Total Maximum Daily Load (TMDL) for the Wabash River Watershed, Ohio

U.S. Environmental Protection Agency Region 5
Watersheds and Wetlands Branch
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ACRONYMS AND ABBREVIATIONS

AL	Aquatic life
AU	Assessment unit
cfs	Cubic feet per second
DO	Dissolved oxygen
EPA	Environmental Protection Agency
GIS	Geographic information system
IBI	Index of Biological Integrity
ICI	Invertebrate Community Index
L	Liter
LA	Load allocations
MIwb	Modified Index of Well-being
MOR	Monthly Operating Report
MOS	Margin of safety
MOU	Memorandum of Understanding
mg	Milligram
NN	Nitrate+nitrite
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
QAPP	Quality assurance project plan
QHEI	Quality Habitat Evaluation Index
STORET	EPA Storage and Retrieval System
SWAT	Soil and Water Assessment Tool
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	Total suspended solids
WLA	Wasteload allocation
WQS	Water quality standard
WWH	Warmwater habitat

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting applicable water quality standards/guidelines or designated uses under technology-based controls. TMDLs specify the maximum amount of a pollutant which a waterbody can assimilate and still meet water quality standards. Based upon a calculation of total load of a specific pollutant that can be assimilated, TMDLs allocate pollutant loads to sources and a margin of safety (MOS). This study determines allowable limits for pollutant loadings to meet water quality standards and designated uses for the Wabash River, Ohio. Pollutant load reduction are allocated among sources and provide a scientific basis for restoring surface water quality in this waterbody. In this way, the TMDL process links the development and implementation of control actions to the attainment and maintenance of water quality standards and designated uses.

This TMDL has been developed by EPA, Region 5, rather than the state of Ohio. To remain in compliance with federal regulations for the development of modeling projects, this TMDL also has a Quality Assurance Project Plan (QAPP) for the Wabash River (USEPA, 2003) that was developed in conjunction with Tetra Tech, Inc.

2.0 IDENTIFICATION OF WATERBODY, POLLUTANT OF CONCERN, POLLUTANT SOURCES, AND PRIORITY RANKING

2.1 Identification of Waterbody

The Wabash River watershed is located in west-central Ohio, near the Indiana-Ohio border, and includes four assessment units (AUs) listed as impaired on the Ohio 2002 Section 303(d) list. These four AUs drain 323 square miles of mostly agricultural land intermixed with several small towns and cities. For this TMDL, the AUs of interest are 010, 030, and 040 as shown in Table 2-1 and Figure 2-1. Assessment unit 020 (not shown in Figure 2-1) and Grand Lake St. Mary's were not a direct focus of this study.

A detailed assessment of the Wabash River drainage basin in Ohio was conducted in 1999. The results of that assessment form the basis for the Section 303(d) listing of the AUs and for the work in this report.

Wabash River downstream of Vanderbush Ditch
(Photo by Tetra Tech, Inc.)

The waterbodies were listed both in the 2002 303(d) listing and the 2004 303(d) listing portion of Ohio's 2004 Integrated Report. The 2002 and 2004 Section 303(d) lists identify the impairments as other habitat alterations which encompasses nutrient and siltation impairments as well as non-pollutant issues such as loss of riparian habitat and flow alteration. The impairment decisions were made using the available chemical, habitat and biological data, such as the Qualitative Habitat Evaluation Index (QHEI), the Index of Biological Integrity (IBI), the modified Index of Well-being (MIWb), and the Invertebrate Community Index (ICI).

Table 2-1. Ohio 2002 Section 303(d) listings within the Wabash River watershed addressed by this TMDL.

Assessment Unit (AU)	Description	High Magnitude Causes	Sources
05120101 010	Wabash River (Headwaters of Wabash River to confluence with Beaver Creek)	Other Habitat Alterations	Minor Municipal Point Sources Nonirrigated Crop Production Animal Feeding Operations Channelization (Agriculture) Removal of Riparian Vegetation Streambank Destabilization
05120101 030	Beaver Creek	Other Habitat Alterations	Nonirrigated Crop Production Animal Feeding Operations Channelization (Agriculture) Removal of Riparian Vegetation Streambank Destabilization
05120101 040	Wabash River (Confluence of Beaver Creek to State Line)	Other Habitat Alterations	Nonirrigated Crop Production Animal Feeding Operations Channelization (Agriculture) Removal of Riparian Vegetation Streambank Destabilization

The purpose of this TMDL is to evaluate the magnitude of load reductions that are necessary to allow the nutrient and sediment water quality targets to be met. It is important to note the TMDL will not (and, in fact, cannot) identify loadings that can be directly compared to the biological targets. The assumption is that management efforts to address nutrient and sediment loadings, in combination with other activities to improve habitat, will result in the attainment of the biocriteria. (Biocriteria will be discussed in the next chapter on water quality standards).

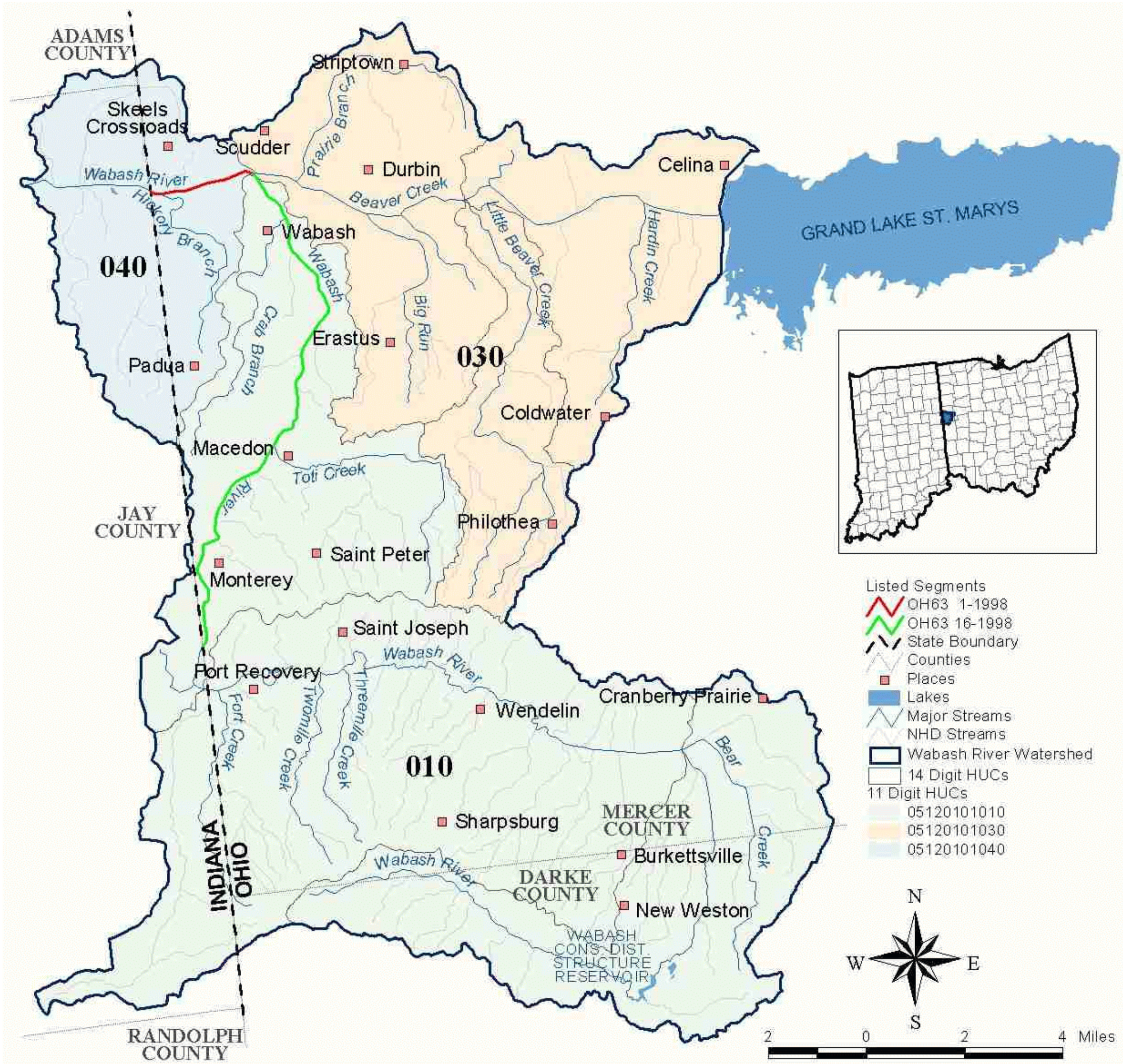

Figure 2-1. Location of the Wabash River watershed, Ohio.

2.2 Pollutants of Concern

The TMDL addresses the sediment and nutrient loadings in the Wabash River and includes recommendations for improving instream habitat. The specific nutrients addressed are nitrate+nitrite and total phosphorus. The riparian habitat and flow alterations are severe stressors, but only sediment and nutrient loadings are directly addressed in this TMDL.

2.3 Pollutant Sources

Many small streams in the Wabash River watershed are degraded by excessive nutrient levels from farm fertilizer runoff, poorly managed livestock waste, home septic systems, and some municipal wastewater. Few wooded areas exist next to these streams. Without vegetation to trap eroded soil, bottom substrate are often smothered with silt. High bedload delivery and transport are components of hydromodification and direct habit alterations.

There are also two industrial facilities and three wastewater treatment plants with National Pollutant Discharge Elimination System (NPDES) permits in the Wabash River watershed that contribute to the sediment and nutrient loadings (Table 2-2). Additionally, there are 29 large concentrated animal feeding operations (CAFOs) in the watershed that are individually listed in Appendix A. CAFOs are point sources as defined by the Clean Water Act 33 USC Section 136.2 (14) and Section 502(14) and are therefore also subject to the NPDES program.

Table 2-2. Industrial facilities and wastewater treatment plants in the Wabash River watershed.

NPDES ID	Facility Name	Standard Industrial Code Description
OH0009482	Stoneco Incorporated Karch Quarry Plant	Cut stone and stone products
OH0010138	Fort Recovery Industries Incorporated	Electroplating, plating, polishing, anodizing, and coloring
OH0025160	Fort Recovery Wastewater Treatment Plant	Sewerage system
OH0020320	Celina Wastewater Treatment Plant	Sewerage system
OH0024694	Coldwater Wastewater Treatment Plant	Sewerage system

2.4 Priority Ranking

The Wabash River is one of the most degraded watersheds in the state. Its priority ranking for TMDL development is High on the 2002 Section 303(d) list.

3.0 DESCRIPTION OF WATER QUALITY STANDARDS, NUMERIC WATER QUALITY TARGETS, AND EXISTING WATER QUALITY

The purpose of developing a TMDL is to identify the pollutant loading that a waterbody can receive and still achieve water quality standards. Under the Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the Clean Water Act's goal of "swimmable/fishable" waters. Water quality standards consist of three components: designated uses, numeric or narrative criteria, and an antidegradation policy. Ohio's water quality standards are summarized in Table 3-1 and explained in greater detail below.

Table 3-1. Ohio water quality standards.

Component	Description
Designated Use	Designated use reflects how the water can potentially be used by humans and how well it supports a biological community. Every water in Ohio has a designated use or uses; however, not all uses apply to all waters (i.e., they are waterbody specific).
Numeric Criteria	Chemical criteria represent the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Biological criteria indicate the health of the in-stream biological community by using one of three indices: • Index of Biotic Integrity (IBI) (measures fish health). • Modified Index of well being (MIwb) (measures fish health). • Invertebrate Community Index (ICI) (measures bug or macroinvertebrate health).
Narrative Criteria	These are the general water quality criteria that apply to all surface waters. These criteria state that all waters must be free from sludge; floating debris; oil and scum; color- and odor-producing materials; substances that are harmful to human, animal or aquatic life; and nutrients in concentrations that may cause algal blooms.
Antidegradation Policy	This policy establishes situations under which OEPA may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need. Refer to <http://www.epa.state.oh.us/dsw/wqs/wqs.html> for more information.

3.1 Biocriteria

The Ohio water quality standards (Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the narrative goals specified by each use designation. Use designations consist of two broad groups: aquatic and nonaquatic life. In applications of the Ohio water quality standards to the management of water resource issues in rivers and streams, the aquatic life use criteria frequently control the resulting protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting aquatic life generally results in water quality suitable for all uses.

All of the waterbody segments in the Wabash River drainage except Grand Lake St. Marys (which is automatically designated exceptional warmwater habitat (EWH) because it is a public lake), are designated for warmwater habitat (WWH). WWH is the use designation that defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams and represents the principal restoration target for the majority of water resource management efforts in the state.

OEPA has evaluated the biological health and water quality of the Wabash River watershed and determined that the WWH aquatic life use was not met in any assessment unit. Impairment determinations were made using the following biological indices: the Index of Biological Integrity (IBI) for fish, the modified Index of Well-being (MIwb) for fish, and the Invertebrate Community Index (ICI) for aquatic insects. The Qualitative Habitat Evaluation Index (QHEI) and chemical criteria were used to substantiate the suspected causes and sources of impairment.

3.2 Numeric Water Quality Targets

The ultimate goal of this TMDL is to attain the appropriate biocriteria. Targets have been established to link water chemistry to the biocriteria. The water quality targets are quantitative measures that are equivalent to attainment of water quality standards.

Ohio does not have nutrient or sediment criteria as part of their formal water quality standards. However, OEPA has established nutrient targets that are linked to the biocriteria (Tables 3-2 and Table 3-3) (OEPA, 1999). Additionally, a site-specific sediment guideline has been selected for the Wabash River based on the available data. Meeting these targets is expected to be one important component of achieving water quality standards in the Wabash River watershed. The purpose of the modeling effort conducted for this TMDL was to evaluate load reduction efforts that will allow the nutrient and sediment guidelines to be met. It is important to note that the modeling effort did not produce output that can be directly compared to the biocriteria. The assumption is that management efforts to address nutrient and sediment concentrations, in combination with other activities to improve habitat, will result in the attainment of the biocriteria.

Table 3-2. Statewide nitrite-nitrate targets (mg/L) for Ohio rivers and streams with the value chosen for the Wabash River TMDLs highlighted.

Watershed Size	Aquatic Life Designations		
	EWH	WWH	MWH
Headwaters (drainage area < 20 mi^2)	0.5	1	1
Wadeable rivers (20 mi^2 < drainage area < 200 mi^2)	0.5	1	1.6
Small rivers (200 mi^2 < drainage area < 1,000 mi^2)	1	1.5	2.2
Large rivers (drainage area > 1,000 mi^2)	1.5	2	2.4

WWH = Warmwater Habitat; EWH = Exceptional Warmwater Habitat; MWH = Modified Warmwater Habitat.
Source: OEPA, 1999.

Table 3-3. Statewide total phosphorus targets (mg/L) for Ohio rivers and streams with the value used for the Wabash River TMDLs highlighted.

Watershed Size	Aquatic Life Designations		
	EWH	WWH	MWH
Headwaters (drainage area < 20 mi^2)	0.05	0.08	0.34
Wadeable rivers (20 mi^2 < drainage area < 200 mi^2)	0.05	0.10	0.28
Small rivers (200 mi^2 < drainage area < 1,000 mi^2)	0.10	0.17	0.25
Large rivers (drainage area > 1,000 mi^2)	0.15	0.30	0.32

WWH = Warmwater Habitat; EWH = Exceptional Warmwater Habitat; MWH = Modified Warmwater Habitat.
Source: OEPA, 1999.

3.3 Existing Water Quality

This section of the document summarizes the available nutrient and sediment water quality data for the Wabash River watershed.

3.3.1 Nutrients

The term nutrients refers to the various forms of nitrogen and phosphorus found in a waterbody. Both nitrogen and phosphorus are necessary for aquatic life, and both elements are needed at some level in a waterbody to sustain life. The natural amount of nutrients in a waterbody varies depending on the type of system. A pristine mountain spring might have little to almost no nutrients, whereas a lowland, mature stream flowing through wetland areas might have naturally high nutrient concentrations. Streams draining larger areas are also expected to have higher nutrient concentrations.

Various forms of nitrogen and phosphorus can exist at one time in a waterbody, although not all forms can be used by aquatic life. Common phosphorus sampling parameters are total phosphorus (TP), dissolved phosphorus, and orthophosphate. Common nitrogen sampling parameters are total nitrogen (TN), nitrite (NO2), nitrate (NO3), nitrate+nitrite (NN), total Kjeldahl nitrogen (TKN), and ammonia (NH3). Concentrations are measured in the lab and are typically reported in milligrams per liter.

Nutrients generally do not pose a direct threat to the designated uses of a waterbody. However, excess nutrients can cause an undesirable abundance of plant and algae growth and this process is called eutrophication. Eutrophication can have many effects on a stream. One possible effect is low dissolved oxygen concentrations caused by excessive plant respiration and/or decay. Aquatic organisms need oxygen to live and they can experience lowered reproduction rates and mortality with lowered dissolved oxygen concentrations. Dissolved oxygen concentrations are measured in the field and are typically reported in milligrams per liter. Ammonia, which is toxic to fish at high concentrations, can be released from decaying organic matter when eutrophication occurs. For these reasons, excessive nutrients can result in the non-attainment of biocriteria and impairment of the designated use.

It should be noted that the impact of nutrients can be moderated by riparian habitat conditions. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the detention, removal, and assimilation of nutrients from or by the water column. Therefore a stream with good riparian habitat is better able to moderate the impacts of high nutrient loads than is a stream with poor habitat. High nutrient concentrations in the Wabash River watershed are therefore compounded by the fact that the natural habitat of many of the streams has been reduced or eliminated.

A 30-day average TP target of 0.17 mg/L has been identified for the Wabash River watershed based on *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (OEPA, 1999). This value corresponds to the protection of WWH waters in small river watersheds (those draining areas between 200 and 1000 square miles). The target is to be applied as a maximum 30-day sliding average applied year-round.

Figure 3-1, Figure 3-2, and Table 3-4 indicate that the TP target is routinely exceeded in the Wabash River watershed. TP concentrations at State Line Road, the most downstream station and the one with the most data, have historically been well above the target. Concentrations steadily decrease during the winter and then begin to increase in May. Average values in June, July, August, and September are all above the target, with values between 0.40 mg/L and 0.60 mg/L. Appendix B summarizes all available TP data for the watershed.

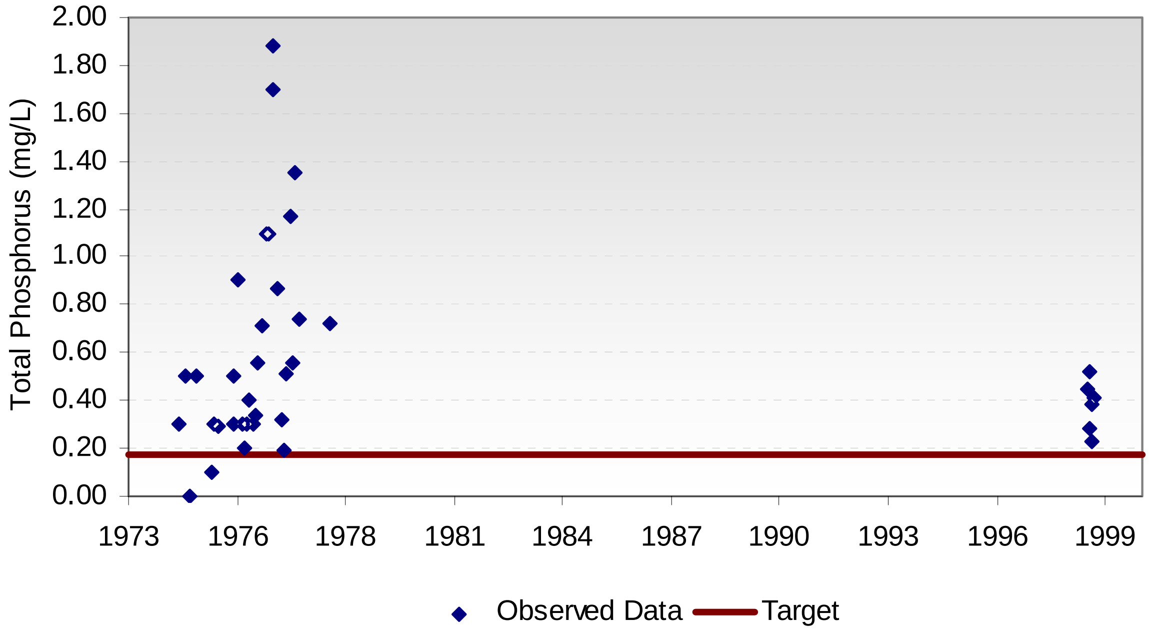

Figure 3-1. All Wabash River total phosphorus data at the State Line Road sampling station. The first sample was collected May 22, 1974 and the last sample was collected September 2, 1999.

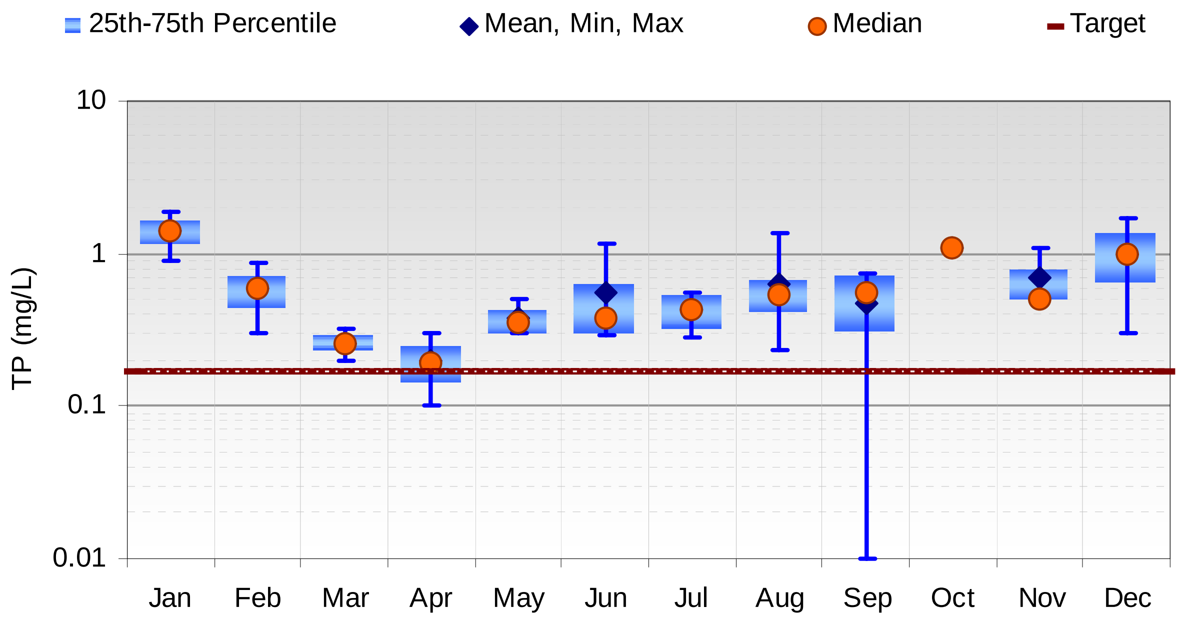

Figure 3-2. Wabash River average monthly total phosphorus data at the State Line Road sampling station. The first sample was collected May 22, 1974 and the last sample was collected September 2, 1999.

Table 3-4. Summary total phosphorus statistics for the Wabash River at the State Line Road sampling station. The first sample was collected May 22, 1974 and the last sample was collected September 2, 1999.

Month	Mean	Median	Min	Max	25th	75th	Exceedances: Total # Samples	Percent Exceeding
Jan	1.39	1.39	0.90	1.88	1.15	1.64	2:2	100%
Feb	0.59	0.59	0.30	0.87	0.44	0.73	2:2	100%
Mar	0.26	0.26	0.20	0.32	0.23	0.29	2:2	100%
Apr	0.20	0.19	0.10	0.30	0.15	0.25	2:3	67%
May	0.38	0.35	0.30	0.51	0.30	0.43	4:4	100%
Jun	0.55	0.38	0.29	1.17	0.30	0.63	4:4	100%
Jul	0.43	0.43	0.28	0.56	0.33	0.53	4:4	100%
Aug	0.62	0.53	0.23	1.35	0.41	0.68	6:6	100%
Sep	0.47	0.56	0.01	0.74	0.31	0.72	3:4	75%
Oct	1.10	1.10	1.10	1.10	1.10	1.10	1:1	100%
Nov	0.70	0.50	0.50	1.10	0.50	0.80	3:3	100%
Dec	1.00	1.00	0.30	1.70	0.65	1.35	2:2	100%

A 30-day average nitrate+nitrite (NN) target of 1.5 mg/L has been identified for the Wabash River watershed based on *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (OEPA, 1999). This value corresponds to the protection of WWH waters in small river watersheds (those draining areas between 200 and 1000 square miles). As with TP, the target is to be applied as a maximum 30-day sliding average applied year-round.

Figure 3-3, Figure 3-4, and Table 3-5 indicate that the NN target is occasionally exceeded in the Wabash River watershed. Numerous concentrations taken at State Line Road in the 1970s were above the target whereas limited data taken in 1999 were below the target. An analysis of all the sampling data from throughout the watershed, however, indicates that 19 percent of all 1999 observations exceeded 1.5 mg/L.

Evaluating the combined 1970s and 1999 data for the State Line Road station indicates that NN concentrations steadily decrease during the winter and then begin to increase in June. Average values in June and July are above the target, while values in August and September are below the target.

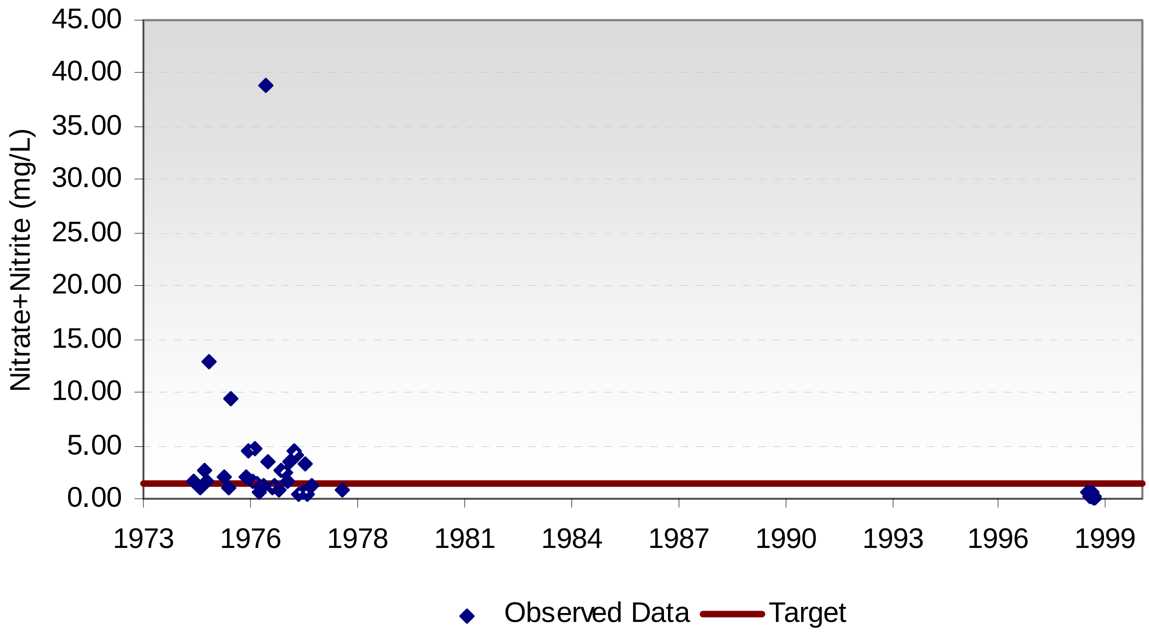

Figure 3-3. All Wabash River nitrate+nitrite data at the State Line Road sampling station. The first sample was collected May 22, 1974 and the last sample was collected September 2, 1999.

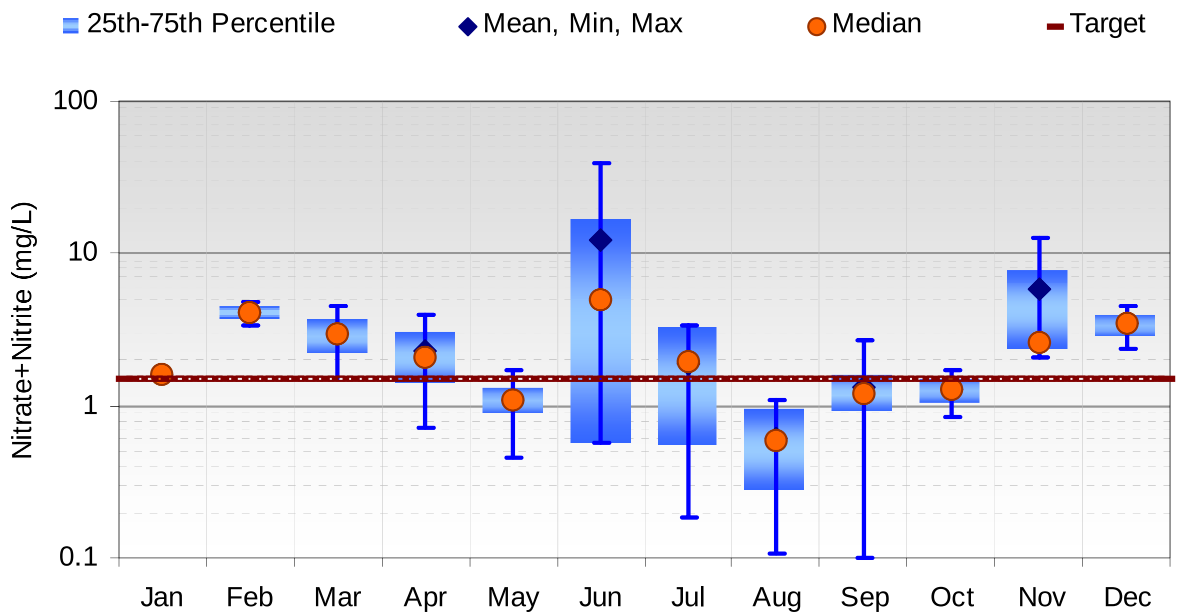

Figure 3-4. Wabash River monthly nitrate+nitrite data at the State Line Road sampling station. The first sample was collected May 22, 1974 and the last sample was collected September 2, 1999.

Table 3-5. Summary NN statistics for the Wabash River at the State Line Road sampling station. The first sample was collected May 22, 1974 and the last sample was collected September 2, 1999.

Month	Mean	Median	Min	Max	25th	75th	Exceedances: Total # Samples	Percent Exceeding
Jan	1.61	1.61	1.60	1.62	1.61	1.62	2:2	100%
Feb	4.10	4.10	3.41	4.79	3.76	4.45	2:2	100%
Mar	2.98	2.98	1.51	4.44	2.24	3.71	2:2	100%
Apr	2.27	2.10	0.71	3.99	1.41	3.05	2:3	67%
May	1.09	1.11	0.45	1.70	0.89	1.30	1:4	25%
Jun	12.34	4.99	0.57	38.80	0.58	16.75	2:4	50%
Jul	1.88	1.96	0.19	3.40	0.55	3.29	2:4	50%
Aug	0.61	0.60	0.11	1.10	0.28	0.95	0:6	0%
Sep	1.30	1.21	0.10	2.70	0.93	1.58	1:4	25%
Oct	1.27	1.27	0.84	1.70	1.06	1.49	1:2	50%
Nov	5.85	2.60	2.10	12.84	2.35	7.72	3:3	100%
Dec	3.43	3.43	2.36	4.50	2.90	3.97	2:2	100%

3.3.2 Sediments

Excess total suspended solids (TSS) in a stream can pose a threat to aquatic organisms. Turbid waters created by excess TSS concentrations reduce light penetration, which can adversely affect aquatic organisms. Also, TSS can interfere with fish feeding patterns because of the turbidity. Prolonged periods of very high TSS concentrations can be fatal to aquatic organisms (Newcombe and Jensen, 1996). As TSS settles to the bottom of a stream, critical habitats such as spawning sites and macroinvertebrate habitats can be covered in sediment. This is referred to as siltation. Excess sediment in a stream bottom can reduce dissolved oxygen concentrations in stream bottom substrates, and it can reduce the quality and quantity of habitats for aquatic organisms. For these reasons, excessive TSS can result in non-attainment of biocriteria and impairment of the designated use.

Erosion and overland flow contribute some natural TSS to most streams. In watersheds with highly erodible soils and steep slopes, natural TSS concentrations can be very high. Excess TSS in overland flow can occur when poor land use and land cover practices are in place. This potentially includes grazing, row crops, construction activities, road runoff, and mining. Grazing and other practices that can degrade stream channels are other possible sources of TSS.

TSS is also a concern because of its ability to transport TP to a waterbody. When anthropogenic sources of phosphorus are delivered to a stream the ratio of dissolved phosphorus immediately available to algae may be high relative to particulate forms of phosphorus (e.g., attached to soil particles; Robinson et al. 1992). Total phosphorus (TP; the form measured in this study) consists of both dissolved phosphorus (DP), which is mostly orthophosphate, and particulate phosphorus (PP), including both inorganic and organic forms (Sharpley et al. 1994). Runoff from conventional tillage is generally dominated by PP; however, the proportion of TP as DP increases where erosion is comparatively low such as with no-till fields or pasture (Sharpley et al. 1994). Streams with low gradients and a morphology that enhances deposition of sediments in the low flow channel (e.g., channelized streams) may continually release dissolved phosphorus from sediments.

OEPA does not have numeric targets for TSS and no statewide recommendations have been published. The reference stream approach is often used in such instances to identify site-specific targets for the development of a TMDL. With the reference stream approach, TSS concentrations in a similar, but unimpaired, watershed are evaluated and used as the basis for meeting water quality standards. No appropriate reference stream for the Wabash River has been identified.

Therefore, the approach for this TMDL is to evaluate the existing TSS data for the Wabash River watershed and select the 25th percentile as the target condition (USEPA, 2000). This number is calculated by using the regional concentrations from the total stream population in the Wabash River watershed. First, a TSS concentration distribution was determined using observed values. Then, the lowest 25th percentile of the distribution produces a concentration, in this case a TSS of 32 mg/l, as the target or threshold point. (This lowest 25th percentile may also be interpreted as using the least contaminated 25 percent of all the observed values as the target). This target relies to some extent on best professional judgement because, to reiterate, there are no reference conditions available in this highly developed agricultural area. The 25th percentile methodology results in a target that is within the range of natural conditions within the watershed, and is believed to be protective of the aquatic community. To choose a lower number would result in values closer to a reference stream, which is not a reasonable target in this area. The target is subject to modification as new data are generated. The target will be expressed as a maximum average value over any 30-day period and may be subject to modification as more information becomes available.

Figure 3-5, Figure 3-6, and Table 3-3 indicate that the TSS target is exceeded in the Wabash River watershed during most of the spring, summer, and winter. The limiting sampling in the fall indicates the target is not exceeded.

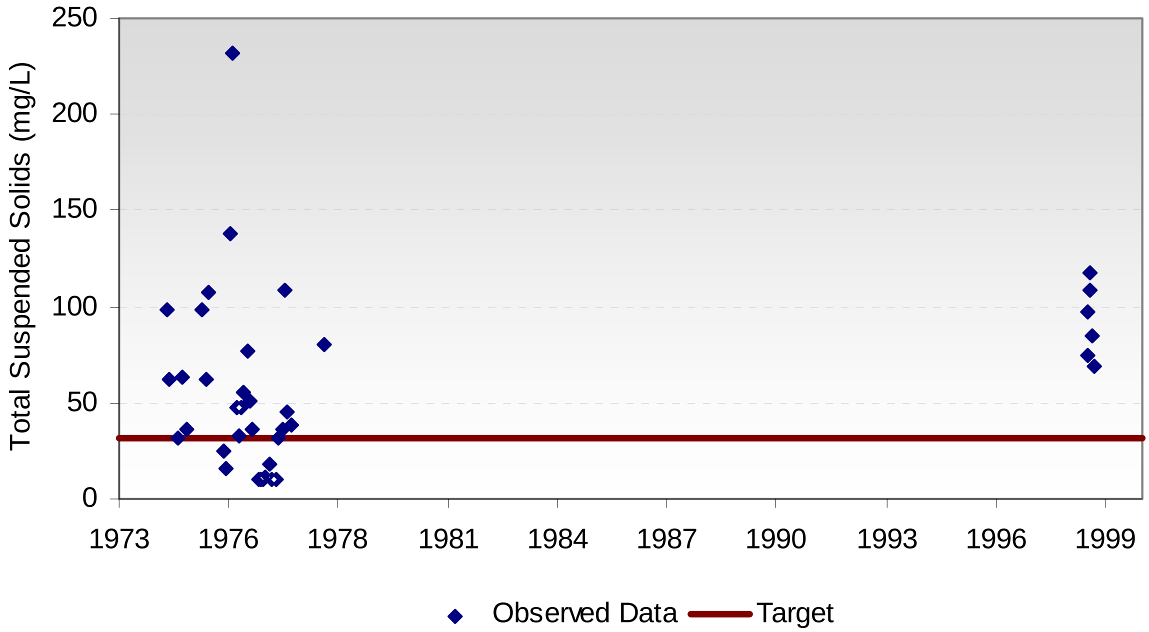

Figure 3-5. All Wabash River total suspended solids data at the State Line Road sampling station. The first sample was collected April 16, 1974 and the last sample was collected September 2, 1999.

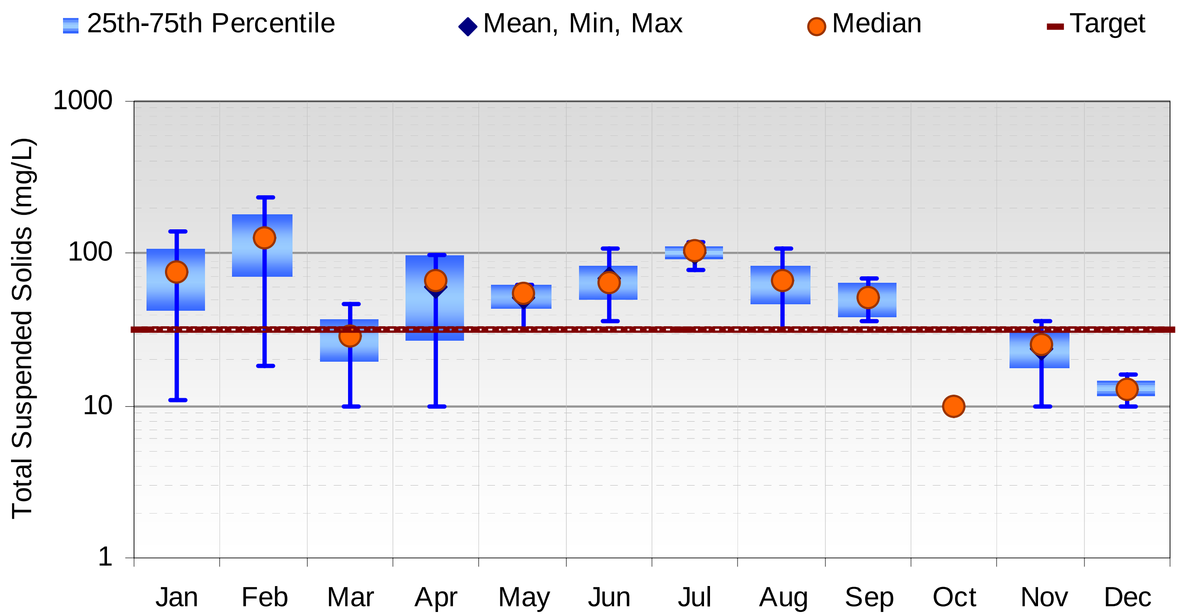

Figure 3-6. Wabash River monthly total suspended solids data at the State Line Road sampling station. The first sample was collected April 16, 1974 and the last sample was collected September 2, 1999.

Table 3-6. Summary TSS (mg/L) statistics for the Wabash River at the State Line Road sampling station. The first sample was collected April 16, 1974 and the last sample was collected September 2, 1999.

Month	Mean	Median	Min	Max	25th	75th	Exceedances: # of Samples	Percent Violating
Jan	75	75	11	138	43	106	1:2	50%
Feb	125	125	18	232	72	179	1:2	50%
Mar	29	29	10	47	19	38	1:2	50%
Apr	60	66	10	98	27	98	3:4	75%
May	51	55	32	62	43	62	3:4	75%
Jun	69	65	36	108	50	83	4:4	100%
Jul	100	103	77	118	92	111	4:4	100%
Aug	67	66	32	109	47	83	5:6	83%
Sep	52	51	36	69	38	65	4:4	100%
Oct	10	10	10	10	10	10	0:1	0%
Nov	24	25	10	36	18	31	1:3	33%
Dec	13	13	10	16	12	15	0:2	0%

4.0 LOADING CAPACITY

The cause-and-effect relationship between pollutant sources (stressor indicators), receiving water chemistry (exposure indicators), and biology was completed using a modeling approach in which pollutant loads from the watershed are transported to the waterbody and then downstream. The linkage between water chemistry and biology is established through the adoption of nutrient and sediment targets associated with the desired biocriteria.

Several factors were considered in choosing a methodology by which to estimate sediment and nutrient loadings. These included identifying the various types of sources (e.g., point, nonpoint, background, atmospheric), the relative location of each of the sources with respect to the impaired waterbody, the transport mechanisms of concern (e.g., direct discharge, storm-event runoff), and the time scale of loading to the waterbody (i.e., duration and frequency of loading to the receiving waters). Based on these considerations the Soil Water Assessment Tool (SWAT) model was chosen for this application.

SWAT was developed by the Agricultural Research Service, the main research agency within the U.S. Department of Agriculture. The model predicts the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use, and management conditions over long periods of time. SWAT can analyze large watersheds and river basins (greater than 100 square miles) by subdividing the area into homogenous subwatersheds. The model uses a daily time step, and can perform continuous simulation for a period of one to 100 years. SWAT simulates hydrology, pesticide and nutrient cycling, erosion and sediment transport.

The SWAT modeling approach was used for the Wabash River TMDLs for the following reasons:

- It models the constituents of concern (total phosphorus, nitrate and nitrite, and sediments).
- It is designed for primarily agricultural watersheds.
- It provides daily output to allow for direct comparison to the water quality targets.
- It provides the ability to directly evaluate management practices (such as altering fertilizer application rates).
- It has been used elsewhere in Ohio for TMDL development.
- It has higher acceptance with the agricultural community because it was developed by the U.S. Department of Agriculture, Agricultural Research Service.

The model was used to allocate loads to determine what implementation measures may be taken to decrease the input levels of sediments and nutrients to the system, with the long term goal of achieving the appropriate biocriteria. SWAT was calibrated and validated by representing source contributions and in-stream response. Calibration consisted of comparing the model results to observed data and adjusting the appropriate model parameters to obtain an acceptable fit between simulated and observed data. After calibration, the parameters were validated, or tested to an independent data set to ensure that the model works under a full range of conditions. Validation was performed using an available appropriate data set independent of the calibration data set. Appendix C provides a complete discussion of the modeling process.

It is important to point out that the model is only capable of predicting nutrient and sediment concentrations and loads (stressors) rather than response variables (such as biological conditions). As described above, the Wabash River TMDL will therefore be based on quantified instream nutrient and sediment targets that are linked to biological indicators. The TMDL also acknowledges the necessity of addressing other stressors (such as habitat) to fully restore beneficial uses.

4.1 Strengths and Weaknesses

There are several strengths associated with using SWAT to determine the loading capacity of the Wabash River. These including the following:

- Detailed consideration of all the factors affecting nutrient and sediment loading and transport, such as soil types, topography, land use, human activities, stream channel conditions, and weather.
- Ability to estimate loads from various source categories, such as by subwatershed or land use type.
- Ability to directly evaluate the effect of various land management practices on instream water quality.
- Ability to predict water quality during critical conditions (e.g., extremely low or high stream flows) when observed data might not be available.

There are also several weaknesses associated with using SWAT, such as:

- The model is fairly intensive in terms of data needs and complexity, resulting in a longer schedule than would have been required with a simpler approach.
- The model's instream capabilities (i.e., ability to simulate pollutant fate and transport within the Wabash River) is not as advanced as some other receiving water models, such as the Water Quality Analysis Simulation Program (WASP).

These two shortcomings are not believed to be significant weaknesses for this project and it is believed that the SWAT model is acceptable for development of the TMDL.

4.2 Critical Conditions

Critical conditions for the nutrient impairments are during the late summer when low stream flows and abundant sunshine are most likely to lead to excessive plant growths. However, loadings throughout the year potentially contribute to high nutrient concentrations during the critical period because of desorption from the sediment. The nutrient targets therefore apply year-round.

Critical conditions for the sediment impairments are not as straightforward. Loadings are highest during wet weather events which lead to sheet erosion and scouring of the streambank. The impacts of excessive siltation and turbidity can occur at various times, however, such as during the late summer when they might contribute to depleted dissolved oxygen concentrations or during the early spring when they might affect spawning. The TSS targets therefore apply year-round.

4.3 Loading Capacity

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. TMDLs are composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

To develop TMDLs for the Wabash River watershed the following approach was taken:

- Simulate baseline conditions
- Assess source loading alternatives
- Determine the TMDL and source allocations

The calibrated model provided the basis for performing the allocation analysis and was first used to project baseline conditions. Baseline conditions represent existing nonpoint source loading conditions and permitted point source discharge conditions. The baseline conditions allow for an evaluation of in-stream water quality under the "worst currently allowable" scenario.

Simulation of baseline conditions provided the basis for evaluating stream response to variations in source contributions. The simulations revealed that stormwater runoff from manured agricultural lands are the largest source of nutrients and sheet and rill erosion from agricultural lands are the largest source of sediments. WWTP effluent is also a significant source of TP in the Beaver Creek subwatershed. These results facilitated developing an effective allocation strategy.

The calibrated SWAT model was used to determine the allowable loads of TP, NN, and TSS for the Wabash River watershed. TSS loads were reduced first because reducing them also resulted in reducing TP. Loads were reduced through a variety of means (e.g., reduced manure application, modifying modeling parameters to simulate reduced streambank and sheet/rill erosion) until the predicted 30-day running average concentrations at the outlet of the watershed were at or below the TMDL targets. It should be noted that most of the load reduction scenarios that were utilized resulted in year-round load reductions such that predicted water quality concentrations are below the targets except for the critical conditions. Some of the best management practices likely to be implemented (e.g., conservation buffers, two-stage ditch design) will in fact result in year-round load reductions, while others (e.g., nutrient management plans) could be timed to occur during critical periods while allowing larger loads during non-critical periods.

The results of the modeling runs are summarized in Figures 4-1 to 4-3. Figure 4-1 indicates that the 30-day average existing TP concentration is above the TMDL target, shown by the target line at 0.17 mg/L, and remains high most months of the year except from about December 1999 to June 2000. There are a few exceedances above the target in the 2000 spring months, but in the winter and spring months in 1999 exceedances occur frequently. Figure 4-1 also shows the 30-day average modeled TP that could be allowed and remain under the target value. When comparing the existing TP and the average modeled TP below the target values, the greatest difference occurs approximately between June through September and therefore the greatest percentage reductions would need to occur in those months. Table 5-1 generally reflects these reductions that are needed in 10 out of 12 months of the year.

Figure 4-2 indicates that the 30-day average existing NN concentration is above the TMDL target, shown by the target line at 1.5 mg/L, and fluctuates above and below the target line in both years. Most exceedances occur primarily from June through October. Figure 4-2 also shows the 30-day average modeled NN that could be allowed and remain under the target value. When comparing the existing NN and the average modeled NN plot, the target is exceeded throughout the year. In order to maintain levels of NN below the target, reductions would have to occur throughout the year. This reduction is generally reflected in the load allocations in Table 5-2, where reductions are needed throughout the year.

Figure 4- 3 indicates that the 30-day average existing TSS is above the TMDL target, shown by the target line at 32 mg/L, most of the time. Figure 4-3 also shows the 30-day average modeled TSS that could be allowed and remain under the target value. When comparing the existing TSS and the average modeled TSS plot, the existing TSS is rarely below the target value. Overall, the TSS values are above the target more frequently than are the TP or NN concentrations. Significant reductions would have to occur throughout the year to maintain levels of TSS below the target. The greater reductions needed in TSS are indicated in the allocations in Table 5-3, where reduction are indicated in all months of the year and at a greater percentage than the TP or NN reductions.

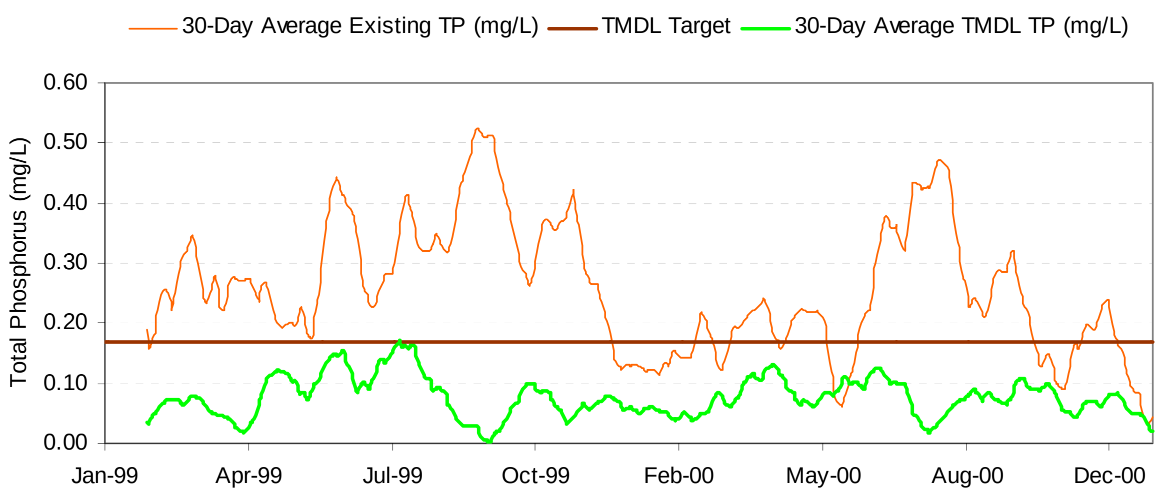

Figure 4-1. Existing total phosphorus conditions and proposed TMDL for the Wabash River watershed.

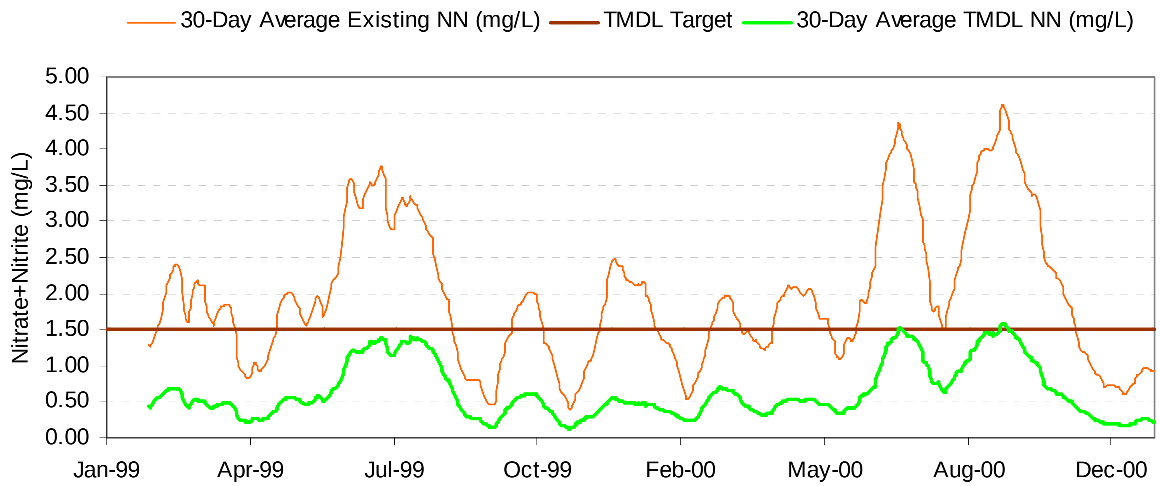

Figure 4-2. Existing nitrate+nitrite conditions and proposed TMDL for the Wabash River watershed.

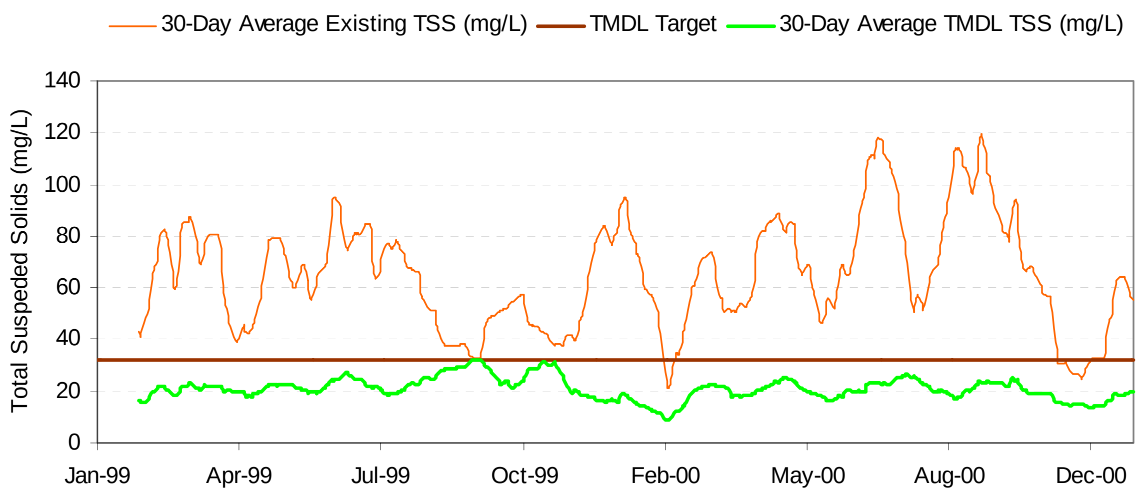

Figure 4-3. Existing total suspended solids conditions and proposed TMDL for the Wabash River watershed.

5.0 LOAD ALLOCATIONS

Load allocations (LAs) are identified for nonpoint source and natural background loading of pollutants in support of final TMDL allocations that will lead to attainment of water quality standards. Allocation analysis was performed by applying the model to identify the assimilative capacity of the receiving water and determine how the allowable loading capacity will be allocated among the various sources. The results are presented in Tables 5-1 to 5-3. The allocation analysis includes the loading capacity (or TMDL), load allocation, wasteload allocation, and margin of safety. The allocation also considers critical conditions and seasonal variation of the loading characteristics, hydrologic variability of the stream flow, and the stream's assimilative capacity.

The load allocations will be used to develop nonpoint source reduction plans based on meeting relevant sediment and nutrient targets. In general, these targets are set such that concentrations at or just less than the targets indicate a potential for unacceptable risks to aquatic life; exceedances are anticipated to produce impairment. If the calculated nonpoint source limit for the particular contaminant is exceeded, then the pollutants will continue to present a hazard by impairing the habitat. The ultimate goal is to improve the IBI, MIwb, and ICI scores so that the Wabash River can be removed from the impaired waters list.

Table 5-1. Total phosphorus TMDL for the Wabash River watershed.

Month	Existing Load (kg/month)	Loading Capacity (kg/month)	MOS (kg/month)	WLA (kg/month)	LA (kg/month)	Reduction
Jan	7,167	1,672	84	288	1,301	77%
Feb	3,916	1,487	74	491	922	62%
Mar	2,663	956	48	499	409	64%
Apr	2,287	1,185	59	717	409	48%
May	754	849	NA	NA	NA	0%
Jun	4,943	1,390	70	317	1,004	72%
Jul	1,546	498	25	346	127	68%
Aug	1,449	473	24	368	81	67%
Sep	4,299	643	32	178	433	85%
Oct	949	949	NA	NA	NA	0%
Nov	1075	429	21	399	9	60%
Dec	1294	669	33	582	54	48%

Table 5-2. Nitrate+nitrite TMDL for the Wabash River watershed.

Month	Existing Load (kg/month)	Loading Capacity (kg/month)	MOS (kg/month)	WLA (kg/month)	LA (kg/month)	Reduction
Jan	65,144	20,759	1,038	2902	16,819	68%
Feb	56,310	16,153	808	4920	10,425	71%
Mar	36,468	9,198	460	4335	4,403	75%
Apr	44,368	10,682	534	4999	5,149	76%
May	62,655	17,106	855	3678	12,573	73%
Jun	80,941	23,529	1,176	3954	18,399	71%
Jul	18,494	5,999	300	3374	2,325	68%
Aug	24,925	8,106	405	3338	4,363	67%
Sep	59,614	18,033	902	3499	13,632	70%
Oct	20,337	4,965	248	2646	2,071	76%
Nov	22,863	7,280	364	705	6,211	68%
Dec	25,389	6,595	330	3551	2,714	74%

Table 5-3. Total suspended solids TMDL for the Wabash River watershed.

Month	Existing Load (kg/month)	Loading Capacity (kg/month)	MOS (kg/month)	WLA (kg/month)	LA (kg/month)	Reduction
Jan	3,274,473	974,160	48,708	21,551	903,901	70%
Feb	3,141,973	728,379	36,419	22,370	669,590	77%
Mar	1,471,248	328,513	16,426	26,094	285,993	78%
Apr	2,168,021	522,655	26,133	28,755	467,767	76%
May	2,319,210	509,349	25,467	27,247	456,635	78%
Jun	2,470,399	496,043	24,802	23,367	447,874	80%
Jul	538,965	79,177	3,959	26,660	48,558	85%
Aug	858,088	118,973	5,949	33,287	79,737	86%
Sep	1,869,732	391,936	19,597	26,924	345,415	79%
Oct	891,717	220,914	11,046	24,532	185,336	75%
Nov	1,389,581	341,247	17,062	18,201	305,984	75%
Dec	1,887,444	461,579	23,079	20,459	418,041	76%

6.0 WASTELOAD ALLOCATIONS

There are two industries, three wastewater treatment plants, and 29 large CAFOs within the Wabash River watershed that are subject to the NPDES permit program. The existing loads from the wastewater treatment plants and industrial facilities have been estimated based on data reported in their monthly operating reports (MORs) or literature values for parameters that they are not required to report. Wasteload allocations for TP have been established based on estimated existing loads and the percent reductions shown in Table 5-1. Wasteload allocations for NN and TSS have been established equal to their estimated existing monthly loads and are shown in Tables 6-1 to 6-3.

The WLA for the Large CAFOs in the Wabash River TMDL are for zero load from production areas. The zero allocation is based on the Effluent Limitations Guidelines and New Source Performance Standards for Large CAFOs requiring, in general, zero discharge from these areas. This limit on load is reasonable due to the requirement for the proper design, construction, operation, and maintenance of the structures to contain all manure, litter, and process wastewater including the runoff and direct precipitation from a 25-year, 24-hour rainfall event. The allocation is also based on the requirement at 40 CFR section 122.42(e) that CAFOs have a nutrient management plan providing adequate storage of manure, litter, and process wastewater, including a volume needed to store material during the maximum length of time anticipated between emptying events. Further, the allocation is based on the conditions of Ohio's NPDES draft general permit for CAFOs providing that Ohio Water Quality Standards shall not be exceeded in the event of an overflow from CAFO production areas. Should there be any effluent from a discharge in a larger storm or rainfall event in wet weather conditions, the effluent limit may not exceed the Ohio water quality standards pertaining to fecal coliforms.

For application of manure, litter, or process wastewater to land under the control of the CAFO, the Waste Load Allocation is zero for discharges that are not agricultural storm water discharges. This limit on load is reasonable due to the conditions of Ohio's NPDES draft general permit for CAFOs providing that there shall be no discharge during the process of applying manure to land.

The Load Allocation (LA) for the CAFOs in the Wabash River TMDL is embedded within the LA columns of Table 5-1 to Table 5-3 and is for discharge of agricultural storm water from the land application of manure, litter, and process wastewater. For the purpose of this paragraph, where the manure, litter, or process wastewater has been applied in accordance with site-specific nutrient management practices that assure appropriate agricultural utilization of nutrients, as specified by conditions of a permit developed in accordance with 40 CFR section 122.42(e)(1)(vi) - (ix), the discharge is an agricultural storm water discharge.

Table 6-1. Total phosphorus wasteload allocations for the NPDES facilities in the Wabash River watershed[1].

Month	All CAFOs (kg/month)	OH0009482 (kg/month)	OH0010138 (kg/month)	OH0025160 (kg/month)	OH0020320 (kg/month)	OH0024694 (kg/month)	Total (kg/month)
Jan	0	0	0	7	186	95	288
Feb	0	0	0	12	322	157	491
Mar	0	0	0	12	302	185	499
Apr	0	0	0	18	484	215	717
May	0	0	0	34	758	529	1321
Jun	0	0	0	9	192	116	317
Jul	0	0	0	9	205	132	346
Aug	0	0	0	10	215	143	368
Sep	0	0	0	5	91	82	178
Oct	0	0	0	33	579	579	1191
Nov	0	0	0	13	220	166	399
Dec	0	0	0	17	347	218	582

[1]None of these facilities are required to report the TP concentrations in their effluent. Estimates of existing loads at the mouth of the watershed due to the wastewater treatment plants were therefore based on their reported monthly flows, a literature value for effluent of 4.0 mg/L TP (Litke, 1999), and a 25 percent loss in transit due to settling and plant uptake. No phosphorus was assumed to be discharged by the industries. WLAs were set based on reducing existing loads by the percent reduction identified in Table 5-1.

Table 6-2. Nitrate+nitrite wasteload allocations for the NPDES facilities in the Wabash River watershed.

Month	All CAFOs (kg/month)	OH0009482 (kg/month)	OH0010138 (kg/month)	OH0025160 (kg/month)	OH0020320 (kg/month)	OH0024694 (kg/month)	Total (kg/month)
Jan	0	0	0	130	2,557	215	2902
Feb	0	0	0	136	4,458	326	4920
Mar	0	0	0	165	3,866	304	4335
Apr	0	0	0	145	4,277	577	4999
May	0	0	0	148	3,186	344	3678
Jun	0	0	0	68	3,449	437	3954
Jul	0	0	0	124	2,830	420	3374
Aug	0	0	0	134	2,957	247	3338
Sep	0	0	0	141	3,032	326	3499
Oct	0	0	0	79	2,481	86	2646
Nov	0	0	0	29	371	305	705
Dec	0	0	0	92	3,187	272	3551

Table 6-3. Total suspended solids wasteload allocations for the NPDES facilities in the Wabash River watershed.

Month	All CAFOs (kg/month)	OH0009482 (kg/month)	OH0010138[1] (kg/month)	OH0025160 (kg/month)	OH0020320 (kg/month)	OH0024694 (kg/month)	Total
Jan	0	1,043	8,498	1,658	1,449	8,903	21,551
Feb	0	1,174	3,643	1,587	2,420	13,546	22,370
Mar	0	742	3,631	2,715	1,314	17,692	26,094
Apr	0	932	9,458	3,151	1,576	13,638	28,755
May	0	1,377	8,452	3,206	714	13,498	27,247
Jun	0	445	8,557	1,339	995	12,031	23,367
Jul	0	476	8,591	5,383	814	11,396	26,660
Aug	0	539	9,969	4,561	607	17,611	33,287
Sep	0	812	9,789	3,632	574	12,117	26,924
Oct	0	1,071	3,919	1,862	577	17,103	24,532
Nov	0	742	3,626	1,812	543	11,478	18,201
Dec	0	1,934	0	2,187	1,433	14,905	20,459

[1]This facility reports total solids rather than total suspended solids. Total suspended solids were therefore estimated based on the assumption that 17 percent of total solids are suspended solids. This value is derived from the existing water quality within the watershed.

7.0 MARGIN OF SAFETY

The MOS accounts for any uncertainty concerning the relationship between pollutant loading and receiving water quality. The MOS can be implicit (e.g., incorporated into the TMDL analysis through conservative assumptions) or explicit (e.g., expressed in the TMDL as a portion of the loading) or a combination of both. For the Wabash River TMDL, the MOS was included explicitly as 5 percent of the loading capacity. A relatively low margin of safety was chosen because the SWAT model relied on several conservative assumptions, such as low instream nutrient transformation rates. The SWAT model is also believed to be providing good information on the relationship between pollutant loadings and receiving water quality. For example, seasonal and annual differences between observed versus simulated stream flow are summarized in Table 7-1. The table shows that simulated flow for the ten-year modeling period agrees very well with observed stream flow data. The greatest errors occur in simulated summer storm volumes, yet these errors are within recommended calibration parameters (Lumb et al., 1994). In general, the hydrologic calibration appears adequate in that it reflects the total water yield, annual variability, and magnitude of individual storm events in the basin. All of the recommended hydrologic criteria are met. Additional information on the results of the modeling are shown in Appendix C and indicate good agreement between modeled and observed data.

Table 7-1. Wabash River Watershed Calibration Results for the Simulation Period October 1, 1977 to September 30, 1987. Units shown are inches.

Total Simulated In-stream Flow:	**102.17**	Total Observed In-stream Flow:	**98.26**
Total of highest 10% flows:	**57.54**	Total of Observed highest 10% flows:	**55.73**
Total of lowest 50% flows:	**6.46**	Total of Observed Lowest 50% flows:	**6.05**
Simulated Summer Flow Volume:	**11.08**	Observed Summer Flow Volume:	**7.82**
Simulated Fall Flow Volume:	**24.54**	Observed Fall Flow Volume:	**19.88**
Simulated Winter Flow Volume:	**36.52**	Observed Winter Flow Volume:	**38.50**
Simulated Spring Flow Volume:	**30.03**	Observed Spring Flow Volume:	**32.06**
Total Simulated Storm Volume:	**102.04**	Total Observed Storm Volume:	**95.66**
Simulated Summer Storm Volume:	**11.05**	Observed Summer Storm Volume:	**7.17**
Errors (Simulated-Observed)		*Recommended Criteria*[1]	
Error in total volume:	**3.83**	10	
Error in 50% lowest flows:	**6.24**	10	
Error in 10% highest flows:	**3.13**	15	
Seasonal volume error - Summer:	**29.39**	30	
Seasonal volume error - Fall:	**18.99**	30	
Seasonal volume error - Winter:	**-5.42**	30	
Seasonal volume error - Spring:	**-6.76**	30	
Error in storm volumes:	**6.25**	20	
Error in summer storm volumes:	**35.08**	50	

[1] Recommended criteria are from Lumb et al., 1994

Figures 7-1 to 7-3 present the results of the model calibration for TP, NN, and TSS. They indicate that the model is a reasonable description of the significant water quality processes in the watershed. The time series plots of modeled versus observed data indicate that the observed data are within the range of the modeled data and generally follow the same temporal pattern. Additional details regarding the modeling are available in Appendix B.

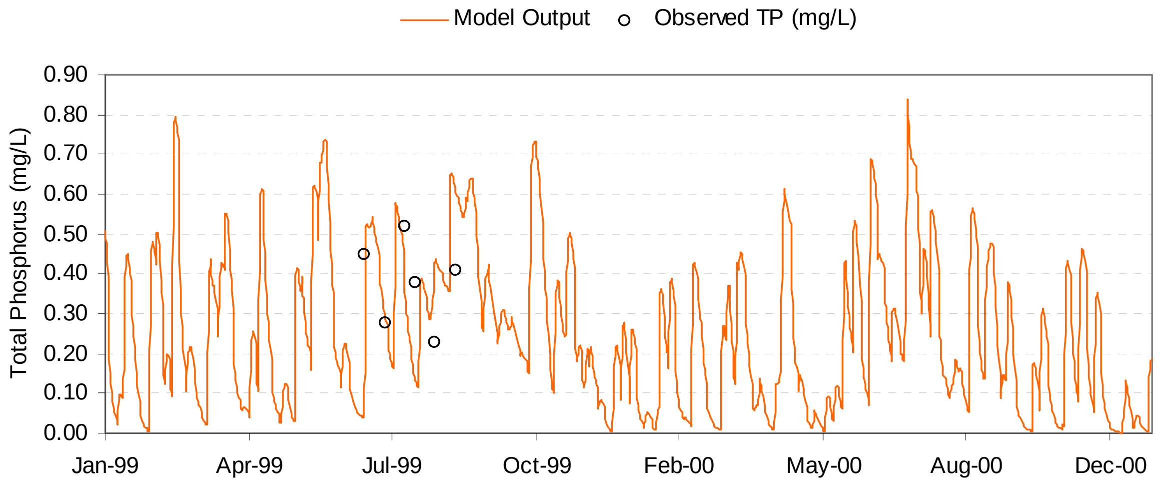

Figure 7-1. Comparison of predicted and observed total phosphorus data for the Wabash River at State Line Road.

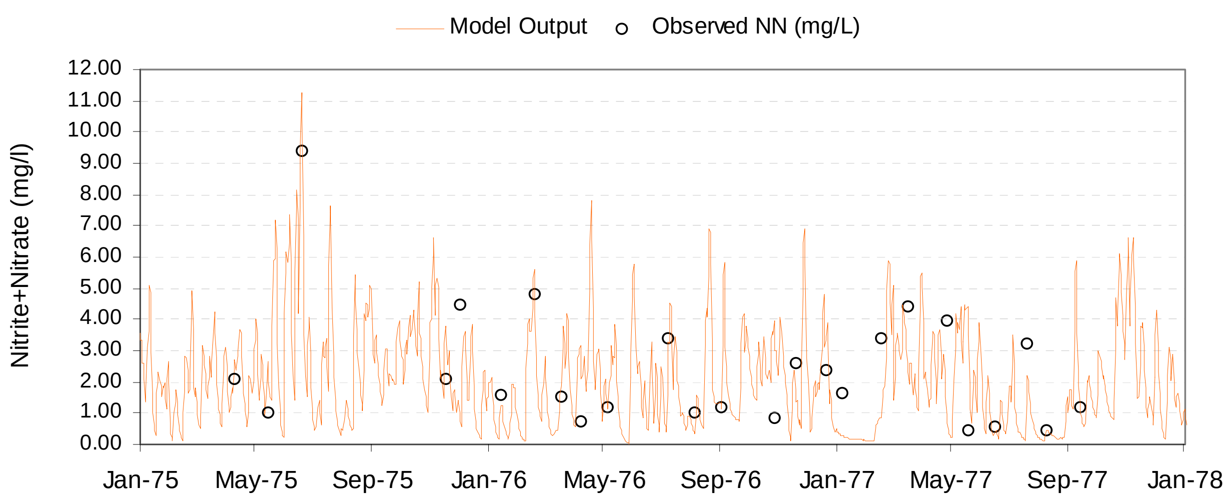

Figure 7-2. Comparison of predicted and observed nitrite+nitrate data for the Wabash River at State Line Road.

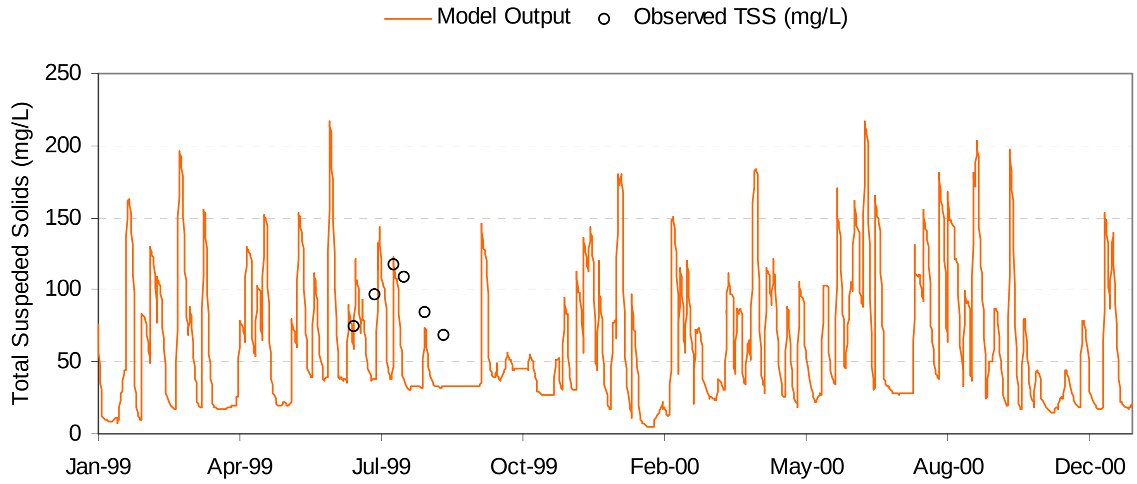

Figure 7-3. Comparison of predicted and observed total suspended solids data for the Wabash River at State Line Road.

8.0 SEASONAL VARIATION

Nutrient and sediment loading in the Wabash River watershed vary seasonally, due to variations in weather and source activity, especially as related to agricultural runoff from seasonal manure application. To account for this seasonality, this TMDL establishes monthly allocations. The allocations represent loads allocated to time periods of similar weather, runoff, and instream conditions and can help to identify times of greatest impairment. TMDL implementation can therefore focus efforts by identifying time periods needing greater load reductions. Tables 5-1 to 5-3 show the load allocations by month and Tables 6-1 through 6-3 provide the monthly wasteload allocations.

9.0 MONITORING PLAN

The watershed will be re-evaluated as part of the rotating basin monitoring schedule established by the OEPA. The monitoring will also be incorporated into the Watershed Action Plan (WAP) for the Wabash River which is scheduled for completion by December 31, 2004. The plans will include the local watershed group volunteer monitoring efforts to collect chemical, physical, and possibly biological samples in the watershed. The WAP will incorporate this TMDL report and serve as a primary means of implementation. The watershed group plans to monitor best management practices (BMPs) upon implementation and confirm TMDL targets.

10.0 REASONABLE ASSURANCE

As part of an implementation plan, reasonable assurances provide a level of confidence that the wasteload allocations and load allocations in TMDLs will be implemented by Federal, State, or local authorities and/or by voluntary action. As proposed in the WAP, stakeholders will implement BMPs that directly correlate to water quality goals and attainment standards. As outlined in the monitoring plan above, chemical sampling will be done by the watershed group to confirm load reduction calculations. BMP implementation is dependent on availability of funding from State, local, and Federal sources including, but not limited to, 319 nonpoint source grants and USDA 2002 Farm Bill conservation programs. Reasonable assurances for planned point source controls, such as wastewater treatment plant upgrades and changes to NPDES permits, include a schedule for implementation of planned NPDES permit actions. In the regulatory framework, basin-wide limits for NPDES dischargers will be an available tool to reduce the discharge. For non-enforceable actions (certain nonpoint source activities), assurances must include 1) demonstration of adequate funding; 2) process by which agreements/arrangements between appropriate parties (e.g., governmental bodies, private landowners) will be reached; 3) assessment of the future of government programs which contribute to implementation actions; and 4) demonstration of anticipated effectiveness of the actions. It will be important to coordinate activities with those governmental entities that have jurisdiction and programs in place to implement the nonpoint source actions (e.g., county soil and water conservation district offices, county health departments, local Natural Resource Conservation Service offices of the U.S. Department of Agriculture, municipalities and local governmental offices).

Non-regulatory actions would include finalization of an implementation plan, discussed further in the next section, which includes education activities, stormwater management, agricultural BMPs, stream channel restoration and periodic stream monitoring to measure progress. BMPs include but are not limited to fertilizer reduction, riparian buffer, two-stage channel ditch design, increased no-till farming, manure/nutrient management, etc.

Incentive-based projects would include 319 projects, funding a watershed coordinator for public outreach and education, and various loan opportunities for agriculture practices and riparian/habitat improvements.

11.0 IMPLEMENTATION

The primary implementation tool will be the locally-lead watershed group and the WAP. This plan will incorporate this TMDL report and serve as a primary means of implementation. The plan will incorporate TMDL results and additional data collected within the community to develop a specific set of action items designed to help meet the TMDL targets. It is intended that this plan be endorsed by the ODNR Division of Soil and Water and the OEPA Division of Surface Water, thus making it eligible and more competitive for Section 319 Implementation Grants, State Revolving Fund (SRF) monies, USDA funds, and potentially other funding sources.

The Wabash River Watershed has had a watershed coordinator since January, 2003, who coordinates local support and implements BMPs for the control of erosion and nutrient runoff, purchases conservation easements, and educates within the watershed. This effort has been funded through a combination of grants from OEPA (CWA Section 319), Ohio DNR (Watershed Management, Streambanking, Manure Nutrient Management, Geographic Information Systems and Watershed Coordinator), and USDA (as outlined in the conservation titles of the 2002 Farm Bill). Funding within the watershed has been going directly to landowners for BMP installation and/or conservation easements. While the results have been noticeable in both land management and water quality much remains to be accomplished.

Generally, implementation of BMPs relies on voluntary and incentive programs, such as government cost-sharing. Therefore, the implementation plan should show there is reasonable assurance that nonpoint source controls will be implemented and maintained. Long-term watershed water quality monitoring will also be important in evaluating the effectiveness of BMPs. The implementation plan will include a time schedule describing when the activities necessary to implement the TMDL will occur. This would include a time line for implementation of BMPs and/or control actions.

Committees were formed to develop implementation strategies, including actions and management measures, time lines, reasonable assurances, and monitoring plans. Stakeholder meetings were held in various parts of the watershed to gather feedback for the WAP. A conservation buffer information session was sponsored by the watershed group to encourage implementation. The Wabash Conservancy District sponsored a lunch meeting to promote low maintenance ditch design. Watershed group members have been actively going door-to-door promoting BMP implementation and gathering feedback for the WAP. Current community capacity was analyzed, and a plan for structuring the TMDL implementation effort was established. Groups consisted of local stakeholders, agricultural producers, and consultants, as well as soil and water conservation staff.

Animal waste is a significant contributor to nonpoint source pollution in the Wabash watershed. Implementation actions include the voluntary development of manure nutrient management plans, promotion of evolving technologies for safe land application of manure, grid soil sampling of lands proposed for manure application, establishment of grassed filter strips, building of manure storage facilities according to NRCS specifications, exclusion of livestock from streams with alternate water supplies, and certification of manure applicators. Assessment units were ranked based on total phosphorus reduction required and willingness of landowner participation.

Urban issues are not a major a problem in the Wabash River watershed, but there are two permitted wastewater treatment plants and two industrial facilities. Nutrients are delivered to the river through normal permitted discharge. As NPDES permits are renewed, limits will be established for phosphorus and nitrogen to levels that supplement reductions from nonpoint sources. Requirements for best available control technology will be the primary mechanism used for reaching the desired limits.

12.0 PUBLIC PARTICIPATION

Public participation is an ongoing process in the watershed. The watershed coordinator has been responsible for hosting numerous meetings on outreach and education, and updating the stakeholders on various issues described in the previous sections. This TMDL "The Total Maximum Daily Load (TMDL) report for the Wabash River, Ohio, Watershed" is completed by the USEPA in conjunction with the OEPA and Tetra Tech, Inc., under Section 303(d) of the Clean Water Act, and was put on public notice on February 26, 2004. The TMDL report includes the name and location of the waterbody segments and the pollutants of concern (nutrients and sediments). The Wabash River watershed was identified as a priority impaired water on Ohio's 2002 303(d) list (OEPA, 2002). Public comments and the responsiveness summary are included in Appendix E.

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