Wabash River Nutrient and Pathogen TMDL Development

FINAL REPORT

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Prepared for
Illinois Environmental Protection Agency
Indiana Department of Environmental Management

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1 INTRODUCTION

The headwaters of the Wabash River are located in west-central Ohio and the river flows for approximately 30 miles before crossing into Indiana. From the Ohio/Indiana state line, the Wabash River flows for more than 475 miles to its confluence with the Ohio River below Mount Vernon. The Wabash River watershed drains two-thirds of Indiana's 92 counties and consists of primarily agricultural land with many small towns and some cities located along the river, notably Terre Haute and Lafayette. The lower Wabash River forms the boundary with the state of Illinois and a significant portion of the drainage area is located in Illinois (see Figure 2-1).

A number of segments of the Wabash River have been listed as impaired on the Indiana and Illinois Section 303(d) lists for various causes of impairment. As described in Section 2.1, this study addressed the impairments related to pathogens (*E. coli* and fecal coliform), nutrients, pH, dissolved oxygen, and impaired biotic communities. Thermal modifications were also evaluated as a potential contributor to the impaired biotic community impairments. The Clean Water Act and U.S. Environmental Protection Agency (USEPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) lists. A TMDL is defined as "the sum of the individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background" such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded. A TMDL is also required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis.

A comprehensive review of the available water quality data for the Wabash River confirmed most of the Section 303(d) listings, although it was determined that no TMDL was needed to address thermal modifications. *E. coli*, fecal coliform, total phosphorus, and nitrate TMDLs were developed and the total phosphorus and nitrate TMDLs also address the pH, dissolved oxygen, and impaired biotic community listings. The overall goals and objectives in developing the Wabash River TMDLs include:

- Assess the water quality of the impaired waterbodies and identify key issues associated with the impairments and potential pollutant sources.

- Use the best available science and available data to determine the maximum load the waterbodies can receive and fully support all of their designated uses.

- Determine current loads of pollutants to the impaired waterbodies.

- If current loads exceed the maximum allowable loads, determine the load reduction that is needed.

- Inform and involve the public throughout the project to ensure that key concerns are addressed and the best available information is used.

- Submit a final TMDL report to the U.S. Environmental Protection Agency (USEPA) for review and approval.

The project is being initiated in two stages. Stage One was completed in September 2005 and involved the assessment of the available water quality data and an identification of potential technical approaches. Several public meetings were held throughout the watershed in both Indiana and Illinois to inform the public of the Stage One results. Stage Two involved model development and calibration, the evaluation of various TMDL scenarios, and implementation planning. This report documents the modeling and

TMDL components of Stage Two and presents a conceptual implementation plan. Due to the size of the Wabash River watershed, more detailed implementation plans are expected to be developed and tailored to individual tributary watersheds as needed. Additional monitoring is also recommended to further refine the estimate of nutrient loads, especially from wastewater treatment plants.

Section 2 of this report presents an inventory and assessment of the available water quality data for the Wabash River, Section 3 discusses the modeling approach that was used during the study, and Section 4 presents the TMDL results and allocations. The public participation activities are summarized in Section 5 and the conceptual implementation plan is presented in Section 6.

2 INVENTORY AND ASSESSMENT OF WATER QUALITY INFORMATION

This section of the document identifies the segments of the Wabash River that were listed for fecal coliform, *E. coli*, nutrients, pH, dissolved oxygen, or impaired biotic communities. Information is first provided on the 303(d) listing status and the applicable water quality standards. The available data are then compared to the water quality standards to confirm the 303(d) impairment status.

2.1 303(d) List Status

The Indiana and Illinois 2002, 2004, and 2006 303(d) listings for the Wabash River are summarized in Table 2-1 through Table 2-3. The tables show that various segments of the Wabash River in Indiana have been listed as impaired for *E. coli*, nutrients, pH, dissolved oxygen, and impaired biotic communities, while only one segment in Illinois has been listed as impaired due to fecal coliform. Based on the comprehensive review of the water quality data presented in Section 2.3, the Indiana Department of Environmental Management (IDEM), the Illinois Environmental Protection Agency (IEPA), and the USEPA determined to develop TMDLs for the following segment/pollutant combinations:

- *E. coli*, nitrate, and phosphorus TMDLs for all segments of the Wabash River from the Indiana/Ohio state line to the confluence of the Wabash and Vermilion Rivers.
- *E. coli* TMDLs for all segments of the Wabash River from the Vermilion River to the Indiana/Illinois state line.
- *E. coli* and fecal coliform TMDLs for all segments of the Wabash River from the Indiana/Illinois stateline to the confluence of the Wabash and Ohio Rivers.

These segments are presented in Table 2-3 and their locations are shown in Figure 2-1. It should be noted that loads of pH and dissolved oxygen were not calculated but instead the nutrient TMDLs are expected to result in attainment of water quality standards for these two parameters. The nutrient TMDLs also address the impaired biotic community listings. This is due to the interrelationship between high nutrient loads, excessive algal growth, and the subsequent impact of excessive algae on dissolved oxygen and pH which then stress biological communities. The link between nutrients, algal growth, dissolved oxygen, and pH is explained below.

2.1.1 Relationship Between Nutrients, Algal Growth, Dissolved Oxygen, and pH

Algae and macrophytes (rooted and floating aquatic plants) require a variety of inorganic elements to sustain life. Two of these elements, phosphorus and nitrogen (including nitrate, which is a component of total nitrogen), are needed in significant concentrations to sustain the production of organic plant material. Algae and some macrophytes mostly obtain these nutrients from the water column (as opposed to from the air or soil). However, the amount of nitrogen and phosphorus an aquatic plant needs is often significantly higher than the naturally occurring concentrations found in water (Vallentyne, 1974). This phenomenon is referred to as the Limiting
Nutrient law, because the concentration of nitrogen and phosphorus in a waterbody almost always limits algae and macrophyte growth (i.e., there simply isn’t enough phosphorus or nitrogen present to further organic matter production). Therefore, increasing the amount of nitrogen and phosphorus in a waterbody tends to cause an increase in algae and macrophyte production (assuming all other variables remain the same). Given an infinite amount of nitrogen and phosphorus in the water column, production would increase until another element limited production (most likely carbon or silicon).

Algae and macrophytes produce and consume oxygen in water. During daylight hours, oxygen is produced by photosynthesis. Plants and algae then consume oxygen from the water column at night (respiration). The entire process is part of the natural cycle of most plants, and this cycle causes dissolved oxygen concentrations to fluctuate throughout the water column in a day. This is called a diurnal oxygen cycle. Various other processes also produce and consume dissolved oxygen in the water column. Processes that consume oxygen include organic decomposition, respiration by fish and invertebrates, and sediment oxygen demand. Additional dissolved oxygen is produced through atmospheric exchange. The amount and timing of oxygen production and consumption depends on several of the following factors (Thomann and Mueller, 1987; Wetzel, 2001).

- Solar radiation and water clarity
- Air and water temperature, wind speed
- Flow
- Algae and macrophyte growth and death/decay rates
- Presence or absence of essential elements
- Type of algae present in the water column
- Amount of dissolved oxygen present in the water column

Oxygen depletion occurs when the balance between oxygen consumption and production is altered, either causing excessive oxygen consumption or reduced oxygen production. The dissolved oxygen concentration in a waterbody becomes too low, thereby threatening oxygen breathing aquatic life. Because algae are typically the largest producers and consumers of oxygen in a river, a shift in that community can greatly affect the dissolved oxygen. The basic processes linking excessive algal biomass to altered pH and dissolved oxygen concentrations are summarized below.

- Most algae communities have natural, seasonal succession. The timing between growth (oxygen producing) and decay (oxygen consuming) can be very different. This shift causes periods when there is excessive decomposition and little new growth, resulting in extreme oxygen depletion.
- Excessive algae and macrophytes cause the diurnal oxygen cycle to expand. Dissolved oxygen becomes extremely high during the daytime, often resulting in oxygen supersaturation. Dissolved oxygen then falls to extremely low concentrations during the night (plant respiration), causing fatal conditions for aquatic life (Thomann and Mueller, 1987).
- As a consequence of photosynthesis, plants utilize carbon dioxide in the day time (removing it from the water) which causes alkaline carbonates and bicarbonates to predominate in the water and the pH to rise. The opposite occurs at night. In the case of heavy algae blooms, the pH of the water can fluctuate quite dramatically through a 24 hour period. While many large fish can survive these fluctuations, small fish can become quite stressed by these rapid pH changes.
- Natural and anthropogenic sources can cause the sudden death of algae and macrophytes. This results in a situation with excessive decay and no biological oxygen production, again causing fatal conditions for aquatic life

2.1.2 Wabash River Impairment Status in Ohio

This TMDL report does not directly address the Wabash River within Ohio because sediment and nutrient TMDLs were previously developed in 2004 (USEPA, 2004). The impact of the Ohio portion of the Wabash River on downstream water quality is further discussed in Section 4.0.

2.1.3 Thermal Modification Impairments

Although thermal modifications were initially evaluated during this study as a possible reason for the impaired biotic community listings, the available temperature data (summarized in Appendix G) do not suggest that in-stream temperature criteria have been exceeded in the Upper, Middle, or Lower Wabash

River segments. Instead, it appears that certain point source facilities have exceeded the in-stream temperature criteria in their effluent (Table G-8), as is allowed in their permits under Clean Water Act Section 316(a) variances. The possibility that the impaired biotic community listings are also related to these discharges is supported by research conducted by the U.S. Fish and Wildlife Service (USFWS, 2005). The Wabash River impairments associated with these dischargers were therefore listed as category 4B on the Indiana 2006 303(d) list. Because they are listed under category 4B, they will be addressed by the IDEM National Pollutant Discharge Elimination (NPDES) Permits Section and temperature TMDLs were not developed.

Table 2-1. Indiana and Illinois Wabash River 2002 303(d) Listed Segments for *E. coli*, Impaired Biotic Communities, and Nutrients/pH/Low DO.

Segment ID Number	Waterbody Name	Cause of Impairment
INB0141_T1023	Wabash River	*E. coli*
INB0163_00	Wabash River	*E. coli*
INB0164_00	Wabash River	*E. coli*
INB0164_T1001	Wabash River	*E. coli*
INB0174_T1005	Wabash River	*E. coli*
INB01E3_M1029	Wabash River	*E. coli*
INB01G1_M1018	Wabash River	*E. coli*
INB0511_M1001	Wabash River	*E. coli*
INB0534_M1005	Wabash River	*E. coli*
INB0573_M1012	Wabash River	*E. coli*
INB0813_M1001	Wabash River	Impaired Biotic Communities
INB0831_M1003	Wabash River	*E. coli*, Impaired Biotic Communities
INB0833_M1004	Wabash River	*E. coli*, Impaired Biotic Communities
INB0871_M1014	Wabash River	Nutrients, pH, Dissolved Oxygen
INB0881_M1015	Wabash River	Nutrients, pH, Dissolved Oxygen
INB0884_M1017	Wabash River	Nutrients, pH
INB0886_M1018	Wabash River	Nutrients, pH
INB0891_M1019	Wabash River	Nutrients, pH
IL B06	Wabash River	Fecal Coliform

Table 2-2. Indiana and Illinois Wabash River 2004 303(d) Listed Segments for E. coli, Impaired Biotic Communities, and Nutrients/pH/Low DO.

Segment ID Number	Waterbody Name	Cause of Impairment
INB01E3_M1029	Wabash River	*E. coli*
INB0164_T1001	Wabash River	*E. coli*
INB01G1_M1018	Wabash River	*E. coli*
INB0511_M1001	Wabash River	*E. coli*
INB0534_M1005	Wabash River	*E. coli*
INB0573_M1012	Wabash River	*E. coli*
INB0813_M1001	Wabash River	Impaired Biotic Communities
INB0884_M1017	Wabash River	Nutrients, pH
INB0886_M1018	Wabash River	Nutrients, pH
INB0891_M1019	Wabash River	Nutrients, pH
INB0881_M1015	Wabash River	Nutrients, pH, Dissolved Oxygen
INB0161_T1025	Wabash River	Impaired Biotic Communities
INB0141_T1023	Wabash River	*E. coli*
INB0871_M1014	Wabash River - Attica	Nutrients, pH, Dissolved Oxygen
INB0831_M1003	Wabash River - Downstream Wea Creek	Impaired Biotic Communities, *E. coli*
INB0833_M1004	Wabash River - Granville Brdg To Flint Creek	Impaired Biotic Communities, *E. coli*
INB0163_00	Wabash River - Threemile Creek	*E. coli*
INB0164_00	Wabash River and Tributary	*E. coli*
INB0174_T1005	Wabash River Mainstem	*E. coli*
IL B 06	Wabash River	Fecal Coliform Bacteria

Table 2-3. Indiana and Illinois Wabash River 2006 303(d) Listed Segments (Category 5) for *E. coli*, Impaired Biotic Communities, and Nutrients/pH/Low DO.

Basin/Waterbody	Segment ID	TMDL for Phosphorus	TMDL for Nitrate	TMDL for *E. coli*	Impairments Addressed
Upper Wabash (05120101)					
Wabash River	INB0141_T1023	X	X	X	*E. coli*, Nutrients
Wabash River	INB0161_T1025				*E. coli*, IBC, Nutrients
Wabash River	INB0162_00				*E. coli*, Nutrients
Wabash River	INB0164_T1001				*E. coli*, Nutrients
Wabash River	INB0171_T1002				*E. coli*, Nutrients
Wabash River	INB01E1_M1010				*E. coli*, Nutrients
Wabash River	INB01E3_M1011				*E. coli*, Nutrients
Wabash River	INB01E3_M1029				*E. coli*, Nutrients
Wabash River	INB01F1_M1012				*E. coli*, Nutrients
Wabash River	INB01F2_M1013				*E. coli*, Nutrients
Wabash River	INB01F5_M1014				*E. coli*, Nutrients
Wabash River	INB01F8_M1015				*E. coli*, Nutrients
Wabash River	INB01F9_M1016				*E. coli*, Nutrients
Wabash River	INB01FA_M1017				*E. coli*, Nutrients
Wabash River	INB01G1_M1018				*E. coli*, Nutrients
Wabash River	INB01G3_M1019				*E. coli*, Nutrients
Wabash River	INB01G4_M1020				*E. coli*, Nutrients
Wabash River	INB01J2_M1021				*E. coli*, Nutrients
Wabash River	INB01J4_M1022				*E. coli*, Nutrients
Wabash River - Below Huntington Lake Dam	INB0192_T1009				*E. coli*, Nutrients
Wabash River - Threemile Creek	INB0163_00				*E. coli*, Nutrients
Wabash River And Tributary	INB0164_00				*E. coli*, Nutrients
Wabash River Mainstem	INB0172_T1003				*E. coli*, Nutrients
Wabash River Mainstem	INB0173_T1004				*E. coli*, Nutrients
Wabash River Mainstem	INB0174_T1005				*E. coli*, Nutrients
Wabash River Mainstem	INB0175_T1006				*E. coli*, Nutrients
Wabash River Mainstem	INB0176_T1007				*E. coli*, Nutrients
Middle Wabash-Deer (05120105)					
Wabash River	INB0511_M1001	X	X	X	*E. coli*, Nutrients
Wabash River	INB0521_M1002				*E. coli*, Nutrients
Wabash River	INB0532_M1003				*E. coli*, Nutrients
Wabash River	INB0533_M1004				*E. coli*, Nutrients
Wabash River	INB0534_M1005				*E. coli*, Nutrients
Wabash River	INB0573_M1012				*E. coli*, Nutrients

Basin/Waterbody	Segment ID	TMDL for Phosphorus	TMDL for Nitrate	TMDL for *E. coli*	Impairments Addressed
Wabash River - Mainstem	INB0561_M1010				*E. coli*, Nutrients
Wabash River - Mainstem	INB0562_M1011				*E. coli*, Nutrients
Middle Wabash – Little Vermilion (05120108)					
Wabash River	INB0813_M1001	X	X	X	*E. coli*, IBC, Nutrients
Wabash River	INB0814_M1002				*E. coli*, Nutrients
Wabash River	INB0839_M1006				*E. coli*, Nutrients
Wabash River	INB0881_M1015				*E. coli*, Dissolved Oxygen, Nutrients, pH
Wabash River	INB0882_M1016				*E. coli*, Nutrients
Wabash River	INB0884_M1017				*E. coli*, Nutrients, pH
Wabash River	INB0886_M1018				*E. coli*, Nutrients, pH
Wabash River	INB0891_M1019				*E. coli*, Nutrients, pH
Wabash River	INB0894_M1020				*E. coli*, Nutrients
Wabash River	INB08F2_M1024				*E. coli*, Nutrients
Wabash River	INB08M1_M1031				*E. coli*, Nutrients
Wabash River	INB08M3_M1032				*E. coli*, Nutrients
Wabash River	INB08M4_M1033				*E. coli*, Nutrients
Wabash River - Attica	INB0871_M1014				*E. coli*, Nutrients, pH, Dissolved Oxygen
Wabash River - Below Independence	INB083B_M1007				*E. coli*, Nutrients
Wabash River - Cayuga Gen Sta To Mill Cr	INB08E1_M1050				*E. coli*, Nutrients
Wabash River - County Line To Little Pine Creek	INB0835_M1005				*E. coli*, Nutrients
Wabash River - Granville Brdg To Flint Creek	INB0833_M1004				*E. coli*, Nutrients
Wabash River - Ltl Vermillion R To Sugar Cr	INB08E6_M1051				*E. coli*, Nutrients
Wabash River - Mill Cr To Below Ltl Vermillion R	INB08E6_M1022				*E. coli*, Nutrients
Wabash River - Sugar Cr To Ltl Raccoon Cr (Vermillion)	INB08F1_M1023				*E. coli*, Nutrients
Wabash River - Vermilion R To Cayuga Gen Sta	INB08E1_M1021				*E. coli*, Nutrients
Wabash River D/S Of Wea Creek	INB0831_M1003				*E. coli*, Nutrients

Basin/Waterbody	Segment ID	TMDL for Phosphorus	TMDL for Nitrate	TMDL for *E. coli*	Impairments Addressed
Middle Wabash – Busseron (05120111)					
Wabash River	INB1145_M1003				*E. coli*
Wabash River	INB1174_M1005				*E. coli*
Wabash River	INB1194_M1007				*E. coli*
Wabash River	INB11C4_M1009				*E. coli*
Wabash River	INB11F1_M1010				*E. coli*
Wabash River	INB11F3_M1011				*E. coli*
Wabash River	INB11H1_M1014				*E. coli*
Wabash River	INB11H2_M1015				*E. coli*
Wabash River	INB11J1_M1017				*E. coli*
Wabash River	INB11K4_M1018				*E. coli*
Wabash River	INB11M1_M1019				*E. coli*
Wabash River	INB11M3_M1020				*E. coli*
Wabash River - Otter Creek To Above Wabash Gen Sta Outfall	INB1142_M1002			X	*E. coli*
Wabash River - Spring Creek To Otter Creek	INB1138_M1001				*E. coli*
Wabash River - Wabash Gen Sta To Lost Creek	INB1142_M1025				*E. coli*
Wabash River-Ashmore Creek (Ill)	INB1176_M1006				*E. coli*
Wabash River-Buzzard Pond	INB11F4_M1012				*E. coli*
Wabash River-Riverview	INB11A5_M1008				*E. coli*
Wabash River-Terre Haute Area	INB1156_M1004				*E. coli*
Lower Wabash (05120113)					
Wabash River	INB1311_M1001			X	*E. coli*
Wabash River	INB1315_M1002				*E. coli*
Wabash River	INB1316_M1003				*E. coli*
Wabash River	INB1331_M1004				*E. coli*
Wabash River	INB1333_M1005				*E. coli*
Wabash River	INB1354_M1007				*E. coli*
Wabash River	INB1361_M1008				*E. coli*
Wabash River	INB1381_M1009				*E. coli*
Wabash River	INB1382_M1010				*E. coli*
Wabash River	INB13A1_M1011				*E. coli*
Wabash River	INB13A3_M1012				*E. coli*
Wabash River	INB13A4_M1013				*E. coli*
Wabash River	INB13C1_M1015				*E. coli*
Wabash River	INB13C2_M1016				*E. coli*

Basin/Waterbody	Segment ID	TMDL for Phosphorus	TMDL for Nitrate	TMDL for *E. coli*	Impairments Addressed
Wabash River	INB13D1_M1017				*E. coli*
Wabash River	INB13D2_M1018				*E. coli*
Wabash River-Greathouse Creek (Ill)	INB1341_M1006				*E. coli*
Wabash River-Wabash Levee Ditch (Ill)	INB13A5_M1014				*E. coli*
Wabash River	IL_B-06				Fecal Coliform

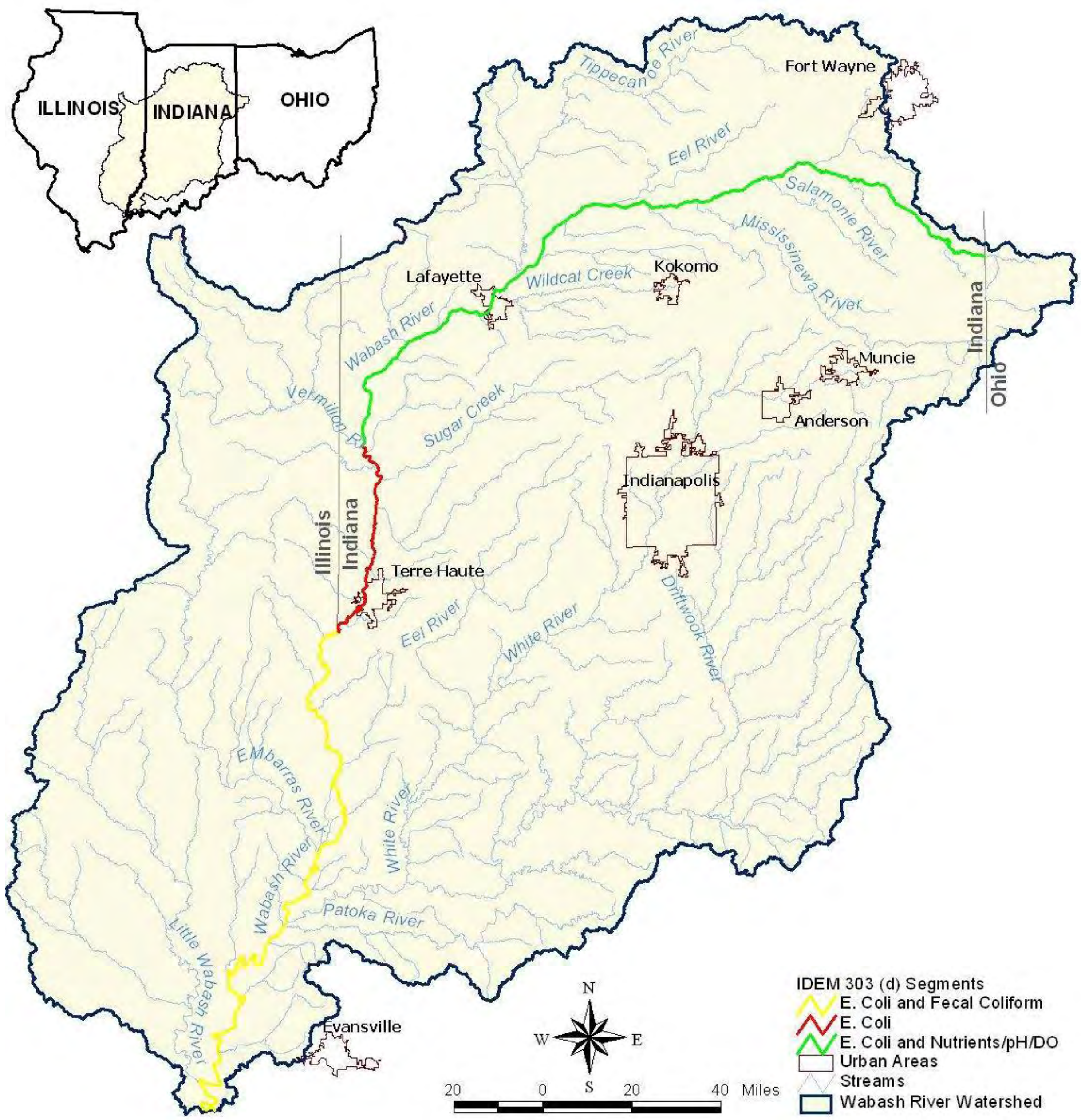

Figure 2-1. Location of impaired Wabash River segments addressed by the TMDLs presented in this report.

2.2 Applicable 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 primarily of two different components:

- **Designated uses** reflect how the water can potentially be used by humans and how well it supports a biological community. Examples of designated uses include aquatic life support, drinking water supply, and recreation. Each water in Illinois and Indiana has a designated use or uses; however, not all uses apply to all waters.
- Criteria express the condition of the water that is necessary to support the designated uses. **Numeric criteria** represent the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. **Narrative criteria** 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

This section describes the water quality standards that apply to the Wabash River in Ohio, Indiana and Illinois for the pollutants of concern.

2.2.1 Ohio Water Quality Standards

Ohio's water quality standards are presented here because of the previously developed TMDL (USEPA, 2004) and the impact the Ohio portion of the Wabash River has on water quality in Indiana.

2.2.1.1 Fecal Coliform and *E. coli*

Ohio currently has water quality standards for both fecal coliform and *E. coli* (Table 2-4). However, the impairment status of the Wabash River for these two parameters is unknown and no TMDL has yet been developed (OEPA, 2006). Therefore, the Indiana *E. coli* TMDL was based on an assumption that Ohio's *E. coli* standard would be met at the state line from April 1 through October 30 (to correspond to Indiana's water quality standard; see section 2.2.2.1). Ohio's *E. coli* standard (126 cfu/100 mL) is essentially the same as Indiana's (125 cfu/100 mL). Additional monitoring in Ohio is recommended to determine whether the standard is being met and, if not, an Ohio *E. coli* TMDL should be developed. (It should be noted that the Ohio Environmental Protection Agency is currently developing an *E. coli* TMDL for the two assessment units located directly upstream of the Wabash River at the Ohio/Indiana state line).

Table 2-4. Fecal coliform and *E. coli* standards for Ohio. Standards only apply for the period May 1 through October 15. [Ohio Administrative Code 3745-1-07]

Parameter	Primary Contact Use	
	Geometric Mean[1]	Instantaneous[2]
Fecal Coliform	1,000/100 mL	2,000/100 mL
E. coli	126/100 mL	298/100 mL

[1] Geometric mean fecal coliform content should not exceed this standard based on not less than five samples within a thirty-day period.
[2] Fecal coliform content should not exceed this standard in more than ten percent of the samples taken in any thirty-day period.

2.2.1.2 Nutrients

Ohio, like most states, has not yet adopted numeric water quality criteria for nutrients to protect aquatic life uses. However, OEPA has established nutrient targets that are linked to the state's biocriteria (OEPA, 1999) and these targets were the basis of the previously developed TMDL (USEPA, 2004). The target for nitrate+nitrite was 1.5 mg/L and the target for total phosphorus was 0.17 mg/L. (Note that these values are significantly lower than Indiana's targets of 10 mg/L nitrate+nitrite and 0.30 mg/L total phosphorus). The nutrient TMDL developed for Indiana was based on an assumption that the Ohio nutrient TMDL would be fully implemented and that the reductions identified in that TMDL would be realized as the Wabash River crosses into Indiana (i.e., the water quality targets for nitrate and phosphorus identified in the Ohio TMDL would be met as the river crosses into Indiana). This methodology ensures that each state is responsible for reducing loads that are generated within their boundary (i.e., loads within Indiana do not need to be overly reduced to address excessive loads generated upstream in Ohio).

2.2.2 Indiana Water Quality Standards

The Wabash River in Indiana is listed as impaired due to *E. coli*, nutrients, pH, low dissolved oxygen, and impaired biotic communities. The water quality standards relating to these listings are described below.

2.2.2.1 E. coli

All water bodies in Indiana are designated for recreational use. The numeric criteria associated with protecting the recreational use are described below:

> "This subsection establishes bacteriological quality for recreational uses. In addition to subsection (a), the criteria in this subsection are to be used to evaluate waters for full body contact recreational uses, to establish wastewater treatment requirements, and to establish effluent limits during the recreational season, which is defined as the months of April through October, inclusive. *E. coli* bacteria, using membrane filter (MF) count, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period." [Source: Indiana Administrative Code Title 327 Water Pollution Control Board. Article 2. Section 1-6(a).]

It should also be noted that because Indiana's recreational use standard is based on *E. coli* and Illinois's is based on fecal coliform, a translator was used during the modeling process (see Sections 2.2.3.1 and 3.2 for more information).

2.2.2.2 Nutrients/Organic Enrichment/Dissolved Oxygen/Excessive Algal Growth

Indiana has not yet adopted numeric water quality criteria for nutrients to protect aquatic life uses. However, Indiana has adopted the following draft nutrient benchmarks:

- Total phosphorus should not exceed 0.3 mg/L.
- Nitrate + nitrite should not exceed 10 mg/L.
- Dissolved oxygen should not be below the water quality standard of 4.0 mg/L and should not consistently be close to the standard (i.e., in the range of 4.0 to 5.0 mg/L). Values should also not be consistently higher than 12 mg/L and average daily values should be at least 5.0 mg/L per calendar day.
- No pH values should be less than 6.0 or greater than 9.0. pH should also not be consistently close to the standard (i.e., 8.7 or higher).
- Algae growth should not be "excessive" based on field observations by trained staff.

IDEM considers a segment to be impaired for "nutrients" when two or more of these benchmarks are exceeded based on a review of all recent data.

2.2.2.3 pH

As discussed above Indiana's pH numeric criteria require that no pH values should be less than 6.0 or greater than 9.0. [Source: Indiana Administrative Code Title 327 Water Pollution Control Board. Article 2. Section 1-6(a).]

2.2.2.4 Dissolved Oxygen

As discussed above Indiana's dissolved oxygen numeric criteria require that dissolved oxygen be maintained above 4 mg/L. [Source: Indiana Administrative Code Title 327 Water Pollution Control Board. Article 2. Section 1-6(a).]

2.2.3 Illinois Numeric Water Quality Standards

The Wabash River in Illinois is listed as impaired due to fecal coliform.

2.2.3.1 Fecal Coliform

Illinois' General Use Water Quality Standard for fecal coliform bacteria specifies that during the months of May through October, based on a minimum of five samples taken over not more than a 30 day period, fecal coliform bacteria counts shall not exceed a geometric mean of 200 cfu (colony forming units)/100 ml, nor shall more than 10 percent of the samples during any 30 day period exceed 400 cfu/100 ml (35 Ill. Adm. Code 302.209 [2003]). This standard protects for Primary Contact (i.e., swimming) use of Illinois waters by humans.

Due to limits in agency resources allotted to surface-water monitoring and assessment, fecal coliform bacteria cannot usually be sampled at a frequency necessary to apply the "General Use" standard (i.e., at least five times per month during May through October). Therefore, the following surrogate assessment guidelines are used to assess this standard:

- Illinois EPA uses measures of fecal coliform bacteria from water samples collected approximately once every six weeks in May through October, over the most recent five-year period.
- Based on these water samples, geometric means and individual measurements of fecal coliform bacteria are compared to the concentration thresholds in Table 2-5.
- To apply part of the guidelines, the geometric mean of fecal coliform bacteria concentration is calculated from the entire set of May-through-October water samples, across the five years.
- Another part of the guidelines, the percent exceedances, is based on fecal coliform bacteria measurements. See Table 2-5 for guideline specifics.

Table 2-5. Guidelines for Assessing Primary Contact (Swimming) Use in Illinois Streams.

Degree of Use Support	Guidelines
Full	Geometric mean of all fecal coliform bacteria observations <200/100 ml, and <10% of observations exceed 400/100 ml
Partial	Geometric mean of all fecal coliform bacteria observations <200/100 ml and >10% of observations exceed 400/100 ml; or Geometric mean of all fecal coliform bacteria observations >200/100 ml and <25% of observations exceed 400/100 ml
Nonsupport	Geometric mean of all fecal coliform bacteria observations >200/100 ml and >25% of observations exceed 400/100 ml

2.3 Impairment Verification

Available water quality data for the Wabash River were compiled and compared against the water quality standards described in Section 2.2. Data were provided by a variety of sources including the following:

- Bluffton Wastewater Treatment Facility
- Clinton Stream Reach Characterization Evaluation Report (SRCER)
- Indiana Department of Natural Resources (DNR) Lake and Reservoir Enhancement (LARE) Study
- Huntington
- IDEM
- IEPA
- Lafayette SRCER
- North Manchester SRCER
- Peru SRCER
- Portland SRCER
- Redkey WWTP
- River Watch
- Rock Creek Conservation District
- Sullivan SRCER
- Tippecanoe County Health Department
- U.S. Geological Survey (USGS)
- Veedersburg WWTP
- West Lafayette WWTP
- Decatur
- Lafayette
- Mount Vernon
- Portland
- Peru
- Huntington
- Lafayette

To facilitate presentation of the data, the Wabash River was divided into three sections[1]:

- Upper Wabash River – Headwaters to the confluence with Tippecanoe River
- Middle Wabash River – Tippecanoe River to the Indiana/Illinois State line
- Lower Wabash River – The Indiana/Illinois State line to the mouth.

These sections of the Wabash River along with the available sampling stations are shown in Figure 2-2.

[1] Please note that these sections do not correspond directly to how the TMDLs were developed. See Section 4 for more details.

Figure 2-2. Water quality sampling stations along the Wabash River.

2.3.1 *E. coli*

The *E.coli* data are summarized in Appendix A and indicate that most stations in the Upper Wabash River are impaired whereas approximately half the stations in the middle and lower Wabash River are impaired. Although median *E.coli* concentrations generally decrease from upstream to downstream, many downstream stations still exceed water quality standards and, based on the available data, it is likely that many non-sampled areas of the river also exceed water quality standards. Furthermore, sources of *E. coli* are pervasive and a holistic approach will be needed to correct the problem. Based on these considerations and after discussions among IDEM, IEPA, and USEPA, *E. coli* TMDLs were developed for all segments of the Wabash River from the Ohio state line to its confluence with the Ohio River.

2.3.2 Fecal Coliform

The available fecal coliform data are summarized in Appendix B and are limited to the samples collected by IEPA at their long-term monitoring station at Hutsonville, Illinois. Although insufficient data are available to make a direct comparison to the geometric mean component of the standard, approximately 30 percent of the samples have exceeded the 200 cfu/100 mL standard.

The fecal coliform data were also compared to the guidelines described in Section 2.2.3.1. Fecal coliform data collected from May through October over the most recent five-year sampling period were used for the assessment. The geometric mean is less than 200 cfu/100. However, 25 percent of the fecal coliform samples exceed 400 cfu/100 mL. IEPA station B-06 is therefore considered to be only partially supporting its primary contact use support and a TMDL is needed.

2.3.3 Nutrients/Organic Enrichment/Low DO/Excessive Algal Growth

The available nutrient data are summarized in Appendix C (total phosphorus), D (nitrate+nitrite), E (dissolved oxygen) and F (pH). Median TP concentrations slightly decrease from upstream to downstream with median concentrations generally less than Indiana's 0.30 mg/L TP benchmark; however, numerous stations have significant numbers of samples that exceed the benchmark.

Although maximum nitrate + nitrite concentrations exceed Indiana's 10 mg/L benchmark at most Wabash River stations, median concentrations are normally less than 5 mg/L. Median concentrations change slightly from upstream to downstream with concentrations at the upper and lower Wabash River stations slightly less than concentrations at the middle Wabash River stations. Nitrate + nitrite concentrations in the middle Wabash River also show more variability in median concentrations than stations in the upper and lower segments.

Median dissolved oxygen concentrations fluctuate between 8 mg/L and 11 mg/L along all monitored Wabash River segments. Only a few stations violate the minimum 4.0 mg/L dissolved oxygen requirement[2], whereas the 12.0 mg/L maximum benchmark is frequently exceeded at the majority of stations.

Median pH values are generally around 8.00 along the entire Wabash River with slightly higher values in the middle Wabash River stations. The middle Wabash River stations also show greater variability in median pH values and exceed the 9 maximum benchmark more frequently than stations in the upper and lower segments. The 6 minimum pH benchmark is only violated once at station WLW040-0003 in the lower Wabash River.

[2] It should be noted that few dissolved oxygen samples are available for the pre-dawn hours when dissolved oxygen is normally expected to be at a minimum due to algal respiration and lack of sunlight to stimulate photosynthesis.

The data were compared to Indiana's benchmarks identified in Section 2.2.2.2 to determine the impairment status for each station for each parameter. A station had to exhibit at least 5 percent exceedances of a benchmark parameter to be considered impaired for that parameter. The results are summarized in Table 2-6 through Table 2-8. Most stations are impaired due to phosphorus and either dissolved oxygen or nitrite + nitrate. The segments corresponding to the stations highlighted in the tables are displayed graphically in Figure 2-3 and show that most segments are upstream of the Indiana/Illinois border (in the Upper and Middle Wabash River segments). Based on this and discussions with IDEM, IEPA, and USEPA, nutrient TMDLs were only developed for the Wabash River upstream of the Vermilion River. Similar to the *E. coli* and fecal coliform TMDLs, the nutrient TMDLs were developed to address all of the Wabash River segments upstream of the Vermilion River rather than taking a segment-by-segment approach. This is because of the likelihood that segments that have not been monitored are impaired, as well as the need to take a holistic approach to the problem.

Table 2-6. Upper Wabash River Nutrient Impairment Matrix.

StationID	TP	NO2+NO3	DO	pH	Impaired?
WLV010-0011					No
WUW140-0005					No
WUW140-0001	X	X	X		Yes
WUW090-0001	X	X	X		Yes
WUW090-0002					No
WUW090-0012	X				No
WUW090-0007	X	X			Yes
WUW090-0004					No
WUW150-0007					No
WUW070-0002	X	X	X		Yes
WUW070-0007			X		No
WUW070-0006					No
WUW150-0001					No
WUW070-0003					No
WUW180-0007					No
WDE010-0003					No
WDE010-0001			X		No
WUW070-0005					No
WUW160-0001			X		No
WUW160-0006	X		X		Yes
WUW180-0002					No
WDE010-0007	X		X		Yes
WUW070-0004					No
WDE020-0007					No
WDE030-0008	X				No
WUW060-0001			X		No
WDE030-0003					No
WUW060-0007	X	X			Yes
WUW060-0002	X	X	X		Yes
WDE030-0007	X				No
WDE030-0009					No
WDE030-0001					No
WUW040-0001			X		No
WUW040-0002					No
WUW040-0005	X	X			Yes
WDE060-0001	X		X		Yes

Table 2-7. Middle Wabash Nutrient Impairment Matrix.

StationID	TP	NO2+NO3	DO	pH	Impaired?
WDE060-0002					No
WDE070-0006	X		X		Yes
WDE070-0002					No
WLV010-0007					No
WLV010-0002					No
WLV010-0003					No
WLV030-0015					No
WLV030-0012					No
WLV030-0003	X		X		Yes
WLV030-0006	X			X	Yes
WLV030-0007					No
WLV030-0001	X				No
WLV070-0001	X			X	Yes
WLV080-0003	X		X		Yes
WLV080-0009	X			X	Yes
WBU040-0003					No
WBU040-0011	X		X		Yes
WBU040-0001			X		No
WLV090-0006			X		No
WLV090-0001					No
WBU050-0010					No
WLV200-0001	X		X		Yes
WBU040-0002			X		No
WLV080-0002					No
WLV080-0005			X	X	Yes
WLV090-0003	X			X	Yes
WLV140-0001	X		X		Yes
WBU050-0001					No
WLV080-0001				X	No
WLV080-0004					No
WBU040-0012					No
WLV150-0001	X		X		Yes
WBU200-0008	X				No
WBU070-0001	X				No

Table 2-8. Lower Wabash River Nutrient Impairment Matrix.

StationID	TP	NO2+NO3	DO	pH	Impaired?
WBU150-0002	X				No
WBU100-0001			X		No
WBU200-0004			X		No
WLW010-0001					No
WLW100-0004					No
WLW040-0003			X		No
WLW080-0004	X				No
WBU200-0003	X		X		Yes
WLW080-0003					No
WLW040-0001					No
WLW100-0001					No
WLW080-0001	X				No
WLW060-0003	X			X	Yes
WLV010-0006					No

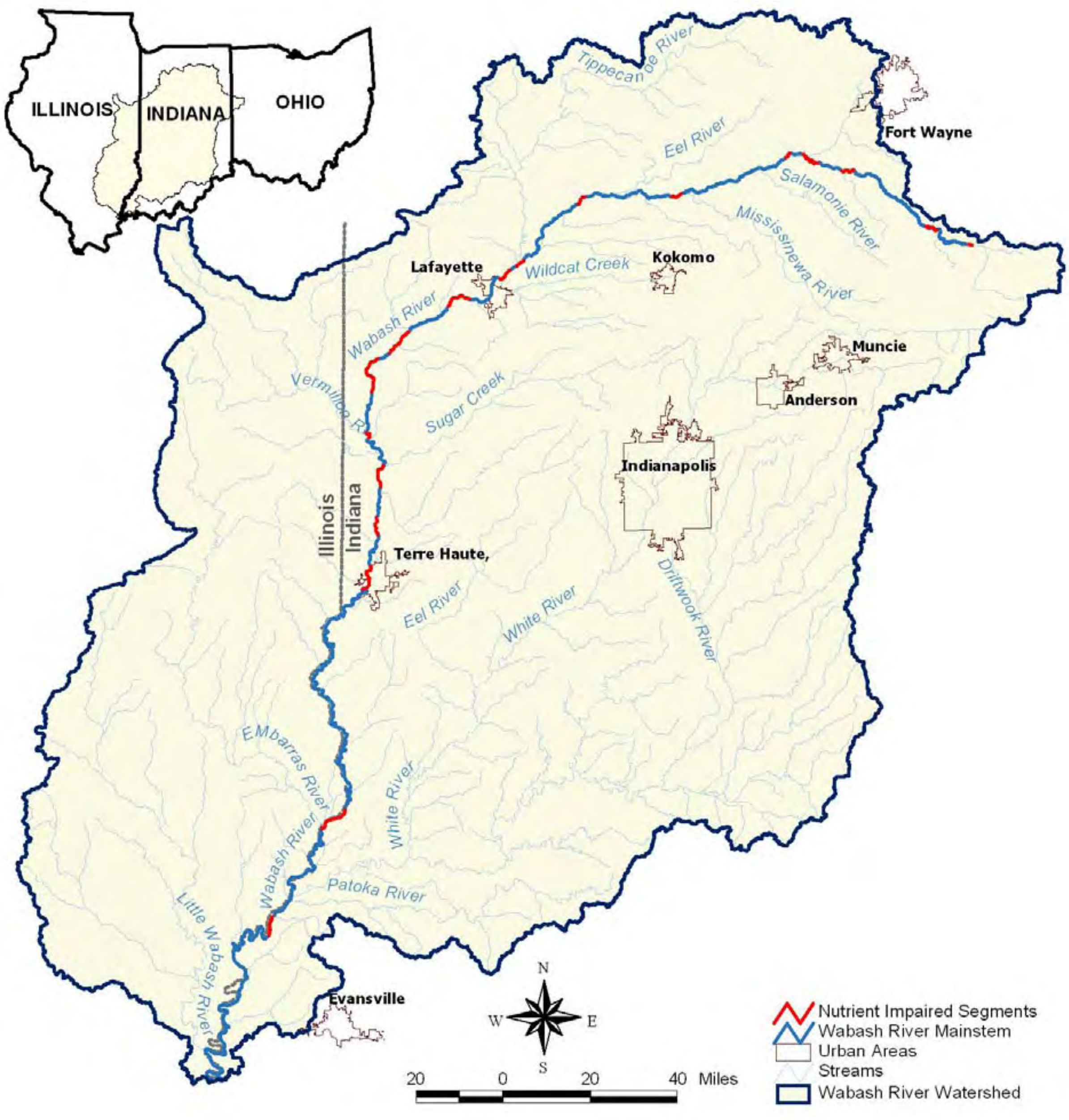

Figure 2-3. Verified nutrient impaired segments.

2.4 Sources

A variety of different types of sources contribute pollutants to the Wabash River. Due to the extremely large size of the watershed it was beyond the scope of this study to evaluate each of these sources individually. Instead, existing loads and load allocations were made to the following three source categories:

1) National Pollutant Discharge Elimination System (NPDES) facilities that discharge directly to the Wabash River
2) Subwatersheds draining directly to the Wabash River

3) The following significant tributaries to the Wabash River:
   a) Deer Creek
   b) Eel River
   c) Embarras River
   d) Little Vermilion River
   e) Little Wabash River
   f) Mississinewa River
   g) Patoka River
   h) Pipe Creek
   i) Salamonie River
   j) Sugar Creek
   k) Tippecanoe River
   l) Vermilion River
   m) White River
   n) Wildcat Creek

These three source categories are described in more detail below.

2.4.1 National Pollutant Discharge Elimination System (NPDES) Facilities that Discharge Directly to the Wabash River

Loads from the twenty NPDES facilities shown in Table 2-9 were directly added to the model (see Section 3 for a description of the modeling). Other facilities that discharge to the Wabash River were not used in the RIV1 modeling because of their small average flows (less than 1 cubic feet per second (cfs)).

A number of the facilities shown in Table 2-9 are industrial facilities or power plants and are therefore not significant sources of nutrients or pathogens. In addition, all of the wastewater facilities with design flows greater than 1 million gallons per day (MGD) have permit limits for *E. coli* and therefore they are not considered significant sources of pathogens. However, none of the facilities have permit limits for nitrate or total phosphorus and therefore they might be significant sources of these pollutants, especially during certain periods of the year (see Section 4.3 for further discussion).

Table 2-9. NPDES facilities discharging directly to the Wabash River.

NPDES	Facility Name	Design Flow (million gallons per day (MGD))
IN0001210	ALUMINUM CO. OF AM. (ALCOA)	0.920
IL0004120	AMEREN ENERGY-HUTSONVILLE	90.080
IN0022411	BLUFFTON UTILITIES	2.600
IN0022608	CLINTON MUNICIPAL STP	2.500
IN0002348	HARRISON STEEL CASTINGS CO.	2.570
IN0003026	INTERNATIONAL PAPER CO.	1.060
IN0054810	JEFFERSON SMURFITT CORP. (JSC/	2.000
IN0032468	LAFAYETTE MUNICIPAL WWTP	16.000
IN0023604	LOGANSPORT WWTP	9.000
IN0001074	LXP-SEC I, LLC	1.856
IL0030023	MOUNT CARMEL STP	2.000
IN0041092	NORTH KNOX WEST ELEM. SCHOOL	0.005
IN0032328	PERU MUNICIPAL STP	8.000
IN0044130	PERU POWER PLANT, PERU UTILITY	15.600
IN0036447	PREMIER BOXBOARD LIMITED LLC	1.700
IN0002763	PSI CAYUGA GENERATING STATION	506.100
IN0002810	PSI WABASH RIVER GEN. STATION	355.000
IN0003328	WABASH ENVIRONMENTAL TECH. LLC	1.100
IN0024741	WABASH MUNICIPAL STP	4.000
IN0024821	WEST LAFAYETTE MUNICIPAL STP	9.000

2.4.2 Combined Sewer Overflows

There are also 13 combined sewer system communities located along the Wabash River that are potential sources of both nutrients and pathogens:

- Attica
- Berne
- Bluffton
- Clinton
- Huntington
- Lafayette
- Logansport
- Markle
- Mt Vernon
- Peru
- Terre Haute
- West Lafayette
- Wabash

Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater into the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies. These overflows, called combined sewer overflows (CSOs), can contain both storm water and untreated human and industrial waste. Because they are associated with wet weather events, CSOs typically discharge for short periods of time at random intervals.

2.4.3 Storm Water Phase II Communities

Storm water runoff can contribute *E. coli*, nutrients, and other pollutants to a waterbody. Material can collect on streets, rooftops, parking lots, sidewalks, yards and parks and then during a precipitation event this material can be flushed into gutters, drains, and culverts and be discharged into a waterbody.

USEPA developed rules in 1990 that established Phase I of the NPDES storm water program. The purpose of this program is to prevent harmful pollutants from being washed by storm water runoff into Municipal Separate Storm Sewer Systems (MS4s) (or from being dumped directly into the MS4) and then discharged into local waterbodies. Phase I of the program required that operators of medium and large MS4s (those generally serving populations of 100,000 or greater) implement a storm water management program as a means to control polluted discharges from MS4s. Only the City of Indianapolis met Phase I criteria within the State of Indiana.

Under Phase II, rules have been developed to regulate most MS4 entities (cities, towns, universities, colleges, correctional facilities, hospitals, conservancy districts, homeowner's associations and military bases) located within mapped urbanized areas, as delineated by the U.S. Census Bureau, or, for those MS4 areas outside of urbanized areas, serving an urban population greater than 7,000 people. The following entities located along the Wabash River fall under the Phase II guidelines: Huntington, Wabash, Peru, Lafayette, Terre Haute, Vincennes, and Logansport.

Operators of Phase II-designated small MS4s are required to apply for NPDES permit coverage and to implement storm water discharge management controls (known as “best management practices” (BMPs)). The loading of *E. coli* and nutrients to the Wabash River from the urban storm water sources listed above are included in the estimates of loads for subwatersheds draining directly to the Wabash River. All other MS4s within the Wabash River watershed are included with the loads for each of the relevant tributaries.

2.4.4 Confined Feeding Operations and Concentrated Animal Feeding Operations

The removal and disposal of the manure, litter, or processed wastewater that is generated as the result of confined feeding operations falls under the regulations for confined feeding operations (CFOs) and concentrated animal feeding operations (CAFOs). Based upon a geographic information system (GIS) analysis, there is only one CAFO within 2000 feet of the Wabash River. The CFO and CAFO regulations (327 IAC 16, 327 IAC 15) require operations “not cause or contribute to an impairment of surface waters of the state.” The one CAFO within 2000 feet of the Wabash River is not considered a large source of pollutants to the river. However, there are numerous CAFOs within the larger Wabash River watershed that are likely significant sources. Loads from these operations are included in this report for each of the relevant tributaries or subwatersheds draining directly to the Wabash River.

2.4.5 Significant Tributaries and Subwatersheds Draining Directly to the Wabash River

During this study most pollutant sources to the Wabash River were lumped into the following two categories: (1) significant Wabash River tributaries and (2) subwatersheds draining directly to the Wabash River. No further analysis was conducted to further evaluate the specific pollutant sources within each drainage area or tributary. However, the nature of these sources can be assessed based upon the available land use/land cover data shown in Table 2-10. It is apparent from this table that agriculture is the dominant land use/land cover within the watershed and therefore sources associated with agricultural activities are likely significant (e.g., sheet/rill erosion from fields, tile drainage, animal operations, fertilizer applications, failing or illicitly connected onsite wastewater systems). Sources associated with the urban land use/land cover in the watershed are likely to include storm water runoff (including lawn fertilizer applications, and pet waste), centralized and onsite wastewater treatment, and CSOs/SSOs. Sources associated with forest/woodland areas may include wildlife, especially animals that spend time in or around waterbodies such as deer, geese, ducks, raccoons, etc.

Table 2-10. Land use/land cover data for the Wabash River watershed.

Tributary	Total Area (sq. miles)	Urban	Agricultural	Forest/Woodland	Other
Deer Creek	300	0.7%	97%	1.3%	1.0%
Eel River	801	0.9%	88%	8.7%	2.8%
Embarras River	2,434	2.1%	83%	12.1%	3.2%
Little Vermilion River	251	2.4%	88%	7.8%	1.5%
Little Wabash River	3,202	1.7%	78%	14.9%	5.2%
Mississinewa River	805	1.9%	89%	6.8%	2.1%
Patoka River	824	1.9%	53%	41.0%	4.0%
Pipe Creek	194	1.7%	95%	2.3%	0.8%
Salamonie River	553	0.5%	90%	7.3%	2.0%
Sugar Creek	798	0.7%	89%	9.7%	0.9%
Tippecanoe River	1,907	1.2%	89%	6.2%	4.0%
Vermilion River	1,431	4.9%	89%	3.7%	2.4%
White River	11,090	3.7%	67%	27.4%	1.6%
Wildcat Creek	787	2.4%	94%	2.0%	1.3%
Subwatersheds Draining Directly to the Wabash River	7,023	2.1%	82%	13.2%	3.0%
Total	32,400	2.6%	78%	17.1%	2.6%

3 TECHNICAL APPROACH

The Wabash River nutrient and pathogen TMDLs were developed using the CE-QUAL-RIV1 (or RIV1) model for the Wabash River main stem combined with observed and statistical estimates of tributary pollutant loads. As discussed previously this approach allowed for a detailed analysis of spatial and temporal trends within the Wabash River main stem and facilitated making allocations to three general source categories:

1) National Pollutant Discharge Elimination System (NPDES) facilities that discharge directly to the Wabash River
2) Subwatersheds draining directly to the Wabash River
3) Significant Wabash River tributaries.

3.1 In-stream Model Selection

The RIV1 model is composed of two sub-models: a hydrodynamic model (RIV1H) and a water quality model (RIV1Q). RIV1H predicts flows, depths, velocities, water surface elevations and other hydraulic characteristics. The hydrodynamic model solves the St. Venant equations as the governing flow equations using the widely accepted four-point implicit finite difference numerical scheme. The results of the RIV1H model are input into the water quality model, RIV1Q, which can predict twelve separate state variables: temperature, carbonaceous biochemical oxygen demand (CBOD), organic nitrogen, ammonia nitrogen, nitrate + nitrite nitrogen, dissolved oxygen, organic phosphorus, dissolved phosphorus, algae, dissolved iron, dissolved manganese, and coliform bacteria.

The primary reasons for using RIV1 for the Wabash River nutrient and pathogen TMDLs over other potential models were:

- Since RIV1 uses continuity and momentum equations, backwater effects that are significant in the Wabash River can be addressed.
- RIV1 can directly evaluate the impacts of point sources because the model can be segmented to provide output directly downstream of the significant point sources.
- The additional spatial resolution (i.e., simulating water quality in two or three dimensions) provided by models such as the Environmental Fluid Dynamics Code (EFDC) and the Water Quality Analysis Simulation Program (WASP) is unnecessary for this project and would require additional resources.

3.2 Derivation of Tributary Flows and Water Quality

RIV1 is not a watershed model and therefore cannot independently estimate flows and pollutant loads associated with tributary inputs and direct runoff. Instead, flows and water quality concentrations from tributaries and direct nonpoint source runoff were input to RIV1 based on a combination of observed data and statistical estimates.

Flows for ungaged tributaries were estimated based on gaged tributaries using a unit-area approach. Where observed water quality data were not available, estimates were made based on regressions between observed flow, observed water quality, and watershed characteristics (soil type, land uses, and slopes). In this way the individual characteristics of each subwatershed were used to estimate the likely pollutant loads. Additional details of this process are provided in Appendix H.

3.3 Model Calibration

Calibration of RIV1 followed a sequential, hierarchical process that began with hydrology, followed by temperature (to support the modeling of other parameters), and, finally: nitrate, total phosphorus, dissolved oxygen, *E. coli*, and chlorophyll *a*. Fecal coliform was not explicitly modeled but was instead estimated based on the ratio between the geometric mean components of the standards (i.e., fecal coliform = 200/125 = 1.6 X *E. coli*). USEPA's *Ambient Water Quality Criteria for Bacteria* (USEPA, 1986) suggests that a fecal coliform count of 200 cfu/100 mL and an *E. coli* count of 125 cfu/100 mL are similar in that they would both cause approximately 8 illnesses per 1000 swimmers in fresh waters. Although there is some uncertainty associated with this approach, it was determined to be appropriate based on the available information and scope of the study.

Hydrologic calibration for the Wabash River relied on comparison of model predictions to observations at the following five locations (Figure 3-1):

- USGS gage 03322900 Wabash River at Linn Grove, Indiana
- US Army Corps of Engineers gage for inflow to J. Edward Roush Lake
- USGS gage 03325000 Wabash River at Wabash, Indiana
- USGS gage 03341500 Wabash River at Terre Haute, Indiana
- USGS gage 03377500 Wabash River at Mt. Carmel, Illinois

Water quality was calibrated at the following five locations (Figure 3-1):

- IDEM site WUW060-0002 at US 27 in Geneva, Indiana
- IDEM site WUW070-0002 at SR 3 Bridge in Markle, Indiana
- IDEM site WLV030-0003 at CR 700 W near Lafayette, Indiana
- IDEM site WBU100-0001 at Fairbanks, Indiana
- IEPA site B-06 at Hutsonville, Illinois

The hydrologic calibration indicates acceptable agreement between observed and simulated streamflows. For example, model error for total observed flow volumes compared to total predicted flow volumes ranged from 3 to 18 percent (depending on location) and the R-square for observed and predicted monthly flows ranged from 0.85 to 0.89. Full calibration statistics are presented in Appendix H.

Insufficient observed data were available to conduct a statistical analysis of the water quality calibration results. Instead, the water quality calibration relied primarily on a visual inspection of modeled compared to observed data. In general the model attained a good fit to observations, with some discrepancies for individual parameters at individual locations. Temperature, nutrients, dissolved oxygen, and chlorophyll *a* are calibrated somewhat better than *E. coli*, which is not unusual because observed pathogen concentrations tend to be highly variable in both space and time (due to both natural variability and analytical uncertainty). The quality of fit is sufficiently good that the model is judged ready for application to management scenarios and TMDL development. Details of the calibration process and results are presented in Appendix H.

Figure 3-1. Location of RIV1 hydrologic and water quality calibration locations.

4 TMDL

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:

$$TMDL = WLA + LA + MOS$$

To develop TMDLs for each of the listed Wabash River segments, the following approach was taken:

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

Water quality standards were assessed at the following representative locations to facilitate the allocation process and the presentation of the results:

- Wabash River at inflow to J. Edward Roush Lake
- Wabash River at confluence with Vermilion River
- Wabash River upstream of Lafayette
- Wabash River at Illinois/Indiana state line
- Wabash River at Hutsonville
- Wabash River at confluence with Ohio River

4.1 Baseline Conditions

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, permitted point source discharge conditions, and the achievement of water quality standards at the Ohio/Indiana state line. The baseline condition allows for an evaluation of in-stream water quality under the “worst currently allowable” scenario. The following specific assumptions were made:

- Loads for the NPDES facilities in the watershed were simulated as discharging daily at their design flows and at the maximum of their permit limits (e.g., *E. coli* equal to 125 cfu/100 mL).
- Nitrate and total phosphorus concentrations from the NPDES facilities were left at existing concentrations since none of the facilities have permit limits for these parameters.
- Loads from combined sewer overflows were assumed equal to existing flows and concentrations at water quality standards. The combined sewer overflow allocations will be better refined in each city’s Long-Term Control Plan.

4.2 Loading Capacity

Simulation of baseline conditions provided the basis for evaluating stream response to variations in source contributions. The simulations revealed that the major sources of *E. coli*, total, phosphorus, and nitrates differed slightly by location but in general were the larger tributaries. These results facilitated developing an effective allocation strategy.

A top-down methodology was followed to develop the TMDLs and allocate loads to sources. Loads were first reduced in the Wabash River from the Ohio state line to J. Edward Roush Lake because this upstream location had an effect on downstream water quality. Loads were reduced from each tributary and direct drainage area until water quality standards were achieved. Loads were only reduced from NPDES facilities if they represented a large proportion of the existing loads and water quality standards could not be met with reasonable tributary or direct drainage reductions. Once water quality standards were met at the upstream location, the model results were then routed through to downstream waterbodies. Therefore, when TMDLs were developed for downstream impaired waterbodies, upstream loads were representing conditions meeting water quality standards.

The loading capacities resulting from this process are presented by month for each of the six assessment locations in Table 4-1 to Table 4-15 and the load reductions needed for each significant tributary are summarized in Table 4-16. All loads in Table 4-1 to Table 4-15 as well as in Appendix I represent the critical daily load within each month for the time period that the RIV1 model was run (2001 to 2003).

Table 4-1. Summarized *E. coli* TMDL for the Wabash River at J. Edward Roush Lake.

Month	Existing Daily Loads (#/day)		Total Maximum Daily Load (#/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	7.51E+08	4.55E+13	N/A	N/A	N/A	N/A	N/A
February	1.37E+09	1.53E+14	N/A	N/A	N/A	N/A	N/A
March	1.97E+09	1.92E+14	N/A	N/A	N/A	N/A	N/A
April	1.81E+09	2.92E+13	1.23E+10	1.53E+12	8.12E+10	0	95
May	1.66E+09	6.02E+14	1.23E+10	3.12E+13	1.64E+12	0	95
June	8.12E+08	6.77E+12	1.23E+10	3.56E+11	1.94E+10	0	95
July	9.31E+08	3.05E+13	1.23E+10	1.76E+12	9.33E+10	0	94
August	1.37E+09	5.36E+12	1.23E+10	2.57E+11	1.42E+10	0	95
September	8.10E+08	1.77E+13	1.23E+10	1.05E+12	5.61E+10	0	94
October	1.99E+09	6.68E+13	1.23E+10	3.50E+12	1.85E+11	0	95
November	7.06E+08	4.90E+12	N/A	N/A	N/A	N/A	N/A
December	1.44E+09	1.21E+14	N/A	N/A	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Table 4-2. Summarized Total Phosphorus TMDL for the Wabash River at J. Edward Roush Lake.

Month	Existing Daily Loads (kg/day)		Total Maximum Daily Load (kg/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	1	201	10	174	10	0	14
February	1	1,397	10	1,100	58	0	21
March	1	1,546	10	1,227	65	0	21
April	1	1,508	10	1,205	64	0	20
May	1	3,200	10	2,589	137	0	19
June	1	197	10	163	9	0	17
July	1	1,316	10	1,125	60	0	15
August	1	238	10	183	10	0	23
September	1	1,916	10	1,681	89	0	12
October	1	1,746	10	1,438	76	0	18
November	1	907	10	757	40	0	17
December	1	1,456	10	1,214	64	0	17

Table 4-3. Summarized Nitrate TMDL for the Wabash River at J. Edward Roush Lake.

Month	Existing Daily Loads (kg/day)		Total Maximum Daily Load (kg/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	30	19,000	30	19,000	1,002	0	0
February	42	47,320	42	47,320	2,493	0	0
March	62	60,530	62	60,530	3,188	0	0
April	59	86,320	59	86,320	4,546	0	0
May	55	133,500	55	133,500	7,028	0	0
June	47	20,500	47	20,500	1,081	0	0
July	45	82,100	45	82,100	4,323	0	0
August	68	8,048	68	8,048	426	0	0
September	41	46,220	41	46,220	2,435	0	0
October	57	25,260	57	25,260	1,332	0	0
November	27	12,490	27	12,490	660	0	0
December	42	40,700	42	40,700	2,144	0	0

Table 4-4. Summarized *E. coli* TMDL for the Wabash River upstream of Lafayette.

Month	Existing Daily Loads (#/day)		Total Maximum Daily Load (#/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	2.29E+10	4.18E+14	N/A	N/A	N/A	N/A	N/A
February	4.07E+10	6.29E+14	N/A	N/A	N/A	N/A	N/A
March	5.18E+10	1.20E+15	N/A	N/A	N/A	N/A	N/A
April	5.32E+10	9.84E+14	1.95E+11	1.20E+14	6.33E+12	0	88
May	5.31E+10	3.26E+15	1.95E+11	3.81E+14	2.01E+13	0	88
June	2.22E+10	1.73E+14	1.95E+11	2.20E+13	1.17E+12	0	87
July	3.04E+10	6.15E+14	1.95E+11	7.79E+13	4.11E+12	0	87
August	3.71E+10	1.03E+14	1.95E+11	1.29E+13	6.91E+11	0	87
September	4.04E+10	1.49E+13	1.95E+11	1.92E+12	1.11E+11	0	87
October	5.49E+10	6.11E+14	1.95E+11	7.45E+13	3.93E+12	0	88
November	5.75E+10	1.38E+14	N/A	N/A	N/A	N/A	N/A
December	4.86E+10	9.36E+14	N/A	N/A	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Table 4-5. Summarized Total Phosphorus TMDL for the Wabash River upstream of Lafayette.

Month	Existing Daily Loads (kg/day)		Total Maximum Daily Load (kg/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)[1]	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	289	5,384	156	5,149	279	46	4
February	371	14,000	156	13,400	714	58	4
March	322	7,359	156	7,038	379	51	4
April	535	12,730	156	11,980	639	71	6
May	518	22,130	156	20,760	1,101	70	6
June	445	1,327	156	1,262	75	65	5
July	447	22,810	156	21,570	1,144	65	5
August	363	3,272	156	3,137	173	57	4
September	332	1,154	156	1,105	66	53	4
October	464	13,540	156	12,770	680	66	6
November	488	2,578	156	2,465	138	68	4
December	420	16,290	156	15,570	828	63	4

Table 4-6. Summarized Nitrate TMDL for the Wabash River upstream of Lafayette.

Month	Existing Daily Loads (kg/day)		Total Maximum Daily Load (kg/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	474	146,100	862	146,100	7,733	0	0
February	624	528,800	862	528,800	27,880	0	0
March	661	422,600	862	422,600	22,290	0	0
April	718	380,800	862	380,800	20,090	0	0
May	733	822,900	862	822,900	43,350	0	0
June	478	164,900	862	164,900	8,722	0	0
July	502	987,700	862	987,700	52,030	0	0
August	648	90,500	862	90,500	4,808	0	0
September	461	21,590	862	21,590	1,182	0	0
October	506	440,000	862	440,000	23,200	0	0
November	532	106,100	862	106,100	5,628	0	0
December	596	444,900	862	444,900	23,460	0	0

Table 4-7. Summarized *E. coli* TMDL for the Wabash River at confluence with Vermilion River.

Month	Existing Daily Loads (#/day)		Total Maximum Daily Load (#/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	3.66E+10	2.57E+14	N/A	N/A	N/A	N/A	N/A
February	5.51E+10	8.72E+14	N/A	N/A	N/A	N/A	N/A
March	6.90E+10	1.56E+15	N/A	N/A	N/A	N/A	N/A
April	6.91E+10	3.77E+14	3.39E+11	4.68E+13	2.48E+12	0	88
May	7.10E+10	4.39E+15	3.39E+11	5.53E+14	2.91E+13	0	87
June	3.81E+10	3.63E+14	3.39E+11	4.71E+13	2.50E+12	0	87
July	4.83E+10	1.15E+15	3.39E+11	1.44E+14	7.60E+12	0	87
August	5.60E+10	5.53E+13	3.39E+11	7.12E+12	3.93E+11	0	87
September	5.50E+10	2.28E+13	3.39E+11	3.00E+12	1.76E+11	0	87
October	7.13E+10	7.47E+14	3.39E+11	9.46E+13	5.00E+12	0	87
November	7.41E+10	1.43E+14	N/A	N/A	N/A	N/A	N/A
December	6.34E+10	1.78E+14	N/A	N/A	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Table 4-8. Summarized Total Phosphorus TMDL for the Wabash River at confluence with Vermilion River.

Month	Existing Daily Loads (kg/day)		Total Maximum Daily Load (kg/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	867	5,838	271	5,603	309	69	4
February	9,081	14,260	271	13,650	733	97	4
March	945	4,147	271	3,948	222	71	5
April	1,310	15,500	271	14,750	791	79	5
May	1,246	20,750	271	19,650	1,048	78	5
June	930	4,837	271	4,642	259	71	4
July	1,139	25,930	271	24,700	1,314	76	5
August	1,370	2,872	271	2,739	158	80	5
September	907	722	271	694	51	70	4
October	1,117	16,000	271	15,230	816	76	5
November	1,142	3,177	271	3,058	175	76	4
December	1,022	26,030	271	24,910	1,326	73	4

Table 4-9. Summarized Nitrate TMDL for the Wabash River at confluence with Vermilion River.

Month	Existing Daily Loads (kg/day)		Total Maximum Daily Load (kg/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	1,085	109,300	1,569	109,300	5,835	0	0
February	1,263	658,700	1,569	658,700	34,750	0	0
March	1,400	531,500	1,569	531,500	28,050	0	0
April	1,406	336,400	1,569	336,400	17,790	0	0
May	1,499	1,079,000	1,569	1,079,000	56,880	0	0
June	1,052	227,500	1,569	227,500	12,050	0	0
July	1,215	970,400	1,569	970,400	51,160	0	0
August	1,430	97,300	1,569	97,300	5,204	0	0
September	1,043	13,180	1,569	13,180	776	0	0
October	1,202	502,600	1,569	502,600	26,540	0	0
November	1,242	118,400	1,569	118,400	6,313	0	0
December	1,212	522,200	1,569	522,200	27,570	0	0

Table 4-10. Summarized *E. coli* TMDL for the Wabash River at Indiana/Illinois state line.

Month	Existing Daily Loads (#/day)		Total Maximum Daily Load (#/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	3.40E+11	3.25E+14	N/A	N/A	N/A	N/A	N/A
February	3.12E+11	2.03E+15	N/A	N/A	N/A	N/A	N/A
March	3.59E+11	3.32E+14	N/A	N/A	N/A	N/A	N/A
April	3.56E+11	2.21E+15	4.45E+12	2.73E+14	1.46E+13	0	88
May	3.54E+11	1.10E+16	4.45E+12	1.36E+15	7.17E+13	0	88
June	3.77E+11	4.83E+14	4.45E+12	6.17E+13	3.48E+12	0	87
July	4.69E+11	1.61E+15	4.45E+12	2.01E+14	1.08E+13	0	88
August	4.74E+11	3.86E+13	4.45E+12	4.92E+12	4.93E+11	0	87
September	4.96E+11	1.97E+13	4.45E+12	2.55E+12	3.69E+11	0	87
October	4.43E+11	1.19E+15	4.45E+12	1.51E+14	8.20E+12	0	87
November	4.00E+11	1.71E+14	N/A	N/A	N/A	N/A	N/A
December	3.58E+11	2.59E+14	N/A	N/A	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Table 4-11. Summarized fecal coliform TMDL for the Wabash River at the Indiana/Illinois state line.

Month	Existing Daily Loads (#/day)		Total Maximum Daily Load (#/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	5.44E+11	5.20E+14	N/A	N/A	N/A	N/A	N/A
February	4.99E+11	3.25E+15	N/A	N/A	N/A	N/A	N/A
March	5.75E+11	5.32E+14	N/A	N/A	N/A	N/A	N/A
April	5.70E+11	3.53E+15	7.12E+12	4.37E+14	2.34E+13	0	88
May	5.67E+11	1.76E+16	7.12E+12	2.17E+15	1.15E+14	0	88
June	6.04E+11	7.73E+14	7.12E+12	9.88E+13	5.57E+12	0	87
July	7.50E+11	2.57E+15	7.12E+12	3.21E+14	1.73E+13	0	88
August	7.59E+11	6.18E+13	7.12E+12	7.87E+12	7.89E+11	0	87
September	7.93E+11	3.16E+13	7.12E+12	4.09E+12	5.90E+11	0	87
October	7.09E+11	1.91E+15	7.12E+12	2.42E+14	1.31E+13	0	87
November	6.40E+11	2.73E+14	N/A	N/A	N/A	N/A	N/A
December	5.72E+11	4.14E+14	N/A	N/A	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Table 4-12. Summarized *E. coli* TMDL for the Wabash River at Hutsonville.

Month	Existing Daily Loads (#/day)		Total Maximum Daily Load (#/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	3.40E+11	3.63E+14	N/A	N/A	N/A	N/A	N/A
February	3.12E+11	2.13E+15	N/A	N/A	N/A	N/A	N/A
March	3.59E+11	3.40E+14	N/A	N/A	N/A	N/A	N/A
April	3.56E+11	2.30E+15	5.31E+12	2.92E+14	1.56E+13	0	87
May	3.54E+11	1.18E+16	5.31E+12	1.52E+15	8.04E+13	0	87
June	3.77E+11	4.95E+14	5.31E+12	6.43E+13	3.66E+12	0	87
July	4.69E+11	1.65E+15	5.31E+12	2.10E+14	1.13E+13	0	87
August	4.74E+11	3.86E+13	5.31E+12	4.92E+12	5.38E+11	0	87
September	4.96E+11	2.06E+13	5.31E+12	2.73E+12	4.23E+11	0	87
October	4.43E+11	1.25E+15	5.31E+12	1.63E+14	8.87E+12	0	87
November	4.00E+11	1.72E+14	N/A	N/A	N/A	N/A	N/A
December	3.58E+11	2.62E+14	N/A	N/A	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Table 4-13. Summarized Fecal coliform TMDL for the Wabash River at Hutsonville.

Month	Existing Daily Loads (#/day)		Total Maximum Daily Load (#/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	5.44E+11	5.80E+14	N/A	N/A	N/A	N/A	N/A
February	4.99E+11	3.40E+15	N/A	N/A	N/A	N/A	N/A
March	5.75E+11	5.45E+14	N/A	N/A	N/A	N/A	N/A
April	5.70E+11	3.68E+15	8.49E+12	4.67E+14	2.50E+13	0	87
May	5.67E+11	1.88E+16	8.49E+12	2.44E+15	1.29E+14	0	87
June	6.04E+11	7.92E+14	8.49E+12	1.03E+14	5.86E+12	0	87
July	7.50E+11	2.64E+15	8.49E+12	3.36E+14	1.81E+13	0	87
August	7.59E+11	6.18E+13	8.49E+12	7.87E+12	8.61E+11	0	87
September	7.93E+11	3.29E+13	8.49E+12	4.37E+12	6.77E+11	0	87
October	7.09E+11	2.00E+15	8.49E+12	2.61E+14	1.42E+13	0	87
November	6.40E+11	2.75E+14	N/A	N/A	N/A	N/A	N/A
December	5.72E+11	4.19E+14	N/A	N/A	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Table 4-14. Summarized *E. coli* TMDL for the Wabash River at confluence with Ohio River.

Month	Existing Daily Loads (#/day)		Total Maximum Daily Load (#/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	4.05E+11	1.23E+15	N/A	N/A	N/A	N/A	N/A
February	3.15E+11	1.28E+15	N/A	N/A	N/A	N/A	N/A
March	3.26E+11	4.58E+15	N/A	N/A	N/A	N/A	N/A
April	3.64E+11	4.96E+15	5.32E+12	8.30E+14	4.40E+13	0	83
May	3.63E+11	2.04E+16	5.32E+12	3.55E+15	1.87E+14	0	83
June	3.87E+11	6.63E+14	5.32E+12	1.13E+14	6.20E+12	0	83
July	4.73E+11	8.27E+14	5.32E+12	1.18E+14	6.48E+12	0	86
August	5.01E+11	2.83E+14	5.32E+12	5.29E+13	3.06E+12	0	81
September	4.96E+11	5.84E+13	5.32E+12	1.07E+13	8.45E+11	0	82
October	4.39E+11	4.94E+15	5.32E+12	8.08E+14	4.28E+13	0	84
November	4.01E+11	1.15E+15	N/A	N/A	N/A	N/A	N/A
December	3.60E+11	4.24E+15	N/A	N/A	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Table 4-15. Summarized Fecal coliform TMDL for the Wabash River at confluence with Ohio River.

Month	Existing Daily Loads (#/day)		Total Maximum Daily Load (#/day)			Percent Reductions	
	Point Sources	Nonpoint Sources	Point Sources (WLAs)	Nonpoint Sources (LAs)	MOS	Point Sources	Nonpoint Sources
January	6.48E+11	1.97E+15	N/A	N/A	N/A	N/A	N/A
February	5.05E+11	2.04E+15	N/A	N/A	N/A	N/A	N/A
March	5.22E+11	7.32E+15	N/A	N/A	N/A	N/A	N/A
April	5.82E+11	7.93E+15	8.52E+12	1.33E+15	7.03E+13	0.00E+00	83
May	5.80E+11	3.26E+16	8.52E+12	5.68E+15	2.99E+14	0.00E+00	83
June	6.19E+11	1.06E+15	8.52E+12	1.80E+14	9.92E+12	0.00E+00	83
July	7.57E+11	1.32E+15	8.52E+12	1.88E+14	1.04E+13	0.00E+00	86
August	8.02E+11	4.53E+14	8.52E+12	8.46E+13	4.90E+12	0.00E+00	81
September	7.93E+11	9.34E+13	8.52E+12	1.72E+13	1.35E+12	0.00E+00	82
October	7.02E+11	7.90E+15	8.52E+12	1.29E+15	6.85E+13	0.00E+00	84
November	6.42E+11	1.84E+15	N/A	N/A	N/A	N/A	N/A
December	5.76E+11	6.79E+15	N/A	N/A	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Table 4-16. Load reductions (%) needed for significant Wabash River tributaries.

Location	Tributary	TP		Nitrate		*E. coli*		Fecal Coliform	
		Existing Load (lbs/yr)	% Reduction	Existing Load (lbs/yr)	% Reduction	Existing Load (#/yr)	% Reduction	Existing Load (#/yr)	% Reduction
Upstream of Lafayette	Salamonie River	8,250	4	94,460	0	1.34E+14	87	N/A	No TMDL
	Mississinewa River	38,140	4	376,450	0	3.69E+14	87	N/A	No TMDL
	Eel River	8,700	4	721,670	0	6.24E+14	87	N/A	No TMDL
	Tippecanoe River	16,020	4	751,260	0	8.43E+14	87	N/A	No TMDL
	Wildcat Creek	14,090	4	379,680	0	1.49E+15	87	N/A	No TMDL
	Deer Creek	5,850	4	403,020	0	4.05E+14	87	N/A	No TMDL
	Pipe Creek	2,040	4	247,720	0	4.51E+14	87	N/A	No TMDL
Upstream of Confluence with Vermillion River	Vermilion River	N/A	No TMDL	N/A	No TMDL	3.06E+15	88	N/A	No TMDL
	Sugar Creek	N/A	No TMDL	N/A	No TMDL	2.75E+15	88	N/A	No TMDL
	Little Vermilion River	N/A	No TMDL	N/A	No TMDL	5.35E+14	88	N/A	No TMDL
Upstream of Confluence with Ohio River	Embarras River	N/A	No TMDL	N/A	No TMDL	N/A	No TMDL	1.24E+16	80
	Little Wabash River	N/A	No TMDL	N/A	No TMDL	N/A	No TMDL	1.24E+16	80
	White River	N/A	No TMDL	N/A	No TMDL	3.35E+15	80	N/A	No TMDL
	Patoka River	N/A	No TMDL	N/A	No TMDL	8.24E+14	80	N/A	No TMDL

4.3 Wasteload Allocations (WLAs)

Individual WLAs were calculated for all NPDES permitted facilities that were included within the model and all MS4 communities that discharge directly to the Wabash River. Existing and allowable loads from the MS4 communities were based on an area-weighted approach (i.e., area of community divided by area of subwatershed multiplied by estimated subwatershed loads). All of the WLAs are presented in Appendix I. No reductions of *E. coli*, fecal coliform, or nitrate were determined to be required from the individual permitted facilities. However, reductions from the MS4 communities are the same as those estimated for the nonpoint source loads in the corresponding subwatershed where they are located.

During the allocation process it was found that the estimated total phosphorus loads from some NPDES facilities represented a large proportion of the load in the river, especially during the low flow months of June through September. For example, estimated loads from WWTPs are more than 50 percent of the low flow Wabash River loads downstream of Lafayette. The estimated WWTP loads therefore needed to be reduced to meet the in-stream 0.30 mg/L benchmark. A value of 7 mg/L was used to estimate WWTPs loads during the modeling process based on the typical range of values published in the literature: 3 to 10 mg/L (Thomann and Mueller, 1987; USEPA, 1997). This approach is appropriate based on the most recent and available information at the time the TMDL was developed. The TMDL is based upon the NPDES facilities meeting a total phosphorus limit of 1 mg/L. An effluent phosphorus concentration of 1 mg/L is a typical permit standard in areas of the United States where phosphorus limits are set (USGS, 1999). As stated in the implementation section, additional sampling is recommended for phosphorus and the TMDL strategy may be amended as new information is developed in the watershed to better account for contributing sources of the impairment and to determine where load reductions are most appropriate.

4.4 Load Allocations (LAs)

Separate LAs were specified for the larger tributaries draining directly to the Wabash River to provide information on the significance of each and to help prioritize watershed management efforts. One final LA was included for all smaller tributaries and direct drainage areas. In general, rather large (80 to 90 percent) load reductions are required for all of the tributaries for *E. coli* and fecal coliform. Only a 4 percent reduction in phosphorus loads is required and no reductions in nitrate were identified.

4.5 Margin of Safety

Section 303(d) of the Clean Water Act and EPA's regulations at 40 CFR 130.7 require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between limitations and water quality." The margin of safety can either be implicitly incorporated into conservative assumptions used to develop the TMDL or added as a separate explicit component of the TMDL (USEPA, 1991).

A five percent explicit MOS was incorporated for the TMDLs by reserving 5 percent of the loading capacity as shown in Table 4-1 to Table 4-15. A relatively low MOS was chosen because it is believed that the RIV1 model is acceptably reducing the uncertainty associated with the relationship between loads and water quality. An implicit MOS is also associated with all of the fecal coliform TMDLs in that allocations are made for the month of April, even though the water quality standard does not apply during this month. (These allocations were necessary because Indiana's *E. coli* standard does apply in April).

4.6 Seasonal Variation

A TMDL must consider seasonal variation in the derivation of the allocation. By using continuous simulation (modeling daily water quality conditions over a period of several years), seasonal variations in hydrologic conditions and source loadings were inherently taken into account. Pollutant concentrations were simulated on a daily basis and daily concentrations were compared to TMDL targets to determine allocations. Daily maximum loads were identified for each month to address the changing loading capacity associated with monthly flows and in accordance with the seasonal fecal coliform and *E. coli* water quality standards.

4.7 Critical Conditions

A TMDL must also consider critical conditions in the derivation of the allocation. The critical condition can be thought of as the "worst case" scenario of environmental conditions in the waterbody during which water quality standards must still be met. Critical conditions for nutrients in the Wabash River include both high flow periods (such as spring runoff) when nutrient loads are high, as well as low flow summer periods when the assimilative capacity of the river is reduced. Critical conditions for *E. coli* are primarily associated with high flow periods when tributary loads increase. Critical conditions were taken into account during the development of the TMDL by identifying allocations that would allow the water quality standards to be met during both low flow and high flow periods (see Appendix H for details).

5 PUBLIC PARTICIPATION

Public participation is an important and required component of the TMDL development process. The following "kickoff" public meetings were held in the watershed to discuss this project:

- October 11, 2005 in Huntington, Indiana
- October 11, 2005 in Lafayette, Indiana
- October 12, 2005 in Robinson, Illinois
- January 26, 2006 in Poseyville, Indiana
- January 31, 2006 in Bluffton, Indiana
- February 1, 2006 in Logansport, Indiana
- February 1, 2006 in Wabash, Indiana
- February 9, 2006 in Terre Haute, Indiana
- February 9, 2006 in Vincennes, Indiana

Final public meetings were held on July 11, 2006 in Huntington, Indiana, July 12, 2006 in Lafayette, Indiana, and July 12, 2006 in Hutsonville, Illinois to present the draft TMDL report. IDEM and IEPA also accepted written comments on the draft report for a period of 30 days; see Appendix K for the comments received and responses.

6 IMPLEMENTATION

Due to the size of the Wabash River watershed, it was not possible or appropriate to develop a detailed implementation plan for this TMDL. Instead, implementation plans are expected to be developed and tailored to individual tributary watersheds as needed. This section of the report therefore discusses the types of activities that will be needed to achieve the identified load reductions and the reasonable assurance that these activities will take place. Reasonable assurance activities are programs that are in place or will be in place to assist in meeting the Wabash River watershed TMDL allocations and the water quality standards.

6.1 NPDES Permitted Dischargers

For the permitted dischargers that have only total residual chlorine limits in their current permits, IDEM's TMDL program proposes that *E. coli* limits and monitoring be added when the next permit renewals are issued.

Furthermore, because the phosphorus loads from NPDES facilities had to be estimated, it is recommended that effluent monitoring be added to the wastewater treatment plant permits. Additional in-stream monitoring should also be performed. If the monitoring confirms that the wastewater treatment plant loads represent a large proportion of low flow Wabash River loads, this will need to be addressed by IDEM and the individual facilities after the sampling results are available.

There are 13 CSO communities that discharge to the Wabash River watershed. These facilities are currently in the NPDES Long Term Control Plan permitting process. This process will address any concern about CSO discharges causing or contributing to the violation of the *E. coli* or nutrient water quality standards.

6.2 Storm Water General Permit Rule 13

MS4 permits are being issued in the state of Indiana. The seven MS4 communities located along the Wabash River watershed are: Huntington, Wabash, Peru, Lafayette, Terre Haute, Vincennes, and Logansport. Once these permits, as well as all other MS4 permits in the Wabash River watershed, have been issued and implemented, they will improve the water quality in the watershed. Guidelines for MS4 permits and timelines are outlined in Indiana's Municipal Separate Storm Sewer System (MS4) Rule 13 (327 IAC 15-13-10 and 327 IAC 15-13-11). These permits will be used to address storm water impacts in the Wabash River watershed.

6.3 Confined Feeding Operations and Confined Animal Feeding Operations

CFOs and CAFOs are required to manage manure, litter, and process wastewater pollutants in a manner that does not cause or contribute to the impairment of water quality standards.

6.4 Watershed Projects

There are a number of watershed projects ongoing throughout the Wabash River watershed, including the development of a variety of watershed management plans by various entities (Appendix J). The information gathered from these plans will provide more specific information regarding the types of management efforts that are needed within each Wabash River tributary watershed. Furthermore, IDEM has Watershed Specialists assigned to different areas of the state. These Watershed Specialists are available to assist stakeholders with starting a watershed group, facilitating planning activities, and serving as a liaison between watershed planning and TMDL activities in the Wabash River watershed.

6.5 Monitoring Plan

Future monitoring of the Wabash River will take place during IDEM's five-year rotating basin schedule and/or once TMDL implementation methods are in place. Monitoring will be adjusted as needed to assist in continued source identification and elimination. IDEM will monitor at an appropriate frequency to determine if Indiana's water quality standards are being met. When these results indicate that the waterbody is meeting the water quality standards, the waterbody will then be removed from the 303(d) list.

Illinois' segment of the Wabash River includes station B-06 which is part of the state's Ambient Water Quality Monitoring Network (AWQMN) consisting of fixed stations to support surface-water data needs. Water samples are collected on a six-week sampling frequency and analyzed for a minimum of 55 universal parameters including fecal coliform.

6.6 Potential Future Activities

Nonpoint source pollution, which is the primary cause of impairments in this watershed, can be reduced by the implementation of BMPs. BMPs are practices used in agriculture, forestry, urban land development, and industry to reduce the potential for damage to natural resources from human activities. A BMP may be structural, that is, something that is built or involves changes in landforms or equipment, or it may be managerial, that is, changing a specific way of using or handling infrastructure or resources. BMPs should be selected based on the goals of a watershed management plan. Livestock owners, farmers, and urban planners can implement BMPs outside of a watershed management plan, but the success of BMPs is typically enhanced if coordinated as part of a watershed management plan. Following are examples of BMPs that may be used to reduce *E. coli* and nutrient loads:

- Riparian Area Management - Management of riparian areas protects stream banks and river banks with a buffer zone of vegetation, either grasses, legumes, or trees.
- Manure Collection and Storage - Collecting, storing, and handling manure in such a way that nutrients or bacteria do not run off into surface waters or leach down into ground water.
- Contour Row Crops - Farming with row patterns and field operations aligned at or nearly perpendicular to the slope of the land.
- Manure Nutrient Testing - If manure application is desired, sampling and chemical analysis of manure should be performed to determine nutrient content for establishing the proper manure application rate in order to avoid overapplication and run-off.
- Drift Fences - Drift fences (short fences or barriers) can be installed to direct livestock movement. A drift fence parallel to a stream keep animals out and prevents direct input of *E. coli* to the stream.
- Pet Clean-up / Education - Education programs for pet owners can improve water quality of runoff from urban areas.
- Septic Management/Public Education - Programs for management of septic systems can provide a systematic approach to reducing septic system pollution. Education on proper maintenance of septic systems as well as the need to remove illicit discharges could alleviate some anthropogenic sources of pathogens.

Additional information on several of these BMPs is provided below.

6.6.1 Vegetated Filter Strips

Vegetated filter strips are used to reduce the amount of nutrients and sediments that enter a waterbody, reduce erosion around a stream channel, and protect a waterbody from encroachment. Targeted placement of vegetated filter strips can play an important role in reducing pollutants in the watershed.

If vegetated buffers are designed correctly, they can prevent suspended solids, nitrogen, and phosphorus from entering a stream. The ability of the buffer to uptake phosphorus depends on the filter strip design, residence time of the water, and slope of the land. Suspended solids (which can transport phosphorus) are more easily removed by vegetated buffers through settling.

Pennsylvania State University (1992) estimates that the preferred filter strip width for phosphorus will remove 50–75 percent of total phosphorus. Local NRCS personnel and soil and water conservation districts should be consulted to determine the most appropriate design criteria and placement of filter strips in the Wabash River watershed.

6.6.2 Nutrient Management Plans

Nutrient management plans are often implemented to help maximize crop yields while using nutrient resources in the most efficient, environmentally sound manner. The plans help guide landowners by analyzing agricultural practices and suggesting appropriate nutrient reduction techniques. This is often done by managing the amount and timing of nutrient fertilizers on agricultural land in the watershed. Nutrient management plans are tailored for specific fields and crops. Because of this, they require site specific sampling and planning. USEPA (1993) suggests that the nutrient management plan include:

- Maps and data regarding the farm size and type of crops grown
- Realistic yield expectations based on soils and past crop yields
- Summary of the nutrient resources available
- An evaluation of field limitations and hazards
- Use of the limiting nutrient concept to apply nutrients based on realistic crop expectations
- Specific timing and application data for nutrients
- Provisions for proper calibration and operation of nutrient application equipment
- Annual reviews and monitoring

Using these plans, a landowner can apply fertilizers based on the limiting nutrient in the soils and realistic crop yields.

Limited information is available on the effectiveness of nutrient management plans to reduce loads of phosphorus. The effectiveness will vary a great deal depending on the application rate prior to implementation of the plan and site-specific factors such as crop types and soil characteristics.

Landowners/operators should contact their local soil and water conservation district to obtain information about obtaining funding.

6.6.3 Septic Systems

Septic systems provide an economically feasible way of disposing of household wastes where other means of waste treatment are unavailable (e.g., public or private treatment facilities). The basis for most septic systems involves the treatment and distribution of household wastes through a series of steps involving the following:

- A sewer line connecting the house to a septic tank
- A septic tank that allows solids to settle out of the effluent
- A distribution system that dispenses the effluent to a leach field
- A leaching system that allows the effluent to enter the soil

Septic system failure occurs when one or more components of the septic system do not work properly and untreated waste or wastewater leaves the system. The waste may pond in the leach field and ultimately run off into nearby streams or percolate into the groundwater system. Untreated septic system waste is a potential source of nutrients, organic matter, suspended solids, and bacteria. The most common reason for failure is improper maintenance. Other reasons include improper installation, location, and choice of system. Harmful household chemicals can also cause failure by killing the bacteria that digest the waste.

Many homeowners do not realize they have a failing septic system, whereas others may know, but choose not to remedy the problem because of cost. One recommendation is to initiate an outreach program to educate residents about septic systems, and, in some cases, provide funding to help fix or replace failing systems. The components of an example outreach program are illustrated below:

- Make homeowners aware of the age, location, type, capacity, and condition of their septic system.
- Teach homeowners to recognize a failing septic system.
- Teach homeowners about proper septic system maintenance.
- Provide information about different types of septic systems, and their costs, advantages, and disadvantages.
- Provide consultation and inspection services to homeowners.
- Teach homeowners about water quality concerns in their watershed.

In addition to conducting a public outreach campaign, an effort should be made to identify and repair failing systems. In some cases extremely old systems might need to be replaced. Systems located in close proximity to the Wabash River should be targeted first. This effort should be coordinated by the appropriate county health department.

Finally, an effort needs to be made to ensure that septic systems are properly maintained. Homeowners should be required to pump out or inspect their septic tanks on a regular schedule. Septic tanks should be pumped when the solids in the tank accumulate to a point where the effluent no longer has enough time to settle and clarify. The timing of the pump-out depends on the tank and household size.

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APPENDIX A: E. COLI SAMPLING DATA

Table A-1. Upper Wabash River E. coli Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum/ (MF/ 100 mL	Median (MF/ 100 mL)	Average (MF/100 mL)	Maximum (MF/ 100 mL)	CV
WLV010-0011	Canal Road	2002	2002	1	88	88.00	88	88	0
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2003	56	10	235.00	1,966	34,000	2.68
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2003	52	1	54.30	599	12,000	3.09
WUW150-0007	Sr 524 At Lagro, D/S of Salamonie Confluence	2003	2003	5	31	95.80	111	214	0.68
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2003	47	10	140.00	664	15,531	3.42
WUW070-0007	Cr 100 W, S of Sr 116	2003	2003	5	74	816.00	9,908	46,110	2.04
WUW150-0001	Wabash, U/S Side of Wabash St, Sr 15 Bridge, 7.1 Miles D/S From Salamonie River	1998	2003	10	27	83.00	451	3,700	2.53
WUW070-0003	Cr 300N Near Bluffton	1998	1998	5	140	350.00	4,882	23,000	2.08
WUW180-0007	600 E Rd. - Cass Stationary Bridge	2003	2003	6	40	147.50	407	1,733	1.62
WDE010-0003	Sr 25 Bridge (Cicott St), IN Logansport	2003	2003	5	86	805.00	892	2,419	1.07
WUW160-0001	Peru, U/S Side of Us 31 Bridge, 0.5 Miles Sw of Peru	2003	2003	5	23	96.00	294	1,120	1.59
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2003	66	10	240.00	1,244	22,000	2.52
WDE010-0007	Cr 675, W of Georgetown	1991	2003	62	10	145.00	1,168	16,000	2.31
WUW060-0001	Linn Grove, Sr 218 Bridge	1998	2003	19	41	658.35	7,068	57,000	2.13
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2003	4	73	1121.15	1,103	2,098	0.81
WUW060-0002	Us 27	1991	2002	45	10	440.00	950	5,600	1.2
WDE030-0009	Bridge W of Delphi - 39 - 421	2003	2003	6	46	62.05	240	727	1.23
WDE030-0001	Cr 200 N Near Delphi	1998	1998	5	36	810.00	837	1,700	0.86
WUW040-0001	State Line Rd	1998	2003	10	173	1570.00	13,214	110,000	2.58
WDE060-0001	Bridge At Americus	2001	2003	8	1	64.95	158	727	1.51

Table A-2. Upper Wabash River E. coli Violation Statistics.

Station ID	Location	Not-To-Exceed Violations	Percent Not-To-Exceed Violations	Geometric Mean Evaluations	Geometric Mean Violations	Percent Geometric Mean Violations
WLV010-0011	Canal Road	0	0%	0	0	0%
WUW140-0001	Sr 105 Bridge, N of Andrews	28	50%	2	1	50%
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	14	27%	1	0	0%
WUW150-0007	Sr 524 At Lagro, D/S of Salamonie Confluence	0	0%	1	0	0%
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	17	36%	1	1	100%
WUW070-0007	Cr 100 W, S of Sr 116	3	60%	1	1	100%
WUW150-0001	Wabash, U/S Side of Wabash St, Sr 15 Bridge, 7.1 Miles D/S From Salamonie River	1	10%	2	1	50%
WUW070-0003	Cr 300N Near Bluffton	3	60%	1	1	100%
WUW180-0007	600 E Rd. - Cass Stationary Bridge	2	33%	1	0	0%
WDE010-0003	Sr 25 Bridge (Cicott St), IN Logansport	3	60%	1	1	100%
WUW160-0001	Peru, U/S Side of Us 31 Bridge, 0.5 Miles Sw of Peru	1	20%	0	0	0%
WUW160-0006	Business Us 31 Bridge, S of Peru	32	48%	1	0	0%
WDE010-0007	Cr 675, W of Georgetown	25	40%	2	1	50%
WUW060-0001	Linn Grove, Sr 218 Bridge	16	84%	6	6	100%
WUW060-0007	At Adams Cr 300W, Ne of Geneva	3	75%	0	0	0%
WUW060-0002	Us 27	36	80%	0	0	0%
WDE030-0009	Bridge W of Delphi - 39 - 421	2	33%	2	1	50%
WDE030-0001	Cr 200 N Near Delphi	4	80%	1	1	100%
WUW040-0001	State Line Rd	8	80%	2	2	100%
WDE060-0001	Bridge At Americus	1	13%	2	0	0%

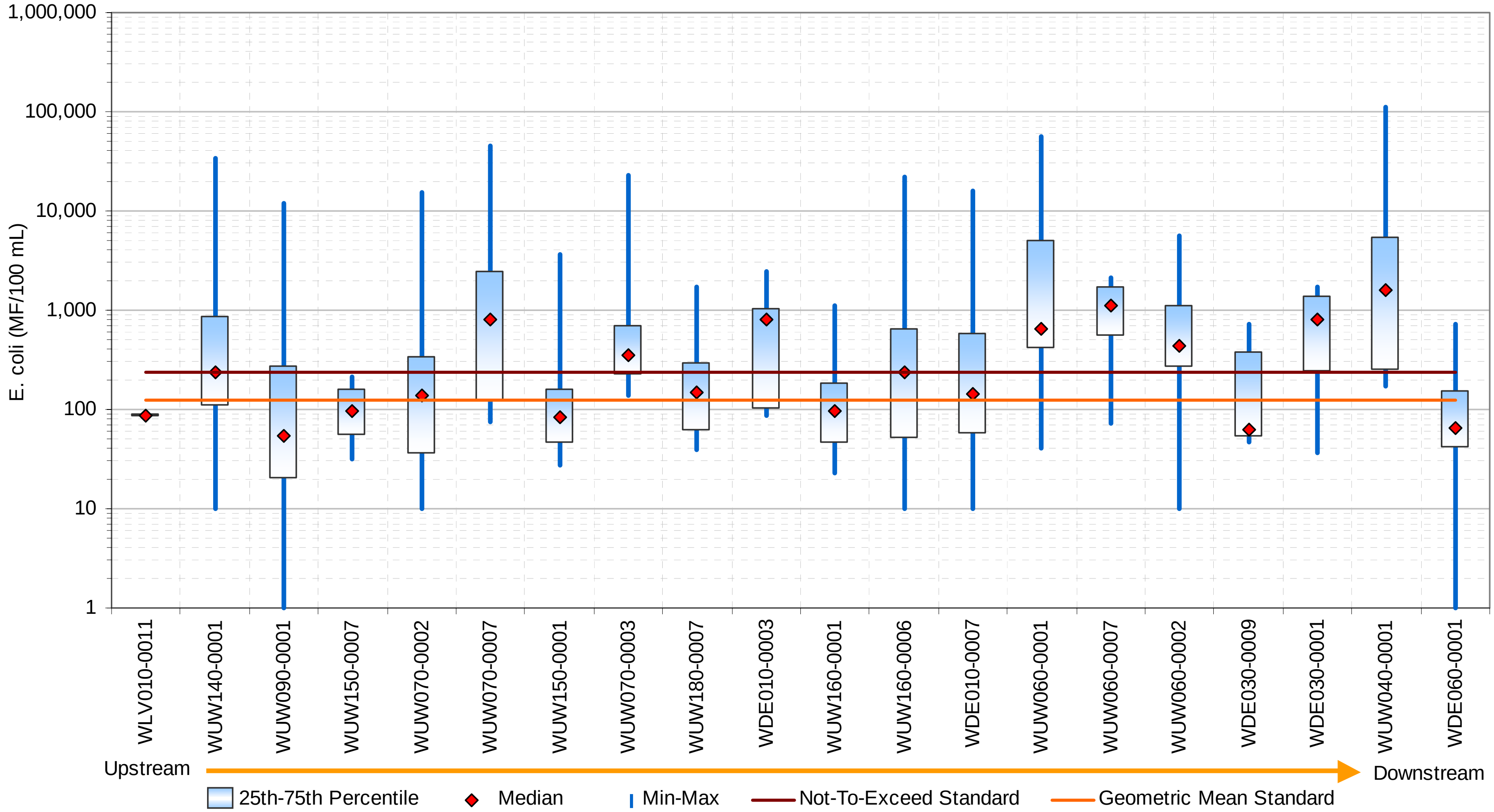


Figure A-1. Upper Wabash River E. coli box plot.

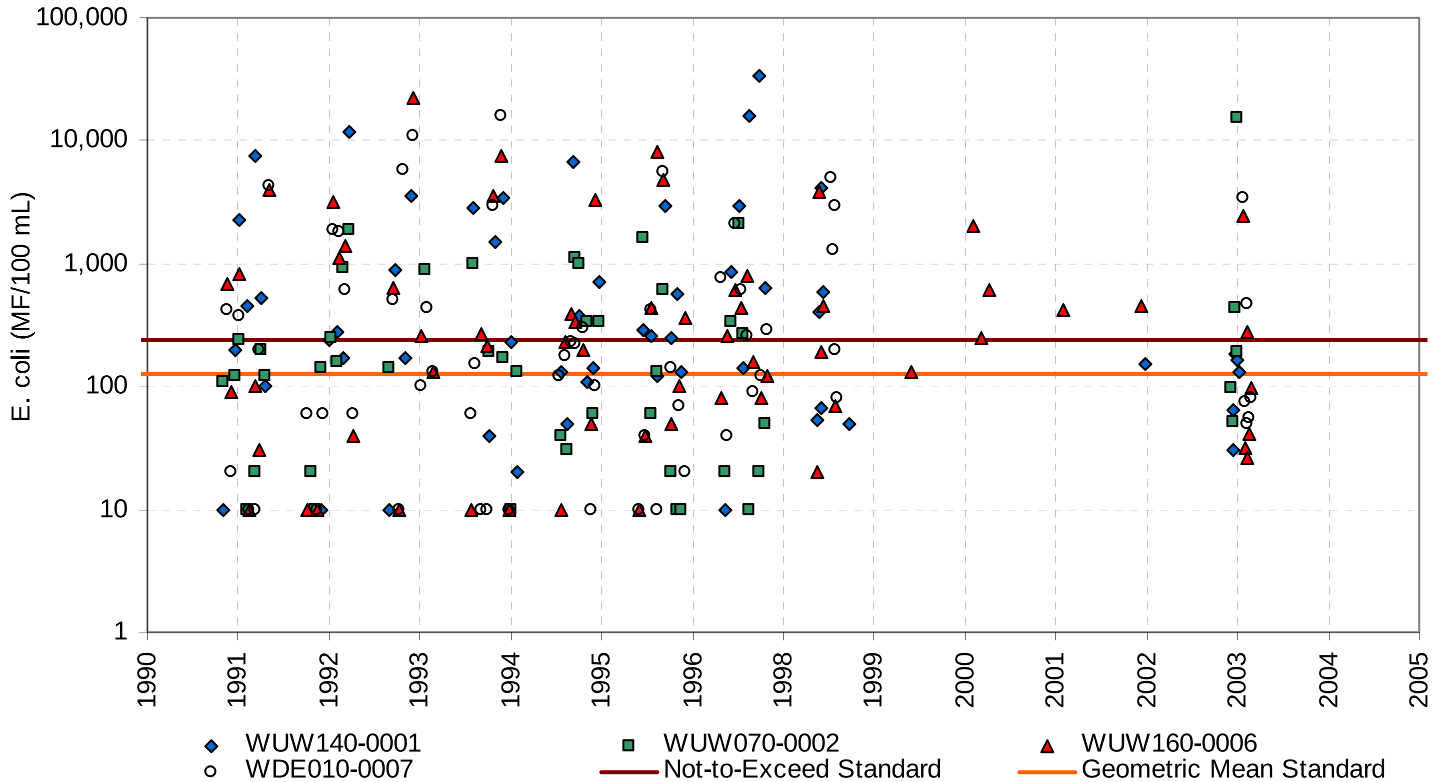


Figure A-2. Upper Wabash River E. coli scatter plot.

Table A-3. Middle Wabash River E. coli Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (MF/100 mL)	Median (MF/100 mL)	Average (MF/100 mL)	Maximum (MF/100 mL)	CV
WDE060-0002	River Junction Br	2002	2002	1	2,419	2419.17	2,419	2,419	0
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	1998	56	10	205.00	1,755	23,000	2.42
WLV010-0003	Main St (Sr 26) Bridge, IN Lafayette	2003	2003	1	387	387.30	387	387	0
WLV030-0015	Granville Bridge	2002	2002	1	128	128.00	128	128	0
WLV030-0003	Cr 700 W, Near Lafayette	1990	2001	70	10	190.00	833	13,000	2.75
WLV030-0007	Ft. Quiatenon Br	2002	2002	1	60	60.00	60	60	0
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2001	12	11	44.00	60	180	0.85
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	5	1	19.50	76	240	1.31
WLV090-0006	At Sr 32	1999	1999	5	1	3.00	8	31	1.56
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2001	61	4	60.00	701	19,000	3.82
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	6	10	70.00	113	300	1.09
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2000	61	10	90.00	319	5,600	2.54
WLV080-0004	Us 136 Bridge, Covington	1999	1999	5	4	18.75	20	33	0.65
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2000	65	1	50.00	741	15,000	3.28
WBU070-0001	Dresser Power Plant, Terre Haute	1991	1991	6	10	35.00	85	310	1.35

Table A-4. Middle Wabash River E. coli Violation Statistics.

Station ID	Location	Not-To-Exceed Violations	Percent Not-To-Exceed Violations	Geometric Mean Evaluations	Geometric Mean Violations	Percent Geometric Mean Violations
WDE070-0006	Sr 225 Near Battleground, At Lafayette	25	23%	1	1	100%
WLV010-0002	Lafayette, 20 Feet D/S From Brown St, 0.2 Miles U/S From Main St Bridge	3	10%	1	1	100%
WLV030-0003	Cr 700 W, Near Lafayette	29	17%	1	1	100%
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	0	0%	5	0	0%
WBU040-0003	Us 40 And Us 150, Terre Haute	0	0%	5	0	0%
WBU040-0011	River Near Sw Corner of American Water Company Treatment Plant, Terre Haute And Upstream of Rr Track.	0	0%	5	0	0%
WBU040-0001	Us 40 And Us 150, 134-068P	0	0%	0	0	0%
WLV090-0006	At Sr 32	0	0%	2	0	0%
WLV200-0001	Sr 163 Bridge, E Clinton	14	8%	2	0	0%
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1	9%	0	0	0%
WLV080-0005	E of Covington, On Right Approach To Old Us Hwy 136 Bridge	0	0%	1	0	0%
WLV140-0001	Sr 234 Bridge, Cayuga	15	9%	1	0	0%
WLV080-0004	Us 136 Bridge, Covington	0	0%	0	0	0%
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	0	0%	0	0	0%

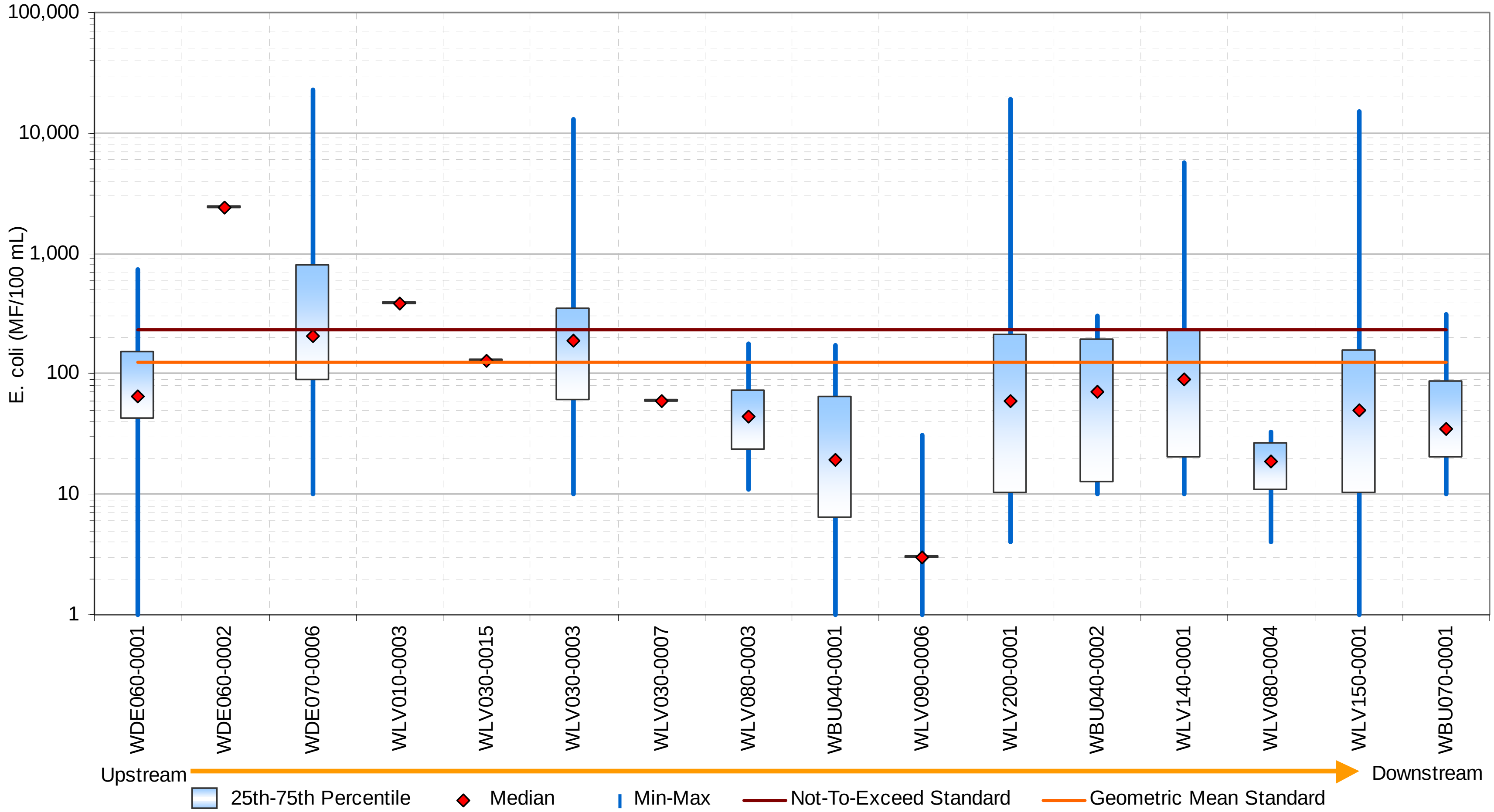


Figure A-3. Middle Wabash River E. coli sampling station box plots.

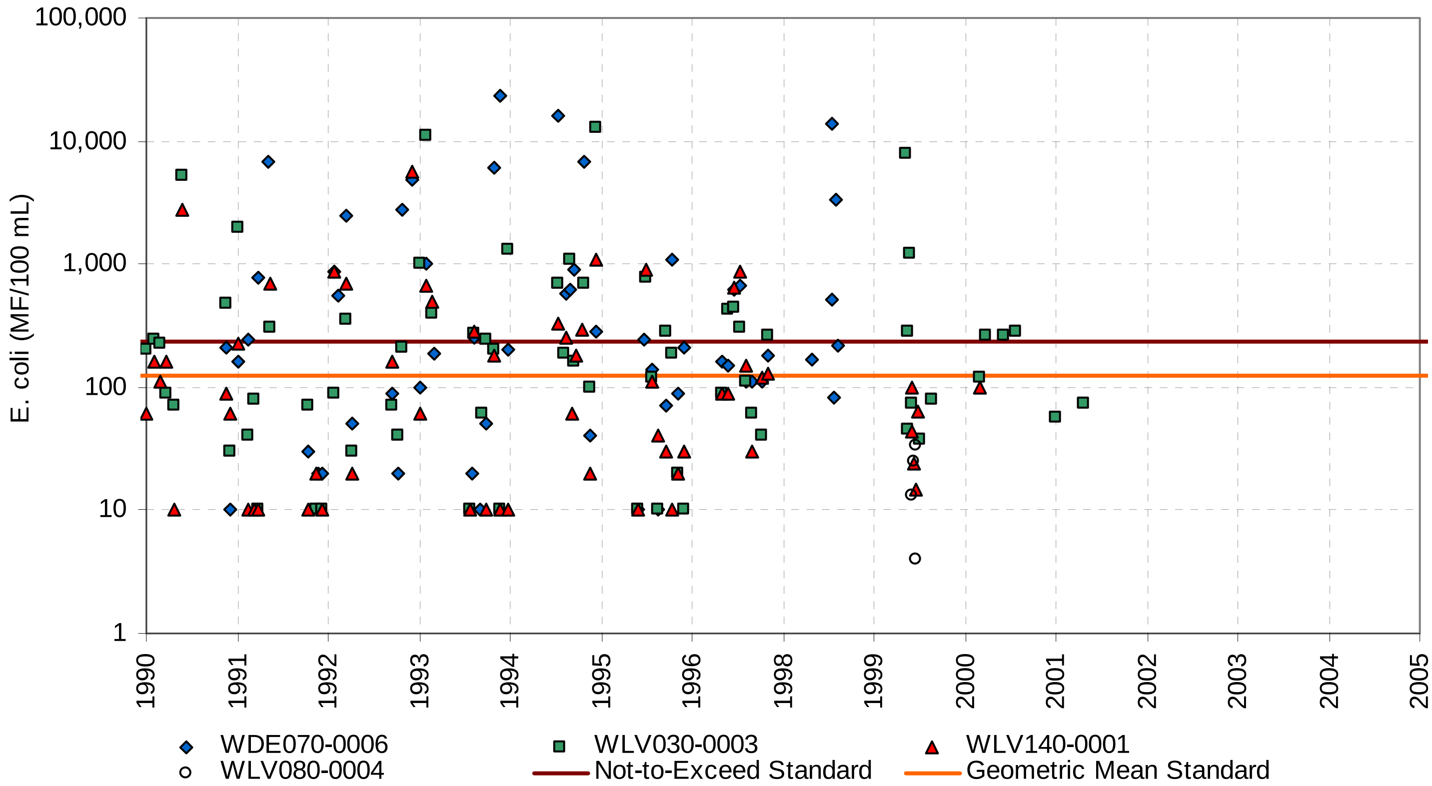


Table A-5. Middle Wabash River E. coli scatter plots.

Table A-6. Lower Wabash River E. coli Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (MF/100 mL)	Median (MF/100 mL)	Average (MF/100 mL)	Maximum (MF/100 mL)	CV
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2001	57	10	100.00	1,119	16,000	2.65
WBU200-0004	At Lincoln Memorial Bridge, Vincennes	1999	1999	5	4	32.00	36	64	0.66
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincennes	1990	2001	58	10	65.00	480	5,900	2.25
WLW080-0003	I-64 Near Griffin	1999	1999	5	3	14.00	21	61	1.13
WLV010-0006	Masacouten Park	2002	2002	1	191	191.00	191	191	0

Table A-7. Lower Wabash River E. coli Violations Statistics.

Station ID	Location	Not-To-Exceed Violations	Percent Not-To-Exceed Violations	Geometric Mean Evaluations	Geometric Mean Violations	Percent Geometric Mean Violations
WBU100-0001	W of Fairbanks, I & M Generating Station	15	26%	0	0	0%
WBU200-0004	At Lincoln Memorial Bridge, Vincennes	0	0%	0	0	0%
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	18	31%	0	0	0%
WLW080-0003	I-64 Near Griffin	0	0%	0	0	0%
WLV010-0006	Masacouten Park	0	0%	0	0	0%

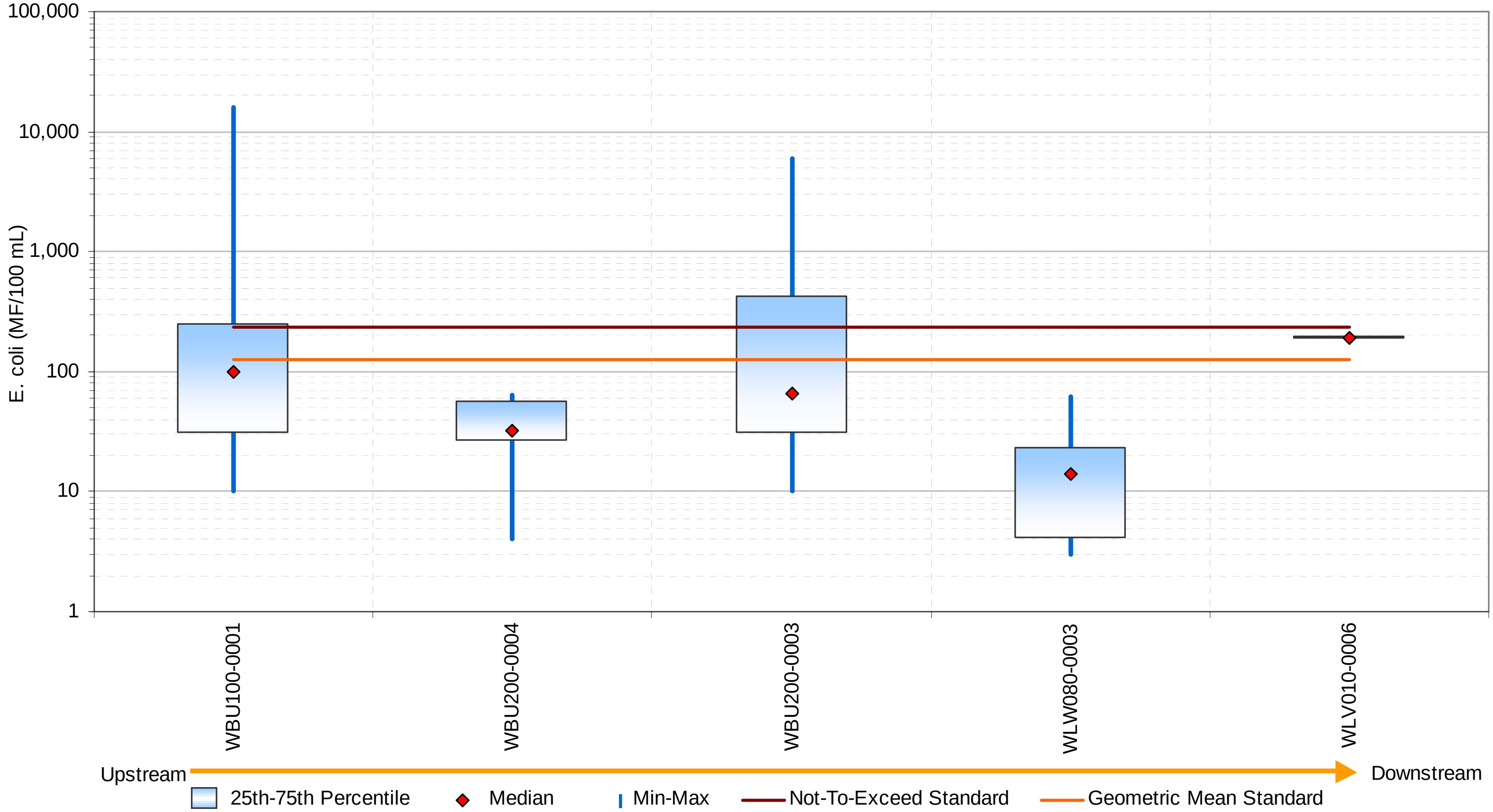


Figure A-4. **Lower Wabash River E. coli sampling station box plots.**

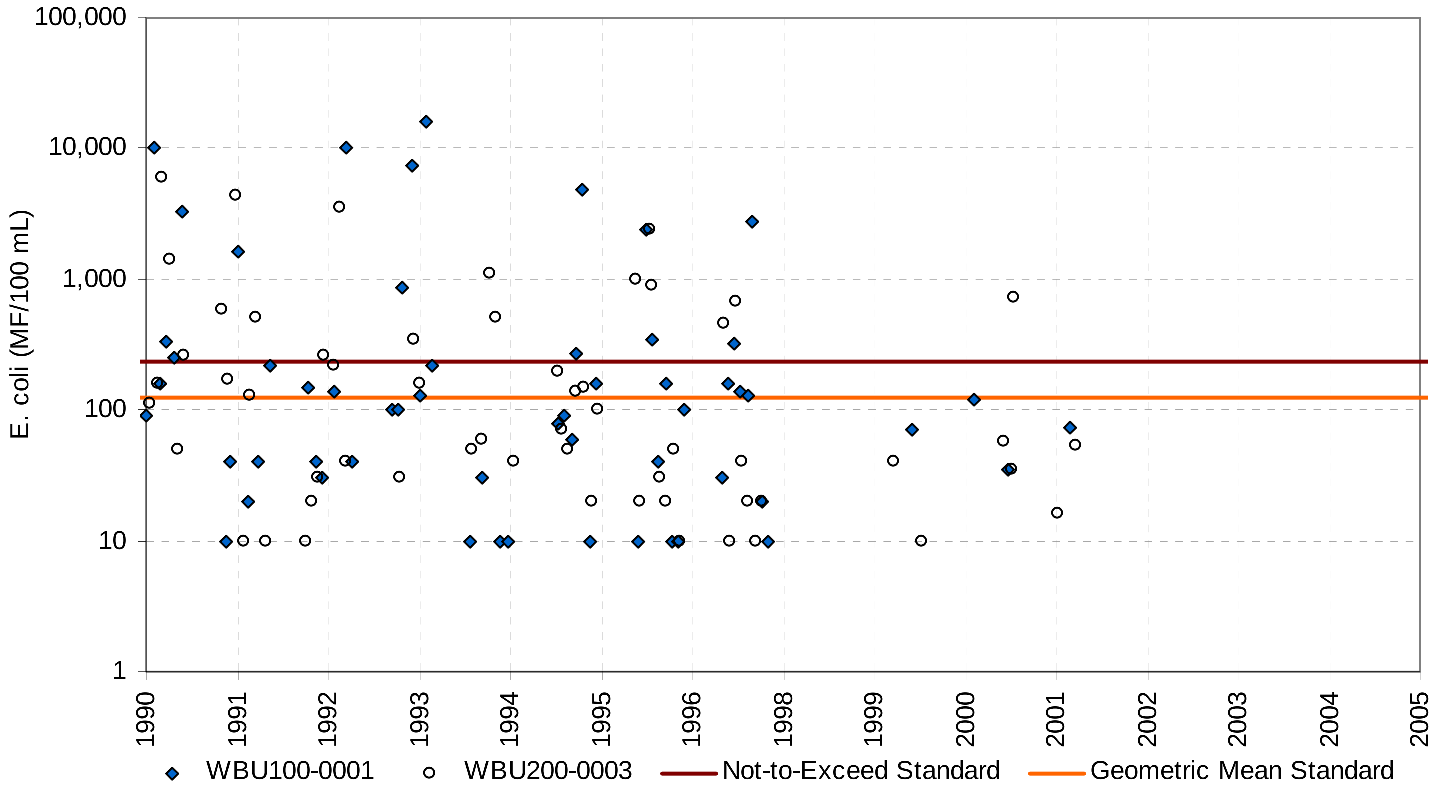


Figure A-5. **Lower Wabash River E. coli sampling station scatter plots.**

APPENDIX B: FECAL COLIFORM SAMPLING DATA

Table B-1. IEPA Fecal Coliform Sampling Statistics.

Station ID	Location	Start	End	Count	Minimum (#/100 mL)	Median (#/100 mL)	Average (#/100 mL)	Maximum (#/100 mL)	CV
B06	At Hutsonville, IL	1990	2004	109	0	150	791	24,000	3.32

Table B-2. IEPA Fecal Coliform Violation Statistics.

Station ID	Location	Geometric Mean Evaluations	Geometric Mean Violations	Percent Geometric Mean Violations	Observations greater than 400/100 mL	Percent Observations greater than 400/100 mL
B06	At Hutsonville, IL	0	NA	NA	18	25%

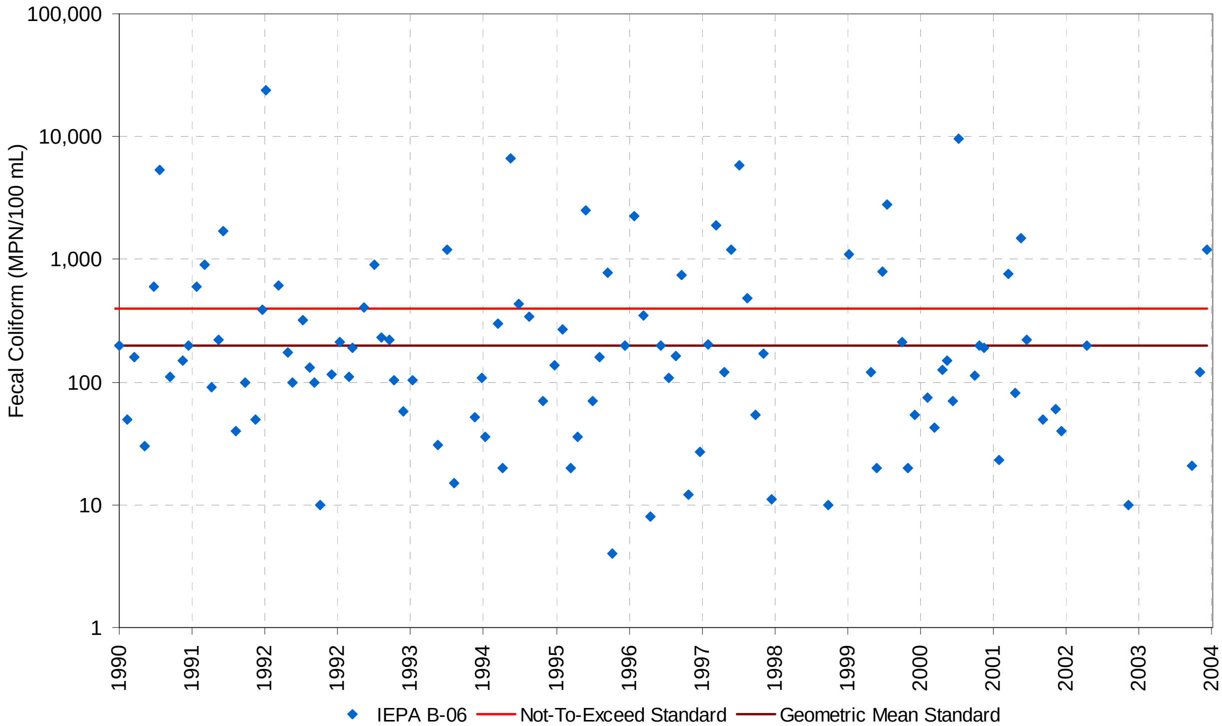


Figure B-1. IEPA fecal coliform scatter plot.

APPENDIX C: TOTAL PHOSPHORUS SAMPLING DATA

Table C-1. Upper Wabash River Total Phosphorus Sampling Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	162	0.05	0.27	0.30	1.08	0.49
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	170	0.05	0.20	0.24	0.79	0.52
WUW090-0012	Cr 200 W	2004	2004	2	0.15	0.24	0.24	0.33	0.52
WUW090-0007	Evergreen Road	2003	2003	1	0.38	0.38	0.38	0.38	0
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	158	0.04	0.29	0.30	0.83	0.41
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	162	0.05	0.19	0.21	0.67	0.51
WDE010-0007	Cr 675, W of Georgetown	1991	2004	165	0.03	0.19	0.21	0.85	0.56
WDE030-0008	Cr 275 W	2003	2003	3	0.15	0.22	0.23	0.31	0.35
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	19	0.21	0.42	0.40	0.64	0.32
WUW060-0002	Us 27	1991	2002	133	0.11	0.37	0.44	3.40	0.74
WDE030-0007	Towpath Rd	2003	2003	3	0.17	0.23	0.24	0.32	0.31
WUW040-0005	At Stateline Bridge	2004	2004	10	0.24	0.42	0.44	0.66	0.31
WDE060-0001	Bridge At Americus	2001	2004	47	0.09	0.19	0.22	0.52	0.47

Table C-2. Upper Wabash River Total Phosphorus Violation Statistics.

Station ID	Location	Start	End	Count	Benchmark Violations	Percent violations
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	162	68	42%
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	170	45	26%
WUW090-0012	Cr 200 W	2004	2004	2	1	50%
WUW090-0007	Evergreen Road	2003	2003	1	1	100%
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	158	70	44%
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	162	23	14%
WDE010-0007	Cr 675, W of Georgetown	1991	2004	165	27	16%
WDE030-0008	Cr 275 W	2003	2003	3	1	33%
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	19	13	68%
WUW060-0002	Us 27	1991	2002	133	95	71%
WDE030-0007	Towpath Rd	2003	2003	3	1	33%
WUW040-0005	At Stateline Bridge	2004	2004	10	8	80%
WDE060-0001	Bridge At Americus	2001	2004	47	10	21%

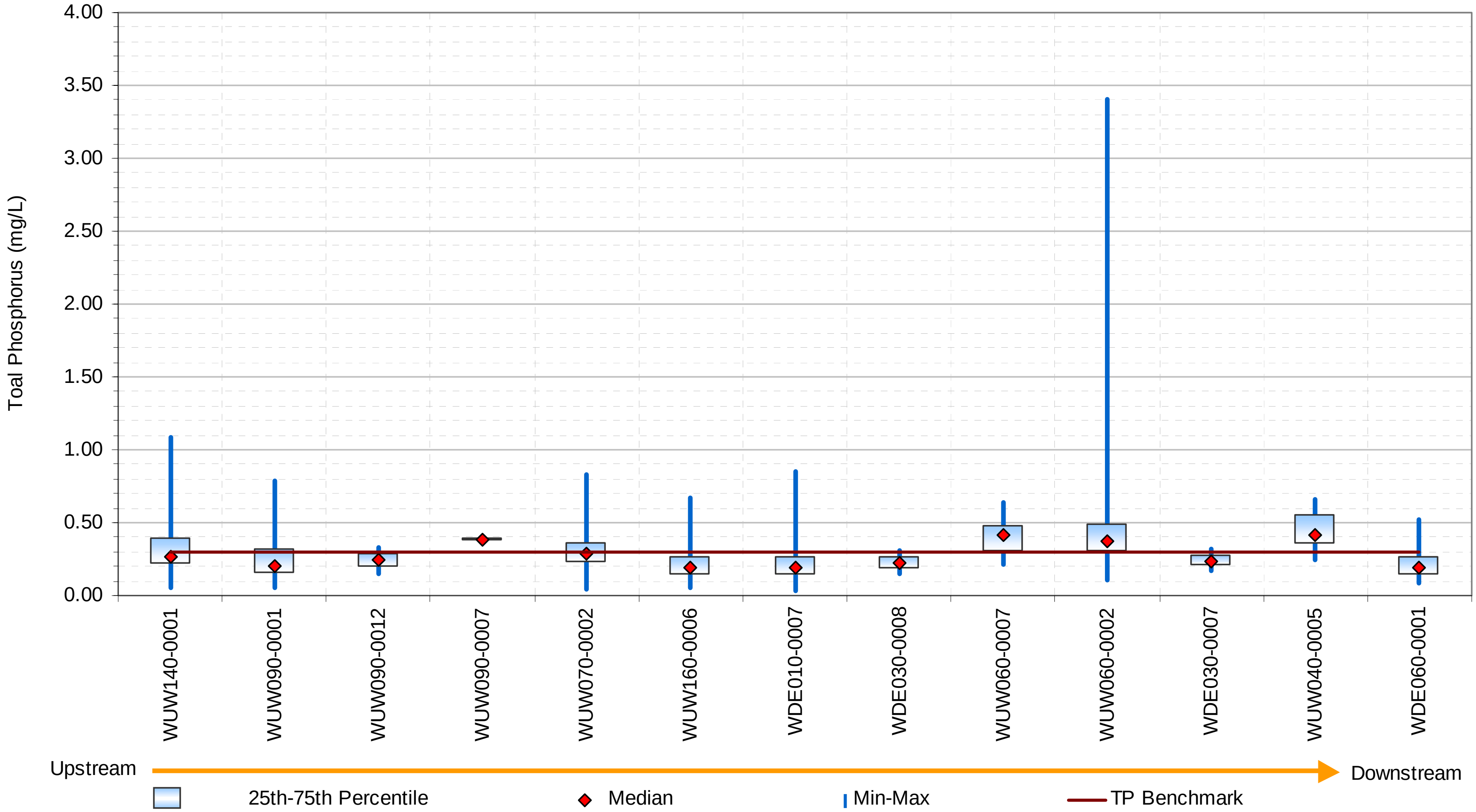


Figure C-1. Upper Wabash River total phosphorus sampling box plots.

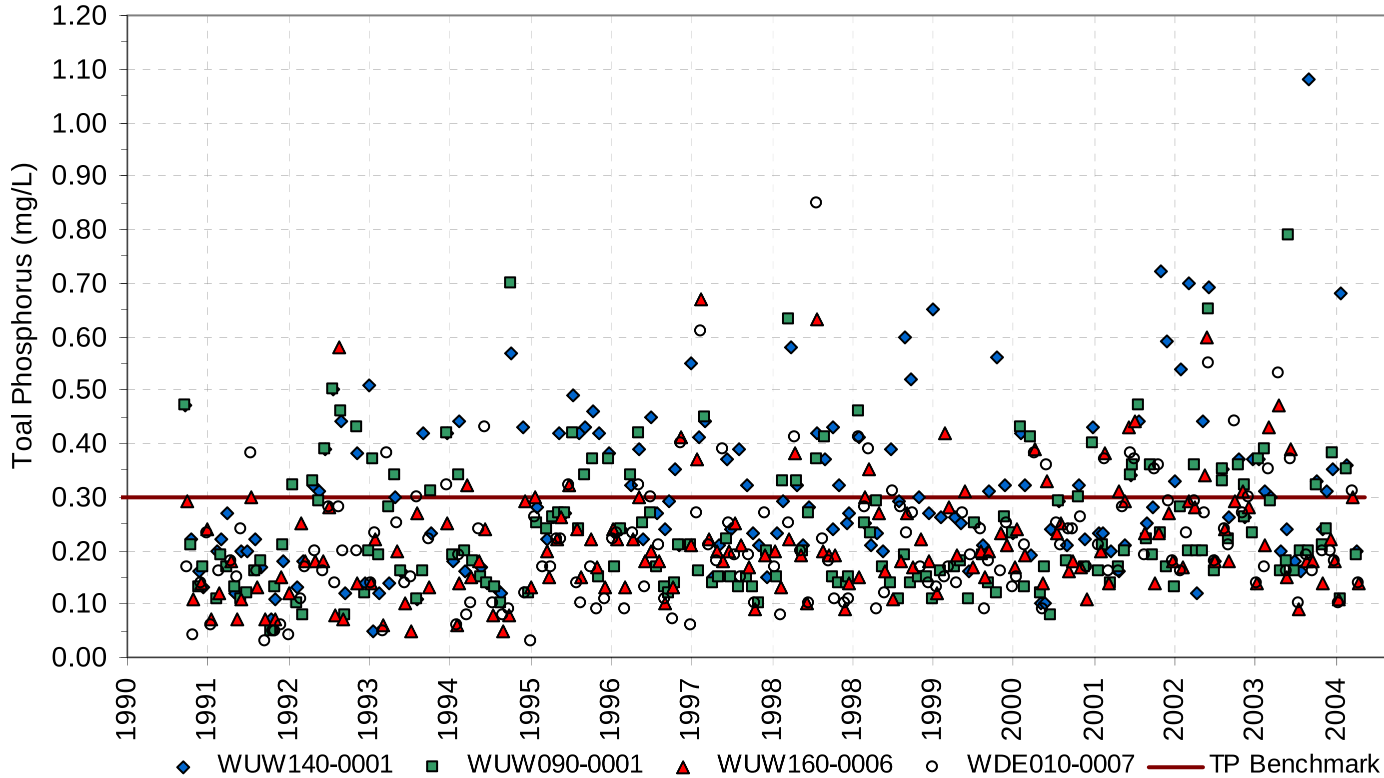


Figure C-2. **Upper Wabash River total phosphorus sampling scatter plots.**

Table C-3. Middle Wabash River Total Phosphorus Sampling Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	112	0.04	0.15	0.17	0.48	0.53
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	171	0.03	0.20	0.21	0.54	0.41
WLV030-0006	Cr 700 W	1999	1999	3	0.27	0.38	0.40	0.55	0.35
WLV030-0001	Cr 500 E 134-145P	1999	1999	1	0.34	0.34	0.34	0.34	0
WLV070-0001	Sr 41	1999	1999	3	0.37	0.39	0.39	0.41	0.05
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2005	68	0.12	0.22	0.22	0.52	0.31
WLV080-0009	Sr 263	1999	1999	3	0.19	0.40	0.35	0.47	0.41
WBU040-0011	River Near Sw Corner of American Water Company Treatment Plant, Terre Haute And Upstream of Rr Track.	2002	2004	9	0.10	0.18	0.23	0.50	0.51
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	1	0.30	0.30	0.30	0.30	0
WLV090-0001	Sr 32 134-045P	1999	1999	1	0.21	0.21	0.21	0.21	0
WBU050-0010	Us 40	2004	2004	2	0.15	0.17	0.16	0.18	0.11
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	166	0.03	0.20	0.21	0.62	0.4
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	12	0.06	0.14	0.13	0.21	0.38
WLV080-0002	Sr 136 134-069P	1999	1999	1	0.24	0.24	0.24	0.24	0
WLV090-0003	D/S I-74	1999	1999	3	0.20	0.25	0.28	0.39	0.35
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	169	0.05	0.20	0.22	0.60	0.38
WLV080-0001	Sr 136 134-053P	1999	1999	1	0.22	0.22	0.22	0.22	0
WBU040-0012	Fairbanks Pk	1999	1999	1	0.25	0.25	0.25	0.25	0
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	173	0.04	0.20	0.21	1.36	0.59
WBU200-0008	Henderson Rd	1999	1999	3	0.15	0.22	0.23	0.33	0.39
WBU070-0001	Dresser Power Plant, Terre Haute	1991	1992	7	0.06	0.17	0.23	0.63	0.82

Table C-4. Middle Wabash River Total Phosphorus Violation Statistics.

Station ID	Location	Start	End	Count	Benchmark Violations	Percent violations
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	112	8	7%
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	171	24	14%
WLV030-0006	Cr 700 W	1999	1999	3	2	67%
WLV030-0001	Cr 500 E 134-145P	1999	1999	1	1	100%
WLV070-0001	Sr 41	1999	1999	3	3	100%
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2005	68	4	6%
WLV080-0009	Sr 263	1999	1999	3	2	67%
WBU040-0011	River Near Sw Corner of American Water Company Treatment Plant, Terre Haute And Upstream of Rr Track.	2002	2004	9	1	11%
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	1	0	0%
WLV090-0001	Sr 32 134-045P	1999	1999	1	0	0%
WBU050-0010	Us 40	2004	2004	2	0	0%
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	166	12	7%
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	12	0	0%
WLV080-0002	Sr 136 134-069P	1999	1999	1	0	0%
WLV090-0003	D/S I-74	1999	1999	3	1	33%
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	169	17	10%
WLV080-0001	Sr 136 134-053P	1999	1999	1	0	0%
WBU040-0012	Fairbanks Pk	1999	1999	1	0	0%
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	173	15	9%
WBU200-0008	Henderson Rd	1999	1999	3	1	33%
WBU070-0001	Dresser Power Plant, Terre Haute	1991	1992	7	1	14%

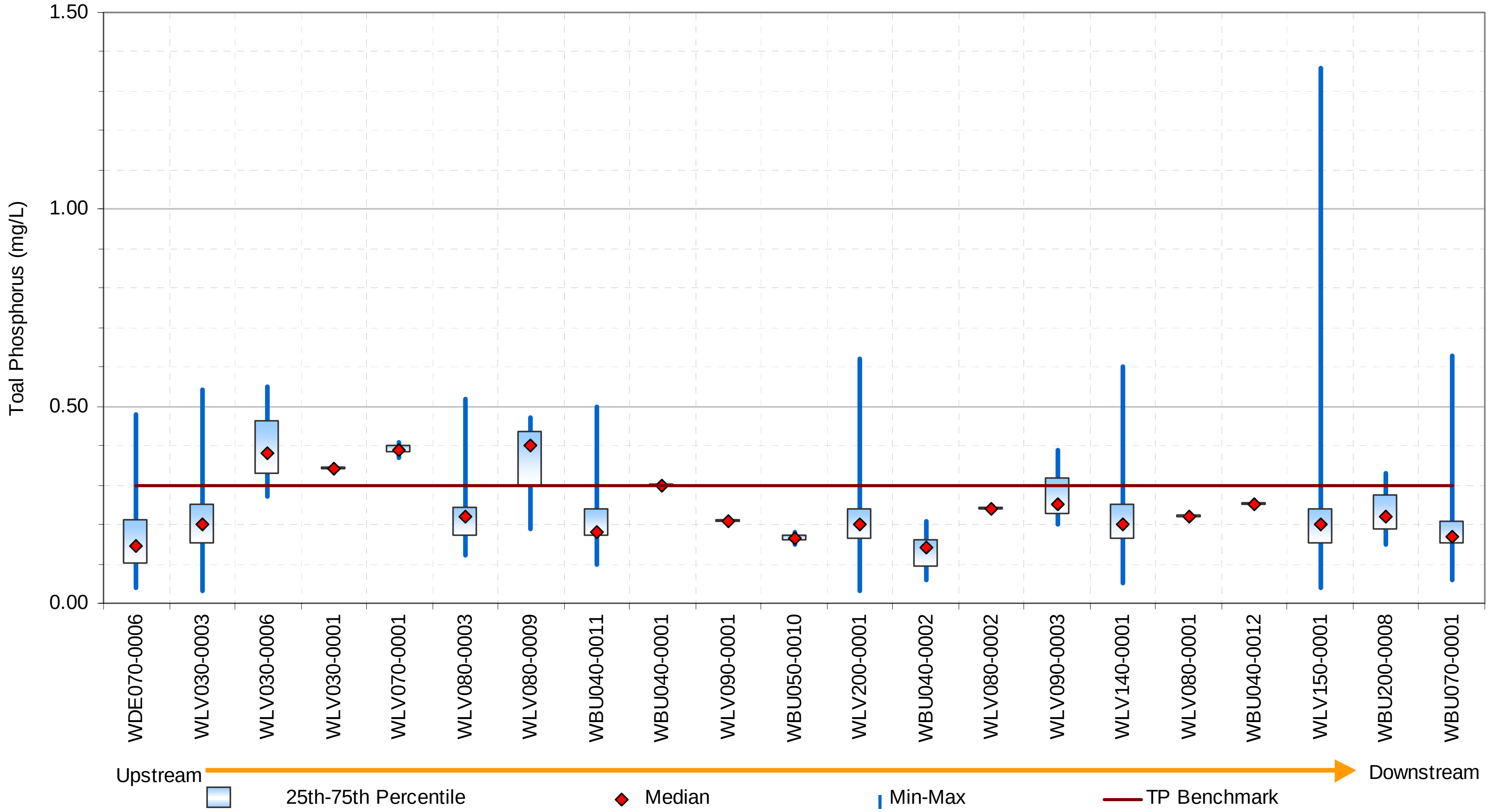


Figure C-3. Middle Wabash River total phosphorus sampling box plots.

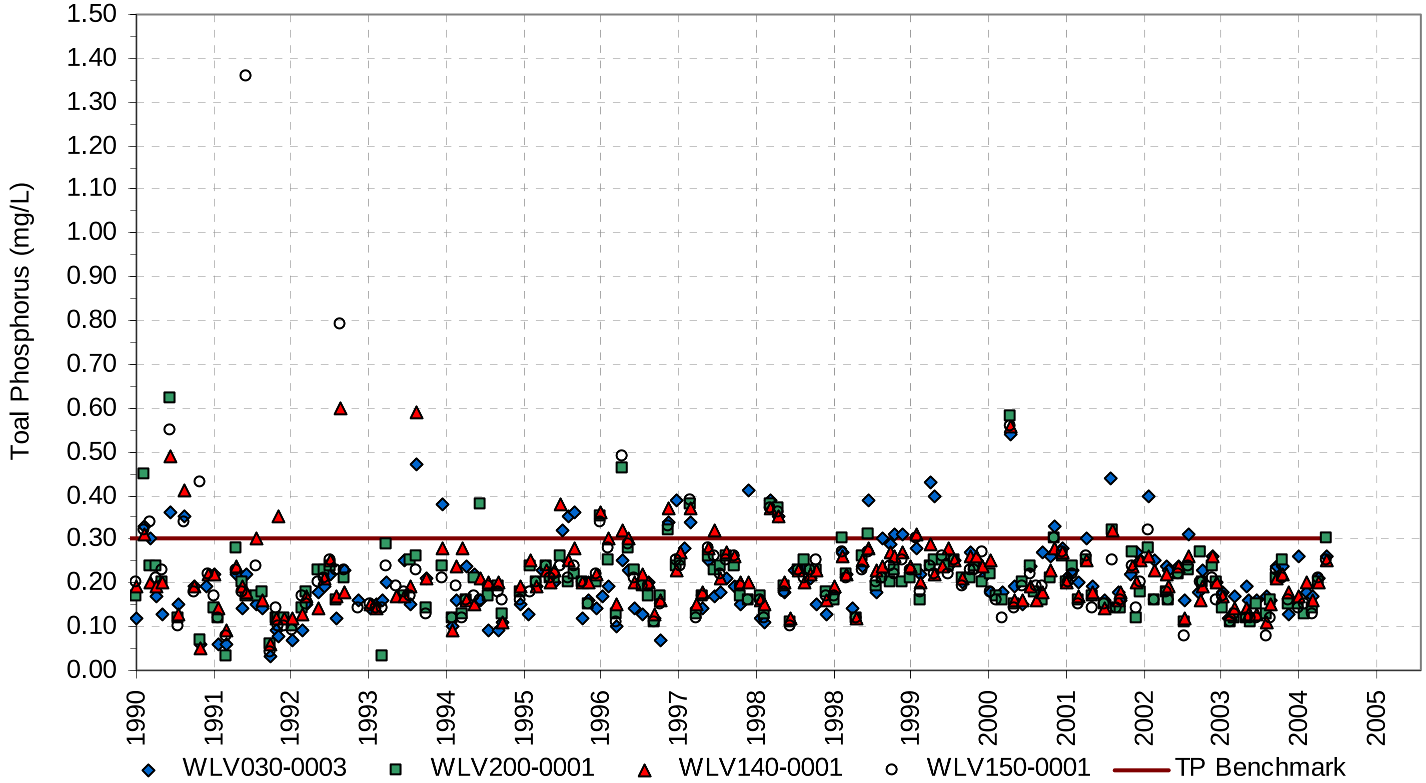


Figure C-4. **Middle Wabash River total phosphorus samplings scatter plots.**

Table C-5. Lower Wabash River Total Phosphorus Sampling Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WA9295M	At New Harmony, IN Mp51.5	1990	1998	51	0.08	0.10	0.16	0.60	0.64
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	170	0.06	0.20	0.21	0.69	0.36
WLW010-0001	St Francisville Rd 134-052P	1999	1999	1	0.25	0.25	0.25	0.25	0
WLW040-0003	200+ Feet Above Rr Tracks, S of Mt. Carmel	2002	2003	6	0.11	0.21	0.20	0.26	0.27
WLW080-0004	Cr 900 N	1999	1999	3	0.14	0.16	0.25	0.46	0.71
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	173	0.06	0.19	0.21	0.61	0.46
WLW100-0001	Sr 66 134-060P	1999	1999	1	0.19	0.19	0.19	0.19	0
WLW080-0001	I-64 134-096	1999	1999	1	0.49	0.49	0.49	0.49	0
WLW060-0003	Crawleyville Boat Ramp	1999	1999	3	0.14	0.18	0.28	0.52	0.75

Table C-6. Lower Wabash River Total Phosphorus Violation Statistics.

Station ID	Location	Start	End	Count	Benchmark Violations	Percent violations
WA9295M	At New Harmony, IN Mp51.5	1990	1998	51	4	8%
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	170	11	6%
WLW010-0001	St Francisville Rd 134-052P	1999	1999	1	0	0%
WLW040-0003	200+ Feet Above Rr Tracks, S of Mt. Carmel	2002	2003	6	0	0%
WLW080-0004	Cr 900 N	1999	1999	3	1	33%
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	173	20	12%
WLW100-0001	Sr 66 134-060P	1999	1999	1	0	0%
WLW080-0001	I-64 134-096	1999	1999	1	1	100%
WLW060-0003	Crawleyville Boat Ramp	1999	1999	3	1	33%

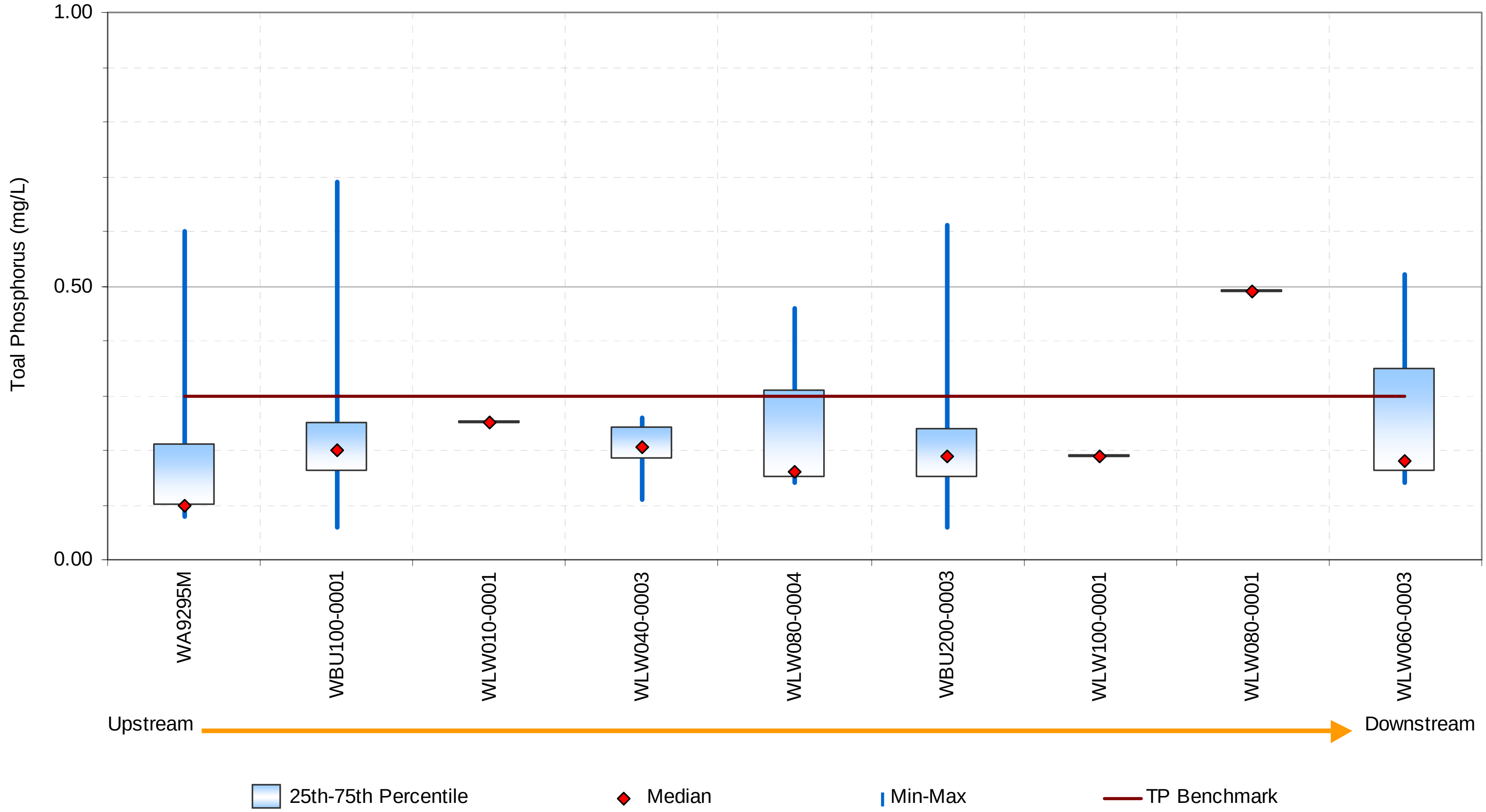


Figure C-5. **Lower Wabash River total phosphorus sampling box plots.**

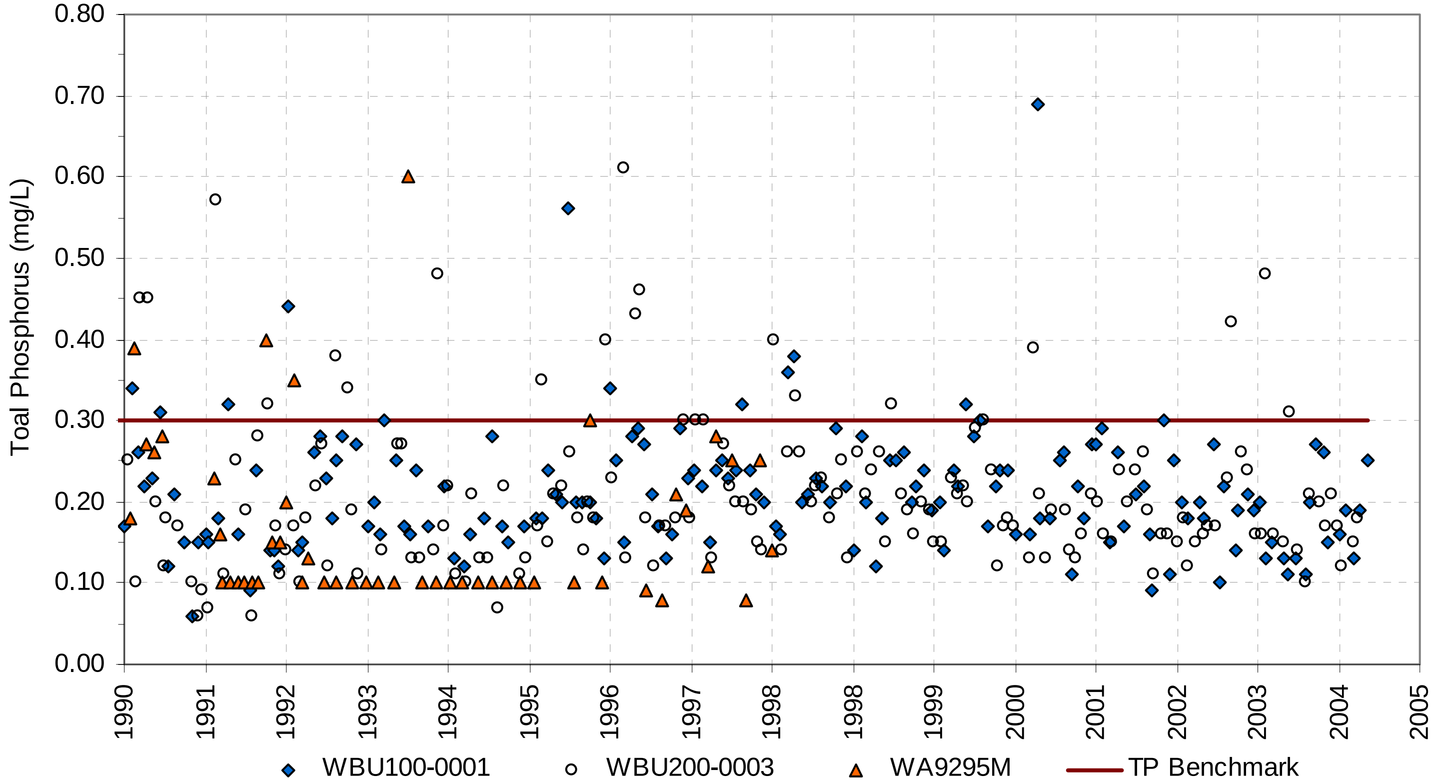


Figure C-6. Lower Wabash River total phosphorus sampling scatter plots.

APPENDIX D: NITRATE + NITRITE SAMPLING DATA

Table D-1. Upper Wabash River Nitrate + Nitrite Sampling Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	162	0.40	3.55	4.48	20.00	0.76
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	163	0.10	4.20	5.11	22.00	0.8
WUW090-0012	Cr 200 W	2004	2004	2	0.37	0.67	0.67	0.97	0.63
WUW090-0007	Evergreen Road	2003	2003	1	11.00	11.00	11.00	11.00	0
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	159	0.10	3.52	4.85	24.00	0.98
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	162	0.10	3.40	3.78	16.00	0.61
WDE010-0007	Cr 675, W of Georgetown	1991	2004	165	0.10	3.15	3.46	12.00	0.61
WDE030-0008	Cr 275 W	2003	2003	3	1.20	2.60	3.83	7.70	0.89
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	19	0.30	4.40	6.92	19.00	0.87
WUW060-0002	Us 27	1991	2002	133	0.10	2.70	4.26	24.00	0.98
WDE030-0007	Towpath Rd	2003	2003	3	1.50	2.60	3.60	6.70	0.76
WUW040-0005	At Stateline Bridge	2004	2004	10	0.60	5.30	7.08	14.00	0.76
WDE060-0001	Bridge At Americus	2001	2004	47	0.50	3.90	4.14	12.00	0.67

Table D-2. Upper Wabash River Nitrate + Nitrite Violation Statistics.

Station ID	Location	Start	End	Count	Benchmark Violations	Percent violations
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	162	11	7%
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	163	10	6%
WUW090-0012	Cr 200 W	2004	2004	2	0	0%
WUW090-0007	Evergreen Road	2003	2003	1	1	100%
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	159	17	11%
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	162	2	1%
WDE010-0007	Cr 675, W of Georgetown	1991	2004	165	1	1%
WDE030-0008	Cr 275 W	2003	2003	3	0	0%
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	19	5	26%
WUW060-0002	Us 27	1991	2002	133	14	11%
WDE030-0007	Towpath Rd	2003	2003	3	0	0%
WUW040-0005	At Stateline Bridge	2004	2004	10	4	40%
WDE060-0001	Bridge At Americus	2001	2004	47	2	4%

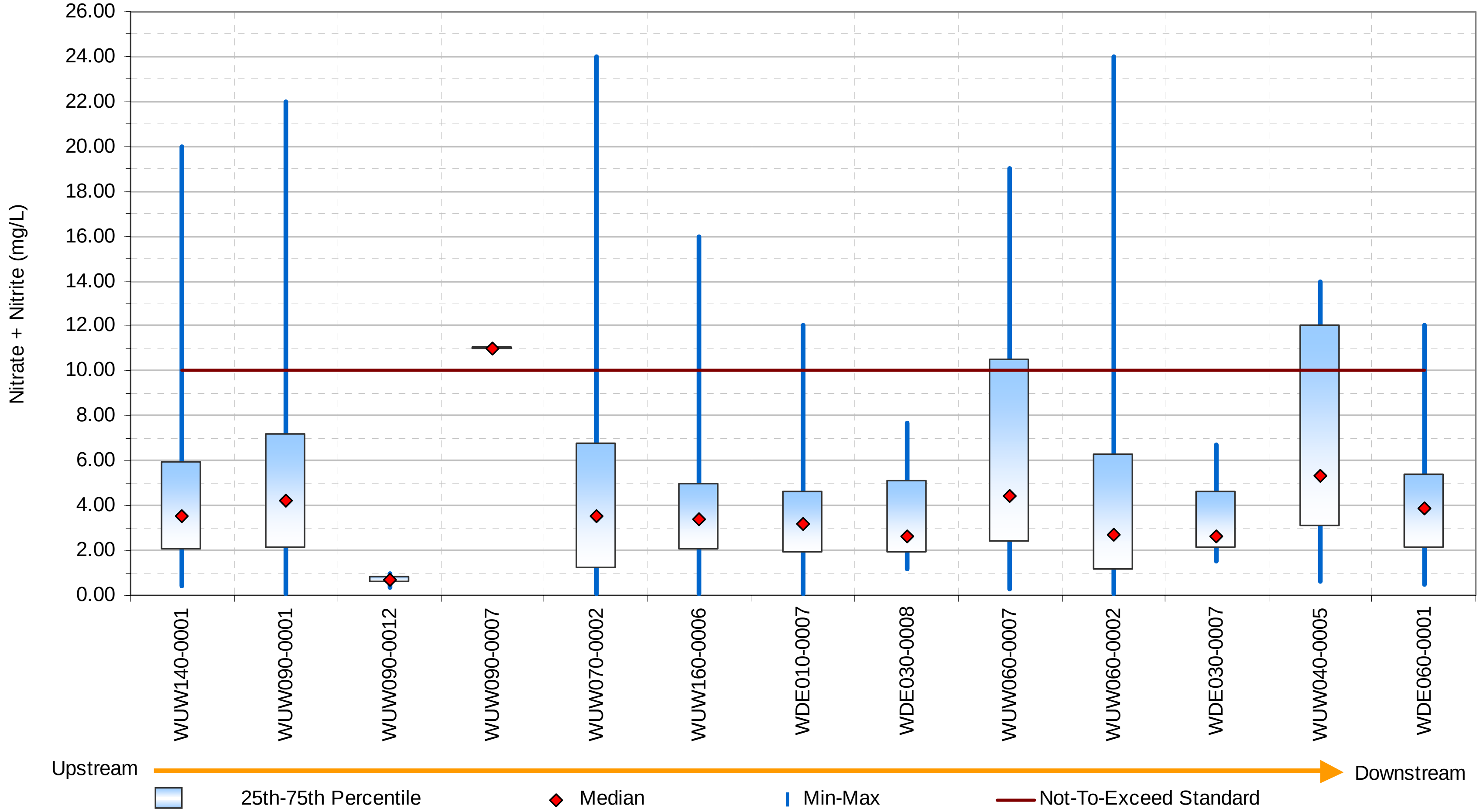


Figure D-1. **Upper Wabash River nitrate + nitrite sampling box plots.**

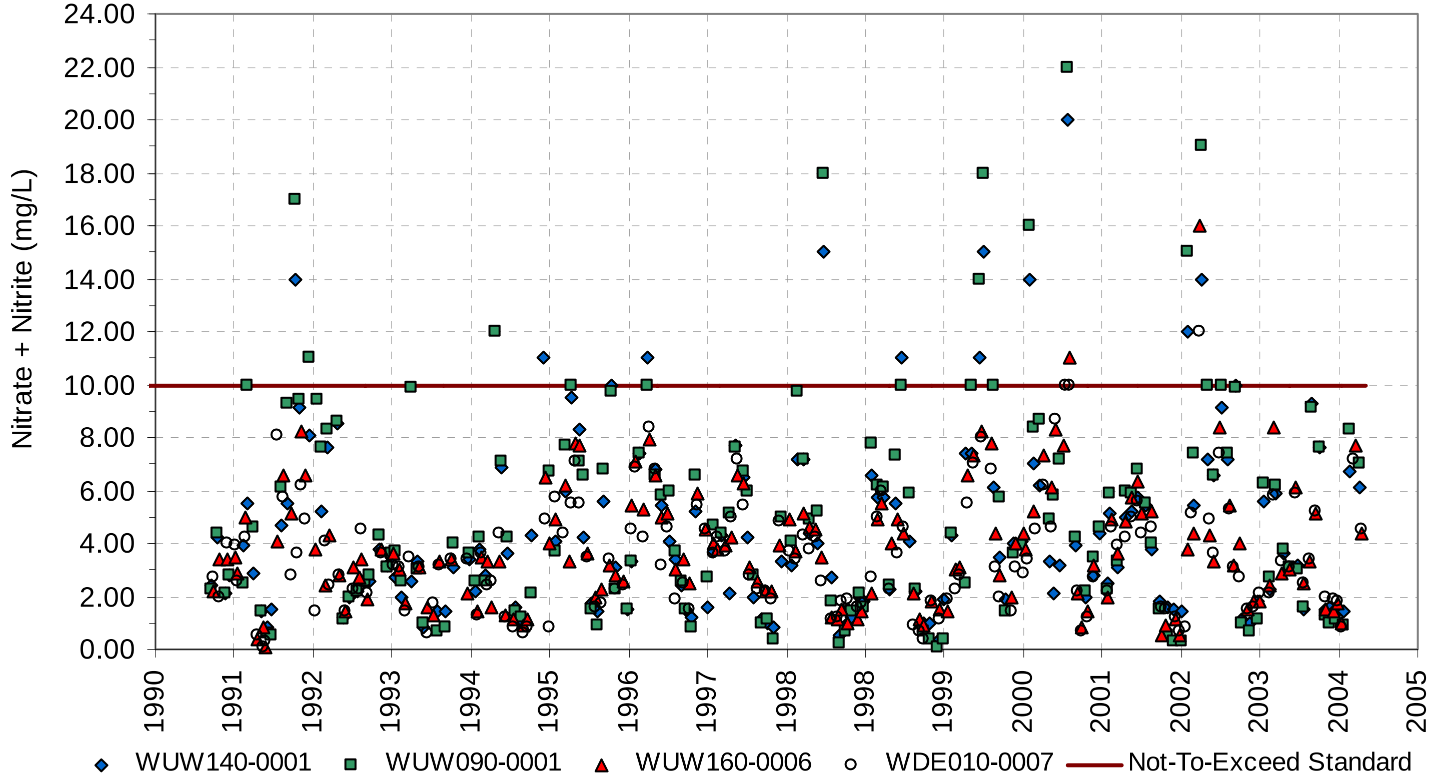


Figure D-2. Upper Wabash River nitrate + nitrite sampling scatter plots.

Table D-3. Middle Wabash River Nitrate + Nitrite Sampling Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	112	0.10	3.45	3.70	9.40	0.56
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	171	0.10	3.60	3.66	10.00	0.57
WLV030-0006	Cr 700 W	1999	1999	3	0.21	1.30	3.60	9.30	1.38
WLV030-0001	Cr 500 E 134-145P	1999	1999	1	0.95	0.95	0.95	0.95	0
WLV070-0001	Sr 41	1999	1999	3	0.12	0.35	1.39	3.70	1.44
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2005	68	0.10	3.75	3.81	11.00	0.63
WLV080-0009	Sr 263	1999	1999	3	0.01	0.01	1.81	5.40	1.72
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	1	0.19	0.19	0.19	0.19	0
WLV090-0001	Sr 32 134-045P	1999	1999	1	4.80	4.80	4.80	4.80	0
WBU050-0010	Us 40	2004	2004	2	2.11	2.15	2.15	2.18	0.02
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	166	0.10	3.90	3.89	11.00	0.6
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	12	0.10	4.75	4.59	7.90	0.42
WLV080-0002	Sr 136 134-069P	1999	1999	1	4.90	4.90	4.90	4.90	0
WLV090-0003	D/S I-74	1999	1999	3	0.01	0.01	1.61	4.80	1.72
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	169	0.10	4.10	4.00	12.00	0.59
WLV080-0001	Sr 136 134-053P	1999	1999	1	0.01	0.01	0.01	0.01	0
WBU040-0012	Fairbanks Pk	1999	1999	1	0.29	0.29	0.29	0.29	0
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	173	0.10	4.00	4.00	11.00	0.56
WBU200-0008	Henderson Rd	1999	1999	3	0.04	0.18	1.71	4.90	1.62
WBU070-0001	Dresser Power Plant, Terre Haute	1991	1992	7	0.10	4.00	3.17	5.30	0.66

Table D-4. Middle Wabash River Nitrate + Nitrite Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Benchmark Violations	Percent violations
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	112	0	0%
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	171	0	0%
WLV030-0006	Cr 700 W	1999	1999	3	0	0%
WLV030-0001	Cr 500 E 134-145P	1999	1999	1	0	0%
WLV070-0001	Sr 41	1999	1999	3	0	0%
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2005	68	1	1%
WLV080-0009	Sr 263	1999	1999	3	0	0%
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	1	0	0%
WLV090-0001	Sr 32 134-045P	1999	1999	1	0	0%
WBU050-0010	Us 40	2004	2004	2	0	0%
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	166	1	1%
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	12	0	0%
WLV080-0002	Sr 136 134-069P	1999	1999	1	0	0%
WLV090-0003	D/S I-74	1999	1999	3	0	0%
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	169	1	1%
WLV080-0001	Sr 136 134-053P	1999	1999	1	0	0%
WBU040-0012	Fairbanks Pk	1999	1999	1	0	0%
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	173	1	1%
WBU200-0008	Henderson Rd	1999	1999	3	0	0%
WBU070-0001	Dresser Power Plant, Terre Haute	1991	1992	7	0	0%

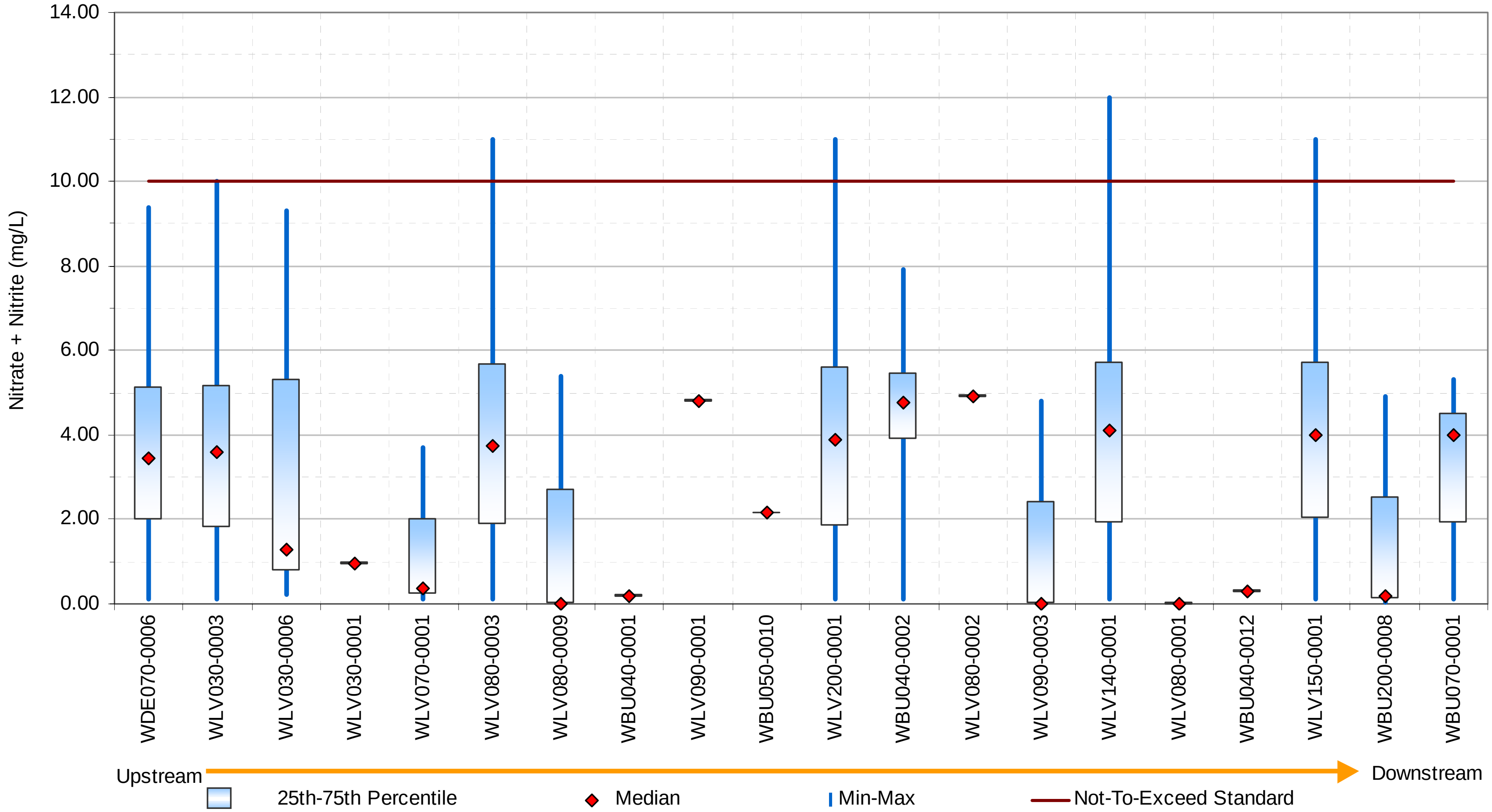


Figure D-3. Middle Wabash River nitrate + nitrite sampling box plots.

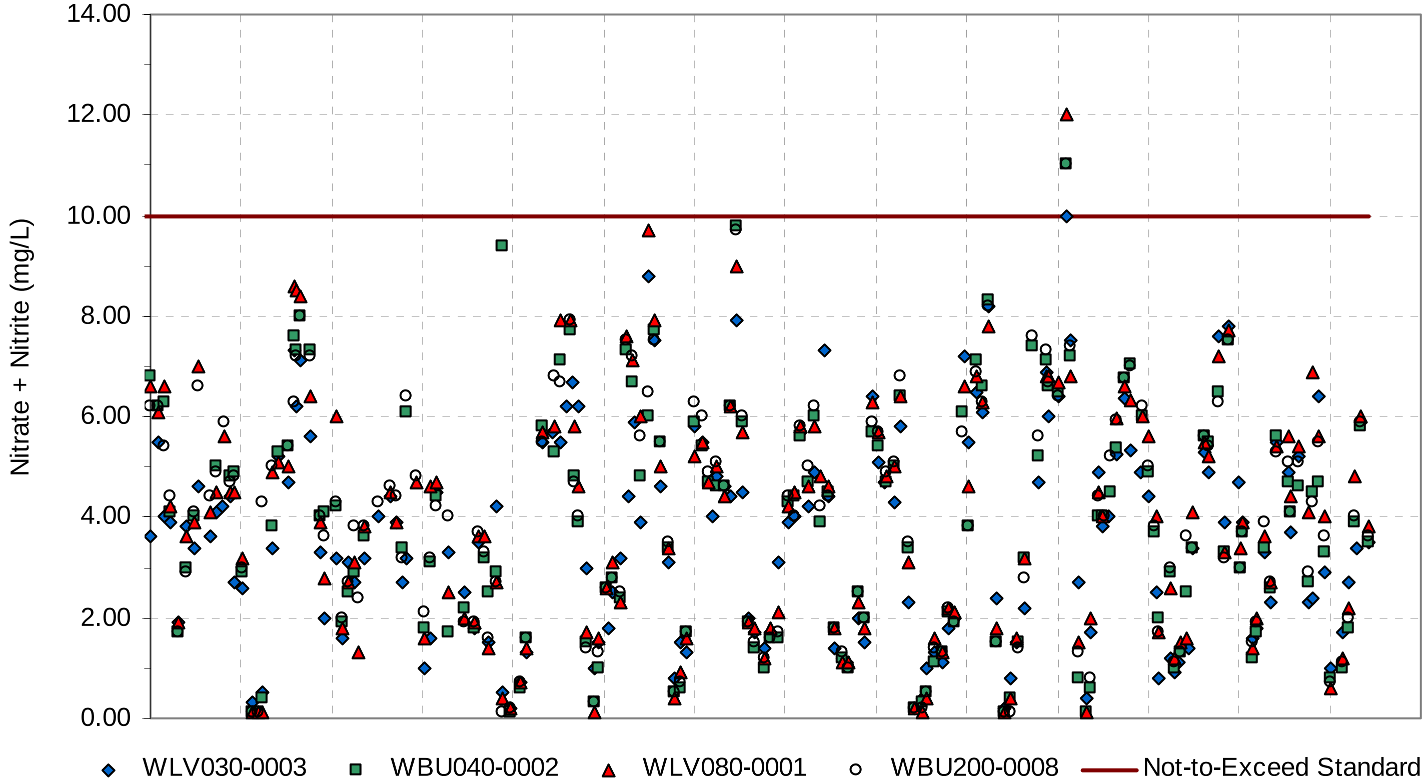


Figure D-4. Middle Wabash River nitrate + nitrite sampling scatter plots.

Table D-5. Lower Wabash River Nitrate + Nitrite Sampling Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WA9295M	At New Harmony, IN Mp51.5	1990	1998	49	0.02	2.50	2.48	9.90	0.73
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	170	0.10	3.60	3.56	10.00	0.58
WLW010-0001	St Francisville Rd 134-052P	1999	1999	1	0.06	0.06	0.06	0.06	0
WLW080-0004	Cr 900 N	1999	1999	3	0.01	0.01	1.24	3.70	1.72
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	174	0.10	3.40	3.34	12.00	0.6
WLW100-0001	Sr 66 134-060P	1999	1999	1	0.01	0.01	0.01	0.01	0
WLW080-0001	I-64 134-096	1999	1999	1	3.50	3.50	3.50	3.50	0
WLW060-0003	Crawleyville Boat Ramp	1999	1999	3	0.01	0.01	0.94	2.80	1.71

Table D-6. Lower Wabash River Nitrate + Nitrite Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Benchmark Violations	Percent violations
WA9295M	At New Harmony, IN Mp51.5	1990	1998	49	0	0%
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	170	0	0%
WLW010-0001	St Francisville Rd 134-052P	1999	1999	1	0	0%
WLW080-0004	Cr 900 N	1999	1999	3	0	0%
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	174	1	1%
WLW100-0001	Sr 66 134-060P	1999	1999	1	0	0%
WLW080-0001	I-64 134-096	1999	1999	1	0	0%
WLW060-0003	Crawleyville Boat Ramp	1999	1999	3	0	0%

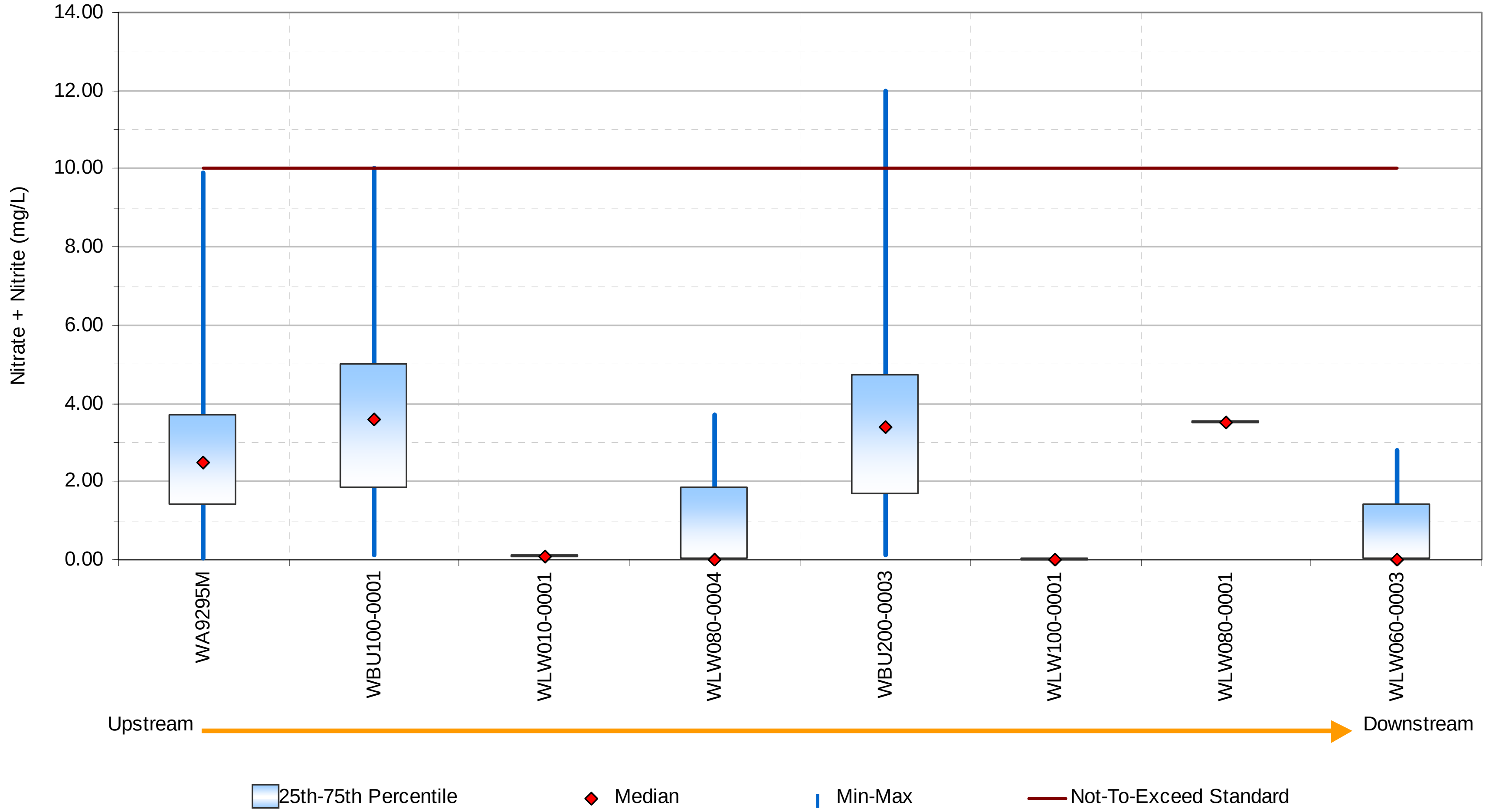


Figure D-5. Lower Wabash River nitrate + nitrite sampling box plots.

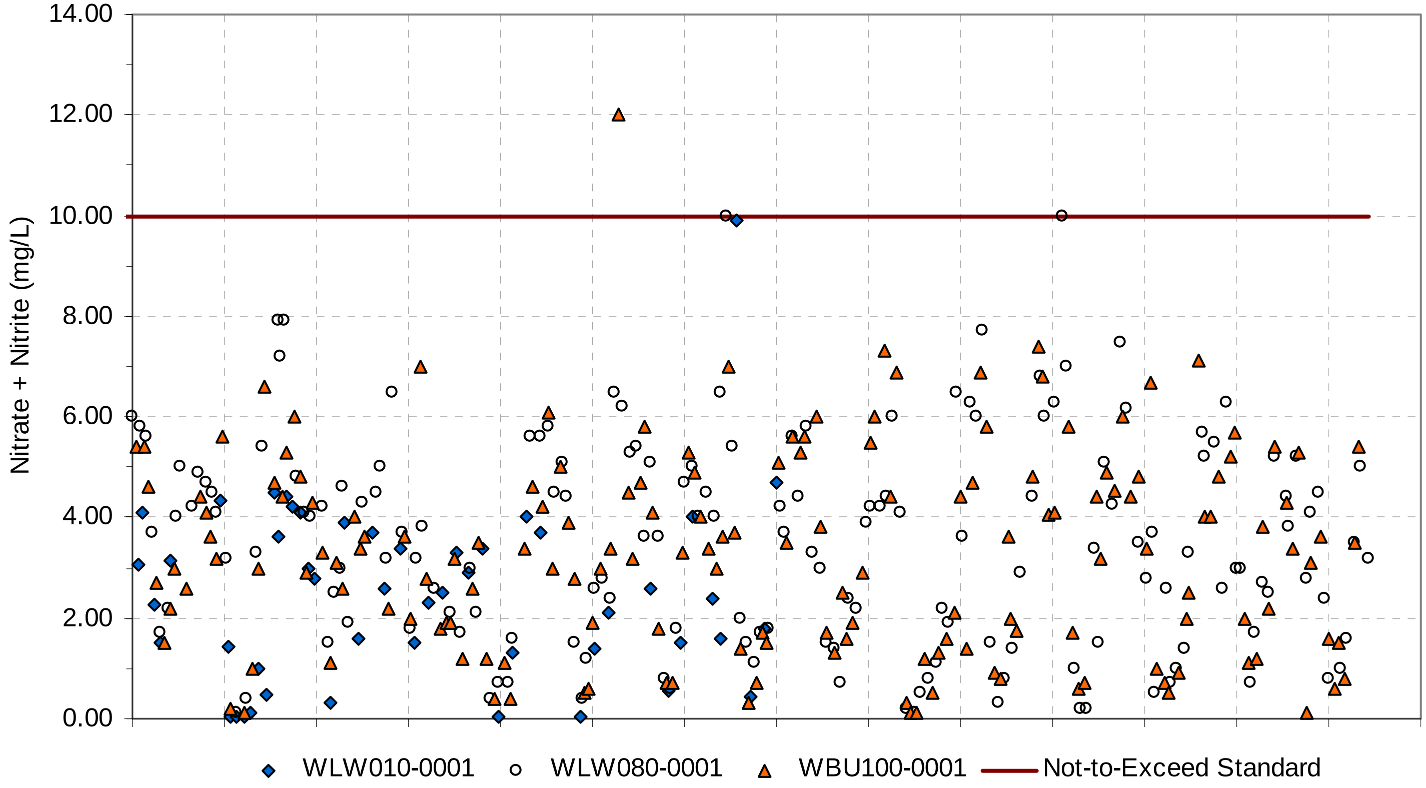


Figure D-6. Lower Wabash River nitrate + nitrite sampling scatter plots.

APPENDIX E: DISSOLVED OXYGEN SAMPLING DATA

Table E-1. Upper Wabash River Dissolved Oxygen Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	160	5.07	10.40	10.24	15.87	0.23
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	163	4.80	10.19	10.26	16.05	0.24
WUW090-0002	Huntington Water And Light Plant, 2 Miles S of Huntington	1998	1998	15	7.37	8.81	9.01	10.70	0.13
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	150	3.50	10.04	10.11	15.39	0.24
WUW070-0007	Cr 100 W, S of Sr 116	2003	2003	5	6.81	10.40	11.12	15.33	0.32
WUW150-0001	Wabash, U/S Side of Wabash St, Sr 15 Bridge, 7.1 Miles D/S From Salamonie River	1998	2003	24	2.50	8.51	8.53	12.91	0.21
WUW070-0003	Cr 300N Near Bluffton	1998	1998	5	4.10	8.90	7.76	9.90	0.3
WUW180-0007	600 E Rd. - Cass Stationary Bridge	2003	2003	6	6.30	8.13	7.80	8.44	0.1
WDE010-0001	Logansport, 150 Feet D/S From Cicott St Bridge, 1,000 Feet D/S From Eel	1998	1998	15	7.42	9.60	10.31	16.70	0.29
WUW160-0001	Peru, U/S Side of Us 31 Bridge, 0.5 Miles Sw of Peru	1998	2003	20	6.00	8.15	9.01	14.08	0.23
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	166	5.11	10.20	10.47	20.67	0.23
WDE010-0007	Cr 675, W of Georgetown	1991	2004	166	5.61	10.89	11.09	20.40	0.23
WUW060-0001	Linn Grove, Sr 218 Bridge	1998	2003	33	0.00	8.60	8.37	15.70	0.42
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	23	5.90	9.40	9.32	12.33	0.2
WUW060-0002	Us 27	1991	2002	119	4.00	9.10	9.41	20.49	0.29
WDE030-0009	Bridge W of Delphi - 39 - 421	2003	2003	6	6.70	8.21	7.93	8.44	0.08
WDE030-0001	Cr 200 N Near Delphi	1998	1998	5	7.20	7.70	7.60	7.90	0.04
WUW040-0001	State Line Rd	1998	2003	10	0.00	7.20	6.90	10.35	0.43
WUW040-0005	At Stateline Bridge	2004	2004	10	7.24	9.82	9.40	11.18	0.15
WDE060-0001	Bridge At Americus	2001	2004	53	5.70	10.54	10.50	20.10	0.25

Table E-2. Upper Wabash River Dissolved Oxygen Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Minumum Standard Violations	Percent Minimum Standard Violations	Maximum Standard Violations	Percent Maximum Standard Violations
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	160	0	0%	39	24%
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	163	0	0%	40	25%
WUW090-0002	Huntington Water And Light Plant, 2 Miles S of Huntington	1998	1998	15	0	0%	0	0%
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	150	1	1%	32	21%
WUW070-0007	Cr 100 W, S of Sr 116	2003	2003	5	0	0%	2	40%
WUW150-0001	Wabash, U/S Side of Wabash St, Sr 15 Bridge, 7.1 Miles D/S From Salamonie River	1998	2003	24	1	4%	1	4%
WUW070-0003	Cr 300N Near Bluffton	1998	1998	5	0	0%	0	0%
WUW180-0007	600 E Rd. - Cass Stationary Bridge	2003	2003	6	0	0%	0	0%
WDE010-0001	Logansport, 150 Feet D/S From Cicott St Bridge, 1,000 Feet D/S From Eel	1998	1998	15	0	0%	4	27%
WUW160-0001	Peru, U/S Side of Us 31 Bridge, 0.5 Miles Sw of Peru	1998	2003	20	0	0%	2	10%
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	166	0	0%	46	28%
WDE010-0007	Cr 675, W of Georgetown	1991	2004	166	0	0%	58	35%
WUW060-0001	Linn Grove, Sr 218 Bridge	1998	2003	33	1	3%	5	15%
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	23	0	0%	1	4%
WUW060-0002	Us 27	1991	2002	119	0	0%	20	17%
WDE030-0009	Bridge W of Delphi - 39 - 421	2003	2003	6	0	0%	0	0%
WDE030-0001	Cr 200 N Near Delphi	1998	1998	5	0	0%	0	0%
WUW040-0001	State Line Rd	1998	2003	10	1	10%	0	0%
WUW040-0005	At Stateline Bridge	2004	2004	10	0	0%	0	0%
WDE060-0001	Bridge At Americus	2001	2004	53	0	0%	13	25%

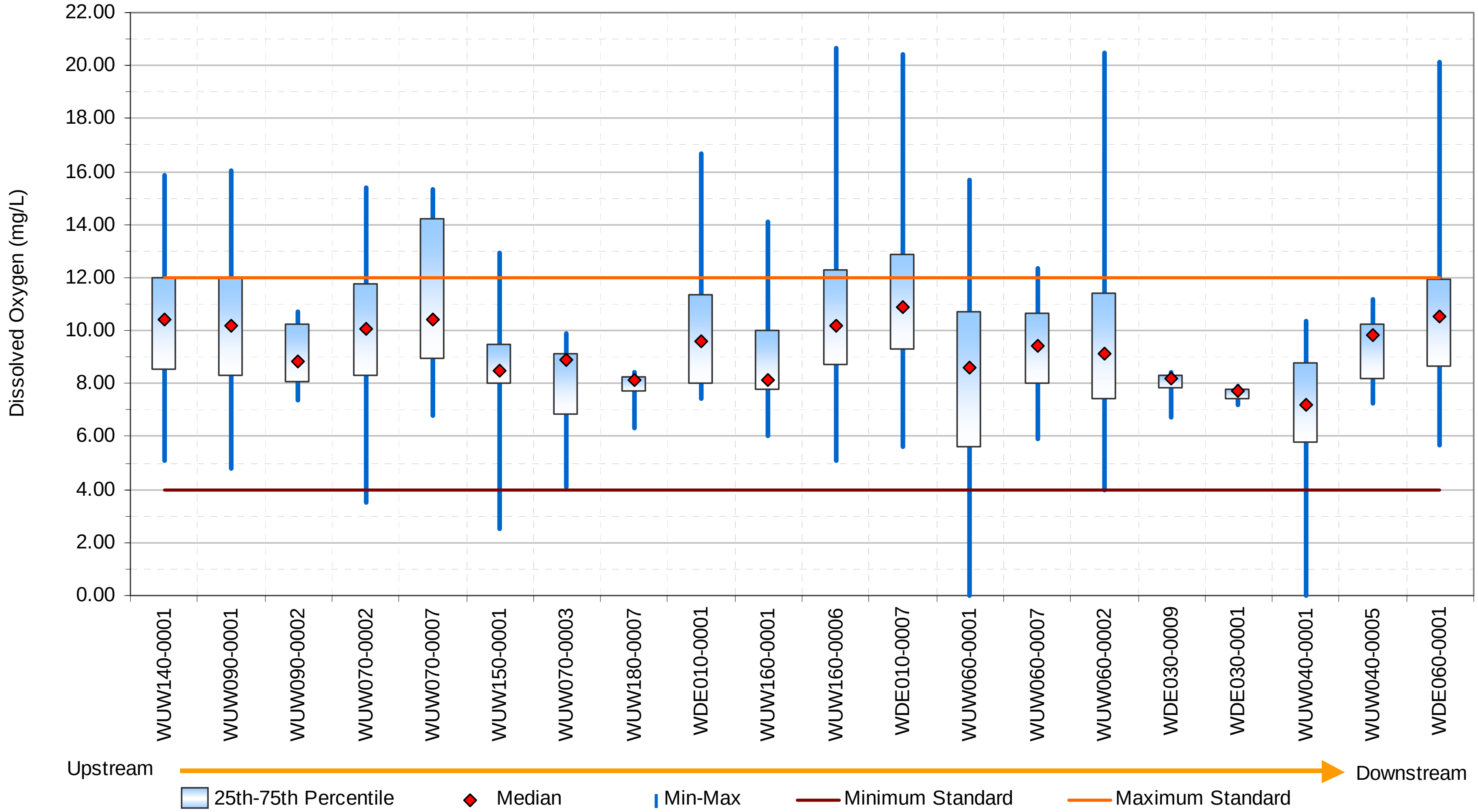


Figure E-1. Upper Wabash River dissolved oxygen sampling box plots.

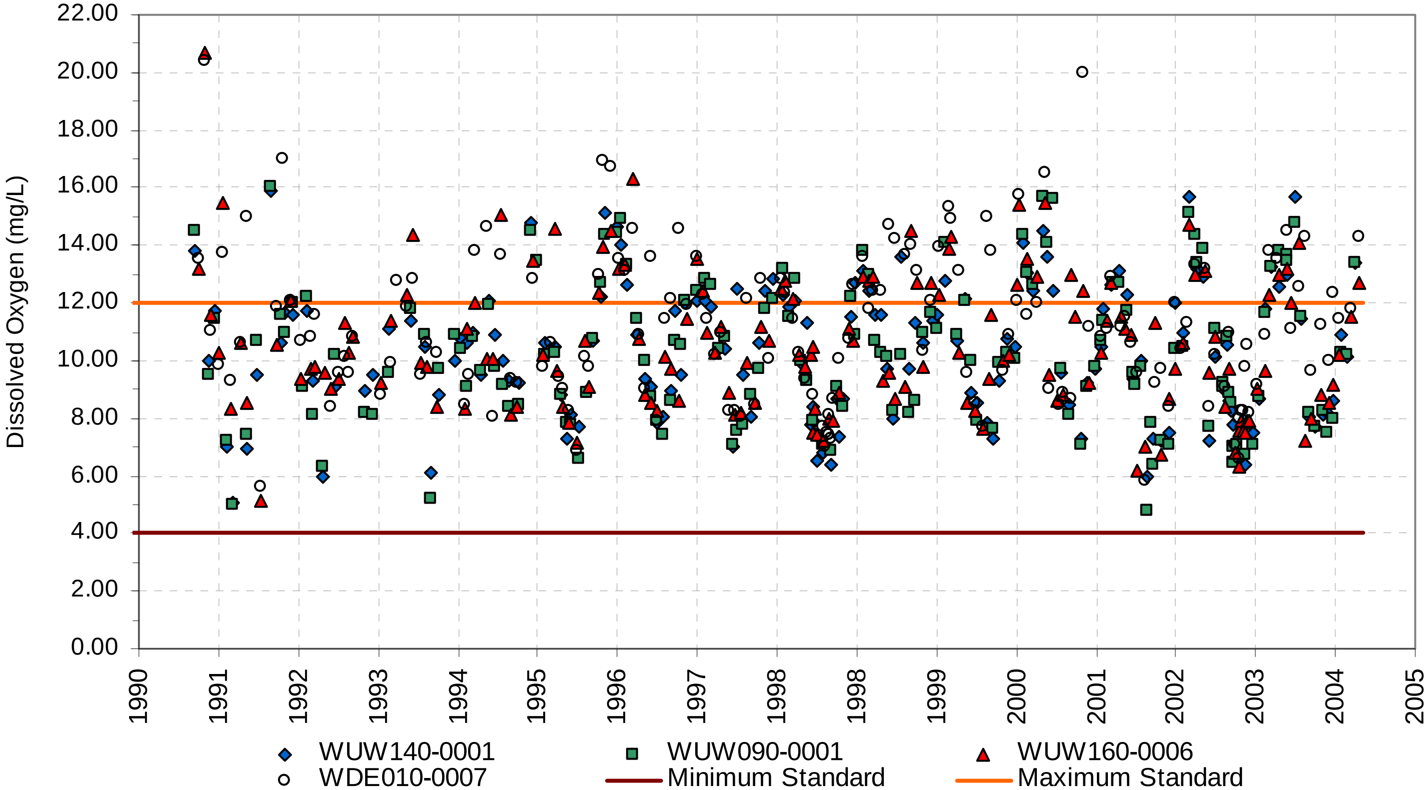


Figure E-2. Upper Wabash River dissolved oxygen sampling scatter plots.

Table E-3. Middle Wabash River Dissolved Oxygen Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	110	4.98	10.10	10.45	15.26	0.21
WLV010-0002	Lafayette, 20 Feet D/S From Brown St, 0.2 Miles U/S From Main St Bridge	1998	1999	31	-4.00	9.31	8.72	12.30	0.32
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	171	5.12	10.20	10.41	17.70	0.21
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2005	73	5.40	11.11	11.24	20.50	0.26
WBU040-0003	Us 40 And Us 150, Terre Haute	1999	1999	15	6.00	9.55	9.26	11.70	0.16
WBU040-0011	River Near Sw Corner of American Water Company Treatment Plant, Terre Haute And Upstream of Rr Track.	2002	2004	10	5.98	11.64	10.01	13.20	0.29
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	6	7.00	7.85	8.74	13.53	0.28
WLV090-0006	At Sr 32	1999	1999	5	12.10	14.70	14.30	15.50	0.09
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	166	5.20	10.22	10.32	19.59	0.21
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	11	5.98	10.00	11.04	19.12	0.32
WLV080-0005	E of Covington, On Right Approach To Old Us Hwy 136 Bridge	1999	1999	15	7.13	12.66	11.94	15.85	0.26
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	168	4.74	10.50	10.78	20.54	0.24
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	186	4.40	10.50	10.53	19.52	0.21

Table E-4. Middle Wabash River Dissolved Oxygen Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Minumum Standard Violations	Percent Minimum Standard Violations	Maximum Standard Violations	Percent Maximum Standard Violations
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	110	0	0%	32	29%
WLV010-0002	Lafayette, 20 Feet D/S From Brown St, 0.2 Miles U/S From Main St Bridge	1998	1999	31	1	3%	1	3%
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	171	0	0%	46	27%
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2005	73	0	0%	27	37%
WBU040-0003	Us 40 And Us 150, Terre Haute	1999	1999	15	0	0%	0	0%
WBU040-0011	River Near Sw Corner of American Water Company Treatment Plant, Terre Haute And Upstream of Rr Track.	2002	2004	10	0	0%	4	40%
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	6	0	0%	1	17%
WLV090-0006	At Sr 32	1999	1999	5	0	0%	5	100%
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	166	0	0%	39	23%
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	11	0	0%	3	27%
WLV080-0005	E of Covington, On Right Approach To Old Us Hwy 136 Bridge	1999	1999	15	0	0%	8	53%
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	168	0	0%	46	27%
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	186	0	0%	47	25%

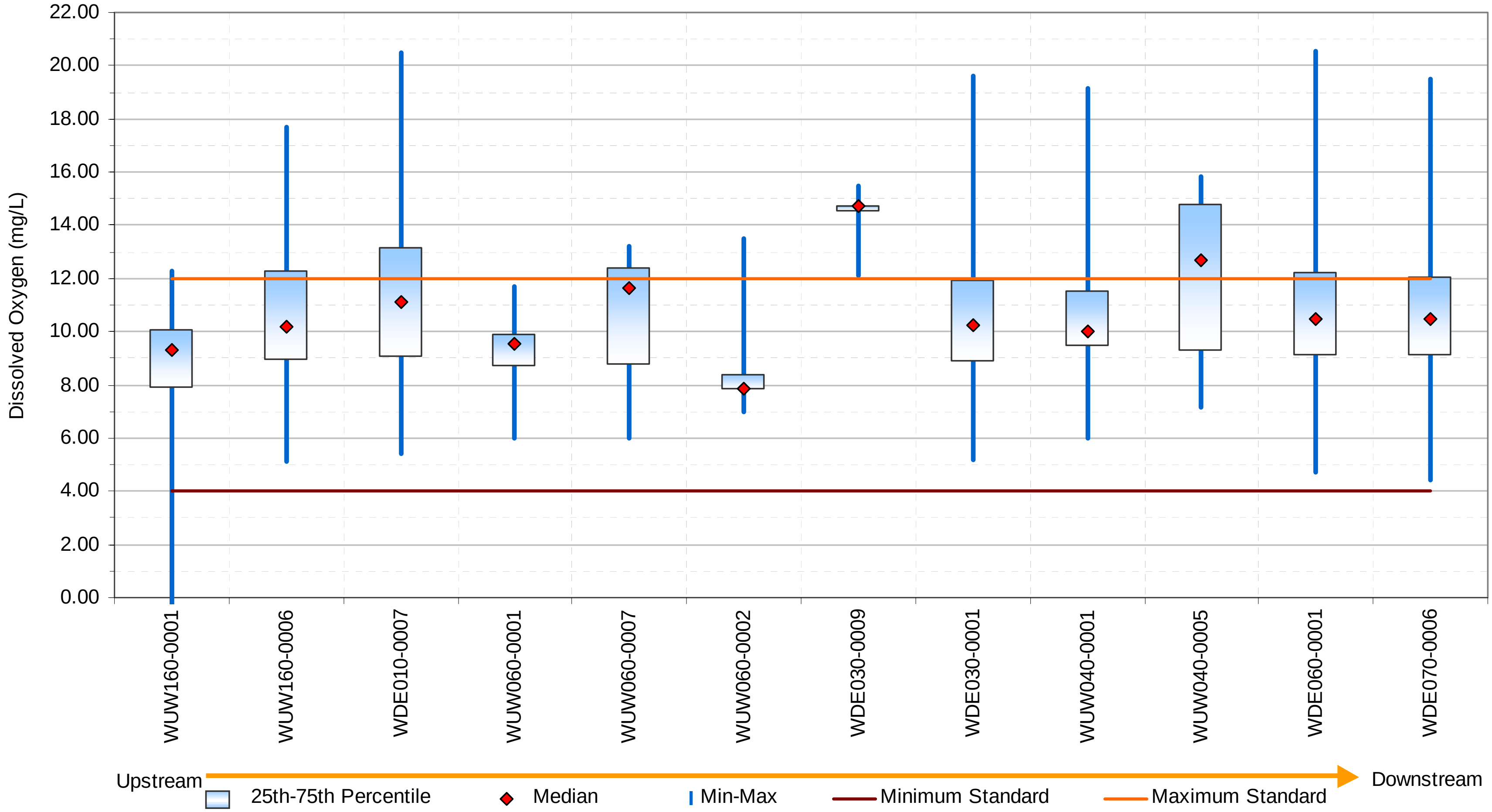


Figure E-3. Middle Wabash River dissolved oxygen sampling box plots.

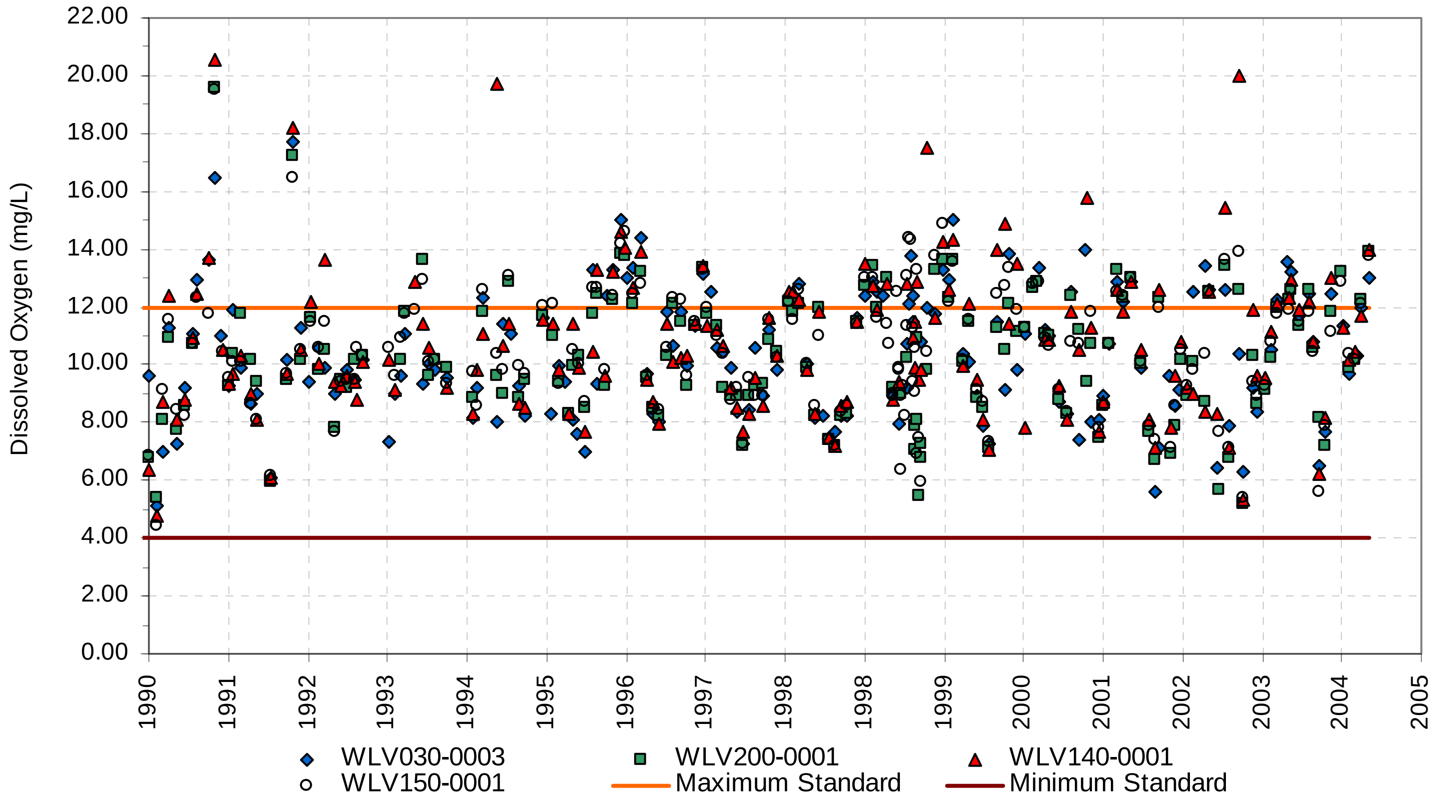


Figure A-6.

Figure E-4. Middle Wabash River dissolved oxygen sampling scatter plots.

Table E-5. Lower Wabash River Dissolved Oxygen Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WBU150-0002	Gaging Station At Riverton	1999	1999	15	6.20	9.03	8.73	10.28	0.13
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	162	3.94	9.50	9.68	15.90	0.23
WBU200-0004	At Lincoln Memorial Bridge, Vincennes	1999	1999	5	8.20	11.10	11.10	12.90	0.17
WLW040-0003	200+ Feet Above Rr Tracks, S of Mt. Carmel	2002	2003	7	6.94	10.47	9.73	12.11	0.2
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	179	4.74	10.22	10.25	17.60	0.22
WLW080-0003	I-64 Near Griffin	1999	1999	5	7.70	8.40	8.42	9.40	0.07
WLW040-0001	At Southern End of Patoka Is., Out From Boat Ramp	1999	1999	15	5.80	8.35	8.47	11.54	0.15

Table E-6. Lower Wabash River Dissolved Oxygen Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Minumum Standard Violations	Percent Minimum Standard Violations	Maximum Standard Violations	Percent Maximum Standard Violations
WBU150-0002	Gaging Station At Riverton	1999	1999	15	0	0%	0	0%
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	162	1	1%	25	15%
WBU200-0004	At Lincoln Memorial Bridge, Vincennes	1999	1999	5	0	0%	2	40%
WLW040-0003	200+ Feet Above Rr Tracks, S of Mt. Carmel	2002	2003	7	0	0%	1	14%
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	179	0	0%	38	21%
WLW080-0003	I-64 Near Griffin	1999	1999	5	0	0%	0	0%
WLW040-0001	At Southern End of Patoka Is., Out From Boat Ramp	1999	1999	15	0	0%	0	0%

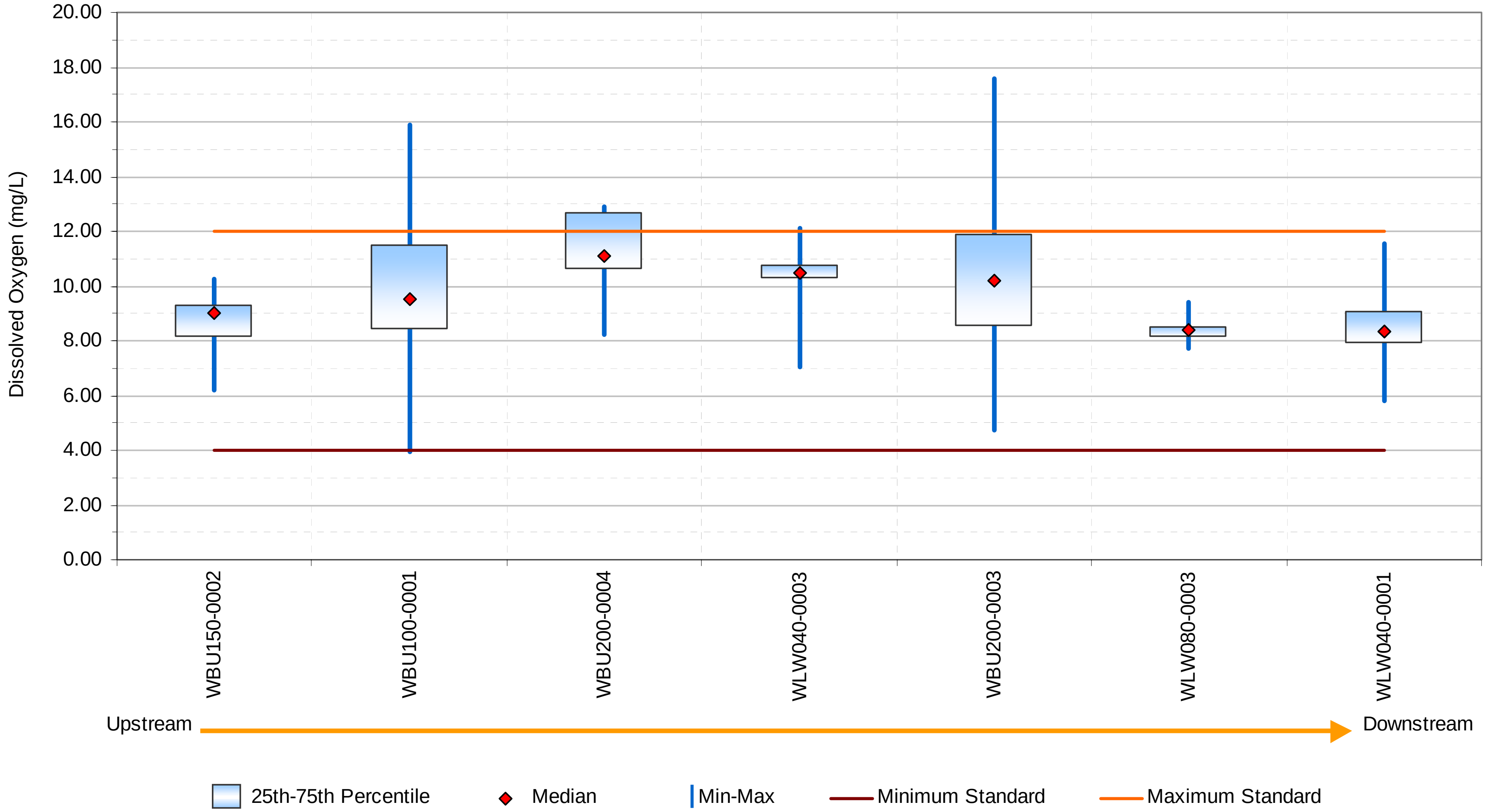


Figure E-5. Lower Wabash River dissolved oxygen sampling box plots.

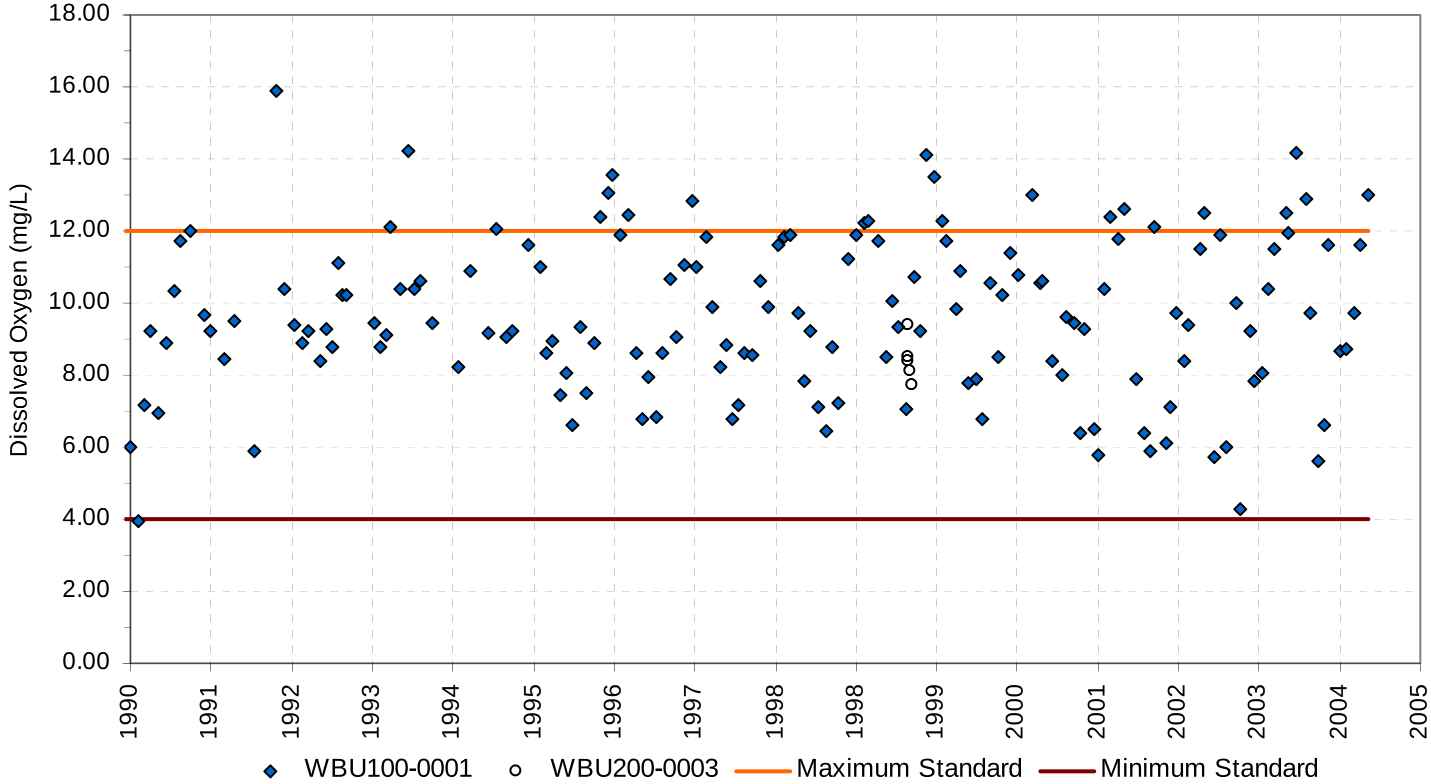


Figure E-6. Lower Wabash River dissolved oxygen sampling scatter plots.

APPENDIX F: pH SAMPLING DATA

Table F-1. Upper Wabash River pH Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WUW140-0005	600 Yds U/S of Rangeline Rd	1991	1991	1	7.42	7.42	7.42	7.42	0
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	314	7.01	7.95	7.97	8.90	0.04
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	330	6.53	7.95	7.94	9.00	0.05
WUW090-0002	Huntington Water And Light Plant, 2 Miles S of Huntington	1998	1998	15	7.34	7.82	7.84	8.35	0.04
WUW090-0012	Cr 200 W	2004	2004	2	7.68	7.94	7.94	8.20	0.05
WUW090-0007	Evergreen Road	2003	2003	1	7.67	7.67	7.67	7.67	0
WUW090-0004	D/S Huntington Reservoir Dam	1991	2004	2	7.44	7.67	7.67	7.90	0.04
WUW150-0007	Sr 524 At Lagro, D/S of Salamonie Confluence	2003	2003	5	7.79	8.15	8.14	8.54	0.03
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	305	6.63	8.04	8.01	8.94	0.05
WUW070-0007	Cr 100 W, S of Sr 116	2003	2003	5	7.58	8.40	8.34	8.89	0.06
WUW070-0006	Cr 300 W	1991	1991	1	6.96	6.96	6.96	6.96	0
WUW150-0001	Wabash, U/S Side of Wabash St, Sr 15 Bridge, 7.1 Miles D/S From Salamonie River	1998	2003	25	7.53	8.01	8.02	8.43	0.03
WUW070-0003	Cr 300N Near Bluffton	1998	1998	5	7.50	8.19	7.99	8.39	0.05
WUW180-0007	600 E Rd. - Cass Stationary Bridge	2003	2003	6	7.41	7.75	7.73	8.03	0.03
WDE010-0003	Sr 25 Bridge (Cicott St), IN Logansport	2003	2003	5	7.92	8.25	8.16	8.40	0.02
WDE010-0001	Logansport, 150 Feet D/S From Cicott St Bridge, 1,000 Feet D/S From Eel	1998	1998	15	7.76	8.10	8.26	9.00	0.05
WUW070-0005	1/4Mi D/S of Sr 1	1991	1991	1	7.34	7.34	7.34	7.34	0
WUW160-0001	Peru, U/S Side of Us 31 Bridge, 0.5 Miles Sw of Peru	1998	2003	20	7.40	8.10	8.01	8.81	0.04
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	320	6.92	8.05	8.07	9.30	0.04
WDE010-0007	Cr 675, W of Georgetown	1991	2004	324	7.05	8.15	8.17	9.30	0.05
WUW070-0004	D/S Sr 316, Bluffton, IN	1993	1993	1	7.50	7.50	7.50	7.50	0
WDE020-0007	Mouth Little Rock Cr	1991	1991	1	8.39	8.39	8.39	8.39	0
WDE030-0008	Cr 275 W	2003	2003	3	8.25	8.51	8.46	8.63	0.02

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WUW060-0001	Linn Grove, Sr 218 Bridge	1998	2003	34	7.09	8.10	8.03	8.80	0.06
WDE030-0003	Towpath Rd	1991	1991	1	8.35	8.35	8.35	8.35	0
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	41	7.13	7.92	7.99	8.93	0.05
WUW060-0002	Us 27	1991	2002	246	6.69	7.95	7.95	8.89	0.04
WDE030-0007	Towpath Rd	2003	2003	3	7.93	8.21	8.29	8.74	0.05
WDE030-0009	Bridge W of Delphi - 39 - 421	2003	2003	6	7.60	7.92	7.92	8.23	0.03
WDE030-0001	Cr 200 N Near Delphi	1998	1998	5	7.69	7.80	7.76	7.80	0.01
WUW040-0001	State Line Rd	1998	2003	10	7.30	8.19	8.11	8.74	0.06
WUW040-0002	Cr 215 E	1991	2004	2	8.17	8.26	8.26	8.34	0.01
WUW040-0005	At Stateline Bridge	2004	2004	19	7.47	8.12	8.08	8.96	0.04
WDE060-0001	Bridge At Americus	2001	2004	99	4.03	8.16	8.18	9.39	0.07

Table F-2. Upper Wabash River pH Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Minumum Standard Violations	Percent Minimum Standard Violations	Maximum Standard Violations	Percent Maximum Standard Violations
WUW140-0005	600 Yds U/S of Rangeline Rd	1991	1991	1	0	0%	0	0%
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	314	0	0%	0	0%
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	330	0	0%	0	0%
WUW090-0002	Huntington Water And Light Plant, 2 Miles S of Huntington	1998	1998	15	0	0%	0	0%
WUW090-0012	Cr 200 W	2004	2004	2	0	0%	0	0%
WUW090-0007	Evergreen Road	2003	2003	1	0	0%	0	0%
WUW090-0004	D/S Huntington Reservoir Dam	1991	2004	2	0	0%	0	0%
WUW150-0007	Sr 524 At Lagro, D/S of Salamonie Confluence	2003	2003	5	0	0%	0	0%
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	305	0	0%	0	0%
WUW070-0007	Cr 100 W, S of Sr 116	2003	2003	5	0	0%	0	0%
WUW070-0006	Cr 300 W	1991	1991	1	0	0%	0	0%
WUW150-0001	Wabash, U/S Side of Wabash St, Sr 15 Bridge, 7.1 Miles D/S From Salamonie River	1998	2003	25	0	0%	0	0%
WUW070-0003	Cr 300N Near Bluffton	1998	1998	5	0	0%	0	0%
WUW180-0007	600 E Rd. - Cass Stationary Bridge	2003	2003	6	0	0%	0	0%
WDE010-0003	Sr 25 Bridge (Cicott St), IN Logansport	2003	2003	5	0	0%	0	0%
WDE010-0001	Logansport, 150 Feet D/S From Cicott St Bridge, 1,000 Feet D/S From Eel	1998	1998	15	0	0%	0	0%

Station ID	Location	Start	End	Count	Minumum Standard Violations	Percent Minimum Standard Violations	Maximum Standard Violations	Percent Maximum Standard Violations
WUW070-0005	1/4Mi D/S of Sr 1	1991	1991	1	0	0%	0	0%
WUW160-0001	Peru, U/S Side of Us 31 Bridge, 0.5 Miles Sw of Peru	1998	2003	20	0	0%	0	0%
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	320	0	0%	2	1%
WDE010-0007	Cr 675, W of Georgetown	1991	2004	324	0	0%	1	<1%
WUW070-0004	D/S Sr 316, Bluffton, IN	1993	1993	1	0	0%	0	0%
WDE020-0007	Mouth Little Rock Cr	1991	1991	1	0	0%	0	0%
WDE030-0008	Cr 275 W	2003	2003	3	0	0%	0	0%
WUW060-0001	Linn Grove, Sr 218 Bridge	1998	2003	34	0	0%	0	0%
WDE030-0003	Towpath Rd	1991	1991	1	0	0%	0	0%
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	41	0	0%	0	0%
WUW060-0002	Us 27	1991	2002	246	0	0%	0	0%
WDE030-0007	Towpath Rd	2003	2003	3	0	0%	0	0%
WDE030-0009	Bridge W of Delphi - 39 - 421	2003	2003	6	0	0%	0	0%
WDE030-0001	Cr 200 N Near Delphi	1998	1998	5	0	0%	0	0%
WUW040-0001	State Line Rd	1998	2003	10	0	0%	0	0%
WUW040-0002	Cr 215 E	1991	2004	2	0	0%	0	0%
WUW040-0005	At Stateline Bridge	2004	2004	19	0	0%	0	0%
WDE060-0001	Bridge At Americus	2001	2004	99	0	0%	0	0%

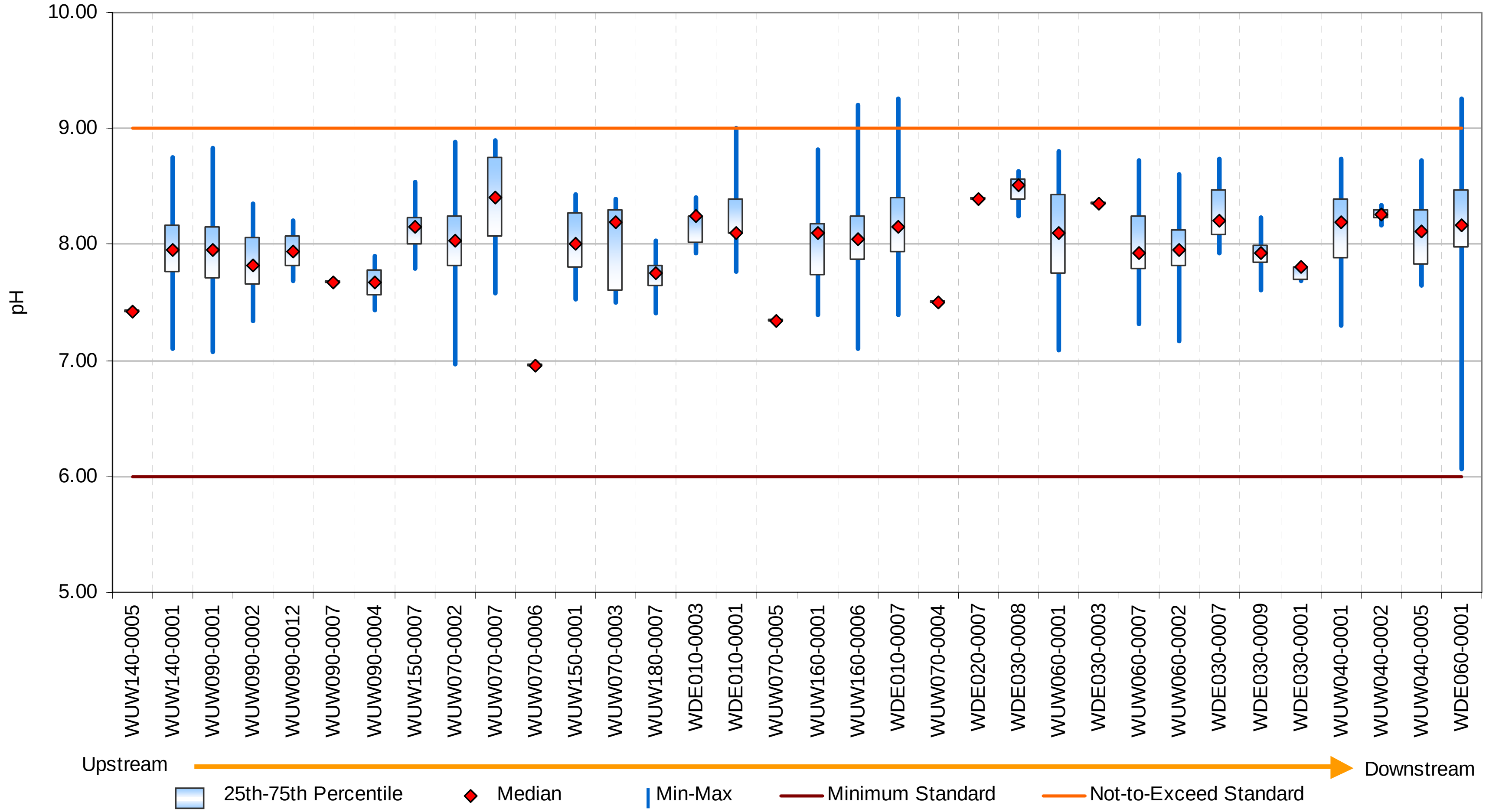


Figure F-1. Upper Wabash River pH sampling box plots.

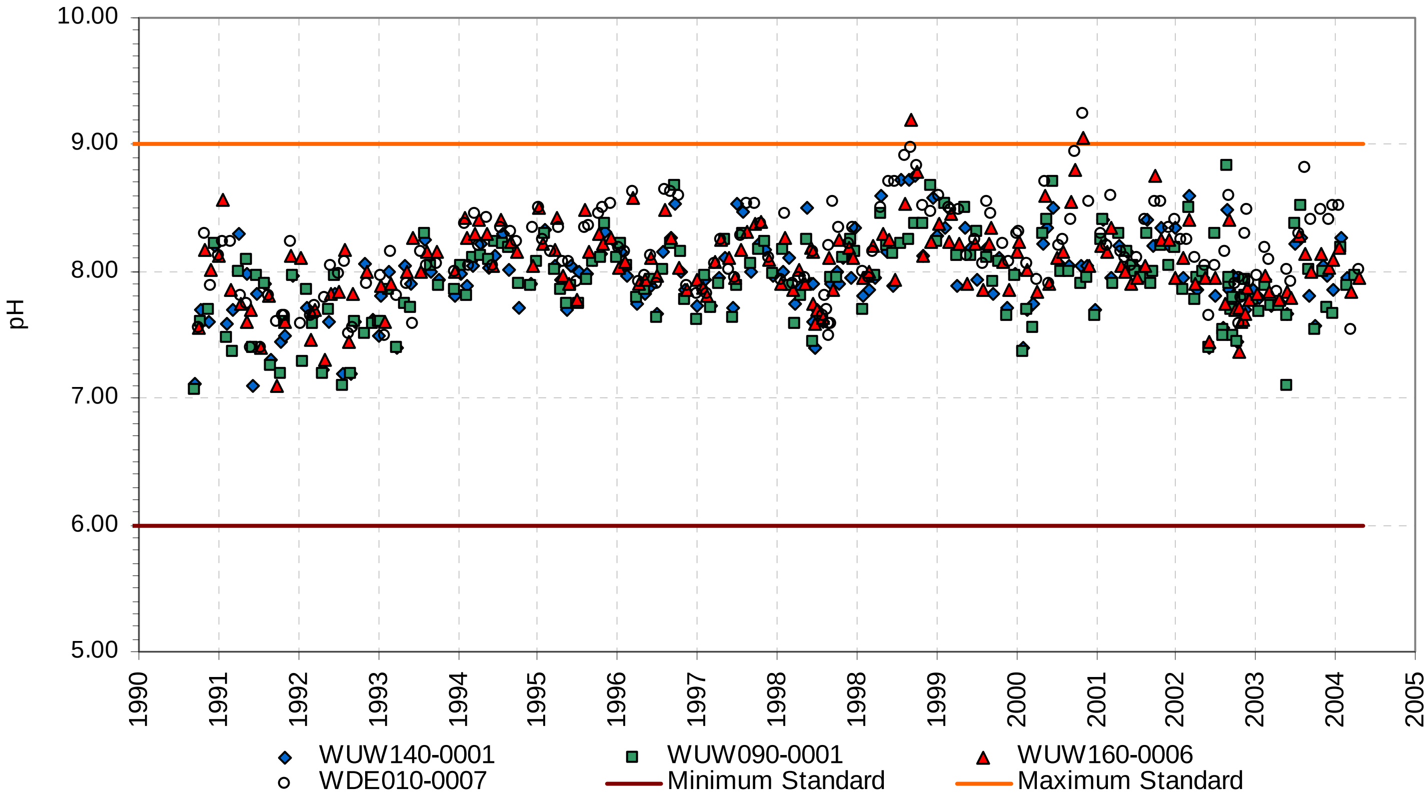


Figure F-2. Upper Wabash River pH sampling scatter plots.

Table F-3. Middle Wabash River pH Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	218	7.09	8.14	8.13	9.10	0.04
WDE070-0002	Sr 225	1995	1995	1	8.84	8.84	8.84	8.84	0
WLV010-0007	Mascouten Pk	1991	1999	2	8.05	8.31	8.31	8.57	0.04
WLV010-0002	Lafayette, 20 Feet D/S From Brown St, 0.2 Miles U/S From Main St Bridge	1998	1999	31	7.46	8.25	8.22	8.60	0.03
WLV010-0003	Main St (Sr 26) Bridge, IN Lafayette	2003	2003	1	7.86	7.86	7.86	7.86	0
WLV030-0012	Granville Bridge	1995	1995	1	8.68	8.68	8.68	8.68	0
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	335	6.36	8.15	8.12	8.94	0.04
WLV030-0006	Cr 700 W	1999	1999	3	7.82	8.72	8.54	9.07	0.08
WLV030-0001	Cr 500 E 134-145P	1999	1999	1	8.80	8.80	8.80	8.80	0
WLV070-0001	Sr 41	1999	1999	3	7.53	8.56	8.59	9.68	0.13
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2005	134	7.00	8.23	8.26	9.43	0.04
WLV080-0009	Sr 263	1999	1999	3	8.22	9.27	9.13	9.89	0.09
WBU040-0003	Us 40 And Us 150, Terre Haute	1999	1999	15	6.98	8.15	8.05	8.39	0.05
WBU040-0011	River Near Sw Corner of American Water Company Treatment Plant, Terre Haute And Upstream of Rr Track.	2002	2004	18	7.40	7.99	8.01	8.53	0.04
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	6	7.90	8.10	8.11	8.48	0.02
WLV090-0006	At Sr 32	1999	1999	5	8.50	8.60	8.62	8.69	0.01
WLV090-0001	Sr 32 134-045P	1999	1999	1	8.47	8.47	8.47	8.47	0
WBU050-0010	Us 40	2004	2004	2	8.00	8.06	8.06	8.12	0.01
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	326	7.00	8.12	8.11	9.10	0.04
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	22	7.30	7.84	7.81	8.56	0.05
WLV080-0002	Sr 136 134-069P	1999	1999	1	8.56	8.56	8.56	8.56	0
WLV080-0005	E of Covington, On Right Approach To Old Us Hwy 136 Bridge	1999	1999	15	7.34	8.57	8.48	9.03	0.05
WLV090-0003	D/S I-74	1999	1999	3	8.56	9.50	9.19	9.52	0.06
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	328	7.00	8.15	8.17	9.39	0.04
WBU050-0001	Fairbanks Pk Dock	1995	1995	1	8.81	8.81	8.81	8.81	0
WLV080-0001	Sr 136 134-053P	1999	1999	1	9.28	9.28	9.28	9.28	0
WLV080-0004	Us 136 Bridge, Covington	1999	1999	5	8.60	8.65	8.72	8.89	0.01
WBU040-0012	Fairbanks Pk	1999	1999	1	8.43	8.43	8.43	8.43	0
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	348	7.10	8.14	8.15	9.00	0.04
WBU200-0008	Henderson Rd	1999	1999	3	6.76	8.28	7.82	8.43	0.12
WBU070-0001	Dresser Power Plant, Terre Haute	1991	1992	11	7.19	7.50	7.71	8.20	0.05

Table F-4. Middle Wabash River pH Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Minimum Standard Violations	Percent Minimum Standard Violations	Maximum Standard Violations	Percent Maximum Standard Violations
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	218	0	0%	1	<1%
WDE070-0002	Sr 225	1995	1995	1	0	0%	0	0%
WLV010-0007	Mascouten Pk	1991	1999	2	0	0%	0	0%
WLV010-0002	Lafayette, 20 Feet D/S From Brown St, 0.2 Miles U/S From Main St Bridge	1998	1999	31	0	0%	0	0%
WLV010-0003	Main St (Sr 26) Bridge, IN Lafayette	2003	2003	1	0	0%	0	0%
WLV030-0012	Granville Bridge	1995	1995	1	0	0%	0	0%
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	335	0	0%	0	0%
WLV030-0006	Cr 700 W	1999	1999	3	0	0%	1	33%
WLV030-0001	Cr 500 E 134-145P	1999	1999	1	0	0%	0	0%
WLV070-0001	Sr 41	1999	1999	3	0	0%	1	33%
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2005	134	0	0%	3	2%
WLV080-0009	Sr 263	1999	1999	3	0	0%	2	67%
WBU040-0003	Us 40 And Us 150, Terre Haute	1999	1999	15	0	0%	0	0%
WBU040-0011	River Near Sw Corner of American Water Company Treatment Plant, Terre Haute And Upstream of Rr Track.	2002	2004	18	0	0%	0	0%
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	6	0	0%	0	0%
WLV090-0006	At Sr 32	1999	1999	5	0	0%	0	0%
WLV090-0001	Sr 32 134-045P	1999	1999	1	0	0%	0	0%
WBU050-0010	Us 40	2004	2004	2	0	0%	0	0%
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	326	0	0%	0	0%
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	22	0	0%	0	0%
WLV080-0002	Sr 136 134-069P	1999	1999	1	0	0%	0	0%
WLV080-0005	E of Covington, On Right Approach To Old Us Hwy 136 Bridge	1999	1999	15	0	0%	1	7%
WLV090-0003	D/S I-74	1999	1999	3	0	0%	2	67%
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	328	0	0%	2	1%
WBU050-0001	Fairbanks Pk Dock	1995	1995	1	0	0%	0	0%
WLV080-0001	Sr 136 134-053P	1999	1999	1	0	0%	1	100%
WLV080-0004	Us 136 Bridge, Covington	1999	1999	5	0	0%	0	0%
WBU040-0012	Fairbanks Pk	1999	1999	1	0	0%	0	0%
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	348	0	0%	0	0%
WBU200-0008	Henderson Rd	1999	1999	3	0	0%	0	0%
WBU070-0001	Dresser Power Plant, Terre Haute	1991	1992	11	0	0%	0	0%

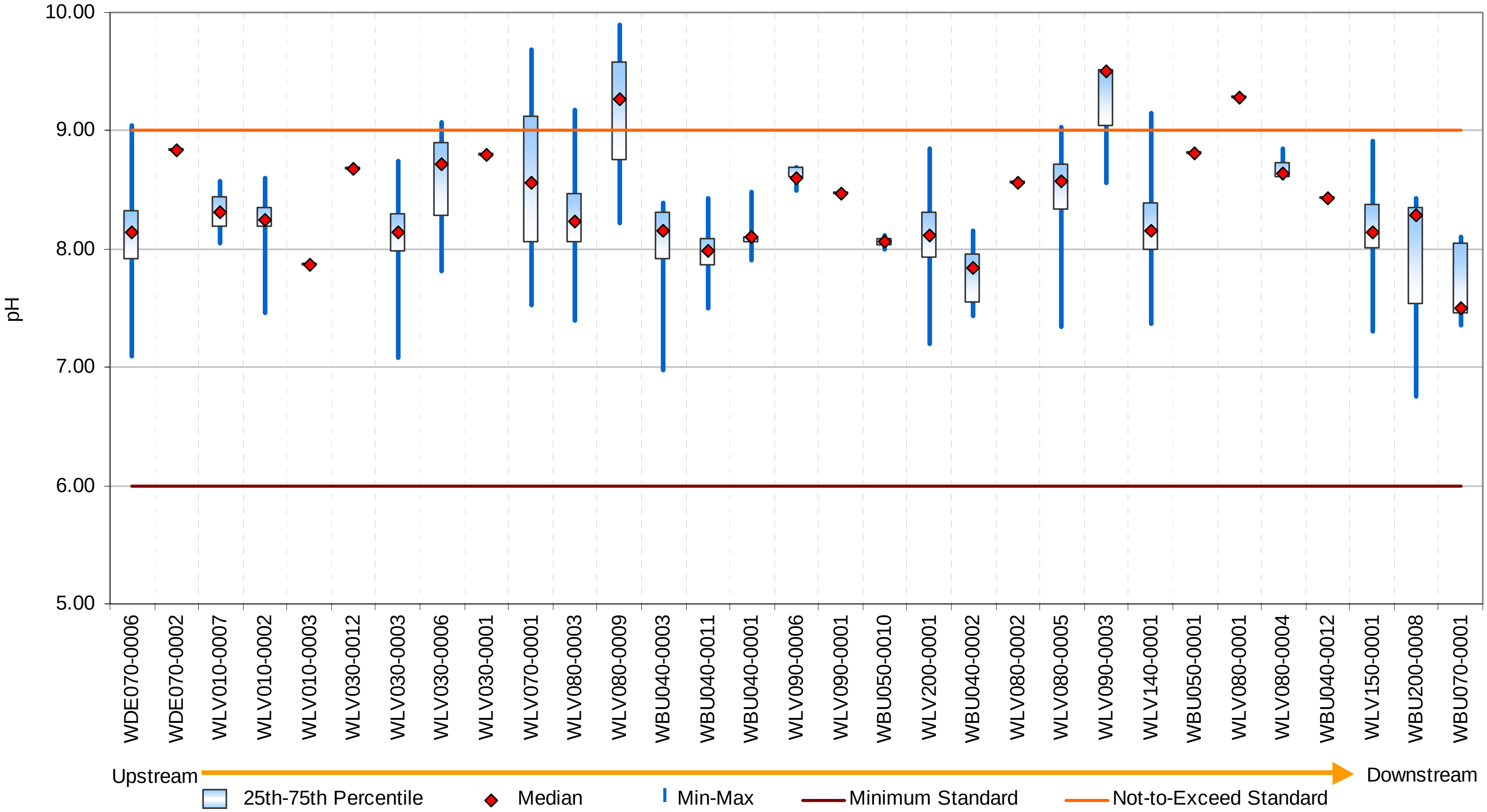


Figure F-3. Middle Wabash River pH sampling box plots.

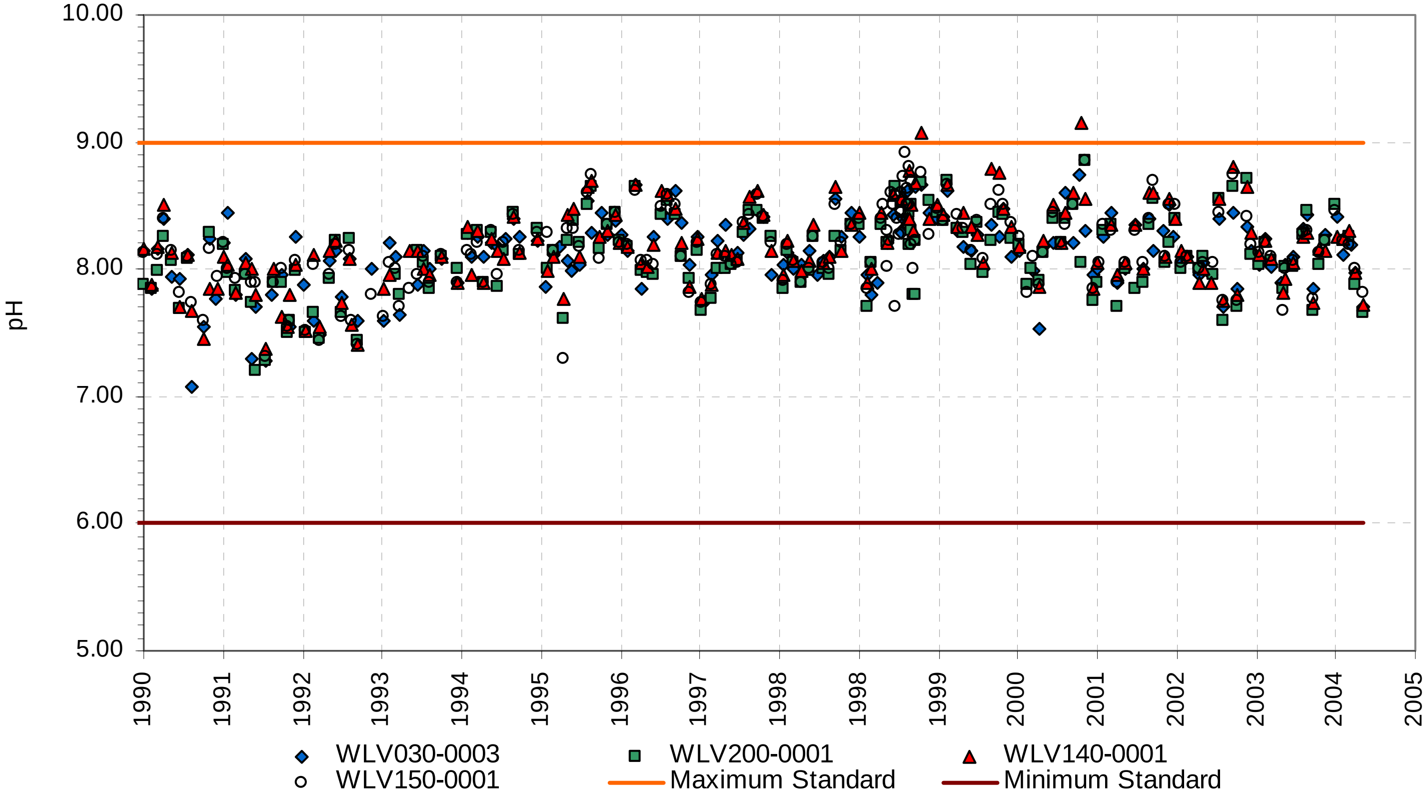


Figure F-4. Middle Wabash River pH sampling scatter plots.

Table F-5. Lower Wabash River pH Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (mg/L)	Median (mg/L)	Average (mg/L)	Maximum (mg/L)	CV
WBU150-0002	Gaging Station At Riverton	1999	1999	15	7.88	8.13	8.18	8.50	0.02
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	324	6.80	8.02	8.03	9.90	0.05
WBU200-0004	At Lincoln Memorial Bridge, Vincennes	1999	1999	5	8.19	8.39	8.41	8.69	0.02
WLW010-0001	St Francisville Rd 134-052P	1999	1999	1	8.30	8.30	8.30	8.30	0
WLW100-0004	New Harmony, IN	1997	1997	1	7.92	7.92	7.92	7.92	0
WLW040-0003	200+ Feet Above Rr Tracks, S of Mt. Carmel	2002	2003	12	-4.00	8.10	7.18	8.58	0.49
WLW080-0004	Cr 900 N	1999	1999	3	8.39	8.47	8.55	8.80	0.03
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	345	6.73	8.09	8.09	9.10	0.05
WLW080-0003	I-64 Near Griffin	1999	1999	5	8.00	8.10	8.08	8.10	0.01
WLW040-0001	At Southern End of Patoka Is., Out From Boat Ramp	1999	1999	15	7.59	8.15	8.05	8.43	0.03
WLW100-0001	Sr 66 134-060P	1999	1999	1	8.71	8.71	8.71	8.71	0
WLW080-0001	I-64 134-096	1999	1999	1	8.50	8.50	8.50	8.50	0
WLW060-0003	Crawleyville Boat Ramp	1999	1999	3	8.55	8.72	8.84	9.26	0.04

Table F-6. Lower Wabash River pH Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Minumum Standard Violations	Percent Minimum Standard Violations	Maximum Standard Violations	Percent Maximum Standard Violations
WBU150-0002	Gaging Station At Riverton	1999	1999	15	0	0%	0	0%
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	324	0	0%	0	0%
WBU200-0004	At Lincoln Memorial Bridge, Vincennes	1999	1999	5	0	0%	0	0%
WLW010-0001	St Francisville Rd 134-052P	1999	1999	1	0	0%	0	0%
WLW100-0004	New Harmony, IN	1997	1997	1	0	0%	0	0%
WLW040-0003	200+ Feet Above Rr Tracks, S of Mt. Carmel	2002	2003	12	1	8%	0	0%
WLW080-0004	Cr 900 N	1999	1999	3	0	0%	0	0%
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	345	0	0%	0	0%
WLW080-0003	I-64 Near Griffin	1999	1999	5	0	0%	0	0%
WLW040-0001	At Southern End of Patoka Is., Out From Boat Ramp	1999	1999	15	0	0%	0	0%
WLW100-0001	Sr 66 134-060P	1999	1999	1	0	0%	0	0%
WLW080-0001	I-64 134-096	1999	1999	1	0	0%	0	0%
WLW060-0003	Crawleyville Boat Ramp	1999	1999	3	0	0%	1	33%

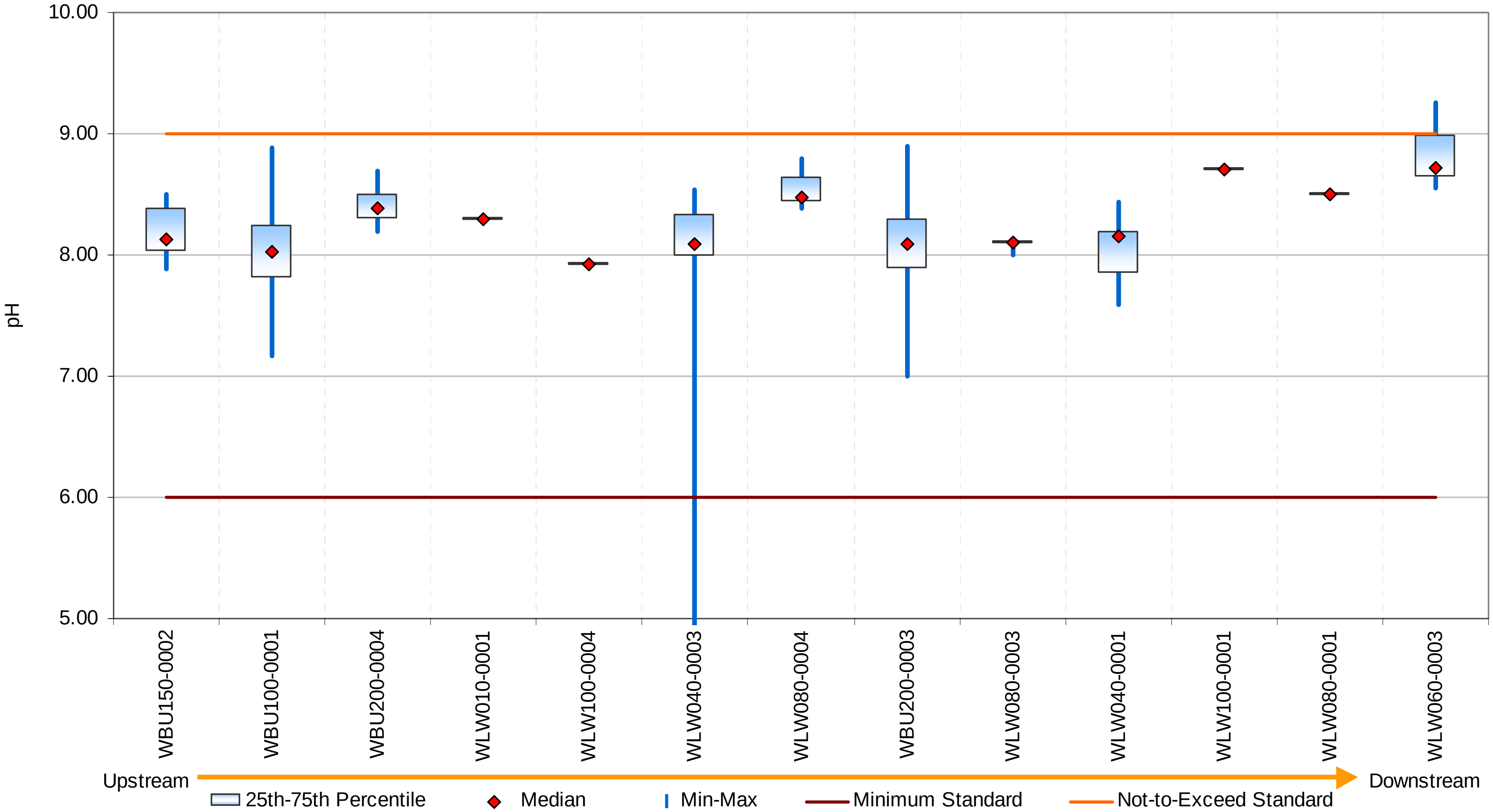


Figure F-5. Lower Wabash River pH sampling box plots.

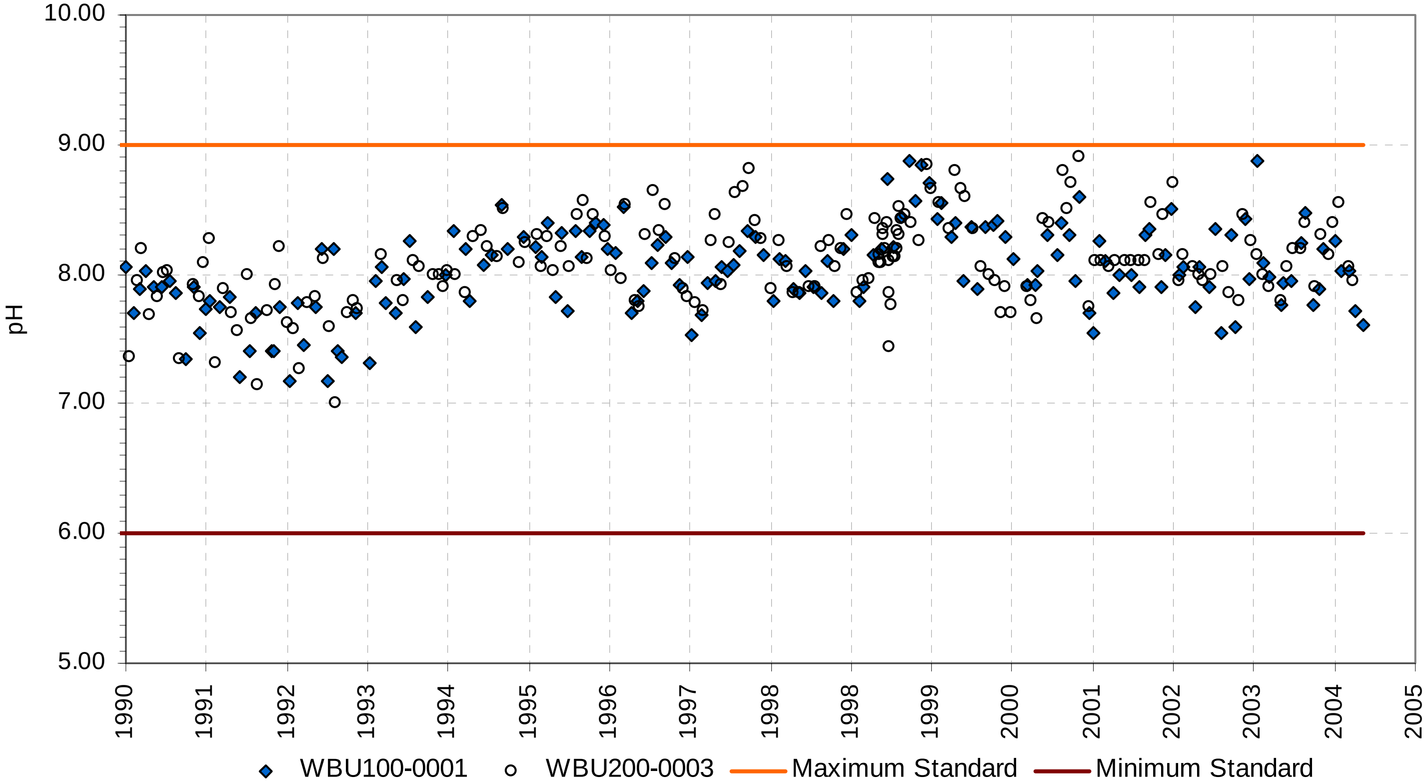


Figure F-6. **Upper Wabash River pH sampling scatter plots.**

APPENDIX G: TEMPERATURE SAMPLING DATA

Ambient Water Quality Stations

Table G-1. Upper Wabash River Temperature Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (Deg C)	Median (Deg C)	Average (Deg C)	Maximum (Deg C)	CV
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	164	0.01	14.15	13.64	27.59	0.62
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	167	0.05	14.02	13.60	29.38	0.64
WUW090-0002	Huntington Water And Light Plant, 2 Miles S of Huntington	1998	1998	15	13.60	21.20	20.96	27.20	0.2
WUW150-0007	Sr 524 At Lagro, D/S of Salamonie Confluence	2003	2003	5	16.62	20.31	20.59	24.02	0.15
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	155	0.07	13.96	13.91	32.56	0.62
WUW070-0007	Cr 100 W, S of Sr 116	2003	2003	5	15.03	21.52	20.69	25.28	0.18
WUW150-0001	Wabash, U/S Side of Wabash St, Sr 15 Bridge, 7.1 Miles D/S From Salamonie River	1998	2003	25	10.01	20.50	19.65	24.24	0.19
WUW070-0003	Cr 300N Near Bluffton	1998	1998	5	16.50	22.00	21.50	25.00	0.15
WUW180-0007	600 E Rd. - Cass Stationary Bridge	2003	2003	6	23.10	23.62	24.00	25.94	0.05
WDE010-0003	Sr 25 Bridge (Cicott St), IN Logansport	2003	2003	5	14.10	15.53	17.54	22.78	0.23
WDE010-0001	Logansport, 150 Feet D/S From Cicott St Bridge, 1,000 Feet D/S From Eel	1998	1998	15	12.50	22.39	20.77	24.39	0.19
WUW160-0001	Peru, U/S Side of Us 31 Bridge, 0.5 Miles Sw of Peru	1998	2003	20	12.30	22.63	21.21	25.10	0.17
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	166	0.33	14.39	18.29	683.00	2.88
WDE010-0007	Cr 675, W of Georgetown	1991	2004	169	0.06	15.10	14.78	29.95	0.6
WUW060-0001	Linn Grove, Sr 218 Bridge	1998	2003	34	12.60	21.79	21.81	28.20	0.18
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	23	1.70	15.09	15.25	25.99	0.44
WUW060-0002	Us 27	1991	2002	125	0.43	13.80	13.81	28.17	0.64
WDE030-0009	Bridge W of Delphi - 39 - 421	2003	2003	6	22.44	22.91	23.49	26.11	0.06
WDE030-0001	Cr 200 N Near Delphi	1998	1998	5	23.00	24.00	23.80	24.50	0.03
WUW040-0001	State Line Rd	1998	2003	10	14.40	20.25	19.95	23.78	0.15
WUW040-0005	At Stateline Bridge	2004	2004	10	6.18	15.11	14.25	24.45	0.44
WDE060-0001	Bridge At Americus	2001	2004	53	0.02	15.77	14.72	29.20	0.63

Table G-2. Upper Wabash River Temperature Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Not-to-Exceed Violations	Percent Not-to-Exceed Violations
WUW140-0001	Sr 105 Bridge, N of Andrews	1991	2004	164	0	0%
WUW090-0001	S Side of Huntington At Old Sr 9 Bridge (Etna Rd)	1991	2004	167	0	0%
WUW090-0002	Huntington Water And Light Plant, 2 Miles S of Huntington	1998	1998	15	0	0%
WUW150-0007	Sr 524 At Lagro, D/S of Salamonie Confluence	2003	2003	5	0	0%
WUW070-0002	Sr 3 Bridge, Markle 2Nd Bridge Going Out of Town	1991	2004	155	0	0%
WUW070-0007	Cr 100 W, S of Sr 116	2003	2003	5	0	0%
WUW150-0001	Wabash, U/S Side of Wabash St, Sr 15 Bridge, 7.1 Miles D/S From Salamonie River	1998	2003	25	0	0%
WUW070-0003	Cr 300N Near Bluffton	1998	1998	5	0	0%
WUW180-0007	600 E Rd. - Cass Stationary Bridge	2003	2003	6	0	0%
WDE010-0003	Sr 25 Bridge (Cicott St), IN Logansport	2003	2003	5	0	0%
WDE010-0001	Logansport, 150 Feet D/S From Cicott St Bridge, 1,000 Feet D/S From Eel	1998	1998	15	0	0%
WUW160-0001	Peru, U/S Side of Us 31 Bridge, 0.5 Miles Sw of Peru	1998	2003	20	0	0%
WUW160-0006	Business Us 31 Bridge, S of Peru	1991	2004	166	0	0%
WDE010-0007	Cr 675, W of Georgetown	1991	2004	169	0	0%
WUW060-0001	Linn Grove, Sr 218 Bridge	1998	2003	34	0	0%
WUW060-0007	At Adams Cr 300W, Ne of Geneva	2003	2004	23	0	0%
WUW060-0002	Us 27	1991	2002	125	0	0%
WDE030-0009	Bridge W of Delphi - 39 - 421	2003	2003	6	0	0%
WDE030-0001	Cr 200 N Near Delphi	1998	1998	5	0	0%
WUW040-0001	State Line Rd	1998	2003	10	0	0%
WUW040-0005	At Stateline Bridge	2004	2004	10	0	0%
WDE060-0001	Bridge At Americus	2001	2004	53	0	0%

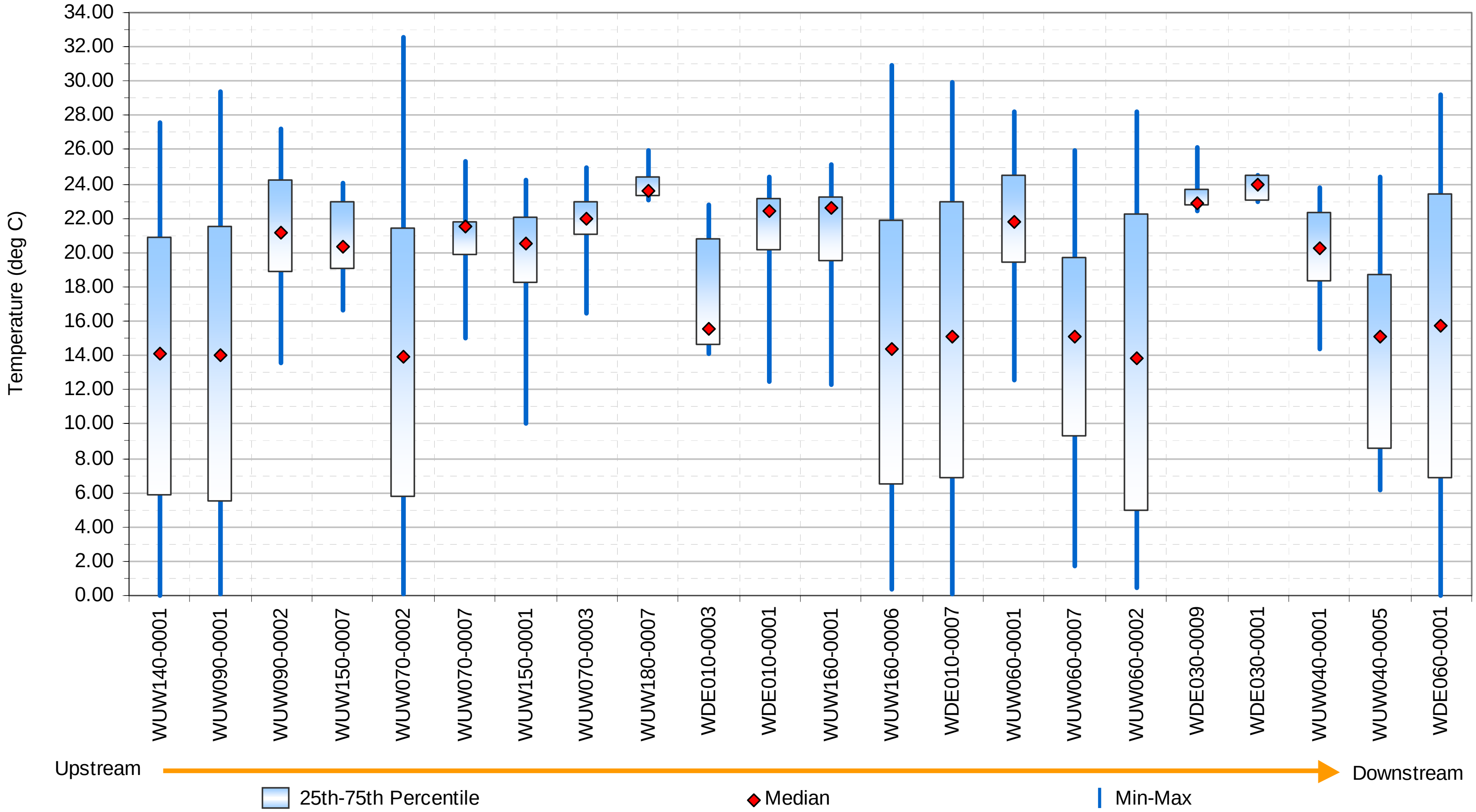


Figure G-1. **Upper Wabash River temperature sampling box plots.**

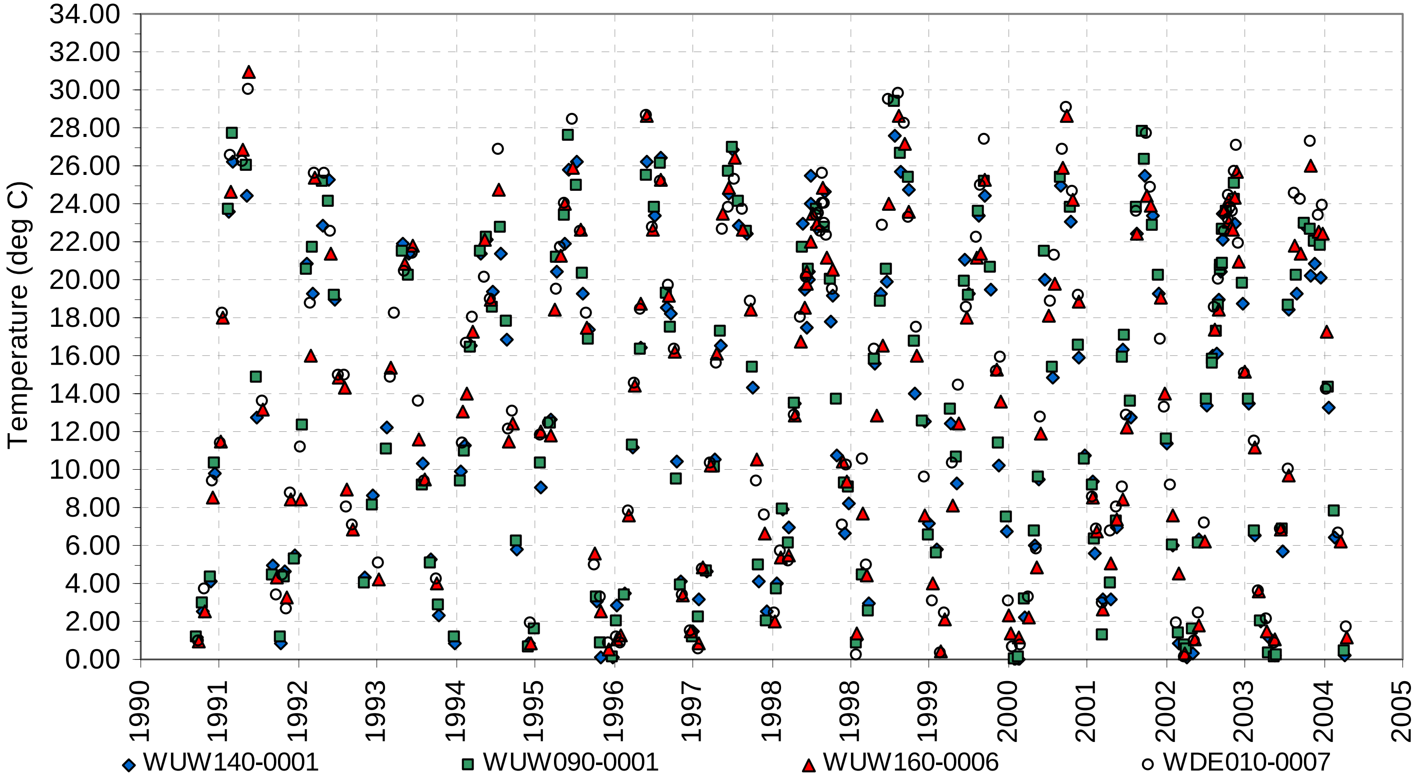


Figure G-2. **Upper Wabash River temperature sampling scatter plots.**

Table G-3. Middle Wabash River Temperature Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (Deg C)	Median (Deg C)	Average (Deg C)	Maximum (Deg C)	CV
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	111	0.09	14.39	14.35	29.68	0.6
WLV010-0002	Lafayette, 20 Feet D/S From Brown St, 0.2 Miles U/S From Main St Bridge	1998	1999	31	11.69	21.60	21.23	27.60	0.2
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	172	0.06	14.30	14.51	31.56	0.6
WLV080-0003	Williamsport, Shawnee Bridge, Cr 160 W	1999	2005	73	0.14	15.37	14.96	28.45	0.6
WBU040-0003	Us 40 And Us 150, Terre Haute	1999	1999	15	14.43	23.55	24.09	32.15	0.2
WBU040-0011	River Near Sw Corner of American Water Company Treatment Plant, Terre Haute And Upstream of Rr Track.	2002	2004	10	2.11	10.60	14.71	28.56	0.7
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	6	24.44	28.50	28.24	30.50	0.1
WLV090-0006	At Sr 32	1999	1999	5	23.00	25.00	24.80	27.50	0.1
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	167	0.23	16.15	15.83	30.60	0.6
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	11	1.00	13.38	13.88	30.56	0.7
WLV080-0005	E of Covington, On Right Approach To Old Us Hwy 136 Bridge	1999	1999	15	13.30	23.35	22.21	31.02	0.3
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	169	0.00	14.55	14.64	31.43	0.6
WLV080-0004	Us 136 Bridge, Covington	1999	1999	5	23.00	24.50	25.00	28.00	0.1
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	188	0.40	16.30	16.07	32.20	0.6

Table G-4. Middle Wabash River Temperature Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Not-to-Exceed Violations	Percent Not-to-Exceed Violations
WDE070-0006	Sr 225 Near Battleground, At Lafayette	1991	2000	111	0	0%
WLV010-0002	Lafayette, 20 Feet D/S From Brown St, 0.2 Miles U/S From Main St Bridge	1998	1999	31	0	0%
WLV030-0003	Cr 700 W, Near Lafayette	1990	2005	172	0	0%
WBU040-0003	Us 40 And Us 150, Terre Haute	1999	1999	15	0	0%
WBU040-0011	River Near Sw Corner of American Water Company Treatment Plant, Terre Haute And Upstream of Rr Track.	2002	2004	10	0	0%
WBU040-0001	Us 40 And Us 150, 134-068P	1999	1999	6	0	0%
WLV090-0006	At Sr 32	1999	1999	5	0	0%
WLV200-0001	Sr 163 Bridge, E Clinton	1990	2005	167	0	0%
WBU040-0002	Fort Harrison Boat Club Near Terre Haute	1991	1993	11	0	0%
WLV080-0005	E of Covington, On Right Approach To Old Us Hwy 136 Bridge	1999	1999	15	0	0%
WLV140-0001	Sr 234 Bridge, Cayuga	1990	2005	169	0	0%
WLV080-0004	Us 136 Bridge, Covington	1999	1999	5	0	0%
WLV150-0001	Us 36 Bridge, W Edge of Montezuma	1990	2005	188	0	0%

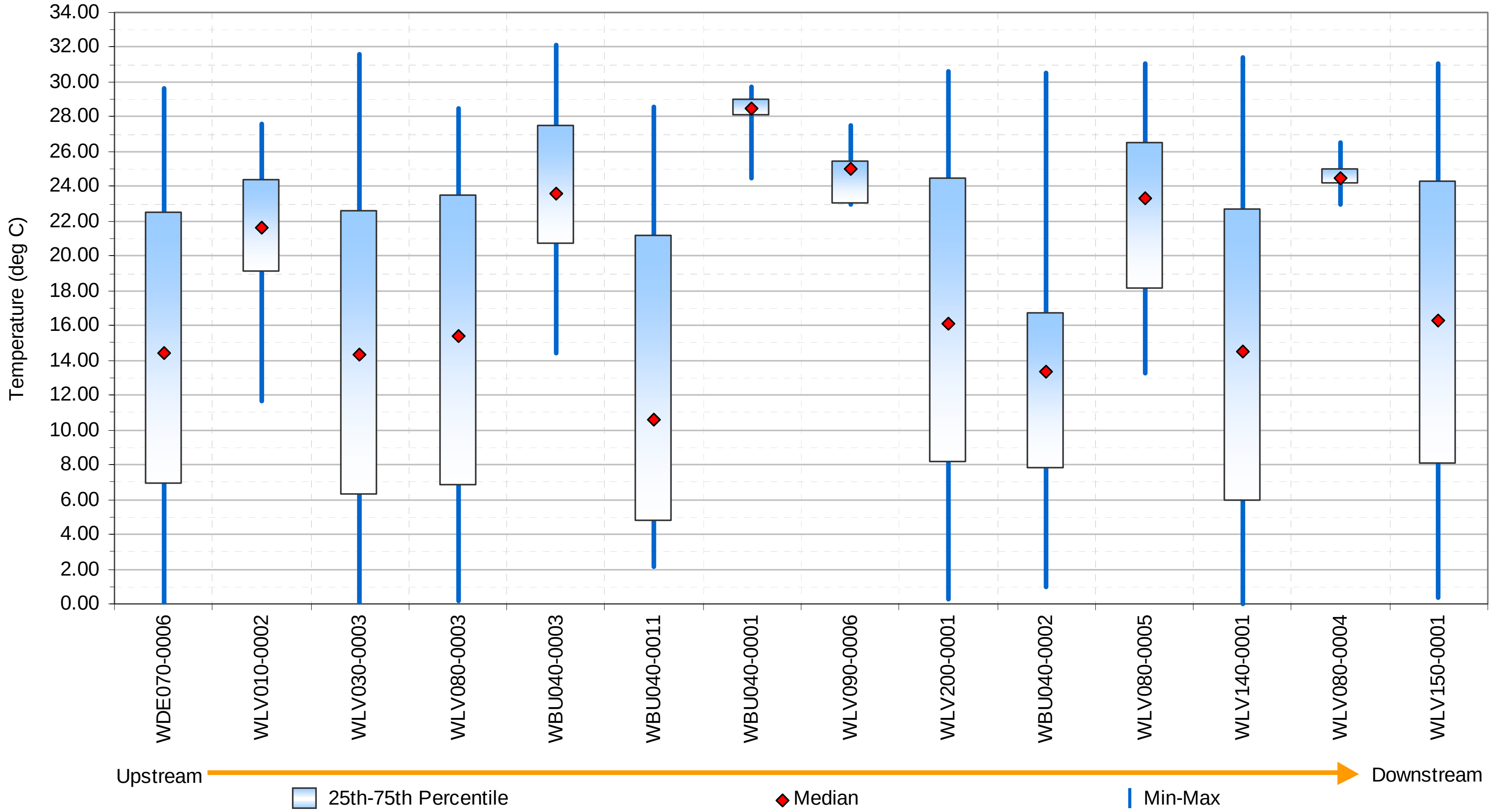


Figure G-3. **Middle Wabash River temperature sampling box plots.**

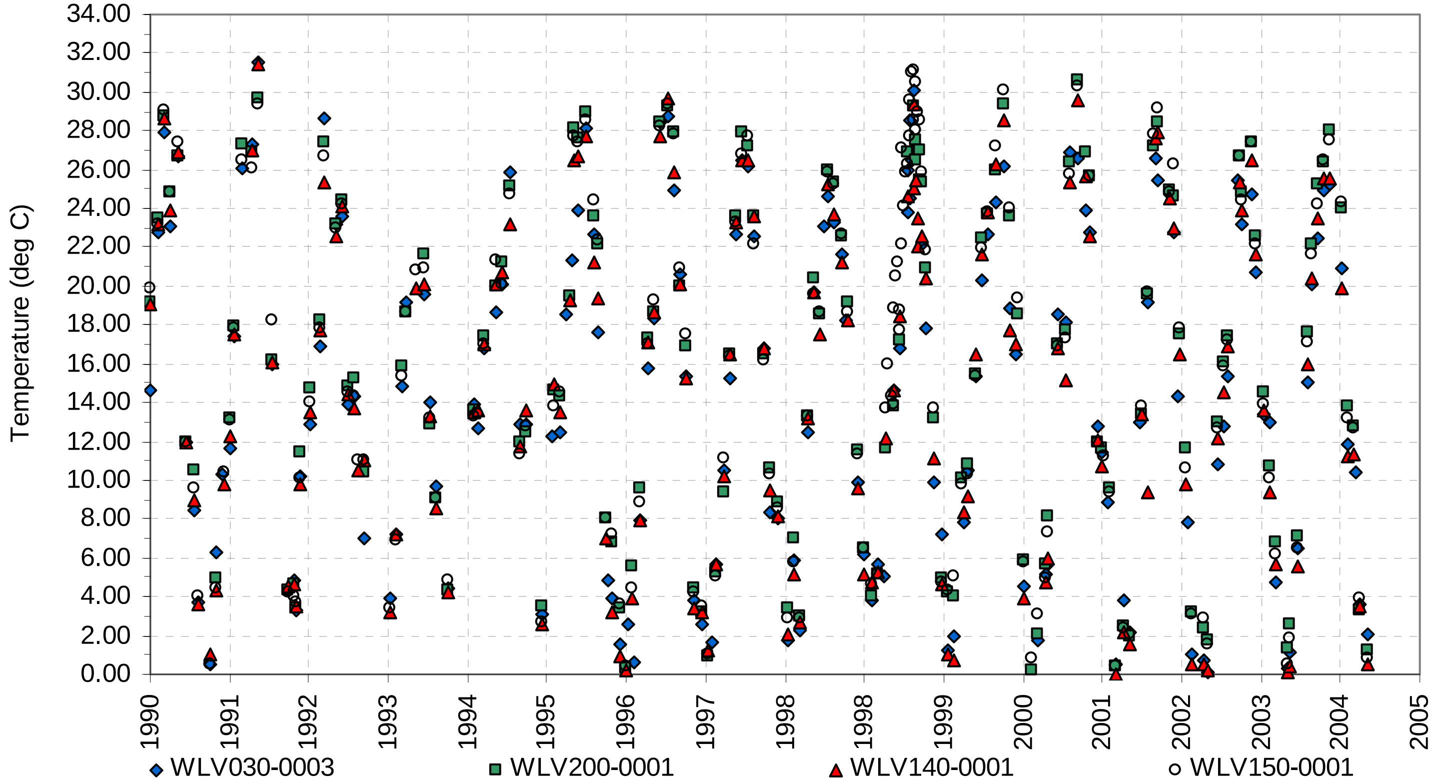


Figure G-4. **Middle Wabash River temperature sampling scatter plots.**

Table G-5. Lower Wabash River Temperature Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (Deg C)	Median (Deg C)	Average (Deg C)	Maximum (Deg C)	CV
WBU150-0002	Gaging Station At Riverton	1999	1999	15	15.64	23.20	23.73	32.04	0.22
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	163	0.40	15.57	15.36	30.60	0.56
WBU200-0004	At Lincoln Memorial Bridge, Vincennes	1999	1999	5	26.50	27.50	27.50	29.50	0.04
WLW040-0003	200+ Feet Above Rr Tracks, S of Mt. Carmel	2002	2003	7	4.75	16.94	17.56	28.50	0.5
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	181	0.15	16.70	16.37	32.11	0.53
WLW080-0003	I-64 Near Griffin	1999	1999	5	25.00	27.00	27.00	29.00	0.05
WLW040-0001	At Southern End of Patoka Is., Out From Boat Ramp	1999	1999	14	15.17	23.16	23.10	31.00	0.2

Table G-6. Lower Wabash River Temperature Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Not-to-Exceed Violations	Percent Not-to-Exceed Violations
WBU150-0002	Gaging Station At Riverton	1999	1999	15	0	0%
WBU100-0001	W of Fairbanks, I & M Generating Station	1990	2005	163	0	0%
WBU200-0004	At Lincoln Memorial Bridge, Vincennes	1999	1999	5	0	0%
WLW040-0003	200+ Feet Above Rr Tracks, S of Mt. Carmel	2002	2003	7	0	0%
WBU200-0003	Old Us Hwy 50 Bridge, Vigo St Vincenes	1990	2004	181	0	0%
WLW080-0003	I-64 Near Griffin	1999	1999	5	0	0%
WLW040-0001	At Southern End of Patoka Is., Out From Boat Ramp	1999	1999	14	0	0%

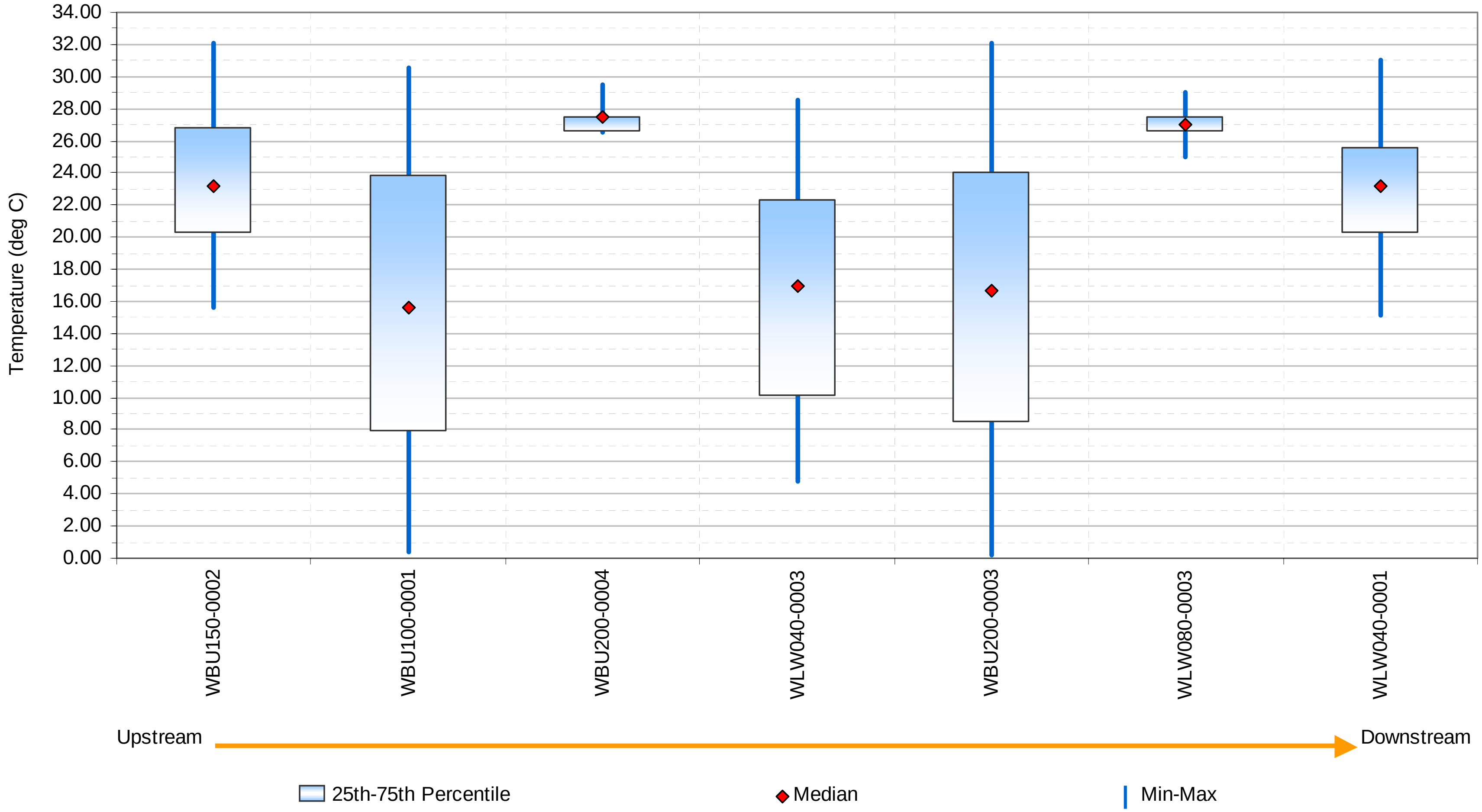


Figure G-5. **Lower Wabash River temperature sampling box polots.**

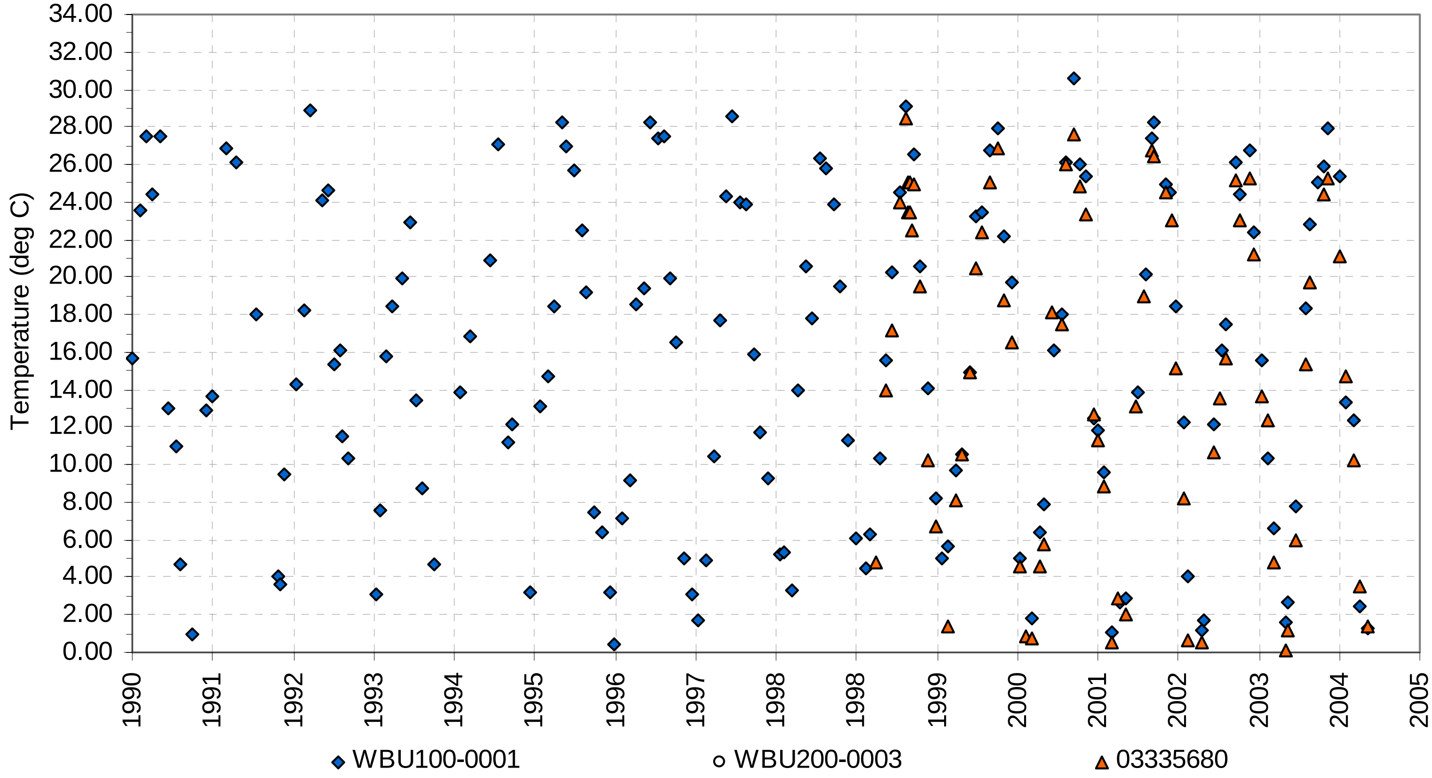


Figure G-6. **Lower Wabash River temperature sampling scatter plots.**

NPDES Water Quality Stations

Table G-7. Indiana NPDES Temperature Sampling Summary Statistics.

Station ID	Location	Start	End	Count	Minimum (Deg F)	Median (Deg F)	Average (Deg F)	Maximum (Deg F)	CV
IN0003484	BPB MANUFACTURING, INC.	2000	2005	58	34.90	58.50	57.64	78.00	0.2
IN0044130	PERU POWER PLANT, PERU UTILITY	2000	2004	114	30.00	77.00	63.97	90.00	0.3
IN0001074	LXP-SEC I, LLC	2000	2004	55	47.00	58.00	57.35	74.00	0.1
IN0003361	CARGILL, INC.	2000	2002	31	40.00	60.00	60.94	76.00	0.2
IN0001210	ALUMINUM CO. OF AM. (ALCOA)	2000	2005	61	50.00	62.00	61.59	72.00	0.1
IN0001481	FAIRFIELD MANUFACTURING CO.	2000	2004	60	40.50	58.50	59.01	76.40	0.2
IN0003859	PURDUE U. PHYSICAL PLANT	2000	2005	118	63.00	75.00	75.40	87.00	0.1
IN0002861	ELI LILLY & CO. TIPPECANOE LAB	2000	2004	59	62.00	72.00	82.34	78.00	1
IN0002348	HARRISON STEEL CASTINGS CO.	2000	2005	60	43.50	57.25	57.06	65.00	0.1
IN0002763	PSI CAYUGA GENERATING STATION	2000	2004	150	32.90	77.80	69.96	97.80	0.2
IN0002852	ELI LILLY & CO., CLINTON LABS	2000	2005	61	66.00	82.00	82.00	96.00	0.1
IN0001627	NOVELIS-ALCAN ALUMINUM CORP.	2000	2005	60	45.25	65.17	65.38	79.75	0.1
IN0002810	PSI WABASH RIVER GEN. STATION	2000	2004	179	34.50	77.40	66.01	97.00	0.3
IN0060844	MIRANT SUGAR CREEK, LLC	2001	2005	22	37.70	63.90	65.15	84.32	0.2

Table G-8. Indiana NPDES Temperature Sampling Violation Statistics.

Station ID	Location	Start	End	Count	Not-to-Exceed Violations	Percent Not-to-Exceed Violations
IN0003484	BPB MANUFACTURING, INC.	2000	2005	58	0	0%
IN0044130	PERU POWER PLANT, PERU UTILITY	2000	2004	114	0	0%
IN0001074	LXP-SEC I, LLC	2000	2004	55	8	15%
IN0003361	CARGILL, INC.	2000	2002	31	5	16%
IN0001210	ALUMINUM CO. OF AM. (ALCOA)	2000	2005	61	4	7%
IN0001481	FAIRFIELD MANUFACTURING CO.	2000	2004	60	1	2%
IN0003859	PURDUE U. PHYSICAL PLANT	2000	2005	118	26	22%
IN0002861	ELI LILLY & CO. TIPPECANOE LAB	2000	2004	59	23	39%
IN0002348	HARRISON STEEL CASTINGS CO.	2000	2005	60	7	12%
IN0002763	PSI CAYUGA GENERATING STATION	2000	2004	150	41	27%
IN0002852	ELI LILLY & CO., CLINTON LABS	2000	2005	61	38	62%
IN0001627	NOVELIS-ALCAN ALUMINUM CORP.	2000	2005	60	9	15%
IN0002810	PSI WABASH RIVER GEN. STATION	2000	2004	179	33	18%
IN0060844	MIRANT SUGAR CREEK, LLC	2001	2005	22	0	0%

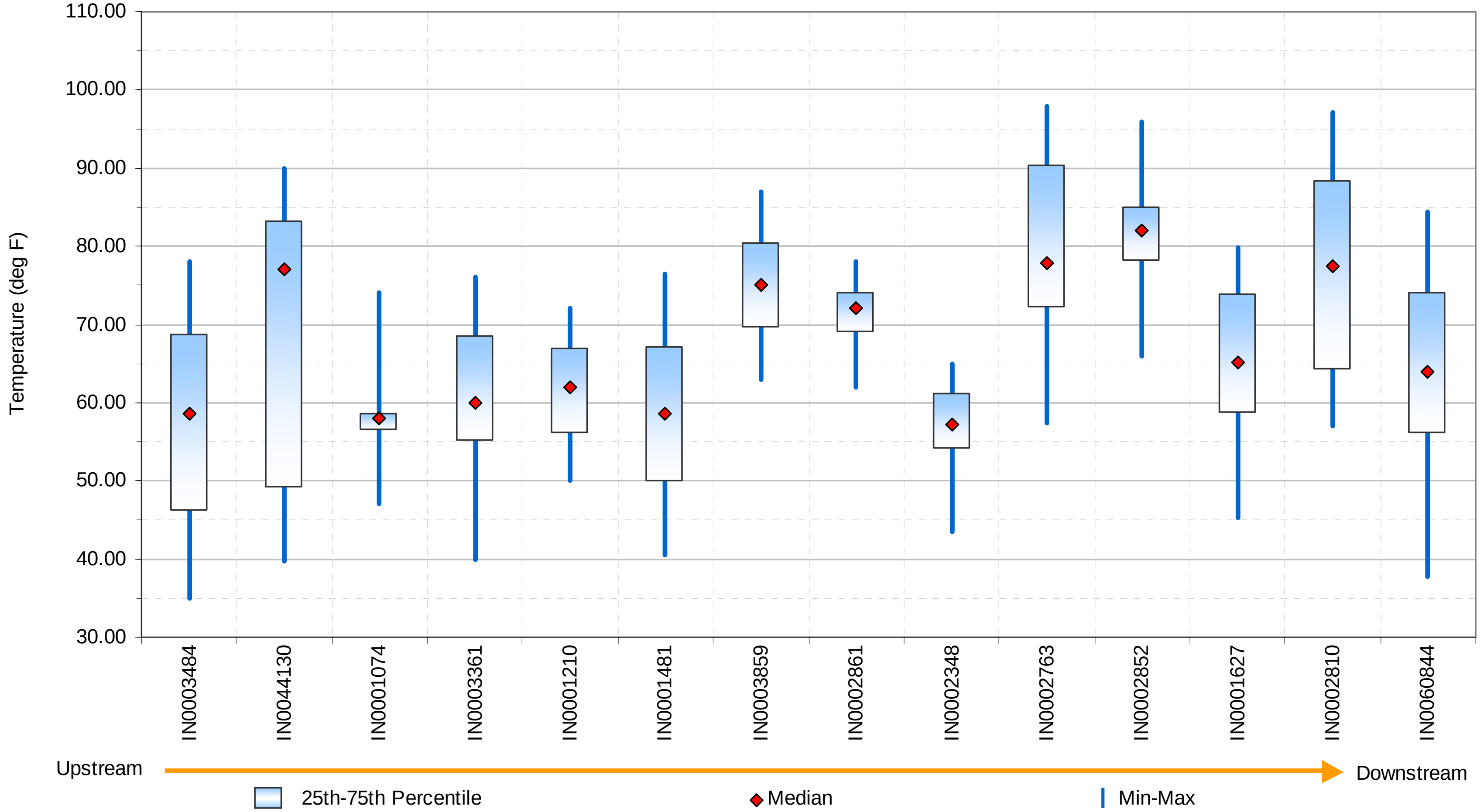


Figure G-7. Indiana NPDES temperature sampling box plots.

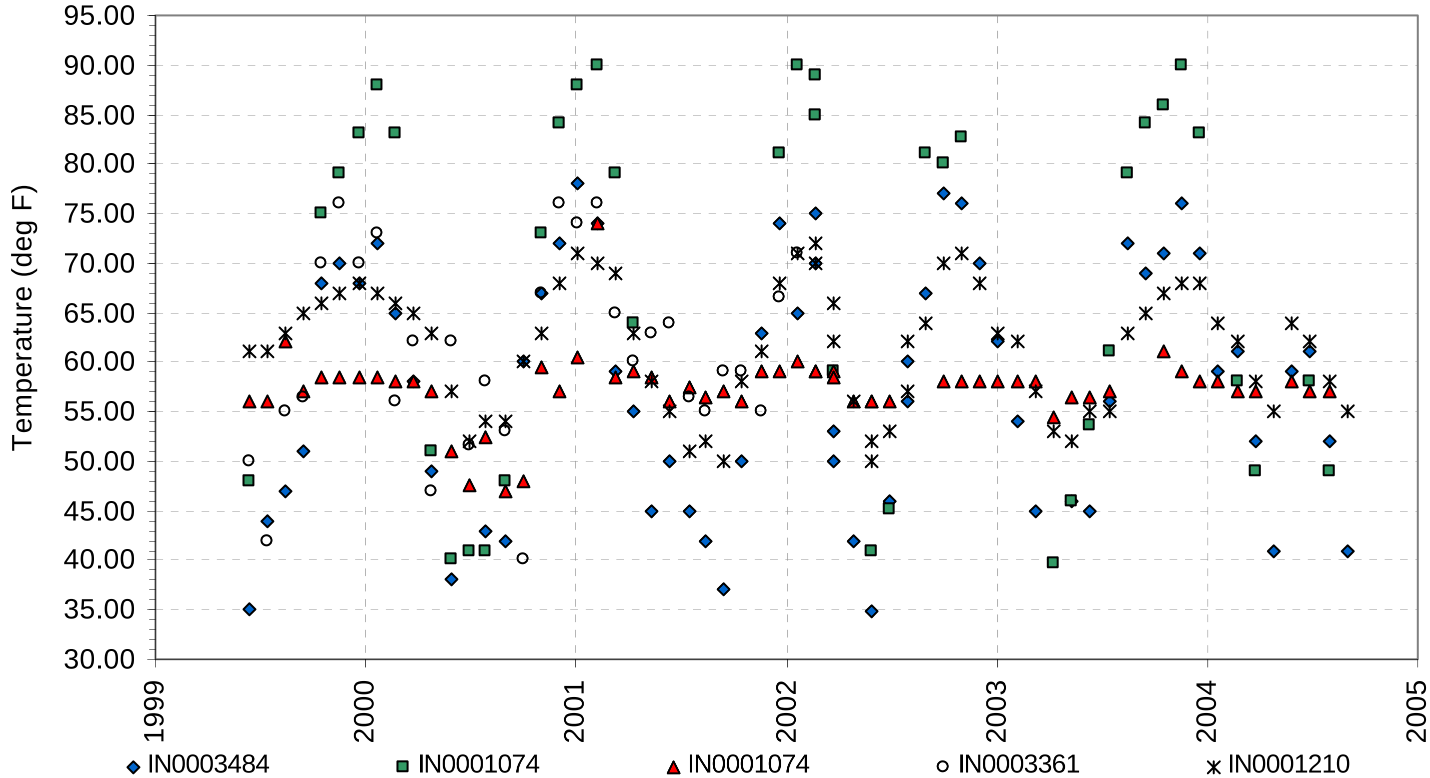


Figure G-8. **Indiana NPDES temperature sampling scatter plots.**

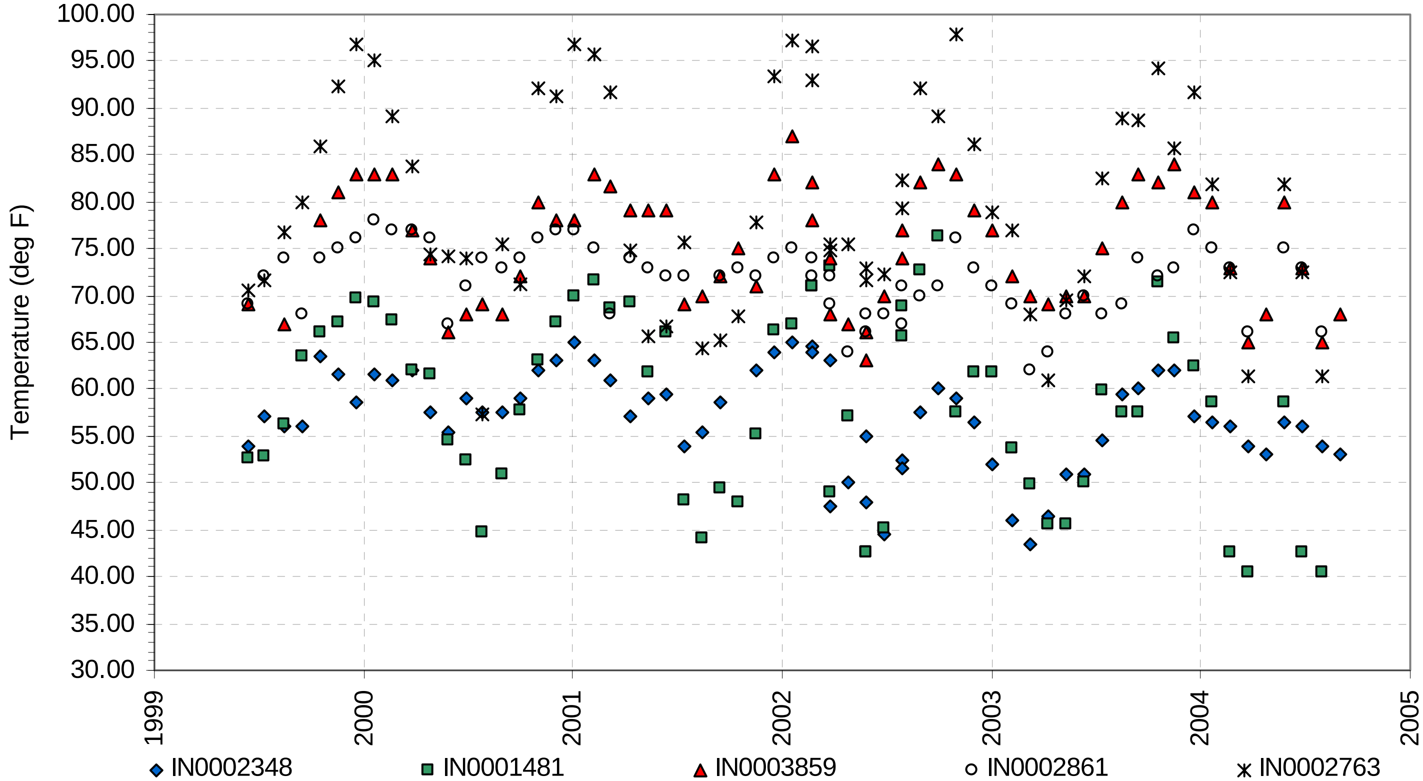


Figure G-9. **Indiana NPDES temperature sampling scatter plots.**

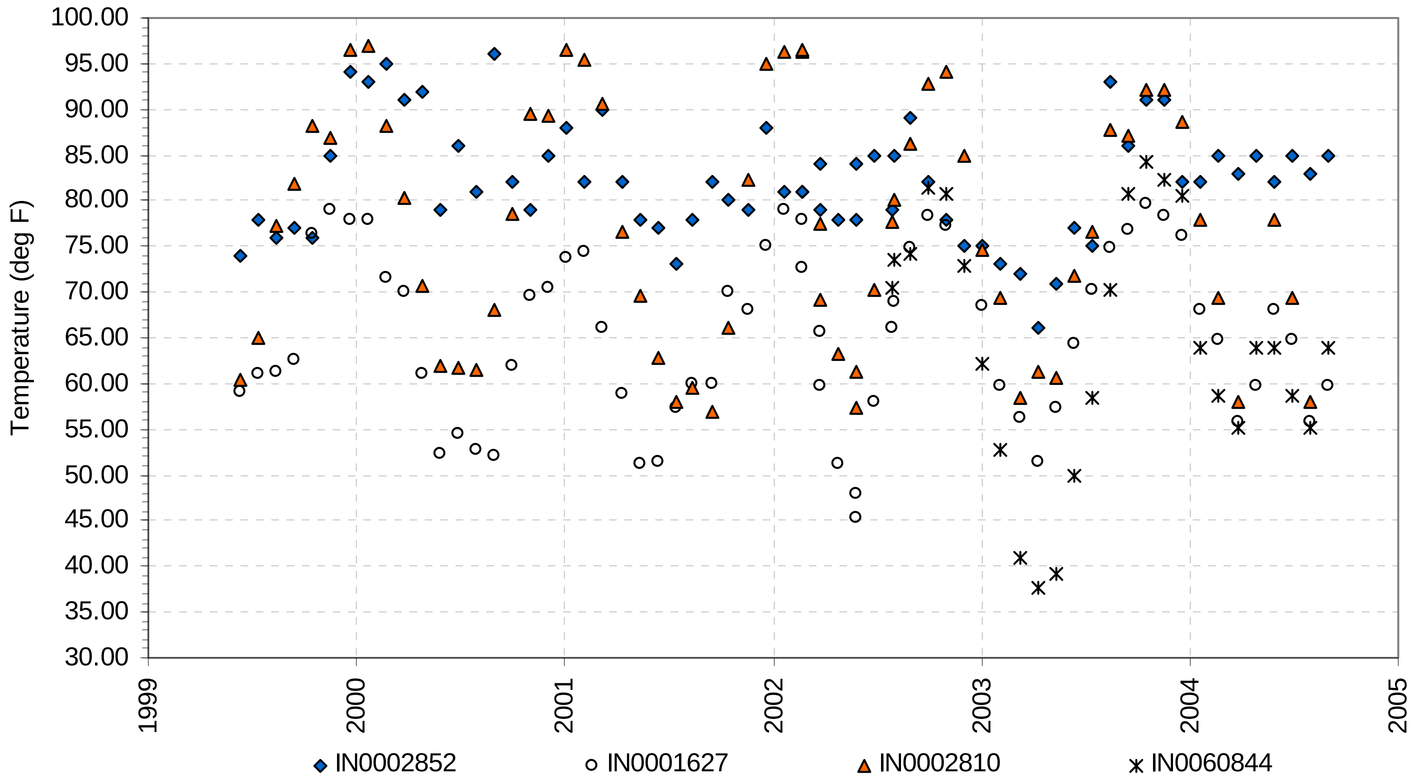


Figure G-10. **Indiana NPDES temperature sampling scatter plots.**

APPENDIX H: RIV1 MODEL CALIBRATION PROCESS AND RESULTS

The Wabash River nutrient and pathogen TMDLs were developed using the CE-QUAL-RIV1 (or RIV1) model for the Wabash River main stem combined with observed and statistical estimates of tributary pollutant loads. This appendix provides additional details on the modeling approach and results.

The RIV1 model is composed of two sub-models: a hydrodynamic model (RIV1H) and a water quality model (RIV1Q). RIV1H predicts flows, depths, velocities, water surface elevations and other hydraulic characteristics. The hydrodynamic model solves the St. Venant equations as the governing flow equations using the widely accepted four-point implicit finite difference numerical scheme. The results of the RIV1H model are input into the water quality model, RIV1Q, which can predict twelve separate state variables: temperature, carbonaceous biochemical oxygen demand (CBOD), organic nitrogen, ammonia nitrogen, nitrate + nitrite nitrogen, dissolved oxygen, organic phosphorus, dissolved phosphorus, algae, dissolved iron, dissolved manganese, and coliform bacteria.

Derivation of Tributary Flows and Water Quality

RIV1 is not a watershed model and therefore cannot independently estimate flows and pollutant loads associated with tributary inputs and direct runoff. Instead, flows and water quality concentrations from tributaries were input to RIV1 based on a combination of observed data and statistical estimates. Flows for ungaged tributaries were estimated based on gaged tributaries using a unit-area approach. Where observed water quality data were not available, estimates were made based on regressions between observed flow, observed water quality, and watershed characteristics (soil type, land uses, and slopes). In this way the individual characteristics of each subwatershed were used to estimate the likely pollutant loads.

Where observed water quality data were not available, estimates were made based on regressions between observed flow and observed water quality by following these steps:

1) Outlying water quality data were eliminated from the analysis where outliers were defined as those samples that fall outside of three standard deviations.
2) Once the outliers had been eliminated, both the flows and water quality data were separated seasonally and sorted from low flows to high flows.
3) Each flow and water quality value was converted into a log value and running averages were computed to dampen out the effect of extreme values (especially for fecal coliform and *E. coli*).
4) A regression curve was determined by evaluating the ability of the running average log of flows to predict the running average log of water quality. Figure H-1 shows an example of a seasonal regression line for the Vermillion River and the Embarrass River for fecal coliform, Total Kjeldahl Nitrogen (TKN), total phosphorus, and nitrite+nitrate.

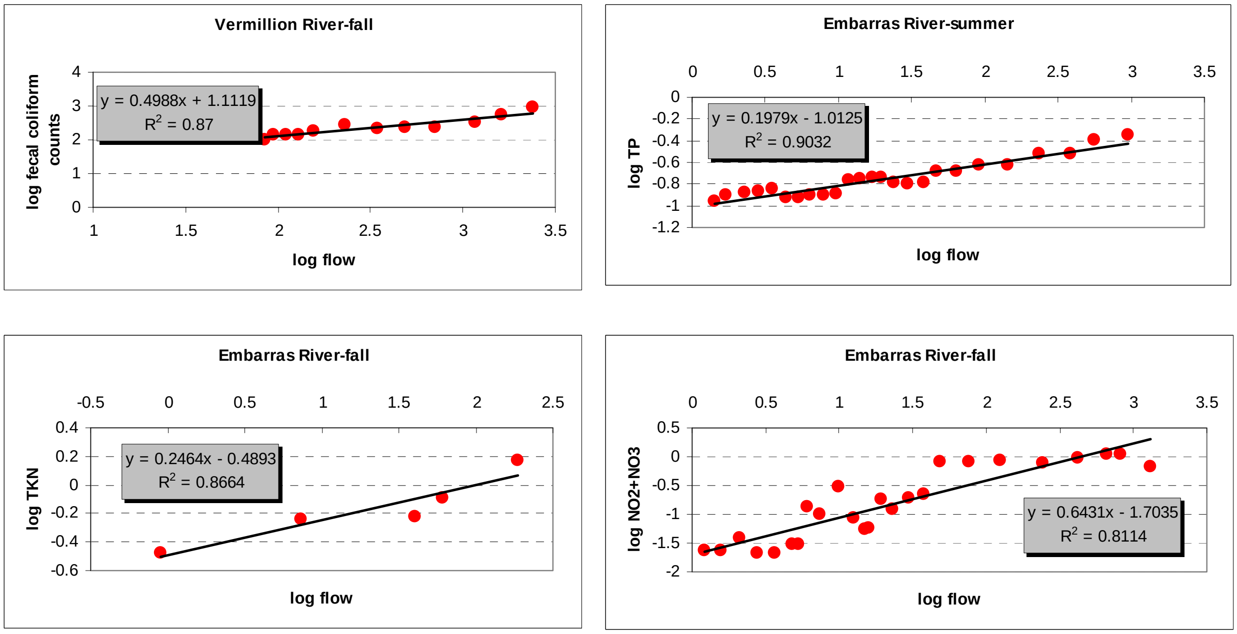


Figure H-1. Examples of seasonal regression lines based on the running average log flows in Vermillion and Embarrass River.

The approach described above of using running average flows and water quality data results in a stronger statistical relationship because extreme values are “damped” out. However, to simulate the actual range of observed water quality data, we assumed that they were normally distributed (Gaussian distribution) and we established a time series of water quality by randomly selecting values from this normal distribution. To generate the normally distributed values, the standard deviation and the mean of the water quality data were needed. The mean was represented by the calculated value from the regression line created by the running average of the log flows, and the standard deviation was based on the samples (before transforming them into the log values) that are used to create the running average.

Figure H-2 shows an example of the derivation of the standard deviation for each flow. Final water quality concentrations from subwatersheds had the predicted mean from the running average regression line with the range derived from the standard deviation of the samples used for the running average. The blue points show the example of the normal distributed possible concentration range estimated from this method.

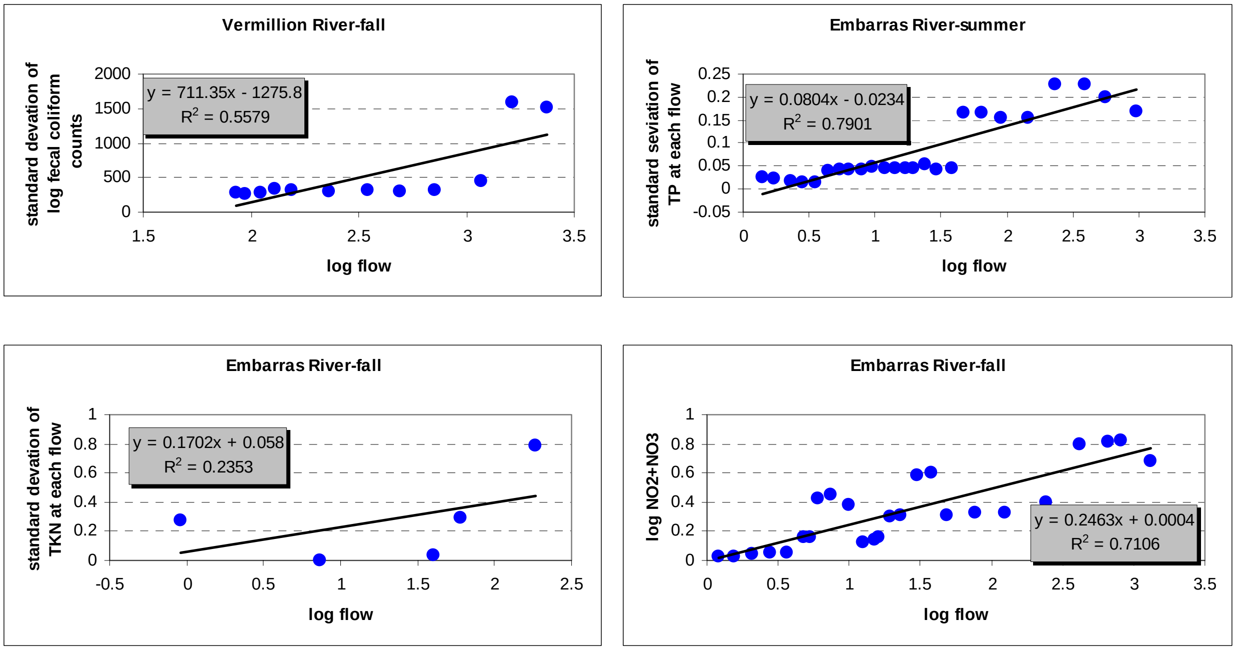


Figure H-2. Examples of Seasonal Regression lines between log flow and standard deviation of water quality parameters in Vermillion and Embarrass River.

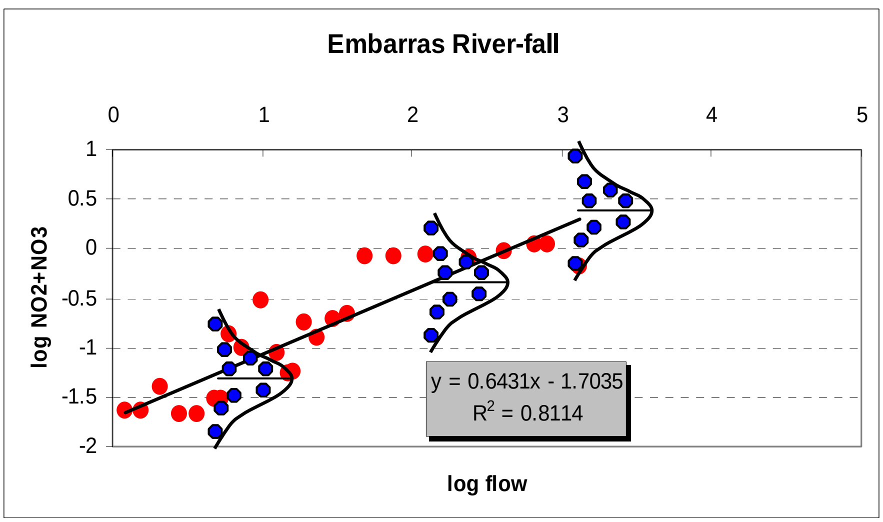


Figure H-3. The normally distributed possible estimated concentrations

Automatic Calibration to Water Quality Concentrations

As described above the estimate of tributary loads were somewhat dependent on randomly assigned water quality concentrations that fall within the normal distribution of observed data. To minimize the errors associated with this approach, the random numbers were generated for a large number of scenarios (10,000 in most cases) and the scenario that resulted in the least error was used as input to the RIV1 model.

Identification of Physical Characteristics Similarities among Subwatersheds

Regression curves to estimate water quality as a function of flow and season were developed for all tributaries with sufficient observed water quality data. These regression curves were then applied to tributaries without data. This section discusses how we determined which regression curves to apply to which tributaries.

Table H-1 summarizes key watershed characteristics for an index subwatershed (i.e., where the regression line was developed using observed water quality data). Note that there were several of these index subwatersheds and the challenge was to determine the applicability of the regression line from the index subwatershed to a subwatershed where no observed data are available (which we refer to as a “patched” subwatershed) (Table H-2). The characteristics of each subwatershed (e.g., land uses, watershed slope, and soil type) were compared and the percentage difference from each category was calculated (see example in Table H-3). The final percentage difference was determined using weighted averages as follows:

$$FinalDifference\% = \sum \frac{C_i \bullet W_i}{T} \quad (1)$$

C : different category (difference of landuse, slope, and soil type)
W: Weighted value
T : sum of the differences from each category

Table H-1. An example of an index subwatershed

	Land use(ac)	watershed slope	Watershed soil (A=1,,B=2,C=3, and D=4)
forest	50	0.005	2
crop	100	0.005	2
pasture	150	0.005	2
urban	20	0.005	2

* the numbers shown in the table are hypothetical numbers

Table H-2. An example of data for a patched subwatershed.

	Landuse(ac)	watershed slope	Watershed Soil A=1,,B=2,C=3, and D=4)
forest	25	0.003	4
crop	80	0.003	4
pasture	130	0.003	4
urban	10	0.003	4

* the numbers shown in the table are hypothetical numbers

Table H-3. Determination of the final percent difference.

difference of landuse	difference of slope	difference of soil type	
1.000	0.667	0.500	
0.250	0.667	0.500	
0.154	0.667	0.500	
1.000	0.667	0.500	Final Difference %
60.096	66.667	50.000	**33.5**

Each characteristic was weighted because some subwatershed characteristics have more influence than others on water quality loadings. For example, the final percentage difference in the example was calculated using twice as great a weight for land use as for slope and soil type. The index subwatershed generating the minimum difference was applied to the patched subwatershed.

Parameter Values for RIV1 Water Quality Model Calibration

The RIV1 model was separated into two linked models: Upper Wabash (from Ohio border to the outlet from J. Edward Roush lake) and Lower Wabash (from the outlet of J. Edward Roush lake to the confluence of the Wabash River and the Ohio River). (Note that these definitions of Upper and Lower are different than those used in the impairment verification process described in Section 2.) The following tables show each individual RIV1 parameter and the values used for the Wabash River water quality calibration.

Table H-4. Parameters and selected values for the upper Wabash River RIV1 model.

Constant Name	Units	Typical	Variable	Value
Covar Reaeration Option	(0=No, 1=Yes)	0 or 1	ICOVAR	1
DO Saturation Equation Option	(0=APHA, 1=ASCE)	0 or 1	NDOSAT	0
Elevation Correction for DO Saturation Option	(0=Yes, 1=No)	0 or 1	IOPT_EL	0
Ref. Elev. for DO Sat. Correction & Temp. Calcs.	feet-msl		ELEV0	750
Theta for Reaeration		1.024	TH_K2	1.024
Theta for Sediment Oxygen Demand		1.065	TH_SOD	1.06
Theta for CBODu1 Decay		1.047	TH_K1	1.04
Theta for CBODu2 Decay		1.047	TH_BOD2	1.047
Theta for NBODu Decay		1.047	TH_NBOD	1.047
Theta for Organic Nitrogen to NH3		1.047	TH_K1N	1.047
Theta for Ammonia to NO3 Transformation		1.085	TH_KNH3	1.085
Theta for Fecal Coliform Die-off		1.047	TH_COLIF	1.047
Theta for Arbituary Constituent 1 Decay			TH_ARB1	1
Theta for Arbituary Constituent 2 Decay			TH_ARB2	1
Theta for Ortho Phosphate Loss			TH_SORP	1
Theta for Benthic Ortho Phosphate Release Rate		1.074	TH_BENP	1.074
Theta for Benthic Ammonia Release Rate		1.074	TH_BENN	1.074
Theta for Phytoplankton Growth		1.047	TH_AGRO	1.047
Theta for Macrophyte Death			TH_MDIE	1.047
Theta for Denitrification for CBODu1		1.047	TH_KDN	1.047
Theta for Denitrification for CBODu2		1.047	TH_ADN2	1.047
Theta for Sediment Denitrification			TH_KDN02	1.5
Theta for Bottom Heat Flux			TH_BHEAT	1
Oxygen/Nitrogen Ratio for Nitrification	mg O2/mg N	4.57	ONITRI	4.57
Oxygen/Nitrogen Ratio for Denitrification	mg O2/mg N	0.35	ONEQUI	0.35
Oxygen Consumption by Plant Decay	mg O2/mg B	1.59	OPDECY	1.59
Oxygen Consumption by Iron Oxidation	mg O2/mg Fe		OFEDEC	0.14
Oxygen Consumption by Manganese Oxidation	mg O2/mg Mn		OMNDEC	0.15
Phytoplankton Phosphorus Content	mg P/mg B	0.01	APCONT	0.01
Phytoplankton Nitrogen Content	mg N/mg B	0.07 - 0.1	ANCONT	0.075
Macrophyte Phosphorus Content	mg P/mg B		MPCONT	0.01
Macrophyte Nitrogen Content	mg N/mg B	0.02 - 0.4	MNCONT	0.075

Table H-5. Parameters and selected values for upper Wabash River RIV1 model.

Constant Name	Units	Typical	Variable	Value
Top of Branch Dam Reaeration Option	(0=No, 1=Yes)	0 or 1	IDAM0	0
Top of Branch Dam Reaeration Coefficient		0.045	DAMK0	0
Wind Driven Reaeration Option	(0=No, 1=Yes)	0 or 1	QWIND0	0
Bottom Heat Exchange Rate	1/day @ 20°C		ATB	0
Source/Sink Temperature for Bottom Heat Exchange	°C		TSINK	0
Organic Nitrogen to NH3 Transform Rate	1/day @ 20°C	0.02 - 0.4	ACK	0.2
Ammonia to NO3 Transform Rate	1/day @ 20°C	0.025 - 6	AKN	5
Organic Phosphorus to Ortho Phosphate Transform Rate	1/day @ 20°C	0.01 - 0.7	KPDK	0.01
Ortho Phosphate Loss Rate	1/day @ 20°C		APO4	0.001
Mangenese Oxidation Rate	1/day @ 20°C		KMNDK	0
Iron Oxidation Rate	1/day @ 20°C		KFEDK	0
Arbitrary Constituent 1 Decay Rate	1/day @ 20°C		AKARB1	0
Arbitrary Constituent 2 Decay Rate	1/day @ 20°C		AKARB2	0
CBODu1 Settling Rate	m/day	-0.36 - 0.36	CBODSR	0.36
CBODu2 Settling Rate	m/day	-0.36 - 0.36	RBODSR	0
Organic Nitrogen Settling Rate	m/day	0.001 - 0.1	XONS	0.001
Organic Phosphorus Settling Rate	m/day	0.001 - 0.1	KPSET	0.001
NBODu Settling Rate	m/day		SRNDOB	0
CBODu1 Denitrification Rate	1/day @ 20°C	0.0 - 1.0	ADN	0.01
CBODu2 Denitrification Rate	1/day @ 20°C	0 to 1	ADN2	0
Sediment Denitrification Rate	1/day @ 20°C		KDNO2	0.15
Phytoplankton Growth Rate	1/day @ 20°C	1 - 3	KALGGRO	1
Phytoplankton Decay Rate	1/day @ 20°C	0.05 - 0.5	KALGDK	0.5
Fraction of Algal/Macrophyte Death which goes to CBODu1	fraction	0 to 1	FCBOD	0.5
Fraction of Algal/Macrophyte Death which goes to CBODu2	fraction	0 TO 1	FCRBOD	0
Algae to Chlorophyll Conversion Factor	ug Chl-a/mg B	10 - 100	ALPHA0	100
DO Threshold for Iron and Manganese Oxidation	mg/L		OXIDAT	0
DO Conc. at which CBODu1 Decay is ½ Max Rate	mg/L		KOCB1	0.5
DO Conc. at which CBODu2 Decay is ½ Max Rate	mg/L		RBODDO	0
DO Concentration at which NBODu decay is ½ Max Rate	mg/L		DONBOD	0
DO Conc. at which Nitrification is ½ Max Rate	mg/L		KON	0.05
DO Conc. at which Denitrification is ½ Max Rate	mg/L	0.1	KOCBDN	0.1
NO3 Conc. at which Denitrification is ½ Rate	mg/L		KNCBDN	0.1
DO Conc. at which Algal Death is ½ Max Rate	mg/L		KOALDK	1
NH3+NO3 Conc. at which Algal Growth Rate is ½ Max Rate	mg/L	0.01 - 0.3	KNPOOL	0.01
Total Phosphorus Conc. at which Algal Growth Rate is ½ Max	mg/L	0.001 - 0.05	KPO4X	0.005
Linear Algal Self-shading Coefficient	(1/m)/(ug Chl-a/L)	0.0088	LAMBDA1	0.008
Non-Linear Algal Self-shading Coefficient	(1/m)/(ug Chl-a/L)^2/3	0.054	LAMBDA2	0.054
Non-Algal Light Extinction Coefficient	1/m		LAMBDA0	0.03
Light Intensity at which Photosynthesis is Reduced by ½	Watts/m²	1.2 - 6	KLITE	3
Surface Light Intensity at Local Noon (for Equilbrium Temp	Watts/m²		HNEFSW	0
Stream Temperature (for Equilbrium Temp Method)	°C		TDUM	0
Surface Heat Exchange Coefficient (for Equilbrium Temp	Watts/m²-°C		ATS	0

Table H-6. Parameters and selected values for Upper Wabash RIV1 model.*

Constant Name ->	Constant Dispersion Rate	Dispersion Coefficient for Equation	Constant Reaeration Rate	O'Connor - Dobbins Equation Coefficient	O'Connor - Dobbins Velocity Exponent	O'Connor - Dobbins Depth Exponent	Tsivoglou - Wallace Escape Coefficient	Sediment Oxygen Demand	CBODu1 Decay Rate	CBODu2 Decay Rate
Units ->	ft^2/sec		m/day				1/ft	g/m^2-day	1/day @	1/day @
Typical ->				12.9	0.5	1.5	0.02 - 0.11	0.05 - 10	0.004 - 4	0.004 - 4
Variable ->	DISPC	DISPK	KREAER	AG	K1	K2	TSIV	SOD	AK1	KRBOD
3	0	10	0	12.9	0.5	1.5	0.054	2	0.15	0

NBODu Decay Rate	Fecal Coliform Die-off Rate	Benthic Ortho Phosphate Release	Benthic Ammonia Release Rate	Macrophyte Density	Macrophyte Growth Rate	Macrophyte Death Rate	Canopy Shading	Reaeration Formula
1/day @	1/day @	g/m^2-day	g/m^2-day	g/m^2	m^2/Watts-day	1/day @	fraction	
0 - 2	0.05 - 4						0 to 1	
AKNBOD	ACOLIDK	BENPO4	BENNH3	MACROB	MACGRO	MACDKY	CANOPY	
0	0.95	0	0	0	0	0	0.15	O-D

*This particular table shows segments 3. The same set of values was repeated for the rest of segments of Lower Wabash.

Table H-7. Parameters and selected values for Lower Wabash RIV1 model.

Constant Name	Units	Typical	Variable	Value
Covar Reaeration Option	(0=No, 1=Yes)	0 or 1	ICOVAR	1
DO Saturation Equation Option	(0=APHA, 1=ASCE)	0 or 1	NDOSAT	0
Elevation Correction for DO Saturation Option	(0=Yes, 1=No)	0 or 1	IOPT_EL	0
Ref. Elev. for DO Sat. Correction & Temp. Calcs.	feet-msl		ELEV0	750
Theta for Reaeration		1.024	TH_K2	1.024
Theta for Sediment Oxygen Demand		1.065	TH_SOD	1.06
Theta for CBODu1 Decay		1.047	TH_K1	1.047
Theta for CBODu2 Decay		1.047	TH_BOD2	1.047
Theta for NBODu Decay		1.047	TH_NBOD	1.047
Theta for Organic Nitrogen to NH3		1.047	TH_K1N	1.047
Theta for Ammonia to NO3 Transformation		1.085	TH_KNH3	1.085
Theta for Fecal Coliform Die-off		1.047	TH_COLIF	1.047
Theta for Arbituary Constituent 1 Decay			TH_ARB1	1
Theta for Arbituary Constituent 2 Decay			TH_ARB2	1
Theta for Ortho Phosphate Loss			TH_SORP	1
Theta for Benthic Ortho Phosphate Release Rate		1.074	TH_BENP	1.074
Theta for Benthic Ammonia Release Rate		1.074	TH_BENN	1.074
Theta for Phytoplankton Growth		1.047	TH_AGRO	1.047
Theta for Phytoplankton Death		1.047	TH_ADIE	1.047
Theta for Macrophyte Growth			TH_MGRO	1.047
Theta for Macrophyte Death			TH_MDIE	1.047
Theta for Denitrification for CBODu1		1.047	TH_KDN	1.047
Theta for Denitrification for CBODu2		1.047	TH_ADN2	1.047
Theta for Sediment Denitrification			TH_KDN02	1.2
Theta for Bottom Heat Flux			TH_BHEAT	1
Oxygen/Nitrogen Ratio for Nitrification	mg O2/mg N	4.57	ONITRI	4.57
Oxygen/Nitrogen Ratio for Denitrification	mg O2/mg N	0.35	ONEQUI	0.35
Oxygen Consumption by Plant Decay	mg O2/mg B	1.59	OPDECY	1.59
Oxygen Consumption by Iron Oxidation	mg O2/mg Fe		OFEDEC	0.14
Oxygen Consumption by Manganese Oxidation	mg O2/mg Mn		OMNDEC	0.15
Phytoplankton Phosphorus Content	mg P/mg B	0.01	APCONT	0.01
Phytoplankton Nitrogen Content	mg N/mg B	0.07 - 0.1	ANCONT	0.075
Macrophyte Phosphorus Content	mg P/mg B		MPCONT	0.01
Macrophyte Nitrogen Content	mg N/mg B	0.02 - 0.4	MNCONT	0.075
Time of Sunrise	Hour	0 to 24	DAWN	5
Time of Sunset	Hour	0 to 24	SUNSET	18.5

Table H-8. Parameters and selected values used for Lower Wabash

Constant Name	Units	Typical	Variable	Value
Top of Branch Dam Reaeration Option	(0=No, 1=Yes)	0 or 1	IDAM0	0
Top of Branch Dam Reaeration Coefficient		0.045	DAMK0	0
Wind Driven Reaeration Option	(0=No, 1=Yes)	0 or 1	QWIND0	0
Bottom Heat Exchange Rate	1/day @ 20°C		ATB	0
Source/Sink Temperature for Bottom Heat Exchange	°C		TSINK	0
Organic Nitrogen to NH3 Transform Rate	1/day @ 20°C	0.02 - 0.4	ACK	0.2
Ammonia to NO3 Transform Rate	1/day @ 20°C	0.025 - 6	AKN	5
Organic Phosphorus to Ortho Phosphate Transform Rate	1/day @ 20°C	0.01 - 0.7	KPDK	0.01
Ortho Phosphate Loss Rate	1/day @ 20°C		APO4	0.0025
Mangenese Oxidation Rate	1/day @ 20°C		KMNDK	0
Iron Oxidation Rate	1/day @ 20°C		KFEDK	0
Arbitrary Constituent 1 Decay Rate	1/day @ 20°C		AKARB1	0
Arbitrary Constituent 2 Decay Rate	1/day @ 20°C		AKARB2	0
CBODu1 Settling Rate	m/day	-0.36 - 0.36	CBODSR	0.18
CBODu2 Settling Rate	m/day	-0.36 - 0.36	RBODSR	0
Organic Nitrogen Settling Rate	m/day	0.001 - 0.1	XONS	0.001
Organic Phosphorus Settling Rate	m/day	0.001 - 0.1	KPSET	0.001
NBODu Settling Rate	m/day		SRNDOB	0
CBODu1 Denitrification Rate	1/day @ 20°C	0.0 - 1.0	ADN	0.01
CBODu2 Denitrification Rate	1/day @ 20°C	0 to 1	ADN2	0
Sediment Denitrification Rate	1/day @ 20°C		KDNO2	0.2
Phytoplankton Growth Rate	1/day @ 20°C	1 - 3	KALGGRO	1
Phytoplankton Decay Rate	1/day @ 20°C	0.05 - 0.5	KALGDK	0.15
Fraction of Algal/Macrophyte Death which goes to CBODu1	fraction	0 to 1	FCBOD	0.5
Fraction of Algal/Macrophyte Death which goes to CBODu2	fraction	0 TO 1	FCRBOD	0
Algae to Chlorophyll Conversion Factor	ug Chl-a/mg B	10 - 100	ALPHA0	10
DO Threshold for Iron and Manganese Oxidation	mg/L		OXIDAT	0
DO Conc. at which CBODu1 Decay is ½ Max Rate	mg/L		KOCB1	0.5
DO Conc. at which CBODu2 Decay is ½ Max Rate	mg/L		RBODDO	0
DO Concentration at which NBODu decay is ½ Max Rate	mg/L		DONBOD	0
DO Conc. at which Nitrification is ½ Max Rate	mg/L		KON	0.05
DO Conc. at which Denitrification is ½ Max Rate	mg/L	0.1	KOCBDN	0.1
NO3 Conc. at which Denitrification is ½ Rate	mg/L		KNCBDN	0.1
DO Conc. at which Algal Death is ½ Max Rate	mg/L		KOALDK	1
NH3+NO3 Conc. at which Algal Growth Rate is ½ Max Rate	mg/L	0.01 - 0.3	KNPOOL	0.01
Total Phosphorus Conc. at which Algal Growth Rate is ½ Max	mg/L	0.001 - 0.05	KPO4X	0.005
Linear Algal Self-shading Coefficient	(1/m)/(ug Chl-a/L)	0.0088	LAMBDA1	0.008
Non-Linear Algal Self-shading Coefficient	(1/m)/(ug Chl-a/L)^2/3	0.054	LAMBDA2	0.054
Non-Algal Light Extinction Coefficient	1/m		LAMBDA0	0.03
Light Intensity at which Photosynthesis is Reduced by ½	Watts/m²	1.2 - 6	KLITE	3
Surface Light Intensity at Local Noon (for Equilbrium Temp	Watts/m²		HNEFSW	0
Stream Temperature (for Equilbrium Temp Method)	°C		TDUM	0
Surface Heat Exchange Coefficient (for Equilbrium Temp	Watts/m²-°C		ATS	0

Table H-9. Parameters and selected values used for Lower Wabash RIV1 model*

Constant Name ->	Constant Dispersion Rate	Dispersion Coefficient for Equation	Constant Reaeration Rate	O'Connor - Dobbins Equation Coefficient	O'Connor - Dobbins Velocity Exponent	O'Connor - Dobbins Depth Exponent	Tsivoglou - Wallace Escape Coefficient	Sediment Oxygen Demand	CBODu1 Decay Rate	CBODu2 Decay Rate
Units ->	ft²/sec		m/day				1/ft	g/m²-day	1/day @	1/day @
Typical ->				12.9	0.5	1.5	0.02 - 0.11	0.05 - 10	0.004 - 4	0.004 - 4
Variable ->	DISPC	DISPK	KREAER	AG	K1	K2	TSIV	SOD	AK1	KRBOD
34	0	100	0	12.9	0.5	1.5	0.054	0.15	0.01	0

NBODu Decay Rate	Fecal Coliform Die-off Rate	Benthic Ortho Phosphate Release	Benthic Ammonia Release Rate	Macrophyte Density	Macrophyte Growth Rate	Macrophyte Death Rate	Canopy Shading	Reaeration Formula
1/day @	1/day @	g/m²-day	g/m²-day	g/m²	m²/Watts-day	1/day @	fraction	
0 - 2	0.05 - 4						0 to 1	
AKNBOD	ACOLIDK	BENPO4	BENNH3	MACROB	MACGRO	MACDKY	CANOPY	
0	0.75	0	0	0	0	0	0.05	O-D

*This particular table shows segments 34. The same set of values was repeated for the rest of segments of Lower Wabash.

Method for Estimating CSO Loads

Information provided by IDEM indicated that there are 13 CSO communities located along the Wabash River. These communities are required to report monthly overflow events to IDEM as part of the NPDES permitting process. However, comprehensive monthly reports for all the communities for the water quality calibration time period of 2001 to 2003 were either not available, incomplete, or were not in a readily-accessible format. Therefore, CSO flows were estimated based on a relationship between precipitation and reported CSO volumes. The data from the City of Lafayette were used to derive this relationship because good data were available and Lafayette is one of the larger communities. Precipitation data were retrieved from the National Climatic Data Center (NCDC) for weather station 129430, located in Lafayette. The regression line resulting between precipitation and reported CSO flows is shown in Figure H-4. This relationship was applied to the remaining CSO communities and pro-rated so that the total annual flow volumes used in the modeling matched the volumes reported by each community (Table H-10). Using these estimated outflow rates, CSO loadings were generated based on available data on typical CSO pollutant concentrations (Table H-11)

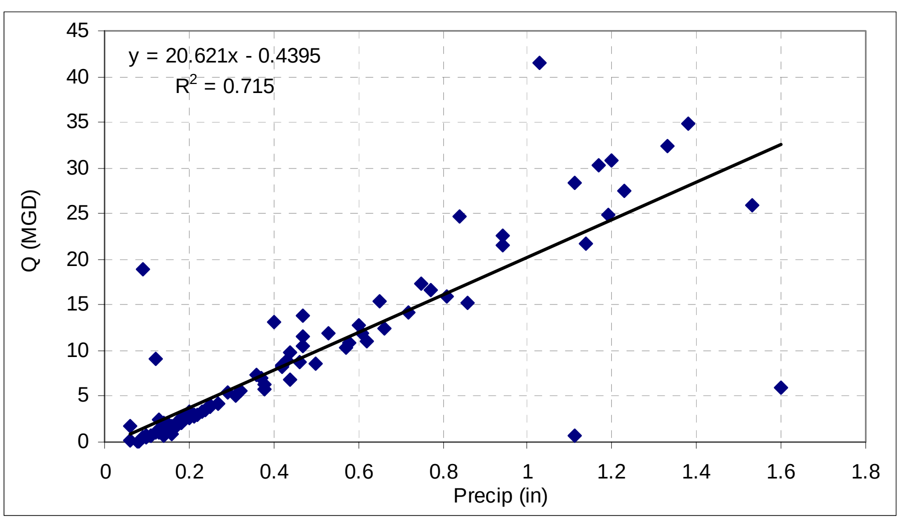


Figure H-4. The relationship between precipitation and CSO outflows events.

Table H-10. A summary of CSO estimates used in RIV1 modeling.

	Attica	Berne	Bluffton	Clinton	Huntingdon	Lafayette	Logansport
Total Q (MG)	2.96	269.03	20.30	18.11	494.70	830.31	134.18
Avg Monthly Q (MG)	0.30	7.27	3.38	0.58	6.42	4.32	1.03
Total Duration (hrs)	10.1	2,213.0	155.2	1,410.4	1,182.4	2,776.7	681.8
Avg Monthly Duration (hrs)	1.0	59.8	25.9	45.5	15.4	14.5	9.0
Total Precip (in)	56.77	48.35	49.44	58.46	43.27	42.12	47.88
Avg Monthly Precip (in)	3.55	3.02	3.09	3.65	2.88	2.63	2.99
Min Event pcp (in)	0.25	0.02	0.02	0.10	0.01	0.10	0.02
Total # Events (Approximate)	17.00	98.00	21.00	117.00	60.00	NA	38.00
	Markle	**Mt Vernon**	**Peru**	**Terre Haute**	**W Lafayette**	**Wabash**	
Total Q (MG)	3.14	42.61	678.46	450.82	150.15	298.17	
Avg Monthly Q (MG)	0.52	1.47	9.42	3.47	3.58	3.21	
Total Duration (hrs)	537.0	1,188.0	4,364.0	1,731.6	1,149.8	1,857.0	
Avg Monthly Duration (hrs)	89.5	41.0	65.5	13.3	26.7	20.0	
Total Precip (in)	49.41	61.70	45.42	62.43	47.98	52.01	
Avg Monthly Precip (in)	3.09	3.86	3.03	3.90	3.00	3.47	
Min Event pcp (in)	0.25	0.04	0.02	0.05	0.01	0.03	
Total # Events (Approximate)	26.00	59.00	143.00	99.00	121.00	50.00	

Table H-11. CSO concentrations assumed for Wabash River RIV1 modeling. (Source: City of Chicago monitoring data provided by Marquette University).

E. coli	96,000 #/100ml
TP	0.64 mg/L
BOD5	9 mg/L
Organic N	1.3 mg/L
Ammonia	0.7 mg/L
NO3	1 mg/L
Fecal Coliform	153,600 #/100ml

NPDES inputs for RIV1 Water Quality model during calibration and TMDL allocation process

Discharge Monitoring Report (DMR) data for all NPDES facility discharging directly into Wabash River were provided by IDEM and IEPA. Averaged discharge rates from these facilities were calculated to assess the significance of each facility's hydrologic and water quality effect to Wabash River. Facilities discharging on average less than 1 cfs were eliminated from RIV1 model as insignificant loading sources.

Available observed data on discharge flows and concentrations were obtained from the DMR data. The available monthly reported flow and water quality data were converted to daily flows and concentrations using a linear interpolation method. Table H-12 shows the facilities that were included in RIV1 with an indication of which water quality parameters were reported for each facility. Facilities with no reported water quality data were assigned literature values or in-stream observed data depending on whether the facility was a wastewater or non wastewater facility. Table H-13 summarizes available DMR data for discharge flows and water quality concentrations. Table H-14 shows the values used during the calibration process for the facilities where no observed data were available.

Table H-12. Availability of observed water quality data and design flow for NPDES facilities included in RIV1 model

NPDES	Facility name	Fecal Coliform	BOD	CBOD	DO	*E. coli*	NH3	TP	Temp	Design flow (MGD)
IN0001074	LXP-SEC I, LLC								x	1.856
IN0001210	ALUMINUM CO. OF AM. (ALCOA)								x	0.92
IN0002348	HARRISON STEEL CASTINGS CO.								x	2.57
IN0002763	PSI CAYUGA GENERATING STATION								x	506.1
IN0002810	PSI WABASH RIVER GEN. STATION						x		x	355
IN0003026	INTERNATIONAL PAPER CO.									1.06
IN0003328	WABASH ENVIRONMENTAL TECH. LLC		x				x			1.1
IN0022411	BLUFFTON UTILITIES		x	x	x	x	x	x		2.6
IN0022608	CLINTON MUNICIPAL STP			x		x				2.5
IN0023604	LOGANSPORT WWTP			x	x	x	x			9
IN0024741	WABASH MUNICIPAL STP			x		x	x			4
IN0024821	WEST LAFAYETTE MUNICIPAL STP			x		x	x			9
IN0032328	PERU MUNICIPAL STP	x		x	x	x	x			8
IN0032468	LAFAYETTE MUNICIPAL WWTP	x		x			x			16
IN0036447	PREMIER BOXBOARD LIMITED LLC					x	x			1.7
IN0041092	NORTH KNOX WEST ELEM. SCHOOL			x	x		x			0.005
IN0044130	PERU POWER PLANT, PERU UTILITY								x	15.6
IN0054810	JEFFERSON SMURFITT CORP. (JSC/									2
IL0004120	AMEREN ENERGY-HUTSONVILLE	x								90.08
IL0030023	MOUNT CARMEL STP	x								2

x: some data available

Table H-13. Average available observed flows and water quality concentration DMR data

NPDES	parameter	Average of observed data	observed counts	Beginning	End
IL0004120	flow	1.11	110	1/31/98	10/31/05
IL0030023	flow	1.66	95	1/31/98	11/30/05
IN0001074	flow	1.70	174	1/31/90	12/31/04
IN0001210	flow	0.94	181	1/31/90	1/31/05
IN0002348	flow	1.82	179	1/31/90	1/31/05
IN0002763	flow	278.03	359	1/31/90	12/31/04
IN0002810	flow	233.38	359	1/31/90	12/31/04
IN0003026	flow	0.89	180	1/31/90	1/31/05
IN0003328	flow	1.53	172	1/31/90	12/31/04
IN0022411	flow	2.39	180	1/31/90	12/31/04
IN0022608	flow	0.67	181	1/31/90	12/31/04
IN0023604	flow	10.10	180	1/31/90	12/31/04
IN0024741	flow	2.72	64	8/31/99	12/31/04
IN0024821	flow	7.79	181	1/31/90	1/31/05
IN0032328	flow	4.00	180	1/31/90	12/31/04
IN0032468	flow	14.97	180	1/31/90	12/31/04
IN0036447	flow	1.58	180	1/31/90	12/31/04
IN0041092	flow	3.28	182	1/31/90	1/31/05
IN0044130	flow	12.03	78	1/31/90	12/31/04
IN0054810	flow	0.85	179	1/31/90	1/31/05
IN0022411	TP	0.41	120	1/31/00	12/31/04
IN0022411	DO	7.21	120	1/31/00	12/31/04
IN0023604	DO	8.19	120	1/31/00	12/31/04
IN0032328	DO	7.26	120	1/31/00	12/31/04
IN0041092	DO	7.65	122	1/31/00	1/31/05
IN0109631	DO	5.69	110	1/31/00	7/31/04
IN0002810	NH3	0.46	120	1/31/00	12/31/04
IN0003328	NH3	8.72	68	1/31/02	12/31/04
IN0022411	NH3	0.53	120	1/31/00	12/31/04
IN0023604	NH3	1.36	120	1/31/00	12/31/04
IN0024741	NH3	0.19	120	1/31/00	12/31/04
IN0024821	NH3	0.11	121	1/31/00	1/31/05
IN0032328	NH3	0.82	120	1/31/00	12/31/04
IN0032468	NH3	2.91	40	5/31/03	12/31/04
IN0036447	NH3	9.33	78	10/31/01	12/31/04
IN0041092	NH3	0.81	122	1/31/00	1/31/05
IL0004120	FC	12.34	59	1/31/89	11/30/93
IL0030023	FC	608.33	132	1/31/89	3/31/05
IN0032328	FC	8.80	6	4/30/00	6/30/00
IN0032468	FC	108.06	70	4/30/00	10/31/04
IN0022411	*E. coli*	8.14	70	4/30/00	10/31/04
IN0022608	*E. coli*	20.58	30	4/30/02	10/31/04
IN0023604	*E. coli*	23.20	70	4/30/00	10/31/04
IN0024741	*E. coli*	18.63	70	4/30/00	10/31/04
IN0024821	*E. coli*	17.91	70	4/30/00	10/31/04
IN0032328	*E. coli*	39.21	64	7/31/00	10/31/04
IN0036447	*E. coli*	73.38	70	4/30/00	10/31/04

Table H-14. Supplemented water quality concentrations for some of NPDES facilities

Wastewater Facilities	TEMP(C°) [a]	BOD [c] (mg/L)	ORG-N [c] (mg/L)	NH3 [c] (mg/L)	NO3 [c] (mg/L)	DO (mg/L)	Ecoli [e] (#/100ml)	TP [c, d] (mg/L)
	16.5	10	6.5	2	6.5	6	24	7
Non-Wastewater Facilities	**TEMP(C°)**	**BOD [a] (mg/L)**	**ORG-N [a] (mg/L)**	**NH3 [a] (mg/L)**	**NO3 [a] (mg/L)**	**DO (mg/L)**	**Ecoli [e] (#/100ml)**	**TP [b] (mg/L)**
	16.5	3.92	1.22	0.31	4.49	6	8	0.30

a: Average of data colleted within Wabash River
b: benchmark of TP for the state of Indiana
c: from EPA's Technical Guidance Manual for Developing Total Maximum Daily Loads (1997, March)
d: from Principles of Surface Water Quality Modeling and Control by Robert V.Thomann and John A. Mueller (1987)
e: average values from waste and non waste water facilities

Model Calibration

Calibration of RIV1 followed a sequential, hierarchical process that began with hydrology, followed by temperature (to support the modeling of other parameters), and, finally: nitrate + nitrite, total phosphorus, dissolved oxygen, *E. coli*, and chlorophyll *a*. Fecal coliform was not explicitly modeled but was instead estimated based on the ratio between the geometric mean components of the standards (i.e., fecal coliform = 200/125 = 1.6 X *E. coli*). USEPA's *Ambient Water Quality Criteria for Bacteria* (USEPA, 1986) suggests that a fecal coliform count of 200 cfu/100 mL and an *E. coli* count of 125 cfu/100 mL are similar in that they would both cause approximately 8 illnesses per 1000 swimmers in fresh waters. Although there is some uncertainty associated with this approach, it was determined to be appropriate based on the available information.

Hydrologic calibration for the Wabash River relied on comparison of model predictions to observations at the following five locations:

- USGS gage 03322900 Wabash River at Linn Grove, Indiana
- US Army Corps of Engineers gage for inflow to J. Edward Roush Lake
- USGS gage 03325000 Wabash River at Wabash, Indiana
- USGS gage 03341500 Wabash River at Terre Haute, Indiana
- USGS gage 03377500 Wabash River at Mt. Carmel, Illinois

Water quality was calibrated at the following five locations:

- IDEM site WUW060-0002 at US 27 in Geneva, Indiana
- IDEM site WUW070-0002 at SR 3 Bridge in Markle, Indiana
- IDEM site WLV030-0003 at CR 700 W near Lafayette, Indiana
- IDEM site WBU100-0001 at Fairbanks, Indiana)
- IEPA site B-06 at Hutsonville, Illinois

The results of the hydrologic calibration are presented below in a series of time series and scatter plots as well as error statistic summaries. The hydrologic calibration indicates acceptable agreement between observed and simulated streamflows. For example, model error for total observed flow volumes compared to total predicted flow volumes ranged from 3 to 18 percent (depending on location) and the R-square for observed and predicted monthly flows ranged from 0.85 to 0.89.

Insufficient observed data were available to conduct a statistical analysis of the water quality calibration results. Instead, the water quality calibration relied primarily on a visual inspection of modeled compared to observed data. See below for graphs of calibration results. In general the model attained a good fit to observations, with some discrepancies for individual parameters at individual locations. Temperature, nutrients, dissolved oxygen, and chlorophyll *a* are calibrated somewhat better than *E. coli*, which is not unusual because observed pathogen concentrations tend to be highly variable in both space and time (due to both natural variability and analytical uncertainty). The quality of fit is sufficiently good that the model was judged ready for application to management scenarios and TMDL development.

Baseline Conditions

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, permitted point source discharge conditions, and the achievement of water quality standards at the Ohio/Indiana state line. The baseline condition allows for an evaluation of in-stream water quality under the "worst currently allowable" scenario. The following specific assumptions were made:

- Loads for the NPDES facilities in the watershed were simulated as discharging daily at their design flows and at the maximum of their permit limits (e.g., *E. coli* equal to 125 cfu/100 mL).
- Nitrate and total phosphorus concentrations from the NPDES facilities were left at existing concentrations since none of the facilities have permit limits for these parameters.
- Loads from combined sewer overflows were assumed equal to existing flows and concentrations at water quality standards.

Visual Confirmation of TMDL Scenarios

Point and nonpoint source loads were reduced from the baseline condition scenario during iterative model runs until the TMDL targets were met throughout the modeling period. The following figures show the baseline (indicated with the red line in the figures) concentrations and concentrations under the final TMDL reduction scenarios.

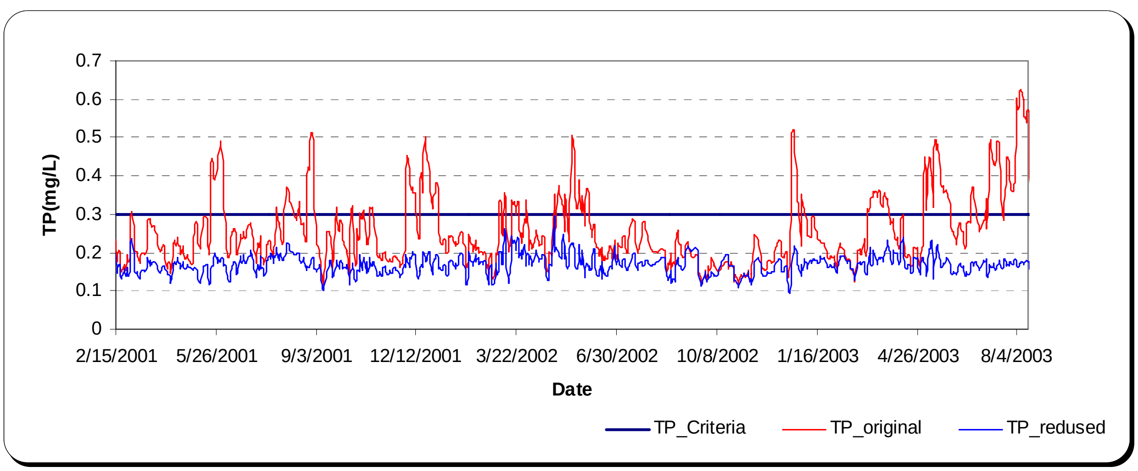


Figure H-5. TP at Upstream J. Edward Roush

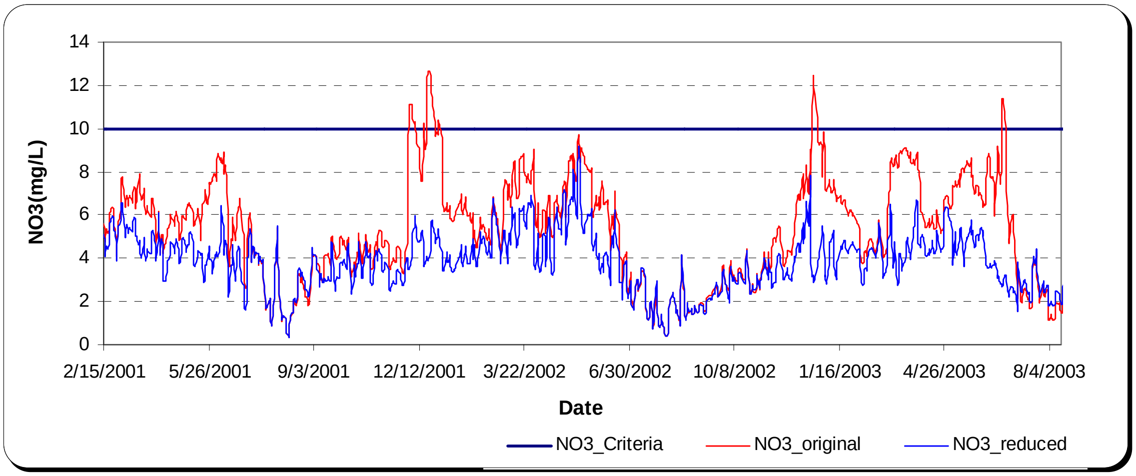


Figure H-6. NO3 at Upstream J. Edward Roush

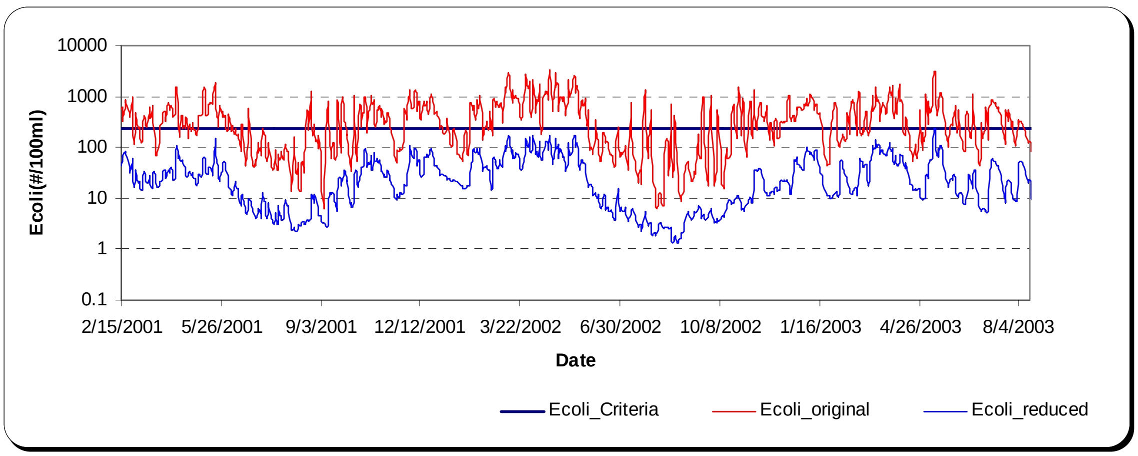


Figure H-7. *E. coli* (instantaneous) at Upstream J. Edward Roush

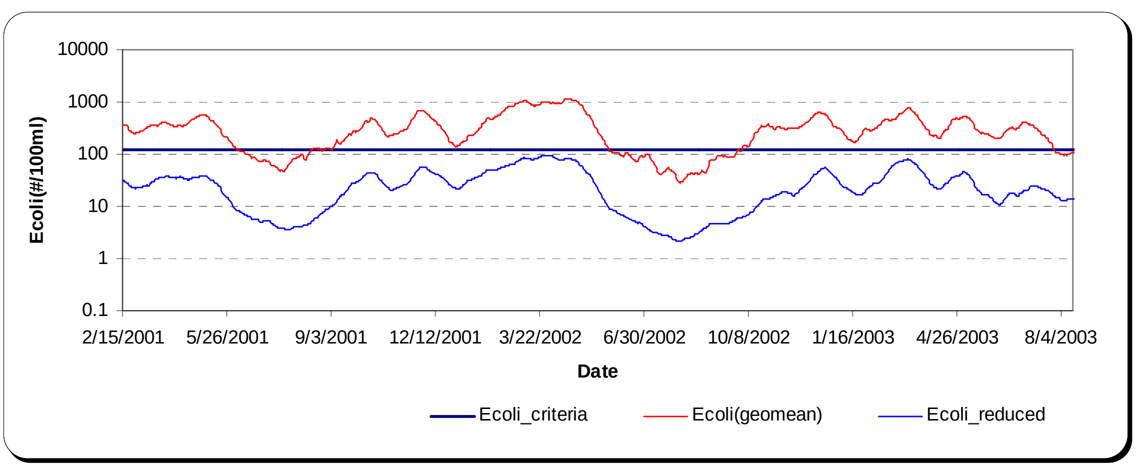


Figure H-8. *E. coli* (30 day geomean) at Upstream J. Edward Roush

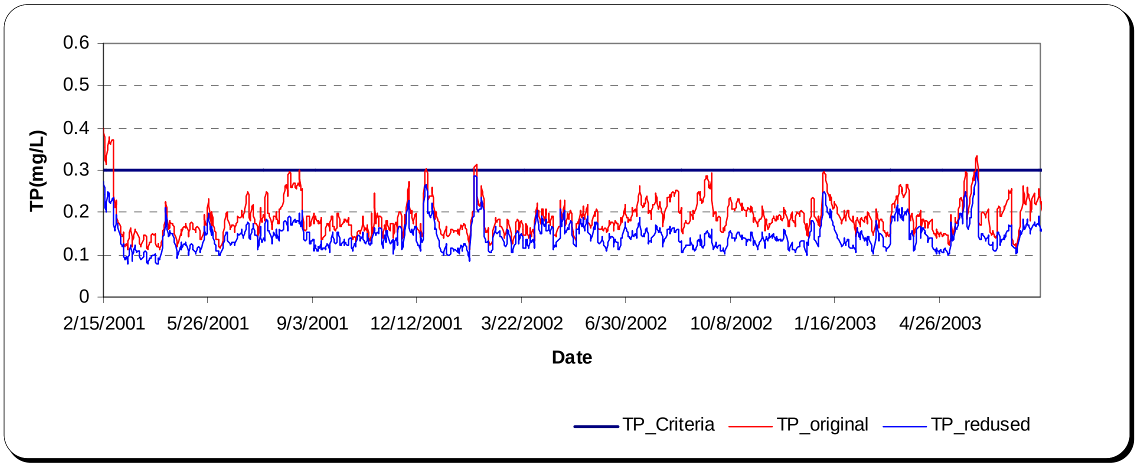


Figure H-9. TP at Upstream Lafayette

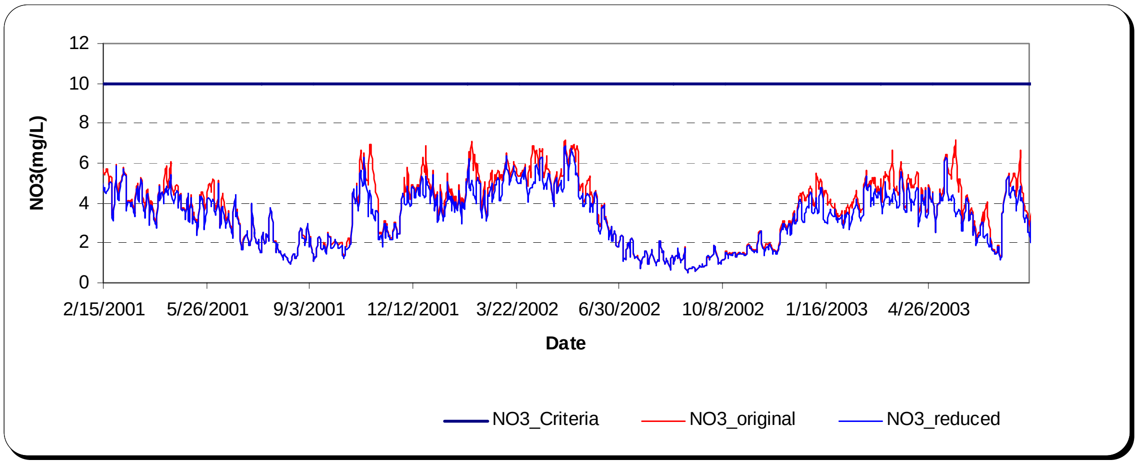


Figure H-10. NO3 at Upstream Lafayette

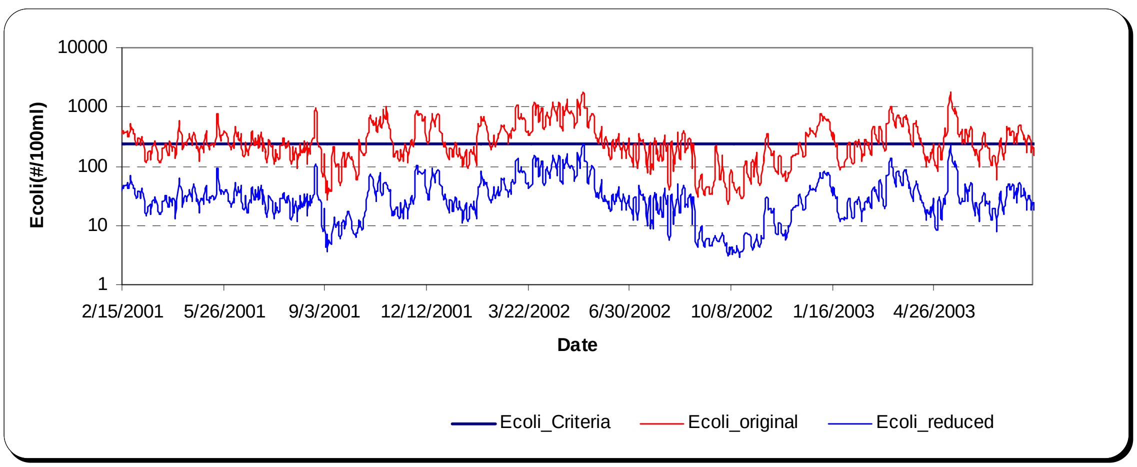


Figure H-11. *E. coli* (instantaneous) Upstream Lafayette

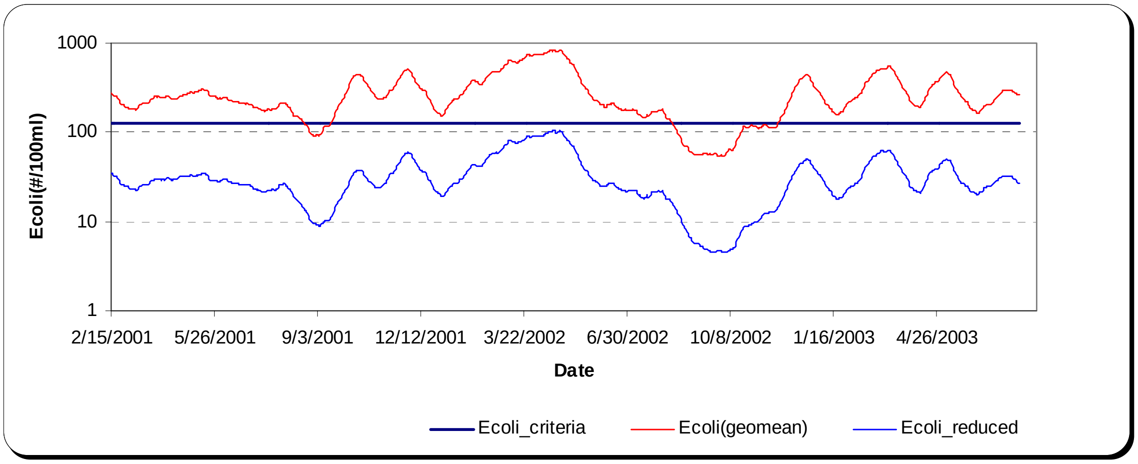


Figure H-12. *E. coli* (30 day geomean) at Upstream Lafayette

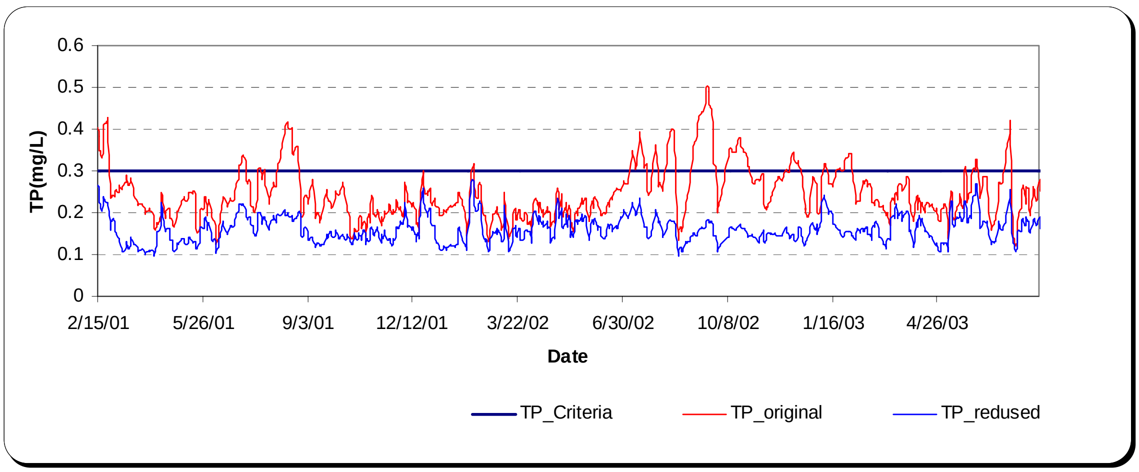


Figure H-13. TP at Upstream Vermillion

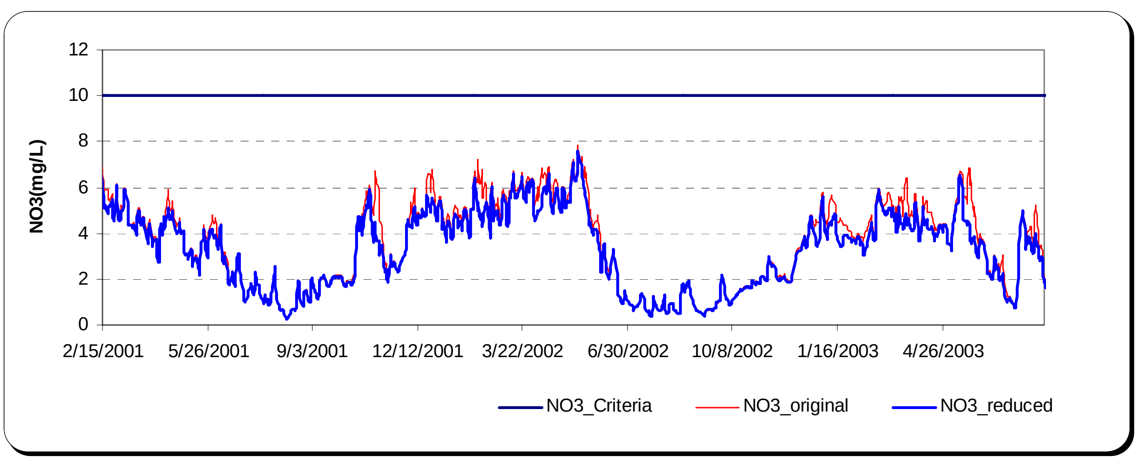


Figure H-14. NO3 at Upstream Vermillion

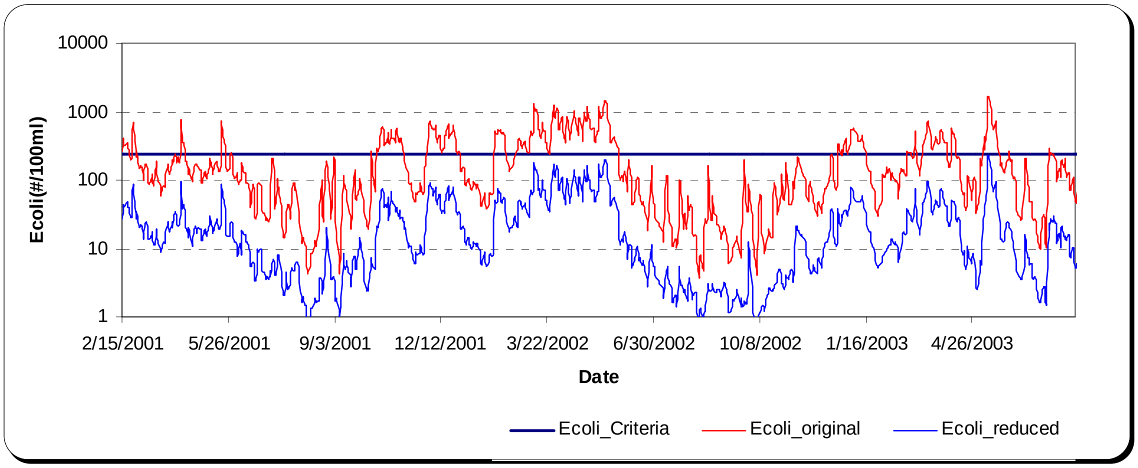


Figure H-15. *E. coli* (instantaneous) at Upstream Vermillion

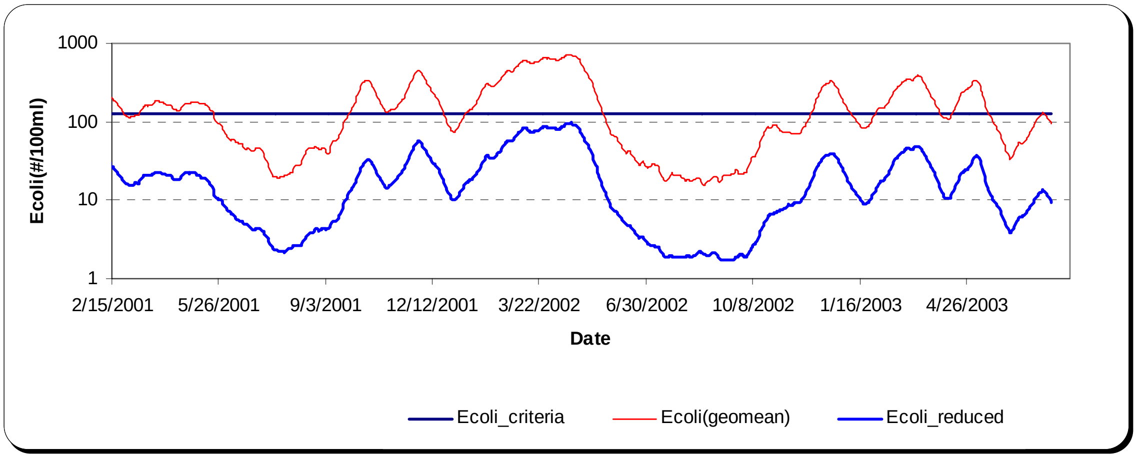


Figure H-16. *E. coli* (30 day geomean) at Upstream Vermillion

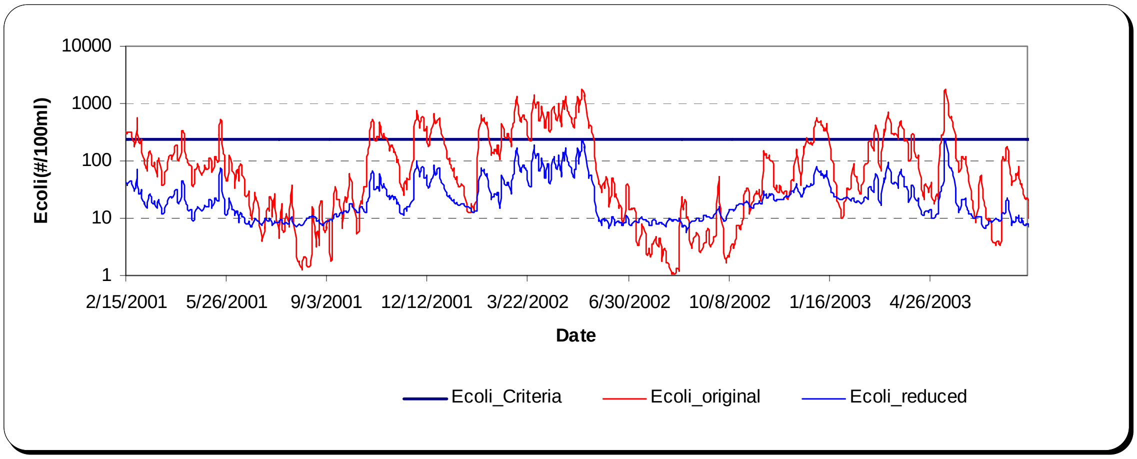


Figure H-17. *E. coli* (instantaneous) at State Line

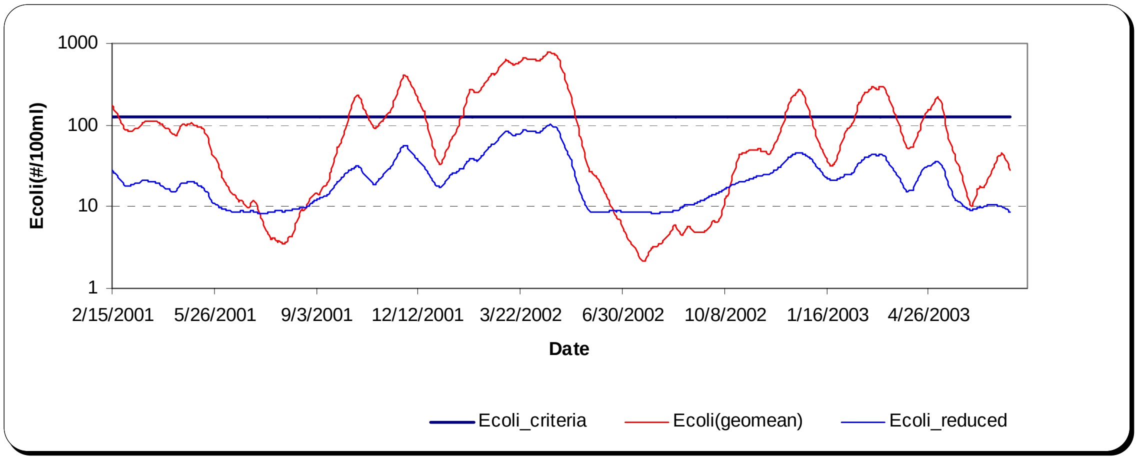


Figure H-18. ***E. coli*** **(30 day geomean) at State Line**

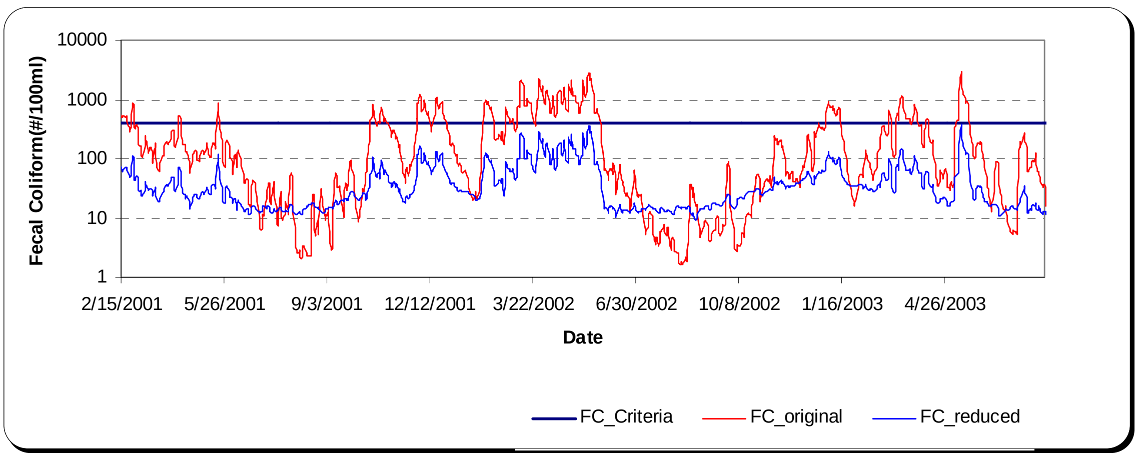


Figure H-19. Fecal Coliform (instantaneous) at State Line

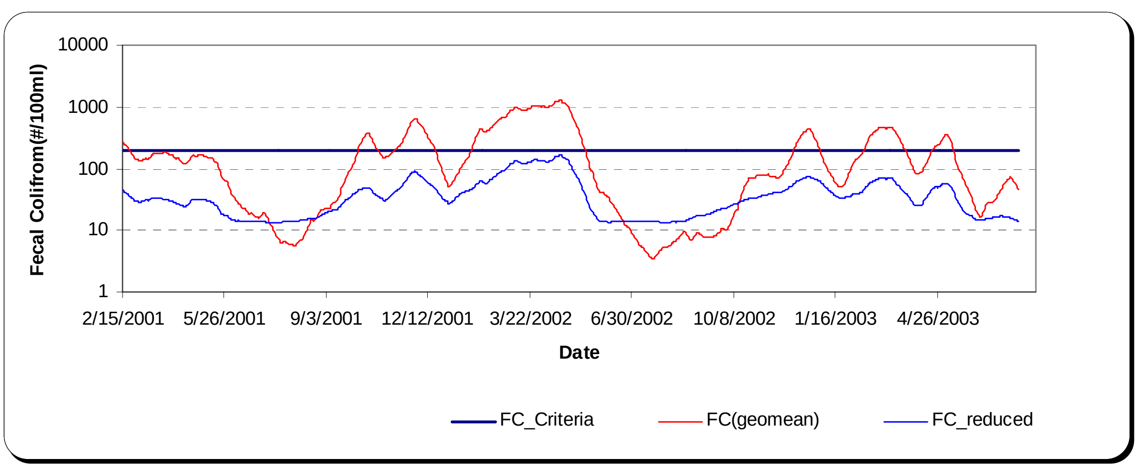


Figure H-20. Fecal Coliform (geomean) at State Line

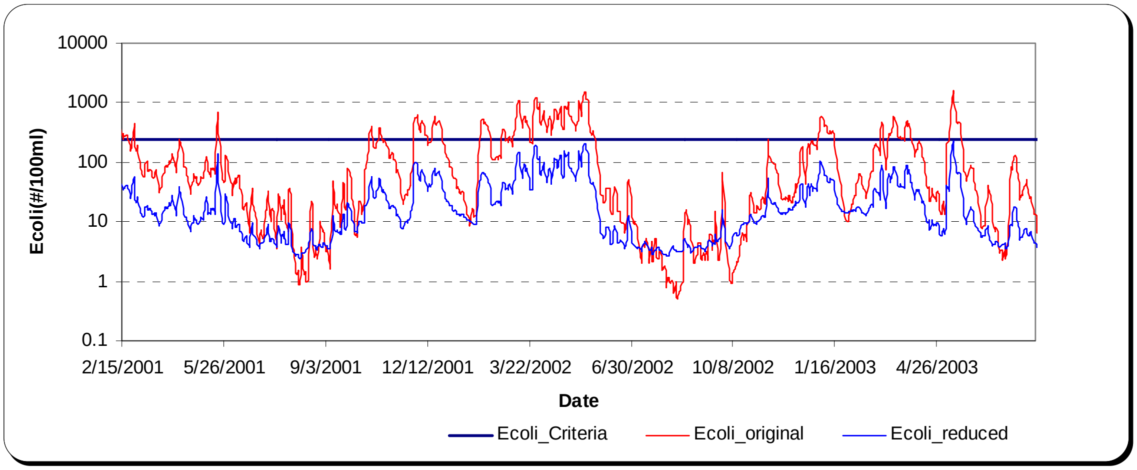


Figure H-21. *E. coli* (instantaneous) at B06 station

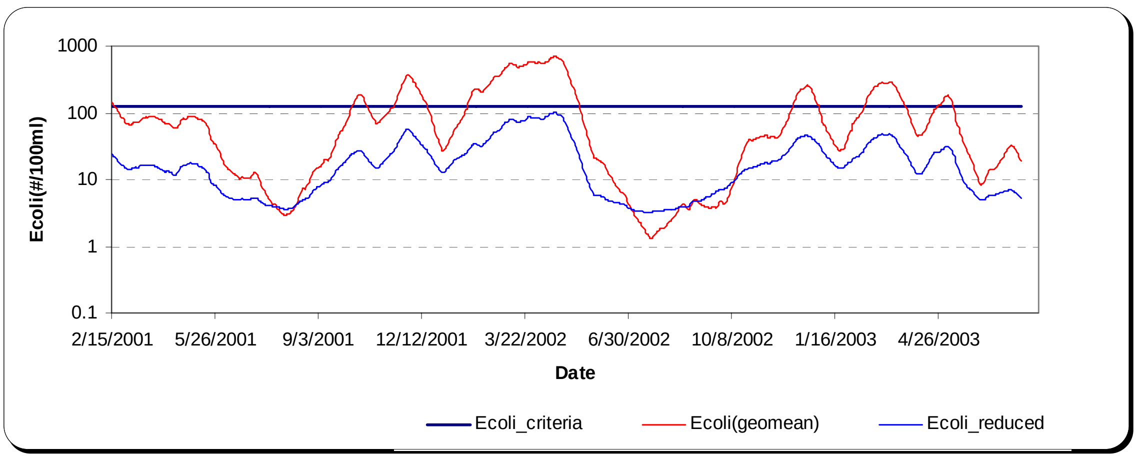


Figure H-22. *E. coli* (30 day geomean) at B06 station

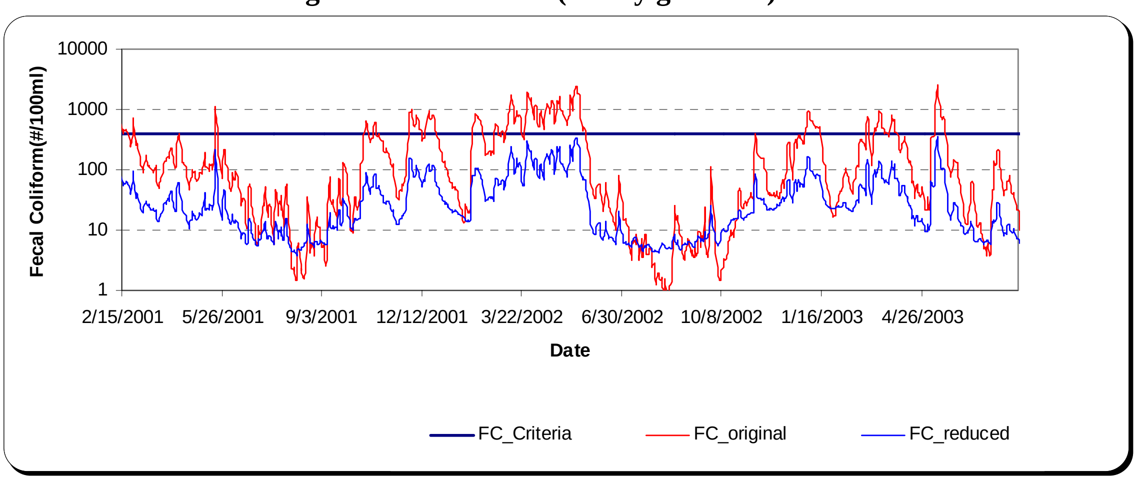


Figure H-23. Fecal Coliform (instantaneous) at B06 station

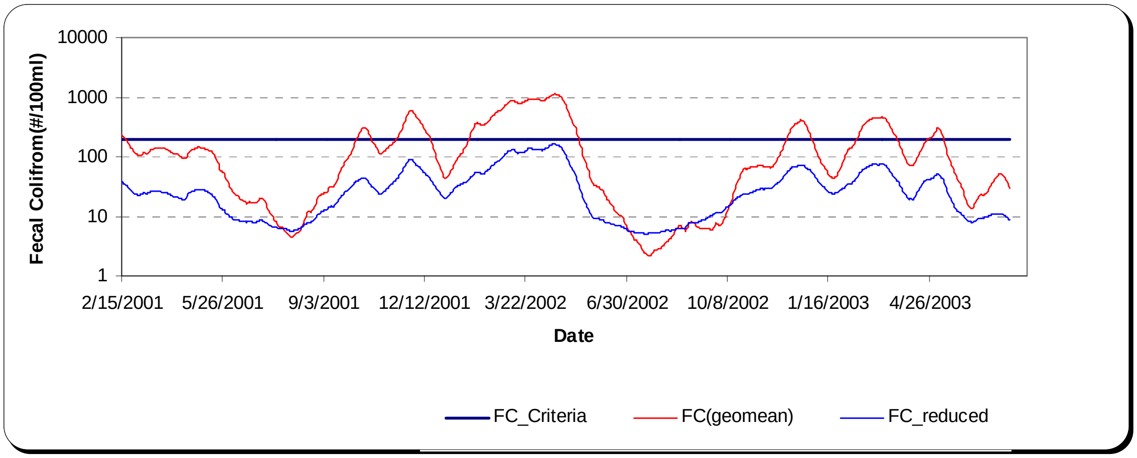


Figure H-24. Fecal Coliform (geomean) at B06 station

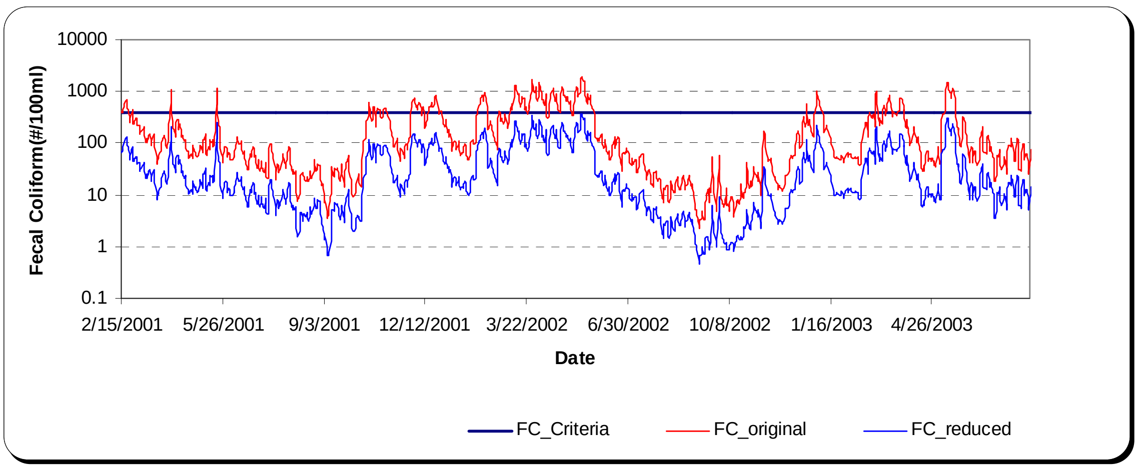


Figure H-25. Fecal Coliform (instantaneous) at the mouth of Wabash River Basin

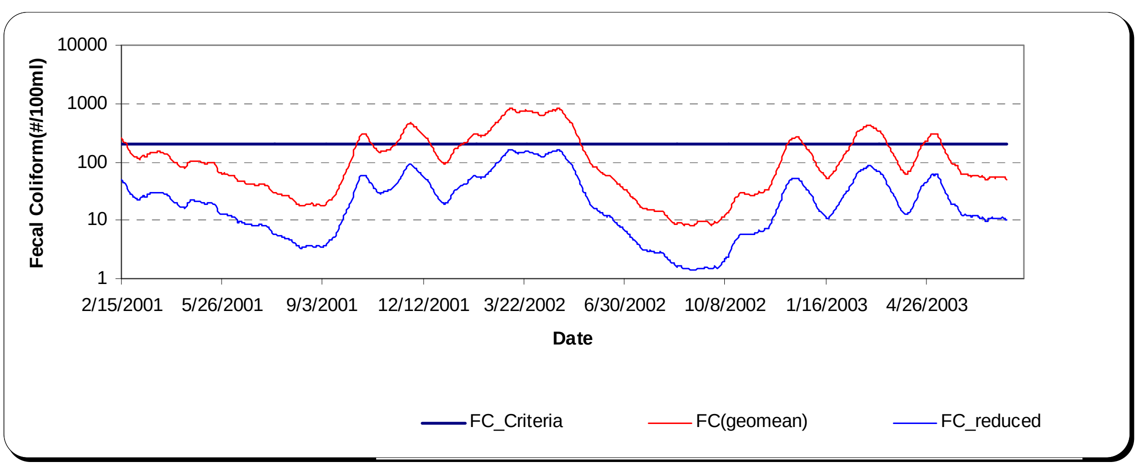


Figure H-26. Fecal Coliform (geomean) at the mouth of Wabash River Basin

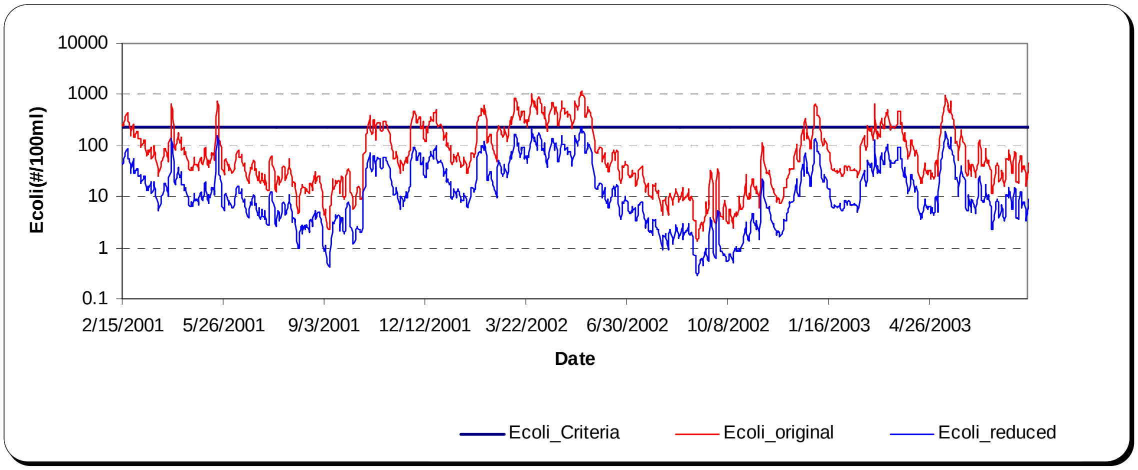


Figure H-27. *E. coli* (instantaneous) at the mouth of Wabash River Basin

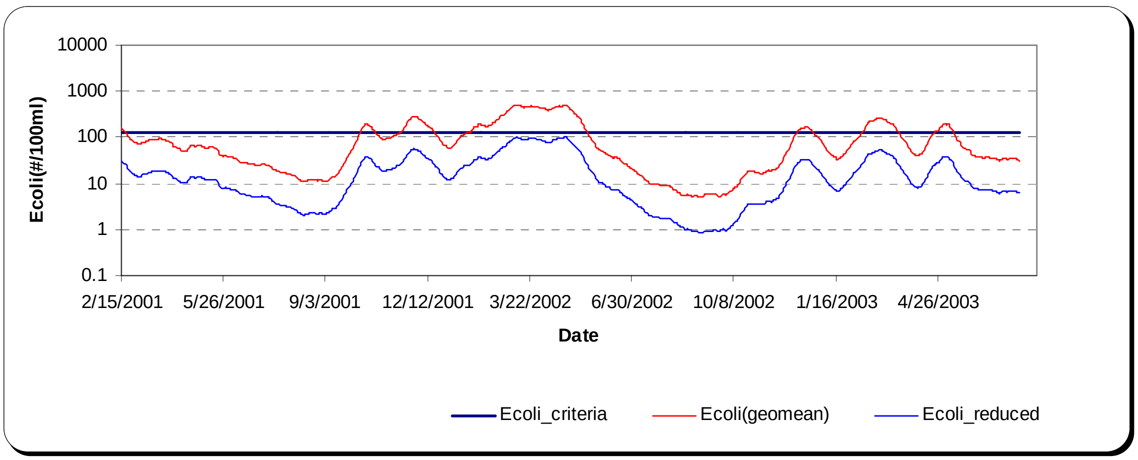
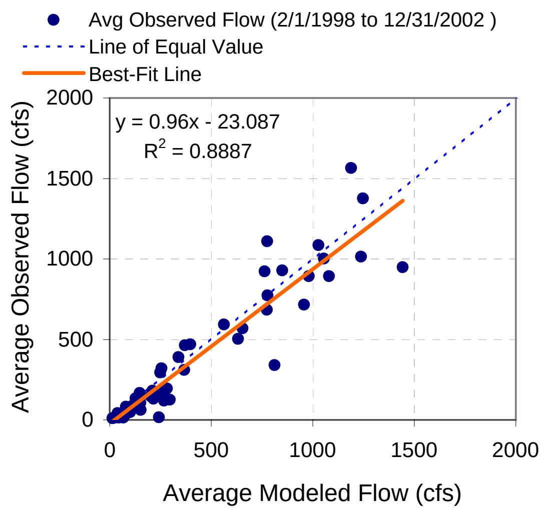
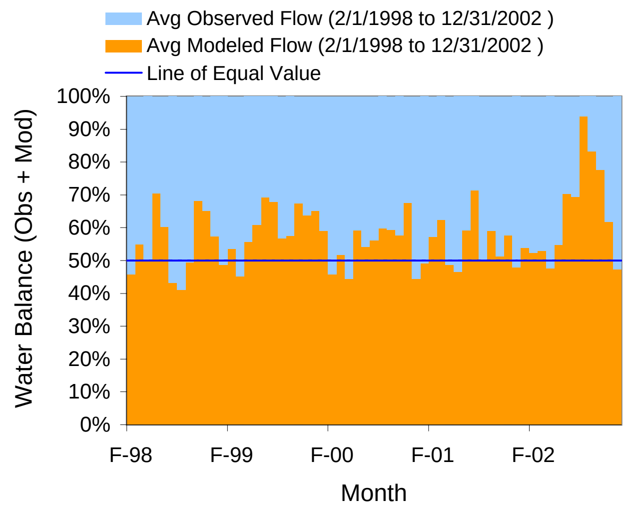
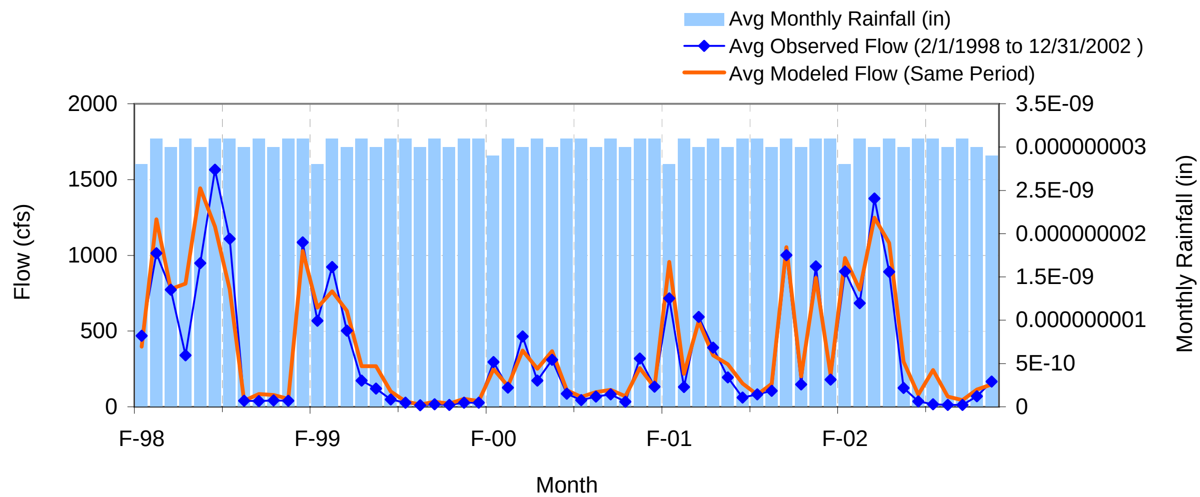
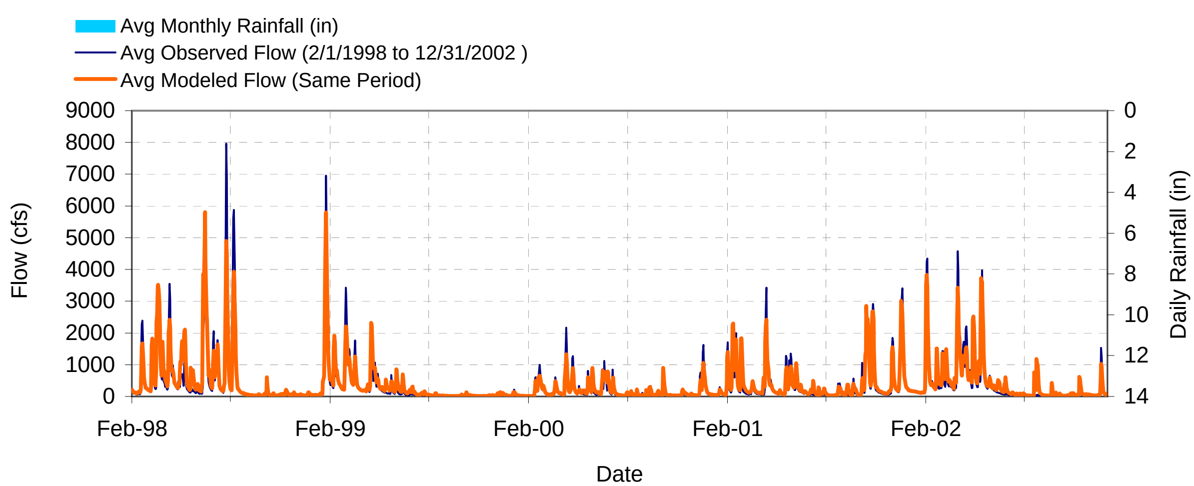


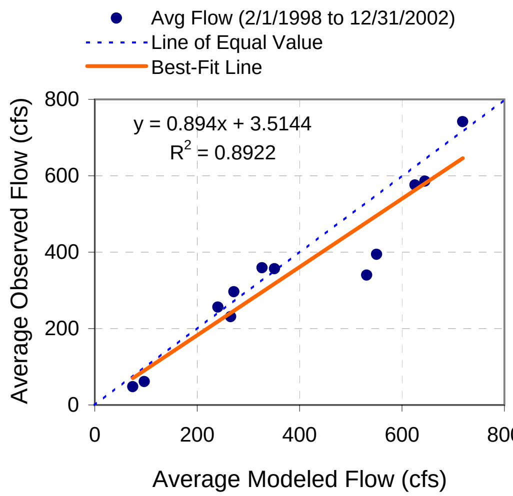
Figure H-28. *E. coli* (30 day geomean) at the mouth of Wabash River Basin

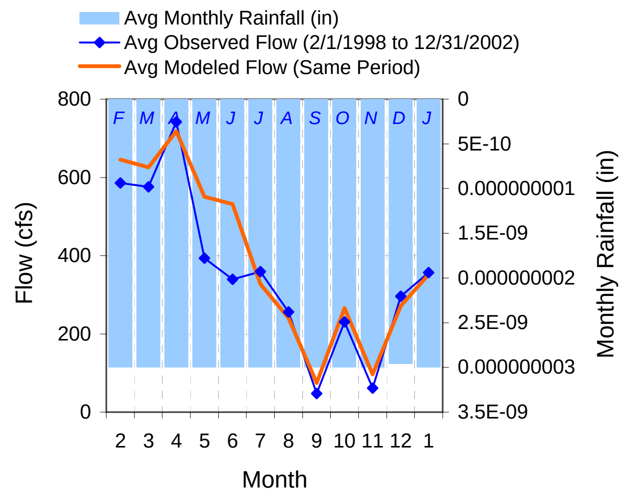

Avg Observed Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Best-Fit Line
y = 0.96x - 23.087
R2 = 0.8887
Average Observed Flow (cfs)
Average Modeled Flow (cfs)
0
500
1000
1500
2000

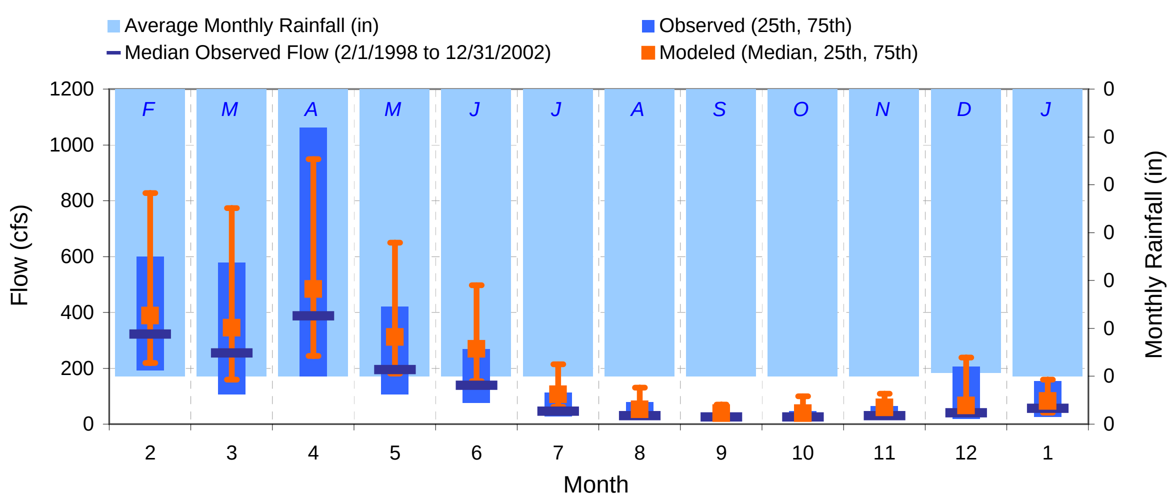

Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Water Balance (Obs + Mod)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
F-98
F-99
F-00
F-01
F-02
Month


Avg Monthly Rainfall (in)
Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
2000
1500
1000
500
0
3.5E-09
0.000000003
2.5E-09
0.000000002
1.5E-09
0.000000001
5E-10
0
Monthly Rainfall (in)
F-98
F-99
F-00
F-01
F-02
Month


Avg Monthly Rainfall (in)
Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Daily Rainfall (in)
0
2
4
6
8
10
12
14
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02
Date

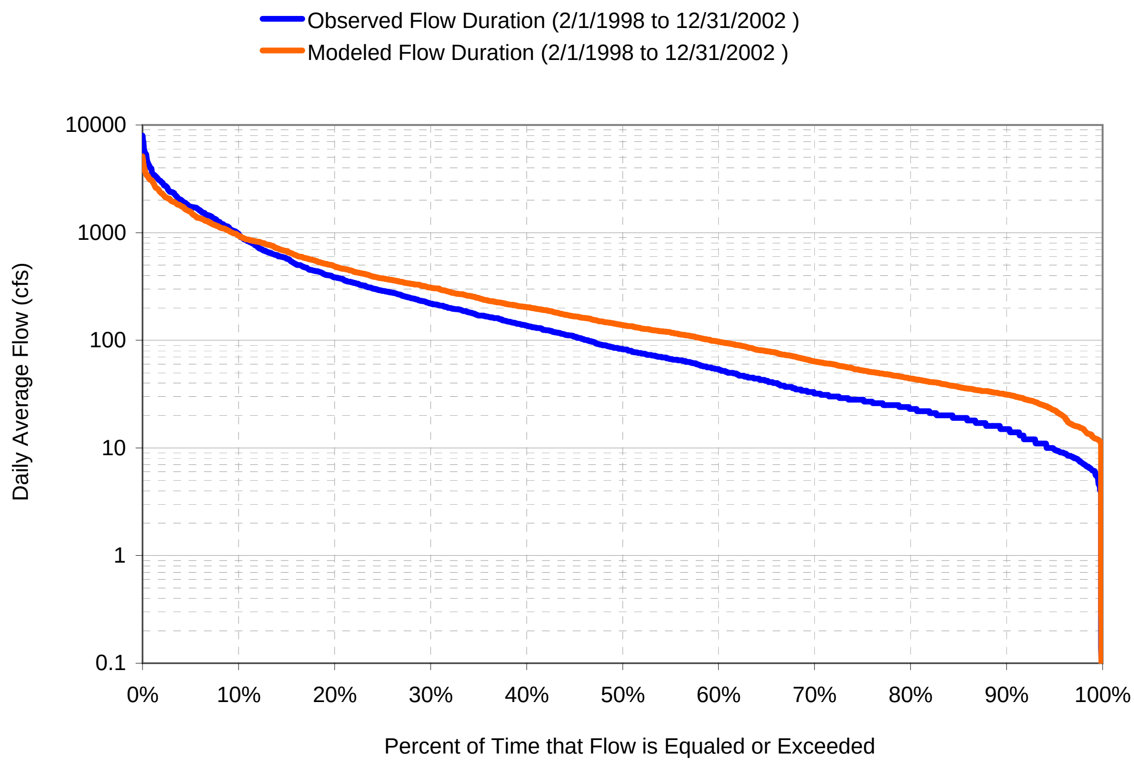


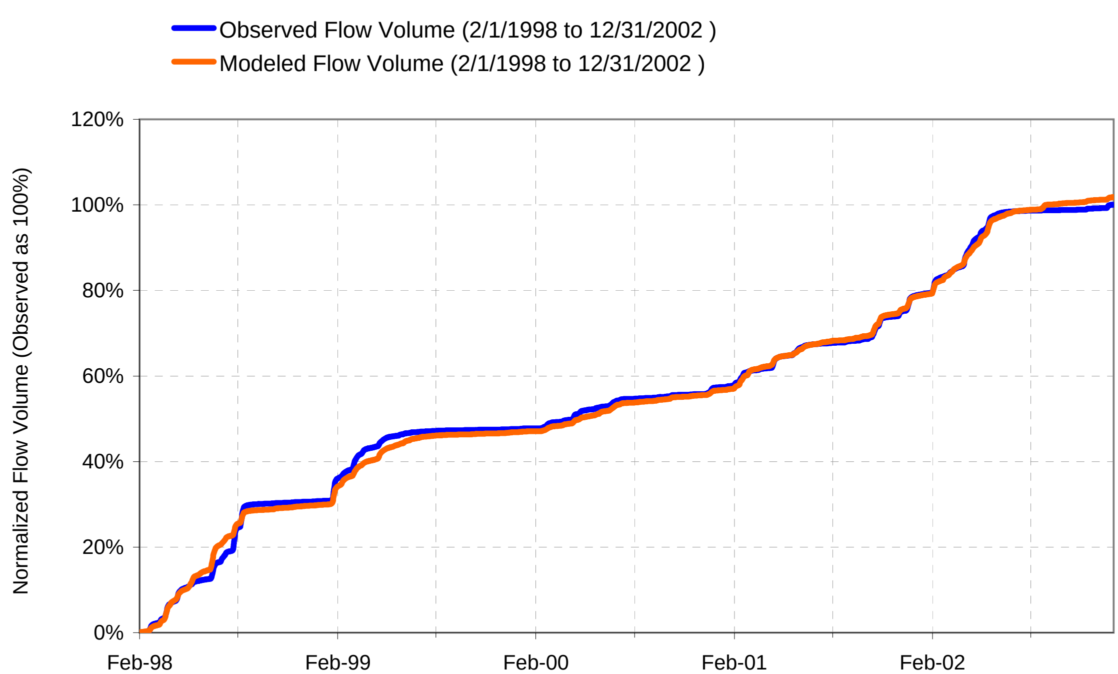




MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Feb	585.76	322.00	193.00	601.00	645.10	388.82	219.38	827.20
Mar	575.99	255.00	108.00	579.00	625.76	344.94	159.62	773.41
Apr	741.78	387.00	170.50	1062.50	718.56	483.52	243.72	948.68
May	393.75	195.00	106.00	421.00	550.68	311.94	181.65	650.37
Jun	339.64	139.00	76.00	268.75	531.38	269.23	153.69	497.73
Jul	359.25	46.00	29.00	113.50	326.83	106.74	61.78	214.16
Aug	255.68	30.00	20.00	79.00	240.36	52.57	28.95	130.21
Sep	47.55	25.00	10.25	42.75	74.53	39.02	26.30	69.82
Oct	230.59	25.00	16.00	46.50	265.94	39.52	30.23	99.86
Nov	61.02	29.50	18.00	63.75	96.85	60.05	35.58	108.70
Dec	296.05	40.00	20.00	206.50	271.92	66.21	36.08	238.61
Jan	356.44	56.00	26.75	153.75	351.56	82.16	41.24	159.78

USGS gage 03322900 Wabash River at Linn Grove, Indiana

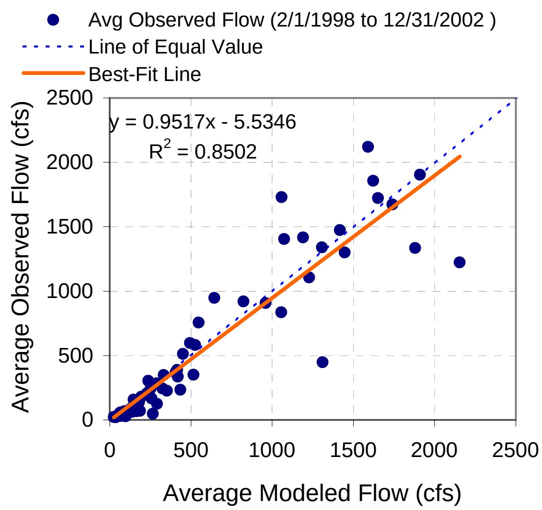

Observed Flow Duration (2/1/1998 to 12/31/2002)
Modeled Flow Duration (2/1/1998 to 12/31/2002)
Daily Average Flow (cfs)
10000
1000
100
10
1
0.1
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time that Flow is Equaled or Exceeded

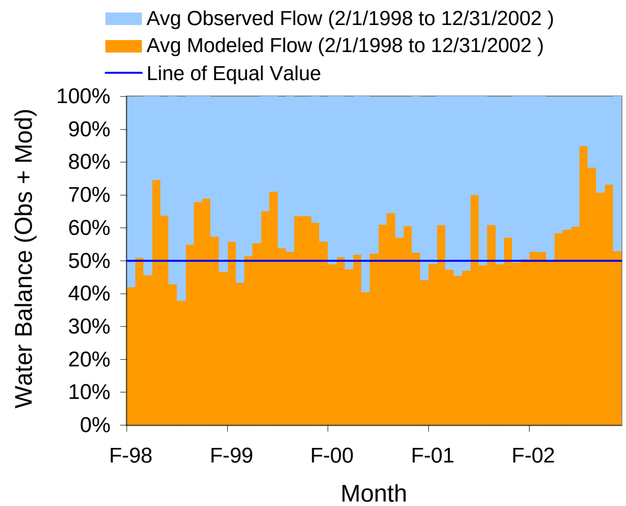

Observed Flow Volume (2/1/1998 to 12/31/2002)
Modeled Flow Volume (2/1/1998 to 12/31/2002)
Normalized Flow Volume (Observed as 100%)
120%
100%
80%
60%
40%
20%
0%
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02

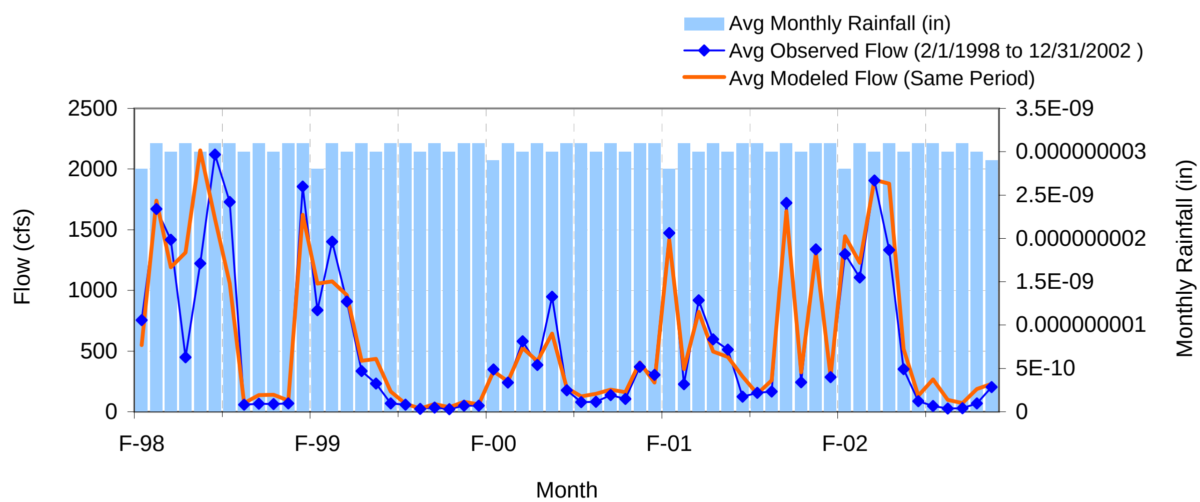
RIV1 Simulated Flow		Observed Flow Gage	
Total Simulated In-stream Flow:	**110.88**	Total Observed In-stream Flow:	**100.00**
Total of simulated highest 10% flows:	**58.70**	Total of Observed highest 10% flows:	**62.32**
Total of Simulated lowest 50% flows:	**8.34**	Total of Observed Lowest 50% flows:	**4.72**
Simulated Summer Flow Volume (months 7-9):	**15.67**	Observed Summer Flow Volume (7-9):	**16.20**
Simulated Fall Flow Volume (months 10-12):	**15.48**	Observed Fall Flow Volume (10-12):	**14.35**
Simulated Winter Flow Volume (months 1-3):	**36.61**	Observed Winter Flow Volume (1-3):	**34.16**
Simulated Spring Flow Volume (months 4-6):	**43.13**	Observed Spring Flow Volume (4-6):	**35.29**
Total Simulated Storm Volume:	**16.88**	Total Observed Storm Volume:	**18.49**
Simulated Summer Storm Volume (7-9):	**2.88**	Observed Summer Storm Volume (7-9):	**3.43**

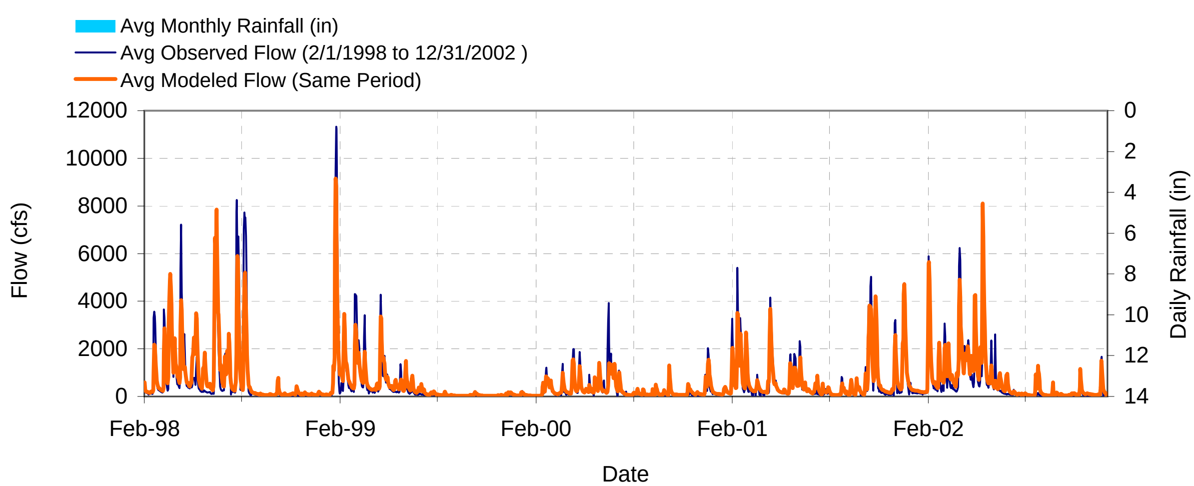
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	10.88	10	11.88	0.07
Error in 50% lowest flows:	76.67	10	-128.06	28.59
Error in 10% highest flows:	-5.80	15	9.35	-15.14
Seasonal volume error - Summer:	-3.27	30	-7.52	16.71
Seasonal volume error - Fall:	7.84	30	51.32	50.60
Seasonal volume error - Winter:	7.16	30	-3.05	-38.94
Seasonal volume error - Spring:	22.22	30	36.63	30.09
Error in storm volumes:	-8.72	20	-17.50	-69.91
Error in summer storm volumes:	-16.00	50	-99.02	-97.59

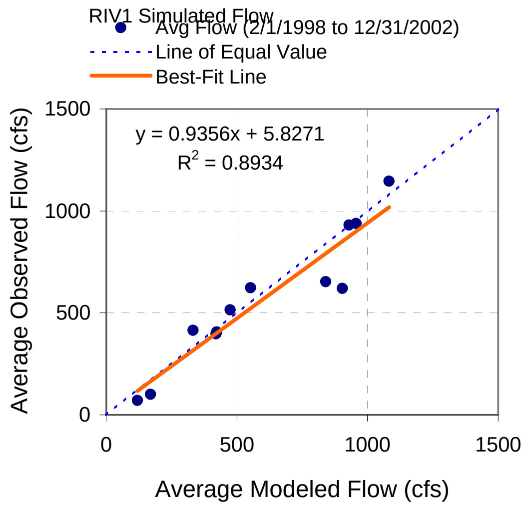
USGS gage 03322900 Wabash River at Linn Grove, Indiana

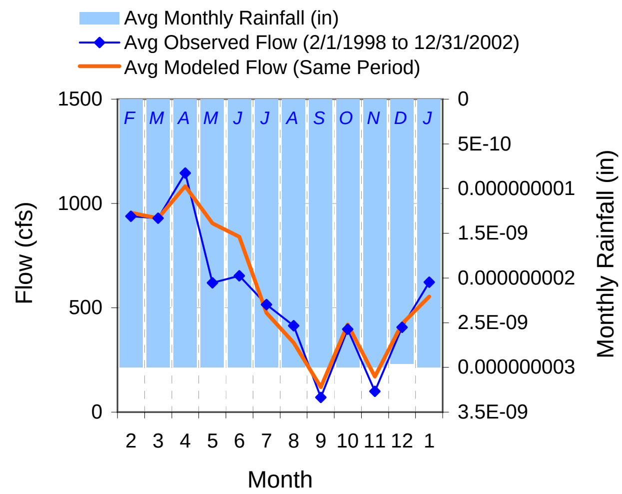

Avg Observed Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Best-Fit Line
y = 0.9517x - 5.5346
R^2 = 0.8502
Average Observed Flow (cfs)
Average Modeled Flow (cfs)
0
500
1000
1500
2000
2500

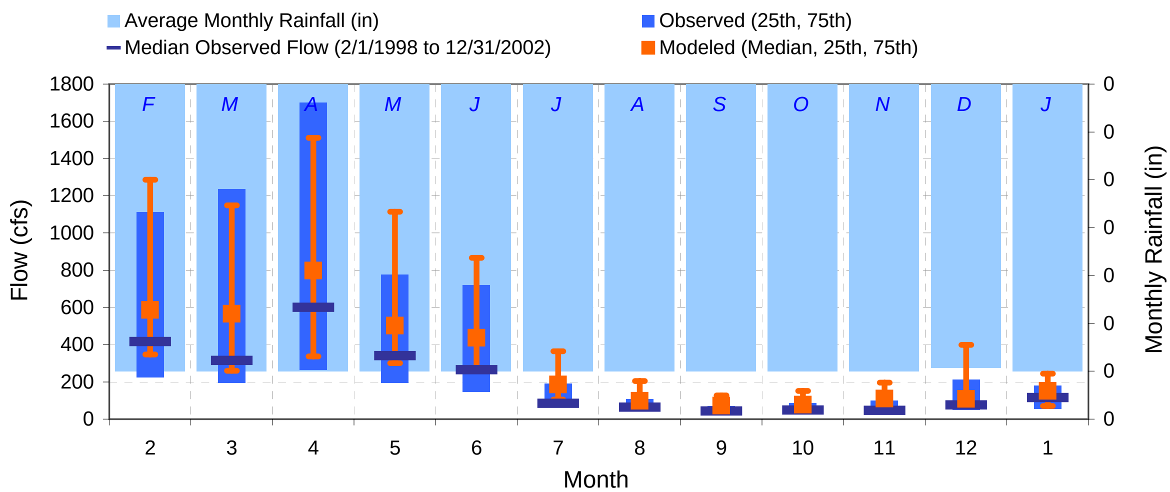

Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Water Balance (Obs + Mod)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
F-98
F-99
F-00
F-01
F-02
Month


Avg Monthly Rainfall (in)
Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
0
500
1000
1500
2000
2500
3.5E-09
0.000000003
2.5E-09
0.000000002
1.5E-09
0.000000001
5E-10
0
Monthly Rainfall (in)
F-98
F-99
F-00
F-01
F-02
Month


Avg Monthly Rainfall (in)
Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
0
2000
4000
6000
8000
10000
12000
0
2
4
6
8
10
12
14
Daily Rainfall (in)
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02
Date

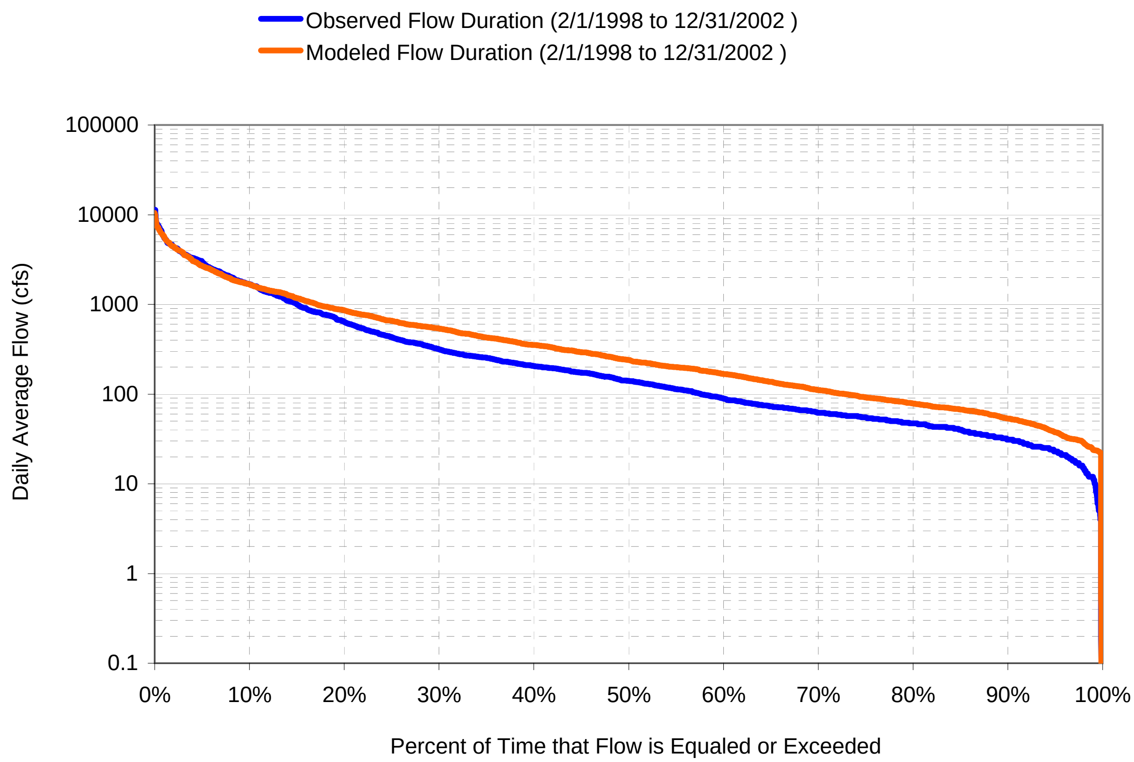


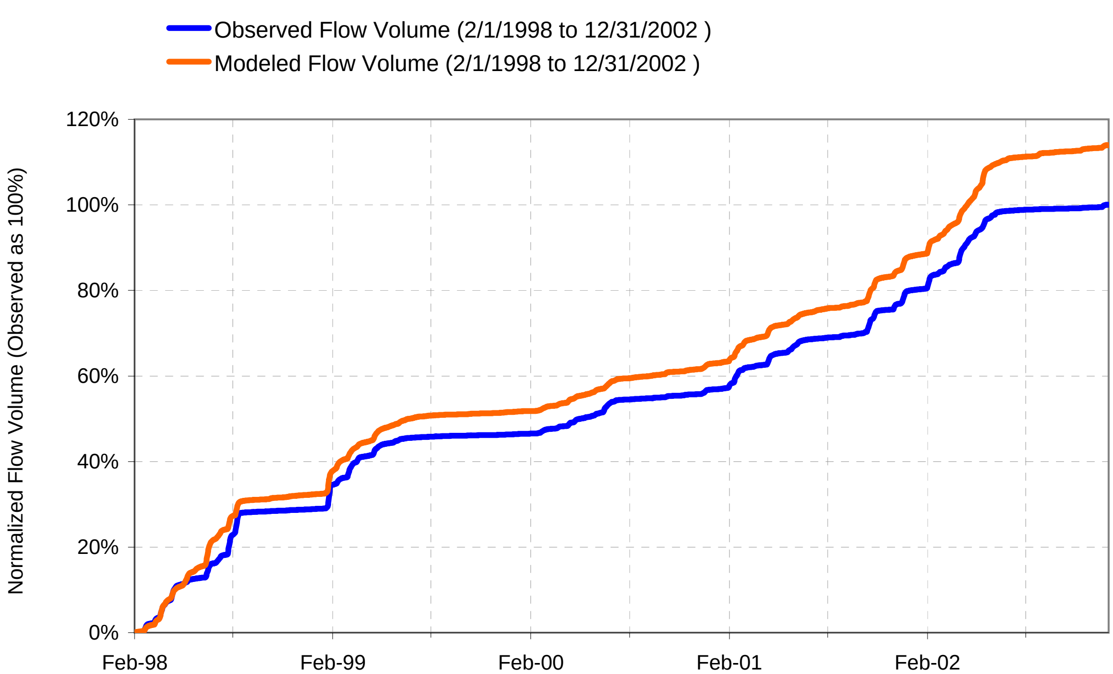




MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Feb	938.14	416.00	225.00	1113.00	956.17	586.56	347.54	1285.28
Mar	929.69	315.00	195.00	1234.00	929.37	565.83	259.21	1147.87
Apr	1146.04	599.50	265.00	1700.00	1082.39	798.45	337.51	1510.90
May	620.10	341.00	195.00	774.50	904.47	501.63	300.32	1113.72
Jun	653.31	264.00	146.75	718.00	841.14	437.19	275.80	866.16
Jul	515.14	85.00	61.50	191.00	474.93	185.49	105.56	364.60
Aug	414.16	64.00	45.50	107.17	332.89	97.57	58.20	203.91
Sep	71.02	43.00	26.00	70.75	120.17	71.74	43.17	126.99
Oct	397.57	48.00	32.00	84.00	420.96	76.86	60.02	150.43
Nov	100.34	47.00	29.00	100.50	170.21	109.70	66.99	195.63
Dec	405.91	76.00	50.50	211.50	422.80	108.91	74.30	399.13
Jan	623.15	115.00	54.38	178.00	553.34	151.86	70.95	243.53

US Army Corps of Engineers gage for inflow to J. Edward Roush Lake

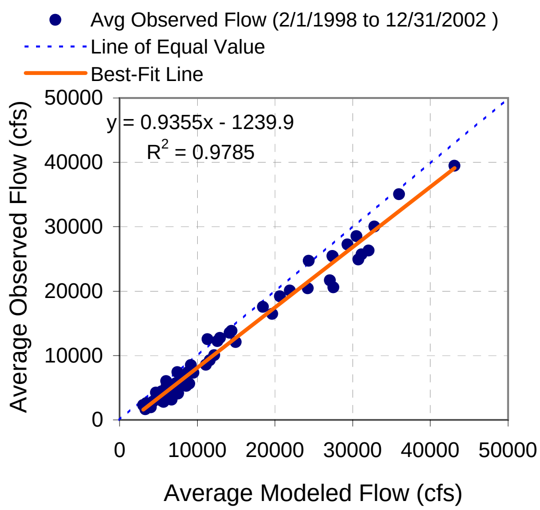


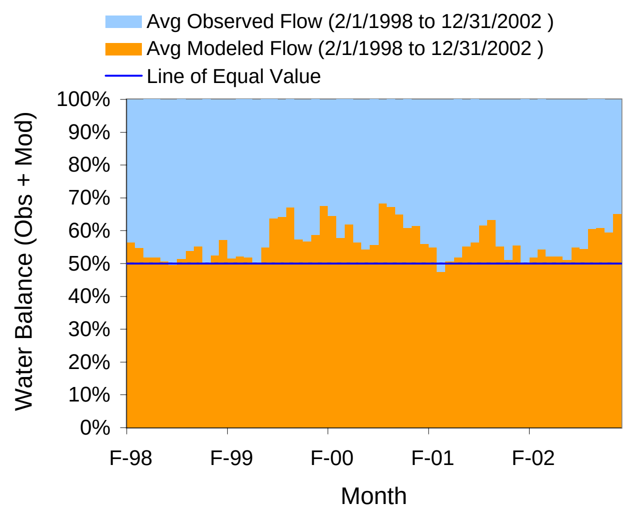


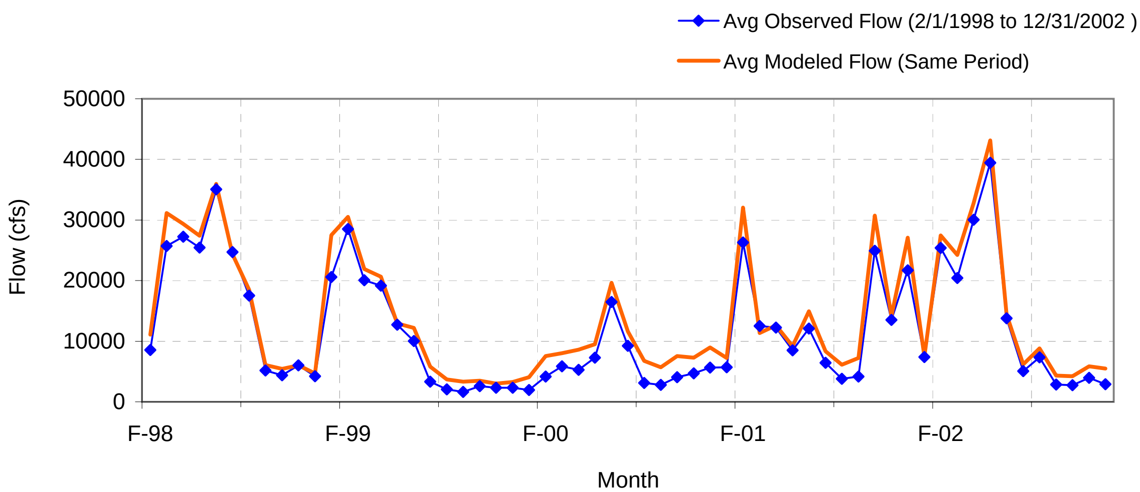
US Army Corps of Engineers gage for inflow to J. Edward Roush Lake

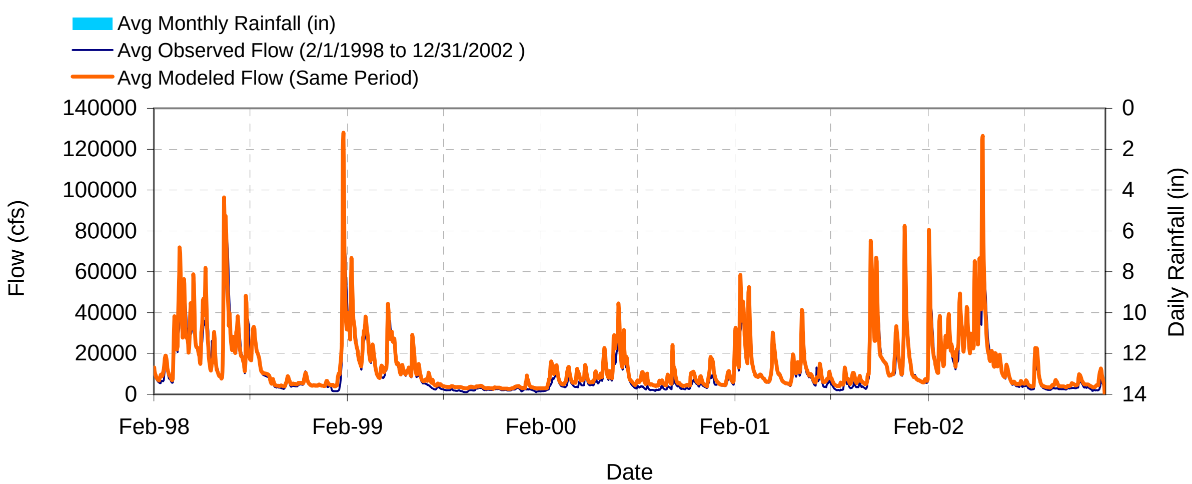
RIV1 Simulated Flow		Observed Flow Gage	
Total Simulated In-stream Flow:	**106.10**	Total Observed In-stream Flow:	**100.00**
Total of simulated highest 10% flows:	**53.57**	Total of Observed highest 10% flows:	**60.64**
Total of Simulated lowest 50% flows:	**9.11**	Total of Observed Lowest 50% flows:	**5.41**
Simulated Summer Flow Volume (months 7-9):	**14.13**	Observed Summer Flow Volume (7-9):	**15.26**
Simulated Fall Flow Volume (months 10-12):	**15.42**	Observed Fall Flow Volume (10-12):	**13.77**
Simulated Winter Flow Volume (months 1-3):	**34.27**	Observed Winter Flow Volume (1-3):	**34.88**
Simulated Spring Flow Volume (months 4-6):	**42.28**	Observed Spring Flow Volume (4-6):	**36.10**
Total Simulated Storm Volume:	**15.58**	Total Observed Storm Volume:	**18.16**
Simulated Summer Storm Volume (7-9):	**2.42**	Observed Summer Storm Volume (7-9):	**2.64**

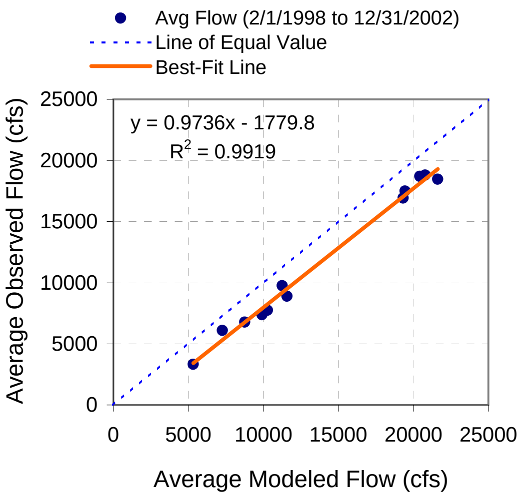
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	6.10	10		
Error in 50% lowest flows:	68.51	10		
Error in 10% highest flows:	-11.66	15		
Seasonal volume error - Summer:	-7.41	30		
Seasonal volume error - Fall:	11.98	30		
Seasonal volume error - Winter:	-1.74	30		
Seasonal volume error - Spring:	17.13	30		
Error in storm volumes:	-14.20	20		
Error in summer storm volumes:	-8.40	50		

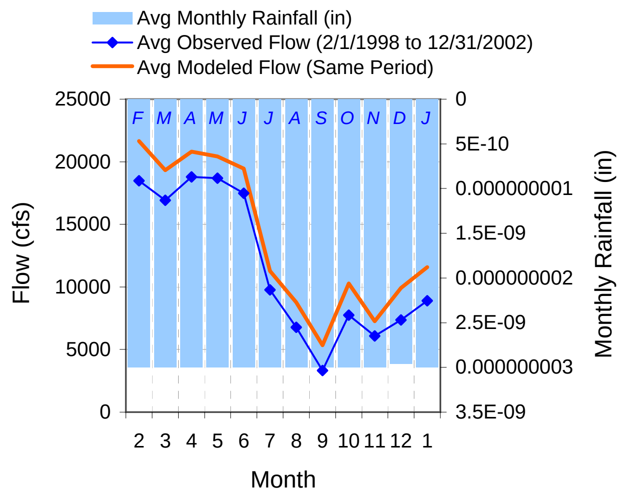

Avg Observed Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Best-Fit Line
y = 0.9355x - 1239.9
R2 = 0.9785
Average Observed Flow (cfs)
Average Modeled Flow (cfs)
0
10000
20000
30000
40000
50000

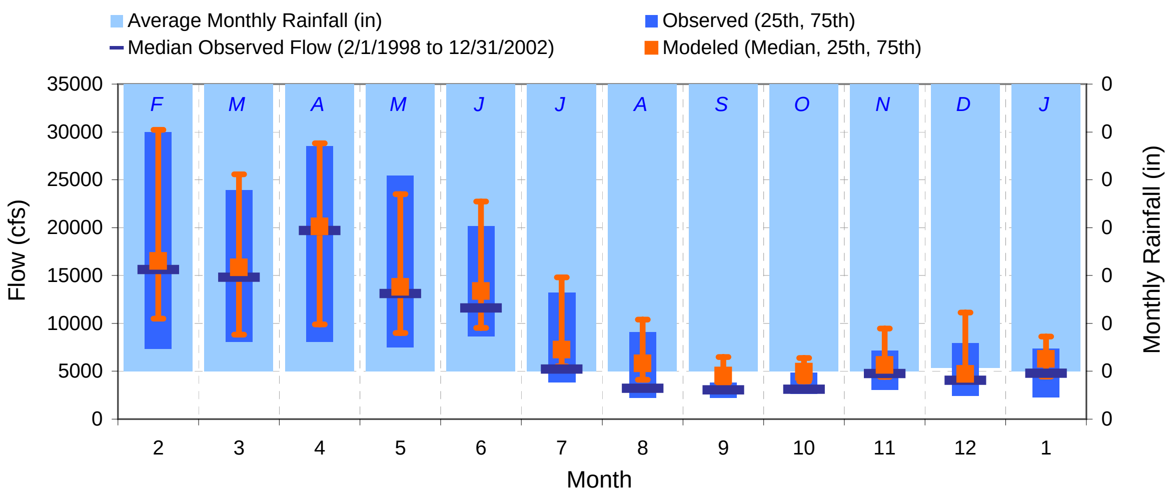

Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Water Balance (Obs + Mod)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
F-98
F-99
F-00
F-01
F-02
Month


Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
50000
40000
30000
20000
10000
0
F-98
F-99
F-00
F-01
F-02
Month

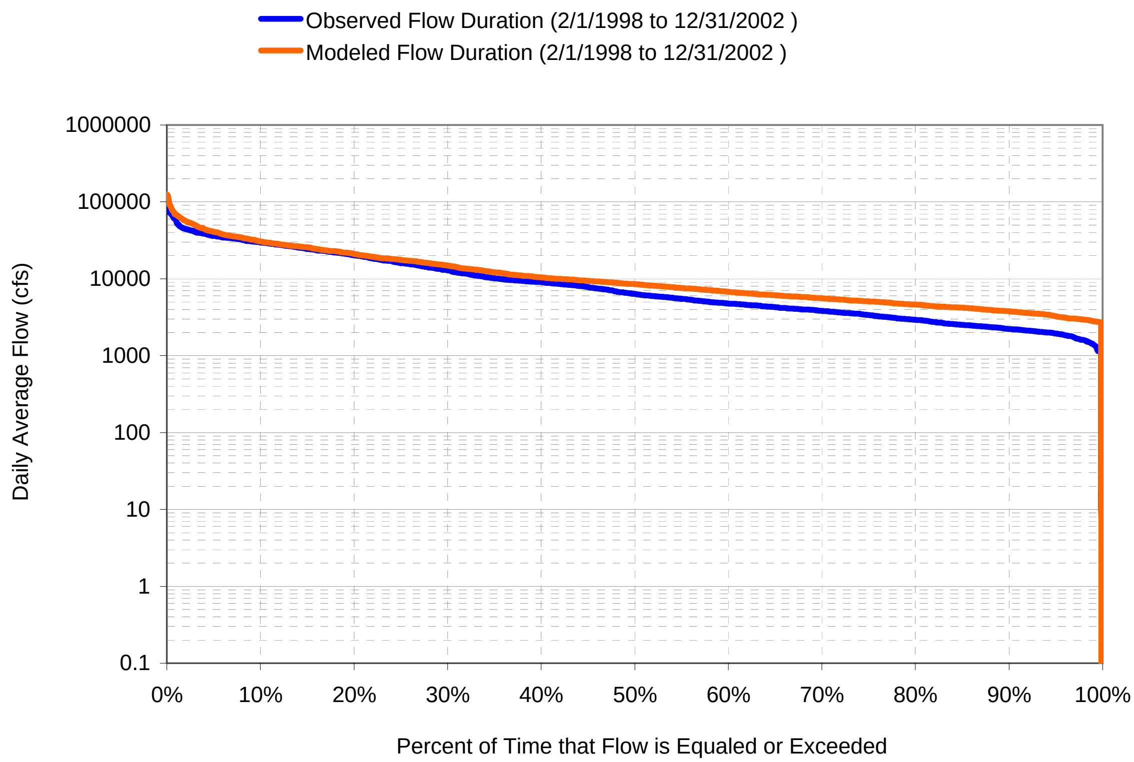

Avg Monthly Rainfall (in)
Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
Daily Rainfall (in)
140000
120000
100000
80000
60000
40000
20000
0
0
2
4
6
8
10
12
14
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02
Date



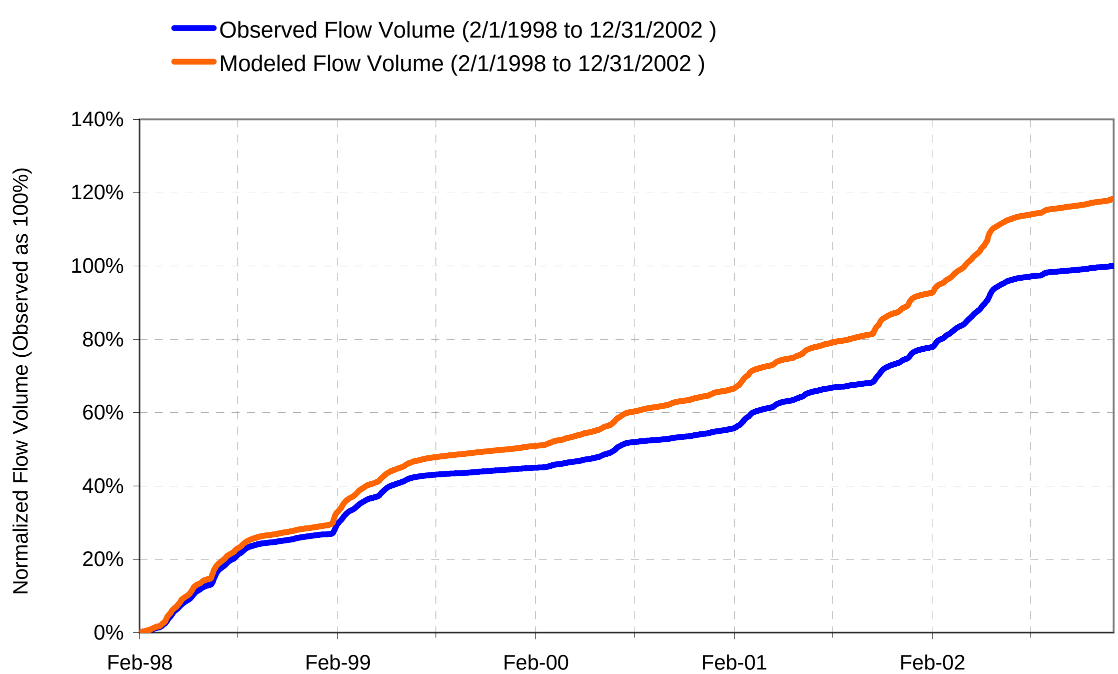




MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Feb	18472.77	15600.00	7320.00	30000.00	21640.16	16528.31	10491.08	30225.36
Mar	16920.71	14800.00	8040.00	23950.00	19333.38	15856.51	8811.25	25565.02
Apr	18794.00	19700.00	8067.50	28475.00	20799.48	20116.04	9879.83	28830.42
May	18693.61	13100.00	7505.00	25450.00	20430.38	13801.49	9006.94	23503.64
Jun	17487.27	11600.00	8655.00	20150.00	19447.74	13364.51	9541.61	22716.00
Jul	9754.06	5230.00	3835.00	13200.00	11260.82	7255.77	5504.32	14823.47
Aug	6776.00	3220.00	2220.00	9075.00	8765.05	5800.24	4103.02	10391.55
Sep	3322.73	3055.00	2190.00	3765.00	5333.84	4539.52	3712.47	6496.53
Oct	7735.74	3110.00	2650.00	4855.00	10285.17	4942.92	3936.43	6401.41
Nov	6091.87	4740.00	3050.00	7142.50	7271.83	5633.78	4413.32	9447.41
Dec	7361.55	4060.00	2440.00	7965.00	9909.85	4712.83	3993.75	11147.69
Jan	8901.53	4765.00	2280.00	7342.50	11576.51	6301.12	4432.66	8636.14



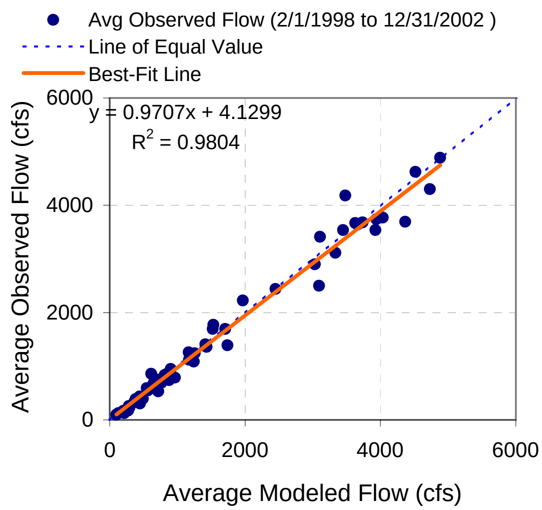
Observed Flow Duration (2/1/1998 to 12/31/2002)
Modeled Flow Duration (2/1/1998 to 12/31/2002)
Daily Average Flow (cfs)
1000000
100000
10000
1000
100
10
1
0.1
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time that Flow is Equaled or Exceeded

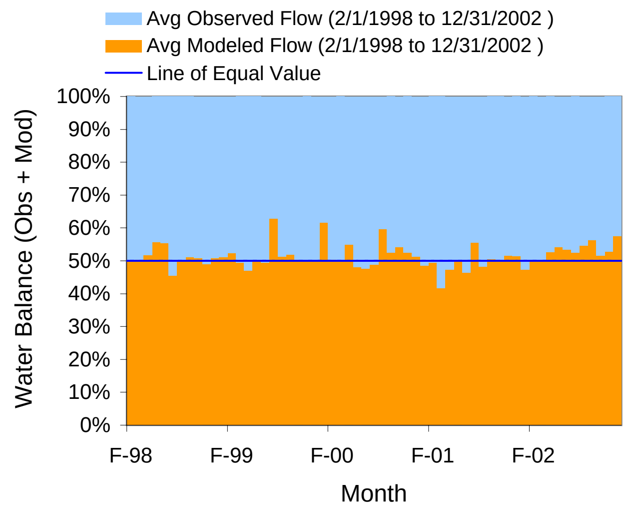


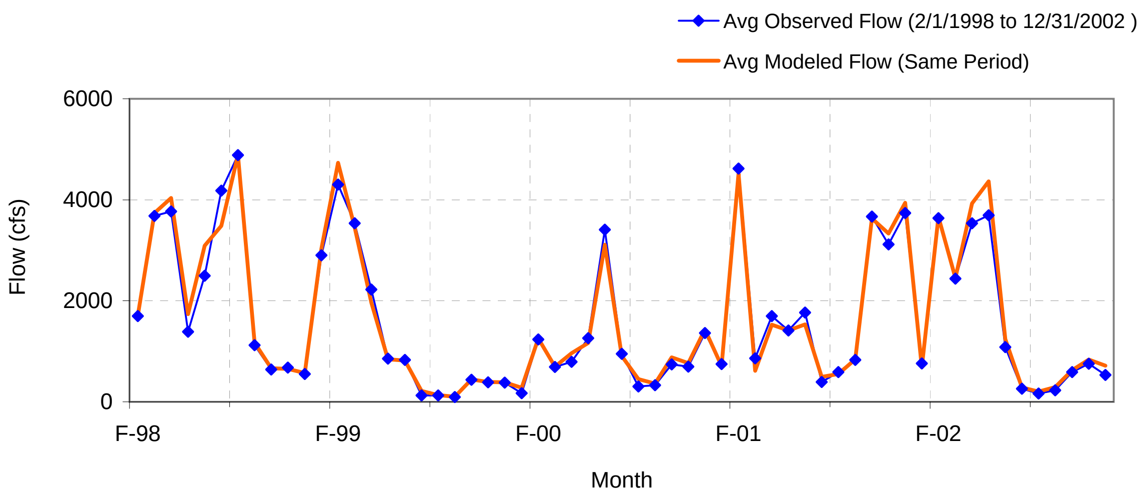
Observed Flow Volume (2/1/1998 to 12/31/2002)
Modeled Flow Volume (2/1/1998 to 12/31/2002)
Normalized Flow Volume (Observed as 100%)
140%
120%
100%
80%
60%
40%
20%
0%
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02

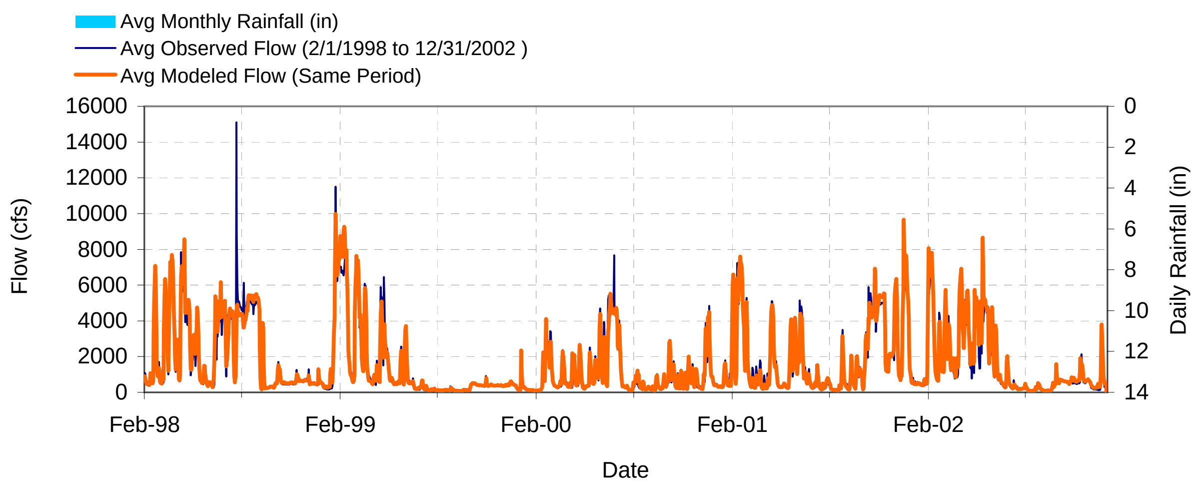
RIV1 Simulated Flow		**Observed Flow Gage**	
Total Simulated In-stream Flow:	**118.24**	Total Observed In-stream Flow:	**100.00**
Total of simulated highest 10% flows:	**41.18**	Total of Observed highest 10% flows:	**34.54**
Total of Simulated lowest 50% flows:	**22.11**	Total of Observed Lowest 50% flows:	**15.05**
Simulated Summer Flow Volume (months 7-9):	**18.60**	Observed Summer Flow Volume (7-9):	**14.58**
Simulated Fall Flow Volume (months 10-12):	**20.11**	Observed Fall Flow Volume (10-12):	**15.51**
Simulated Winter Flow Volume (months 1-3):	**35.66**	Observed Winter Flow Volume (1-3):	**30.17**
Simulated Spring Flow Volume (months 4-6):	**43.86**	Observed Spring Flow Volume (4-6):	**39.74**
Total Simulated Storm Volume:	**8.86**	Total Observed Storm Volume:	**5.29**
Simulated Summer Storm Volume (7-9):	**1.13**	Observed Summer Storm Volume (7-9):	**0.95**

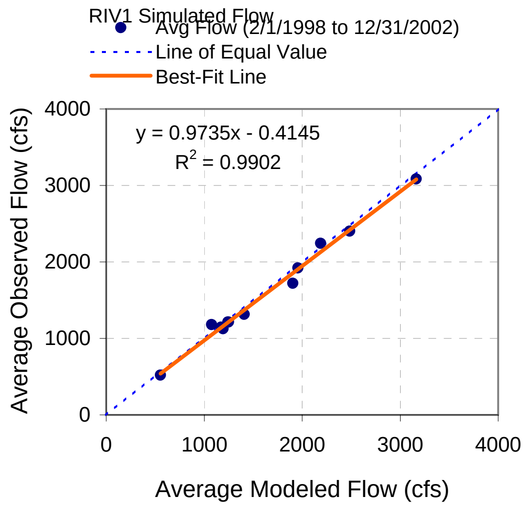
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	18.24	10	11.88	0.07
Error in 50% lowest flows:	46.93	10	-128.06	28.59
Error in 10% highest flows:	19.20	15	9.35	-15.14
Seasonal volume error - Summer:	27.56	30	-7.52	16.71
Seasonal volume error - Fall:	29.72	30	51.32	50.60
Seasonal volume error - Winter:	18.20	30	-3.05	-38.94
Seasonal volume error - Spring:	10.36	30	36.63	30.09
Error in storm volumes:	67.58	20	-17.50	-69.91
Error in summer storm volumes:	19.19	50	-99.02	-97.59

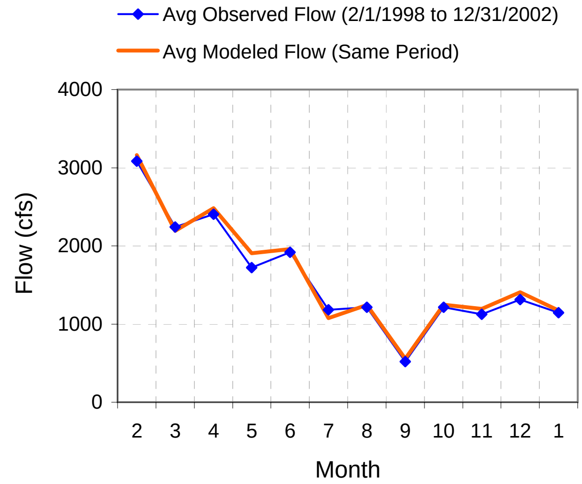

Avg Observed Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Best-Fit Line
y = 0.9707x + 4.1299
R^2 = 0.9804
Average Observed Flow (cfs)
Average Modeled Flow (cfs)
0
2000
4000
6000

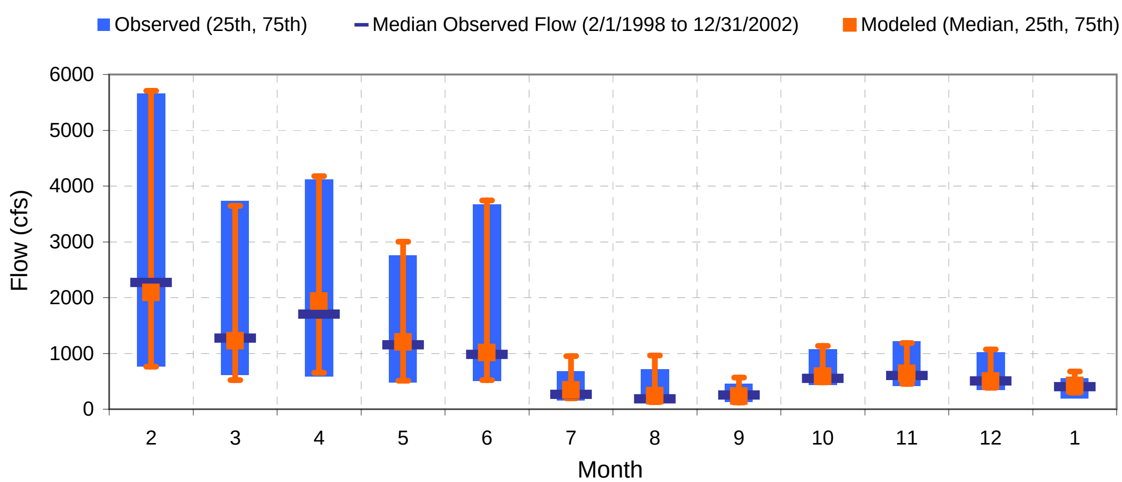

Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Water Balance (Obs + Mod)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
F-98
F-99
F-00
F-01
F-02
Month


Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
6000
4000
2000
0
F-98
F-99
F-00
F-01
F-02
Month

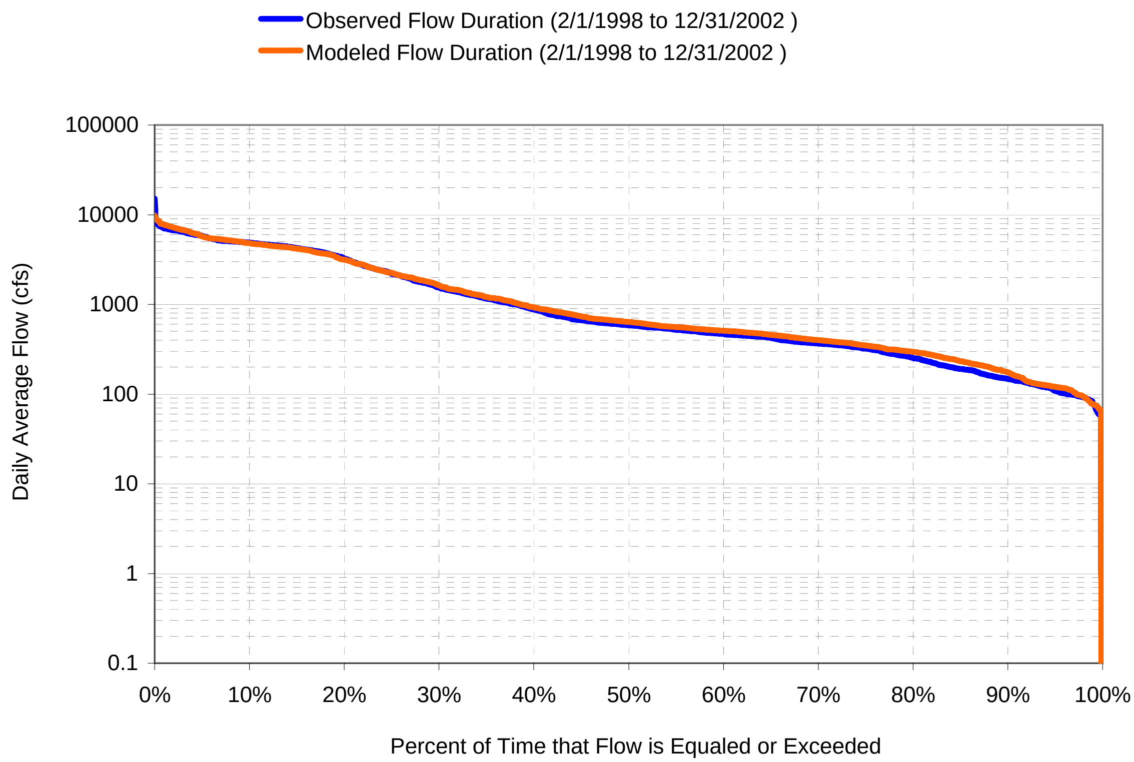

Avg Monthly Rainfall (in)
Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
16000
14000
12000
10000
8000
6000
4000
2000
0
Daily Rainfall (in)
0
2
4
6
8
10
12
14
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02
Date

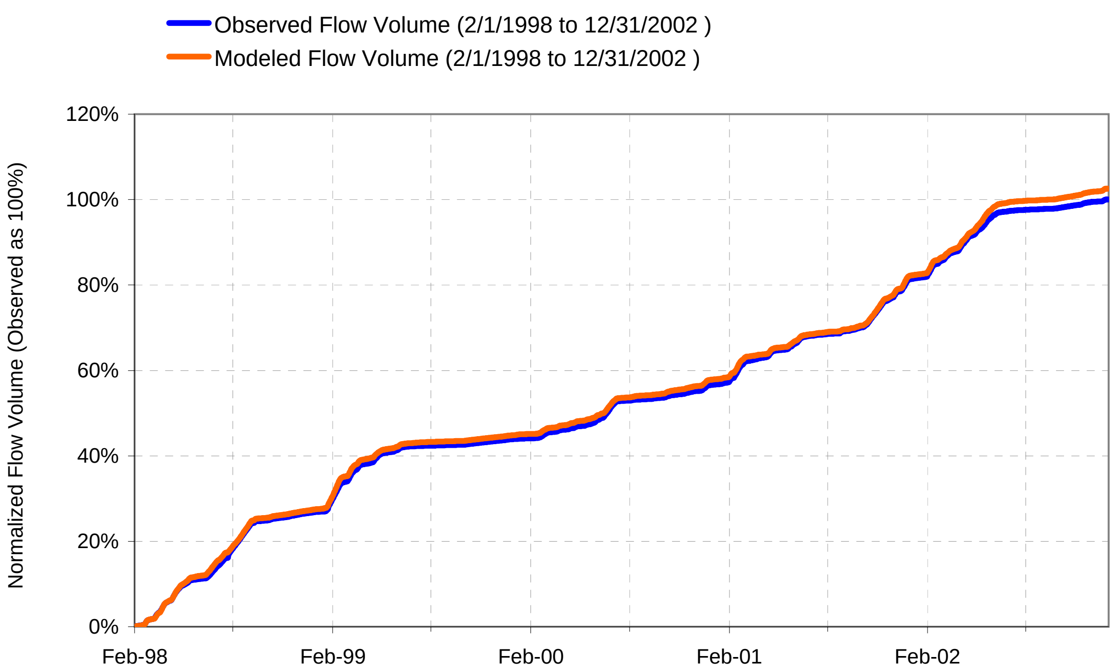




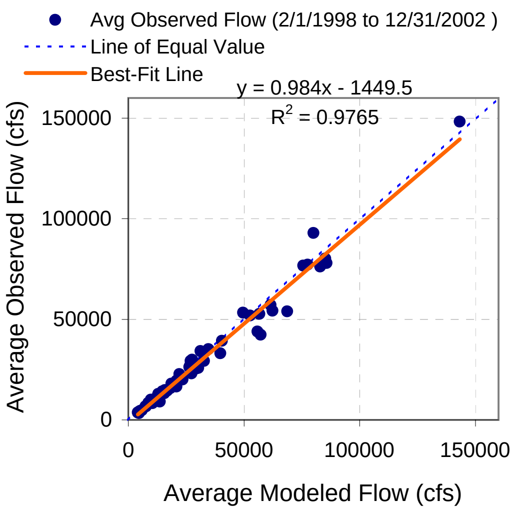


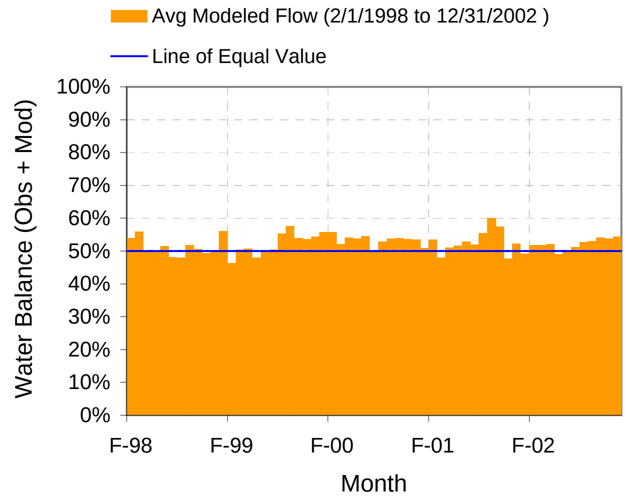
MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Feb	3085.40	2270.00	768.00	5660.00	3163.13	2091.83	761.18	5709.86
Mar	2241.16	1270.00	610.50	3730.00	2190.34	1224.71	519.34	3645.65
Apr	2403.61	1700.00	584.00	4117.50	2484.64	1935.78	651.56	4175.46
May	1720.19	1150.00	481.50	2760.00	1906.32	1204.16	509.84	3003.97
Jun	1919.12	978.00	503.00	3670.00	1959.01	1013.96	520.03	3743.24
Jul	1181.96	266.00	154.50	682.00	1076.74	344.47	193.15	951.10
Aug	1214.83	183.00	119.50	714.50	1243.61	239.44	126.04	960.84
Sep	520.67	253.00	126.25	455.00	555.52	234.27	118.41	569.35
Oct	1215.01	552.00	436.00	1080.00	1249.26	589.78	481.25	1136.89
Nov	1125.02	604.50	410.00	1215.00	1195.59	643.60	454.46	1186.80
Dec	1312.32	506.00	344.50	1020.00	1408.91	504.16	384.36	1072.59
Jan	1144.84	398.50	194.75	554.75	1175.46	426.00	296.35	674.56

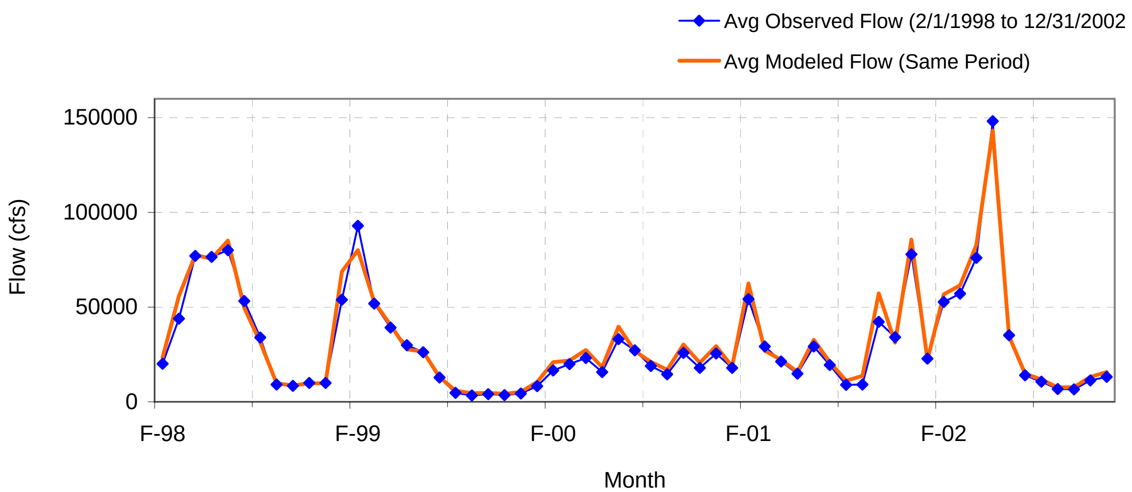

Observed Flow Duration (2/1/1998 to 12/31/2002)
Modeled Flow Duration (2/1/1998 to 12/31/2002)
Daily Average Flow (cfs)
100000
10000
1000
100
10
1
0.1
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time that Flow is Equaled or Exceeded

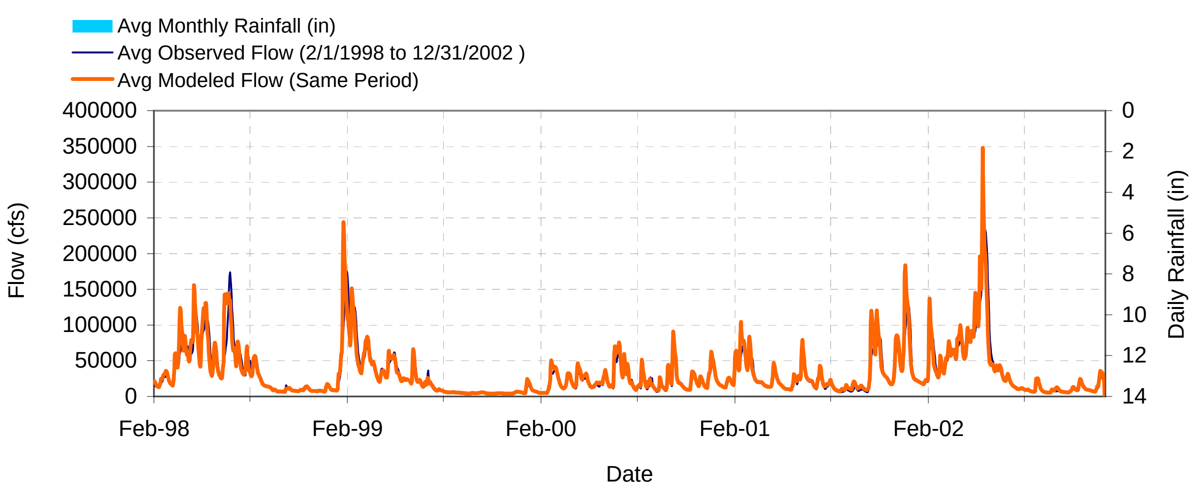

Observed Flow Volume (2/1/1998 to 12/31/2002)
Modeled Flow Volume (2/1/1998 to 12/31/2002)
Normalized Flow Volume (Observed as 100%)
120%
100%
80%
60%
40%
20%
0%
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02

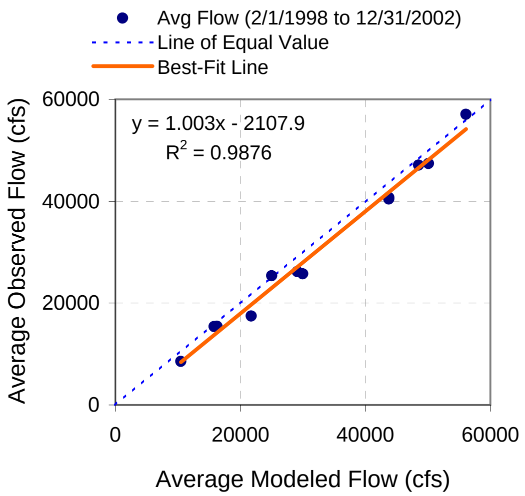
RIV1 Simulated Flow		Observed Flow Gage		
Total Simulated In-stream Flow:	**102.74**	Total Observed In-stream Flow:		**100.00**
Total of simulated highest 10% flows:	**39.17**	Total of Observed highest 10% flows:		**37.90**
Total of Simulated lowest 50% flows:	**10.79**	Total of Observed Lowest 50% flows:		**9.87**
Simulated Summer Flow Volume (months 7-9):	**15.55**	Observed Summer Flow Volume (7-9):		**15.78**
Simulated Fall Flow Volume (months 10-12):	**20.75**	Observed Fall Flow Volume (10-12):		**19.67**
Simulated Winter Flow Volume (months 1-3):	**32.68**	Observed Winter Flow Volume (1-3):		**32.44**
Simulated Spring Flow Volume (months 4-6):	**33.76**	Observed Spring Flow Volume (4-6):		**32.11**
Total Simulated Storm Volume:	**10.73**	Total Observed Storm Volume:		**11.25**
Simulated Summer Storm Volume (7-9):	**1.49**	Observed Summer Storm Volume (7-9):		**1.86**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	2.74	10	11.88	0.07
Error in 50% lowest flows:	9.38	10	-128.06	28.59
Error in 10% highest flows:	3.34	15	9.35	-15.14
Seasonal volume error - Summer:	-1.47	30	-7.52	16.71
Seasonal volume error - Fall:	5.51	30	51.32	50.60
Seasonal volume error - Winter:	0.74	30	-3.05	-38.94
Seasonal volume error - Spring:	5.14	30	36.63	30.09
Error in storm volumes:	-4.65	20	-17.50	-69.91
Error in summer storm volumes:	-19.78	50	-99.02	-97.59

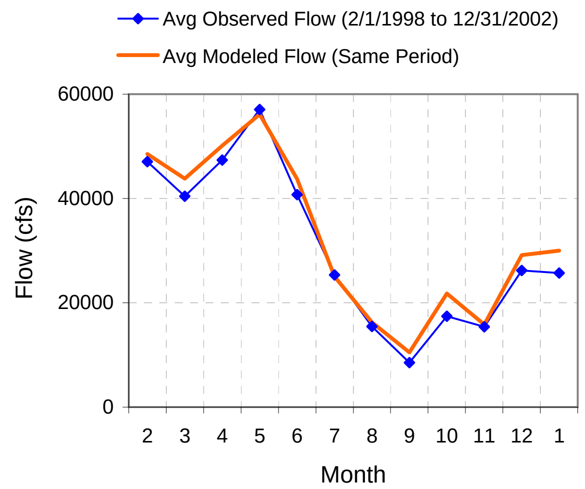

Avg Observed Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Best-Fit Line
y = 0.984x - 1449.5
R2 = 0.9765
Average Observed Flow (cfs)
150000
100000
50000
0
0
50000
100000
150000
Average Modeled Flow (cfs)

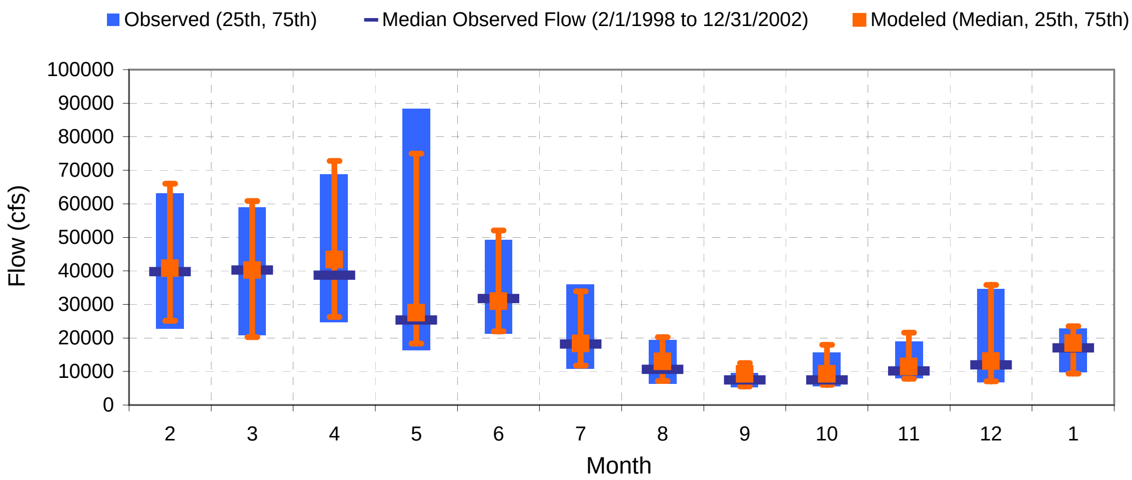

Avg Modeled Flow (2/1/1998 to 12/31/2002)
Line of Equal Value
Water Balance (Obs + Mod)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
F-98
F-99
F-00
F-01
F-02
Month


Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
150000
100000
50000
0
F-98
F-99
F-00
F-01
F-02
Month

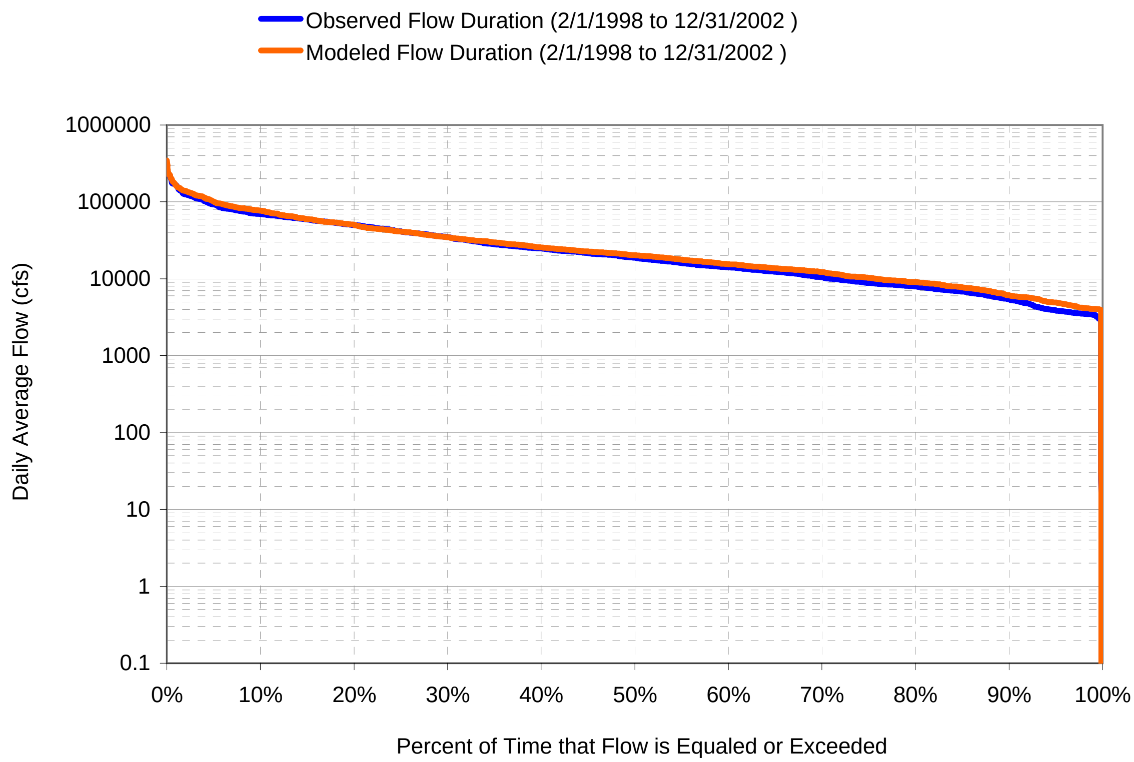

Avg Monthly Rainfall (in)
Avg Observed Flow (2/1/1998 to 12/31/2002)
Avg Modeled Flow (Same Period)
Flow (cfs)
400000
350000
300000
250000
200000
150000
100000
50000
0
Daily Rainfall (in)
0
2
4
6
8
10
12
14
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02
Date

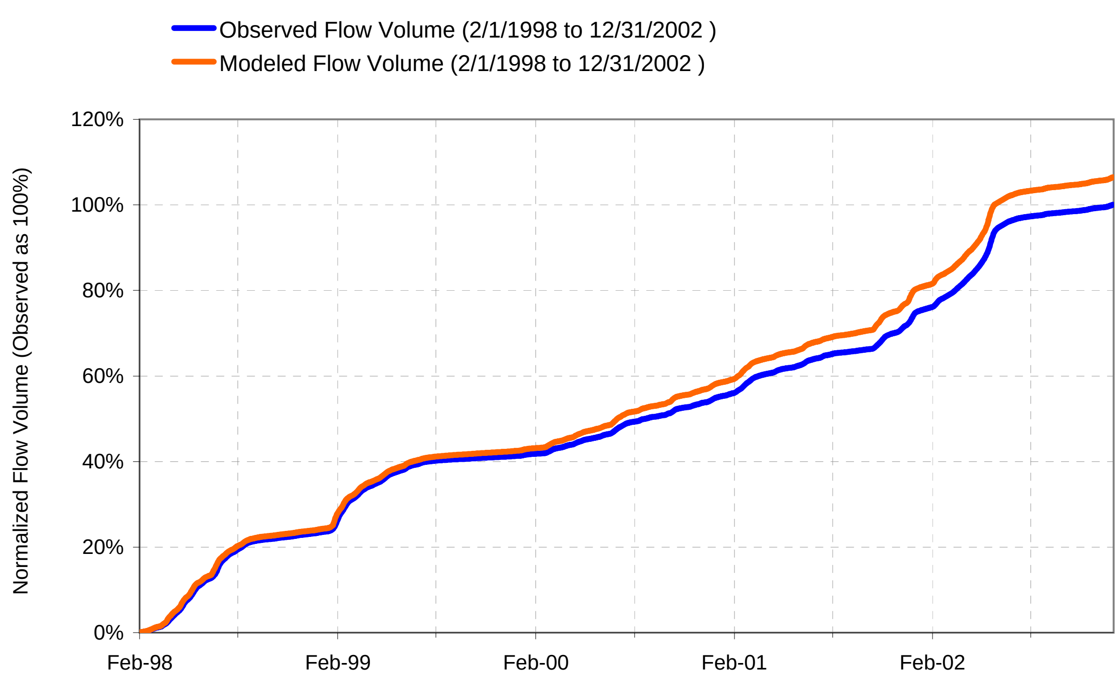






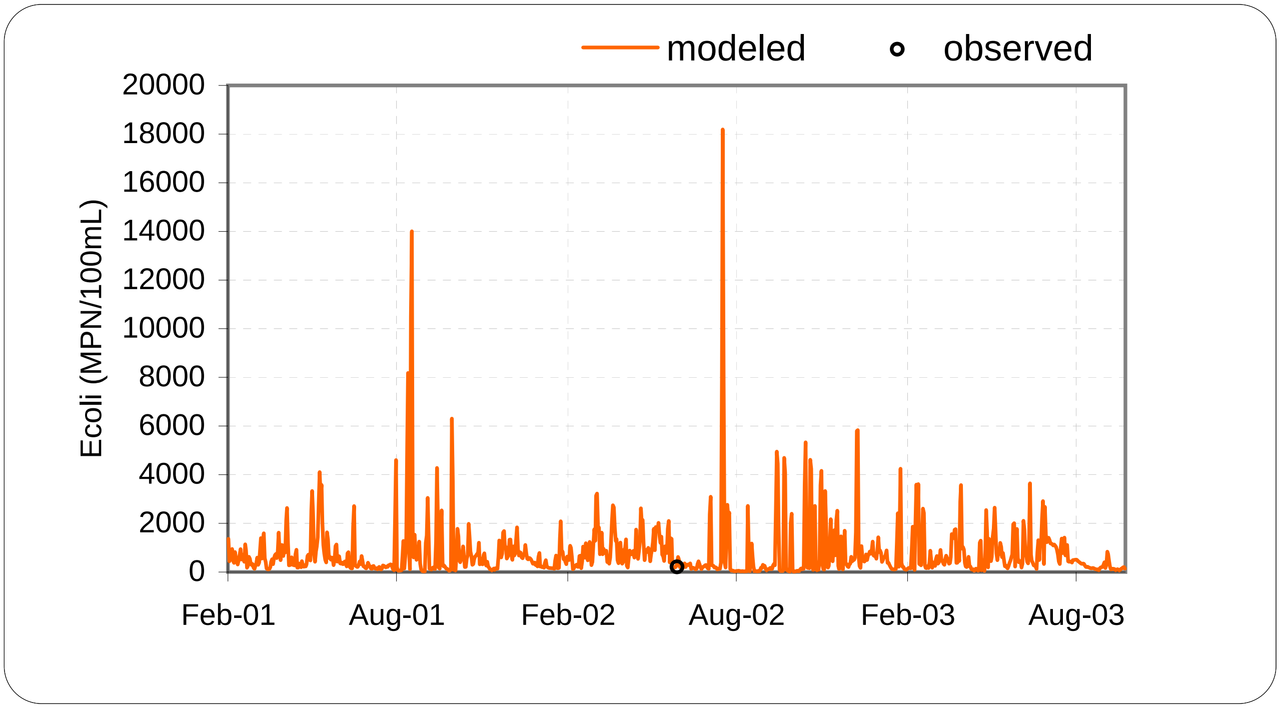
MONTH	OBSERVED FLOW (CFS)				MODELED FLOW (CFS)			
	MEAN	MEDIAN	25TH	75TH	MEAN	MEDIAN	25TH	75TH
Feb	47047.52	39700.00	22700.00	63000.00	48535.90	40763.61	25072.80	66018.82
Mar	40429.03	40200.00	20800.00	59050.00	43783.18	40191.28	20252.06	60818.63
Apr	47362.00	38650.00	24725.00	68825.00	50107.33	43375.51	26253.60	72769.26
May	57056.77	25300.00	16300.00	88350.00	56127.24	27515.48	18298.46	75010.54
Jun	40754.67	31750.00	21275.00	49325.00	43761.59	30988.66	21973.23	52085.87
Jul	25345.10	18100.00	10800.00	36050.00	25058.81	18359.69	11752.35	33916.26
Aug	15435.03	10600.00	6260.00	19350.00	16265.21	13024.70	7133.23	20249.80
Sep	8543.53	7485.00	5305.00	9595.00	10486.24	9287.26	5572.06	12500.76
Oct	17443.87	7480.00	5535.00	15700.00	21761.54	9266.31	5999.51	17959.14
Nov	15407.20	10150.00	8055.00	19000.00	15819.36	11448.03	7840.74	21630.30
Dec	26179.29	11900.00	6840.00	34650.00	29140.13	13131.68	7101.66	35817.61
Jan	25720.73	17000.00	9702.50	22850.00	30005.29	18417.08	9383.60	23469.17

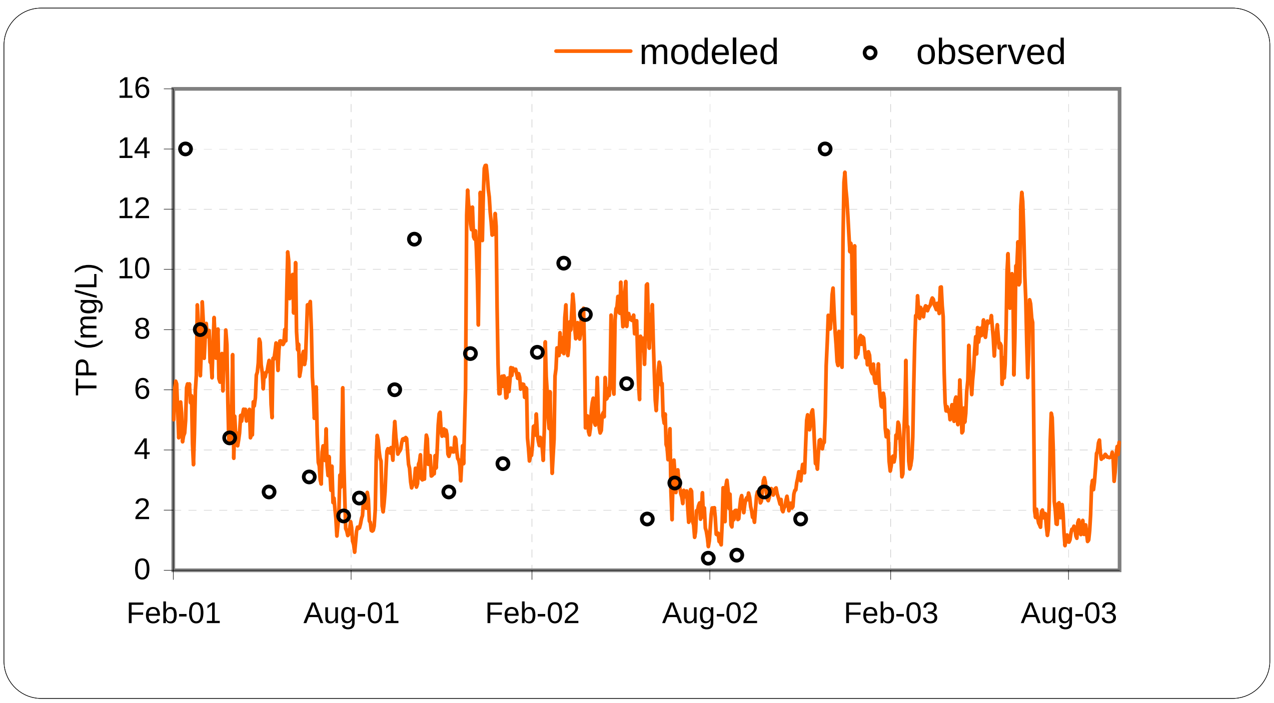

Observed Flow Duration (2/1/1998 to 12/31/2002)
Modeled Flow Duration (2/1/1998 to 12/31/2002)
Daily Average Flow (cfs)
1000000
100000
10000
1000
100
10
1
0.1
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time that Flow is Equaled or Exceeded


Observed Flow Volume (2/1/1998 to 12/31/2002)
Modeled Flow Volume (2/1/1998 to 12/31/2002)
Normalized Flow Volume (Observed as 100%)
120%
100%
80%
60%
40%
20%
0%
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02

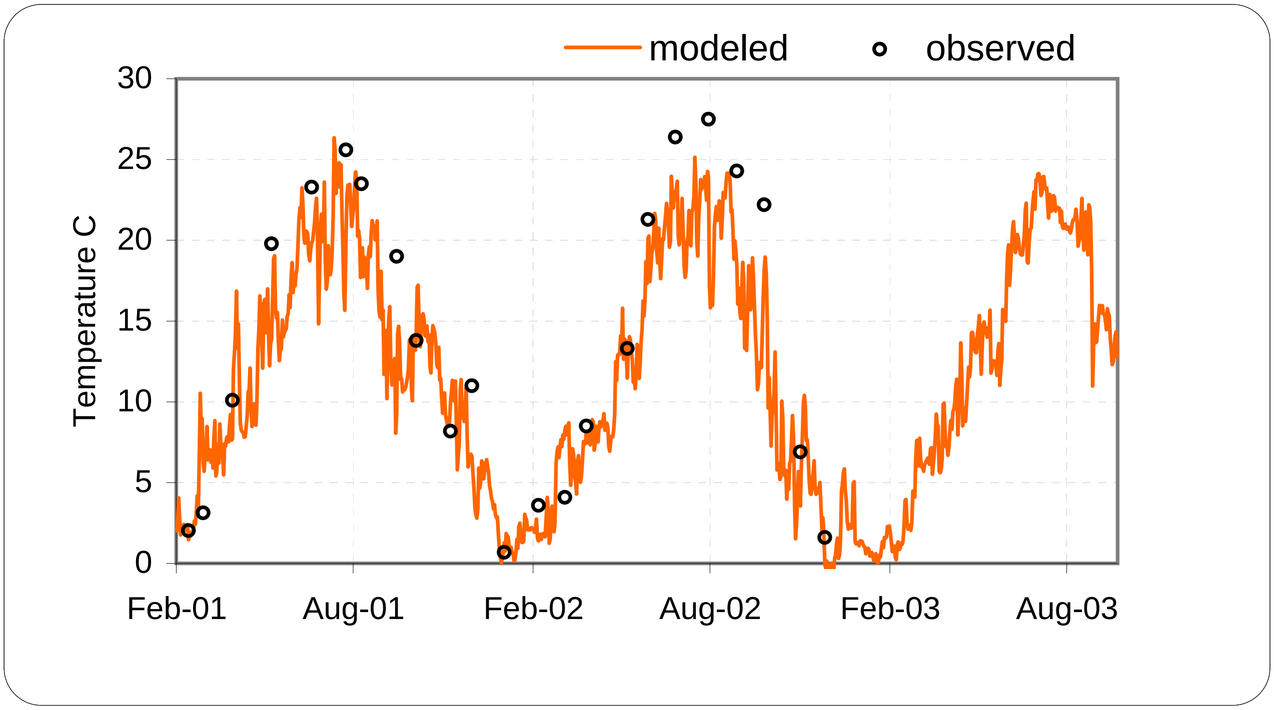
RIV1 Simulated Flow		Observed Flow Gage	
Total Simulated In-stream Flow:	**106.47**	Total Observed In-stream Flow:	**100.00**
Total of simulated highest 10% flows:	**38.19**	Total of Observed highest 10% flows:	**34.79**
Total of Simulated lowest 50% flows:	**17.72**	Total of Observed Lowest 50% flows:	**15.84**
Simulated Summer Flow Volume (months 7-9):	**14.55**	Observed Summer Flow Volume (7-9):	**13.87**
Simulated Fall Flow Volume (months 10-12):	**18.72**	Observed Fall Flow Volume (10-12):	**16.55**
Simulated Winter Flow Volume (months 1-3):	**31.65**	Observed Winter Flow Volume (1-3):	**29.35**
Simulated Spring Flow Volume (months 4-6):	**41.55**	Observed Spring Flow Volume (4-6):	**40.24**
Total Simulated Storm Volume:	**6.15**	Total Observed Storm Volume:	**4.03**
Simulated Summer Storm Volume (7-9):	**0.90**	Observed Summer Storm Volume (7-9):	**0.83**

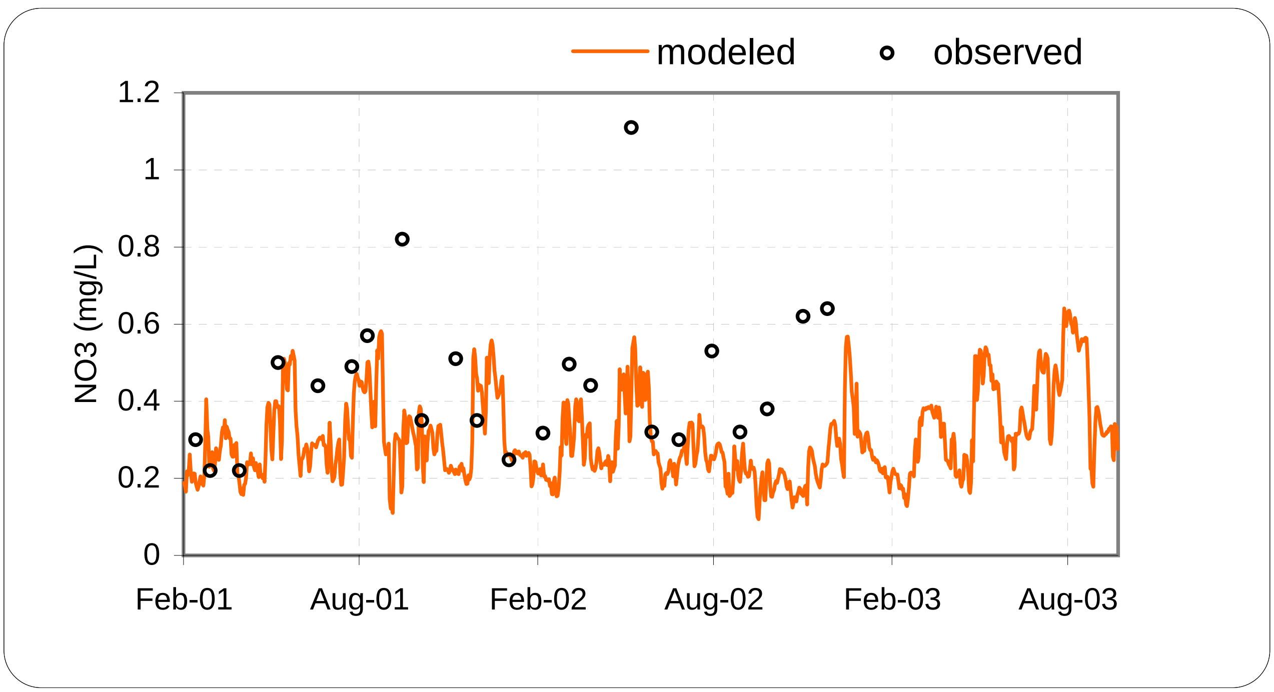
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	6.47	10	11.88	0.07
Error in 50% lowest flows:	11.88	10	-128.06	28.59
Error in 10% highest flows:	9.78	15	9.35	-15.14
Seasonal volume error - Summer:	4.94	30	-7.52	16.71
Seasonal volume error - Fall:	13.12	30	51.32	50.60
Seasonal volume error - Winter:	7.84	30	-3.05	-38.94
Seasonal volume error - Spring:	3.26	30	36.63	30.09
Error in storm volumes:	52.35	20	-17.50	-69.91
Error in summer storm volumes:	8.21	50	-99.02	-97.59



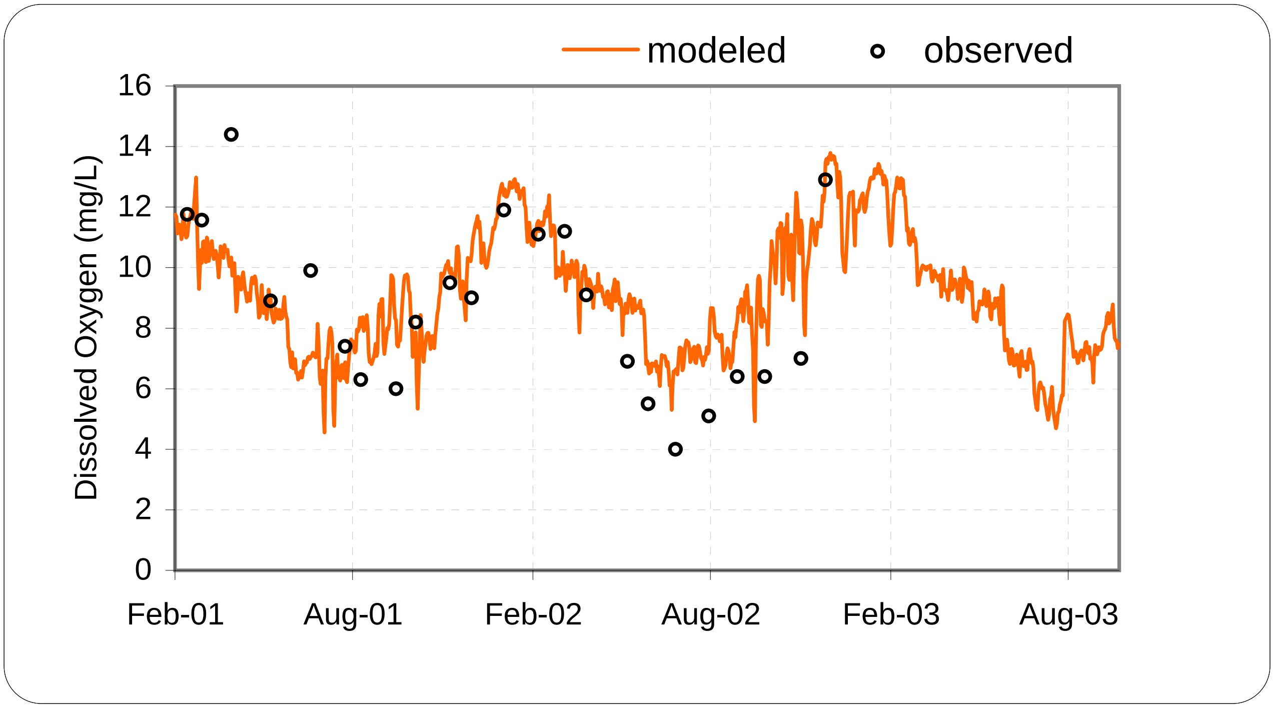


IDEM site WUW060-0002 (at US 27)

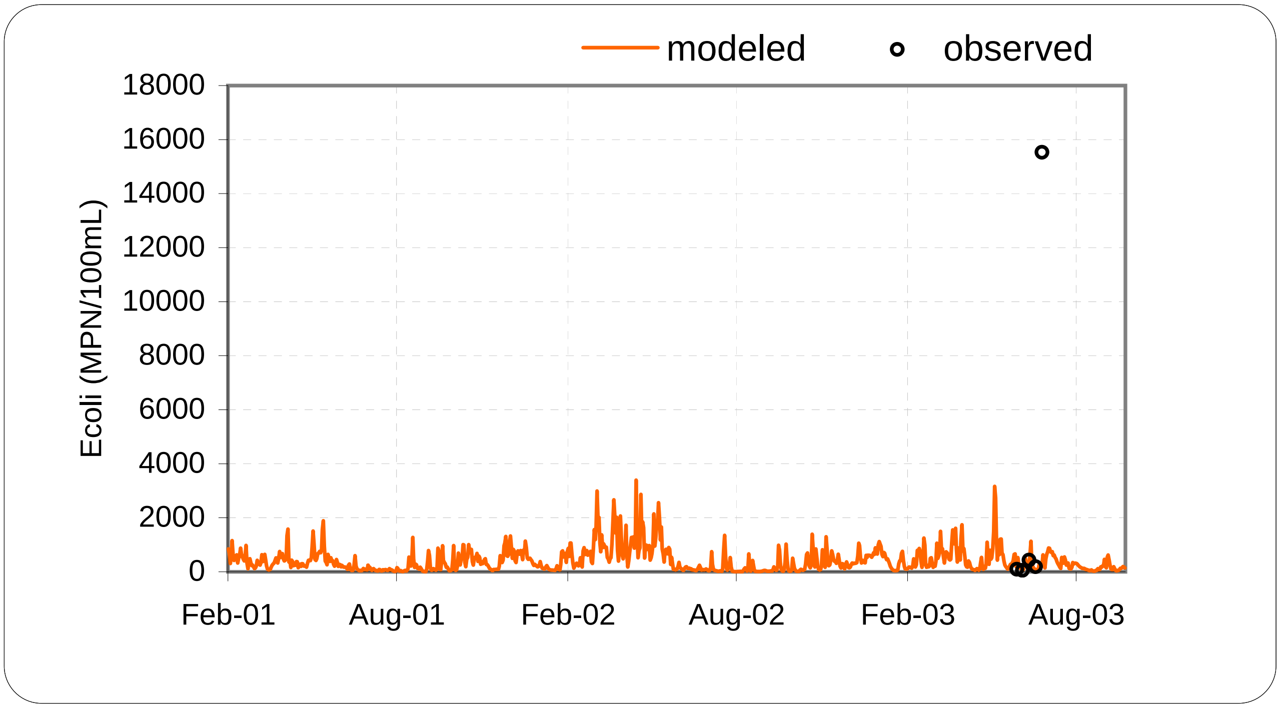


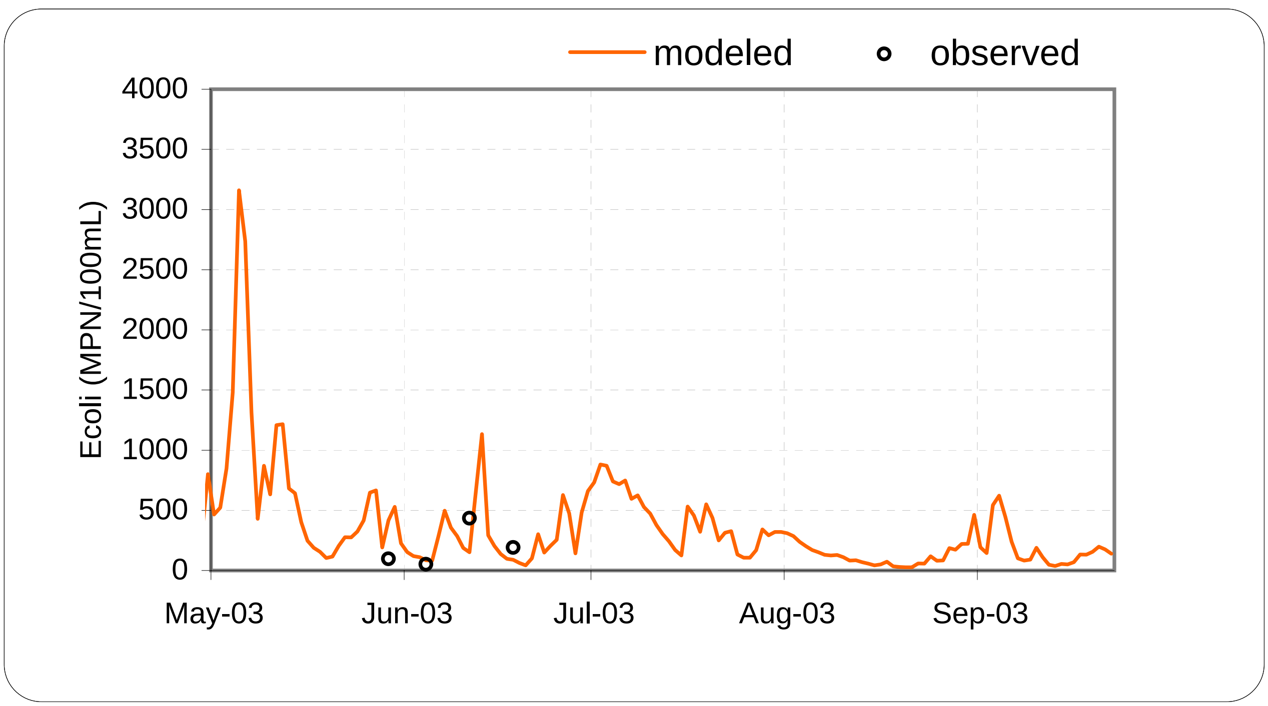


IDEM site WUW060-0002 (at US 27)

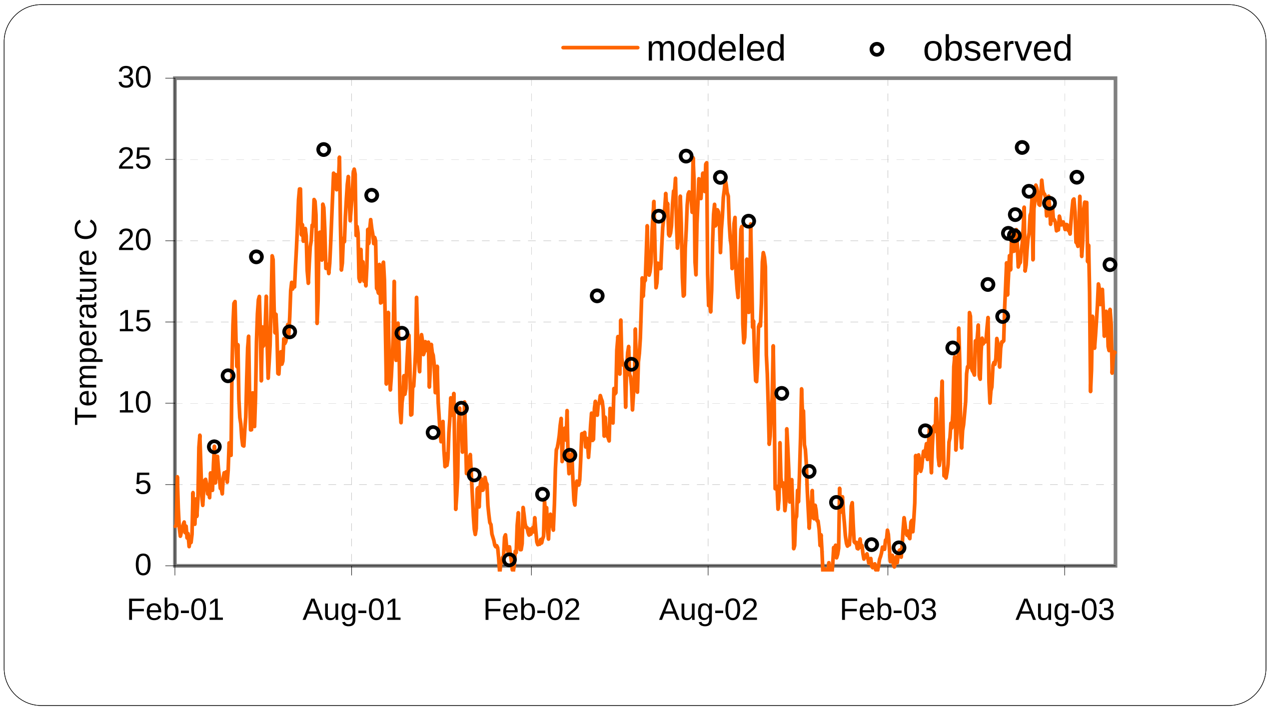


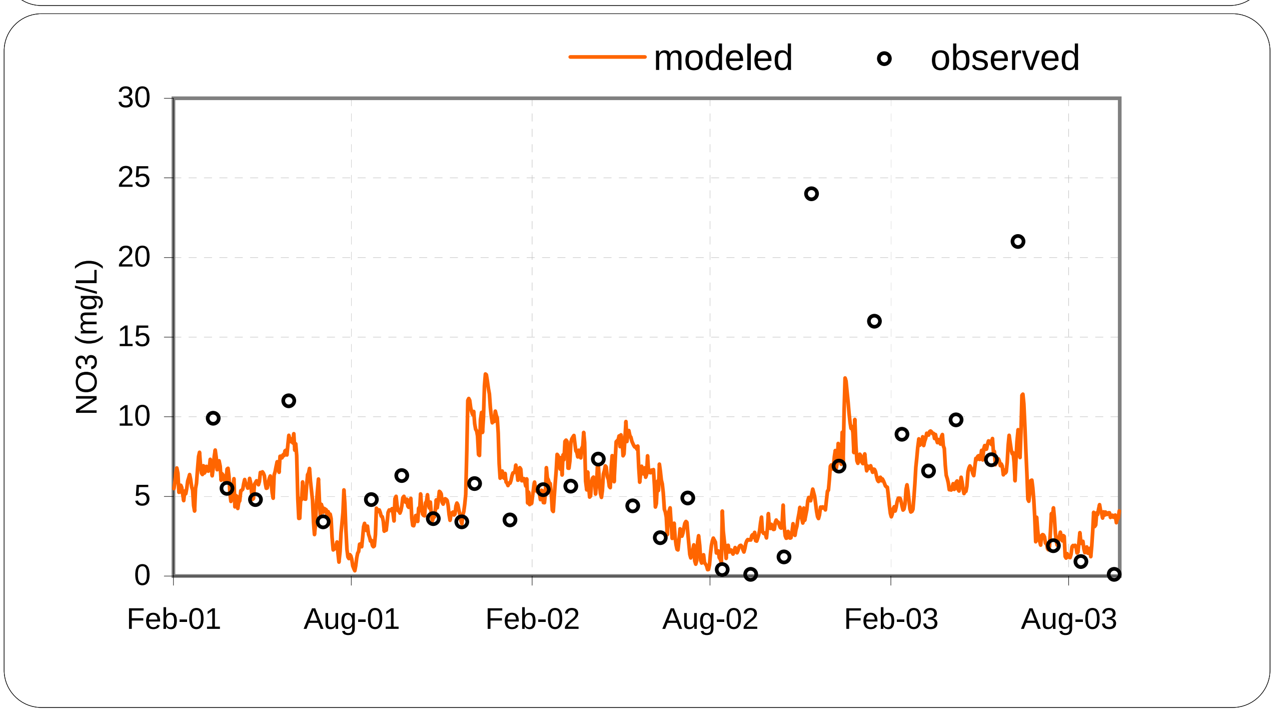
IDEM site WUW060-0002 (at US 27)



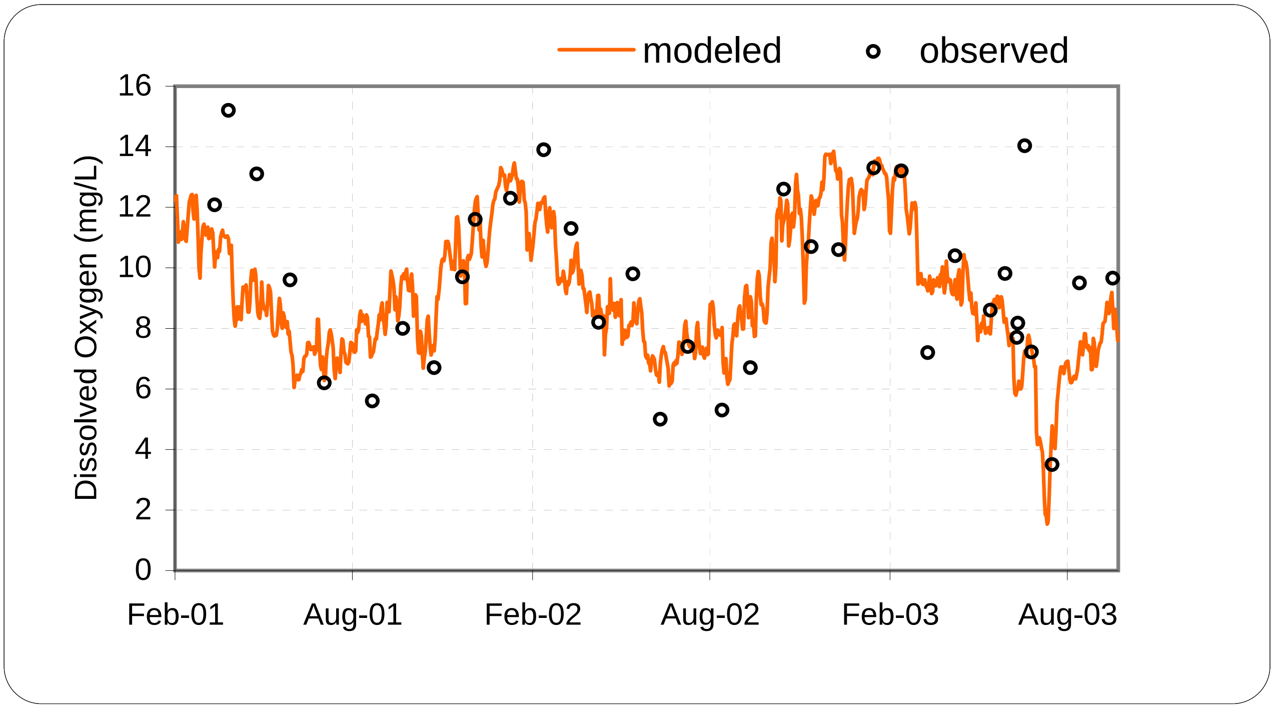


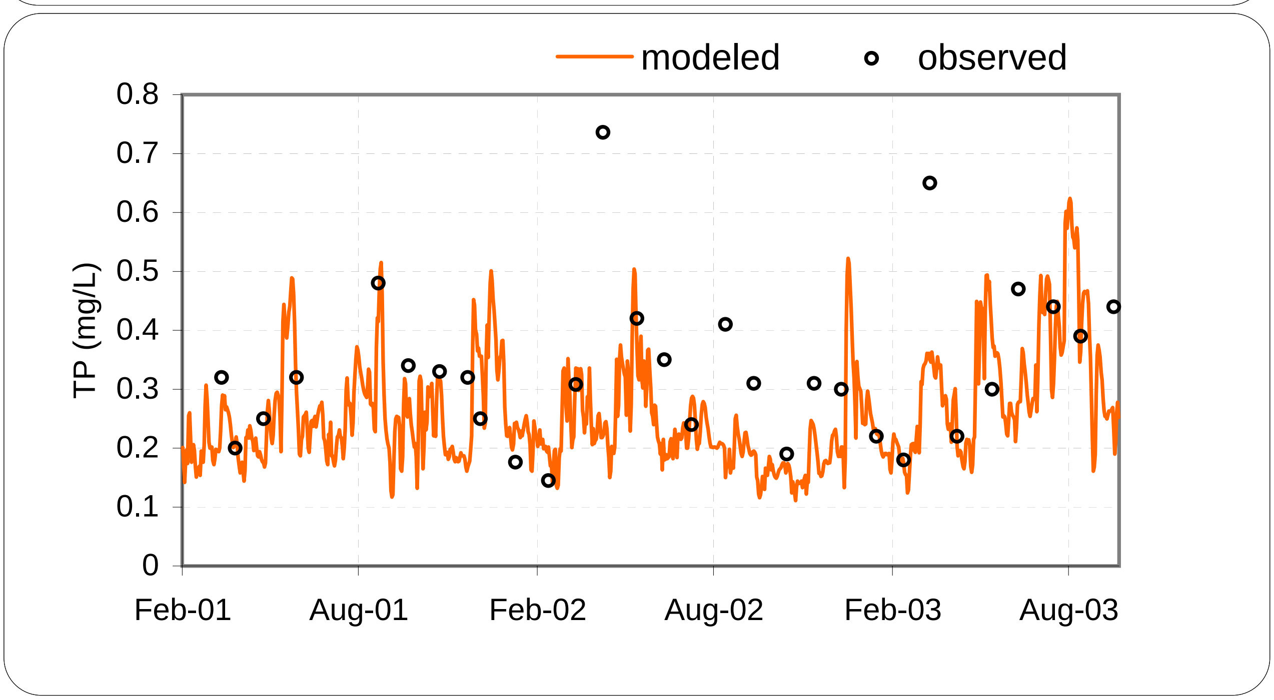
IDEM site WUW070-0002 (at SR 3 Bridge, Markle)



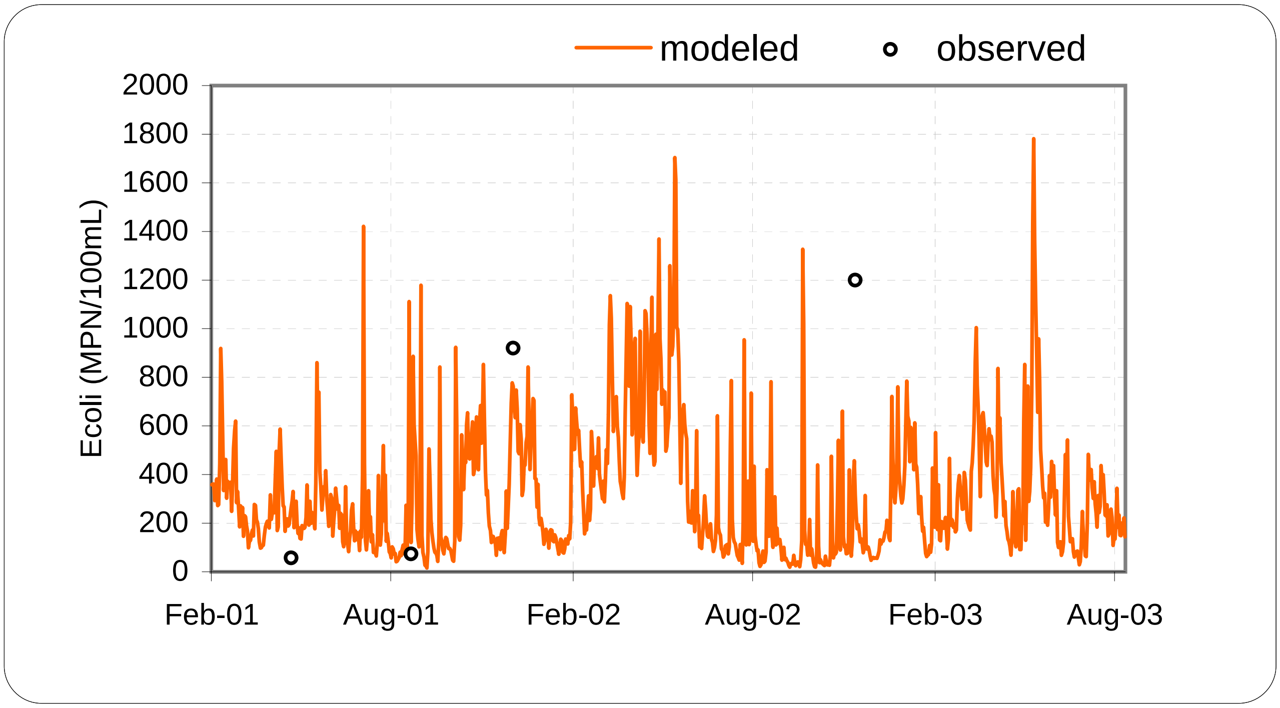


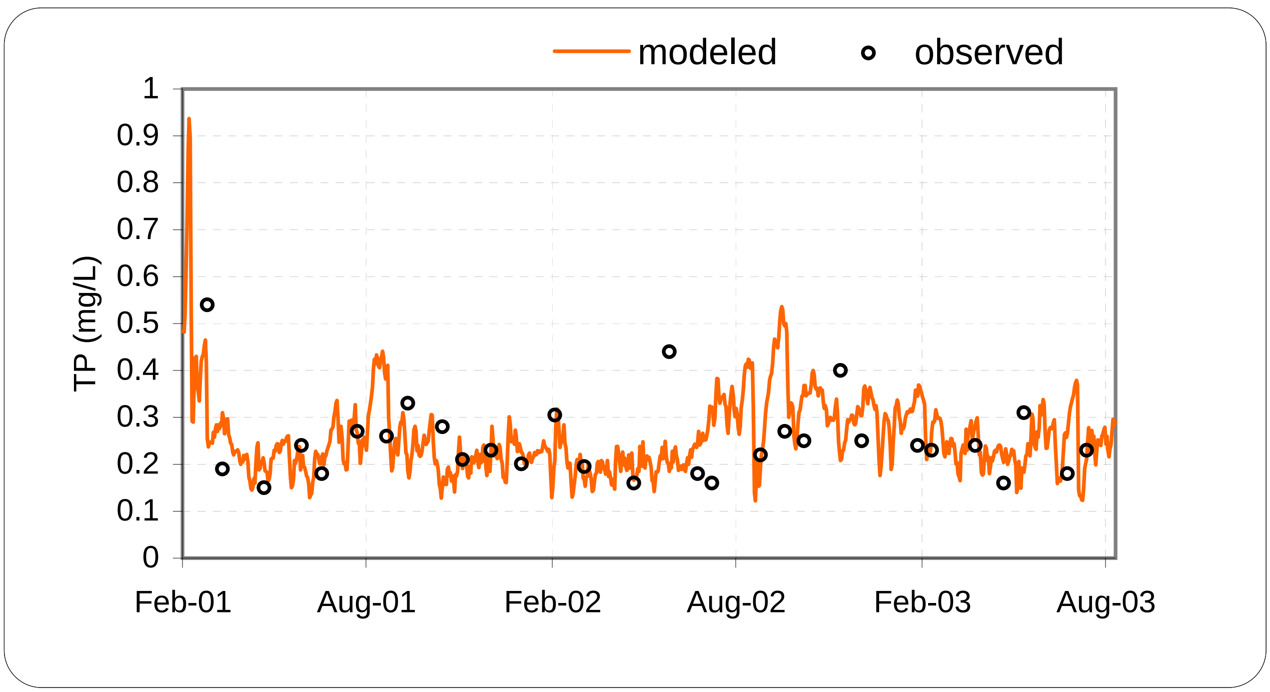
IDEM site WUW070-0002 (at SR 3 Bridge, Markle)



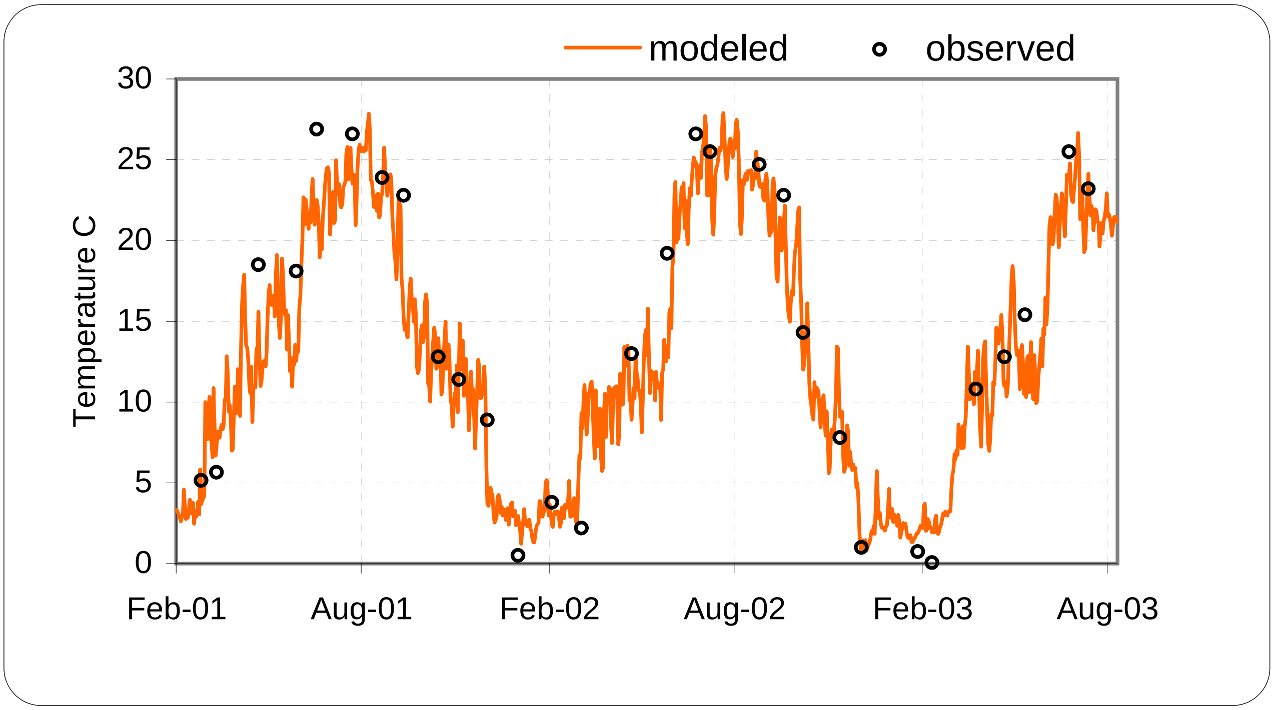


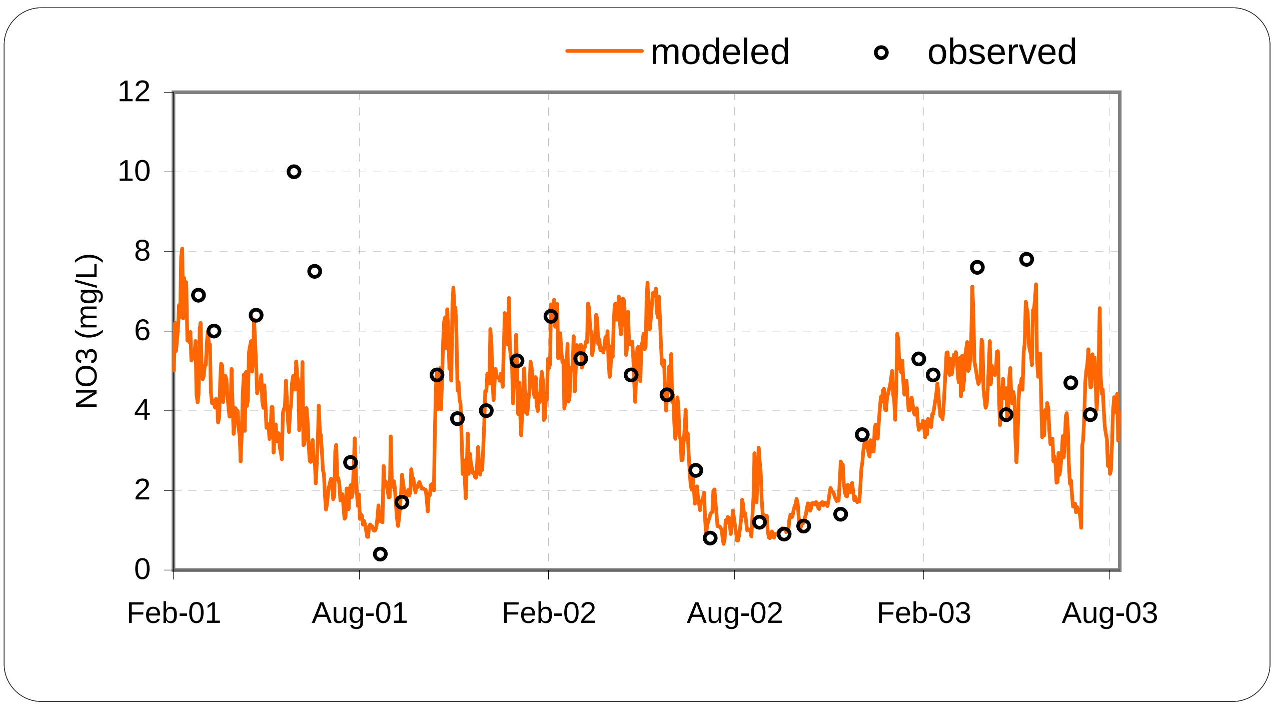
IDEM site WUW070-0002 (at SR 3 Bridge, Markle)



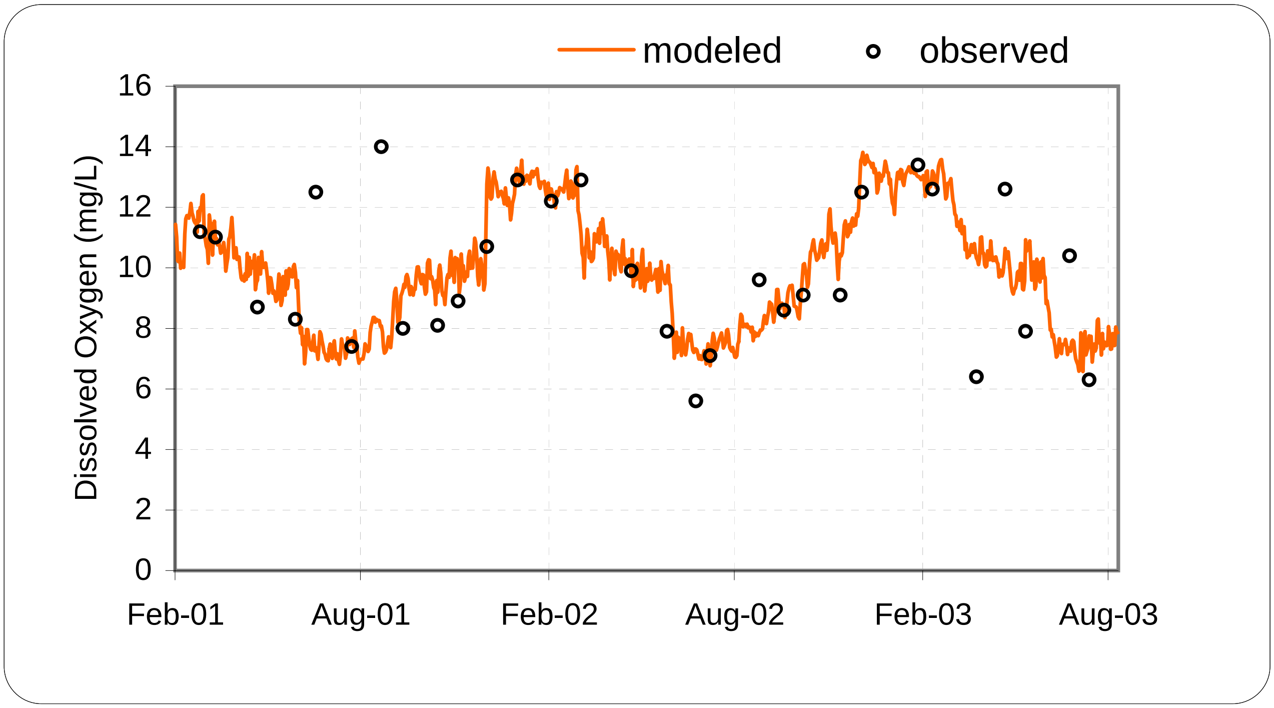


IDEM site WLV030-0003 (CR 700 W, Near Lafayette)

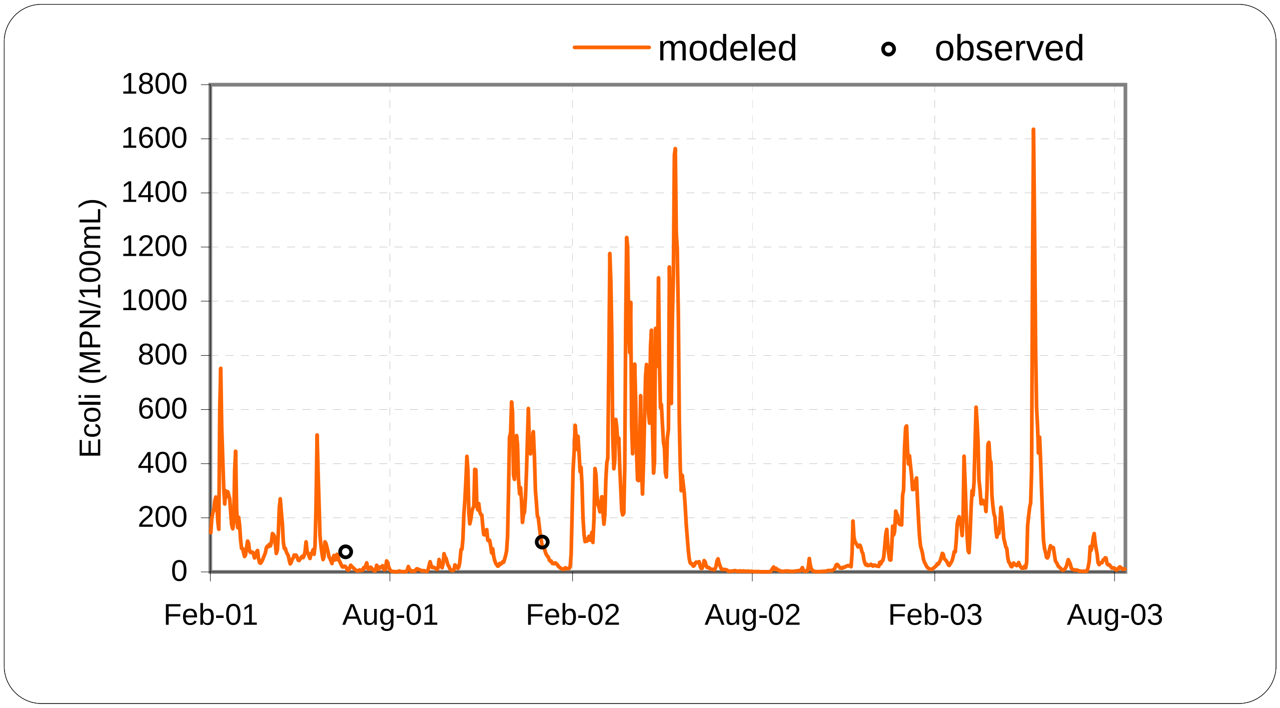


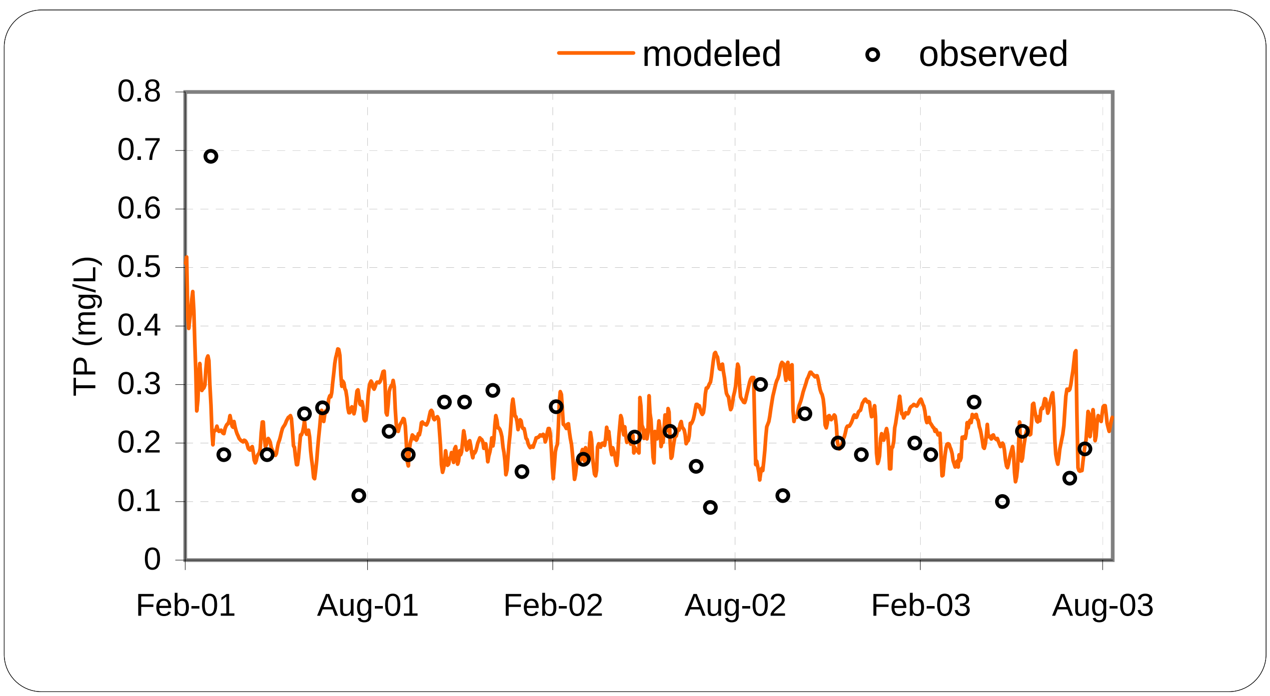


IDEM site WLV030-0003 (CR 700 W, Near Lafayette)

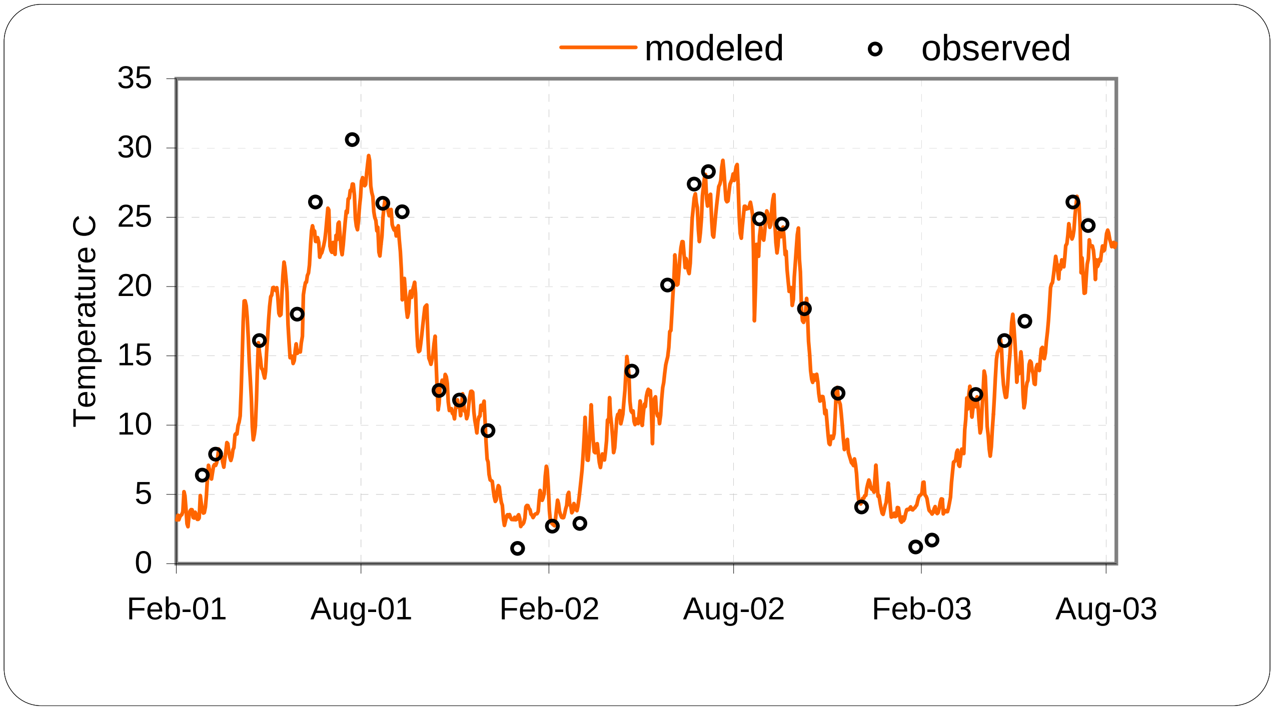


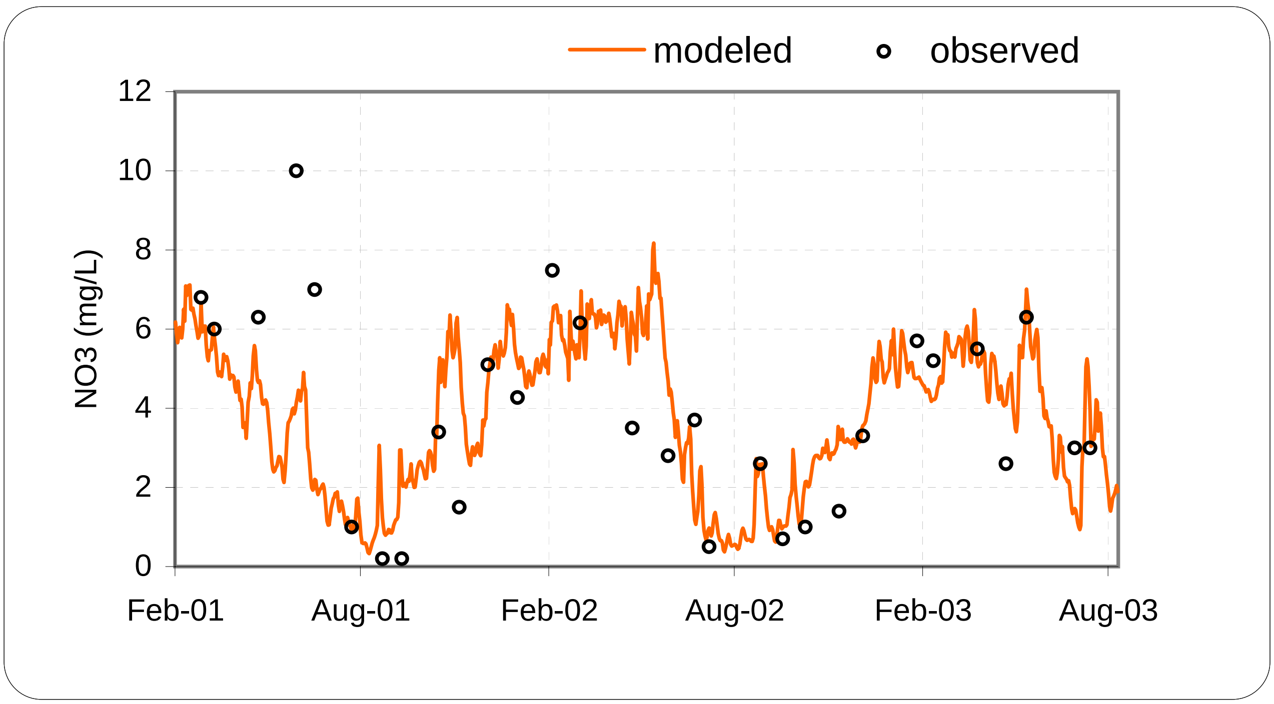
IDEM site WLV030-0003 (CR 700 W, Near Lafayette)



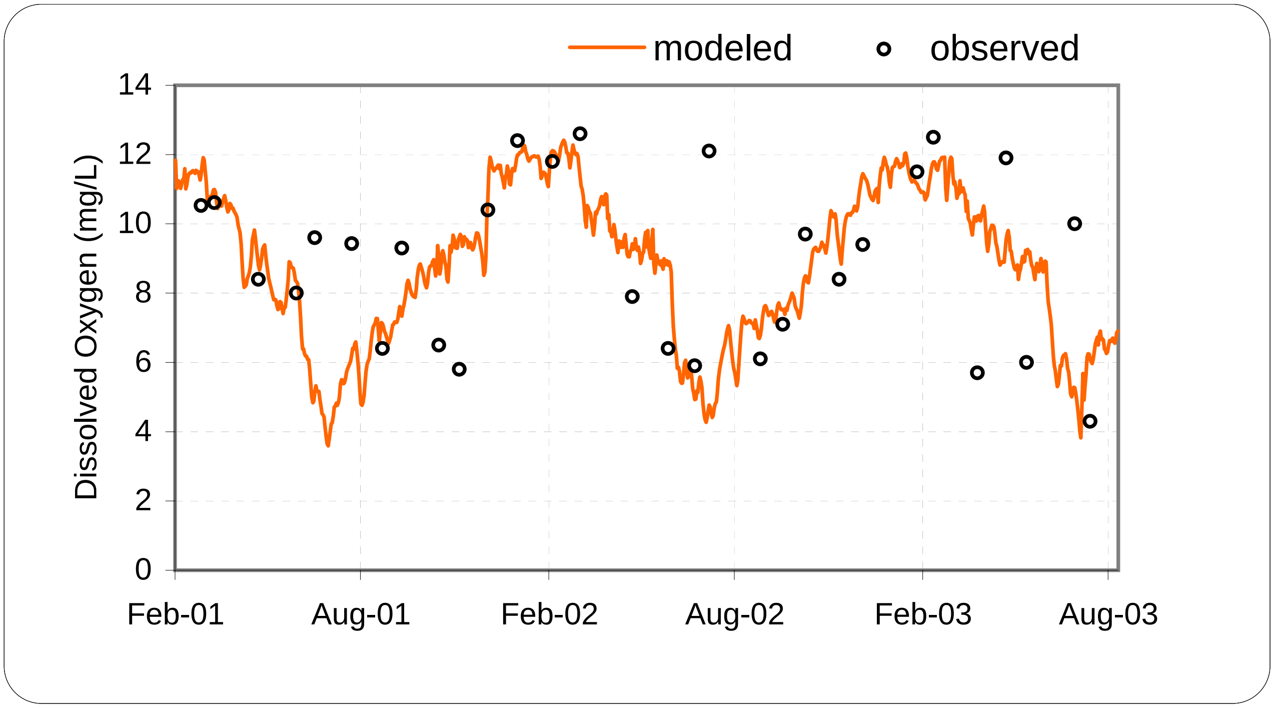


IDEM site WBU100-0001 (W of Fairbanks, I & M Generating Station)

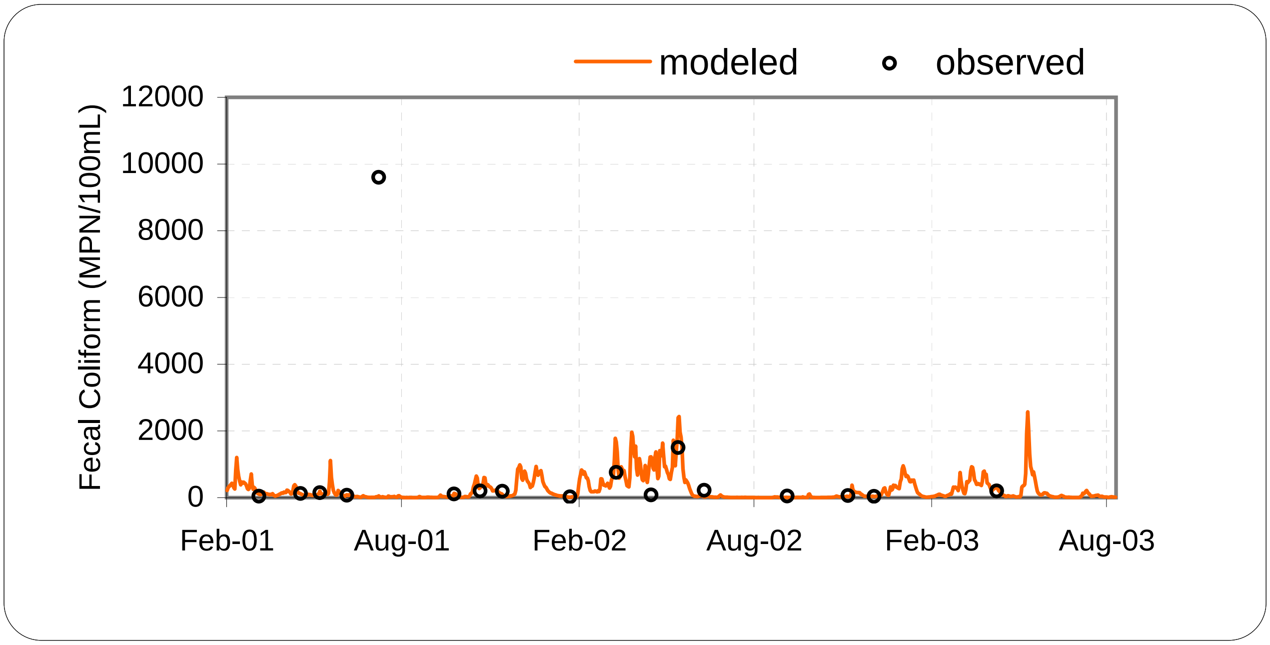


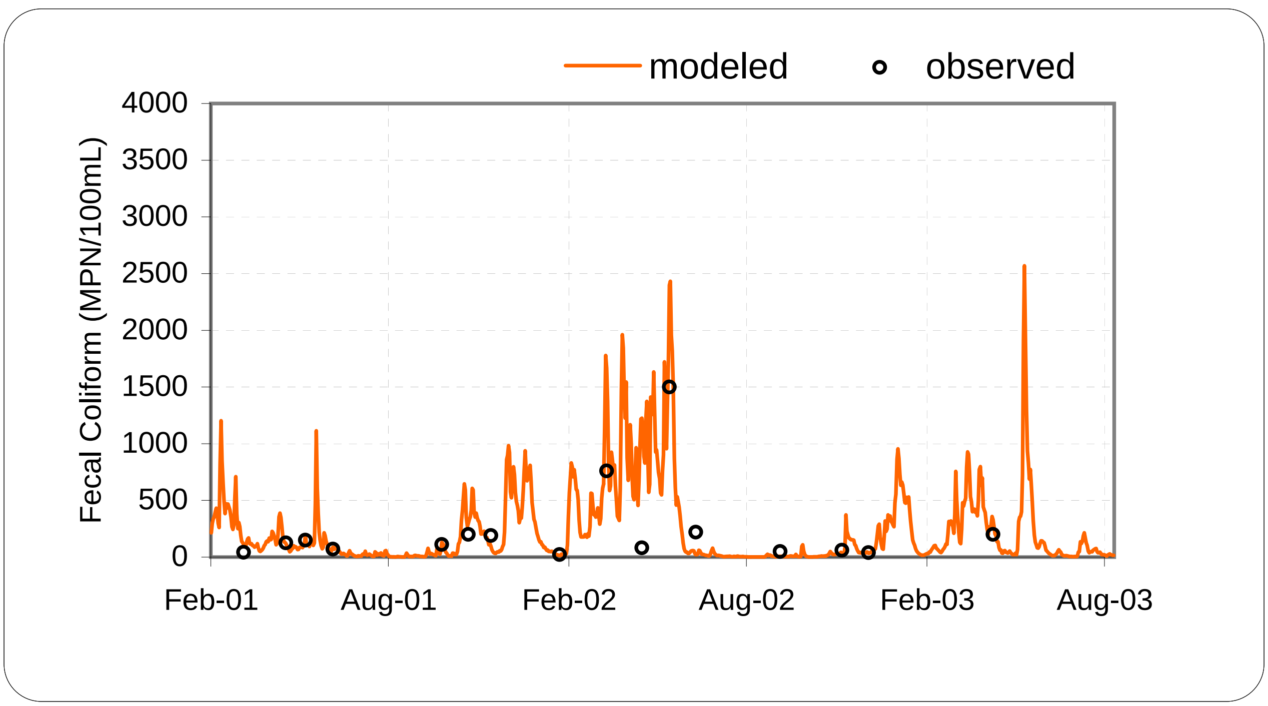


IDEM site WBU100-0001 (W of Fairbanks, I & M Generating Station)

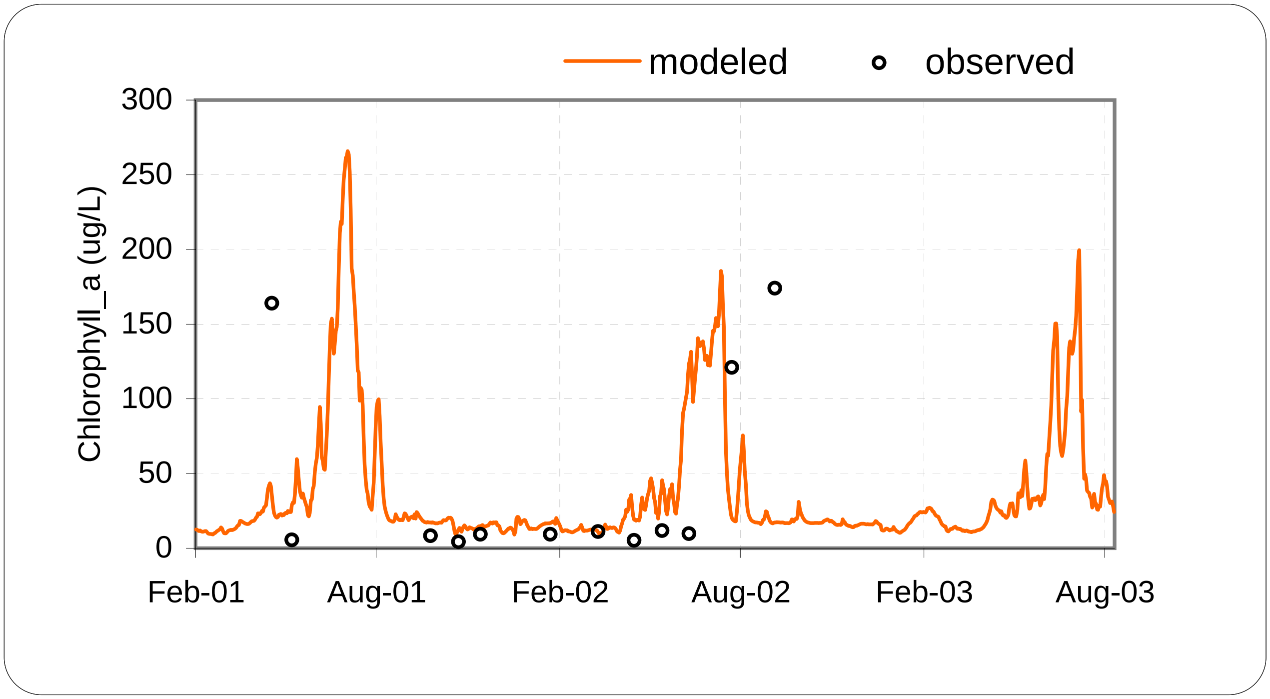


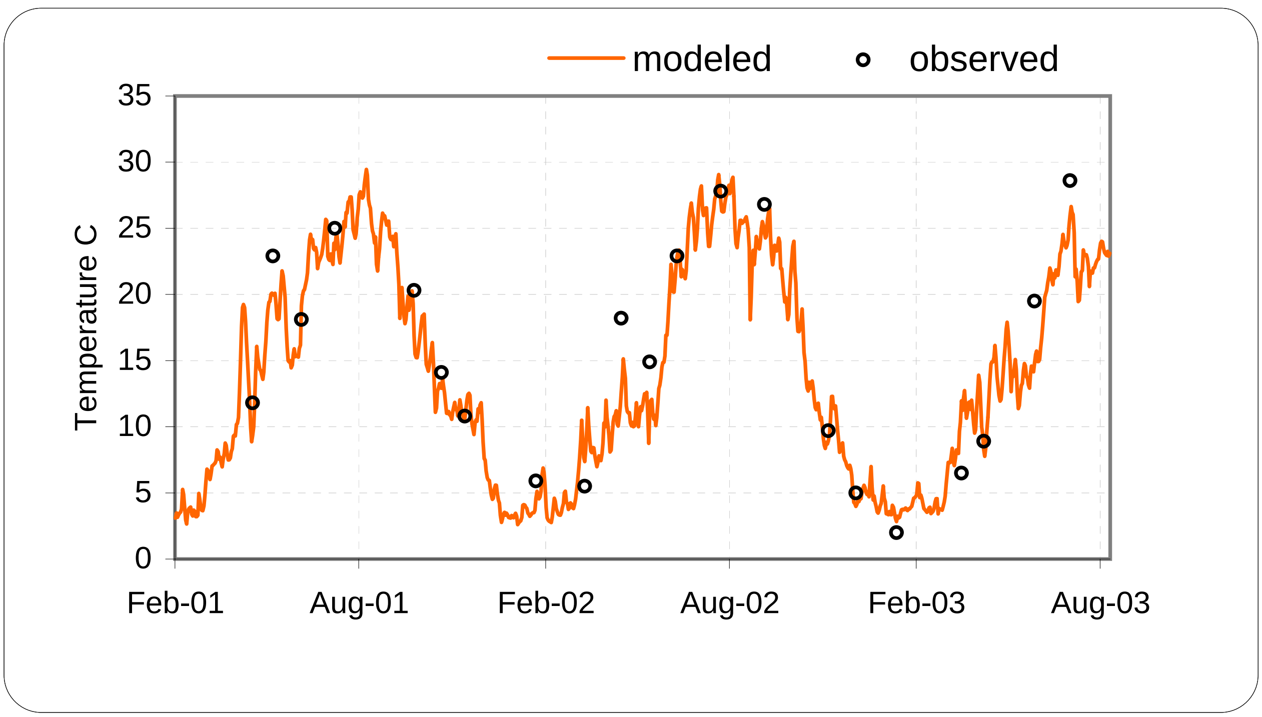
IDEM site WBU100-0001 (W of Fairbanks, I & M Generating Station)



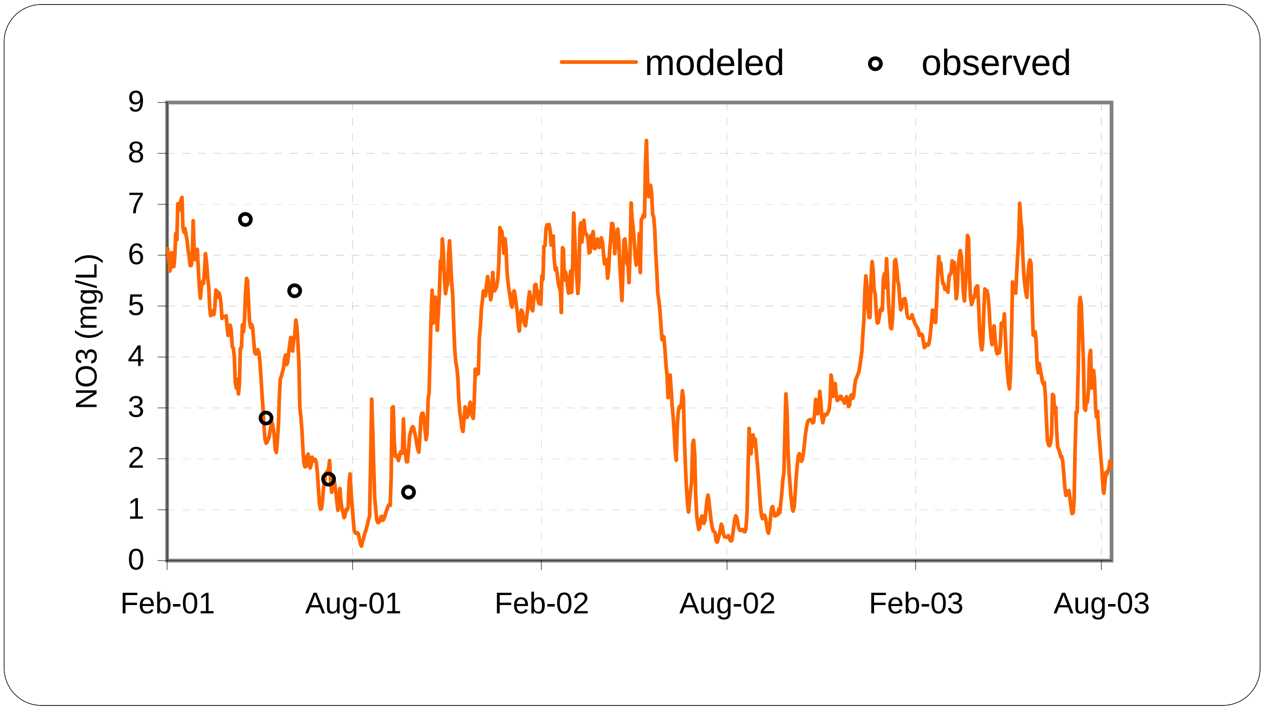


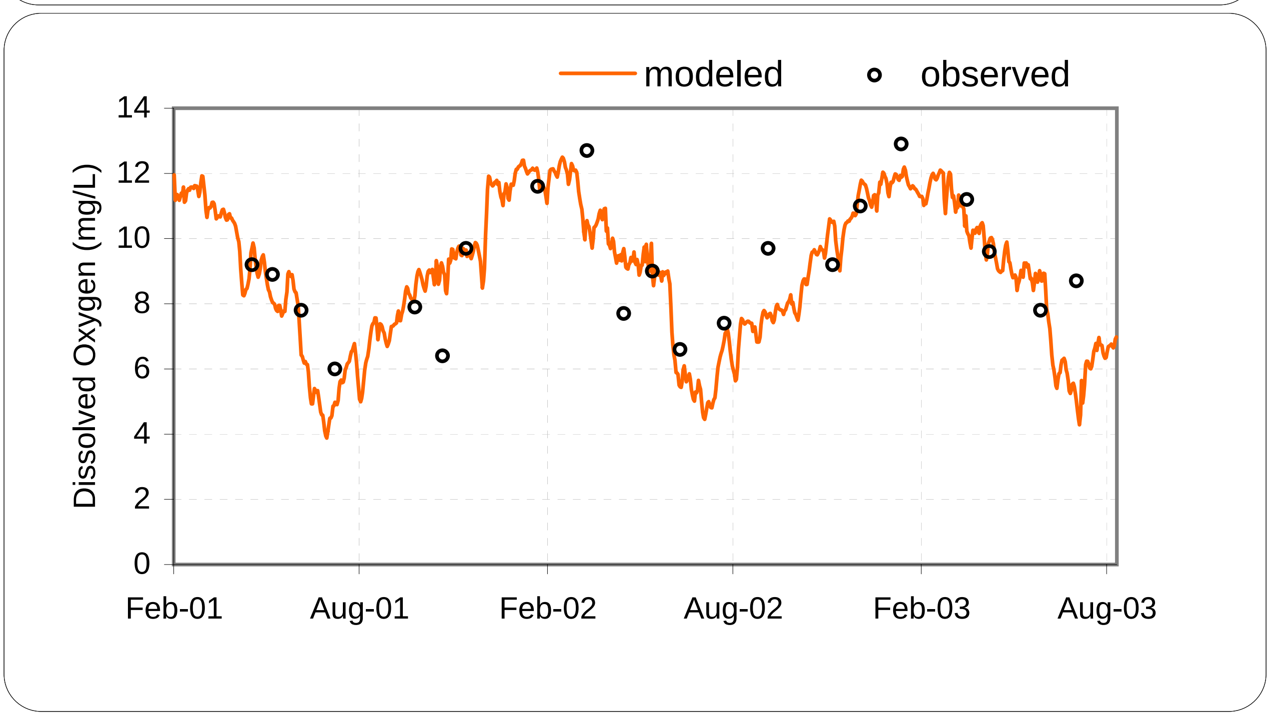
IEPA site B-06 (at Hutsonville)



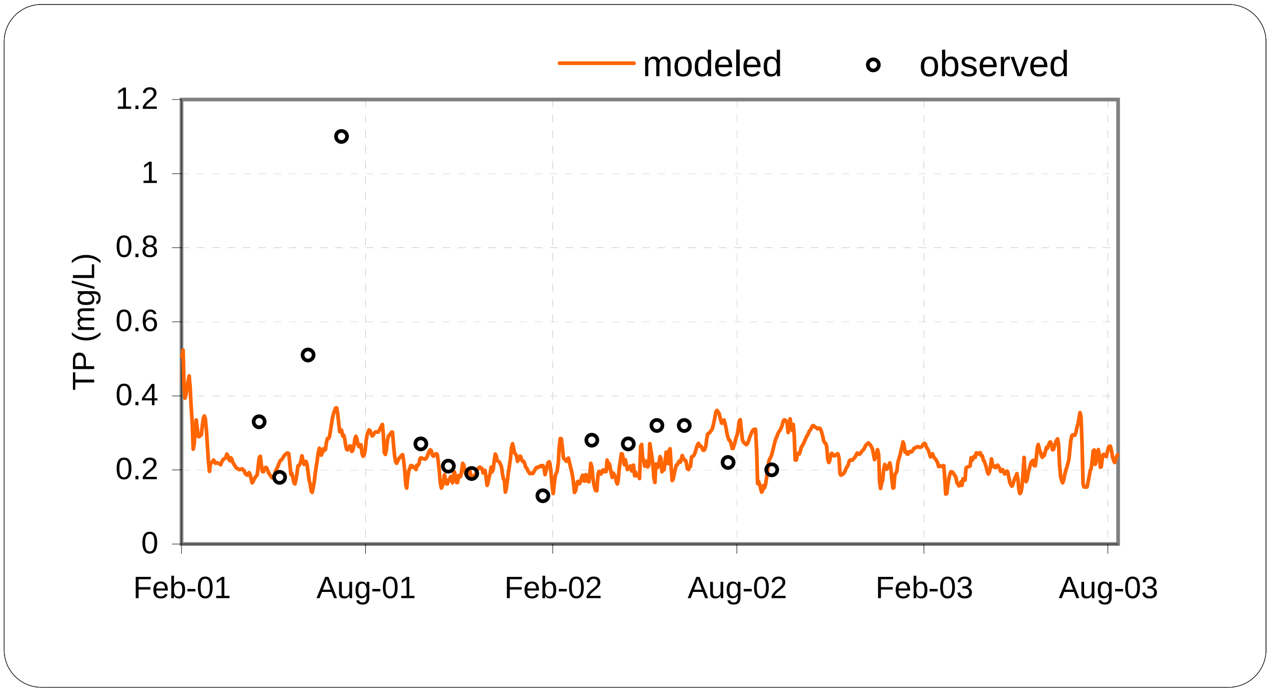


IEPA site B-06 (at Hutsonville)





IEPA site B-06 (at Hutsonville)



IEPA site B-06 (at Hutsonville)

APPENDIX I: INDIVIDUAL WLAS AND LAS

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	54.1	15.2	72	50.2	98.6	0	5.65E+08	N/A	N/A
February	69.1	15.2	78	63.5	98.6	0	9.32E+08	N/A	N/A
March	62.9	15.2	76	93.2	98.6	0	1.32E+09	N/A	N/A
April	111.7	15.2	86	98.7	98.6	0	1.38E+09	1.90E+10	0
May	100.3	15.2	85	93.2	98.6	0	1.27E+09	1.90E+10	0
June	99.3	15.2	85	73.8	98.6	0	2.03E+09	1.90E+10	0
July	78.6	15.2	81	71.9	98.6	0	6.69E+08	1.90E+10	0
August	75.3	15.2	80	90.3	98.6	0	8.16E+08	1.90E+10	0
September	70.4	15.2	78	67.4	98.6	0	1.09E+09	1.90E+10	0
October	109.7	15.2	86	101.9	98.6	0	1.60E+09	1.90E+10	0
November	116.1	15.2	87	107.8	98.6	0	1.69E+09	N/A	N/A
December	90.4	15.2	83	82.2	98.6	0	1.25E+09	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	0.8	7.6	0	11.4	34.1	0	0.00E+00	N/A	N/A
February	0.4	7.6	0	5.9	34.1	0	0.00E+00	N/A	N/A
March	0.8	7.6	0	12.9	34.1	0	0.00E+00	N/A	N/A
April	0.9	7.6	0	12.8	34.1	0	0.00E+00	9.48E+09	0
May	0.9	7.6	0	13.0	34.1	0	0.00E+00	9.48E+09	0
June	0.9	7.6	0	7.7	34.1	0	0.00E+00	9.48E+09	0
July	0.9	7.6	0	13.1	34.1	0	0.00E+00	9.48E+09	0
August	0.5	7.6	0	12.9	34.1	0	0.00E+00	9.48E+09	0
September	0.4	7.6	0	6.8	34.1	0	0.00E+00	9.48E+09	0
October	0.4	7.6	0	5.4	34.1	0	0.00E+00	9.48E+09	0
November	0.4	7.6	0	5.3	34.1	0	0.00E+00	N/A	N/A
December	0.4	7.6	0	5.6	34.1	0	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Fecal Coliform		
	Existing Load	WLA	
Month	(#/day)	(#/day)	Percent Reduction
January	N/A	N/A	N/A
February	N/A	N/A	N/A
March	N/A	N/A	N/A
April	1.16E+10	3.03E+10	0
May	1.35E+10	3.03E+10	0
June	7.60E+09	3.03E+10	0
July	3.55E+09	3.03E+10	0
August	1.75E+09	3.03E+10	0
September	4.07E+09	3.03E+10	0
October	1.56E+09	3.03E+10	0
November	N/A	N/A	N/A
December	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	E. coli		
		WLA	
Month	**Existing Load (#/day)**	**(#/day)**	**Percent Reduction**
January	N/A	N/A	N/A
February	N/A	N/A	N/A
March	N/A	N/A	N/A
April	0.00E+00	2.36E+07	0
May	0.00E+00	2.36E+07	0
June	0.00E+00	2.36E+07	0
July	0.00E+00	2.36E+07	0
August	0.00E+00	2.36E+07	0
September	0.00E+00	2.36E+07	0
October	0.00E+00	2.36E+07	0
November	N/A	N/A	N/A
December	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Fecal Coliform		
	Existing Load	WLA	
Month	(#/day)	(#/day)	Percent Reduction
January	N/A	N/A	N/A
February	N/A	N/A	N/A
March	N/A	N/A	N/A
April	1.69E+07	1.37E+12	0
May	2.52E+07	1.37E+12	0
June	3.59E+07	1.37E+12	0
July	2.80E+07	1.37E+12	0
August	3.26E+07	1.37E+12	0
September	2.54E+07	1.37E+12	0
October	1.85E+07	1.37E+12	0
November	N/A	N/A	N/A
December	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	E. coli		
Month	**Existing Load (#/day)**	**WLA (#/day)**	**Percent Reduction**
January	N/A	N/A	N/A
February	N/A	N/A	N/A
March	N/A	N/A	N/A
April	3.69E+08	5.03E+09	0
May	4.15E+08	5.03E+09	0
June	2.59E+08	5.03E+09	0
July	2.88E+08	5.03E+09	0
August	2.53E+08	5.03E+09	0
September	2.51E+08	5.03E+09	0
October	2.69E+08	5.03E+09	0
November	N/A	N/A	N/A
December	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	E. coli		
Month	**Existing Load (#/day)**	**WLA (#/day)**	**Percent Reduction**
January	N/A	N/A	N/A
February	N/A	N/A	N/A
March	N/A	N/A	N/A
April	4.08E+07	5.21E+09	0
May	4.50E+07	5.21E+09	0
June	8.10E+08	5.21E+09	0
July	6.75E+07	5.21E+09	0
August	5.27E+07	5.21E+09	0
September	6.20E+08	5.21E+09	0
October	6.19E+08	5.21E+09	0
November	N/A	N/A	N/A
December	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	E. coli		
	Existing Load (#/day)	**WLA (#/day)**	
Month			**Percent Reduction**
January	N/A	N/A	N/A
February	N/A	N/A	N/A
March	N/A	N/A	N/A
April	1.42E+11	1.68E+12	0
May	1.48E+11	1.68E+12	0
June	1.67E+11	1.68E+12	0
July	2.10E+11	1.68E+12	0
August	1.90E+11	1.68E+12	0
September	1.99E+11	1.68E+12	0
October	1.75E+11	1.68E+12	0
November	N/A	N/A	N/A
December	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	E. coli		
Month	**Existing Load (#/day)**	**WLA (#/day)**	**Percent Reduction**
January	N/A	N/A	N/A
February	N/A	N/A	N/A
March	N/A	N/A	N/A
April	9.40E+07	1.19E+10	0
May	1.64E+08	1.19E+10	0
June	5.03E+07	1.19E+10	0
July	1.13E+09	1.19E+10	0
August	2.90E+08	1.19E+10	0
September	5.06E+07	1.19E+10	0
October	6.38E+07	1.19E+10	0
November	N/A	N/A	N/A
December	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	E. coli		
Month	**Existing Load (#/day)**	**WLA (#/day)**	**Percent Reduction**
January	N/A	N/A	N/A
February	N/A	N/A	N/A
March	N/A	N/A	N/A
April	3.01E+08	8.06E+09	0
May	2.86E+08	8.06E+09	0
June	2.64E+09	8.06E+09	0
July	1.83E+08	8.06E+09	0
August	2.42E+08	8.06E+09	0
September	3.38E+08	8.06E+09	0
October	2.75E+08	8.06E+09	0
November	N/A	N/A	N/A
December	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	E. coli		
	Existing Load (#/day)	**WLA**	
Month		**(#/day)**	**Percent Reduction**
January	N/A	N/A	N/A
February	N/A	N/A	N/A
March	N/A	N/A	N/A
April	1.41E+11	2.40E+12	0
May	1.34E+11	2.40E+12	0
June	1.69E+11	2.40E+12	0
July	2.09E+11	2.40E+12	0
August	2.38E+11	2.40E+12	0
September	2.40E+11	2.40E+12	0
October	2.03E+11	2.40E+12	0
November	N/A	N/A	N/A
December	N/A	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Total Phosphorus			**Nitrate**			*E. coli*		
Month	**Existing Load (kg/day)**	**WLA (kg/day)**	**Percent Reduction**	**Existing Load (kg/day)**	**WLA (kg/day)**	**Percent Reduction**	**Existing Load (#/day)**	**WLA (#/day)**	**Percent Reduction**
January	2.4	9.7	0	35.7	43.8	0	6.36E+08	N/A	N/A
February	2.4	9.7	0	34.4	43.8	0	6.12E+08	N/A	N/A
March	2.5	9.7	0	34.5	43.8	0	6.15E+08	N/A	N/A
April	2.1	9.7	0	34.4	43.8	0	6.13E+08	1.22E+10	0
May	2.3	9.7	0	34.2	43.8	0	6.09E+08	1.22E+10	0
June	2.7	9.7	0	40.5	43.8	0	7.22E+08	1.22E+10	0
July	1.8	9.7	0	27.5	43.8	0	4.89E+08	1.22E+10	0
August	0.7	9.7	0	11.2	43.8	0	1.99E+08	1.22E+10	0
September	2.7	9.7	0	40.7	43.8	0	7.25E+08	1.22E+10	0
October	2.4	9.7	0	36.4	43.8	0	6.48E+08	1.22E+10	0
November	2.4	9.7	0	35.3	43.8	0	6.29E+08	N/A	N/A
December	2.3	9.7	0	34.9	43.8	0	6.21E+08	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

WLA for NPDES Facility IN0032468 - Lafayette Municipal WWTP

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	340.1	60.7	82	315.8	394.4	0	1.17E+10	N/A	N/A
February	1599.0	60.7	96	321.0	394.4	0	1.19E+10	N/A	N/A
March	365.4	60.7	83	399.8	394.4	0	1.48E+10	N/A	N/A
April	447.2	60.7	86	400.3	394.4	0	1.48E+10	7.58E+10	0
May	443.9	60.7	86	412.4	394.4	0	1.52E+10	7.58E+10	0
June	369.3	60.7	84	342.9	394.4	0	1.27E+10	7.58E+10	0
July	459.4	60.7	87	426.6	394.4	0	1.58E+10	7.58E+10	0
August	513.9	60.7	88	477.2	394.4	0	1.76E+10	7.58E+10	0
September	372.8	60.7	84	346.1	394.4	0	1.28E+10	7.58E+10	0
October	399.4	60.7	85	370.8	394.4	0	1.37E+10	7.58E+10	0
November	400.3	60.7	85	374.8	394.4	0	1.38E+10	N/A	N/A
December	371.3	60.7	84	344.7	394.4	0	1.27E+10	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Total Phosphorus			**Nitrate**			*E. coli*		
Month	**Existing Load (kg/day)**	**WLA (kg/day)**	**Percent Reduction**	**Existing Load (kg/day)**	**WLA (kg/day)**	**Percent Reduction**	**Existing Load (#/day)**	**WLA (#/day)**	**Percent Reduction**
January	0.2	3.5	0	3.1	15.7	0	5.44E+07	N/A	N/A
February	0.5	3.5	0	8.6	15.7	0	1.53E+08	N/A	N/A
March	0.2	3.5	0	6.5	15.7	0	1.17E+08	N/A	N/A
April	0.7	3.5	0	6.7	15.7	0	1.19E+08	4.36E+09	0
May	0.7	3.5	0	9.9	15.7	0	1.77E+08	4.36E+09	0
June	0.4	3.5	0	6.7	15.7	0	1.19E+08	4.36E+09	0
July	0.4	3.5	0	6.0	15.7	0	1.07E+08	4.36E+09	0
August	0.6	3.5	0	8.6	15.7	0	1.53E+08	4.36E+09	0
September	0.5	3.5	0	8.0	15.7	0	1.42E+08	4.36E+09	0
October	0.9	3.5	0	13.4	15.7	0	2.38E+08	4.36E+09	0
November	0.9	3.5	0	14.4	15.7	0	2.57E+08	N/A	N/A
December	0.4	3.5	0	6.5	15.7	0	1.16E+08	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	233.2	34.1	85	216.5	221.8	0	6.64E+08	N/A	N/A
February	296.6	34.1	88	229.0	221.8	0	9.18E+08	N/A	N/A
March	252.5	34.1	86	258.3	221.8	0	9.94E+08	N/A	N/A
April	321.7	34.1	89	259.7	221.8	0	9.98E+08	4.27E+10	0
May	279.5	34.1	88	262.2	221.8	0	9.76E+08	4.27E+10	0
June	176.4	34.1	81	163.8	221.8	0	7.56E+08	4.27E+10	0
July	229.3	34.1	85	213.0	221.8	0	5.40E+08	4.27E+10	0
August	274.2	34.1	88	254.6	221.8	0	6.27E+08	4.27E+10	0
September	185.5	34.1	82	172.2	221.8	0	7.59E+08	4.27E+10	0
October	247.0	34.1	86	229.4	221.8	0	9.83E+08	4.27E+10	0
November	254.9	34.1	87	239.1	221.8	0	1.02E+09	N/A	N/A
December	229.3	34.1	85	212.9	221.8	0	8.80E+08	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	2.5	7.0	0	37.1	31.6	0	6.61E+08	N/A	N/A
February	3.2	7.0	0	46.0	31.6	0	8.20E+08	N/A	N/A
March	2.2	7.0	0	40.1	31.6	0	7.15E+08	N/A	N/A
April	3.2	7.0	0	40.4	31.6	0	7.20E+08	8.80E+09	0
May	3.2	7.0	0	47.3	31.6	0	8.43E+08	8.80E+09	0
June	0.8	7.0	0	12.3	31.6	0	2.19E+08	8.80E+09	0
July	2.1	7.0	0	31.6	31.6	0	5.62E+08	8.80E+09	0
August	2.5	7.0	0	37.1	31.6	0	6.61E+08	8.80E+09	0
September	1.3	7.0	0	19.6	31.6	0	3.49E+08	8.80E+09	0
October	3.1	7.0	0	46.5	31.6	0	8.28E+08	8.80E+09	0
November	3.1	7.0	0	46.5	31.6	0	8.29E+08	N/A	N/A
December	1.0	7.0	0	15.2	31.6	0	2.72E+08	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Total Phosphorus			Nitrate			*E. coli*		
	Existing	WLA		Existing	WLA		Existing	WLA	
Month	Load (kg/day)	(kg/day)	Percent Reduction	Load (kg/day)	(kg/day)	Percent Reduction	Load (#/day)	(#/day)	Percent Reduction
January	149.8	34.1	77	139.0	221.8	0	5.69E+09	N/A	N/A
February	178.9	34.1	81	161.8	221.8	0	8.64E+09	N/A	N/A
March	163.3	34.1	79	212.6	221.8	0	1.09E+10	N/A	N/A
April	264.2	34.1	87	229.5	221.8	0	1.16E+10	4.27E+10	0
May	261.3	34.1	87	242.6	221.8	0	1.20E+10	4.27E+10	0
June	209.6	34.1	84	167.4	221.8	0	6.94E+09	4.27E+10	0
July	247.5	34.1	86	224.1	221.8	0	7.59E+09	4.27E+10	0
August	185.0	34.1	82	323.4	221.8	0	1.06E+10	4.27E+10	0
September	166.6	34.1	80	162.7	221.8	0	9.56E+09	4.27E+10	0
October	225.3	34.1	85	209.2	221.8	0	1.20E+10	4.27E+10	0
November	236.1	34.1	86	219.3	221.8	0	1.25E+10	N/A	N/A
December	195.6	34.1	83	180.6	221.8	0	9.96E+09	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Total Phosphorus			Nitrate			*E. coli*	
	Existing Load	WLA		Existing Load	WLA		Existing Load	WLA
Month	**(kg/day)**	**(kg/day)**	**Percent Reduction**	**(kg/day)**	**(kg/day)**	**Percent Reduction**	**(#/day)**	**(#/day)**
January	71.5	30.3	58	66.3	197.2	0	1.59E+10	N/A
February	104.5	30.3	71	94.9	197.2	0	2.98E+10	N/A
March	86.9	30.3	65	124.7	197.2	0	3.76E+10	N/A
April	142.3	30.3	79	128.5	197.2	0	3.83E+10	3.79E+10
May	140.9	30.3	78	130.8	197.2	0	3.82E+10	3.79E+10
June	123.3	30.3	75	102.5	197.2	0	1.24E+10	3.79E+10
July	116.2	30.3	74	106.8	197.2	0	2.13E+10	3.79E+10
August	90.1	30.3	66	125.8	197.2	0	2.43E+10	3.79E+10
September	88.5	30.3	66	82.5	197.2	0	2.85E+10	3.79E+10
October	126.4	30.3	76	117.4	197.2	0	3.94E+10	3.79E+10
November	133.0	30.3	77	123.5	197.2	0	4.13E+10	N/A
December	120.8	30.3	75	111.1	197.2	0	3.60E+10	N/A

N/A= Not Applicable because standard does not apply during these months.

Percent Reduction
N/A
N/A
N/A
0
0
0
0
0
0
0
N/A
N/A

	Total Phosphorus			**Nitrate**			***E. coli***		
Month	**Existing Load (kg/day)**	**WLA (kg/day)**	**Percent Reduction**	**Existing Load (kg/day)**	**WLA (kg/day)**	**Percent Reduction**	**Existing Load (#/day)**	**WLA (#/day)**	**Percent Reduction**
January	12.0	59.2	0	177.0	265.6	0	0.00E+00	N/A	N/A
February	16.5	59.2	0	257.0	265.6	0	0.00E+00	N/A	N/A
March	7.4	59.2	0	154.7	265.6	0	0.00E+00	N/A	N/A
April	14.7	59.2	0	188.1	265.6	0	0.00E+00	7.40E+10	0
May	13.3	59.2	0	198.4	265.6	0	0.00E+00	7.40E+10	0
June	11.1	59.2	0	79.5	265.6	0	0.00E+00	7.40E+10	0
July	2.7	59.2	0	41.6	265.6	0	0.00E+00	7.40E+10	0
August	10.9	59.2	0	27.7	265.6	0	0.00E+00	7.40E+10	0
September	4.7	59.2	0	108.1	265.6	0	0.00E+00	7.40E+10	0
October	1.0	59.2	0	15.4	265.6	0	0.00E+00	7.40E+10	0
November	1.1	59.2	0	16.1	265.6	0	0.00E+00	N/A	N/A
December	11.6	59.2	0	173.6	265.6	0	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	0.5	9.9	0	29.8	29.8	0	7.5E+08	N/A	N/A
February	0.9	9.9	0	41.8	41.8	0	1.37E+09	N/A	N/A
March	1.4	9.9	0	62.5	62.5	0	1.97E+09	N/A	N/A
April	1.2	9.9	0	58.6	58.6	0	1.81E+09	1.23E+10	0
May	1.1	9.9	0	54.5	54.5	0	1.67E+09	1.23E+10	0
June	0.7	9.9	0	46.8	46.8	0	8.12E+08	1.23E+10	0
July	0.6	9.9	0	44.7	44.7	0	9.31E+08	1.23E+10	0
August	0.9	9.9	0	67.9	67.9	0	1.37E+09	1.23E+10	0
September	0.6	9.9	0	41.3	41.3	0	8.1E+08	1.23E+10	0
October	1.4	9.9	0	56.5	56.5	0	1.99E+09	1.23E+10	0
November	0.8	9.9	0	26.8	26.8	0	7.06E+08	N/A	N/A
December	1.0	9.9	0	42.4	42.4	0	1.44E+09	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

	Fecal Coliform			*E. coli*		
	Existing Load	WLA		Existing Load	WLA	
Month	**(kg/day)**	**(kg/day)**	**Percent Reduction**	**(kg/day)**	**(kg/day)**	**Percent Reduction**
January	4.26E+11	7.38E+10	83	2.66E+11	4.62E+10	83
February	4.41E+11	7.36E+10	83	2.76E+11	4.60E+10	83
March	1.58E+12	2.52E+11	84	9.88E+11	1.58E+11	84
April	1.71E+12	2.87E+11	83	1.07E+12	1.79E+11	83
May	7.04E+12	1.23E+12	83	4.40E+12	7.66E+11	83
June	2.29E+11	3.89E+10	83	1.43E+11	2.43E+10	83
July	2.86E+11	4.07E+10	86	1.79E+11	2.54E+10	86
August	9.78E+10	1.83E+10	81	6.11E+10	1.14E+10	81
September	2.02E+10	3.70E+09	82	1.26E+10	2.31E+09	82
October	1.70E+12	2.79E+11	84	1.07E+12	1.75E+11	84
November	3.98E+11	7.54E+10	81	2.49E+11	4.71E+10	81
December	1.47E+12	2.56E+11	83	9.16E+11	1.60E+11	83

MS4 WLA for Terre Haute

Month	Fecal Coliform			*E. coli*		
	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction
January	1.33E+12	1.68E+11	87	8.28E+11	1.05E+11	87
February	8.29E+12	1.02E+12	88	5.18E+12	6.38E+11	88
March	1.35E+12	1.71E+11	87	8.47E+11	1.07E+11	87
April	9.01E+12	1.11E+12	88	5.63E+12	6.96E+11	88
May	4.48E+13	5.54E+12	88	2.80E+13	3.46E+12	88
June	1.97E+12	2.52E+11	87	1.23E+12	1.57E+11	87
July	6.56E+12	8.18E+11	88	4.10E+12	5.11E+11	88
August	1.57E+11	2.01E+10	87	9.84E+10	1.25E+10	87
September	8.05E+10	1.04E+10	87	5.03E+10	6.51E+09	87
October	4.87E+12	6.17E+11	87	3.04E+12	3.86E+11	87
November	6.96E+11	8.93E+10	87	4.35E+11	5.58E+10	87
December	1.05E+12	1.33E+11	87	6.59E+11	8.34E+10	87

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction
January	6.15E+00	5.88E+00	4	1.67E+02	1.67E+02	0	4.77E+11	5.68E+10	88
February	1.60E+01	1.53E+01	4	6.04E+02	6.04E+02	0	7.17E+11	8.30E+10	88
March	8.40E+00	8.03E+00	4	4.82E+02	4.82E+02	0	1.37E+12	1.61E+11	88
April	1.45E+01	1.37E+01	6	4.35E+02	4.35E+02	0	1.12E+12	1.37E+11	88
May	2.53E+01	2.37E+01	6	9.39E+02	9.39E+02	0	3.72E+12	4.35E+11	88
June	1.51E+00	1.44E+00	5	1.88E+02	1.88E+02	0	1.97E+11	2.51E+10	87
July	2.60E+01	2.46E+01	5	1.13E+03	1.13E+03	0	7.02E+11	8.89E+10	87
August	3.73E+00	3.58E+00	4	1.03E+02	1.03E+02	0	1.17E+11	1.48E+10	87
September	1.32E+00	1.26E+00	4	2.46E+01	2.46E+01	0	1.71E+10	2.19E+09	87
October	1.55E+01	1.46E+01	6	5.02E+02	5.02E+02	0	6.97E+11	8.50E+10	88
November	2.94E+00	2.81E+00	4	1.21E+02	1.21E+02	0	1.57E+11	2.03E+10	87
December	1.86E+01	1.78E+01	4	5.08E+02	5.08E+02	0	1.07E+12	1.30E+11	88

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction
January	3	3	4	93	93	0	2.65E+11	3.16E+10	88
February	9	9	4	336	336	0	3.99E+11	4.61E+10	88
March	5	4	4	268	268	0	7.59E+11	8.97E+10	88
April	8	8	6	242	242	0	6.25E+11	7.62E+10	88
May	14	13	6	523	523	0	2.07E+12	2.42E+11	88
June	1	1	5	105	105	0	1.10E+11	1.40E+10	87
July	14	14	5	627	627	0	3.91E+11	4.95E+10	87
August	2	2	4	57	57	0	6.53E+10	8.22E+09	87
September	1	1	4	14	14	0	9.49E+09	1.22E+09	87
October	9	8	6	279	279	0	3.88E+11	4.73E+10	88
November	2	2	4	67	67	0	8.74E+10	1.13E+10	87
December	10	10	4	282	282	0	5.94E+11	7.24E+10	88

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction
January	7	6	4	183	183	0	5.23E+11	6.22E+10	88
February	18	17	4	661	661	0	7.86E+11	9.09E+10	88
March	9	9	4	529	529	0	1.50E+12	1.77E+11	88
April	16	15	6	476	476	0	1.23E+12	1.50E+11	88
May	28	26	6	1029	1029	0	4.08E+12	4.77E+11	88
June	2	2	5	206	206	0	2.16E+11	2.76E+10	87
July	29	27	5	1235	1235	0	7.69E+11	9.74E+10	87
August	4	4	4	113	113	0	1.29E+11	1.62E+10	87
September	1	1	4	27	27	0	1.87E+10	2.40E+09	87
October	17	16	6	550	550	0	7.64E+11	9.32E+10	88
November	3	3	4	133	133	0	1.72E+11	2.22E+10	87
December	20	19	4	556	556	0	1.17E+12	1.43E+11	88

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction
January	6	6	4	169	169	0	4.82E+11	5.74E+10	88
February	16	15	4	610	610	0	7.26E+11	8.39E+10	88
March	8	8	4	488	488	0	1.38E+12	1.63E+11	88
April	15	14	6	440	440	0	1.14E+12	1.39E+11	88
May	26	24	6	950	950	0	3.76E+12	4.40E+11	88
June	2	1	5	190	190	0	1.99E+11	2.54E+10	87
July	26	25	5	1140	1140	0	7.10E+11	8.99E+10	87
August	4	4	4	104	104	0	1.19E+11	1.49E+10	87
September	1	1	4	25	25	0	1.72E+10	2.21E+09	87
October	16	15	6	508	508	0	7.05E+11	8.60E+10	88
November	3	3	4	122	122	0	1.59E+11	2.05E+10	87
December	19	18	4	514	514	0	1.08E+12	1.32E+11	88

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction
January	14	13	4	255	255	0	6.00E+11	7.72E+10	87
February	33	32	4	1539	1539	0	2.04E+12	2.55E+11	87
March	10	9	5	1242	1242	0	3.65E+12	4.53E+11	88
April	36	34	5	786	786	0	8.82E+11	1.09E+11	88
May	48	46	5	2521	2521	0	1.02E+13	1.29E+12	87
June	11	11	4	531	531	0	8.49E+11	1.10E+11	87
July	61	58	5	2267	2267	0	2.67E+12	3.36E+11	87
August	7	6	5	227	227	0	1.29E+11	1.66E+10	87
September	2	2	4	31	31	0	5.33E+10	7.00E+09	87
October	37	36	5	1174	1174	0	1.74E+12	2.21E+11	87
November	7	7	4	277	277	0	3.35E+11	4.35E+10	87
December	61	58	4	1220	1220	0	4.15E+11	5.36E+10	87

	Total Phosphorus			Nitrate			*E. coli*		
		WLA			WLA			WLA	
Month	Existing Load (kg/day)	(kg/day)	Percent Reduction	Existing Load (kg/day)	(kg/day)	Percent Reduction	Existing Load (#/day)	(#/day)	Percent Reduction
January	0.0	0.0	N/A	0.0	0.0	0	0.00E+00	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
June	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
July	5.5	2.6	53%	1.5	15.4	0	1.48E+12	1.93E+09	100%
August	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	13.1	6.2	53%	0.0	0.0	0	0.00E+00	N/A	N/A
December	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	0.2	0.1	53%	0.6	5.6	0	5.40E+11	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.2	0.1	53%	0.3	2.9	0	2.82E+11	3.67E+08	100%
June	0.0	0.0	0	0.4	4.2	0	3.99E+11	5.20E+08	100%
July	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
August	0.1	0.1	53%	0.2	2.2	0	2.11E+11	2.75E+08	100%
September	2.0	0.9	53%	3.1	30.8	0	2.96E+12	3.85E+09	100%
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	1.2	0.6	53%	1.9	18.6	0	1.79E+12	N/A	N/A
December	0.0	0.0	0	0.3	3.2	0	3.05E+11	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	0.1	0.0	53%	0.0	0.0	0	0.00E+00	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
June	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
July	0.1	0.1	53%	0.0	0.0	0	0.00E+00	0.00E+00	0
August	0.1	0.0	53%	0.1	1.5	0	1.41E+11	1.84E+08	100%
September	0.3	0.1	53%	0.4	4.2	0	3.99E+11	5.20E+08	100%
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	0.2	0.1	53%	0.4	3.9	0	3.76E+11	N/A	N/A
December	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	9.0	4.2	53%	0.0	0.0	0	0.00E+00	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	1.8	0.9	53%	2.9	28.6	0	2.75E+12	3.58E+09	100%
June	0.0	0.0	0	6.1	61.2	0	5.87E+12	7.65E+09	100%
July	0.0	0.0	0	8.4	84.4	0	8.10E+12	1.06E+10	100%
August	0.0	0.0	0	21.9	219.2	0	2.10E+13	2.74E+10	100%
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
December	0.0	0.0	0	5.2	51.9	0	4.98E+12	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	1.7	0.8	53%	0.0	0.0	0	0.00E+00	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
June	0.0	0.0	0	0.9	8.6	0	8.22E+11	1.07E+09	100%
July	0.0	0.0	0	4.8	48.2	0	4.63E+12	6.03E+09	100%
August	2.5	1.2	53%	4.7	46.7	0	4.49E+12	5.84E+09	100%
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
December	0.0	0.0	0	3.3	32.5	0	3.12E+12	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	20.1	9.4	53%	0.0	0.0	0	0.00E+00	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	2.1	1.0	53%	3.3	32.8	0	3.15E+12	4.10E+09	100%
June	0.0	0.0	0	10.3	102.8	0	9.86E+12	1.28E+10	100%
July	7.8	3.7	53%	0.0	0.0	0	0.00E+00	0.00E+00	0
August	7.8	3.7	53%	18.6	185.7	0	1.78E+13	2.32E+10	100%
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	5.8	2.7	53%	9.0	90.0	0	8.64E+12	N/A	N/A
December	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	3.8	1.8	53%	0.0	0.0	0	0.00E+00	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
June	0.0	0.0	0	1.5	15.4	0	1.48E+12	1.93E+09	100%
July	0.0	0.0	0	14.8	147.8	0	1.42E+13	1.85E+10	100%
August	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
December	0.7	0.3	53%	3.7	36.7	0	3.52E+12	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	9.0	4.2	53%	14.0	140.4	0	1.35E+13	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
June	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
July	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
August	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	1.1	0.5	53%	0.0	0.0	0	0.00E+00	N/A	N/A
December	1.3	0.6	53%	2.0	20.1	0	1.93E+12	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	25.0	11.7	53%	39.1	391.2	0	3.76E+13	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
June	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
July	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
August	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
December	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	0.1	0.1	53%	0.2	2.0	0	1.88E+11	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
June	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
July	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
August	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
December	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			**Nitrate**			***E. coli***		
Month	**Existing Load (kg/day)**	**WLA (kg/day)**	**Percent Reduction**	**Existing Load (kg/day)**	**WLA (kg/day)**	**Percent Reduction**	**Existing Load (#/day)**	**WLA (#/day)**	**Percent Reduction**
January	0.3	0.1	53%	0.4	4.2	0	3.99E+11	N/A	N/A
February	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
June	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
July	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
August	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
December	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (kg/day)	WLA (kg/day)	Percent Reduction	Existing Load (#/day)	WLA (#/day)	Percent Reduction
January	2.5	1.2	53%	3.9	38.7	0	3.71E+12	N/A	N/A
February	1.9	0.9	53%	0.0	0.0	0	0.00E+00	N/A	N/A
March	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
April	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
May	0.0	0.0	0	8.5	85.4	0	8.20E+12	1.07E+10	100%
June	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
July	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
August	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
September	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
October	0.0	0.0	0	0.0	0.0	0	0.00E+00	0.00E+00	0
November	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A
December	0.0	0.0	0	0.0	0.0	0	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.

Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

	Fecal Coliform		
		WLA	
Month	Existing Load (kg/day)	(kg/day)	Percent Reduction
January	0.00E+00	N/A	N/A
February	0.00E+00	N/A	N/A
March	0.00E+00	N/A	N/A
April	0.00E+00	0.00E+00	0%
May	0.00E+00	0.00E+00	0%
June	0.00E+00	0.00E+00	0%
July	0.00E+00	0.00E+00	0%
August	6.28E+12	8.17E+09	100%
September	0.00E+00	0.00E+00	0%
October	0.00E+00	0.00E+00	0%
November	0.00E+00	N/A	N/A
December	0.00E+00	N/A	N/A

N/A= Not Applicable because standard does not apply during these months.
Note: CSO Existing Loads and WLAs are based on the "critical condition" day for each month (i.e., the day with the highest TP or bacteria level during the model run). In some cases there were no CSOs on the "critical condition day" and thus no loads appear in the table. However, this does not necessarily mean that CSOs do not occur in these months, only that they did not occur on the day that was used to determine the allocations.

Load Allocation Summary for the Salamonie River

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	1,097	1,053	4	14,860	14,860	0	4.58E+13	N/A	N/A
February	2,283	2,191	4	1,814	1,814	0	2.49E+12	N/A	N/A
March	1,972	1,893	4	2,113	2,113	0	3.55E+13	N/A	N/A
April	344	330	4	40,640	40,640	0	9.25E+12	1.20E+12	87
May	234	225	4	6,313	6,313	0	6.54E+12	8.50E+11	87
June	550	528	4	8,016	8,016	0	3.09E+12	4.02E+11	87
July	65	62	4	499	499	0	1.33E+12	1.73E+11	87
August	862	828	4	6,834	6,834	0	1.71E+13	2.22E+12	87
September	108	104	4	2,603	2,603	0	1.70E+11	2.21E+10	87
October	59	56	4	870	870	0	7.26E+11	9.44E+10	87
November	371	356	4	9,054	9,054	0	1.18E+13	N/A	N/A
December	309	297	4	845	845	0	2.36E+11	N/A	N/A

	Total Phosphorus			Nitrate			*E. coli*		
Month	**Existing Load (kg/day)**	**LA (kg/day)**	**Percent Reduction**	**Existing Load (kg/day)**	**LA (kg/day)**	**Percent Reduction**	**Existing Load (#/day)**	**LA (#/day)**	**Percent Reduction**
January	3,033	2,912	4	19,340	19,340	0	3.34E+13	N/A	N/A
February	8,054	7,732	4	71,210	71,210	0	5.07E+12	N/A	N/A
March	3,535	3,393	4	71,320	71,320	0	2.71E+13	N/A	N/A
April	3,161	3,035	4	49,840	49,840	0	3.94E+13	5.13E+12	87
May	3,619	3,475	4	66,650	66,650	0	6.66E+13	8.66E+12	87
June	101	97	4	18,260	18,260	0	3.30E+13	4.28E+12	87
July	4,703	4,515	4	19,370	19,370	0	7.24E+13	9.41E+12	87
August	549	527	4	8,343	8,343	0	5.46E+12	7.10E+11	87
September	426	409	4	927	927	0	2.78E+12	3.62E+11	87
October	2,032	1,951	4	15,040	15,040	0	6.35E+13	8.25E+12	87
November	134	128	4	1,625	1,625	0	5.62E+11	N/A	N/A
December	8,796	8,444	4	34,530	34,530	0	1.95E+13	N/A	N/A

Load Allocation Summary for the Patoka River

	E. coli		
	Existing Load	**LA**	
Month	**(#/day)**	**(#/day)**	**Percent Reduction**
January	5.04E+13	1.01E+13	N/A
February	3.61E+13	7.21E+12	N/A
March	2.38E+14	4.75E+13	N/A
April	1.70E+13	3.40E+12	80
May	4.28E+14	8.56E+13	80
June	3.85E+12	7.69E+11	80
July	3.84E+12	7.67E+11	80
August	2.72E+11	5.43E+10	80
September	9.41E+11	1.88E+11	80
October	5.47E+12	1.09E+12	80
November	5.68E+12	1.14E+12	N/A
December	3.48E+13	6.96E+12	N/A

Load Allocation Summary for the White River

	E.Coli		
Month	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	6.73E+13	1.35E+13	N/A
February	2.39E+14	4.78E+13	N/A
March	1.20E+14	2.41E+13	N/A
April	8.02E+13	1.60E+13	80
May	7.26E+14	1.45E+14	80
June	2.81E+14	5.63E+13	80
July	1.11E+14	2.23E+13	80
August	2.27E+14	4.53E+13	80
September	3.78E+13	7.56E+12	80
October	4.31E+14	8.61E+13	80
November	9.52E+14	1.90E+14	N/A
December	8.12E+13	1.62E+13	N/A

Load Allocation Summary for the Little Wabash River

	Fecal			E.Coli		
	Existing Load	LA		Existing Load	LA	
Month	(#/day)	(#/day)	Percent Reduction	(#/day)	(#/day)	Percent Reduction
January	7.38E+14	N/A	N/A	4.62E+14	N/A	N/A
February	2.71E+14	N/A	N/A	1.70E+14	N/A	N/A
March	1.28E+15	N/A	N/A	8.00E+14	N/A	N/A
April	1.22E+15	2.43E+14	80	7.61E+14	1.52E+14	80
May	6.31E+15	1.26E+15	80	3.95E+15	7.89E+14	80
June	5.13E+13	1.03E+13	80	3.21E+13	6.41E+12	80
July	5.44E+12	1.09E+12	80	3.40E+12	6.81E+11	80
August	5.14E+11	1.03E+11	80	3.21E+11	6.43E+10	80
September	1.02E+12	2.04E+11	80	6.37E+11	1.28E+11	80
October	9.53E+14	1.91E+14	80	5.96E+14	1.19E+14	80
November	9.86E+12	N/A	N/A	6.16E+12	N/A	N/A
December	1.61E+15	N/A	N/A	1.00E+15	N/A	N/A

Load Allocation Summary for the Embarras River

	Fecal			E.Coli		
	Existing	LA		Existing	LA	
Month	Load (#/day)	(#/day)	Percent Reduction	Load (#/day)	(#/day)	Percent Reduction
January	2.95E+13	N/A	N/A	1.85E+13	N/A	N/A
February	1.92E+14	N/A	N/A	1.20E+14	N/A	N/A
March	7.12E+14	N/A	N/A	4.45E+14	N/A	N/A
April	2.24E+15	4.48E+14	80	1.40E+15	2.80E+14	80
May	8.32E+15	1.66E+15	80	5.20E+15	1.04E+15	80
June	5.40E+13	1.08E+13	80	3.37E+13	6.75E+12	80
July	2.87E+13	5.74E+12	80	1.80E+13	3.59E+12	80
August	8.65E+11	1.73E+11	80	5.41E+11	1.08E+11	80
September	1.26E+12	2.51E+11	80	7.85E+11	1.57E+11	80
October	1.24E+15	2.48E+14	80	7.74E+14	1.55E+14	80
November	1.41E+13	N/A	N/A	8.79E+12	N/A	N/A
December	1.56E+15	N/A	N/A	9.75E+14	N/A	N/A

Load Allocation Summary for the Little Vermilion River

	Fecal			E.Coli		
Month	Existing Load (#/day)	LA (#/day)	Percent Reduction	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	3.13E+13	N/A	N/A	1.96E+13	N/A	N/A
February	7.45E+13	N/A	N/A	4.66E+13	N/A	N/A
March	1.25E+13	N/A	N/A	7.81E+12	N/A	N/A
April	9.68E+13	1.16E+13	88	6.05E+13	7.26E+12	88
May	5.34E+14	6.40E+13	88	3.34E+14	4.00E+13	88
June	1.35E+13	1.62E+12	88	8.43E+12	1.01E+12	88
July	4.06E+13	4.87E+12	88	2.54E+13	3.04E+12	88
August	4.11E+10	4.93E+09	88	2.57E+10	3.08E+09	88
September	5.28E+11	6.34E+10	88	3.30E+11	3.96E+10	88
October	4.80E+13	5.75E+12	88	3.00E+13	3.60E+12	88
November	1.70E+12	N/A	N/A	1.06E+12	N/A	N/A
December	3.26E+12	N/A	N/A	2.04E+12	N/A	N/A

Load Allocation Summary for Sugar Creek

	E.Coli		
	Existing Load	LA	
Month	(#/day)	(#/day)	Percent Reduction
January	3.63E+13	N/A	N/A
February	1.28E+14	N/A	N/A
March	4.61E+12	N/A	N/A
April	2.22E+14	2.66E+13	88
May	2.09E+15	2.51E+14	88
June	9.63E+12	1.16E+12	88
July	1.05E+14	1.26E+13	88
August	3.85E+12	4.62E+11	88
September	1.90E+11	2.28E+10	88
October	7.63E+13	9.16E+12	88
November	1.64E+13	N/A	N/A
December	5.88E+13	N/A	N/A

Load Allocation Summary for the Vermilion River

	Fecal			E.Coli		
Month	Existing Load (#/day)	LA (#/day)	Percent Reduction	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	3.18E+13	N/A	N/A	1.99E+13	N/A	N/A
February	7.08E+14	N/A	N/A	4.43E+14	N/A	N/A
March	1.24E+14	N/A	N/A	7.74E+13	9.29E+12	88
April	7.48E+14	8.97E+13	88	4.67E+14	5.61E+13	88
May	2.43E+15	2.92E+14	88	1.52E+15	1.83E+14	88
June	6.46E+13	7.75E+12	88	4.04E+13	4.85E+12	88
July	3.93E+14	4.72E+13	88	2.46E+14	2.95E+13	88
August	6.73E+12	8.08E+11	88	4.21E+12	5.05E+11	88
September	2.16E+12	2.59E+11	88	1.35E+12	1.62E+11	88
October	3.20E+14	3.84E+13	88	2.00E+14	2.40E+13	88
November	8.57E+12	N/A	N/A	5.36E+12	N/A	N/A
December	1.15E+13	N/A	N/A	7.17E+12	N/A	N/A

Load Allocation Summary for Pipe Creek

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	83	79	4	2,092	2,092	0	1.63E+13	N/A	N/A
February	82	79	4	19,490	19,490	0	4.69E+13	N/A	N/A
March	115	110	4	33,390	33,390	0	9.43E+13	N/A	N/A
April	324	311	4	11,340	11,340	0	6.41E+13	8.33E+12	87
May	281	270	4	16,810	16,810	0	1.11E+14	1.44E+13	87
June	40	39	4	4,550	4,550	0	1.97E+12	2.56E+11	87
July	781	749	4	120,500	120,500	0	2.27E+13	2.95E+12	87
August	15	14	4	627	627	0	6.92E+11	8.99E+10	87
September	31	30	4	1,260	1,260	0	5.27E+11	6.85E+10	87
October	133	128	4	18,470	18,470	0	2.96E+13	3.84E+12	87
November	16	16	4	3,631	3,631	0	7.54E+11	N/A	N/A
December	141	136	4	15,550	15,550	0	6.24E+13	N/A	N/A

Load Allocation Summary for Deer Creek

	Total Phosphorus			Nitrate			*E. coli*		
	Existing	LA		Existing	LA		Existing	LA	
Month	Load (kg/day)	(kg/day)	Percent Reduction	Load (kg/day)	(kg/day)	Percent Reduction	Load (#/day)	(#/day)	Percent Reduction
January	40	38	4	2,467	2,467	0	4.61E+12	N/A	N/A
February	304	292	4	31,560	31,560	0	1.33E+13	N/A	N/A
March	201	193	4	42,770	42,770	0	5.91E+13	N/A	N/A
April	1,408	1,352	4	27,380	27,380	0	5.29E+13	6.88E+12	87
May	1,596	1,533	4	25,030	25,030	0	1.08E+14	1.41E+13	87
June	39	38	4	2,331	2,331	0	5.16E+12	6.70E+11	87
July	974	934	4	195,800	195,800	0	4.22E+13	5.48E+12	87
August	60	58	4	1,662	1,662	0	2.47E+11	3.21E+10	87
September	29	28	4	284	284	0	2.84E+11	3.69E+10	87
October	547	525	4	33,850	33,850	0	2.54E+13	3.30E+12	87
November	126	121	4	9,176	9,176	0	7.46E+12	N/A	N/A
December	523	502	4	30,690	30,690	0	8.59E+13	N/A	N/A

Load Allocation Summary for Wildcat Creek

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	206	197	4	6,673	6,673	0	3.29E+13	N/A	N/A
February	476	456	4	39,480	39,480	0	3.23E+13	N/A	N/A
March	158	152	4	29,780	29,780	0	1.50E+14	N/A	N/A
April	2,801	2,689	4	18,600	18,600	0	1.67E+14	2.17E+13	87
May	4,511	4,330	4	41,570	41,570	0	7.10E+14	9.23E+13	87
June	113	108	4	4,453	4,453	0	5.88E+12	7.64E+11	87
July	1,657	1,590	4	160,200	160,200	0	8.15E+13	1.06E+13	87
August	160	154	4	5,199	5,199	0	6.86E+11	8.91E+10	87
September	135	130	4	1,551	1,551	0	9.92E+11	1.29E+11	87
October	2,304	2,210	4	36,990	36,990	0	7.55E+13	9.82E+12	87
November	421	405	4	2,680	2,680	0	2.07E+13	N/A	N/A
December	1,146	1,100	4	32,500	32,500	0	2.14E+14	N/A	N/A

Load Allocation Summary for the Eel River

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	64	61	4	5,788	5,788	0	7.46E+12	N/A	N/A
February	531	510	4	143,100	143,100	0	9.93E+13	N/A	N/A
March	405	388	4	67,050	67,050	0	2.98E+14	N/A	N/A
April	649	623	4	51,380	51,380	0	1.10E+13	1.44E+12	87
May	1,671	1,604	4	104,100	104,100	0	5.60E+13	7.27E+12	87
June	109	105	4	29,600	29,600	0	1.98E+13	2.58E+12	87
July	1,775	1,704	4	78,930	78,930	0	6.47E+13	8.41E+12	87
August	757	726	4	23,430	23,430	0	1.99E+13	2.58E+12	87
September	80	77	4	7,012	7,012	0	2.58E+11	3.35E+10	87
October	551	529	4	87,790	87,790	0	3.11E+13	4.05E+12	87
November	279	268	4	8,794	8,794	0	4.51E+12	N/A	N/A
December	1,836	1,762	4	114,700	114,700	0	1.23E+13	N/A	N/A

Load Allocation Summary for the Tippecanoe River

	Total Phosphorus			Nitrate			*E. coli*		
Month	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (kg/day)	LA (kg/day)	Percent Reduction	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	64	62	4	4,741	4,741	0	1.84E+11	N/A	N/A
February	1,020	980	4	18,130	18,130	0	1.35E+13	N/A	N/A
March	255	245	4	44,460	44,460	0	2.13E+13	N/A	N/A
April	956	917	4	57,620	57,620	0	3.02E+13	3.93E+12	87
May	2,129	2,043	4	95,000	95,000	0	8.30E+13	1.08E+13	87
June	207	198	4	19,720	19,720	0	7.02E+13	9.13E+12	87
July	6,303	6,052	4	214,100	214,100	0	2.52E+14	3.27E+13	87
August	713	685	4	17,350	17,350	0	4.33E+13	5.63E+12	87
September	145	140	4	545	545	0	8.27E+12	1.08E+12	87
October	2,857	2,742	4	181,300	181,300	0	2.09E+14	2.72E+13	87
November	954	916	4	58,330	58,330	0	8.68E+13	N/A	N/A
December	415	398	4	39,960	39,960	0	2.48E+13	N/A	N/A

Load Allocation Summary for Direct Drainage Area -- Wabash River at Confluence with Ohio River

	E. coli		
Month	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	3.83E+14	6.31E+13	84
February	2.96E+14	4.76E+13	84
March	1.68E+15	2.49E+14	85
April	1.53E+15	2.34E+14	85
May	7.28E+15	1.15E+15	84
June	8.07E+13	1.25E+13	84
July	1.01E+14	1.46E+13	86
August	8.33E+12	1.25E+12	85
September	9.10E+12	1.53E+12	83
October	2.26E+15	3.41E+14	85
November	2.46E+13	3.91E+12	84
December	1.52E+15	2.44E+14	84

	Fecal Coliform		
Month	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	6.13E+14	1.01E+14	84
February	4.74E+14	7.61E+13	84
March	2.69E+15	3.98E+14	85
April	2.44E+15	3.74E+14	85
May	1.16E+16	1.83E+15	84
June	1.29E+14	2.00E+13	84
July	1.62E+14	2.33E+13	86
August	1.33E+13	1.99E+12	85
September	1.46E+13	2.45E+12	83
October	3.62E+15	5.45E+14	85
November	3.93E+13	6.26E+12	84
December	2.43E+15	3.90E+14	84

Load Allocation Summary for Direct Drainage Area -- Wabash River at Hutsonville

	E. coli		
Month	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	2.43E+14	3.44E+13	86
February	1.22E+15	1.59E+14	87
March	1.36E+14	1.80E+13	87
April	1.08E+15	1.42E+14	87
May	6.67E+15	9.02E+14	86
June	1.51E+14	2.01E+13	87
July	5.11E+14	6.51E+13	87
August	2.02E+12	2.72E+11	87
September	2.84E+13	4.13E+12	85
October	1.17E+15	1.55E+14	87
November	9.44E+14	1.34E+14	86
December	3.61E+13	4.80E+12	87

	Fecal Coliform		
Month	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	3.89E+14	5.51E+13	86
February	1.96E+15	2.55E+14	87
March	2.18E+14	2.88E+13	87
April	1.73E+15	2.26E+14	87
May	1.07E+16	1.44E+15	86
June	2.41E+14	3.22E+13	87
July	8.18E+14	1.04E+14	87
August	3.23E+12	4.34E+11	87
September	4.54E+13	6.61E+12	85
October	1.87E+15	2.47E+14	87
November	1.51E+15	2.15E+14	86
December	5.78E+13	7.67E+12	87

Load Allocation Summary for Direct Drainage Area -- Wabash River at Illinois/Indiana State Line

	E. coli		
Month	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	2.05E+14	2.64E+13	87
February	1.13E+15	1.39E+14	88
March	1.28E+14	1.63E+13	87
April	9.95E+14	1.23E+14	88
May	5.90E+15	7.37E+14	88
June	1.39E+14	1.76E+13	87
July	4.68E+14	5.59E+13	88
August	2.25E+12	2.72E+11	88
September	4.57E+12	6.03E+11	87
October	5.69E+14	7.33E+13	87
November	1.52E+13	1.94E+12	87
December	3.25E+13	4.03E+12	88

	Fecal Coliform		
Month	Existing Load (#/day)	LA (#/day)	Percent Reduction
January	3.28E+14	4.22E+13	87
February	1.80E+15	2.22E+14	88
March	2.05E+14	2.60E+13	87
April	1.59E+15	1.96E+14	88
May	9.44E+15	1.18E+15	88
June	2.22E+14	2.81E+13	87
July	7.48E+14	8.94E+13	88
August	3.60E+12	4.35E+11	88
September	7.32E+12	9.65E+11	87
October	9.10E+14	1.17E+14	87
November	2.43E+13	3.10E+12	87
December	5.20E+13	6.45E+12	88

	E. coli		
Month	Existing Load	LA (#/day)	Percent Reduction
January	2.77E+14	3.14E+13	89
February	4.16E+14	4.50E+13	89
March	5.11E+14	5.22E+13	90
April	6.10E+14	7.14E+13	88
May	2.12E+15	2.33E+14	89
June	3.38E+13	3.95E+12	88
July	7.87E+13	8.15E+12	90
August	1.54E+13	1.59E+12	90
September	1.66E+12	1.92E+11	88
October	1.76E+14	1.80E+13	90
November	4.99E+12	5.37E+11	89
December	5.17E+14	5.95E+13	88

	Nitrate		
Month	Existing Load	LA (#/day)	Percent Reduction
January	90,100	90,100	0
February	204,100	204,100	0
March	131,600	131,600	0
April	124,000	124,000	0
May	467,400	467,400	0
June	77,920	77,920	0
July	198,300	198,300	0
August	27,060	27,060	0
September	7,405	7,405	0
October	65,680	65,680	0
November	12,770	12,770	0
December	176,100	176,100	0

	Total Phosphorus		
Month	Existing Load	LA (#/day)	Percent Reduction
January	797	746	6
February	1,254	1,159	8
March	719	666	7
April	3,087	2,723	12
May	8,087	7,284	10
June	169	151	11
July	6,550	5,969	9
August	156	146	6
September	198	187	5
October	5,060	4,623	9
November	277	256	8
December	3,122	2,930	6

Load Allocation Summary for Direct Drainage Area -- Wabash River at Confluence with Vermilion River

	E. coli		
Month	Existing Load	LA (#/day)	Percent Reduction
January	2.10E+14	2.69E+13	87
February	3.62E+14	4.43E+13	88
March	8.77E+14	1.05E+14	88
April	2.08E+14	2.48E+13	88
May	3.27E+15	4.09E+14	88
June	7.78E+13	9.97E+12	87
July	3.79E+14	4.45E+13	88
August	6.16E+12	7.34E+11	88
September	1.31E+13	1.73E+12	87
October	3.13E+14	3.81E+13	88
November	1.08E+13	1.38E+12	87
December	1.98E+13	2.43E+12	88

	Nitrate		
Month	Existing Load	LA (#/day)	Percent Reduction
January	42,260	42,260	0
February	218,100	218,100	0
March	241,000	241,000	0
April	161,300	161,300	0
May	730,800	730,800	0
June	104,000	104,000	0
July	210,800	210,800	0
August	32,570	32,570	0
September	5,073	5,073	0
October	128,500	128,500	0
November	25,100	25,100	0
December	195,100	195,100	0

	Total Phosphorus		
Month	Existing Load	LA (#/day)	Percent Reduction
January	1,255	1,204	4
February	2,059	1,939	6
March	1,446	1,357	6
April	5,884	5,520	6
May	8,163	7,570	7
June	1,845	1,771	4
July	9,672	9,092	6
August	572	531	7
September	138	134	3
October	7,539	7,102	6
November	698	677	3
December	8,180	7,783	5

Load Allocation Summary for Direct Drainage Area -- Wabash River at inflow to J. Edward Roush Lake

	E. coli		
Month	Existing Load	LA (#/day)	Percent Reduction
January	4.55E+13	2.66E+12	94
February	1.53E+14	7.91E+12	95
March	1.92E+14	1.01E+13	95
April	2.92E+13	1.53E+12	95
May	6.02E+14	3.12E+13	95
June	6.77E+12	3.56E+11	95
July	3.05E+13	1.76E+12	94
August	5.36E+12	2.57E+11	95
September	1.77E+13	1.05E+12	94
October	6.68E+13	3.50E+12	95
November	4.90E+12	2.54E+11	95
December	1.21E+14	6.78E+12	94

	Nitrate		
Month	Existing Load	LA (#/day)	Percent Reduction
January	19,000	19,000	0
February	47,320	47,320	0
March	60,530	60,530	0
April	86,320	86,320	0
May	133,500	133,500	0
June	20,500	20,500	0
July	82,100	82,100	0
August	8,048	8,048	0
September	46,220	46,220	0
October	25,260	25,260	0
November	12,490	12,490	0
December	40,700	40,700	0

	Total Phosphorus		
Month	Existing Load	LA (#/day)	Percent Reduction
January	201	174	14
February	1,397	1,100	21
March	1,546	1,227	21
April	1,508	1,205	20
May	3,200	2,589	19
June	197	163	17
July	1,316	1,125	15
August	238	183	23
September	1,916	1,681	12
October	1,746	1,438	18
November	907	757	17
December	1,456	1,214	17

APPENDIX J: ACTIVE WATERSHED GROUPS IN INDIANA

Sponsor	Watershed Project	County(s)
Patoka Lake Regional Water & Sewer District	Patoka Lake WMP	Orange, Crawford, Dubois
Dubois County SWCD	Patoka River WMP	Dubois
Gibson County Commissioners	Patoka River WMP	Gibson, Pike
Tippecanoe Environmental Lake and Watershed Foundation	Upper Tippecanoe River WMP	
Upper Wabash River Basin Commission	Upper Wabash River WMP	
Lake Perry Property Owners Association	Eel River-Tick Creek WMP	
The Nature Conservancy	Tippecanoe River WMP	
Pike County SWCD	Patoka River WMP	Pike
Sullivan County SWCD	Middle Wabash Busseron WMP	Sullivan, Vigo, Greene, Clay
Vermillion County SWCD	Little Vermillion River WMP	Vermillion, and State of Illinois
Vigo County SWCD	Middle Wabash Busseron WMP	
White River RC&D	Lower East Fork White	Orange, Lawrence, Jackson, Washington
MIAMI CO SWCD	TRIBUTARIES OF WABASH RIVER	MIAMI,CASS,GRANT

APPENDIX K: RESPONSIVENESS SUMMARY

K.1 COMMENTS SUBMITTED TO ILLINOIS EPA

The Stage 3 Meeting for the Wabash River TMDL was held at 6 p.m. on July 12th, 2006 at the Robinson Community Center in Robinson, Illinois. 195 public notices were mailed out to individuals throughout the state and watershed. Public notices were put in the Lawrenceville Daily Record, Robinson Daily News, Casey Reporter, and Marshall Independent Choice. Approximately 15 individuals attended the meeting.

The following questions/comments were given by individuals at the public meeting.

1. There are many agricultural operations in place. You mention in the report that Confined Animal Feeding Operations (CAFOs) are not a problem, but even though there are not a lot of operations along the river itself, there are quite a lot in the watershed. Can you be more specific about operations in the report? We believe that they could be part of the problem. For dairy farms in Crawford County, what kind of permits will need to be looked at? Who do they go through for this process?

Response: The CAFO program will be administered under the Illinois EPA NPDES permit system in the future. By June of 2007, federal regulations for CAFO facilities should be finalized and more information should be available under the NPDES permit system. For more information on CAFOs, go to http://www.epa.state.il.us/water/cafo/ . Until the federal regulations are finalized, reliable information on the number and location of CAFOs is not available.

2. Has anyone looked into economic incentives such as trading? Please give us examples of watersheds that have used trading.

Response: Water quality trading is a relatively new implementation action. Trading for Illinois' parameter of fecal coliform is probably not the best choice, but nutrient trading is an option for Indiana. For more information on the water quality trading policy, please go to U.S. EPA's trading website at http://www.epa.gov/owow/watershed/trading/finalpolicy2003.html . An agricultural water quality trading guide is available at http://www.conservationinformation.org/?action=learningcenter_publications_waterqualitytrading . For specific projects and other information on trading, go to http://www.epa.gov/owow/watershed/trading/tradelinks.html .

3. What happens when nobody does anything with the implementation plan? Does the Illinois EPA come back and do anything? How are you going to convince nonpoint source farmers that they need to do some implementation actions?

Response: Point source and nonpoint sources are very different when it comes to implementation. The Illinois EPA requirements regulate point sources by issuing permits. Illinois EPA can change the NPDES permits if the TMDL shows that is needed. For nonpoint sources, no permits are required. EPA has no regulatory authority for nonpoint sources and therefore actions are voluntary. Our implementation plan gives general guidelines on ways the local community can clean up impaired waters. We therefore hope that there are people in the community, whether it be a local watershed group or a farmer, that will come forward and be willing to take steps. Both Indiana and Illinois have staff that can help a community start and maintain a watershed group. We also have 319 Nonpoint Source Program funds available for projects. We have project managers that can assist with project development. If there are interested persons, please let us know by emailing us from our websites or calling the numbers below.

Indiana-
http://www.in.gov/idem/programs/water/wsp/watershedmgmtinfo.html

- Watershed Specialists
  - Upper Wabash- Tim Kroeker (317) 234-3312
  - Middle Wabash- Linda Schmidt (317) 234-1432
  - Lower Wabash- Bonny Elifritz (317) 234-0922
- 319 Coordinators
  - Upper Wabash- Kathleen Hagan (317) 233-8801
  - Middle/Lower Wabash- Pamela Brown (317) 234-3406

Illinos-
http://www.epa.state.il.us/water/watershed/nonpoint-source.html

- Watershed Specialists
  - Watershed Liason with Assocication of Illinos SWCDs and Illinois EPA- Jim Nelson- (217) 744-3414
  - Lower Illinois- Margaret Fertaly [Illinois EPA]- (618) 993-7200
- 319 Coordinator
  - Amy Walkenbach [Illinois EPA]- (217) 782-3362

4. Illinois has done a lot of positive work in these watersheds and maybe that is why the Wabash River in Illinois is not impaired for nutrients. Specifically, Clark County has a lot of wetland reserve acreage. Thousands of acres have been taken out of production. I do not believe that is accounted for in the TMDL. Can you see how that would change the modeling if that was accounted for?

Response: Pollutant loads to the Wabash River were estimated based on observed water quality data collected approximately between 1990 and 2003, as well as land use data from the year 2000. Therefore anything that has happened within the past few years (such as the conversion of cropland to wetland) would likely not be accounted for in the TMDL. Such efforts are an excellent step toward implementation of the TMDL and might very well accomplish some of the load reductions that were recommended as part of this study.

5. Are grants available for working with the health departments and educating the public on septic system maintenance? It looks like septic systems failures are a problem and we would like more information on how we can remedy this.

Response: The 319 Nonpoint Source Program funds education projects. The 319 coordinators who can give you more information are listed in the response to question 3. This topic will be discussed at the implementation meeting. If you are not on the mailing list to receive notice of this meeting, please call or email Sarah Tadla (Illinois EPA) at (217) 782-5562, Sarah.Tadla@epa.state.il.us .

6. In projecting baseline conditions, loads for the NPDES facilities in the watershed were simulated as discharging daily at their daily flows and at the maximum of their permit limits. In review of permit compliance within the context of TMDL review of other watersheds, we regularly see fecal coliform effluent limits exceeded over half the time. Calculating baseline conditions assuming that sewage treatment plants are meeting effluent limits all of the time is not supportable.

Response: For the most part, facilities were meeting their limits, but Illinois EPA will continue to investigate compliance of all facilities in the watershed. Agency enforcement procedures will be followed if any violations are found.

7. The implementation strategy presented only details steps to be taken by the Indiana Department of Environmental Management. Please provide information as to what Illinois EPA plans as their strategy to address NPDES permitted dischargers, stormwater permits, confined animal feeding operations, and nonpoint source watershed projects within Illinois' portion of the Wabash River watershed.

Response: Illinois EPA will follow Agency procedures for NPDES noncompliance issues as prescribed under current state statute (i.e. Section 31 of the Illinois Environmental Protection Act). As for stormwater permits, there are no MS4 permits due for issuance in this watershed. Concentrated Animal Feeding Operations (CAFOs) are discussed in the response to question 1. Illinois EPA does not have any specific CAFO, permitting or compliance projects in this watershed. We hope that with the help of this TMDL, interested parties may want to begin watershed projects. See the response to question 3 for more information on watershed specialists and 319 coordinator contacts.

8. Implementation plans we have seen proposed as part of TMDL development in the past have fallen short in some important areas. Specifically, there has been no quantification of expected load reductions from the various control measures and no guidance about where in the watersheds control measures would provide the greatest benefit. There was no indication of what the next steps would be or who would be responsible for the implementation of load reductions and adaptive management. We understand that implementation plans are expected to be developed and tailored to individual tributary watersheds as needed and we would like to see the following components included.
   An Implementation Plan should:
   1) Include a watershed–specific load reduction plan, listing the assortment of load reduction measures (along with their locations in the watershed) that are expected to achieve the load reductions needed to meet water quality standards, and the time frame within which water quality standards will be met or controls re-evaluated. If IEPA is unwilling to develop a load reduction plan without stakeholders input, then the Implementation Plan should include a few sample load reduction plans showing different ways load reductions could be achieved through the watershed, as a starting point for any stakeholder process.
   2) Establish a schedule for at least the following specific steps:
      a. Develop a load reduction plan (if not already completed as part of the implementation plan),
      b. Identify specific funding sources for load reduction measures, as appropriate,
      c. Pursue funding for load reduction measures, as appropriate,
      d. Modify NPDES permits as needed to incorporate load reductions and monitoring requirements,
      e. Install and implement nonpoint source control measures,

f. Collect data to evaluate success of load reductions measures,
g. Assess water quality standards attainment, and
h. If needed, modify approach through adaptive management techniques.

This scheduling should coordinate all the various activities (permitting, BMPs, monitoring, etc.), define a reporting interval, and involve all appropriate local authorities, state and federal agencies, and watershed stakeholders.

3) Establish an assessment and adaptive management plan, including performance criteria, checkpoints, and alternative actions that will be taken if performance criteria are not being met.
4) Assign responsibility for each of the steps in the schedule to a specific person or agency.

Response: Although U.S. EPA does not require development of Implementation Plans as part of the total maximum daily load process, Illinois EPA has decided to provide general guidance on how to implement a TMDL. The Illinois EPA will include information of what load reductions can be expected with certain BMPs. Illinois EPA also attempts to obtain information on where in the specific watershed certain BMPs have been implemented; however, to date we have been unsuccessful in obtaining this information. The vast majority of TMDLs in Illinois indicate that significant reductions in non-point loads are needed. However, implementing these reductions is problematic in that Illinois EPA does not have a legal mechanism by which to ensure that specific activities in specific locations are done. At this time, nonpoint source control remains a voluntary effort, dependent on active watershed groups for skilled planning initiative and long term financing. Illinois EPA will continue to seek these reductions through voluntary efforts and incentives while working to ensure that appropriate requirements related to approved TMDL activities are included in NPDES permits.

Illinois EPA is reluctant to develop a schedule for performing load reduction activities as part of a TMDL implementation plan since we have no legal authority to enforce such a schedule. However, such tasks are an appropriate part of certain funding mechanisms for implementing non-point control projects within a watershed, such as 319 funding. Schedules for load reduction, implementing and installing non-point sources controls, and data collection for evaluation of these controls through adaptive implementation can appropriately be included through certain funding mechanisms.

K.2 Comments Submitted to Indiana Department of Environmental Management

1. Fecal Coliform and *E.coli* – Section 2.2.1.1

The report states that the impairment status of the Wabash River for Fecal Coliform and *E.coli* in Ohio is unknown and no TMDL has yet been developed. Therefore, the Indiana *E.coli* TMDL was based on the assumption that Ohio's *E.coli* Standard would be met at the state line.

Considering that the entire stretch of the Wabash River is considered to be impaired as it flows through Indiana, it seems very unlikely that the river will meet the water quality standard for *E.coli* once it crosses the political boundary between Indiana and Ohio. Please expand this discussion to clarify how and why this conclusion was drawn.

> **Response:** Portions of the Wabash River in Ohio are listed as impaired for Fecal Coliform and *E. coli*, although at the state line the primary contact beneficial use of the river is listed as Unknown. Ohio EPA intends to continue to monitor the Wabash River and will develop Fecal Coliform and/or *E. coli* TMDLs if the monitoring indicates impairment (Source: Ohio EPA. 2006. Integrated Water Quality Monitoring and Assessment Report. Ohio Environmental Protection Agency Division of Surface Water. Final Report. Submitted to U.S. EPA: March 27, 2006. Approved by U.S. EPA: May 1, 2006). Based on the anticipated Ohio Wabash River TMDL, the Indiana Wabash River TMDL was developed on the premise that water quality standards would be met as the river crosses the state line. This methodology ensures that each state is responsible for reducing loads that are generated within their boundary (i.e., loads within Indiana do not need to be overly reduced to address excessive loads generated upstream in Ohio).

2. Nutrients - 2.2.1.2

The nutrient TMDL for the Indiana portion of the Wabash River was based on an assumption that the nutrient TMDL for the Ohio portion of the Wabash River would be fully implemented and that the reductions identified in the TMDL would be realized as the Wabash River crosses into Indiana. The report also states that this methodology ensures that each state is responsible for reducing loads that are generated within their boundary (i.e. loads within Indiana do not need to be overly reduced to address excessive loads generated upstream in Ohio.)

This assumption seems to be arbitrarily made. While Indiana communities should not be forced to address water quality problems created by Ohio communities, the TMDL should address what happens if the Wabash River still does not meet water quality standards despite fulfillment of TMDL requirements. The TMDL should explain in more detail how future water quality sampling will be interpreted and what effect that interpretation will have on Indiana communities.

> **Response:** Both Ohio and Indiana plan on continuing to monitor the Wabash River to determine if water quality standards are met. Ohio's phosphorus and nitrate targets are 0.17 mg/L and 1.5 mg/L, respectively and Indiana's phosphorus and nitrate targets are 0.30 mg/L and 10.0 mg/L, respectively. If monitoring indicates that these water quality targets are not met (i.e., a significant number of samples exceed the target values), the respective TMDLs will need to be revised, including re-visiting the implementation activities that are believed necessary to meet water quality standards.

3. NPDES Facilities that Discharge Directly to the Wabash River – Section 2.4.1

The report states that all of the wastewater facilities with design flows greater than 1 million gallons per day have permit limits for *E.coli* and therefore are not considered significant sources of pathogens.

This assumption seems to be arbitrarily made. Were NPDES records reviewed to verify that NPDES facilities are indeed meeting their permit requirements or was it assumed that because these facilities have been issued permits, they are automatically fulfilling their permit requirements? This assumption should be clarified.

> **Response:** The NPDES records were reviewed and, for the most part, facilities were meeting their limits. However, IDEM will continue to investigate the compliance of all facilities in the watershed. Enforcement procedures will be followed if any violations are found.

4. Storm Water General Permit Rule 13 – Section 6.2

When discussing Stormwater requirements in the implementation section, the report states that once MS4 permits in the watershed are issued and implemented, they will improve the water quality in the watershed.

A joint MS4 permit for the communities of Tippecanoe County, Lafayette, West Lafayette, Battleground, Dayton, Ivy Tech, and Purdue was issued in 2003. These communities are considered Co-Permittees and are currently acting under a joint MS4 permit to fulfill their permit requirements. Best Management Practices (BMPs) are currently being implemented to address the six Minimum Control Measures (MCM) identified in the Co-Permittee's Storm Water Quality Management Plan (SWQMP). These MCMs include public education and outreach, public involvement and participation, construction site storm water run-off control, post-construction storm water management in new development and redevelopment, illicit discharge detection and elimination, and pollution prevention and good housekeeping for municipal operations. The public education and outreach and illicit discharge detection and elimination components of the Co-Permittee's SWQMP will be especially effective in reducing sources of *E.coli* associated with urban stormwater runoff.

As a component of their SWQMP, the Co-Permittees have adopted an ordinance prohibiting illicit connections to their storm sewer system, and will be developing and implementing a dry weather screening program for all stormwater outfalls. As a part of this program, Co-Permittee staff will identify and screen all stormwater outfalls within their Municipal Separate Storm Sewer System (MS4) jurisdictions. Any outfall identified as having a dry weather discharge or illicit discharge will be investigated by the Co-Permittees, and identified problems will be corrected. In addition, the Co-Permittees will be attending an IDDE training program, designed to ensure that future IDDE efforts are as efficient and effective as possible. The Co-Permittees public education program also includes the development of educational brochures that will include information on the water quality impacts of inadequately functioning septic systems.

> **Response:** Thank you for this comment. The Co-Permittees are to be commended for the management actions that they are already taking.

5. General Comment

Overall, the TMDL lacks specific recommendations and does not provide stakeholders within the Wabash River watershed with a plan of action on how to move forward with implementation. Additionally, the document should be expanded to include a discussion on the potential consequences that might result if future water quality monitoring efforts indicate that water quality standards are not being attained despite the initiation of regional watershed planning efforts and the implementation of BMPs designed to address *E.coli* and nutrient impairments.

Among other practices, the TMDL lists riparian area management, manure collection and storage, contour row cropping, and drift fences as being potential solutions to reducing the extent of the *E.coli* and nutrient problems in the watershed. However, the document provides no guidance in terms of where these practices should be implemented, how much it will cost to implement the practices, or the estimated pollution reduction that will result from the implementation of these practices.

Future watershed planning efforts and BMP implementation will certainly be helpful in improving water quality. However, it seems that the TMDL document ignores the single most important variable on which the success of the project depends, funding. Any BMP implemented as a result of this TMDL will have a financial cost associated with it. As a result of this TMDL, the Wabash River Watershed should be considered a **priority** for future state and federal funding of watershed planning and implementation projects.

Response: U.S. EPA does not require development of Implementation Plans as part of the total maximum daily load process and a detailed plan was outside the scope of this project. At this time, nonpoint source control remains a voluntary effort, dependent on active watershed groups for skilled planning initiative and long term financing. IDEM will continue to seek these reductions through voluntary efforts and incentives while working to ensure that appropriate requirements related to approved TMDL activities are included in NPDES permits.

IDEM is reluctant to develop a schedule for performing load reduction activities as part of a TMDL implementation plan since we have no legal authority to enforce such a schedule. However, such tasks are an appropriate part of certain funding mechanisms for implementing non-point control projects within a watershed, such as 319 funding. Schedules for load reduction, implementing and installing non-point sources controls, and data collection for evaluation of these controls through adaptive implementation can appropriately be included through certain funding mechanisms.

6. The entire result seems flawed due to the dropping out of point sources when modeling both baseline and violation of standards. From hydrology forward, ‘baseline’ appears to be set, as do goals, which will assure violation of ultimate necessary standards: (1) Rain events/hydrology and their effect due to CSOs and runoff are minimalized; (2) “random” observations of departure from modeling results are discarded rather than considered; (3) baselines are set with NPDES at “worst allowable”, along with CSOs, even though the permit process allowed permits without consideration of TMDL (i.e., the permits and allowed discharges are without consideration of what the river can withstand); (4) Finally, all standards both past and with any new TMDL, seem based on dry conditions only – it rains in Indiana.

Response: Point sources were not “dropped out” during any part of the modeling effort. They were represented during the calibration process based on reported discharge flows and concentrations, including instances when the permit limits were exceeded. During the TMDL development model runs, point sources were simulated as discharging at their permit limits to simulate their maximum allowable loads. This is standard practice when developing a TMDL. These permit limits are derived specifically to protect water quality standards during all flow conditions. Similarly, CSOs were simulated during the calibration process based on available information regarding reported overflows and were a recognized contributor to violations of the water quality standards. Based on this, the TMDL recommends significant (53% for phosphorus and 99.5% for pathogens) load reductions from CSOs. During the model calibration process it was noted that certain observed water quality observations were far greater than predicted by the model. However, these observations were not "discarded" but are rather attributed to activity unknown to the model (e.g., a spill or a runoff event not captured by the available flow data). Sampling or lab error might also be responsible for these outlying values. In general, the majority of observed data fall within the range of values predicted by the model and thus it was determined to be an acceptable tool to use for TMDL development.