4.0 IDENTIFYING CRITICAL AREAS

Water quality data, trends in land use development, and comments from stakeholders in the watershed were utilized to identify critical areas within the Upper Wabash River watershed. Critical areas include areas that are of benefit to water quality and storage within the watershed, areas that are suspected of degrading water quality, and impeding the natural drainage and infiltration of the watershed. Areas that are considered to be beneficial to the Upper Wabash River watershed should be protected or enhanced, and those areas or activities suspected of degrading water quality or increasing the risk of flooding should be targeted for implementation of management measures.

4.1 BENEFICIAL CRITICAL AREAS

Identifying land uses and activities that have a negative impact on water quality or the assimilation of increased water quantity is often the primary focus of watershed planning. While managing the impacts of these activities can and does improve water quality and assimilation, it is equally important to identify the existing land use conditions and activities in a watershed that currently enhance or protect water quality and reduce the risk of flood related damages. As these areas are protected, the potential of further degradation will be reduced.

Buffered Stream Reaches

The term buffer includes those areas where permanent vegetation has been established with the intention of trapping pollutants and managing other natural resource concerns, such as field wind breaks, vegetated fence rows, filter strips, and riparian buffers. Buffered stream reaches can be beneficial to the watershed in many ways. Loadings of sediments, nutrients, and pesticides can be significantly reduced after passing though a vegetated buffer adjacent to the stream or ditch. These corridors are also important to the wildlife of the area as they provide habitat and food sources perhaps not found elsewhere. Overhanging vegetation, even if only tall grasses, allows the water course to be shaded in areas, creating a cooler environment, maintaining more consistent dissolved oxygen levels within the water, and providing a conducive habitat for aquatic organisms.

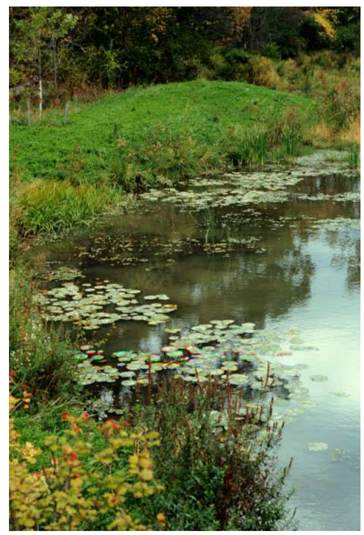
Within the Upper Wabash River watershed, there are approximately 330 miles of streams. Based on visual inspection of digital aerial photography, it has been estimated that approximately 208 stream miles, or 63% have 30 feet or more of vegetated buffer on one or both of the streambanks. Additionally, the mainstem of the Upper Wabash River appears to have a healthy riparian buffer system in excess of 75 feet of vegetation on either bank. These buffers provide a valuable water quality benefit and should be protected from encroaching development or neighboring land uses. Those stretches lacking sufficient cover should be revegetated. NRCS Practice Standard 393 suggests that with a minimum average flow length of 30 feet, reductions in the dissolved contaminants, nutrients, and suspended sediments in the overland runoff can be achieved. Healthy riparian buffers and/or corridors along the Wabash River and tributary streams may also provide flood control benefits, reductions in personal property damages, and increased retention and detention during high water events to allow for enhanced infiltration. Root systems associated with properly maintained and proportioned streambank vegetation such as tall grasses and woody vegetation also reduce the potential for streambank erosion and destabilization. When these root systems are removed or prohibited from growing, streambanks are more susceptible to sloughing and eventual collapse.

Areas of buffered stream reaches considered critical and in need of long-term protection include those reaches of the Wabash River main-stem with greater than 75 feet of riparian corridor.

Smaller streams and tributaries with greater than 50 feet of buffered streambank should also be provided protection. These areas not only provide habitat for land and aquatic species, they also provide crucial protection and enhancement capabilities for overall water quality, provide storage areas for high water events, and reduce potential monetary damages and injuries due to flooding.

A method for protecting these well buffered areas is to adopt a basin wide ordinance requiring a minimum of 75 feet setback along the Wabash River and tributaries, ensuring that the riparian area will be maintained and protected from encroachment. Other effective measures include developing a Greenways Plan, purchasing floodplain and/or conservation easements along the mainstem and other currently established riparian buffers, and continual outreach and educational efforts to inform individual landowners of the importance and overall value of riparian buffers.

Wetlands



Within the Upper Wabash River Watershed, there are nearly 2,000 acres of woody or emergent herbaceous wetlands. There are approximately 70 acres within the 05120101-010 subwatershed, 430 acres of wetlands within the 05120101-040 subwatershed, 600 acres of wetlands within the 05120101-050 subwatershed, and within the 05120101-060 subwatershed an approximate 700 acres of wetlands exist. Areas identified as wetlands by the National Wetland Inventory (NWI) are located in **Exhibit 6**.

These wetlands have the ability to serve several functions in regard to the protection and enhancement of water quality. Water flowing into, or stored in a wetland may be retarded allowing increased time for the uptake of nutrients, settling of suspended solids, and evaporation or infiltration of excess water. If wetlands did not exist, this water would be directed to the nearest open water system; pollutants included. The ability to recharge the surrounding area with slowly released water helps provide a more consistent soil moisture level in an agricultural setting, while allowing for groundwater recharge at the same time. Wetlands also serve the watershed as wildlife habitat areas providing cover from predators while also serving as a food source. Several projects listed above involved restoration or protection of critical wetlands and these areas will be beneficial to the functioning of the natural landscape as well as the historical heritage of the area.

The individual County Comprehensive Plans have identified the importance of wetlands to the environmental and the need for protection of existing wetlands. The Adams County Comprehensive Plan of 1994 discusses the need to consider existing wetlands in reviewing development proposals, promote preservation of existing wetlands, and to encourage landowners to restore marginally productive farm land to wetland status. Jay County has stated that any development that will destroy or harm any environmentally sensitive areas, such as wetlands) should be discouraged. While the Wells County Comprehensive Plan does not specifically identify wetlands, it does state that an extensive system of conserved open space following the county's major watercourses has been proposed.

In order to provide the most benefit to the Upper Wabash River Basin, the 11-digit HUC prioritized for wetland protection should be the 05120101-060 subwatershed, while the 11-digit HUC prioritized for wetland construction or restoration efforts should be the 05120101-010 subwatershed. However, as none of the 11-digit subwatersheds have more than 2% of the land use classified as woody or emergent wetlands, protection, restoration, and construction efforts should be carried out watershed wide.

Protected Lands

Areas that are protected through the purchase of conservation easements carry with them obligations for perpetuity. These areas are often obtained as a measure of protection prior to land use alterations. However, it is possible, and successful to purchase a particularly sensitive area and restore the flora, fauna, and water quality benefits that had been removed or damaged. Areas maintained through a conservation easement have the ability to lessen pollutant loadings, provide habitat, reduce flood damages, and allow for protection of critical land uses.

Parks, recreational areas, and open space areas allow for the increased potential for infiltration of stormwater, uptake of nutrients, and entrapment of solids such as sediment, thus reducing the loadings to streams, rivers and ditches. These low development areas, if placed in sensitive locations can also reduce monetary damages caused by frequent flooding. Flood damages to the open space or recreational areas could be far lower than damages to residences or other structures routinely found along a water course.

The listing below identifies the nearly 2,800 acres of land protected by conservation easement or maintained as a natural area within the boundaries of the Upper Wabash River Watershed, or within close proximity.

- **Ouabache State Park -** This State Park is located in the south-east quadrant of Wells County and is bordered to the west by County Road 450E, to the north by County Road 100 S, and to the east by IND 301. The entire southern edge of the 1,104 acre park property abuts the Wabash River.
- **Ouabache State Park** - These 39.36 acres are adjacent to the park entrance and the Wabash River. This land provides potential for development of bike and hiking trails with Bluffton.
- **Rainbow Bend –** This area consists of 14 acre floodplain forest adjacent to the Wabash River.
- **Wabash River Greenway Trail** - This 6 acre parcel provides public access to the Wabash River as a part of The City of Bluffton Wetlands Restoration and Trail Project.
- **Bluffton Wetlands & Greenway**, Adjacent to the Ouabache State Park, and bordered on the south by the Wabash River, this 115.084 acres helps to conserve and preserve a natural wetland as part of the existing Wabash River Greenway trail.
- **Limberlost State Historic Site and Swamp Wetlands –** The following listing details over 1,400 acres of wetland areas in various stages of restoration within the watershed.
  - Original 12 acres of the Limberlost Bird Sanctuary established in 1947 contains 8 acres of flatwoods wetland and a 4-acre Nature Preserve forest.
  - 143 acres in the Loblolly Marsh in Jay County 1996 is a restored marsh with a wetland overlook and an Americans with Disabilities Act trail.
  - 45 acres in the Loblolly Marsh in Jay County 1996 – restored pothole has an Americans with Disabilities Act trail and boardwalk over a restored wetland.

- 240 acres in the Loblolly Marsh in Jay County 1997 – restored marsh and potholes to teach geology. The 25-acre woodland is arrayed with many native plants and several rare species.
- 38 acres in the Limberlost Swamp in Adams County 1998 – restored floodplain wetlands show nearly a decade of restoration regeneration.
- 152 acres in the Limberlost Swamp in Adams County 1999 – restored potholes and a swamp Nature Preserve. This property is very secluded and will provide a refuge for the wildlife in the area.
- 327 acres in the Limberlost Swamp in Adams County 2000 – partially restored
- 26 acres of the Limberlost Bird Sanctuary Addition 2000 – restored forest land shows 6 years of regeneration and a wildlife watering facility.
- 9 acres in the Limberlost Swamp in Adams County 2001 – partially restored
- 65 acres in the Wabash River Area in Adams County 2001 – restored floodplains has Americans with Disabilities Act trails to the Wabash River's edge, a canoe launch for river studies, an Americans with Disabilities Act trail to a restored oxbow wetland, Native American Indian restored historic trail and river ford.
- 24 acres in the Wabash River Area in Adams County 2001 – mature floodplain wetland forest with proposed Americans with Disabilities Act trail
- 8 acre oxbow island in the Wabash River Area in Adams County 2002 – Nature Preserve mature floodplain forest on an oxbow with Great Blue Heronry
- 27 acres in the Limberlost Swamp in Adams County 2003 – reforestation and emergent wetlands planned
- 20 acres in the Limberlost Swamp in Adams County 2005 – planning
- 39 acres of the Limberlost Bird Sanctuary Addition 2005 – restored
- 113 acres in the Limberlost Swamp in Adams County 2005 – planning
- 58 acres in the Limberlost Swamp in Adams County 2005 – planning
- 14 acres of the Limberlost Bird Sanctuary Addition 2006 – planning
- 15 acres of the Limberlost Bird Sanctuary Addition 2006 – Reforestation planned.
- 70 acres in early contractual purchase agreement during 2007-08 – future purchases will continually improve the water quality and reduce the intensity of the flooding losses.

Areas with Central Sewer or Other Treatment Facilities

Residential areas that are serviced by a centralized wastewater facility such as a WWTP or an operational package plant have reduced the potential for sewage or other household effluent to enter a nearby drainage ditch, stream or river. While there are risks and impacts associated with such services, the benefits far outweigh the detriments regarding the protection and enhancement of water quality. Treatment facilities have the ability to efficiently and effectively treat household wastewater while discharging significantly cleaner water into the receiving water bodies.

Areas serviced by centralized treatment facilities in the watershed include the Town of Geneva and the Town of Bryant. The City of Bluffton, the City of Portland and the Town of Berne are areas serviced by centralized treatment facilities, very near to the watershed boundaries. As these incorporated areas continue to grow in population, it may eventually become necessary to extend the service areas for the wastewater treatment plants. This may provide the opportunity for residences to abate their current on-site septic systems, thus reducing the overall potential for untreated household wastewater to enter the streams and tributaries in the Upper Wabash River watershed.

Critical service areas are those municipalities with separated storm and sanitary sewer utilities operating at less than or equal to half the design capacity. Feasibility studies need to be completed for these critical areas to determine the facility's operational ability and cost projections to extend services to those residents within 2 miles of the current service area.

4.2 CRITICAL AREAS AS POTENTIAL SOURCES OF POLLUTION

Critical areas identified below are considered by the UWRBC Steering Committee to be potential sources of pollution within the watershed. In order to minimize the water quality impacts associated with these areas, it will be important to target the implementation of management measures identified later in **Table 5-1, Table 5-2, Table 5-3, and Table 5-4** toward these critical areas.

Failing Septic Systems

A source of the elevated pathogen bacteria in the watershed may be associated with improperly functioning, failed, or non-existent residential septic systems. Many factors can lead to the failure of a residential septic system; the age of the system, lack of regular maintenance to the system, and heavy clay soils. Within the Upper Wabash River watershed, the unincorporated areas lack a centralized sewage disposal system, limiting homeowners to on-site septic systems. It is crucial that these homeowners are equipped with the necessary information and knowledge as to the proper maintenance of the system to prevent failure. As the more populated areas of the City of Berne, the City of Bluffton, the Town of Bryant, the Town of Geneva, and the City of Portland continue to grow in size, it will become more feasible to provide sanitary sewer services to those residences in close proximity to these areas. The importance to provide a centralized sanitary sewer system is underlined by information prepared by Purdue University Extension onsite regarding wastewater disposal in Indiana. Adams County, according to 1990 US Census data had an approximate 4,300 households utilizing onsite wastewater disposal systems. Soils in Adams County considered to be severely limited for proper septic system function based on NRCS criteria was estimated to be 100%. Similarly, within Jay and Wells Counties there are an estimated 3,700 and 4,700 households respectively utilizing onsite wastewater treatment systems. Further, in each of Jay and Wells Counties more than 96% of the soils are classified by NRCS as severely limited for septic systems.

Residential on-site sewage systems located within the floodway or 100-year floodplain are at a higher risk of discharging improperly treated effluent, bacteria, and pathogens into receiving waterbodies. As the soils become saturated due to rainfall, and the receiving streams are inundated, there is little to no treatment occurring within the soil absorption field. Routine flooding of those systems located in the floodplain may also have detrimental effects on the individual components of the system.

The most critical are those areas within the watershed is where a cluster of 20 or more rural homes with residential septic systems installed more than 10 years ago in soils with NRCS defined severe limitation for onsite wastewater disposal or treatment. Utilizing digital aerial photography, 8 clusters of septic systems as well as the Town of Linn Grove and the Town of New Corydon were identified and are shown on Exhibit 5. These clusters are all located near to the Wabash River or associated tributary streams and may provide concentrated loadings of nutrients and/or bacteria if several of these systems are failing to adequately treat the household wastes. Water quality monitoring should be initiated immediately upstream as well as immediately downstream of these areas to further assess the impact on water quality and macro-invertebrate communities.

Unbuffered Stream Reaches

Unbuffered streams and tributaries are highly exposed to overland runoff and the non-point source pollutants that are carried with it. Without the protection of several feet of vegetated buffer, pollutants such as sediment, nutrients and chemicals can be directly delivered to the stream system. In addition to reductions in pollutant loadings, vegetated buffers also provide a shading effect that can provide a more habitable environment for aquatic organisms regarding temperature and dissolved oxygen. Exhibit 5 highlights the areas of the streams and tributaries to the Upper Wabash River that have less than 30 feet of vegetation on either streambank. These areas were identified utilizing digital aerial photography of the watershed.

The most critical are those areas within the watershed where streams and tributaries have less than 30 feet of vegetated buffer and are bordered by agricultural fields utilizing conventional tillage methods during crop production. There are approximately 330 miles of streams within the watershed, and of that, it is estimated that approximately 122 miles, or 37%, of streams have less than 30 feet of vegetated buffer on one or both of the streambanks. The majority of such streambanks are located in the upland portions of the watershed surrounding headwater streams amid agricultural land uses. A more detailed assessment, including a tillage survey and buffer survey should be completed to provide a more accurate overview of the watershed.

Utilizing a visual inspection of digital aerial photography for the Upper Wabash River watershed, it is estimated that within the 05120101-040 subwatershed, approximately 23 stream miles have less than 30 feet of established vegetation on either streambank. In addition, it is estimated that 53 unbuffered stream miles are present in the 05120101-050 and 46 stream miles are present in the 05120101-060 subwatersheds. Based on the estimated number of unbuffered stream miles, the 05120101-050 subwatershed should be targeted for efforts to establish grassy or woody vegetation along the streambanks. The promotion of existing Federal Incentive programs such as Conservation Reserve Program (CRP), Conservation Security Program (CSP), and Environmental Quality Incentive Program (EQIP) can lead to the establishment of various forms of stream buffers providing benefits not only to the Upper Wabash River, but also to the individual landowners.

Areas Prone to Flooding

Areas prone to flooding can also be sensitive to other issues related to water or habitat quality degradation, as well as cumulative effects of increased water quantity within the stream system. Poorly managed floodplains where increased construction or other land use changes have occurred result in increased vulnerabilities to the new structures and to downstream areas as well. If water is not allowed to infiltrate the soil layers due to increased impervious surfaces, runoff volumes and downstream loadings will be increased. These increased volumes of water may mobilize trees and other near stream debris creating the potential for in-stream obstructions or log jams.

The term “log-jam” is defined by the Indiana Administrative Code as the accumulation of lodged trees, root wads, or other debris that impedes the ordinary flow of water through a waterway. As these log jams are created, areas of significant erosion and streambank destabilization are created further degrading water quality through sedimentation. Log jams may range in severity from leaning trees that need to be removed and utilized to stabilize the nearby streambank, to areas requiring large excavation equipment from both the land and within the stream for proper removal. With each degree of severity and corresponding workload, restrictions and guidelines provided by IDNR and the US Army Corps of Engineers (USACE) must be adhered to rigorously. Plans of work and permits are also required for more intensive situations. Some areas in the Wabash River watershed are sensitive to log jams and associated debris deposition and/or increased streambank erosion. These areas, shown on Exhibit 5, were selected by the Adams, Jay, and Wells County Surveyors and are considered critical requiring constant observation and maintenance.

The risks to structural damages and watercourse damages can be decreased through preventative measures including detailed stream studies to establish floodways, floodplains, and base flood elevations. Utilizing the associated information will provide better knowledge regarding the stream and allow for proper floodplain management. Furthermore, the installation of United States Geological Survey (USGS) stream gages designed to monitor water quality, elevation, and flow will provide the necessary baseline information as well as information regarding low and high water events. Longevity of record for each gage is also important to monitor trends over several years. The combination of information obtained through detailed stream studies and long term monitoring can be valuable when proposing methods to prevent repeated flood events as well as reducing the impacts of flooding to water quality and personal property. Areas sensitive to repeated flooding, property damages, and the locations of existing are identified on Exhibit 4.

Livestock with Access to Stream

Livestock with access to the stream, or even feedlots and pastures bordering streams and tributaries can have a direct impact on water quality. Loadings of bacteria, such as *E. coli*, are directly deposited through fecal matter or delivered via stormwater runoff from the nearby feedlots and pastures. Sediment is delivered to the stream via erosion of worn livestock entrance paths and degraded streambanks. When livestock are excluded from the open streams and/or feedlots and pastures have been setback, it is important to establish a vegetated buffer to further reduce the potential of the above mentioned pollutants entering the stream system.

All areas where livestock have unrestricted access to open streams and tributaries, or where feedlots and pastures are within 500 feet of the open stream or tributary without a vegetated buffer are considered critical areas for the purpose of this plan. Furthermore, these areas would be considered extremely critical areas should they also be located in an area with HEL classified soils.

Conventionally Tilled Agricultural Fields

Conventional tillage of crop land allows the soil to remain exposed to the elements for extended periods of time. The majority of conventional tillage is completed following the crop harvest in the fall and no crop residue remains on the surface of the field. Thus the topsoil is exposed to the snow and more importantly during the spring snow melts and rain events. As the snow melts and the rain falls, the potential for soil erosion and the resulting sedimentation of receiving waters is greatly increased and nearly guaranteed.

Within the Upper Wabash River watershed, the primary tillage method for corn production remains to be conventional tillage. The percentage of conventional tillage is well over half in both Adams County (60%) and Wells County (82%), while Jay County has been estimated at 54% conventional tillage. It does seem that soybean production has moved away from conventional tillage as the percentages are significantly lower in all three counties: Adams – 20%, Jay – 19% and Wells – 28%.

Fields utilizing conventional tillage for crop production on HEL soils within 500 feet of a stream or tributary are to be considered critical areas due to the increased erosion and pollution potential. For a more detailed view of these critical areas, a tillage inventory should be completed within the watershed and those results should be cross-referenced with NRCS HEL determinations.

Highly Erodible Lands

HEL determinations, made by NRCS, are based on a mathematical equation, USLE, the Universal Soil Loss Equation. This equation takes into account the rainfall factor, erodibility of the soil type, allowable loss for that soil type and the length and the slope of the area. Soil map units may also be classified as 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.

Within the Upper Wabash River watershed, there are approximately 4,200 acres (2.6% of the entire watershed) of HEL classified soils. Further, approximately 1,300 acres of HEL are located within the 05120101-040 subwatershed. An additional 78,400 acres (49% of the entire watershed) has been labeled as having characteristics similar to HEL soils and therefore are classified as potential HEL soils requiring individual field determinations. These soils, both HEL and PHEL, need proper management to reduce the increased potential for soil erosion. Thus, areas of HEL or PHEL soils currently in production and within 500 feet of a tributary stream of the Wabash River within the 05120101-040 are considered the most critical. These areas will need to be investigated in order to produce a conservation plan outlining potential BMPs and management techniques to reduce erosion. These areas are identified on Exhibit 5.

4.3 ESTIMATING POLLUTANT LOADINGS & REDUCTIONS

In order to determine the overall effectiveness of recommended management measures identified in this plan, it is important to have an understanding of the existing pollutant loads in the Watershed.

Pollutant Loadings

Flow data on the Wabash River was available for several USGS gaging stations, including Wabash River at New Corydon (OH-IN state line) for the period of 1951 through 1988; Wabash River at Linn Grove for the period of 1965 through 2006; Wabash River near Bluffton for the period of 2002 through 2005; and Wabash River at Bluffton for the period of 1931 through 1971. In order to determine the estimates of coincident long-term average mean annual flow at various points of interest, average mean annual flow was determined for various record periods that coincided with each of the stations. The ratio of long-term (1965-2006) average mean annual flow to average mean annual flow for each of these coincident periods at the Linn Grove station was determined and utilized for adjusting each station's average value for the respective coincident record period with the Linn Grove gaging station. Estimates of the long-term average mean annual flow for the intermediary area between the gaging stations were also determined by subtracting flow values at each upstream and downstream gaging station.

The above process to estimate the long-term average mean annual flow for various locations in the Upper Wabash River Basin based upon the Linn Grove Indiana gaging station is summarized in **Table4-1**.

The estimated long-term mean annual flow was then multiplied by the mean pollution concentrations for nitrate, phosphorus, and *E.coli* based samples collected near the 11-digit watershed outlets. These sampling stations were determined as a component of the IDEM, Clean Water Act – Section 205(j): Water Quality Planning Grant awarded to the UWRBC in 2004.

Target pollutant loads were then determined by multiplying the estimated long-term mean annual flow by a target concentration set for each pollutant. The targets utilized for this method were also utilized to develop the TMDLs for the Wabash River in both Ohio and Indiana. Target load reductions were then determined by subtracting the targeted loadings from the estimated existing loadings. Based on these calculations, the existing pollutant loads, targets, and target reductions were developed for Phosphorus, Nitrogen, *E.coli*, and TSS. Reductions needed to achieve attainment status in Indiana as well as Ohio are provided in **Tables 4-2, 4-3, 4-5, & 4-6**.

Table 4-1: Estimation of Long-Term (1965-2006) Average Mean Annual Flow

	Wabash River near New Corydon (USGS 03322500)		Wabash River at Linn Grove (USGS 03322900)		Wabash River near Bluffton (USGS 03322985)		Wabash River at Bluffton (USGS 03323000)
Area of Watershed Represented	Ohio Drainage	Intermediary Area	Entire Area upstream of Gaging station	Intermediary Area	Entire Area upstream of Gaging Station	Intermediary Area	Entire Area upstream of Gaging Station
Drainage Area (mi^2)	262	191	453	55	508	24	532
Period of Coincident Discharge Record with Linn Grove Long-Term Data	(1965-1988)		(1965-2006)		(2002-2005)		(1965-1971)
Avg. Mean Annual flow	208		413		671		349
Long term record Adjustment Factor	1.13		1.00		0.69		1.42
Adjusted flow (cfs)	235	178	413	50	463	33	496
Unit flow production (cfs/mi^2)	0.897	0.932	0.912	0.909	0.911	1.358	0.932
Estimated flow (cfs)	235.0	178.0	413.1	50.0	462.8	32.6	495.8

Table 4-2: Targeted Phosphorus Load Reductions for the Upper Wabash River Basin

Point of interest	Watershed of Interest	Drainage Area (Mi^2)	Unit Flow Production (cfs/mi^2)	Long-term Average Mean Annual Flow (cfs)	Existing Average Concentration (mg/L)	Estimated Existing Loadings (tons/year)	Target Concentration (mg/L)		Target Load Reduction (Tons/year)		Percent Reduction	
							IN	OH	IN	OH	IN	OH
Ohio-Indiana State Line	**Ohio Drainage Area + IN portion of 05120101010**	**262**	**0.897**	**235**	**2.6 mg/L**	**603.4**			**534.0**	**564.1**	**89.0%**	**94.0%**
Outlet of 05120101040 Just u/s of Loblolly Creek	Total Wabash River Watershed upstream of the point of interest (u/s of Geneva)	296	0.901	267	1.18	310.0			231.4	265.3	74.6%	85.6%
Mouth of Loblolly Creek	**Entire Drainage area associated with 05120101050**	**110**	**0.932**	**103**	**0.55**	**55.7**	**0.30**	**0.17**	**25.3**	**38.5**	**45.5%**	**69.1%**
Outlet of 05120101060 Just d/s of Six Mile Creek	Total Wabash River Watershed upstream of the point of interest (u/s of Bluffton)	506	0.911	461	0.26	117.9			Below Target	40.8	Below Target	34.6%

Table 4-3: Targeted Nitrate + Nitrogen Load Reductions for the Upper Wabash River Basin

Point of interest	Watershed of Interest	Drainage Area (Mi^2)	Unit Flow Production (cfs/mi^2)	Long-term Average Mean Annual Flow (cfs)	Existing Average Concentration (mg/L)	Estimated Existing Loadings (tons/year)	Target Concentration (mg/L)		Target Load Reduction (Tons/year)		Percent Reduction	
							IN	OH	IN	OH	IN	OH
Ohio-Indiana State Line	**Ohio Drainage Area + IN portion of 05120101010**	**262**	**0.897**	**235**	**5.6**	**1,295**	10.0	1.5	**Below Target**	**948**	**Below Target**	**73%**
Outlet of 05120101040 Just u/s of Loblolly Creek	Total Wabash River Watershed upstream of the point of interest (u/s of Geneva)	296	0.901	267	8.1	2128			Below Target	1734	Below Target	81.5%
Mouth of Loblolly Creek	**Entire Drainage area associated with 05120101050**	**110**	**0.932**	**103**	**6.1**	**618**			**Below Target**	**466**	**Below Target**	**75.4%**
Outlet of 05120101060 Just d/s of Six Mile Creek	Total Wabash River Watershed upstream of the point of interest (u/s of Bluffton)	506	0.911	461	9.6	4353			Below Target	3673	Below Target	84.4%

Table 4-4: Targeted *E. coli* Load Reductions for the Upper Wabash River Basin

Point of interest	Watershed of Interest	Drainage Area (mi^2)	Unit Flow Production (cfs/mi^2)	Long-term Average Mean Annual Flow (cfs)	Existing Average Concentration (cfu/100mL)	Estimated Existing Loadings (cfu/year)	Target Concentration	Target Load Reduction (cfu/year)	Percent Reduction
Ohio-Indiana State Line	**Ohio Drainage Area + IN portion of 05120101010**	**262**	**0.897**	**235**	**674.5**	**1.41E +15**	**235 cfu/100 mL**	**9.22E +14**	**65.2%**
Outlet of 05120101040 Just u/s of Loblolly Creek	Total Wabash River Watershed upstream of the point of interest (u/s of Geneva)	296	0.901	267	2760	6.6E +15		6.0E +15	91.5%
Mouth of Loblolly Creek	**Entire Drainage area associated with 05120101050**	**110**	**0.932**	**103**	**163**	**1.50E +14**		**Below Target**	**Below Target**
Outlet of 05120101060 Just d/s of Six Mile Creek	Total Wabash River Watershed upstream of the point of interest (u/s of Bluffton)	506	0.911	461	135	5.6E +14		Below Target	Below Target

Table 4-5: Targeted Sediment Load Reductions for the Upper Wabash River Basin

Point of interest	Watershed of Interest	Drainage Area (Mi^2)	Unit Flow Production (cfs/mi^2)	Long-term Average Mean Annual Flow (cfs)	Existing Average Concentration (mg/L)	Estimated Existing Loadings (tons/year)	Target Concentration (mg/L)	Target Load Reduction (Tons/year)	Percent Reduction
Ohio-Indiana State Line	**Ohio Drainage Area + IN portion of 05120101010**	**262**	**0.897**	**235**	**95.9**	**22,170.6**	**80.0**	**3,675.8**	**16.6%**
Wabash River at Linn Grove	Entire area upstream of Gaging Station	453	0.912	413.1	114.4	46,491.3		13,979.9	30.1%

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Pollutant Reductions
Following the estimation of current pollutant loadings and the reductions needed to reach target levels of Total Phosphorus, Total Nitrogen and *E. coli*, various scenarios were developed to predict pollutant load reductions realized by implementing BMPs throughout the watershed. It should be noted that several BMPs may need to be implemented in combination to provide adequate reductions in loadings in order to meet Indiana target levels. A more long term goal would be to strive for pollutant loading reductions in order to meet Ohio target loadings for increased water quality improvements.

Utilizing information found in Schueler's "The Practice of Watershed Protection", calculations to determine phosphorus and nitrogen loadings and potential load reductions were also produced utilizing estimated septic system inputs from household wastewater per person, per day, using an estimate of the number of households within the watershed. According to 1990 data from Purdue University, all of Adams County had an approximate 4,200 homes with onsite wastewater systems. Likewise, all of Jay County had an approximate 3,600 systems, and Wells County was estimated to have nearly 4,700 homes utilizing septic systems. County estimates were then altered to show the estimated percentage of those systems within the Upper Wabash River Basin. Estimates were then produced to determine septic system outputs for systems that are failing, or non-existent, as well as systems that are efficiently and effectively treating the household wastewater. These estimates assume that routine maintenance and cleaning of the septic system components is occurring. These values are identified in **Table 4-6**. It can be further estimated that with septic system pumping, routine maintenance, and system replacements, 3.6 – 4.7 tons of phosphorus per year and 15.0 – 19.6 tons per year of nitrogen can be reduced.

Table 4-6: Estimated Loadings and Reductions for Septic Systems within the Upper Wabash River Basin

County	Est. number of on-site systems	Est. failing systems (25%)	Est. Phosphorus reduction (Tons/year)	Est. Nitrogen reduction (Tons/year)
Adams	1,218	305	1.2	5.1
Jay	1,764	441	2.0	7.4
Wells	987	247	0.9	4.1
TOTAL	**3,969**	**993**	**4.1**	**16.6**

<u>*Existing and Target Row Crop Sediment Loads*</u>
Sediment monitoring was completed throughout the Upper Wabash River Basin at IDEM fixed-site monitoring locations. Two of these locations were sampled through USGS stream gages utilized in earlier loading and reduction calculations; the Ohio-Indiana State Line and Linn Grove. Considering all samples for these locations, average concentrations of TSS were obtained and multiplied by the calculated Long-Term average mean flow found in Table 4-1. The estimated average annual loading at the Linn Grove site is 47,259 Tons/year, above the target loading of 32,511 Tons/year. Similarly, the estimated average annual loading at the Ohio-Indiana State Line is 22,170 Tons/year, above the target loading of 18,494 Tons/year. This can be utilized to indicate the need for management measures to be implemented in the Ohio drainage area. Management measures should also be taken within the Indiana drainage area to reduce the potential sediment loadings to the watershed since conventional tillage practices are still being widely utilized. The individual, 100 acre farm load reduction for sediment described below could be utilized to determine a target goal for the watershed.

<u>*Load Reduction on an Individual, 100 acre Farm for Sediment, Phosphorous, and Nitrogen*</u>
Load reduction spreadsheets (Region 5 Model) accepted by IDEM, Ohio Department of Natural Resources (ODNR), Michigan Department of Environmental Quality (MDEQ), and the Illinois Environmental Protection Agency (IEPA), along with the RUSLE2 predicted annual soil loss (ton/year) were utilized to produce estimated load reductions for sediment, phosphorus, and nitrogen as a result of implementing agricultural field practices and/or filter strips on a 100 acre farm in 2 different soil types. This spreadsheet is better utilized with field specific information, but is beneficial in this application as it provides estimates of how various BMPs can reduce pollutant loadings. The Region 5 Model assumes that all of the runoff from the 100 acres is being treated by the BMPs used in the calculation.

The NRCS RUSLE2 Worksheet Erosion Calculation Record was utilized with general local information provided by the Wells County NRCS District Conservationist and these records can be found in **Appendix 5**. RUSLE2, the Revised Universal Soil Loss Equation, is a mathematical equation which considers a rainfall factor, erodibility of individual soil types, allowable loss for that soil type and the length and the slope of the area.

Regarding the Upper Wabash River watershed, 82.5% of land use, or 132,808 acres, is classified as row crop production occurring predominantly in Blount and Pewamo soils. The assumption can be made that with high agricultural, row crop land use, significant load reductions should be achieved by implementing agricultural BMPs, such as conservation tillage and filter strips, throughout the watershed. Based on information derived from local sources and spreadsheets mentioned, the estimated reductions in phosphorus loadings by implementing conservation tillage and filterstrips on a single 100 acre, row crop farm would range from approximately 31 lbs/year to 158 lbs/year. In regard to nitrogen, the reductions range from approximately 58 lbs/year to 300 lbs/year. **Table 4-7** was produced outlining these findings and demonstrates the potential reductions based on 2 different soil types. The Region 5 Model Worksheets to produce these findings can be found in Appendix 5. The Region 5 Model assumes that all 100 acres would have conservation tillage and filterstrips.

Livestock with direct access to a nearby stream or drainage way can provide significant inputs of nutrients and bacteria. Pasture lands or feedlots without a proper filter strip, within 500 feet of a tributary stream or open ditch may also provide considerable amounts of excess nutrients and bacteria. Following the estimation of current pollutant loadings and the reductions needed to reach target levels of Total Phosphorus, Total Nitrogen and *E. coli*, various scenarios were developed to predict pollutant load reductions realized by implementing BMPs throughout the watershed. It should be noted that several BMPs may need to be implemented in combination to provide adequate reductions in loadings in order to meet Indiana target levels.

Calculations within the load reduction spreadsheets previously mentioned were utilized to determine potential load reductions associated with installation of livestock exclusion fencing and/or filterstrips along feedlot and pasture areas. These estimated reductions will vary based on species or combinations of species per operation, number of operations implementing livestock exclusion and/or feedlot setbacks. The animal unit estimates are values below permitting levels. Values ranging from 8 lbs/year phosphorus reductions through 1,061 lbs/year phosphorus reductions per operation are identified in **Table 4-8**. The Region 5 Model Worksheets to produce these findings can be found in Appendix 5. No BMP efficiency data was available for nitrogen removal through livestock exclusion and/or feedlot setbacks.

Table 4-7: Estimated Loadings and Reductions, Ag BMPs

EST. LOAD REDUCTIONS per 100 ac farm	PEWAMO			BLOUNT B		
	Ag Field Practices	Filter Strips	TOTAL	Ag Field Practices	Filter Strips	TOTAL
Sediment (Tons/yr)	2	10	**12 T/yr**	26	69	**95 T/yr**
Phosphorus (lbs/yr)	4	27	**31 lbs/yr**	33	126	**159 lbs/yr**
Nitrogen (lbs/yr)	8	50	**58 lbs/yr**	65	234	**300 lbs/yr**

(IDEM Region 5 Model, April 2007)

Table 4-8: Estimated Loadings and Reductions, Feedlots, Pastures and Access Areas

Species	Average Animals	Est. Phosphorus Loadings without Filterstrip (lbs/yr)	Est. Phosphorus Loadings with Filterstrip (lbs/yr)
Beef	275	1,248	187
Dairy	299	1,248	187
Horse	5	10	1
Sheep	400	109	16
Swine	599	734	110

(IDEM Region 5 Model, April 2007)

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Based on these estimates, the implementation of these management measures at specific sites would greatly reduce the pollutant loadings potentially meeting the targeted phosphorus load reductions for the watershed as indicated in Tables 4-2 and 4-4. All target load reduction numbers for nitrogen were below reduction target values, as shown in Table 4-3, so theoretically no management measures for nitrogen would even need to be implemented in the watershed.

Table 4-9 identifies the predicted load reductions associated with implementing some of the management measures discussed above.

Table 4-9: Potential Load Reductions, Critical Area Management Measures

Management Measure	Total Phosphorous Reduction	Total Sediment Reduction	Total Nitrogen Reduction
Septic System Improvements (systems)	1: 14 lb/yr 993: 13,902 lb/yr	N/A	1: 34 lb/yr 993: 33 762 lb/yr
Implementation of Filter/Buffer Strips (miles)	1: 0.2-1.2 T/yr 122 : 24.4-146.4 T/yr	1: 125.6-1,716.3 T/yr 122: 15,323.2-209,352.0 T/yr	1: 0.3- 2.3 T/yr 122: 36.6-280.6 T/yr
Implementation of Agricultural Conservation Measures (100 acre farm)	1: 4.0-33.0 lb/yr 1,328: 5,312.0-43,824.0 lb/yr	1: 2.0-26.0 lb/yr 1,328: 2,656.0-34,528.0 lb/yr	1: 8.0-65.0 lb/yr 1,328: 10,624.0-86,320.0 lb/yr
Streambank Stabilization/Restoration (per each 250 feet long X 10 high streambank with a recession rate of 0.2 feet per year*)	1: 10 lb/yr 10: 100 lb/yr	1: 10 lb/yr 10: 100lb/yr	1: 20 lb/yr 10: 200 lb/yr

(*Region 5 Model example, see Appendix 5)

While the above calculations indicate reductions in pollutant loads, it is difficult to estimate the percentage of these reductions per subwatershed. However, it can be assumed that with the implementation of these BMPs, the Upper Wabash River Watershed will move towards attainment of the Indiana target concentrations for Phosphorus, Nitrogen, and sediment. In the individual subwatersheds where the existing concentrations are currently estimated to fall below the target concentrations, implementation of BMPs should also be promoted as a method to further reduce the pollutant loadings and achieve a great water quality benefit. It can be assumed that as the Upper Wabash River and tributaries progress through the watershed, the cumulative effects of BMPs implemented will have a positive effect on water quality. Thus it would seem that the water quality would be greater leaving the watershed versus the quality of the water entering the watershed from Ohio.

Water quality sampling events, USGS gaging stations, and the information obtained through the IDEM fixed site sampling locations seem to indicate a great amount of pollutant concentrations stemming from the Ohio Wabash River drainage area. While the Indiana Wabash River drainage area should not be held responsible for reducing these loadings as well, it does highlight the inherent need to operate and implement on a watershed-wide scale without State divisions.

It is important that the established pollutant reduction targets be utilized as reference points and not as hard and fast indicators through which to evaluate the long term success of this watershed management plan. Both existing pollutant loadings and pollutant reduction targets are subject to a wide variety of assumptions, and are based on the best data currently available. The overall success of the watershed management plan should not only be evaluated by whether or not target load reductions or instream standards are achieved, but also on the basis of whether or not water quality improves as a result of implementing the watershed management plan. If existing pollutant loads are estimated too high, achieving target pollutant load reductions may not result in achieved in-stream pollutant concentrations. Alternatively, if existing pollutant loadings are estimated too low with goals that are easily achieved, in-stream target concentrations may be fulfilled prior to reaching target pollutant load reductions resulting in an inadequate number of BMPs to effectively improve overall water quality.