outreach efforts for use in implementation of the proposed management measures and to assist with other outreach efforts such as MS4 Phase I and Phase II Public Education/Public Involvement, SWCD educational materials, and the larger 8-digit HUC Upper White River Watershed Alliance (UWRWA) on at least an annual basis.

5.2 DECISIONS

Throughout Steering Committee meetings, Work Group meetings, and with input from stakeholders, potential management measures were identified and recorded. During the May 13, 2008 Steering Committee members were invited to discuss, wordsmith, combine, and delete the list of potential management measures. Once the measures were agreed upon, the Steering Committee identified responsible partners, financial and technical resources, and an estimated timeframe for implementation. The management measures are grouped by goal (sediment, nutrient, pathogen, and education) in **Table 5-1** through **Table 5-4**.

Figure 3-4 was utilized with tables 5-1 through 5-4 to determine areas where proposed management measures could be targeted with beneficial impacts to water quality or where BMPs could be installed as demonstrational practices in highly visible or utilized areas throughout the watershed.

Table 5-1: Sediment Management Measures

Management Measures	Responsible / Partnering Entity	Financial / Technical Assistance Needed	Timeline for Implementation	Milestones for Implementation
Educate contractors and developers regarding Rule 5 & Rule 13 requirements, inspections, and enforcement. ***Where:*** • ***City of Lawrence due to high percentage of HEL or PHEL classified soils*** • ***Town of Fishers, City of Noblesville, and Town of McCordsville as areas under development pressure***	IDEM Hoosier Heartland Resource, Conservation, & Development (HHRCD) MS4 Communities ***All*** SWCDs ***All*** Building Association of Greater Indianapolis (BAGI)	• Educational materials (IDEM, EPA) • List of contractors and developers to invite • List of construction sites for field exercise • Feedback mechanism to improve on annual training • Rule 5 & Rule 13 program expertise • Inspection forms • List of local, state, federal penalties for non-compliance • Training materials • ***$3,500 per full day training***	5 years	1. Build partnerships with HHRCD, MS4s SWCD, BAGI, etc. 2. Develop training module (field and classroom) materials 3. Conduct annual pre-construction season training
Stabilize streambanks within the watershed with native vegetation (target adjacent publicly owned open spaces and golf courses), removing invasive species if present. ***Where:*** • ***Public areas where access and willingness may be higher*** • ***Commonwealth Biomonitoring Site #6*** • ***IUPUI Assessment sites based on feasibility and cost/benefit*** ***Estimated Load Reductions:*** ***Utilizing STEPL: 300 linear feet, 15 feet height Severe lateral recession (0.3-0.5 ft/year), Clay soil*** ***Pre stabilization = 63.0 tons/year sediment load*** ***Post stabilization = 3.2 tons/year sediment load*** ***Reduction = 59.8 tons/year sediment*** ***(Also includes 110 lb/yr Nitrogen; 42 lb/yr Phosphorus; and 220 lb/yr BOD***	Parks Departments ***All*** Golf Course Managers Keep Indianapolis Beautiful (KIB) SWCDs ***Hamilton County*** ***Marion County***	• GIS for mapping and prioritization • Detailed topography for design • Engineer to model stream and design stabilization alternatives • Invasive species field guide and hand tools • Volunteers • Contractors and equipment • Permits writer and fees • Stabilization materials (plants, stone, fabric) • ***$200 - $1,000 per linear foot stabilized***	5 years	1. Starting with public owned open space and golf courses, conduct a comprehensive streambank inventory 2. Prioritize areas for stabilization 3. Starting with the high priority sites, develop design alternatives 4. Obtain permits, stabilization materials 5. Schedule construction, coordinate laborers 6. Stabilize streambank according to selected design

Management Measures	Responsible / Partnering Entity	Financial / Technical Assistance Needed	Timeline for Implementation	Milestones for Implementation
Develop a Lake Management Plan for priority lakes ***Where:*** • ***Indian Lake due to observed and experienced problems*** • ***Other lakes as willing***	HOAs ***All*** Planning & Zoning Departments ***Indianapolis DMD*** ***Town of Fishers*** SWCDs ***Marion County*** ***Hamilton County*** Lower Fall Creek Watershed Alliance (LFCWA)	• Model Lake Management Plan • Coordinator (paid or volunteer) • GIS for analysis and exhibits • Existing physical, chemical, biological data • ***$5,000 - $30,000 (will vary with size of lake/watershed)***	5-10 years	1. Identify pollutants, sources, and causes (collect data if needed) 2. Work with HOA and DMD to develop Lake Management Plan 3. "Adopt" Lake Management Plan by HOA 4. Work with DMD or Planning and Zoning Department to establish Overlay Zone or amend allowable land uses/densities upstream (if warranted)
Reduce soil erosion and stormwater runoff from construction sites. ***Where:*** • ***Construction sites located on HEL or PHEL classified soils*** ***Estimated Load Reductions:*** ***[obtaining potential load reductions for construction BMPs]***	MS4 Communities ***All*** IDEM SWCDs ***All*** Developers and Contractors	• ESC and SWPP plan reviewers • Inspectors • Checklist for review and inspection • Enforcement support from MS4 and IDEM • Training for developers, contractors, plan reviewers, inspectors • ***Cost will be dependent on status of MS4 program and staff availability***	10 years	1. Develop checklist for plan review and inspection 2. Review ESC practices, SWPP, etc for active construction sties 3. Inspect construction site, discuss deficiencies with contractor 4. Enforce penalty in ESC Ordinance for non-compliance
Create a Highly Erodible Land (HEL) Overlay Zone for planning & zoning purposes. ***Where:*** • ***Throughout Lower Fall Creek Watershed***	Planning & Zoning Departments ***All*** SWCDs ***All*** Lower Fall Creek Watershed Alliance (LFCWA)	• GIS for mapping and analysis • NRCS Soil Data • Model HEL Ordinance • Legal to review Ordinance • HEL literature • ***No direct cost if development of overlay is completed by Planning & Zoning Departments***	5-10 years	1. Draft language for HEL Overlay Zone. 2. Create HEL maps. 3. Build support with decision-makers. 4. Adopt HEL Overlay Zone into Development Ordinance.

Management Measures	Responsible / Partnering Entity	Financial / Technical Assistance Needed	Timeline for Implementation	Milestones for Implementation
Establish signage program to identify active construction sites or developers that are in compliance with IDEM's Rule 5 program. ***Where:*** • ***City of Indianapolis as the largest community*** • ***Town of Fishers, City of Noblesville, Town of McCordsville due to development pressure***	Planning & Zoning Departments ***All*** SWCDs ***All*** LFCWA	• Examples elsewhere • Inspectors (trained) • Yard signs • GIS for tracking • ***$300 per sign***	25 years	1. Establish criteria 2. Build support among decision-makers and contractors 3. Develop signs, inspection forms, tracking 4. Train inspectors 5. Inspect sites, install yard signs
Partner with County SWCD and NRCS to identify lands non eligible for CRP, EQIP or other federal programs and work with landowners to implement BMPs such as conversion to conservation tillage or establishment of filter strips. ***Where:*** • ***Agricultural lands within Hamilton, Hancock, and Madison Counties***	SWCDs ***All*** NRCS ***All*** LFCWA	• GIS for mapping and analysis • NRCS eligibility guidelines • Staff for site visits to discuss program with landowners • ***Existing staff time***	5 years	1. Meet with NRCS and SWCD representatives to determine areas in agricultural production. 2. Highlight areas not eligible for federal programs 3. Meet with landowners within the watershed to discuss their long-term goals for the land 4. Implement or install appropriate BMPs

Table 5-2: Nutrient Management Measures

Management Measures	Responsible / Partnering Entity	Financial / Technical Assistance Needed	Timeline for Implementation	Milestones for Implementation
Evaluate Development Ordinances based on the Center for Watershed Protection's "Code & Ordinance Worksheet Tool". ***Where:*** • ***City of Indianapolis, City of Lawrence due to locations within WFPAs***	Planning & Zoning Departments ***All*** Upper White River Watershed Alliance (UWRWA) Ball State or IUPUI School of Planning	• Code & Ordinance Worksheet tool • Local Ordinances • Planning Students • Legal to review amended language • Support of decision-makers to adopt changes (if needed) • ***Existing staff time***	5 years	1. Secure assistance of planning student(s) 2. Review Code & Ordinance Worksheet 3. Modify Worksheet (if needed) 4. Review Ordinances, meet with local planning for clarification (if needed) 5. Draft recommendations 6. Amend Ordinances
Prepare a Wellfield Protection Ordinance for the Madison County WFPA. ***Where:*** • ***Madison County***	Health Departments ***Madison County*** Planning & Zoning Departments ***Madison County***	• Model Wellfield Protection Ordinance • Legal to review Ordinance • GIS to map WFPA and Overlay Zone • ***Existing staff time***	5-10 years	1. Review model Ordinance 2. Modify language to meet needs of Madison County 3. Build support among decision-makers 4. Adopt ordinance, create Overlay Zone
Encourage golf courses along Fall Creek and lakes larger than 50 acres to participate in the Audubon Cooperative Sanctuary Program, Groundwater Guardian Green Sites, National Wildlife Federation, or a similar conservation program. ***Where:*** • ***Golf Courses and lakes located within WFPAs***	Golf Course Managers Marion County Wellfield Education Corporation (MCWEC) Office Indiana State Chemist (OISC) HOAs, Neighborhood Associations ***Lake 50+ acres*** ***Adjacent to Fall Creek***	• Program information • GIS for targeting and tracking • Educational materials • Expertise to assist with program requirements and annual reporting (if needed) • ***Existing staff time***	10 years	1. Review program materials 2. Identify target areas within focus group 3. Develop educational materials (if needed) 4. Conduct meetings with targeted Golf Course Managers, HOAs, and Neighborhood Associations 5. Assist with program requirements and annual reporting (if needed)
Integrate Low Impact Development (LID) practices into new or re-development projects. ***Where:*** • ***(re)developments within WFPAs if appropriate*** • ***(Re)developments adjacent to streams and tributaries*** ***Estimated Load Reductions:*** ***Indiana Stormwater Quality Manual suggests the following potential removal rates:*** ***<u>Infiltration Trench</u>: 90% TSS, Bacteria and Metals; 60% Phosphorus and Nitrogen*** ***<u>Bio-retention area</u>: 90% TSS, Bacteria, and Metals; 60% Phosphorus and Nitrogen*** ***<u>Stormwater Wetland</u>: 67% TSS; 77% bacteria; 30-60% metals; 50% Phosphorus; and 28% Nitrogen***	Developers Planning & Zoning Departments ***All*** SWCDs ***All*** HHRCD MCWEC UWRWA Water Utilities	• LID factsheets and guidance • Specific on BMPs (infiltration rates, sizing, design details, etc.) • Model Ordinance • Legal to review Ordinance language • Incentives Programs • LID training (design, construction, maintenance) • ***$500 - $10,000 (will vary with practice and size requirements)***	25 years	1. Research LID practices 2. Identify BMPs suitable for soils, climate, etc. 3. Develop design/technical standards 4. Integrate language from Model Ordinance into local Ordinance 5. Establish incentives 6. Build support of decision-makers, developers, and contractors 7. Train plan reviewers and inspectors 8. Amend Ordinance

Table 5-3: Pathogen Management Measures

Management Measures	Responsible / Partnering Entity	Financial / Technical Assistance Needed	Timeline for Implementation	Milestones for Implementation
Establish or enhance shoreline and streambank riparian buffers to reduce potential increases in bacteriological impacts from wildlife and domestic pets throughout the Lower Fall Creek Watershed. ***Where:*** • ***Areas of (re)development where stormwater ponds are present*** • ***Priority lakes*** • ***Golf Courses*** ***Estimated Load Reductions:*** ***Studies indicate that approximately 80% of E. coli in stormwater runoff can be removed through a 100 foot vegetated filter strip.***	Health Departments ***All*** Planning & Zoning Departments ***All***	• Educational materials • GIS to map and track progress • Model Ordinance language (vegetation mowed to 12 inches max) • Educational signage • Trees, shrubs, herbaceous plants for buffer • ***$50 - $2,000 per acre established***	5 years	1. Identify and prioritize target areas 2. Review Model Ordinances and other resources 3. Draft Ordinance language for maintenance adjacent to waterbodies 4. Build support decision-makers, HOAs 5. Enhance shoreline/streambank 6. Install educational signage
Partner with the Indiana State Fair Board to reduce ***E. coli*** loadings to Fall Creek. ***Where:*** • ***Indiana State Fairgrounds***	4-H / Future Farmers of America (FFA) Fair Board Fair Commission Health Departments ***Marion County*** Mapleton - Fall Creek Neighborhood Association	• Engineer to model stormwater runoff, design alternatives • Water quality data • "Pathway to Water Quality" materials • Construction equipment, materials for demonstration project • ***Cost will vary with BMP alternative***	5-10 years	1. Confirm source of E.coli loadings 2. Research and prioritize alternatives 3. Build support of decision-makers 4. Construct demonstration project and outdoor laboratory to monitor changes in water quality 5. Enhance "Pathway to Water Quality"
Partner with County SWCD and NRCS to identify lands non eligible for CRP, EQIP or other federal programs and work with landowners to implement BMPs such as nutrient management or establishment of filter strips. ***Where:*** • ***Agricultural lands within Hamilton, Hancock, and Madison Counties***	SWCDs ***All*** NRCS ***All*** LFCWA	• GIS for mapping and analysis • NRCS eligibility guidelines • Staff for site visits to discuss program with landowners • ***Existing staff time***	5 years	1. Meet with NRCS and SWCD representatives to determine areas in agricultural production. 2. Highlight areas not eligible for federal programs 3. Meet with landowners within the watershed to discuss their long-term goals for the land 4. Implement or install appropriate BMPs

Support the Septic Tank Elimination Program (STEP) especially within the WFPAs and floodplains of the Lower Fall Creek Watershed.	Health Departments ***Marion County*** Indianapolis DPW Health & Hospital Corporation ***Marion County*** HOAs, Neighborhood Associations ***High, Medium, Low Priority***	• STEP literature • Septic maintenance information • GIS to map individual septic systems • Water quality data • Grant writing and administration • ***Existing staff time***	10-25 years	1. Identify septic systems in WFPAs 2. Target these areas for connection to sewers 3. Distribute literature to HOA 4. Prepare grants to assist homeowners with connection fees
Provide education and outreach to areas outside of Marion County that with anticipated inadequately functioning septic systems or illicit storm sewer connections.	Health Departments ***All*** Indiana State Department of Health LFCWA	• Existing septic system literature • Septic maintenance information • GIS to map individual septic systems • Water quality data • Hamilton South Eastern sewer service areas • Grant writing and administration	10-25 years	1. Gather and distribute existing literature to provide to homeowners 2. Obtain sanitary sewer service coverage layers from Hamilton South Eastern Utility

Table 5-4: Education Management Measures

Management Measures	Responsible / Partnering Entity	Financial / Technical Assistance Needed	Timeline for Implementation	Milestones for Implementation
Create education demonstration project(s) to illustrate good urban development or redevelopment practices and good stormwater management in critical watershed areas. **Appendix 6** includes a BMP Demonstration Report prepared as part of this WMP. ***Where:*** • ***WFPAs*** • ***Areas of HEL or PHEL classified soils***	MS4 Communities ***All*** Planning & Zoning Departments ***All*** HOAs ***All*** Community Development Corporations (CDCs) ***All***	• BMP Demonstration Report • Willing landowner, developer, contractor • Technical assistance for design, construction, and maintenance • Stormwater management literature • Engineer to design BMP • Permits writer and fees (if needed) • BMP materials • Construction equipment and laborers	5 years	1. Prioritize demonstration site using BMP Demonstration Report research 2. Identify landowner and willingness to participate 3. Conduct site inventory and analysis and determine suitability, identify stormwater practice to implement 4. Design and construct BMP 5. Monitor and document long-term effectiveness
Develop future education & outreach programs based on results of the Social Indicators Survey. ***Where:*** • ***Areas will be dependent on survey results***	LFCWA Purdue University	• Survey results (Purdue interpretation) • Education materials, programs, etc. (depending on survey results) • Follow-up survey • ***2nd survey to be completed by Purdue*** • ***Existing staff time***	5-10 years	1. Conduct survey, compile results 2. Identify target areas and message for education and outreach 3. Develop and distribute materials (format depending on survey results) 4. Develop follow-up survey (with Purdue)
Host an annual "Watershed Awareness" or "Celebrate Fall Creek" event (stream clean-up, water quality monitoring, educational workshops, safety, health and wellness). ***Where:*** • ***Along Fall Creek in an Indy Park for accessibility and visibility***	LFCWA Natural Resources Education Council Parks & Recreation ***All*** UWRWA Health Departments ***All*** Fort Benjamin Harrison State Park MS4 Communities ***All***	• Marketing expertise • Social Indicator Survey results (identify target audience, target message) • Event planner • Media coverage • ***Cost will vary based on partnership and contributions***	5-10 years	1. Partner and coordinate with similar entities 2. Identify target stakeholders (Social Indicators Survey) and tailor event to attract them 3. Identify high profile work project to be the focus of event

Evaluate land use planning strategies based on the Center for Watershed Protection's "Managing Stormwater in Your Community". ***Where:*** • ***City of Indianapolis, City of Lawrence due to locations within WFPAs*** • ***Communities along 303(d) listed streams*** • ***Areas of localized flooding per MHMPs, FRP, or Mayor's Action Center***	Planning & Zoning Departments ***All*** Upper White River Watershed Alliance (UWRWA) Ball State or IUPUI School of Planning	• CWP document • Local Ordinances • Planning Students • Legal to review amended language • Support of decision-makers to adopt changes (if needed) • ***Existing staff time***	5 years	1. Secure assistance of planning student(s) 2. Review Managing Stormwater in Your Community 3. Review planning strategies, meet with local planning for clarification (if needed) 4. Draft recommendations 5. Amend Land Use Plan
Obtain funding for Urban Conservationist position within the Marion County SWCD ***Where:*** • ***Marion County SWCD (or partnering organization such as Hoosier Heartland RC&D)***	Marion County SWCD Hoosier Heartland RC&D NRCS	• New employee with conservation and/or urban conservation experience • Office space and appropriate equipment (computer, GIS, etc.) • ***Approximately $40,000 per annum***	5 years	1. Secure funding through grants or special partnership with another organization. 2. Interview potential hires 3. Utilize Lower Fall Creek WMP to implement management measures 4. Provide education and outreach to targeted audiences regarding urban conservation measures and outcomes.

6.0 MONITORING EFFECTIVENESS

Monitoring effectiveness is an essential part of implementation of the WMP. Monitoring is based on a series of indicators that describe how the implementation steps will be tracked and evaluated to ultimately measure the success of the WMP.

6.1 IDENTIFYING INDICATORS

An indicator is a fact or datum that can be measured to show rate of change. There are 3 types of indicators: 1) administrative, such as something that can be counted – the number of permits, number of grassed waterways, or policy and ordinances adopted or enforced; 2) environmental, are long-time measurements of water quality of habitat – concentration of phosphorous or nitrogen in water; and 3) social, indicating changes in stakeholder attitudes and behaviors.

Indicators have been identified for each goal and management measure. Section 5 of this WMP discussed the problem, goal, and target for sediment, nutrient, pathogen, and education/outreach. These goals are as follows:

1. Reduce sediment delivery to waterbodies within the Lower Fall Creek Watershed.
2. Reduce excess nutrient loadings to waterbodies within the Lower Fall Creek Watershed.
3. Reduce pathogen loadings to waterbodies within the Lower Fall Creek Watershed.
4. Increase watershed related public education and outreach efforts within the Lower Fall Creek Watershed.

Table 6-1 through **Table 6-4** identifies the administrative, environmental, and social indicators and the tracking process for each of the management measures identified in Section 5. For consistency with Section 5, indicators are identified by sediment, nutrient, pathogen, and education/outreach. The successful implementation of the Lower Fall Creek WMP depends on the participation of a number of responsible/partnering entities (Table 5-1). However, tracking progress of this WMP will be the responsibility of the Marion County SWCD and the Lower Fall Creek Watershed Alliance.

Table 6-1: Sediment Indicators

Management Measure	Indicator	Tracking Process
Educate contractors and developers regarding Rule 5 & Rule 13 requirements, inspections, and enforcement.	Environmental – reduce sediment runoff from construction sites Social – change attitude and behavior of contractors and developers	• Number and type of contractors and developers that participate in training(s)
Stabilize streambanks along Fall Creek with native vegetation (target adjacent publicly owned open spaces and golf courses), removing invasive species if present.	Administrative – number of linear feet of streambank stabilized with natives Environmental – reduce sediment from failing streambanks Social – increase awareness about natives and value for water quality, streambank stabilization	• Feet of streambank where bank stabilized, natives planted, and invasives removed • Volume of invasive species removed, natives added, and materials to stabilize streambank • Number and type of participants
Develop a Lake Management Plan for priority lakes.	Administrative – completed Lake Management Plan Social – through the development of the Plan, change attitudes and behaviors of lake residents	• Completed Lake Management Plan
Reduce soil erosion and stormwater runoff from construction sites.	Administrative – enforce erosion and sediment control ordinances Environmental – reduce sediment runoff from construction sites	• Number of ordinance violations issued • Volume of sediment runoff reduced
Create a Highly Erodible Land (HEL) Overlay Zone for planning & zoning purposes.	Administrative – adoption of a HEL Overlay Zone Environmental – reduce sediment runoff Social – increase awareness of HEL soils and need for protection	• Adopted HEL Overlay Zone
Partner with County SWCD and NRCS to identify lands non eligible for CRP, EQIP, or other federal programs and work with landowners to implement BMPs such as conversion to conservation tillage or	Administrative – Implementation of BMPs Environmental – reduce sediment runoff Social – increase awareness of benefits of conservation tillage or other BMPs	• Number of acres converted, number of acres of filter strips, or number of other BMPs implemented • Volume of sediment runoff

establishment of filter strips		reduced
Establish signage program to identify active construction sites or developers that are in compliance with IDEM's Rule 5 program.	Administrative – implement program Environmental – reduce sediment runoff from construction sites Social – change attitudes and behavior about construction BMPs	• Number of signs installed • Volume of sediment runoff reduced

Table 6-2: Nutrient Indicators

Management Measure	Indicator	Tracking Process
Evaluate Development Ordinances based on the Center for Watershed Protection's "Code & Ordinance Worksheet Tool".	Administrative – amend Development Ordinances Environmental – improved water quality through better land use and site design practices Social – change attitudes and behaviors about land use planning and water quality	• Amended Development Ordinances
Prepare a Wellfield Protection Ordinance for the Madison County WFPA.	Administrative – adopt Wellfield Protection Ordinance Environmental – reduce potential for surface and groundwater pollution by regulating land use Social – change attitudes and behaviors about land use planning and water quality	• Adopted Wellfield Protection Ordinance
Encourage golf courses along Fall Creek and lakes larger than 50 acres to participate in the Audubon Cooperative Sanctuary Program, Groundwater Guardian Green Sites, National Wildlife Federation, or a similar conservation program.	Environmental – reduce nutrient runoff Social – increase awareness among golf course managers and residential property owners about nutrient application	• Number of participants in programs
Integrate Low Impact Development (LID) practices into new or re-development projects.	Administrative – amend Development Ordinances to allow for LID practices Environmental – capture and treat nutrients on-site; reduce runoff to receiving water Social – change attitudes and behaviors among decision-makers, developers, and land owners	• Number of LID techniques installed • Volume of nutrients captured and treated with LID BMPs

Table 6-3: Pathogen Indicators

Management Measure	Indicator	Tracking Process
Establish or enhance shoreline and streambank riparian buffers to reduce potential increases in bacteriological impacts from wildlife and domestic pets throughout the Lower Fall Creek Watershed.	Environmental – reduced pathogens from wildlife and domestic animals Social – change attitudes and behaviors among landowners around lakes and along waterways	• Volume of pathogens reduced
Partner with the Indiana State Fair Board to reduce ***E. coli*** loadings to Fall Creek.	Environmental – reduce pathogens from State Fairgrounds Social – change attitudes and behaviors of fairground managers	• Volume of pathogens reduced
Partner with County SWCD and NRCS to identify lands non eligible for CRP, EQIP, or other federal programs and work with landowners to implement BMPs such as nutrient management or establishment of filter strips	Administrative – Implementation of BMPs Environmental – reduce pathogen laden runoff Social – increase awareness of benefits of nutrient management or other BMPs	• Number of Nutrient Management Plans developed, or number of other BMPs implemented • Volume of pathogen laden runoff reduced
Support the Septic Tank Elimination Program (STEP) especially within the WFPAs and floodplains of the Lower Fall Creek Watershed.	Administrative – implementation of STEP in WFPA and floodplain Environmental – reduced pathogens from failing septic systems	• Volume of pathogens reduced • Number of septic tanks eliminated in WFPA and floodplain
Provide education and outreach to areas outside of Marion County with anticipated inadequately functioning septic systems or illicit storm sewer connections.	Administrative – Educational materials distributed or provided Environmental – reduced pathogens from failing septic systems or illicit connections Social – increased awareness of septic system maintenance and water quality impacts	• Number of materials provided, homeowners reached

Table 6-4: Education Indicators

Management Measure	Indicator	Tracking Process
Create education demonstration project(s) to illustrate good urban development or redevelopment practices and good stormwater management in critical watershed areas. **Appendix 6** includes a BMP Demonstration Report prepared as part of this WMP.	Administration – BMP Demonstration Report implemented Environmental – reduced sediment, nutrients, and pathogen loads to receiving waters Social – change attitudes and behaviors of landowners installing BMPs and public viewing BMP	• Number of BMP Demonstration projects implemented • Volume of pollutants reduced
Develop future education & outreach programs based on results of the Social Indicators Survey.	Administrative – establish programs based on survey responses Social – change attitudes and behaviors of survey participates	• Number of programs established
Host an annual “Watershed Awareness” or “Celebrate Fall Creek” event (stream clean-up, water quality monitoring, educational workshops, safety, health and wellness).	Social – change attitudes and behaviors of event participants	• Number of participants • Number of workshops • Miles stream clean-up
Evaluate land use planning strategies based on the CWP’s “Managing Stormwater in Your Community”	Administrative – amend Land Use Plans Environmental – improved water quality through better land use and site design practices Social – change attitudes and behaviors about land use planning and water quality	• Number of Land Use Plans amended

6.2 PLAN EVALUATION

The Marion County SWCD in partnership with the Lower Fall Creek Watershed Alliance will be responsible for the regular review and update of this WMP. This plan should be evaluated on a biannual basis to document and celebrate progress; assess effectiveness of efforts; modify activities to better target water quality issues; and keep implementation of the plan on schedule. The plan should be revised as needed to better meet the needs of the watershed stakeholders and to meet water quality goals.

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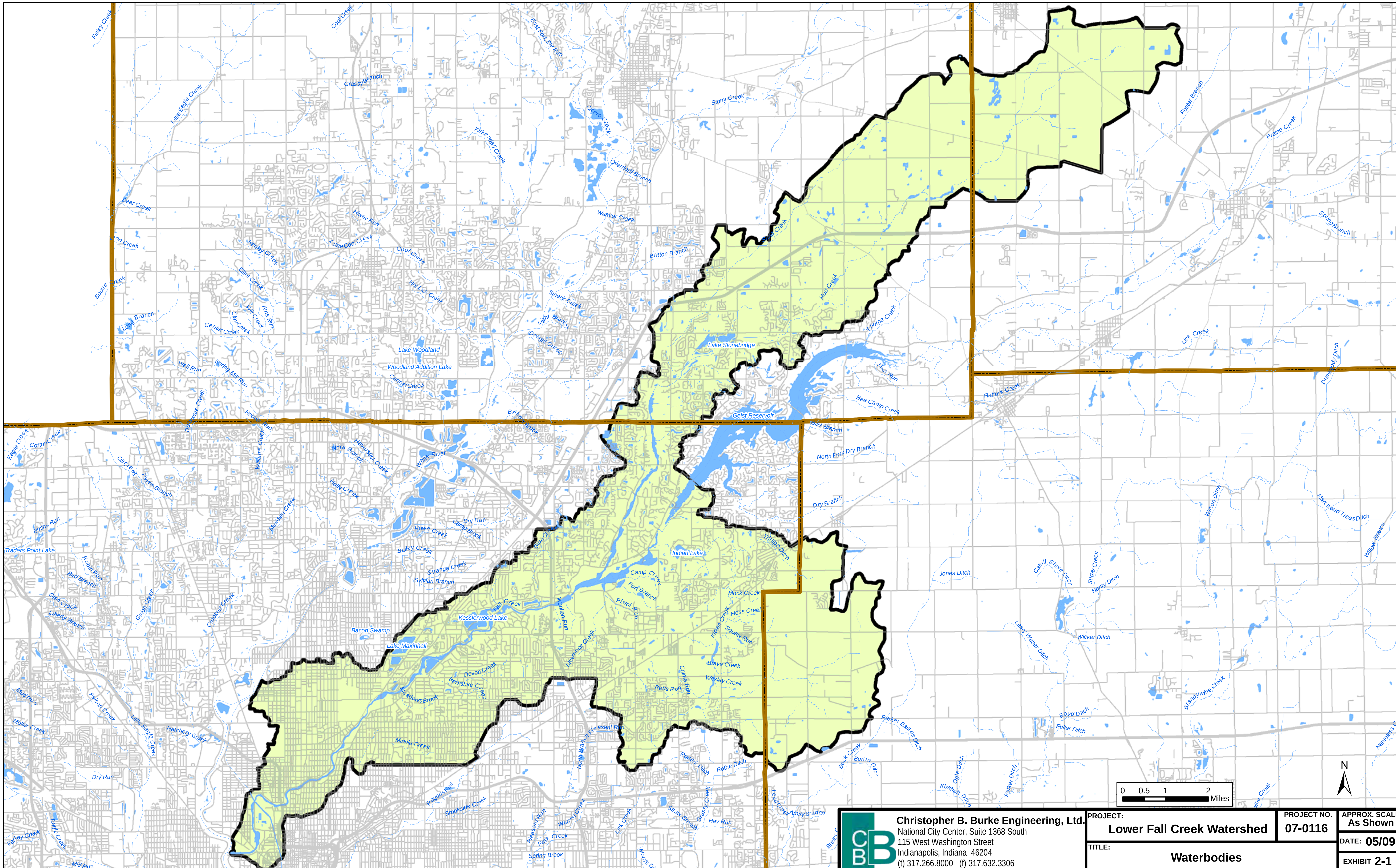

Christopher B. Burke Engineering, Ltd.
National City Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306

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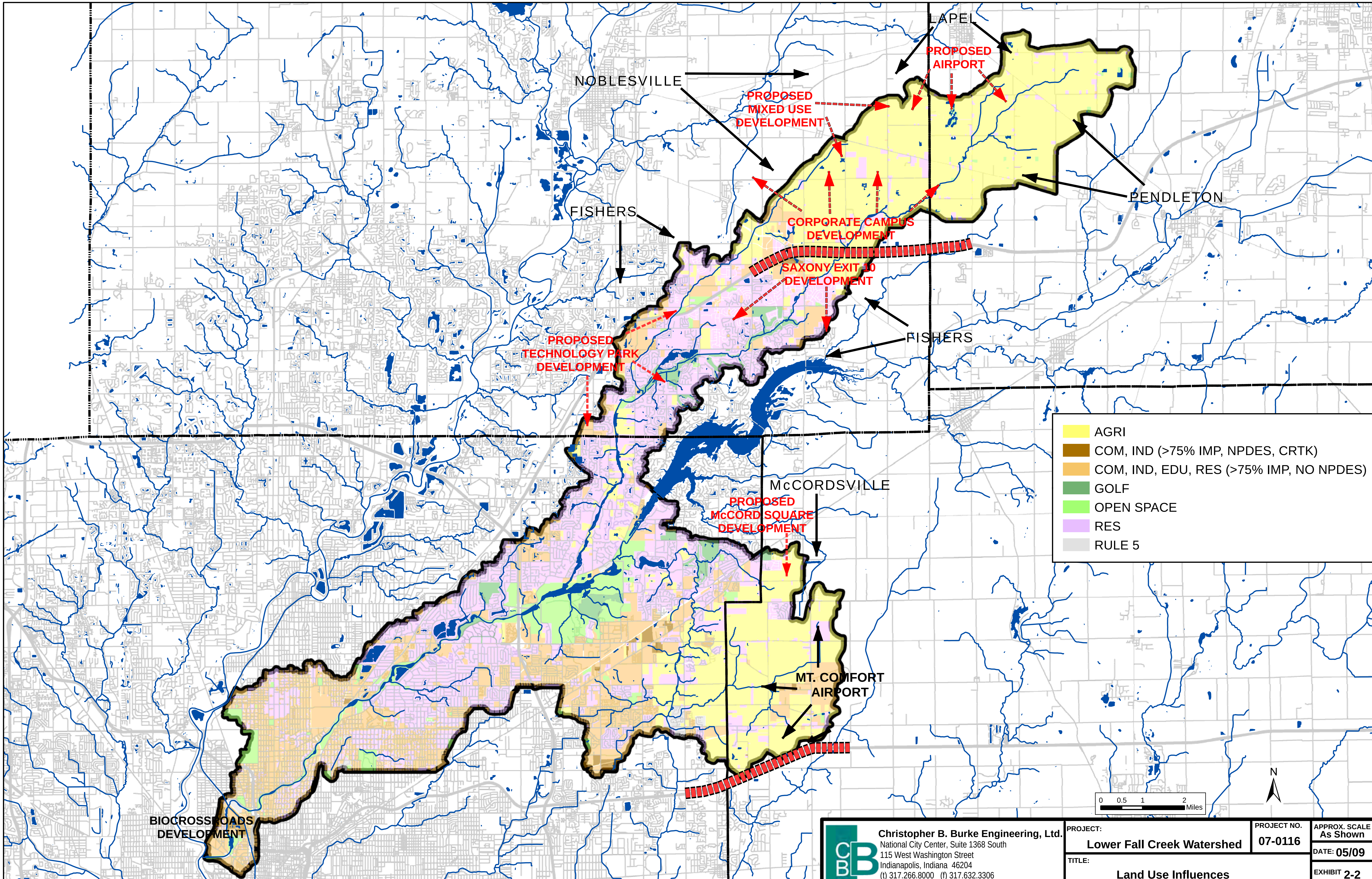

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PROPOSED AIRPORT
PROPOSED MIXED USE DEVELOPMENT
PENDLETON
FISHERS
CORPORATE CAMPUS DEVELOPMENT
SAXONY EXIT 10 DEVELOPMENT
FISHERS
PROPOSED TECHNOLOGY PARK DEVELOPMENT
McCORDSVILLE
PROPOSED McCORD SQUARE DEVELOPMENT
MT. COMFORT AIRPORT
BIOCROSSROADS DEVELOPMENT
AGRI
COM, IND (>75% IMP, NPDES, CRTK)
COM, IND, EDU, RES (>75% IMP, NO NPDES)
GOLF
OPEN SPACE
RES
RULE 5
N
0 0.5 1 2 Miles
Christopher B. Burke Engineering, Ltd.
National City Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306
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As Shown
DATE: 05/09
TITLE:
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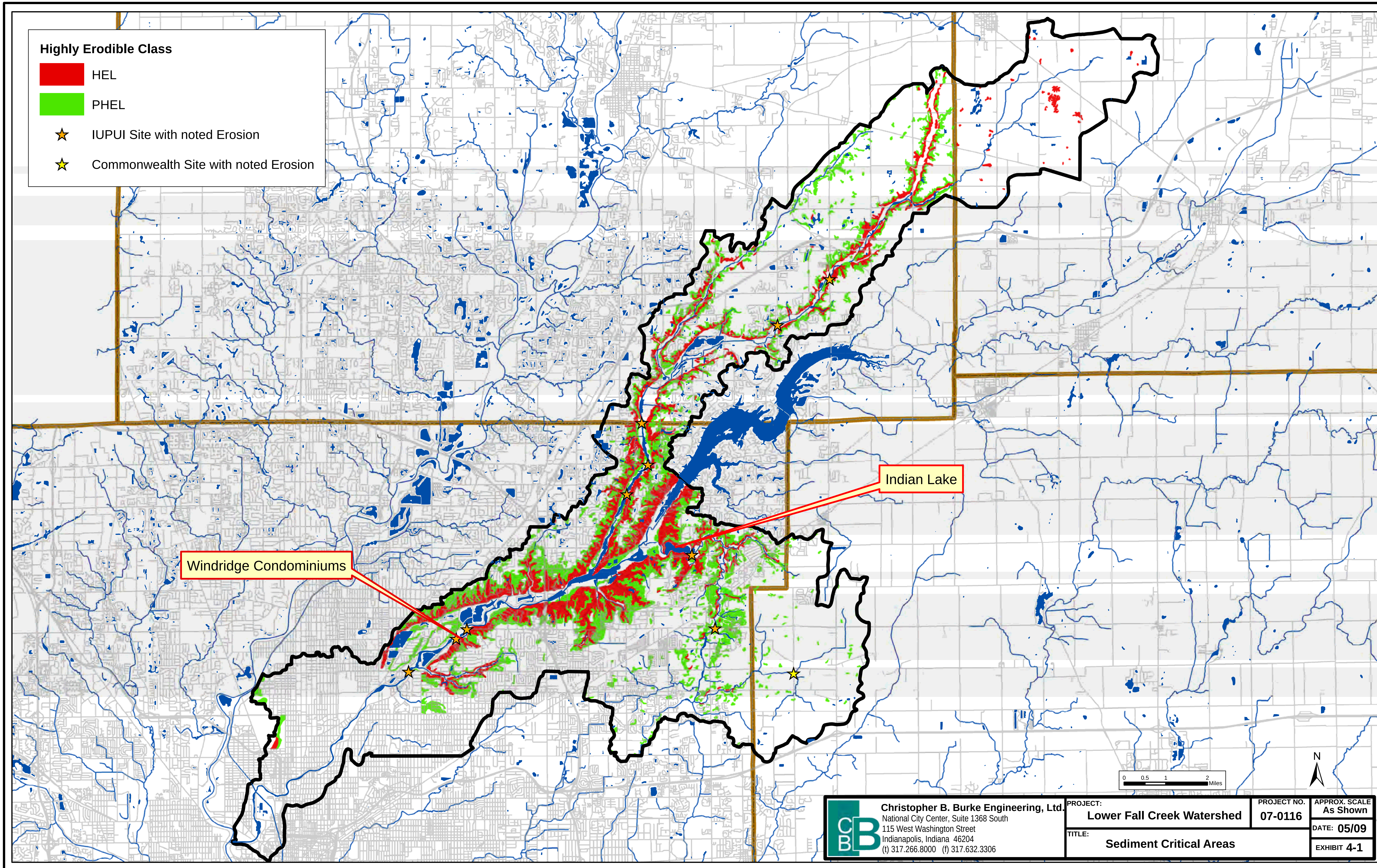

Highly Erodible Class
HEL
PHEL
IUPUI Site with noted Erosion
Commonwealth Site with noted Erosion
Indian Lake
Windridge Condominiums
0 0.5 1 2 Miles
N
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National City Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306
PROJECT:
Lower Fall Creek Watershed
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07-0116
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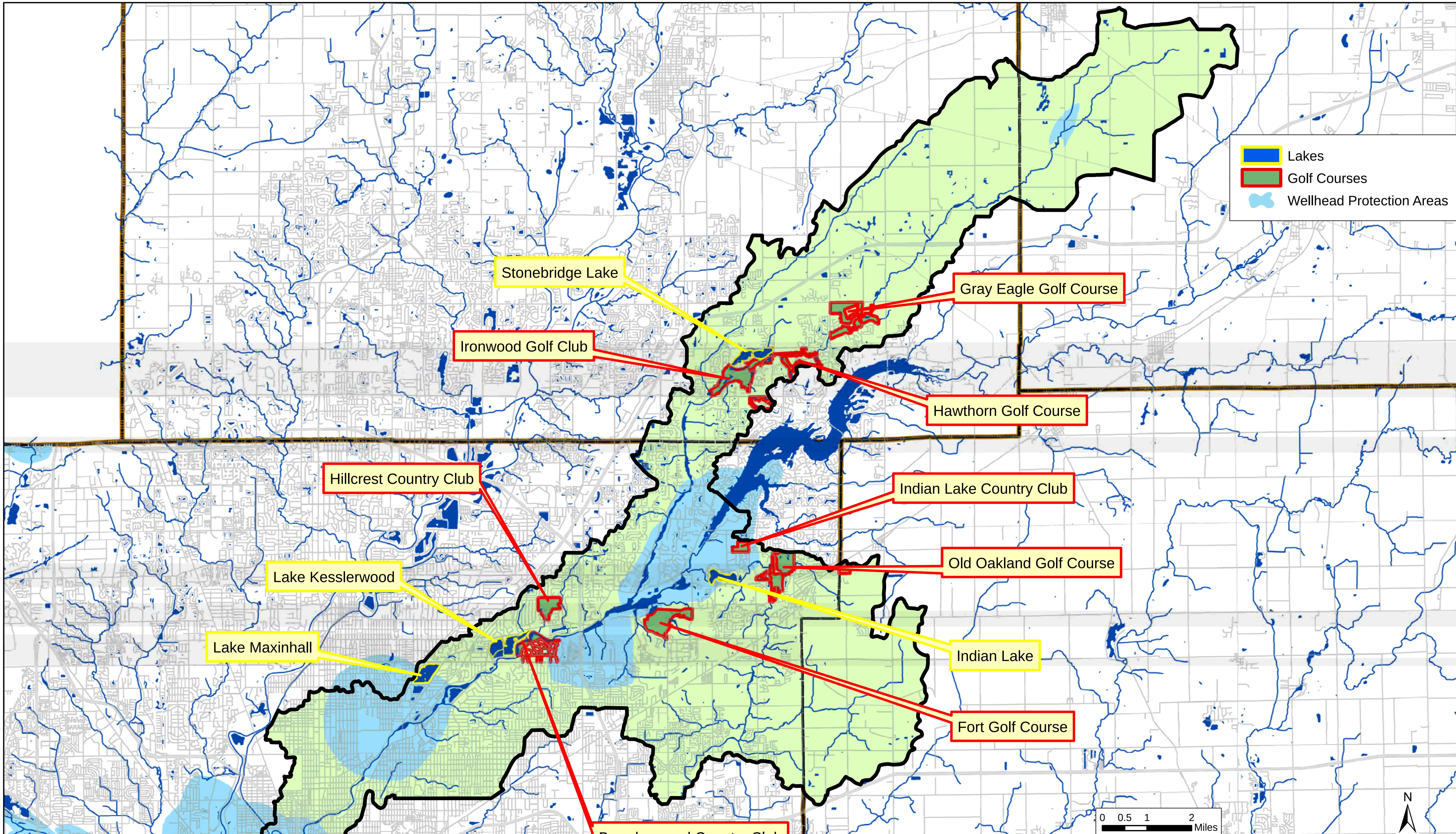

Christopher B. Burke Engineering, Ltd.
National City Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306

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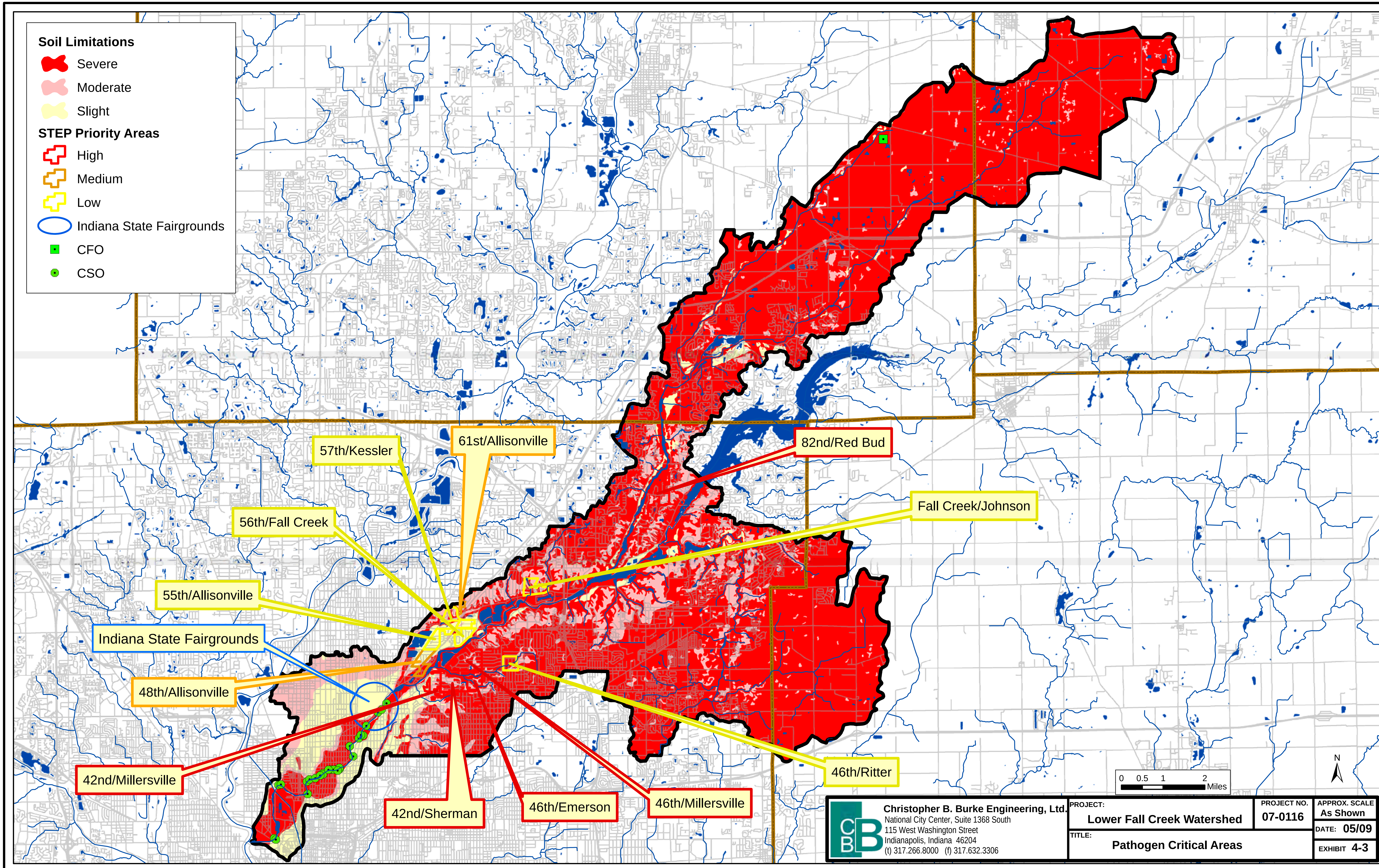

Soil Limitations
Severe
Moderate
Slight
STEP Priority Areas
High
Medium
Low
Indiana State Fairgrounds
CFO
CSO
57th/Kessler
61st/Allisonville
82nd/Red Bud
Fall Creek/Johnson
56th/Fall Creek
55th/Allisonville
Indiana State Fairgrounds
48th/Allisonville
42nd/Millersville
42nd/Sherman
46th/Emerson
46th/Millersville
46th/Ritter
0 0.5 1 2 Miles
N
Christopher B. Burke Engineering, Ltd.
National City Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306
PROJECT:
Lower Fall Creek Watershed
PROJECT NO.
07-0116
APPROX. SCALE
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DATE: 05/09
TITLE:
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EXHIBIT 4-3