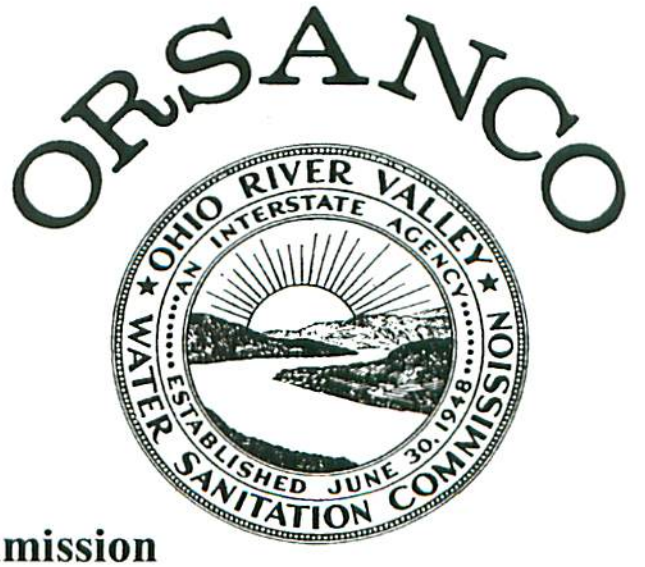
FINAL REPORT

December 2004

WET WEATHER IMPACT STUDY ON THE OHIO RIVER

Louisville/Southern Indiana Area



Ohio River Valley Water Sanitation Commission

EXECUTIVE SUMMARY

This is a final report of a study conducted by the Ohio River Valley Water Sanitation Commission (ORSANCO) titled, "A Study Of Impacts And Control Of Wet Weather Sources Of Pollution On Large Rivers." The purpose of this study was to transfer the methodologies and technologies developed in the Cincinnati/Northern Kentucky area study to a segment of the Ohio River in the vicinity of Louisville, Kentucky, for the evaluation of combined sewer overflows (CSOs) and other wet weather impacts on the water quality of a large river, and to evaluate resulting benefits from certain abatement scenarios.

This study was primarily funded by the United States Environmental Protection Agency (U.S. EPA). ORSANCO served as the project manager and employed a technical team for a portion of the work including consultant services from Limno-Tech, Inc., the United States Geological Survey, J.E. Edinger Associates, Inc., Strand Associates Inc. and XCG Consultants Ltd. The Louisville Metropolitan Sewer District, the Indiana cities of Charlestown, Clarksville, Jeffersonville and New Albany, Louisville, Kentucky, the Oak Park Conservancy District, the Louisville Water Company, the United States Army Corps of Engineers and the Indiana Department of Environmental Management provided funds and/or in-kind contributions to the project.

Bacteria levels have been identified as a major cause of impairment to Ohio River water quality. An inventory compiled by the U.S. EPA showed a total of 9,471 individual CSO outlets nationally. Fifteen percent of the total national CSOs, approximately 1,400 CSOs, are located along the Ohio River. The Ohio River is used extensively for recreation and is a source of drinking water for nearly three million people. Prior to the Cincinnati Wet Weather Study, very little was done to study the causes, sources and effects of abatement efforts on the water quality of large rivers.

Specific objectives of the study included: 1) Determination of the extent and severity of wet weather water quality impacts on the Ohio River; 2) Identification of the pollutants and sources of impairment; 3) Classification of the relative importance of the identified sources, and; 4) Evaluation of the resulting improvements in Ohio River water quality from various CSO abatement scenarios. Major project components included: multiple wet and dry weather water quality surveys; dye surveys during both high and low-flow conditions to determine lateral mixing; landside modeling to estimate pollutant loadings from CSOs and other important sources; hydrodynamic modeling to simulate the complex hydrodynamics of the study area, particularly around the McAlpine Locks and Dam; setup and execution of a river model to determine the extent and severity of wet weather water quality impacts and resulting improvements to water quality from various CSO abatement scenarios; and a special study to evaluate the Colilert method for *Escherichia coli* analysis. Select modeling results are viewable on CD in a special animator available with this report.

The study area lies within the McAlpine and Cannelton pools of the Ohio River and borders Kentucky and Indiana. There are approximately 140 CSO outlets, numerous sanitary sewer overflow (SSO) outlets, eight municipal wastewater treatment plants, three water intakes, and approximately 55 direct permitted industrial discharges within the study area. No major

tributaries enter into the study area, however, many of the smaller streams in the urban area, such as Beargrass Creek in Kentucky and Silver Creek in Indiana, are severely affected by CSOs and SSOs. At normal pool, this portion of the Ohio River has an average width of 1,857 feet, an average depth of 29 feet, a harmonic mean flow of 49,000 cubic feet per second (cfs) and a low flow of 11,000 cfs. Silver Creek, with a drainage area of 225 square miles, has the highest drainage area of all tributaries identified in the study area. A complex hydrodynamic situation exists in the middle of the study area at river mile 605, where the McAlpine Locks and Dam structures are located adjacent to the only naturally occurring waterfall on the Ohio River. Additionally, an island with a hydropower facility separates the lock chamber from the dam.

Three dry weather surveys, five wet weather surveys, two dye surveys and two hydrographic surveys were conducted as part of this study. Results of these studies, along with data collected from local sources, were used to develop three models. The landside loading model and the hydrodynamic model were developed to serve as input to the water quality model.

The landside loading model is an HSPF model with an HEC-2 component model for stream transport. It was developed to estimate pollutant loads from landside sources (CSOs, SSOs and surface runoff) in the study area based on rainfall. It is a continuous simulation model that not only assesses the events, but also the low-flow impacts of the pollutant loadings that are delivered during high flow.

The hydrodynamic model is a two-dimensional RMA-2 model. It was developed to simulate the complex hydrodynamics of the Ohio River in the study area. The model was split into two segments because of the hydrodynamic complexities introduced by the McAlpine Locks and Dam. The final model was used to simulate the steady-flow patterns of the Ohio River for flows ranging from 6,500 to 197,000 cfs.

The water quality model is a WASP5 model. It was developed to simulate fecal coliform and *E coli*, as bacteria were determined to be the wet weather pollutants of concern. The purpose of the model is to serve as a planning tool for evaluating relative improvements in Ohio River water quality resulting from CSO or other source controls. The model was generally consistent with observed data, although it appears that there may be pollutant sources whose loads are not accounted for in the model inputs. The model is therefore better suited to evaluate relative impacts of various sources and control actions, as opposed to being used as a predictor of absolute concentrations in the river.

Special studies included an evaluation of the Colilert method for *E. coli* analysis. *E. coli* samples analyzed by the Colilert method were collected from each sampling site for all three dry weather surveys and the first three wet weather surveys. Approximately ten percent duplicate samples were collected and analyzed by the membrane filtration method. Data from the first year of side-by-side sample collection were not comparable. Linear regressions of the 1998 dry and wet weather survey data and the 2000 wet weather survey data indicated R-square values of 0.954 and 0.932, respectively, where a value of 1.0 indicates perfect correlation. Although chromogenic substrate detection methods, such as Colilert, have not yet been approved as standard methods for wastewater by the U.S. EPA or by the Standard Methods Committee, this

study found that there is no significant difference between results obtained by Colilert and those obtained using approved standard methods.

Event modeling results are included on CD in an animation viewer package.

Major conclusions from the study include:

- The project framework from the Cincinnati/Northern Kentucky study was successfully transferred to another section of the Ohio River.
- Bacteria (*E. coli* and fecal coliform indicators) were determined to be the pollutants of concern regarding adverse wet weather water quality impacts for the Louisville study area. This was also the case in the Cincinnati/Northern Kentucky study area, however, this conclusion may not apply to other large river urban areas.
- Ohio River bacteria levels exceed criteria for the protection of human health from contact recreation and drinking water, at times even during dry weather conditions.
- Based on modeling results (subject to error) for the four wet weather events conducted between 1998 and 2001, tributaries contribute an average of 80 percent of the total fecal coliform load and 75 percent of the total *E. coli* load. CSOs within the study area contribute most of the remaining bacteria load (18 percent fecal coliform and 22 percent *E. coli*).
- Of the tributaries, Beargrass Creek in Kentucky and Silver Creek in Indiana, followed by Falling Run in Indiana and the Mill Creek Cutoff in Kentucky, contribute the greatest bacteria loads to the Ohio River.
- Model results suggest that there may be pollutant sources whose loads are not accounted for in the model inputs.
- Upstream flow dominates the volume of water entering the study area during the typical year of December 2000 through November 2001 with nearly 99 percent of the total flow, and the remaining one percent being comprised of CSO, WWTP and tributary flows.
- Based on model results (subject to error), the annual load distribution by source type for fecal coliform and *E. coli* for the typical year are the following:

	Fecal coliform	***E. coli***
Indiana WWTPs	<0.1%	<0.1%
Indiana CSOs	0.1%	0.1%
Indiana Tributaries	38.8%	44.4%
Kentucky WWTPs	0.3%	0.6%
Kentucky CSOs	15.7%	16.9%
Kentucky Tributaries	38.8%	37.4%
Upstream	6.4%	0.5%

- Based on model results (subject to error), the single sample maximum criterion is a more stringent water quality standard than the 30-day geometric mean criterion because more frequent exceedances of the single sample maximum criterion were observed.
- Based on model results (subject to error), in the months when the fecal coliform geometric mean criterion is not met, exceedances in 40 to 50 percent area of the Ohio

River are due to tributary sources, while CSOs account for exceedances in 10 to 20 percent area of the Ohio River.

- Based on model results (subject to error), between 10 and 30 percent of the days during the contact recreation season exceed the single sample maximum criteria because of tributary sources. An additional 5 to 10 percent of the days during the contact recreation season exceed the single sample maximum criteria because of CSO sources.
- Based on model results (subject to error), CSOs have a big influence on peak concentrations during a wet weather event, accounting for approximately 50 percent of the concentration on the Kentucky side and 40 percent in the center channel of the river.

A number of important lessons were learned during this project and are detailed in Chapter 6. The most important being that delays caused by uncooperative weather must be anticipated and accounted for in project budgets and schedules. In development of the hydrodynamic model, the collection of bathymetry data during both of the calibration surveys would have reduced the positive bias in the average cross-sectional velocities. In development of the landside loading model, postponement until after the individual communities had completed their own CSO work (development of GIS coverages and hourly overflow estimates) would have saved this project a lot of resources. In development of the water quality model, analysis of the CSO samples for bacteria parameters would have provided valuable information. It is doubtful that the results of the predictive water quality model developed for this project would be significantly different than what is reported, but these recommendations from the consultants could serve to make future wet weather projects run more smoothly and efficiently.

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1.0 INTRODUCTION

This is a final report of a study conducted by the Ohio River Valley Water Sanitation Commission (ORSANCO) titled, "Wet Weather Impact Study On The Ohio River." This study focuses on wet weather water quality issues of the Ohio River in the Greater Louisville area. The ultimate objective of this study is to transfer the methodologies and technologies developed in the Greater Cincinnati area for a study titled "A Study Of Impacts And Controls Of Wet Weather Sources Of Pollution On Large Rivers," to the Greater Louisville area. This study was funded by the United States Environmental Protection Agency (U.S. EPA) under Federal Assistance Agreement #CX825699-01-0, with matching contributions of cash and/or in-kind services provided by a number of local entities. These contributors include: the Louisville Metropolitan Sewer District, the Louisville Water Company, the City of Louisville, the Kentucky Division of Water, the Indiana Cities of New Albany, Jeffersonville and Clarksville, the Oak Park Conservancy District, the U.S. Geological Survey, the U.S. Army Corps of Engineers and the Indiana Department of Environmental Management. Project management and design and implementation of the water quality monitoring surveys were provided by ORSANCO. Major modeling components were contracted to Limno-Tech, Inc., Ann Arbor, Michigan, the U.S. Geological Survey, Louisville, Kentucky and J.E. Edinger Associates, Inc., Wayne, Pennsylvania. Assessment of available data, to define additional monitoring needs, was performed by XCG Consultants Limited, Kingston, Ontario, Canada. Contact the Ohio River Valley Water Sanitation Commission, 5735 Kellogg Ave., Cincinnati, OH 45228 for additional information.

1.1 BACKGROUND

Combined sewer overflows (CSOs) are seen as a problem in the Ohio River Basin due to their prevalence within the basin states. A national inventory compiled by the U.S. EPA showed a nationwide total of 9,471 individual CSOs located in 772 communities. Approximately two-thirds of the national total CSOs are located within the boundaries of ORSANCO's member states. Over 1,400 CSOs are located in the cities and towns along the Ohio River. This represents approximately 15 percent of the CSOs in the United States. Because the Ohio River serves as a boundary between states for most of its length, approximately two-thirds of the Ohio River CSOs are located in interstate urban areas. Those areas also encompass more than one U.S. EPA Region. For example, Louisville, Kentucky (Region IV) has 118 CSOs, while the communities directly across the river in Southern Indiana (Region V) have 15 CSOs.

While many large rivers receive discharges from CSOs, most of the CSO water quality impact studies in the United States were conducted on marine waters and lakes. Little is known about the specific impacts of CSOs on the water quality of large rivers. It is likely that the impacts of CSOs on a large river differ from those impacts found in the marine and lake environments due to certain distinguishing characteristics such as volume and velocity. Likewise, little is known about the expected improvements in the water quality of large rivers due to abatement of CSOs.

ORSANCO has worked with state agencies, municipal sewer districts, the U.S. EPA, the U.S. Army Corps of Engineers (ACOE) and the U.S. Geological Survey (USGS), to develop a basic

strategy for monitoring CSO impacts on the Ohio River. An initial objective of the strategy was to identify successful monitoring approaches. To do so, the strategy assigned areas of responsibility and called for the sharing of information on a regular basis. Dischargers were called on to monitor CSOs and the receiving waters most likely to show the greatest impacts, such as smaller tributaries receiving large volumes of overflows. As an interstate entity for the entire Ohio River, ORSANCO was responsible for monitoring the impacts of interstate CSO "clusters" on the river. The states and U.S. EPA were called on to provide information on CSO impacts from other areas and to provide their expertise in the cooperative assessment of monitoring results.

ORSANCO's approach to its responsibilities under the strategy has been to compile available information on CSOs including locations, sizes and quantities discharged. This allowed the identification of areas along the river that are most likely to show impacts from CSOs. It is anticipated that, as information from dischargers' monitoring efforts becomes available, a better understanding of the content of CSOs and the impacts on smaller streams will emerge. This should result in a better idea of what and where impacts are likely to occur on the Ohio River, and thereby help determine future monitoring needs.

A drawback to ORSANCO's approach is that its resources restrict the scope of its monitoring efforts. Operating on its own, it would take ORSANCO ten or more years to carry out the studies needed, even on a bare bones basis, to define the impacts of all interstate CSO areas on the Ohio. Given the current schedule for CSO abatement, both the cities and the regulatory agencies want answers on a shorter-term basis. In recognition of this fact, U.S. EPA Regions III and IV provided ORSANCO with a grant to carry out a study that investigated the impacts of CSOs on bacteria levels in the river. The work was conducted in the Wheeling (West Virginia/Ohio) and Huntington (West Virginia/Kentucky/Ohio) areas. The fieldwork associated with these studies concluded in November 1994. The knowledge and experience gained from this effort was useful in the development of future monitoring strategies.

In April 1995, ORSANCO was awarded a grant to conduct a Demonstration Study on the Ohio River in the Greater Cincinnati area. This study incorporated a holistic approach to evaluating the impacts of wet weather sources of pollution, such as CSOs, SSOs, stormwater and nonpoint sources of pollution. Activities associated with this multi-million dollar project were completed in September 2002. The principal product of the study was a water quality model that predicts pollutant loadings to the River during wet weather events, and is able to simulate water quality improvements resulting from various pollution control alternatives. One of the key goals of the Cincinnati project was that the developed methodologies and tools be transferable to other large river communities. In 1997, a multi-year program was designed to test and demonstrate the transferability of the methods and technologies developed during the Cincinnati study, to a segment of the Ohio River in the vicinity of Louisville, Kentucky.

1.2 STUDY PURPOSE AND OBJECTIVES

A U.S. EPA study estimates that $46.7 billion will be necessary to control the nation's 9,471 CSOs located throughout 772 communities. At the same time, the expected environmental benefits from such controls are not clear, including whether implementation of all controls will result in attainment of water quality objectives. It is anticipated that certain communities will experience significant socioeconomic burden resulting from CSO control requirements.

The primary goal of this study is to test the transferability of the methods and technologies developed during the Cincinnati Wet Weather Study to other large river communities. These technologies and methodologies were developed for the evaluation of CSOs and other wet weather water quality impacts and the resulting benefits from certain abatement scenarios. The study more specifically defines, for the Louisville, Kentucky/Southern Indiana urban segment of the Ohio River: 1) The extent and severity of urban wet weather water quality impacts on the Ohio River; 2) The causes and sources of impacts; 3) The relative importance of the identified wet weather pollutant sources, and; 4) The resulting improvements in water quality from various CSO control scenarios. Additional objectives of the study include evaluating the Colilert method for *E. coli* analysis.

1.3 PROJECT COMPONENTS

The following major project elements were necessary to meet the study objectives:

- Water Quality Surveys
  - Dry weather water quality surveys were conducted to characterize baseline water quality conditions within the study area, free from the influence of CSOs and other wet weather pollution sources.
  - Wet weather water quality surveys were conducted to determine pollutants of concern and characterize wet weather water quality conditions.
- Pollutant Loading Estimates
  - Landside load modeling was conducted to generate boundary conditions for the river model.
- Hydrodynamic Modeling
  - Hydrodynamic modeling was conducted to determine the steady-flow patterns of the Ohio River in the study area.
- Estimation of River Conditions for a "Typical Year"
  - A detailed river model was set up, calibrated, verified and run for a "typical year" to estimate river water quality.
- Evaluation of CSO Control Scenarios
  - The river model was re-run with CSO loading reduction scenarios to evaluate resulting improvements in water quality.
- Information Delivery
  - A computer-based map viewer with animation capabilities was developed to display river model results in terms of duration and severity of water quality impacts.

1.4 PROJECT MANAGEMENT

To successfully undertake and complete a major comprehensive study of wet weather sources of pollution in the Louisville/Southern Indiana area, several agencies and organizations were utilized. ORSANCO provided project management and employed a consultant team for a large portion of the work. The consultant team was comprised of representatives from Limno-Tech, Inc., J.E. Edinger Associates, Inc. and the USGS. The Louisville and Jefferson County Metropolitan Sewer District and the Indiana cities of New Albany and Jeffersonville actively participated and provided project funds and staffing. ORSANCO's Technical Committee, composed of state and federal agency regulatory personnel, were also kept appraised of project progress.

1.5 STUDY AREA DESCRIPTION

The Ohio River is one of the "Great Rivers" of the U.S. and hence a visibly appropriate site for a study on CSO impacts and controls on large rivers. It is well suited for this study because of its size, abundance of CSOs, unique hydrodynamic characteristics and the amount of supporting data available in the Louisville area. Indiana and Kentucky border this stretch of the Ohio River. Environmental regulatory authorities with jurisdiction over the study area include the Indiana Department of Environmental Management, the Kentucky Division of Water, U.S. EPA Regions IV and V, and ORSANCO.

1.5.1 OHIO RIVER

The study area begins at the northeast corner of Jefferson County, Kentucky and extends southwestward. The study area is contained within two navigation pools, divided by the McAlpine Locks and Dam (Figure 1-1). The upper 17 miles of the study area lie within the McAlpine Pool (river miles 588 through 605), while the lower 25 miles are located within the Cannelton Pool (river miles 605 through 630), ending just upstream of the Salt River confluence. The structures that compose the McAlpine Locks and Dam are located on the northwestern side of Louisville, Kentucky and extend from river miles 604.4 to 607.4. This area presents a complex hydrodynamic situation where the McAlpine Locks and Dam structure is located adjacent to the only naturally occurring waterfall on the Ohio River. Additionally, an island separates the lock structure from the dam, which contains a hydropower facility.

Approximately 140 CSOs and numerous SSOs discharge to a ten-mile stretch of river, which also receives the discharges from eight municipal wastewater facilities. In addition, there are approximately 55 industrial facilities with permitted discharges directly to the Ohio River within this segment.

Table 1-1 provides selected information on the McAlpine and Cannelton Pools of the Ohio River.

Figure 1-1. Study Area

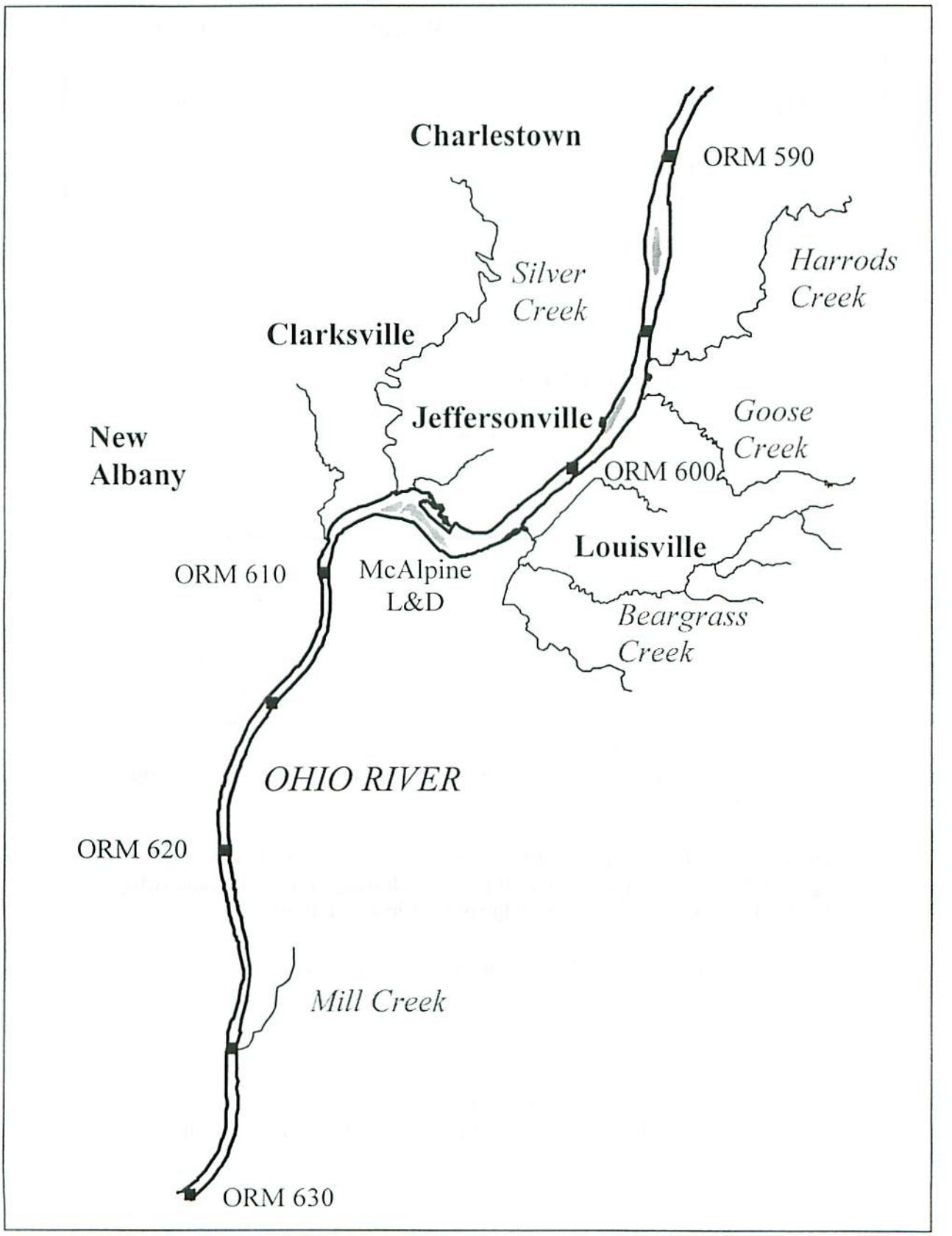


Table 1-1. McAlpine and Cannelton Pool Information

	McAlpine	Cannelton
Pool Length: (mi)	75.3	113.9
Pool River Miles:	531.5 – 606.8	606.8 – 720.7
Normal Pool Elevation (ft):	420	383
Average Depth (ft):	25	32
Average Width (ft):	2,040	1,674
Bottom Slope (ft/mi):	0.3	0.3
Normal Pool Stage (ft):	12	9
Flood Stage (ft):	55	42
*Minimum 7-Day, 10-Year Low-Flow (cfs):	11,000	13,000
Harmonic Mean Flow (cfs):	47,300	55,900
Long Term Flow Data (1994-2002)		
Average Flow (x1,000 cfs):	Upper Gates: 121.72	Upper Gates: 126.80
	Lower Gates: 121.70	Lower Gates: 158.50
Average Velocity (mph):	Upper Gates: 1.19	Upper Gates: 2.05
	Lower Gates: 2.02	Lower Gates: 1.49
*Calculated for entire pool		

1.5.2 STUDY TRIBUTARIES

No major tributaries, defined by a drainage area of greater than 1,000 square miles, enter into the study area. Many of the smaller streams in the urban areas are severely affected by CSOs and SSOs. For example, Beargrass Creek in Kentucky is affected by CSOs and SSOs, and Silver Creek in Indiana is affected by SSOs. Water quality was investigated in 12 area tributaries. The study tributaries are listed below, from upstream to downstream, with a short description and available date sources:

Fourteen Mile Creek (IN) — Fourteen Mile Creek is the uppermost tributary within the study area, entering the Ohio River at mile 589.5. It provides drainage for the Indiana Army Ammunitions Plant, as well as the western edge of Charlestown, Indiana.

Harrods Creek (KY) — Harrods Creek enters the Ohio River at mile 595.9, with a drainage area of approximately 108 square miles. Stream slopes are moderate to flat at approximately 15 feet per mile from the headwaters to mile 15, 10 feet per mile for the next 7.5 miles, 5 feet per mile for the next 3.3 miles, and virtually no slope in the lower 4.2 miles. The lower 4.2 miles are located in Ohio River backwater. The backwater area is greater than 50 feet wide and 15 feet deep in places. The USGS operates one gaging station at mile point 3.0. Monthly data are available for specific conductance, pH, temperature and dissolved oxygen from March 1988 to the present. The Kentucky Division of Water conducted a low-flow survey of Harrods Creek in July of 1990.

Lentzier Creek (IN) — Lentzier Creek enters the Ohio River at mile 596.3, just downstream of Utica, Indiana. Very little information was available at the writing of this report about this small watershed (10 square miles).

Goose Creek (KY) — Goose Creek enters the Ohio River at mile 596.9, with a drainage area of nearly 50 square miles. Little Goose Creek flows into Goose Creek approximately 0.4 miles upstream of the confluence with the Ohio River. The USGS operates gaging stations at miles 5.5 and 2.1 on Goose Creek and mile 1.8 on Little Goose Creek. Data are available for instantaneous flow, specific conductance, pH, temperature and dissolved oxygen from 1988 to the present.

Lancassange Creek (IN) — Lancassange Creek enters the Ohio River at mile 597.8, with a drainage area of 10 square miles. It is located upstream of Jeffersonville, Indiana and provides drainage for much of Oak Park, Indiana.

Beargrass Creek (KY) — Beargrass Creek enters the Ohio River at mile point 602.1, just upstream of Towhead Island. The Middle, Muddy and South Forks of Beargrass Creek converge just upstream of the confluence with the Ohio River, to form the main channel of this creek. The drainage area of the entire Beargrass watershed is approximately 61 square miles, with the Middle, Muddy and South Forks draining areas of 25.1 mi^2, 8.8 mi^2 and 27.1 mi^2, respectively. The USGS operates seven gaging stations located throughout the watershed. Land use is primarily residential, with a population of nearly 190,000. Much of the area is served by combined sewers, which send flow to the Louisville MSD Morris Forman wastewater treatment plant. A total of 57 CSOs discharge to Beargrass Creek and its three forks.

Mill Creek (IN) — Mill Creek enters the Ohio River through a culvert at mile 606.1, just downstream of the Falls of the Ohio. With a drainage area of 7.5 square miles, it provides drainage to the Indiana cities of Jeffersonville and Clarksville. Four Jeffersonville CSOs are located along Mill Creek, however, only two of the CSOs are now active.

Silver Creek (IN) — Silver Creek forms the borders of the Indiana cities of New Albany and Clarksville, as well as the borders of Floyd and Clark counties, as it flows south into the Ohio River at mile 607.0. The drainage area of the Silver Creek watershed is approximately 219 square miles. The USGS operates one gaging station located at mile 12.2, near Sellersburg, Indiana. The drainage area at this point is 189 square miles. Flow records for this station date back to 1954. The annual mean flow at Sellersburg is 216 cfs, and the $Q_{7,10}$ low flow is 0.0 cfs. Flow in the stream exceeds 51 cfs approximately 50 percent of the time. No CSOs are located along Silver Creek, however, there are an unknown number of SSOs which discharge to Silver Creek.

Falling Run (IN) - Falling Run enters the Ohio River at mile 609.3, with a drainage area of 10.3 square miles. It provides drainage to New Albany, Indiana.

Mill Creek Cutoff (KY) - The ACOE constructed the Mill Creek Cutoff as part of the original floodwall project in the 1950s. The Cutoff runs west from Mill Creek proper and enters the Ohio River at mile point 616.5.

Mill Creek (KY) - Mill Creek flows parallel to the Ohio River, then enters into it at mile 625.1. The Mill Creek watershed drainage area is 14.8 square miles. The USGS operates a gaging station at the Orell Road Bridge, located at mile 1.5. The drainage area at this point is 13.5 square miles. Data are available for instantaneous flow, specific conductance, pH, temperature and dissolved oxygen dating back to 1988. The sampling point for this study was also located at the Orell Road Bridge.

Salt River (KY) – The Salt River enters the Ohio River at mile 630, at the downstream boundary of the modeled study area. It is by far the largest tributary in the study area at 125 miles in length with a drainage area of 2,890 square miles. The closest USGS gaging station to the confluence is located at mile 22.9 mile, near Shepherdsville, Kentucky. Numerous other gaging stations are located on small tributaries to the Salt River.

2.0 WATER QUALITY SURVEYS

A major component of this demonstration study involved water quality surveys. A number of surveys were completed including three dry weather surveys and five wet weather surveys. A large number of parameters were analyzed in this study. ORSANCO used information collected from the Cincinnati Wet Weather Study and the source data provided in Table 2-1, along with assistance from the participating communities and the U.S. EPA, to design, coordinate and complete each of these water quality surveys. Survey designs were adjusted over the course of this study based on the information acquired from the previous surveys.

Conductivity, pH, DO and temperature were recorded at each point where stream samples were collected. Ohio River crews used a multi-parameter probe, while tributary crews used individual parameter probes. These instruments were pre-calibrated and post-calibrated for each circuit. A Secchi disk reading was also taken at each Ohio River sampling site.

Bacteria samples were collected on the Ohio River in accordance with the procedures contained in the *Standard Operating Procedures for the Collection of Bacteria Samples Utilizing Glove Method*, a copy of which is provided in Appendix A. The remaining Ohio River samples and all of the tributary samples were collected in accordance with the procedures contained in the *Standard Operating Procedures for the Collection of Discrete Water Samples*, a copy of which is provided in Appendix B. The discrete water samples were collected with a Kemmerer sampling device. The Kemmerer was rinsed twice with deionized water between sampling sites to eliminate contamination between locations, then rinsed with river water at each sampling site to eliminate dilution from the deionized water. This deionized water decontamination procedure was developed during the Cincinnati Wet Weather Study through a field test of multiple methods. Ohio River crews collected bacteria field blanks and method blanks following each sampling circuit, while tributary crews collected only field blanks. Field blanks and equipment blanks were collected for the remaining parameters by both Ohio River crews and tributary crews.

The remainder of Section 2.0 describes the location and selection of the sampling sites. Sections 2.1 and 2.2 provide detailed discussions of the dry and wet weather sampling events, respectively. Section 2.3 provides a detailed discussion of the quality control and quality assurance measures put in place for this study, as well as a description of the QA/QC samples collected by the field crews. Section 2.4 presents and discusses the results of the field studies, whereas, Sections 2.0 through 2.3 provide more logistical information for planning such wet weather studies.

2.0.1 OHIO RIVER AND TRIBUTARY SAMPLE SITES

Investigations were conducted to develop and document profiles for 18 water quality parameters of interest for the Ohio River. Profiles were constructed with grab samples collected from the Ohio River, tributaries receiving discharges from CSOs and SSOs, CSOs and wastewater treatment plant influent. The river sampling started upstream of the CSOs and continued to a point downstream of the last CSOs in the Louisville/Southern Indiana area. Tributary samples

Table 2-1. Selected Information on Sources in the Study Area

ORSANCO Monitoring Stations

ORMP 594.0	Louisville WTP – Bacteria Monitoring Station
ORMP 600.4	King Fish Restaurant – Bimonthly Monitoring Station
ORMP 608.7	Downtown Louisville – Bacteria Monitoring Station
ORMP 619.3	West Point – Bacteria Monitoring Station
ORMP 625.9	West Point – Bimonthly Monitoring Station

Municipal Drinking Water Treatment Plants

		Pumping Rate
ORMP 594.5	Louisville, Kentucky	115.0 MGD
ORMP 600.6	Louisville, Kentucky	2.4 MGD
ORMP 609.0	New Albany, Indiana	5.0 MGD

Publicly Owned Treatment Works (Wastewater Treatment Plants)

		Design Flow
ORMP 592.0	Charlestown, Indiana	2.2 MGD
ORMP 597.0	Glenview Bluff Subdivision, Kentucky	0.01 MGD
ORMP 602.0	Oak Park Conservancy District, Indiana	1.23 MGD
ORMP 604.1	Jeffersonville, Indiana	5.2 MGD
ORMP 606.0	Clarksville, Indiana	5.0 MGD
ORMP 609.5	New Albany, Indiana	6.878 MGD
ORMP 612.0	Louisville/Jefferson County-Morris Forman	120 MGD
ORMP 615.7	Wellington Elementary, Kentucky	0.0075 MGD
ORMP 620.0	Shacklette Elementary School, Kentucky	0.008 MGD
ORMP 623.3	Louisville/Jefferson County-West County	19.5 MGD
ORMP 631.4	West Point, Kentucky	0.2 MGD
ORMP 637.4	Otter Creek Park, Kentucky	0.012 MGD
ORMP 642.3	Brandenburg, Kentucky-Doe Valley	0.15 MGD
ORMP 645.8	Brandenburg, Kentucky	0.3 MGD

Approximate Ohio River Mile Points of CSOs and SSOs

ORMP 592	Charlestown, Indiana WWTP
*ORMP 589.3	Fourteen Mile Creek (SSOs)
*ORMP 591.2	Pleasant Run Creek (SSOs)
ORMP 600 – 604	Jeffersonville, Indiana WWTP (11 Ohio River CSOs)
*ORMP 606.1	Mill Creek (two CSOs) and Cane Run (one CSO)
ORMP 605	Clarksville, Indiana WWTP (three Ohio River SSOs)
*ORMP 606.1	Mill Creek (one SSO)
*ORMP 607.0	Silver Creek (four SSOs)
*ORMP 609.5	New Albany, Indiana WWTP (Plant Bypass on Falling Run)
ORMP 602 - 612	Louisville & Jefferson Co. MSD (61 Ohio River CSOs)
*ORMP 602.1	Beargrass Creek (57 CSOs)

ORMP – Ohio River Mile Point
*ORMP – Mile Point of Confluence with Ohio River

Figure 2-1. Study Area Wet Weather Sources of Pollution

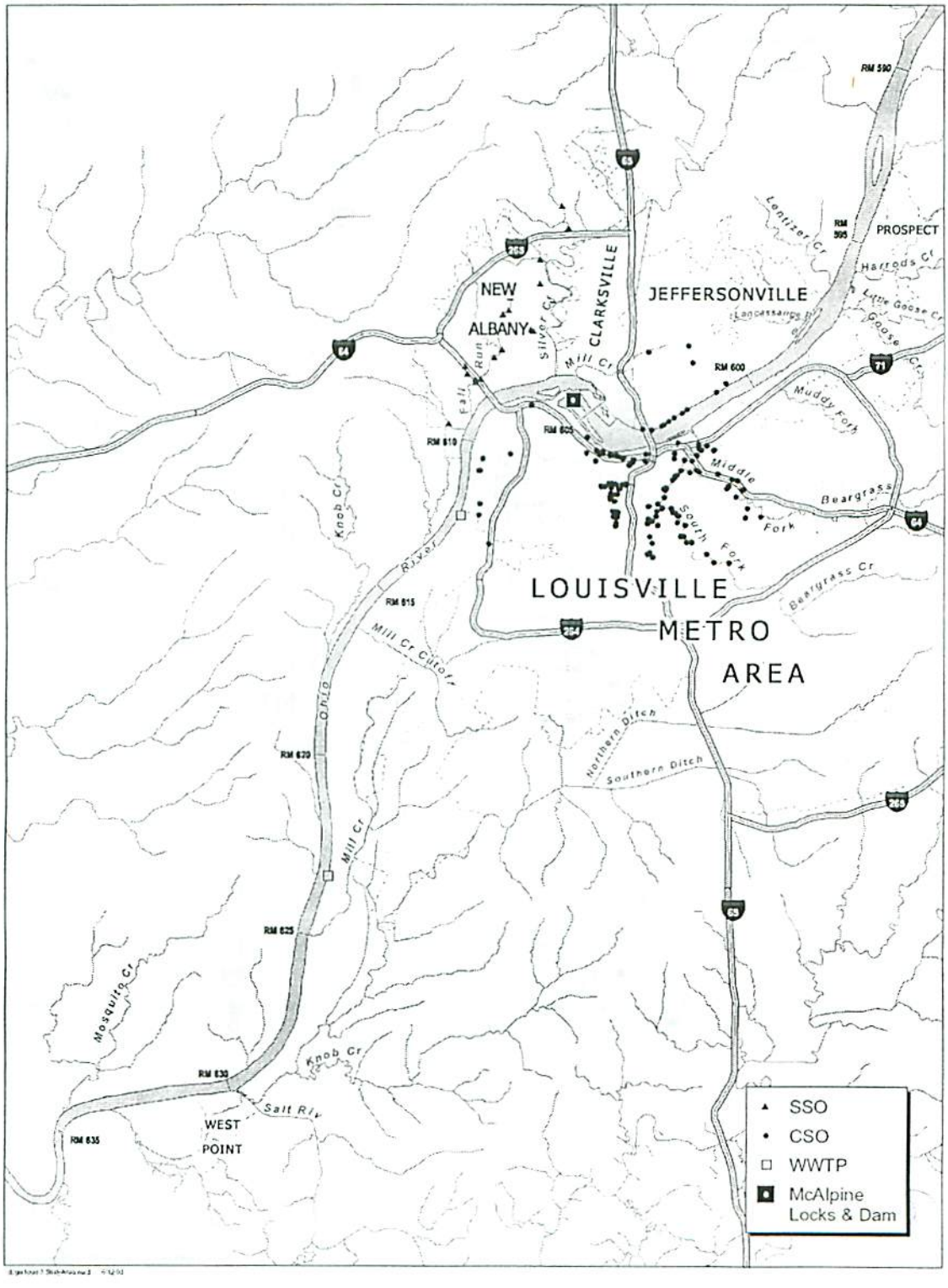
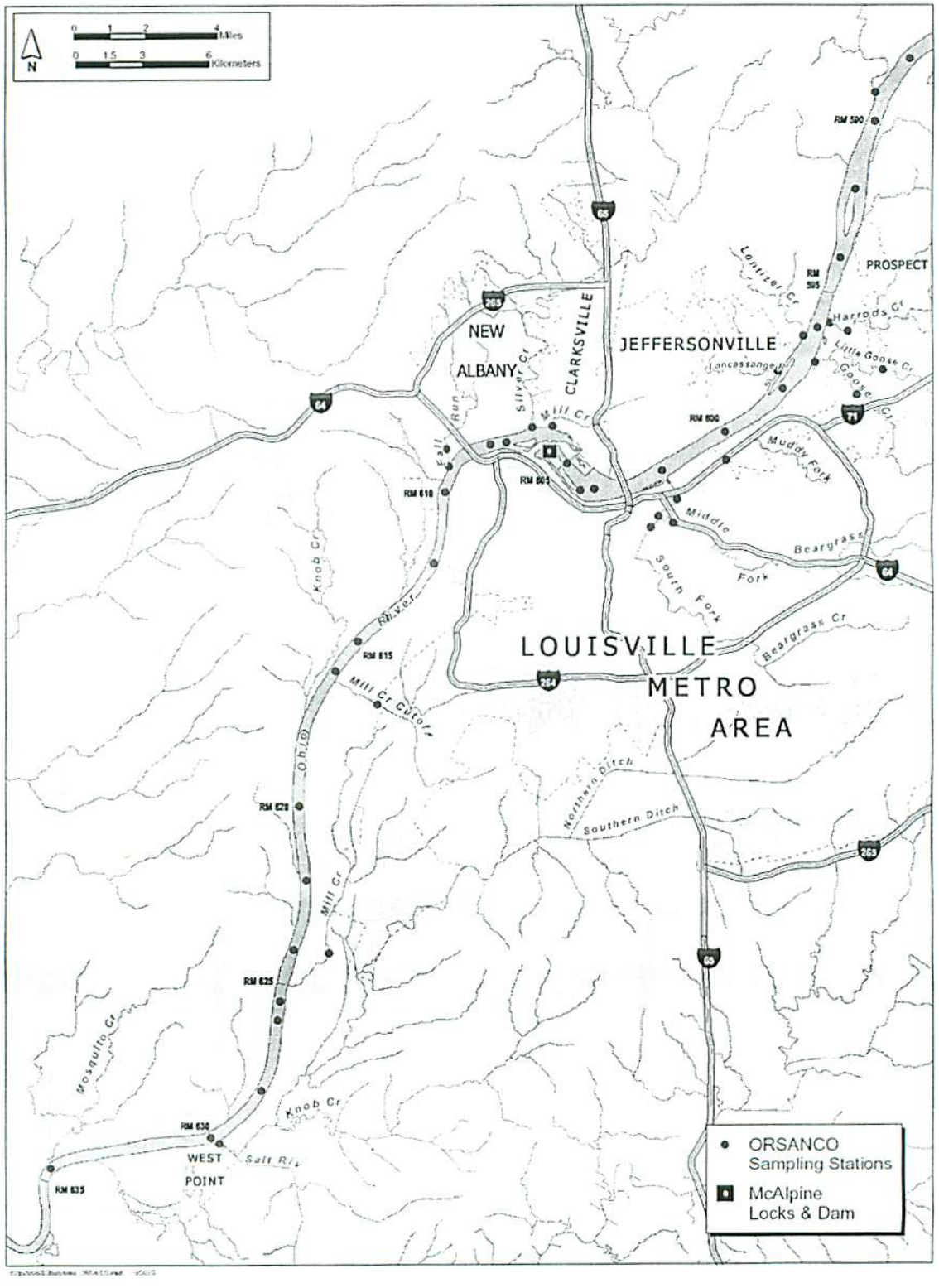


Figure 2-2. Study Area Sampling Sites



were collected upstream of Ohio River backwater influences, but not more than five miles above the stream's confluence with the Ohio River.

Ohio River sampling sites were established at two-mile increments resulting in a total of 21 sites. Figure 2-1 shows the approximate locations of the sources identified in Table 2-1. Figure 2-2 depicts the study area and sampling locations. The objective was to bracket locations of CSO clusters, tributaries with CSOs and discharges from municipal wastewater treatment plants (WWTPs), in order to determine background water quality conditions in the river. Table 2-2 lists all of the Ohio River mainstem sites sampled during the dry and wet weather surveys.

Table 2-2. Mainstem Cross-Sectional Sampling Sites

Mile Point	Sampling Site Description	Site Rationale
588	Beigs Daymark	Upstream all CSOs and WWTPs
590	Martin Marietta Company	Downstream Fourteen Mile Cr.
592	Twelve Mile Island	Charlestown WWTP
594	Pipeline Crossing	Upstream Harrods Cr.
596	Rubiyat Boat Club	Downstream Harrods Cr.
598	Six Mile Island Light and Daymark	Downstream Goose Cr. and Lancassange Cr.
600	Federal Mooring Buoys	Upstream Beargrass
602	Beargrass Creek	Beargrass Cr. and Oak Park Conserv. WWTP
604	George Rogers Clark Bridge	Jeffersonville WWTP
608	New Albany Boat Club	Downstream Silver Cr.
610	PSI Company	Downstream Falling Run
612	Gulf Oil Company	Morris Forman WWTP
614	Kerr-McGee Terminal, Inc.	Downstream Morris Forman WWTP
616	Hughes Bar Light & Daymark	Upstream Mill Cr. Cutoff
618	Jefferson Riverport	Downstream Mill Cr. Cutoff
620	Sun Refining & Marketing Co.	
622	Sheet Piling on LDB	Upstream West County WWTP
624	Eversole Creek	Downstream West County WWTP
626	Louisville Gas & Electric	Downstream Mill Cr.
628	Louisville Environmental Service	Upstream Salt River
630	Salt River	Salt River

Past studies conducted by ORSANCO on the mainstem for numerous water quality parameters have not indicated significant vertical stratification, but have shown substantial variability across the stream. Cross-sectional sampling was conducted at three points across at each of the Ohio River sampling sites (50 to 100 feet from the left descending bank (KY), midstream, and 50 to 100 feet from the right descending bank (IN)).

Twelve tributaries of interest were sampled during the course of this study. Tributary sampling sites are listed in Table 2-3. Figure 2-2 shows the tributary sample locations. The tributaries sampled were selected and classified based on size, known presence of CSOs or SSOs, or local concern.

Table 2-3. Tributary Sampling Sites

Mile Point/ State	Sampling Site Description	Site Rationale
589.3 / IN	Fourteen Mile Creek @ Confluence	Charlestown SSOs
595.9 / KY	Harrods Creek @ Capt. Quarters Marina	Marinas
596.3 / IN	Lentzier Creek @ Utica Pike	Jeffersonville request
596.9 / KY	Goose Creek @ River Road	Louisville request
596.9 / KY	Little Goose Creek @ Barbour Lane	Louisville request
597.8 / IN	Lancassange Creek @ Utica Pike	Jeffersonville request
602.1 / KY	Muddy Fork Beargrass Cr. @ Mockingbird	Louisville CSOs
602.1/ KY	Middle Fork Beargrass Cr. @ Payne Street	Louisville CSOs
602.1 / KY	South Fork Beargrass Cr. @ Baxter Avenue	Louisville CSOs
602.1 / KY	Mid/South Fork Beargrass Cr. @ Mellwood	Louisville CSOs
606.1 / IN	Mill Creek @ Frontage Road	Clarksville, Jeffersonville CSOs
607.0 / IN	Silver Creek @ Route 62	New Albany SSOs
609.3 / IN	Falling Run @ Pump Station	New Albany WWTP effluent
616.4 / KY	Mill Creek Cutoff @ Cane Run	Louisville request
625.1 / KY	Mill Creek @ Orell Road	Louisville request
629.9 / KY	Salt River @ West Point Boat Ramp	Large Drainage Area

2.0.2 PARAMETERS

The monitoring program included a wide range of parameters not only to characterize impacts on the river, but also to provide inputs and calibration datasets for the models. Ultimately, bacteria were identified as the only wet weather constituents impacting the Ohio River (same as in Cincinnati), but the results of the monitoring program are presented in their entirety because this conclusion may not apply to other large rivers in urban areas. The following is a short description of each of the parameters sampled for:

- ***E. coli*, Fecal Coliform:** Boating, water skiing and other forms of recreation, particularly in major metropolitan areas, are among the most valued uses of the Ohio River. The principal threats to recreational activities are elevated levels of bacteria and pathogens, which primarily occur after wet weather events. The potential risk to human health posed by bacteria, and the numerous sources of bacteria that exist in the Louisville area, make *E. coli* and fecal coliform the two parameters of greatest concern in this study.
- **5-Day Carbonaceous Biological Oxygen Demand ($CBOD_5$):** Due to concerns regarding the potential for low dissolved oxygen (DO) levels and the ultimate goal of developing a predictive water quality model for the study area, $CBOD_5$ was sampled, as it is a major component of DO demand.
- **20-Day Carbonaceous Biological Oxygen Demand ($CBOD_{20}$):** $CBOD_{20}$, also known as ultimate CBOD, is a further study of DO demand.

- **Total Suspended Solids (TSS):** TSS was sampled in order to evaluate their influence on the fate and transport of certain toxic materials. Most toxicants preferentially adhere to solids, affecting their transport and bioavailability (e.g. metals are more toxic to aquatic life in the dissolved form).
- **Total Dissolved Solids (TDS):** TDS were monitored on the tributaries in order to delineate nonpoint sources of pollution.
- **Chlorophyll-*a*:** Chlorophyll-*a* concentrations provide a means of measuring algal productivity, which in turn influences instream DO concentrations. Algae produce oxygen through the process of photosynthesis during the day, while respiration without the production of oxygen takes place during the night, resulting in diurnal variations in DO concentrations. Additionally, death and decomposition of algae will also deplete instream DO concentrations.
- **Total Kjeldahl Nitrogen (TKN):** TKN concentrations, which indicate levels of organic and inorganic nitrogen within the system, provide a measure to the level of eutrophication.
- **Ammonia-Nitrogen:** As with TKN, ammonia-nitrogen is one of several parameters that must be monitored in order to estimate DO demand. In addition, high concentrations of ammonia-nitrogen can be toxic to aquatic life.
- **Total Phosphorus (TP):** TP was monitored in order to determine whether the study area was phosphorus limited.
- **Orthophosphate (Ortho-P):** Ortho-P was monitored to estimate how much phosphorus was available to algae for photosynthesis.
- **Alkalinity:** Monitoring alkalinity concentrations primarily benefits the drinking water intakes within the study area. The effectiveness of the coagulants used in the drinking water treatment process is influenced by the alkalinity concentration of the raw water.
- **Total Hardness:** Concentrations influence the toxicity to aquatic life of several metals.
- **Dissolved Oxygen (DO):** Low DO concentrations present risks to aquatic life. ORSANCO's instream criteria for DO state that average concentrations shall be at least 5.0 mg/L for each calendar day, and shall not be less than 4.0 mg/L at any given time. Though a review of historical data shows no violations of the criteria in the study areas, concentrations during the summer months have been in the 5 to 7 mg/L range. DO is a field measurable parameter, and is relatively easy and inexpensive to monitor.
- **pH:** Aquatic life concerns arise when pH values are outside the range of 6.0 to 9.0 Standard Units. Levels of pH influence the toxicity of ammonia to aquatic life. This, like DO, is a field measurable parameter, and is relatively easy and inexpensive to monitor.
- **Conductivity:** Conductivity is also a field measurable parameter. It is used to help delineate areas of Ohio River backwater and tributary mixing zones. Conductivity can also provide an estimate of TDS levels.
- **Temperature:** Temperature, along with DO, pH and conductivity, are field measurable parameters. Stream temperatures, in combination with pH, influence the toxicity of ammonia, as well as all biological processes that affect DO. Temperature also affects the rate at which bacteria die.
- **Secchi Depth:** Measurements of river transparency are collected using a Secchi disk, a simple black and white disk, which is lowered into the river until it disappears from sight. The Secchi depth measurements also provide an estimate of the photic zone.

2.1 DRY WEATHER WATER QUALITY SURVEYS

The primary objective of this task was to collect sufficient baseline water quality data to determine water quality conditions free from the influences of CSOs and local precipitation. The baseline water quality data were used for calibration and verification of the water quality model. Based on previous experience with the Cincinnati Wet Weather Study, dry weather conditions were defined by a minimum 72-hour antecedent dry period to meet the baseline objective. Ideally, river stage and flow would be at or near normal pool conditions. This task involved the collection of one set of stream samples from the Ohio River and the tributary sampling sites located in the study area. A total of three dry weather surveys were completed between 1997 and 1999.

2.1.1 MAINSTEM CROSS-SECTIONAL SURVEYS

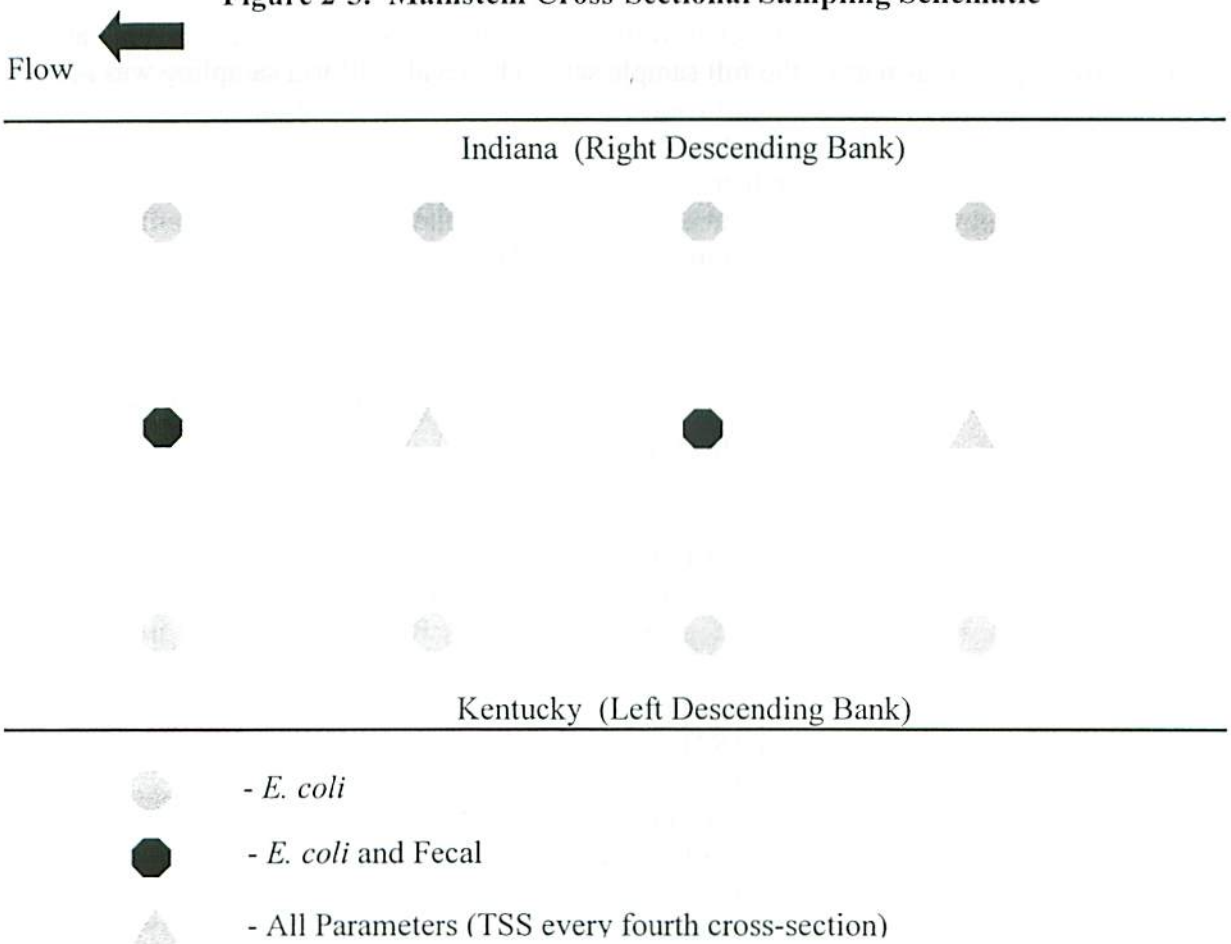
The first dry weather survey was conducted on October 9, 1997. Secchi disk measurements and physical parameters were recorded at each sampling site, prior to the collection of water samples. "Full sample sets" were collected from every other cross-section beginning with the initial cross-section at river mile 590. Full sample sets consisted of *E. coli*, fecal coliform, $CBOD_5$, TKN, ammonia, alkalinity and hardness samples collected from the midstream sampling site, with only *E. coli* samples collected from the left and right descending bank sampling sites. The *E. coli* and fecal coliform samples were collected as surface grab samples, while the remaining parameters were collected as depth-composite samples. The composite samples consisted of water samples collected from three discrete depths (surface, mid-depth and bottom), which were combined and homogenized using a churn sample splitter. "Partial sample sets" were collected from the remaining cross-sections. Partial sample sets consisted of *E. coli* and fecal coliform samples collected from the midstream sampling site, with only *E. coli* samples collected from the left and right descending bank sampling sites. The *E. coli* samples collected at each site were analyzed by the Colilert method. Duplicate *E. coli* samples were collected from two midstream sampling sites and analyzed by the membrane filtration method for comparison with the Colilert results. TSS samples were collected as depth-composite samples at every fourth midstream site. The full and partial sample set parameters for the first dry weather survey are shown below in Table 2-4.

Table 2-4. Full and Partial Sample Set Parameters for the First Dry Weather Survey

Set Designation	Left Descending Bank	Midstream	Right Descending Bank
Full Sample Set	*E. coli*	*E. coli*, Fecal coliform, $CBOD_5$, TKN, Ammonia, Alkalinity, Hardness, TSS (every other set)	*E. coli*
Partial Sample Set	*E. coli*	*E. coli*, Fecal coliform	*E. coli*

Figure 2-3 shows the cross-sectional sampling schematic for the Ohio River sampling.

Figure 2-3. Mainstem Cross-Sectional Sampling Schematic



In addition to the sampling described above, cross-sectional chlorophyll-*a* and DO monitoring were conducted at river miles 600 and 604 in the McAlpine Pool and river mile 615 in the Cannelton Pool. This additional monitoring was conducted in order to identify background conditions that might be favorable to causing algae blooms, which can lead to taste and odor problems with drinking water and impact the aquatic life community. A multi-parameter probe was used to obtain vertical profiles of physical parameter measurements from three points across at each of these river miles. Depth readings were taken at one-foot increments in order to determine whether DO stratification existed. Profiles were collected twice in the morning and once just before sunset in an effort to define diurnal variations in DO concentrations. Chlorophyll-*a* samples were collected from the midstream at river miles 600 and 615 and from three points across at river mile 604. Section 2.1.2 contains information about additional physical parameter monitoring conducted from a fixed station.

The second dry weather survey was conducted on August 17, 1998. Several changes from the first dry weather survey were implemented for the mainstem monitoring during the second dry weather survey. A cross-section was added at mile point 588 in order to collect background conditions uninfluenced by Fourteen Mile Creek. The full sample sets collected at every other

midstream site were collected beginning with the new initial sampling site at mile point 588. *E. coli* samples analyzed by the membrane filtration method were collected from three points across, at two cross-sectional sampling sites, with one cross-section located in each navigation pool. Fecal coliform samples were collected from the midstream and left descending bank at every other cross-section, as part of the full sample sets. The fecal coliform sampling was added to the left descending bank based on significantly greater *E. coli* concentrations observed along the Kentucky side of the river during the first dry weather survey. The midstream full sample sets were collected from the surface, rather than as depth-composite samples. Additional $CBOD_5$ samples and physical parameter measurements were collected from the bottom at every other midstream site, as part of the full sample sets. $CBOD_{20}$ samples were collected from the surface and bottom at two midstream sites, with one site located in each navigation pool. TSS and nitrate-nitrite sampling were added to every other midstream sampling site, as part of the full sample sets. Total phosphorus was added to the midstream site at the upper and lower boundaries of the study area, in order to verify that the system is not phosphorus limited. The full and partial sample set parameters for the second dry weather survey are shown below in Table 2-5.

Table 2-5. Full and Partial Sample Set Parameters for the Second Dry Weather Survey

Set Designation	Left Descending Bank	Midstream Surface	Midstream Bottom	Right Descending Bank
Full Sample Set	*E. coli*, Fecal coliform	*E. coli*, Fecal coliform, $CBOD_5$, TKN, Ammonia, Nitrate/Nitrite, Alkalinity, Hardness, TSS, Total Phosphorus (boundary sites), $CBOD_{20}$ (2 sites)	$CBOD_5$, $CBOD_{20}$ (2 sites)	*E. coli*
Partial Sample Set	*E. coli*	*E. coli*	No samples collected	*E. coli*

Additional cross-sectional physical parameter monitoring was conducted at river miles 590, 596 and 600 in the McAlpine Pool. The physical parameter monitoring was focused in the McAlpine Pool because DO problems are more likely to exist upstream of a dam where there is less flow and more pooling. A multi-parameter probe was used to obtain vertical profiles of physical parameter measurements two times during the survey. Depth readings were taken at two-foot increments from three points across at each of these river miles. Section 2.1.2 contains information about additional physical parameter monitoring conducted from a fixed station.

Minimal changes were made to the monitoring for the third dry weather survey conducted on June 23, 1999. Fecal coliform sampling was added to the right descending bank at every other cross-section, as part of the full sample sets. Chlorophyll-*a* sampling was added at every other midstream sampling site in the McAlpine Pool and at the downstream boundary of the study area. Midstream total phosphorus sampling was added at the upstream and downstream

boundaries of each navigation pool. Section 2.1.2 provides more information about the fixed station physical parameter monitoring conducted as part of this survey.

Table 2-6 lists the total number of mainstem samples collected during the three dry weather surveys.

Table 2-6. Total Number of Dry Weather Mainstem Samples Collected

Parameter	Number Samples	Blanks	Duplicates	Total Samples
E. coli Colilert	204	11	18	233
E. coli MF	14	2	0	16
Fecal Coliform	78	11	6	95
$CBOD_5$	31	17	6	54
$CBOD_5$ Depth	21	0	4	25
$CBOD_{20}$	4	2	0	6
$CBOD_{20}$ Depth	4	0	0	4
TSS	27	18	5	50
Total Phosphorus	8	6	1	15
TKN	32	17	6	55
Ammonia	32	17	6	55
Nitrate-Nitrite	22	12	4	38
Alkalinity	32	17	6	55
Hardness	32	17	6	54
Chlorophyll-*a*	12	3	2	17

2.1.2 MAINSTEM FIXED STATION MONITORING

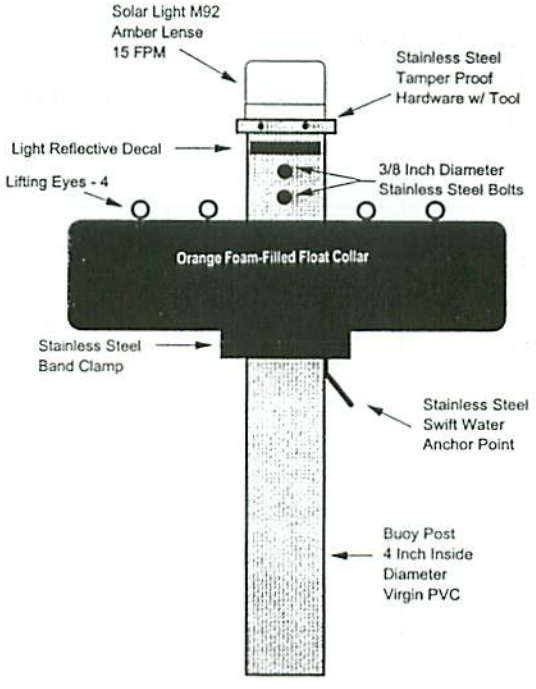
In addition to the physical parameter profiles collected by boat crews at river miles 600, 604 and 615, a continuous monitor with data-logging capability was stationed at river mile 603.8 to record physical parameter measurements every 15 minutes during the first dry weather survey in 1997. A multi-parameter probe was chained to the downstream side of an abutment for the George Rogers Clark Bridge. Due to an equipment failure, the instrument did not provide useable data.

It was determined through the first wet weather survey that the fixed monitor was positioned in an area of noncirculating river water due to eddying around the bridge abutment. For this reason, the probe was placed in a perforated PVC pipe and chained to the upstream side of the same bridge abutment for the second dry weather survey. These data did not compare well with data collected by the boat crews, so it was determined that the perforated PVC pipe did not allow enough river water to flow over the multi-parameter probe sensors.

For the third dry weather survey, the multi-parameter probe was mounted to a buoy assembly as pictured in Figure 2-4. The buoy was anchored midstream at river mile 604.5 in the restricted zone upstream of the McAlpine Locks and Dam, in line with the navigation buoy marking the

entrance to the Portland Canal. Because the buoy was located in a restricted area, the only anticipated boat traffic was an entertainment cruise paddlewheel.

Figure 2-4. Fixed Station Monitor



The probe was hung from two stainless steel bolts, inside a four-inch diameter PVC pipe, with only the probe sensors protruding from the bottom of the pipe. This protected the probe from floating debris, while minimizing disruption of river flow around the probe sensors. The PVC pipe was fitted with an orange polyethylene, foam-filled float collar as well as a light reflective decal and a solar light for easy identification by any boat traffic. The buoy parts were assembled with tamper-proof hardware that required a special tool for removal. Four lifting eyes were mounted to the top of the float collar for removing the buoy assembly from the water. A swift water anchor point was mounted to the bottom of the float collar for connection to two anchors.

The buoy was deployed at the beginning of the third dry weather survey and retrieved at the end of that survey. The multi-parameter probe was both pre-calibrated and post-calibrated, and side-by-side readings were taken by the McAlpine Pool sampling crew. The probe was programmed to record physical parameter measurements at 15-minute increments from approximately three feet below the water surface. After retrieval from the river, the data were downloaded from the probe to a laptop computer. The data collected from this survey were very comparable to the data collected from the boat crew.

2.1.3 TRIBUTARY SURVEYS

Tributary monitoring coincided with the sampling on the Ohio River. Landside field crews conducted the majority of the tributary monitoring. Field crews were provided by Jeffersonville, New Albany and Louisville to sample the tributaries in each of their respective service areas. Strand Associates was contracted to sample a portion of the Louisville tributaries and some additional tributaries.

The tributaries sampled in the study area were classified into three levels. The level one tributaries are the largest streams in the study area and therefore have the greatest potential to significantly impact the Ohio River. The level two tributaries are relatively small and less likely to have a major impact on the Ohio River, however, they are particularly important to the surrounding communities. Surface grab samples were collected from the midstream and both banks of the level one tributaries. These grab samples were composited and homogenized using a churn sample splitter in accordance with the procedures contained in *Standard Operating Procedures for the Collection of Discrete Water Samples*. A single surface grab sample was collected from the midstream of the level two tributaries. The level three tributaries are streams with unique conditions or circumstances, which were sampled by the Ohio River crews due to access limitations from the land. The tributary level classifications changed from year to year based on the results of the previous surveys. Table 2-7 shows the level classification for each tributary sampling site by dry weather event. A shaded box indicates that a particular tributary site was not sampled for that event.

Table 2-7. Tributary Level Classification

Tributary	Dry Event #1	Dry Event #2	Dry Event #3
Goose Creek	1	1	2
Little Goose Creek			2
Silver Creek	1	1	1
Beargrass Creek – Muddy Fork	2	1	1
Beargrass Creek – Mid Fork	2		
Beargrass Creek – South Fork	2		
Beargrass Creek – Mid/South Forks		1	1
Falling Run	2	2	1
Lancassange Creek	2	2	2
Lentzier Creek	2	2	2
Mill Creek (KY)	2	2	2
Mill Creek (IN)	2	2	1
Mill Creek Cutoff	2	2	1
Fourteen Mile Creek	3		
Harrods Creek	3	1	2
Salt River	3	3	3

For the first dry weather event, 14 tributary sites were sampled as described above. Sampling of the level three tributaries was determined in the field. Due to access limitations, a three-depth composite sample was collected from the mixing zone of Fourteen Mile Creek. The lower four miles of Harrods Creek were influenced by Ohio River backwater, therefore, impacts from

Harrods Creek were measured with cross-sectional sampling on the Ohio River both above and below the confluence. Samples were collected from the Salt River in the same fashion as the level one tributaries, however, the three samples were not composited. Each of the three forks of Beargrass Creek (Muddy, Middle and South) was sampled because the mainstem of the creek is heavily influenced by Ohio River backwater. *E. coli*, $CBOD_5$, TDS, total phosphorus, orthophosphate, nitrate-nitrite, TKN, ammonia, alkalinity and hardness samples were collected at each tributary site, excepting Fourteen Mile Creek. Fourteen Mile Creek was sampled for TSS rather than TDS and was not sampled for orthophosphate, nitrite-nitrate or total phosphorus. Fecal coliform samples were collected from the Kentucky tributaries and from Fourteen Mile Creek.

For the second dry weather survey, some changes from the first dry weather survey were implemented in order to save money and field crew time. No samples were collected from Fourteen Mile Creek. The number of sample sites on Beargrass Creek was reduced from three to two by sampling at a point located downstream of the confluence of the Middle and South forks. The new site was called Mid/South Fork. The number of parameters was reduced by eliminating orthophosphate, alkalinity and hardness analyses. TSS sampling was added to the level one tributaries at the request of the contract modelers.

For the third dry weather survey, the Goose Creek sampling point was moved upstream of the confluence with Little Goose Creek because it was determined that the first and second dry weather survey samples were collected in Ohio River backwater. This necessitated the addition of a sampling site on Little Goose Creek. No TSS samples were collected.

Table 2-8 lists the total number of tributary samples collected during the three dry weather surveys.

Table 2-8. Total Number of Dry Weather Tributary Samples Collected

Parameter	Number Samples	Blanks	Duplicates	Total Samples
E. coli Colilert	34	31	6	71
E. coli MF	10	1	2	13
Fecal Coliform	25	25	3	53
$CBOD_5$	22	29	4	55
TDS	23	31	5	69
TSS	6	6	2	14
Total Phosphorus	32	31	5	69
Orthophosphate	9	8	1	18
TKN	33	31	5	69
Ammonia	32	31	5	69
Nitrate-Nitrite	32	31	5	69
Alkalinity	10	8	1	19
Hardness	10	8	1	19

2.1.4 FALLING RUN SURVEY

High bacteria levels were observed on Falling Run during each of the three dry weather surveys. A longitudinal bacteria survey of Falling Run was conducted in order to pinpoint the dry weather sources of pollution causing the elevated bacteria levels. On November 10, 1999, ORSANCO and the City of New Albany, Indiana collected water quality samples from seven locations along Falling Run. Falling Run samples were collected from the upstream boundary of the New Albany collection system to downstream of the New Albany pump station effluent. An additional sample was collected from an actively discharging stormwater outfall. These water samples were analyzed for *E. coli* by the Colilert method, *E. coli* by the membrane filtration method and fecal coliform.

The results indicated elevated bacteria levels upstream of the New Albany collection system area and the stormwater discharge was found to contain no measurable levels of fecal coliform or *E. coli* bacteria. Although the bacteria levels on Falling Run still exceeded instream criteria in some places, levels were much lower than those previously observed during the dry weather surveys. The lower bacteria levels most likely reflected improvements made to the City of New Albany's sewer system over the year prior to this special survey of Falling Run.

2.2 WET WEATHER WATER QUALITY SURVEYS

The primary objective of this task was to collect sufficient water quality data to identify the extent and duration of wet weather impacts on the Ohio River. The water quality data were used for calibration and verification of the water quality model. Based on previous experience with the Cincinnati Wet Weather Study, wet weather conditions were defined by one inch of widespread rainfall within a six-hour period following a minimum 72-hour antecedent dry period. This task involved the collection of multiple sets of samples from the Ohio River, select tributaries, CSOs and WWTPs influent. Table 2-9 shows the dates and rainfall characteristics for each of the four wet weather surveys completed between 1997 and 2001.

Table 2-9. Wet Weather Event Descriptions

	Wet Event #1	Wet Event #2	Wet Event #3	Wet Event #4	Wet Event #5
Survey Dates	11/13 thru 11/15/1997	10/7 thru 10/10/1998	8/8 thru 8/14/2000	5/7 thru 5/14/2001	10/5 thru 10/10/2001
Rainfall Volume	0.8 in	1.34 in	0.56 in	0.52 in	1.29 in
Maximum Intensity	1.25 in/hr	0.72 in/hr	1.44 in/hr	2.52 in/hr	0.60 in/hr
Duration	4 hours	2 hours	1.5 hours	5 hours	4 hours

Sampling began shortly after the initiation of rainfall and continued for a maximum of five consecutive days. The data collected over this time period were expected to provide a reasonable definition of the pollutagraph while allowing enough time for the local streams and the Ohio River to return to pre-storm conditions. Sampling on the tributaries, CSOs and WWTPs influent was conducted around the clock, while sampling on the Ohio River mainstem was limited to daylight hours for safety reasons.

Wet Weather sampling was initiated by the ORSANCO monitoring leader, based on the prediction of a precipitation event that would satisfy the criteria for wet weather sampling on the Ohio River. If tributary sampling was initiated for an anticipated wet weather event, and it was subsequently determined that the event did not satisfy the criteria, then the tributary sampling was halted and any samples collected to that point were discarded.

2.2.1 MAINSTEM CROSS-SECTIONAL SURVEYS

Sampling focused on the upper 42 miles of the study area, however, longitudinal sampling sites extending downstream to river mile 660 were added during later surveys. The longitudinal sampling is described further in Section 2.2.2. Left bank sampling sites were added immediately upstream and downstream of the McAlpine Lock and Dam structures during later surveys.

The first wet weather survey was initiated on November 13, 1997. Samples were collected once per day from each of the Ohio River sampling sites for three consecutive days. A fourth day of sampling was suspended based on the assumption that the swift river velocity had likely moved

the wet weather pollutants out of the study area. Secchi disk measurements and physical parameters were recorded at each sampling site, prior to the collection of water samples. Full sample sets were collected from every other cross-section beginning with the initial cross-section at river mile 590. Full sample sets consisted of *E. coli*, fecal coliform, $CBOD_5$, TKN, ammonia, alkalinity and hardness samples collected from the midstream sampling site, with only *E. coli* samples collected from the left and right descending bank sampling sites. The *E. coli* and fecal coliform samples were collected as surface grab samples, while the remaining parameters were collected as depth-composite samples. The composite samples consisted of water samples collected from three discrete depths (surface, mid-depth and bottom), which were combined and homogenized using a churn sample splitter. Partial sample sets were collected from the remaining cross-sections. Partial sample sets consisted of *E. coli* and fecal coliform samples collected from the midstream sampling site, with only *E. coli* samples collected from the left and right descending bank sampling sites. The *E. coli* samples collected at each site were analyzed by the Colilert method. Duplicate *E. coli* samples were collected from four midstream sampling sites and analyzed by the membrane filtration method for comparison with the Colilert results. TSS samples were collected as depth-composite samples at every fourth midstream site. The full and partial sample set parameters for the first wet weather survey are shown below in Table 2-10. Figure 2-3 in Section 2.1.1 shows the cross-sectional sampling schematic for the Ohio River sampling.

Table 2-10. Full and Partial Sample Set Parameters for the First Wet Weather Survey

Set Designation	Left Descending Bank	Midstream	Right Descending Bank
Full Sample Set	*E. coli*	*E. coli*, Fecal coliform, $CBOD_5$, TKN, Ammonia, Alkalinity, Hardness, TSS (every other set)	*E. coli*
Partial Sample Set	*E. coli*	*E. coli*, Fecal coliform	*E. coli*

The *E. coli* samples collected at each site were analyzed by the Colilert method. Duplicate *E. coli* samples were collected from four midstream sampling sites and analyzed by the membrane filtration method for comparison with the Colilert results. Fecal coliform samples were collected from every midstream sampling site. $CBOD_5$, TKN, ammonia, alkalinity and hardness were collected as composite samples from every other midstream sampling site beginning with the initial sampling site at river mile 590. TSS samples were collected as composite samples at every fourth midstream site. Composite samples consisted of water collected from three discrete depths (surface, mid-depth and bottom), which were combined and homogenized using a churn sample splitter.

In addition to the sampling described above, cross-sectional chlorophyll-*a* and DO monitoring were conducted at river miles 600 and 604 in the McAlpine Pool and river mile 615 in the Cannelton Pool. This additional monitoring was conducted in order to determine the potential for wet weather pollution to cause algae blooms, which can lead to taste and odor problems with drinking water and impact the aquatic life community. A multi-parameter probe was used to

obtain vertical profiles of physical parameter measurements from three points across at each of these mile points. Readings were taken at three discrete depths (surface, mid-depth and bottom) twice per day for each of the three days of the survey. Chlorophyll-*a* samples were collected from the midstream at river miles 600 and 615 and from three points across at river mile 604 during the first and third days of the survey. There was no physical parameter monitoring conducted from a fixed station during this survey.

The second wet weather survey was initiated on October 7, 1998. Due to a late afternoon rain event, bacteria samples from the McAlpine Pool sampling sites were the only mainstem samples collected on the first day of the survey. For the following three days, samples were collected once per day from each of the Ohio River sampling sites. Several changes from the first wet weather survey were implemented for the mainstem monitoring during the second wet weather survey. A cross-section was added at mile point 588 to collect background conditions uninfluenced by Fourteen Mile Creek. The full sample sets collected at every other midstream site were collected beginning with the new initial sampling site at mile point 588. *E. coli* samples analyzed by the membrane filtration method were collected from three points across, at two cross-sectional sampling sites, with one cross-section located in each navigation pool. Fecal coliform samples were collected from the midstream and left descending bank at every other cross-section, as part of the full sample sets. The fecal coliform sampling was added to the left descending bank based on significantly greater *E. coli* concentrations observed along the Kentucky side of the river during the first wet weather survey. The midstream full sample sets were collected from the surface, rather than as depth-composite samples. Additional $CBOD_5$ samples and physical parameter measurements were collected from the bottom at every other midstream site, as part of the full sample sets. $CBOD_{20}$ samples were collected from the surface and bottom at two midstream sites, with one site located in each navigation pool. TSS and nitrate-nitrite sampling were added to every other midstream sampling site, as part of the full sample sets. Total phosphorus was added to the midstream site at the upper and lower boundaries of the study area, in order to verify that the system is not phosphorus limited. The full and partial sample set parameters for the second wet weather survey are shown below in Table 2-11.

Table 2-11. Full and Partial Sample Set Parameters for the Second Wet Weather Survey

Set Designation	Left Descending Bank	Midstream Surface	Midstream Bottom	Right Descending Bank
Full Sample Set	*E. coli*, Fecal coliform	*E. coli*, Fecal coliform, $CBOD_5$, TKN, Ammonia, Nitrate/Nitrite, Alkalinity, Hardness, TSS, Total Phosphorus (boundary sites), $CBOD_{20}$ (2 sites)	$CBOD_5$, $CBOD_{20}$ (2 sites)	*E. coli*
Partial Sample Set	*E. coli*	*E. coli*	No samples collected	*E. coli*

The additional physical parameter monitoring conducted by a third boat during from the first wet weather survey, was eliminated from this survey due to resource constraints. No chlorophyll-*a* samples were collected because the algal production and respiration have greater effect on DO concentrations during dry weather conditions, when the stream velocities and turbidity are generally lower. Section 2.2.3 contains information about additional physical parameter monitoring conducted from a fixed station.

Significant changes were made to the mainstem monitoring for the third wet weather survey initiated on August 8, 2000. Due to a false start on the day before this wet weather survey, Ohio River sampling on the first day consisted only of bacteria sampling from three cross-sections in the McAlpine Pool. All samples were collected once per day from each of the Ohio River cross-sectional sampling sites for three consecutive days beginning on August 9. Some of the bacteria samples collected over the first two days of the survey were not analyzed because they were sent to the wrong laboratories by the project team. Fecal coliform sampling was added to the right descending bank at every other cross-section, as part of the full sample sets. Chlorophyll-*a* sampling was added to every other midstream sampling site, as part of the full sample sets. The full and partial sample set parameters for the third wet weather survey are shown below in Table 2-12. Bacteria sampling sites were added on the left descending bank immediately upstream and downstream of the McAlpine lock structures at river miles 605 and 607. These sites were added to better determine the flow of water through the lock structures. Section 2.2.3 contains information about additional physical parameter monitoring conducted from a fixed station. Two days of longitudinal monitoring were added following the three days of cross-sectional sampling. The longitudinal monitoring is described further in Section 2.2.2.

Table 2-12. Full and Partial Sample Set Parameters for the Third Wet Weather Survey

Set Designation	Left Descending Bank	Midstream Surface	Midstream Bottom	Right Descending Bank
Full Sample Set	*E. coli*, Fecal coliform	*E. coli*, Fecal coliform, $CBOD_5$, TKN, Ammonia, Nitrate/Nitrite, Alkalinity, Hardness, TSS, Chlorophyll-*a*, Total Phosphorus (boundary sites), $CBOD_{20}$ (2 sites)	$CBOD_5$, $CBOD_{20}$ (2 sites)	*E. coli*, Fecal Coliform
Partial Sample Set	*E. coli*	*E. coli*	No samples collected	*E. coli*

The fourth wet weather survey was initiated on May 7, 2001. Ohio River sampling did not begin until May 8 because of an equipment scheduling conflict. Some changes from the third wet weather survey were implemented for the mainstem monitoring during the fourth wet weather survey. Total phosphorus samples were collected from every other midstream site in the

McAlpine Pool, in addition to the upper and lower boundaries of the Cannelton Pool. Colilert sampling was eliminated from the project due to scheduling conflicts with Louisville MSD's laboratory, which was providing the Colilert analyses as an in-kind service. All *E. coli* samples were analyzed by the membrane filtration method. Section 2.2.3 contains information about additional physical parameter monitoring conducted from a fixed station. The longitudinal monitoring is described in Section 2.2.2.

The fifth wet weather survey was initiated on October 5, 2001. This rain event hit the study area unexpectedly, causing Ohio River sampling to be delayed until October 6. There were no changes from the mainstem sampling conducted during the fourth wet weather survey. Section 2.2.3 contains information about additional physical parameter monitoring conducted from a fixed station. The longitudinal monitoring is described in Section 2.2.2.
Table 2.13 lists the total number of cross-sectional mainstem samples collected during the wet weather surveys.

Table 2-13. Total Number of Wet Weather Cross-Sectional Mainstem Samples Collected

Parameter	Number Samples	Blanks	Duplicates	Total Samples
E. coli Colilert	590	37	59	686
E. coli MF	441	28	36	505
Fecal Coliform	423	59	40	522
$CBOD_5$	160	88	30	278
$CBOD_5$ Depth	211	0	24	235
$CBOD_{20}$	24	16	0	40
$CBOD_{20}$ Depth	24	0	0	24
TSS	125	88	27	240
Total Phosphorus	42	36	9	87
TKN	121	89	24	234
Ammonia	121	89	24	234
Nitrate-Nitrite	121	71	24	216
Alkalinity	121	85	24	230
Hardness	119	85	23	228
Chlorophyll-*a*	96	27	9	132

2.2.2 MAINSTEM LONGITUDINAL SURVEYS

The longitudinal monitoring was conducted for two days following the three days of cross-sectional sampling and consisted of two phases. During the first phase, water quality samples and physical parameter measurements were collected "on the fly" with a flow-through sampling system mounted on a small watercraft traversing the midstream of the Ohio River in a downstream direction. The water quality samples were collected at five-mile increments and the physical parameters measurements were recorded every 15 seconds. The longitudinal sampling sites are listed below in Table 2-14. A full set of parameters was collected at each midstream site, including: *E. coli*, fecal coliform, $CBOD_5$, TSS, nitrate-nitrite, TKN, ammonia, total

hardness and chlorophyll-*a*, with one $CBOD_{20}$ sample collected at river mile 635. During the second phase, physical parameter measurements were collected from the midstream surface and bottom at the same five-mile increments. If the difference between the surface and bottom DO concentrations was greater than 0.5 mg/L, then depth profiles were created at two-foot increments.

The first phase of the longitudinal monitoring was conducted utilizing a flow-through system, which was developed for the purpose of surface profiling large study areas. The flow-through system was composed of separate instrumentation and sample collection lines (port and starboard, respectively), which were fed by two pitot tube intakes mounted beneath the boat hull. When the boat was traveling "on plane", fresh river water continuously ran through both lines. Midstream grab samples were collected from the sample collection line into a stainless steel pitcher in order to homogenize the sample before it was dispensed into individual sample containers. Physical parameter measurements were recorded by a multi-parameter probe that was equipped with data-logging capabilities and located in the instrumentation line. The data-logging equipment was programmed to record measurements at 15-second intervals while the boat traversed the 50-mile study segment at 30 miles per hour. This resulted in a resolution of approximately eight readings per mile. The speed of the boat was adjusted using the GPS velocity function.

Table 2-14. Wet Weather Mainstem Longitudinal Sampling Sites

Mile Point	Sampling Site Description
610	PSI Company
615	Stauffer Company
620	Sun Refining & Marketing Company
625	Fishtown Daymark
630	Salt River
635	Mosquito Daymark
640	RDB Channel Markers
645	Brandenburg Daymark
650	Haunted Daymark
655	New River Lime Company
660	Cold Friday Daymark

During the Cincinnati Study, the flow-through system proved to be an efficient way to collect samples and measure physical parameters over lengthy river reaches in a relatively short period of time. This type of sampling is contingent upon having a well-mixed river. Data were collected through the Cincinnati Study to support the assumption that the system could be effectively decontaminated with a 25-gallon tap water flush between circuits and that physical parameter measurements were not significantly altered by the system.

During this study, the longitudinal monitoring was conducted in the Cannelton Pool of the Ohio River, from river miles 610 through 660, for two days following the three days of cross-sectional sampling. The longitudinal monitoring was added to the sampling plan for the third wet weather survey and remained unchanged for the fourth and fifth wet weather surveys. In addition to the

Ohio River samples, one set of samples was collected on the Salt River during each day of the longitudinal monitoring. The total number of samples collected during the three longitudinal surveys are shown below in Table 2-15.

Table 2-15. Total Number of Longitudinal Samples Collected

Parameter	Number Samples	Blanks	Duplicates	Total Samples
E. coli Colilert	19	3	2	24
E. coli MF	45	9	4	58
Fecal Coliform	64	12	6	82
$CBOD_5$	63	12	6	81
$CBOD_{20}$	5	0	0	5
TSS	63	12	6	81
TKN	64	12	6	82
Ammonia	64	12	6	82
Nitrate-Nitrite	64	12	6	82
Hardness	64	12	4	80
Chlorophyll-*a*	64	12	6	82

2.2.3 MAINSTEM FIXED STATION MONITORING

A multi-parameter probe connected to a buoy assembly was deployed for the second, third, fourth and fifth wet weather surveys. Refer back to Section 2.1.2 for a complete description of the buoy assembly. The multi-parameter probe was both pre-calibrated and post-calibrated, and side-by-side readings were taken by the McAlpine Pool sampling crew. The probe was programmed to record physical parameter measurements at 15-minute increments from approximately three feet below the water surface. After retrieval from the river, the data were downloaded from the probe to a laptop computer. The data collected from these surveys were very comparable to the data collected from the boat crew.

2.2.4 TRIBUTARY SURVEYS

Samples were collected in the same manner as during the dry weather surveys where the level one tributaries were sampled from three points across and composited using a churn sample splitter, while the level two tributaries were sampled from a single midstream point. The tributary sampling protocol differed from the mainstem in that multiple sets of samples were collected from the tributaries each day during the wet weather event. The level one tributaries were sampled intensively over the first 48 hours, and then sampled once per day for the third and fourth days of each wet weather event. The level two tributaries were sampled three times per day for the first two days of each wet weather event. Level one tributary sampling was conducted around-the-clock while level two tributary sampling was conducted only during daylight hours. The level three tributaries were sampled once per day, for up to five days following the wet weather event. Field crews were on call to initiate sampling shortly before the

onset of precipitation to collect background conditions. It was important to collect samples immediately following the onset of precipitation because water quality impacts occur more quickly on the tributaries than on the mainstem.

For the first wet weather survey, the tributaries were categorized into the same three levels (Section 2.1.3) and sampled from the same locations (Section 2.0.1) for the same parameters as during the first dry weather survey. Fourteen samples sets were collected on the level one tributaries. Table 2-16 shows when the sample sets were collected relative to the onset of precipitation, where the first sample set was collected at hour 0 which was when the rain started, the second sample set was collected at hour 2 which was two hours later, etc. The shaded sample sets were analyzed for a full set of parameters. The remaining samples sets were analyzed for a partial set of parameters. The full sample sets were analyzed for the same parameters as during the first dry weather survey (Section 2.1.3), while the partial sample sets were analyzed for *E. coli*, fecal coliform (only on the Kentucky tributaries) and TDS. Fecal coliform samples were not collected on the Indiana tributaries because Indiana does not have a water quality standard for fecal coliform.

Table 2-16. Sampling Schedule – Level One Tributaries

Sample Set	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sample Hour	0	2	4	6	8	12	16	20	24	32	40	48	Day 3	Day 4

Six sample sets were collected on the level two tributaries. Table 2-17 shows the sample set identifiers (M for midstream, followed by the sample set number). The shaded sample sets were analyzed for a full set of parameters. The remaining sample sets were analyzed for a partial set of parameters.

Table 2-17. Sampling Schedule – Level Two Tributaries

	Day 1			Day 2		
Sample Set	1	2	3	4	5	6
Sample Identifier	M1	M2	M3	M4	M5	M6

For the second wet weather survey, the tributaries were categorized into the same three levels and sampled for the same parameters as during the second dry weather survey. Samples were collected from the same locations as during the second dry weather survey, with one exception. The Goose Creek sampling point was moved upstream of the confluence with Little Goose Creek because it was determined that the first wet weather survey samples were collected in Ohio River backwater. This necessitated the addition of a sampling point on Little Goose Creek. Little Goose Creek was sampled as a level one tributary.

For the third wet weather survey, the tributaries were categorized into the same levels and sampled from the same locations as during the third dry weather survey. The full sample sets were analyzed for the same parameters as during the third dry weather survey, with one exception. The hour 12 and hour 48 samples from the level one tributaries were analyzed for $CBOD_{20}$. A fifth day of sampling for the full set of parameters was added to the level one tributaries.

Tributary sampling for the fourth and fifth wet weather surveys was the same as during the third wet weather survey, with the exception that a fifth day of sampling was only conducted on those tributaries with a confluence to the Ohio River below the McAlpine locks and dam.

The total number of wet weather tributary samples collected are shown below in Table 2-18.

Table 2-18. Total Number of Wet Weather Tributary Samples Collected

Parameter	Samples	Blanks	Duplicates	Total Samples
E. coli Colilert	274	84	40	398
E. coli MF	238	31	31	300
Fecal Coliform	402	118	48	568
$CBOD_5$	272	144	67	483
$CBOD_{20}$	58	1	6	65
TDS	489	139	66	694
TSS	51	52	23	126
Total Phosphorus	243	135	61	439
Orthophosphate	40	24	13	77
TKN	243	135	61	439
Ammonia	243	135	61	439
Nitrate-Nitrite	243	135	61	439
Alkalinity	41	25	13	79
Hardness	41	25	13	79

2.2.5 POINT SOURCE MONITORING

Sampling was conducted at three local wastewater treatment plants (WWTPs) and several CSO locations (shown in Table 2-19) during the wet weather events. Influent flow to the Jeffersonville, the New Albany and the Louisville Morris Forman plants, was manually sampled on an hourly basis for up to nine hours following the onset of precipitation. CSO sampling varied by CSO and by event. All source samples were collected in accordance with *Standard Operating Procedures for the Collection of Discrete Water Samples*, a copy of which is included in Appendix B.

Table 2-19 lists the CSO sampling sites and identifies during which wet weather events they were sampled. In this table; an "X" indicates that samples were collected from the CSO for a particular event, a blank box indicates that no samples were collected because the CSO did not overflow during a particular event, and a shaded box indicates that the CSO was excluded from the study during a particular event.

Table 2-19. CSO Sampling Sites

Sewer District	CSO Number	Location	Wet Weather Event				
			#1	#2	#3	#4	#5
Louisville	CSO#108	Newburg @ Trevilian Way		X			
Louisville	CSO#125	I-64 @ Grinstead		X			
Jeffersonville	CSO#018*	10th Street Lift Station	X	X	X	X	
Louisville	CSO#16	45th Street @ Winnrose			X	X	X
Louisville	CSO#19	34th Street @ Rudd			X	X	X
Louisville	CSO#50	12th Street			X	X	X
Louisville	CSO#189	Shawnee Park Flood PS			X	X	X
Louisville	CSO#190	17th Street @ NW Pkwy.			X	X	X
Louisville	CSO#210				X	X	X
Louisville	SO	Southern Outfall			X	X	X

*Jeffersonville CSO #002 was renamed CSO#018 in 1999

During the first wet weather survey, ten hourly samples were collected from all three WWTPs (hours 0 through 9) and three hourly samples were collected from Jeffersonville CSO #018 (hours 0 through 2). CSOs #108 and #125 did not discharge. All influent and CSO samples were analyzed for $CBOD_5$ and TDS, while samples from hours 2, 5 and 8 were also analyzed for TKN.

During the second wet weather survey, ten hourly samples were collected from all three WWTPs, eight hourly samples were collected from Louisville CSO #108, six hourly samples were collected from Louisville CSO #125, and two hourly samples were collected from Jeffersonville CSO #018. All influent and CSO samples were analyzed for a partial set of parameters to include $CBOD_5$ and TDS. Every other sample, starting with hour 0, was also analyzed for a full set of parameters, to include total phosphorus, nitrate/nitrite, TKN and ammonia. The hour 2 samples were also analyzed for $CBOD_{20}$.

During the third wet weather survey, the influent sampling remained unchanged from the second wet weather survey, but the CSOs sampled and the frequency of CSO sampling changed. The influent and CSO samples were analyzed for the same parameters as during the second wet weather survey. Ten hourly samples were collected from the Louisville Morris Forman and New Albany WWTPs and two hourly samples were collected from the Jeffersonville WWTP. Sampling was eliminated from the two Louisville CSOs sampled in previous years. Louisville CSOs #16, #210 and the Southern Outfall were sampled at 15-minute increments for 60 minutes from the onset of discharge, then at 30-minute increments for the next 120 minutes, then hourly for up to six hours following the onset of discharge. The sampling schedule for these CSOs is shown on the following page in Table 2-20, where the shaded samples were analyzed for a full set of parameters and the remaining samples were analyzed for a partial set of parameters. Sampling was conducted at 15-minute intervals for 135 minutes from the onset of discharge (S0, S15, S30…S135) at Jeffersonville CSO #018 and Louisville CSOs: #19, #50, #189 and #190. The sampling schedule for these CSOs is shown on the next page in Table 2-21, where the shaded samples were analyzed for a full set of parameters and the remaining samples were analyzed for a partial set of parameters. WWTP influent sampling was suspended when the CSOs stopped discharging.

Table 2-20. Sampling Schedule – Louisville CSOs #16, #210 and Southern Outfall

Sample Set	1	2	3	4	5	6	7	8	9	10	11	12
Sample Number	S0	S15	S30	S45	S60	S90	S120	S150	S180	SH4	SH5	SH6

Table 2-21. Sampling Schedule – Jeffersonville CSO #018 and Louisville CSOs #19, #50, #189 and #190

Sample Set	1	2	3	4	5	6	7	8	9	10
Sample Number	S0	S15	S30	S45	S60	S75	S90	S105	S120	S135

No changes were made to the source sampling for the fourth or fifth wet weather surveys. During the fourth wet weather survey, Jeffersonville was the only WWTP sampled due to a power outage at the Louisville Morris Forman plant and a lack of available personnel at the New Albany plant. The Louisville Morris Forman plant was the only WWTP sampled during the fifth wet weather survey due to a lack of personnel at both the Jeffersonville and New Albany plants. Jeffersonville CSO #018 did not discharge during the fifth wet weather survey.

The total number of wet weather source samples collected are shown below in Table 2-22.

Table 2-22. Total Number of Wet Weather Source Samples Collected

Parameter	Samples	Blanks	Duplicates	Total Samples
$CBOD_5$	321	22	33	376
$CBOD_{20}$	29	1	1	31
TDS	338	22	35	395
Total Phosphorus	166	20	32	218
TKN	176	22	27	225
Ammonia	166	20	32	218
Nitrate-Nitrite	166	20	32	218

2.3 FIELD SAMPLING QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

The monitoring team collected four types of QA/QC samples in the field to assist in validating the chemical data sets: sample duplicates, equipment blanks, method blanks and field blanks. All QA/QC samples were collected in accordance with *Standard Operating Procedures for the Collection of Bacteria Samples Utilizing the Glove Method* and *Standard Operating Procedures for the Collection of Discrete Water* Samples, copies of which are included in Appendices A and B, respectively.

Physical parameter data sets were validated through the use of equipment calibration procedures. The multi-parameter probes were calibrated in accordance with *Standard Operating Procedures for the Hydrolab Equipment*, a copy of which is provided in Appendix C.

Signatures of all personnel involved in the collection, transport and receipt of each sample were recorded on a chain-of-custody form and kept with the samples until received by the laboratory for analysis.

2.3.1 QA/QC SAMPLES

Approximately ten percent of the samples were collected in duplicate. Duplicate samples were collected sequentially in the field into two separate sample containers. Sample duplicates were handled as separate samples at the laboratory and analyzed for the same parameters. Comparison of the duplicate analytical results provided an evaluation of the sample collection precision.

Field blanks were collected by each sampling crew at the conclusion of sampling each day. Deionized water provided by ORSANCO was poured directly into sample containers for analysis at the laboratory for all parameters. Results were used to determine the potential for contamination of samples by the sample containers or the deionized water used to decontaminate the equipment.

Equipment blanks were collected by each sampling crew both before sampling and at the conclusion of sampling each day. Deionized water provided by ORSANCO was poured into the sample collection device (either stainless steel bucket, Kemmerer or pitcher), then dispensed into sample containers for analysis at the laboratory for all parameters. Equipment blanks were collected in the same manner as the tributary, CSO or WWTP influent samples were collected, except that the sample collected was deionized water. Results were used to assess the potential for cross-contamination of the samples by improper cleaning of the equipment between samples.

Method blanks were collected by each Ohio River sampling crew at the conclusion of sampling each day and analyzed for bacteria. Ohio River sampling crews utilized the glove method (see Appendix A) for bacteria sample collection where no sample collection device (stainless steel bucket, Kemmerer or pitcher) is used for sample collection. A bacteria sample was collected by the glove method from a deionized water cubitainer provided by ORSANCO. The purpose of the

method blanks was to assess the potential for contamination of samples by the glove method of collection.

2.3.2 EQUIPMENT CALIBRATION

During tributary and Ohio River monitoring, physical parameters were measured at each sampling site with multi-parameter probe instruments and recorded on field data sheets. These instruments were both pre- and post-calibrated each sampling day, according to the manufacturer's operating manual. Comparison of the data recorded during the calibration to the data recorded during the post-check at the end of the monitoring day, provided an evaluation of the instrument precision (electronic drift.) At the conclusion of each event, all calibration sheets were submitted to the ORSANCO Monitoring Leader to serve as a record of instrument performance during the event.

2.3.3 CHAIN-OF-CUSTODY PROCEDURES

Samples were assigned a unique identification code, which identified the site name, sample number, bank description and any QA/QC descriptors. Sample custody began when the field crews collected the samples and was documented on a chain-of-custody form. The chain-of-custody forms outlined sample locations, identification, collection times and dates, and specific parameters to be analyzed for each sample. Properly completed chain-of-custody forms were required to accompany all samples.

Designated custodians and subsequent personnel signed the chain-of-custody forms at each transfer of sample custody. In certain instances, sample custody was transferred to runners to transport the samples to a drop-off point or directly to the laboratory. The chain-of-custody form ended with the signature of the laboratory. The laboratory was responsible for carefully checking the samples for leakage and verifying that the sample container labels were consistent with the chain-of-custody forms. The laboratory was responsible for reporting any problems to the ORSANCO Monitoring Leader, in order to discuss and implement any necessary corrective actions.

2.4 RESULTS OF FIELD STUDIES

Results from three dry weather surveys and five wet weather surveys are included in Appendix D. Selected results from the following three surveys are presented in this section: a dry weather survey conducted on August 17, 1998, a wet weather survey conducted from October 7 through October 10, 1998 and a wet weather survey conducted from May 7 through May 12, 2001. The 1998 events were selected because the dry and wet weather surveys were conducted less than two months apart. During such a short time period, it is unlikely that any significant changes were made to the collection systems or wastewater treatment plant operations located within the study area. The May 2001 event was selected because the largest mainstem dataset was collected through this survey. Supporting graphs are located at the end of this section due to their large number. The primary purpose of these surveys was to calibrate and verify the water quality model, but some important observations can be made from the data. Refer back to Figures 2-1 through 2-3 for study area maps including wet weather sources of pollution and sampling locations.

2.4.1 PRECIPITATION AND RIVER CONDITIONS

The 1998 dry weather survey was conducted following the fifth wettest July on record. The antecedent dry period of nine days exceeded the established criterion of 72 hours. Velocity readings were 0.2 MPH above the dam and 1.3 MPH below the dam. Recorded flows in the McAlpine Pool were approximately 22,200 CFS, which is below the harmonic mean flow of 49,000 CFS, but above the $Q_{7,10}$ flow of 11,000 CFS.

Dry weather conditions began in the middle of August and continued throughout September with September being the fifth driest on record. A significant rainfall did not occur until October 3, when the study area received approximately 1.03 inches of rain. Although this rain event met the minimum criteria for a wet weather event, it was not sampled due to the extended antecedent dry period. The study area received no measurable rainfall from October 4 through October 6. The next significant rainfall occurred on October 7, when the study area received approximately 1.34 inches of rain. The antecedent dry period was three days, which met the established criterion of 72 hours. Precipitation began around 10:00 AM and continued into the early evening, with the bulk of the precipitation occurring between 1:00 PM and 3:00 PM. Figure 2-5 graphs the hourly precipitation summary the day of the event. Velocity readings ranged from 0.2 to 0.5 MPH above the dam and 0.8 to 1.6 MPH below the dam. Recorded flows in the McAlpine Pool ranged from 20,900 to 46,000 CFS over the course of the survey.

The May 2001 wet weather survey was conducted following a month in which the study area received 3.14 inches of rainfall below normal. A significant rainfall occurred on May 7, when the study area received an average of 0.52 inches of rain. This storm was not uniform across the study area as evidenced by rain gage records. Some rain gages recorded over two inches of rain, while others recorded none. The antecedent dry period of 11 days exceeded the established criterion of 72 hours. Precipitation began around 3:00 PM and continued into the evening, with the bulk of the precipitation occurring between 5:00 PM and 10:00 PM. Trace precipitation was recorded during the survey and another significant rainfall occurred on May 11, when the study area received an average of 0.68 inches of rain. Figure 2-6 graphs the hourly precipitation

summary the day of the event. Velocity readings ranged from 0.4 to 0.5 MPH above the dam and 1.4 to 1.6 MPH below the dam. Recorded flows in the McAlpine Pool ranged from 46,900 to 38,400 CFS over the course of the survey.

2.4.2 BACTERIA RESULTS

Bacteria samples were collected from the Ohio River and the study tributaries. As with other similar studies conducted on the Ohio River in Huntington, West Virginia and Cincinnati, Ohio, data collected during this study indicated that bacteria are the primary parameters of concern during wet weather conditions. The applicable ORSANCO standards for the protection of contact recreation from May through October require that:

- *E. coli* content shall not exceed 130 colony forming units per 100 milliliters (CFU/100 mL) as a monthly geometric mean based on at least five samples, nor exceed 240 CFU/100 mL in any sample; and
- Fecal coliform content shall not exceed 200 CFU/100 mL as a monthly geometric mean based on at least five samples, nor exceed 400 CFU/100 mL in more than ten percent of all samples taken during the month.

Contact recreation season on the Ohio River extends from May through October. At the conclusion of the contact recreation season, the applicable ORSANCO standards change to reflect the protection of public drinking water supply as follows:

- *E. coli* content has no provisions for the months of November through April; and
- Fecal coliform content shall not exceed 2,000 CFU/100 mL as a monthly geometric mean based on at least five samples.

In general, fecal coliform levels followed a similar pattern to that of *E. coli*. *E. coli* levels and trends are discussed in detail because so much more data are available.

Figure 2-7 shows the Ohio River cross-sectional *E. coli* data for the 1998 dry weather survey. Ohio River *E. coli* concentrations throughout the study area were in compliance with ORSANCO standards. A total of 68 *E. coli* samples were collected during the dry weather survey, none of which exceeded the 240 CFU/100 mL single sample maximum criterion. In addition, 24 fecal coliform samples were collected during the dry weather survey. None of the fecal coliform samples exceeded the 400 CFU/100 mL standard and most were less than 20 CFU/100 mL.

During the 1998 dry weather survey, bacteria concentrations on the tributaries were generally below or only slightly exceeding the single sample maximum criterion. *E. coli* samples from Falling Run and the Middle/South Fork of Beargrass Creek exceeded water quality standards with concentrations of 14,100 and 3,790 CFU/100 mL, respectively. Possible explanations for these concentrations include dry weather overflows or sample contamination. A dry weather survey on Falling Run in 1999 indicated significantly lower bacteria concentrations, which were attributed to improvements made at the New Albany WWTP.

Figures 2-8 through 2-11 show the Ohio River cross-sectional *E. coli* data for the 1998 wet weather survey. 234 *E. coli* samples and 88 fecal coliform samples were collected from the Ohio River for this survey. Bacteria concentrations upstream of the dam were all well below the instream criteria, with the exception of samples collected from river mile 604. The time

difference between the onset of precipitation and the initiation of mainstem sampling may have resulted in missing impacts on the upstream side of the dam. Impacts resulting from Beargrass Creek loadings, which enter the Ohio River at mile 602, may have been seen on the downstream side of the dam or were not significant enough to have an impact above the dam. Sampling was not conducted below the dam on the first day of this survey. On the second day of sampling, *E. coli* criteria exceedances were observed from river miles 604 through 624 with the highest concentration of 86,600 CFU/100 mL observed on the left descending bank at river mile 624. The highest right descending bank concentration of 7,980 CFU/100 mL, was observed at river mile 622. The samples collected from the right descending bank were an order of magnitude lower than those collected from the midstream and the left descending bank. By the third day of sampling, bacteria concentrations upstream of river mile 614 were all well below the instream criteria. *E. coli* criteria exceedances extended from river mile 614 through the end of the study area at river mile 630, with the highest concentration of 2,710 CFU/100 mL observed on the left descending bank at river mile 628. Bacteria levels had nearly returned to baseline conditions by the fourth day of sampling, with no samples exceeding water quality criteria.

During the 1998 wet weather survey, bacteria concentrations on the tributaries exceeded criteria for the majority of the sampling. All of the study tributaries began exceeding criteria within a few hours of the onset of precipitation, with the exception of Beargrass Creek, where the first samples collected were already in exceedance of criteria. Bacteria concentrations peaked between four and twelve hours after sampling began. The highest *E. coli* levels were observed in the Middle/South and Muddy Forks of Beargrass Creek, with concentrations of 81,600 CFU/100 mL and 199,000 CFU/100 mL, respectively. Bacteria concentrations had nearly returned to baseline conditions by the fourth day of sampling, with the exception of the Middle/South Fork of Beargrass Creek which was still in exceedance of criteria with an *E. coli* concentration of 6,570 CFU/100 mL. Figures 2-12 through 2-14 show a time series of bacteria concentrations for some of the major tributaries within the study area. Bacteria concentrations in the tributaries spiked quickly and began to tail off shortly after the rain event. Sampling was initiated on the level two tributaries three to four hours after the level one tributary sampling. As a result, the initial rise in bacteria levels was not observed, though the peaks in each stream seem to have been captured.

Figures 2-15 through 2-17 show the Ohio River cross-sectional *E. coli* data and Figures 2-18 and 2-19 show the Ohio River longitudinal *E. coli* data, for the May 2001 wet weather survey. 231 *E. coli* samples and 141 fecal coliform samples were collected from the Ohio River for this survey. Bacteria concentrations upstream of the dam were all well below instream criteria, with the exception of samples collected from river mile 604. On the first day of sampling, *E. coli* criteria exceedances were observed on the left descending bank from river miles 614 through 630, with the highest concentration of 17,800 CFU/100 mL observed at river mile 624. Only four samples collected from the midstream and right descending bank exceeded instream criteria. On the second day of sampling, instream bacteria criteria were exceeded from river miles 616 through 624. The highest *E. coli* concentration of 1,650 CFU/100 mL was observed on the left descending bank at river mile 616. The highest *E. coli* concentration observed on the right descending bank was 320 CFU/ 100 mL at river mile 620, which is only slightly higher than instream criteria. On the third day of sampling, instream bacteria criteria were exceeded beginning at river mile 616. The highest *E. coli* concentration of 1,200 CFU/100 mL was

observed on the right descending bank at river mile 628, with the highest left descending bank concentration of 1,060 CFU/100 mL observed at river mile 624. Bacteria concentrations were decreasing on the left descending bank, but still increasing on the right descending bank and the midstream. Generally, the concentrations were lower than on day three, but more evenly distributed across the river. By the fourth day of sampling, only midstream samples were collected downstream of the dam, from river miles 610 through 660. All *E. coli* concentrations were well below instream criteria with no concentrations exceeding 100 CFU/100 mL. Rain on the evening of day four resulted in elevated bacteria levels on the fifth day of sampling. Instream bacteria criteria exceedances were observed from river miles 610 through 635. The highest *E. coli* concentration of 8,400 CFU/100 mL was observed at river mile 620.

During the May 2001 wet weather survey, bacteria concentrations on the tributaries exceeded criteria for the majority of the sampling. All of the study tributaries were exceeding bacteria criteria at the onset of sampling. Bacteria concentrations peaked within four hours after sampling began. The highest *E. coli* level of 140,000 CFU/100 mL was observed on the Mill Creek Cutoff. Silver Creek returned to background conditions approximately 48 hours following the onset of precipitation. The remaining tributaries returned to near baseline conditions by the fourth day of sampling. Falling Run and the Mill Creek Cutoff were the only tributaries sampled on day five. The bacteria concentrations on these two tributaries were again in exceedance of criteria due to a rain event on the night of day four. Figures 2-20 through 2-23 show a time series of bacteria concentrations for some of the major tributaries within the study area. Bacteria concentrations in the tributaries spiked quickly and began to tail off shortly after the rain event.

2.4.3 NUTRIENTS RESULTS AND PRIMARY PRODUCTIVITY

Nutrients parameters were monitored primarily because they are important components in determining the dissolved oxygen deficit, rather than for aquatic life or human health concerns. Chlorophyll-*a* samples were collected in order to provide an estimate of primary productivity in the mainstem. Since algal productivity is promoted in slower moving waters with lower turbidity, the average levels upstream of the dam were higher than those below the dam.

Nutrient samples were collected from the midstream of the Ohio River at four-mile increments during the dry and wet weather surveys. A review of the data indicates that concentrations of these parameters remained fairly consistent between upstream and downstream sites as well as between wet and dry weather conditions. These observations are consistent with the findings seen in the review of historical water quality data in the area. The data ranges on the Ohio River are presented below in Table 2-23.

Table 2-23. Range of Nutrients and Primary Productivity Results on Ohio River

Survey	Total Phosphorus	Nitrate-Nitrite	TKN	Ammonia	Chlorophyll-*a*
1998 Dry	0.08	1.0 to 1.5	0.15 to 0.64	0.04 to 0.18	4.19 to 7.84
1998 Wet	0.08 to 0.11	0.36 to 1.8	0.15 to 0.66	0.05 to 0.32	Not sampled
May 2001 Wet	0.02 to 0.08	0.11 to 2.7	0.11 to 0.63	0.03 to 0.14	10.11 to 20.05

With the exception of chlorophyll-*a*, nutrient samples were also collected from the tributaries, CSOs and WWTP influent. Ammonia and total phosphorus concentrations at these locations were an order of magnitude higher than those on the Ohio River. Nitrite-nitrate concentrations at these locations were only slightly higher than those on the Ohio River. TKN concentrations on the tributaries were only slightly higher than on the Ohio River, however, they were an order of magnitude higher in the CSOs and WWTPs. Of the nutrients investigated, only nitrate-nitrite displayed a noteworthy change during wet weather conditions. No trends were apparent in the remaining nutrient data. No one tributary stood out as having exceptionally high nutrient levels.

2.4.4 SOLIDS

TSS samples were collected from the midstream of the Ohio River at eight-mile increments for the first year of this study, then at four-mile increments for the remaining surveys. TDS samples were collected from the study area tributaries. As expected, the concentrations of TSS and TDS during the wet weather surveys were elevated in comparison with the corresponding dry weather levels, likely due to the increased loadings of suspended materials from stormwater runoff and CSOs. Although elevated over dry weather levels, the TSS concentrations were relatively consistent throughout the study area during the wet weather surveys. Since the CSOs are located primarily in the middle of the study area, this would seem to indicate that the increase in TSS levels is a result of nonpoint source pollution as opposed to CSOs.

TSS levels on the Ohio River remained relatively constant from upstream to downstream during the dry weather surveys. The highest dry weather TSS concentration observed was 21 mg/L and the highest wet weather TSS concentration observed was 35 mg/L. TSS samples were collected from some select tributaries. TSS levels on these tributaries increased above dry weather conditions immediately following the rain event, then quickly returned to background conditions.

TDS levels on the tributaries during dry weather conditions ranged from 230 to 610 mg/L. Wet weather TDS levels were elevated in comparison with the corresponding dry weather levels. The Mill Creek in Indiana consistently displayed the highest TDS levels, where the highest concentration observed was 1,515 mg/L. The highest TDS levels in the CSOs were generally observed at the Southern Outfall in Louisville. Influent TDS levels were highest at the Jeffersonville WWTP.

2.4.5 OXYGEN DEMAND

Oxygen demand is a measure of the quantity of oxygen consumed by microorganisms during the decomposition of organic matter. $CBOD_5$ and $CBOD_{20}$ tests were used to measure oxygen demand. Quality control equipment blanks were collected using laboratory grade deionized water. During the first year of this study, the field blanks were clean, but the equipment blanks indicated contamination.

Results of the first dry weather survey led the project team to remove the phosphate-free detergent, Liqui-Nox, from the decontamination procedure. Despite triple rinsing the equipment with deionized water after using the Liqui-Nox, the project team suspected that detergent residue was adhering to the equipment and causing an oxygen demand in the blanks. The revised

protocol required the use of methanol and deionized rinse water to clean the equipment between samples.

The contamination problem continued during the first wet weather survey leading the project team to suspect the methanol as the source of contamination. ORSANCO conducted a mini-sampling project in an effort to verify this hypothesis. A Kemmerer and churn sample splitter were used to collect river water samples for laboratory analysis. The river water samples were submitted for laboratory analysis in order to show that each parameter was present in amounts sufficient to contaminate the equipment. Decontamination of both pieces of sampling equipment consisted of a single methanol rinse, followed by rinsing with deionized water. After decontamination, the Kemmerer was filled with deionized water, from which a sample was taken. The remainder of the water was transferred into the churn sample splitter, and a second sample was collected. This same procedure was used to collect quality control blank samples from the churn sample splitter without using the Kemmerer. The procedure was repeated with using only deionized water in the decontamination process. Finally, field blanks were submitted for analysis to ensure that the deionized water was not contaminated. The data presented in Table 2-24 clearly demonstrated that methanol caused a contamination problem.

As a result of the contamination problems encountered, ORSANCO staff, in consultation with numerous water quality experts, including representatives from USEPA, has further revised and simplified the sampling/decontamination procedures for the remaining surveys. The use of Liqui-Nox and methanol was removed from the procedure and replaced by a double deionized water rinse.

Table 2-24. Oxygen Demand Decontamination Procedure Study

Sampling Equipment Used	No. of Samples	Decontamination Procedure	CBOD5 (mg/L)	Total Phosphorus (ug/L)	Nitrate-Nitrite (mg/L)	Fecal Coliform (CFU/100 mL)
Field Blank	2	N/A	<1.0	<10	<0.1	<4
River Sample	1		3.8	195	1.2	1,840
Kemmerer	3	Methanol/ Deionized Water	27.7 to <36.0	---	---	---
Churn Splitter	2	Methanol/ Deionized Water	<1.0 to 5.1	---	---	---
Kemmerer & Churn Splitter	3	Methanol/ Deionized Water	26.7 to >33.7	---	---	---
Kemmerer & Churn Splitter	4	Deionized Water	<1.0 to 1.1	<10	<0.1	<4

$CBOD_5$ samples were collected from the midstream of the Ohio River at four-mile increments from both the surface and bottom. A review of the data indicated that concentrations of $CBOD_5$ remained fairly consistent between upstream and downstream sites as well as between wet and

dry weather. $CBOD_5$ levels on the Ohio River were all below 6 mg/L, with most of the samples below 2 mg/L. These observations are consistent with the findings seen in the review of historical water quality data in the area.

$CBOD_5$ samples were collected from the tributaries, WWTP influent and CSOs. $CBOD_5$ levels were fairly consistent between dry and wet weather surveys. $CBOD_5$ levels on the tributaries were all below 20 mg/L, with most of the samples below 5 mg/L. Levels of $CBOD_5$ in the CSOs and WWTP influent were much higher, with many samples in the hundreds of milligrams per liter. The initial samples collected during each event generally exhibited the highest concentrations. Of the 80 WWTP influent samples collected, 77 samples exceeded the wastewater discharge requirement of 40 mg/L for the arithmetic mean of samples collected in a week. Nearly half of the 247 CSO samples collected exceeded this same criteria.

2.4.6 ALKALINITY AND HARDNESS

Alkalinity and total hardness samples were collected from the tributaries during the first year of this study and from the midstream of the Ohio River at four-mile increments. Detergent used in the cleaning of the sample equipment was identified as a source of contamination in the blanks from the first dry and wet weather surveys. The detergent contamination problem experienced during the first year of this study is detailed above in Section 2.4.5. Alkalinity and hardness levels were slightly higher during wet weather conditions than during dry weather conditions. Observed concentrations were highest on the first day of the wet weather surveys, then decreased slightly over the following days.

2.4.7 PHYSICAL PARAMETERS

The project team was concerned about stratification in the Ohio River upstream of the McAlpine Locks and Dam as a potential issue of concern. Extensive physical parameter monitoring was conducted in the study area to evaluate the physical conditions of the water during both the dry and wet weather surveys. This monitoring is detailed in Sections 2.1 and 2.2. Evaluation of the physical parameter data generated from this analysis indicates a fairly well mixed water column both upstream and downstream of the dam. The project team expected thermal stratification, however, observed temperatures from the surface to the bottom differed by less than 0.4 degrees Centigrade. In addition, surface and bottom physical parameter monitoring was conducted at each midstream Ohio River sampling site throughout the entire course of this study. In the event that the difference between the surface and bottom DO readings was greater than 0.5 mg/L, additional monitoring was conducted at two-foot increments.

2.4.8 DISSOLVED OXYGEN

Dissolved oxygen was previously considered one of the primary parameters of concern related to urban wet weather impacts, other than bacteria. Ohio River dissolved oxygen levels ranged from a low of 6.02 mg/L to a high of 11.34 mg/L during the wet weather surveys and from 6.10 to 10.54 mg/L during the dry weather surveys. The highest and lowest dissolved oxygen levels were generally observed between river miles 600 and 602 for each survey. The operation of the McAlpine locks and dam is the likely cause for the high and low extremes in dissolved oxygen

levels being observed at the same river miles. Dissolved oxygen levels on the Ohio River were all above 6.0 mg/L, which is 1.0 mg/L above the level of concern for aquatic life protection. Ohio River dissolved oxygen concentrations followed some general trends during individual surveys, but the trends varied by survey. Concentrations increased in a downstream direction during some surveys, while concentrations decreased during others. Concentrations increased over time during some of the wet weather surveys, while concentrations decreased during others. Throughout the wet weather surveys, DO concentrations below the dam were consistently lower on the left descending bank, than at the midstream or right descending bank. This trend was not observed upstream of the dam, nor during dry weather.

DO levels on the tributaries were generally lower during dry weather conditions than during wet weather conditions. The low DO levels were likely due to decreased flow and velocity in the tributaries. During wet weather conditions, the general trend in DO levels was an increase at the beginning of sampling, followed by a gradual decrease to near baseline conditions. Falling Run, Mill Creek in Indiana and Lancassange Creek all exhibited DO levels that were at times below the instream criterion of 5 mg/L during both dry and wet weather conditions.

Correlations between CSO discharges, estimated using precipitation, and historical Ohio River dissolved oxygen data were evaluated during the Cincinnati Study to determine whether CSOs impact Ohio River dissolved oxygen levels. That evaluation determined that dissolved oxygen is not a problem particular to wet weather impacts.

2.4.9 GENERAL CONCLUSIONS

A large number of parameters were collected in conjunction with this study. While it was necessary to collect such information to ascertain whether particular pollutants were of concern, a lengthy parameter list may not be necessary in the future for the evaluation of urban wet weather impacts in similar sized river systems, following initial surveys to confirm such a fact. Even with this knowledge, site-specific considerations should be kept in mind when selecting parameter sets.

Additional bacteria monitoring data for the study tributaries, upstream of the CSO drainage areas, were needed to better characterize tributary bacteria loads from upstream catchment areas. Limited historical bacteria data were used to estimate bacteria concentrations on tributaries upstream of CSO catchment areas, as well as near-mouth bacteria data from the wet and dry weather surveys. Long-term, routine bacteria sampling on the major tributaries upstream of the CSO catchment areas, as well as near the confluences with the Ohio River, would have generated more valuable data. Monitoring for bacteria in the CSO and wastewater treatment plant influent samples would have also been more useful than using estimated bacteria loads.

Figure 2-5. October 7, 1998 Rainfall Summary

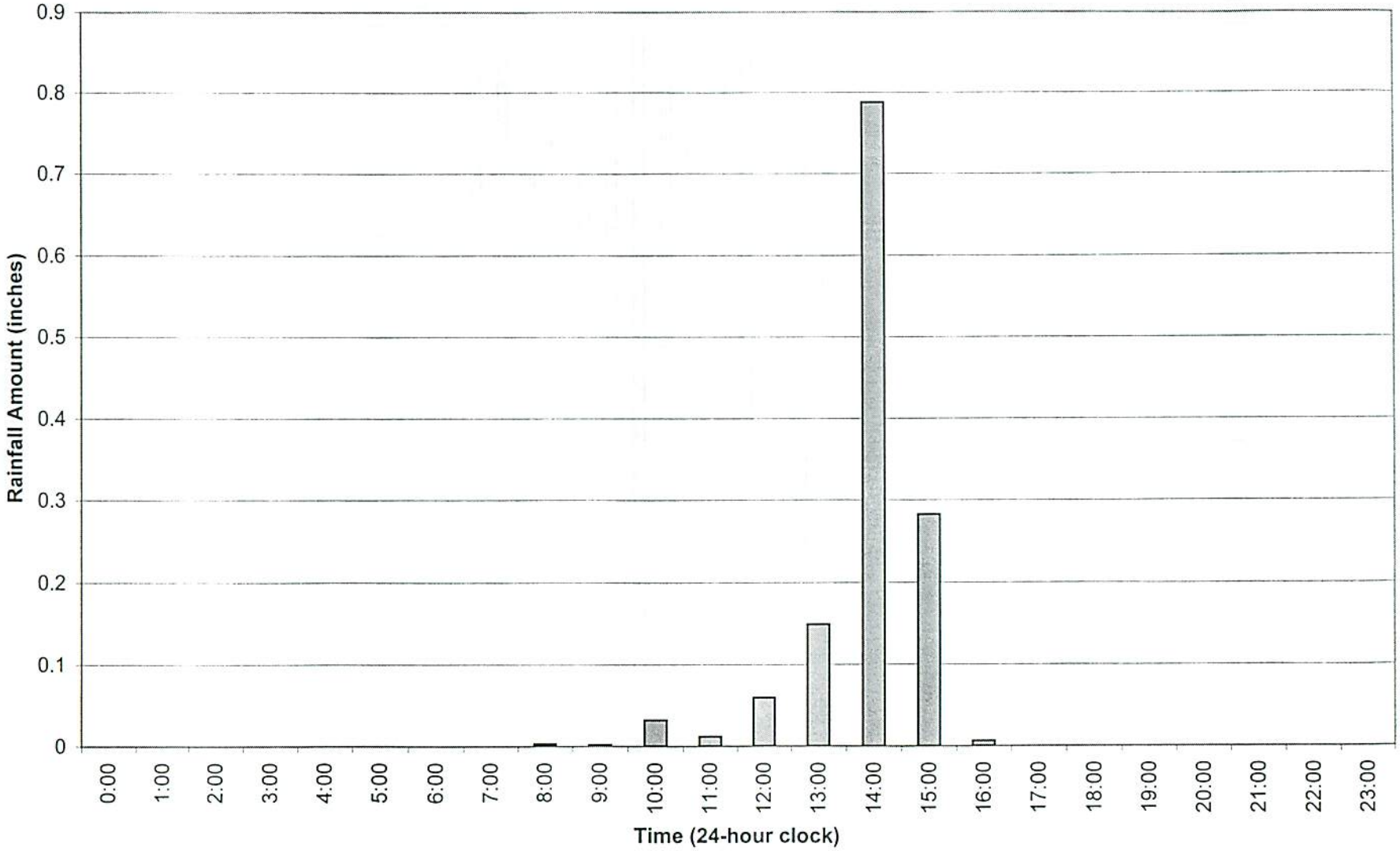


Figure 2-6. May 7 - 8, 2001 Rainfall Summary

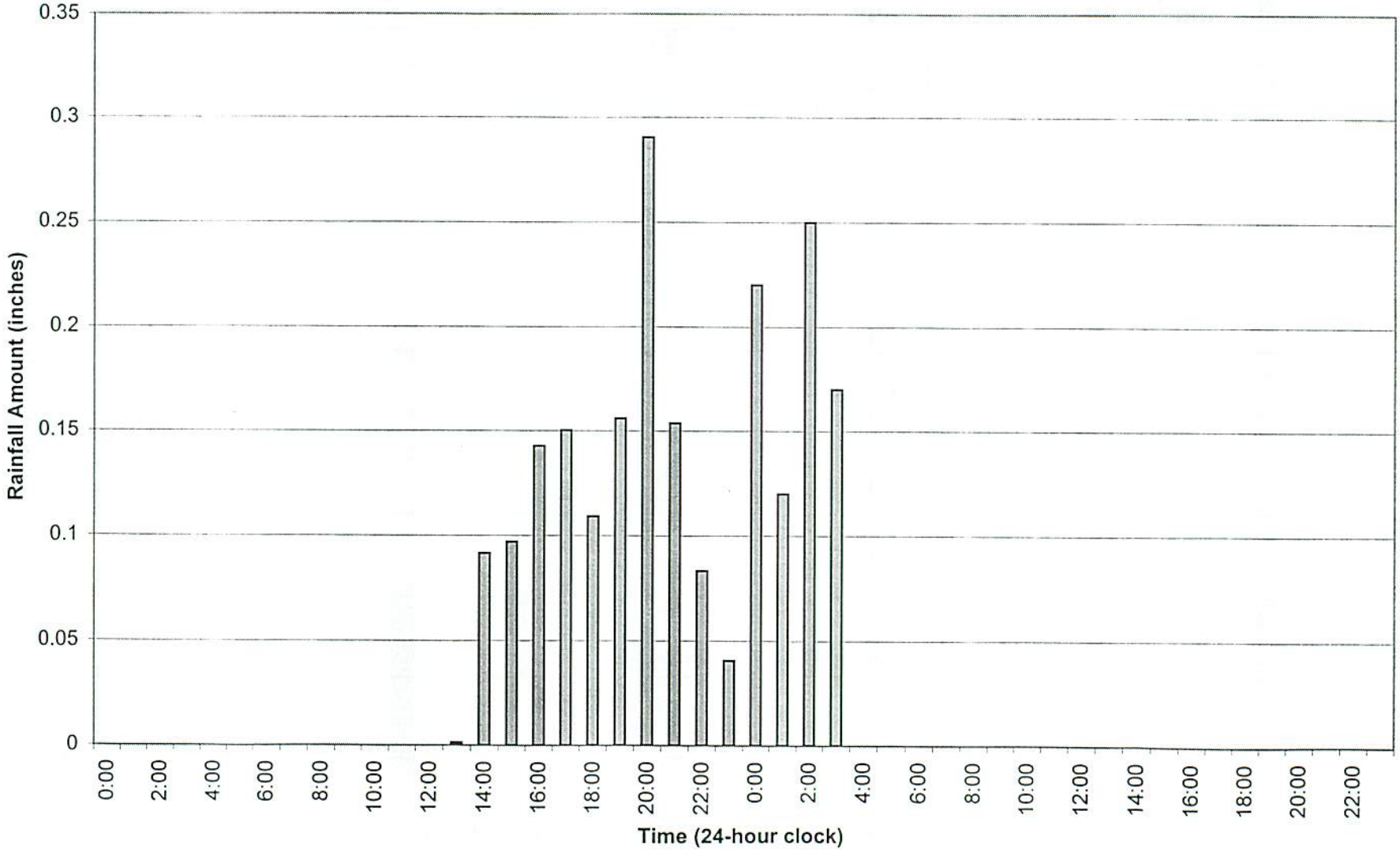


Figure 2-7. 1998 Dry Weather Event - Ohio River *E. Coli* Data

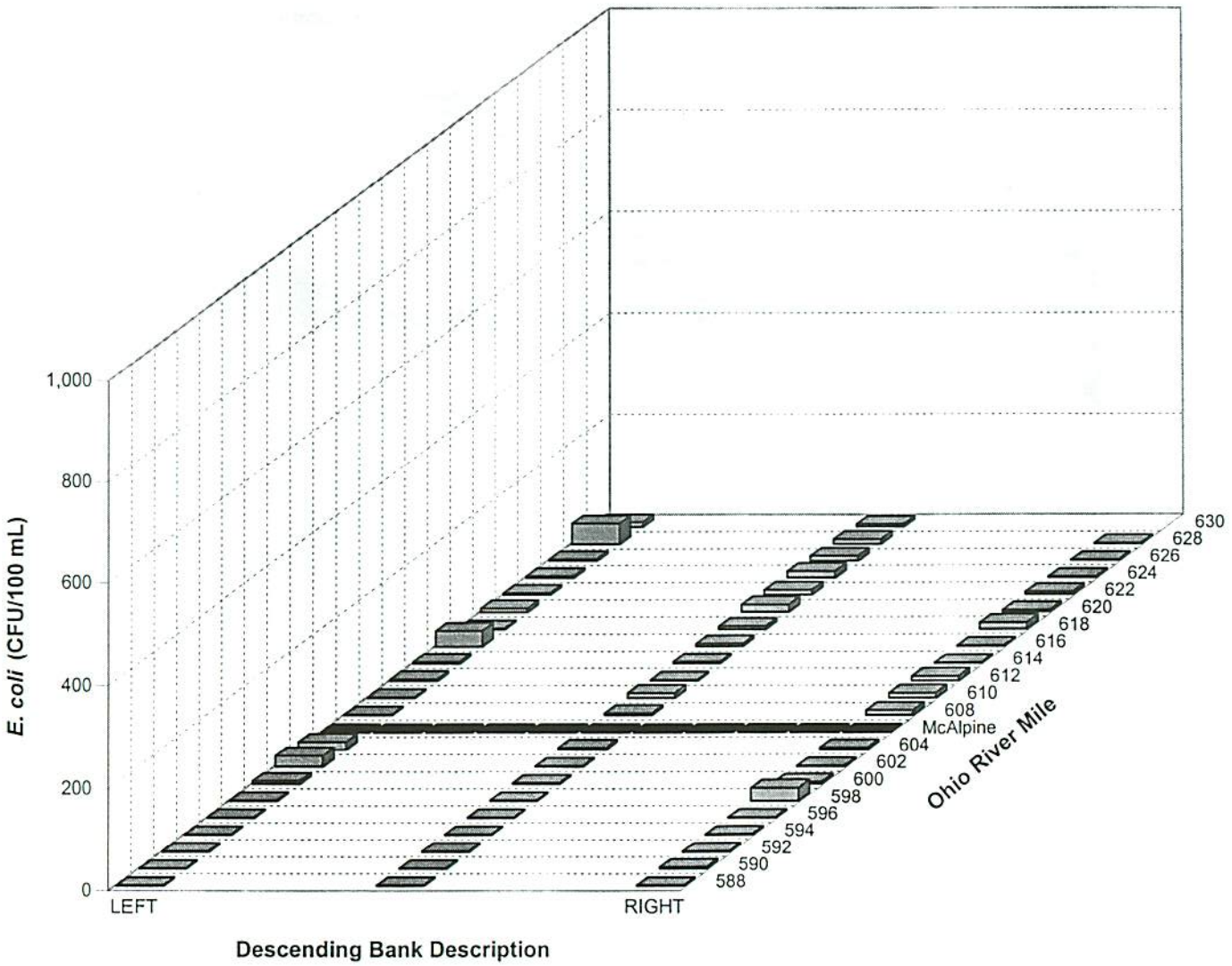


Figure 2-8. 1998 Wet Weather Event - Ohio River *E. Coli* Data - Day 1

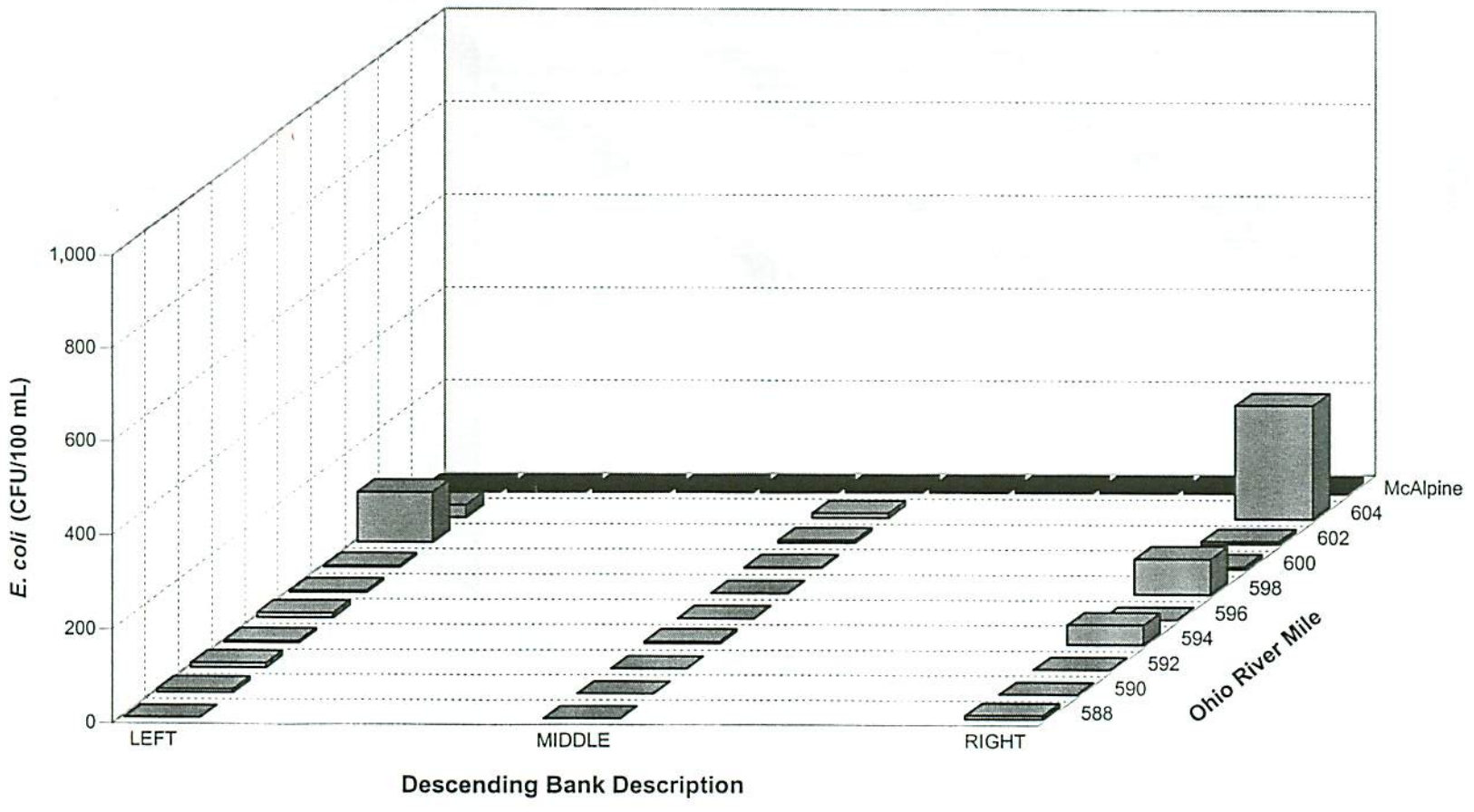


Figure 2-9. 1998 Wet Weather Event - Ohio River *E. Coli* - Day 2

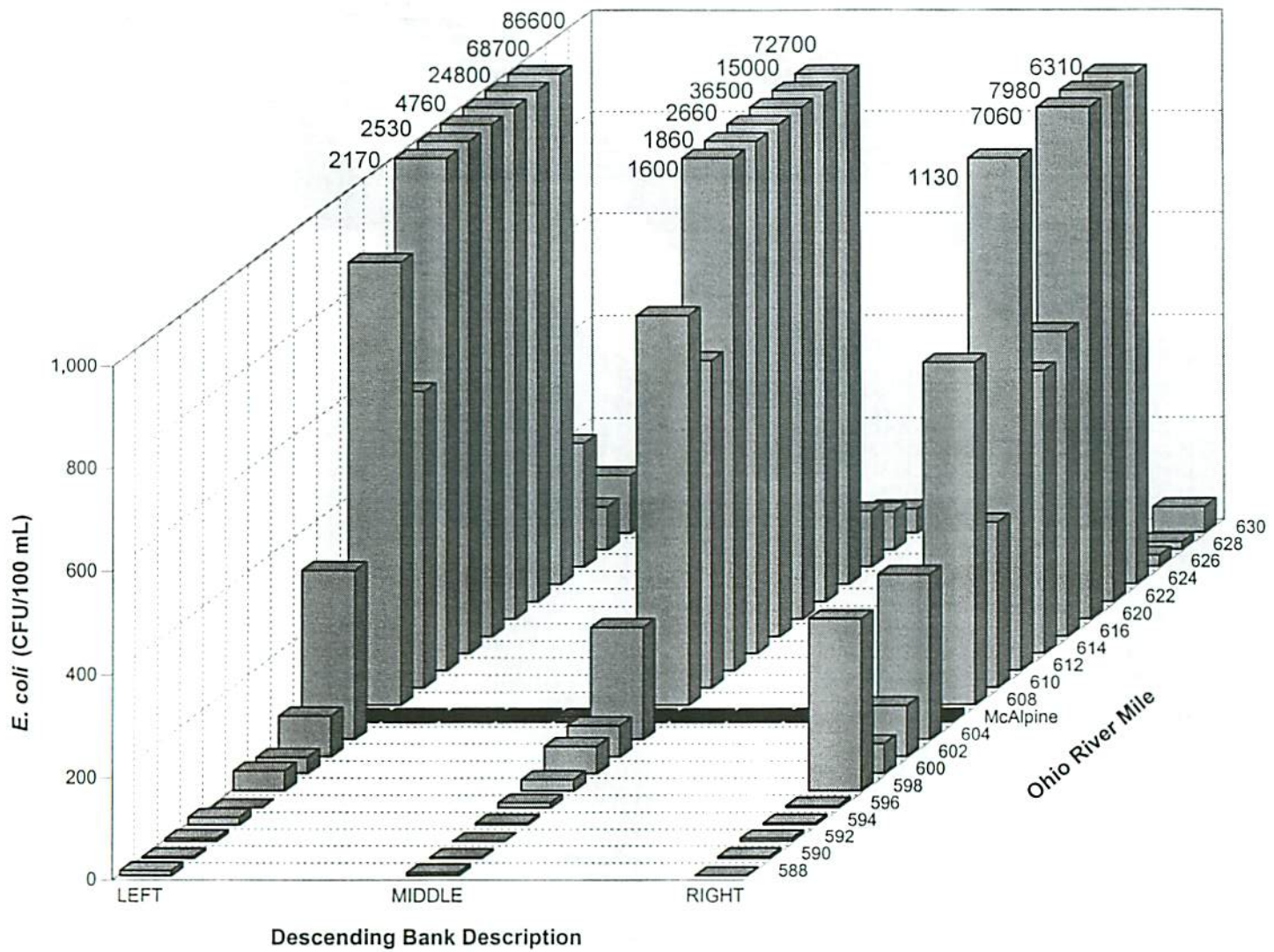


Figure 2-10. 1998 Wet Weather Event - Ohio River *E. Coli* Data - Day 3

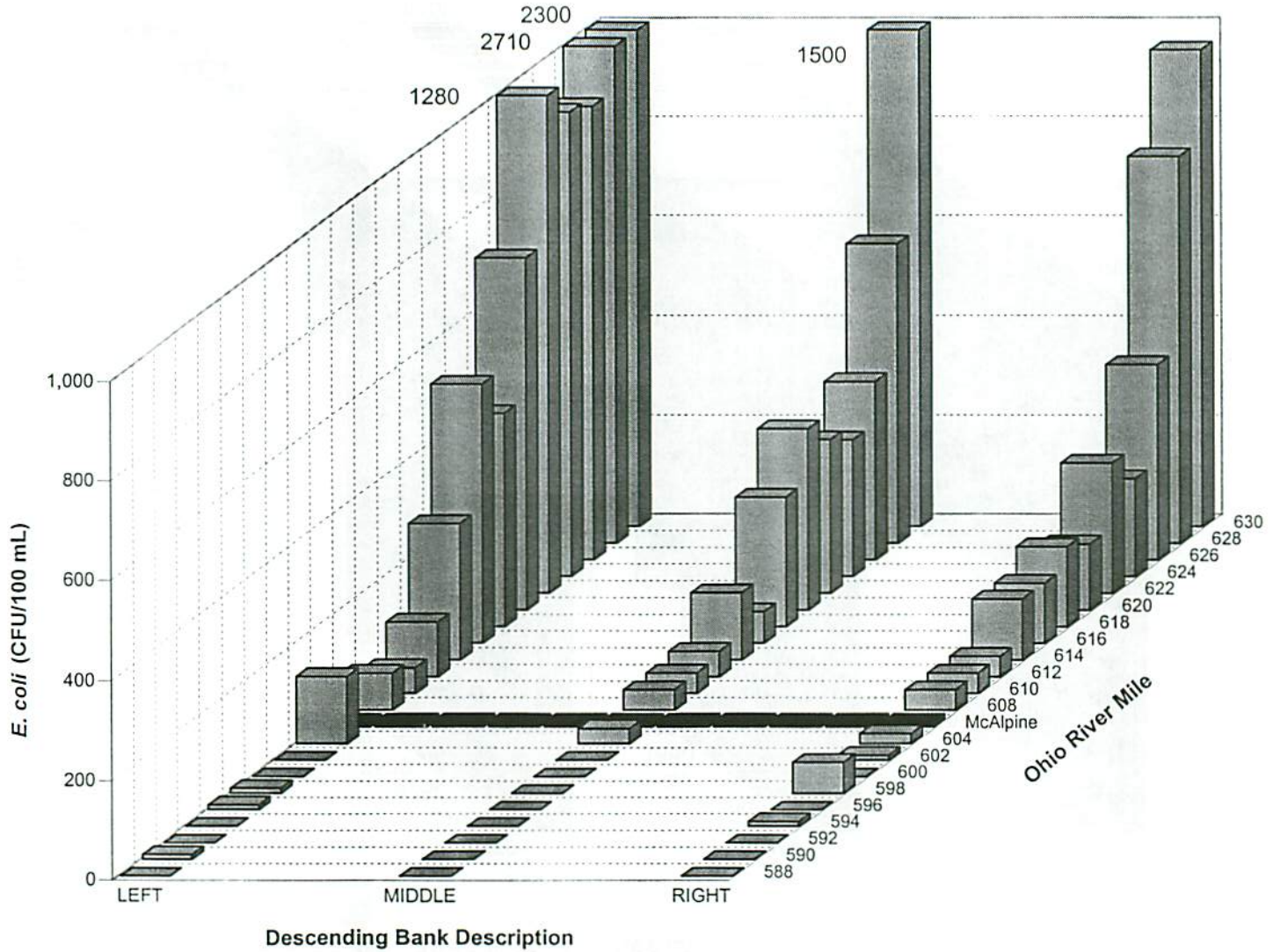


Figure 2-11. 1998 Wet Weather Event - Ohio River *E. Coli* Data - Day 4

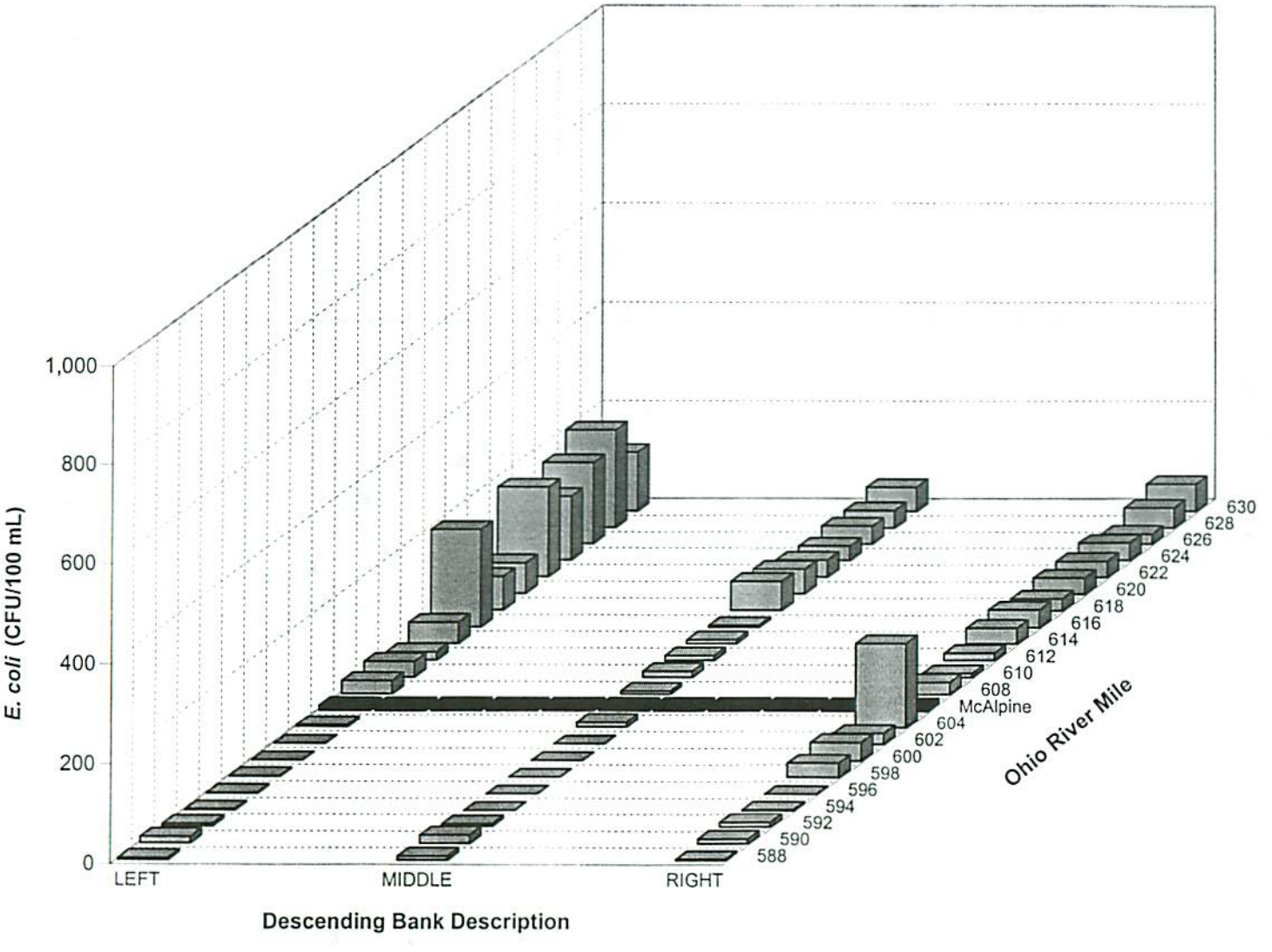


Figure 2-12. 1998 Wet Weather Event - Beargrass Creek *E. Coli* Data

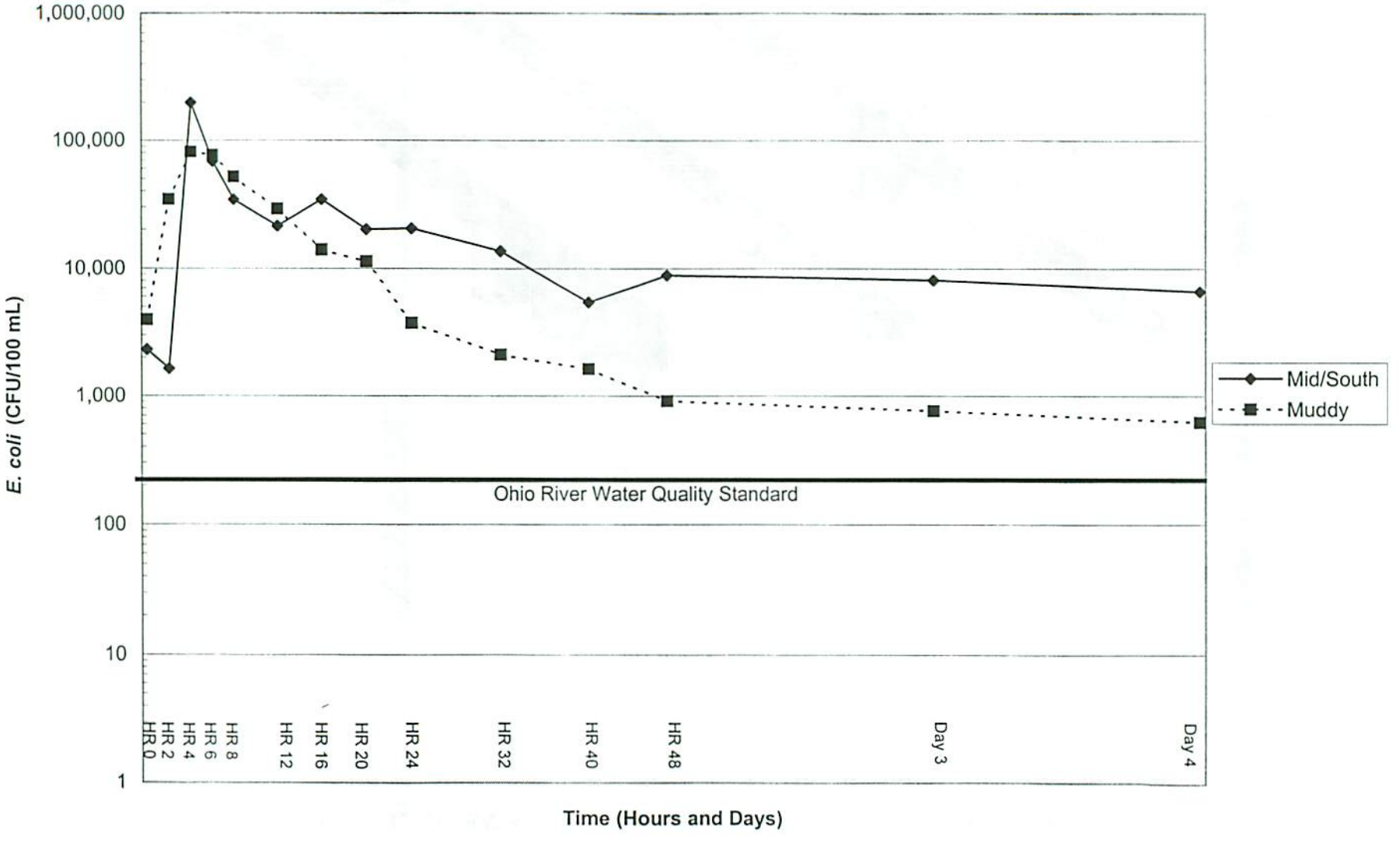


Figure 2-13. 1998 Wet Weather Event - Goose, Little Goose and Harrods Creeks *E. Coli* Data

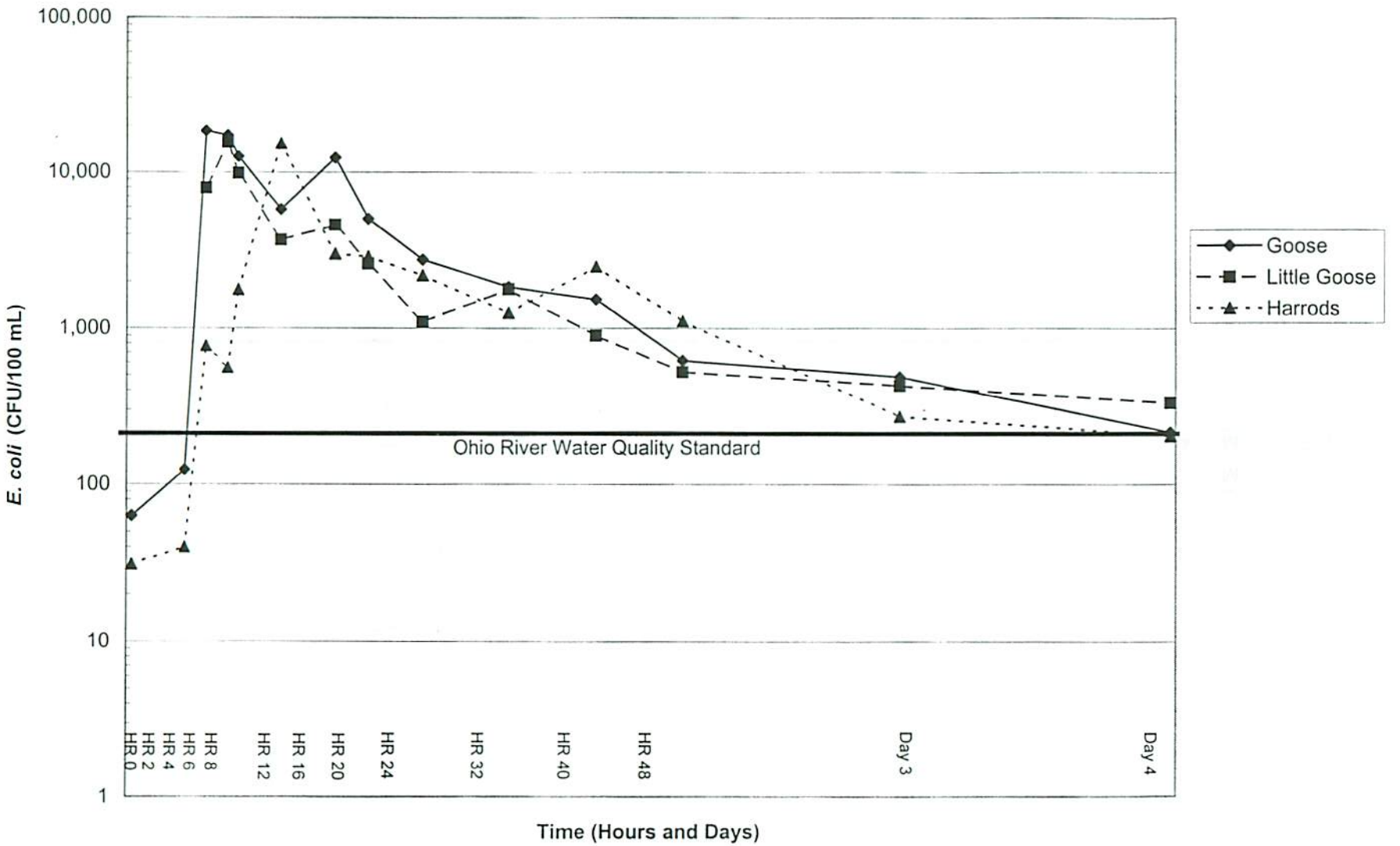


Figure 2-14. 1998 Wet Weather Event - Mill Creek (KY) and Mill Creek Cutoff *E. Coli* Data

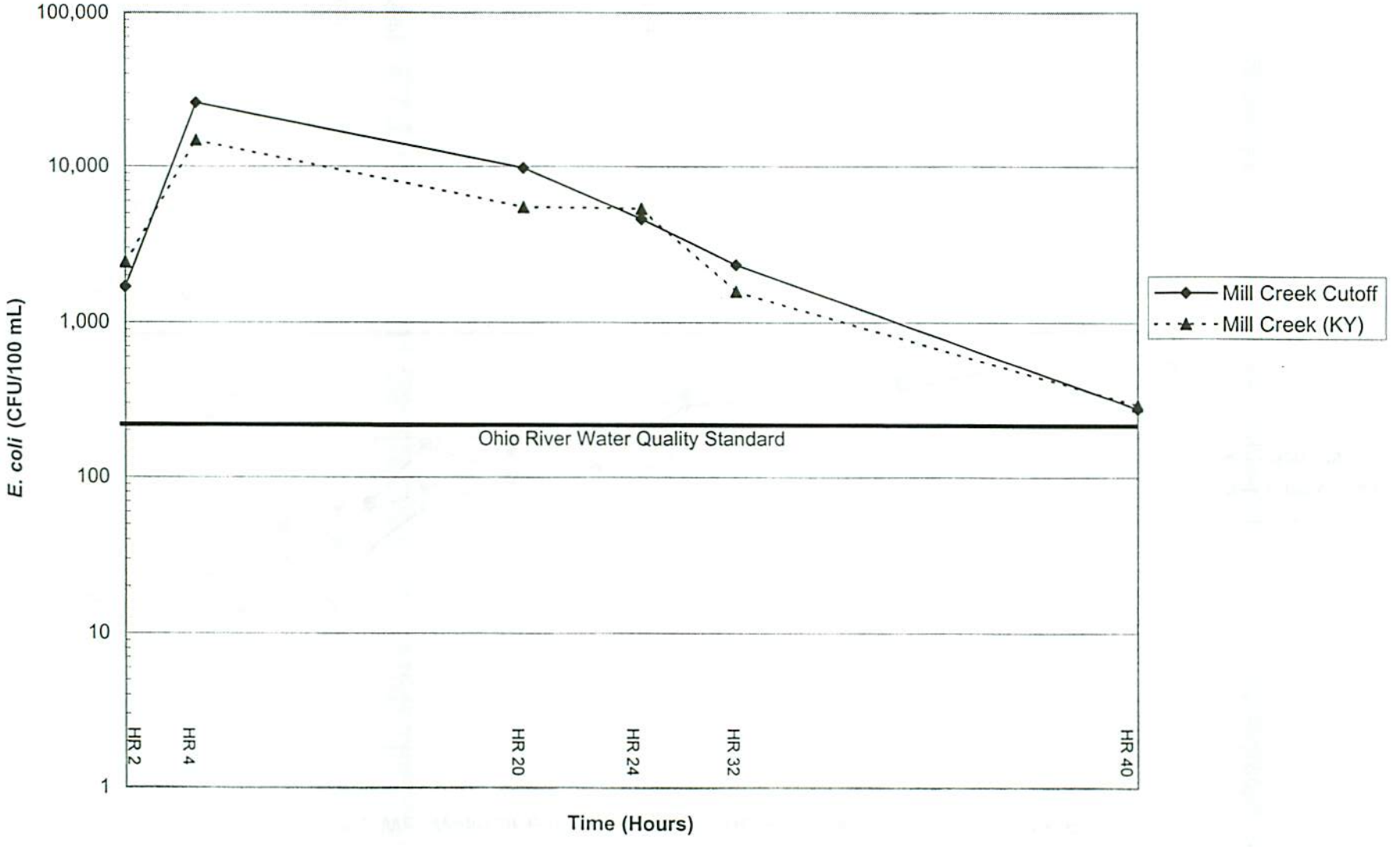


Figure 2-15. May 2001 Wet Weather Event - Ohio River *E. Coli* Data - Day 1

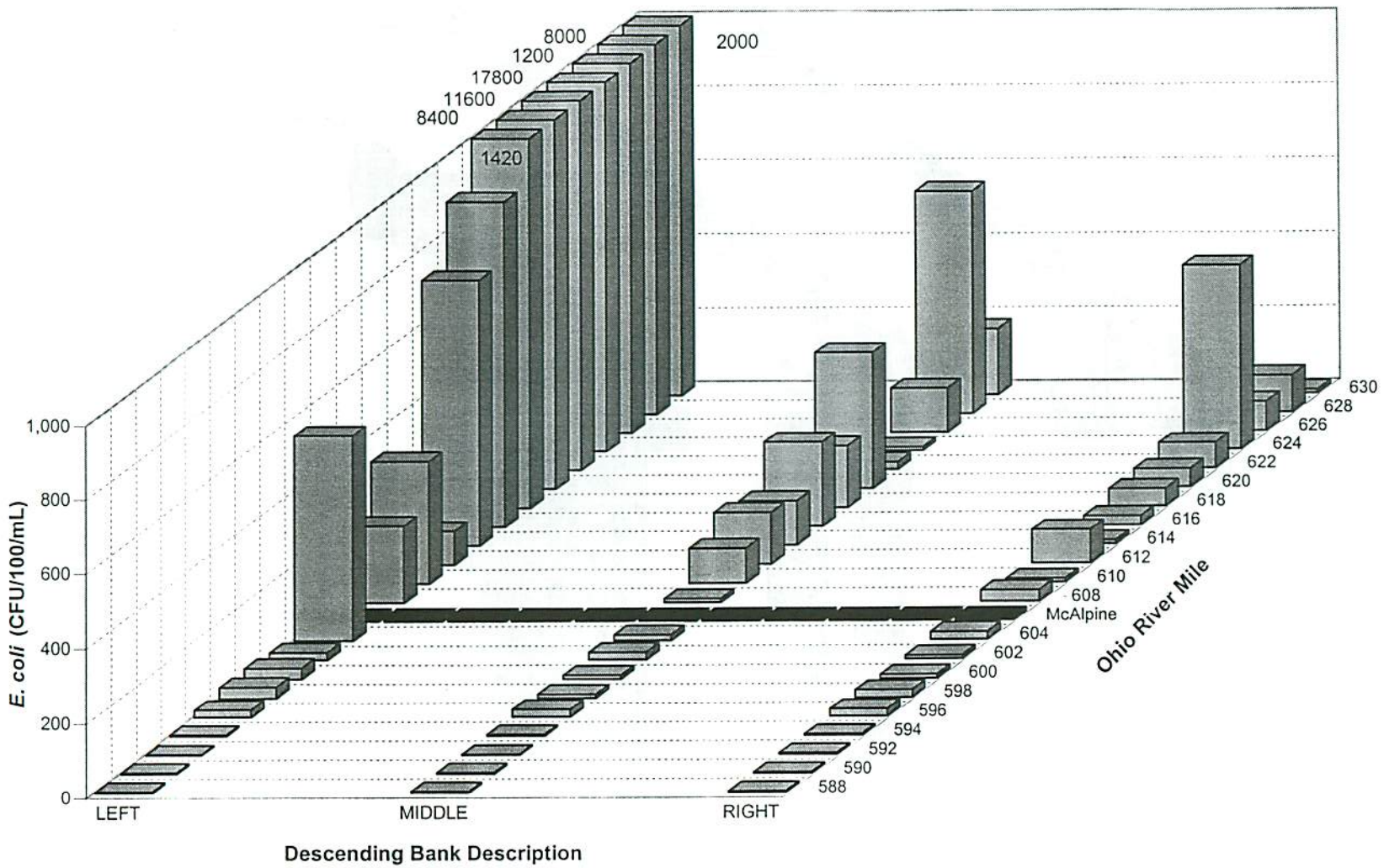


Figure 2-16. May 2001 Wet Weather Event - Ohio River *E. Coli* Data - Day 2

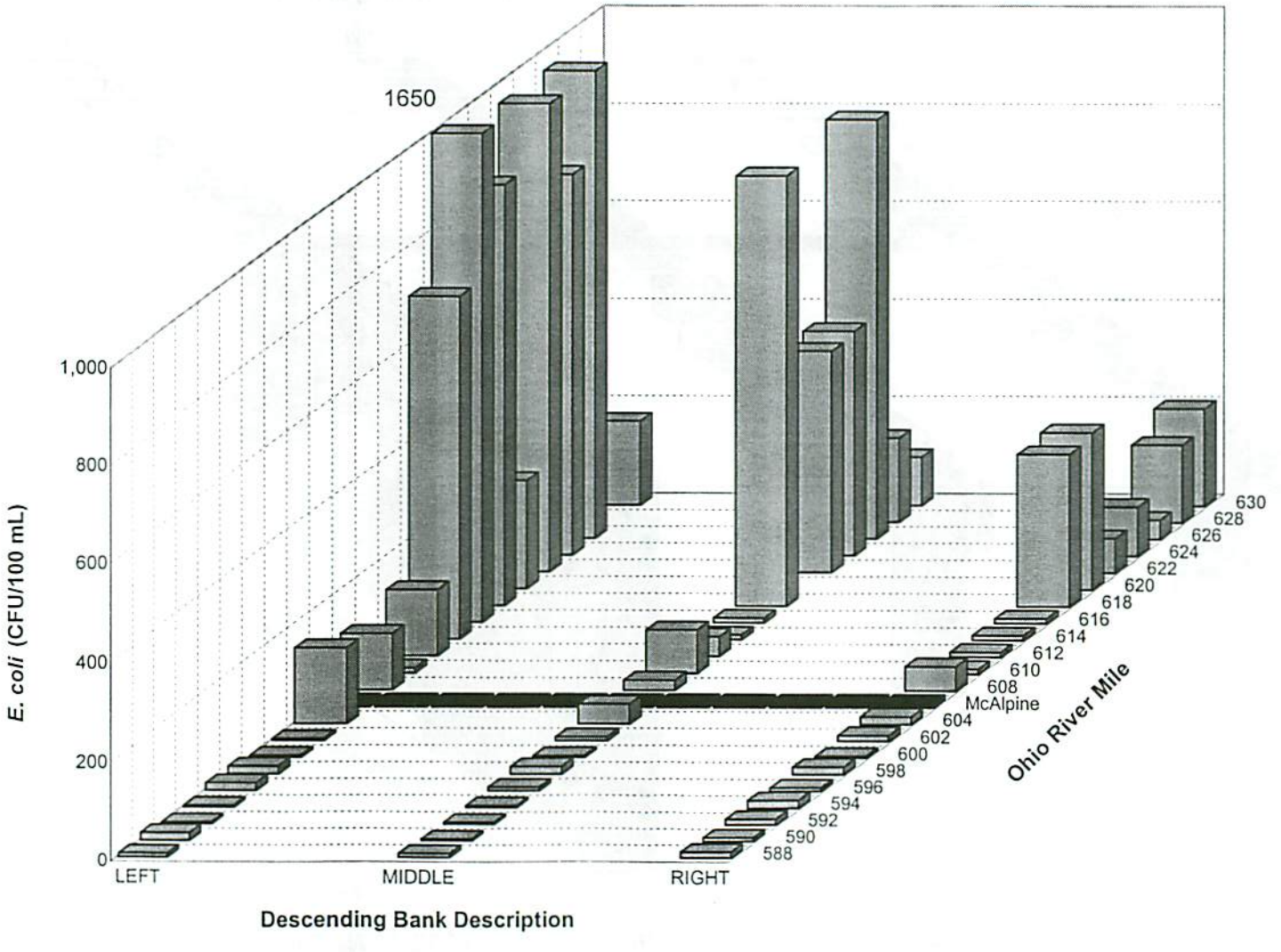


Figure 2-17. May 2001 Wet Weather Event - Ohio River *E. Coli* Data - Day 3

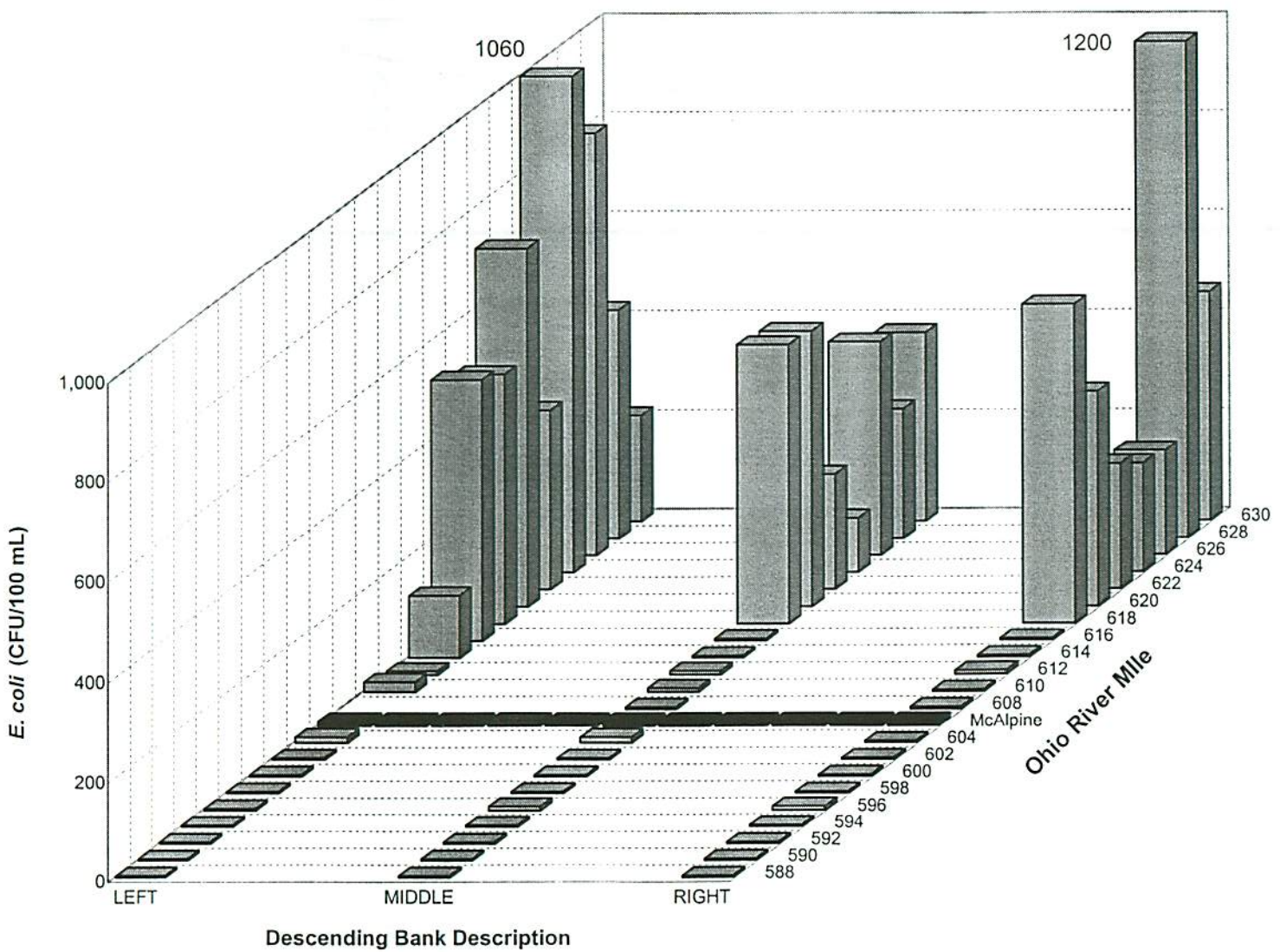


Figure 2-18. May 2001 Wet Weather Event - Midstream Ohio River *E. Coli* Data - Day 4

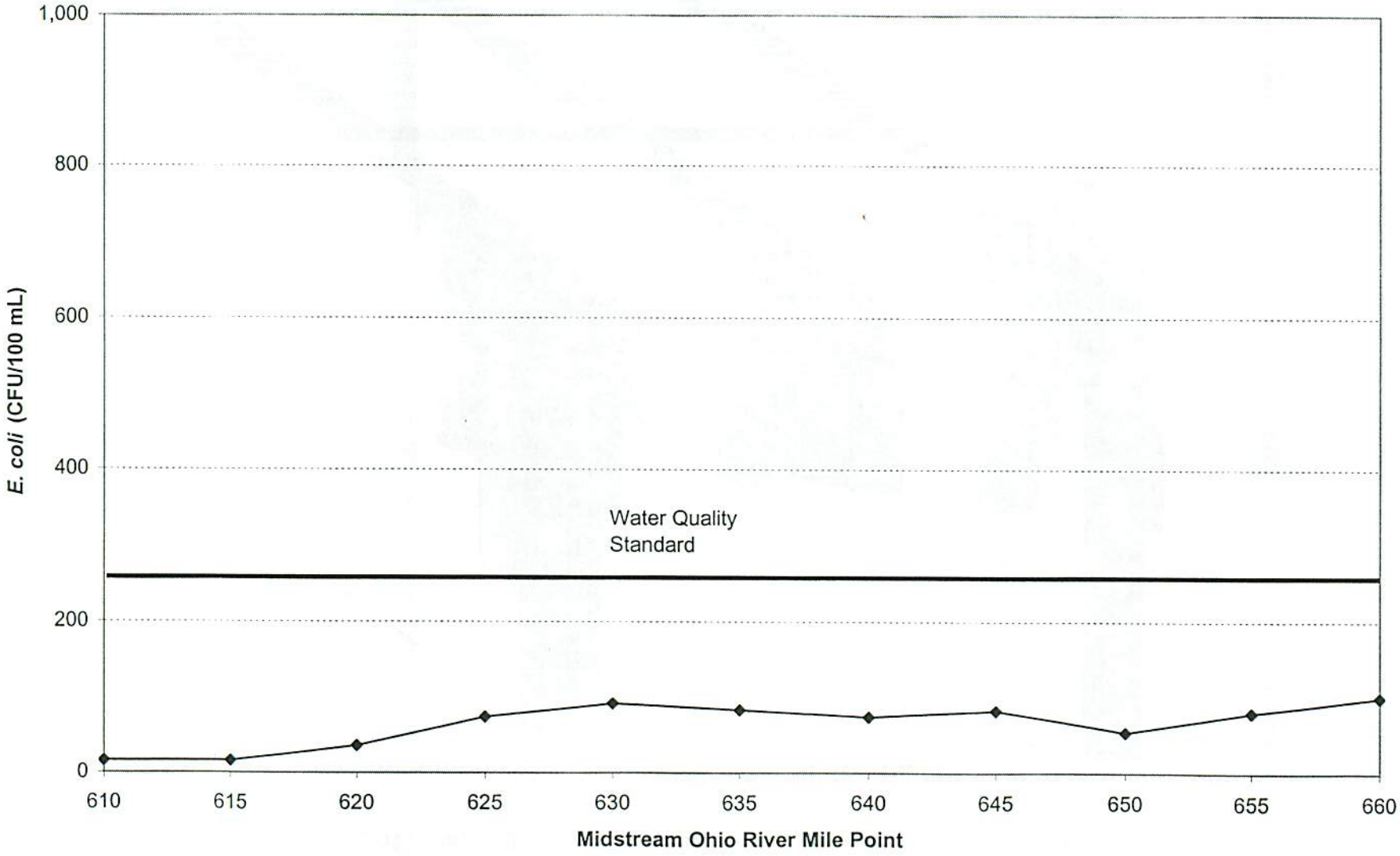


Figure 2-19. May 2001 Wet Weather Event - Ohio River *E. Coli* Data - Day 5

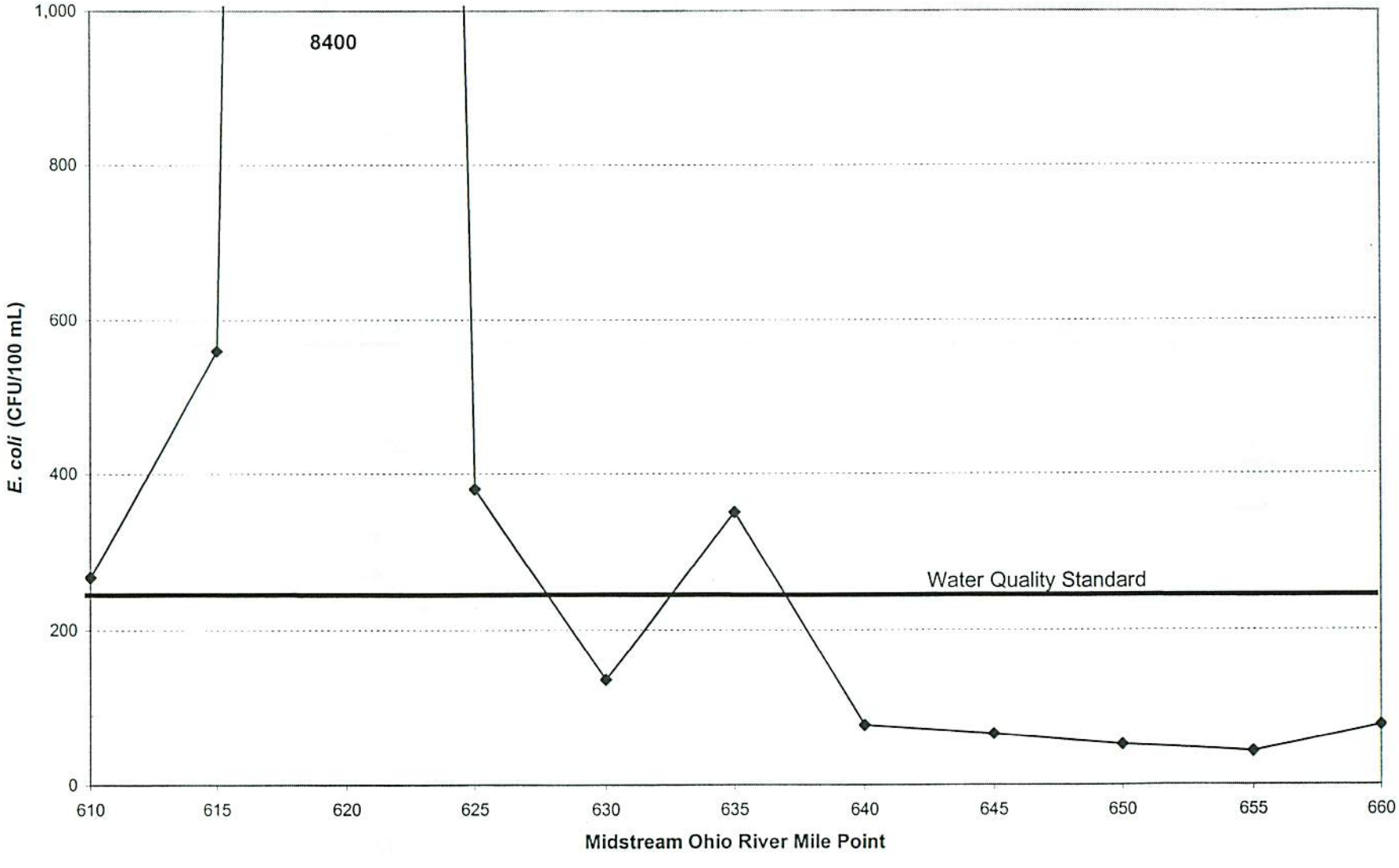


Figure 2-20. May 2001 Wet Weather Event - Beargrass Creek *E. Coli* Data

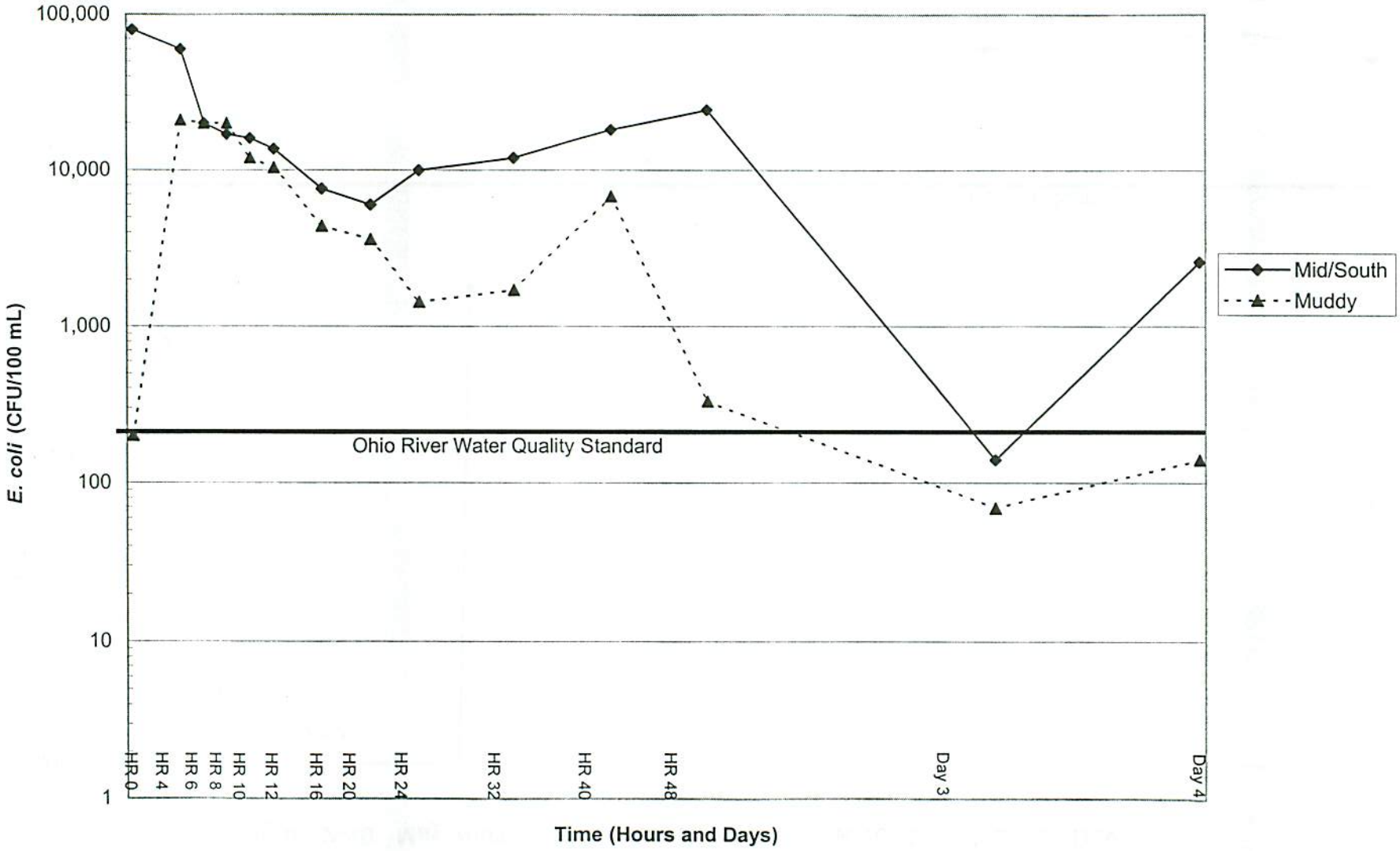


Figure 2-21. May 2001 Wet Weather Event - Goose, Little Goose and Harrods Creeks *E. Coli* Data

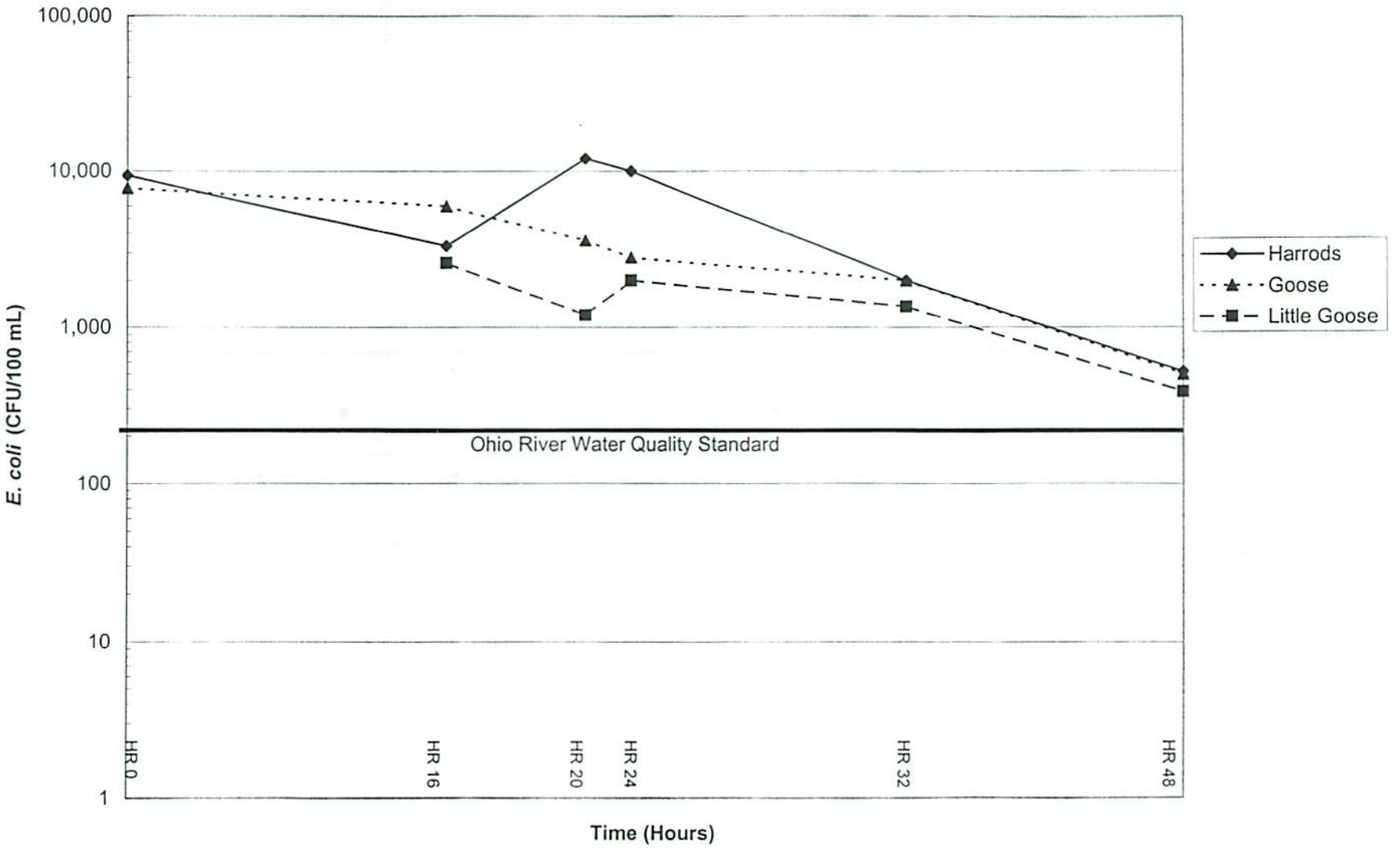


Figure 2-22. May 2001 Wet Weather Event - Mill (IN) and Silver Creeks *E. Coli* Data

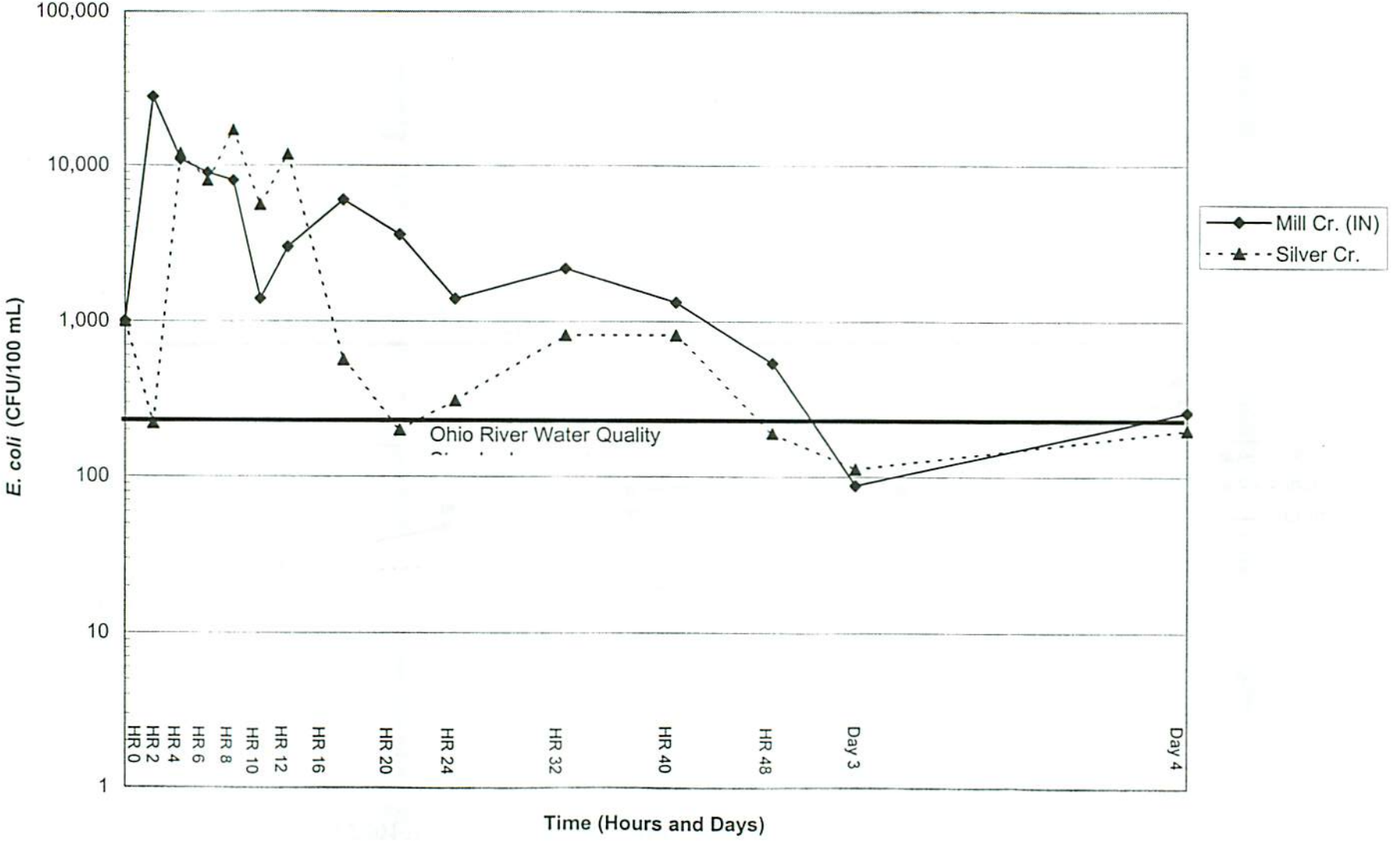
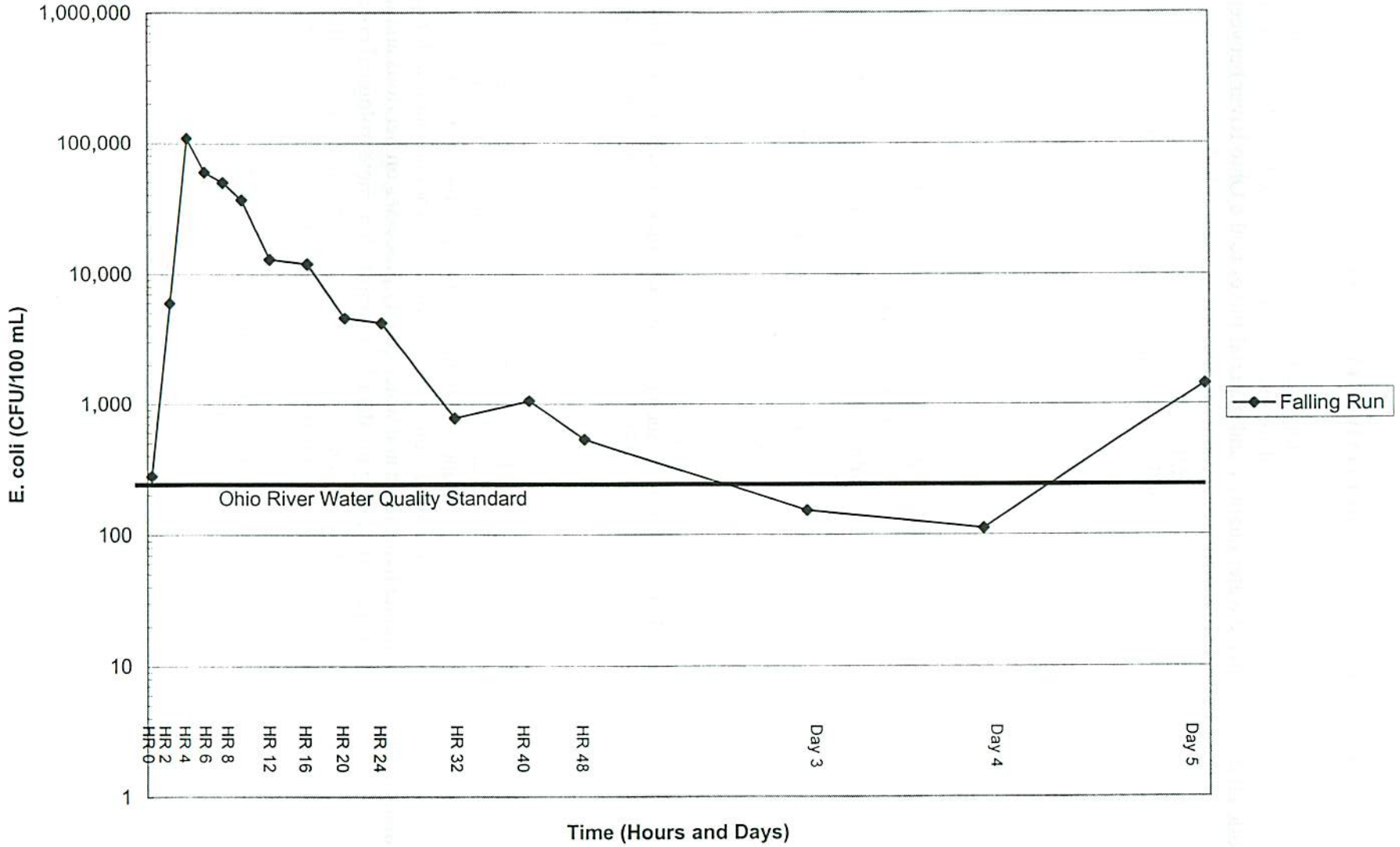


Figure 2-23. May 2001 Wet Weather Event - Falling Run *E. Coli* Data



3.0 LANDSIDE MODELING FOR LOAD ESTIMATION

The primary objective of the land-side loading model was to provide boundary conditions for the predictive water quality model constructed for the Ohio River. These boundary conditions include all direct drainage water quantity and material fluxes to the Ohio River between river miles 588 and 630, excluding Ohio River inputs upstream of river mile 588. To accomplish this objective, J. E. Edinger Associates, Inc. (JEEAI) compiled and assessed information regarding the spatial and temporal dynamics of pollutant and flow sources, along with existing water quality/quantity data for the Ohio River.

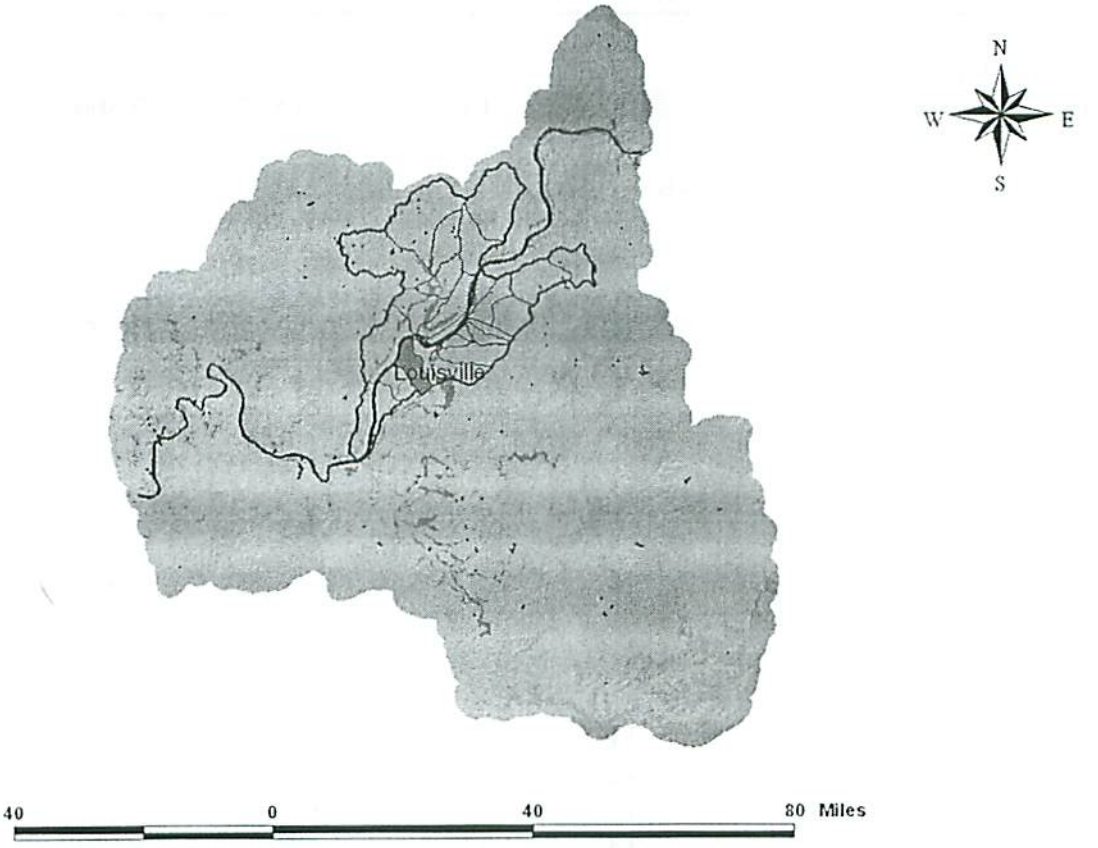
3.1 INTRODUCTION

The land-side loading model developed for this project was named the Louisville/Southern Indiana Water Quality Model (LSIWQM). LSIWQM is a Hydrological Simulation Program-FORTRAN Version 12 (HSPF) model with an HEC-2 component model for stream transport. The LSIWQM was designed to simulate overland flow and water quality in 25 subdrainages of seven major drainages located in the Kentucky counties of Jefferson and Oldham and the Indiana counties of Floyd, Clark and Harrison. Figure 3-1 shows the subdrainages within the outlined study area. The drainage area being modeled comprises most of hydrologic unit 05140101, which is 714 square miles in area. The only portion of this hydrologic unit not modeled is the portion located upstream of the Fourteen Mile Creek confluence with the Ohio River.

Many models are event-based simulations that focus on individual storms but do not simulate the variation through time or between storms. Such static models make assumptions about antecedent conditions. Alternatively, the HSPF model is a continuous simulation model, which not only assesses the events, but also assesses the low-flow impacts of the mass loading delivered during high flow.

The HSPF model was selected because of its ability to integrate and utilize large, detailed databases of both spatial and temporal data. The model can simulate for long periods of time, increasing the accuracy of the water balance simulations and allowing for better assessment of basin storage and travel times. The model also permits relatively sophisticated water quality calculations and can simulate hydrologic and water quality processes on pervious and impervious surfaces. The model integrates time-varying data for precipitation, meteorological conditions, potential evapotranspiration, and point source inputs with biogeochemical process algorithms. The availability of continuously measured water temperature and pH enhances water quality calculations by allowing these time series to be input directly instead of simulated. This tool is a detailed attempt to fully characterize the physical, chemical and biological mechanisms that underlie buildup, erosion, transport and degradation processes that occur in an urban drainage system.

Figure 3-1. Subdrainages within Study Area



3.2 WATERSHED INFORMATION

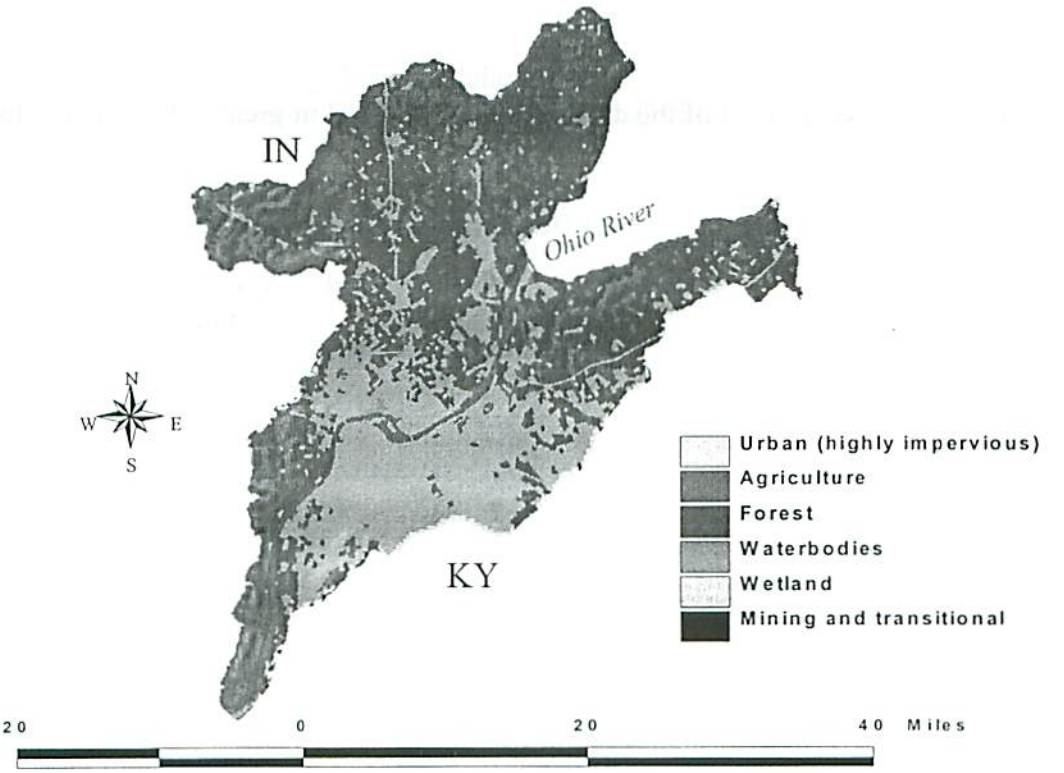
The study area watersheds drain over 690 square miles of southern Indiana and northern Kentucky. These watersheds drain into the Ohio River between river miles 588 and 630. Jefferson County is the most densely populated area in northern Kentucky. Jefferson County has a moist continental climate with moderately cold winters and hot, humid summers. The annual precipitation in Jefferson County averages 43 inches, most of which is rainfall. The annual snowfall in Jefferson County averages less than 17 inches and generally occurs between November and April. Historically, March is the wettest month of the year while October is the driest. Frontal systems approaching from the southwest provide the precipitation during most of the year, but, in late summer, convective storms may produce locally heavy rainfall. According to the USGS, approximately 70 storms, defined as 0.1 inches of precipitation with at least 0.01 inches falling each hour, occur each year in Jefferson County. The climate across the river in southern Indiana is approximately the same as that of Jefferson County in northern Kentucky.

Anderson Level 2 land use was derived from US EPA's Better Assessment Science Integrating point and Nonpoint Sources (BASINS) database. Land use in the basin is predominantly single-family residential urban, followed by agricultural and forested. The study area land use acreage is provided in Table 3-1 and pictured in Figure 3-2. The subbasins and free-flow Reaches/Mixed Reservoirs (RCHRES) segments identified in Table 3-1 are further discussed in Section 3.3.1.

Table 3-1. Study Area Land Use in Acres by RCHRES Segment

	RCHRES	Urban	Agriculture	Forest	Other
INDIANA					
Fourteen Mile Creek					
Headwater	1	1,600	33,857	7,500	12
Outlet	2	2,769	12,340	6,932	4
Lancassange, Lentzier, and Mill Creek					
Outlet	3	14,584	7,229	3,880	126
Silver Creek					
Headwater	4	4,355	18,579	22,345	91
Headwater	5	4,228	13,597	23,859	377
Headwater	6	1,205	10,233	4,925	63
Midstream	7	2,928	12,092	525	0
Outlet	8	8,730	6,010	3,104	60
Falling Run					
Outlet	9	8,265	4,625	15,833	228
Downstream Tributaries					
Outlet	10	241	3,537	8,750	39
KENTUCKY					
Harrods Creek					
Headwater	11	1,528	12,082	2,115	43
Midstream	12	2,237	16,281	4,652	58
Headwater	13	4,639	9,512	3,466	0
Outlet	14	2,779	7,713	3,179	19
Upstream Tributaries					
Outlet	15	4,118	3,635	1,558	10
Goose Creek					
Headwater	16	4,809	1,189	361	0
Outlet	17	2,138	2,372	683	0
Beargrass Creek					
Headwater	18	3,465	91	307	0
Headwater	19	15,745	2,124	328	0
Outlet	20	15,434	1,336	567	0
Louisville urban drainage					
Outlet	21	6,153	0	0	3
Outlet	22	13,640	42	149	0
Mill Creek Cutoff					
Outlet	23	8,920	635	1,724	0
Mill Creek					
Outlet	24	4,985	4,265	1,382	23
Downstream Tributaries					
Outlet	25	430	388	0	170
Total area per land use		**91,021**	**61,664**	**20,471**	**326**
Total area	**443,140**				

Figure 3-2. Study Area Land Use



Most of the developed land near the Ohio River is sewered with separate sanitary and storm sewers. The dense commercial and central business districts are mainly drained by a complex system of combined sanitary and storm sewers, with a few open channels. Periodically, high precipitation events lead to overflows from the combined sewer system, that either discharge directly to the Ohio River or to tributary surface waters which also discharge to the Ohio River.

Considerable background studies on tributaries, CSO loadings, and land-based conditions in the Louisville area have already been conducted. The information provided by these studies is integral to the objectives of this project.

3.3 METHODS

The HSPF model incorporates many variables that influence the study area, including:

- Watershed segmentation,
- Rainfall data,
- Other meteorological data,
- Stream flow data,
- Water quality data,
- Known point and nonpoint sources of pollution,
- Land use and imperviousness, and

- Hydrologic Response Units (HRUs were chosen such that land use, soil types and slopes were relatively constant throughout the area).

The data collected for the development of this model are cataloged in Table 3-2. Each model component and the development of the databases are discussed in greater detail in the following sections.

Table 3-2. Model Development Data Sources

Data Sources	Water Quality Data	Hydrologic Data	Meteorological Data	Watershed Data	Point-Source Data	Nonpoint Source Data
Louisville MSD	X		X	X	X	X
ORSANCO	X				X	
NCDC			X			
EPA	X			X	X	X
USGS		X				
NRCS				X		X

3.3.1 WATERSHED SEGMENTATION

The study area drainage was divided into 25 subdrainages, which corresponded to 27 HSPF RCHRES segments. Figure 3-3 shows the model schematic of the HSPF RCHRES segments. Figure 3-4 shows delineation of the sub-drainages in the study area. RCHRES is the receiving water component of the HSPF model and essentially acts as a Continuously Stirred Tank Reactor (CSTR), in which water quality transformations and transport occur uniformly and instantaneously throughout the volume. Two RCHRES segments were used to characterize the Ohio River, one above the McAlpine Locks and Dam and one below. The other 25 RCHRES segments contribute directly to one or the other of the two Ohio River RCHRES segments. Table 3-3 shows the simulated RCHRES segment area by HRU. Refer back to Table 3-1 for the stream components of each RCHRES segment.

Figure 3-3. HSPF Model Schematic of RCHRES Segments

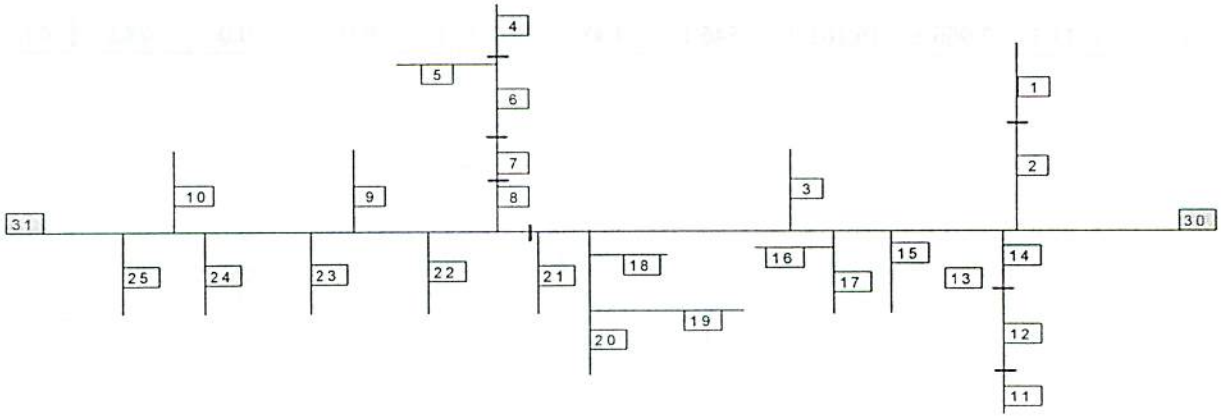


Figure 3-4. Delineation of Subdrainages

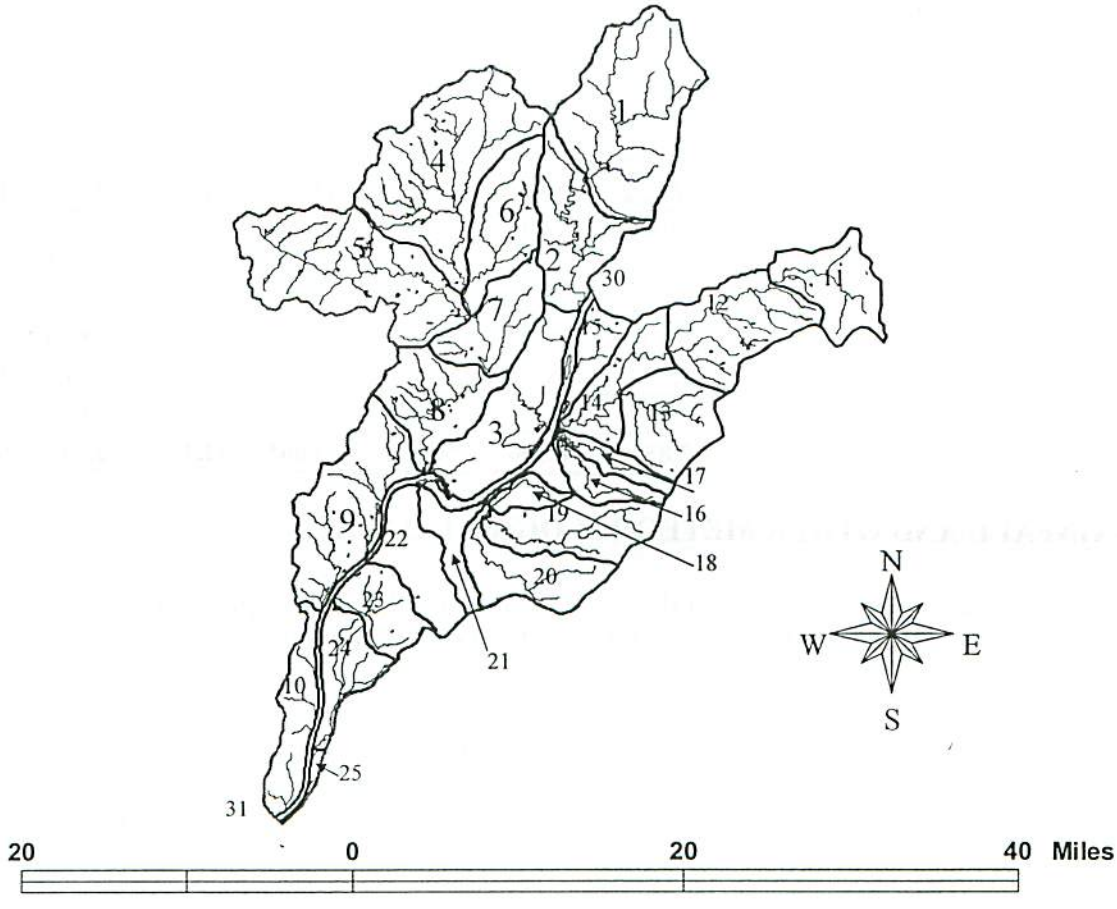


Table 3-3. Simulated RCHRES Area in Acres

HRU →	0	1	2	3	4	5	6	7	8	Totals
INDIANA RCHRES										
1	11.1	2,966.5	16,161.9	546.1	4,480.0	17,551.9	941.5	0.0	78.5	42,737
2	1.9	5,430.8	8,788.3	617.8	1,458.5	3,489.1	940.9	0.0	1,205.3	21,932
3	116.8	2,770.0	2,932.5	728.3	1,073.1	1,926.2	5,734.1	2,322.8	8,555.4	26,159
4	98.2	538.7	0.0	0.0	21,665.6	8,562.8	3,405.7	9,881.1	935.9	45,088
5	378.7	1,464.1	2,611.9	71.7	22,261.1	3,379.2	3,554.0	7,542.9	645.6	41,909
6	63.6	73.5	937.1	6.2	4,827.2	7,731.9	1,000.2	1,505.5	218.7	16,364
7	0.0	97.6	6,095.5	483.7	423.2	3,419.3	1,765.6	2,508.7	1,663.0	16,457
8	57.5	36.4	605.4	113.1	3,053.6	3,090.1	5,726.7	2,302.4	2,831.2	17,816
9	222.4	2,798.5	354.6	391.0	12,950.8	67.3	5,482.0	4,181.0	2,398.2	28,846
10	30.3	8,270.0	1,372.1	132.2	437.4	0.0	59.3	2,152.3	41.4	12,495
KENTUCKY RCHRES										
11	44.5	2,082.5	12,016.7	997.7	0.0	0.0	0.0	0.0	532.5	15,674
12	55.6	4,630.8	16,140.9	1,327.6	0.0	0.0	0.0	0.0	1,060.1	23,215
13	0.0	3,467.5	9,427.7	2,990.6	0.0	0.0	0.0	0.0	1,789.7	17,675
14	18.5	2,994.3	7,377.3	1,505.5	177.9	302.7	512.1	0.0	767.9	13,656
15	10.5	404.0	1,971.3	1,396.1	1,152.1	1,630.9	1,364.0	0.0	1,568.5	9,497
16	0.0	304.6	1,171.3	3,468.1	51.9	0.0	73.5	0.0	1,255.3	6,325
17	0.0	569.6	2,276.5	1,300.4	95.8	87.7	208.8	0.0	620.2	5,159
18	0.0	0.6	7.4	1,556.8	301.5	82.2	710.4	0.0	1,175.6	3,834
19	0.0	324.9	2,103.5	10,052.2	0.0	0.0	507.8	0.0	5,128.7	18,117
20	0.0	539.9	1,318.9	6,795.4	22.9	0.0	2,356.1	0.0	6,185.0	17,218
21	3.1	0.0	0.0	0.0	0.0	0.0	1,949.7	0.0	4,172.4	6,125
22	0.0	131.6	0.0	1,034.1	17.3	40.2	6,621.8	0.0	6,058.4	13,903
23	0.0	661.0	0.0	310.1	1,052.7	641.2	6,277.1	0.0	2,383.9	11,326
24	22.9	360.8	0.0	25.9	1,003.2	4,234.1	3,712.1	0.0	1,254.1	10,613
25	173.0	0.0	0.0	0.0	0.0	386.1	158.8	0.0	279.8	998
TOTAL	**1,308**	**40,918**	**93,671**	**35,851**	**76,506**	**56,623**	**53,062**	**32,397**	**52,805**	**443,140**

3.3.2 RAINFALL AND OTHER METEOROLOGICAL DATA

Meteorological data were compiled from the USGS/Louisville MSD precipitation network and from the National Climatic Data Center (NCDC). A total of ten rain gages were used within the study area, each with five-minute data available for the five-year simulation period. Hourly potential evapotranspiration data were generated using the Hamon Potential Evapotranspiration method and the National Weather Service (NWS) Penman-Montieth method. The 1991 through 2001 meteorological data records were collected from a NWS station located approximately 75 miles south of Louisville, with missing data collected from the Patoka Lake station located approximately 80 miles northwest of Louisville.

NWS station WBAN 93821 is located in Jefferson County at the Louisville Standiford Field, at an elevation of 481 feet above sea level (latitude 38°11'N, longitude 85°44'W). Hourly, and

sometimes more frequent, observations of air temperature, dew point temperature, wind speed, wind direction and cloud cover were available. Shortwave solar radiation was computed using latitude, longitude, time and cloud cover. The cloud cover data were collected by visual observation until August 1, 1994, when use of an Automated Station Observation System (ASOS) was implemented. The ASOS measures cloud cover using a laser device, which only scans vertically to 12,000 feet. Due to the limitations of this laser device, no cloud cover was reported for cloud layers above 12,000 feet. This limitation could have resulted in a systematic overestimation of the solar radiation rate.

Each of these datasets was transformed into a standard format for importation to a database using JEEAI's W2Met tool.

3.3.3 WATER QUALITY DATA

3.3.3.1 CONTINUOUS MONITORING DATA

Several key water quality parameters were continuously monitored by mini-monitors at 19 locations in the study area, 14 of which were located within the Beargrass Creek watershed. The mini-monitors recorded water temperature, DO, DO saturation, pH and specific conductivity at 15-minute intervals. Some of the mini-monitors also recorded the concentration of ammonia as NH_4^+. Over 1.7 million data points were available from these mini-monitors for the period of 1999 through 2001. The 15-minute data were consolidated into hourly data by averaging the four data points collected each hour. Once consolidated, there were over 445,000 hourly data points for the Beargrass Creek watershed alone. Additional information is available in the JEEAI 2002 report for the Louisville MSD Water Quality Tool project.

3.3.3.2 PERIODIC AND EVENT SAMPLING

Periodic wet and dry weather sampling was conducted throughout the 1997 to 2001 period to provide water quality data for calibration of the HSPF, WASP and RMA2 models. These sampling efforts were distributed between streams, sewers and CSOs.

Bacteria data were used to calibrate the HSPF model and to calculate Event Mean Concentrations (EMCs). EMCs were calculated and/or estimated for the CSOs and for the tributaries. The development of EMCs for CSOs is discussed below in Section 3.3.4.1. The tributary EMCs were based on 1,158 observed fecal coliform data. These data were collected over the five-year period of 1997 through 2001 from nine of the 12 tributaries simulated. A strategy to estimate missing data was necessary because some tributaries were sampled more frequently than others and very few sample sites were sampled for all eight events. The calculated and estimated EMCs are provided in Appendix E.

The strategy for estimating missing data utilized weights that were developed as a function of the average relative relationship between locations for a particular time period. These weights were then used, along with the average or median fecal coliform concentrations, for the time period of interest. For example, fecal coliform samples were collected from Fourteen Mile Creek during the time period of October 8 through October 9, 1997. The influence weight w_I was calculated

as the average fecal coliform concentration at Fourteen Mile Creek, divided by the average of all the fecal coliform EMCs for this time period. This weight was then multiplied by the average EMC of the time period for which Fourteen Mile Creek data were not available. The method was refined to partition weights between high and low flow periods. Weights developed for the low flow period followed the procedure presented above with a single deviation. Instead of using the average of the EMCs for the period, the median value was used to avoid inflated values resulting from the lognormal distribution characteristic of the fecal coliform data.

3.3.4 KNOWN POINT AND NONPOINT SOURCES OF POLLUTION

3.3.4.1 POINT SOURCE DISCHARGES

Permitted Discharges

Permitted point source discharge data were collected from the EPA Permit Compliance System (PCS) database. Only 14 of the 145 permitted dischargers to the study area had discharges relevant to this study. Monthly data were available from the PCS database, with the greatest concentration of data available for the time period between 1999 and 2001.

For modeling purposes, the monthly reported values were assigned to each hour within that month. Missing data were estimated using best professional judgment procedures. Short gaps in data of one to two months were filled through interpolation between the neighboring data. Long gaps in data were filled with data from the corresponding month in the nearest year that data were available.

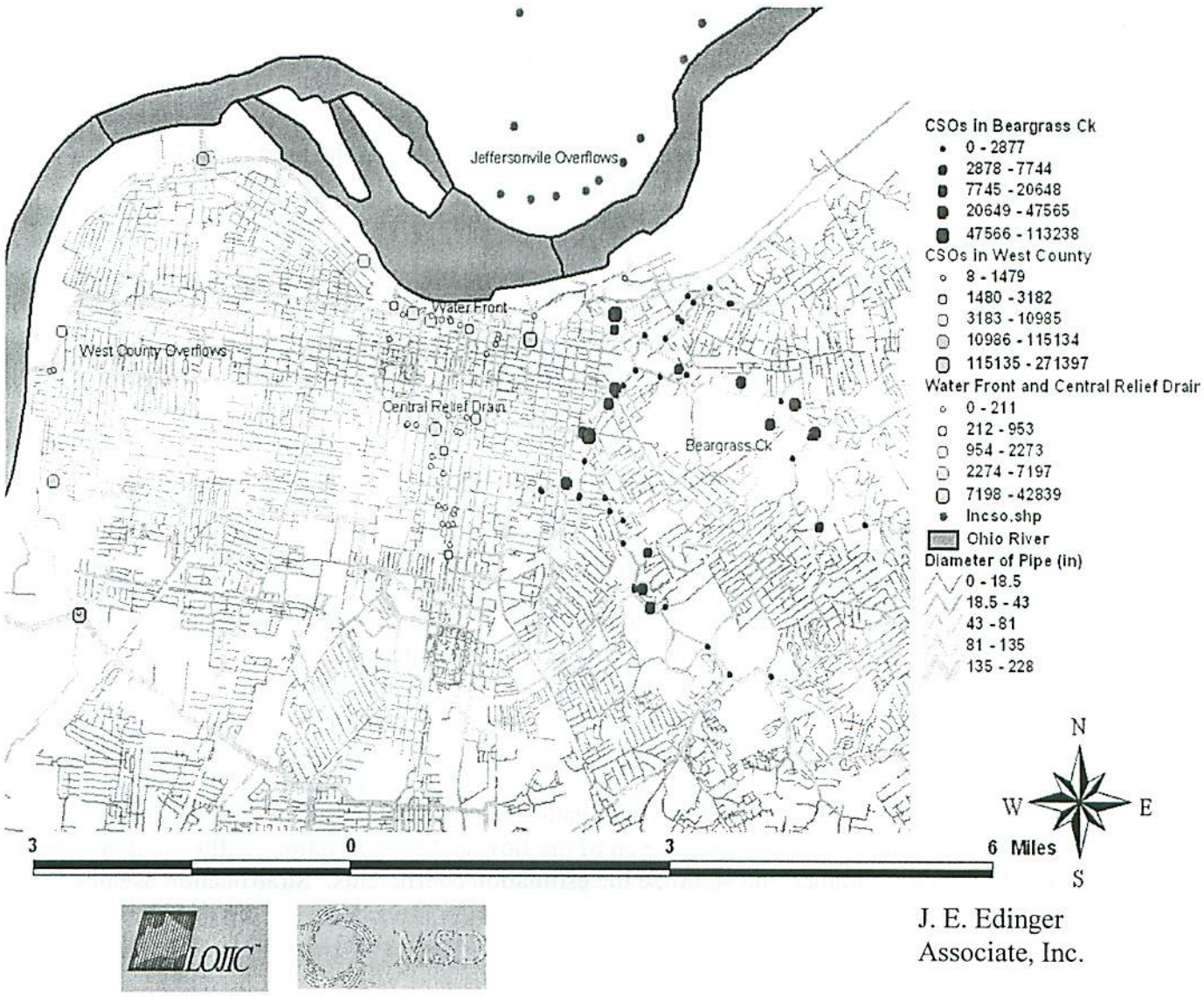
CSOs

CSOs in the Louisville area were well documented, while CSOs in Southern Indiana were not well documented at the time of this study. Since the time that this landside model was developed, a SWMM model for the Jeffersonville CSOs was developed and used in the modeling of control scenarios, as described in Chapter 10. For the purpose of this model, it was assumed that the Southern Indiana CSOs behaved similarly to the median Louisville CSO. The median CSO was defined as the average of two representative CSOs, which were defined by volume and frequency of overflows. Hourly overflow volumes were simulated using regression equations from the SWMM model of Louisville's combined sewer system, developed by OMNI, Inc and O'Brien & Gere Inc. Discharge points to the Ohio River were determined with ARCVIEW. Figure 3-5 depicts a theme coverage that links Ohio River mile to end of pipe locations. For this study, the CSOs were divided into four subsystems. The Beargrass Creek CSOs discharge to Beargrass Creek, the Central Relief Drain CSOs discharge to the Ohio River near the Louisville downtown waterfront area, the West County CSOs discharge to the Ohio River downstream of the McAlpine Locks and Dam, and the Indiana CSOs discharge to the Ohio River near the Mill Creek confluence.

CSO data included data collected by ORSANCO and data for the Beargrass Creek CSOs collected by Louisville MSD. A strategy to estimate missing data was necessary because many CSOs were not sampled, and some were sampled more frequently than others. Missing data were estimated using a K-means analysis. CSOs were clustered by location, volume and frequency, using K-means techniques. This approach assumed that the quality of the overflows

was a function of the approximate location of the CSO and the frequency and volume of overflows. Future efforts by the Louisville MSD will consider temporal patterns associated with land use, but those data are not yet available.

Figure 3-5. CSO Location Map



Estimated data were assigned to each CSO based on the clustering results and EMCs were calculated for each storm. The hourly times of the estimated data and the observed data do not directly correspond to one another. The CSO regression equations were designed to predict overflows with respect to precipitation and did not include a lag factor for the precipitation. The sampling depended on the lagged flows, which corresponded to delayed time to observed concentrations in the runoff and sewer flow. It was assumed that the CSO regression equations adequately estimated the total overflow volume from the CSOs per precipitation event. Consequently, multiplying the total overflow volume by the event mean concentration should

provide an adequate estimate of the total event load, although not capturing the time varying nature very accurately in the short interval.

3.3.4.2 NONPOINT SOURCE CONTRIBUTIONS

Nonpoint source contributions were developed by first compiling all available water quality and water quantity data for the streams in the study area. Most of the streams were not adequately sampled for water quality and/or water quantity. A mechanistic watershed water quality model was used to reduce the overall estimation error and estimate stream flow.

Flux

The mass loading process is continuous and can be represented as the product of flow and concentration over time, as shown in the following equation:

$$L = \int_0^T CQdt$$

where;

L = load (mass/time),
C = concentration (mass/volume),
Q = flow (volume/time), and
dt = change in time.

Loads are often estimated using continuous flow and discrete interval concentration data, as shown in the following equation:

$$L = \sum_{j=1}^{T/\Delta t} C_j Q_j \Delta t$$

Multiple loading algorithms were assessed for each site and each constituent using the ACOE FLUX software. The techniques used to compute loads for the study streams depended on adequately calculating loads with respect to flow, month of year and long terms trends in the flow data.

Estimation adequacy was based on fitting model residuals to independent variables representing flow, month and year. Model efficiency was gauged using the coefficient of variation for the mean of the calculated flows. Stratification of the flow and concentration by flow and/or date was used to reduce variance and stabilize the estimation coefficients. Stratification usually improved model performance.

Non-Point Fecal Coliform Sources

Dr. Mansour Samadpour, a molecular biologist with the University of Washington in Seattle, has pioneered efforts to trace microbial genetics in an effort to identify source contamination. Much of his work has been in the Seattle area. In Seattle's heavily urbanized Pipers Creek watershed, genetic testing results strongly suggest that sanitary sewer lines or failing septic systems are not the cause of high instream bacteria levels. Nearly 20 percent of the bacteria isolates that could be matched with host animals were matched to dogs, with cats and ducks accounting for a significant share of the remaining matches.

The Humane Society of the United States reports that 40 percent of households own one or more dogs, with an average dog ownership of 1.7 dogs per family. 1990 and 2000 census tract data were used to estimate dog densities per tract in the Beargrass Creek drainage. The Beargrass Creek drainage encompasses several partial census tracts. The number of households per census tract was adjusted for the portion of the tract located within the project area, and then the number of adjusted households was multiplied by 0.4 to estimate the number of dogs per tract. A study in Northern Virginia estimated that dogs produce approximately 0.3125 pounds of waste per dog per day.

Runoff from the Louisville Zoo may contribute fecal coliform contamination from a variety of zoo animals to the Beargrass stream segments located near or downstream of Trevilian Way.

In addition to contributions from domestic and zoo animals and urban wildlife, sewer lines may contribute to fecal coliform and *E. coli* contamination. All sewer lines are engineered with a certain allowed environmental exchange rate, i.e. leakage. While the leakage from any one section of a properly functioning sewer line is relatively minor, the combined contributions of the entire sewer system may be significant. Streams are particularly affected by this leakage because many sewer lines run immediately adjacent to, cross, or underlie streambeds.

3.3.5 HSPF MODEL STRUCTURES

The HSPF model was constructed using geographic information system (GIS) datasets provided by: the USEPA for the BASINS 2.0 modeling system, the USGS the Louisville and Jefferson County Information Consortium and the Kentucky Office of GIS. Information regarding the quality and origin of these data, was obtained from the respective agencies and from the USEPA website. Specific datasets included: statsgo soils, digital elevation models, Anderson Level 2 land use, National Hydrologic Datasets, rain gage locations, CSO locations (with considerable modifications), 2000 census coverage, sewer line coverage, building coverage and road coverage. River reach data were derived from the Reach File Version 3 (RF3) and from local cross-sectional analyses. Elevation data were derived from the USEPA one-degree Digital Elevation Model (DEM) shapefiles. These shapefiles are polygonal representations of the original USGS DEM raster files, where the raster files were resampled to a 300-meter by 300-meter cell size. Polygonal representations divide an area into polygons, each with a rain gage located at its center.

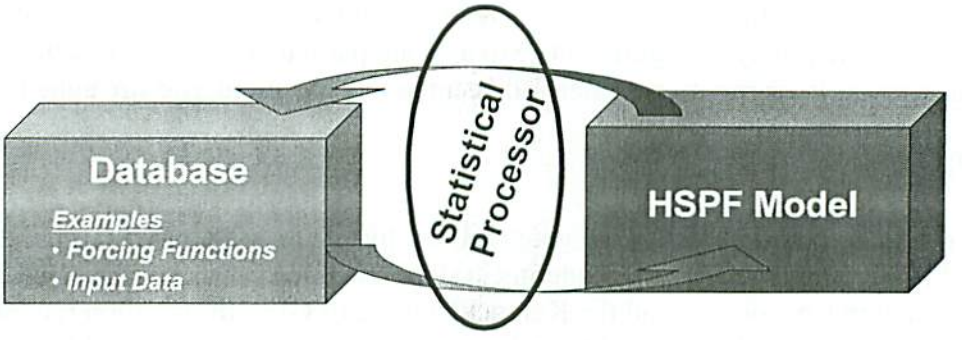
Information about the system dynamics were derived from input time series data, referred to as forcing functions, and the discrete and time series data used in calibration. Forcing function data included precipitation, air temperature, solar radiation, cloud cover, potential evapotranspiration, wind speed and dew point temperature. The calibration database included: time series data for DO, specific electrical conductance and discrete water quality samples collected as part of this study; Louisville MSD's ambient monitoring program; and several Louisville MSD special projects.

Figure 3-6 represents the iterative process by which modeling systems take shape. The input data and forcing functions databases drive the model development. The data were passed through a statistical processor for efficient insertion into the developed HSPF model. The HSPF

model was run and the resulting output was passed through the statistical processor again for comparison to the observed data in the database. Once the model was fully calibrated, it was run for a confirmation system similar in size, land use, and hydrology to the calibration system. The simulated data from this confirmation run were compared to the observed data for the confirmation system. This comparison ensured that the model was adequately calibrated for broader use than simply the data used to build the model. In this study, the Middle Fork of Beargrass Creek was used as the calibration basin and the South Fork of Beargrass Creek was used as the confirmation basin.

By using the statistical processor to determine the effectiveness of the model calibration after each run, modifications to the HSPF model were made and the cycle repeated, until the desired HSPF model performance was achieved.

Figure 3-6. Schematic of Iterative HSPF Calibration Process



3.3.5.1 FORCING FUNCTION INPUT SERIES

Eighteen parameters are available in HSPF for simulating the rainfall-runoff process from pervious surfaces. Table 3-4 lists the abbreviations for these 18 parameters along with explanations for each. The three most sensitive pervious surface parameters for controlling the annual and monthly water balances are: lower zone evapotranspiration (LZETP), lower zone nominal storage capacity (LZSN) and soil infiltration rate (INFILT). Initial estimation of these parameters was accomplished using spatially distributed digital data coverages for trees and soils.

The LZETP parameter, which ranges from 0.01 - 0.99, was calculated as the sum of the fractional area of tree cover within each grid cell for each polygon. This value was then allowed to vary monthly as a function of the monthly evapotranspiration data distribution. Calibration of the magnitude of this parameter required that the relations of the parameter values, between the HRUs and months of the year, remained fixed, while the magnitudes of the parameter were adjusted to obtain the initial water balance. The soil type information was derived from the Natural Resource Conservation Service's (NRCS) County Soil Surveys.

Table 3-4. HSPF Parameters Used to Simulate Hydrology

Abbreviation	Explanation
LZETP	Lower-zone evapotranspiration. An index value (ranging from 0 to 0.99) representing the density of deep-rooted vegetation in pervious surfaces.
INFILT	Infiltration capacity. An index to the infiltration capacity of the soils. This parameter also affects percolation to the ground-water zone.
INFEXP	Exponent for the infiltration equation. Controls rate of infiltration decrease as a function of increasing soil moisture.
INFILD	Ratio of maximum to mean infiltration rate.
INTFW	Interflow index. An index that controls the amount of infiltrated water that flows as shallow subsurface runoff.
IRC	Interflow recession coefficient. An index for the rate of shallow subsurface flow.
CEPSC	Interception storage capacity of pervious surfaces.
RETSC	Retention storage capacity of impervious surfaces.
LZSN	Lower zone nominal storage. An index to the soil moisture holding capacity.
UZSN	Upper zone nominal storage. An index to the amount of surface storage in depressions and the upper few inches of soil.
BASETP	Fraction of available potential evapotranspiration demand that can be met from groundwater outflow. Simulates evapotranspiration from riparian vegetation.
AGWETP	Fraction of available potential evapotranspiration demand that can be met from stored groundwater. Simulates evapotranspiration from phreatophytes, in general.
AGWRC	Groundwater recession parameter. An index of the rate at which groundwater drains from the land.
KVARY	Groundwater outflow modifier. An index of how much effect recent recharge has on groundwater outflow.
DEEPFR	Fraction of groundwater that does not discharge to the surface within the boundaries of the modeled area.
LSUR	Average length of the overland flow plane (pervious or impervious surface).
SLSUR	Average slope of the overland flow plane (pervious or impervious surface).
NSUR	Average roughness of the overland flow plane (pervious or impervious surface).

Infiltration was estimated for each polygon by computing an area-weighted mean permeability value with the following equation:

$$I = \frac{\sum_{i=1}^{n} (a_i P_i)}{\sum_{i=1}^{n} a_i}$$

where;

I = area-weighted minimum infiltration value,
a_i = area in acres for each soil,
P_i = minimum permeability value for each soil, and
n = number of polygons in the basin.

The soil capacity for water storage was estimated by multiplying the available water capacity by the depth to the seasonally high water table. This produced an estimate of pore volume for each soil. An area-weighted mean storage volume was computed for each polygon. Values for parameters, which had not been measured, were initially estimated from relevant literature values, then slightly adjusted, based on a sensitivity analysis.

3.3.5.2 HYDROLOGIC CALIBRATION

Parameter calibration was used to estimate the approximate global optimum of several modeling parameters which were not measurable in the field. Ultimately, the point of calibration was to reduce the difference between the objective function for a computed time series and an observed time series. Calibration was complete when the degree of fit between observed and computed objective functions was minimized.

Hydrologic calibration was accomplished using USGS flow data from 1998 through 2001 from nine stream flow stations. Hydrologic calibration was generally fair, with good simulations in Beargrass, Silver and Goose Creeks. Fair calibrations were accomplished in Harrods Creek and poor calibrations were accomplished in Kentucky's Mill Creek and the Mill Creek Cutoff.

Initial calibration of the hydrologic model was accomplished using expert system techniques, statistical techniques and visual techniques to relate simulated discharge to observed discharge. The initial model was calibrated at a one-hour timestep for the four-year period of 1998 through 2001. Calibration was complete when error statistics were reduced to target levels or further success was limited by the scope of this study.

Calibration time series (O_{t1} - O_{tn}) were generated from continuous monitoring data and routine wet and dry weather monitoring data. After each iterative run of the HSPF model, the simulated data (S_{t1}) were paired with and compared against relevant observed data (O_{t1}), to produce residuals ($R_{t1} = S_{t1} - O_{t1}$). These residuals were subdivided into categories by month, by flow, by air temperature, etc., and the results were assessed for both the total and the systematic difference. The model was then adjusted to reduce any systematic differences and run again. This calibration procedure was repeated over 500 times during this study.

The following model fit statistics were calculated for the model calibration and confirmation:

- Mean and standard deviation of the observed and simulated stream flows,
- Mean and standard deviation of the residuals (simulated value - observed value)
- Relative error (simulated value - observed value)/observed value,
- Coefficient of efficiency, and
- Coefficient of determination.

3.3.5.3 WATER QUALITY CALIBRATION

Hourly estimates of bacterial inputs were transferred to the HSPF model using the EXT-SOURCES module. The data included WWTP and CSO inputs of water volumes in acre-ft/ivld, bacteria counts in CFU/ivld and mass in pounds/ivld, where "ivld" is the time interval of the

data. The WWTPs contributed low-level inputs continuously and the CSOs contributed periodic, storm-related inputs. Methods for producing the WWTP time-series were more accurate than those for producing the CSO data.

The primary accumulation and removal processes that control fecal coliform bacteria were derived for the pervious and impervious land surfaces in the drainage areas. Bacteria were characterized by the following three parameters: (1) the daily rate, in CFU/acre, at which bacteria accumulate on the surface in scat, livestock feces, or applied manure; (2) the limit, in CFU/acre, of bacteria build-up on the surface, and (3) the rate of surface runoff, in inches/hour, that removes 90 percent of the accumulated bacteria from the surface.

The daily rate was varied monthly and spatially in the pervious land segments, but only spatially in the impervious land segments. Initial values were estimated based on animal populations and manure applications. The limit also functions as a decay rate, on the assumption that the accumulation of bacteria on the surface will reach an asymptotic limit determined by a daily die-off rate. This resulted in initial limit values which were approximately nine times the application rate.

The rate of surface runoff was determined by calibration for each of the HRUs. Fecal coliform bacteria were represented as a dissolved substance subject to temperature-corrected, first-order decay. The decay rate of bacteria for any given timestep was determined by raising the decay rate at 20 degrees Celsius to the (T-20) power, then multiplying by the factor 1.07, where T is the water temperature in degrees Celsius. The decay rate was determined by calibration and varied by RCHRES segment.

3.3.5.4 HSPF MODEL ERROR ANALYSIS

A key goal of continuous hydrologic modeling is to use mathematics and physics to produce an artificial system which is analogous in structure and dynamics to a simplified drainage basin. An adequate model should convert precipitation data into stream flow data in a manner analogous to the prototype basin conversion. Error-free simulation is never possible because of the necessary simplification processes and the fact that the true basin response is spatially and temporally continuous while model simulation is always discrete and most data available for input are discrete. Discrete information was interpolated across the modeled basin. Interpolation methods used in this model included continuous smoothing techniques such as kriging, and discrete classification techniques, such as cluster analysis. The resulting integral contains original measurement error, translation error, interpolation error and scaling error.

A hydrologic post-audit of the model was conducted for six subbasins to further evaluate the lack of model fit or error. Model error was evaluated in terms of the residuals from the simulated and observed discharge series because of the ease of interpretation. Other error terms were also evaluated, such as the error in the logarithm-transformed data, and the relative difference. These error terms were useful for assessing accuracy for simulation of low flows as well as high flows. The absolute error of the nontransformed simulated values minus the observed values exaggerates the influence of the high flows.

The general results regarding the systematic pattern in the error were the same regardless of the error term used. Subtraction of the observed data from the simulated data results in a vector of residuals, which, if positive, indicate oversimulation and, if negative, indicate undersimulation. Residual values of zero indicate no deviation or perfect agreement between the model expression and the observed data.

Residuals were generated for the maximum daily flow, the median daily flow and the minimum daily flow. The model ran at a five-minute timestep, which produced 288 values per day. Assessment of mean daily flow values alone was inappropriate because a principle objective of the model was water quality simulation.

Model bias was investigated using nonparametric regression techniques commonly referred to as smoothing. Traditional methods for evaluating relationships between two variables may be inefficient because bias may not exhibit simple linear relationships to the processes of interest. Parametric methods may even introduce bias if the assumptions of the relationships between the two variables are wrong. Graphical methods provided a quick and reliable means to evaluate the results of nonparametric regression. The smooth generated by the nonparametric regression was overlain on scatterplots of the residuals versus time, flow duration curves, flow recession curves, estimates of basin dryness (storage characteristic), rainfall variability, etc.

3.4 RESULTS

Output data were produced using a combination of databases and modeling techniques. Databases included the ORSANCO wet weather database, the Louisville MSD Beargrass Creek Wet Weather Tool database, the Louisville MSD long-term monitoring database, the Louisville MSD contact recreation database, the continuous water quality monitoring network, the precipitation gaging network, the NCDC meteorological database, the USGS stream flow gaging network, the USGS atmospheric deposition network, historically available water quality information maintained in the USEPA STORET database, and an ACOE Phase II environmental assessment of Fourteen Mile Creek. These databases were combined and used to simulate, calibrate and confirm a system of statistical and mechanistic watershed scale models. HSPF was used as an umbrella-modeling tool for integrating hydrology and water quality from point and nonpoint sources. Model output consists of the following hourly timestep data, presented for 12 locations identified by Ohio River mile point of confluence, for the period of October 1, 1997 through September 30, 2001:

- Date and Time
- Location
- Stream Flow and Temperature
- *E. coli* and Fecal coliform
- Total phosphorous
- Total suspended solids
- Total nitrate-nitrogen
- BOD_5
- Total ammonia nitrogen

Appendix F contains plots of event data for locations where observed data were available. These data indicate that the smoothed model fits the upper end of the observed data relatively well, but further calibration efforts are necessary to capture system dynamics with an acceptable level of accuracy.

E. coli bacteria were not simulated separately from fecal coliform, but were instead estimated by applying a conversion factor. Fecal coliform levels were converted to *E. coli* using the following equation:

$$\text{Log 2 (EC)} = -0.0172 + 0.91905 * \text{Log 2 (FC)}$$

where;

EC = *E. coli* concentration (CFU/100 ml)
FC = fecal coliform concentration (CFU/100 ml)

3.5 CONCLUSIONS

The smoothed model output provided boundary conditions for the WASP water quality model. The model fit for hydrology was considered poor to good. Observed data were used to smooth model results such that the boundary condition data were both continuous and generally accurate for all of the WASP simulation periods. R-square values for the smoothed model output exceeded 0.9 for all basins where observed data existed. A similar approach was used for the fecal coliform and *E. coli* data with the biggest difference being that empirically developed models between observed fecal coliform bacteria and stream flow were used as the smoothing agents. Resulting R-square values for the bacteria were still quite poor, however, review of the scatterplots suggested better fits than the statistics.

An alternative to using the smoothed HSPF data was to use the EMC data calculated from the raw data and estimated from event related proportional dependencies. This data presents concentrations that vary spatially and temporally but provides only a single value per site per event.

Using EMCs yields a reasonable prediction of bacteria loads on average, however, individual rainfall events may have significantly different EMCs as a result of differences in antecedent periods, differences in temperature and differences in surface and pipe velocities.

Physical changes to individual overflow regulators during or prior to a rainfall event, such as clogging with debris, may also influence overflow volumes.

4.0 HYDRODYNAMIC MODEL

This section describes the calibration and validation of a two-dimensional Resource Management Associates-2 (RMA-2) model developed to simulate the complex hydrodynamics of the Ohio River in the study area. The field data used to calibrate and validate the model are also described.

4.1 INTRODUCTION

The quantification of current patterns is an essential component of a Water Quality Analysis Simulation Program (WASP) application in a riverine environment. The USGS provided a field validated two-dimensional RMA-2 hydrodynamic model capable of quantifying the steady-flow patterns in the Ohio River extending from river miles 590 to 630. The model was split into two segments because of the hydrodynamic complexities introduced by the McAlpine Locks and Dam located in the middle of the study area. The upstream river reach extended from the dam upstream to the upper boundary of the study area at Ohio River mile 590, and the downstream reach extended from the dam downstream to a lower boundary at Ohio River mile 630.

The model was calibrated to a low-flow hydraulic survey with a flow of approximately 35,000 cubic feet per second (cfs) and verified by a high-flow hydraulic survey with a flow of approximately 390,000 cfs. The model calibration and validation process included matching water-surface elevations at ten locations and velocity profiles at 30 cross sections throughout the study area. Based on the calibration and validation results, the model is a representative simulation of the Ohio River steady-flow patterns below discharges of approximately 400,000 cfs.

4.2 SCOPE

As mentioned above, this model was developed in two segments, one upstream of the dam and one downstream. Floodplains were not included in the model domain because of the project emphasis on low-flow periods spanning the contact recreation period of May through October. The final model was used to simulate the steady-flow patterns of the Ohio River for flows ranging from 6,500 to 197,700 cfs. The lower limit of the simulated flows is consistent with the discharge during a dye survey conducted in September 1999 (discussed in further detail in Section 5.3.4). The upper limit of the simulated flows corresponds to the 90-percentile flow during the contact recreation period based on historical discharge data from 1987 through 1998. Although more historical discharge data are available, ORSANCO and a private consultant chose to use only recent data to determine the 90^{th}-percentile flow.

4.3 STUDY AREA

The Ohio River study area begins at the northeast corner of Jefferson County, Kentucky, extends southwestward through the county, and ends at the mouth of the Salt River. The upstream reach is located in the McAlpine Pool, where the water level is kept at an elevation of approximately 420 feet above sea level during low-flow periods. The downstream reach of the study area is located in the Cannelton Pool, where the water level is held at an elevation of

approximately 383 feet above sea level. The channel has a trapezoidal geometry with steep banks rising at slopes greater than 22 percent (0.22 feet/foot). The banks along the upstream reach extend to an approximate elevation of 440 feet, whereas the banks of the downstream reach rise to approximately 420 feet.

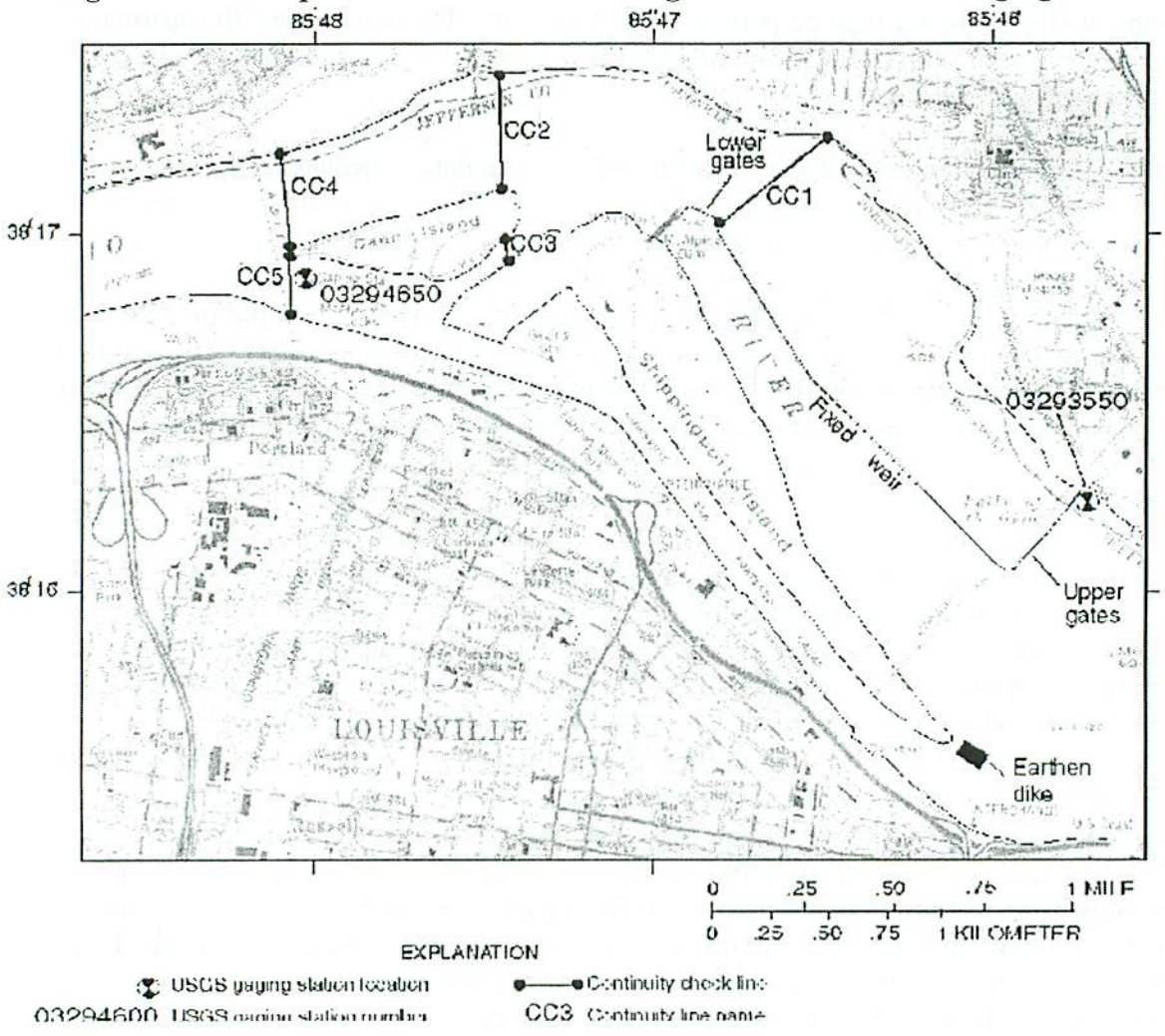
The following river characteristics were determined from the data collected during the hydrographic surveys. At a discharge of 36,000 cfs, the average depth of the river thalweg was approximately 30 feet in the upstream reach and 20 feet in the downstream reach. The average width of the river was approximately 3,000 feet in the upstream reach and 1,600 feet in the downstream reach. A discharge of 390,000 cfs produced an average depth in the thalweg of approximately 45 feet in both the upstream and downstream reaches. The width of the river was approximately 4,000 feet in the upstream reach and 2,500 feet in the downstream reach. The bank and bed material of the study area varies between cohesive and noncohesive sediment. The bank vegetation predominately consists of small shrubbery and vegetation, and is void of large trees.

The structures that compose the McAlpine Locks and Dam are located on the northwestern side of Louisville, Kentucky, and extend from Ohio River mile 604.4 to 607.4. The current lock and dam configuration, as shown in Figure 4-1 on the following page, consists of a hydroelectric powerhouse; two lock chambers (one 600 by 110 feet and the other 1,200 by 110 feet in length and width, respectively); nine tainter gates, four near the powerhouse and five just upstream of the Conrail Railroad Bridge; and a fixed weir with a crest at an elevation of 422 feet at the downstream gates, incrementally raised to an elevation of 423 feet at the upper set of gates. An earthen dike was constructed at the upstream end of Shippingport Island to reduce the crosscurrents affecting vessels navigating the lock canal. The shoal area that exists downstream from the upper gates and fixed weir is referred to as the Falls of the Ohio and is an area of archeological importance. To facilitate public use of the fossil beds at the Falls of the Ohio, the ACOE has agreed to a two-month operational period (typically August-October) each year when the fixed weir and upper gates are not used to pass flow, except for extreme hydrological events. Under low flow or when the upper gates of the McAlpine Dam are not in operation, the Falls of the Ohio is an area of slack flow.

4.4 MODEL CALIBRATION AND VALIDATION

At least two data sets are required to adequately calibrate and validate a numerical model. The general procedure used to calibrate and validate the RMA-2 model was to first collect field data in order to develop the computational mesh. The model was then calibrated to the water-surface elevations and velocities observed in the field for the initial flow. A second flow condition was then simulated without changing the computational mesh or model parameters, and the simulated water-surface elevations and velocities were compared with those observed in the field for this second flow condition.

Figure 4-1. McAlpine Locks and Dam Configuration with USGS Gaging Stations



4.4.1 MODEL DESCRIPTION

RMA-2 is a two-dimensional, depth-averaged, finite-element hydrodynamic numerical model, capable of computing water-surface elevations and horizontal-velocity components for subcritical, free-surface flow in two-dimensional flow fields. The model is designed for problems in which vertical accelerations are negligible, and velocity vectors generally point in the same direction over the entire depth of the water column at any discrete period in time.

Typical applications of the RMA-2 numerical model include calculating water-surface elevations and flow distribution around islands; flow patterns at bridges having one or more relief openings, in contracting and expanding reaches, into and out of off-channel hydropower plants, and at river junctions; circulation and transport in water bodies with wetlands; and water levels and flow patterns in rivers, reservoirs, and estuaries.

One of the predominating operating assumptions in RMA-2 is that acceleration of flow in the vertical direction is negligible. The model is not intended for applications in which vortices, vibrations, or vertical accelerations are the primary interests; therefore, the simulation of vertically stratified flow fields is beyond the capabilities of RMA-2.

4.4.2 FIELD DATA COLLECTION AND INTERPRETATION

Water-surface elevations, channel-bathymetry, and detailed water-velocity measurements were collected at two flow conditions (36,000 and 390,000 cfs) and used in the model for calibration and validation, respectively. Water-surface elevations were measured at ten locations, four upstream and six downstream, along the study reach concurrent with both hydraulic surveys. Detailed water-velocity measurements and channel bathymetry data were collected at 30 cross sections, 12 upstream and 18 downstream, during each of the hydraulic surveys. The cross sections were spaced approximately 1.5 miles apart. The maps on the following two pages show the upstream, Figure 4-2, and downstream, Figure 4-3, sampling locations. A separate data-collection trip was used to collect channel-bathymetry data in sufficient detail for the development of a computational mesh.

4.4.3 WATER-SURFACE ELEVATIONS

Water-surface elevations were surveyed with a total station at seven locations throughout the reach. To document the changes in river stage during a hydraulic survey, the water-surface elevations were surveyed in the morning and then again in the afternoon. The average water-surface elevation was used to determine a water-surface slope corresponding to the average discharge measured during the survey.

The 40-mile study section of the Ohio River includes a total of four USGS stream gages—two each in both the upstream and downstream reaches. Both upstream gages—gage number 03293548 located on the Second Street Bridge and gage number 03293550 located at the Indiana Pass—are located near river mile 604 and provided to assist the ACOE, Louisville District in maintaining the McAlpine normal pool elevation. The Second Street Bridge gage is located on a pier near the center of the channel about 4,000 feet upstream from the McAlpine Dam, and the Indiana Pass gage is located on the Indiana shore about 500 feet downstream from the Second Street Bridge gage. The McAlpine tailwater and Kosmosdale gaging stations (numbers 03294500 and 03294600, respectively) are located within the downstream reach. The McAlpine tailwater gage is located near the Kentucky shore on the downstream end of the lock guide wall at river mile 607). The Kosmosdale gage is located on the Kentucky shore, approximately 19.8 miles downstream from the tailwater gage at river mile 628.

Figure 4-2. Upstream Sampling Locations

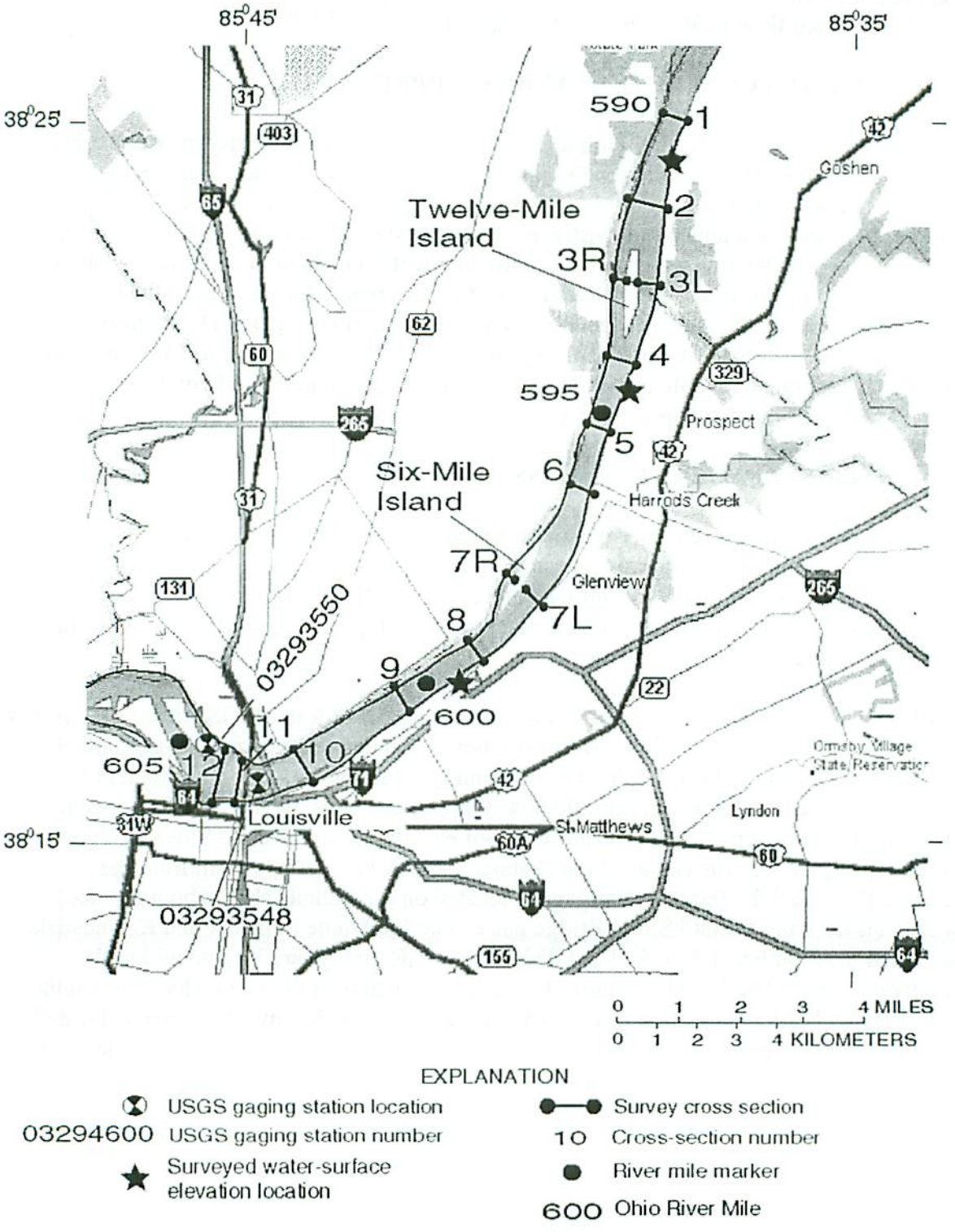
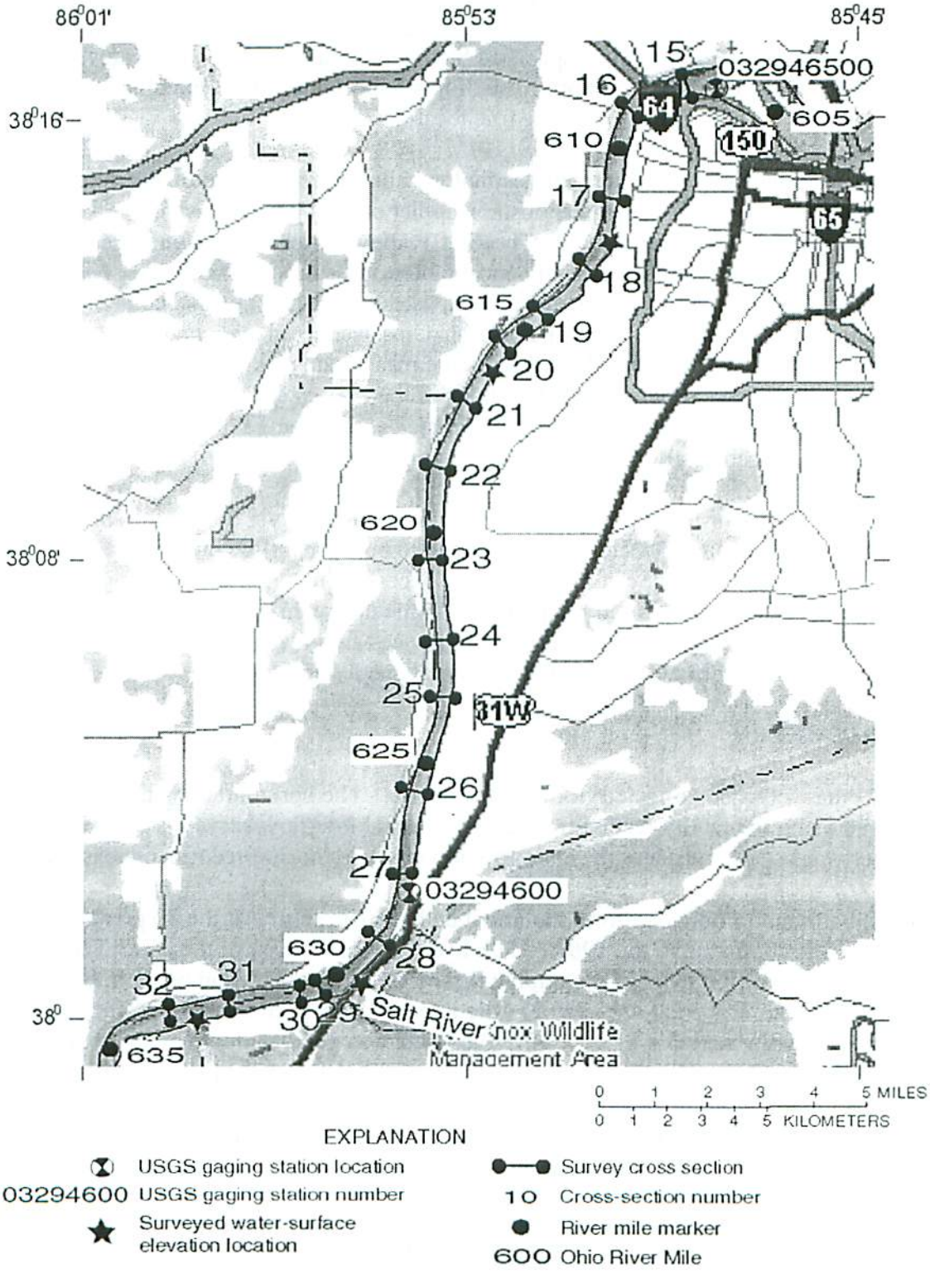


Figure 4-3. Downstream Sampling Locations



4.4.4 VELOCITY AND DISCHARGE

Water-velocity and discharge data were collected from a moving boat. The horizontal position of the boat was measured using a differentially corrected global positioning system (DGPS) receiver. This DGPS system receives its differential corrections from a commercial service communications satellite. It is specified by the manufacturer to be accurate to 3.3 feet at two standard deviations. Tests and prior use of this unit indicate that typically about 80 percent of the data are within 3.3 feet of the true location.

Recent advances in velocity-measurement technology allow three-dimensional velocities to be collected from a moving boat using an acoustic Doppler current profiler (ADCP). All velocities were measured with an ADCP. The ADCP allows three-dimensional velocities to be measured from approximately four feet beneath the water surface to within six percent of the depth to the bottom. Established methods were used to estimate the discharge in the unmeasured top and bottom portions of the profile. Cross-sectional average velocities were computed by dividing the measured discharge by the measured cross-sectional area. Depth-averaged velocities were computed for subsections of the flow in each cross section; however, these discrete depth-averaged velocities were computed as an average of the measured velocity and did not account for the velocity in the unmeasured portions of the water column.

In order to compensate for the slight changes in discharge of the river during the survey, all the discharge measurements collected were averaged to produce a flow rate that was representative of the entire survey period. The time necessary to complete a hydraulic survey on each of the simulated sections did not permit both the upstream and downstream reaches to be surveyed on the same day; therefore, minor differences are present in the discharge measurements used to calibrate and validate the upper and lower models.

4.4.5 BATHYMETRY

Bathymetry data were also collected from a moving boat. The horizontal position of the boat was measured using the DGPS receiver. During the initial low-flow survey, a 200-kiloHertz echo sounder was used to measure the channel bathymetry at the 30 predefined cross sections.

The channel bathymetry obtained from the initial bathymetric survey at the 30 predefined cross sections was compared to the 1963 ACOE hydrographic survey of the area. The surveyed data points of the 1963 hydrographic survey were digitized from paper maps along straight cross sections spaced at one-quarter mile intervals and oriented perpendicular to flow. A triangulated irregular network (TIN) of the 1963 data was generated to extract cross sections from the 1963 data for the 30 locations surveyed for this project. The shapes of the cross sections measured in the downstream reach were similar to cross sections extracted from the 1963 hydrographic-survey data. Differences in elevation were within the errors expected from the survey technologies of 1963 and those used in this survey. Data from the 1963 hydrographic survey were used for the downstream reach channel bathymetry in the hydrodynamic model. The shape of the cross sections measured in the upstream reach displayed differences from the cross sections extracted from the 1963 hydrographic-survey data, therefore, a second bathymetric survey of the upstream reach was completed with cross

sections spaced approximately 1,000 feet apart. The second bathymetric survey of the upstream reach was used for the channel bathymetry in the hydrodynamic model.

Bathymetric data surveyed with the echo sounder in the upstream reach did not fall on perfectly straight cross sections because of inconsistencies in the boat course across the river. The internal triangulation routine done by the RMA-2 interface software package—Surface-water Modeling Systems (SMS), version 7.0—did not properly interpret the collected bathymetry data, resulting in triangulation within the same cross section and a large portion of the area between two cross sections estimated with only three data points. An example of the raw-data triangulation is presented in Figure 4-4A. The raw data collected along each cross section was mathematically forced onto a straight line and re-triangulated. Figure 4-4B shows the re-triangulation of the section shown in Figure 4-4A. Although forcing the data points onto a straight line introduces some error, the straight-line cross sections produced a better representation of the upstream channel bathymetry than the unadjusted data.

4.4.6 UPSTREAM RIVER REACH

The simulated upstream reach begins three miles upstream of the Jefferson/Oldham County line at Ohio River mile 590, and extends downstream to the McAlpine Dam at Ohio River mile 607. Twelve Mile Island, located at Ohio River mile 593, and Six Mile Island, located at Ohio River mile 598, add hydraulic complexities to this reach. The configuration of the McAlpine Dam includes upper and lower sets of tainter gates and a hydropower plant that served as downstream boundary conditions for the model.

4.4.6.1 COMPUTATIONAL-MESH CONFIGURATION

The finite-element network for the upstream river reach consisted of 6,920 elements. The islands and dike were simulated by installing gaps in the mesh because the simulated flows did not overtop these features (Figures 4-5 and 4-6). The boundary nodes at the upstream and downstream points of the islands were specified as "stagnation points," defined as locations of zero velocity. These specifications generally are located in corners of grids or along boundaries with relatively negligible flow velocities and are applied to reduce artificial loss of discharge out of the channel boundaries. The resolution of the grid was increased in the area around the McAlpine Dam in order to reproduce the hydraulic complexities induced by these structures (Figure 4-7). In order to maintain numerical stability, the sloping banks were truncated at an elevation of 418 feet. Above this elevation, the banks were assumed to be vertical walls.

Figure 4-4. Surface Water Modeling Triangulation for Part of Upstream Reach

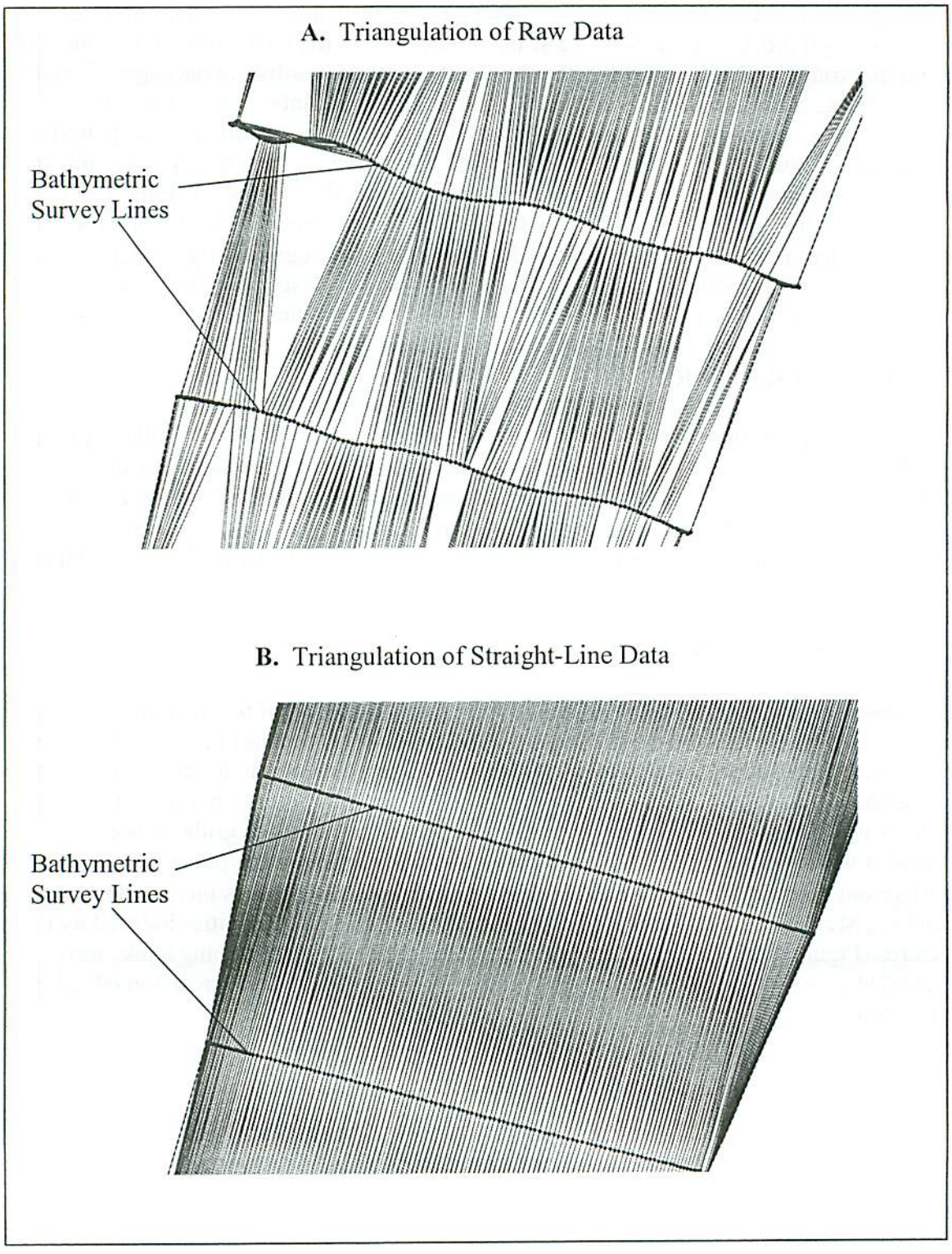


Figure 4-5. Mesh Configuration Around the Earthen Dike Located Upstream of McAlpine Dam

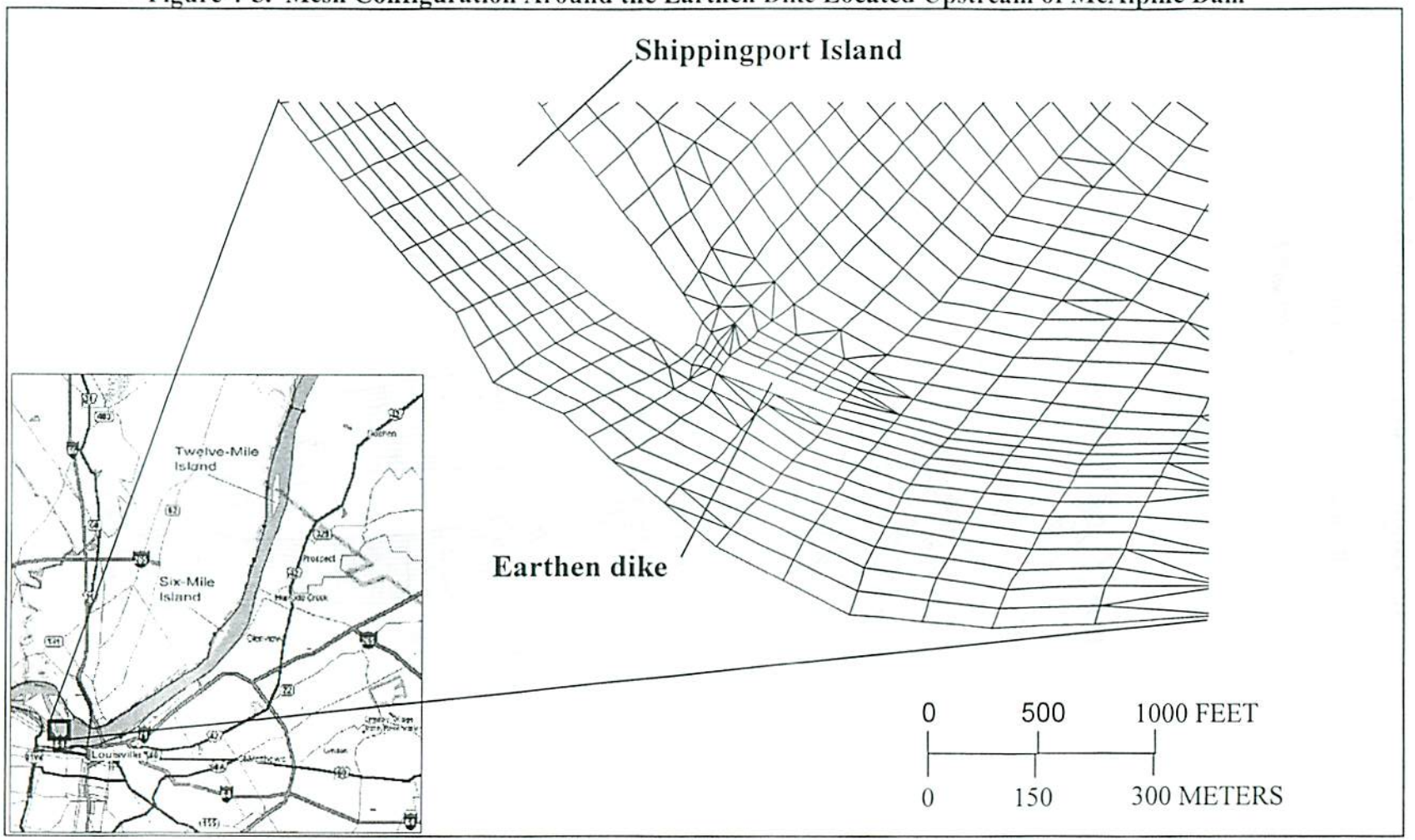


Figure 4-6. Mesh Configurations Around Six and Twelve-Mile Islands

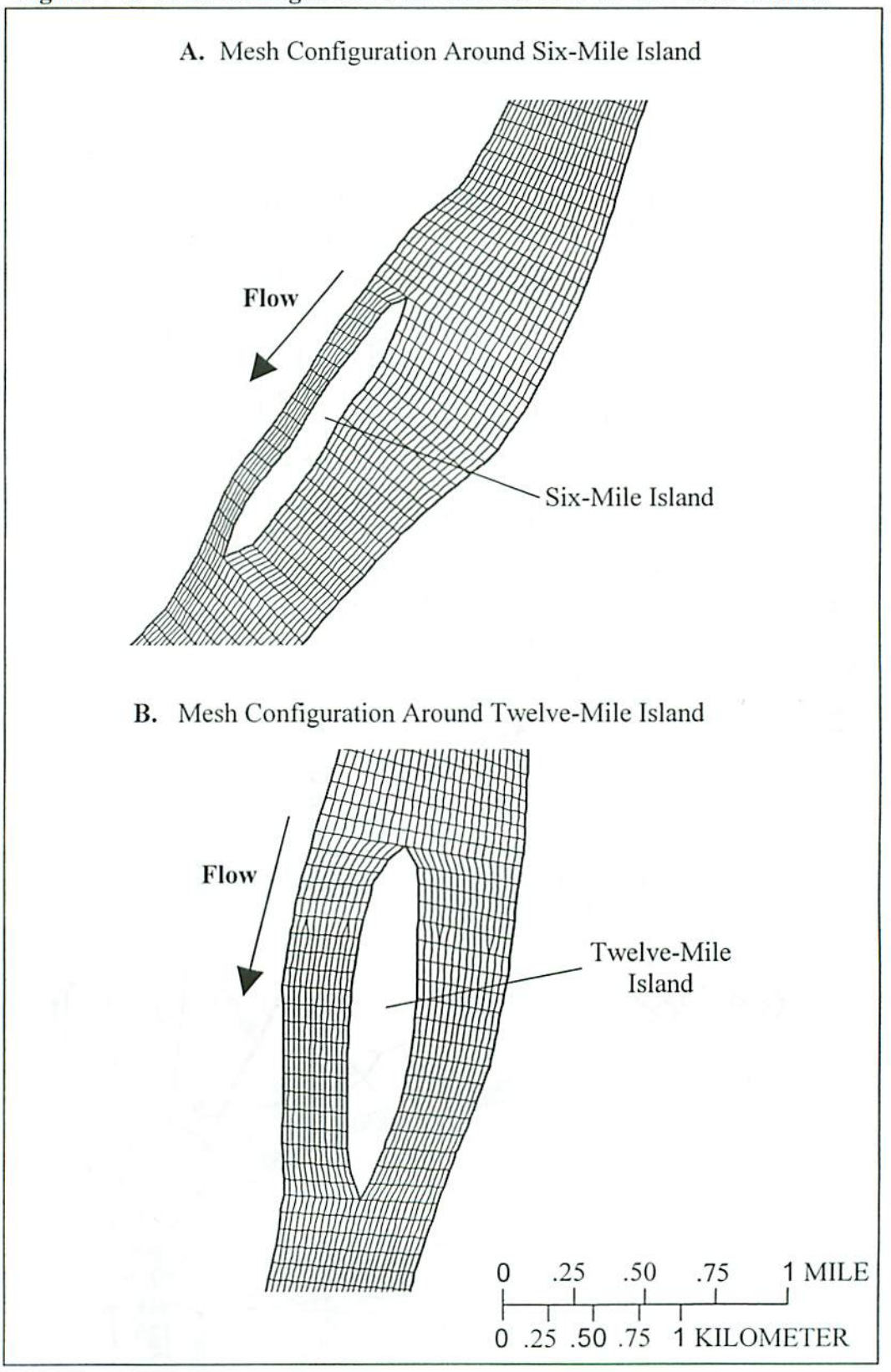
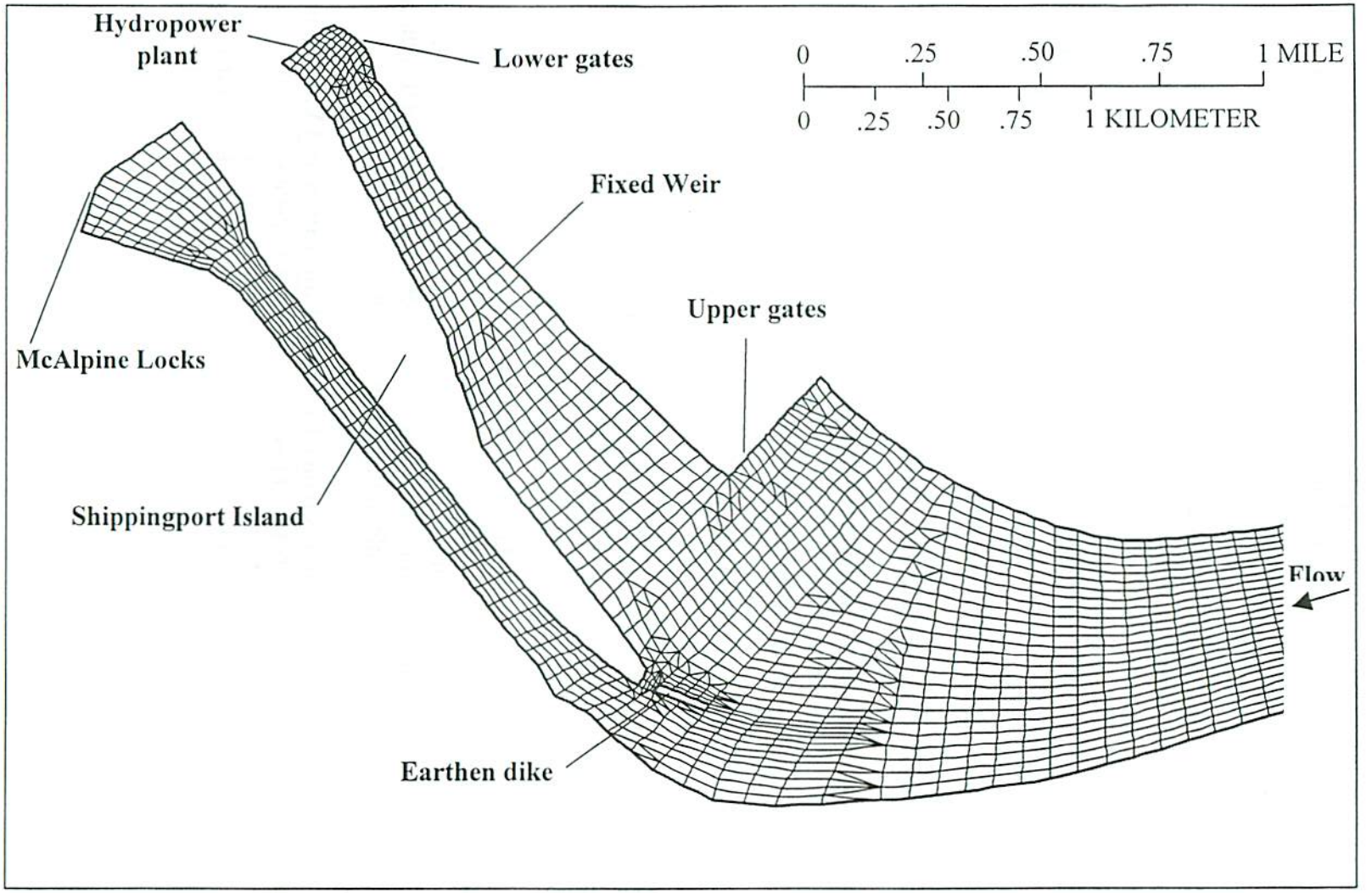


Figure 4-7. Mesh Configuration Around McAlpine Locks and Dam in Upstream Reach



4.4.6.2 BOUNDARY CONDITIONS

Steady-state discharges of 34,000 and 383,000 cfs were used to calibrate and validate the model. These discharges were used as the upstream boundary condition for the model and the lateral-flow distribution was assumed to be uniform across the inflow boundary for both discharges.

The downstream boundary condition consisted of outflows through the lower gates and hydropower plant (low-flow only) and a head condition assigned to the upper gates. The lower set of tainter gates carried 14,000 cfs, whereas the hydropower plant passed the remaining 20,000 cfs under the low-flow condition. At 383,000 cfs, the flow is divided between the upper and lower gates, with 126,350 cfs passing through the lower gates and the remaining 256,650 cfs passing through the upper gates. The McAlpine Pool elevations for both discharges were determined from the USGS gaging station records at Indian Pass and Second Street Bridge. The normal pool elevation of 419.6 feet was used for the 34,000 cfs flow, and a pool elevation of 423.9 feet was used for the 383,000 cfs flow.

4.4.6.3 RESULTS OF CALIBRATION AND VALIDATION

Data from the low-flow hydraulic survey were used to calibrate the model, and data from the high-flow survey were used to validate the model. The calibration and validation process consisted of comparing the simulated water-surface elevations and velocity profiles, with those surveyed in the field. A Manning's roughness coefficient was assigned to each element and iteratively adjusted until the model adequately simulated the surveyed water-surface elevations and velocity profiles.

Inspection of the velocity profiles collected in the field revealed no-slip conditions along the riverbanks, indicating that the shear stress along the banks is great enough to cause the tangential velocity to approach zero. To simulate this characteristic with RMA-2, the Manning's coefficient was increased to 0.035 for one row of elements along the outer boundary of the mesh. The calibrated Manning's coefficient in the remainder of the channel was 0.024. This combination produced the best simulation of water-surface elevation, velocity magnitudes, and lateral-velocity distribution for both low- and high-flow conditions, as shown in Table 4-1. Matching the high-flow water-surface elevations verified that the area lost by truncating the banks was negligible in the model simulation.

Table 4-1. Upstream Reach Water Surface Elevation Calibration and Validation

	8/13/1998 Low Flow			2/16/2000 High Flow		
Station	Field WS Elev (feet)	Model WS Elev (feet)	Difference (feet)	Field WS Elev (feet)	Model WS Elev (feet)	Difference (feet)
Harmony Landing	419.99	419.66	-0.33	427.59	427.68	0.09
Louisville Water Co.	419.91	419.64	-0.27	426.51	426.46	-0.05
Cox's Park Well	419.86	419.62	-0.24	425.19	425.04	-0.15
Indiana Pass	419.60	419.60	0	423.88	423.90	0.02

The simulated velocity magnitudes and distributions compared well with the field measurements. A comparison of the simulated and field velocity profiles for cross section number 5 (located 13 miles upstream from the McAlpine Dam) is shown in Figure 4-8. The shapes of the field and simulated velocity distributions were similar, whereas, the velocity magnitudes were within 0.1 ft/s on average. The model adequately reproduced the average field velocities for the 12 cross sections, as shown in Figures 4-9 and 4-10. The model also accurately reproduced the measured flow distributions around Twelve and Six-Mile Islands, as shown in Table 4-2.

Table 4-2. Summary of Flow-Split Calibration and Validation for Upstream Islands

	Low Flow		High Flow	
Location	Field Flow split (percent)	Model Flow split (percent)	Field Flow split (percent)	Model Flow split (percent)
Twelve Mile Island - Right	53.6	51.7	51.6	49.9
Twelve Mile Island - Left	46.4	48.3	48.4	49.5
Six Mile Island - Right	8.9	7.8	11.2	10.0
Six Mile Island - Left	91.1	92.0	88.8	90.0

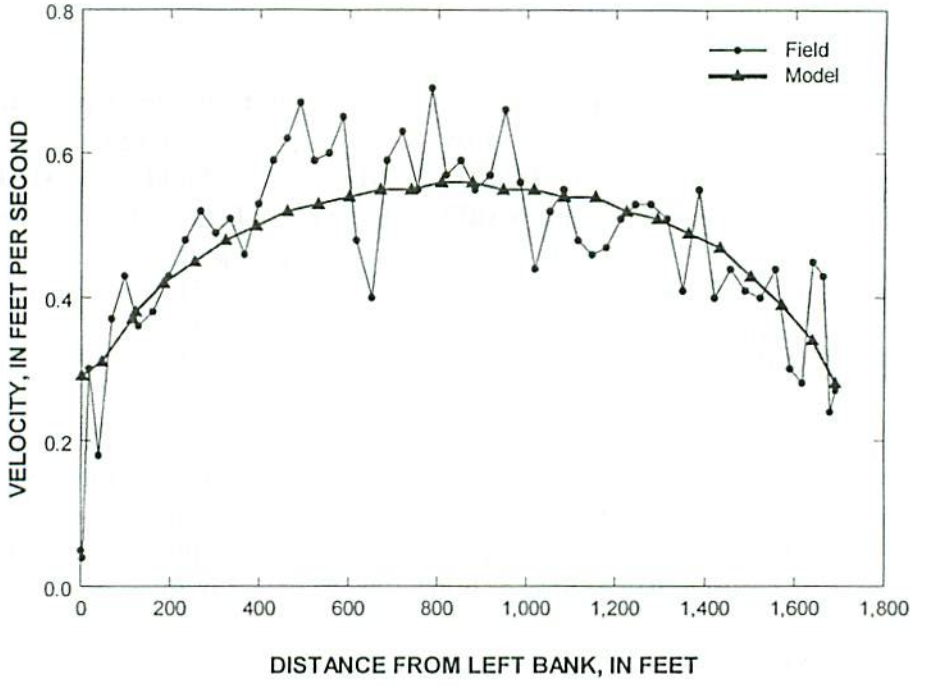
Continuity was checked throughout the downstream model to assure that mass was being conserved. The model conserved mass throughout the reach under high flow, but a three percent loss resulted under low flow in the approach to the lower tainter gates and hydropower plant (see Table 4-3). A tolerance of plus or minus three percent in mass-conservation discrepancy is typically acceptable for most models. Algorithms used to import RMA-2 output into the WASP water-quality model can correct for mass-conservation discrepancies.

Table 4-3. Continuity Checks for Upstream Reach

	Percent of Total Discharge	
Continuity Check Line Description	Low Flow	High Flow
Inflow	100	100
Cross Section 2	99.5	99.8
Cross Section 3R	51.8	50.1
Cross Section 3L	48.2	49.5
Cross Section 5	100	100
Cross Section 7R	8.0	10.2
Cross Section 7L	92.0	89.6
Cross Section 11	100	99.7
Upper Gates	0	66.5
Lower Gates	45.2	32.8
Hydropower Plant	52.0	0
Total Outflow	**97.2**	**99.3**

Figure 4-8. Velocity Profiles for Cross Section Number Five

A. Low-flow velocity profile comparison



B. High-flow velocity profile comparison

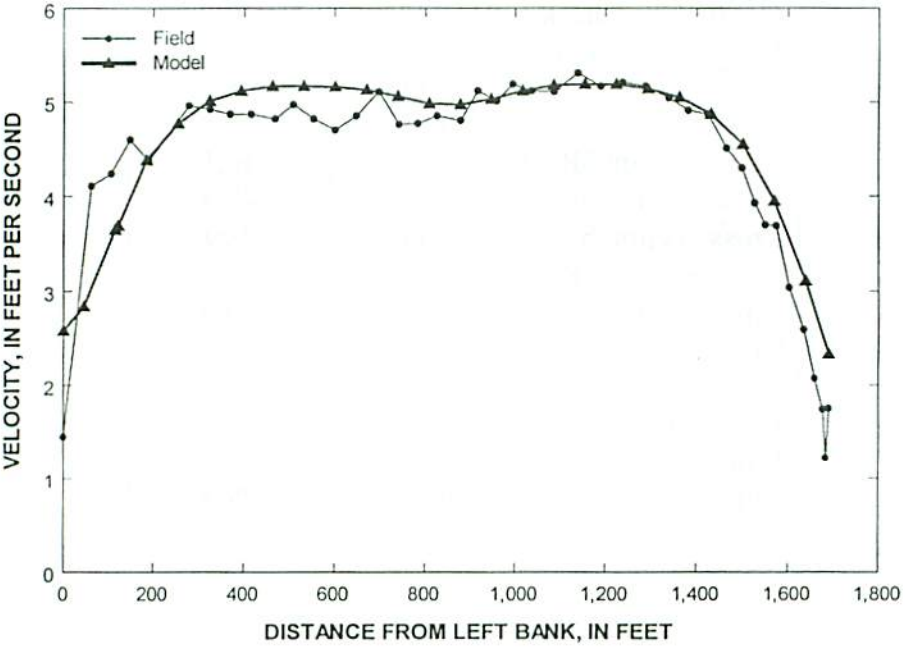


Figure 4-9. Low-Flow Cross-Sectional Velocities in Upstream Reach

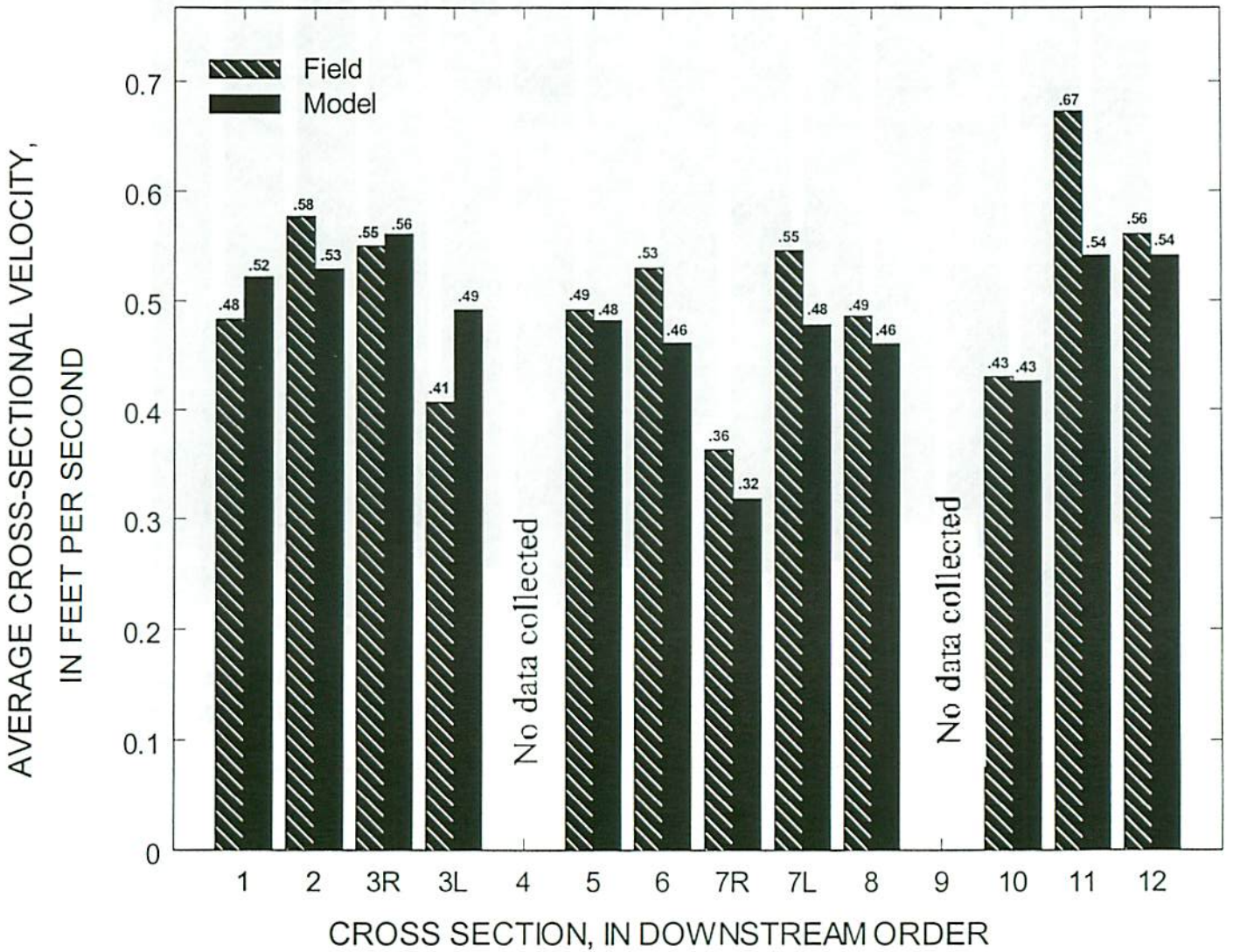
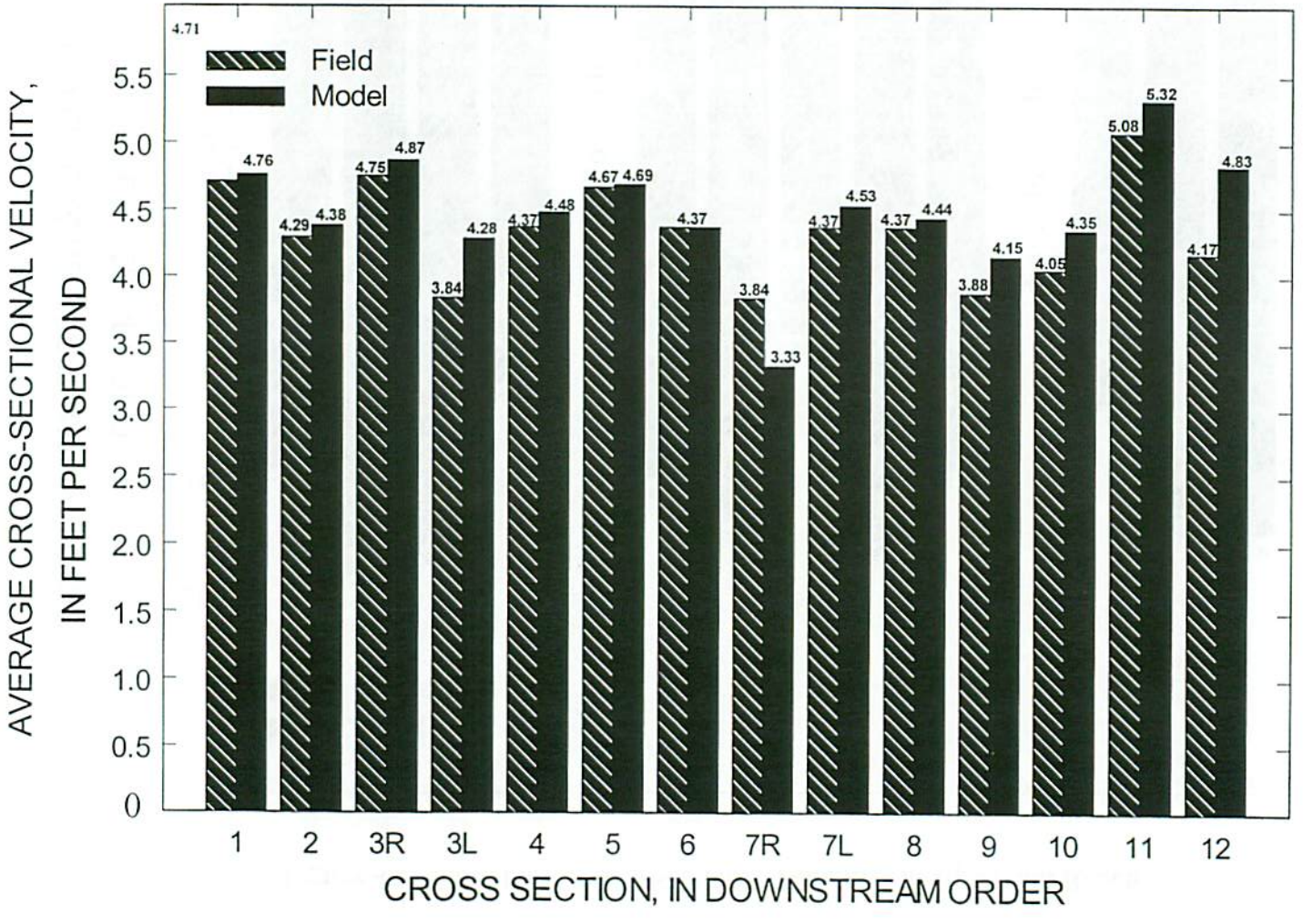


Figure 4-10. High- Flow Cross-Sectional Velocities in Upstream Reach



4.4.7 DOWNSTREAM RIVER REACH

The simulated downstream reach begins at the McAlpine Dam at Ohio River mile 607 and extends downstream to Ohio River mile 630. This section of the model is located in the Cannelton Locks and Dam pool, which is held at a normal pool elevation of 383 feet. Two sets of tainter gates, a hydropower plant, a lock wall supported on piles which allow flow beneath the wall, and Sand Island all contribute to the hydraulic complexities of the area located immediately downstream of the McAlpine Locks and Dam.

4.4.7.1 COMPUTATIONAL-MESH CONFIGURATION

The finite-element network for the downstream river reach consisted of 10,803 elements. In order to maintain numerical stability, the sloping banks were truncated at an elevation of 380 feet. Above this elevation, the banks were assumed to be vertical walls.

Sand Island and an unnamed island in the Falls of the Ohio region were simulated by installing gaps in the mesh at the location of these features. The resolution of the grid is increased in the area around Sand Island, the hydropower plant, the lock wall, and both sets of tainter gates to improve simulation of the hydraulic complexities induced by these structures (Figure 4-11). In order to simulate the passage of flow under the lock wall, an increased Manning's roughness coefficient of 0.50 was assigned to the elements representing the lock wall. This value allowed flow through the elements under a much greater resistance. Stagnation points were created at sharp break points along Sand Island and the mesh boundary in the area of the lower tainter gates to reduce artificial loss of discharge through the boundaries.

4.4.7.2 BOUNDARY CONDITIONS

Steady-state discharges of 36,000 and 397,000 cfs were used to calibrate and validate the model, respectively. At 36,000 cfs, the hydropower plant passed 22,000 cfs, whereas the lower gates passed 14,000 cfs. At 397,000 cfs, the inflow is divided between the upper and lower gates, with 266,030 cfs passing from the upper gates and 130,970 cfs passing from the lower gates.

The downstream head-boundary conditions for both discharges were determined from stage-discharge relations developed from USGS gaging station records at the McAlpine tailwater and Kosmosdale. The relation between stage and discharge was determined by plotting the discharge computed for the McAlpine gage with the stages measured at the McAlpine tailwater and Kosmosdale gaging stations (Figures 4-12 and 4-13). A relation between discharge and water-surface slope between the McAlpine tailwater and Kosmosdale gages was also developed (Figure 4-14). The downstream head-boundary conditions were determined by translating the observed water-surface elevations from the Kosmosdale gage, located five miles downstream, to the model boundary by use of the discharge water-surface slope relation. For simulated flows other than those measured for calibration and validation, the stage at Kosmosdale can be determined from a known discharge and the stage-discharge relation and then translated to the downstream end of the model based on the discharge water-surface slope relation (Figure 4-14). The difference between the McAlpine tailwater rating and the RMA-2 simulated water-surface elevation ranges from 0.16 to 0.4 feet.

Figure 4-11. Mesh Configuration Around Tailwater Area

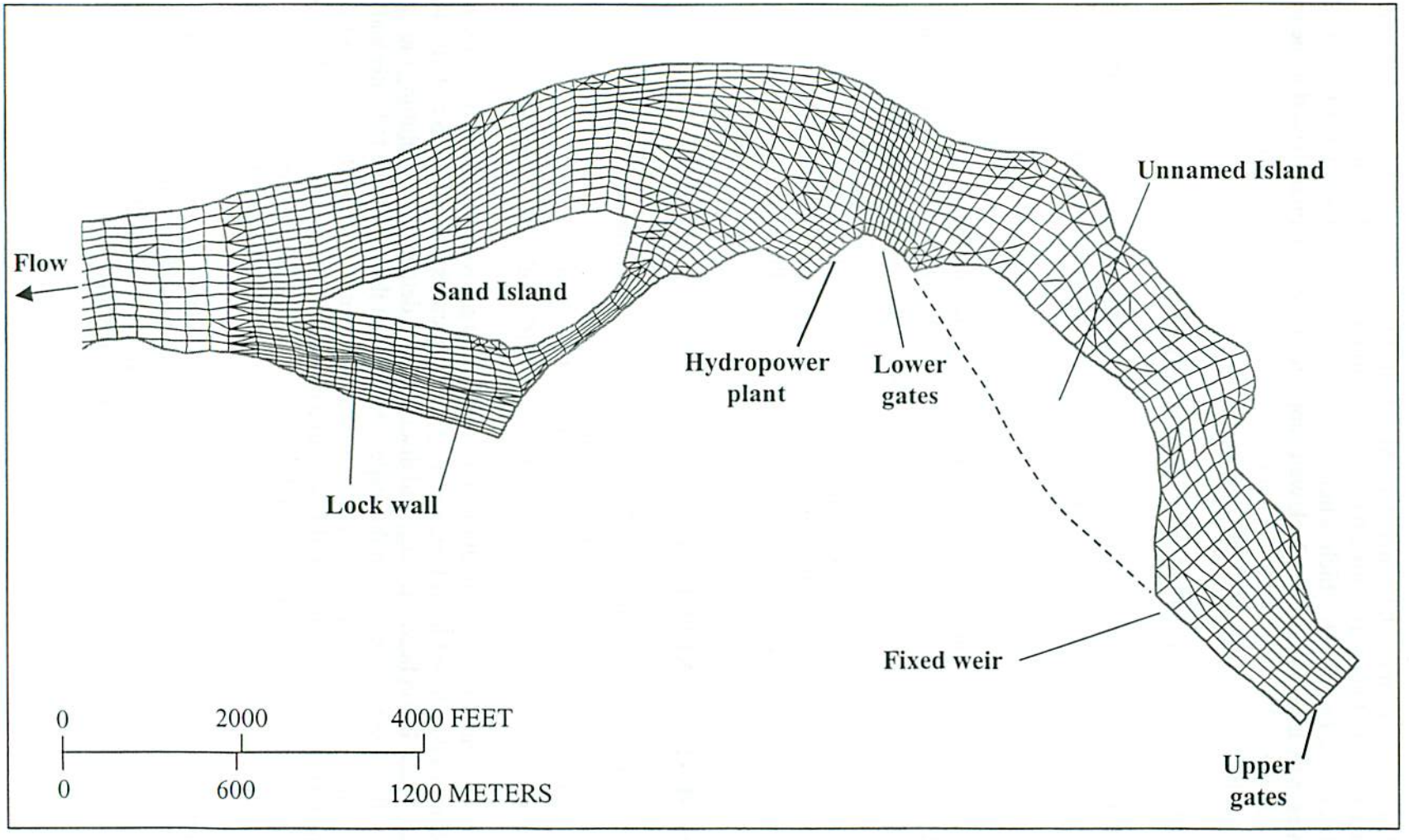


Figure 4-12. Stage-Discharge Curve for McAlpine Tailwater Gaging Station

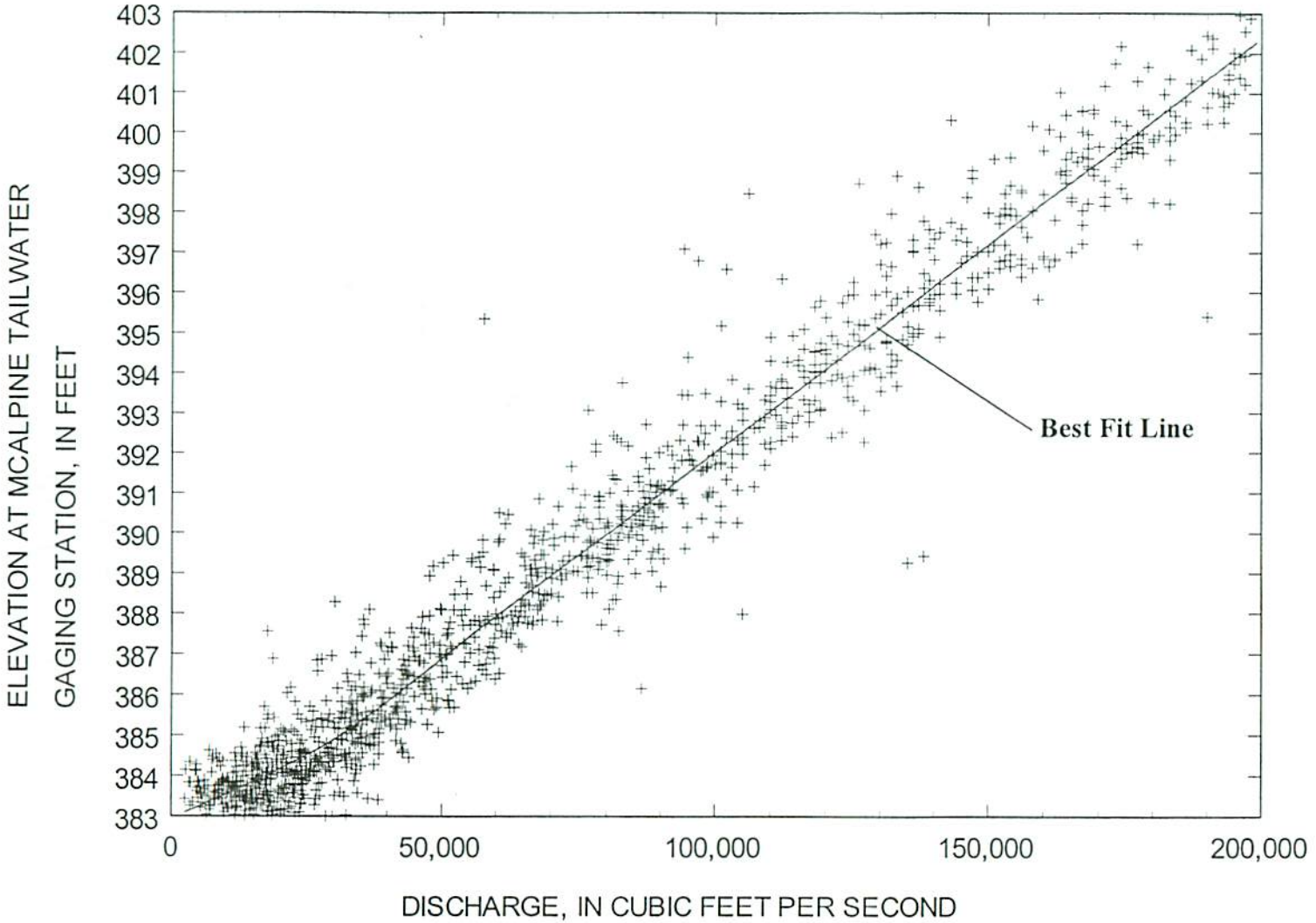


Figure 4-13. Stage-Discharge Curve at Kosmosdale Gaging Station

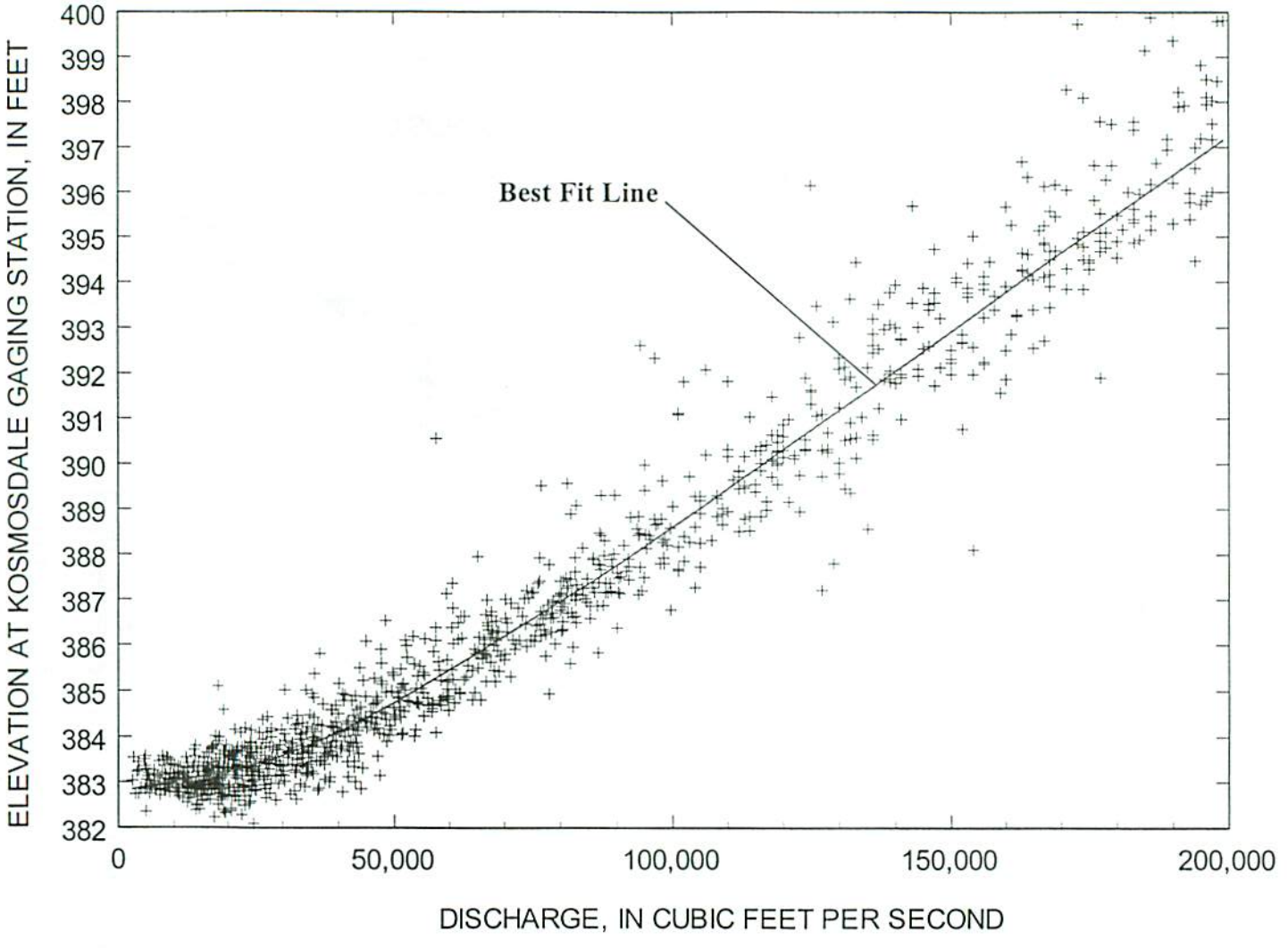
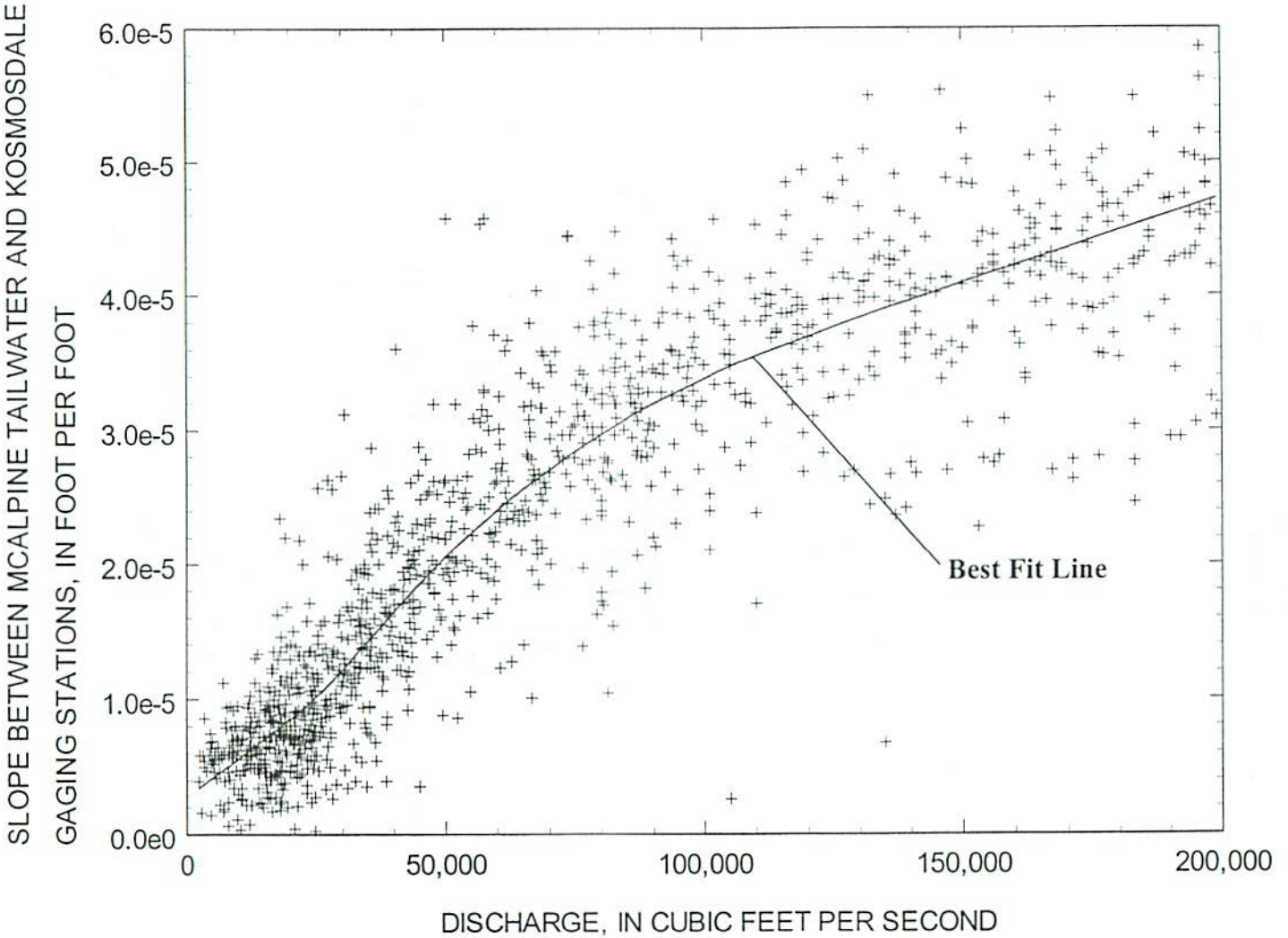


Figure 4-14. Discharge-Slope Curve between McAlpine Tailwater and Kosmosdale Gaging Stations



4.4.7.3 RESULTS OF CALIBRATION AND VALIDATION

Similar to the upstream reach, data from the low-flow hydraulic survey were used to calibrate the model and data from the high-flow survey were used to validate the simulation. The calibration and validation process consisted of comparing the simulated water-surface elevations and velocity profiles (Table 4-4) with those surveyed in the field. A Manning's roughness coefficient was assigned to each element and iteratively adjusted until the model adequately simulated the surveyed water-surface elevations and velocity profiles.

Table 4-4. Evaluation of RMA-2 Simulation of Downstream Reach

Downstream Discharge (cfs)	Boundary Condition (feet)	Rating WS Elev McAlpine Tailwater (feet)	Model WS Elev McAlpine Tailwater (feet)
16,000	382.74	383.60	383.22
23,000	382.98	384.20	383.80
43,000	383.86	386.10	385.94
97,000	387.25	391.80	392.23
200,000	395.54	402.60	402.27

Inspection of the velocity profiles collected in the field revealed no-slip conditions along the riverbanks, which were similar to the upstream reach. To simulate this characteristic with RMA-2, the Manning's coefficient was increased to 0.035 for one row of elements along the outer boundary of the mesh. The calibrated Manning's coefficient in the remainder of the channel was 0.024. This combination produced the best simulation of water-surface elevation (Table 4-5), velocity magnitude, and lateral-velocity distribution for both low and high-flow conditions. Matching the high-flow water-surface elevations verified that the area lost by truncating the banks was negligible.

Table 4-5. Water Surface Elevation for Downstream Study Reach

	5/19/2000 Low Flow			2/17/2000 High Flow		
Low Flow Station	Field WS Elev (feet)	Model WS Elev (feet)	Difference (feet)	Field WS Elev (feet)	Model WS Elev (feet)	Difference (feet)
McAlpine TW	385.20	384.90	-0.30	416.18	416.13	-0.05
Shawnee Well	384.75	384.50	-0.25	415.10	415.21	0.11
RR-22 Well	384.68	384.20	-0.48	413.65	413.83	0.18
Kosmosdale	383.85	383.50	-0.35	410.10	410.12	0.02
West Point	383.54	383.40	-0.14	409.70	409.50	-0.20

Comparison of the simulated velocity magnitudes and distributions with field measurements showed good agreement for the low-flow simulation but less favorable agreement for the high-flow simulation. Examples of the general agreement between the simulated velocities and the field-measured velocities are shown in Figure 4-15. The maximum difference at low flow was about 0.25 ft/s. For the high-flow condition, the simulated velocities consistently were greater than the measured velocities, despite excellent agreement in the water-surface elevations.

To identify the cause of the disagreement between the simulated and measured velocities for the high-flow condition, the cross-sectional areas of the model and the field were evaluated. The difference between the magnitudes of the model and field average cross-sectional velocities is correlated closely with differences in cross-sectional area (Figure 4-16). This difference in areas for the high-flow condition indicates that truncating the channel bathymetry at an elevation of 380 feet may not be acceptable for high flows. Extending the bathymetry to an elevation of 390 feet improved the agreement between field and model velocities but failed to explain all of the error. For low flow conditions, the errors between the field data and the model are somewhat randomly distributed around zero. The errors for the high-flow condition with banks truncated at an elevation of 380 feet show a linear pattern, while the errors for the high-flow condition with banks truncated at an elevation of 390 feet show a less distinct pattern but still well below zero. The patterns indicated by the high-flow data indicate that something outside the scope of the model may be responsible for the apparent errors. Scouring of the channel bottom occurred during high flow and is partially responsible for the large difference between the model and field cross-sectional areas and average velocities because the model is not able to simulate the scouring of the channel bed (Figures 4-17 and 4-18). A comparison of the average cross-sectional velocities for the field and two model meshes are shown in Figures 4-19 and 4-20.

Although extending the banks to an elevation of 390 feet improved the overall accuracy of the high-flow simulation (3.4 percent in average cross-sectional velocity), the primary reason for the difference between the model and field cross-sectional areas and velocities is that the model has a fixed bed and the river adjusted its cross section in the downstream reach during high flow. To minimize errors of future simulations, the bathymetry was truncated at an elevation of 380 feet for flows less than 200,000 cfs, and bathymetry was truncated at an elevation of 390 feet for flows ranging from 200,000 to 400,000 cfs.

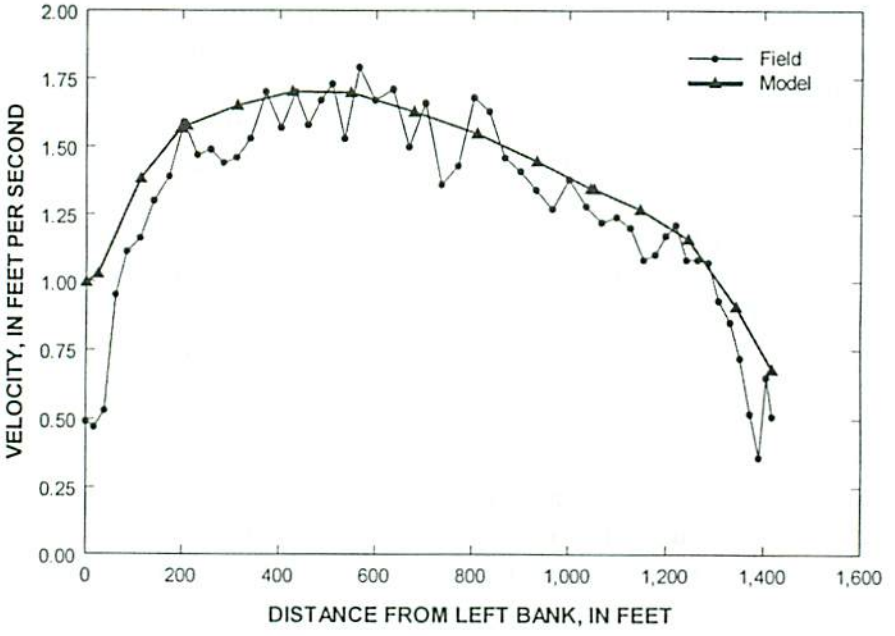
Continuity was checked throughout the model to ensure that mass was being conserved. Table 4-6 shows that mass is conserved around Sand Island and the Falls of the Ohio. Based on the calibration and validation results, the model is a representative simulation of the Ohio River steady-flow patterns below discharges of approximately 400,000 cfs.

Table 4-6. Continuity Checks for Downstream Reach

Continuity-Check Line Description	Percent of Total Discharge	
	Low Flow	High Flow
Upper gates-inflow	0.0	67.0
Hydropower-inflow	60.4	0
Lower gates-inflow	39.4	33.0
Total inflow	99.8	100.0
CC1	0.1	65.6
CC2	84.0	101
CC3	17.6	-0.4
CC4	79.4	100.7
CC5	19.2	-0.5
Cross section 15	102	98.4
Cross section 22	100	99.9
Outflow	100	100

Figure 4-15. Velocity Profiles for Cross Section Numbers 19 and 25

A. Low flow velocity profile for cross section 19



B. Low flow velocity profile for cross section 25

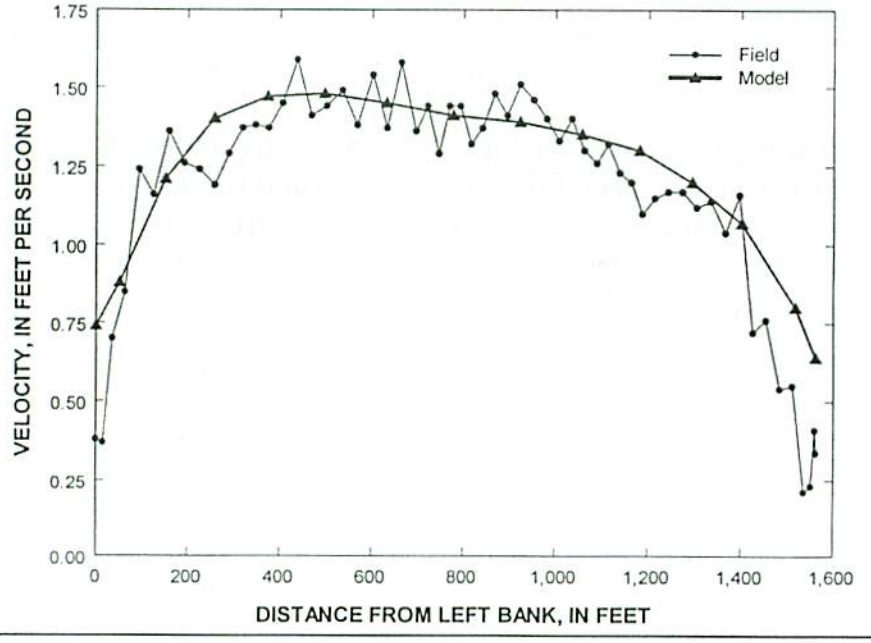
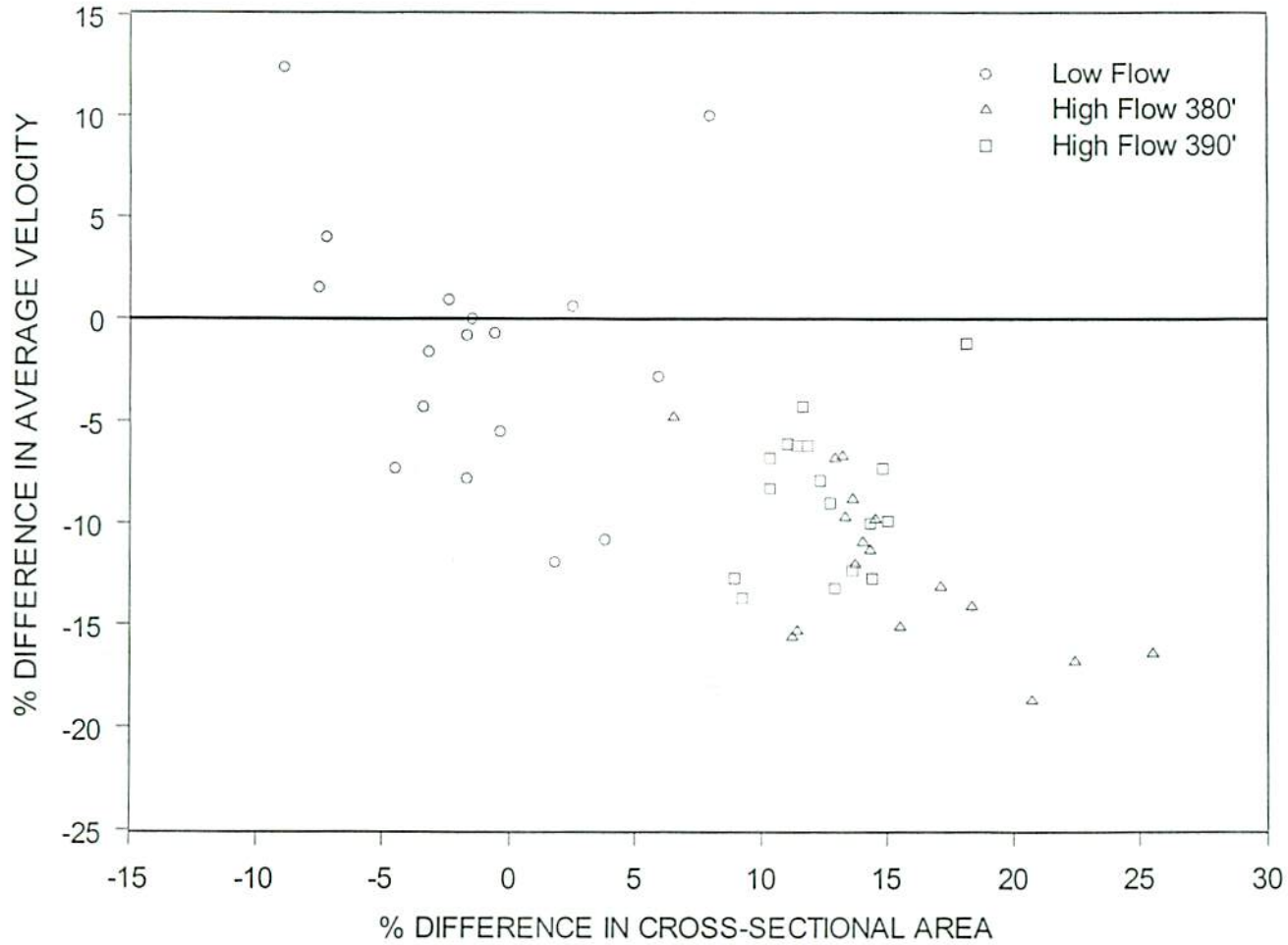


Figure 4-16. Scatter Plot of Cross-Sectional Area and Average Velocity Differences for Downstream Reach



High Flow 380 feet – All bathymetry truncated at elevation 380 feet above sea level
Low Flow 390 feet – All bathymetry truncated at elevation 390 feet above sea level

Figure 4-17. Comparison of Cross Section Number 24 Bathymetry

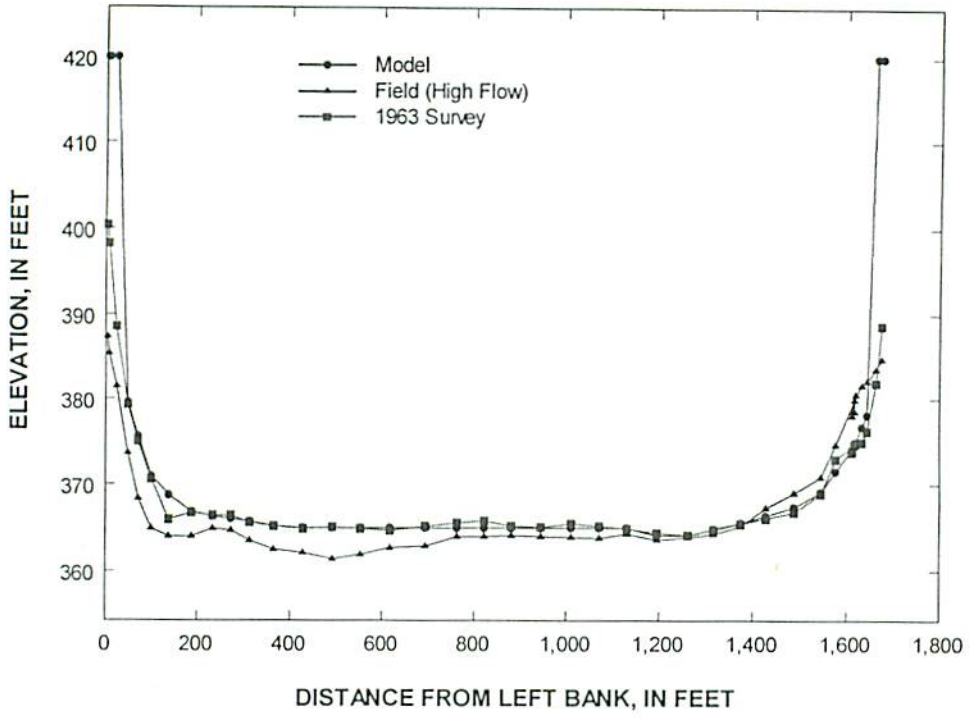


Figure 4-18. Comparison of Cross Section Number 20 Bathymetry

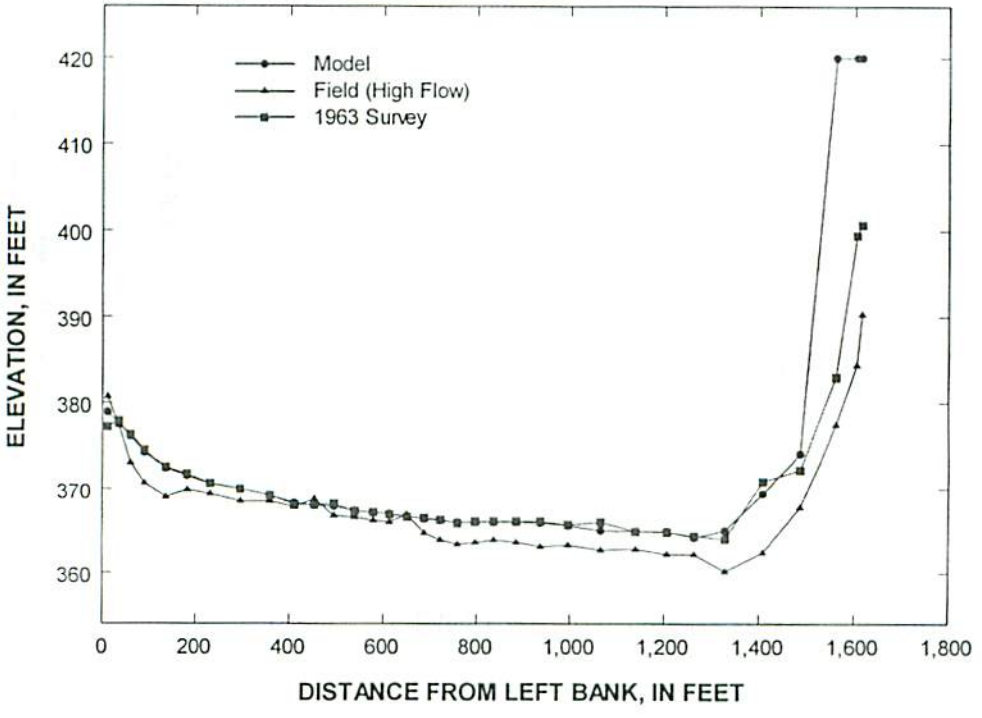


Figure 4-19. Low Flow Cross-Sectional Velocity Profile for Downstream Reach

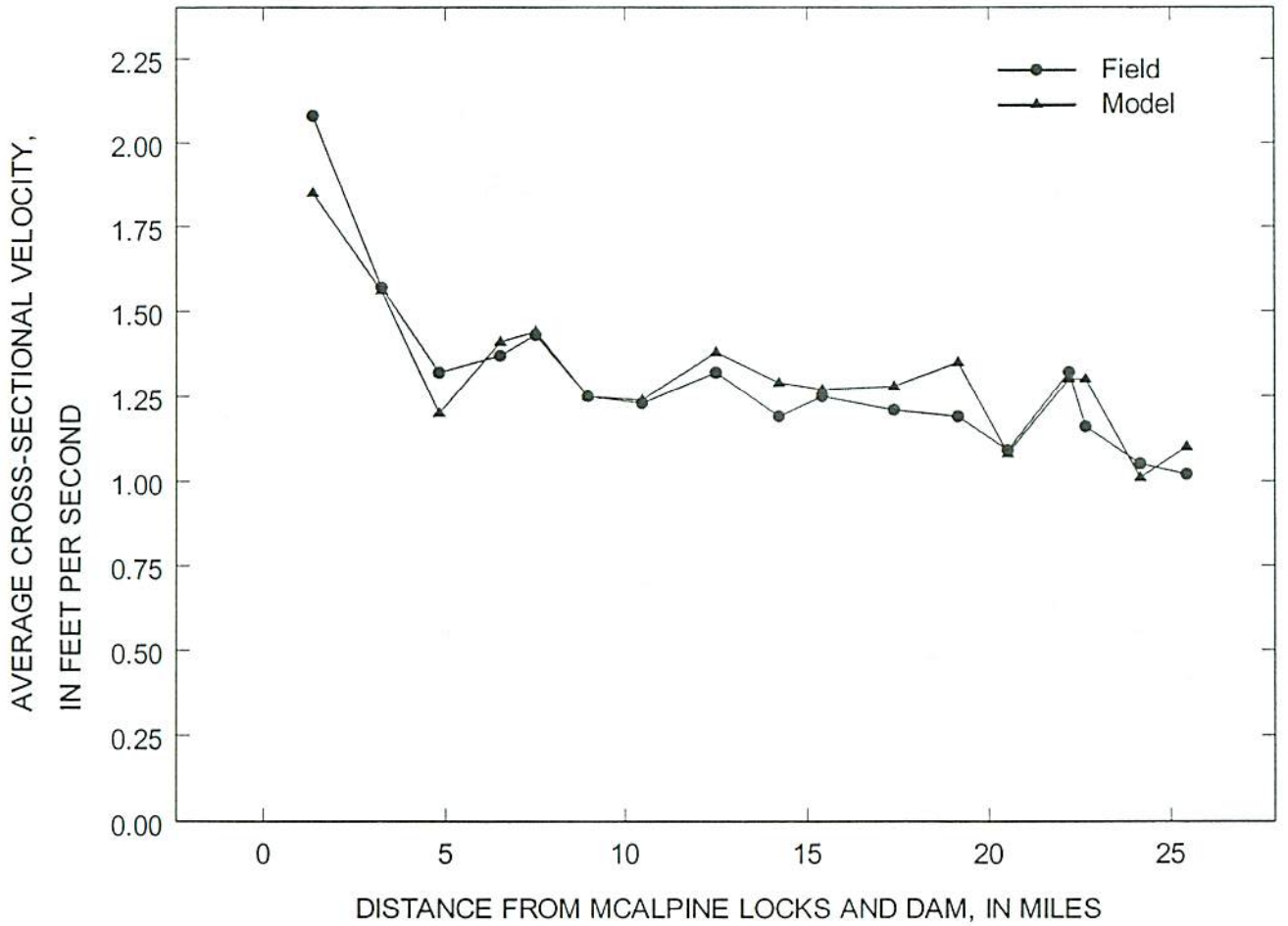
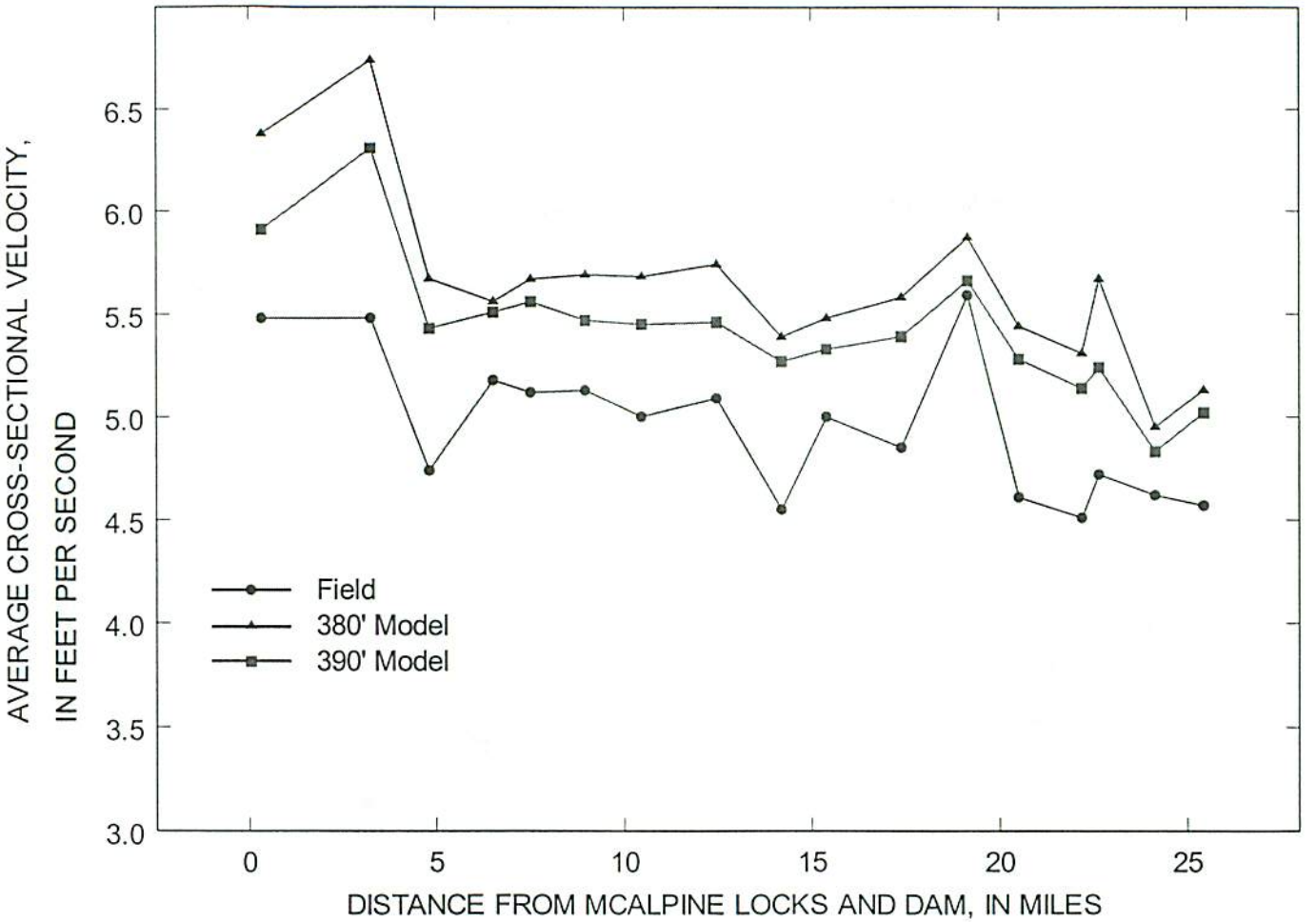


Figure 4-20. High Flow Cross-Sectional Velocity Profile for Downstream Reach



Model 380 feet – All bathymetry truncated at elevation 380 feet above sea level
Model 390 feet – All bathymetry truncated at elevation 390 feet above sea level

4.5 SUMMARY

The determination of current patterns is an essential component of a Water Quality Analysis Simulation Program (WASP) in a riverine environment. The USGS, in cooperation with ORSANCO, developed a field-validated two-dimensional hydrodynamic model capable of quantifying the steady flow patterns in the reach of the Ohio River extending from Ohio River mile 590 to 630 for the ORSANCO water-quality modeling efforts on that reach. The model was calibrated to a low-flow hydraulic survey and validated with data collected during a high-flow survey. The model calibration and verification process included matching water-surface elevations at ten locations and velocity profiles at 30 cross sections in the study reach. The study area was separated into upper and lower river reaches, separated by the McAlpine Locks and Dam. A bathymetric survey was conducted on the upstream reach to determine the channel geometry. Data from the 1963 COE Ohio River survey were used to determine bathymetry on the downstream reach. Data collected during the upstream bathymetric survey was mathematically forced onto straight cross-section lines providing a more accurate triangulation of the data in the modeling software package. Bathymetry of both reaches was truncated along the banks to eliminate RMA-2 convergence problems associated with the steeply sloping banks of the Ohio River. The upper reach was truncated at an elevation of 418 feet for both flow conditions, whereas the lower reach was truncated at an elevation of 380 feet for flows less than 200,000 cfs, and an elevation of 390 feet for flows between 200,000 and 400,000 cfs.

Based on historical discharge data during the period of 1987 through 1998, the 90^{th}-percentile flow during the contact recreational period of May through September is 197,700 cfs; therefore, only the model with bathymetry truncated at an elevation of 380 feet is needed to simulate these flows.

The model was calibrated and validated using water-surface elevations and average cross-sectional velocities to achieve the minimum error for both high and low-flow conditions. The simulated low-flow water-surface elevations typically were biased low between 0.2 and 0.3 feet, whereas the simulated high-flow water-surface elevations were within 0.1 feet of the field conditions. When compared with field data, simulated average cross-sectional velocities were typically within 0.1 ft/s for low-flow and 0.3 ft/s for high-flow.

5.0 WATER QUALITY MODEL

5.1 INTRODUCTION

This chapter presents a description of the development of the water quality model used to assess the water quality impacts of wet weather sources, including nonpoint runoff and CSOs, on the Ohio River in the study area. Due to their large number, all tables and figures are presented at the end of this chapter.

Models of the receiving waters are needed as assessment "tools" to provide a causal linkage between the discharge of pollutants and their impacts on water quality. They provide a more complete assessment of water quality conditions than data alone by filling gaps between sampling locations and collection times. The models also provide the capability to forecast relative improvements in water quality conditions resulting from various CSO or stormwater controls. Water quality models are useful tools for predicting future water quality conditions in response to alternative pollutant loading rates or environmental conditions.

Water quality models describe the transport, chemical transformations and degradation of pollutants within the system. Models of the tributary watersheds and combined sewer overflows (described in Chapter 3) are used to generate estimates of pollutant loads entering the river system. Pollutant loads from other sources, such as wastewater treatment plants and nonpoint source runoff, are also input into the water quality model. Figure 5-1 illustrates how all of these models are used together to simulate the Ohio River system studied in this project.

The study area includes the portion of the Ohio River beginning at river mile 588, which is upstream of the Louisville metropolitan area, and extending downstream to just below the confluence with the Indian Creek, at river mile 660. The water quality model was structured to cover the same domain as the hydrodynamic model described in Chapter 4, approximately 45 miles, and covers the portion of the Ohio River from river mile 590 downstream to just past the confluence with the Salt River at river mile 635. Urban areas begin at approximately river mile 595. The McAlpine Dam is located in the center of the model domain at river mile 607.

The study area includes inputs from the major tributaries simulated with the landside model (described in Chapter 3) as well as from the combined sewer areas of the Louisville-Jefferson County Metropolitan Sewerage District (Louisville MSD) and Jeffersonville, Indiana (Jeffersonville).

The water quality model was calibrated to data collected for four wet weather events between 1998 and 2001. The model was generally consistent with observed data, although it appears that there may be pollutant sources whose loads are not accounted for in the model inputs. The model is not well suited for use as a predictor of absolute concentrations in the river. The model calibration and validation provide support for the use of the model as a planning tool for evaluating relative improvements in water quality in the Ohio River resulting from CSO or other source controls.

This chapter is organized in three major sections that follow a normal sequence of model development and calibration. Section 5.2 describes the selection of the water quality model used in this study. Once the model was selected, Section 5.3 describes the development of site-specific inputs to the model (using the water quality data collected by ORSANCO (described in Chapter 2), the hydrodynamic model results (described in Chapter 4) and the landside model results (described in Chapter 3). Section 5.4 describes how these inputs were used in the model to simulate four wet weather events that provide a calibration and validation of the model for this system.

5.2 WATER QUALITY MODEL DEVELOPMENT

This section describes the factors considered in selecting a water quality model and provides a description of the selected model's formulation. Mathematical formulations of the major mass transport and transformation processes are presented. Project and site-specific inputs to the model are described in the next section.

5.2.1 MODEL SELECTION

A variety of water quality models, ranging from very simple to very complex, are available and have been used in the past to model the Ohio River. The factors considered in selecting a water quality model include the following categories:

- Management objectives,
- Project constraints, and
- Site-specific characteristics.

Primary emphasis in model selection is given to the study's modeling objectives, which can be summarized as follows:

- Define the parameters that violate water quality standards during wet weather in the Ohio River under present conditions. Parameters considered include fecal coliform, *E. coli* and oxygen demanding constituents.
- Estimate the duration of criteria exceedance for all parameters.
- Provide a description of the spatial extent (i.e. area) of exceedance.
- Serve as a template for other wet weather studies in large rivers.

Based upon these objectives, project constraints and site-specific characteristics of the Ohio River, the "Water Quality Analysis Simulation Program" (WASP), Version 5, was selected for use in this study. This model is supported by the USEPA and has been widely used. It has the capability to simulate all of the parameters of concern in this study, to provide time-variable simulations capable of defining the duration of criteria exceedances, and to simulate lateral and longitudinal concentration gradients important in large rivers. The WASP model was successfully applied to the Ohio River during the Cincinnati Wet Weather Study. The use of the WASP model for this study is described further in Sections 5.3 and 5.4.

The ACOE's hydrodynamic model, RMA-2V, was applied to properly route the water flowing through the river because lateral gradients are important in the Ohio River. RMA-2V simulates lateral and longitudinal variability in river hydraulics. The use of the RMA-2V model for this

study is described further in Chapter 4. The results from this model were incorporated into the WASP water quality model as described in Section 5.3.

5.2.2 MODEL DESCRIPTION

This section describes the basic formulations used in the WASP water quality model. WASP5 is a three-dimensional finite difference model that computes constituent concentration in a compartmentalized representation of the physical study area using the principle of conservation of mass. WASP5 can simulate the dynamic response of aquatic systems to pollutant loadings, including CSO discharges and tributary inflows.

The model balances water volume and constituent mass in each model segment over space and time using a governing equation that includes the following water quality processes:

- transport processes, such as advection, diffusion, dispersion and boundary exchanges;
- external loadings such as CSO; and
- transformation such as decay.

The generalized mass balance partial differential equation applied to the Ohio River study area is:

$$\frac{\delta C}{\delta t} = \frac{-\delta}{\delta x}(U_x C) - \frac{\delta}{\delta y}(U_y C) + \frac{\delta}{\delta x}\left(E_x \frac{\delta C}{\delta x}\right) + \frac{\delta}{\delta y}\left(E_y \frac{\delta C}{\delta y}\right) + S_L + S_B + S_K$$

where;
C= Concentration of the water quality constituent state variable, mg/L [M/L^3]
t =time, days [T]
U_x, U_y= vertically-averaged longitudinal and lateral advective velocities, m/day [L/T]
E_x, E_y = longitudinal and lateral diffusion coefficients, m^2/day [L^2/T]
S_L = direct and diffuse external loading rate, g/m^3-day [M/L^3-T]
S_B =boundary loading rate (including upstream, downstream, and sediment), g/m^3-day [M/L^3-T]
S_K =total kinetic transformation rate; positive indicates a source, negative indicates a sink, g/m^3-day [M/L^3-T]

A more rigorous description of the governing equation and water quality processes used in the model is available in the WASP5 user's manual.

In the Ohio River study, WASP5 was applied in a two-dimensional mode to address lateral and longitudinal variations in concentration. Model simulated concentrations represent a vertically averaged (or depth-averaged) concentration. EUTRO5 is a sub-component of the WASP5 model used to simulate conventional pollution such as DO, CBOD, nutrients and eutrophication, while TOXI5 is the sub-model used to simulate toxic pollution resulting from constituents such as metals, organic chemicals and bacteria.

In the Cincinnati Study, the EUTRO5 model code was modified so that bacteria and DO constituents could be simulated simultaneously in a single model run. This version of the model was used for the calibration and validation described in Section 5.4, although bacteria was the only constituent simulated in this study.

5.3 MODEL DEVELOPMENT

This section describes how the generic WASP5 water quality model framework was tailored for use in this Ohio River study. It also includes descriptions of the water quality model construction/segmentation and parameterization of the WASP5 model's fundamental transport processes, such as advection and dispersion, using site-specific information.

The WASP5 model was constructed in two sections to correspond to the RMA model formulations of the study area. The first section covered the portion of the study area upstream of the McAlpine Locks and Dam, while the second section of the model covered the portion of the study area downstream of the McAlpine Dam. These sections were later combined into a single model as described in Sections 5.3.2 and 5.3.3.

5.3.1 WASP5 PROGRAM MODIFICATIONS

The site-specific modifications to the EUTRO5 portion of the WASP5 model's kinetic formulations include the following:

- During the Cincinnati project, fecal coliform bacteria was inserted to replace the unused organic phosphorus state variable. A first-order decay (die-off) rate for fecal coliform was used in place of the phosphorus mineralization kinetics. This change to the model code was kept for the Louisville model and was also used to simulate *E. coli*.
- The maximum number of model segments was increased from 500 to 800, so that the portions of the river upstream and downstream of the McAlpine Dam could be combined into a single model.

These changes had no effect on the science used in the model and were conducted solely to allow model application to proceed more efficiently.

5.3.2 MODEL SEGMENTATION

Although the hydrodynamic model domain encompassed the Ohio River from river mile 590 to river mile 636, that model was split into two sections with the McAlpine Dam as the boundary between the sections (see Chapter 4). The McAlpine Locks and Dam system includes upper and lower sets of tainter gates and a hydropower plant whose operations vary depending on flow through the system. The increased flow complexity around the McAlpine Dam necessitated the split in the hydrodynamic modeling. The water quality model was originally set up in two sections that corresponded to the hydrodynamic model sections and was then combined into a single model prior to calibration and validation.

The water quality model is two-dimensional, describing concentration variations both laterally and longitudinally. Water quality model results are vertically averaged. The modeled area includes all of the CSOs from both Louisville MSD and Jeffersonville discharging directly into the Ohio River as well as tributaries that receive CSO loads from these sewerage districts and SSO loads from New Albany, Indiana. Discharges from WWTPs with outfalls to the Ohio River are also included in the model domain. Consequently, the portion of the Ohio River simulated

with the water quality model is the area where the biggest impacts from CSOs are expected and where near shore effects would be most pronounced.

The scale required by the RMA-2V model for hydrodynamic stability was too refined to adapt directly for use in the water quality model. As a result, the WASP5 water quality model segmentation was defined as a "subset" of the hydrodynamic grid, where the WASP5 segment contained, on average, twenty-four hydrodynamic model elements.

The model's spatial resolution was based upon the approach used in the Cincinnati Study, where it was determined that the model would consist of five lateral segments, approximately divided as follows:

- Bankside channel on each shore = ~10 percent of each cross-sectional area
- Intermediate channel on each side of the centerline = ~20 percent of each cross-sectional area
- Center segment = ~40 percent of each cross-sectional area

The average segment lengths were defined by the length of the hydrodynamic elements and were approximately 0.30 miles long. The model segmentation immediately upstream of the McAlpine Dam was much larger than the rest of the model domain, so that the flow through McAlpine could be reasonably simulated under varying conditions using some simplifying assumptions. The area immediately downstream of the McAlpine Dam does not maintain the five segment lateral geometry because of the complexity in river bathymetry and flow patterns through the McAlpine area. The WASP5 segmentation is shown in Figure 5-2.

The water quality model contains 738 segments in the Ohio River. Of these, 228 segments span the reach upstream of the McAlpine Dam and 510 segments span the reach downstream of the dam.

5.3.3 LINKAGE TO HYDRODYNAMIC MODEL

The hydrodynamic model results are used to drive the transport in the water quality model, however, direct input of the RMA-2V model results into the WASP model is not possible for several reasons. First, the RMA-2V model is spatially defined by a set of nodes, whereas the WASP model is spatially defined by a series of segments. The RMA-2V model produces a velocity field defined at the nodes, while WASP5 requires a set of balanced and routed steady state flows defined for segment interfaces. Thus, the RMA-2V results have to be translated into WASP5 segment space. The second reason is that RMA-2V conserves momentum but does not inherently conserve water mass, which is required by the WASP5 model under the steady state flow conditions that the RMA-2V simulations were conducted.

A program was written to convert finite element nodal information from the hydrodynamic model into water quality model segment volumes, dispersion areas and mixing lengths. A series of three programs were created to transform the RMA-2V model results into inputs for the WASP5 model. These programs performed the following operations:

- Converted strings of RMA-2V nodes into WASP5 segment interfaces;
- Smoothed (balanced) the inter-segment flows calculated by RMA-2V for the WASP5 segment interfaces; and
- Converted the individual smoothed segment flows into flow routings through the WASP5 model so that water mass was balanced in each water quality model segment.

As expected for a large river system, the linkage between the RMA-2V model and the WASP model routes the majority of the flow from one segment to a segment located immediately downstream of it, rather than laterally to an adjacent segment.

5.3.3.1 FLOW AROUND MCALPINE LOCKS AND DAM

The hydrodynamic-water quality model linkage was complicated by the need to incorporate a representation of the McAlpine Locks and Dam structures and their operating rules into the routings. The area of the river immediately upstream and downstream of McAlpine (approximately 1.5 miles in either direction) is complex and varies depending on the upstream flow and hydropower needs. Routings through the McAlpine area were balanced by hand as described below.

The McAlpine Locks and Dam consist of structures on the Ohio River extending from river miles 604.4 to 607.4. The following three discharge points are illustrated in Figure 5-3:

- the Lower Gates, which consist of four gates and a number of hydropower units for producing electricity;
- the Upper Gates, which consist of five gates; and
- the Locks, which discharge a relatively small portion of the flow.

Each hydropower unit discharges at a rate of several thousand cubic feet per second (cfs) when operating. The remaining flow, other than the Locks, is split between the Lower Gates and the Upper Gates depending on the ratio of feet of gate opening for each (i.e., one gate open one foot gives one foot of gate opening). Configurations vary based on the time of year, number of hydropower units in operation, etc. It may not be possible to predict the specific operation of the dam at a given time, however, Table 5-1 presents information prepared by the USGS showing typical modes of operating procedure.

A set of empirical equations was developed by regression analysis, based on the data in Table 5-1, to predict a reasonably likely operating procedure for a given flow. The first equation relates flow to hydropower units in operation and feet of gate opening and has an R-square value of 0.999. This equation predicts a discharge of 3,882 cfs from each operating hydropower unit (slightly less than the USGS estimate of 4,000 to 4,400 cfs per unit), a discharge of 1,835 cfs for each foot of total gate opening, plus a constant 951 cfs, which is assigned to the locks discharge.

$$Flow(cfs) = [3{,}882 * (\#\ HydroUnits)] + [1{,}835 * (GateOpening, ft)] + 951$$

The next equation relates the number of hydro units in operation (when the result is rounded to the nearest integer) to the flow and has an R-square value of 0.502.

$$\text{Units} = -10.61 + 1.407 \times \left(\ln(\text{Flow, cfs} - 951)\right)$$

From these two equations, the flows through the locks, the hydro units, and the total gate flow were predicted. The remaining variable is the split in gate flow between the lower and upper gates. The following equation relates the ratio of flow through the lower gates to total gate flow, to the total flow and has an R-square value of 0.887. As in Table 5-1, no flow is predicted through the upper gates if the total flow is less than 36,000 cfs.

$$\frac{\text{Lower Gate}}{\text{Gate Total}} = 1.0 \quad if \ (\text{discharge} \le 36{,}000 \text{ cfs})$$

$$\frac{\text{Lower Gate}}{\text{Gate Total}} = \min\left(1.0,\ 0.1667 + \frac{1.083e9}{(\text{Flow, cfs} - 951)^2}\right)$$

where;
the Euler constant e=2.71838...

A spreadsheet was developed, which uses the RMA to WASP flow routing just above the dam, the above equations, and simple hand-developed flow routing relationships, to route flow through the dam and downstream to the start of the downstream RMA section. The routings generally transport flow to the segment immediately downstream of the segment being routed.

An analysis of routings around the McAlpine Dam indicates that the fraction of flow through each model segment can be described using routings corresponding to three flow regimes. The low flow routings simulate conditions below 36,000 cfs, when the upper gates are closed. The low flow routing for this flow regime were developed from the spreadsheet results for a flow of 22,900 cfs, which corresponds to the 25th percentile flow at USGS gage number 03294500, located below the McAlpine Dam. The average flow routings simulate conditions between 36,000 cfs and 70,000 cfs, when the upper gates are open less than the lower gates (see Table 5-1). The average flow routings for this flow regime were developed from the spreadsheet results for a flow of 42,150 cfs, the median summer flow based on records at the USGS gage located below the McAlpine Dam. High flow routings simulate conditions above 70,000 cfs, when the flow is split largely between the hydropower units and the upper gates with only a small fraction of flow going through the lower gates. The high flow routings for this flow regime were developed from the spreadsheet results for a flow of 96,625 cfs, which corresponds to the 75th percentile flow at the USGS gage located below the McAlpine Dam. The choice of representative routing used in the model is dependent on the upstream flow at the boundary of the model domain and can be changed daily.

5.3.4 LATERAL MIXING CALIBRATION TO DYE SURVEYS

While the RMA-2V hydrodynamic model can describe lateral and longitudinal movement of water through the study area, it cannot describe the mixing of water quality constituents caused by dispersion. The term "dispersion" is used here to include the effects of molecular and

turbulent diffusion and velocity gradients that occur on a scale smaller than the WASP model segments. ORSANCO conducted two dye surveys in the Ohio River during the fall of 1999 and spring of 2000 to determine the magnitude of this mixing under a range of flow conditions. The results from these surveys were used to calibrate dispersion coefficients in the WASP5 water quality model as described below.

5.3.4.1 SEPTEMBER 23, 1999 DYE SURVEY

The first dye survey was conducted on September 23, 1999 with a very low Ohio River flow of 6,500 cfs. Rhodamine-WT dye (20 percent solution) was injected into the discharge of the Morris Forman WWTP at river mile 612. A total of 106.5 pounds of dye were injected continuously over the time period from 9:35AM to 4:00 PM, which corresponded to a dye injection rate of 0.276 pounds/minute. Ohio River samples were collected every quarter-mile, starting three hours after the beginning of the dye injection, for three miles downstream of the Morris Forman WWTP outfall. At each location, grab samples were collected from approximately one foot below the water surface and two feet above the river bottom.

5.3.4.2 MAY 16, 2000 DYE SURVEY

The second dye survey was conducted on May 16, 2000 with an Ohio River flow of 43,100 cfs. Rhodamine-WT dye (20 percent solution) was again injected into the discharge of the Morris Forman WWTP. A total of 238 pounds of dye were injected continuously over the time period from 9:07 a.m. to 3:45 p.m., which corresponded to a dye injection rate of 0.60 pounds/minute. Ohio River samples were collected every one-half mile, starting three hours after the beginning of the dye injection, for seven miles downstream of the Morris Forman WWTP outfall. Samples were also collected upstream of the WWTP outfall, at river mile 610, to provide a background measurement of fluorescence in the river. At each location, grab samples were collected from approximately two feet below the water surface and two feet above the river bottom.

5.3.4.3 DYE SURVEY RESULTS

The dye surveys were simulated using the WASP5 water quality model and used the model dispersion coefficient as the calibration parameter for fitting the data. Loads of 181 kg/day for the October 1999 survey and 392 kg/day for the May 2000 survey were entered into the WASP5 model at segment 323, on the left bank of the model near river mile 612. The model was run to steady state to simulate the complete mixing of the dye across the river, and concentrations calculated for the WASP5 model segments corresponding to sampling locations were compared to the data from each survey.

A constant value was used for the dispersion coefficient for all dispersive exchanges. The data falling in the farthest downstream cross section was chosen as the target data, so that the degree of mixing of the dye solution with the river flow would be greatest. The spread of concentrations across the target cross section was the chosen criterion for calibration because the objective was to determine the coefficient which would best represent lateral mixing, rather than to model dye concentrations.

Results of the dye survey are illustrated in Figures 5-4 and 5-5 for the May 2000 survey, using a lateral and longitudinal dispersion coefficient of zero. Sensitivities conducted with the model at higher dispersion coefficient values resulted in a greater over-prediction of dye concentration from the mid-channel to the right bank of the river, as shown in Figure 5-4 for a dispersion coefficient of 0.1 m^2/s. Though less dramatic in simulating dye concentration changes in the river, model simulations of the low flow dye survey confirmed the dispersion values derived from simulations of the high flow dye survey.

5.4 MODEL CALIBRATION/VALIDATION

The water quality model was calibrated to data collected by ORSANCO during four wet weather water quality surveys conducted between 1998 and 2001. The model calibration process can serve to demonstrate the predictive capacity of the model, as well as to identify gaps in the understanding of the system. As Figure 5-1 illustrates, the water quality model resides at the end of a string of linked models, so the water quality calibration is actually a test of all of the models' predictive capacity. Simulating bacteria with a water quality model is relatively simple since it is based solely on the conservation of mass and downstream transport, however, certain discrepancies identified in the model calibration process represent physical impossibilities that could never be explained by the water quality model. Examples include tenfold to hundredfold increases in observed instream concentrations in the absence of a corresponding load, and discrete locations where the observed instream *E. coli* concentration was significantly greater than the observed fecal coliform concentration.

WASP5 water quality model simulations were conducted for periods corresponding to the four water quality surveys between 1998 and 2001. The environmental and sampling information is summarized by event in Table 5-2. The May 2001 dataset included the greatest spatial and temporal sampling coverage. The dilution potential and downstream extent of impacts of landside loadings for a range of flows can be assessed with the August 2000 and October 2001 events, which have upstream flows of approximately 100,000 cfs and 22,000 cfs, respectively, during their events.

Fecal coliform and *E. coli* were simulated with the water quality model. The State of Kentucky uses fecal coliform as its indicator organism while the State of Indiana uses *E. coli* as its indicator of public health protection. ORSANCO, which has jurisdiction on the Ohio River itself, accepts either bacteria constituent as an indicator of water quality in the Ohio River.

The approach to calibrating and validating the model was to specify site-specific model inputs whenever possible, including loads, boundary concentration, flows, environmental conditions and to run the simulation. The model output was compared to observed data at specific points in time. Reproducing observed concentration differences between near shore and center channel areas and simulating the observed timing and location of peak concentrations were the primary calibration objectives. Matching the magnitude of observed concentrations was a secondary objective due to the uncertainty in loadings.

Water quality data, model inputs and simulation results are presented in this section. The events sampled by ORSANCO represent a range of environmental conditions (precipitation, upstream

flow) and have wide spatial and temporal data coverage, therefore, no single event constitutes a condition to which the model should be calibrated. Rather, the results of the model simulations for all of the events, when considered collectively, present a calibrated and validated model. Comparison of model simulated concentrations to observed data are presented both spatially and temporally. Calibration statistics are also provided. The statistics demonstrate a good correlation between model predictions and observed data in many locations; however, they are not as good as generally desired in some areas due to uncertainties in the loadings.

5.4.1 SAMPLING EVENT DATA

The Ohio River wet weather event data used to calibrate and validate the model were collected by ORSANCO between 1998 and 2001. Sampling information is summarized in Table 5-2 and discussed in more detail in Chapter 2. Approximately 30 rainfall gages were used to monitor the rainfall volume throughout the watershed. Rainfall data shown in Table 5-2 represent an average of the daily gage records. The USGS gage located just below McAlpine Dam was used to monitor flow in the Ohio River during the sampling period of each event.

Constituents monitored during these sampling events are shown in Table 5-3. Table 5-3 also indicates which constituents were adversely affected by wet weather sources, as evaluated by comparing measured data to water quality standards. Only the instream concentrations for fecal coliform and *E. coli* showed consistent and significant wet weather impacts. Thus, the water quality model was used to simulate the instream concentrations for only these two constituents. Tables 5-4 and 5-5 present summaries of the comparison between water quality standards and the observed bacteria concentrations for each event.

5.4.2 MODEL INPUTS

The WASP5 model simulates pollutant mass in each model segment as the result of transport processes, external loadings and transformation processes. It requires user-specified inputs of calculation timesteps and duration, environmental conditions, boundary conditions, pollutant inputs and choices of kinetic processes, rates and coefficients. This section describes model inputs for the transport and transformation processes as well as flow and loading inputs for the events simulated with the water quality model.

5.4.2.1 TRANSPORT PROCESS INPUTS

Transport processes modeled with the WASP5 model include advection, dispersion, diffusion and boundary exchanges. For advection, the daily average flow measured at the USGS gage below the McAlpine Dam (river mile 607) was applied at the model's upstream boundary and routed downstream using the linkage described in Section 5.3.3. All tributary, CSO and WWTP flows to the Ohio River were added to the model at the model segment corresponding to the source inflow location.

Dispersion was simulated using the segment areas determined from the hydrodynamic-water quality model linkage (Section 5.3.3) and the site-specific dispersion coefficient determined from the dye survey calibrations described in Section 5.3.4.

Boundary exchanges at the upstream and downstream ends of the model were based on concentrations observed during the water quality surveys. These are described in more detail in Section 5.4.2.3.

5.4.2.2 TRANSFORMATION PROCESS INPUTS

Since bacterial impacts are the focus of the water quality modeling, the primary transformation process in the WASP5 model is bacteria die-off. A first-order decay rate was used in the water quality model to simulate die-off and other loss processes, such as settling.

Dry weather data were evaluated for use in determining a site-specific decay rate. Large concentrations, measured at several downstream locations, prevented the data from being used for this purpose. A value of 1.0 day^{-1} for both fecal coliform and *E. coli* was determined through the calibration and validation procedure. This value is the same rate that was used for fecal coliform in the Cincinnati Study. Evaluation of the model sensitivity to the choice of decay rate is described in Section 5.4.4.

Bacteria die-off is temperature dependent. The decay rate used in the model was adjusted for temperature effects using the following equation:

$$k_{T,^oC} = k_{20^oC} * \theta^{T-20}$$

where;

$k_{T,^oC}$ = decay rate at temperature T in °C, day^{-1}
k_{20^oC} = decay rate at 20°C = 1.0, day^{-1}
θ , a unitless temperature adjustment factor = 1.047

Water temperatures measured during the surveys ranged between 19° C and 27° C, depending on the survey. The August 2000 event had the highest temperatures, ranging from 25°C to 27°C whereas the October 2001 event had the lowest temperatures, ranging from 19°C to 20°C. Temperatures during each event varied by less than two degrees. A daily temperature time series was input into the model for each event simulation.

5.4.2.3 UPSTREAM FLOW AND LOAD/CONCENTRATION

A daily flow time series was developed from the average daily flows measured at the USGS gage located below the McAlpine Dam (river mile 607) and was applied at the model's upstream boundary at river mile 590. Tributary inflows between the model boundary and the USGS gage were generally less than five percent of the gage flow, so the upstream model flow was not adjusted. Tributary inflows to the Ohio River were generated from the landside HSPF model (see Chapter 3). Table 5-6 illustrates the ratio of tributary inflows upstream of the USGS gage to the gage flows for each event simulation period. All tributary, CSO and WWTP flows to the Ohio River were added to the model at the model segment corresponding to the source inflow location.

ORSANCO collected bacteria data daily from three points across (left descending bank, midstream and right descending bank) at the upstream model boundary for each event. These concentrations were applied to the left-most, center and right-most WASP segments, respectively, at the model boundary. Remaining segment concentrations were estimated by interpolating the measured data. In general, concentrations at the boundary rarely exceeded the water quality standards. The boundary concentration time series used for each event are shown in Table 5-7.

5.4.2.4 LANDSIDE FLOWS AND LOADS

External loadings of pollutants to the Ohio River include point sources discharges, tributary loadings, which may include CSO loads, and direct drainage. Point sources include CSOs and WWTP effluents. External flows and loads were developed using the following approach:

- Louisville CSO volumes draining directly to the Ohio River were estimated using the rainfall regressions developed by MSD for calculating individual CSO volumes. Pollutant loads were developed by applying event mean concentrations to the estimated volumes.
- The average volume estimated from two representative Louisville CSOs was used to estimate the volume for each of the Jeffersonville CSOs draining directly to the Ohio River (see Chapter 3). An event mean concentration was applied to the volume to develop the loads associated with each Jeffersonville CSO,
- Tributary flows from the landside model output were combined with concentration output from the landside model to estimate tributary loads (see Chapter 3),
- WWTP effluent volume and loads were estimated using available data, and
- Direct drainage flows and loads were estimated using the landside model output.

Load inputs to the water quality model are summarized in Table 5-8 and shown in Figure 5-2. Chapter 3 presents a detailed explanation of the landside modeling approach used to estimate flow and concentration for each of the sources in Table 5-8. This section presents a summary of the results from the landside modeling pertinent to this study and explains further development of the landside results for input to the water quality model. Flow and bacteria loadings used in the model for the first two days of each event are summarized in Table 5-9.

Combined Sewer Overflows (CSOs)

Individual Louisville CSO volumes were estimated using relationships between rainfall and overflow volume developed by MSD in earlier work. These equations are summarized in Table 5-10 and were used to estimate the total volume for each event. The volume for the Central Relief Drain outfall was calculated as the sum of the CSOs that are routed to it and are indicated in Table 5-10. An hourly flow time series for each CSO was generated by evenly distributing the total event volume across the hours of rainfall for each event. This time series was input into the water quality model. In general, CSO overflows estimated with these equations had durations of less than a day.

Louisville MSD monitored fecal coliform concentrations in CSOs discharging to Beargrass Creek in 2001. The k-means clustering of CSOs described in Chapter 3 presented a method to link CSOs with very little data to monitored CSOs that most closely resemble the characteristics

of the unmonitored CSO in terms of overflow volume, overflow frequency and CSO location. Since all of the CSOs monitored for fecal coliform were in the same k-means cluster (see Chapter 3), a representative event mean concentration (EMC) was estimated as the geometric mean of the nineteen summer (April-October) measurements of all of the monitored CSOs and was 650,000 #/100 ml. No *E. coli* data were available for any of the CSOs so the event mean concentration used for *E. coli* was estimated as 60% of the fecal coliform EMC and was 400,000 #/100 ml. These values are summarized in Table 5-11.

No data or information were available for the Jeffersonville/Southern Indiana CSOs. The median Louisville CSO volume was used as an approximation of the volume from each Southern Indiana CSO. This volume was estimated as the average of two Louisville CSOs that were deemed to be representative of the area in terms of land use and service area population characteristics. The same fecal coliform and *E. coli* EMCs developed for the Louisville CSOs were applied to the Southern Indiana CSOs to develop the load time series.

An hourly loading time series for each CSO during each simulation event was developed and input into the water quality model. Loadings entering the same model segment were summed together. Separate time series were developed for *E. coli* and fecal coliform loads.

Tributaries

The HSPF model described in Chapter 3 was used to estimate flow and concentration at the mouths of the numerous tributaries located in the study area. HSPF model output for twelve subwatersheds, as described in Table 5-8, served as input to the water quality model.

Of the tributaries in the study area, Beargrass and Silver Creeks have the greatest potential for impacting bacteria levels on the Ohio River. Beargrass Creek flows through the heart of the Louisville metropolitan area and receives discharge from approximately half of the City's CSOs. The loadings from Beargrass Creek were separated into two components, CSO loads and tributary loads. Silver Creek receives sanitary sewer overflows from the community of New Albany. HSPF model output for Fourteen Mile Creek were not included in the water quality model loadings because the tributary's confluence with the Ohio River is located upstream of the model boundary and the load estimates were one to three orders of magnitude higher than the other tributaries for several events.

The HSPF model was run for a five-year period corresponding to the project study time period (1997-2001). HSPF model results for the periods corresponding to the monitored events were extracted from the output and compared to the tributary concentration data measured by ORSANCO. These model-to-data comparisons are shown in Figures 5-6 through 5-9. Although some comparisons were complicated by aggregated subwatersheds in the HSPF model, the model results compared favorably to the concentration data for most of the monitored days. The model data varied from observed data by one to two orders of magnitude on some days for some tributaries (ex. Figure 5-6-Goose Creek confluence on 10/9/98). The HSPF model tended to underpredict concentrations in Goose Creek and overpredict concentrations in Silver Creek. A similar comparison of model flow to measured flow was not possible because most of the tributaries are not gauged.

The HSPF model output consisted of hourly flow, fecal coliform and *E. coli* concentrations at locations that corresponded to tributary confluences with the Ohio River. These time series were used as inputs to the water quality model. Chapter 3 provides greater detail regarding the HSPF modeling for this project.

Wastewater Treatment Plants (WWTPs)
Four WWTPs discharge directly to the Ohio River, as indicated in Table 5-8. Louisville MSD's Morris Forman WWTP, which discharges to the Ohio River at river mile 612.3, is the largest of the four facilities with a design flow of 105 million gallons per day (MGD).

Daily fecal coliform and flow data were available for Louisville MSD's Morris Forman and West County facilities. A daily loading time series was input to the model for these facilities as the product of the daily flow and daily concentration. An *E. coli* loading time series was estimated as 60 percent of the fecal coliform load time series.

Monthly flow information was available for the Indiana facilities of Charlestown and Clarksville. The monthly average flow was applied at a daily frequency to develop a flow time series for each facility to input into the water quality model. Since the West County WWTP facility is sized most closely to the Indiana facilities, the daily concentration data for West County was used for the Indiana facilities in order to generate fecal coliform and *E. coli* daily loading time series inputs for the water quality model.

Loading Summary
Although upstream flow dominates the volume of water entering the study area, as shown in Table 5-6, elevated fecal coliform and *E. coli* concentrations observed in the river during wet weather are largely the result of tributary and CSO loads draining directly into the Ohio River.

Figure 5-10 illustrates the relative contribution of each external and internal loading source: CSOs draining directly to the Ohio River, tributaries, and loads originating upstream of the study area. Beargrass Creek in Kentucky is the only tributary with flow from CSOs. The loads coming from Beargrass Creek were separated into two components, CSO loads and tributary loads. A comparison of fecal coliform loads from these loading sources indicates that tributaries are the dominant loading source in each event.

5.4.3 MODEL CALIBRATION/VALIDATION RESULTS

This section presents the results of the WASP5 model simulations of the four wet weather events. Results are presented in both spatial and temporal formats. The longitudinal river fecal coliform and *E. coli* concentration profiles along each bank and in the center channel during the survey period show the overall pattern observed and its comparison with the predicted levels. The temporal comparison displays the observed data and the water quality model predictions over time at a particular location. Maximum concentrations in each model segment on each day of each event are also displayed to illustrate the transport of pollutants out of the system.

The model calibration/validation provides support for the use of the model as a planning tool for evaluating relative improvements in water quality in the Ohio River resulting from CSO or other source controls. The model is not well suited for use as a predictor of absolute concentrations in the river as the discussion of model-data comparisons below indicates.

5.4.3.1 OCTOBER 1998 EVENT

An average of 1.34 inches of rain fell on the study area on October 7, 1998. River conditions for this event spanned a wide range of flows, from 7,290 cfs on October 8, to 40,900 cfs on October 9.

ORSANCO collected data for this event beginning on October 7, 1998 through October 10, 1998. Bacteria concentrations at the model boundary were less than 20 CFU/100 mL, so elevated concentrations observed in the model domain are a reflection of the source loadings described above. Surprisingly, all of the fecal coliform measurements made on 10/7/98 were non-detects at less than 10 CFU/100 mL, whereas most of the corresponding *E. coli* measurements were detected and ranged in concentration from 5 CFU/100 mL to 200 CFU/100 mL. Since *E. coli* bacteria are a class of fecal coliforms, concentrations of *E. coli* should not be higher than fecal coliform. Possible explanations for the inconsistency include differences in analytical methods, sample handling or non-homogenous aliquots. A regression of fecal coliform data to *E. coli* data is shown in Figure 5-11 to illustrate this issue. The figure shows that approximately half of the co-located samples had *E. coli* measurements greater than the corresponding fecal coliform measurement.

Spatial plots, comparing observed data to the model output at the hour closest to the time the samples were collected, are shown in Figures 5-12 and 5-13 for fecal coliform and *E. coli*, respectively. Comparisons for each area of the river (left descending bank, midstream, right descending bank) are shown for each day of the event. The minimum and maximum concentrations predicted each day are also shown on these figures to provide an "envelope" of the concentration range predicted with the model. Temporal plots of model and observed data for each area of the river are included in Appendix G. Maximum concentrations in each model segment are shown schematically in Appendix H.

The HSPF modeled *E. coli* source loadings input to the water quality model are smaller than the fecal coliform loadings, whereas on the first day of the event, the opposite is true for the observed bacteria data. The model was unable to reproduce the concentration magnitudes for both parameters because of this discrepancy. The model concentrations are more consistent with the *E. coli* data than the fecal coliform data for this day.

On subsequent days of the event, the model compares well to the data in all areas of the river. One exception being that on October 8, 1998, elevated concentrations of both parameters were measured at and below river mile 620, that were not simulated with the water quality model. The reason for this discrepancy was investigated, but could not be resolved with the available information. The simulated *E. coli* concentrations for the right descending bank are higher than the observed data below river mile 607. This is likely due to the elevated concentrations simulated with the HSPF model in Silver Creek, which appear to be approximately half to a full

order of magnitude higher than the observed data (see Figure 5-6). No fecal coliform data were available, therefore, a similar analysis could not be made for this parameter.

Regressions of daily observed data to the daily model geometric mean concentration are shown in Figure 5-14. The model and data tend to follow the 1:1 line until measured concentrations exceed 5,000 CFU/100 mL. The model tends to underpredict high concentrations, likely reflecting the discrepancy in data and model results observed below river mile 620, which was described previously. Figure 5-14 also shows that there was no trend or improvement in the regression when analyzed on the basis of sampling location or day of sampling.

5.4.3.2 AUGUST 2000 EVENT

An average of 0.56 inches of rain fell on the study area between August 5 and August 10, 2000. The highest daily rainfall occurred on August 8, when 0.47 inches of rainfall occurred. River conditions for this event were the highest of any of the monitored events, ranging from 93,500 cfs to 142,000 cfs. Concentrations at the model boundary were also the highest of the monitored events and were typically greater than the water quality standards for fecal coliform and *E. coli*. See Table 5-7 for details on upstream concentration and Figure 5-10 for the contribution of upstream loads relative to the other sources.

ORSANCO collected data for this event beginning on August 8, 2000 through August 13, 2000. As with the 1998 event, data for the first day of the event are sparser than on subsequent days. The bacteria data for this event are smaller in magnitude than data from other events, rarely exceeding 1,000 CFU/100 mL. This is probably due to several factors, including the high river flow, the extended rainfall, and the lack of data during the most intense rainfall period. There are some locations where the measured *E. coli* concentration is greater than the fecal coliform concentration, as shown in Figure 5-11.

Spatial plots, comparing observed data to the model output at the hour closest to the time the samples were collected, are shown in Figures 5-16 and 5-17 for fecal coliform and *E. coli*, respectively. Comparisons for each area of the river (left descending bank, midstream and right descending bank) are shown for each day of the event. The minimum and maximum concentrations predicted each day are also shown on these figures. Temporal plots of model and observed data for each area of the river are included in Appendix G. Maximum concentrations in each model segment are shown schematically in Appendix H.

In the center channel, where the most data are available, the model compares favorably to observed data and is generally within an order of magnitude of the observed concentrations. The model is less reliable on the near shore areas of the river. As with the 1998 event, elevated *E. coli* concentrations on the second and third day of the event were measured downstream of river mile 615 on the Kentucky near shore and were not reflected in model simulations. The cause of this discrepancy is not known, though an unaccounted load is one possible explanation. This pattern could not be evaluated for fecal coliform due to the lack of near shore data.

Regressions of daily observed data to the daily model geometric mean concentration are shown in Figure 5-17. The fecal coliform regression shows that the model concentrations generally

range by less than an order of magnitude, while observed concentrations range by three orders of magnitude. The *E. coli* regression shows a similar behavior, although the model tended to predict more high concentration values that matched the high observed concentrations. As with the 1998 event, there was no improvement in the regression fit when conducted on a sampling location or sampling day basis.

5.4.3.3 MAY 2001 EVENT

An average of 0.52 inches of rain fell on the study area on May 7, 2001, although the storm was not uniform across the watershed. Some gages recorded over two inches of precipitation, while other gages did not record any precipitation. Trace rainfall occurred on subsequent days of the event. An average of 0.68 inches of rain fell on the study area on May 11.

This event has the most extensive Ohio River dataset of the events monitored. Measurements of fecal coliform and *E. coli* have excellent spatial and temporal coverage. Concentrations measured at the upstream model boundary were less than 50 CFU/100 mL for fecal coliform and less than 20 CFU/100 mL for *E. coli*. All of the measured *E. coli* concentrations are less than the corresponding fecal coliform concentrations, as shown in Figure 5-11.

Spatial plots, comparing observed data to the model output at the hour closest to the time the samples were collected, are shown in Figures 5-18 and 5-19 for fecal coliform and *E. coli*, respectively. Comparisons for each area of the river (left descending bank, midstream and right descending bank) are shown for each day of the event. The minimum and maximum concentrations predicted each day are also shown on these figures. Temporal plots of model and observed data for each area of the river are included in Appendix G. Maximum concentrations in each model segment are shown schematically in Appendix H.

In general, the model reproduces the concentration pattern observed in the stream data from upstream to downstream. The model also seems to reasonably reproduce the pattern in lateral transport across the river. Again, the model does not reproduce the elevated concentrations observed downstream of river mile 614 on the second and third days of the event. As a result, the model underpredicts concentrations downstream of river mile 614 during most of the event. The source of this elevated concentration could not be identified and does not appear to be included in the existing loading inputs to the model. An alternative set of tributary loading inputs was developed using the ORSANCO tributary data and run with the model. This observed tributary data may be limited in that peak concentrations may not have been captured in the sampling because the frequency of sampling was every six to twelve hours, depending on the day. Model results using these loadings as inputs also tend to underpredict bacteria concentrations in the downstream reaches for this event and do not result in significantly better model to data comparisons.

Regressions of daily observed data to the daily model geometric mean concentration are shown in Figure 5-20. The data generally follow the 1:1 line, although the slope is less, indicating that the model tends to underpredict the observed data. This is likely due to the inability of the model to reproduce the high concentrations observed downstream of river mile 614 that may be the explained by the absence of an apparent loading source in this vicinity. The correlation for *E.*

coli is poorer than for fecal coliform. The *E. coli* regression has much more scatter over a wider range of concentrations, especially at low concentrations. The *E. coli* regression does illustrate the same trend as the fecal coliform regression in that both parameters were underpredicted by the model at high concentrations.

5.4.3.4 OCTOBER 2001 EVENT

An average of 1.29 inches of rain fell on the study area on October 5, 2001 and was relatively uniformly distributed. Upstream flow was relatively low, approximately 22,000 cfs, during the event. Concentrations at the upstream model boundary were also low, generally less than 20 CFU/100 mL throughout the duration of the event. Elevated concentrations observed in the model domain are a reflection of the source loadings.

The October 2001 event also contained an extensive dataset for comparing model data to observed data. ORSANCO monitored water quality in the Ohio River from October 6, 2001 through October 10, 2001. Although water quality was not monitored on the day of the rainfall, the low in-stream velocity slowed the transport of wet weather-induced loads, so that their effects were captured in the monitoring conducted on the days following the rainfall. Fecal coliform and *E. coli* data are available for all sections of the river for all of the days that were monitored, providing a robust dataset for comparing to model simulated concentrations. All but a few of the *E. coli* measurements were less than the corresponding fecal coliform measurements, as shown in Figure 5-11.

Spatial plots, comparing observed data to the model output at the hour closest to the time the samples were collected, are shown in Figures 5-21 and 5-22 for fecal coliform and *E. coli*, respectively. Comparisons for each area of the river (left descending bank, midstream and right descending bank) are shown for each day of the event. The minimum and maximum concentrations predicted each day are also shown on these figures. Temporal plots of model and observed data for each area of the river are included in Appendix G. Maximum concentrations in each model segment are shown schematically in Appendix H.

As Figures 5-21 and 5-22 illustrate, the model-simulated concentrations are within an order of magnitude of the observed data for both bacteria parameters for most of the simulation period. In general, the model reproduces the concentration pattern observed in the stream data from upstream to downstream. The model also seems to reasonably reproduce the pattern in lateral transport across the river. The model does not reproduce the elevated concentrations observed downstream of river mile 614 on the third day of the monitoring period. The source of this elevated concentration could not be identified and does not appear to be included in the loading inputs. Model simulated concentrations on the Indiana near shore are higher than the measured data below river mile 607. No data were available for Silver Creek, so an evaluation of the magnitude of the loading input from the HSPF model for this tributary could not be evaluated, though the concentrations from the HSPF model are likely higher than expected, given the results for the other events.

Regressions of daily observed data to the daily model geometric mean concentration are shown in Figure 5-23. The regressions follow the 1:1 line for both parameters, but show a lot of scatter around the 1:1 line. The regressions also show a consistently low bias in the model predictions at concentrations greater than 10,000 CFU/100 mL, reflecting the absence of an apparent loading source.

5.4.4 MODEL INPUT SENSITIVITY ANALYSES

Selection of model inputs can have a significant influence on water quality model concentration predictions. Each of the model inputs has a degree of uncertainty associated with it. The effect on simulated concentrations of the uncertainty associated with two model inputs, the bacteria decay rate and the source loadings, were tested with additional simulations of the events.

Sensitivity of the model to the values of the fecal coliform and *E. coli* decay rates were evaluated by rerunning the simulations using the additional decay rates of 0 day^{-1} and 2.5 day^{-1}. Model simulated concentrations using these decay rates were compared to observed data, as shown in Figure 5-24, for the center channel. Emphasis was given to matching observed data at the most downstream stations at river miles 628 and 630. Model predicted concentrations were affected by missing downstream loads in the May 2001 event. Model predicted concentrations that most closely matched observed data at these downstream stations during events that were not as severely impacted by the missing downstream load (August 2000 and October 1998 events) were simulated using a decay rate of 1 day^{-1}. A decay rate of 0 day^{-1} also produced good model-to-data fits, but the decay rate of 2.5 day^{-1} resulted in a consistent underprediction of observed concentration data.

A second set of sensitivities was performed to evaluate the effect on model-to-data fit due to uncertainty in the CSO and tributary loadings. In this analysis, all loads were varied by plus or minus 50 percent. Results are shown in Figures 5-25 and 5-26 for fecal coliform and *E. coli*, respectively, for the first two days of the October 2001 event in the near shore and center channel areas of the river. This event is used to simulate effects of the sensitivity analysis because of the low upstream flow and loading condition. Increasing the loads improved model predictions along the left descending bank below river mile 620 on the second day of the event. Decreasing the loads improved model predictions between river miles 600 and 616 on the second day of the event. In general, the loads used in the calibration result in the best overall model predictions of instream concentrations at all locations.

Table 5-1. Operating Procedures Observed at McAlpine Dam

Discharge, cfs	Lower Gate Opening, ft	Upper Gate Opening, ft	Hydro Units in Operation
200,000	32	65	5
100,000	4	39	6
43,000	7	1	7
36,000	9	0	5
23,000	11	0	1
23,000	2	0	4
16,000	1	0	3
6,500	1	0	1

Table 5-2. Wet Weather Sampling Event Summary

Event ID	Start Date	End Date	Total Rainfall (in)	Average Q (cfs)	Minimum Q (cfs)	Maximum Q (cfs)	Upstream RM Monitored	Downstream RM Monitored	Sampling Began	Number of days sampled	Number of Tributary Stations Sampled	Number of CSOs sampled
98WET1	10/7/1998	10/10/1998	1.34	25,948	7,290	40,900	588	629.9	10/7/1998	4	12	3
00WET1	8/8/2000	8/14/2000	0.56	97,500	58,000	138,800	588	660	8/8/2000	6	11	8
01WET1	5/7/2001	5/14/2001	0.52	44,330	37,400	55,400	588	660	5/8/2001	5	13	8
01WET2	10/5/2001	10/10/2001	1.29	21,600	19,600	24,700	588	660	10/6/2001	5	11	7

Table 5-3. Constituents Monitored During Wet Weather Sampling

Constituent	98WET1 (10/7-10/98)		00WET1 (8/8-14/00)		01WET1 (5/7-14/01)		01WET2 (10/5-10/01)	
	Monitored?	WQ Impairment?	Monitored?	WQ Impairment?	Monitored?	WQ Impairment?	Monitored?	WQ Impairment?
Alkalinity	✔		✔		✔		✔	
CBOD20	✔		✔		✔		✔	
CBOD5	✔		✔		✔		✔	
Chlorophyll *a*			✔		✔		✔	
Conductivity	✔		✔		✔		✔	
Dissolved oxygen	✔		✔	✔	✔		✔	
E. coli, MF-method 1	✔	✔	✔	✔				
E. coli, Colilert-method 2	✔	✔	✔	✔	✔	✔	✔	✔
Fecal coliform	✔	✔	✔	✔	✔	✔	✔	✔
Total Hardness	✔		✔		✔		✔	
Ammonia nitrogen	✔		✔		✔		✔	
Nitrate-nitrite nitrogen	✔		✔		✔		✔	
pH	✔		✔		✔		✔	
Secchi Disk	✔		✔		✔		✔	
TDS	✔							
Water temperature	✔		✔		✔		✔	
TKN	✔		✔		✔		✔	
Total phosphorus	✔		✔				✔	
TSS	✔		✔				✔	

Table 5-4. Fecal coliform Results Summary by Wet Weather Event

Event	Area	River Mile Range	Number of Measurements	Measurements > WQS	Max Conc. (#/100 ml)
98WET1	Above CSO area	588-602	34	0	80
10/7-10/98	CSO Area above McAlpine Dam	602-607	14	0	140
	CSO Area below McAlpine Dam	607-612	6	2	1,040
	Below Morris Forman WWTP	612-625	28	11	75,000
	Below Louisville metropolitan area	625-660	6	2	1,140
00WET1	Above CSO area	588-602	29	9	7,600
8/8-14/00	CSO Area above McAlpine Dam	602-607	13	5	2,500
	CSO Area below McAlpine Dam	607-612	11	3	3,600
	Below Morris Forman WWTP	612-625	34	3	3,200
	Below Louisville metropolitan area	625-660	23	7	2,000
01WET1	Above CSO area	588-602	36	0	180
5/7-14/01	CSO Area above McAlpine Dam	602-607	16	3	4,400
	CSO Area below McAlpine Dam	607-612	15	5	4,800
	Below Morris Forman WWTP	612-625	42	24	43,000
	Below Louisville metropolitan area	625-660	27	12	68,000
01WET2	Above CSO area	588-602	35	0	260
10/5-10/01	CSO Area above McAlpine Dam	602-607	14	1	470
	CSO Area below McAlpine Dam	607-612	17	8	3,800
	Below Morris Forman WWTP	612-625	49	33	300,000
	Below Louisville metropolitan area	625-660	27	19	120,000

WQS = Single Sample Maximum Concentration = 400#/100 ml

Table 5-5. *E. coli* Results Summary by Wet Weather Event

Event	Area	River Mile Range	Number of Measurements	Measurements > WQS	Max Conc. (#/100 ml)
98WET1	Above CSO area	588-602	84	1	334
10/7-10/98	CSO Area above McAlpine Dam	602-607	48	8	520
	CSO Area below McAlpine Dam	607-612	18	6	863
	Below Morris Forman WWTP	612-625	80	40	86,600
	Below Louisville metropolitan area	625-660	27	10	2,710
00WET1	Above CSO area	588-602	66	24	948
8/8-14/00	CSO Area above McAlpine Dam	602-607	45	14	497
	CSO Area below McAlpine Dam	607-612	24	6	472
	Below Morris Forman WWTP	612-625	85	15	2,200
	Below Louisville metropolitan area	625-660	45	12	2,280
01WET1	Above CSO area	588-602	63	0	30
5/7-14/01	CSO Area above McAlpine Dam	602-607	29	2	600
	CSO Area below McAlpine Dam	607-612	23	3	330
	Below Morris Forman WWTP	612-625	74	33	17,800
	Below Louisville metropolitan area	625-660	43	15	8,000
01WET2	Above CSO area	588-602	62	0	68
10/5-10/01	CSO Area above McAlpine Dam	602-607	30	0	153
	CSO Area below McAlpine Dam	607-612	26	11	1,400
	Below Morris Forman WWTP	612-625	70	52	620,000
	Below Louisville metropolitan area	625-660	48	30	96,000

WQS = Single Sample Maximum Concentration = 230#/100 ml

* Includes results for both methods used during event=Colilert and Membrane Filtration

Table 5-6. Tributary Flow Contribution to Gauged Ohio River Flows

Event	Date	Tributary Daily Average Flow[1] (cfs)	Ohio River Gage Daily Average Flow (cfs)	Tributary Flow Contribution to Ohio River Gage Flow
98WET1 10/7-10/98	10/7/1998	1,346	16,848	7.99%
	10/8/1998	1,459	12,605	11.57%
	10/9/1998	557	35,959	1.55%
	10/10/1998	291	37,720	0.77%
00WET1 8/8-14/00	8/8/2000	106	92,560	0.11%
	8/9/2000	93	121,182	0.08%
	8/10/2000	148	136,906	0.11%
	8/11/2000	65	123,667	0.05%
	8/12/2000	42	121,979	0.03%
	8/13/2000	33	99,122	0.03%
	8/14/2000	27	75,415	0.04%
01WET1 5/7-14/01	5/7/2001	449	40,251	1.12%
	5/8/2001	931	42,339	2.20%
	5/9/2001	202	47,273	0.43%
	5/10/2001	131	45,503	0.29%
	5/11/2001	169	35,556	0.48%
	5/12/2001	326	28,619	1.14%
	5/13/2001	137	32,109	0.43%
	5/14/2001	103	32,143	0.32%
01WET2 10/5-10/01	10/5/2001	1,241	20,327	6.10%
	10/6/2001	1,013	23,885	4.24%
	10/7/2001	395	23,479	1.68%
	10/8/2001	235	22,117	1.06%
	10/9/2001	154	21,763	0.71%
	10/10/2001	116	20,736	0.56%

[1] Includes sum of flows generated by landside model from tributaries between RM 590 and RM 605

Table 5-7. Fecal coliform and *E. coli* Upstream Boundary Concentrations

Event	Date	Fecal coliform					*E. coli*				
		RB	RQ	MD	LQ	LB	RB	RQ	MD	LQ	LB
98WET1	10/7/1998	10	10	10	10	10	4.5	2.8	1	2.8	4.5
10/7-10/98	10/8/1998	18.8	18.8	18.8	18.8	18.8	2.5	3.3	4	5.5	7
	10/9/1998	10	10	10	10	10	1	1	1	3.3	5.5
	10/10/1998	40	40	40	25	10	6	9.3	12.5	10.5	8.5
00WET1	8/8/2000	70	93.6	117.2	121.5	125.8	5.9	5.6	5.3	6.3	7.3
8/8-14/00	8/9/2000	478.6	639.3	800	830.8	861.5	114	80.2	46.3	46.1	45.8
	8/10/2000	30	65	100	112.5	125	65	76	87	134	180.9
	8/11/2000	290	345	400	450	500	307	627.5	948	632	316
	8/12/2000	70	93.6	117.2	121.5	125.8	4.4	4.4	4.4	4.4	4.4
	8/13/2000	9.5	9.5	9.5	9.5	9.5	4.4	4.4	4.4	4.4	4.4
	8/14/2000	9.5	9.5	9.5	9.5	9.5	4.4	4.4	4.4	4.4	4.4
01WET1	5/7/2001	2	3	4	27	50	2	3	4	4	4
5/7-14/01	5/8/2001	2	3	4	27	50	2	3	4	4	4
	5/9/2001	24	28	32	24	16	12	10	8	8	8
	5/10/2001	2	2	2	2	2	2	2	2	2	2
	5/11/2001	2	2	2	2	2	2	2	2	2	2
	5/12/2001	2	2	2	2	2	2	2	2	2	2
	5/13/2001	2	2	2	2	2	2	2	2	2	2
	5/14/2001	2	2	2	2	2	2	2	2	2	2
01WET2	10/5/2001	6.2	6.2	6.2	6.2	6.2	3	3	3	3	3
10/5-10/01	10/6/2001	6.2	6.2	6.2	6.2	6.2	3	3	3	3	3
	10/7/2001	16	14	12	8	4	7	8.5	10	5.2	0.5
	10/8/2001	2	3	4	4	4	2	2	2	2	2
	10/9/2001	6.2	6.2	6.2	6.2	6.2	3	3	3	3	3
	10/10/2001	6.2	6.2	6.2	6.2	6.2	3	3	3	3	3

Table 5-8. Bacteria Sources Input to the Water Quality Model

No.	Model Segment	River Mile	Source ID	Description	Volume/Flow Quantification Method	Fecal coliform Concentration Quantification Method	*E. coli* Concentration Quantification Method
1	1	589.30	RM 589.3	14-Mile Creek-Indiana	HSPF	HSPF	HSPF
2	101	596.30	RM 596.3	Lancassange & Lentizer Creeks-Indiana	HSPF	HSPF	HSPF
3	241	607.00	RM 607	Silver Creek-Indiana	HSPF	HSPF	HSPF
4	284	609.30	RM 609.3	Fall Run, Vincennes Run, French Creek-Indiana	HSPF	HSPF	HSPF
5	604	628.30	RM 628.3	4-Mile Creek, other small tribs-Indiana	HSPF	HSPF	HSPF
6	100	595.90	RM 595.9	Harrod's Creek-Kentucky	HSPF	HSPF	HSPF
7	135	598.00	RM 598	Little Huckleberry, other small tribs-Kentucky	HSPF	HSPF	HSPF
8	115	596.90	RM 596.9	Goose Creek-Kentucky	HSPF	HSPF	HSPF
9	200	602.10	RM 602.1	Beargrass Creek-Kentucky	HSPF	HSPF	HSPF
10	408	616.40	RM 616.4	Mill Creek Cutoff-Kentucky	HSPF	HSPF	HSPF
11	553	625.10	RM 625.1	Mill Creek-Kentucky	HSPF	HSPF	HSPF
12	623	629.00	RM 629	Unnamed tribs-Kentucky	HSPF	HSPF	HSPF
13	16	591.00	IN0020508	Charlestown Municipal WWTP	NPDES Monthly Data	West County WWTP Data	0.6 * Fecal
14	230	606.00	IN0047058	Clarksville Municipal WWTP	NPDES Monthly Data	West County WWTP Data	0.6 * Fecal
15	328	612.25	KY0022411	Morris Forman WWTP	NPDES Daily Data	NPDES Daily Data	0.6 * Fecal
16	528	623.50	KY0078956	West County WWTP	NPDES Daily Data	NPDES Daily Data	0.6 * Fecal
17	343	613.03	Ky CSO-015	Southwestern Pump Station	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
18	323	611.80	Ky CSO-016	Miles Park Bypass	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
19	258	607.47	Ky CSO-019	34th St. Pump Station	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
20	225	603.75	Ky CSO-022	4th St. Pump Station	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
21	225	604.14	Ky CSO-050	12th St. Overflow	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
22	225	604.01	Ky CSO-051	11th St. Overflow	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
23	225	604.01	Ky CSO-052	10th St. Overflow	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
24	225	603.87	Ky CSO-054	7th St. Overflow	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
25	225	603.82	Ky CSO-055	6th St. Overflow	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
26	220	603.25	Ky CSO-058	Preston St. Overflow	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
27	308	610.80	Ky CSO-104	Southwestern Parkway @ Broadway	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
28	308	610.80	Ky CSO-105	Western Outfall @ Broadway	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
29	225	604.14	Ky CSO-155	Rowan St. Combined Sewer	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
30	225	603.50	Ky CSO-160	Alley North of 1st & Market St.	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
31	225	603.50	Ky CSO-161	Market St. Sanitary Diversion	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
32	205	602.38	Ky CSO-172	Adams St.	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
33	303	610.52	Ky CSO-189	Northwestern Sanitary Diversion	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
34	225	604.40	Ky CSO-190	17th St. Sanitary Diversion	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
35	343	613.03	Ky CSO-191	Algonquin Parkway	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
36	225	603.97	Ky CSO-CRD	Central Relief Drain	CSO Rainfall Regression	Geometric Mean of Summer 2001	0.6 * Fecal
38	176	600.85	Jeff CSO-01	CSO-01 (#015 Arctic Springs)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
39	181	601.25	Jeff CSO-02	CSO-02 (#014 Blanchel Terrace)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
40	191	601.60	Jeff CSO-03	CSO-03 (#013 Graham Street)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
41	196	602.10	Jeff CSO-04	CSO-04 (#012 Penn Street)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
42	201	602.25	Jeff CSO-05	CSO-05 (#011 Meigs)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
43	201	602.25	Jeff CSO-06	CSO-06 (#011 Meigs)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
44	206	602.60	Jeff CSO-07	CSO-07 (#010 Walnut Street)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
45	211	602.90	Jeff CSO-08	CSO-08 (#009 Wall Street)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
46	216	603.23	Jeff CSO-09	CSO-09 (#008 Spring Street)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
47	221	603.50	Jeff CSO-10	CSO-10 (#007 Clark)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
48	216	603.30	Jeff CSO-11	CSO-11 (#006 River Pointe)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
49	216	603.32	Jeff CSO-12	CSO-12 (#005 Missouri Avenue)	Median Ky CSO	Louisville CSO EMC	Louisville CSO
50	216	603.33	Jeff CSO-13	CSO-13	Median Ky CSO	Louisville CSO EMC	Louisville CSO
51	206	602.75	Jeff CSO-14	CSO-14 (#018 Tenth Street Pump Station)	Median Ky CSO	Louisville CSO EMC	EMC

Table 5-9. Volume and Load Input Summary for WQ Model Event Simulations

				Total Rainfall (in)	1.34			0.72			2.38			1.47		
				Max Rainfall (in/hr)	1.34			0.47			1.31			1.3		
				Minimum Q (cfs)	7,290			58,000			37,400			19,600		
				Average Q (cfs)	25,948			97,490			44,330			21,600		
				Maximum Q (cfs)	40,900			138,800			55,400			24,700		
					October 1998 Event (10/7-10/98)			August 2000 Event (8/8-14/00)			May 2001 Event (5/7-14/01)			October 2001 Event (10/5-10/01)		
Segment	Description	Area (ac)	River Mile	Load Type	Volume (MG)	E. coli Load (#)	Fecal coliform Load (#)	Volume (MG)	E. coli Load (#)	Fecal coliform Load (#)	Volume (MG)	E. coli Load (#)	Fecal coliform Load (#)	Volume (MG)	E. coli Load (#)	Fecal coliform Load (#)
1	14-Mile Creek-Indiana	42,737	589.3	HSPF	3,448.5	2.98E+16	8.95E+16	6,147.3	6.97E+16	2.14E+17	426.1	2.33E+14	5.56E+14	531.5	4.18E+14	1.03E+15
100	Harrod's Creek-Kentucky	70,220	595.9	Tributary	1,181.7	4.93E+13	9.99E+13	36.4	2.68E+12	5.33E+12	105.3	1.02E+13	2.14E+13	456.8	4.63E+13	9.85E+13
101	Lancassange & Lentizer Creeks-Indiana	26,159	596.3	Tributary	280.3	5.82E+13	1.27E+14	33.6	4.64E+11	7.94E+11	64.4	2.71E+12	5.10E+12	74.1	3.00E+12	5.66E+12
115	Goose Creek-Kentucky	11,484	596.9	Tributary	15.9	2.46E+11	4.80E+11	5.9	3.05E+11	6.32E+11	50.3	4.14E+12	9.79E+12	183.8	9.58E+12	2.05E+13
135	Little Huckleberry, other small tribs-Kentucky	9,497	598.0	Tributary	50.6	5.58E+12	1.14E+13	6.5	7.72E+11	1.60E+12	18.8	5.24E+12	1.17E+13	21.5	5.70E+12	1.27E+13
200	Beargrass Creek-Kentucky	39,169	602.0	Tributary	284.3	1.39E+15	4.08E+15	46.3	3.46E+13	8.71E+13	333.8	1.28E+15	3.66E+15	720.1	1.53E+16	5.09E+16
241	Silver Creek-Indiana	137,634	607.0	Tributary	954.9	2.72E+15	7.54E+15	204.5	2.28E+13	4.75E+13	578.9	6.89E+14	1.76E+15	524.8	4.85E+14	1.21E+15
284	Fall Run, Vincennes Run, French Creek-Indiana	28,846	609.3	Tributary	189.9	2.74E+14	7.16E+14	73.5	7.78E+12	1.59E+13	104.5	5.28E+13	1.25E+14	87.1	2.42E+13	5.43E+13
408	Mill Creek Cutoff-Kentucky	11,326	616.4	Tributary	225.8	2.46E+14	6.27E+14	14.9	4.25E+12	9.52E+12	207.4	1.87E+14	4.66E+14	180.2	1.58E+14	3.93E+14
553	Mill Creek-Kentucky	10,613	625.1	Tributary	157.2	2.74E+13	5.88E+13	20.0	8.34E+12	1.93E+13	412.0	1.08E+14	2.45E+14	176.9	6.59E+13	1.53E+14
604	4-Mile Creek, other small tribs-Indiana	12,495	628.3	Tributary	92.9	1.81E+13	3.91E+13	6.1	1.03E+12	2.19E+12	63.8	3.20E+13	7.50E+13	93.1	2.51E+13	5.59E+13
623	Unnamed tribs-Kentucky	998	629.0	Tributary	9.8	6.96E+11	1.37E+12	1.0	4.88E+10	9.35E+10	1.2	2.74E+11	6.02E+11	9.9	1.36E+12	2.84E+12
176	CSO-01		600.7	Jeffersonville CSO	1.0	1.48E+13	2.41E+13	0.2	2.96E+12	4.81E+12	0.5	7.19E+12	1.17E+13	1.0	1.47E+13	2.39E+13
181	CSO-02		601.0	Jeffersonville CSO	1.0	1.48E+13	2.41E+13	0.2	2.96E+12	4.81E+12	0.5	7.19E+12	1.17E+13	1.0	1.47E+13	2.39E+13
191	CSO-03		601.6	Jeffersonville CSO	1.0	1.48E+13	2.41E+13	0.2	2.96E+12	4.81E+12	0.5	7.19E+12	1.17E+13	1.0	1.47E+13	2.39E+13
196	CSO-04		601.9	Jeffersonville CSO	1.0	1.48E+13	2.41E+13	0.2	2.96E+12	4.81E+12	0.5	7.19E+12	1.17E+13	1.0	1.47E+13	2.39E+13
201	CSO-05, CSO-06		602.3	Jeffersonville CSO	2.0	2.96E+13	4.81E+13	0.4	5.92E+12	9.62E+12	0.9	1.44E+13	2.34E+13	1.9	2.94E+13	4.78E+13
206	CSO-07, CSO-14		602.5	Jeffersonville CSO	2.0	2.96E+13	4.81E+13	0.4	5.92E+12	9.62E+12	0.9	1.44E+13	2.34E+13	1.9	2.94E+13	4.78E+13
211	CSO-08		602.9	Jeffersonville CSO	1.0	1.48E+13	2.41E+13	0.2	2.96E+12	4.81E+12	0.5	7.19E+12	1.17E+13	1.0	1.47E+13	2.39E+13
216	CSO-09, CSO-11, CSO-12, CSO-13		603.1	Jeffersonville CSO	3.9	5.92E+13	9.62E+13	0.8	1.18E+13	1.92E+13	1.9	2.88E+13	4.67E+13	3.9	5.89E+13	9.57E+13
221	CSO-10		603.4	Jeffersonville CSO	1.0	1.48E+13	2.41E+13	0.2	2.96E+12	4.81E+12	0.5	7.19E+12	1.17E+13	1.0	1.47E+13	2.39E+13
205	Adams St.		602.5	Louisville CSO	0.0	8.80E+07	1.43E+08	0.0	6.29E+03	1.02E+04	0.0	0.00E+00	0.00E+00	0.0	2.47E+06	4.02E+06
220	Preston St. Overflow		603.1	Louisville CSO	0.0	0.00E+00	0.00E+00	0.0	0.00E+00	0.00E+00	0.0	0.00E+00	0.00E+00	0.0	0.00E+00	0.00E+00
225	4th St. Pump Station		603.8	Louisville CSO	0.0	1.36E+01	2.21E+01	0.0	2.68E+08	4.36E+08	0.0	2.81E-03	4.56E-03	0.0	1.01E+08	1.64E+08
258	34th St. Pump Station		607.6	Louisville CSO	0.0	0.00E+00	0.00E+00	0.6	9.57E+12	1.56E+13	0.0	0.00E+00	0.00E+00	1.1	1.59E+13	2.58E+13
303	Northwestern Sanitary Diversion		610.5	Louisville CSO	4.4	6.64E+13	1.08E+14	0.0	6.84E+10	1.11E+11	0.0	2.39E+09	3.88E+09	3.3	5.04E+13	8.19E+13
308	Southwestern Parkway @ Broadway		610.8	Louisville CSO	0.0	4.19E+04	6.82E+04	0.0	1.75E-19	2.85E-19	0.0	2.88E-23	4.68E-23	0.0	1.26E-03	2.05E-03
323	Miles Park Bypass		612.0	Louisville CSO	0.7	1.09E+13	1.77E+13	0.1	1.26E+12	2.05E+12	0.2	3.53E+12	5.74E+12	0.7	1.01E+13	1.64E+13
343	Southwestern Pump Station		613.0	Louisville CSO	51.3	7.77E+14	1.26E+15	7.2	1.09E+14	1.76E+14	22.8	3.45E+14	5.60E+14	52.7	7.98E+14	1.30E+15
225	12th St. Overflow		604.1	Louisville CSO	0.0	4.84E+01	7.87E+01	0.0	2.54E+08	4.13E+08	0.0	1.92E-02	3.12E-02	0.0	1.09E+08	1.77E+08
225	11th St. Overflow		604.0	Louisville CSO	0.0	3.06E-04	4.97E-04	0.0	5.36E-24	8.72E-24	0.0	2.19E-43	3.56E-43	0.0	1.23E-11	2.00E-11
225	10th St. Overflow		604.0	Louisville CSO	0.0	0.00E+00	0.00E+00	0.0	0.00E+00	0.00E+00	0.0	0.00E+00	0.00E+00	0.0	0.00E+00	0.00E+00
225	7th St. Overflow		603.9	Louisville CSO	0.0	1.02E+10	1.66E+10	0.0	2.70E+08	4.39E+08	0.0	6.88E+06	1.12E+07	0.0	2.66E+09	4.32E+09
225	6th St. Overflow		603.8	Louisville CSO	0.0	1.02E+10	1.66E+10	0.0	2.70E+08	4.39E+08	0.0	6.88E+06	1.12E+07	0.0	2.66E+09	4.32E+09
308	Western Outfall @ Broadway		610.8	Louisville CSO	0.3	3.87E+12	6.29E+12	0.0	3.57E+06	5.79E+06	0.0	3.81E+05	6.19E+05	0.0	4.44E+10	7.21E+10
225	Rowan St. Combined Sewer		604.1	Louisville CSO	0.0	2.06E+10	3.34E+10	0.0	2.91E+08	4.72E+08	0.0	4.07E+06	6.61E+06	0.0	4.19E+09	6.81E+09
225	Alley North of 1st & Market St.		603.5	Louisville CSO	0.0	2.13E+10	3.46E+10	0.0	2.92E+08	4.74E+08	0.0	3.97E+06	6.45E+06	0.0	4.29E+09	6.97E+09
225	Market St. Sanitary Diversion		603.5	Louisville CSO	0.0	1.71E+10	2.79E+10	0.0	2.85E+08	4.63E+08	0.0	4.65E+06	7.56E+06	0.0	3.72E+09	6.04E+09
225	17th St. Sanitary Diversion		604.4	Louisville CSO	0.0	1.38E+11	2.25E+11	0.0	3.62E+08	5.88E+08	0.0	0.00E+00	0.00E+00	0.0	1.51E+10	2.45E+10
343	Algonquin Parkway		613.0	Louisville CSO	0.1	1.02E+12	1.65E+12	0.0	2.40E+08	3.91E+08	0.0	6.95E+07	1.13E+08	0.0	7.21E+10	1.17E+11
225	Central Relief Drain		604.0	Louisville CSO	0.5	7.83E+12	1.27E+13	0.6	8.49E+12	1.38E+13	0.4	5.94E+12	9.65E+12	1.2	1.89E+13	3.07E+13
16	Charlestown Municipal WWTP		591.0	NPDES	1.7	1.97E+09	3.28E+09	1.9	2.23E+09	3.72E+09	1.8	2.05E+09	3.41E+09	2.3	2.66E+09	4.43E+09
230	Clarksville Municipal WWTP		605.9	NPDES	4.4	5.08E+09	8.46E+09	5.2	6.04E+09	1.01E+10	5.1	5.88E+09	9.81E+09	7.4	8.56E+09	1.43E+10
328	Morris Forman WWTP		612.3	NPDES	217.1	6.94E+10	1.16E+11	212.6	7.33E+12	1.22E+13	187.5	1.99E+14	3.32E+14	195.3	8.07E+11	1.35E+12
528	West County WWTP		623.5	NPDES	0.0	0.00E+00	0.00E+00	26.3	5.57E+10	9.28E+10	37.0	2.54E+10	4.23E+10	39.6	2.21E+09	3.68E+09
1-5	Upstream Ohio River		590.0	Upstream	16,408.8	2.17E+12	7.78E+12	139,917.9	8.74E+13	9.87E+14	53,575.9	3.49E+13	6.90E+12	25,721.6	3.98E+12	7.00E+12
	Total				**20,146**	**5.87E+15**	**1.50E+16**	**140,624**	**3.47E+14**	**1.46E+15**	**55,778**	**3.06E+15**	**7.46E+15**	**28,567**	**1.72E+16**	**5.47E+16**
	Total - Upstream				*3,737*	*5.86E+15*	*1.50E+16*	*706*	*2.60E+14*	*4.78E+14*	*2,202*	*3.03E+15*	*7.45E+15*	*2,845*	*1.72E+16*	*5.47E+16*

Table 5-10. Rainfall Regression Equations Used to Estimate Louisville CSO

CSO	Discharge Location	Rain Gage	Regression Equation	Limits of Regression
15	Ohio River	10	V=7396725*R^1.3206	none
16	Ohio River	10	V=116601*R^1.5120	none
19	Ohio River	29	V=0 V=762289*R^1.984147	R<0.15 R>0.15
22	Ohio River	29	V=68974*R^9.2719 V=131564*R^0.9902	R<1.06 R>1.06
28	Central Relief Drain	29	V=81888.4*R^1.06716	none
29	Central Relief Drain	29	V=164.61*R^99.497747 V=38512.81*R^1.1250086	R<1.06 R>1.06
30	Central Relief Drain	29	V=306.09*R^4.7541521 V=1558.3*R^36.48286 V=9501.59*R^1.360833	R<0.95 0.95<R<1.06 R>1.06
33	Central Relief Drain	29	V=0 V=77.89*R^3.2874068	R<2.58 R>2.58
34	Central Relief Drain	29	V=0.01*R^84.106997 V=9571.6*R^1.5394759	R<1.18 R>1.18
36	Central Relief Drain	29	V=976.31*R^5.7175538 V=3190.45*R^28.803197 V=13176.67*R^1.10971	R<0.95 0.95<R<1.06 R>1.06
38	Central Relief Drain	29	V=0.06*R^8.9558043	R>1.76
49	Ohio River	29	V=0	none
50	Ohio River	29	V=30054.69*R^8.5707 V=50045*R^1.246696	R<0.60 R>0.60
51	Ohio River	29	V=36.62*R^70.196057 V=2800.8*R^1.9735894	R<1.06 R>1.06
52	Ohio River	29	V=0 V=3176.16*R^1.8900253	R<0.95 R>0.95
53	Central Relief Drain	29	V=4825.35*R^7.0447086 V=13175.56*R^26.6278 V=48189.01*R^1.118672	R<0.95 0.95<R<1.06 R>1.06
54	Ohio River	29	V=1105.73*R^5.8209435 V=4304.47*R^2.0297761	R<0.95 R>0.95
55	Ohio River	29	V=1105.73*R^5.8209435 V=4304.47*R^2.0297761	R<0.95 R>0.95
56	Ohio River	29	V=0	none
57	Ohio River	29	V=0	none
58	Ohio River	29	V=0 V=26187*R^1.50557	R<0.95 R>0.95
104	Ohio River	10	V=55.47*R^43.42323 V=14114.84*R^1.818708	R<1.15 R>1.15
105	Ohio River	10	V=741000*R^11.2105 V=1010000*R^1.3885	R<1.10 R>1.10
150	Central Relief Drain	29	V=40401.82*R^8.80969 V=42553.52*R^1.352609	R<0.95 R>0.95
155	Ohio River	29	V=3296.82*R^6.72832 V=410.76*R^1.9145325	R<0.95 R>0.95
156	Ohio River	29	V=0	none
160	Ohio River	29	V=3475.5*R^6.7721568 V=3931.17*R^1.177508	R<0.95 R>0.95
161	Ohio River	29	V=2480.28*R^6.491945 V=3761.33*R^1.264137	R<0.95 R>0.95
172	Ohio River	29	V=0 V=443.07*R^14.731423 V=2018*R^2.4185	R<0.30 0.30<R<1.18 R>1.18
178	Central Relief Drain	29	V=36.48*R^70.12403 V=1680.89*R^1.324735	R<1.06 R>1.06

Table 5-10. Rainfall Regression Equations Used to Estimate Louisville CSO

CSO	Discharge Location	Rain Gage	Regression Equation	Limits of Regression
181	Central Relief Drain	29	V=42873*R^1.1939	none
189	Ohio River	10	V=5.97e13*R^16.72067 V=915143.83*R^1.62569	R<0.30 R>0.30
190	Ohio River	29	V=0 V=63691.42*R^9.1774325 V=80867*R^1.5198	R<0.30 0.30<R<0.95 R>0.95
191	Ohio River	10	V=56894*R^6.734 V=147766*R^1.7331	R<1.06 R>1.06
192	Central Relief Drain	29	V=4.63*R^6.8493036	none
193	Central Relief Drain	29	V=0.01*R^20.987684 V=405.85*R^3.1241073	R<1.76 R>1.76
194	Central Relief Drain	29	V=0	none
195	Central Relief Drain	29	V=0	none
196	Central Relief Drain	29	V=2207.28*R^6.39509 V=3261.86*R^14.00894 V=6234.32*R^1.306275	R<0.95 0.95<R<1.06 R>1.06
197	Central Relief Drain	29	V=48.72*R^75.76201 V=1960.8*R^1.7722973	R<1.06 R>1.06
198	Central Relief Drain	29	V=1794.32*R^6.33048 V=6743.28*R^1.5105345	R<1.35 R>1.35
199	Central Relief Drain	29	V=0.04*R^14.800225 V=65.51*R^2.7389118	R<1.76 R>1.76
200	Central Relief Drain	29	V=8108.8*R^1.2808321	none
201	Central Relief Drain	29	V=2.99*R^11.016806 V=1059.83*R^1.0328046	R<1.76 R>1.76
202	Central Relief Drain	29	V=0.03*R^16.267905 V=88.67*R^3.4214855	R<1.76 R>1.76
203	Central Relief Drain	29	V=0	none
204	Central Relief Drain	29	V=16858.03*R^1.154460	none
207	Ohio River	29		
208	Ohio River	29		
DS	Ohio River	10	V=2746550*R^1.4606627	none

Table 5-11. CSO Event Mean Concentrations

Parameter	Summer Geometric Mean Concentration (#/100 mL)	Event Mean Concentration Used in Water Quality Model (#/100 ml)	Method for Estimating Representative Summer Concentration
Fecal coliform	657,426	650,000	Geometric mean of 19 measurements made between May and October of 2001
E. coli	394,455	400,000	0.6 * Fecal coliform geometric mean concentration

Figure 5-1. Modeling Flow Chart (and Organization Responsible for Model Application)

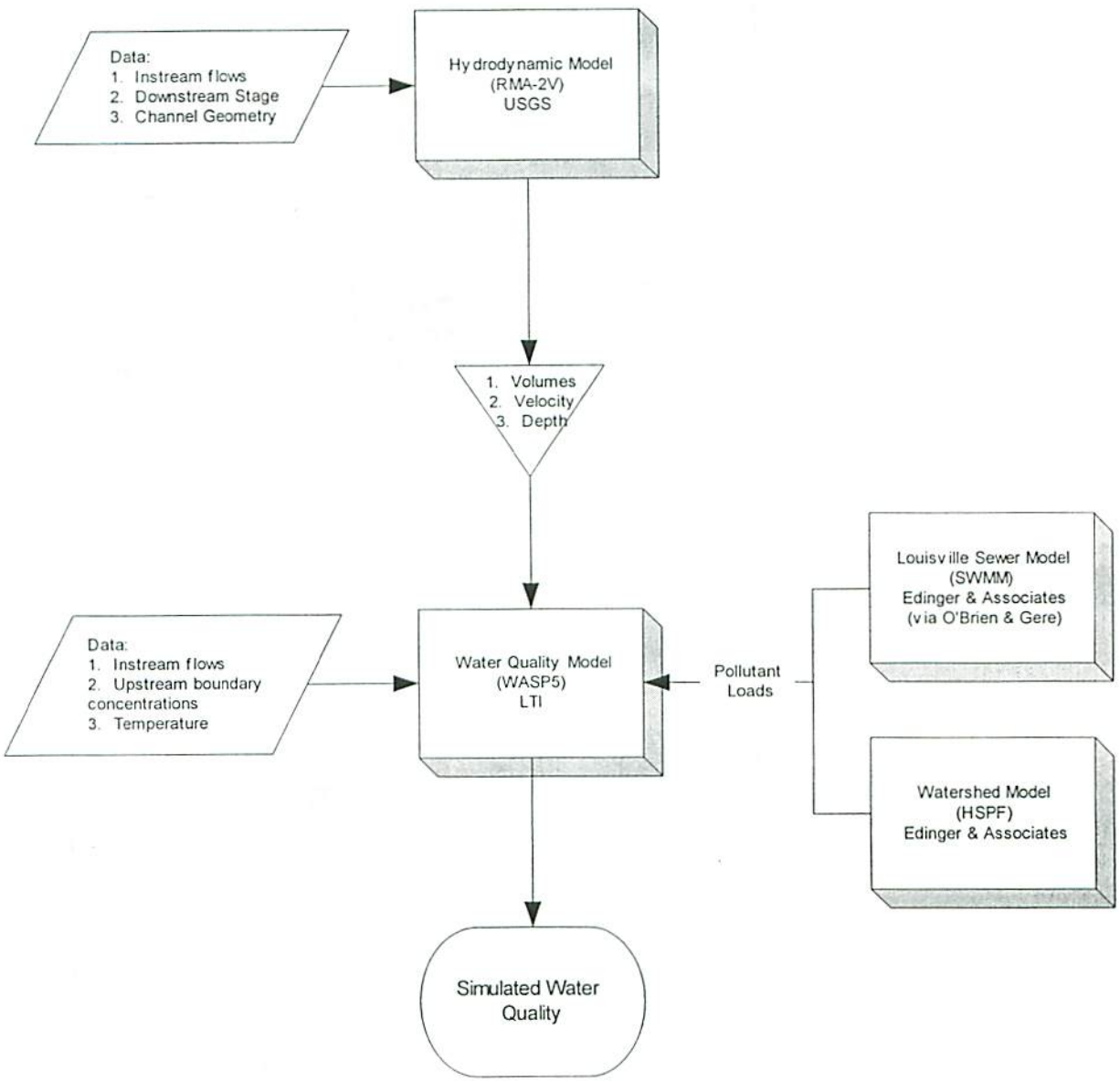


Figure 5-2. Water Quality Model Segmentation

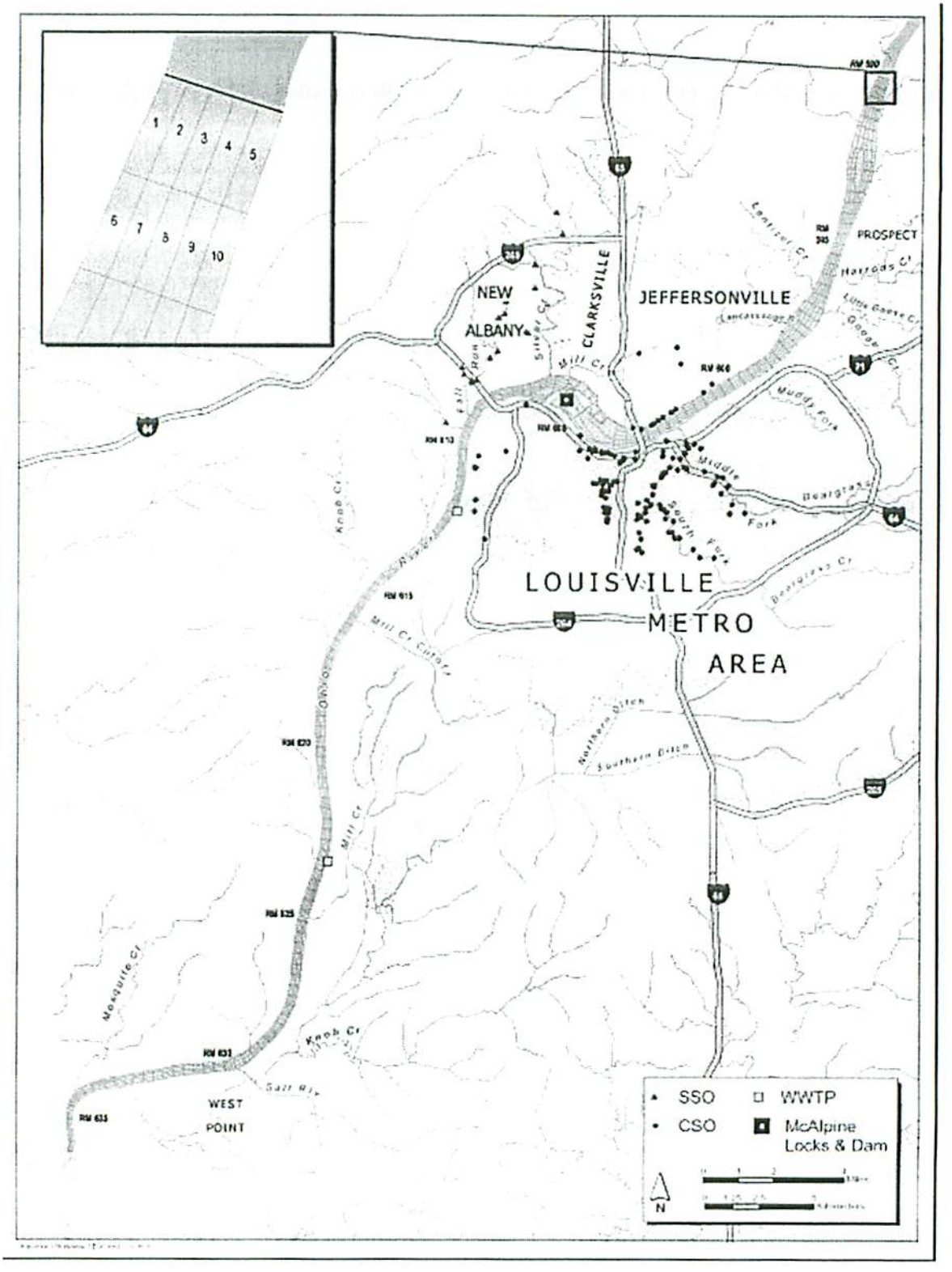


Figure 5-3. Structural Features of McAlpine Dam

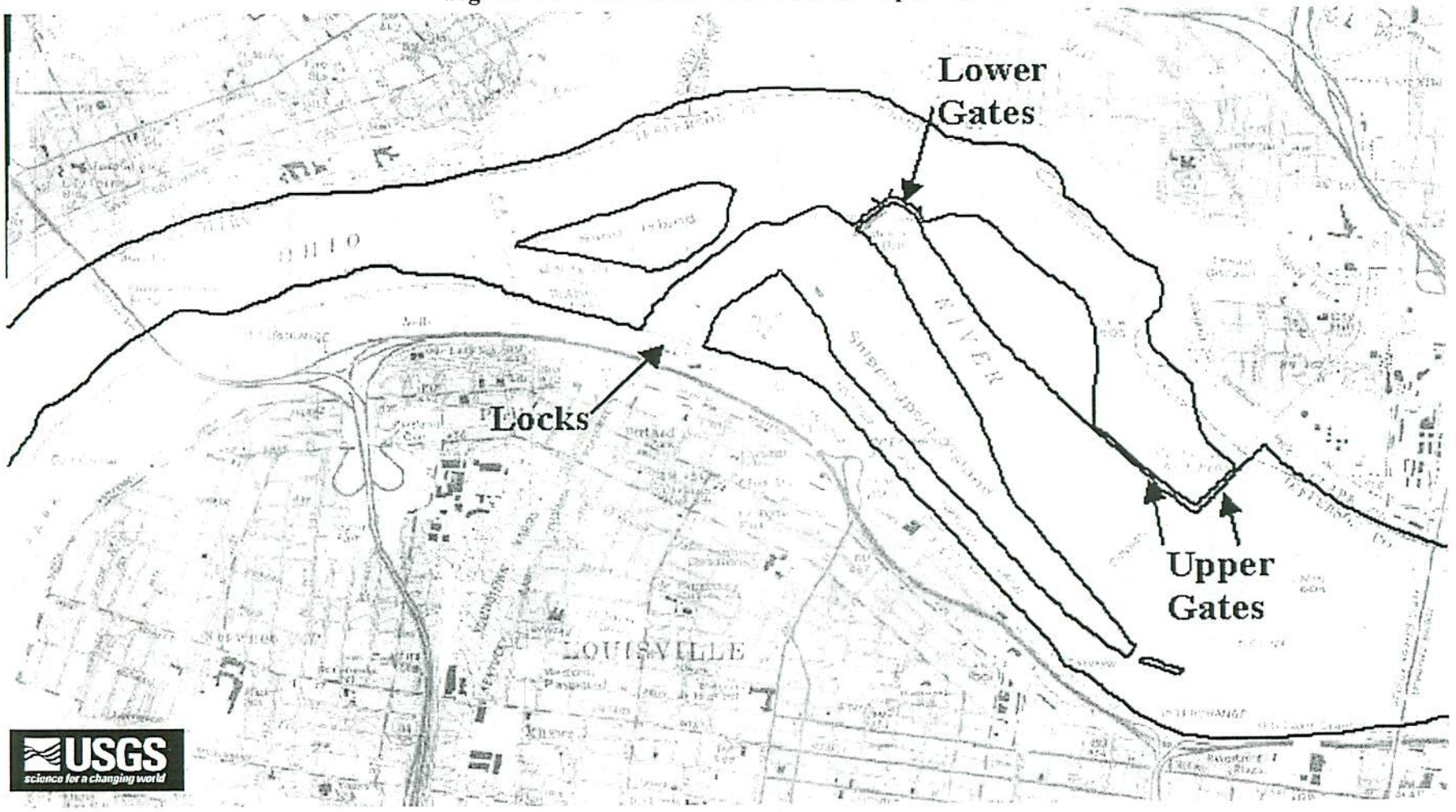


Figure 5-4. Model Calibration to May 16, 2000 Dye Survey Rhodamine-WT Dye Concentrations

(Lateral Dispersion: d = 0 m^2/s and d = 0.1 m2/s)

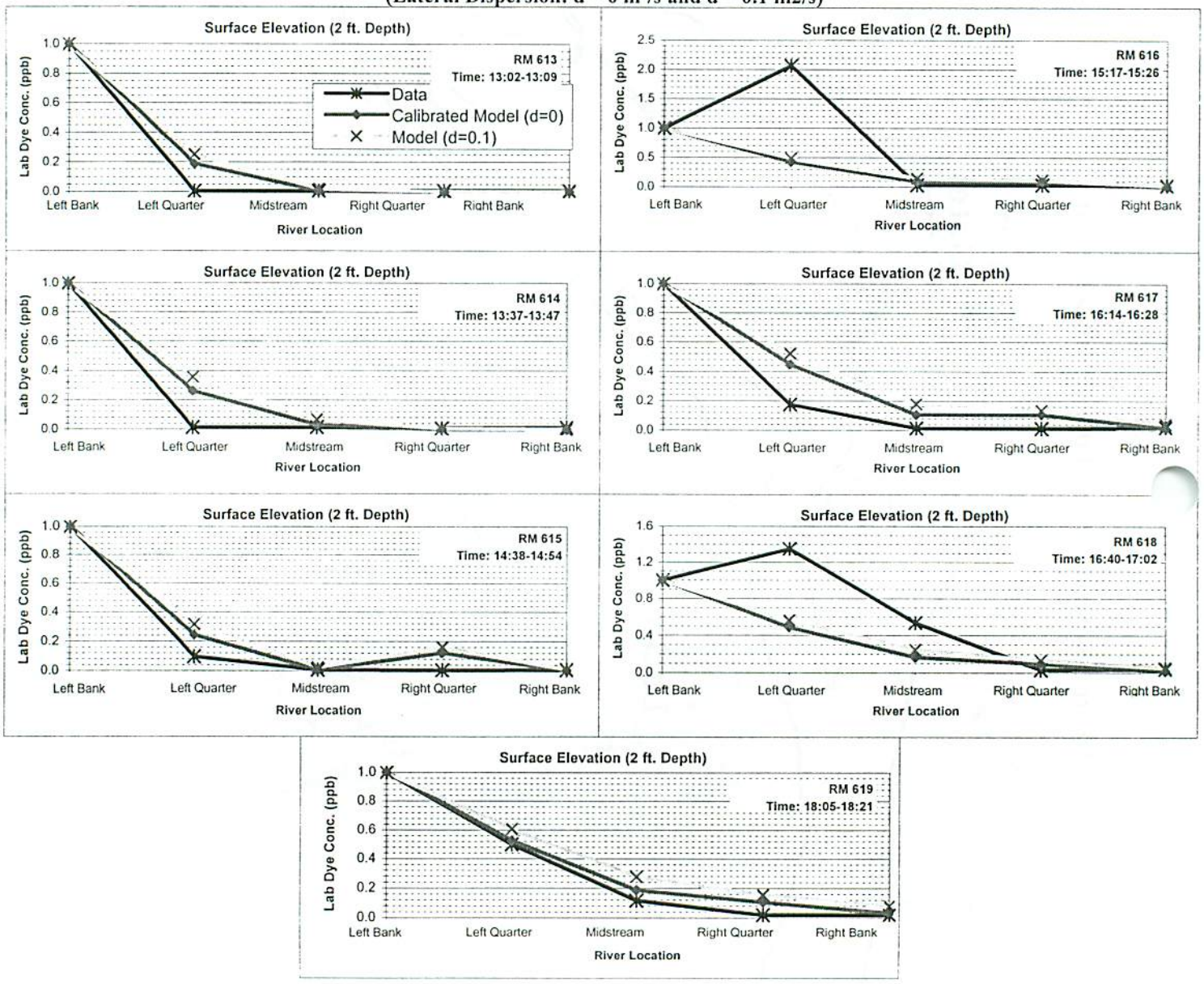


Figure 5-5. Model Simulated Transport of Rhodamine-WT Dye During May 16, 2000 Survey

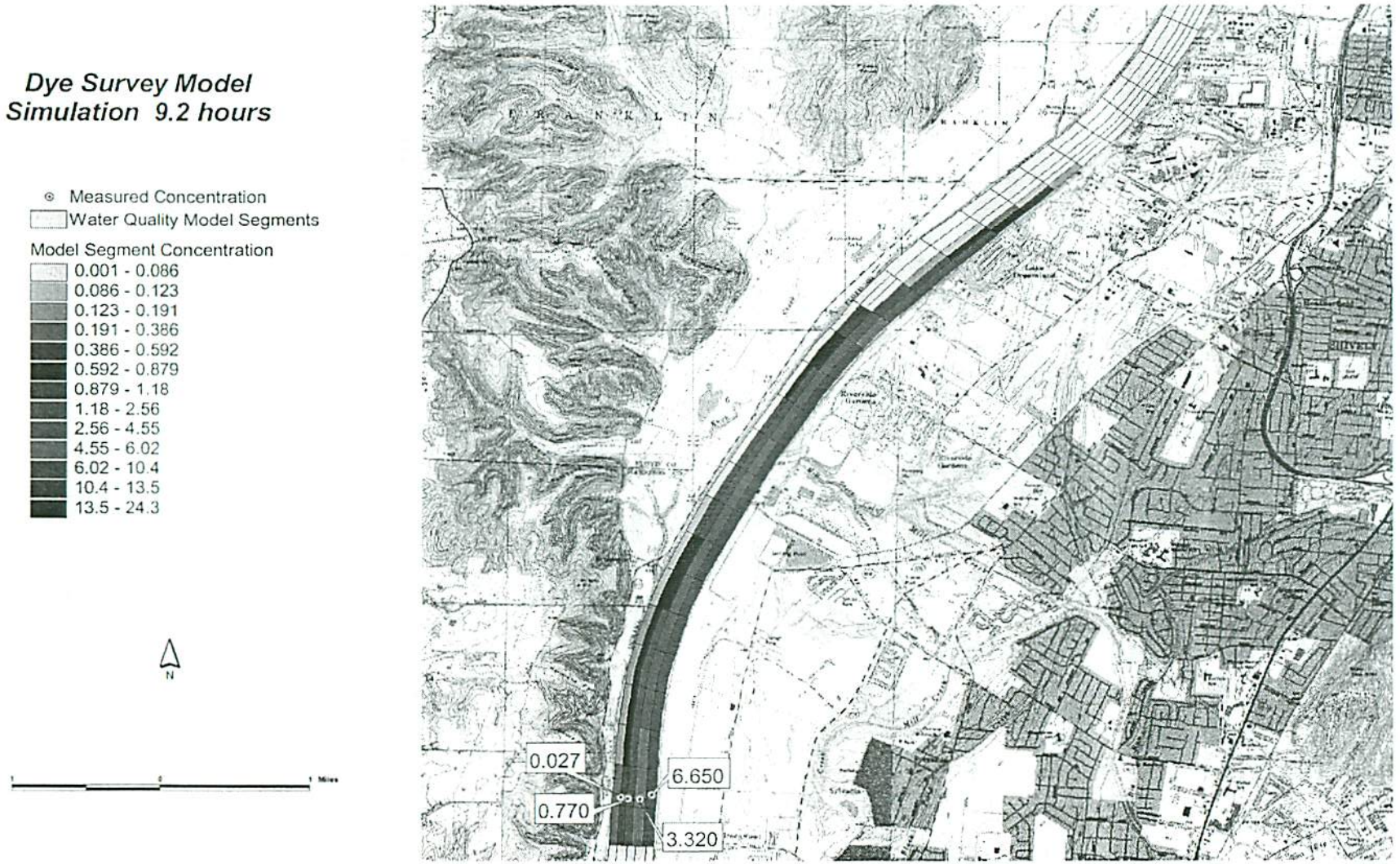
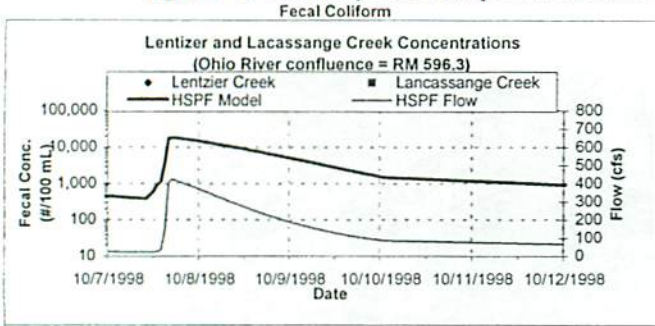
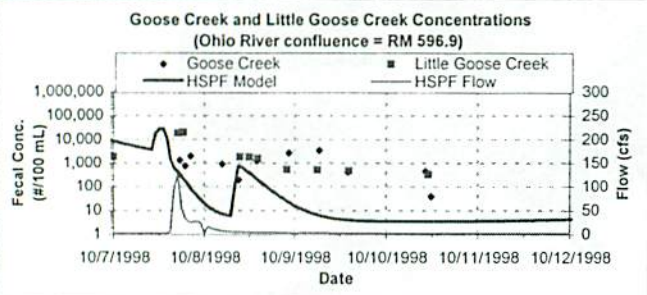
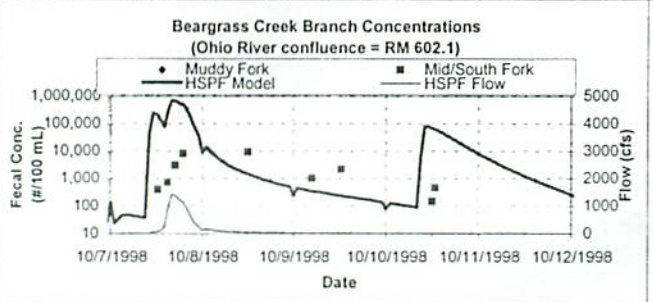


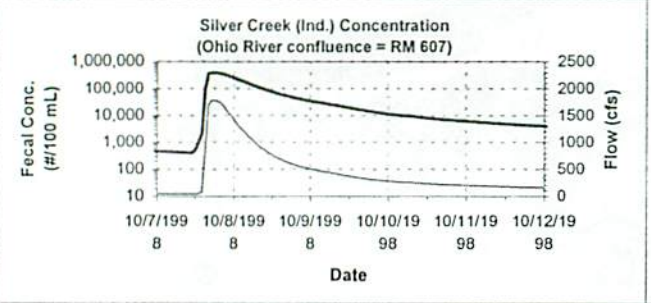
Figure 5-6. Tributary Data Comparison to HSPF Model Output for October 1998 Wet Weather Event

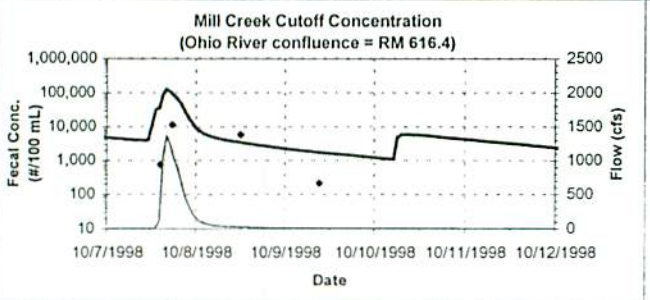
Fecal Coliform

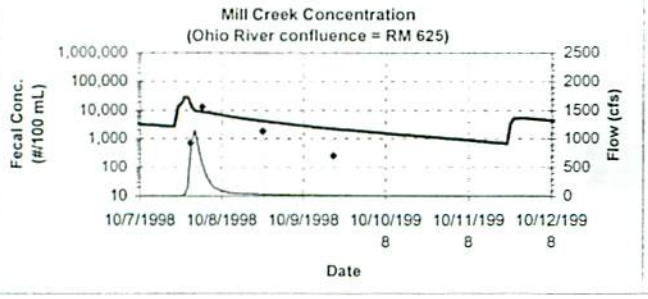




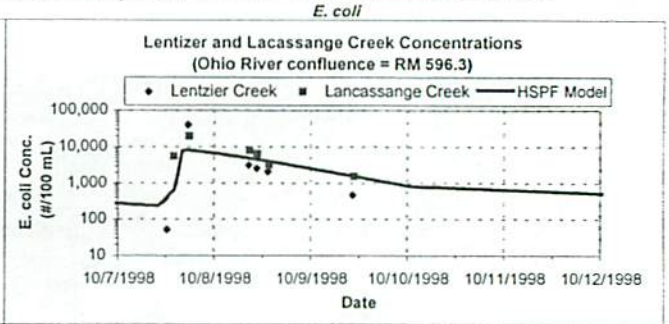


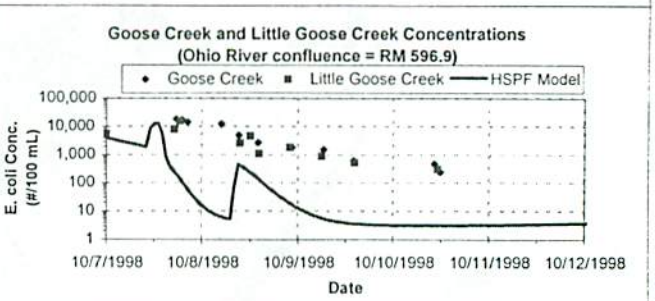


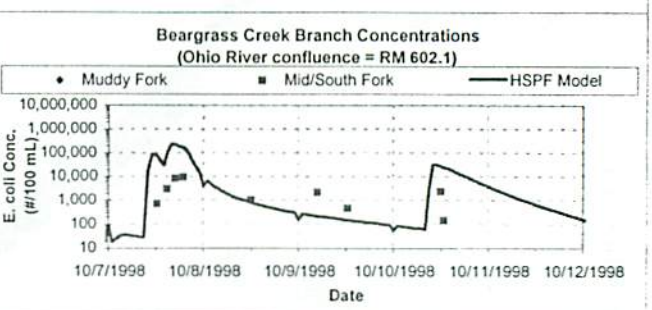


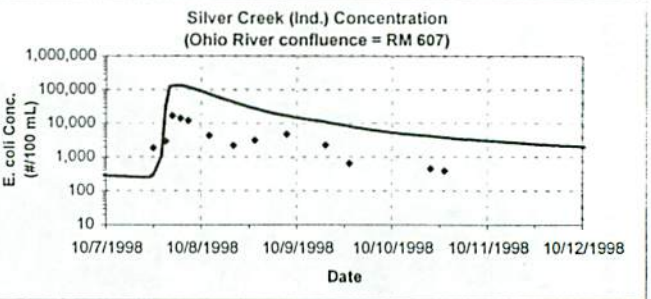


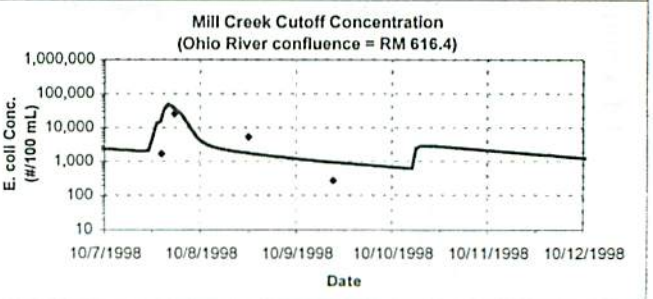
E. coli











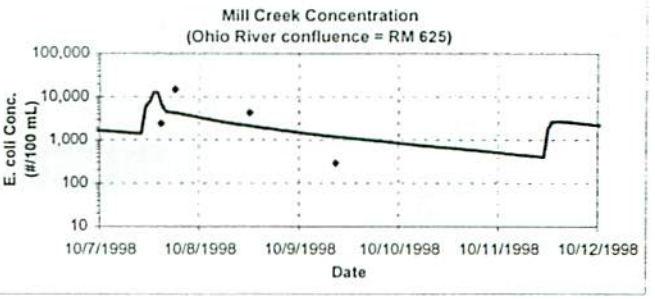
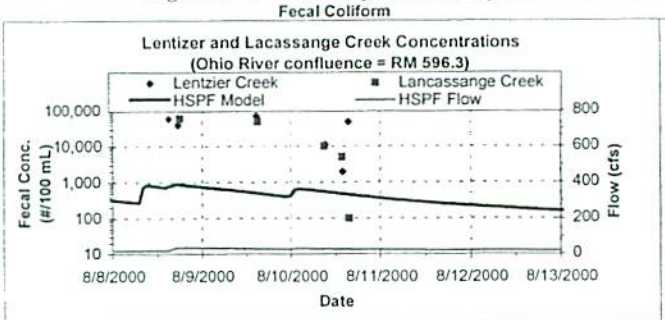
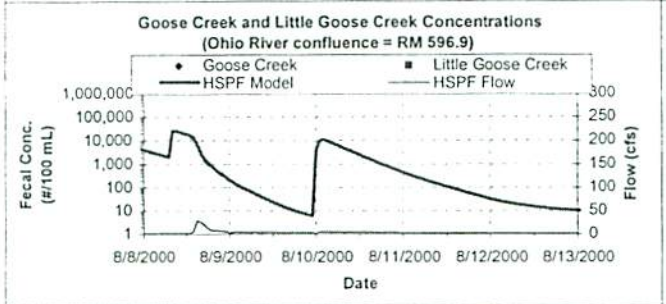
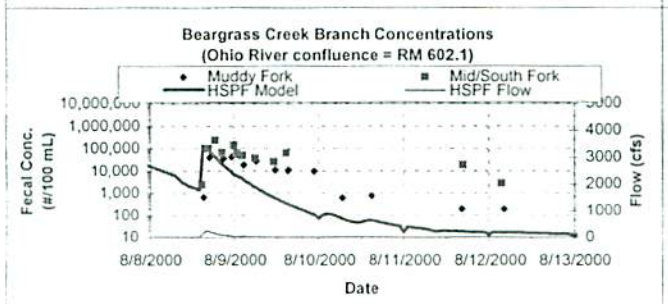


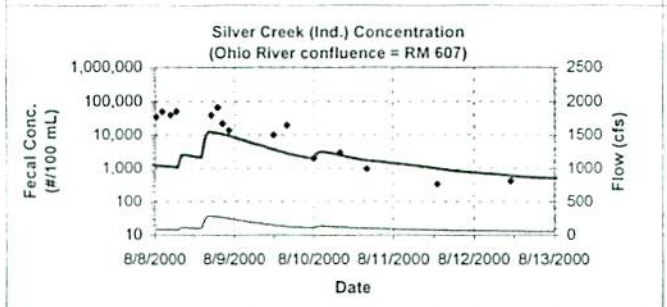
Figure 5-7. Tributary Data Comparison to HSPF Model Output for August 2000 Wet Weather Event

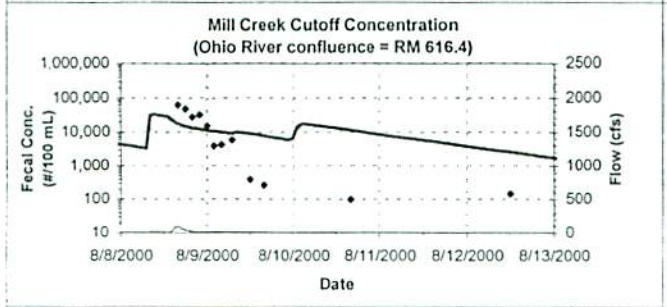
Fecal Coliform

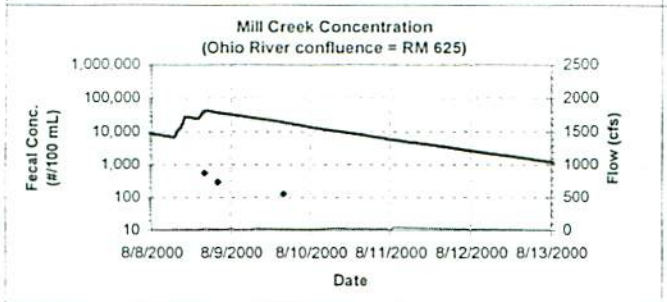




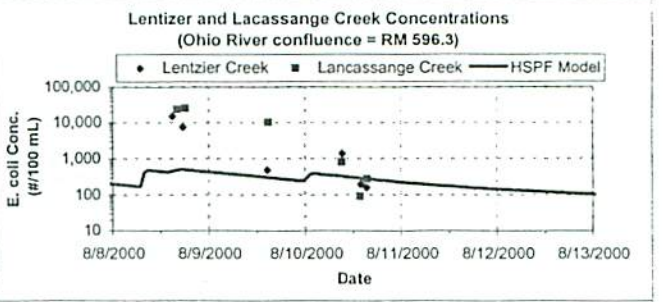


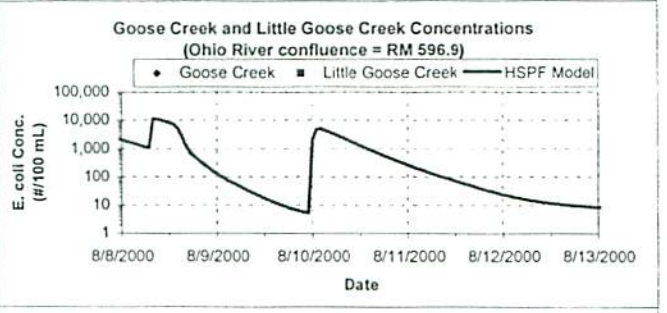


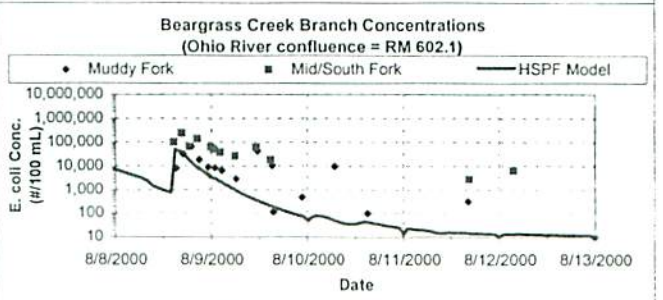


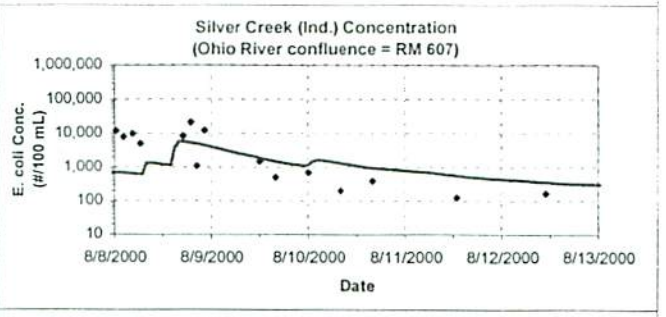


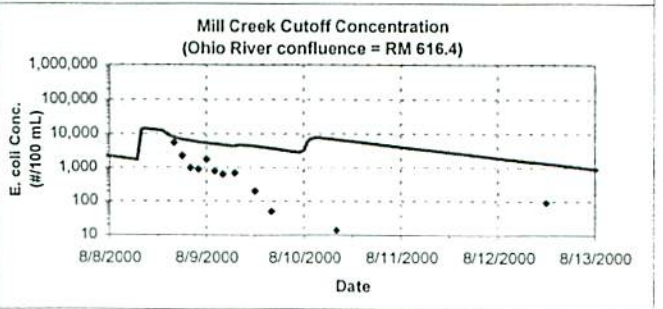
E. coli











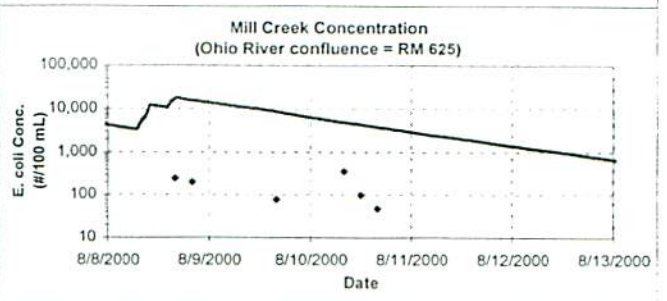
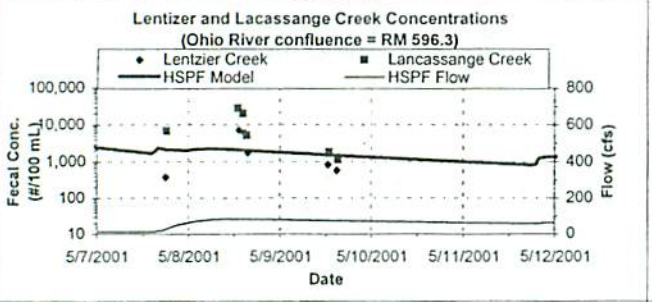
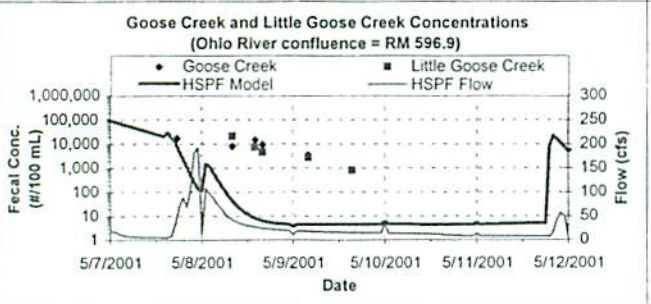
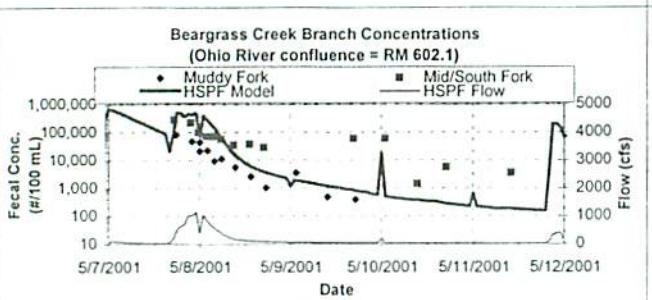


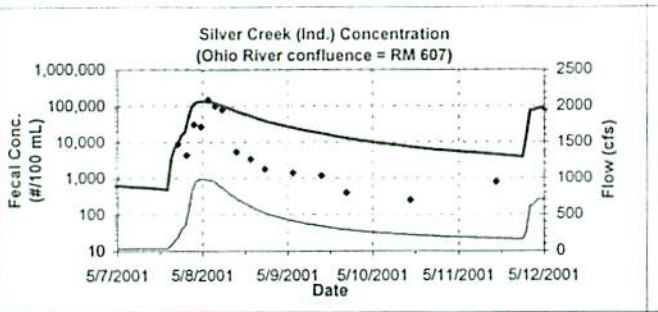
Figure 5-8. Tributary Data Comparison to HSPF Model Output for May 2001 Wet Weather Event

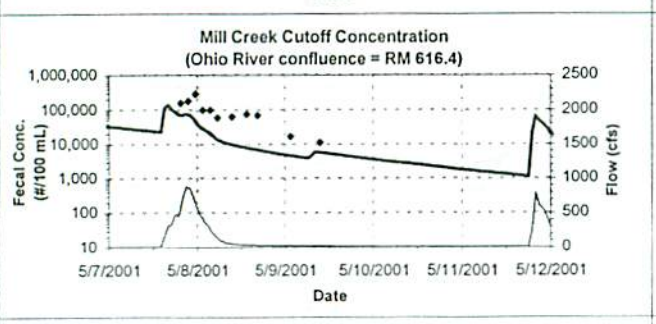
Fecal Coliform

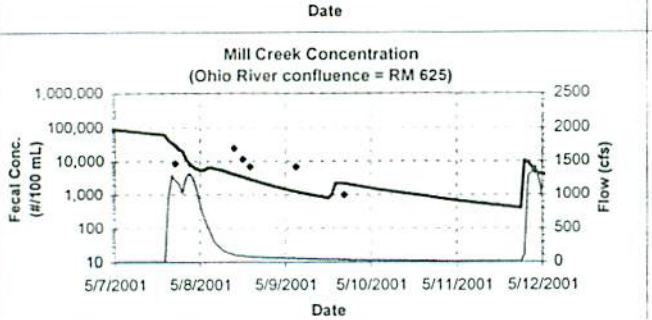




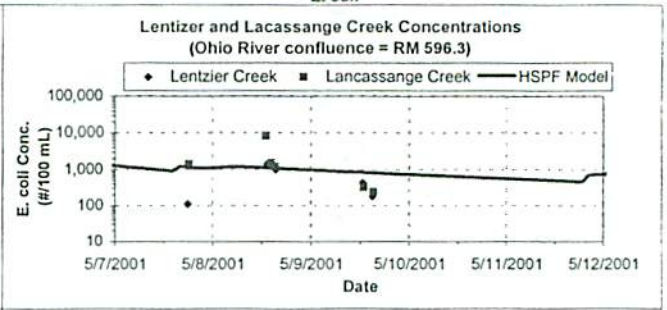


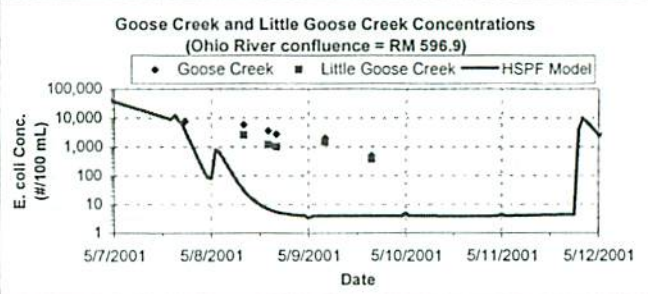


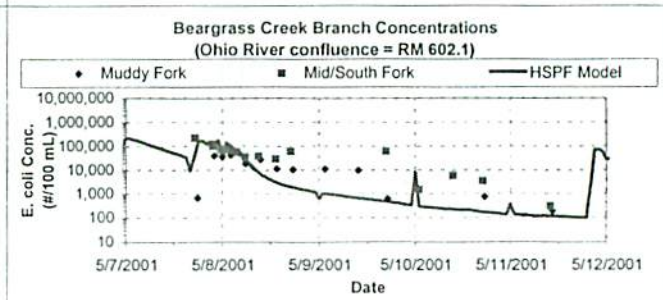


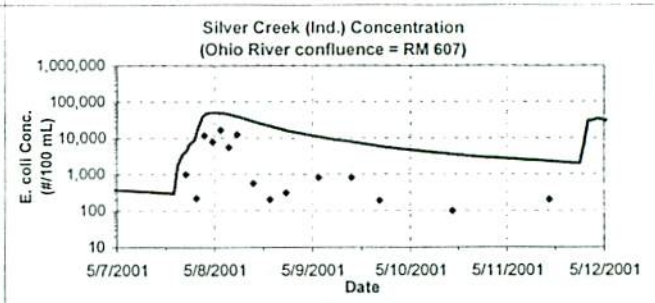


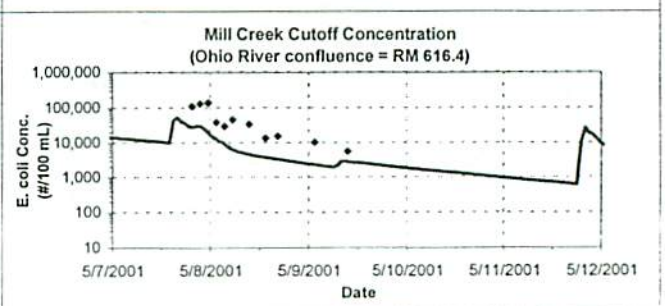
E. coli











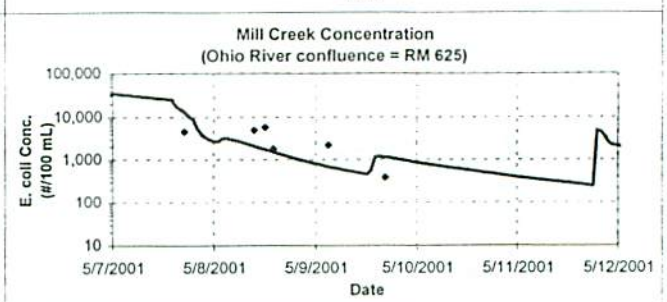
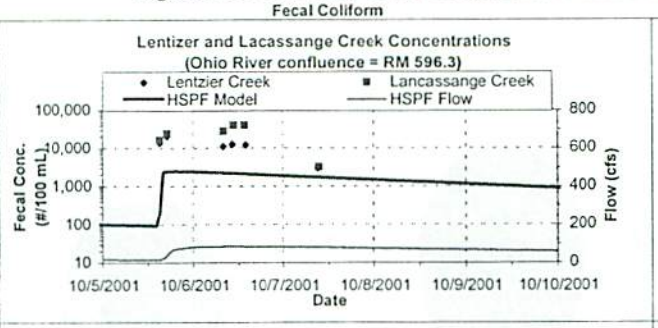
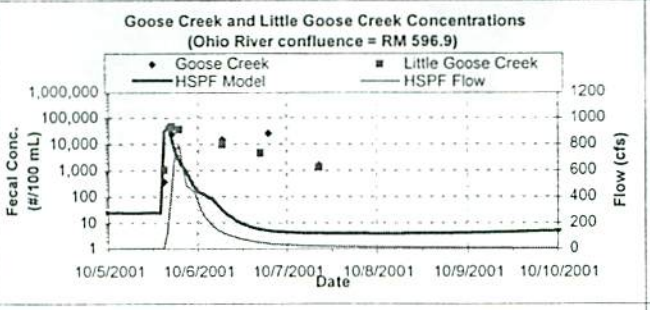
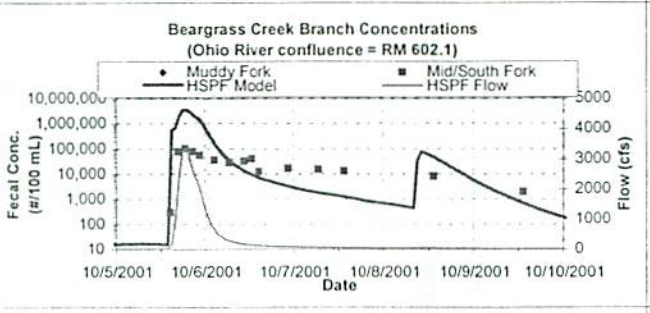


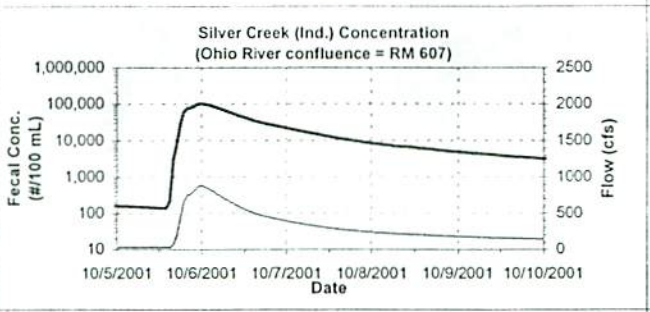
Figure 5-9. Tributary Data Comparison to HSPF Model Output for October 2001 Wet Weather Event

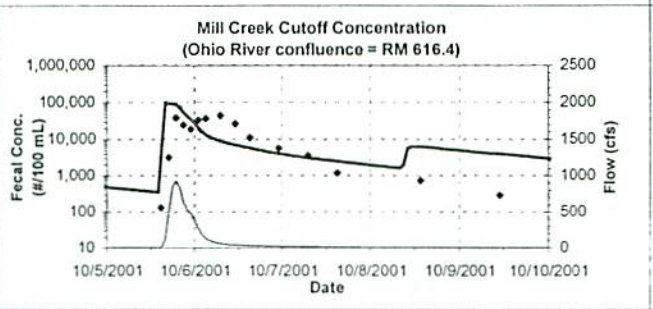
Fecal Coliform

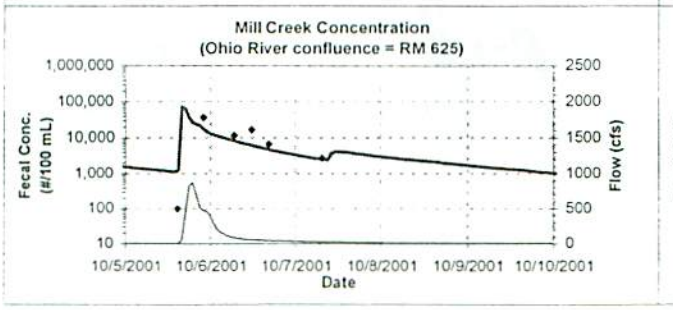




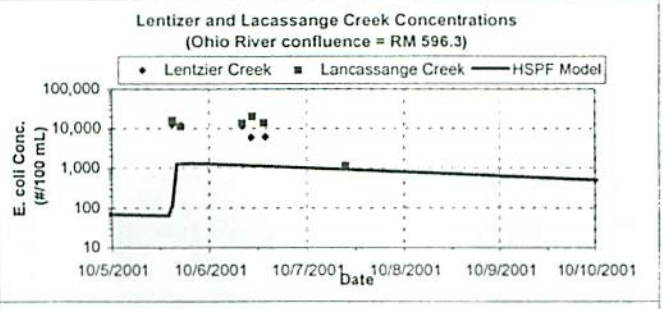


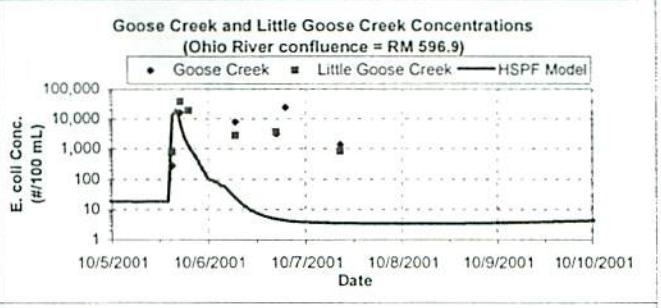


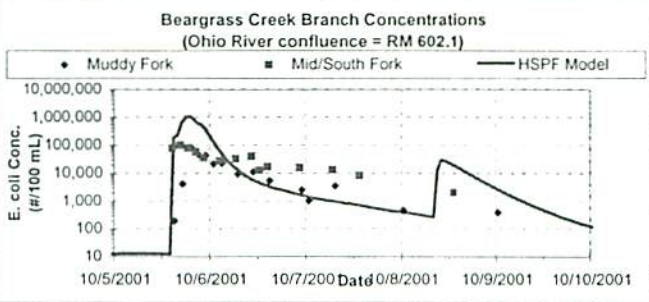


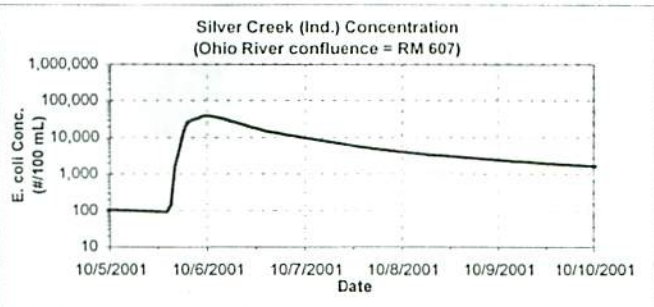


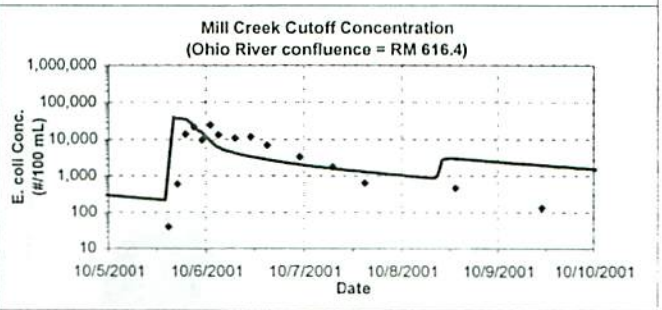
E. coli











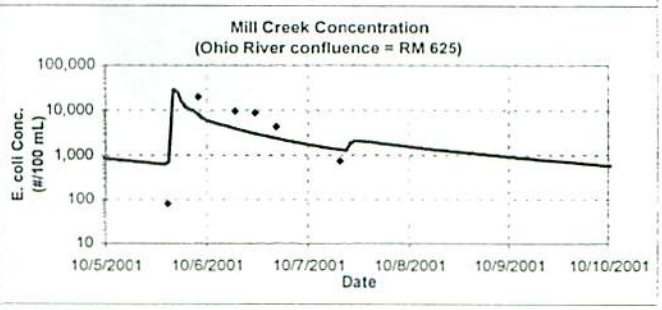


Figure 5-10. Load and Volume Summary by Source Type for Each Wet Weather Event

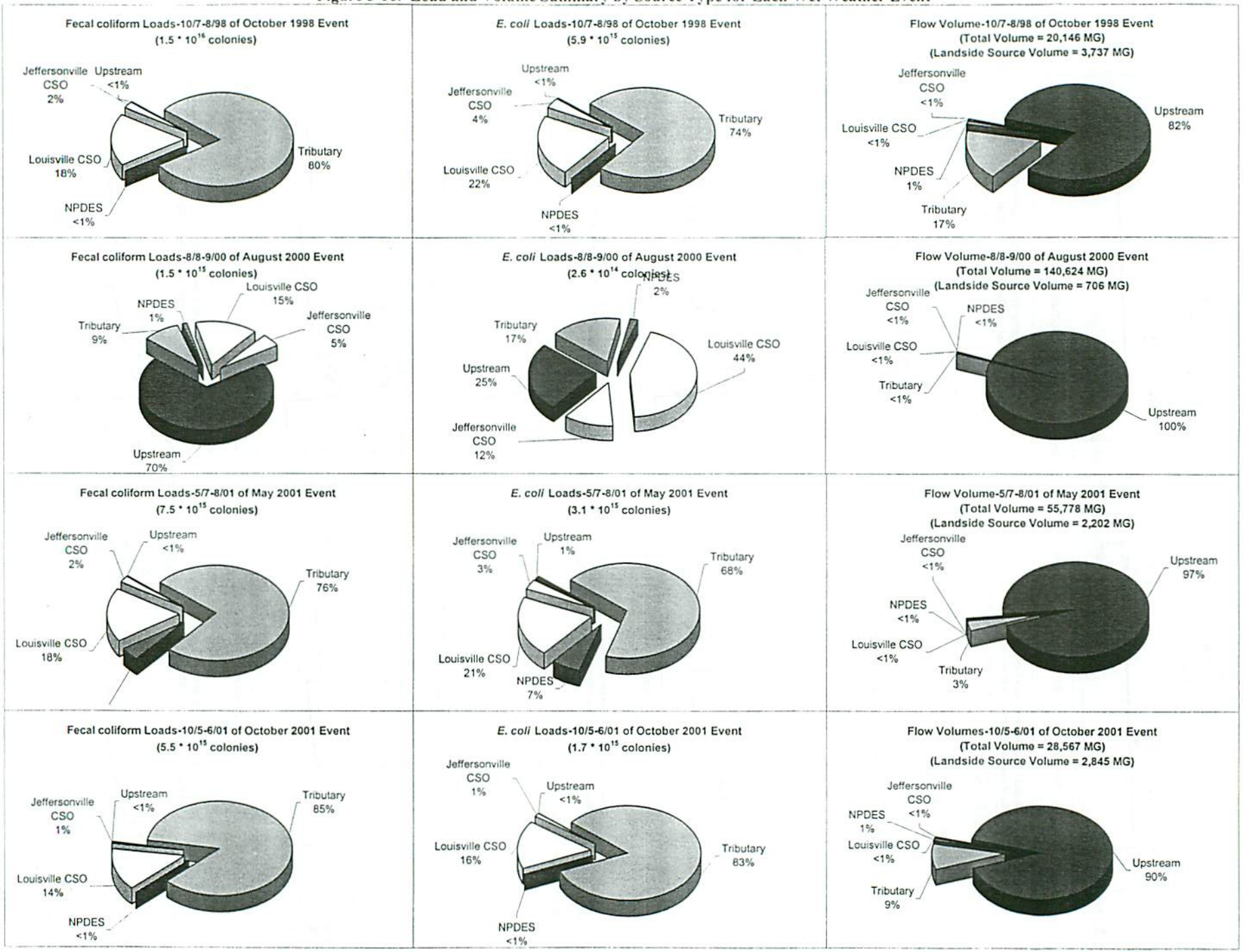


Figure 5-11. Analysis of Co-Located Fecal Coliform and *E. coli* Measurements in Ohio River

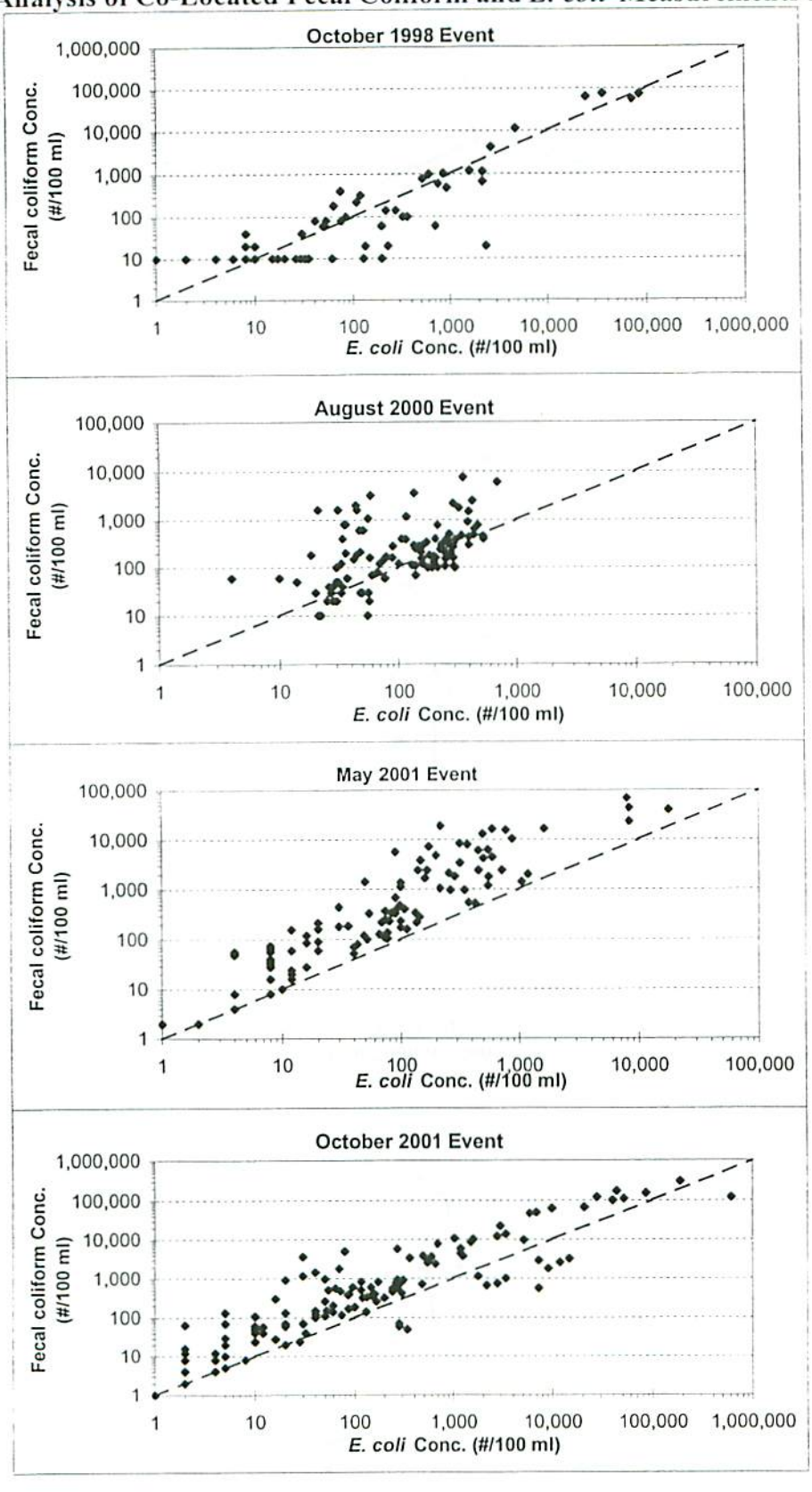
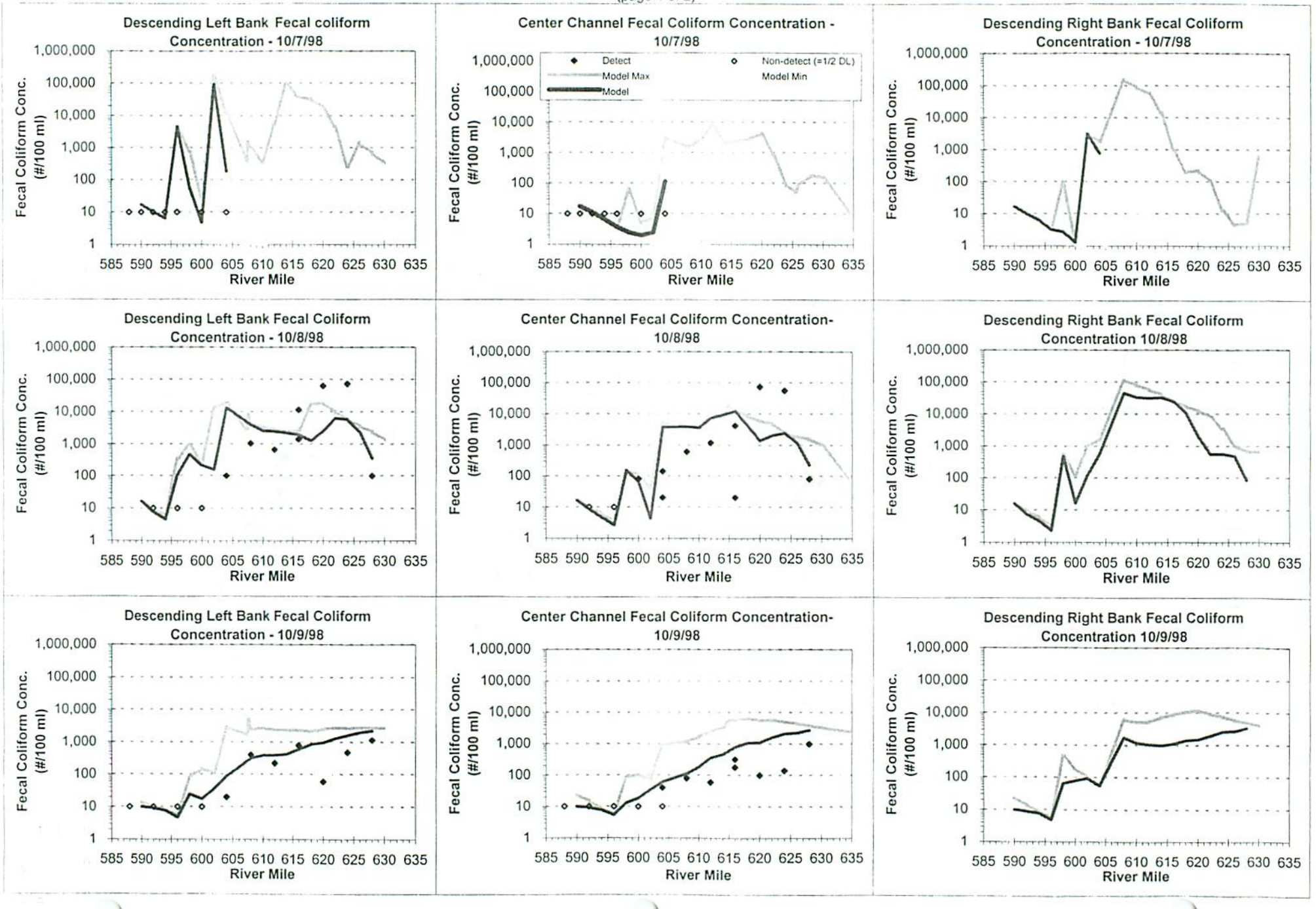


Figure 5-12. Spatial Comparison of Model Simulated Fecal Coliform Concentration vs. Observed Data - October 1998 Event

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...gure 5-12. Spatial Comparison of Model Simulated Fecal ...liform Concentration vs. Observed Data - October 1998 L...nt

(page 2 of 2)

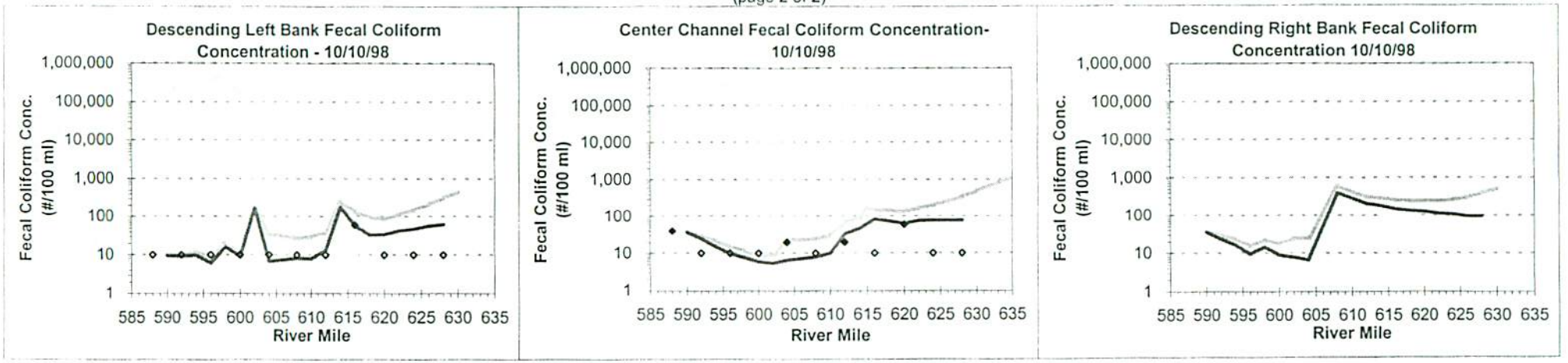


Figure 5-13. Spatial Comparison of Model Simulated *E. coli* Concentration vs. Observed Data - October 1998 Event

(page 1 of 2)

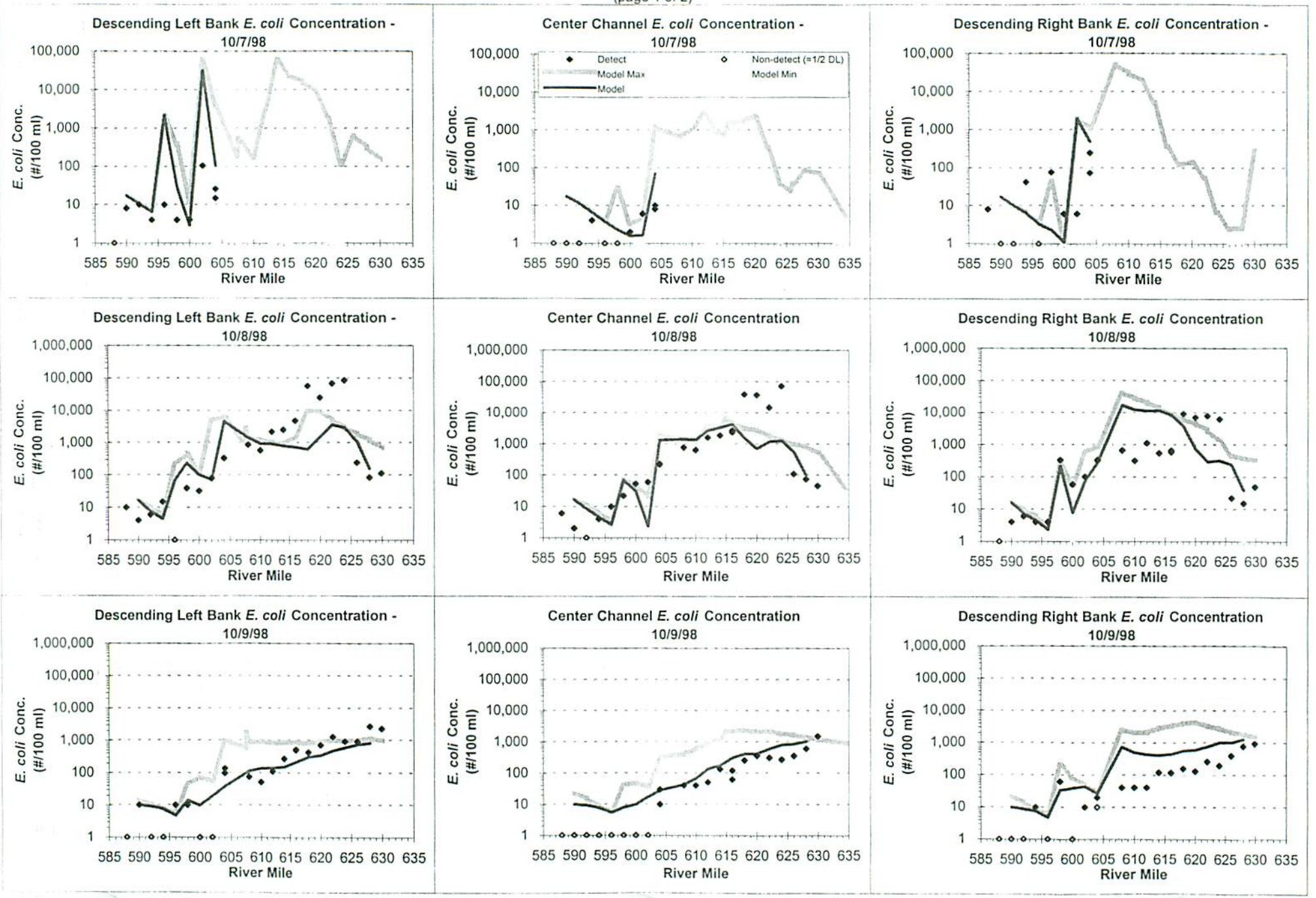


Figure 5-13. Spatial Comparison of Model Simulated *E. coli* Concentration vs. Observed Data - October 1998 Event

(page 2 of 2)

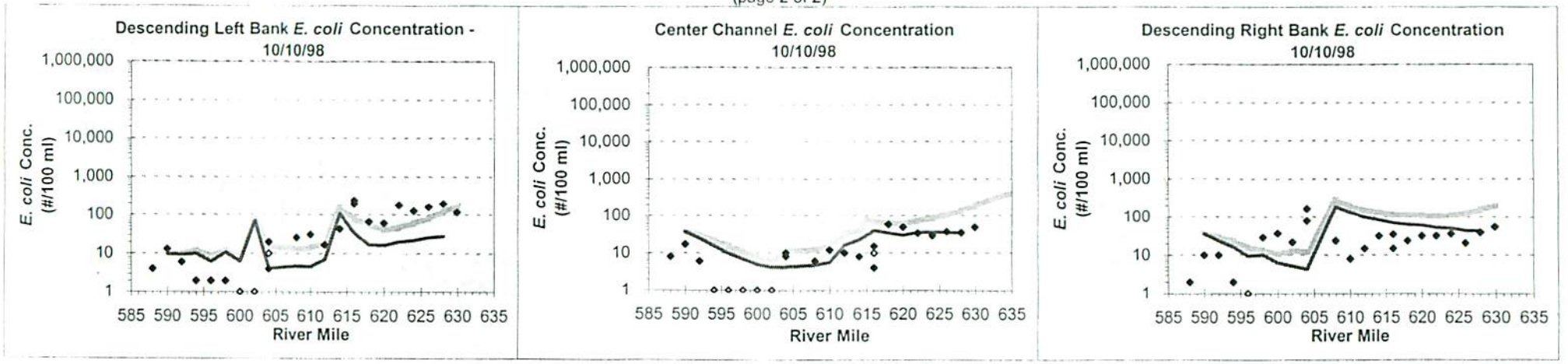
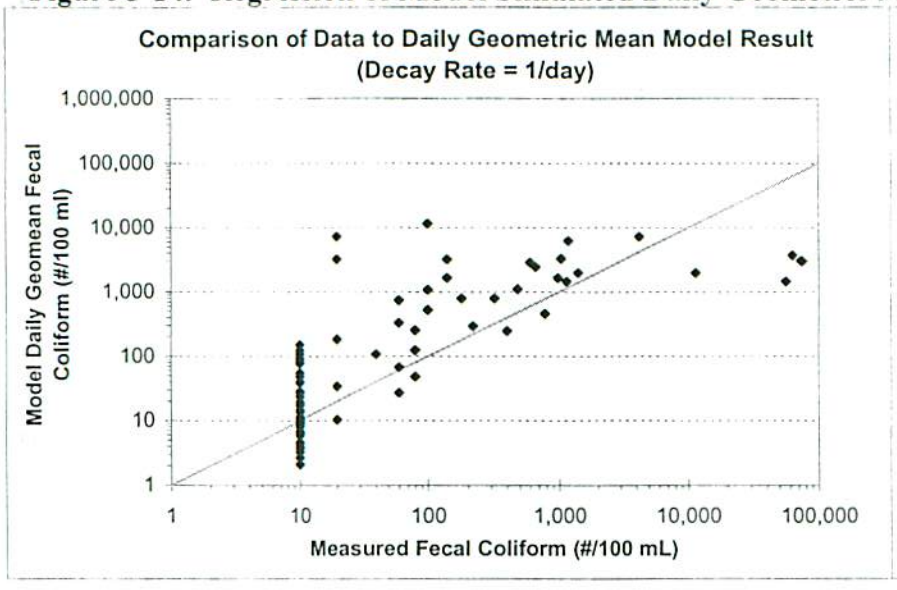
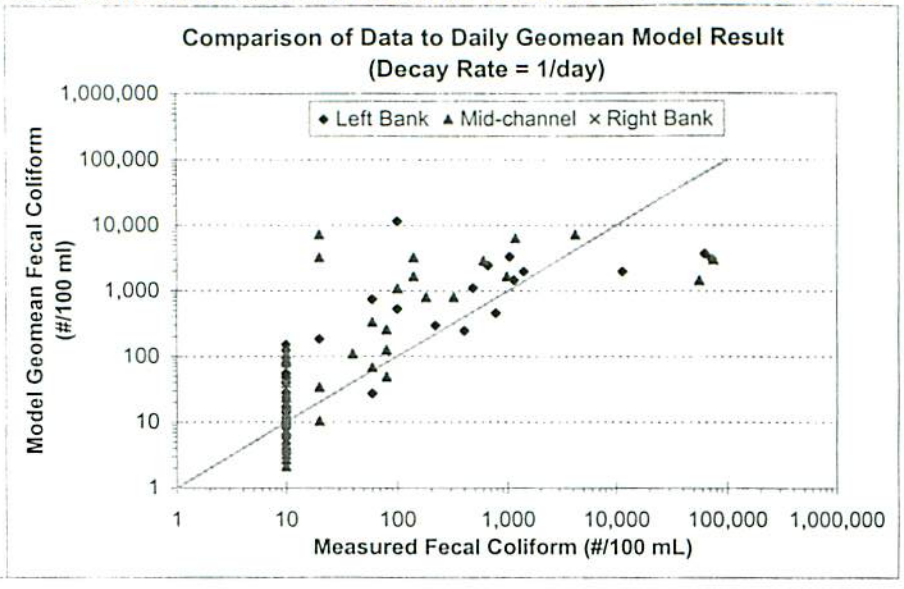
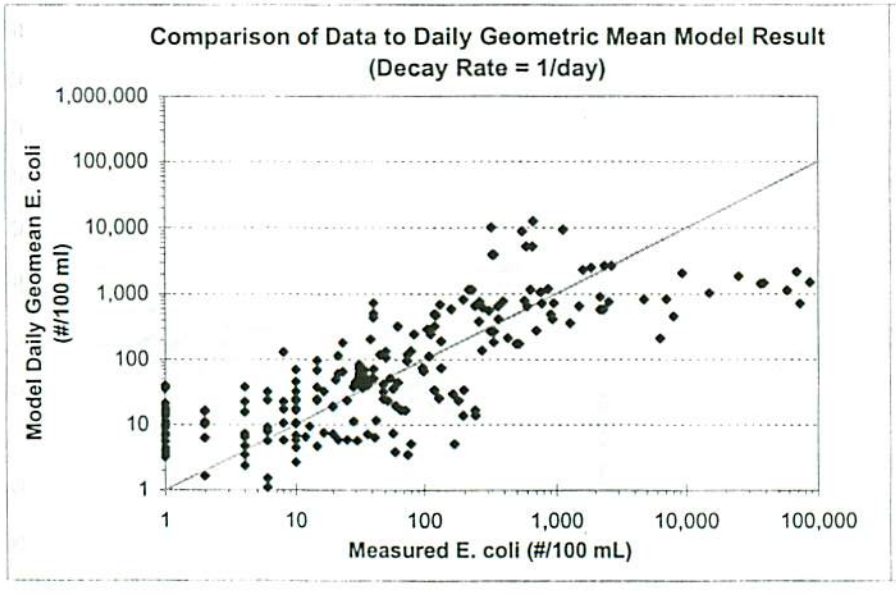


Figure 5-14. Regression of Model Simulated Daily Geometric Mean Concentrations to Measured Data for October 1998 Event







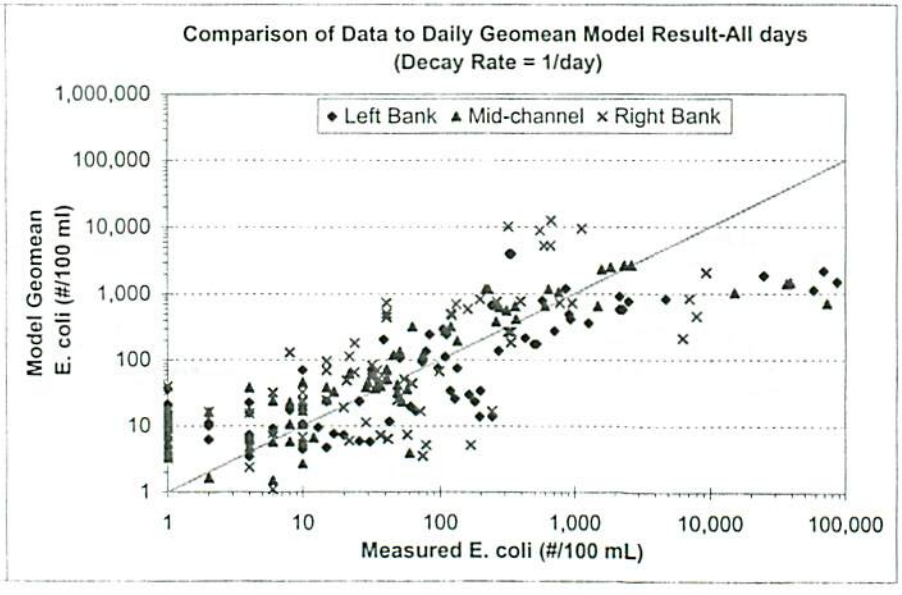


Figure 5-15. Spatial Comparison of Model Simulated Fecal Coliform Concentration vs. Observed Data - August 2000 Event

(page 1 of 2)

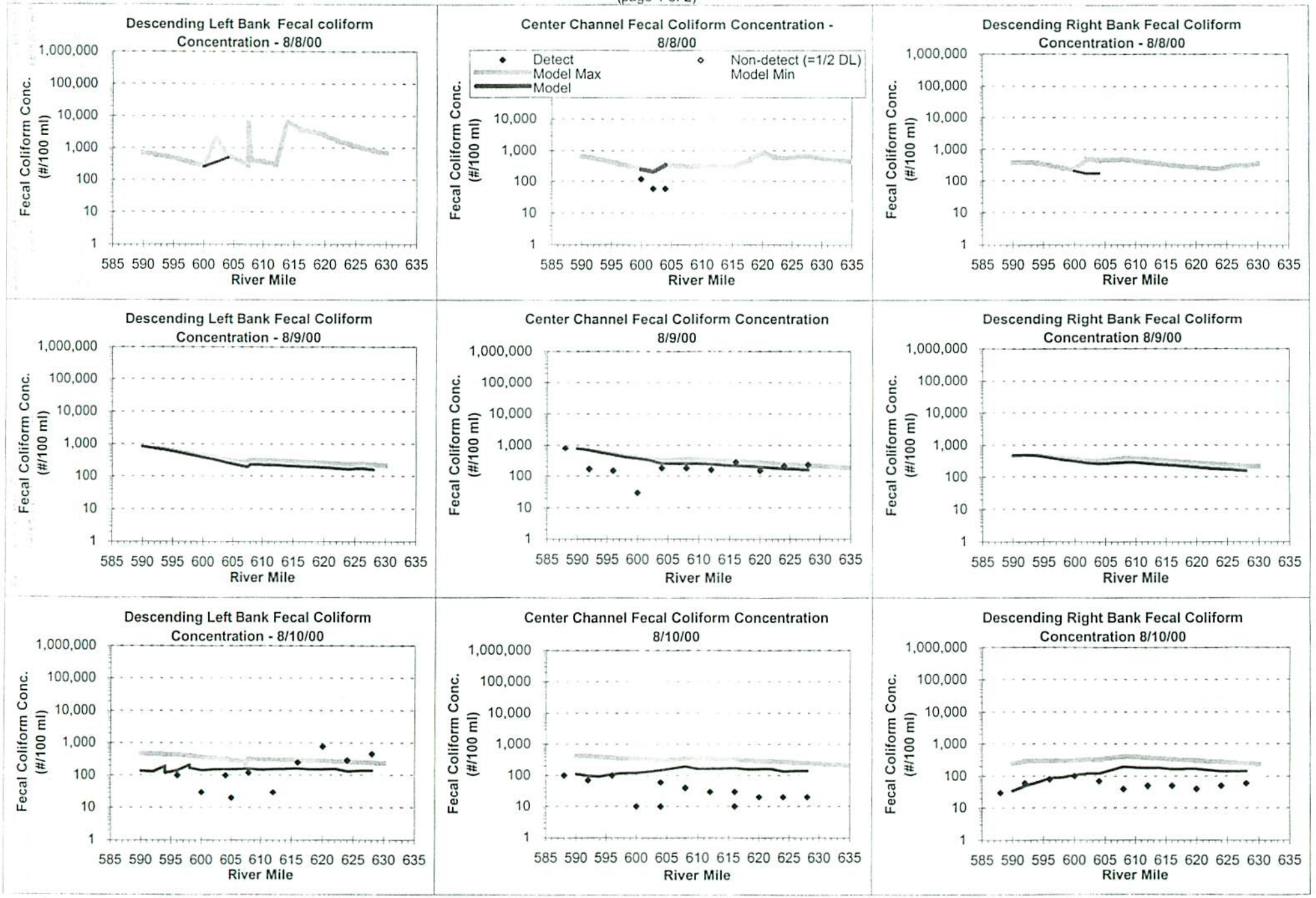


Figure 5-15. Spatial Comparison of Model Simulated Fecal Coliform Concentration vs. Observed Data - August 2000 Event

(page 2 of 2)

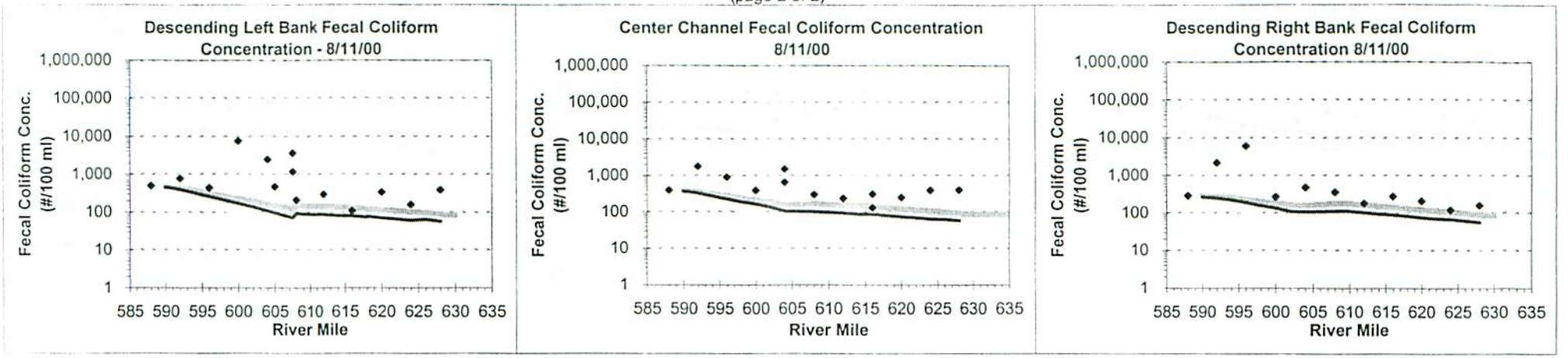


Figure 5-16. Spatial Comparison of Model Simulated *E. coli* Concentration vs. Observed Data - August 2000 Event

(page 1 of 2)

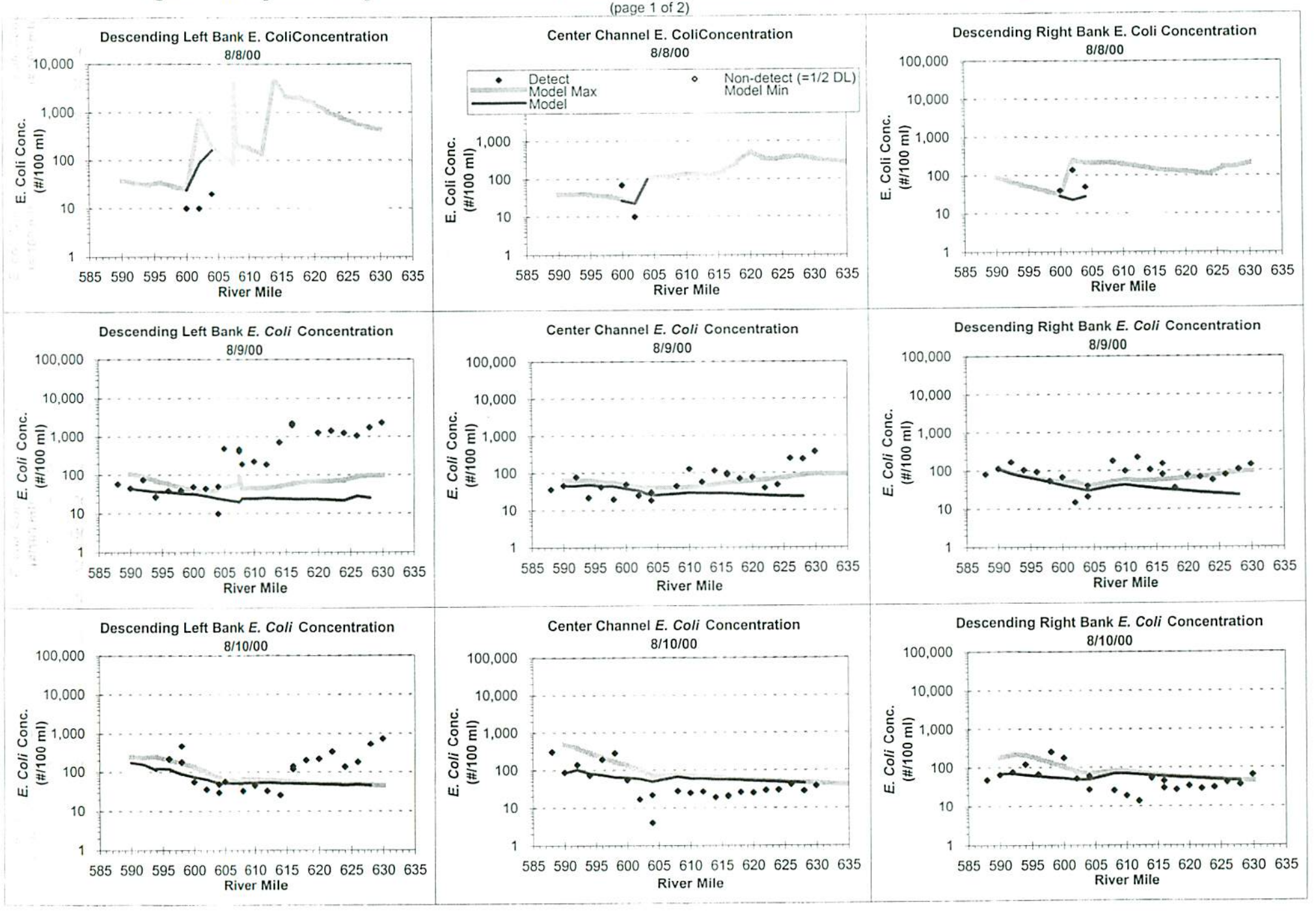


Figure 5-16. Spatial Comparison of Model Simulated *E. coli* Concentration vs. Observed Data - August 2000 Event

(page 2 of 2)

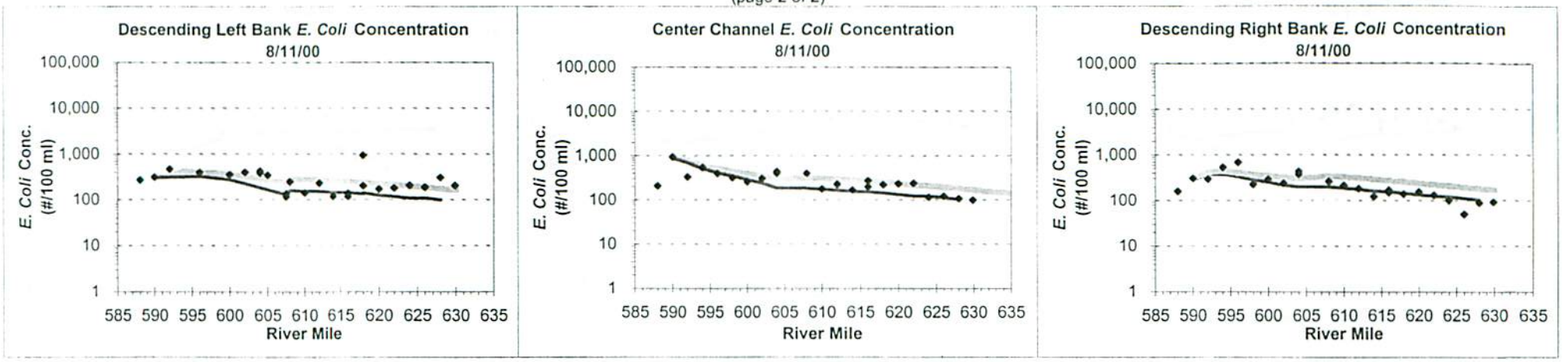
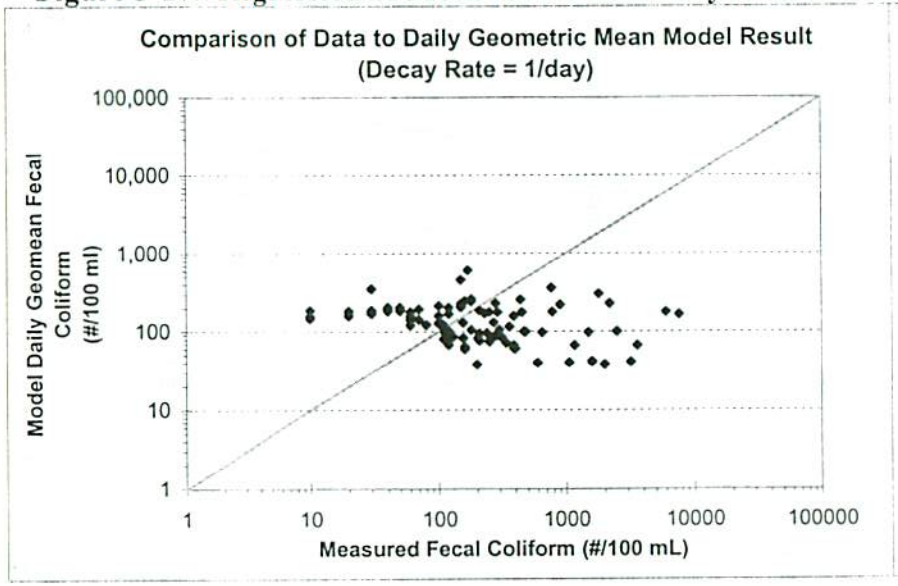
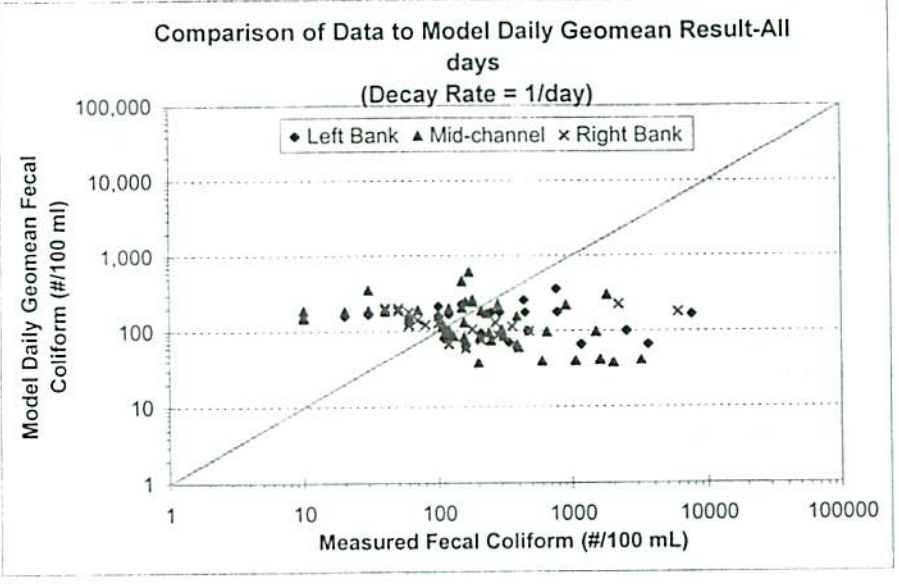
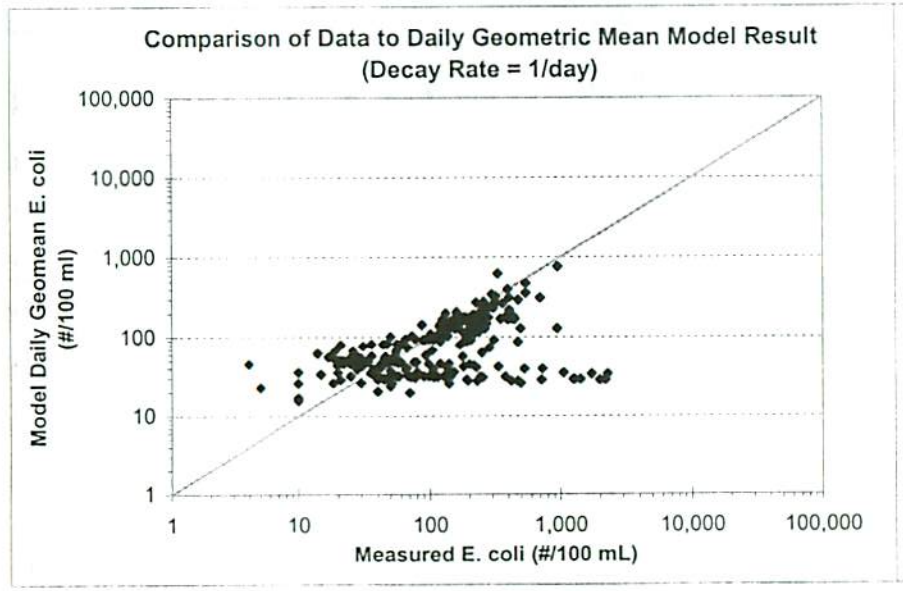


Figure 5-17. Regression of Model Simulated Daily Geometric Mean Concentrations to Measured Data for August 2000 Event







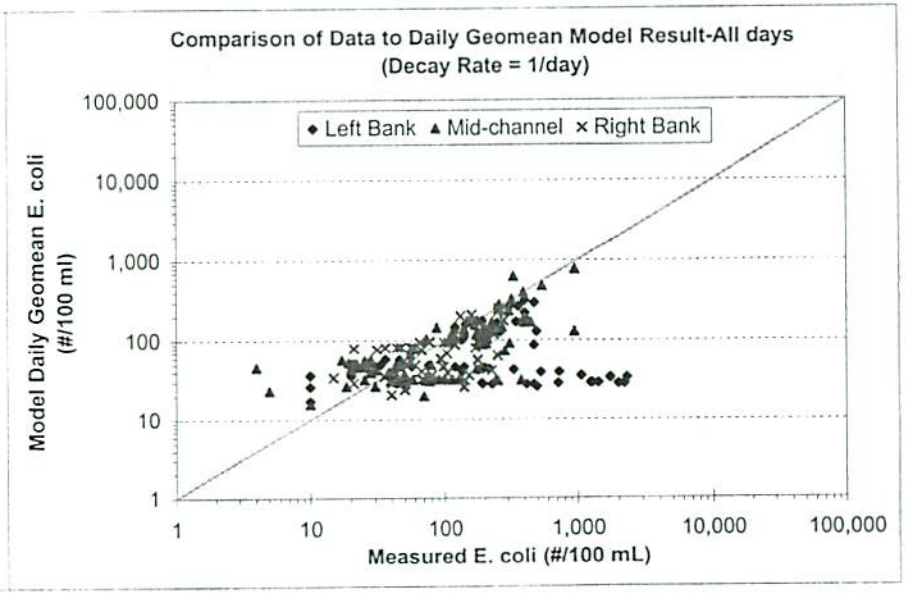


Figure 5-18. Spatial Comparison of Model Simulated Fecal Coliform Concentration vs. Observed Data - May 2001 Event

(page 1 of 2)

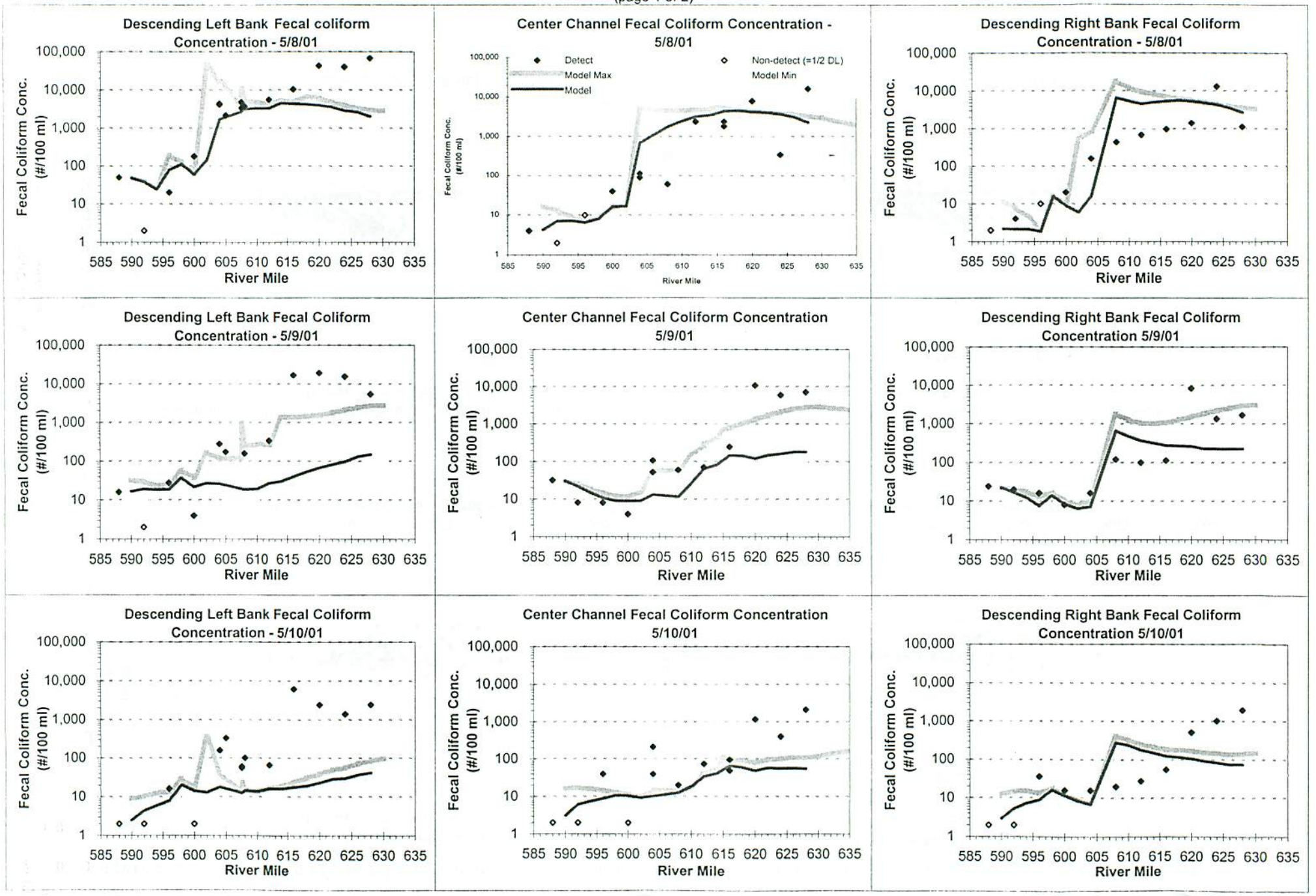


Figure 5-18. Spatial Comparison of Model Simulated Fecal Coliform Concentration vs. Observed Data - May 2001 Ev

(page 2 of 2)

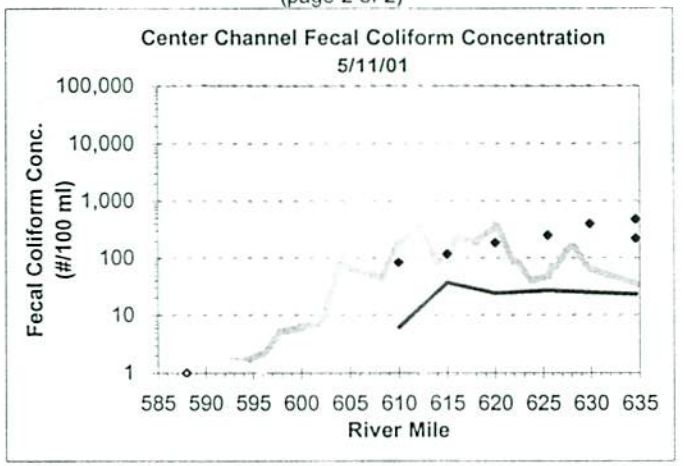


Figure 5-19. Spatial Comparison of Model Simulated *E. coli* Concentration vs. Observed Data - May 2001 Event

(page 1 of 2)

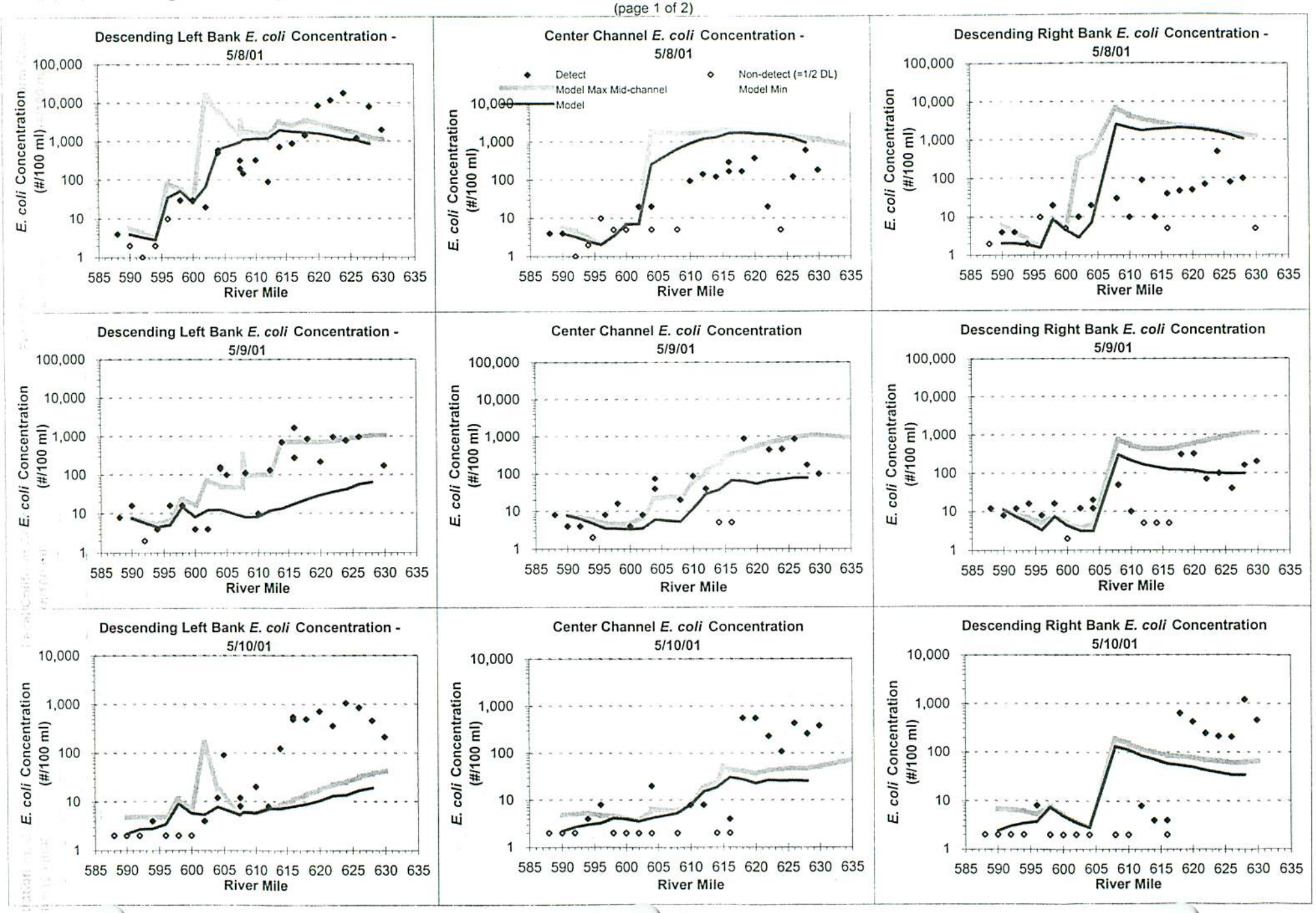


Figure 5-19. Spatial Comparison of Model Simulated *E. coli* Concentration vs. Observed Data - May 2001 Event

(page 2 of 2)

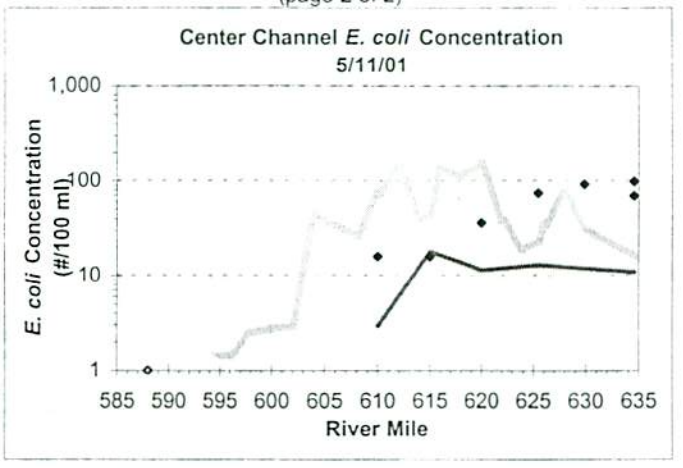


Figure 5-20. Regression of Model Simulated Daily Geometric Mean Concentrations to Measured Data for May 2001 Event

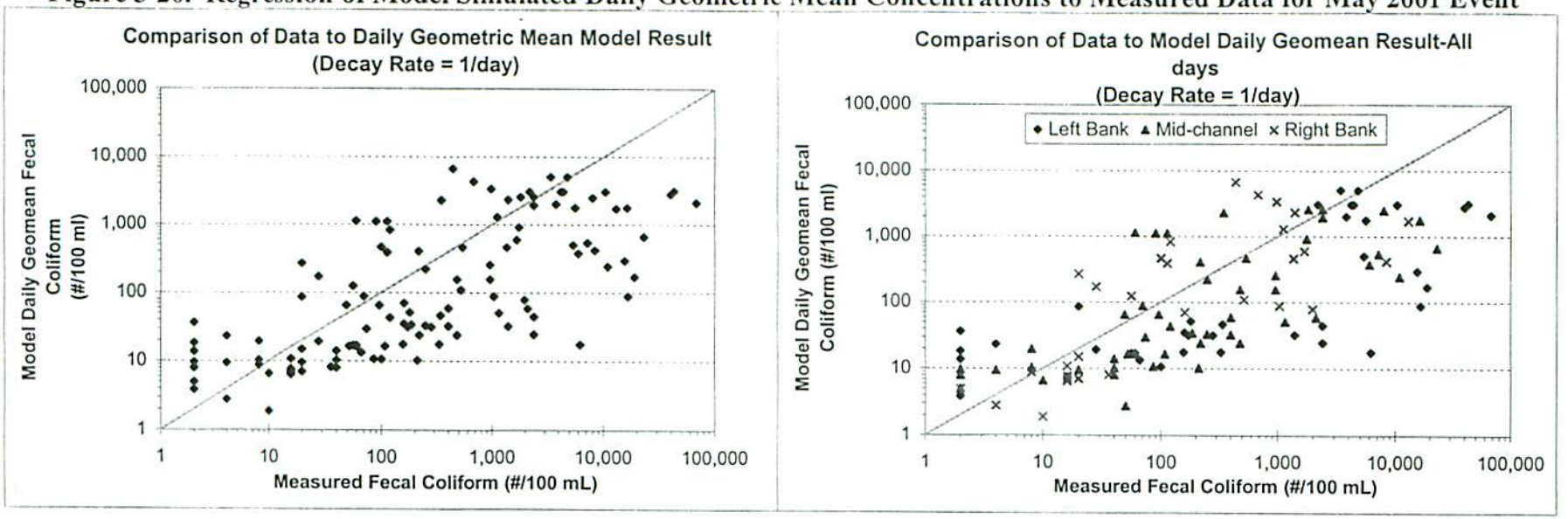


Figure 5-21. Spatial Comparison of Model Simulated Fecal Coliform Concentration vs. Observed Data - October 2001 Event

(page 1 of 2)

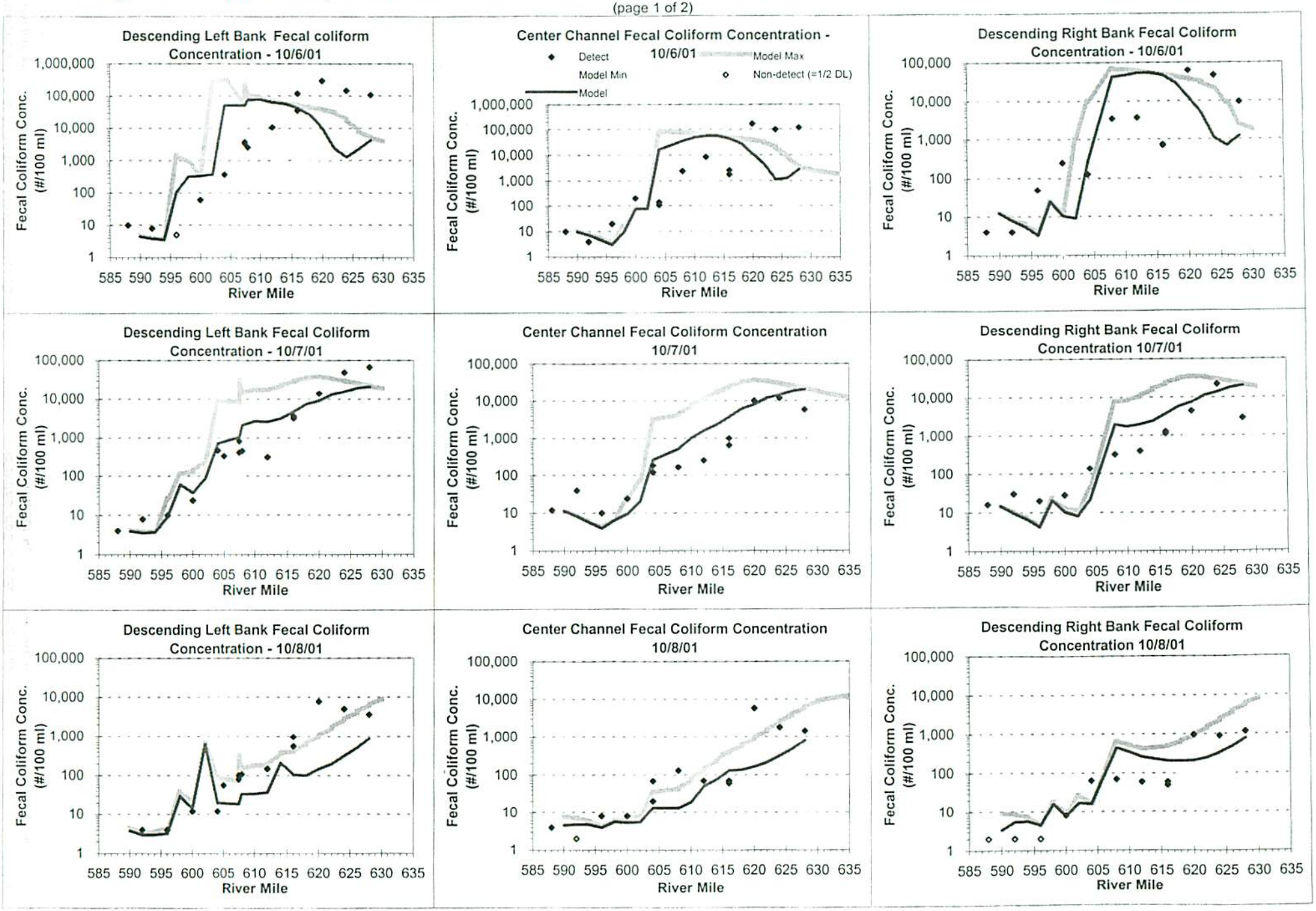


Figure 5-21. Spatial Comparison of Model Simulated Fecal Coliform Concentration vs. Observed Data - October 2001 Event

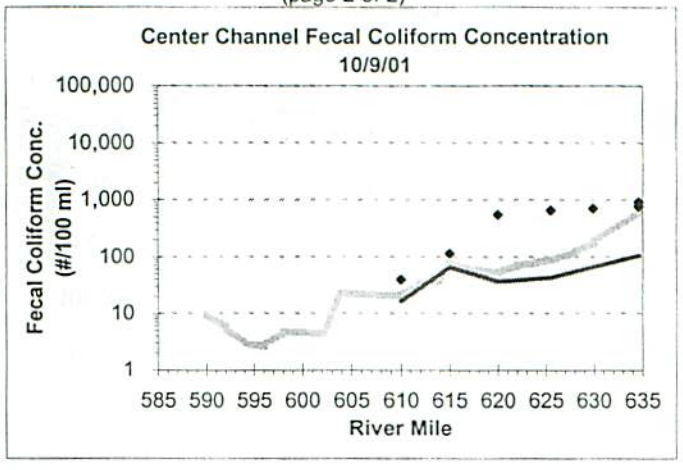


Figure 5-22. Spatial Comparison of Model Simulated *E. Coli* Concentration vs. Observed Data - October 2001 Even.

(page 1 of 2)

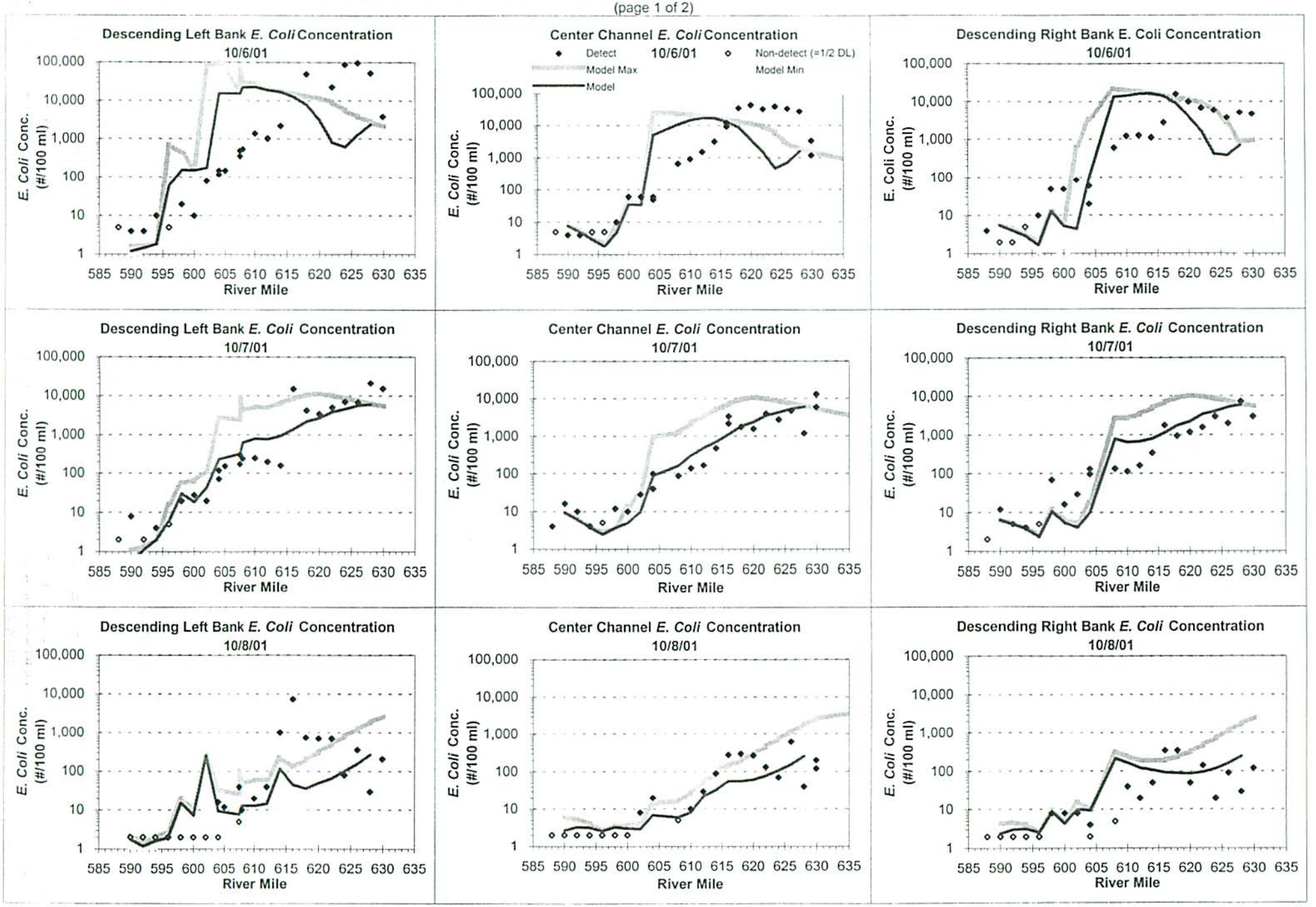


Figure 5-22. Spatial Comparison of Model Simulated *E. coli* Concentration vs. Observed Data - October 2001 Event

(page 2 of 2)

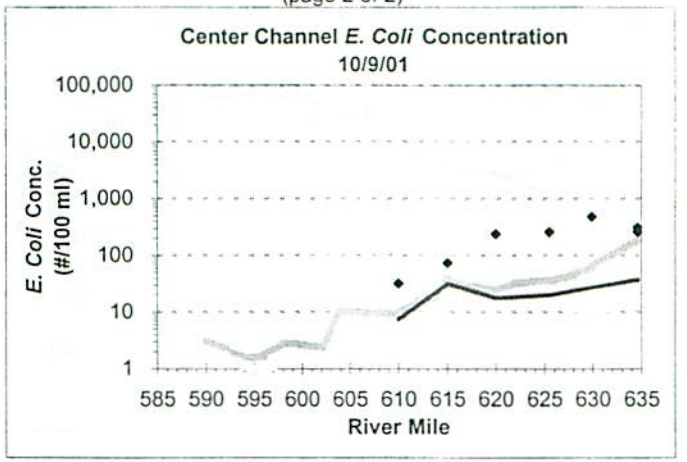


Figure 5-23. Regression of Model Simulated Daily Geometric Mean Concentrations to Measured Data for October 2001 Event

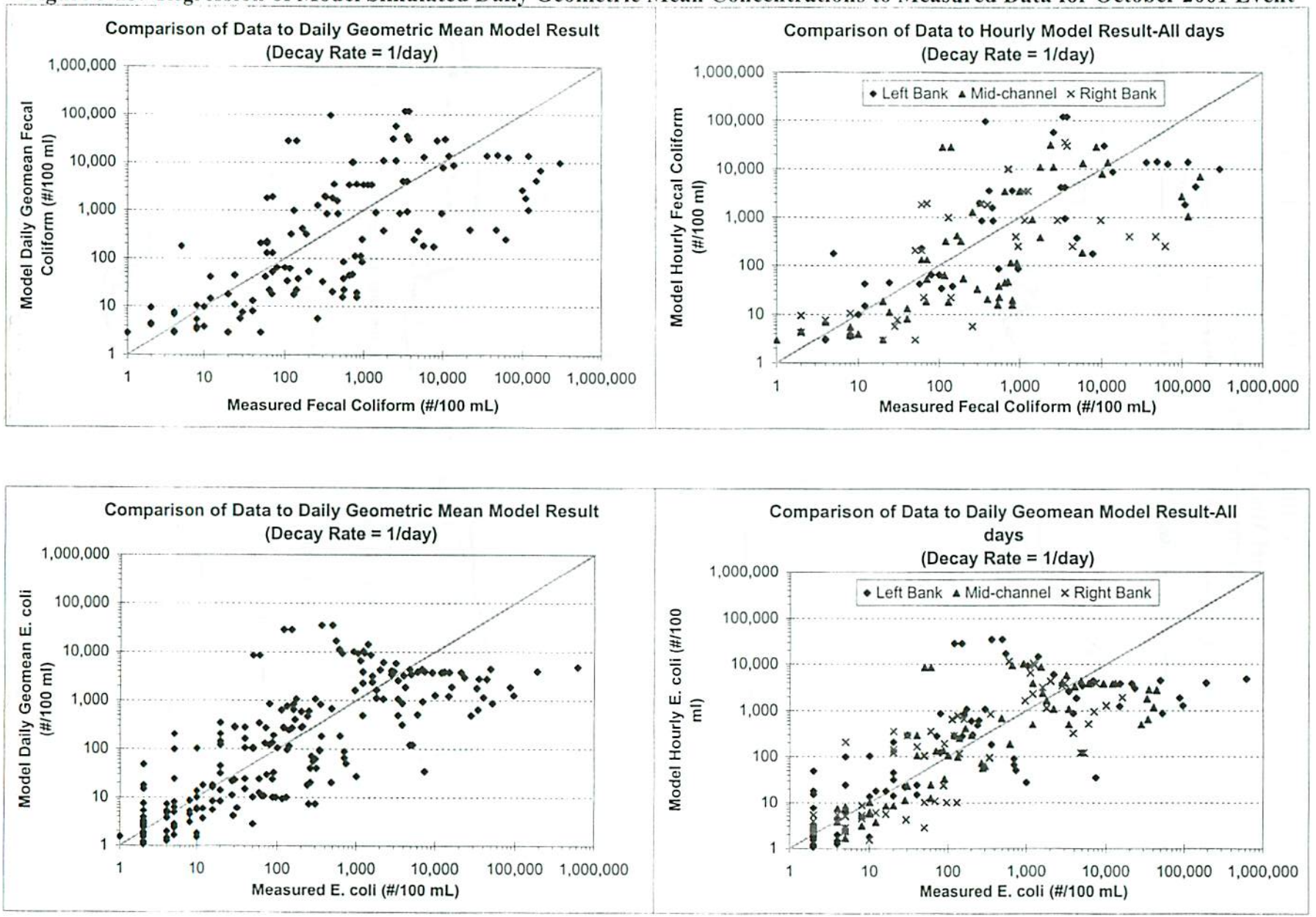


Figure 5-24. Comparison of Decay Rate Coefficients for Fecal Coliform and *E. coli* in Center Channel Model Segments

(Results displayed correspond to ~1 day into each event)

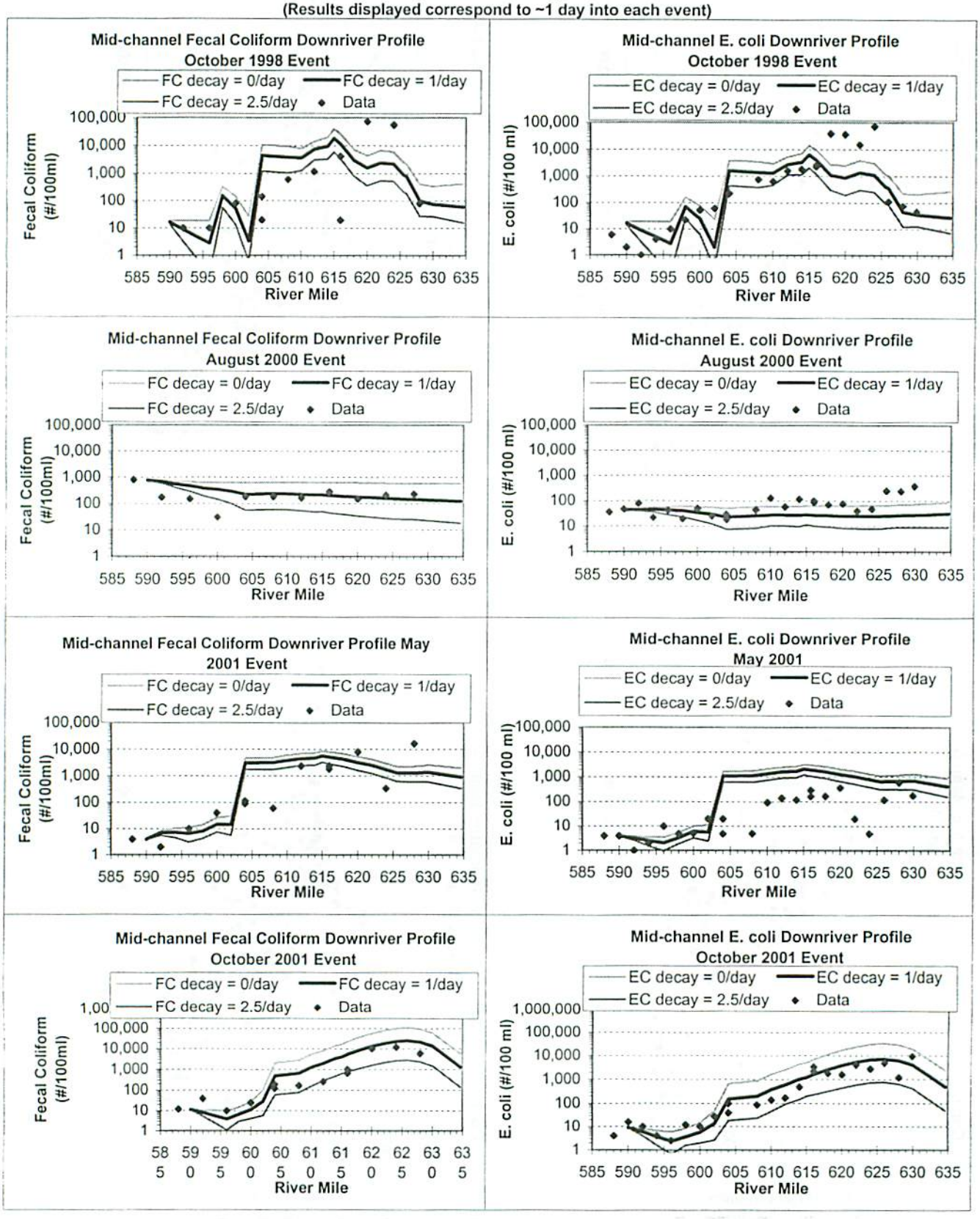


Figure 5-25. Model Sensitivity to Landside Loadings for Fecal Coliform - October 2001 Event

(page 1 of 2)

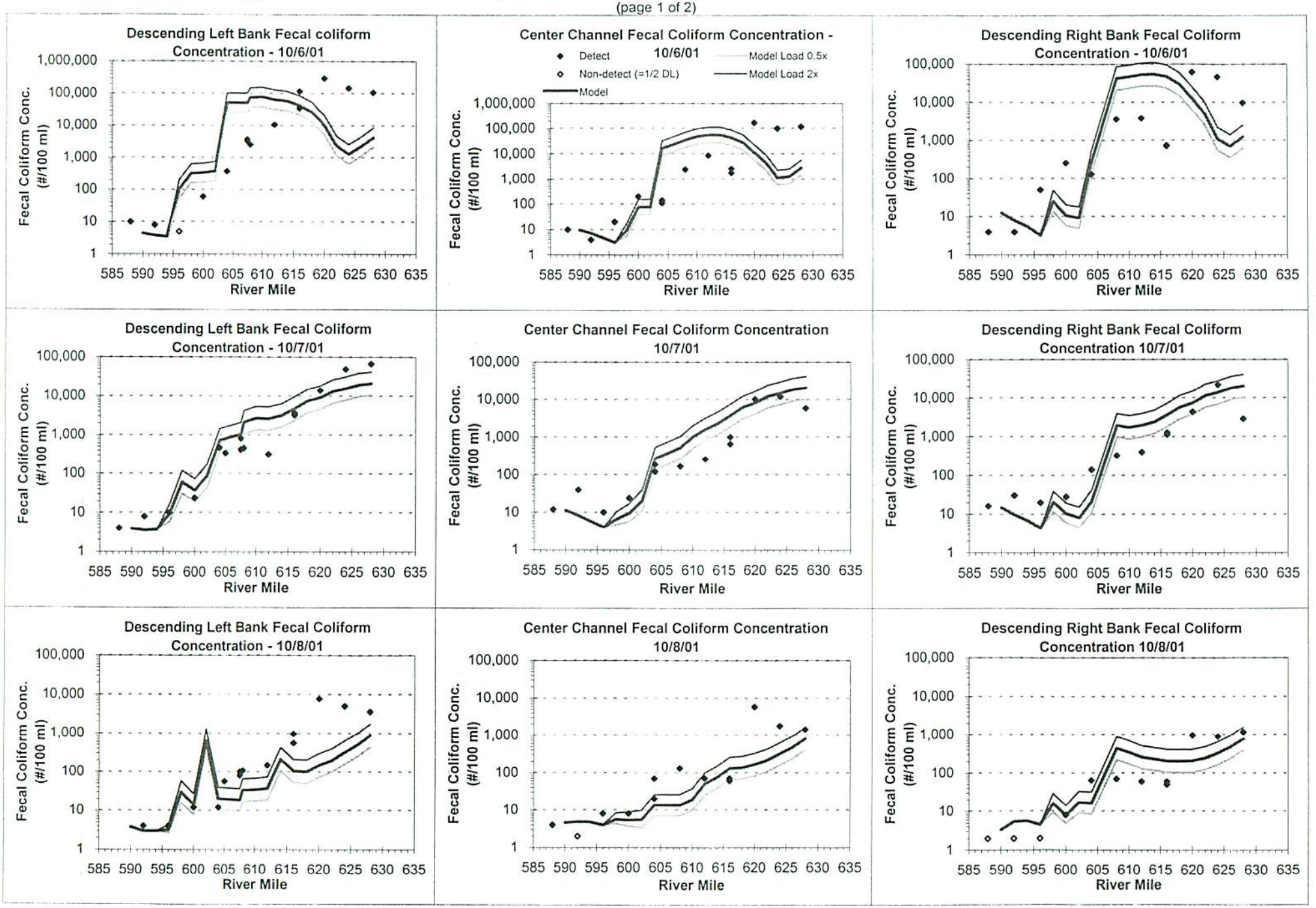


Figure 5-25. Model Sensitivity to Landside Loadings for Fecal Coliform - October 2001 Event

(page 2 of 2)

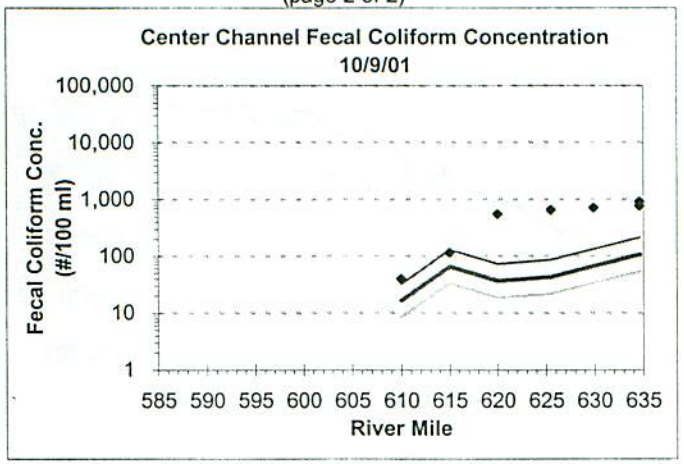


Figure 5-26. Model Sensitivity to Lands... Loadings for *E. coli* - October 2001 Event

(page 1 of 2)

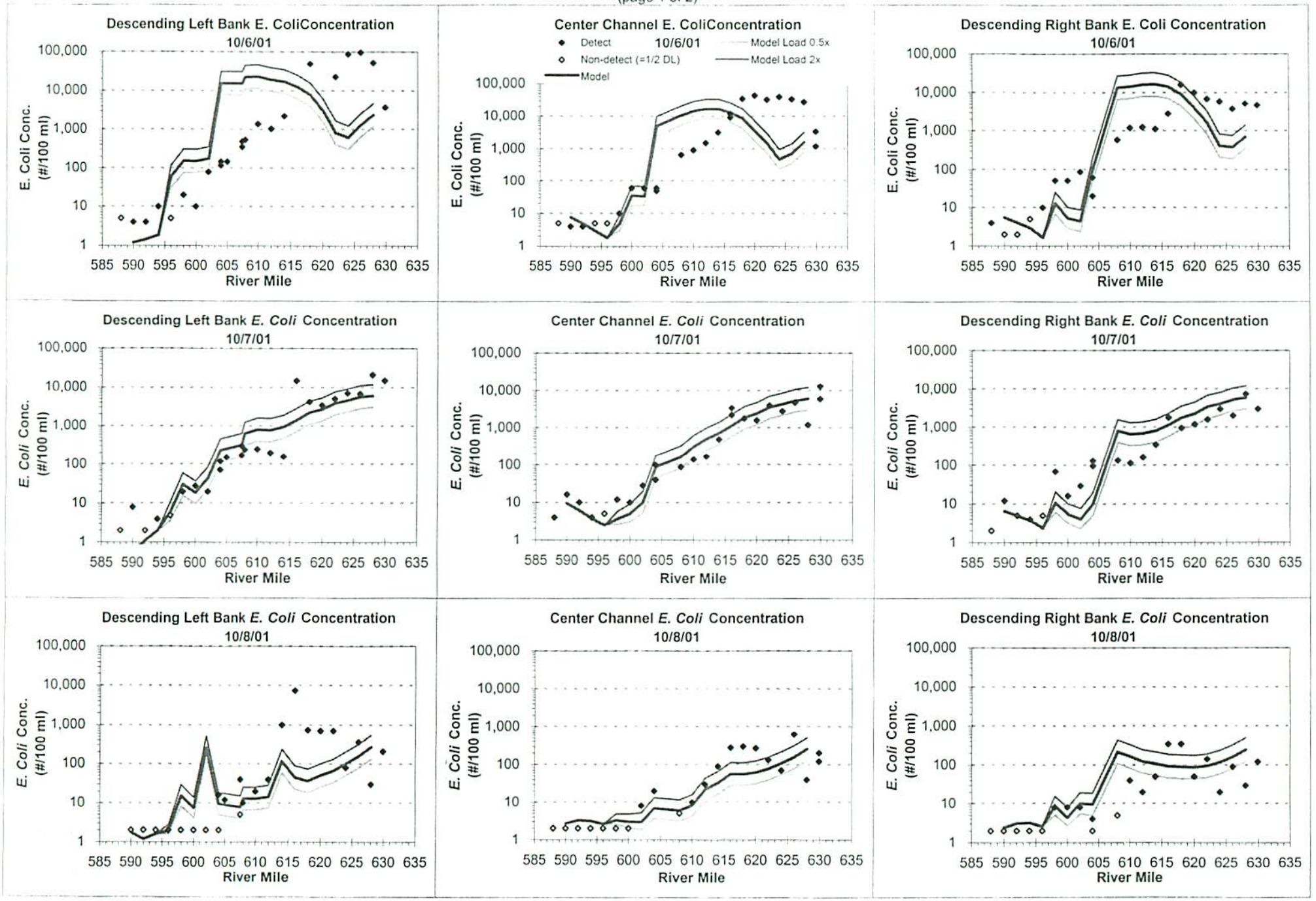
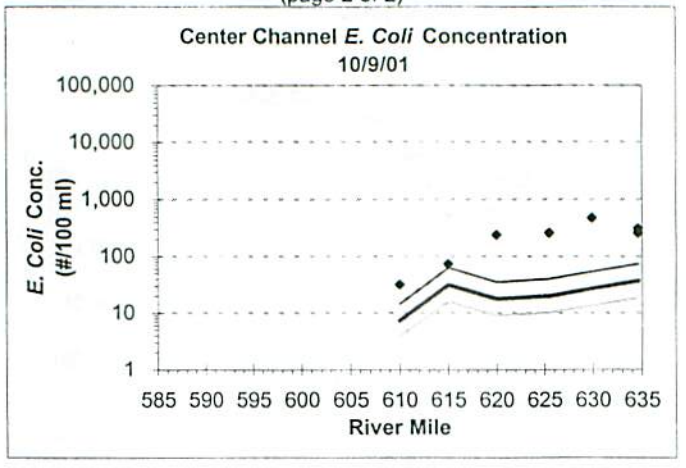


Figure 5-26. Model Sensitivity to Landside Loadings for *E. coli* - October 2001 Event

(page 2 of 2)



6.0 APPLICATION OF STUDY FRAMEWORK TO OTHER LARGE RIVER SITES

6.1 INTRODUCTION

The primary objective of this study was to test and demonstrate the transferability of the methodologies and technologies developed in the Cincinnati/Northern Kentucky area study, for the evaluation of wet weather water quality problems and control measures, to a segment of the Ohio River in the vicinity of Louisville, Kentucky. This chapter presents a framework which describes the factors considered in developing the methodology used in this study, the sequence of tasks conducted using the methodology and the degree of success in transferring this framework from the Cincinnati/Northern Kentucky area to the Louisville area.

This section is divided into three parts. Section 6.2 describes the unique characteristics of large rivers as they relate to wet weather water quality assessments. The methodology is described in Section 6.3, with separate discussions on Study Objectives, Monitoring Plans, Model Development and Model Application. This section provides guidance for other communities to apply this framework to their specific location. Section 6.4 summarizes the material presented in this chapter.

6.2 LARGE RIVER CHARACTERISTICS

The Ohio River is one of the "Great Rivers" of the United States. Bacteria levels resulting from urban wet weather pollution are a major cause of impairment to Ohio River water quality, which impacts beneficial uses such as contact recreation. More than 1,400 combined sewer overflows are located in cities along the Ohio River mainstem, representing nearly 15 percent of the national total. Land use in the Ohio River watershed ranges from forested areas with very little imperviousness, to largely impervious urban areas.

Efforts to study and, ultimately, improve water quality in large rivers can be complicated by several factors unique to large rivers. These factors include having multiple community and regulatory jurisdictions, large watershed areas and the physical characteristics of the river itself. Different reaches of the same river can even be significantly different from one another as shown by comparing this study to the Cincinnati Study. These factors are described in further detail using examples from this project.

6.2.1 MULTIPLE JURISDICTIONS

Large rivers often serve as interstate boundaries and thus, can span state, EPA regional and municipal boundaries. Consequently, there may be several significant stakeholders who have potentially diverse objectives stemming from legal or political concerns or from competing agency/organizational missions. Building consensus up front, during the project planning stage, can greatly improve stakeholder buy-in and help ensure the completion of the project. Oversight of the project at a national or regional level can provide a means for reducing conflicts that may result from competing agendas.

This wet weather demonstration project focused on a 40-mile segment of the Ohio River, extending from river mile 590 downstream to river mile 630. From an environmental regulatory perspective, the study area falls within the jurisdiction of two states (Indiana and Kentucky), two U.S. EPA Regions (Regions IV and V) and a regional authority (ORSANCO). Major urban areas within the study area include Louisville, Kentucky and the Indiana cities of Clarksville, Jeffersonville and New Albany. Stakeholders providing funding for the project included the U.S. EPA Office of Wastewater Management; Louisville and Jefferson County Metropolitan Sewer District; Indiana cities of New Albany and Jeffersonville; and the Louisville Water Company. Additional in-kind services were provided by the Cities of Clarksville and Louisville, the Coast Guard and the ACOE.

6.2.2 LARGE WATERSHED AREA

The large drainage basins of the Ohio River and other similar large rivers can complicate wet weather assessments. The drainage area for the entire Ohio River is over 200,000 square miles. No major tributaries, defined as having a drainage area of greater than 1,000 square miles, enter the Ohio River within the study area. Many of the smaller streams in the urban areas are severely impacted by CSOs and SSOs.

Large watershed areas complicate the assessment of wet weather impacts on large rivers in several ways. Precipitation is rarely uniformly distributed throughout a large area. Long lag times can elapse between the onset of precipitation and the occurrence of water quality impacts in large watersheds. Larger watersheds also have more variety in land use and population. This variety means a large number of potential pollutant sources that are very diverse in their discharge characteristics, such as types of pollutants, magnitude of pollutant loadings and volume released. The implications of each of these factors on interpreting wet weather impacts on water quality in large rivers are discussed in detail below.

Wet weather water quality assessments are most readily conducted when relatively uniform precipitation occurs across the entire watershed. The precipitation falling over a large watershed area can vary greatly by location. As an example, during the May 2001 wet weather event, gages throughout the study area measured rainfall amounts ranging from zero to 2.93 inches. Such variations can significantly change the amount of nonpoint source runoff and collection system modeled overflow volumes predicted for an area. For example, CSOs may discharge in some areas of the watershed and not in others. These common conditions complicate assessing which water quality impacts in large rivers are truly due to wet weather.

Determining the relative contribution of each source loading to the river is also difficult when the precipitation is not uniformly distributed. Sources in areas with heavy precipitation will contribute more loading to a river and will be incorrectly emphasized as major sources of impairment by not accounting for the varying rainfall pattern. Setting up an extensive rainfall gage network (discussed in Section 6.3.2) will permit good understanding of the rainfall pattern and, when incorporated into the collection system modeling, will reduce uncertainty in model predictions. Another approach, which was used in this study, was to have the collection system modelers use the average rainfall recorded throughout the watershed.

The second characteristic of large watershed areas that complicates wet weather assessments is the large variation in time response between the occurrence of a wet weather event and the occurrence of water quality impacts. For example in Louisville, wet weather loads generated in the downtown area will show up in the Ohio River immediately; wet weather loads generated near the headwaters of Beargrass Creek or the Falling Run may take hours to days to arrive in the Ohio River; while wet weather loads generated in watersheds upstream of the study area on the Ohio River may take days to weeks to show up in Louisville. This range of response times makes it impossible to capture all of the wet weather water quality impacts in a large river with short duration sampling events. Depending on when the sampling is conducted, the river water quality may be responding to only a small subset of the total number of wet weather sources that contribute to it. The range of response times also means that wet weather sources having long travel times before reaching the study area are subject to transformation that must be considered in the analysis

The final characteristic of large watershed areas that complicates assessment of wet weather impacts on large rivers is the amount of diverse sources. Pollutant loading sources include nonpoint sources and point sources, including CSOs, SSOs, industrial permitted dischargers and WWTPs. In the Louisville study area, there are approximately 148 CSOs, 55 industrial permitted dischargers and eight WWTPs. Nonpoint sources include basins upstream of the study area, stormwater runoff from areas with separated sewers, and runoff from non-urban land uses, such as agriculture. Pollutant loadings from all of these source types must be incorporated into the study to obtain a reasonable estimate of the relative magnitude that each source contributes to the loads in the river.

The process of acquiring information on the variety of sources in a watershed(s) can be very challenging. The sources need to be identified and located within the study area. Representative loadings from each source need to be quantified. Review of available data and targeting the monitoring program (described in section 6.3.2) to fill in data gaps can provide this information. A time series of pollutant loadings from each source needs to be incorporated into the model of the study area. Ideally, this would reflect travel time and potential transformation and losses of contaminants that occur before the source load reaches the river. A method for estimating these loadings in the absence of data may also be necessary.

6.2.3 PHYSICAL CHARACTERISTICS OF LARGE RIVERS

The physical characteristics of large rivers warrant special consideration when developing a water quality study. Large rivers require logistical monitoring considerations, such as safety consideration for high flow sampling and potentially long travel times between sampling sites. These are discussed in detail in Section 6.3.2.2. The width, depth and length of large rivers increase the likelihood that spatial gradients may be important. The physical dimensions can potentially cause a need for a multi-dimensional water quality model that can account for spatial variations in flow and concentration. For example in Louisville, monitoring data showed periods of high bacteria concentrations along one shore of the Ohio River and not the other, depending upon local rainfall patterns. Use of a laterally-averaged water quality model common for smaller rivers would underestimate peak river concentrations by providing only an average shore-to-

shore concentration. The presence of these lateral gradients necessitated the use of a two-dimensional model that could describe these variations.

Large rivers often have many diverse areas. These include sensitive areas, such as wildlife habitat and recreation areas, and distinctive physical features, such as dams and large islands. Protecting sensitive areas by improving water quality is very often one of the objectives of water quality studies, while distinctive features often complicate the understanding of flow and pollutant transport in the river itself.

6.2.4 DIFFERENT REACHES OF THE SAME LARGE RIVER

Comparing this study to the study conducted in the Cincinnati area demonstrates how different reaches of the same large river can be significantly different from one another. The drainage area increases from 83,000 to 91,000 square miles going from Cincinnati to Louisville. The average monthly stream flow is higher in Louisville. The McAlpine Pool in Louisville is wider (2,040 feet compared to 1,594 feet) and shallower (25 feet deep compared to 31 feet) than the Markland Pool in Cincinnati. The population in the Cincinnati area is approximately 1.5 million people while the population in Louisville is less than one million. The Cincinnati area has more power companies, marinas and CSOs than Louisville. Louisville has more industrial permitted dischargers and WWTPs. The presence of the McAlpine Dam in the middle of the Louisville study area and the islands in both the upstream and downstream reaches, created much more complex hydrodynamics than in the Cincinnati study area. These distinctive physical features necessitated conducting two dye surveys.

6.3 METHODOLOGY

The methodology applied in this study was developed specifically for large rivers. The unique characteristics of large rivers required special consideration in setting project objectives and developing a series of tasks that would meet these objectives. This section presents the methodology in chronological order, beginning with setting detailed study objectives, monitoring and model development. This chronology is recommended for use at other large river sites.

Details regarding the application of this methodology in Louisville are presented in Chapters 2-5, however, this section discusses key elements of the methodology design. The lessons learned and insights gained from the application of this plan are presented as guidance to aid other communities in successfully transferring this methodology to other large river sites.

6.3.1 DETAILED STUDY OBJECTIVES

Setting appropriate study objectives is a key component of wet weather impact studies, especially for large river systems. These projects are typically initiated with a limited number of broad objectives. The broad objectives for this study were to:

- Provide an assessment of wet weather water quality impacts on the Ohio River in the vicinity of Louisville; and
- Document the transferability of the methodologies and technologies developed during the Cincinnati study to the Louisville area.

More specific detail must be added to these broad objectives during the initial stages of the project to establish the scope and schedule needed to complete the study. Both management and technical objectives need to be established early in the project process for complicated large river studies.

Specification of detailed objectives for large river studies is also important to achieve consensus for the potentially large number of diverse stakeholders common to large rivers. For this study, ORSANCO conducted a series of meetings with the project participants to detail specific project objectives prior to completion of the work plan. The project participants included representatives from: Charlestown Treatment Plant, City of Louisville, Clark County Health Department, Clarkesville WWTP, Indiana Department of Environmental Management, Jefferson County Health Department, Jeffersonville WWTP, Kentucky Division of Water, Louisville and Jefferson County MSD, Louisville Water Company, New Albany WWTP, Oak Park Conservancy District, U.S. EPA Office of Wastewater Management and the USGS. The specific management and technical objectives that resulted from these meeting are described below. The project participants also met on a routine basis throughout the duration of the study to provide clarifying guidance on project objectives as questions arose.

6.3.1.1 MANAGEMENT OBJECTIVES

Management objectives include determining what the project products would be while taking into account resource availability and site-specific characteristics, such as those presented in Section 6.2. In the Louisville study, these more detailed objectives included: 1) determining the extent and severity of urban wet weather water quality impacts on the Ohio River; 2) identifying the pollutants and sources of impairment and estimating their relative contribution to loadings; and, 3) evaluating the Colilert method for *E. coli* analysis.

Wet weather water quality impacts were initially defined as any pollutant that caused, or could be expected to cause, a violation of existing water quality standards in the Ohio River.

Another required management objective corresponded to defining the specific boundaries of the study domain. This domain was defined as the Louisville metropolitan area. The spatial domain of the water quality analysis was defined as the maximum downstream extent of water quality impacts. Converting this management objective into a specific area is a technical issue discussed below, as it requires analysis of the water quality data to define this extent.

Resource availability includes an assessment of the available data, time, level of effort and staff expertise. It is important to consider resource availability when determining whether the objectives are realistic. Management objectives typically result in a desire for a high degree of model detail and reliability, although available resources are generally insufficient to meet these goals. Experience gained from this project indicates that there is a geometric increase in resource needs relative to smaller systems. For example, water quality samples need to be collected from multiple locations across the width of a river, as well as from multiple downstream locations. Acquiring the resources needed to characterize a complicated large river system can be expensive and time-consuming, and must be factored into the process of setting objectives.

6.3.1.2 TECHNICAL OBJECTIVES

Certain technical aspects of project objectives must be defined before a project can proceed. Technical objectives related to this project included setting the spatial and temporal dimensions of the monitoring, and determining the parameters of concern to be considered. Many of the technical objective decisions were based on knowledge gained through the Cincinnati Study.

The spatial considerations include both the length of the river reach and the degree of detail to be provided. A two-dimensional approach, which considered both lateral (i.e. side-to-side) and longitudinal (i.e. upstream-downstream) changes in water quality, was implemented for the study area based on lateral gradients observed in water quality in the Cincinnati Study. The upstream boundary of the study area was established upstream of all known and suspected wet weather sources of pollution in the urban areas. In this study, the upstream boundary was originally set to river mile 590, then was moved to river mile 588 because of the confluence of Fourteen Mile Creek at river mile 589.5. Louisville Water Company was interest in the loadings coming from Fourteen Mile Creek because of a military instillation located in the watershed.

Based on the Cincinnati Study, bacteria were expected to be the only parameters of concern. The worst bacteria impacts were anticipated at or very near downstream of the source locations. The downstream boundary of the study area was established over five miles downstream of the Louisville metropolitan area and 20 miles downstream of the biggest WWTP. The downstream boundary was located immediately upstream of the confluence of the Salt River at river mile 630. The technical basis for this decision was that most of the Salt River's 2,890 square miles of drainage area lie outside of the study area of interest. Screening level longitudinal monitoring was conducted from below the McAlpine Dam to approximately 30 miles downstream of the Salt River in order to evaluate the extent and persistence of the wet weather pollution.

The temporal domain includes the length of time that water quality in the river will be evaluated. For the Louisville project, the water quality was evaluated on an event basis for the purposes of calibrating and validating the receiving water model. Intensive water quality monitoring was conducted for three to four days following a rain event. Additional screening level monitoring was conducted below the McAlpine Dam on the fourth and fifth days for the last three wet weather surveys.

The initial water quality sampling should include all parameters with historical violations of local water quality. The list of parameters can be refined as the project work progresses. XCG Consultants was contracted to compile and analyze historical water quality data from the study area. The parameters studied in Louisville were based on the historical data and the results of the Cincinnati study. Ultimately, *E. coli* and fecal coliform were identified as significantly impairing water quality during wet weather and were the only parameters modeled.

6.3.2 MONITORING PLAN

The purpose of the monitoring plan was to collect data with sufficient spatial and temporal detail to provide a better understanding of the system and to provide complete datasets for developing reasonably constrained models of the system. The data collected during the monitoring were entered into the system models to meet several of the objectives presented in Section 6.3.1.1 - determining the extent and severity of wet weather water quality impacts and identifying the causes and sources of impairment and quantifying their relative contribution to instream loadings.

The monitoring plan was designed to provide targeted information for all three of the models used to characterize the study area (landside loading, hydrodynamic and water quality models) as described in Chapter 2. This is an extremely important aspect of the monitoring design. A monitoring plan that does not take into consideration the system model needs will result in models that are not as well constrained in their specification of site-specific inputs and in their comparisons to observed data. Poorly constrained models are less useful as planning tools, as discussed in Section 6.3.4.1, and do not meet the project objectives. Monitoring plan development should include meetings with the model developers to discuss the specific data needs in order to facilitate design of the framework.

The monitoring plan is the design by which the data collection effort will be conducted. It addresses the reasons for sampling, for which parameters to sample, where to collect the samples, when and for how long to conduct the monitoring, who will collect the samples, and by what methods the samples will be collected and analyzed. The previous paragraph explains that model development is the reason for the monitoring. Model development drives the answers to the remaining questions, which are addressed in the remaining sections through discussion of the following aspects of the sampling plan: sampling considerations, field logistics and laboratory selection.

6.3.2.1 SAMPLING CONSIDERATIONS

The sampling plan must address the technical considerations raised as part of the study objectives, as discussed in Section 6.3.1, when determining the parameters to sample and analyze, the sampling locations, the sampling frequency and the number of events. This section addresses these aspects of the plan design.

Constituents To Sample

The constituents of concern were identified during the planning stages of the project. Results of the Cincinnati study and review of the historical water quality data collect by XCG Consultants, led the project team to initially sample for physical parameters, bacteria, oxygen demand, solids and nutrients. The number and type of samples collected at each site were adjusted over the period of the study. The ability to adapt the sampling plan based on interim results is especially important in large river systems, due to the potential for collecting a large number of unnecessary samples.

One or more dye surveys may be necessary where the river hydrodynamics are not well defined. Two dye surveys, one conducted during high flow conditions and other during low flow conditions, provided a better understanding of the lateral and longitudinal mixing of water quality constituents as they are transported downstream. The dye surveys provided calibration and validation datasets for developing the dispersion coefficient used in the water quality model (Section 4.4.2.4) to describe the lateral and longitudinal mixing of water quality constituents as they are transported downstream. The dye surveys improved the confidence in the ability of the water quality model to successfully route constituents downstream in a manner consistent with the true routing of the flow in the river.

Sampling Locations

Concentrations of particular constituents can vary significantly laterally, longitudinally and by depth in large rivers, therefore, all dimensions should be considered when determining locations to sample. Laterally, samples were collected from three points across at each river mile sampled. Longitudinally, sampling sites were located at two-mile intervals. The lateral and longitudinal frequencies were reduced following three days of the sampling described above. Single midstream samples were collected at five-mile intervals below the McAlpine Dam. For depth considerations, physical parameters were collected at one-foot intervals, from points both above and below the McAlpine Dam in order to identify any vertical physical stratification. Oxygen demand samples were collected from the surface and bottom of the water column at every other midstream site in order to identify vertical gradients in chemical water quality. Results of this effort led the project team to collect surface grab samples at all mainstem and tributary sites.

Tributaries and point sources, such as CSOs and WWTPs, were sampled in order to address the data needs of the landside loading model. CSOs were sampled to represent all types of land use in the CSO service areas. The CSO portion of this sampling plan was more successful in the Cincinnati study. Samples were initially collected hourly, then at shorter intervals after the first two surveys. The WWTP influents were sampled hourly while the CSOs discharged.

Tributary samples were collected downstream of the known point source discharges and upstream of Ohio River backwater influence. Physical parameter monitoring, particularly conductivity, was used to differentiate between the tributary water and Ohio River backwater. Samples were collected from three points across on the larger tributaries and homogenized. Single midstream samples were collected from the smaller tributaries. Measurements of flow rate or overflow volume are also desirable at these sites for modeling purposes.

Sample Frequency And Duration

Other sampling considerations include determining how frequently and for how long each location should be sampled during each event. This is important for large river systems compared to smaller systems, because the larger spatial scale of the system can result in a much longer duration of monitoring for wet weather events. Ideally, the frequency should be high enough that temporal variations in water quality in the river and tributaries can be defined, while still surveying the spatial extent needed. Considerations that place limits on ideal sampling frequency include: analytical requirements (sample size, preservative, filtered versus unfiltered and holding time), available space on the boats or vehicles, time necessary for sampling and traveling between sites, physical characteristics of the sampling locations (McAlpine Dam and access to tributary and CSO sampling sites), field crew mobilization and limitations, hours of daylight, and laboratory analytical capacity.

The duration of sampling is dependent on the type of event. A single round of sample collection is sufficient for a dry weather event. The entire event duration should be sampled for a wet weather event. Instream wet weather impacts persist longer than the precipitation event causing the effects, therefore, water quality monitoring should continue until the stream returns to background conditions. A simple nomograph was developed that indicated how long wet weather impacts would be observed in the study segment of the Ohio River, based upon observed river stage. Monitoring was required for a minimum of two to three days following the precipitation event. The duration of sampling during wet weather is largely dependent on the size of the storm and the instream flow conditions. Wet weather event sampling ranged from three to five days in this study.

Number Of Events

The final sampling consideration is determining the number of dry and wet weather events to monitor. A minimum of two wet weather events are required in order to provide both a calibration dataset and a validation dataset for the water quality modeling. Sampling more than two wet weather events is preferred since large rivers experience a wide range of flows conditions. Collecting data under a wide range of flow conditions ensures that the performance of the receiving water model can be confirmed over varying flows. Larger watersheds typically require more sampling events because it is less likely that any given precipitation event would generate wet weather impacts across the entire watershed. Commonly, rather than waiting for a single watershed-wide precipitation event, multiple smaller events are sampled which generate wet weather impacts in portions of the study area.

Dry weather sampling is another necessary component of the monitoring program. Dry weather surveys provide baseline water quality information that is free from wet weather-related influences. Dry weather sampling should be conducted on both the main stem and tributaries, under a range of flow conditions. Three dry weather and five wet weather surveys were conducted during this study.

Field Logistics

Field logistics deal with the considerations of how the monitoring plan will be executed and who will collect which samples. This section describes the field logistics associated with conducting

a wet weather survey. Many of these considerations are also applicable to the much simpler dry weather surveys.

The complexity of large river sites requires extensive planning of sample collection, timing and crew coordination. Poorly planned or executed logistics can undermine the intent of a sampling program by providing incomplete datasets for characterizing the system and for the models. Logistics for large river site sampling plans should consider the following complexities: the large area requiring sampling at a relatively high frequency, safety considerations, and dealing with inconsistent rainfall patterns. Ultimately, each of these components in the logistics is factored into a "Go/No go" decision on whether to sample an event.

Field logistics were simplified in this study by holding pre-season planning and training meetings for the field crews, at which they were provided with pre-labeled sample containers and field packets. The meetings ensured that everyone knew what their duties were and when to perform them in order to minimize problems during a sampling event. The field packets contained contact information, standard operating procedures for sample collection, and chains-of-custody which provided a complete description of the sampling plan.

Spatial Coverage

Main stem, tributary and source sampling are desired for a complete dataset. Each location is sampled very intensely early in the event, and then the frequency decreases as the event passes through the system. To accommodate the spatial coverage and frequency of sampling desired, multiple crews and sets of equipment are needed.

Large rivers are generally not wadable, therefore, sampling at these locations will need to be conducted from a boat. If the pollutant loadings enter the river over a long reach, more than one boat and crew may be necessary to capture water quality impacts in a timely manner with the sample collections. The presence of physical features, such as dams or large sandbars, that might inhibit expeditious boat travel down the river, may necessitate use of a second boat and crew to collect the samples at the prescribed locations and frequency. Sampling tributaries is less problematic because they can usually be sampled by wading or from bridges using a bucket on a rope.

The crew and equipment needs for wet weather surveys involving large rivers often exceed the sampling capacity of any single organization. Successful sampling programs often involve coordination of local stakeholders or consultants with sampling expertise. For example, using local utility personnel to sample CSO outfalls can be a means of freeing up resources to handle other components of the sampling plan. Another example is to utilize a laboratory courier to transport samples from the field to the laboratory for analysis.

In this study, the wet weather monitoring was divided into three phases. In Phase 1, "snapshots" of water quality conditions were determined by conducting rounds of cross-sectional sampling on the mainstem using a boat during a wet weather event. Samples were collected once per day on the mainstem for the duration of the event. In Phase 2, "snapshots" of water quality in the tributaries and point sources were measured during and after wet weather events. Tributary sampling was conducted every two hours immediately following a precipitation event, then

tapered off with the sampling frequency eventually dropping to once per day. CSOs were sampled every 15 minutes following the first flush, then decreased to hourly sampling. WWTP influents were sampled hourly while the respective collection system CSOs were discharging. In Phase 3, a longitudinal profile of the physical parameters (temperature, pH, dissolved oxygen and conductivity) in the main stem was collected by boat over a 50-mile stretch using a flow-through system that recorded information at 15-second increments. Separating the sampling program into these phases aided in managing the crews and ensuring that samples were collected at the designated locations and at the prescribed frequencies.

In this study, ORSANCO served as a point of contact for all of the sampling crews. The participants sampled their own WWTP influents, CSOs and tributaries located within their service areas. A local contractor was utilized to sample the remaining tributaries. ORSANCO provided two crews for sampling on the Ohio River, one crew for the reach upstream of the McAlpine Dam and one crew for the downstream reach. The location of the McAlpine Dam in the middle of the survey area necessitated the use of two crews on the Ohio River because one crew would not have had enough time for collecting samples from both reaches and for lockage. Sample drops were arranged for all of the crews to deliver their samples to one location for pickup by a laboratory courier. This allowed ORSANCO to audit the sample collection by reviewing the samples and chains-of-custody.

Safety Considerations

Safety considerations are important for conducting any wet weather monitoring, but are elevated for large rivers. During wet weather conditions, sampling a large river from a boat deck can be extremely dangerous. At higher flows, large rivers have much greater total energy in the form of velocity, elevation and pressure heads, than smaller rivers. Large objects, such as uprooted trees, will float in large rivers causing hazardous conditions for boaters. For the purposes of this study, ORSANCO suspended sampling once the river reached a certain stage because of the increased risk of encountering large debris washing down the river. ORSANCO also suspended sampling once the river reached a certain velocity considered unsuitable for safe boat operation.

All safety considerations should be made and implemented prior to initiating sampling. This includes basics such as having enough life preservers for every person on board a boat, to alerting the Coast Guard that sampling is occurring during wet weather. Most importantly, personal safety should never be compromised in order to collect a water sample. If the weather deteriorates or a sampling crew determines that conditions are unsafe to continue, sampling should be suspended immediately. A decision to terminate the entire event will need to be made by the project manager, usually in consultation with other project team members and sampling crews. If this occurs, a notification system should be in place so that all crews can be advised to suspend their sampling as well. The use of cellular telephones and pagers can simplify this notification process.

It is highly recommended that all tributary and CSO samplers work in pairs. These sample sites can be particularly dangerous due to rapidly changing stream conditions, slippery stream banks, nighttime sample collection and automobile traffic on bridges. Any sampler who works close to a stream should wear a life preserver and samplers who work from bridges should wear reflective highway safety vests.

Inconsistent Rainfall

Inconsistent rainfall was identified in section 6.2.2 as one of the unique problems facing wet weather studies of large river sites. An ideal wet weather event consists of sufficient rain across the watershed to cause wet weather impacts through the overflow of CSOs and large runoff volume from nonpoint sources. A minimum of 0.1 inches of rainfall is typically required to trigger wet weather impacts, however, a minimum of 1.0 inch of rainfall is often desired. In order to complete the monitoring portion of a wet weather study in a timely manner, it is necessary to compromise and use a less than ideal rainfall event. Study requirements can be fulfilled by monitoring multiple, less-than-ideal, rainfall events during the course of a wet weather study. Having a network of rainfall gages distributed throughout the watershed is extremely valuable in providing information about the inconsistent rainfall. Resources for rain gauge information may include the National Weather Service, local airports, the USGS and the Automated Flood Warning System (http://www.afws.net/).

Real-time rainfall information was readily available on the internet during the last year of this study. Louisville MSD operates and maintains telemetered rain gauges located throughout their service area. A running daily total (in inches) and rainfall rates (in inches per hour) for each telemetered gauge were automatically updated every five minutes and available for viewing at http://www.msdlouky.org/aboutmsd/rainfall.cfm.

"Go/No Go" Decision

A critical decision for any wet weather study is whether to initiate sampling based upon a given rainfall forecast. The project manager ultimately makes the "go/no go" decision regarding the initiation of monitoring a rainfall event. This decision is made difficult by large river site characteristics such as large watershed area, inconsistent precipitation and in-stream conditions. Utilizing all available resources increases the likelihood of making a correct "go/no go" decision. Resources include evaluation of conditions across the watershed and consultation with other project team members, sampling crews and the laboratory. All of the logistical factors described in the sections above should also be considered in the final decision. The readiness of the sampling crews, equipment and laboratory should also be considered. Since wet weather event sampling typically lasts beyond the rainfall duration, the weather forecast should also be a factor in deciding whether to start sampling. For example, if rain is forecasted for a few consecutive days with increasing intensity, sampling may be unsafe or the wet weather effects in the river may be prolonged. This situation may lead to collecting more samples and, consequently, more expense.

It is important for the project manager to notify all project team members, sampling crews and the laboratory when weather forecasts suggest the possibility of conducting a wet weather event. Because tributary water quality responds very quickly to rainfall, the project manager may elect to have the tributary crews collect their hour 0 samples prior to making the "go/no go" decision and even prior to the onset of precipitation, in order to capture true background conditions. The project manager will likely send the CSO crews to their sampling locations prior to the onset of precipitation in order to capture the "first flush". River crews will most likely not mobilize until a "go/no go" decision is made.

6.3.2.2 LABORATORY SELECTION

One of the most important decisions in the monitoring program is the selection of a laboratory to perform the analyses on the samples collected. The choice is not a trivial matter since the laboratory provides the analytical results that are used by the project team to meet the study objectives. Large rivers provide unique challenges for laboratory selection due to the large quantity of samples being generated during a given event.

Laboratory selection should be based on the ability of the laboratory to: perform the standard methods for analyses within their QA/QC guidelines, handle a large influx of samples over a short period of time, meet short holding times for parameters such as bacteria, provide results within a reasonable amount of time and do all of this at a reasonable cost. It is important to not allow cost to be the driving factor in laboratory selection. Short-term savings in analytical costs may result in long-term project costs and delays if an inexpensive but poor quality laboratory produces large amounts of unusable data.

A local laboratory is typically selected because of the short holding times of some key wet weather constituents, such as bacteria and oxygen demand. When feasible, a single laboratory should perform all of the analyses of a particular parameter to avoid the uncertainty associated with comparing and interpreting results for the same parameter from two different laboratories. Adhering to this concept will result in the delivery of a large number of samples to the laboratory periodically throughout a wet weather sampling event. This study produced approximately 450 *E. coli* samples over a five-day period at the peak of the sampling program. When possible, using a single laboratory for all of the analyses simplifies the sample drop-off procedure, reducing the potential for broken sample containers during transport and delivery of samples to the wrong laboratory.

Analytical results are often qualified and potentially unusable when hold times or other QA/QC requirements are not met. Good communication with the laboratory can help to minimize these QA/QC failures. Including the laboratory in a "go/no go" decision, informing them when sampling starts and arranging sample delivery times will allow them time to align their resources to meet the project demands.

Analytical results may also be unusable when the results are outside the range of the analytical procedure. This is caused by either overdilution or underdilution of a sample prior to analysis. It is recommended that the chains-of-custody and labels on sample bottles clearly indicate the source of the sample (CSO, WWTP influent, tributary or receiving stream), as some samples require special handling in the laboratory. Pollutant concentrations in CSO outfall samples can range over several orders of magnitude and are significantly higher in concentration than receiving water samples, therefore, several dilutions are likely needed to ensure a result within the analytical range. The laboratory should be prepared to perform extra measures to prevent cross-contamination between samples during the sample preparation and analysis.

Finally, laboratories sometimes offer services that can make wet weather sampling easier for the project team. Some laboratories provide couriers to pick up the samples in the field, saving the project manager from devoting precious field resources to transportation of the samples to the

laboratory. Some laboratories subcontract analyses that they do not perform. It is reasonable to expect the laboratory to handle all aspects of sub-contracting analyses, but this expectation should be clarified prior to signing a contract with a laboratory.

Based on laboratory problems experienced during the Cincinnati study, ORSANCO utilized an EPA bacteria expert to audit a laboratory prior to signing a contract for wet weather analytical work. The audit included review of documentation for the Standard Operating Procedures, Quality Assurance Manual and Wet Chemistry Contingency Plan. The audit also included a two-day site visit consisting of: review of the QA/QC records, observation of the bacteria staging area, bacteria equipment and laboratory staff performance of bacteria filtration and bacteria counts.

The contract laboratory selected for this study provided a courier to pick up samples from one central location in the Louisville area and provided laboratory-grade deionized water for use by the field crews. Louisville MSD and Clarksville provided in-kind bacteria analyses early in this project. The importance of using a single laboratory for all of the analytical work became obvious when the hold time on several bacteria samples was exceeded due to samples being sent to the wrong laboratory.

6.3.3 MODEL DEVELOPMENT

In this study, the complexity of the large river site and the project objectives required site characterization beyond the information provided by the monitoring data. This will likely be true for other large river sites where this framework is adapted. It would be cost-prohibitive to collect sufficient data with the monitoring plan to thoroughly characterize the response of the system to wet weather impacts. Sufficient data would include landside data measurements of overflow volume, constituent concentrations from each source, and water quality measurements in the river at much closer spatial and temporal frequencies. Given the impracticality of these data requirements, landside/collection system and receiving water models are used to fill the gaps between sampling locations and collection times.

Models offer other advantages in that they provide a method to link landside loadings to their impact on instream water quality and they have the ability to forecast changes in water quality conditions in response to alternative pollutant loading rates or environmental conditions. Models are also an effective way to integrate the large number of diverse sources that are typically encountered in large river sites (as discussed in Section 6.2.2) into an analysis of the entire system. They also have the ability to simulate observed lag times within the model domain that are common in large river sites. Having established the benefits of using models in these studies, this section presents the factors to consider in selecting a model and provides a description of the formulation of the model.

6.3.3.1 MODEL SELECTION

Primary emphasis in identifying and selecting models for use in a study is usually given to the study objectives and types of available data. The site-specific characteristics, both instream and landside, must also be merged into the model selection process. Consideration of these

objectives and factors will aid in determining the level of sophistication needed in the receiving water and landside/collection system models.

A variety of models, ranging from simple to complex, are available for modeling watersheds and/or collection systems. Factors to consider include the variety of point and nonpoint sources and the watershed area to model. Management objectives to consider include, for example, the level of specificity in separating loadings given the available information. In this study, SSO information was very limited so modeling these releases with a landside model was not practical. Finally, the landside/collection system model needs to be compatible with the receiving water quality model. An example of incompatible models is a receiving water quality model that requires hourly load inputs and a landside/collection system model with daily load output.

Generally, CSO communities on both sides of the large river under study will need to be characterized with a model if the objective of the study is to evaluate wet weather impacts on receiving water quality. In this study, CSO loads were estimated using rainfall regressions developed by Louisville MSD. Selection of a model to simulate surface runoff from watersheds depends on the size and number of watersheds to model and availability of site-specific inputs for the model. The model selected for this study was an HSPF model with an HEC-2 component for stream transport.

Site characteristics also influence the selection of the receiving water hydrodynamic and water quality models. Large rivers (as described in Section 6.2.3), have unique physical characteristics, including a wide range of flows and velocities and significant spatial variations of velocities and pollutant concentrations in potentially all three dimensions of the river. To properly capture these characteristics of a large river, it is likely that both a hydrodynamic and a water quality model of the river will be needed. Hydrodynamic models describe the movement of water within a river system while water quality models describe the transport, chemical transformations and degradations of pollutants within the river. Although a variety of hydrodynamic and water quality models are available to model large rivers, the particular models selected will need to have the ability to reproduce the spatial and temporal variations in water and pollutant movement. In this study, RMA-2V (USACE, 1997) and WASP5 (USEPA, 1993) were selected as the hydrodynamic and water quality models (see section 5.2 for details), respectively. An analysis of the project objectives, constraints and site-specific characteristics should be done at each site to select appropriate models.

An important consideration in model selection for large rivers with multiple jurisdictions is whether the model is part of the public domain or is privately supported. Generally, public domain models are created by government agencies, such as the EPA or USGS. Examples of public domain models are WASP and HSPF, which were used in this study. The primary advantage of these models is that they are openly available and are accessible by anyone. This arrangement is advantageous to large river studies where there are multiple agencies and other stakeholders who may be potential users of the models, because it eliminates many of the distribution issues associated with private domain models. Private domain models are copyright protected and proprietary issues will likely have to be addressed before these models can be distributed to stakeholder agencies or groups. Public domain models can be readily distributed

to local agencies or other parties interested in using the models for more detailed simulations or with scenarios that are outside the scope of the study.

6.3.3.2 MODEL SETUP

Once the models are selected, they need to be developed for the study area. This includes structuring the models to be consistent with project objectives and available data, incorporating site-specific data into the models and developing additional tools to facilitate meeting project objectives and linking the models efficiently.

Initial set up decisions include the level of temporal and spatial definition within the model. These definitions in the models should be fine enough to allow for meaningful comparisons to data collected in the monitoring program because these data are used to calibrate the model. In this study, the Ohio River water quality model was composed of rows of segments where each row contained five segments across and each segment averaged 0.30 miles in length (see Section 4.4.2.2). It is important to not structure the model so finely that it causes operational inefficiencies in the form of long run or processing times.

Site-specific model inputs are also part of the model development. In addition to utilizing data collected from the monitoring program, site-specific data from other sources should be utilized if available. Groups or agencies that may have site-specific data include the USGS, US EPA, US ACE, National Oceanic and Atmospheric Administration (NOAA), regional agencies such as ORSANCO for the Ohio River, and local groups such as universities and health departments. Examples of site-specific data used in model development for this study include: precipitation, meteorological conditions and potential evapotranspiration for the landside loading model; river bathymetry and channel slope for the receiving water hydrodynamic model; and the operating rules and hydropower unit discharges for the McAlpine Locks and Dam and environmental conditions for the water quality model.

Because large sites like this are complex and require several models, an aspect of the model development may include making modifications to the model code to reflect site-specific or project objectives. The types of models used at a site are interconnected. For example, the landside model provides load inputs to the receiving water quality model. Likewise the flow movement output from the hydrodynamic model is translated into the water quality model. Often tools to directly link these models are unavailable and may need to be developed at this stage in the framework. In this study, a program was written to convert finite element nodal information from the hydrodynamic model into water quality segment volumes, dispersion areas and mixing lengths.

6.3.3.3 MODEL CALIBRATION AND VALIDATION

Taking the models through a calibration and validation process increases confidence in the models selected and developed for use at a site. The calibration process can serve to demonstrate the predictive capacity of a model, as well as identify gaps in the understanding of the system. This process will demonstrate the ability of the model to reasonably simulate conditions for which there are no available data, such as investigating alternative loading scenarios. The

calibration and validation approach for large river sites do not vary significantly from the approach for other sites, however, the priority of large river calibration and validation endpoints should be to reflect the uniqueness of large rivers.

The calibration and validation procedures are fairly straightforward and are made easier in this framework by designing the monitoring plan to provide datasets for use in calibrating and validating the models. The approach to calibrating a model is to specify site-specific inputs, whenever possible, for a selected event and to run the model. The model output is compared to observed data at specific points in time and, if deemed acceptable, the process is repeated with one or more different datasets to validate the model.

The monitoring plan is designed to provide several complete wet weather datasets for use in evaluating the performance of the models. Determining which of these events to use to calibrate the models should be based on an assessment of the most complete dataset for the purposes of all of the models, because this will provide the most rigorous evaluation of model performance. Another criterion to consider is the number of potential wet weather sources discharging pollutant loadings to the river. An event that has more active sources is preferred to an event with fewer sources, because this type of event will have more impacts on water quality and will provide better feedback on the accuracy of the model in capturing water quality impacts.

All available site-specific and event-specific data should be input into the model for calibrating. This reduces uncertainty in the model inputs and better constrains the models by having fewer inputs to vary, thereby also reducing uncertainty in the model outputs. Examples of specific inputs include: environmental conditions for the landside model; stage and flow for the hydrodynamic model; and loads, boundary conditions, flows and environmental conditions for the water quality model.

The strategy for determining the "goodness of fit" of a model simulation of an event to the measured data should account for the distinctive features of large river sites. For the receiving water quality model, calibration targets included reproducing observed concentration gradients between near shore and center channel areas and simulating the observed timing and location of peak concentrations. Matching the magnitude of observed concentrations was a secondary objective due to the uncertainty in loadings. The hydrodynamic model targets were instream velocity measurements made during the hydraulic surveys.

The purpose of validating the model is to demonstrate that the model formulations produce reasonable results for a different set of model inputs. Thus, the best test of a calibrated model's formulations is to run it with a set of inputs that represent much different conditions in the system than the inputs that were used to calibrate it. It is recommended to validate the models to several wet weather events because large river sites have a wide range of flow and environmental conditions.

6.3.4 MODEL APPLICATION

The calibrated and validated models developed in the previous section can be used to further investigate the impact of wet weather sources of pollution on water quality under a range of

environmental and future source loading conditions. By applying the models to a variety of storm and environmental conditions, it may be possible to assess the extent to which wet weather sources impact water quality for a range of conditions. The models can then be used to forecast improvements in water quality resulting from various levels of source controls. Alternatively, the models can be used to investigate the applicability of stream-designated uses during wet weather. The methodology framework developed for this project is sufficiently generalized to allow application of the models for a range of scenarios, which are discussed in the following sections.

6.3.4.1 MULTI-JURISDICTIONAL CONSIDERATIONS

As described in Section 6.2.1, large river sites often span multiple federal, state and local jurisdictions. The modeling framework was designed to reflect the multi-jurisdictional nature of these sites by developing a suite of tools that can be used to investigate future conditions using broad assumptions or with more detailed analyses.

Broad scenarios would typically be of interest to project stakeholders at the federal or regional level. These scenarios are not very detailed and involve large-scale (watershed or study area) changes to the system and the resulting improvement to water quality in the river and are more general and investigative in nature.

The calibrated models developed under this framework also provide local communities with the tools for evaluating more detailed analyses. These scenarios would probably incorporate regulatory, political and cost considerations into the simulations of future conditions.

6.3.4.2 ENVIRONMENTAL CONSIDERATIONS

Despite the intentions of the monitoring program to measure instream water quality for a range of flow and storm conditions, it is impossible, given the resource constraints, to monitor all of the possible combinations of these two parameters. In addition to storm and flow conditions, other environmental factors of interest include temperature, which often affects the kinetic rates in transformation reactions, and wind speed, which influences instream dissolved oxygen concentrations. The calibrated models can be used to evaluate instream water quality for a range of environmental conditions.

Applying the models over a range of environmental conditions will permit a more complete characterization of the system under both dry and wet weather conditions. Trends and correlations may become apparent when simulating a range of conditions.

Seasonal variations may be of interest in areas where different water quality standards are applicable during different times of the year, as was the case in Louisville. The model applications may indicate that certain times of the year are more sensitive to wet weather events than others, either because of compliance with water quality standards or because of the seasonal effects on loads. For example, solids loadings from agricultural lands are likely higher in spring, when the fields are plowed but without vegetation, than in the fall, when the fields are well vegetated.

Several approaches have been used to apply the models over a range of environmental conditions. One approach is to model a "typical" year, where a year that had rainfall and instream flows which approximated the historically observed ranges in rainfall and flows, was selected for simulation (see Section 5.2). This approach offers an advantage in that it uses conditions that have actually occurred in the area. The disadvantage is that historical records may not reflect future conditions, particularly as impervious areas increase through land development and as meteorological patterns change.

Another approach to consider is to develop synthetic hyetographs and hydrographs for the study area that are of particular interest to the user and to simulate those conditions with the models. An example would be using the models to simulate a 100-year precipitation event for a range of environmental conditions (flow and temperature) that would simulate conditions in each season. This approach offers the advantage of simulating worst-case scenarios and may be better able to reflect future conditions. Disadvantages in the design storm approach are that these conditions have never been observed and their likelihood of actually occurring is unknown, though they can be predicted statistically. Also, the design of hyetographs and hydrographs at the project study scale would require more resources than using the "typical" year approach.

6.3.4.3 DESIGNATED USES CONSIDERATIONS

Large river sites often have many designated uses. The designated uses are maintained through compliance with water quality standards. The EPA, through the National CSO Policy, has recognized that current water quality standards may not be appropriate for wet weather conditions (EPA, 2001). The National Academy of Sciences has also reached the same conclusion (NRC, 2001). Changing the designated uses of a stream is one method of reviewing and changing water quality standards to better reflect reasonable expectations of stream uses during wet weather.

The models developed using this framework can be used as tools for conducting a Use Attainability Analysis (UAA). This type of application of the models can be used to evaluate how long a designated use is impaired for a given wet weather condition. It can also be used to evaluate several options for revising water quality standards associated with a designated use, such as: whether adopting a seasonal use is appropriate, if incorporating a high-flow threshold into the water quality standard is appropriate and whether a variance should be issued for designated uses during wet weather conditions.

6.3.4.4 MODEL RESULTS

Understanding the model results is critical in large river sites because they are subject to all of the complicating factors described in Section 6.2, which confound model results. Uneven rainfall patterns could potentially cause the model results for any given event to show misleading results. An area that received the heaviest rainfall may appear as the primary cause of all water quality impacts in the river, whereas, under differing rainfall distribution, other areas of the watershed would appear to be the primary cause. It is important to carefully specify model inputs when applying the model for various control scenarios to ensure that the model results

will yield useful information, particularly when the purposes of the modeling include determining relative magnitude of sources and using the models to identify areas for targeting source controls.

A two-dimensional model is usually required to meet the challenge of presenting the model results in a simple yet meaningful manner for large river sites. In this study, the model output was generated every hour for each of the 738 model segments. An animation viewer was developed which shows the changes in bacteria concentration in each segment using different colors.

6.4 SUMMARY

The study framework used for this project was designed during the Cincinnati study to be easily transferable to other large river sites. This framework accounts for the unique characteristics of large rivers that complicate wet weather studies including: their multiple regulatory jurisdictional nature; their large watersheds which typically have variable rainfall and large numbers of diverse sources; and the physical characteristics of the river itself, which usually require careful planning of the monitoring phase of the study and a two-dimensional model to characterize the lateral and longitudinal gradients in the river.

The methodology consists of four discrete steps: setting objectives, developing a monitoring plan, developing models of the study area, and applying the models under alternative scenarios. Each step must be carefully planned and executed because large river sites are complex systems, however, each of these steps cannot occur in a vacuum. Consideration of the other pieces of the framework is necessary to get the most value out of the study and ensure its overall success for all of the stakeholders. This chapter presents the framework components, aspects of their interdependency and the factors unique to large rivers that will enable the reader to successfully apply it at another large river site.

7.0 LESSONS LEARNED

7.1 WET WEATHER TRACKING

The project had a predefined wet weather condition necessary to conduct a water quality survey. This was necessary to ensure that CSOs were discharging during a sampling event. The necessary wet weather condition will vary by location and is best determined by the WWTPs because they know what will trigger their CSOs to discharge. Tracking weather for the desired storm event can be time consuming, and requires a substantial employee commitment on a 24-hour basis. Holidays can also present a problem, particularly with laboratories and contract samplers who are not always available during these times. The Kentucky Derby was a unique obstacle to the Louisville study because there were no hotel rooms available for the ORSANCO crews who traveled from Cincinnati for the monitoring events. Additionally, stream conditions may be non-representative due to such things as heavier boat traffic and fireworks celebrations.

Twenty-four hour internet access to weather forecasts at work and home is essential to effectively track weather conditions for sampling event initiation. A regular dialogue with local meteorologists can also prove to be valuable.

7.2 MOBILIZATION LOGISTICS

Numerous field crews and laboratories were involved in the sampling events, all requiring 24-hour notification of a potential sampling event. Recent popular use of wireless phones and economical pagers significantly eased this task. Preseason meetings and appropriate training also helped smooth the process.

It is important for the project manager to alert everyone involved at the first indication that a sufficient wet weather event may occur. Early notification helps to avoid the problems associated with last minute notice, such as time and equipment conflicts. It also ensures that all people involved are carrying their pagers.

In this study, ORSANCO provided two river sampling crews from their office located in Cincinnati, approximately 100 miles from Louisville. The time required to travel this distance, while towing boats, required that ORSANCO employees sometimes drive to Louisville before making the final "go/no go" decision. This resulted in some unnecessary trips, but ensured that crews were in place and prepared in case of a wet weather event.

7.3 FALSE STARTS

The wet weather monitoring program was designed to begin sampling just prior to the beginning of a storm event. The likelihood of correctly predicting, prior to the onset of precipitation, that a particular storm would provide enough uniform rainfall for a wet weather event is not high. As a result, the project had a few false starts, where sampling was initiated, but enough rainfall did not

occur. In these cases, the monitoring event was eventually cancelled and all samples were discarded. Replacement bottles and chains-of-custody were then required to ready the project team for the next potential wet weather event.

The possibility of one or more false starts should be considered and accounted for when developing budgets and project schedules.

7.4 PROJECT SCHEDULE & BUDGET

The project schedule and budget must account for uncooperative weather. This project experienced one year of delay due to the drought in 1999, which could not have been predicted. Such weather-related delays add substantial unanticipated time and unbudgeted costs to the project, which are difficult to estimate.

7.5 USE OF THE FLOW-THROUGH SYSTEM

The flow-through system allowed for collection of surface water samples and measurement of physical parameters from a moving boat. This system proved to be an efficient way to collect samples and measure physical parameters over lengthy river reaches of 70 miles in a relatively short timeframe of two to three hours. This type of sampling is contingent upon having a well-mixed river. A concern with the system was decontamination between sampling events. However, data was collected to support the assumption that the system could be decontaminated effectively. Data was also collected to support the assumption that physical parameter measurements were not significantly altered by the system.

7.6 TRIBUTARY SAMPLING

The following sampling frequency and duration were found to be the most effective in defining the "pollutograph" for bacteria from the tributaries:

1st 12 Hours:	Sample collected every two hours
2nd 12 Hours:	Sample collected every four hours
Next 24 Hours:	Sample collected every eight hours
3rd 24 Hours:	Sample collected mid-day
4th 24 Hours:	Sample collected mid-day
5th 24 Hours:	Sample collected mid-day

Some tributaries, which contained fewer pollutant sources and had smaller drainage areas, were sampled on a less frequent basis because they were not anticipated to have as much impact on the quality of the receiving stream. These tributaries were sampled three times per day for two days. The exact timing of the sampling was left to the discretion of the field crews.

7.7 SAMPLING EQUIPMENT CLEANING

During the Cincinnati study, elaborate "decontamination" procedures using acid or methanol rinses, an Alconox/Liquinox wash, followed by clean water rinses, were put in place to clean the sampling equipment between sites. Sporadic contaminated blanks appeared from the laboratory results. After performing side-by-side tests, it was confirmed that the wash products were never completely removed by the rinse procedure and, thus, causing the contamination problems. Results of the decontamination procedures study are provided in more detail in Section 2.4.5.

Subsequently, a new procedure was established for stainless steel equipment using only three deionized water rinses followed by a river rinse between sampling sites. This procedure was tested and verified to remove the parameters of concern and minimize cross-contamination.

7.8 BACTERIA 24-HOUR HOLD TIME

Standard Methods specifies a six-hour holding time for bacteria sample analyses. This time constraint can be difficult to achieve, particularly with surveys having a large number of samples to analyze. In this study, samples were also being transported from Louisville to a laboratory in Northern Kentucky for analyses. ORSANCO consulted with U.S. EPA and conducted a study to evaluate the differences in analytical results for bacteria for triplicate river samples with holding times of 6, 15 and 24 hours. Results of the study indicated that a 24-hour hold time for bacteria samples was sufficient for the purposes of this project. It was also the opinion of U.S. EPA national experts that a 24-hour hold time would be adequate for this project. A 24-hour hold time was used for all fecal coliform and *E. coli* samples.

7.9 BACTERIA DILUTIONS AND COLONY COUNT REPORTING

A major difficulty encountered with the analytical program was determining appropriate dilutions in the analyses of fecal coliform and *E. coli* samples, especially those collected on tributaries early in a survey due to their high bacteria densities. Numeric values are necessary in order to calibrate and/or verify the water quality model, therefore, data reported as too numerous to count. Therefore, the contract laboratory utilized a "pre-dilution" method which allowed for bacteria counts in the millions CFU/100mL range. Additionally, ORSANCO developed a procedure for determining bacteria concentrations from samples with various dilution density counts that further enhances the procedures defined in Standard Methods. This procedure was developed with national experts from the US EPA's Briedenbach Research Center. The calculation procedure is included in Appendix I. This methodology is useful for obtaining the best numeric results for samples in which the density counts do not occur within Standard Methods' "ideal range" of 20 to 60 counts.

7.10 BLENDING STUDY

In 1999, concern was raised over the high bacteria densities present in the tributaries during wet weather events and whether is would be appropriate to homogenize samples, utilizing a laboratory blender, before filtration according to Standard Methods. This concern was raised by experts from US EPA's Briedenbach Center and based on a CSO study that was conducted in the eastern U.S. This US EPA study showed that particulate matter interfered with bacteria counts. In an effort to address this concern, duplicate samples were collected and analyzed by the membrane filtration method, one blended and the other not. Results indicate, for samples with turbidities as high as 260 NTU, that blending does not enhance recovery of fecal coliform. Therefore, it was concluded that blending fecal coliform samples was not necessary.

7.11 LABORATORY QA/QC & OVERSIGHT

Laboratory QA/QC and oversight by project management were major issues that caused significant delays in this project. A number of issues arose here which are discussed below in brief:

- Sample Capacity – It is critical to ascertain whether a lab can handle a large volume of bacteria samples usually necessary to complete a wet weather survey of a large river setting. A laboratory that can proficiently handle tens of bacteria analyses concurrently might be completely incapable of handling hundreds of samples. A pre-survey audit of the lab should be conducted to determine that appropriate and correct equipment is available and in good condition to handle the proposed volume of samples.

- Lab Audits – It pays to audit the lab during the analyses of survey samples. A number of serious deficiencies were identified by an audit conducted during one of the wet weather surveys that identified invalid data and resulted in discarding laboratory results from the entire sampling event.

- Pink Growth – Incorrect incubation temperatures (lower than specified by Standard Methods) in the laboratory caused a pink overgrowth on the membrane filter plates. This pink overgrowth was identified as *E. cloacae*, which caused erroneous fecal coliform and *E. coli* results. The occurrence of this phenomenon was repeated by national experts from U.S. EPA's Briedenbach research laboratory. They concluded that the pink colony overgrowth problem could be reduced or eliminated with proper incubation temperatures.

- Review of Laboratory Bench Sheets – Review of laboratory bench sheets, which show the bacteria counts for each of the individual sample dilutions, can assist in identifying lab problems.

- Blanks – Field and method blanks add substantial analytical costs to a survey but are critical in proving that the data are valid or to identify problems. This is important to all types of analyses, but even more so for bacteria analyses which tend to have a lesser degree of accuracy and precision.

8.0 SPECIAL STUDIES

8.1 COLILERT® VERSUS MEMBRANE FILTRATION

8.1.1 STUDY OBJECTIVE

The objective of this portion of the study was to provide a comparison of *E. coli* data collected through analysis by the Colilert method to the more traditional membrane filtration method. At the time this study was conducted, Colilert analysis was approved for drinking water, but not for wastewater applications.

8.1.2 INTRODUCTION

In 1986, the US EPA released a study evaluating the effectiveness of fecal coliforms, *E. coli* and entertococcus bacteria as indicators of water quality. In that report, US EPA characterized fecal coliforms as poor indicators of water quality. Indicator bacteria are not necessarily pathogenic, but they are found abundantly in human wastes, where other pathogenic organisms may exist. Bacterial indicators are used in preference to direct measurement for pathogens because bacteria indicator measurements are less expensive, more reliable and correlate well with the incidence of illness in contact recreation bathers. Indicator bacteria have historically been measured using either membrane filtration or multiple tube fermentation, though chromogenic substrate methods have recently been gaining popularity. Chromogenic substrate methods, such as Colilert, have not yet been approved as standard methods for analysis of wastewaters by the USEPA nor by the Standard Methods Committee. These different methods are based upon measuring different products of bacterial growth. Membrane filtration enumerates bacterial colonies on a specific growth substrate. Chromogenic methods measure the ability of organisms to metabolize a specific labeled substrate, thereby producing color and/or fluorescing. These differences in analytical endpoint provide the potential for differing results among methods. The variation is expected to be greater for membrane filtration than Colilert because of the physical interference at the membrane surface, and somewhat subjective nature of visual colony enumeration and combined interference from confluent and competing growth. The Colilert method is not subject to the numerous interferences associated with membrane filtration and, thus, the results are more reproducible.

A simple comparison of the Colilert method and the membrane filtration method indicates several advantages. For membrane filtration by Standard Method 9213D, it is necessary to sterilize the equipment by either autoclave or ultraviolet light, filter the samples, incubate the samples at 35 degrees Celsius for two hours then incubate for another 22 hours at 44.5 degrees Celsius, transfer the sample to a prepared urea substrate, then wait 15 minutes before visually identifying and counting the colonies under a microscope. For the Colilert method, a pre-made reagent is added to the water sample before sealing in a pre-sterilized tray for a single incubation step of 24 hours at 35 degrees Celsius, then the number of positive wells are counted and the bacteria density is read from a chart. The advantages of Colilert over membrane filtration include: no media preparation, no dilutions for counts less than 2,419 CFU/100 mL, no

glassware, no pipeting, a single incubation step, no colony counting, no subjectivity due to overlapping or atypical growth, no confluent growth, and heterotrophic interferences are minimized. The Colilert method can suppress heterotrophic bacteria up to 2 million CFU/100 mL.

The use of the Colilert method has become increasingly popular in the past few years because it is less expensive and requires less formal training than historically used methods. The use of Colilert requires minimal space and equipment, making it ideal for agencies without microbiology laboratories. However, these advantages are of little value if the results produced by Colilert are not comparable to those from the more traditional methods. IDEXX, the maker of Colilert, reports a correlation of 0.905 between Colilert and membrane filtration for total coliforms and *E. coli*.

8.1.3 METHOD

During this study, water samples were collected from all Ohio River and tributary sampling sites for *E. coli* analysis by the Colilert method. The Colilert method was chosen as the primary technique for *E. coli* analysis due to the limited hands-on time and minimal space and equipment required to process the samples. These three factors allowed the laboratory to process a much larger sample volume than could otherwise be handled by the membrane filtration method.

Ohio River and tributary samples collected on the Kentucky side were collected in duplicate and analyzed for fecal coliform, due to the large volume of historical fecal coliform data and permit limits on Kentucky permits. Ten percent of the total water samples were also collected in duplicate for additional *E. coli* analysis by the membrane filtration method for comparison with the Colilert data.

To analyze a water sample by the Colilert method, the pre-measured Colilert reagent powder was first added to a 100-mL water sample. For undiluted samples, the Colilert reagent powder was added directly to the sample container. For samples that required dilution, the Colilert reagent powder was added to a sterile, non-fluorescent container with the diluted sample. The water sample was capped and shaken until the reagent was dissolved. The sample reagent mixture was poured into a pre-sterilized Quanti-Tray® and sealed with the Quanti-Tray sealer. The sealer evenly distributed the sample volume into the individual wells of the tray. The trays were then incubated for 24 hours at 35 degrees Celsius. After incubation, a comparator was used to compare the color of each well on the tray. If the well changed from colorless to a yellow color equal to or greater than the comparator, then the presence of total coliforms was confirmed and the well was counted as positive. If the color of a well was not uniform or if it was lighter than the comparator, it was incubated an additional four hours for a maximum of 28 hours total incubation time. If the well was total coliform positive, the yellow intensified to the shade of the comparator. If it did not intensify, the well was counted as negative. The total coliform positive wells were checked for fluorescence by placing the tray under a 365-nm ultraviolet light in a dark environment. If the fluorescence was equal to or greater than the fluorescence of the comparator, the presence of *E. coli* was confirmed and the well was counted as positive. The Most Probable Number (MPN) table provided with the Quanti-Tray relates the number of positive wells to a statistical estimate of the bacteria density based on probability formulas. The

laboratory analyst determined the MPN of total coliforms through counting the yellow wells and the MPN of *E. coli* through counting the yellow wells that also fluoresced.

8.1.4 RESULTS

Side-by-side Colilert and membrane filtration samples were collected during surveys conducted from 1997 through 2000. The 2001 surveys did not include Colilert analysis because of scheduling conflicts with the Louisville MSD laboratory, which had conducted the Colilert analyses for the previous surveys in addition to the fecal coliform analysis. During 2001, MSD's laboratory scheduled several large projects necessary to meet NPDES requirements. These large projects made the laboratory intermittently unavailable for the large volume of bacteria samples collected as part of a wet weather survey. Due to the unpredictable nature of conducting a wet weather survey, alternate arrangements were made for Cardinal Laboratories to conduct all of the laboratory analyses. Cardinal did not have the equipment, the capacity or the manpower to conduct Colilert analysis in addition to all of the other analytical work.

Linear regressions of the Colilert data versus the membrane filtration data indicated that the data collected by these methods in 1997 were not comparable. Most of the samples indicated levels of bacteria less than 20 CFU/100 mL. Samples with higher membrane filtration bacteria levels were not consistent with Colilert levels that were sometimes higher and sometimes lower than the membrane filtration levels. Tributary samples showed the worst correlation with Colilert levels consistently lower than the membrane filtration levels. Since 1997 was the first year that surveys were conducted, the source of error could have been from either of the laboratories or from the sample collection. Linear regressions of the 1998 data indicated an R-square value of 0.954, where 1.0 indicates perfect correlation. No statistical analyses were performed on the 1999 dry weather survey data because only a few data points were collected. Linear regressions of the 2000 data indicated an R-square value of 0.932. These R-square values are higher than the 0.905 value reported by the manufacturers of Colilert.

These results were also subjected to Pearson linear regression analyses using Microsoft Excel's statistical capabilities. Pearson's coefficient is a measure of the degree of linear relationship between two variables measured from the same individual and ranges from –1.00 to +1.00, where +1.00 indicates a perfectly positive relationship. The Pearson linear correlation coefficient was 0.919, showing a strong linear correlation between the two methods. The significance of Pearson's coefficient can be determined using a standard F Test for sample variance. The F value for these data was lower than the $F_{critical}$ value read from a statistical table, therefore, the F Test indicates no statistically significant difference between the two methods.

8.1.5 CONCLUSIONS

The Colilert method proved to be invaluable to this study. The minimal hands-on time, equipment and space required to analyze water samples by the Colilert method made it possible to process a large volume of bacteria samples during the course of a wet weather survey. The reduced cost of the Colilert method also made it possible to analyze more samples than could have otherwise been afforded by the project.

Chromogenic substrate detection methods, such as Colilert, have not yet been approved as standard methods for wastewater by the US EPA or by the Standard Methods Committee. This study found that there is no significant difference between results obtained by Colilert and those obtained using approved standard methods.

9.0 WATER QUALITY MODEL APPLICATION

9.1 SUMMARY

The goal of this project was to evaluate whether the modeling framework developed for Cincinnati could be successfully transferred to another large river area with urban communities that face similar issues as the Cincinnati area. As the results presented in this chapter illustrate, the modeling framework was successfully adapted and applied in the Louisville metropolitan area. The Ohio River water quality model developed for the Louisville metropolitan area (described in Chapter 5) indicates that loads originating from combined sewer overflows (CSOs) and other urban wet weather sources contribute to increased bacteria concentrations in the Ohio River.

This chapter describes the application of the Ohio River water quality model over a year with typical hydrometeorological conditions (i.e. a "typical" year) for several screening-level CSO and tributary reduction scenarios. By applying the model to a variety of storm and environmental conditions, it may be possible to assess the extent to which CSOs and other wet weather sources impact water quality. For example, model simulations that incorporate a measure of CSO control (reduction in CSO volume or bacteria concentration) are an efficient way to evaluate the effectiveness of the controls in reducing the impacts on water quality in the receiving waters.

The year spanning December 2000 through November 2001 was selected for use as the "typical" year. The landside, collection system and water quality models were applied for conditions encountered over this year. Hypothetical source reduction scenarios evaluated in this application include:

- No reduction (current conditions);
- 50% CSO reduction;
- 75% CSO reduction;
- Individual CSO-specific reduction;
- 100% CSO reduction; and,
- 100% tributary (e.g. storm water) reduction.

The effects of each community's CSOs on the Ohio River's water quality were isolated by running several of the reduction scenarios with only that community's CSOs activated (at whatever control level specified) in the model. Results were compared to applicable water quality standards.

This application of the model was intended as a simple demonstration of how the modeling tools developed in this project could be used for CSO and storm water planning. Major findings from the application include:

1. **Storm water (and other nonpoint runoff) is the primary cause of violations of water quality standards in the Ohio River.** Storm water sources are responsible for 2-5 times greater spatial extent of violations than CSOs. The overall importance of storm water is magnified when it is considered that a large percentage of the bacterial load from CSOs

2. **CSOs are relatively more important when considering peak concentrations after a storm.** Combined sewer overflows account for approximately half of the peak concentrations observed in the Ohio River after a wet weather event.

3. **The most reasonably achieved CSO controls will provide very little benefit in terms of reducing the frequency of water quality standard violation, but will provide a noticeable benefit in reducing peak concentrations.** This conclusion follows directly from the two preceding conclusions.

Since one goal of this demonstration project was to provide a tool for the communities to use in their CSO planning, neither the load reduction scenarios nor the analyses presented in this chapter are intended to be comprehensive. Additional application or analyses, beyond the scope of this project, can be undertaken by the project stakeholders in the future. For example, ORSANCO and Ohio River communities are currently evaluating approaches for defining wet weather water quality standards. The tools developed in this demonstration project can be used for this purpose and so comparisons to alternative criteria are presented as examples of the utility and versatility of these modeling tools.

9.2 INTRODUCTION

Section 9.3 describes the model application approach, including "typical" year, the reduction scenarios and updates to the model. Section 9.4 describes the water quality model inputs, including boundary concentrations and flows, environmental conditions and landside (external) loadings from CSO and other sources. Results from the water quality model are presented in Section 9.5. Section 9.6 presents conclusions and Section 9.7 presents recommendations for further study. Due to their large number, all figures and tables are provided at the end of this chapter.

9.3 MODEL APPLICATION APPROACH

The approach for applying the Ohio River model developed for the Louisville area was to identify a 12-month period with "average" conditions, identify source reduction scenarios and to incorporate updates to the model to facilitate its use for this application. Each of these components is described in this section.

9.3.1 "TYPICAL" YEAR

This section presents information regarding the development and rationale for selecting a "typical" year.

Regulatory Basis for Simulating a "Typical" Year

The urban drainage, sewers, and the nearby receiving waters in the Louisville, Kentucky metropolitan area comprise a complex interrelated system. Several highly variable natural forces, primarily rainfall and river flows profoundly influence this system. Rainfall over the study area, when it occurs in sufficient amount, generates urban storm water, CSO, and increased treated wastewater flow. These events can all contribute bacteria and pollutants to the Ohio River and nearby tributaries.

The effect of these contributors on the Ohio River mainly depends on the magnitude and duration of rainfall events and on the prevailing ambient river conditions controlling dilution and transport of the pollutants. This variability and complexity poses a significant challenge to accurately assessing the performance of wet weather and CSO control alternatives for each community. Rainfall and river flow can vary over a wide range of values, and therefore the range of possible combinations is impossible to adequately define using a set of "design" or "reference" rainfall and river scenarios (e.g. a six-month design storm).

A design storm approach can result in significant "over-design" of wet weather controls. This is because regulatory and public attention tends to focus on the improbable worst-case combinations without an objective means to put predicted river water quality into proper perspective. When sufficient long-term records are available, continuous simulation avoids these problems by matching rainfall with the actual prevailing river conditions. Therefore, continuous simulation is generally acknowledged as a superior approach for modeling wet weather controls and water quality effects (EPA, 1999).

Simulating a "typical" year with a water quality model offers the following advantages:

- Simulated water quality reflects the range of conditions that typically appear;
- Reduction scenario effectiveness is based on conditions that typically occur and are not distorted by extreme environmental conditions; and
- The "typical" year provides a realistic continuous simulation period for modeling wet weather controls and water quality effects.

For these reasons, a "typical" year is chosen based on analysis of records of flow, rainfall and environmental characteristics in the study area.

Selection of "Typical" Year

The impacts of wet weather sources on receiving water largely depend on four factors:

- **Time of year** - This is important because the recreation season occurs from May through October (when people are most likely exposed to bacteria from body contact).
- **Total amount of rain** - Rainfall characteristics determine the magnitude and duration of the CSO and wet weather source discharges.
- **Maximum rainfall intensity** - This is another rainfall characteristic affecting the magnitude and duration of wet weather source discharges.
- **Upstream flow rate of the receiving waters** - The upstream receiving water flow rate affects the magnitude of the upstream pollutant loads, serves to flush pollutants out of the river and also provides dilution of the landside pollutant loadings.

Four years, 1998-2001, were considered for this application of the model. These years correspond to the period simulated with the landside HSPF model (described in Chapter 3). The rainfall and Ohio River flow during each year was compared to historical rainfall and flow data. Conditions for the year 2001 (actually December 2000 through November 2001) most closely matched the average historical record. Figure 9-1 shows the daily rainfall and flow conditions in the study area.

Rainfall

Rainfall data from 1948-2002 at the National Weather Service (NWS) gage at Standiford Field in Louisville, Kentucky (gage ID 15495400) were analyzed to determine:

1. Number of rainfall events
2. Total rainfall (inches)
3. Average rainfall volume per event (inches)
4. Maximum storm volume (inches)
5. Maximum intensity (inches/hour)
6. Average storm duration (hours)

These annual rainfall characteristics were determined using the Rain algorithm in the USEPA Storm Water Management Model (SWMM). Results of the comparison of historical data to conditions in 2001 are shown in Table 9-1 for all precipitation. Significant rainfall volume (greater than 0.1 inches) is usually needed to exert enough stress on combined collection systems to cause a CSO overflow. Table 9-2 presents the comparison for storm events where the total precipitation volume was greater than or equal to 0.10 inches.

The data were also evaluated for the recreation season, which is defined in the ORSANCO Pollution Control Standards (ORSANCO, 2003) as May through October. Results for all precipitation events are shown in Table 9-1 and for storm events (nominally defined as rainfall greater than 0.1 inches of total rainfall) in Table 9-2.

Conditions during the recreation season in 2001 were wetter than the long-term historical average conditions, as evidenced by the higher number of storm events (44 vs. 35) and total rainfall volume (25.79 inches vs. 20.43 inches). However, the maximum rainfall intensity during 2001 (0.83 in/hr) was smaller than the historical average maximum intensity (1.20 in/hr). This suggests that the rainfall during 2001 was more evenly distributed during each storm than the historical record.

Precipitation conditions in 2001 were comparable to the long-term historical annual averages in terms of number of events, total rainfall volume and average event duration. The maximum intensity observed in 2001 was ten percent smaller than the long-term average (0.83 in/hr vs. 0.92 in/hr). However, because the models rely primarily on rainfall volume and frequency for estimating CSO volume and number of overflows per year (respectively), the maximum intensity metric is less critical for comparison than other rainfall metrics. The frequency distribution of historical storm events and 2001 storm events are presented graphically in Figure 9-2.

Finally, the historical rainfall record was analyzed with the SWMM model to determine characteristic return periods, as shown in Table 9-3. These return periods are a convenient way to characterize individual storms. For example, during the "typical" year, the worst storm event (total rainfall volume = 3.15 inches) corresponds approximately to a 2-year storm frequency (total rainfall volume = 3.09 inches). The worst storm event during the recreation season (total rainfall volume = 2.03 inches during May 7-10, 2001) corresponds to approximately a 6-month storm (total rainfall volume = 2.10 inches). Individual storm events (total rainfall > 0.1 inches) for the "typical" year are provided in Appendix J.

Flows

The USGS has maintained a gage near McAlpine Dam since the 1920s (USGS Gage #03294500). Average daily flow records from 1948-2002 were evaluated to determine how well the flow characteristics from the "typical" year compare to the long-term record. Both annual and recreation season periods were evaluated. Figure 9-3 shows the frequency distribution of the "typical" year and historical flows for annual and recreation season periods. As this figure shows, on an annual basis, the "typical" year flows tended to be lower than the historical period. The mean flow during the "typical" year was only 49,400 cubic feet per second (cfs) while the mean flow during 1948-2002 was 77,600 cfs.

However, during the recreation season, when bacteria standards are more stringent, the "typical" year flows tended to be very similar to the historical flows. The mean flow during the "typical" year's recreation season (2001) was 42,250 cfs while the historical recreation season mean flow was 42,300 cfs.

9.3.2 REDUCTION SCENARIOS

Ten hypothetical scenarios were examined using the Ohio River water quality model. These scenarios are presented in Table 9-4. The scenarios are screening-level analyses that show the impact of five broad levels of source reduction. The source and reduction levels examined with these scenarios are:

1. **No reduction (Base or current conditions).** This scenario represents the current discharges from the combined sewer systems, tributary loads and treated wastewater discharges.

2. **50% CSO reduction.**

3. **75% CSO reduction.**

4. **Individual CSO-specific reduction.** The "reduction" scenarios (50%, 75%, 100%, and individual %) represent hypothetical situations where all CSO discharges have been treated or eliminated to the degree specified, and other contributors (upstream, tributary) remain unchanged from the "baseline" scenario.

5. **100% CSO reduction.** Two 100% CSO reduction scenarios were run with the model. In the first of these scenarios, the CSO bacteria loads were completely eliminated, which would illustrate the maximum theoretical benefit from CSO reduction. In the second 100% CSO reduction scenario, only the sanitary component of the CSO bacteria load was removed while the storm water component of the CSO load was input to the Ohio River water quality model. This scenario illustrates a more realistic reduction strategy that approximates the effects of sewer separation.

6. **100% tributary (e.g. storm water) reduction.** This scenario was run by completely eliminating bacteria loads from tributaries and keeping all other sources (including CSOs) active at current levels. This scenario would illustrate the maximum benefit from non-CSO wet weather source reduction (e.g. urban storm water, nonpoint source runoff).

Several scenarios at each reduction level were conducted so that the effects from individual source types could be isolated. For example, as shown in Table 9-4, two scenarios were conducted using the 50% reduction level, one with only the Louisville CSOs active and reduced 50% and one scenario with only the Jeffersonville CSOs active and reduced 50%. This approach allows the communities to approximate the spatial and temporal extent of their CSO discharges on the Ohio River water quality. More detailed simulations that consider sewer system design and operation could be completed for each sewer district as a tool in developing a long-term control plan.

9.3.3 MODEL UPDATES

Although the physical representation of the river and the bacteria kinetic rates were not changed in the model, other updates were made to the model inputs and to the model itself. These updates are described in the following subsections.

Model Code

Several changes were made to the model's computer code to allow the scenarios to be run and processed more efficiently. These changes included modifying the model code so that results for two bacteria constituents, fecal coliform and *E. coli*, could be generated in a single run.

Approximately 13 million outputs were generated from each model run for fecal coliform and *E. coli*. The model's computer code was also modified so that the results for these constituents were the only results stored in the output file. This change greatly reduced the output file size and allowed the modeling post-processing programs to run more efficiently.

Flow Routings Balance

Flows in the Ohio River over the simulation year ranged from 7,000 cubic feet per second (cfs) to 350,000 cfs. Over this range of flows and duration of simulation (365 days), the model experienced numerical instabilities during its initial run. To rectify the computational instabilities, the flow routings in and out of each model segment were rebalanced and the routing around McAlpine Dam under average flow conditions was used for the entire simulation (see Section 5.3.3.a for details on the McAlpine Dam operations). This simplification increases the uncertainty in the model results under extremely low and high flows, when the dam operations differ from average flow conditions, affecting how water is routed around the dam.

Jeffersonville Collection System Model

When the water quality model was calibrated and validated (described in Section 5.4.2.4), no information was available regarding CSO volume and duration from Jeffersonville's combined collection system. Subsequent to the model calibration, Jeffersonville and its consultants developed a SWMM model of their combined collection system.

CSO volumes were simulated with the collection system model for the calibration and validation events and compared to the CSO volumes used in the water quality model during these events. The collection system model predicted approximately 1/3 of the volume that was used in the calibration and validation. However, because the Jeffersonville CSOs deliver a relatively small bacteria load to the Ohio River (see Figure 5-11), the water quality model calibration and validation did not change appreciably as a result of this update to the model. Therefore, no

change to the model calibration was required. Appendix N presents updated model to data comparisons for two of the calibration and validation events.

Louisville Collection System Model

The combined portion of the Louisville collection system has overflows that discharge to two receiving waters-the Ohio River and Beargrass Creek. The District also has a diversion structure at the Morris Forman WWTP that overflows during some storm events. Two updates were made to the Ohio River model for this application.

First, the main diversion structure at the WWTP was added to the model. This overflow was not included in the model inputs during the model's calibration and validation. Overflow volumes for the scenario year were estimated using a regression between rainfall and volume developed by the Louisville MSD.

Second, the bacteria loads from the Beargrass Creek watershed was simulated with the landside HSPF model described in Chapter 3. The landside model output at the mouth of the creek was used as input to the Ohio River model during the model's calibration and validation. However, for this application, it was necessary to separate the Beargrass Creek load into CSO and non-CSO components so that the CSO reductions to the Louisville system could be properly applied to all of their CSOs.

The volume and flow time series for the Beargrass Creek CSOs were estimated using relationships between rainfall volume and duration. These flows were lagged one to three hours and subtracted from the flow predicted by the landside model at the mouth of the creek. The CSO flows were lagged to account for the travel time between the CSO overflow points and the mouth of the creek. To separate the CSO and non-CSO components of the concentration at the mouth, a ratio of the CSO concentration to the non-CSO concentration was estimated using best professional judgment and set to a value of 10. The concentration time series from the landside model was then separated into CSO and non-CSO components. Using this assumption, the CSO concentration was approximately equal to the summer average concentration of the CSO data collected by MSD. New CSO and non-CSO loading time series were computed and input to the model as separate sources.

9.4 WATER QUALITY MODEL INPUTS

The scenarios presented in this chapter were simulated with the same water quality model used for the calibration and validation events (described in Chapter 5). Boundary conditions, source loads (e.g. CSO, tributary, wastewater treatment plants), and environmental conditions were expanded to include an entire year. The physical representation of the river system and environmental kinetic rates were not changed. Both fecal coliform and *E. coli* were simulated in this application of the model. This section of this chapter presents updates to the model and the development of the model inputs.

9.4.1 UPSTREAM FLOW AND BOUNDARY CONCENTRATIONS

This section describes how the inputs at the model's upstream boundary were developed for the "typical" year.

Upstream Flow

The records for the USGS gage in Louisville (gage #03294500) provided a daily average flow for each day in the simulation year. The data from this gage were interpolated to develop an hourly time series of flow over the simulation year.

However, this gage is located near river mile 607, which is 17 miles within the model domain. Thus, it was necessary to adjust the gage flow to account for additional inflow between the model's upstream boundary and the gage. An hourly flow time series at the model's upstream boundary was calculated by subtracting all of the external flows (tributary, CSO and WWTP) entering the Ohio River between the model boundary and the gage from the flow at the gage.

Upstream Concentrations

In this model application, representative concentrations at the upstream and downstream boundary were selected using available data collected by ORSANCO for this project (described in Chapter 2).

The data were evaluated for relationships between concentration and precipitation condition, flow, temperature and season so that, if possible, a concentration time series that represents the range of concentrations at the boundary could be developed. However, the only correlation that could be identified from the data was between upstream fecal coliform concentration and flow, as shown in Figure 9-4. At flows greater than 100,000 cfs, the average fecal coliform concentration increases from ~10 cfu/100 ml to 360 cfu/100 ml. The average upstream *E. coli* concentration was 5 cfu/100 ml. Averages of the available data at the downstream boundary were used in the model. The fecal coliform concentration was 385 cfu/100 ml and the E. coli concentration was 500 cfu/100 ml. The boundary concentrations are also presented in Table 9-5.

9.4.2 LANDSIDE FLOW AND LOADS

Other flow and load sources to the Ohio River besides the upstream Ohio River include tributaries to the Ohio River within the model domain, combined sewer overflows, and the waste water treatment plants that discharge directly to the Ohio River.

Flows from external sources are a function of rainfall intensity and duration. Rainfall data from 31 rain gages in the area were used to estimate tributary flow and CSO volumes and durations (see Chapter 3 for more details). Depending how uniformly a rain event was distributed over the study area, the relative contribution of volume (and load) from a particular source (e.g. 'Tributary-x' or 'CSO-y') could change significantly from event to event.

The annual flow distribution by these source types is shown in Figure 9-5. As shown in this figure, the flow entering the study area from upstream is the dominant source of water flowing through the model over the entire simulation year. However, on a daily or even hourly basis, the tributaries, CSOs and WWTPs can account for up to 35% of the flow input to the model.

The bacteria loads from external sources were calculated as the product of flow and concentration, as described in the following subsections. For each of the control scenarios, both the flow and load were scaled appropriately to achieve the percent reduction desired for the

scenario. Table 9-6 provides a summary of how each source was scaled in each of the control alternative scenarios.

Tributary

There are numerous tributaries that enter the Ohio River between river mile 590, the start of the water quality model, and river mile 635, the end of the water quality model. Flow in the tributaries may include urban storm water, CSOs, SSOs, point sources such as WWTPs, and/or nonpoint surface runoff.

As described in Chapter 3, some of the tributary subwatersheds were aggregated in the landside model. The hourly flow time series predicted by the landside HSPF model for each of the subwatersheds were used as flow inputs to the Ohio River model. Bacteria loading time series for the water quality model were estimated by combining the hourly flow and concentration from the landside model. This method was described in detail in Section 5.4.2.4.

CSOs

Individual Louisville CSO volumes were estimated using relationships between rainfall and overflow volume developed by Louisville MSD in earlier work. The equations describing these relationships were provided in Table 5-10 and were used to estimate the total volume for each event. An hourly flow time series for each CSO was generated by evenly distributing the total event volume across the hours of rainfall for each event. These time series were used as input to the Ohio River model.

The flows from the Jeffersonville CSOs were updated for the control scenarios using the output from the new Jeffersonville collection system model. Individual CSO volumes were estimated using a SWMM model of the Jeffersonville combined collection system. The City's consultants used rainfall data from the two most nearby gages in the study area's rain gage network for the simulation year as input to their collection system model to generate the CSO volumes and overflow durations used in the Ohio River model.

Bacteria loadings for both communities' CSOs were estimated using the event mean concentrations (EMC) developed from the available data (see Section 5.4.2.4). The EMC was 650,000 cfu/100 ml for fecal coliform and 400,000 cfu/100 ml for *E. coli*. Loads for each parameter were estimated as the product of the flow and the EMC. Separate time series for the model were developed for fecal coliform and *E. coli* loads.

WWTPs

Average daily or monthly flow data over the "typical" year period from each WWTP facility were input to the water quality model at a daily frequency.

Daily fecal coliform loading time series were developed for the two Louisville WWTP facilities using the average flow and concentration data reported by each facility. *E. coli* loads were estimated from the fecal coliform data using the assumption that *E. coli* constitutes approximately 60% of the fecal coliform concentration.

No bacteria data is reported by the Indiana WWTP facilities. Since the Louisville MSD's West County WWTP facility is sized most closely to the Indiana facilities, the daily concentration data

for West County was used for the Indiana facilities to generate fecal coliform and *E. coli* daily loading time series inputs for the Ohio River model.

Load Analysis

The annual load distribution by source type for fecal coliform and *E. coli* are shown in Figure 9-6 and Figure 9-7, respectively, for current conditions (Base case-scenario 10). Although upstream flow dominates the volume of water entering the study area (as shown in Figure 9-5), elevated fecal coliform and *E. coli* concentrations in the river are largely the result of the tributaries draining to the river. Both Indiana and Kentucky tributaries contribute approximately 40% of the total load to the river over the "typical" year. As stated above, these tributaries contain loadings from a variety of sources, including nonpoint source runoff, sanitary sewer overflows, and urban storm water.

Beargrass Creek and Cane Run are the only tributaries that receive CSO discharges. As described in Section 9.3.3, the Beargrass Creek flows and loads were separated into CSO and non-CSO components. Cane Run receives overflow from Jeffersonville's 10th Street Pump Station. However, this overflow was not simulated within the landside model's subwatershed for Cane Run and so the load from this CSO was input to the water quality model directly at the Cane Run confluence with the Ohio River. CSO loadings to the tributaries were not included in the tributary category but rather in the CSO categories. As these figures illustrate, Louisville CSOs (overflowing to both the Ohio River and Beargrass Creek) comprise approximately 15% of the total load. The contribution from the Jeffersonville CSOs (overflowing to both the Ohio River and Cane Run), the WWTPs and upstream sources contribute a very small portion of the annual load (~5%).

It is important to note that Figures 9-5, 9-6 and 9-7 are annualized summaries of the model inputs. There were 71 storm events (rainfall > 0.1") during the "typical" year. Because flows and loads from the tributaries and CSOs are based on data from a network of rainfall gages, relative loadings by individual source type can vary significantly from event to event. Examples and additional discussion are provided in Section 9.5.4.

9.4.3 ENVIRONMENTAL CONDITIONS

Water temperature was the only environmental condition needed as input to the water quality model because bacteria die-off rates are temperature dependent. The monthly average water temperatures from the Ohio River Fact Book, published by ORSANCO, were used for the Ohio River. This monthly average is based on data collected from 1961-1986.

The temperature time series is shown in Table 9-7. The average monthly temperature was input to the model at the midpoint of the month. The model interpolated temperatures between the average values for the remaining days of the simulation.

9.5 MODEL APPLICATION RESULTS

Ten screening-level simulations of the "typical" year were conducted using the WASP water quality model. Each simulation represented a different level of source reduction, which was simulated in the model by reducing the source flow and loads to the appropriate percentage.

The key results from the "typical" year modeling are summarized below:

- Of the existing expressions of water quality standards for bacteria, the single sample maximum criterion is a more stringent water quality standard than the 30-day geometric mean standard. This is because more frequent exceedances of the maximum criterion were observed than for the geometric mean criterion.
- In the months when the fecal coliform geometric mean criterion is not met, exceedances in 40-50 percent of area of the Ohio River in the modeling domain are due to tributary (e.g. storm water) sources while CSOs account for exceedances in 10-20 percent of the area of the river (note: these areas affected by each source type overlap).
- Reducing CSO loads does not appreciably improve the area of the river complying with the geometric mean criteria for fecal coliform and *E. coli*.
- Exceedances along the Indiana bank of the Ohio River are driven by loads originating from Indiana while exceedances along the Kentucky bank are driven by loads originating from Kentucky. Exceedances in the center channel are primarily driven by loads originating from Kentucky.
- 10-30 percent of the days during the recreation season (184 days total) exceed the single sample maximum criteria because of tributary sources. An additional 5-10 percent of the days during the recreation season exceed the criteria because of CSO sources.
- Controlling/reducing CSO or tributary sources alone does not provide as much potential benefit as targeting reductions in both sources. If CSOs are eliminated, tributary (e.g. storm water) sources will continue to cause exceedances of the single sample maximum water quality standard. If tributary (e.g. storm water) sources are eliminated, CSOs will continue to cause exceedances of the single sample maximum water quality standard. This suggests that sewer separation in and of itself would not be a very effective solution for addressing CSO overflows.
- The most realistic CSO reduction alternative will have very little benefit in reducing the frequency of days that exceed the single sample maximum water quality standard. However, this alternative does have a noticeable benefit in reducing peak in-stream concentrations.
- The absolute magnitude of the frequency of exceedance of the single sample maximum water quality standard depends on the type of comparison made. For example, restricting the water quality standard comparison to only the model results corresponding to the daylight hours changes the maximum percent exceedance from 60 percent to 40 percent.
- CSOs have a big influence on peak concentrations during a wet weather event, accounting for approximately 50% of the concentration on the Kentucky side of the river and 40% in the center channel. The influence on the Indiana side is difficult to discern because of the larger influence of a tributary source (Silver Creek) just downstream of Jeffersonville's CSOs.

Section 9.5.1 provides an explanation of the approach used to evaluate the model output. More detailed results of the comparison to water quality standards are presented in Section 9.5.2. Since this is a demonstration project having a goal of providing a tool for the communities to use in their CSO planning, neither the load reduction scenarios nor the analyses presented in this section are intended to be comprehensive. Examples of additional analyses that could be conducted with the model results are provided in Section 9.5.3. Concentration profiles for a select event within the recreation season of the simulation year are presented in Section 9.5.4.

Section 9.5.5 presents examples of additional analyses that can be done using the model results. Model results are available in the Appendices K-M.

9.5.1 EVALUATION APPROACH

Hourly bacteria concentrations simulated with the model in each segment were stored in an output file. Approximately 13 million model outputs were generated with each model run. The large amount of output from the model required some simplification and filtering so that the analyses of the results on an annual basis could be conducted.

Project-specific post-processors and databases were developed to manage the model output. These post-processing programs calculated the daily minimum, maximum and average concentrations in each segment, the monthly geometric mean concentration in each segment, and extracted the hourly results in each segment during the most severe recreation season storm. These results were stored in an Access database and processed further to produce the tables and graphs presented in this section.

Results from the modeling are presented graphically in four groups where each group contains a subset of the scenarios. This was done so the results from similar scenarios (e.g. all of the Jeffersonville only scenarios) could be easily evaluated together. The group descriptions and corresponding scenario subsets are (see Table 9-4 for descriptions of the scenarios):

1. **CSO Reduction Grouping**. This group includes scenarios 1 (100% CSO elimination) and 10 (current conditions). This grouping simply presents the maximum theoretical benefit of CSO control.

2. **Source Control Grouping.** This group includes scenarios 1, 2 (CSO specific reduction), 7 (100% tributary elimination), and 10. This grouping allows the user to diagnose what sources (CSO vs. tributary (e.g. storm water)) are contributing to the water quality in the Ohio River.

3. **Jeffersonville CSO Control Grouping**. This group includes scenarios 1, 2, 3, 5, 8, and 10. This grouping allows the user to track load contribution and the resulting benefits to water quality in the Ohio River from Jeffersonville's incremental CSO reduction.

4. **Louisville CSO Control Grouping**. This group includes scenarios 1, 2, 4, 6, 9 and 10. This grouping allows the user to track the load contribution and the resulting benefits to water quality in the Ohio River from Louisville's incremental CSO reduction.

The active sources and level of reduction in each scenario were presented in Table 9-6. The scenario groupings are summarized in Table 9-8.

The approach used to evaluate the model results for the ten scenarios consisted of four steps.

1. Compare the predicted concentrations in each model segment to applicable Ohio River water quality standards (see Section 9.5.2).

2. Compare the model results in each segment to alternative water quality standards (see Section 9.5.3).

3. Determine the effectiveness of reduction scenarios in reducing peak concentrations and durations of high concentrations for a large storm event (see Section 9.5.4).

4. Consider additional approaches for analyzing model results that are more spatially or temporally refined (see Section 9.5.5).

9.5.2 COMPARISON TO CRITERIA

The Ohio River is subject to fecal coliform water quality standards over the entire year, though the magnitude of the numeric limit changes, depending on the season. *E. coli* water quality standards are applicable only during the recreation season. ORSANCO has published the following bacteria Pollution Control Standards for the Ohio River (ORSANCO, 2003):

> *To provide protection to human health, the following criteria shall be met outside the mixing zone:*
>
> > *1a. Maximum allowable level of fecal coliform bacteria for use as a source of public water supply—for the months of November through April, content shall not exceed 2,000/100 ml as a monthly geometric mean based on not less than five samples per month.*
> >
> > *1b. Maximum allowable level of fecal coliform bacteria for contact recreation—for the months of May through October, content shall not exceed 200/100 ml as a monthly geometric mean based on not less than five samples per month; nor exceed 400/100 ml in more than 10 percent of all samples taken during the month.*
> >
> > *1c. Maximum allowable level of Escherichia coli bacteria for contact recreation—for the months of May through October, measurements of Escherichia coli bacteria may be substituted for fecal coliform. Content shall not exceed 130/100 ml as a monthly geometric mean, based on not less than five samples per month, nor exceed 240/100 ml in any sample.*

The states of Indiana and Kentucky have also developed bacteria water quality standards for waters in their respective states. Indiana uses *E. coli* as its indicator species (monthly geometric mean concentration $\leq$ 125 cfu/100 ml and single sample maximum concentration $\leq$ 235 cfu/100 ml). Kentucky uses fecal coliform rather than *E. coli* (monthly geometric mean concentration $\leq$ 200 cfu/100 ml and single sample maximum concentration $\leq$ 400 cfu/100 ml).

This section presents a comparison of the model results to the ORSANCO criteria for the Ohio River.

Loading Analysis

Annual fecal coliform and *E. coli* loads for the various levels of control considered in the reduction scenarios are shown in Figure 9-8 and Figure 9-9, respectively. Since tributaries are

the largest source of bacteria loadings to the river, reducing the CSO load does not significantly change the total load to the river. However, in the scenario where the tributary sources were turned off, the total loading to the Ohio River was reduced by 75% of the base (current) condition. The point sources (WWTPs), Indiana CSOs and upstream were very small (<5%) contributors to the overall bacteria load to the Ohio River.

Comparison to 30-day Geometric Mean Water Quality Standard

To compare the model results to ORSANCO's monthly geometric mean water quality standards, the hourly output for each model segment was averaged to determine a daily concentration. The geometric mean for each month of the simulation period was calculated for each model segment from the daily average concentration. The calculated geometric mean concentration in each segment was compared to the appropriate standards. The areas of the segments that violated the standard were summed, then normalized to the total area of the modeled portion of the river to compute a percent area of violations. Whereas typical compliance is evaluated on the basis of five samples collected over a month-long time period, the model results are evaluated on the basis of a daily concentration for day within the month.

Results for fecal coliform are shown in Table 9-9 for each scenario. Although there are applicable criteria for fecal coliform for every month of the year, the only months where exceedances occurred were in May and October, when the criterion is 200 cfu/100 ml. The exceedances in May are likely due to the large number of wet weather events that month (5 inches of rainfall over 8 events). The exceedances in October are also likely due to precipitation volume (6 inches of rainfall over 7 events) and because the river flow was very low so the river's capacity to dilute the landside loadings was diminished compared to the rest of the recreation season when the flows tended to be higher (see Figure 9-1).

Exceedances occurred in all scenarios for these months, although the area of the river that exceeded varied from scenario to scenario. As expected, the "Base" scenario (#10) had the largest area of the river that exceeded the criterion. The "No Tribs" scenario (#7) had the smallest area of the river exceeding the criterion, which was approximately half of the impaired area of the other scenarios (a quarter of the total river area). This result suggests that removing storm water (e.g. tributaries) is more effective at improving water quality than removing CSOs. In fact, very little improvement in the area of the river exceeding the geometric mean occurred even when the CSOs were eliminated entirely.

Results for *E. coli* are shown in Table 9-10 for each scenario. *E. coli* geometric mean criteria are applicable during only the recreation season. During this period, the only month with exceedances of the criterion, 130 cfu/100 ml, was October. In general, a much smaller area was impacted for *E. coli* than for fecal coliform. This may be because the landside tributary loads are not linearly scaled between fecal coliform and *E. coli* or because the *E. coli* upstream boundary concentration was much smaller than the fecal coliform concentration so the Ohio River had more assimilative capacity for *E. coli* than for fecal coliform. The *E. coli* comparison results are consistent with the findings from the fecal coliform comparison in that removing the storm water is more effective (0% of area exceeding geometric mean standard) at improving compliance with the water quality standard than removing CSO (3% of area exceeding criterion).

Comparison to Single Sample Maximum Water Quality Standard

To compare the model results to ORSANCO's single sample maximum water quality standards, the daily maximum concentration in each segment was compared to the appropriate criterion (400 cfu/100 for fecal coliform, 240 cfu/100 ml for *E. coli*). For both fecal coliform and *E. coli*, the single sample maximum criterion applies only to the recreation season (May-October), which has 184 days. If the maximum concentration was greater than the criterion, then that day was counted as a day of exceedance. The percent of time the standard was exceeded in each segment was calculated as the total number of days of exceedance divided by the total number of days that the criterion is applicable (184 days). This approach is designed to provide the most conservative comparison of the model results to the water quality standards.

Results are presented by the scenario groups for the bank and center channel segments in Figures 9-10 through 9-13 for fecal coliform and Figures 9-14 through 9-17 for *E. coli*. As Figure 9-10 illustrates, complete elimination of CSO sources will, at most, reduce the frequency of exceedance from 60% to 40% along the Kentucky shoreline near river mile 615. In other sections of the river (upstream to downstream, across the channel), the benefit is much smaller (less than 10%).

The results in Figure 9-11 suggest that, using the center channel graph, that tributary (e.g. storm water) loads cause 25-35 percent of the recreation season days to exceed the water quality standard (illustrated by scenario 1 results). An additional 5-10 percent of the recreation season days exceed the water quality standard downstream of the metropolitan area (river mile 620) because of CSO source loads (illustrated by scenario 7 results). Even in the vicinity of the CSO outfalls (river miles 602-615), eliminating tributary (e.g. storm water) sources is more effective at decreasing the number of days that the water quality standard is exceeded (scenario 7 results) in the center channel and right (Indiana) bank than eliminating CSO sources (scenario 1 results). Along the left (Kentucky) bank, eliminating CSO sources is more effective at improving water quality than eliminating tributary sources is. However, the most realistic CSO control scenario (scenario 2) shows very little improvement in reducing the frequency of water quality standard violations compared to the current condition (scenario 10).

The results in Figure 9-12 and Figure 9-13 show the effect of each community's CSO source loads on water quality across the Ohio River. These figures illustrate that the Ohio River water quality along the left (KY) bank is driven by the loads originating from Kentucky. Likewise, water quality on the right (IN) bank are driven by loads originating in Indiana. The benefits of CSO reduction are most apparent along the river bank of the community reducing their load. The effects of either community's CSO reductions on the opposite side of the river are very small, to the point of being nearly superimposed on the results from the 100% reduction scenario.

There is a greater difference in the days of exceedance between the 75% and 100% reduction scenarios than between the 50% and 75% reduction scenarios in the near shore segments (for example, see the left bank fecal coliform results between river mile 612 and 617 for scenario group 4). This is likely because the water quality standard is so much lower than the typical CSO concentration (400 cfu/100 ml vs. 650,000 cfu/100 ml) that complete elimination of the CSOs are required before significant differences (improvements) in water quality can be observed in the model results.

Similar conclusions are reached from the results for *E. coli*, shown in Figures 9-14 through 9-17, although the percent of days exceeded differs from the corresponding fecal coliform scenario results.

9.5.3 COMPARISON TO ALTERNATIVE WATER QUALITY STANDARDS

There are three reasons for conducting alternative comparisons of the model results to water quality standards:

1. The results presented in Section 9.5.2 represent the most conservative comparison of the model to the water quality standards. Using a less conservative analysis will change the absolute magnitude of the frequency of exceedance (how much?) and may provide additional insight into the effectiveness of CSO control;

2. USEPA Region V has suggested data displays for LTCP alternatives that include comparisons to higher bacterial benchmarks, such as five times the water quality standard (LTCP meeting between USEPA Region V and South Bend, 1/23/03);

3. ORSANCO and communities along the Ohio River are currently investigating wet weather water quality standards. In addition, communities may have reasons in the future to conduct a Use Attainability Analysis in their portion of the Ohio River. The model comparisons presented in this section demonstrate the versatility of the modeling tools and their potential application for these types of projects.

To address the first reason, the same analysis presented in Section 9.5.2. were conducted using the daily average concentration from the model rather than the daily maximum concentration. To address the second reason, the same analysis presented in Section 9.5.2 was conducted using a criterion of five times the water quality standard rather than the water quality standard. For fecal coliform, the daily maximum concentration from the model was compared to a criterion of 2,000 cfu/100 ml (actual water quality standard compared in Section 9.5.2 is 400 cfu/100 ml). For *E. coli*, the daily maximum concentration from the model was compared to a criterion of 1,200 cfu/100 ml (actual water quality standard compared in Section 9.5.2 is 240 cfu/100 ml). This comparison also addresses the third reason cited above. However, an additional comparison was done with the model results where the maximum concentration during the daylight period only (nominally 8:00 a.m. to 9:30 p.m.) was compared to the water quality criterion. Since the water quality standards are intended be protective of primary contact recreation, this comparison is intended to limit the analysis of water quality to portions of the day when primary contact recreation is actually occurring in the river.

A comparison of model results for the base condition (scenario 10) to the various alternatives is presented in Figure 9-18 for fecal coliform and Figure 9-19 for *E. coli*. These figures show that there is a difference in the frequency of exceedance at a given location in the river by 20% (roughly corresponds to 36 additional days), depending on how the comparison is made. For example, restricting the comparison of fecal coliform to daylight hours only in the left bank at river mile 613 changes the frequency of exceedance from 58% to 44%. Using the daily average concentration at this location rather than the daily maximum concentration produces a similar result.

The average frequency of exceedance in the left bank, center channel and right bank are shown for the four approaches in Table 9-11 for fecal coliform and Table 9-12 for *E. coli*. Increasing the criterion for comparison to 5x WQS only reduced the frequency of exceedance by approximately half (e.g. left bank fecal coliform base scenario (#10) frequency of exceedance using WQS = 42% and using 5*WQS = 24%).

9.5.4 CHARACTERISTIC EVENT RESULTS

Water quality in the Ohio River is a function of both rainfall and in-stream conditions (flow and concentration). Rainfall drives the magnitude of landside bacteria loads to the river while the in-stream conditions indicate how these loads are transported and diluted. Running the water quality model for a "typical" year allows a wide range of rainfall and in-stream flow conditions to be simulated and analyzed with the model results. Ideally, the model results for characteristic event periods within the "typical" year (e.g. a dry period, a light storm, an average storm and a heavy storm) could be assessed to evaluate the relationship between environmental conditions and source effects (and their reduction) on water quality in the river.

From event to event within the "typical" year, the relative pollutant load contribution and resulting effect on water quality from each source can vary significantly. This is especially true in this application because rainfall data from a network of gages were used to develop the source loadings. Thus, two events with similar rainfall at a discrete location (e.g. Standiford Field) may paint entirely different pictures regarding source loads. Figure 9-20 is an example. This figure presents a loading distribution analysis for two storm events with similar rainfall (at Standiford Field) and in-stream flow conditions. The total load for each storm differs by almost an entire order of magnitude. Loads for the July event show that Kentucky sources (tributaries and CSOs) account for 98% of the total fecal coliform load. However, loads for the October event show that Indiana sources (tributaries) account for 90% of the total fecal coliform load. This discrepancy is likely due to varying rainfall amounts across the study area (for example, in the July event, Kentucky likely received much more rainfall than Indiana did) during each storm, which were reflected in the loads from the landside model. Thus, an inaccurate perception of the relationship between environmental conditions and sources and water quality could results, depending on the event chosen for comparison.

This section presents a detailed analysis of bacteria concentrations in the Ohio River for only one event, the largest storm event during the recreation season. This event, May 7-11, 2001, was also an event that was monitored by ORSANCO. The purpose of this analysis is to illustrate how peak in-stream concentrations for a wet weather event are affected by CSO reductions.

The event characteristics from the Standiford Field rain gage and the USGS flow gage are shown in Table 9-13. This storm was a 6-month storm with a total rainfall of approximately two inches over a 13-hour period. The average rainfall, based on the entire rain gage network, was 1.3 inches. Rainfall recorded at individual gages within the network ranged from 0.1 inches to 2.9 inches. The loads for each of the source reduction scenarios are shown in Figure 9-21 for fecal coliform and Figure 9-22 for *E. coli*. Approximately 25% of the load is from the area CSOs and 66% is from the tributary sources (e.g. storm water).

Peak Concentration Results

Maximum fecal coliform concentrations during this event are presented in Figure 9-23, Figure 9-24, and Figure 9-25 for scenario groupings 2, 3, and 4, respectively. Corresponding maximum *E. coli* concentrations are presented in Figure 9-26, Figure 9-27, and Figure 9-28. Concentrations are nearly an order of magnitude higher along the near shore than in the center of the river for the base scenario. Large loads from Beargrass Creek (Kentucky) and Silver Creek (Indiana) cause the highest concentrations in the Ohio River to occur near the confluences with these tributaries (Left Bank River Mile 602 = Beargrass Creek, Right Bank River Mile 607 = Silver Creek).

CSOs also have a significant impact on peak concentrations. Approximately half of the concentration along the Kentucky bank is due to CSO load (illustrated as the difference between peak concentrations for scenario 10 and scenario 1). Along the Indiana bank, CSOs are not significant contributors to peak concentrations, which is not surprising, given the small number of CSOs from Jeffersonville. Tributaries (e.g. storm water) are large contributors to peak concentrations (illustrated as the difference between peak concentrations for scenario 10 and scenario 7), particularly along the Indiana bank. The most realistic CSO reduction alternative (scenario 2) has a noticeable impact on peak concentrations, reducing center channel peak concentrations by 15-20%.

9.5.5 OTHER USES/ANALYSES WITH MODELING TOOL

The analyses of the model results presented in this section of the report are not intended to be comprehensive nor complete. The goal of this project was to develop a modeling framework for large rivers capable of providing information to communities regarding the extent and severity of urban wet weather water quality impacts on the Ohio River. With this information, these model results could, for example, aid communities in developing their CSO Long Term Control Plans (LTCP). This section provides a brief description and examples of additional analyses conducted with the model results at the request of Jeffersonville for their CSO LTCP.

These analyses conducted for Jeffersonville are more spatially refined than the results presented in the previous sections of this chapter. Jeffersonville was interested in the model's simulated water quality at five key locations near their CSOs. These are:

1. Directly upstream of all of Jeffersonville's CSOs-river mile 600.6;
2. Near the I-65 bridge-river mile 603.05;
3. Directly upstream of the Mill Creek/Cane Run confluence-river mile 605.8;
4. Directly upstream of the Silver Creek confluence-river mile 606; and,
5. Between Silver Creek and Falling Run-river mile 608.85.

Results at these four locations include a comparison of the model results to the monthly geometric mean and single sample maximum *E. coli* criteria. These results are shown in Figure 9-29 (geometric mean) and Figure 9-30 (single sample maximum). In addition, peak *E. coli* concentrations at these locations were also graphed, as shown in Figure 9-31.

In addition, the comparisons to the water quality standards discussed in previous sub-sections are shown for scenario grouping 1 in Figure 9-32 (geometric mean) and Figure 9-33 (single sample max) in a slightly different format from what was used previously.

9.6 CONCLUSIONS

The ultimate success of CSO control is compliance of receiving waters with applicable water quality standards. Control of bacteria is especially important during the recreational season, from May through October for the Ohio River, because people are using the river and are more likely to come into contact with water that may pose a health risk. It is impossible to monitor conditions in the river at every moment and at every location to protect human health during the recreation season. A water quality model of the system can supplement monitoring programs by filling in the gaps in space and time that monitoring cannot cover. Thus, water quality models can be used as a predictive tool for assessing when conditions in the river are safe for designated uses, given a specific rainfall event. Applying the model in a "typical" year simulation can indicate the range of environmental and storm conditions that trigger violations of water quality standards and thus, require CSO reduction. The use of a water quality model can be expanded to assess the effectiveness of a proposed control scenario. Applying the water quality model in the Louisville area using the screening level reduction scenarios has provided additional insights into this study area. These conclusions are:

1. Both storm water (e.g. tributaries) and CSOs are contributing to water quality standard exceedances in the Ohio River.

2. Both storm water and CSO sources need to be addressed to successfully comply with the water quality standards because targeting reductions in only one of these sources (e.g. either CSO or storm water) will not eliminate exceedances of the standards.

3. Reducing CSO loads is more effective at reducing peak in-stream concentrations than in reducing the frequency that water quality standards are exceeded.

On a big picture level, this application of the model was designed to evaluate whether the modeling framework developed for Cincinnati could be successfully transferred to another large river area with urban communities that face similar issues as the Cincinnati area. Results presented in this and previous chapters indicate that the framework is robust enough to use in other areas. In addition, the modeling tools can be used not only for meeting the goals of this project, but are versatile enough to be used in other applications or to meet other community needs.

9.7 RECOMMENDATIONS

This project evaluated screening level source reduction scenarios. The models developed as part of this project can be used as tools for conducting more rigorous simulations of the study area. Use of the landside and water quality models with more detailed CSO reduction scenarios will provide more insight into the system behavior. Recommendations for future use of these tools include:

1. To better understand relative impact by source, the same rainfall data should be used throughout the system for estimating the pollutant load inputs to the model.

2. Continued sampling of combined sewer overflows and storm water will provide better constraints on the loading estimates used in the water quality model.

3. The planning for more detailed or specific scenarios should include a careful consideration of the flow regime around McAlpine Dam. The distribution of loads originating upstream of McAlpine Dam below the dam is very dependent on the dam operations, which, in turn, are dependent on the flow and stage of the river.

4. Additional characterization of Louisville's CSOs may provide a set of inputs to the Ohio River that more realistically simulates the duration that each CSO overflows rather than simply distributing the CSO volume over the duration of the rainfall.

The modeling tools developed here can be used not only for meeting the goals of this project, but are versatile enough to be used in other applications or to meet other community needs.

Table 9-1. Comparison of Historical Average and 2001 Rainfall Statistics for All Rain Events[1]

Parameter	1948-2002 Average			2001		
	Rec. Season[2]	Winter[3]	Total	Rec. Season[2]	Winter[3]	Total
Number of Events	55	59	114	58	51	109
Total Rainfall (inches)	21.17	22.21	43.38	26.29	17.70	43.99
Average Storm Volume (inches)	0.39	0.38	0.38	0.45	0.35	0.40
Maximum Storm Volume (inches)	2.72	2.55	2.64	2.03	3.15	3.15
Maximum Storm Intensity (inches/hr)	1.20	0.64	0.92	0.83	0.69	0.83
Average Duration (hours)	5.20	8.30	6.82	5.20	7.50	6.27

[1] Rainfall data is from the NWS gage (#15495400) at Standiford Field (Louisville, KY)

[2] Rec. Season = May-October

[3] Winter = November-April

Table 9-2. Comparison of Historical Average and 2001 Rainfall Statistics for All Storm Events (Rainfall > 0.1")[1]

Parameter	1948-2002 Average			2001		
	Rec. Season[2]	Winter[3]	Total	Rec. Season[2]	Winter[3]	Total
Number of Events	35	35	70	44	27	71
Total Rainfall (inches)	20.43	21.37	41.80	25.79	16.80	42.60
Average Storm Volume (inches)	0.59	0.61	0.60	0.59	0.62	0.60
Maximum Storm Volume (inches)	2.72	2.55	2.64	2.03	3.15	3.15
Maximum Storm Intensity (inches/hr)	1.20	0.64	0.92	0.83	0.69	0.83
Average Duration (hours)	7.05	11.93	9.50	6.30	12.00	8.50

[1] Rainfall data is from the NWS gage (#15495400) at Standiford Field (Louisville, KY)

[2] Rec. Season = May-October

[3] Winter = November-April

Table 9-3. Storm Event Return Frequency from Standiford Field Rain Gage (NWS Gage ID 15495400) Data

Return Period	Rainfall Volume (inches)
50 years	6.87
25 years	6.16
10 years	5.36
5 year	4.34
2 year	3.09
1 year	2.57
6 month	2.10
3 month	1.62
1 month	0.96
2 week	0.56
1 week	0.22

Table 9-4. Description of Source Control Scenarios

Scenario No.	Description	Active CSOs at Control Level Specified		
		Jeffersonville [1]	Louisville MSD [2]	Both Communities
1	100% control (all CSO volume eliminated)			✔
2	100% control of sanitary component of CSOs for Jeffersonville; Individual CSO-specific control level for Louisville			✔
3	75% control	✔		
4	75% control		✔	
5	50% control	✔		
6	50% control		✔	
7	CSO only (no control), No tributaries			✔
8	CSO only (no control), with tributaries	✔		
9	CSO only (no control), with tributaries		✔	
10	CSO only (no control), with tributaries (Current conditions)			✔

[1] The Louisville CSOs will be turned off in these scenarios.

[2] The Jeffersonville CSOs will be turned off in these scenarios.

Table 9-5. Boundary Concentrations in Ohio River for Typical Year

Location	Applicable Condition	Fecal coliform (cfu/100 ml)	E. coli (cfu/100 ml)
Upstream	Low Q (< 100,000 cfs)	10.8	
	High Q (>= 100,000 cfs)	360	
	All		5
Downstream	All	385	500

Table 9-6. Load Adjustment Factors Applied to Each Source for Each Control Alternative Scenario

Model Seg	River Mile	Category	ID	Description	Source	Scaling Factor Applied to Flows and Loads									
						Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9	Scenario 10
16	591	IN WWTP	IN0020508	Charlestown Municipal WWTP	NPDES	1	1	1	1	1	1	1	1	1	1
230	606	IN WWTP	IN0047058	Clarksville Municipal WWTP	NPDES	1	1	1	1	1	1	1	1	1	1
181	601.25	IN CSO	Jeff CSO 005	Missouri St.	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
191	601.6	IN CSO	Jeff CSO 006	River Pointe	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
196	602.1	IN CSO	Jeff CSO 007	Clark	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
201	602.25	IN CSO	Jeff CSO 008	Spring	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
206	602.6	IN CSO	Jeff CSO 009	Wall	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
211	602.9	IN CSO	Jeff CSO 010	Walnut	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
216	603.23	IN CSO	Jeff CSO 011a+b	Meigs	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
216	603.33	IN CSO	Jeff CSO 013	Graham	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
221	603.5	IN CSO	Jeff CSO 014	Blanchel Terrace	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
236	606	IN CSO	Jeff CSO 018	10th St. Pump Station	SWMM Model	0	0.01	0.75	0	0.5	0	1	1	0	1
101	596.3	IN TRIB	RM 596.3	Lancassange & Lentizer Creeks-Indiana	HSPF	1	1	1	1	1	1	0	1	1	1
241	607	IN TRIB	RM 607	Silver Creek-Indiana	HSPF	1	1	1	1	1	1	0	1	1	1
284	609.3	IN TRIB	RM 609.3	Fall Run, Vincennes Run, French Creek-Indiana	HSPF	1	1	1	1	1	1	0	1	1	1
604	628.3	IN TRIB	RM 628.3	4-Mile Creek, other small tribs-Indiana	HSPF	1	1	1	1	1	1	0	1	1	1
328	612.25	KY WWTP	KY0022411	Morris Forman WWTP	NPDES	1	1	1	1	1	1	1	1	1	1
528	623.5	KY WWTP	KY0078956	West County WWTP	NPDES	1	1	1	1	1	1	1	1	1	1
200	602.1	KY CSO	Ky CSOs-BG Cr	Total Beargrass Creek CSOs	Synthesized	0	0.62	0	0.75	0	0.5	1	0	1	1
205	602.38	KY CSO	Ky CSO-172	Adams St.	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
220	603.25	KY CSO	Ky CSO-058	Preston St. Overflow	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	603.5	KY CSO	Ky CSO-160	Alley North of 1st & Market St.	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	603.5	KY CSO	Ky CSO-161	Market St. Sanitary Diversion	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	603.75	KY CSO	Ky CSO-022	4th St. Pump Station	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	603.82	KY CSO	Ky CSO-055	6th St. Overflow	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	603.87	KY CSO	Ky CSO-054	7th St. Overflow	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	603.97	KY CSO	Ky CSO-CRD	Central Relief Drain	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	604.01	KY CSO	Ky CSO-051	11th St. Overflow	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	604.01	KY CSO	Ky CSO-052	10th St. Overflow	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	604.14	KY CSO	Ky CSO-050	12th St. Overflow	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	604.14	KY CSO	Ky CSO-155	Rowan St. Combined Sewer	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
225	604.4	KY CSO	Ky CSO-190	17th St. Sanitary Diversion	CSO Rainfall Regression	0	0.68	0	0.75	0	0.5	1	0	1	1
258	607.47	KY CSO	Ky CSO-019	34th St. Pump Station	CSO Rainfall Regression	0	0.44	0	0.75	0	0.5	1	0	1	1
303	610.52	KY CSO	Ky CSO-189	Northwestern Sanitary Diversion	CSO Rainfall Regression	0	0.51	0	0.75	0	0.5	1	0	1	1
308	610.8	KY CSO	Ky CSO-104	Southwestern Parkway @ Broadway	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
308	610.8	KY CSO	Ky CSO-105	Western Outfall @ Broadway	CSO Rainfall Regression	0	1	0	0.75	0	0.5	1	0	1	1
323	611.8	KY CSO	Ky CSO-016	Miles Park Bypass	CSO Rainfall Regression	0	0.61	0	0.75	0	0.5	1	0	1	1
328	612.25	KY CSO	KY CSO MDS	Morris Forman Main Diversion Structure	CSO Rainfall Regression	0	0.61	0	0.75	0	0.5	1	0	1	1
343	613.03	KY CSO	Ky CSO-015	Southwestern Pump Station	CSO Rainfall Regression	0	0.76	0	0.75	0	0.5	1	0	1	1
343	613.03	KY CSO	Ky CSO-191	Algonquin Parkway	CSO Rainfall Regression	0	0.76	0	0.75	0	0.5	1	0	1	1
100	595.9	KY TRIB	RM 595.9	Harrod's Creek-Kentucky	HSPF	1	1	1	1	1	1	0	1	1	1
115	596.9	KY TRIB	RM 596.9	Goose Creek-Kentucky	HSPF	1	1	1	1	1	1	0	1	1	1
135	598	KY TRIB	RM 598	Little Huckleberry, other small tribs-Kentucky	HSPF	1	1	1	1	1	1	0	1	1	1
200	602.1	KY TRIB	RM 602.1	Total Beargrass Creek Non-CSO Sources	Synthesized	1	1	1	1	1	1	0	1	1	1
200	602.1	KY TRIB	RM 602.1	Beargrass Creek-Kentucky	HSPF	1	1	1	1	1	1	0	1	1	1
408	616.4	KY TRIB	RM 616.4	Mill Creek Cutoff-Kentucky	HSPF	1	1	1	1	1	1	0	1	1	1
553	625.1	KY TRIB	RM 625.1	Mill Creek-Kentucky	HSPF	1	1	1	1	1	1	0	1	1	1
623	629	KY TRIB	RM 629	Unnamed tribs-Kentucky	HSPF	1	1	1	1	1	1	0	1	1	1

Table 9-7. Water Temperature Time Series Input to Model

Date/Time	Temp (deg C)
12/1/2000 0:00	9.3
12/15/2000 12:00	6.3
1/15/2001 12:00	3.7
2/14/2001 0:00	3.8
3/15/2001 12:00	7.2
4/15/2001 0:00	12.7
5/15/2001 12:00	18.4
6/15/2001 0:00	23.7
7/15/2001 12:00	26.9
8/15/2001 12:00	27.3
9/15/2001 0:00	24.8
10/15/2001 12:00	19.1
11/15/2001 0:00	12.5
11/30/2001 23:00	9.5

Table 9-8. Scenario Groupings for Presenting Results

Scenario No.	Description	Scenario Group			
		1 CSO Reduction	2 Source Reduction	3 Jeffersonville Control	4 Louisville Control
1	100% control (all CSO volume eliminated)	✔	✔	✔	✔
2	100% control of sanitary component of CSOs for Jeffersonville; Individual CSO-specific control level for Louisville		✔	✔	✔
3	75% control-Jeffersonville only, Louisville off			✔	
4	75% control-Louisville only, Jeffersonville off				✔
5	50% control-Jeffersonville only, Louisville off			✔	
6	50% control-Louisville only, Jeffersonville off				✔
7	CSO only (no control), No tributaries		✔		
8	CSO only (no control), with tributaries-Jeffersonville only, Louisville off			✔	
9	CSO only (no control), with tributaries-Louisville only, Jeffersonville off				✔
10	CSO only (no control), with tributaries (Current conditions)	✔	✔	✔	✔

Table 9-9. Percent of Ohio River Area Exceeding Fecal Coliform Monthly Geometric Mean Criteria

Month	GM Criterion	Scenario No. 1	2	3	4	5	6	7	8	9	10
1	2,000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	2,000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	2,000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	2,000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5	200	49%	50%	49%	49%	49%	50%	22%	49%	50%	50%
6	200	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7	200	0%	0%	0%	0%	0%	0%	0%	0%	2%	2%
8	200	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	200	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10	200	37%	42%	37%	39%	37%	41%	2%	37%	43%	43%
11	2,000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12	2,000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 9-10. Percent of Ohio River Area Exceeding *E. coli* Monthly Geometric Mean Criteria[1]

Month	GM Criterion	Scenario No.									
		1	2	3	4	5	6	7	8	9	10
5	130	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6	130	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
7	130	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	130	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	130	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10	130	3%	6%	3%	4%	3%	6%	0%	3%	8%	8%

[1] There is no monthly geometric mean criterion for the winter months (November through April)

Table 9-11. Average Number of Days of Exceedance of Fecal Coliform Criterion for Alternative Comparison Methods

Left Bank-Fecal coliform

Time Period Considered:	*Entire Day*	*Entire Day*	*Entire Day*	*Daylight Only Only*
Model Result:	*Daily Max.*	*Daily Avg.*	*Daily Max.*	*Daily Max.*
Numeric Criteria:	*WQS*	*WQS*	*5 * WQS*	*WQS*
Scenario	**Avg. % Days of Exceedance**			
1	29%	18%	14%	21%
2	24%	16%	11%	18%
3	31%	20%	16%	23%
4	33%	20%	18%	23%
5	24%	16%	11%	18%
6	34%	22%	18%	24%
7	34%	22%	18%	25%
8	0%	0%	0%	0%
9	0%	0%	0%	0%
10	0%	0%	0%	0%

Mid Channel-Fecal coliform

Time Period Considered:	*Entire Day*	*Entire Day*	*Entire Day*	*Daylight Only*
Model Result:	*Daily Max.*	*Daily Avg.*	*Daily Max.*	*Daily Max.*
Numeric Criteria:	*WQS*	*WQS*	*5 * WQS*	*WQS*
Scenario	**Avg. % Days of Exceedance**			
1	22%	16%	11%	17%
2	21%	16%	11%	17%
3	24%	17%	12%	18%
4	24%	13%	9%	17%
5	21%	16%	11%	17%
6	28%	18%	13%	21%
7	28%	18%	13%	21%
8	0%	0%	0%	0%
9	0%	0%	0%	0%
10	0%	0%	0%	0%

Right Bank-Fecal coliform

Time Period Considered:	*Entire Day*	*Entire Day*	*Entire Day*	*Daylight Only*
Model Result:	*Daily Max.*	*Daily Avg.*	*Daily Max.*	*Daily Max.*
Numeric Criteria:	*WQS*	*WQS*	*5 * WQS*	*WQS*
Scenario	**Avg. % Days of Exceedance**			
1	21%	15%	13%	17%
2	22%	15%	13%	17%
3	22%	16%	14%	18%
4	16%	9%	7%	12%
5	22%	15%	13%	17%
6	24%	16%	14%	19%
7	24%	16%	14%	20%
8	0%	0%	0%	0%
9	0%	0%	0%	0%
10	0%	0%	0%	0%

Table 9-12. Average Number of Days of Exceedance of *E. coli* Criterion for Alternative Comparison Methods

Left Bank-*E. coli*

Time Period Considered:	*Entire Day*	*Entire Day*	*Entire Day*	*Daylight Only*
Model Result:	*Daily Max.*	*Daily Avg.*	*Daily Max.*	*Daily Max.*
Numeric Criteria:	*WQS*	*WQS*	*5 * WQS*	*WQS*
Scenario	**Avg. % Days of Exceedance**			
1	18%	14%	21%	0%
2	16%	11%	18%	0%
3	20%	16%	23%	0%
4	20%	18%	23%	0%
5	16%	11%	18%	0%
6	22%	18%	24%	0%
7	22%	18%	25%	0%
8	0%	0%	0%	0%
9	0%	0%	0%	0%
10	0%	0%	0%	0%

Mid channel-*E. coli*

Time Period Considered:	*Entire Day*	*Entire Day*	*Entire Day*	*Daylight Only*
Model Result:	*Daily Max.*	*Daily Avg.*	*Daily Max.*	*Daily Max.*
Numeric Criteria:	*WQS*	*WQS*	*5 * WQS*	*WQS*
Scenario	**Avg. % Days of Exceedance**			
1	16%	11%	17%	0%
2	16%	11%	17%	0%
3	17%	12%	18%	0%
4	13%	9%	17%	0%
5	16%	11%	17%	0%
6	18%	13%	21%	0%
7	18%	13%	21%	0%
8	0%	0%	0%	0%
9	0%	0%	0%	0%
10	0%	0%	0%	0%

Right Bank-*E. coli*

Time Period Considered:	*Entire Day*	*Entire Day*	*Entire Day*	*Daylight Only*
Model Result:	*Daily Max.*	*Daily Avg.*	*Daily Max.*	*Daily Max.*
Numeric Criteria:	*WQS*	*WQS*	*5 * WQS*	*WQS*
Scenario	**Avg. % Days of Exceedance**			
1	15%	13%	17%	0%
2	15%	13%	17%	0%
3	16%	14%	18%	0%
4	9%	7%	12%	0%
5	15%	13%	17%	0%
6	16%	14%	19%	0%
7	16%	14%	20%	0%
8	0%	0%	0%	0%
9	0%	0%	0%	0%
10	0%	0%	0%	0%

Table 9-13. Rainfall and Flow Conditions During May 7, 2001 Event

Start Date	End Date	Total Rainfall (in)	Max Intensity (in/hr)	Duration (hrs)	Time Since Last Rainfall (hrs)	Season	Average Q (cfs)	Minimum Q (cfs)	Maximum Q (cfs)
5/7/01 15:00	5/8/01 4:00	2.03	0.4	13	327	Rec. Season	44,330	37,400	55,400

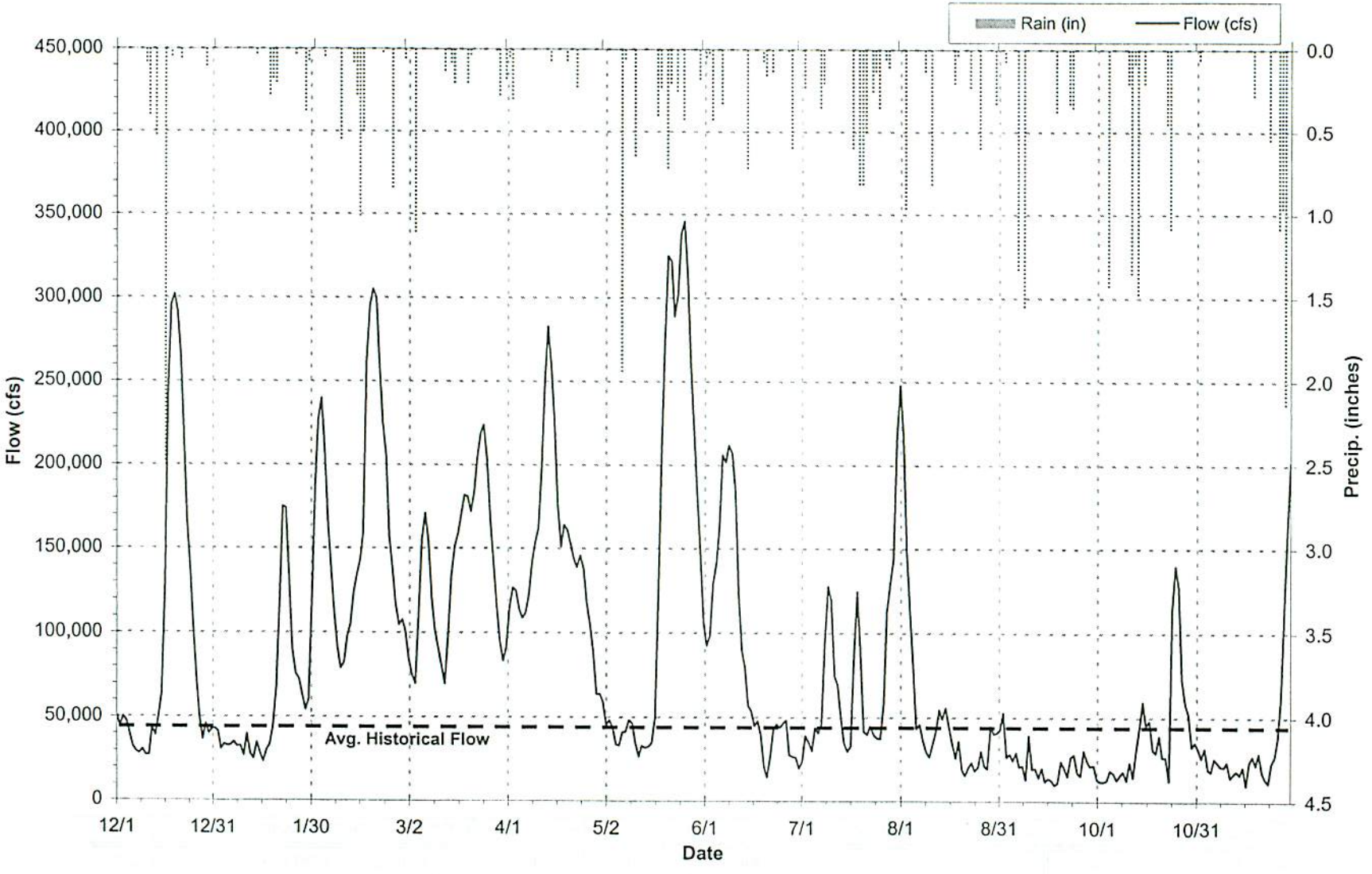


Figure 9-1. Daily Rainfall and Ohio River Flow during Simulation Year (December 2000-November 2001)

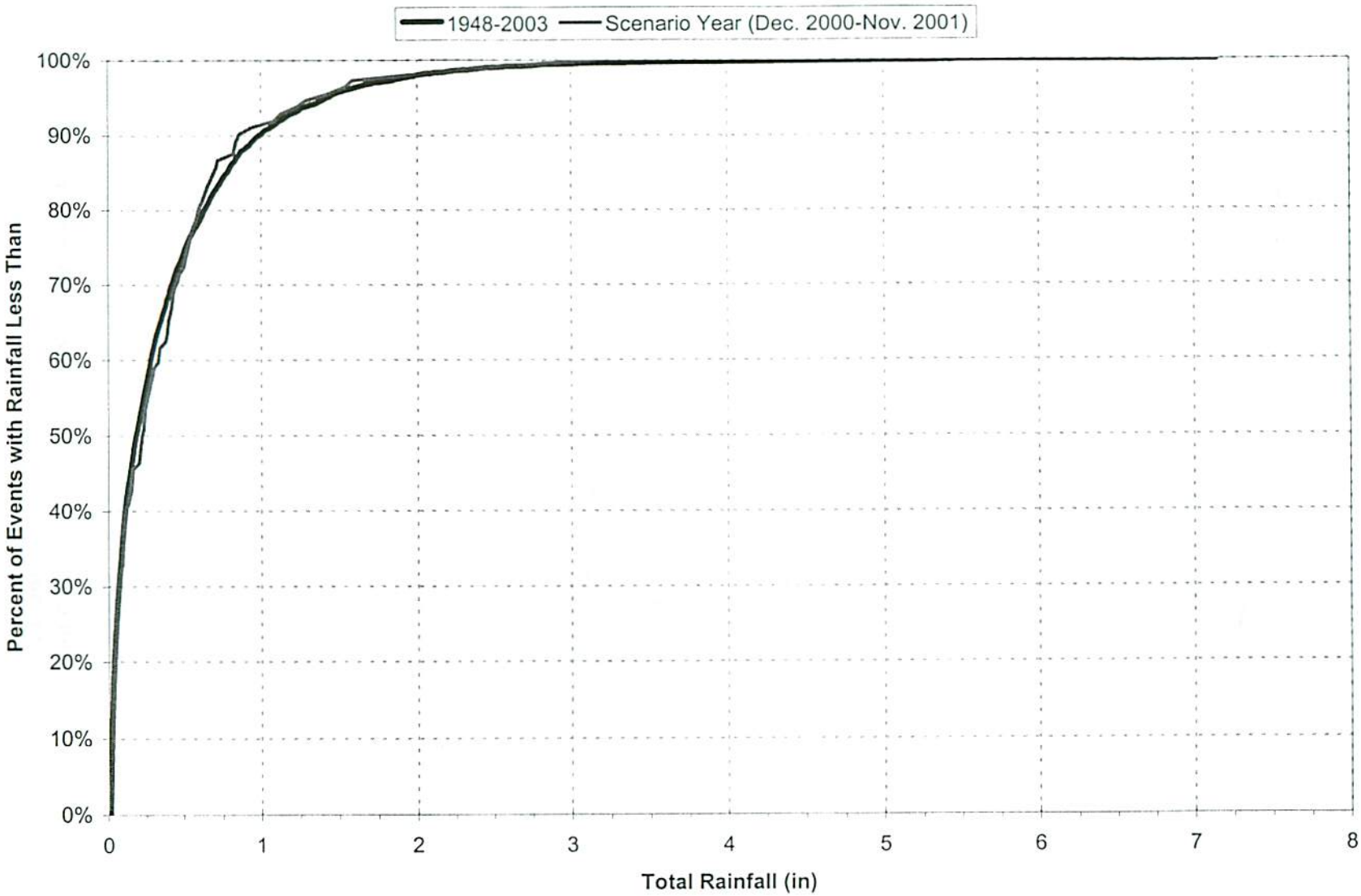
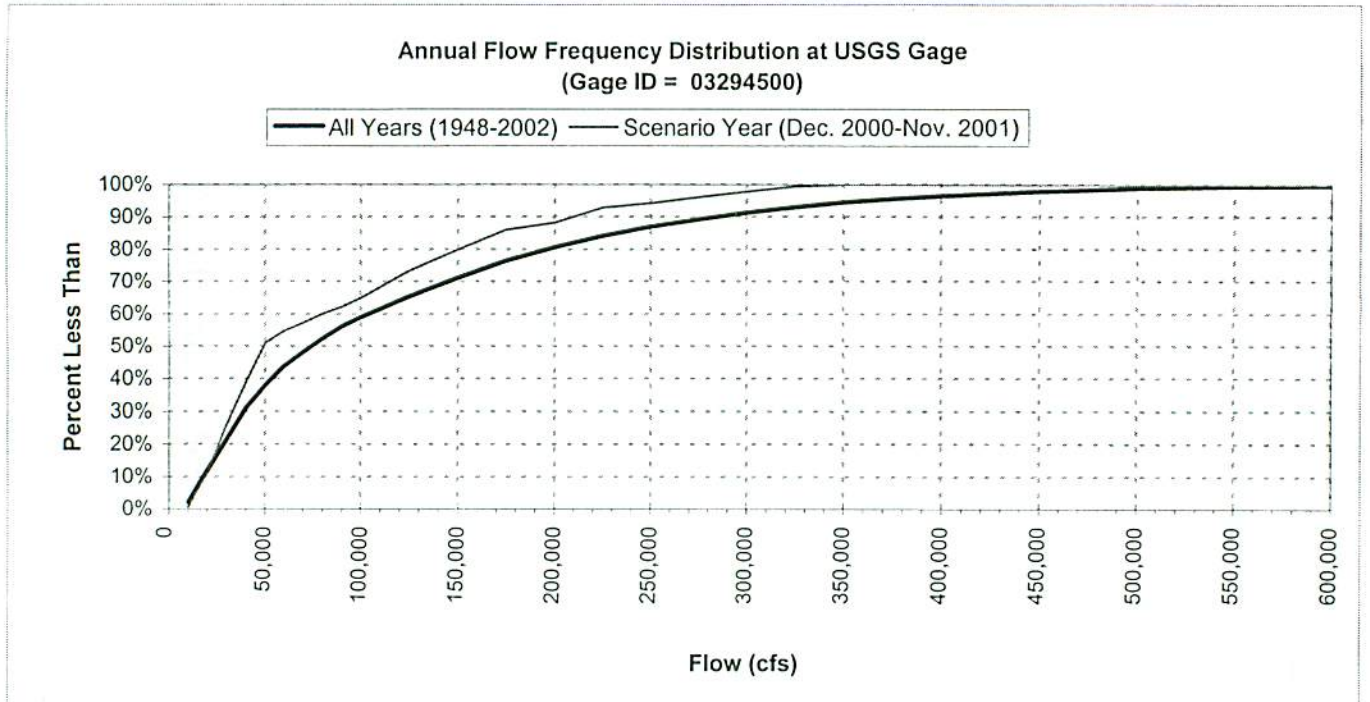


Figure 9-2. Frequency Distribution of Historical and 2001 Rainfall at Standiford Field (Louisville, KY)



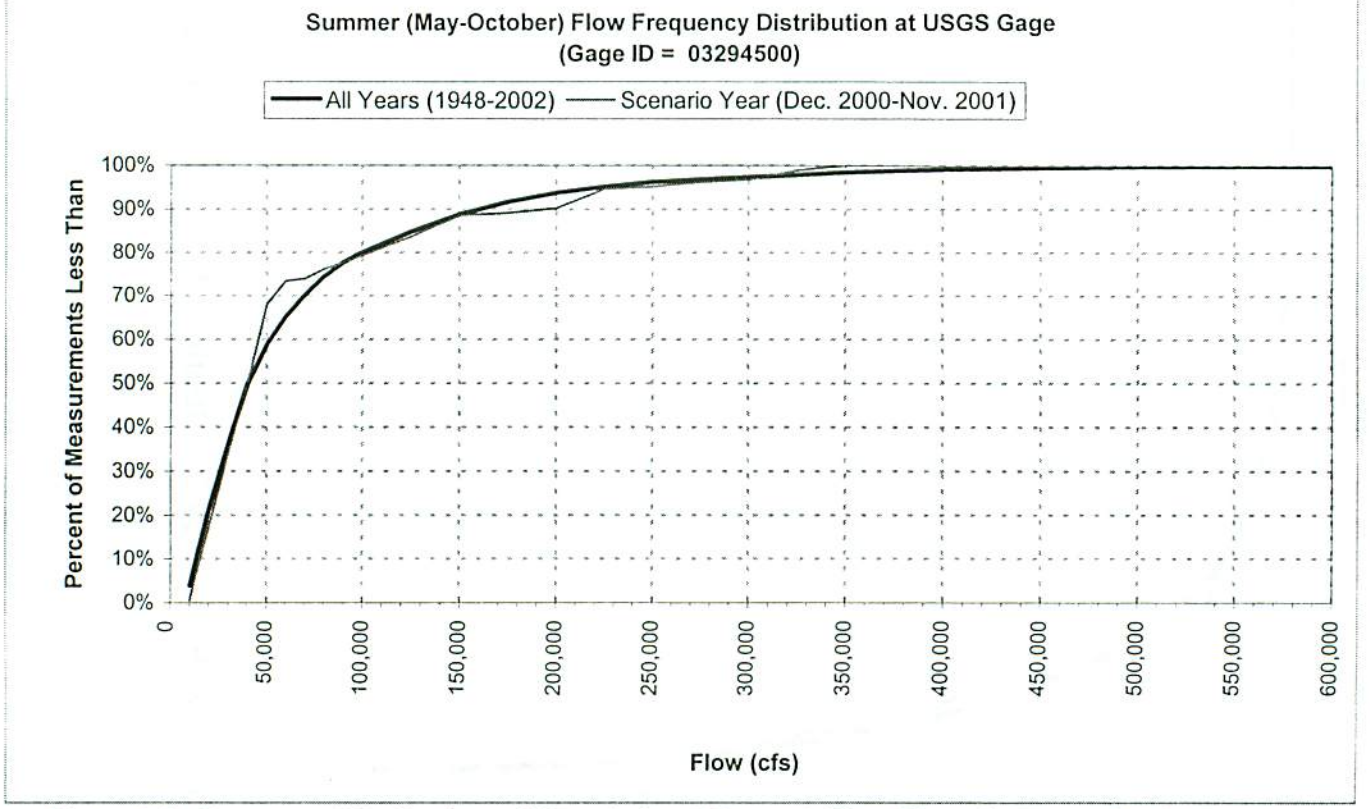


Figure 9-3. Frequency Distribution of Historical and Scenario Year Flows for Annual and Recreation Season Periods

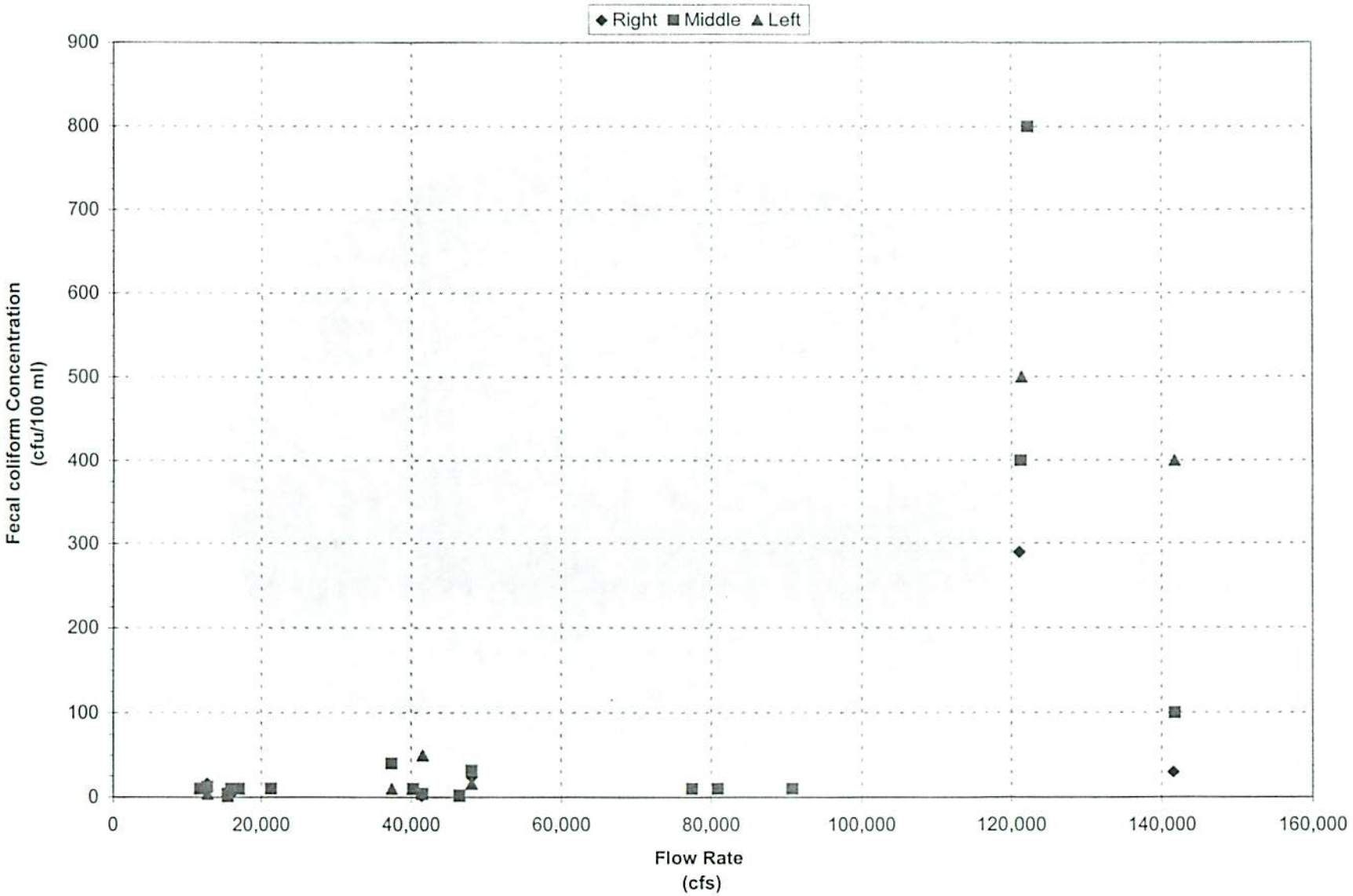


Figure 9-4. Relationship Between Fecal Coliform Concentration Data at River Mile 590 and Flow Rate

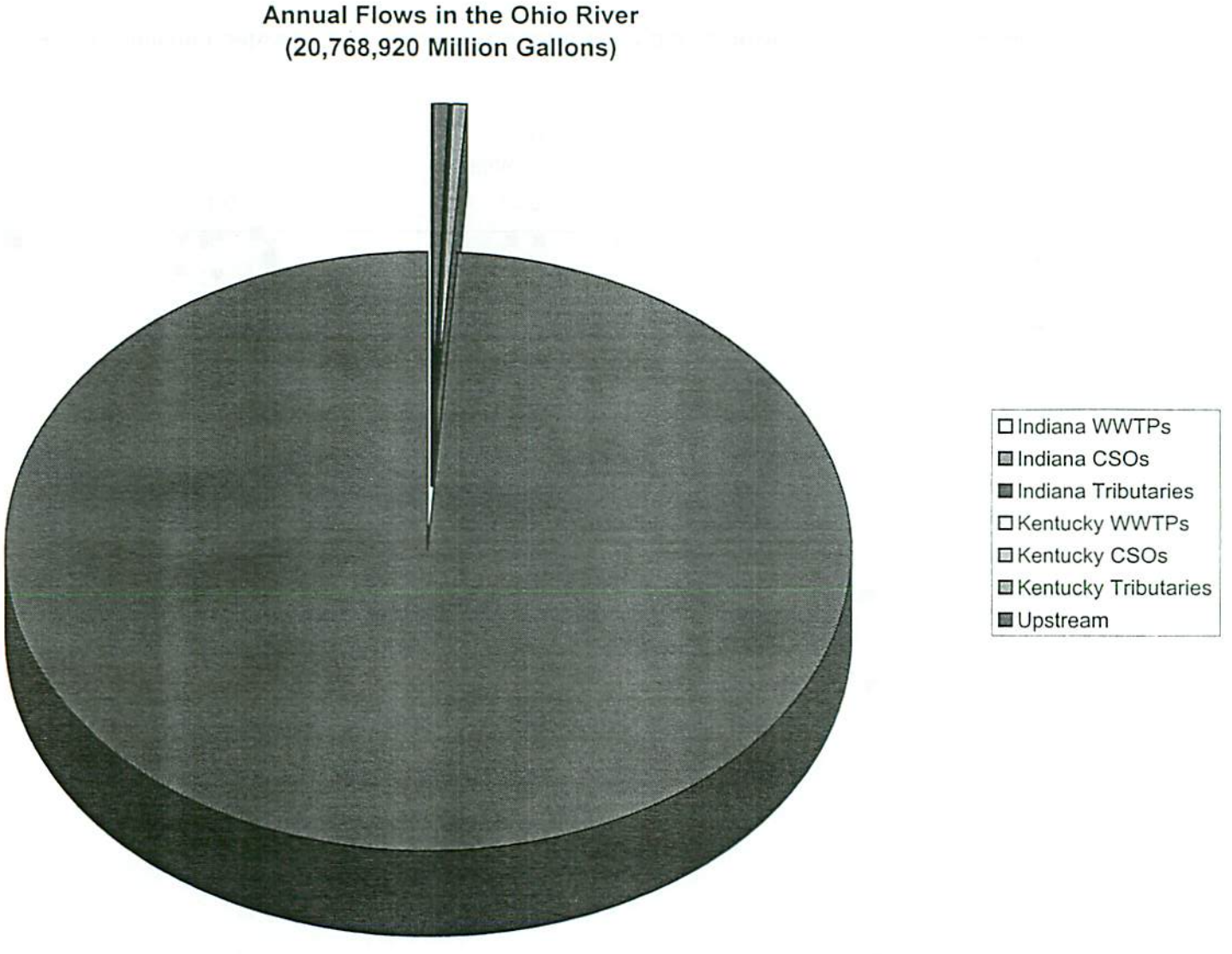


Figure 9-5. Flow Volume Distribution by Source Type Over "Typical" Year

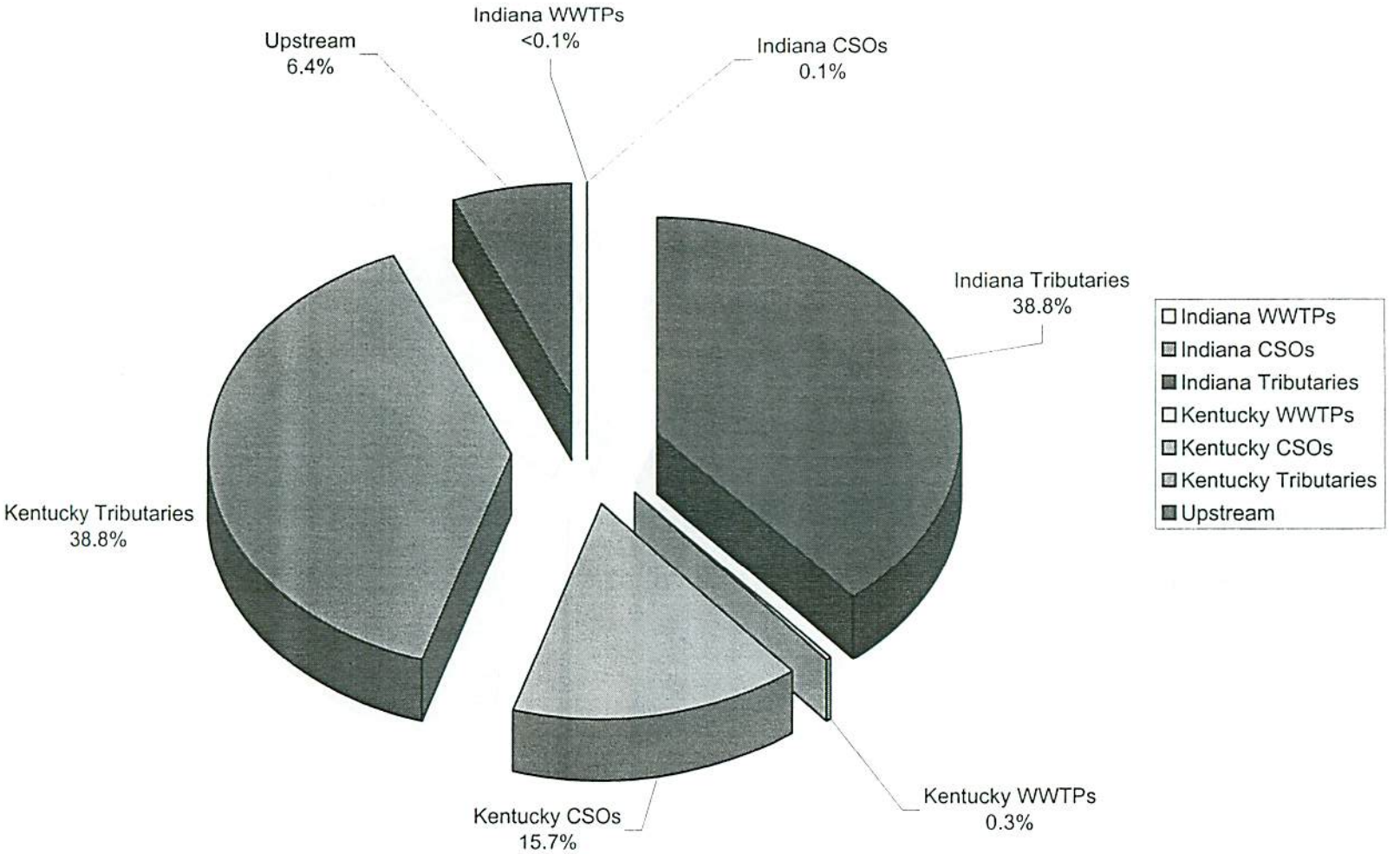


Figure 9-6. Annual Fecal coliform Loads Under Baseline (Current) Conditions

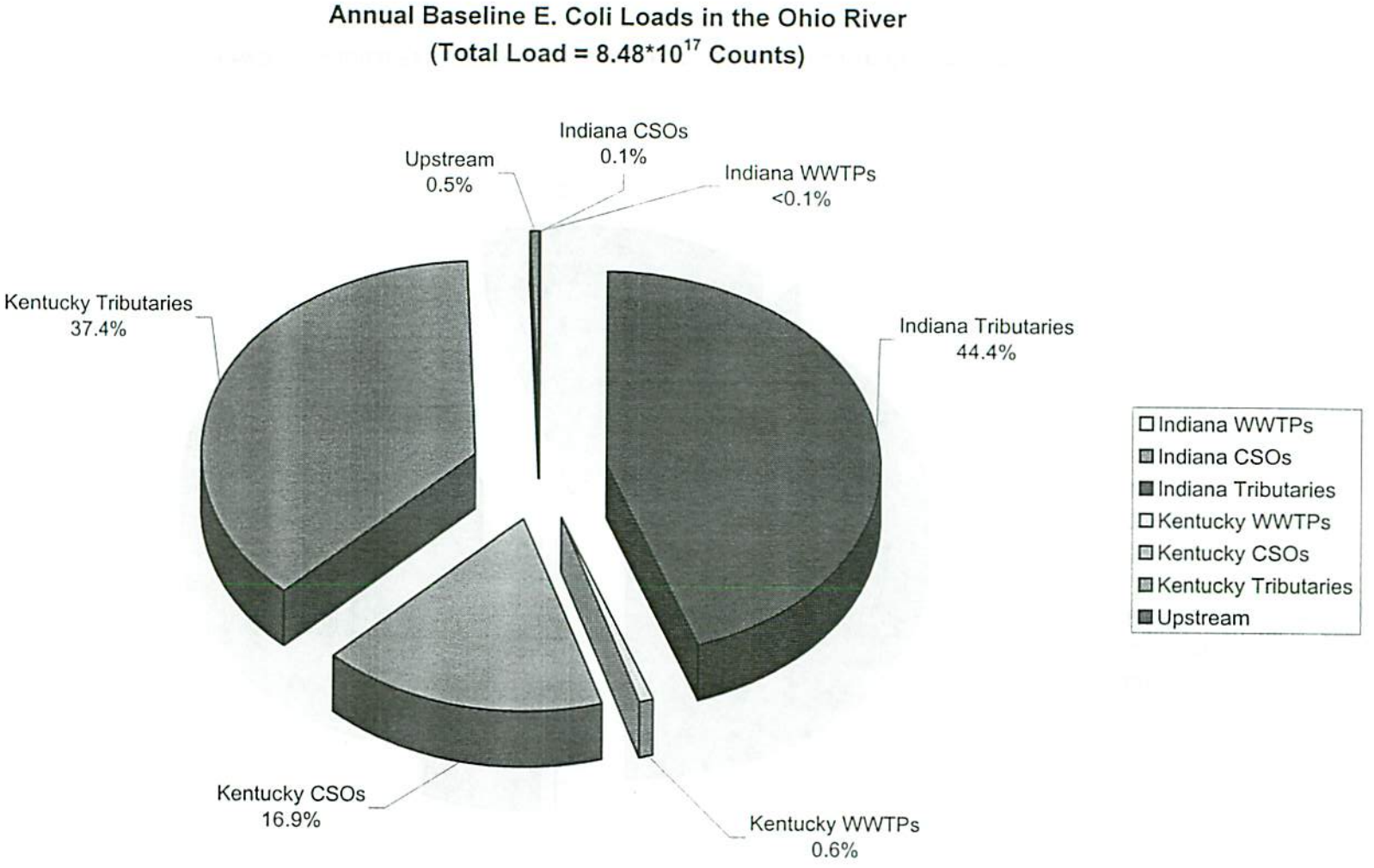


Figure 9-7. Annual *E. Coli* Loads Under Baseline (Current) Conditions

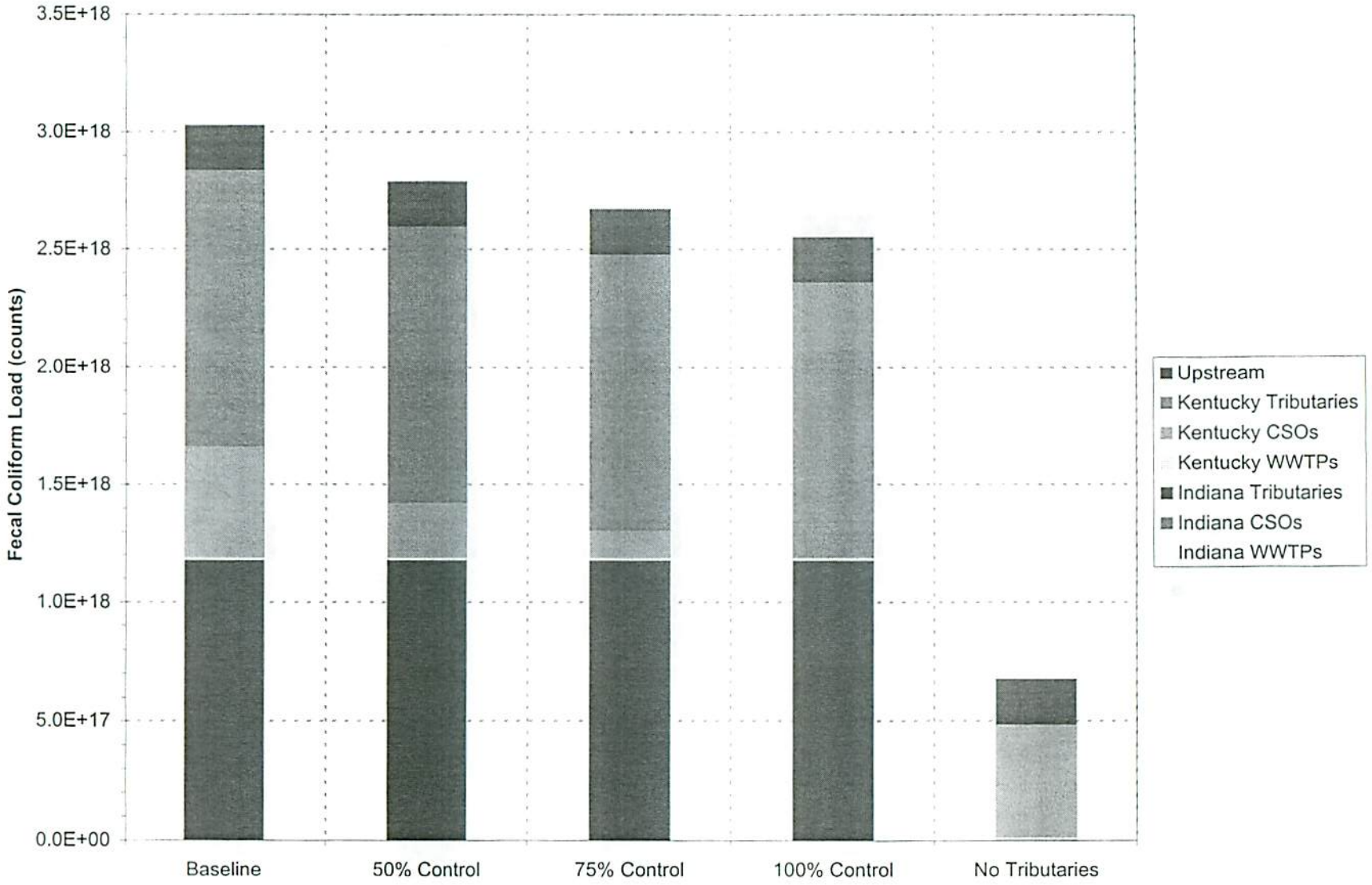


Figure 9-8. Annual Fecal coliform Load Distribution for Reduction Scenarios

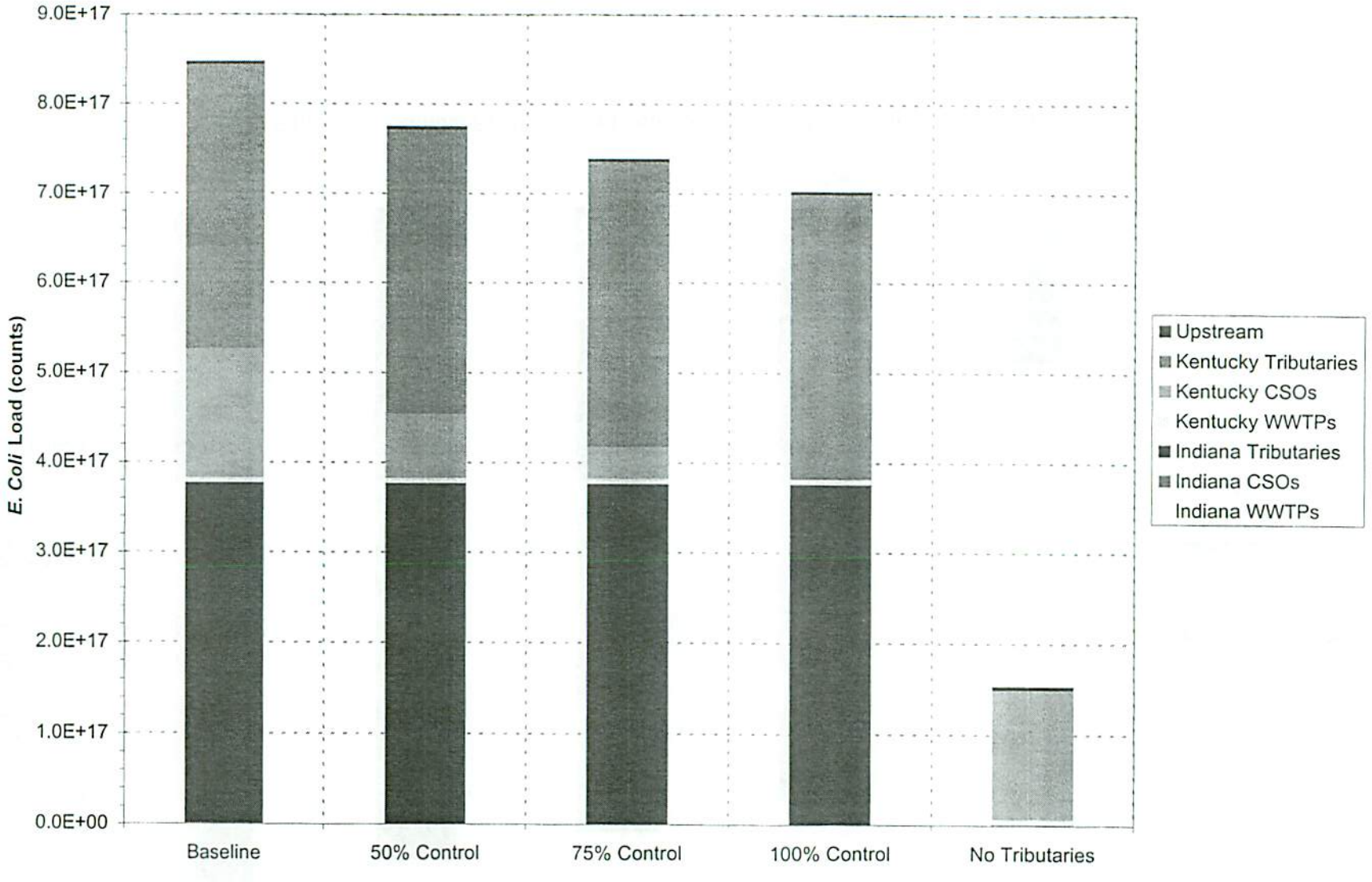


Figure 9-9. Annual *E. Coli* Load Distribution for Reduction Scenarios

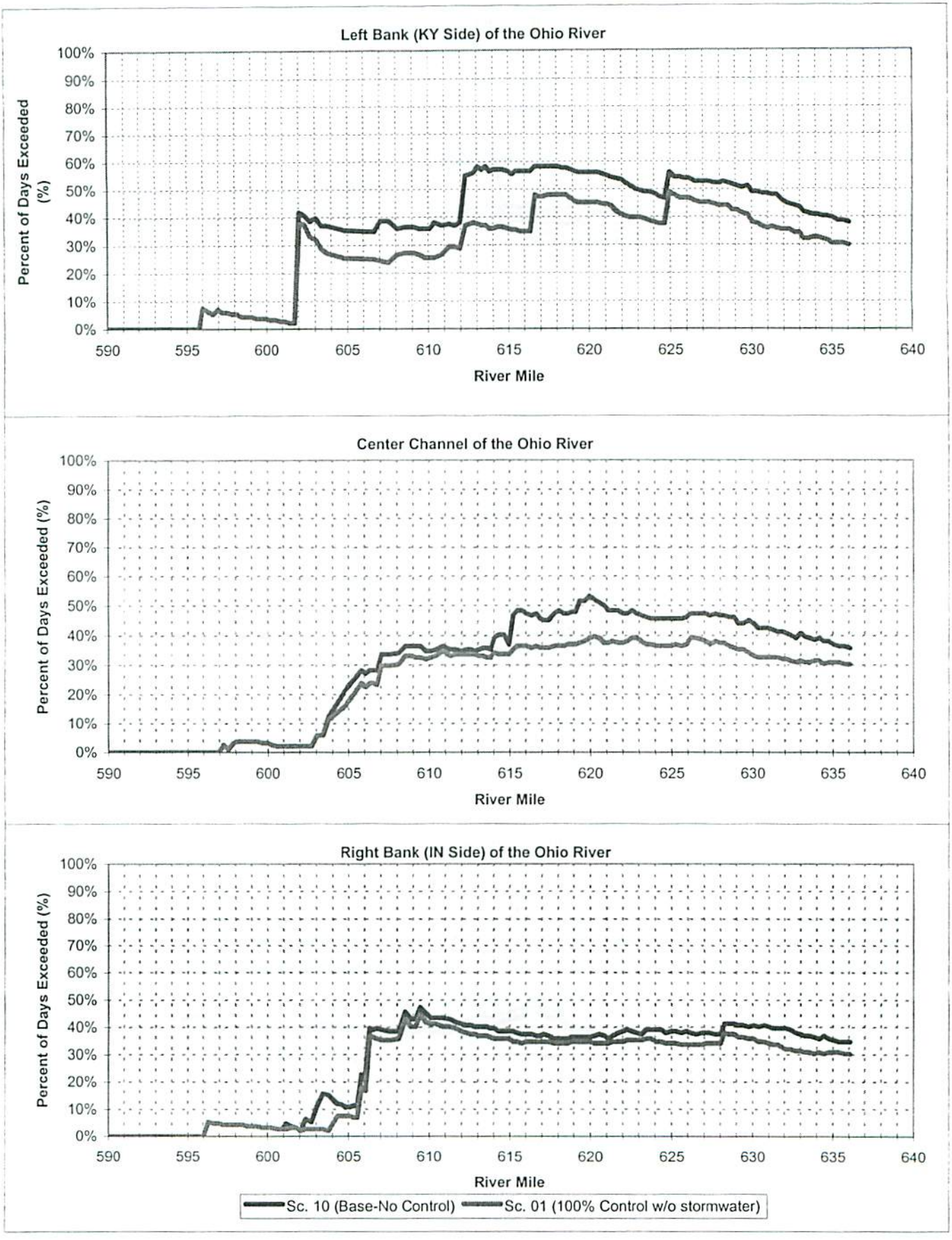


Figure 9-10. Frequency of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) During Recreation Season (184 Days) for Scenario Grouping 1

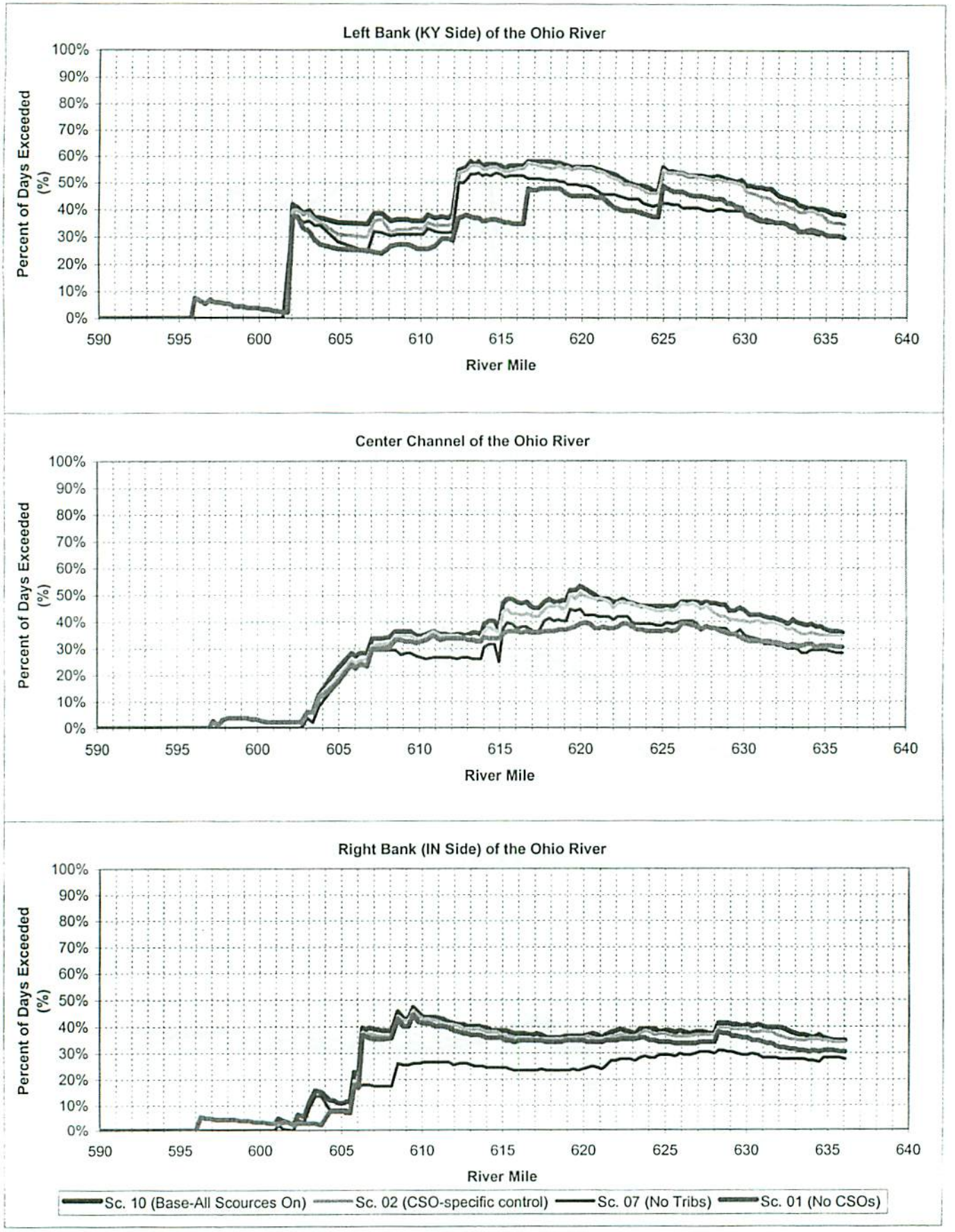


Figure 9-11. Frequency of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) During Recreation Season (184 Days) for Scenario Grouping 2

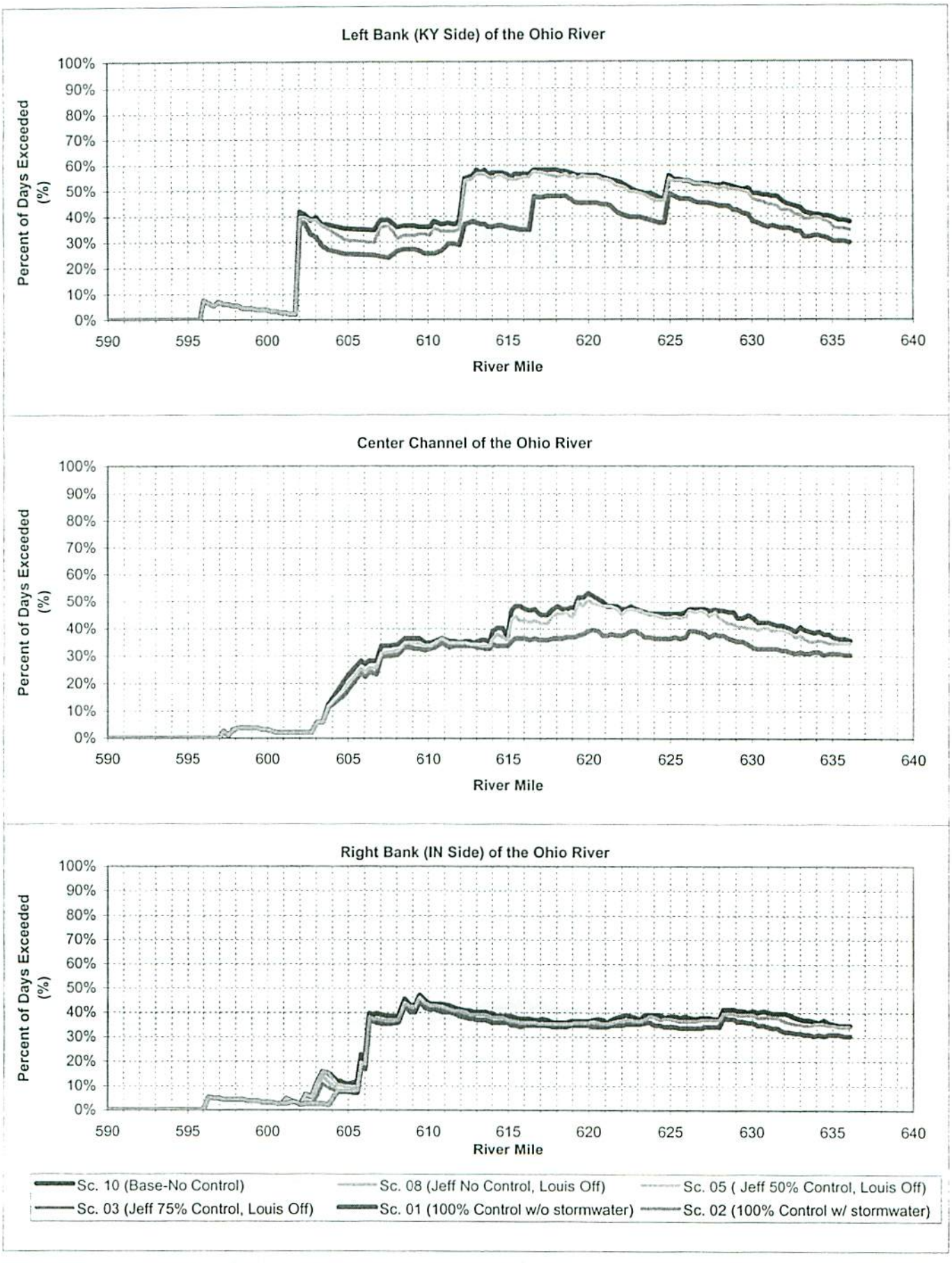


Figure 9-12. Frequency of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) During Recreation Season (184 Days) for Scenario Grouping 3

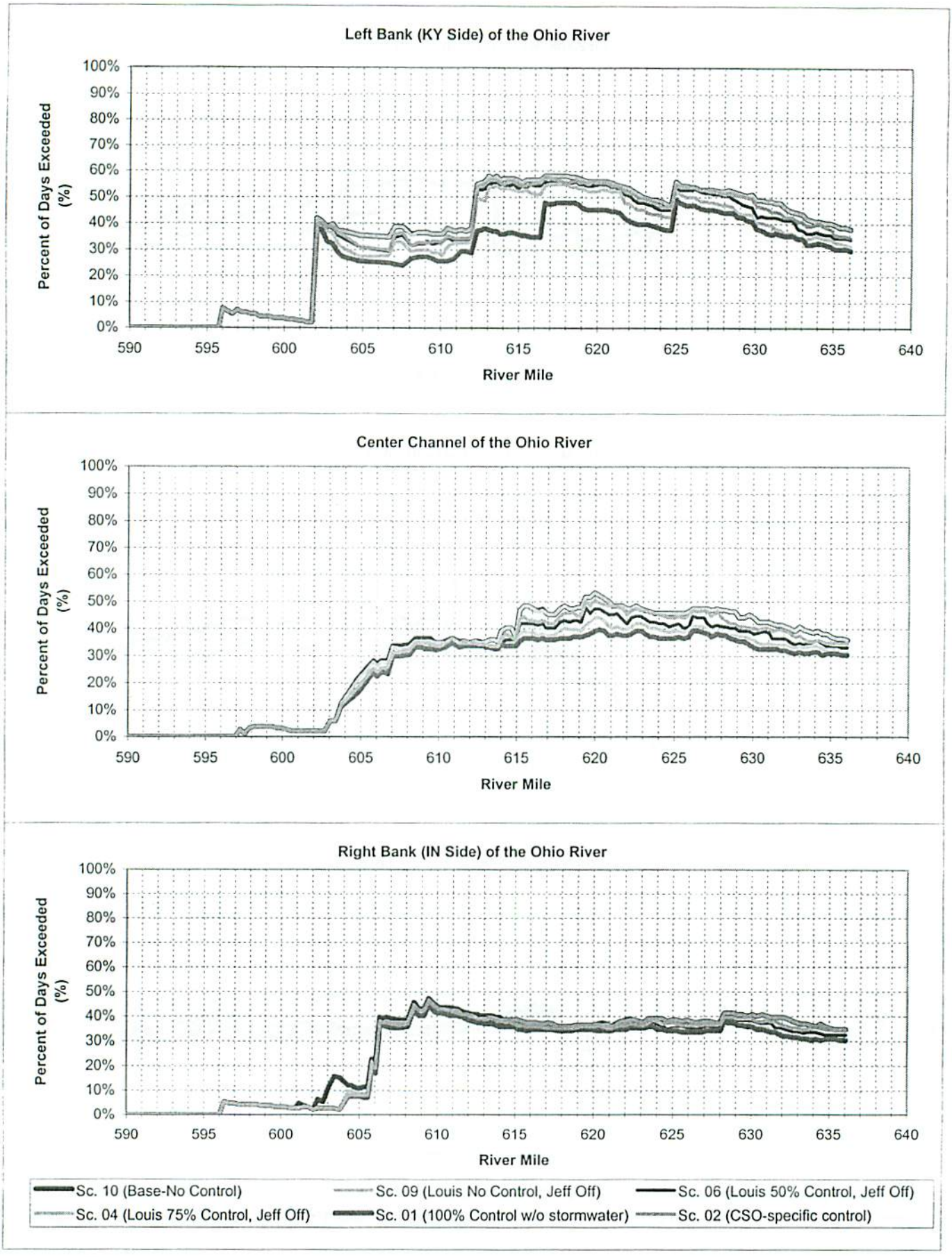


Figure 9-13. Frequency of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) During Recreation Season (184 Days) for Scenario Grouping 4

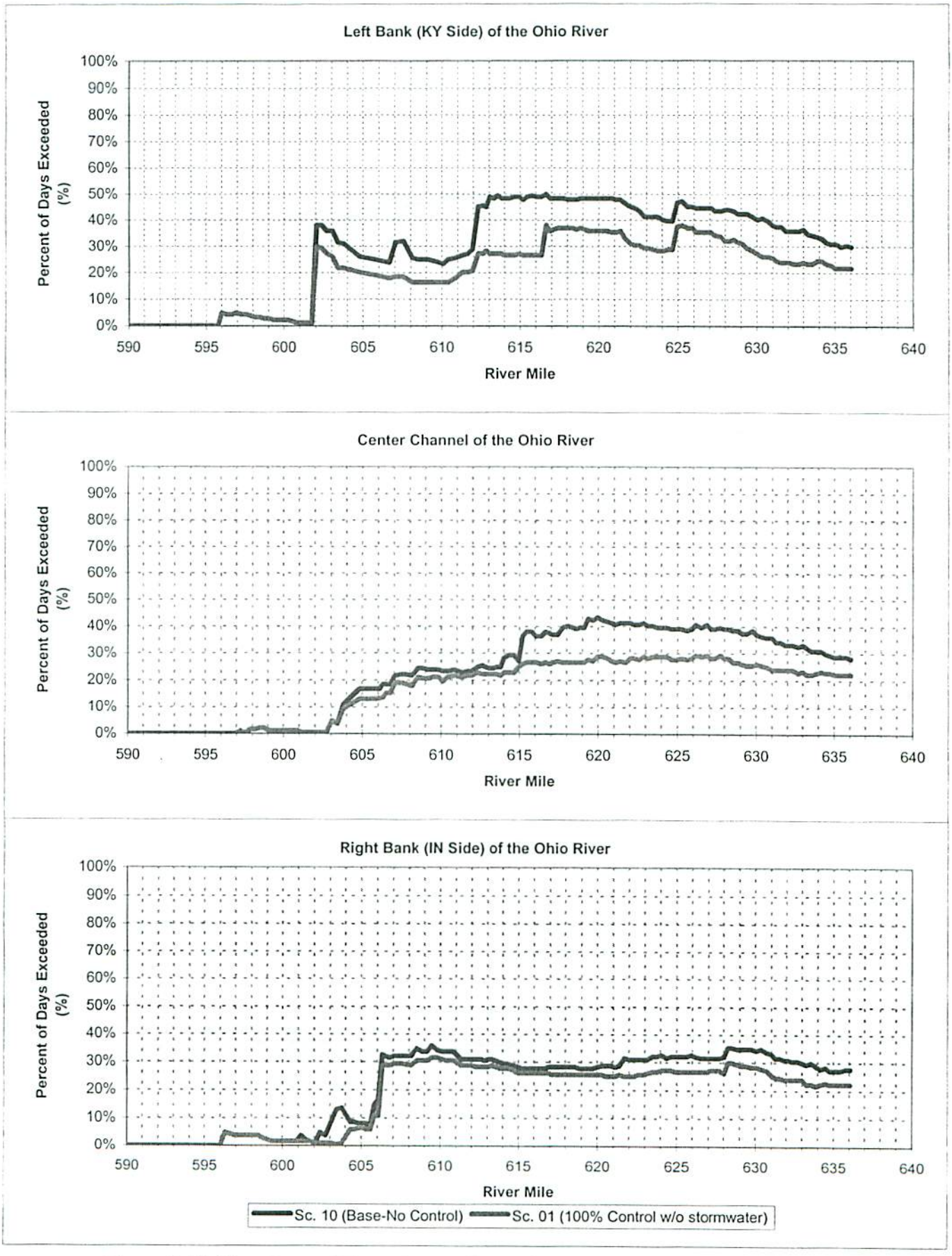


Figure 9-14. Frequency of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) During Recreation Season (184 Days) for Scenario Grouping 1

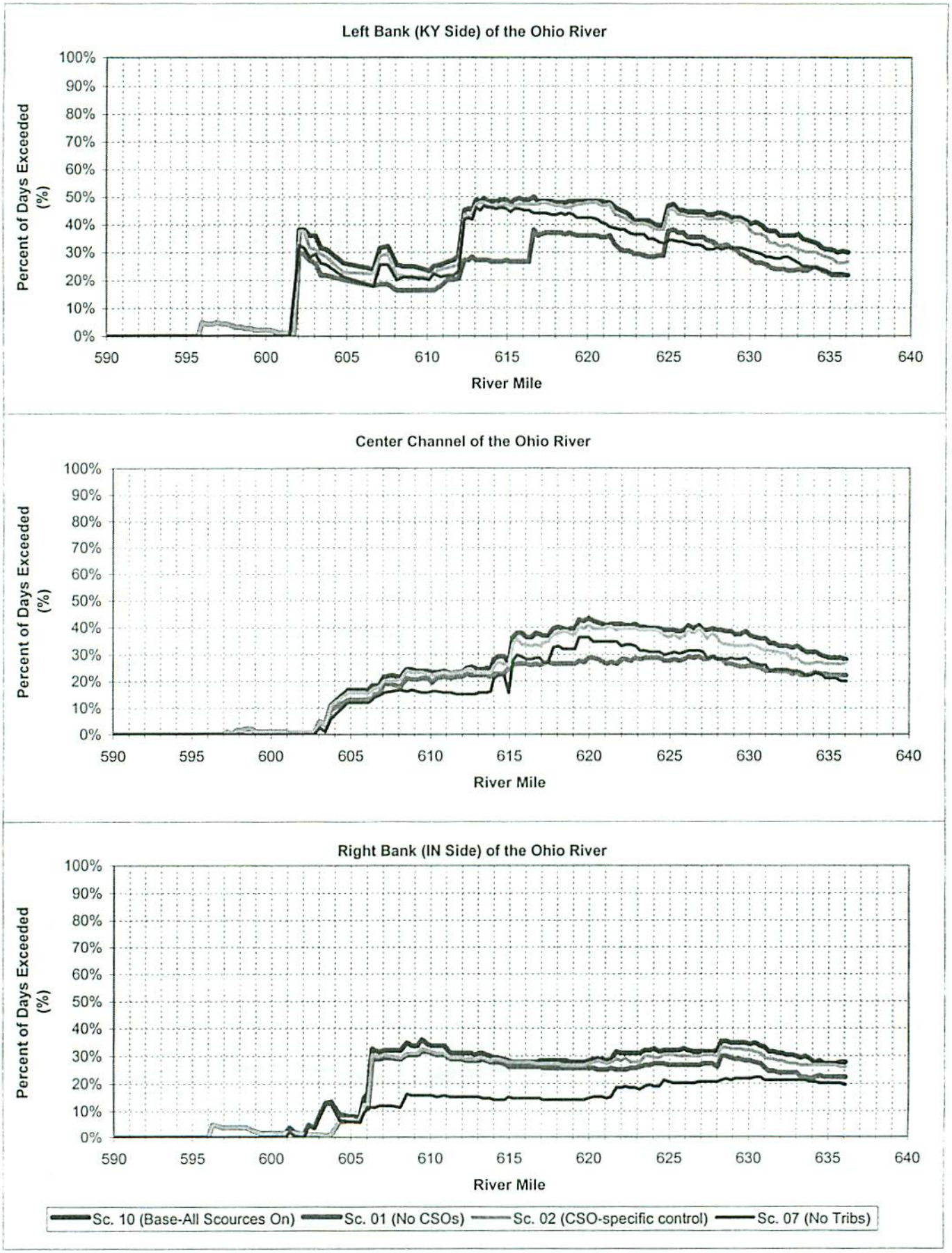


Figure 9-15. Frequency of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) During Recreation Season (184 Days) for Scenario Grouping 2

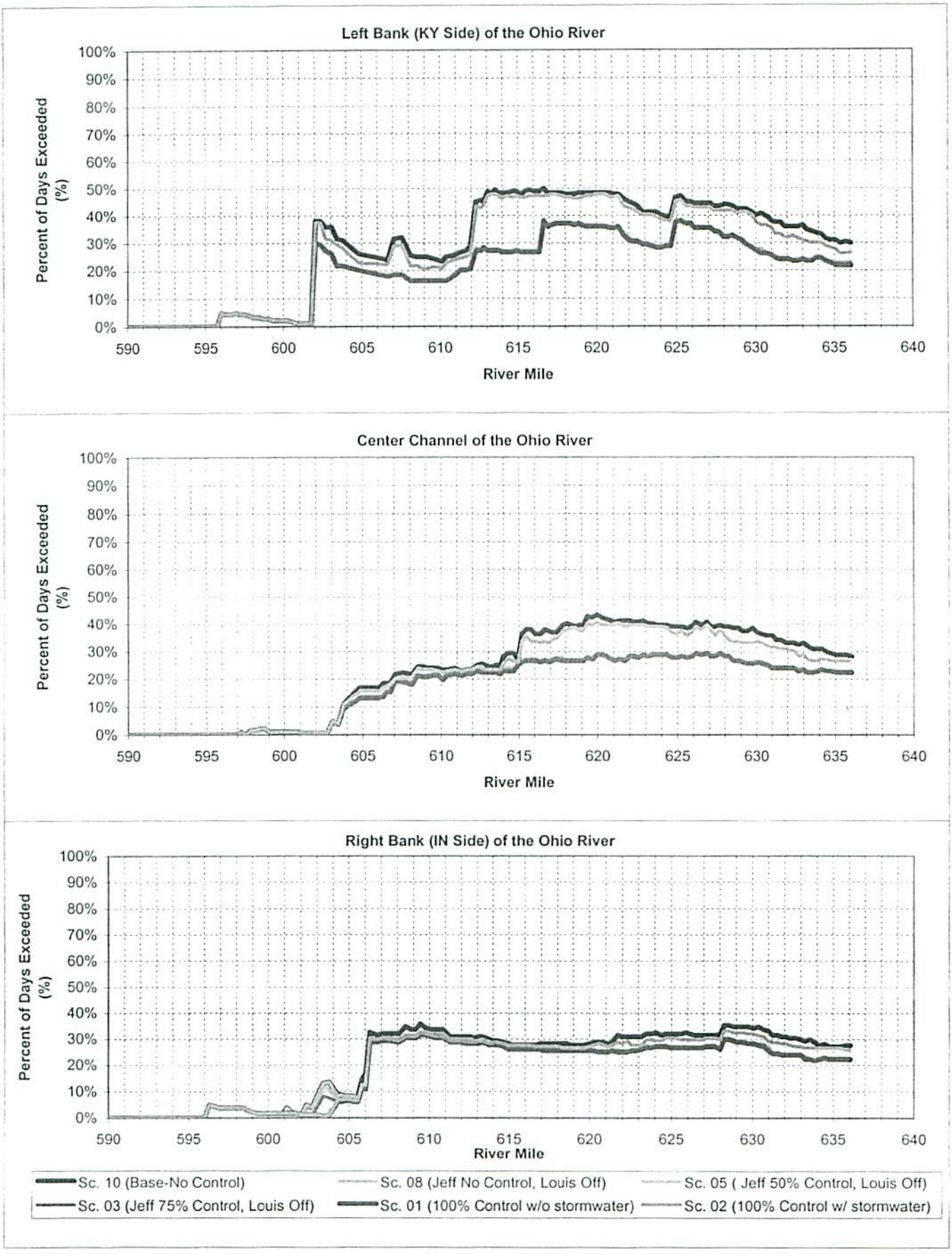


Figure 9-16. Frequency of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) During Recreation Season (184 Days) for Scenario Grouping 3

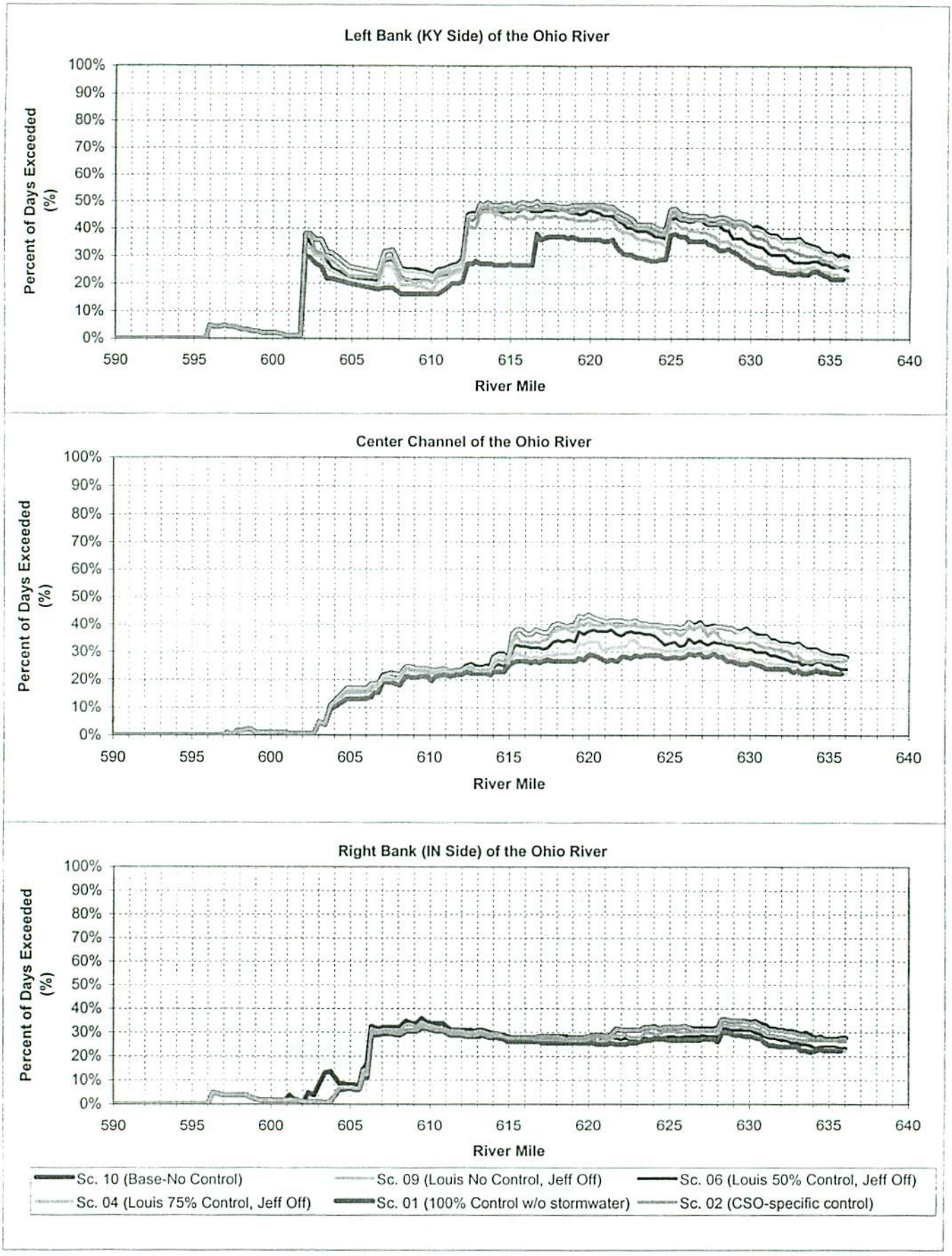


Figure 9-17. Frequency of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) During Recreation Season (184 Days) for Scenario Grouping 4

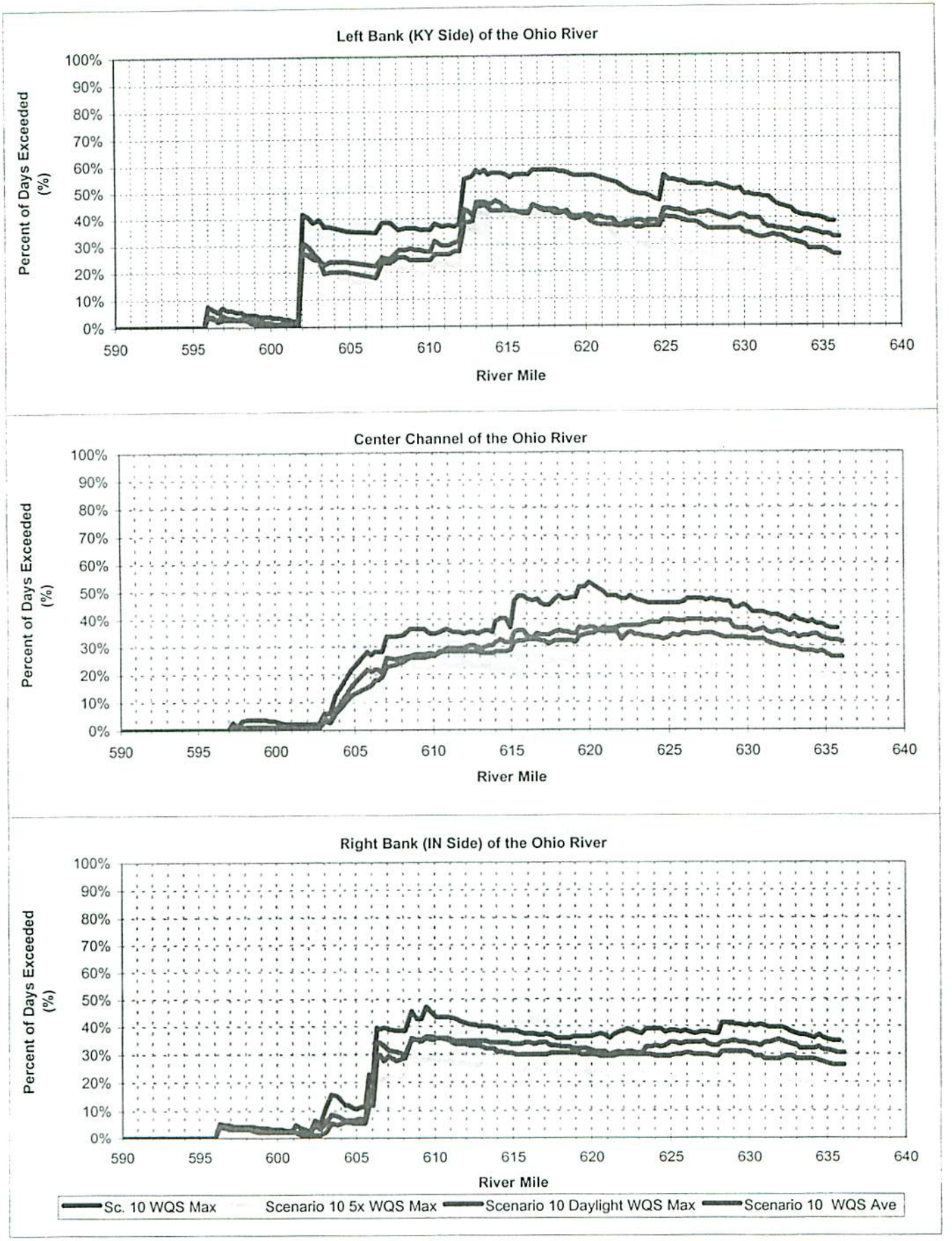


Figure 9-18. Alternative Comparisons of Frequency of Exceedance of Single Sample Maximum Fecal Coliform Criterion for Current Condition Scenario (#10)

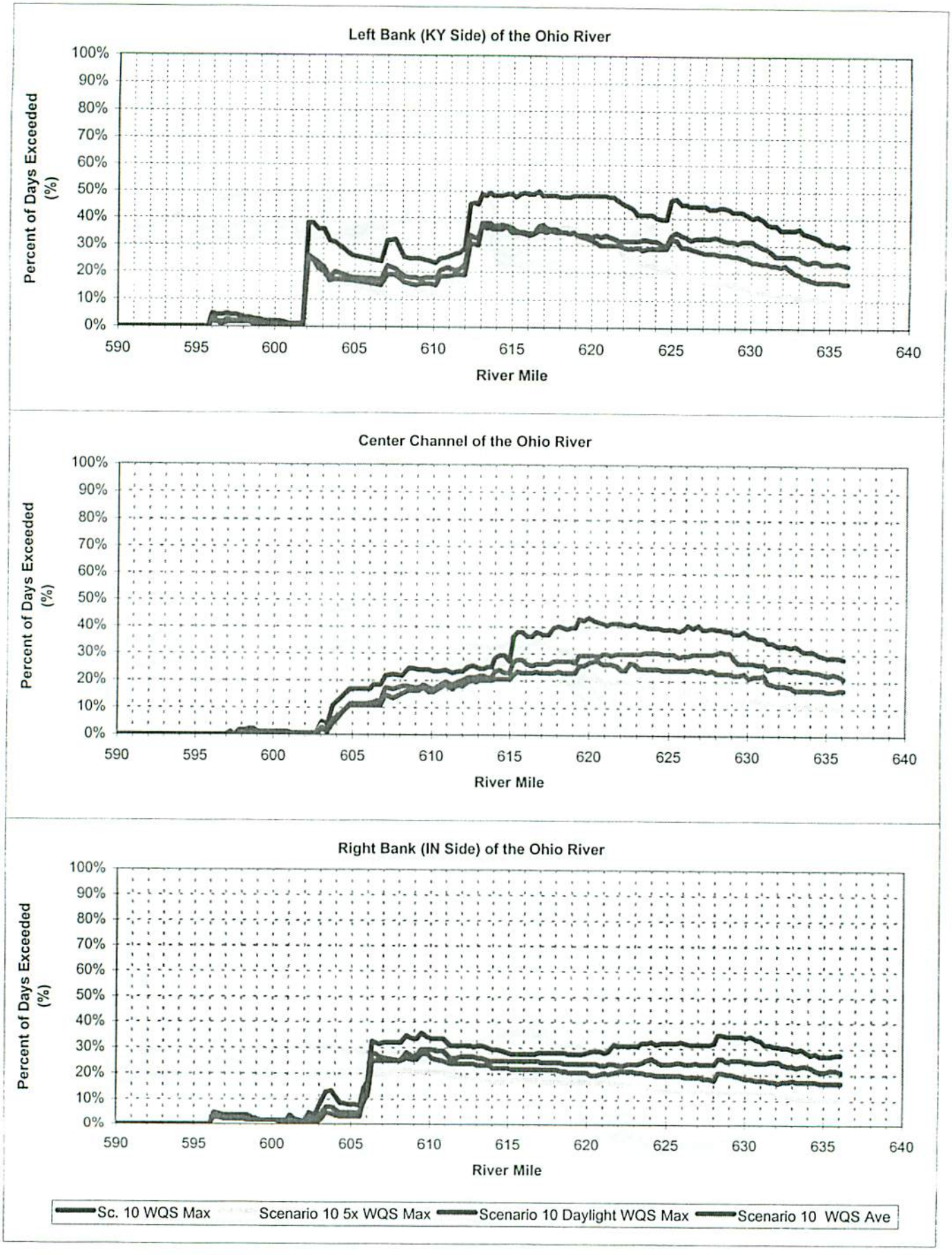


Figure 9-18. Alternative Comparisons of Frequency of Exceedance of Single Sample Maximum E. coli Criterion for Current Condition Scenario (#10)

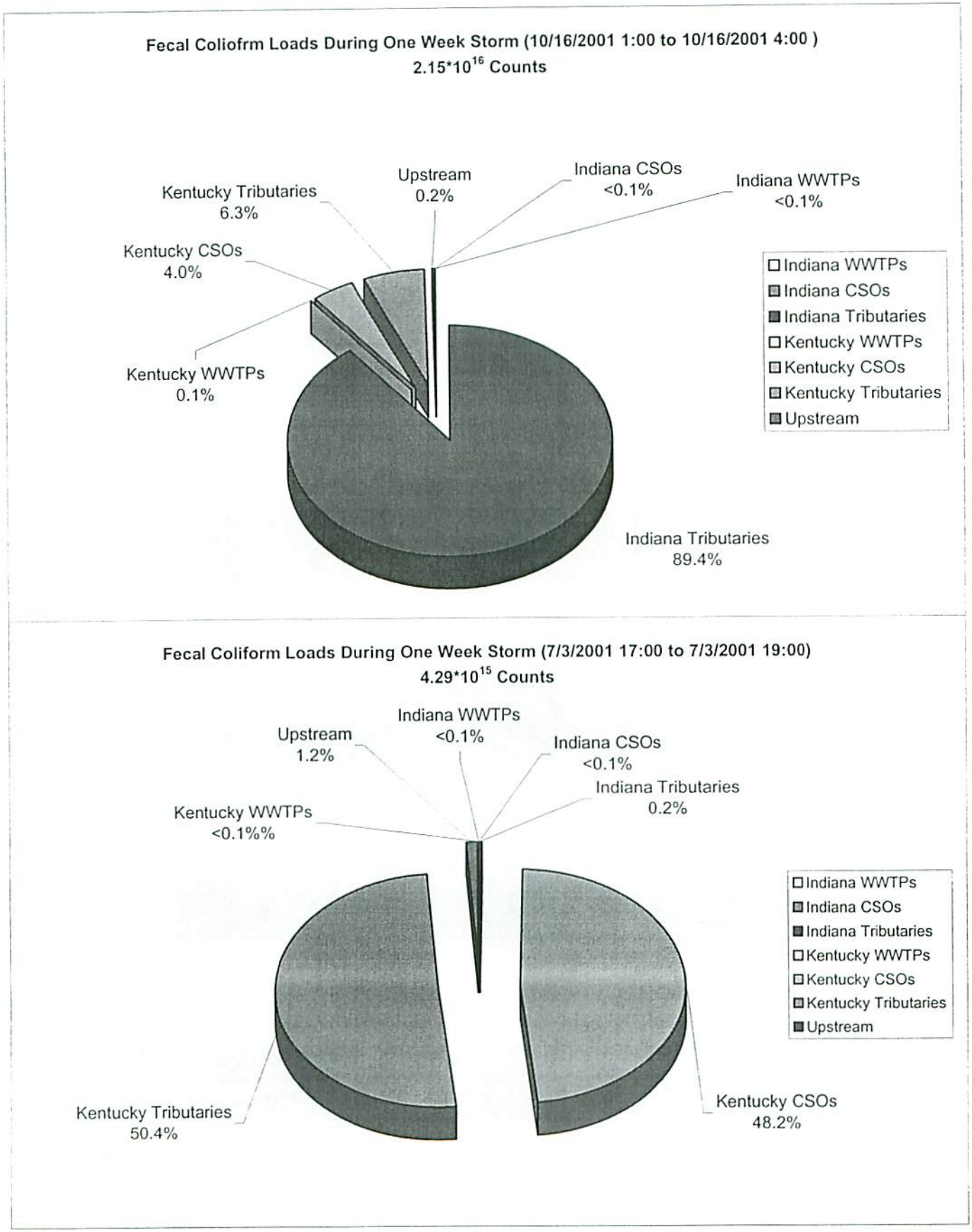


Figure 9-20. Fecal coliform Loads for Two 1-week Storms (0.2 inches) During "Typical" Year

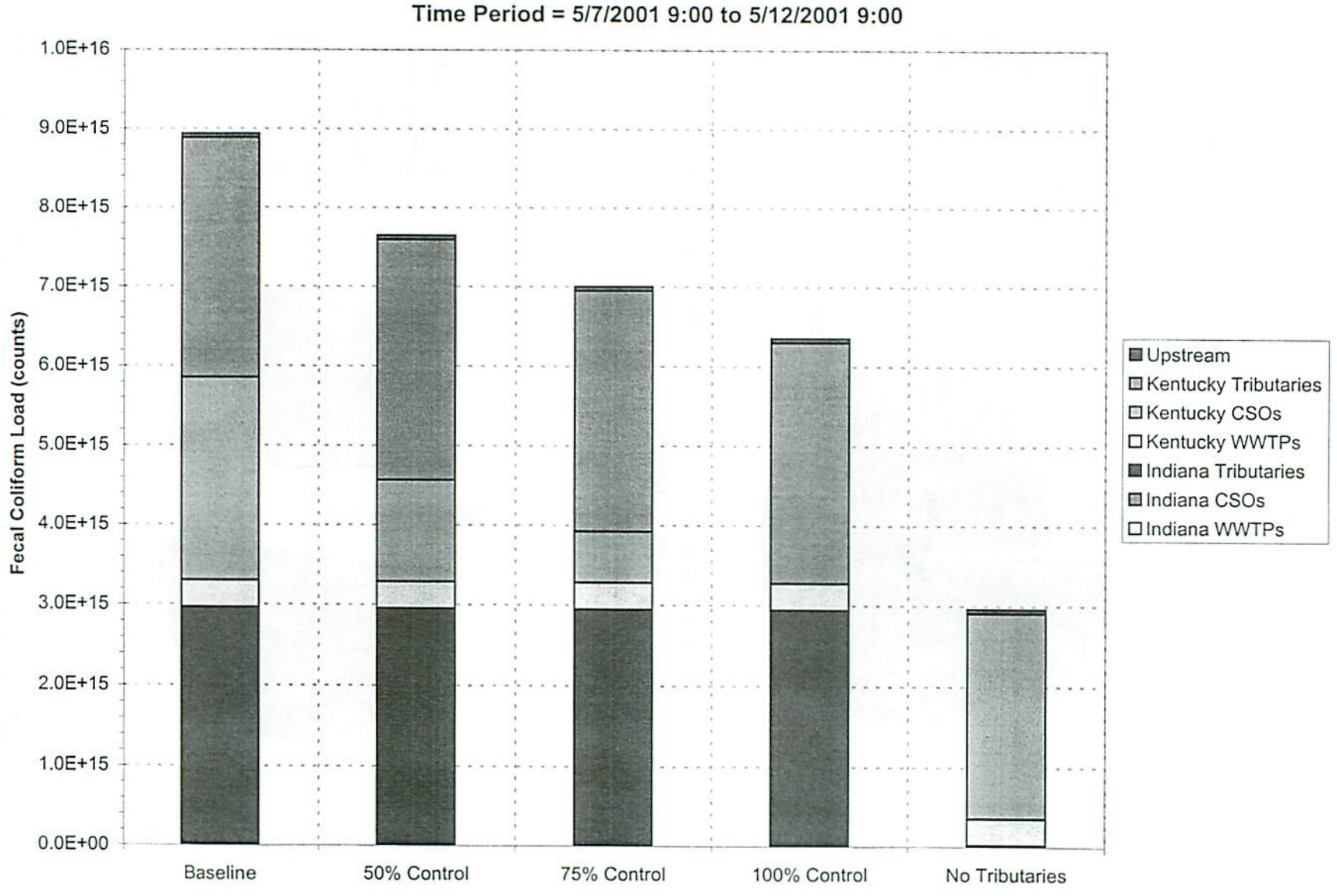


Figure 9-21. May 7, 2001 Event Fecal Coliform Load Distribution by Source Type for Reduction Scenarios

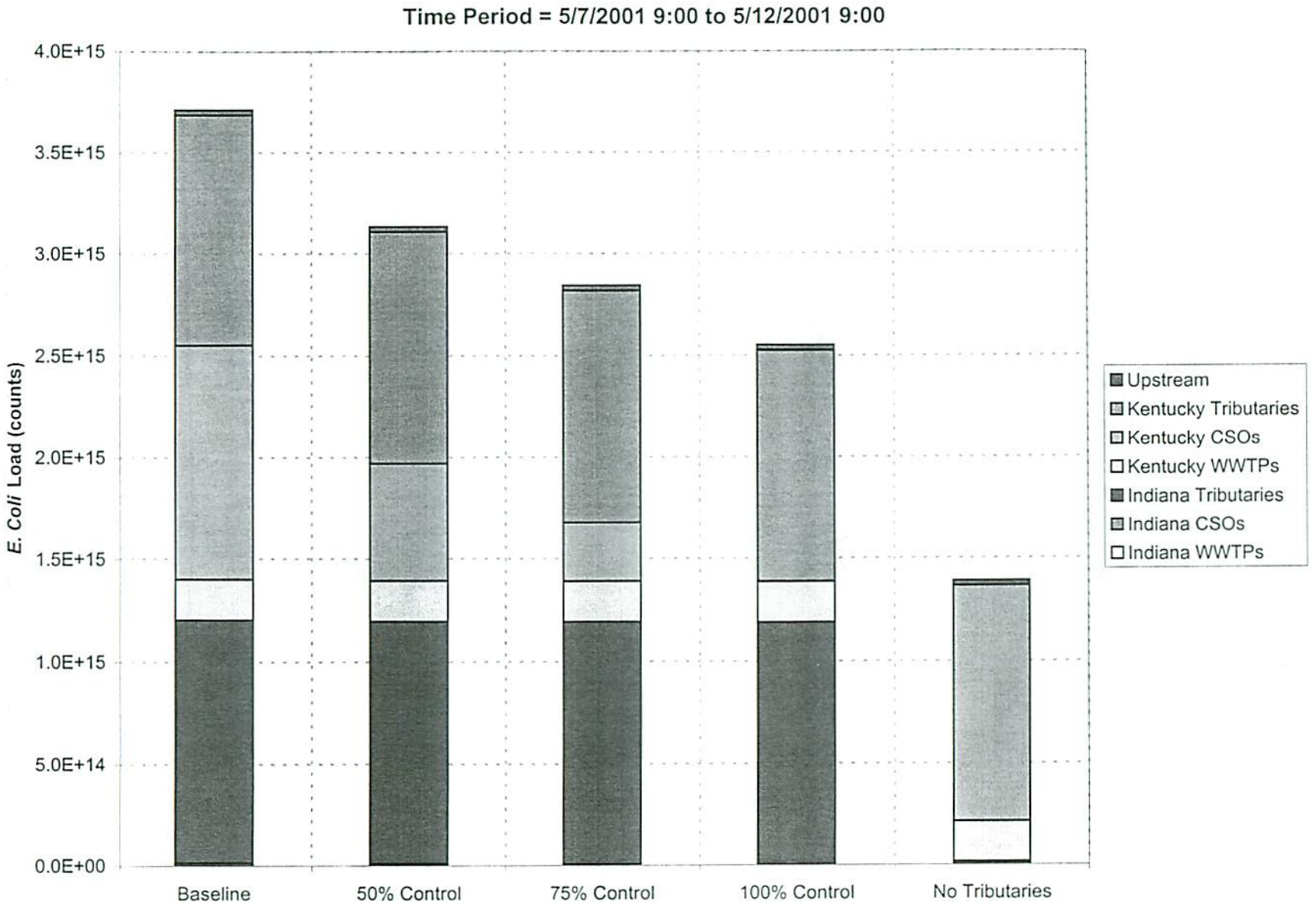


Figure 9-22. May 7, 2001 Event *E. coli* Load Distribution by Source Type for Reduction Scenarios

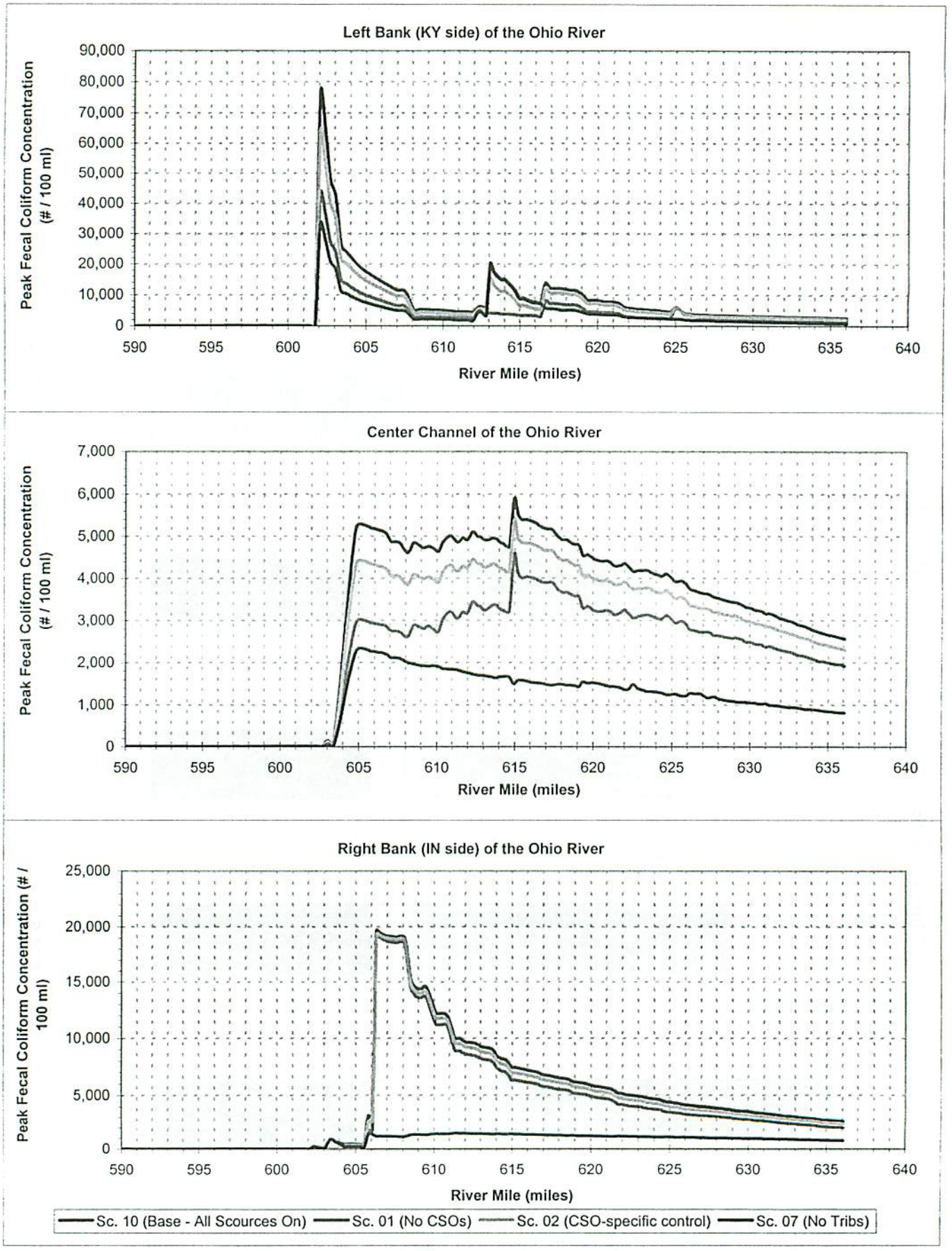


Figure 9-23. Peak Fecal Coliform Concentrations During May 7, 2001 Event for Scenario Group 2 (Source Control)

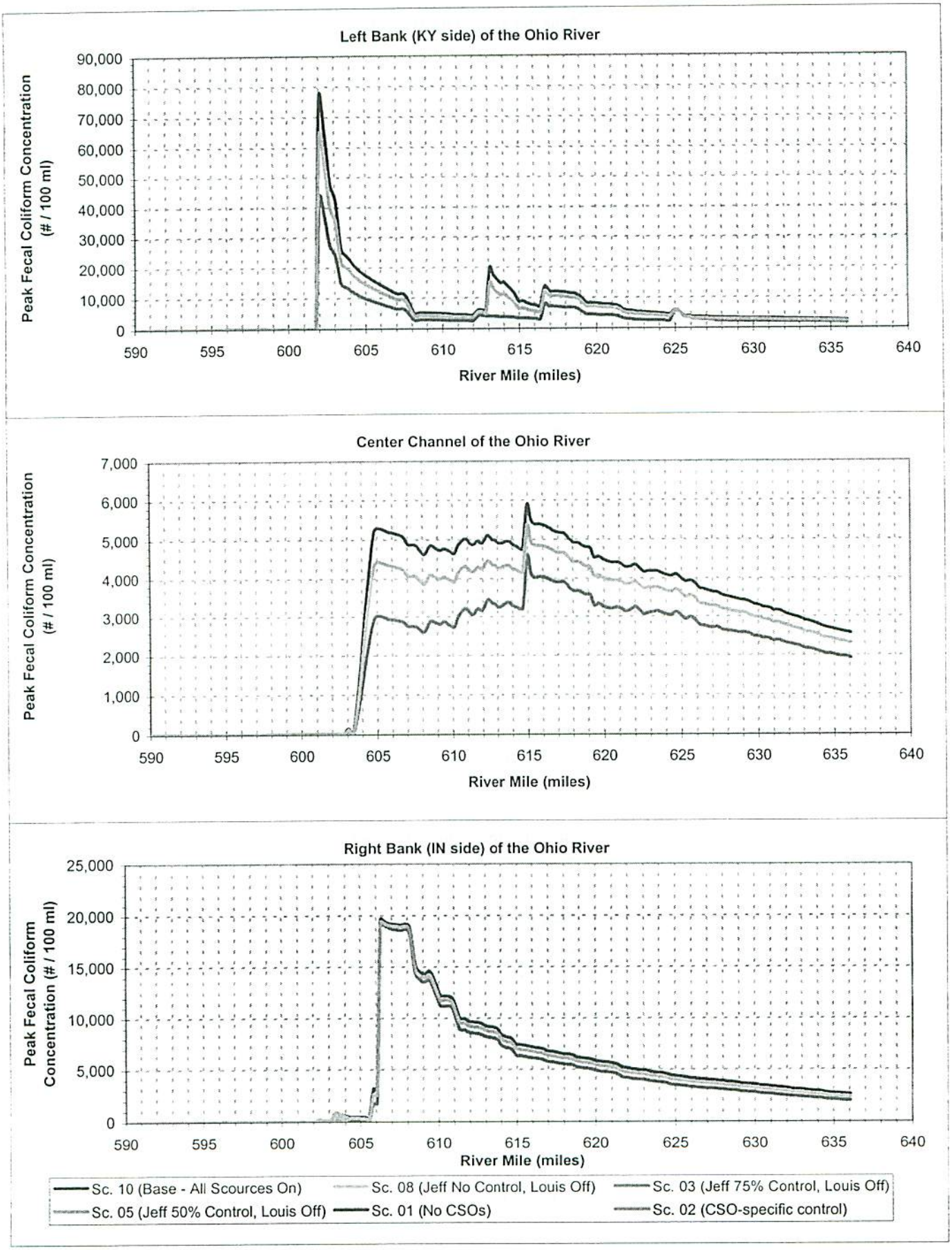


Figure 9-24. Peak Fecal Coliform Concentrations During May 7, 2001 Event for Scenario Group 3 (Jeffersonville Only Control)

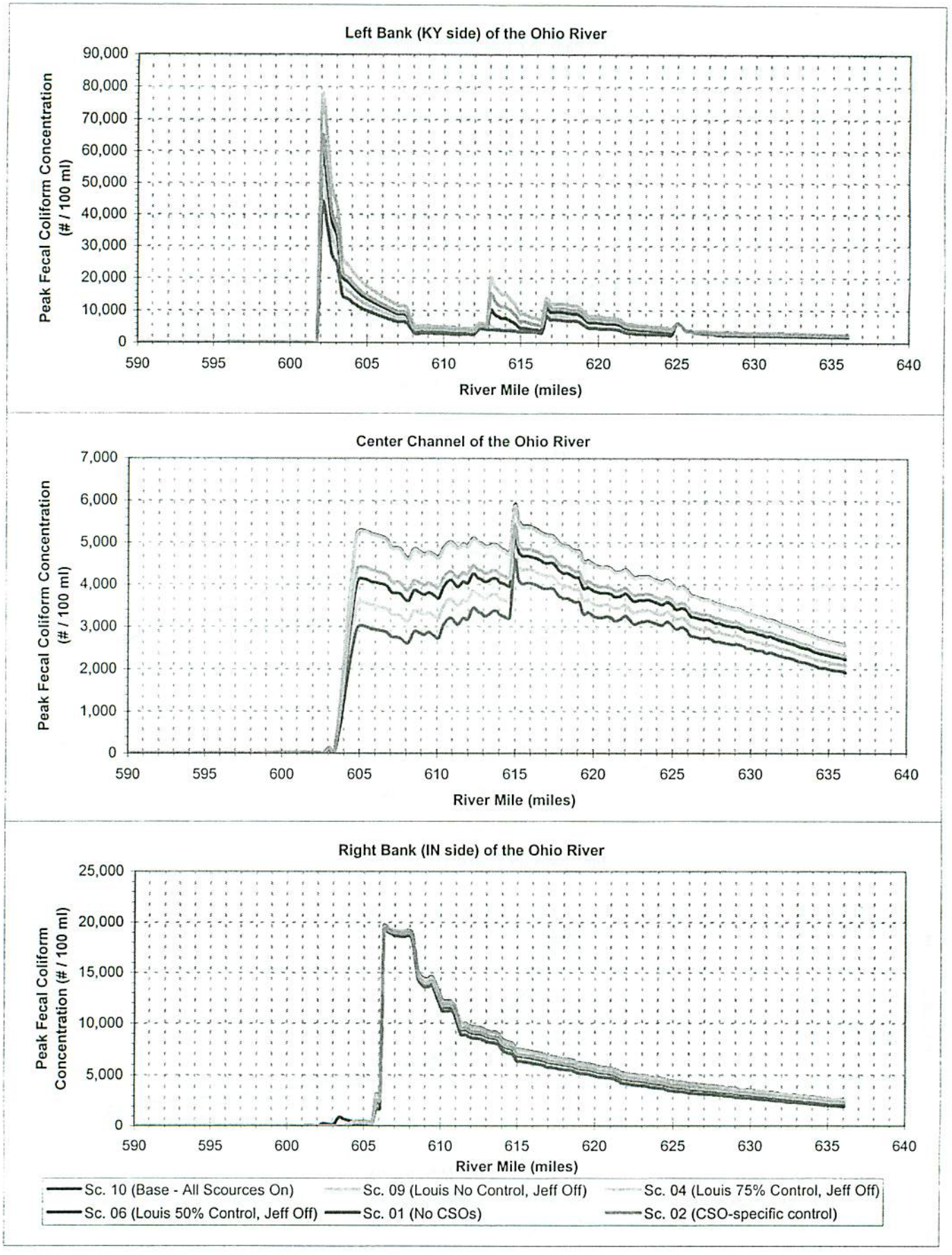


Figure 9-25. Peak Fecal Coliform Concentrations During May 7, 2001 Event for Scenario Group 4 (Louisville Only Control)

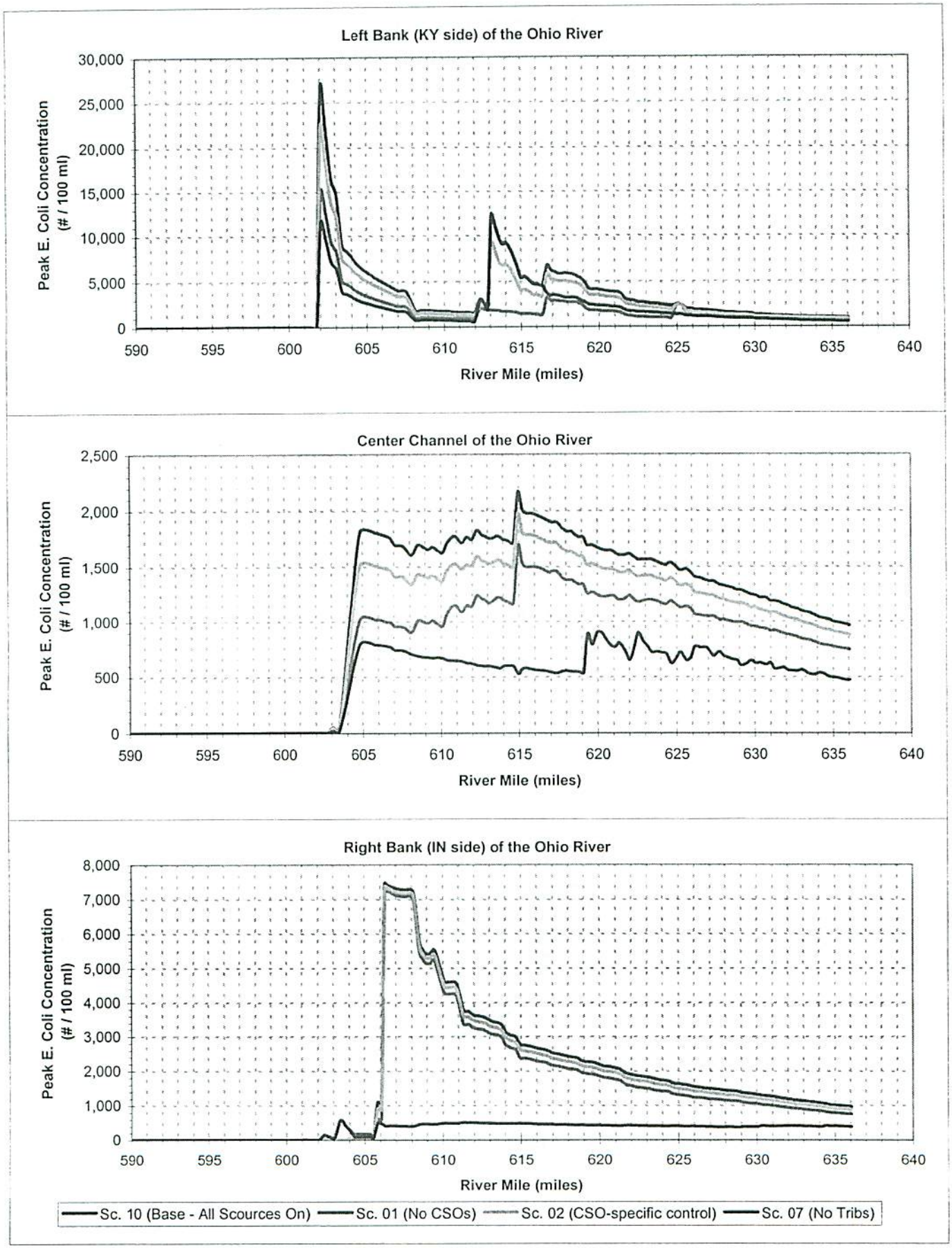


Figure 9-26. Peak *E. coli* Concentrations During May 7, 2001 Event for Scenario Group 2 (Source Control)

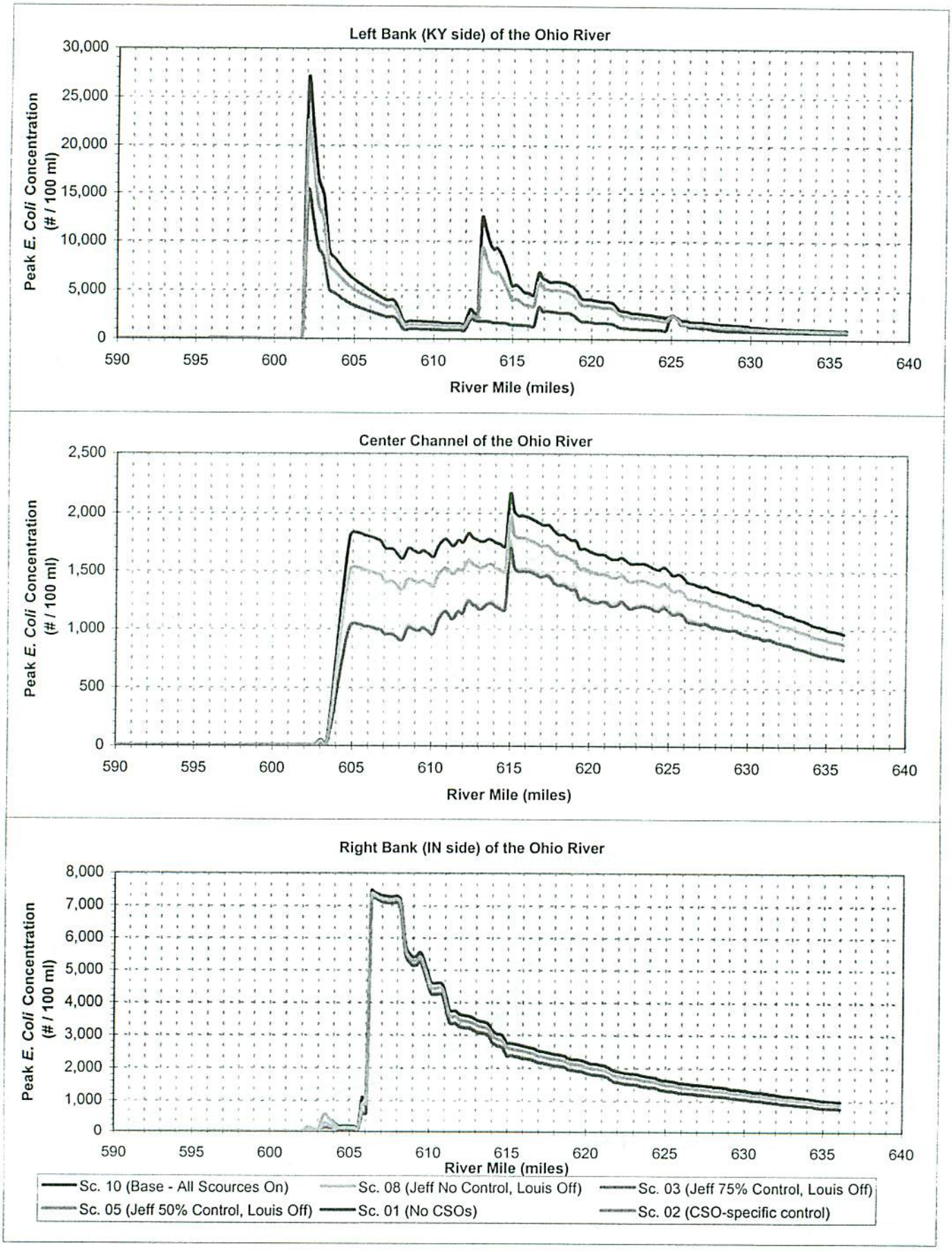


Figure 10-9 Peak *E. coli* Concentrations During May 7, 2001 Event for Scenario Group 3 (Jeffersonville Only Control)

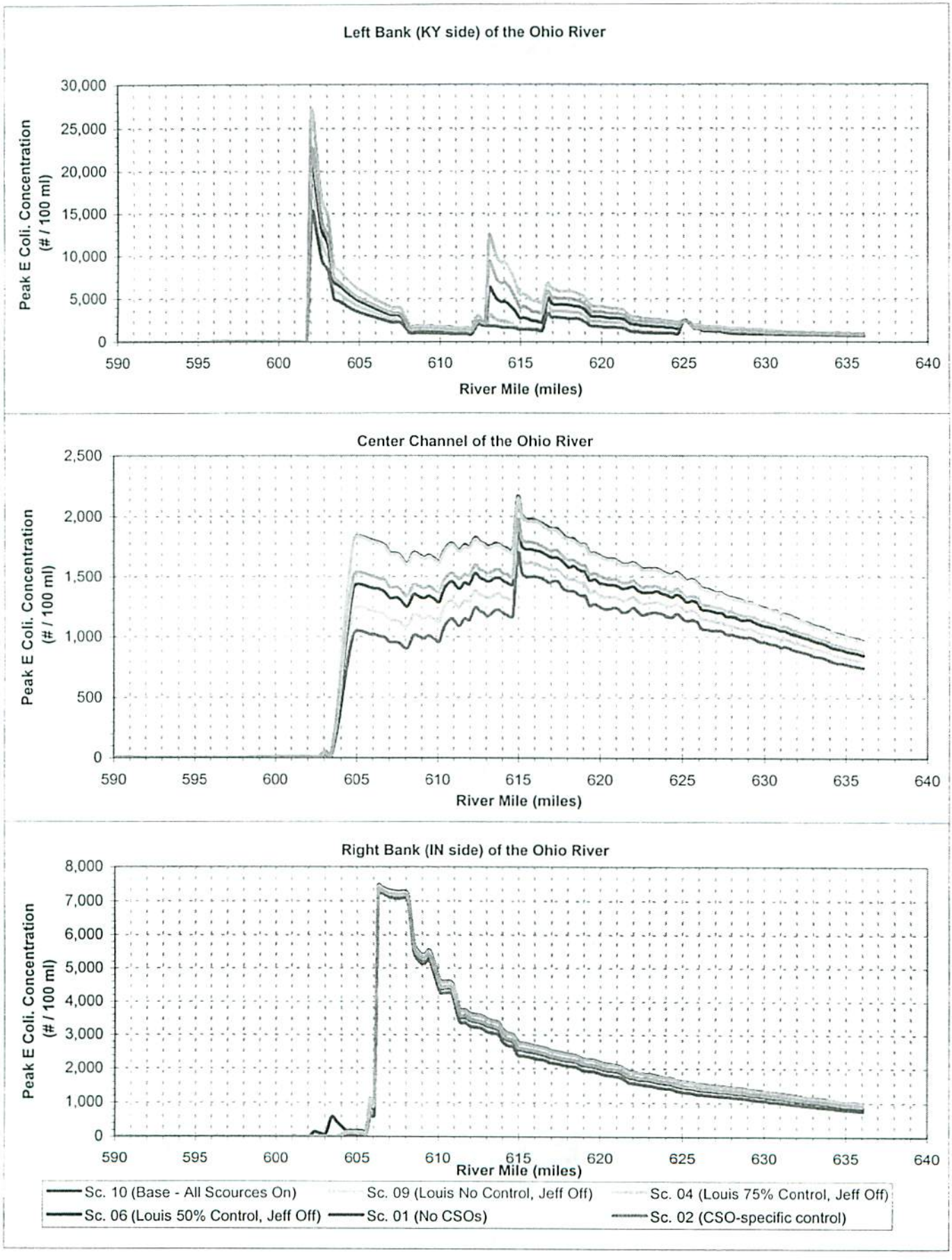


Figure 10-9 Peak *E. coli* Concentrations During May 7, 2001 Event for Scenario Group 4 (Louisville Only Control)

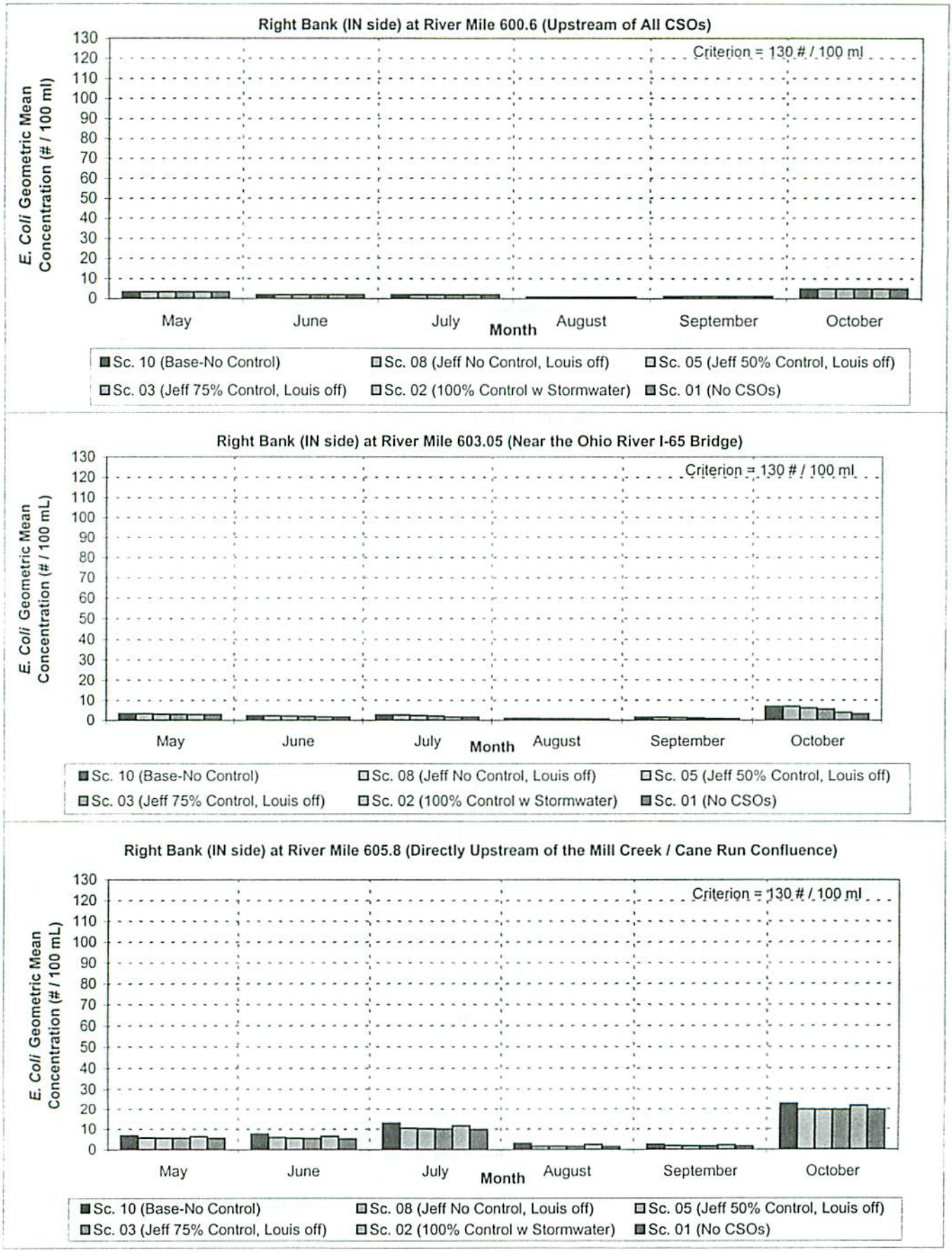


Figure 9-29. Monthly *E. coli* Geometric Mean Concentrations at Five Locations Near Jeffersonville

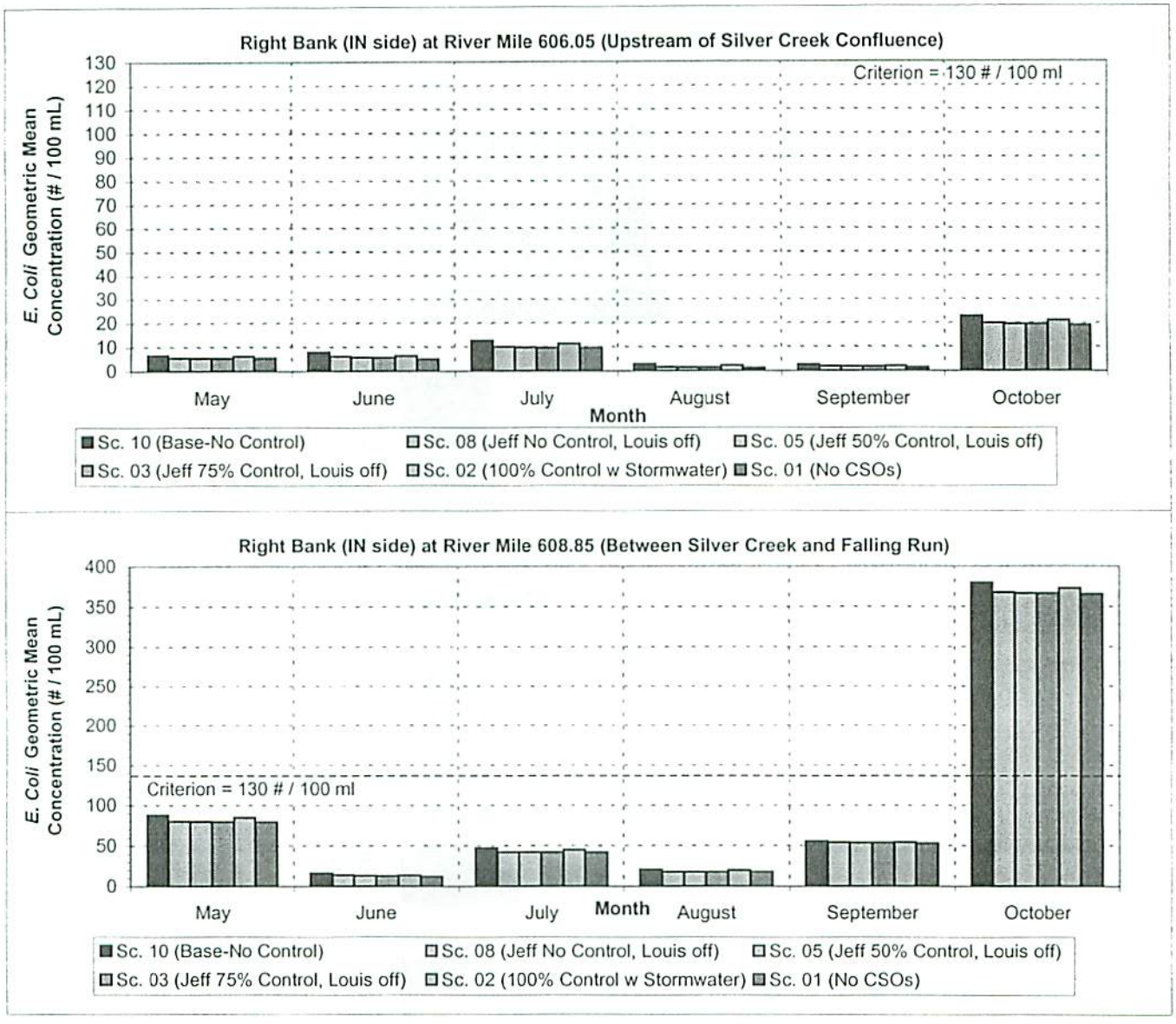


Figure 9-29. Monthly *E. coli* Geometric Mean Concentrations at Five Locations Near Jeffersonville

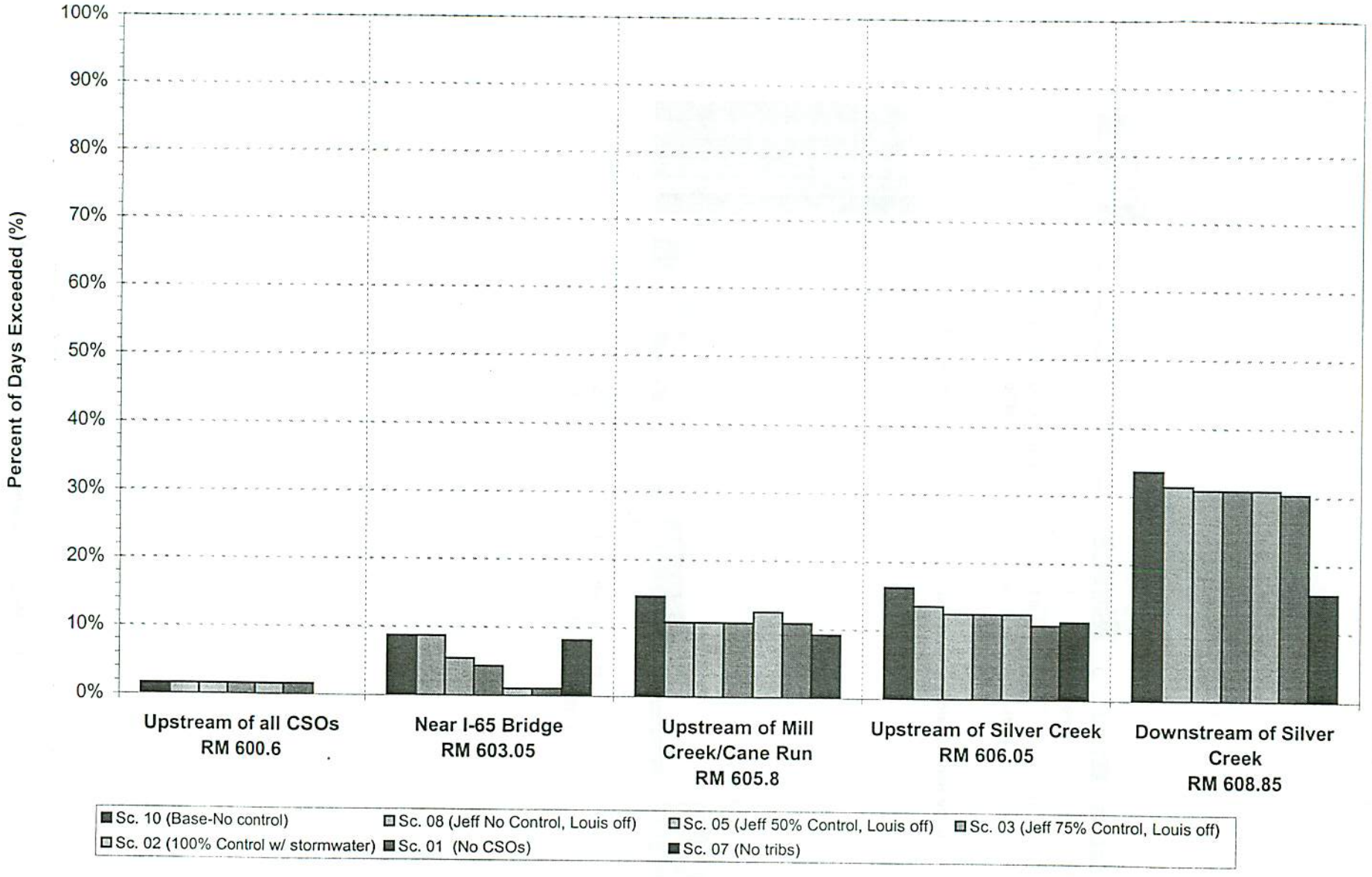


Figure 9-30. Comparison of Percent Exceedance of E. coli Single Sample Maximum Criterion (240 cfu/100 ml) at Five Locations Near Jeffersonville

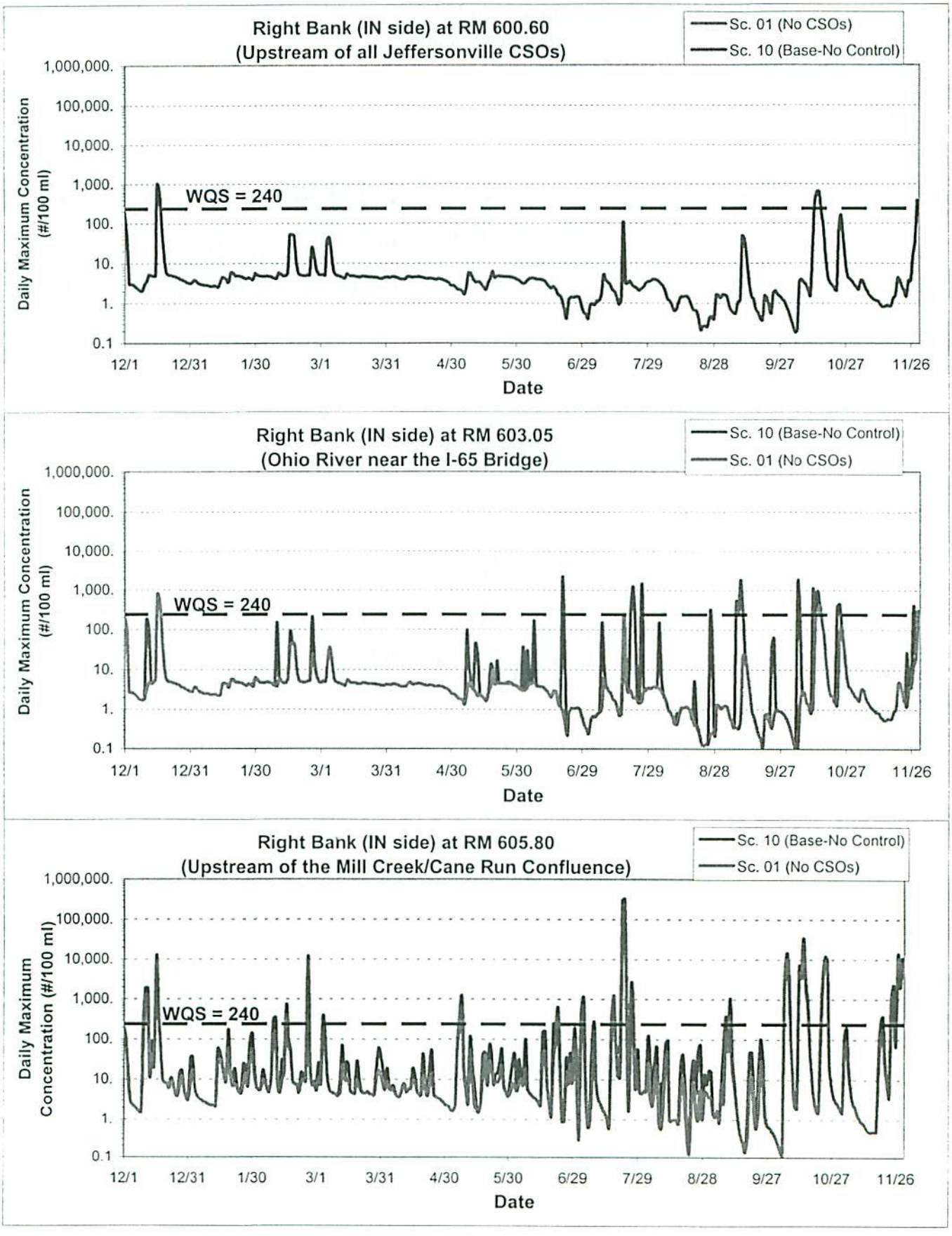


Figure 9-31. Daily Maximum *E. coli* Concentrations at Five Locations Near Jeffersonville for Scenario Grouping 1 (CSO Control)

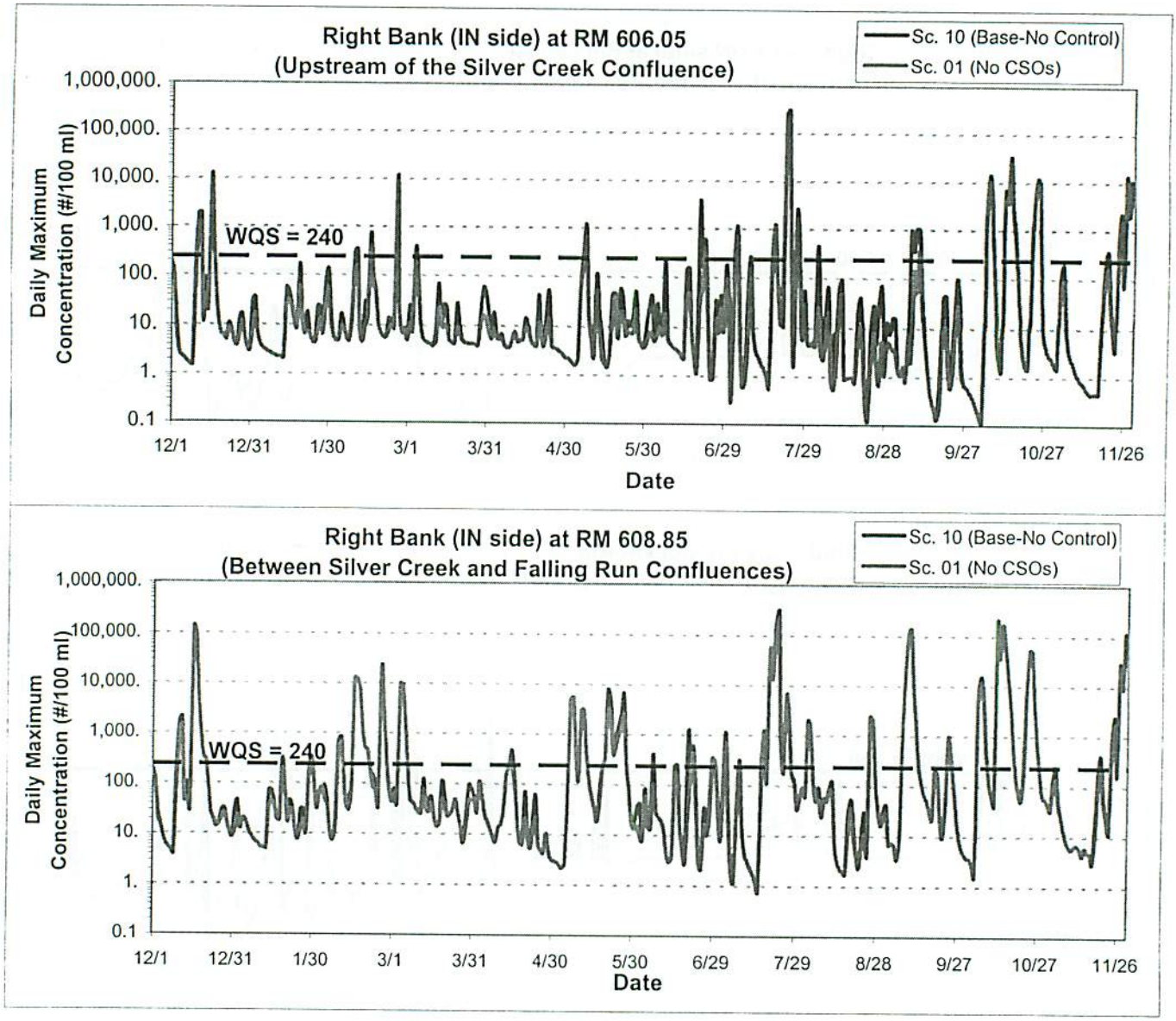


Figure 9-31. Daily Maximum *E. coli* Concentrations at Five Locations Near Jeffersonville for Scenario Grouping 1 (CSO Control)

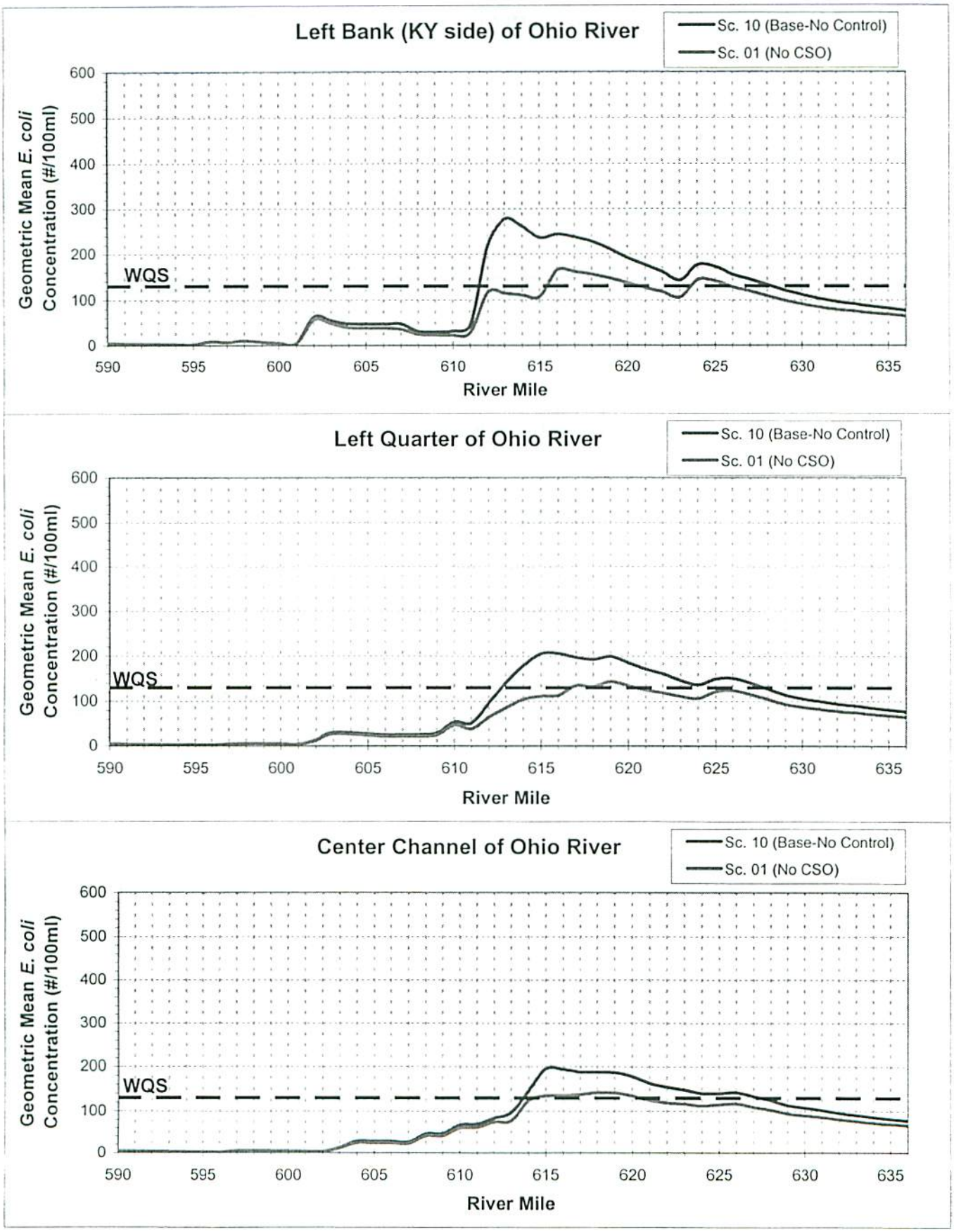


Figure 9-32. Longitudinal Profile of October *E. coli* Geometric Mean Concentrations for Scenario Grouping 1 (CSO Control)

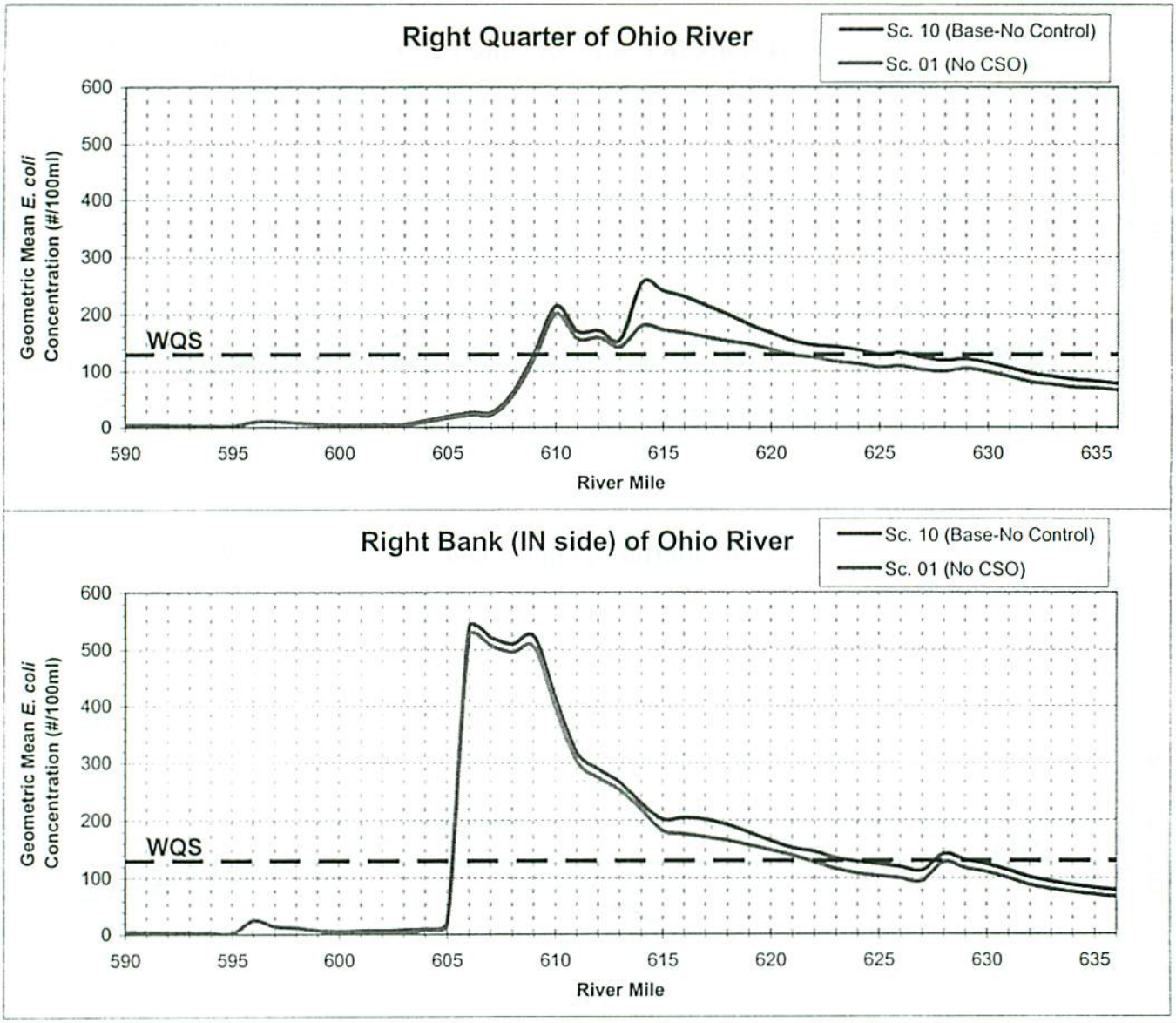


Figure 9-32. Longitudinal Profile of October *E. coli* Geometric Mean Concentrations for Scenario Grouping 1 (CSO Control)

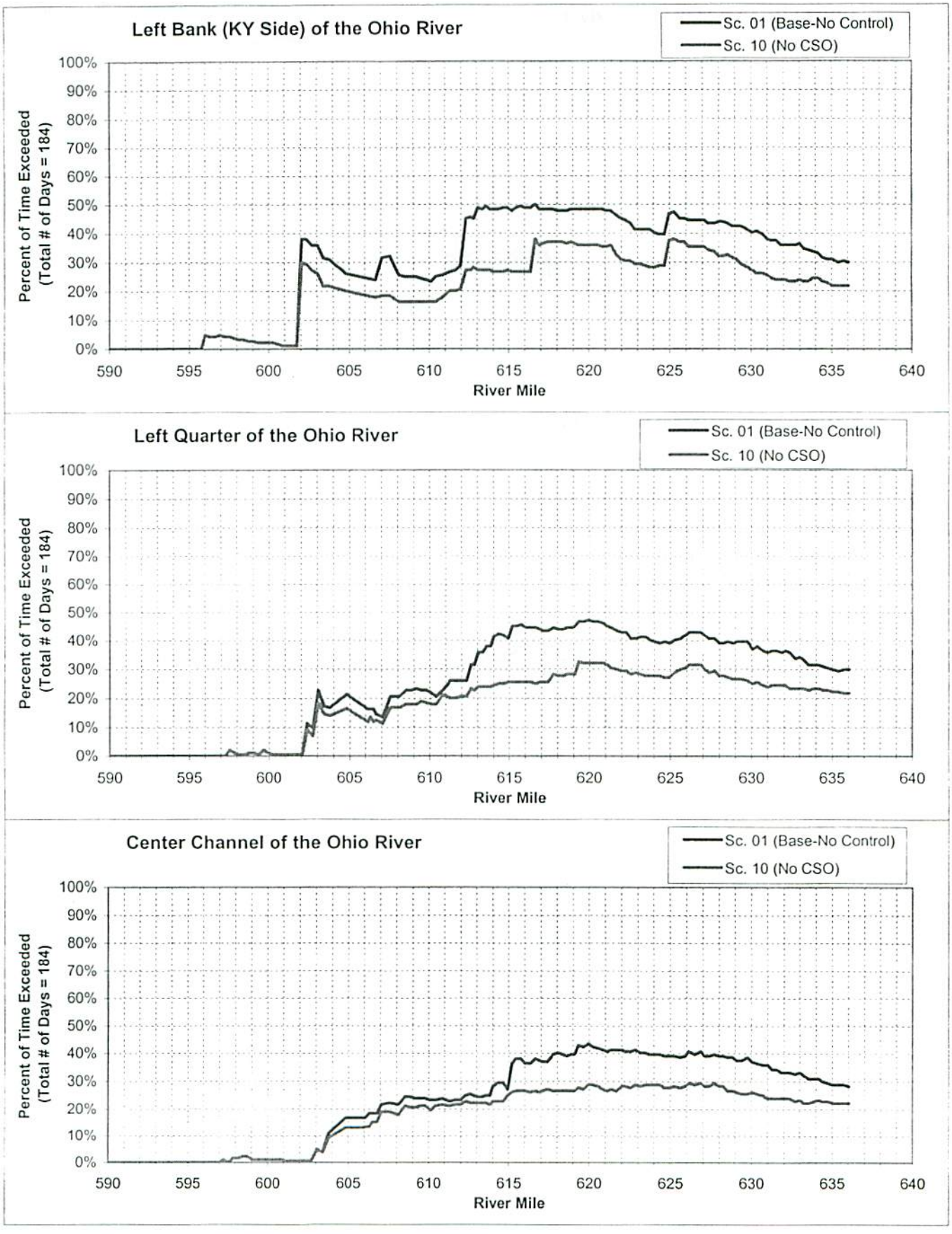


Figure 9-33. Longitudinal Profiles of *E. coli* Single Sample Maximum Criterion (240 cfu/100 mL) Exceedance Frequency for Scenario Grouping 1 (CSO Control)

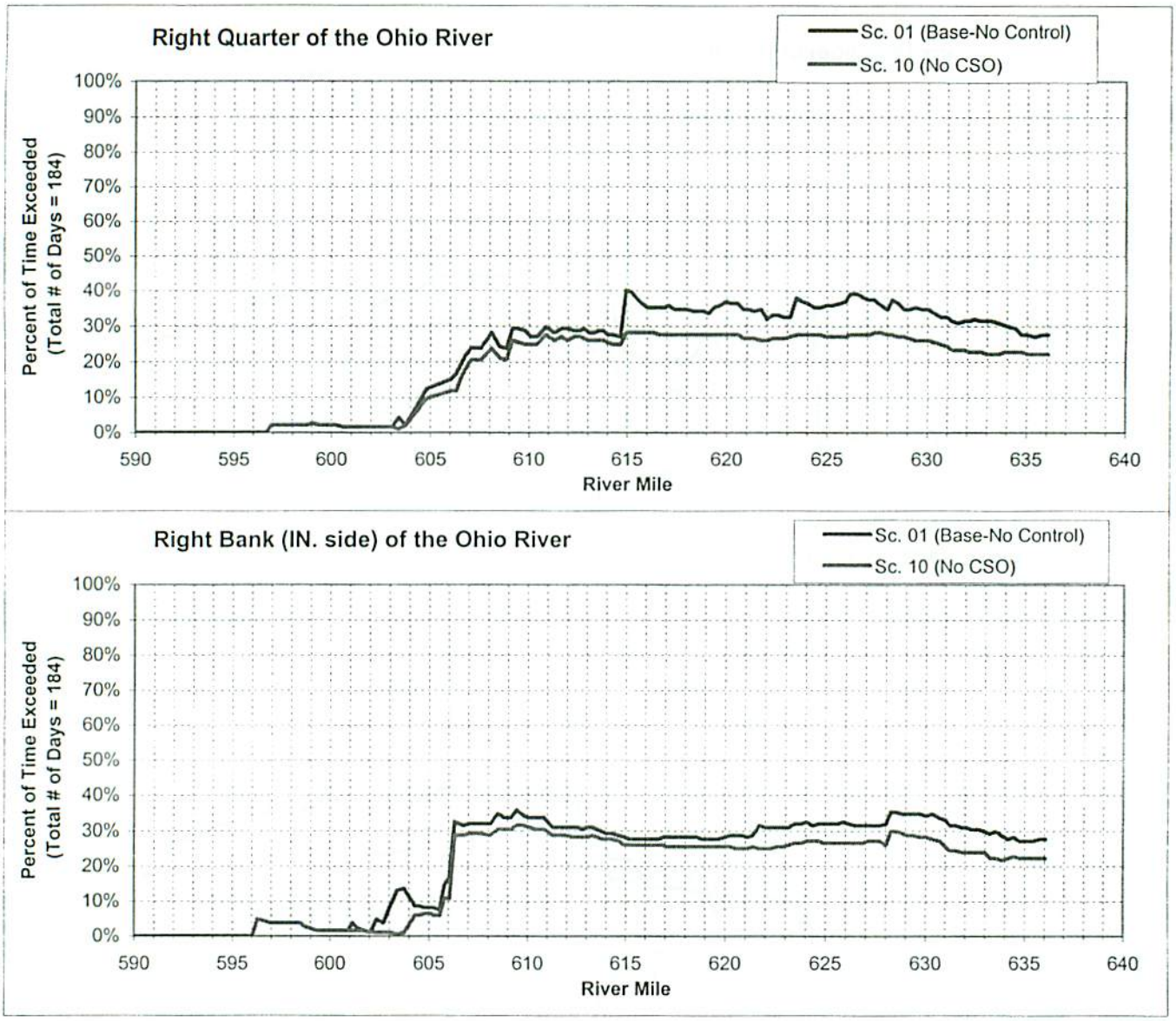


Figure 9-33. Longitudinal Profiles of *E. coli* Single Sample Maximum Criterion (240 cfu/100 mL) Exceedance Frequency for Scenario Grouping 1 (CSO Control)

10.0 SUMMARY

This section summarizes results and conclusions from individual chapters of this report and contains several items not discussed elsewhere.

10.1 TRANSFERRABILITY OF FRAMEWORK

A primary objective of this study was to transfer the methodologies and technologies developed in the Cincinnati/Northern Kentucky Wet Weather Demonstration Study for the evaluation of wet weather impacts and controls on large rivers, to a segment of the Ohio River in the vicinity of Louisville, Kentucky. The successfully transferred framework in summary includes:

1) Monitoring to identify pollutants of concern, calibrate/validate water quality river models, and estimate boundary conditions.
2) Landside modeling to estimate wet weather loads to surface waters. In this case, HSPF was used for both the Louisville and Southern Indiana sides of the river.
3) Hydrodynamic modeling to simulate the complex hydrodynamics of the Ohio River around the McAlpine Locks and Dam, located in the middle of the study area. A two-dimensional RMA-2 model was used.
4) River water quality modeling to predict water quality conditions during periods not monitored and to evaluate resulting water quality from various pollution abatement scenarios. WASP5 was used to model Ohio River water quality.
5) Execution of the model for typical conditions and various control scenarios.

10.2 POLLUTANTS OF CONCERN

Based on water quality studies and historical data, bacteria were determined to be the only cause of impairment from wet weather. A large number of parameters were monitored, as noted in Chapter 2, in order to reach this conclusion. Dissolved oxygen (DO) was heavily scrutinized, including an evaluation of historical data in order to determine that DO is not a wet weather concern for the Louisville area. This conclusion should not be construed to apply to other urban areas. Each urban area should be considered to be unique, with problems particular to the area being evaluated. For instance, in the Wheeling, West Virginia area, ORSANCO evaluated dissolved metals as a wet weather concern from acid mine drainage, whereas acid mine drainage would not be considered in the Louisville, Kentucky area.

10.3 WET AND DRY WEATHER WATER QUALITY SURVEY OBSERVATIONS

- Ohio River bacteria concentrations exceed levels for the protection of human health from contact recreation and drinking water, at times even during dry weather.

- Ohio River bacteria concentrations in the Greater Louisville area tend to be very high during the first two days following a storm event, then decline rapidly. During the 1999 and 2000 wet weather water quality surveys, maximum Ohio River bacteria concentrations were two orders of magnitude greater than the level for the protection of human health from contact recreation.
- Of the major tributaries within the study area, Beargrass Creek in Kentucky and Silver Creek in Indiana have the highest bacteria concentrations after a storm event, followed by Falling Run in Indiana and the Mill Creek Cutoff in Kentucky. These observations are consistent with the numbers of CSOs and SSOs located within each drainage area.
- The highest concentrations in the Ohio River occur immediately downstream of the major tributary confluences.
- The tributaries in the Greater Louisville area contributed 80 percent of the bacteria loads to the Ohio River during three of the four wet weather events.

10.4 LANDSIDE LOADING ESTIMATES

CSOs in Louisville were well documented, while CSOs in Southern Indiana were not well documented at the time of this study. Since the completion of the landside loading model, Jeffersonville developed a SWMM model capable of predicting CSO loads. Results from this model were used during the model application stage of this project. For the purposes of the landside loading model, it was assumed that the Southern Indiana CSOs behaved similarly to the median Louisville CSO. Hourly overflow volumes were simulated using regression equations from the SWMM model of Louisville's collection system. CSOs were clustered by location, volume and frequency to estimate missing data. Event Mean Concentrations (EMCs) were calculated for each storm. Total event loads were estimated by multiplying the total overflow volumes by the EMCs. Additional water quality monitoring of the CSO outfalls would have been useful for estimating the EMCs.

In addition to estimating bacteria loads from CSOs in each of the major tributary watersheds, nonpoint source bacteria loads from tributaries were also estimated for the period of this study. It would have been beneficial to have long term, routine monitoring of the tributary upstream catchment areas, as well as at their confluence with the Ohio River to facilitate more accurate estimates of bacteria loads coming from non-CSO sources.

10.5 RIVER WATER QUALITY MODEL

- The river model is comprised of the RMA-2V hydrodynamic model to simulate flow and the WASP5 model to simulate pollutant transport and fate. The purpose of these models is to predict water quality conditions for specific storm events as well as "typical conditions," and to evaluate the resulting effects on Ohio River water quality from various pollutant reduction strategies.
- The WASP5 water quality model was calibrated to data collected for four wet weather events between 1998 and 2001. The model was generally consistent with observed data, although it

appears that there may be pollutant sources whose loads are not accounted for in the model inputs.

10.6 MODEL APPLICATION

- Upstream flow dominates the volume of water entering the study area during the typical year of December 2000 through November 2001 with nearly 99 percent of the total flow, and the remaining one percent being comprised of CSO, WWTP and tributary flows.
- Based on model results (subject to error), the annual load distribution by source type for fecal coliform and *E. coli* for the typical year are the following:

	Fecal coliform	***E. coli***
Indiana WWTPs	<0.1%	<0.1%
Indiana CSOs	0.1%	0.1%
Indiana Tributaries	38.8%	44.4%
Kentucky WWTPs	0.3%	0.6%
Kentucky CSOs	15.7%	16.9%
Kentucky Tributaries	38.8%	37.4%
Upstream	6.4%	0.5%

- Based on model results (subject to error), the single sample maximum criterion is a more stringent water quality standard than the 30-day geometric mean standard because more frequent exceedances of the single sample maximum criterion were observed.
- Based on model results (subject to error), in the months when the fecal coliform geometric mean criterion is not met, exceedances in 40 to 50 percent area of the Ohio River are due to tributary sources, while exceedances in 10 to 20 percent area of the Ohio River are due to CSO sources.
- Based on model results (subject to error), between 10 and 30 percent of the days during the contact recreation season exceed the single sample maximum criteria because of tributary sources. An additional 5 to 10 percent of the days during the contact recreation season exceed the single sample maximum criteria because of CSO sources.
- CSOs have a big influence on peak concentrations during a wet weather event, accounting for approximately 50 percent of the concentration on the Kentucky side and 40 percent in the center channel of the river.

10.7 CSO REDUCTION SCENARIOS

- The model was executed for the typical year with the CSO reduction scenarios of 25, 50, 75 and 100 percent.
- The most realistic CSO reduction alternative will have very little benefit in reducing the frequency of days that exceed the single sample maximum water quality standard. This alternative does have a noticeable benefit in reducing peak in-stream concentrations.

10.8 LESSONS LEARNED

A number of important lessons were learned during this project and are detailed in Chapter 6. Many involved laboratory QA/QC oversight since large numbers of bacteria samples (one hundred or more) tend to be difficult for laboratories to handle. Another important lesson learned was that delays caused by uncooperative weather must be anticipated and accounted for in project budgets and schedules.

APPENDIX A

STANDARD OPERATING PROCEDURES FOR THE COLLECTION OF BACTERIA SAMPLES UTILIZING GLOVE METHOD

Standard Operating Procedures

for the

Collection of Bacteria Samples

Utilizing Glove Method

Ohio River Valley Water Sanitation Commission
5735 Kellogg Avenue
Cincinnati, OH 45228
(513) 231-7719

Revision Number: 2
March 2001

Introduction

This document describes the procedures for the collection of bacteria grab samples utilizing the glove method. This method has been implemented to eliminate the use of sampling equipment (i.e. a Kemmerer) for collecting bacteria surface samples. The elimination of equipment reduces cleaning procedures and possible sources of contamination. In addition, this method significantly reduces sampling time. This standard operating procedures document (SOP) has been developed to maintain consistent data collection procedures, and to ensure the quality of the data collected.

1.0 Field Equipment

The following equipment is needed to implement the Bacteria Glove Method collection technique.

- Sterilized Latex Gloves
- Sterilized 110mL Sample Bottles
- Cooler and Ice
- Permanent Marker (Sharpie)
- 1 Gallon Container of Blank Water (Distilled or Reagent Grade Deionized – RGDI)
- Anti-Bacterial Soap
- Knife

Sample Bottles: Corning™ Coliform Containers are purchased from Fisher Scientific in cases of 100. These 110mL bottles have a locking lid to ensure sterility and a dechlorinating tablet (sodium thiosulfate) already included in the bottle. The lid, when pressed down completely, will form a watertight seal; a plastic tie is then fed through the appropriate holes in the lid to assure sample integrity. This tie must then be cut in order to open the bottle. The bottles have two raised marks near the lid: the first is a 100mL mark and the second is the EPA fill line. Bottles should be filled to the EPA fill line.

2.0 Preparation

Before collecting the sample, properly fill out the label (date, time, sampling point, sample ID number, analysis required, and the name of the collecting entity) using a permanent marker and affix the label to the bottle. In addition to the sample label, identify the lid of the bottle with the sample ID number using the permanent marker. Ideally, the label is filled out (except data and time) and attached to the sample bottle and the lid of the bottle is labeled before the sampling event occurs.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers may be wiped down or washed with a mild soap and thoroughly rinsed if they have any contaminants present.

The sampler's hands should be washed with an anti-bacterial soap and water immediately before the sampling event begins. When actually collecting the samples, latex gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the bottle or lid.

3.0 Procedures

Keep sample bottles closed until they are to be filled. At the collection site, the sampler will wear a new set of gloves and detach the lock mechanism from the lid. Fill the bottle by holding the bottle upright and plunging it into the stream directed toward the current. Keep the lid closed (so as not to lose the dechlorination tablet) until you have reached a depth of 6 to 12 inches below the surface. When the sample is collected, leave ample air space in the bottle to facilitate mixing by shaking. Avoid placing the sample bottle in contact with the streambed or bank. If sampling from a boat or structure, collect the sample from the upstream side.

The bottles provided have an "EPA fill line" just above the 100mL mark. Fill to this line (if more water is collected than needed, carefully pour out the excess). Properly close the lid, secure the tie, and then gently shake the sample for thirty seconds to expedite the dissolving of the tablet.

After the sample is collected and sealed, the sample bottle should be placed in a cooler and covered with crushed ice. A new set of sterile gloves will be worn for each sample collected.

4.0 QA Samples

Quality assurance samples should comprise at least ten percent of the total number of stream samples collected.

4.1 Duplicate Samples

To collect duplicate samples, plunge bottles into the river and fill one immediately after another.

4.2 Blanks

Blanks should be collected at the completion of each survey day. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blank

Pour blank water from an unopened gallon container directly into the sample bottle.

4.2.2 Method Blank

With a clean pocketknife, cut off the top of an unused bottle. Simulate stream collection by plunging the bottle, while wearing gloves, into the cut open gallon container. Keep the bottle upright and let the water flow over the top of the bottle until it is filled.

5.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

6.0 Reference

USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8-78/017.

APPENDIX B

STANDARD OPERATING PROCEDURES FOR THE COLLECTION OF DISCRETE WATER SAMPLES

Standard Operating Procedures

for the

Collection of Discrete Water Samples

Ohio River Valley Water Sanitation Commission
5735 Kellogg Avenue
Cincinnati, OH 45228
(513) 231-7719

Revision Number: 2
March 2001

Introduction

This document describes the procedures for the collection of discrete water samples from the Ohio River and its tributaries. These methods allow for the collection of grab or composite samples utilizing a Kemmerer Sampling Bottle, bailer, or stainless steel bucket and a Churn Sample Splitter. This standard operating procedures document (SOP) has been developed to maintain consistent data collection procedures, and to ensure the quality of the data collected.

1.0 Field Equipment

The following equipment is needed to implement the sampling techniques.

- Kemmerer Sampling Bottle Kit
- Bailer w/ Rope
- Stainless Steel Bucket w/ Rope
- Churn Sample Splitter
- Blank Water (Distilled or Reagent Grade Deionized – RGDI)
- Sample Bottles
- Coolers and Ice
- Sterilized Latex Gloves
- Field Sampling Plan
- Permanent Marker (Sharpie)

The following parameters can be collected with the ensuing sampling techniques: alkalinity, ammonia, atrazine, bacteria, biochemical oxygen demand (BOD_5), caffeine, carbonaceous biochemical oxygen demand ($CBOD_5$), chlorophyll *a*, nitrate-nitrite, orthophosphate (refer to Attachment 1 for filtration procedures), total dissolved solids (TDS), total hardness, total Kjeldahl nitrogen (TKN), total phosphorus and total suspended solids (TSS).

2.0 Preparation

Before collecting the sample, properly fill out the label (date, time, sampling point, sample ID number, analysis required, and the name of the collecting entity) using a permanent marker and affix the label to the bottle. In addition to the sample label, identify the lid of the bottle with the sample ID number using the permanent marker. Ideally, the label is filled out (except data and time) and attached to the sample bottle and the lid of the bottle is labeled before the sampling event occurs.

Prior to collecting samples, both the coolers and the sample bottles should be visually inspected for presence of any dirt, chemicals, or other contaminants. If a sample bottle has any contaminants present, discard it and use another. The coolers should be wiped down or washed with a mild soap and thoroughly rinsed if it has any contaminants present. In addition all sampling equipment must be inspected for proper operation.

The sampler's hands should be washed with a mild soap and water immediately before the sampling event begins. When actually collecting the samples, latex gloves shall be worn and care taken to avoid touching or otherwise contaminating the inner surface of the sample bottles or lids.

3.0 Procedures

Keep all sampling bottles closed until they are ready to be filled. At each collection site, the sampler will wear a new set of gloves for decontamination procedures and a new set of gloves for sample collection. If sampling from a boat or structure, collect the sample from the upstream side. Avoid placing the sampling device in contact with the streambed or bank. Once the sample is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.1 Kemmerer Sampling Bottle

Prior to sampling, the Kemmerer must be inspected to ensure that the triggering mechanism is functioning properly, and that the nylon rope is not torn or frayed.

3.1.1 Decontamination Procedures

The Kemmerer must be cleaned before each sample is collected.

Step 1 – Blank Water Rinse

- Rinse the inside of the Kemmerer with blank water.
- Purge a small amount of the blank water from the drain valve.
- Discard the remaining blank water.
- Repeat Step 1.

3.1.2 Sample Collection Procedures

Discrete water column grab samples are collected using the following procedures.

Step 1 – River Rinse

- Open the Kemmerer bottle.
- River rinse by submerging the Kemmerer into the stream at the collection site.
- Activate the closing mechanism of the Kemmerer.
- Remove the Kemmerer from the stream.
- Purge a small amount of the river water from the drain valve.
- Discard the remaining contents.

Step 2 – Sample Collection

- Lower the Kemmerer to the appropriate depth (utilize the boat fathometer to determine mid-depth and bottom depth).

  a) Surface – Lower the Kemmerer to a depth of approximately one-foot below the surface.
  b) Mid-Depth – Lower the Kemmerer to the appropriate depth.
  c) Bottom – Lower the Kemmerer to a depth of approximately two-feet from the bottom (If Kemmerer contacts bottom sediment, repeat decontamination procedures before sample collection).

- Activate the closing mechanism of the Kemmerer to acquire sample volume.
- Remove the Kemmerer from the stream.
- Purge a small amount of sample volume from the drain valve.
- Fill the required sample bottles.

3.2 Bailer

Prior to sampling, the bailer must be inspected to ensure that the ball valve seats properly, and that the nylon rope is not torn or frayed.

3.2.1 Decontamination Procedures

The bailer must be cleaned before each sample is collected.

Step 1 – Blank Water Rinse

- Rinse the inside of the bailer thoroughly with blank water.
- Discard the blank water.
- Repeat Step 1.

3.2.2 Sample Collection Procedures

Discrete surface grab samples are collected using the following procedures.

Step 1 – River Rinse

- River rinse by submerging the bailer into the stream at the collection site.
- Remove the bailer from the stream and discard its contents.

Step 2 – Sample Collection

- Lower the bailer into the stream to obtain a surface grab sample.
- Remove the bailer from the stream.
- Fill the required sample bottles.

3.3 Stainless Steel Bucket

Prior to sampling, the stainless steel bucket must be inspected to ensure that it is in good condition, and that the nylon rope is not torn or frayed.

3.3.1 Decontamination Procedures

The stainless steel bucket must be cleaned before each sample is collected.

Step 1 – Blank Water Rinse

- Rinse the outer lip and the inside of the bucket with blank water.
- Discard the blank water.
- Repeat Step 1.

3.3.2 Sample Collection Procedures

Discrete surface grab samples (most often used for shallow tributary sampling from a bridge or stream bank) are collected using the following procedures.

Step 1 – River Rinse

- River rinse by submerging the bucket into the stream at the collection site.
- Remove the bucket from the stream and discard its contents.

Step 2 – Sample Collection

- Lower the bucket into the stream to obtain a surface grab sample.
- Remove the bucket from the stream.
- Fill the required sample bottles.

3.4 Churn Sample Splitter

Prior to sampling, the churn sample splitter must be inspected to ensure that is in good condition, and that it is functioning properly.

3.4.1 Decontamination Procedures

The churn sample splitter must be cleaned before sub-samples are homogenized. In addition, the appropriate sample collection device must also be cleaned (Kemmerer – 3.1, bailer – 3.2, or the stainless steel bucket – 3.3).

Step 1 – Blank Water Rinse

- Rinse the plunger and the inside of the churn splitter with blank water.
- Purge a small amount of the blank water from the spigot.
- Discard the remaining blank water.
- Repeat Step 1.

3.4.2 Sample Collection Procedures

Sub-samples (vertical or horizontal), obtained with a Kemmerer bottle, bailer, or a stainless steel bucket, are homogenized into composite samples using the following procedures.

Step 1 – River Rinse

- River rinse by filling the churn splitter with the sampling device at the collection site.
- Purge a small amount of the stream water from the spigot.
- Discard the remaining contents.

Step 2 – Sample Collection

- Obtain sub-samples following either Kemmerer, bailer, or bucket collection procedures.
- Fill the churn splitter with approximately equal volumes from each sub-sample.

Step 3 – Homogenizing Sub-samples

- Mix the contents of the churn splitter, at a uniform churning rate, for ten strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.0 Quality Assurance

Quality assurance samples should comprise at least ten percent of the total number of stream samples collected.

4.1 Duplicate Samples

To collect duplicate grab samples fill the required bottles from the same Kemmerer, bailer, or stainless steel bucket drop. To collect duplicate composite samples fill the required bottles from the same Churn Splitter sample volume.

4.2 Blanks

Blanks should be collected during each day of the survey. The sampler should wear a new set of gloves for each blank processed. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

4.2.1 Field Blanks

Pour blank water from an unopened container directly into the sample bottle.

4.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Kemmerer Bottle

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the Kemmerer with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the Kemmerer.
- Fill the required sample bottles.

Bailer or Stainless Steel Bucket

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the bailer or stainless steel bucket with enough blank water to fill the sample bottles.
- Fill the required sample bottles.

Churn Sample Splitter

- Perform the "Blank Water Rinse" (Decontamination Procedure) for a total of three rinses.
- Fill the appropriate collection device (Kemmerer, bailer, or stainless steel bucket) with enough blank water to fill the sample bottles.
- Purge a small amount of blank water from the appropriate collection device.
- Pour the blank water from the collection device into the churn splitter.
- Mix the contents of the churn splitter, at a uniform churning rate, for 10 strokes prior to withdrawal of the first sample.
- Purge a small amount of sample volume from the spigot.
- While continuing to churn the sample volume, fill the required sample bottles.

4.2.3 Trip Blanks (Optional)

Depending on study design, a trip blank may be utilized. This is a sample of RGDI water taken from the laboratory to the sampling site and returned to the laboratory unopened.

5.0 Chain of Custody Procedures

All samples are to be recorded on a Chain of Custody form with its identifying information. The Chain of Custody form is to be signed and submitted to the laboratory along with the samples.

Attachment 1
Collection of Orthophosphate Samples

Introduction
This attachment describes the additional procedures needed for the collection of orthophosphate samples.

1.0 Additional Field Equipment
The following additional equipment is needed to implement the orthophosphate filtration method.

- Disposable 60cc Syringes (Luer-Lok tip)
- Disposable 25 mm Filter Cartridges (1µm Glass Fiber Filter and 0.45µm Nylon Membrane Filter)
- Sample Bottles

2.0 Procedures
A new disposable syringe and filter cartridge (syringe filtration unit) will be used for each sample.

2.1 Decontamination Procedures
The syringe filtration units must be cleaned before each sample is filtered.

Step 1 - Blank Water Rinse

- Rinse the inside of the syringe by plunging 50mls of blank water through the housing.
- Attach the filter cartridge to the syringe.
- Rinse the inside of the entire unit by plunging 50mls of blank water through the unit.

2.2 Sample Collection Procedures
Samples can be filtered from the Kemmerer bottle, bailer, stainless steel bucket, or churn splitter using the following procedures.

Step 1 – Sample Filtration/Collection

- Fill the syringe filtration unit with sample from the appropriate collection device.
- Place the plunger into the syringe.
- Purge a small amount of sample volume through the filter.
- Discharge water through the filtration unit into a sample bottle.
- Repeat the previous three bullets until enough sample has been filtered into the sample bottle.
- Discard the syringe filtration unit.

3.0 Quality Assurance
Quality assurance samples should comprise at least 10 percent of the total number of stream samples collected.

3.1 Duplicate Samples
To collect duplicate samples continue to fill the syringe filtration unit from the same Kemmerer, bailer, or stainless steel bucket drop and filter into the required bottles.

3.2 Blanks
Blanks should be collected during each day of the survey. Once the blank is collected and sealed, the sample bottle should be immediately placed in a cooler and covered with crushed ice.

3.2.1 Field Blanks
Pour blank water from an unopened container directly into the sample bottle.

3.2.2 Equipment Blanks

Equipment blanks should be collected at the beginning and end of each survey day.

Unfiltered Equipment Blank

An equipment blank utilizing the appropriate collection device should be collected at the beginning of each survey day.

- Fill the appropriate collection device (Kemmerer, bailer, stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the required sample bottle.

Filtered Equipment Blank

An equipment blank utilizing the syringe filtration unit should be collected at the end of each survey day. The syringe filtration unit is decontaminated using the previously outlined procedure before the blank is collected.

- Fill the appropriate collection device (Kemmerer, bailer, stainless steel bucket, or churn splitter) with enough blank water to fill the sample bottle.
- Purge a small amount of blank water from the appropriate collection device.
- Fill the syringe filtration unit with sample from the appropriate collection device.
- Place the plunger into the syringe.
- Purge a small amount of blank water through the filter.
- Discharge water through the filtration unit into a sample bottle.
- Repeat the previous three bullets until enough volume has been filtered into the sample bottle.
- Discard the syringe filtration unit.

APPENDIX C

STANDARD OPERATING PROCEDURES FOR THE HYDROLAB EQUIPMENT

Standard Operating Procedures

for the

Hydrolab Equipment

Ohio River Valley Water Sanitation Commission
5735 Kellogg Avenue
Cincinnati, OH 45228
(513) 231-7719

Revision Number: 1
March 1999

Introduction
This document contains information and directions on using the Hydrolab equipment (H20® Sondes, DataSonde® 3 Multiprobe Logger, Surveyor® 3 Display Logger, and Scout® 2 Display Unit). This standard operating procedures document (SOP) has been developed to maintain properly functioning equipment, and to ensure the quality of the data collected.

1.0.0 Maintenance
The following procedures are to be utilized to maintain the Hydrolab equipment.

1.1.0 H20® Sonde
The outside housing of the sonde should be kept free of sediments, bio-films, oils, etc. by cleaning with soap and water. The storage cup must be installed (filled with distilled or deionized water) at all times when the unit is not in use to protect the sensors from damage and from drying out. Refer to section 3.10 of the *H20 Operating Manual*. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 4.6 of the *H20 Operating Manual*.

1.1.1 Temperature Sensor
The temperature sensor does not require any scheduled maintenance. Refer to section 3.3 of the *H20 Operating Manual*.

1.1.2 Dissolved Oxygen Sensor
DO sensor maintenance is usually only required when calibration becomes impossible or when the membrane becomes wrinkled, bubbled, torn, dirty, or otherwise damaged. Refer to section 3.7 of the *H20 Operating Manual* for electrolyte and membrane changing procedures. When the membrane is changed, the sensor should soak approximately 12 hours (in the storage cup) to allow the membrane time to relax to its final shape before the sensor is calibrated. During extended periods of non-use (winter months) the electrolyte should be drained and a membrane installed over the dry sensor.

1.1.3 pH Sensor
The pH reference electrolyte and porous reference junction should be replaced at least annually. Refer to section 3.5 of the *H20 Operating Manual* for these procedures. The pH glass electrode should be cleaned with isopropyl alcohol and a cotton ball as needed to remove any oil, sediment or biological growth on the glass. Once maintenance has been performed on the sensor, the sensor should re-equilibrate for approximately 12 hours in distilled or deionized water before it is calibrated, especially if alcohol has been used.

1.1.4 Conductivity Sensor
The conductivity probes should be polished at least annually. Refer to section 3.4 of the *H20 Operating Manual* for these procedures. Once maintenance has been performed on the sensor, the sensor should re-equilibrate for approximately 12 hours in distilled or deionized water before it is calibrated.

1.1.5 Depth Sensor
The depth sensor generally does not need maintenance. If deposits (calcium, biological growth, etc.) begin forming in the port rinse with a very weak acid, such as acetic. Refer to section 3.8 of the *H20 Operating Manual*.

1.1.6 Polarizing (Warm-up) Batteries
When the unit is not in use during the sampling season, the polarizing batteries should be disabled to increase the life of the DO sensor. During extended periods of non-use (winter months) the warm-up batteries should be removed from the sonde to prevent battery acid leakage. Once the warm-up batteries are changed or enabled, it takes a few hours for the DO sensor to stabilize. Refer to section 3.12 of the *H20 Operating Manual* for battery changing procedures. The 3.5 volt lithium batteries should be replaced when the voltage drops below 2.0 volts.

1.2.0 DataSonde®3 Multiprobe Logger

The DataSonde 3 Multiprobe Logger is very similar to the H20 Sonde with the added ability to be used as an unattended monitor. Return to section 1.1.0 for maintenance procedures.

1.2.1 Sensors and Polarizing Batteries

Refer back to sensors and polarizing batteries discussed under sections (1.1.1 – 1.1.6).

1.2.2 Submersible Battery Pack

The submersible battery back consists of 12 "C" alkaline batteries that provide 18 volts when fully charged. When the battery pack becomes exhausted (below 10.5 volts) the batteries should be replaced in order for the logger to continue unattended monitoring.

1.3.0 Surveyor® 3 Display Logger

The display logger should be protected from mechanical shock and excessive vibrations. Refer to section 4.1 of the *Surveyor 3 Operating Manual*. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 4.3 of the *Surveyor 3 Operating Manual*. The Surveyor 3 contains internal rechargeable batteries that provide 16 volts when fully charged. The battery power is exhausted at 14.4 volts and should be recharged for 14 hours to ensure a full charge. To prevent "charge memory", recharge the batteries only when the battery power is exhausted. Refer to section 3.2 of the *Surveyor 3 Operating Manual*. The Surveyor 3 also contains an internal lithium system battery that is good for approximately three years.

1.4.0 Scout® 2 Display Unit

The display unit should be protected from mechanical shock and excessive vibrations. Refer to section 4.1 of the *Scout 2 Operating Manual*. The unit's operating range is 23°F to 122°F (-5°C to 50°C). Exposure of the unit to temperatures outside of this range may result in mechanical or electronic damage. Refer to section 4.3 of the *Scout 2 Operating Manual*. The Scout 2 contains an internal battery pack consisting of 10 "AA" alkaline batteries that provide 15 volts when fully charged. When the battery pack becomes exhausted (below 10 volts) the internal batteries should be replaced or an external battery should be connected to the display unit. If an external power source is used, the internal batteries should always be removed to prevent them from being discharged. Refer to section 3.2 of the *Scout 2 Operating Manual* for changing the internal batteries.

1.5.0 External Rechargeable Battery Pack

The external rechargeable battery pack provides 12 volts when fully charged. The battery pack is exhausted below 9 volts and should be recharged for 12 hours to ensure a full charge. To prevent "charge memory", recharge the battery pack only when the battery power is exhausted.

1.6.0 Cables

Cables should be kept clean and protected from abrasion, unnecessary tension, repetitive flexure (fatigue), and bending over sharp radii (such as the edge of a boat). Connections that plug into terminals are not waterproof and should be kept dry at all times. Refer to section 3.11 of the *H20 Operating Manual*. When cables are not in use, be sure to insert all dummy plugs and dust caps to protect the electrical connectors.

1.7.0 Stirrer

If the stirrer begins to malfunction, silicone can be sprayed on the shaft to provide lubrication. The stirrer should be used instead of the weighted sensor guard to insure adequate flow across the DO membrane for reliable readings. Refer to section 4.3 of the *H20 Operating Manual*.

1.8.0 Flow Cell

The pressure in the flow cell should not exceed 15psi. Refer to section 4.4 of the *H20 Operating Manual*.

2.0.0 Terminal Setup

The H20 Sonde and the DataSonde 3 Multiprobe Logger can be used with Hydrolab display units (Surveyor 3 or Scout 2) or with a computer. To setup a computer as a display unit for a sonde, utilize the following procedure (requires an IBM compatible computer with Windows95 as the operating system).

From the Computer's Accessories Menu – Select

- HyperTerminal Folder
- Hypertrm.exe
  - New Connection
    - Name: Hydrolab
    - Connect using: Direct to Com 1
  - Port Settings
    - Bits per second: 1200 (9600 for DataSonde 3)
    - Data bits: 8
    - Parity: none
    - Stop bits: 1
    - Hardware control: Xon/Xoff
  - Hydrolab.ht has now been created

From Hydrolab HyperTerminal Menu – Select

- File – Properties – Settings Tab
  - Emulation: ANSI (Leave all other options as their default)
- Be sure to save the file before exiting

3.0.0 Multiprobe Setup

The following settings should be configured for normal operation. The parameters and variables setup sections applies to both the H20 Sondes and the DataSonde 3 Multiprobe Logger.

3.1.0 Parameters

For routine monitoring the following parameters setup should be utilized. Refer to section 2.4 of the *H20 Operating Manual.*

- pH – Enable
- Specific Conductance/Resistivity – Enable
- Salinity/TDS – Enable
- % Saturation – Enable
- Dissolved Oxygen – Enable
- Redox – Disable
- Depth/Level – Enable
- Turbidity – Disable
- Battery – Enable

3.2.0 Variables

For routine monitoring the following variables setup should be utilized. The current variables setup can be reviewed by using the REPORT function in the Variables Menu. Refer to section 2.6 of the *H20 Operating Manual.*

- Temperature – Celsius
- Conductivity – Specific Conductance, µS/cm, Fresh Water, Autorange, Salinity, Temperarture Compensated
- % Saturation – The current barometric pressure used in calibration is displayed here.
- Dissolved Oxygen – DO mg/L (not % Saturation), Standard DO Membrane, Salinity Compensated
- Depth – Feet
- Warm-up Batteries – Enable
- Autolog – Disable
- Header – Enable
- Buzzer – Disable
- Stirrer – Enable (Attended Monitoring), Disable (Unattended Monitoring)
- Expert – Disable
- Baud Rate – 1200
- Date Format – MMDDYY

4.0.0 Calibration Procedures

If a stand is used to hold the sonde during calibration, secure the sonde only around the end caps, **never** around the housing. Use either distilled or deionized water as rinse water during the calibration procedures. The sondes should be calibrated and post checked after each use to track any electronic drift. The calibration procedures apply to both the H20 Sondes and the DataSonde 3. Record all calibration information on the ORSANCO Field Equipment Calibration Sheet – Attachment A. Refer to section 2.5 of the *H20 Operating Manual.*

4.1.0 Temperature

The temperature sensor is factory-set and does not require further calibration. Refer to section 3.3 of the *H20 Operating Manual.*

4.2.0 Dissolved Oxygen

The dissolved oxygen sensor is calibrated at % saturation, but is read as mg/L. Refer to section 3.7 of the *H20 Operating Manual.*

4.3.0 pH

Since in-stream pH levels are generally above 7.0, the pH sensor is calibrated using a standard of 10.0 to determine the slope. If levels below 7.0 are expected, calibrate using a standard of 4.0 to determine the slope. Rinse the probe with a small amount of the appropriate standard before each calibration step. Refer to section 3.5 of the *H20 Operating Manual.*

4.4.0 Conductivity

Since in-stream conductivity concentrations are generally below 1000µS/cm the specific conductance sensor is calibrated using a standard of 1000µS/cm to determine the slope. If low concentrations are expected, calibrate using a standard of 180µS/cm to determine the slope. Rinse the probe with a small amount of the appropriate standard before the calibration step. Refer to section 3.4 of the *H20 Operating Manual.*

4.5.0 Depth

The depth sensor can be zeroed in air, near the surface of the water to be sampled, or it can be set at a known depth in the water column to be calibrated. Refer to section 3.8 of the *H20 Operating Manual*

4.6.0 Time

Use the TIME function to enter the correct time (HHMMSS) and date (MMDDYY). Refer to section 2.5.10 of the *H20 Operating Manual.*

5.0.0 Data Logging Setup

Use the following procedures to setup the DataSonde® 3 Multiprobe Logger for an unattended logging run. Make sure the status of the buzzer, stirrer, and enabled parameters are correct before the logging run is setup. In addition, check the status of the sonde in regards to data logging (STATUS function) and remove any nonessential files (ERASE function).

Step 1 – Setup Communications

From the Computer's Accessories Menu – Select

- HyperTerminal Folder
- Hydrolab.ht

Step 2 – Connect Calibration Cable

- Connect the calibration cable to the sonde and the external battery pack.
- Connect the calibration cable to the communications port of computer.

Step 3 – Setup Logging Run

From the Hydrolab Basic Menu – Select

- Logging
- Setup
  - Enter Log File Name
  - Enter Starting Date (MMDDYY)
  - Enter Starting Time (HHMMSS)
  - Enter Stopping Date (MMDDYY)
  - Enter Stopping Time (HHMMSS)
  - Enter Interval (HHMMSS)
  - Do not Enable Warm-up (Not needed if polarizing batteries are enabled)
- Electronically disconnect communications and close the HyperTerminal program.

Make sure the DataSonde 3 Multiprobe Logger is correctly deployed before the logging run begins.

6.0.0 Unattended Deployment

The multiprobe can be positioned upright (probes pointing down) or on-side for deployment. Avoid placing the unit in areas of swift currents, areas that might receive deep deposits of sediment during periods of heavy rainfall, or areas where potential vandalism may occur. Attempt to use any available protection that a site may provide (e.x. attach to downstream of bridge piling to protect from floating debris).

6.1.0 PVC Capsule Specifications

- Cut 6" (inside diameter) PVC pipe to the desired length (approximately 42") to create protective sleeve.
- Drill approximately 1" diameter holes throughout the sleeve to allow adequate water flow through the capsule.
- Drill approximately 3/4" diameter holes throughout the top of the end caps.
- Glue one end cap to the bottom of the sleeve.
- Place the other end cap on the open end of the sleeve and drill 5/8" hole through the end cap and the sleeve.
- Place a ½" bolt through the end cap and the sleeve and secure with two nuts.

6.2.0 Deployment

- Wrap the DataSonde 3 and the submersible battery pack with duct insulation (keeping away from the probes).
- Place the DataSonde 3 unit into the PVC capsule (probes pointing down).
- Place the top end cap on the PVC capsule and align the 5/8" holes.
- Suspend the DataSonde 3 unit inside of the PVC capsule with the ½" bolt passing through the capsule and the DataSonde 3 bail.
- Secure the PVC capsule to an appropriate structure with heavy-duty cables and locks.

6.3.0 On-Site Servicing

The unit should be cleaned and recalibrated at least once a week depending on water quality conditions (i.e. solids loading and biological growth – bio-films).

- Download the logging file and check the battery status.
- Clean and recalibrate the unit.
- Setup the next logging file.

7.0.0 Data Logging Retrieval

Utilize the following procedures to download data from the DataSonde® 3 Multiprobe Logger.

Step 1 – Setup Communications

From the Computer's Accessories Menu – Select

- HyperTerminal Folder
- Hydrolab.ht

Step 2 – Connect Calibration Cable

- Connect the calibration cable to the logger and the external battery pack.
- Connect the calibration cable to the communications port of computer.

Step 3 – Retrieving Data

From the Hydrolab Basic Menu – Select

- Logging
  - Dump
  - Power Down Probes
  - Select Log File Number
  - Spreadsheet Importable
  - Setup variables and calibration
  - Display reads "Starting Xmodem Transfer…"

From the Hydrolab HyperTerminal Menu – Select

- Transfer
- Receive File
  - Select path
  - Xmodem protocol
  - Specify file name
- Display reads "Transfer completed!"
- Electronically disconnect communications and close the HyperTerminal program.

Step 4 – Import Data to Excel Spreadsheet

From the Excel Menu – Select

- Open
- Select path and file name
- Text Import Wizard
  - Delimited Data
  - Start import at row: 1
  - File Origin: Windows (ANSI)
  - Delimiters: Comma
  - Text Qualifier: "
- Save the parsed data file in an Excel format.

8.0.0 References

DataSonde® 3 Multiprobe Logger, Operating Manual. Revision ?. Hydrolab Corporation. Month Year.

H20® Water Quality Multiprobe, Operating Manual. Revision *. Hydrolab Corporation. November 1993.

Scout® 2 Display Unit, Operating Manual. Revision D. Hydrolab Corporation. January 1994.

Surveyor® 3 Display Logger, Operating Manual. Revision E. Hydrolab Corporation. January 1994.

APPENDIX D

WATER QUALITY DATA

October 1997 Dry Weather Event

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 11/13/97

Confluence Mile Point	Tributary	Site Description	State	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total (Suspended) Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Orthophosphate (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Time
589.3	Fourteen Mile Creek	Confluence	IN	<2	<20	<20	12.8	(12)				0.27	<0.03	96	200	11:30
596.3	Lentzier Creek	Utica Pike	IN	Dry-N/S												
596.9	Goose Creek	River Road	KY	19	20	<20	3.4	320	<0.01	<0.01	0.97	0.35	0.11	117	214	15:00
	Duplicate			17		<20	1.6	310	0.04	<0.01	0.91	0.30	0.10	121	201	15:00
597.8	Lancastange Creek	Utica Pike	IN	312			<1.0	400	0.03	<0.01	2.75	0.23	<0.03	249	301	9:00
602.1	Beargrass Creek		KY													
	Muddy Fork	Mockingbird Avenue		96		40	2.1	360	0.09	0.07	0.98	0.23	0.08	146	214	9:30
	Middle Fork	Payne Street		>241,900		247,000	5.7	360	0.82	0.37	<0.01	3.80	2.70	202	252	10:20
	South Fork	Baxter Avenue		124		40	1.3	470	<0.01	0.03	1.26	0.37	0.04	159	274	11:55
606.1	Mill Creek	Frontage Road	IN	145	140		1.2	590	0.07	0.06	0.12	0.27	0.10	281	408	11:50
607.0	Silver Creek	State Route 62	IN	19	<20		3.0	260	<0.01	0.02	<0.1	0.26	0.03	115	220	14:00
	Duplicate			15	<20		1.2	230	<0.01	<0.01	<0.1	<0.1	<0.03	110	208	14:00
609.3	Falling Run	Pump Station	IN	90	20		1.3	480	0.07	0.20	0.76	0.45	0.04	205	314	15:20
616.4	Mill Creek Cutoff	Can Run	KY	54		40	8.5	480	<0.01	<0.01	0.82	0.14	<0.03	319	407	12:00
625.1	Mill Creek	Orell Road	KY	80	120	120	1.6	470	0.03	0.04	<0.1	0.22	<0.03	301	380	11:30
	Louisville MSD	Equipment Blank		<1		<1	<1.0	25	<0.01	<0.01	<0.1	<0.1	<0.03	44	2	10:30
	Louisville MSD	Equipment Blank		<2		<1	2.4	<10	<0.01	<0.01	<0.1	0.10	<0.03	28	10	12:30
	Jeffersonville	Equipment Blank		<1			<1.0	<10	<0.01	<0.01	<0.1	<0.1	<0.03	36	20	9:00
	Jeffersonville	Equipment Blank														
	Carksville	Equipment Blank		<1			2.0	12	<0.01	<0.01	<0.1	<0.1	<0.03	11	6	11:20
	New Albany	Equipment Blank		<1			3.2	12	<0.01	0.05	<0.1	<0.1	<0.03	10	25	14:40
	Strand & Associates	Equipment Blank		<2		<1	3.4	<12.5	<0.01	<0.01	<0.1	0.12	<0.03	16	6	9:00
	Strand & Associates	Field Blank		<2		<1	<1.0	<10	<0.01	<0.01	<0.1	<0.1	<0.03	24	14	15:20
	Strand & Associates	Equipment Blank		<2		<1	2.3	<10	<0.01	<0.01	<0.1	<0.1	<0.03	15	4	15:30

Note: Goose Creek and Silver Creek samples are composited from the left descending bank, midstream, and right descending bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/9/97

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Coliert *Escherichia coli* (CFU/100 mL)	Geomean: Mean	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Suspended Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Time
590	Martin Marietta Company	L	2	6	4									10 15
		M	2	4			<20	>24	9.0	0.64	<0.03	88	140	12 10
		R	2	2										11 55
592	Twelve Mile Island	L	2	<2	2									12 35
		M	2	<2			<20							12 30
		R	2	<2										12 25
594	Pipeline Crossing	L	2	<2	2									13 00
		M	2	<2			<20	16.6		0.52	0.04	89	186	12 55
		R	2	<2										12 45
596	Rubicyst Boat Club	L	2	<2	2									13 50
		M	2	2			<20							13 45
		R	2	<2										13 40
598	Six Mile Island Light & Day Marks	L	2	<2	2									14 10
		M	2	<2			<20	10.9	8.5	0.23	<0.03	93	175	14 05
		R	2	10										13 55
600	Federal Mooring Buoys	L	2	4	5									15 05
		M	2	<2			<20							15 00
		R	2	4										14 55
602	Beargrass Creek	L	2	<2	2									15 40
		M	2	2		100	<20	10.7		0.22	<0.03	89	174	15 25
		R	2	<2										15 15
602	Duplicate	L	2	4	4									15 40
		M	2	2			<20	10.6		0.32	<0.03	100	172	15 25
		R	2	8										15 15
604	George Rogers Clark Bridge	L	2	2	3									15 55
		M	2	<2			<20							15 50
		R	2	6										15 45
608	New Albany Boat Club	L	2	84	7									10 20
		M	2	2			<20	1.9	17.5	0.32	0.04	93	182	10 22
		R	2	<2										10 30
610	PSI Company	L	2	65	4									10 45
		M	2	4			<20							10 50
		R	2	<2										11 00
612	Gulf Oil Company	L	2	29	9									11 05
		M	2	<2			<20	>24		0.24	0.04	96	175	11 09
		R	2	<2										11 12
614	Kerr-McGee Terminal, Inc.	L	2	24	10									11 20
		M	2	24			20							11 23
		R	2	2										11 26
616	Hughes Bar Light & Day Marks	L	2	1,720	30									11 45
		M	2	8		40	20	11.6	8.3	0.42	0.23	97	192	11 50
		R	2	<2										11 55
616	Duplicate	L	2	1,440	18									11 45
		M	2	<2			<20	9.2	15.5	0.42	0.23	96	180	11 50
		R	2	2										11 55
618	Jeffersonville Riverport	L	2	91	59									12 35
		M	2	29			60							12 40
		R	2	78										12 45
620	Sun Refining & Marketing Company	L	2	57	26									13 00
		M	2	19			<20	10.2		0.52	0.20	100	186	13 05
		R	2	17										13 10
622	Sheet Piling on LDH	L	2	19	20									13 25
		M	2	30			<20							13 30
		R	2	15										13 35
624	Eversole Creek	L	2	21	11									13 50
		M	2	56			20	10.1	11.7	0.39	0.15	103	176	13 55
		R	2	2										14 00
626	Louisville Gas & Electric	L	2	10	7									14 10
		M	2	19			<20							14 15
		R	2	2										14 20
628	Louisville Environmental Service	L	2	<2	4									14 25
		M	2	6			<20	>24		0.35	0.15	98	172	14 30
		R	2	6										14 40
630	Salt River	L	2	2	3									14 50
		M	2	8			<20							14 55
		R	2	<2										15 00
	Crew 1 Equipment Blank							4.1	<1.0	0.13	<0.03	2	8	9 28
	Crew 1 Field Blank			<2			<1	<1.0	<1.0	<0.1	<0.03	39	6	16 30
	Crew 1 Method Blank			Not Sampled			Not Sampled							
	Crew 1 Equipment Blank							7.3	<1.0	Not Sampled	Not Sampled	37	<1	16 30
	Crew 2 Equipment Blank							8.6	<1.0	<0.1	<0.03	14	4	9 00
	Crew 2 Field Blank			<1			<20	<1.0	<1.0	<0.1	<0.03	7	4	15 20
	Crew 2 Method Blank			<1			<20							15 25
	Crew 2 Equipment Blank							14.5	<1.0	<0.1	<0.03	5	4	15 30

Note: L = Left Bank; M = Midstream; R = Right Bank

APPENDIX D

WATER QUALITY DATA

November 1997 Wet Weather Event

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date 11/13/97

Confluence Mile Point	Tributary	Site Description	State	Sample ID	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Orthophosphate (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
596.9	Goose Creek	River Road Bridge	KY	HR0	2		<20	1.8	365	0.06	0.06	1.40	0.42	0.05	133	244	11/13/97	3:50:00 PM
				HR2	4		<20		365								11/13/97	5:50:00 PM
				HR4	22		<20	<1	350	0.06	0.06	1.50	0.18	<0.03	167	256	11/13/97	7:50:00 PM
				HR6	98		120		367								11/13/97	9:50:00 PM
				HR8	128		260		325								11/13/97	11:50:00 PM
				HR12	580		540	2.8	315	0.07	0.07	2.60	0.39	<0.03	180	274	11/14/97	4:00:00 AM
				DUPLICATE	600		700	2.4	310	0.07	0.09	3.90	0.34	<0.03	191	265	11/14/97	4:00:00 AM
				HR16	1,010		1,020		255								11/14/97	8:00:00 AM
				HR20	533		800	3.3	250	0.16	0.07	1.40	0.44	<0.03	137	224	11/14/97	12:00:00 PM
				HR24	568		280		267								11/14/97	4:00:00 PM
				HR32	592		200	3.3	255	0.14	0.11	1.40	0.42	<0.03	152	220	11/15/97	12:30:00 AM
				HR40	646		680		245								11/15/97	8:30:00 AM
				HR48	418		340	1.2	240	0.09	0.07	1.10	0.32	<0.03	150	223	11/15/97	4:05:00 PM
				133	221	<20	200	1.6	255	0.09	0.08	1.50	0.22	<0.03	174	246	11/16/97	2:00:00 PM
				DUPLICATE													11/16/97	2:00:00 PM
607.0	Silver Creek	State Route 62	IN	HR0	24			1.4	365	0.03	<0.01	<0.1	0.27	<0.03	148	249	11/13/97	4:00:00 PM
				HR2	35				355								11/13/97	6:05:00 PM
				HR4	37			4.5	340	0.06	<0.01	<0.1	0.37	<0.03	139	248	11/13/97	7:50:00 PM
				HR6	2,980				295								11/13/97	10:05:00 PM
				HR8	4,460				260								11/13/97	11:45:00 PM
				HR12	3,280			6.0	197	0.09	0.01	0.50	0.40	0.06	70	171	11/14/97	5:00:00 AM
				DUPLICATE	2,980			5.4	290	0.13	<0.01	0.42	0.61	0.05	74	188	11/14/97	5:00:00 AM
				HR16	1,530				250								11/14/97	9:00:00 AM
				HR20	541			3.4	308	0.03	0.01	0.29	0.48	<0.03	115	212	11/14/97	12:30:00 PM
				HR24	303				340								11/14/97	4:30:00 PM
				HR32	65			2.4	355	0.04	0.04	0.20	0.37	<0.03	139	220	11/15/97	1:30:00 AM
				HR40	37				375								11/15/97	9:00:00 AM
				HR48	76			2.5	390	0.07	0.04	0.26	0.22	<0.03	156	244	11/15/97	4:45:00 PM
				133	26	<20		1.1	355	0.10	0.05	<0.1	0.34	<0.03	157	234	11/16/97	4:00:00 PM
				DUPLICATE	19			1.9	365	0.09	0.05	<0.1	0.46	<0.03	158	256	11/16/97	4:00:00 PM
	Strand & Associates	Equipment Blank			<1		<1	2.5	16	<0.01	<0.01	<0.1	<0.1	<0.03	3	<1	11/13/97	3:50:00 PM
	Strand & Associates	Equipment Blank			<1		<1	2.3	13	<0.01	<0.01	0.27	<0.1	<0.03	12	<1	11/14/97	12:00:00 AM
	Strand & Associates	Equipment Blank			<1			1.5	<10	<0.01	Missing	<0.1	<0.1	<0.03	<1	<1	11/13/97	3:45:00 PM
	Strand & Associates	Equipment Blank			<1			>8 / 12.5	13	<0.01	<0.01	<0.1	<0.1	<0.03	3	<1	11/14/97	12:00:00 AM
	Strand & Associates	Field Blank			<2		<20	3.4	<10	<0.01	<0.01	<0.1	<0.1	<0.03	5	<1		4:45:00 PM
	Strand & Associates	Equipment Blank			<1		<1	2.3	<10	<0.01	<0.01	<0.1	<0.1	<0.03	6	<1	11/16/97	1:45:00 PM
	Strand & Associates	Equipment Blank			<1		<1	1.8	<10	<0.01	<0.01	<0.1	<0.1	<0.03	3	<1	11/16/97	4:45:00 PM

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 11/13/97

Confluence Mile Point	Tributary	Site Description	State	Sample ID	Colilert *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total (Suspended) Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Orthophosphate (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
589.3	Fourteen Mile Creek	Confluence	IN	M1	8	<20		12.0	(13.7)	N/A	N/A	N/A	0.30	0.06	82	194	11/14/97	11:15
595.9	Harrods Creek	Captain's Quarters Marina	KY		No samples collected													
596.3	Lentzier Creek	Utica Pike Bridge	IN	M1	3,080			3.9	215	0.16	0.09	1.40	0.52	<0.03	107	200	11/14/97	8:10
				M2	3,600				180								11/14/97	12:01
				M3	135			1.9	290	0.14	0.05	1.85	0.79	0.04	209	280	11/14/97	16:00
				DUPLICATE	6,890			3.9	280	0.13	0.05	2.10	0.50	0.04	150	226	11/14/97	16:15
597.8	Lancassange Creek	Utica Pike Bridge	IN	M1	278			3.0	335	0.06	0.05	0.80	0.12	<0.03	195	280	11/14/97	8:31
				M2	131				330								11/14/97	12:25
				M3	83		83	<1	360	0.06	0.03	1.25	0.44	<0.03	178	290	11/14/97	16:25
				DUPLICATE	147			2.0	355	0.07	0.05	1.35	0.54	<0.03	207	288	11/14/97	16:35
602.1	Beargrass Creek		KY															
	Muddy Fork	Mockingbird Avenue Bridge		M1	4,050	600		6.0	260	0.20	0.14	1.30	0.31	<0.03	114	184	11/14/97	8:30
				M2	3,690	2,400			270								11/14/97	11:15
				M3	2,010	1,660	20	2.3	310	0.12	0.10	1.75	0.32	<0.03	138	220	11/14/97	16:15
	Middle Fork	Payne Street Bridge		M1	5,150	5,600		2.5	110	0.11	0.10	0.89	0.55	0.14	80	120	11/14/97	9:30
				M2	8,840	8,600			175								11/14/97	11:45
				M3	4,880	10,200	131	5.2	205	0.15	0.08	0.97	0.47	0.16	100	169	11/14/97	17:15
	South Fork	Baxter Avenue Bridge		M1	6,810	7,400		5.1	145	0.14	0.10	0.88	0.37	0.08	78	168	11/14/97	10:20
				M2	4,810	5,000			200								11/14/97	12:15
				M3	3,920	6,000	262	2.2	200	0.17	0.10	0.96	0.41	0.06	82	152	11/14/97	17:45
606.1	Mill Creek	Frontage Road Bridge	IN	M1	216			2.7	545	0.26	0.19	0.70	0.61	0.08	93	204	11/14/97	8:30
				M2	934				660								11/14/97	12:15
				M3	1,110		20	1.9	782	0.25	0.20	0.69	0.55	0.08	128	265	11/14/97	16:10
				DUPLICATE	1,400			1.6	772	0.31	0.36	0.62	0.32	0.08	<1	254	11/14/97	16:10
609.3	Falling Run	Pump Station	IN	M1	4,470			6.3	247	0.29	0.24	1.00	0.96	0.44	77	164	11/14/97	9:00
				M2	3,610				300								11/14/97	13:00
				M3	3,850		213	2.2	320	0.28	0.27	1.57	0.87	0.37	94	228	11/14/97	17:00
				DUPLICATE	3,780			5.0	305	0.26	0.28	1.60	1.06	0.38	95	201	11/14/97	17:00
616.4	Mill Creek Cutoff	Cane Run Bridge	KY	M1	6,940	5,000		3.6	130	0.45	0.20	1.40	1.00	0.23	6	119	11/14/97	10:00
				M2	Missing	6,000			145								11/14/97	12:45
				M3	2,680	4,600	100	3.3	180	0.29	0.19	1.00	0.79	0.25	88	184	11/14/97	15:30
625.1	Mill Creek	Orell Road Bridge	KY	M1	2,950	1,240		6.6	235	0.28	0.26	0.94	0.66	0.11	117	186	11/14/97	9:00
				M2	2,380	1,380			175								11/14/97	11:45
				M3	1,780	1,840	<20	3.7	185	0.29	0.10	0.68	0.45	0.04	104	184	11/14/97	14:45
	Louisville MSD Crew 1	Equipment Blank		BEB	<1	<1		<1	<10	<0.01	<0.01	<0.1	<0.1	<0.03	<1	<1	11/14/97	10:00
	Louisville MSD Crew 1	Equipment Blank		AEB	<1	<1		<1	<10	<0.01	<0.01	<0.1	<0.1	<0.03	4	<1	11/14/97	15:30
	Louisville MSD Crew 2	Equipment Blank		BEB	<1	<1		<1	<10	<0.01	<0.01	<0.1	<0.1	<0.03	<1	<1	11/14/97	9:00
	Louisville MSD Crew 2	Equipment Blank		AEB	<1	<1		<1	14	<0.01	<0.01	<0.1	<0.1	<0.03	3	<1	11/14/97	14:45
	Jeffersonville	Equipment Blank		BEB	<1			<1	<10	<0.01	<0.01	<0.1	<0.1	<0.03	1	<1	11/14/97	8:05
	Jeffersonville	Equipment Blank		AEB	<1			<1	<10	<0.01	<0.01	<0.1	<0.1	<0.03	2	<1	11/14/97	16:55
	Clarksville	Equipment Blank		BEB	<1			1.7	15	<0.01	<0.01	<0.1	<0.1	<0.03	2	<1	11/14/97	8:05
	Clarksville	Equipment Blank		AEB	<1			5.2 / >420	27	<0.01	<0.01	<0.1	<0.1	<0.03	<1	<1	11/14/97	16:00
	New Albany	Equipment Blank		BEB	<1			6.7	<10	<0.01	<0.01	<0.1	<0.1	<0.03	3	<1	11/14/97	8:25
	New Albany	Equipment Blank		AEB	1			2.7	12	<0.01	<0.01	<0.1	<0.1	<0.03	6	<1	11/14/97	17:15
	Strand & Associates	Equipment Blank		BEB	<1	<1		4.2	<10	<0.01	<0.01	<0.1	<0.1	<0.03	1	<1	11/14/97	8:15
	Strand & Associates	Equipment Blank		AEB	<1	<1		1.2	12	<0.01	<0.01	<0.1	<0.1	<0.03	2	<1	11/14/97	18:15

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 11/13/97

Confluence Mile Point	Tributary	Site Description	State	Sample ID	Colilert *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total (Suspended) Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Orthophosphate (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
589.3	Fourteen Mile Creek	Confluence	IN	M2	36	83	120	1.0	(23)				0.29	0.11	82	206	11/15/97	9:50
				D3	8	<20	<20	<1	(9)								11/16/97	9:55
595.9	Harrods Creek	Captain's Quarters Marina	KY		No Samples Collected													
596.3	Lentzier Creek	Utica Pike Bridge	IN	M4	12,400				345								11/15/97	8:03
				M5	7,030			1.3	355	0.09	<0.01	2.50	0.52	<0.03	202	270	11/15/97	12:04
				M6	5,980				385								11/15/97	16:10
597.8	Lancassange Creek	Utica Pike Bridge	IN	M4	154				330								11/15/97	8:20
				M5	128	167		1.4	330	0.10	0.01	1.20	0.51	<0.03	190	276	11/15/97	12:25
				M6	4,410				385								11/15/97	16:20
602.1	Beargrass Creek		KY															
	Muddy Fork	Mockingbird Avenue Bridge		M4	941		700		340								11/15/97	9:45
				M5	673	83	480	2.1	335	0.10	0.07	1.80	0.23	<0.03	184	282	11/15/97	13:50
				DUPLICATE	635		440	3.1	345	0.10	0.06	1.65	0.40	<0.03	178	288	11/15/97	13:50
				M6	405		380		380								11/15/97	15:45
	Middle Fork	Payne Street Bridge		M4	3,580		4,200		225								11/15/97	10:20
				M5	29,100	131	38,000	1.7	215	0.13	0.09	0.98	0.92	0.23	133	204	11/15/97	12:55
				DUPLICATE	33,300		43,000	1.2	244	0.14	0.06	0.90	1.44	0.24	131	204	11/15/97	12:55
				M6	104,000		47,000		225								11/15/97	14:30
	South Fork	Baxter Avenue Bridge		M4	4,350		3,800		295								11/15/97	10:45
				M5	4,040	295	Broken	1.3	305	0.11	0.04	1.40	0.37	0.09	118	210	11/15/97	13:20
				DUPLICATE	3,810		4,100	1.9	296	0.12	0.08	1.00	0.32	0.07	112	228	11/15/97	13:20
				M6	5,600		4,100		255								11/15/97	15:00
606.1	Mill Creek	Frontage Road Bridge	IN	M4	496				1,515								11/15/97	8:00
				M5	621	40		1.4	1,305	0.14	0.05	1.10	0.37	0.13	140	444	11/15/97	12:00
				M6	6				1,170								11/15/97	16:00
609.3	Falling Run	Pump Station	IN	M4	3,710				360								11/15/97	8:15
				M5	2,600	426		5.7	355	0.23	0.23	1.80	0.79	0.50	105	270	11/15/97	12:30
				M6	101				355								11/15/97	16:15
616.4	Mill Creek Cutoff	Cane Run Bridge	KY	M4	2,490		Missing		215								11/15/97	9:45
				M5	2,600		2,290	1.7	235	0.33	0.23	1.10	0.91	0.32	133	194	11/15/97	12:15
				DUPLICATE	2,130		2,700	2.3	240	0.26	0.21	1.50	1.40	0.34	139	201	11/15/97	12:15
				M6	2,130		1,840		245								11/15/97	14:50
625.1	Mill Creek	Orell Road Bridge	KY	M4	903		2,600		303								11/15/97	9:20
				M5	707	150	880	1.4	302	0.17	0.07	0.76	0.16	<0.03	209	300	11/15/97	11:50
				DUPLICATE	1,140		660	1.1	305	0.28	0.07	0.89	0.34	<0.03	210	295	11/15/97	11:50
				M6	205		560		290								11/15/97	14:25
	Louisville MSD Crew 1	Equipment Blank		AEB	<1	<1	<1	<10	0.02	<0.01	<0.1	<0.1	<0.03	5	<1	11/15/97	15:00
	Louisville MSD Crew 2	Equipment Blank		AEB	<1	<1	<1	<10	<0.01	<0.01	<0.1	<0.1	<0.03	3	<1	11/15/97	14:25
	Jeffersonville	Equipment Blank		AEB	<1			<1	<10	<0.01	<0.01	<0.1	<0.1	<0.03	2	<1	11/15/97	16:39
	Clarksville	Equipment Blank		AEB	<1			>420 / 2,050	23	<0.01	<0.01	<0.1	<0.1	<0.03	<1	<1	11/15/97	16:00
	New Albany	Equipment Blank		AEB	<1			2.8	<10	<0.01	<0.01	<0.1	<0.1	<0.03	3	<1	11/15/97	16:30
	Strand & Associates	Equipment Blank		AEB	<1		<1	1.9	<10	0.02	0.01	<0.1	<0.1	<0.03	5	<1	11/15/97	15:35

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 11/13/97

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Coliert *Escherichia coli* (CFU/100 mL)	Qualifier	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Suspended Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
590	Martin Marietta Company	L	2	8										11/14/97	11:25
		M	2	8		<20	<20	20.7	18.0	0.90	0.09	74	197	11/14/97	11:30
		R	2	8										11/14/97	11:45
592	Twelve Mile Island	L	2	6										11/14/97	11:55
		M	2	8			60							11/14/97	11:55
		R	2	6										11/14/97	11:55
594	Pipeline Crossing	L	2	6										11/14/97	12:10
		M	2	6			<20	<25		0.64	0.11	82	183	11/14/97	12:15
		R	2	13										11/14/97	12:20
596	Rubiyat Boat Club	L	2	10										11/14/97	12:55
		M	2	10			20							11/14/97	13:00
		R	2	13										11/14/97	13:05
598	Six Mile Island Light & Day Marks	L	2	<2										11/14/97	13:10
		M	2	6			20	6.1	31.5	0.68	0.07	79	182	11/14/97	13:20
		R	2	6										11/14/97	13:30
600	Federal Mooring Buoys	L	2	6										11/14/97	13:45
		M	2	2			20							11/14/97	13:50
		R	2	13										11/14/97	13:55
602	Beargrass Creek	L	2	10										11/14/97	14:10
		M	2	4		<20	<20	3.0		0.46	0.09	82	196	11/14/97	14:20
		R	2	8										11/14/97	14:30
602	Duplicate	L	2	24										11/14/97	14:10
		M	2	<2			<20	2.5		0.34	0.06	82	220	11/14/97	14:20
		R	2	10										11/14/97	14:30
604	George Rogers Clark Bridge	L	2	13										11/14/97	14:50
		M	2	19			<20							11/14/97	15:00
		R	2	15										11/14/97	15:10
608	New Albany Boat Club	L	2	436										11/14/97	9:45
		M	2	6		<20	20	3.5	33.0	0.45	0.06	87	183	11/14/97	9:50
		R	2	82										11/14/97	10:00
610	PSI Company	L	2	443										11/14/97	10:10
		M	2	87			80							11/14/97	10:13
		R	2	15										11/14/97	10:15
612	Gulf Oil Company	L	2	379										11/14/97	10:23
		M	2	46			20	5.0		0.41	0.06	72	182	11/14/97	10:30
		R	2	37										11/14/97	10:37
614	Kerr-McGee Terminal, Inc	L	2	312										11/14/97	10:45
		M	2	19			20							11/14/97	10:50
		R	2	65										11/14/97	10:52
616	Hughes Bar Light & Day Marks	L	2	828										11/14/97	11:15
		M	2	81		20	60	4.3	23.6	<0.1	0.07	74	184	11/14/97	11:20
		R	2	36										11/14/97	11:40
616	Duplicate	L	2	697										11/14/97	11:15
		M	2	65			20	3.2	22.0	0.41	0.07	77	195	11/14/97	11:20
		R	2	35										11/14/97	11:40
618	Jeffersonville Riverport	L	2	564										11/14/97	12:17
		M	2	155			180							11/14/97	12:19
		R	2	51										11/14/97	12:21
620	Sun Refining & Marketing Company	L	2	652										11/14/97	12:30
		M	2	148			100	2.8		0.32	0.06	79	183	11/14/97	12:40
		R	2	63										11/14/97	12:45
622	Sheet Piling on LDD	L	2	582										11/14/97	12:53
		M	2	155			140							11/14/97	12:55
		R	2	90										11/14/97	12:58
624	Riverside Creek	L	2	768										11/14/97	13:03
		M	2	131			140	5.4	28.0	0.52	0.07	82	192	11/14/97	13:10
		R	2	101										11/14/97	13:18
626	Louisville Gas & Electric	L	2	558										11/14/97	13:26
		M	2	99			120							11/14/97	13:28
		R	2	111										11/14/97	13:30
628	Louisville Environmental Service	L	2	2,950										11/14/97	13:35
		M	2	145			240	5.8		0.63	0.14	83	186	11/14/97	13:45
		R	2	192										11/14/97	13:50
630	Salt River	L	2	1,840										11/14/97	13:54
		M	2	82			140							11/14/97	13:56
		R	2	128										11/14/97	13:58
	Crew 1 Equipment Blank							>7.3	<1	<0.1	<0.03	<1	<1	11/14/97	11:00
	Crew 1 Field Blank			<2			<20	<1.0	<1	<0.1	<0.03	2	<1	11/14/97	15:20
	Crew 1 Method Blank			<2			Not Analyzed							11/14/97	15:20
	Crew 1 Equipment Blank							1.4	<1	<0.1	<0.03	2	<1	11/14/97	15:20
	Crew 2 Equipment Blank							1.6	<1	<0.1	<0.03	3	<1	11/14/97	9:10
	Crew 2 Field Blank			<2			<20	<1.0	<1	<0.1	<0.03	8	<1	11/14/97	14:32
	Crew 2 Method Blank			<2			<20							11/14/97	14:36
	Crew 2 Equipment Blank							5.5	<1	<0.1	<0.03	4	<1	11/14/97	14:42

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 11/13/97

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Colilert *Escherichia coli* (CFU/100 mL)	Geometric Mean	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Suspended Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
590	Martin Marietta Company	L	2	6	12									11/14/97	10:05
		M	2	13		83	<20	6.5	18.7	0.32	0.12	75	184	11/15/97	10:10
		R	2	24										11/15/97	10:25
592	Twelve Mile Island	L	2	17	16									11/15/97	10:35
		M	2	10			40							11/15/97	10:35
		R	2	22										11/15/97	10:40
594	Pipeline Crossing	L	2	22	24									11/15/97	10:55
		M	2	35			40	5.5		0.27	0.11	76	194	11/15/97	11:00
		R	2	53										11/15/97	11:10
596	Rubiyat Boat Club	L	2	14	26									11/15/97	11:25
		M	2	24			20							11/15/97	11:25
		R	2	51										11/15/97	11:30
598	Six Mile Island Light & Day Marks	L	2	47	31									11/15/97	11:50
		M	2	36			40	5.3	17.5	0.32	0.12	70	193	11/15/97	12:00
		R	2	17										11/15/97	12:10
600	Federal Mooring Buoys	L	2	35	38									11/15/97	12:30
		M	2	46			140							11/15/97	12:35
		R	2	35										11/15/97	12:40
602	Deergrass Creek	L	2	27	22									11/15/97	13:00
		M	2	20		133	20	4.1		0.34	0.11	72	190	11/15/97	13:10
		R	2	19										11/15/97	13:20
602	Duplicate	L	2	2	9									11/15/97	13:00
		M	2	15			40	4.1		0.42	0.13	76	185	11/15/97	13:10
		R	2	26										11/15/97	13:20
604	George Rogers Clark Bridge	L	2	2	5									11/15/97	13:30
		M	2	8			<20							11/15/97	13:35
		R	2	8										11/15/97	13:40
608	New Albany Boat Club	L	2	<2	9									11/15/97	9:36
		M	2	2		344	20	1.6	19.7	0.37	0.11	70	130	11/15/97	9:39
		R	2	20										11/15/97	9:48
610	PSI Company	L	2	35	23									11/15/97	9:54
		M	2	165			20							11/15/97	9:56
		R	2	2										11/15/97	9:59
612	Gulf Oil Company	L	2	37	23									11/15/97	10:08
		M	2	14			20	2.3		0.46	0.08	74	177	11/15/97	10:11
		R	2	22										11/15/97	10:22
614	Kerr-McGee Terminal, Inc	L	2	57	20									11/15/97	10:31
		M	2	10			<20							11/15/97	10:33
		R	2	45										11/15/97	10:35
616	Hughes Bar Light & Day Marks	L	2	26	23									11/15/97	10:52
		M	2	34		20	<20	3.5	29.5	0.29	0.15	80	185	11/15/97	11:00
		R	2	42										11/15/97	11:08
616	Duplicate	L	2	76	37									11/15/97	10:52
		M	2	17			40	4.6	22.8	0.42	0.14	82	196	11/15/97	11:00
		R	2	29										11/15/97	11:08
618	Jeffersonville Boatyard	L	2	77	28									11/15/97	11:44
		M	2	10			<20							11/15/97	11:50
		R	2	29										11/15/97	11:53
620	Sun Refining & Marketing Company	L	2	78	21									11/15/97	11:59
		M	2	6			20	4.5		0.29	0.11	76	160	11/15/97	12:10
		R	2	19										11/15/97	12:14
622	Sheet Piling on I-130	L	2	82	35									11/15/97	12:19
		M	2	17			40							11/15/97	12:22
		R	2	31										11/15/97	12:24
624	Riverside Creek	L	2	73	44									11/15/97	12:29
		M	2	27			40	4.5	22.5	0.27	0.11	73	180	11/15/97	12:34
		R	2	43										11/15/97	12:44
626	Louisville Gas & Electric	L	2	83	38									11/15/97	12:52
		M	2	15			<20							11/15/97	12:55
		R	2	43										11/15/97	12:56
628	Louisville Environmental Service	L	2	81	41									11/15/97	13:00
		M	2	19			20	5.0		0.27	0.11	86	146	11/15/97	13:05
		R	2	45										11/15/97	13:15
630	Salt River	L	2	65	36									11/15/97	13:20
		M	2	43			20							11/15/97	13:22
		R	2	62										11/15/97	13:24
	Crew 1 Equipment Blank							5.9	1	0.1	<0.03	<1	<1	11/15/97	9:50
	Crew 1 Field Blank			<2			<20	1	<1	0.1	0.03	8	<1	11/15/97	14:00
	Crew 1 Method Blank			<2			20							11/15/97	14:00
	Crew 1 Equipment Blank							4.7	1	0.1	0.03	3	<1	11/15/97	14:00
	Crew 2 Equipment Blank							5.3	<1	0.1	0.03	2	<1	11/15/97	9:05
	Crew 2 Field Blank			<2			<20	1	<1	<0.1	<0.03	8	<1	11/15/97	14:00
	Crew 2 Method Blank			<2			<20							11/15/97	14:05
	Crew 2 Equipment Blank							6.0	<1	<0.1	<0.03	5	<1	11/15/97	14:10

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 11/13/97

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Colilert *Escherichia coli* (CFU/100 mL)	Geometric mean	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Suspended Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
590	Martin Marietta Company	L	2	22	14									11/16/97	10:00
		M	2	17		<20	<20	4.4	26.0	0.32	0.06			11/16/97	10:05
		R	2	8										11/16/97	10:10
592	Twelve Mile Island	L	2	10	5									11/16/97	10:25
		M	2	2			<20							11/16/97	10:30
		R	2	6										11/16/97	10:35
594	Pipeline Crossing	L	2	8	5									11/16/97	10:40
		M	2	10			<20	21.0		<0.1	0.12			11/16/97	10:45
		R	2	4										11/16/97	10:50
596	Rubeyat Boat Club	L	2	6	7									11/16/97	11:10
		M	2	6			<20							11/16/97	11:15
		R	2	8										11/16/97	11:15
598	Six Mile Island Light & Day Marks	L	2	15	12									11/16/97	11:30
		M	2	10		<20	<20	5.6	16.5	0.34	0.08			11/16/97	11:35
		R	2	13										11/16/97	11:40
600	Federal Mooring Buoys	L	2	13	13									11/16/97	12:25
		M	2	10			<20							11/16/97	12:30
		R	2	15										11/16/97	12:30
602	Beargrass Creek	L	2	13	6									11/16/97	12:50
		M	2	4		<20	<20	6.1		0.37	0.13			11/16/97	12:55
		R	2	4										11/16/97	13:00
602	Duplicate	L	2	17	13									11/16/97	12:50
		M	2	8			<20	5.5		0.21	0.12			11/16/97	12:55
		R	2	15										11/16/97	13:00
604	George Rogers Clark Bridge	L	2	4	8									11/16/97	13:20
		M	2	8			40							11/16/97	13:20
		R	2	15										11/16/97	13:25
608	New Albany Boat Club	L	2	38	18									11/16/97	9:50
		M	2	8		<20	<20	1.9	16.0	0.29	0.06	75	179	11/16/97	9:55
		R	2	19										11/16/97	9:58
610	PSI Company	L	2	40	21									11/16/97	10:05
		M	2	15			<20							11/16/97	10:06
		R	2	15										11/16/97	10:08
612	Gulf Oil Company	L	2	13	15									11/16/97	10:13
		M	2	15			<20	3.8		<0.1	0.07	80	188	11/16/97	10:18
		R	2	17										11/16/97	10:25
614	Kerr-McGee Terminal, Inc.	L	2	30	35									11/16/97	10:30
		M	2	32			<20							11/16/97	10:32
		R	2	36										11/16/97	10:34
616	Hughes Bar Light & Day Marks	L	2	46	26									11/16/97	10:47
		M	2	19		<20	20	5.0	16.0	0.31	0.08	74	186	11/16/97	10:55
		R	2	27										11/16/97	11:00
616	Duplicate	L	2	63	33									11/16/97	10:47
		M	2	15			20	4.3	19.5	0.32	0.11	81	200	11/16/97	10:55
		R	2	35										11/16/97	11:00
618	Jeffersonville Riverport	L	2	34	20									11/16/97	11:10
		M	2	17			40							11/16/97	11:12
		R	2	41										11/16/97	11:14
620	Sun Refining & Marketing Company	L	2	35	21									11/16/97	11:44
		M	2	10			<20	>24 / 23		0.19	0.12	77	182	11/16/97	12:12
		R	2	27										11/16/97	12:18
622	Sheet Piling on I-65	L	2	54	30									11/16/97	12:28
		M	2	15			20							11/16/97	12:30
		R	2	33										11/16/97	12:32
624	Eversole Creek	L	2	40	19									11/16/97	12:37
		M	2	13			<20	9.5	12.0	0.27	0.08	80	204	11/16/97	12:40
		R	2	13										11/16/97	12:48
626	Louisville Gas & Electric	L	2	43	31									11/16/97	12:53
		M	2	24			60							11/16/97	12:55
		R	2	29										11/16/97	12:58
628	Louisville Environmental Service	L	2	49	28									11/16/97	13:02
		M	2	24			<20	3.1		0.27	0.07	96	180	11/16/97	13:08
		R	2	15										11/16/97	13:14
630	Salt River	L	2	63	36									11/16/97	13:18
		M	2	24			<20							11/16/97	13:20
		R	2	30										11/16/97	13:22
	Crew 1 Equipment Blank							1.1	<1	<0.1	<0.03			11/16/97	9:50
	Crew 1 Field Blank			<2			<20	<1.0	<1	<0.1	<0.03			11/16/97	14:00
	Crew 1 Method Blank			<2			<20							11/16/97	14:00
	Crew 1 Equipment Blank							4.2	<1	<0.1	<0.03			11/16/97	14:00
	Crew 2 Equipment Blank							>7 / 119	<1	<0.1	<0.03	2	<1	11/16/97	9:15
	Crew 2 Field Blank			<2			20	1.1	<1	<0.1	<0.03	2		11/16/97	13:45
	Crew 2 Method Blank			<2			20							11/16/97	13:50
	Crew 2 Equipment Blank							3.2	<1	<0.1	<0.03		<1	11/16/97	13:55

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Combined Sewer Outfall Analytical Data

Site Description	Sample ID	Carbonaceous BOD5 (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Sample Date	Sample Time
Jeffersonville CSO#002	HR0	152 / 122	170		11/13/97	16:55
	HR1	120	185		11/13/97	17:55
	HR2	85	117	5.40	11/13/97	18:55

Wet Weather Impact Study
Waste Water Treatment Plant Influent Analytical Data

Site Description	Sample ID	Carbonaceous BOD5 (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Sample Date	Sample Time
Morris Foreman WWTP	HR0	147	307		11/13/97	19:00
	HR1	<160 / 170	267		11/13/97	20:00
	HR2	<300 / 107	250	9.8	11/13/97	21:00
	Duplicate	<110 / 125	237	11.4	11/13/97	21:00
	HR3	86	260		11/13/97	22:00
	HR4	79	255		11/13/97	23:00
	HR5	68	315	16.8	11/14/97	0:00
	HR6	106	355		11/14/97	1:00
	HR7	175	500		11/14/97	2:00
	HR8	165	530	27.3	11/14/97	3:00
	HR9	176	552		11/14/97	4:00
Jeffersonville WWTP	HR0	125	385		11/13/97	17:30
	HR1	79	390		11/13/97	18:35
	HR2	92	505	11.0	11/13/97	19:30
	Duplicate	61	470	9.6	11/13/97	19:30
	HR3	61	465		11/13/97	20:36
	HR4	121	600		11/13/97	21:30
	HR5	105	435	11.1	11/13/97	22:30
	HR6	89	880		11/13/97	23:30
	HR7	92	695		11/14/97	0:30
	HR8	107	975	17.1	11/14/97	1:30
	HR9	102	655		11/14/97	2:30
New Albany WWTP	HR0	193	775		11/13/97	16:45
	HR1	248	610		11/13/97	17:45
	HR2	157	515	39.8	11/13/97	18:45
	Duplicate	167	490	36.3	11/13/97	18:45
	HR3	155	390		11/13/97	19:45
	HR4	117	435		11/13/97	20:45
	HR5	82	440	12.0	11/13/97	21:45
	HR6	57	563		11/13/97	22:45
	HR7	82	485		11/13/97	23:45
	HR8	73	515	18.1	11/14/97	0:45
	HR9	63	557		11/14/97	1:45
Louisville MSD	Field Blank	<1	<10	<0.1	11/13/97	11:00

APPENDIX D

WATER QUALITY DATA

August 1998 Dry Weather Event

Wet Weather Impact Study
Ohio River Physical Parameter Data

Survey Start Date: 8/17/98

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Secchi Disk (Feet)	Readings				
					Temperature (°C)	pH	D.O. (mg/L)	Conductivity (uS/cm)	Sample Time
588	Beigs Daymark	L	2	4.5	28.56	7.43	6.56	419	11:06:00 AM
		M	2	3.5	28.55	7.41	6.47	417	11:10:00 AM
		M							11:30:00 AM
		R	2						11:36:00 AM
590	Martin Marietta Company	L	2						11:44:00 AM
		M	2						11:46:00 AM
		R	2						11:48:00 AM
592	Twelve Mile Island	L	2	4.0					11:54:00 AM
		M	2	4.0					11:59:00 AM
		M							12:03:00 PM
		R	2	3.75					12:08:00 PM
594	Pipeline Crossing	L	2	4.5					12:14:00 PM
		M	2	4.5					12:26:00 PM
		R	2	4.5					12:30:00 PM
596	Rubiyat Boat Club	L	2	4.0					12:36:00 PM
		M	2	4.0					12:41:00 PM
		M							12:44:00 PM
		R	2	4.5					12:49:00 PM
598	Six Mile Island Light & Day Marks	L	2	4.0					12:55:00 PM
		M	2	4.0					1:01:00 PM
		R	2	3.0					1:07:00 PM
600	Federal Mooring Buoys	L	2	4.0					1:15:00 PM
		M	2	3.5					1:36:00 PM
		M							1:40:00 PM
		R	2	3.5					1:47:00 PM
602	Beargrass Creek	L	2	4.0					1:55:00 PM
		M	2	3.5					1:58:00 PM
		R	2	3.5					2:00:00 PM
604	George Rogers Clark Bridge	L	2	4.0					2:09:00 PM
		M	2	4.5					2:17:00 PM
		M							2:23:00 PM
		R	2	4.0					2:28:00 PM
608	Duplicate	L	2	2.5	28.24	7.41	7.40	395	11:00:00 AM
		M	2	1.5	28.30	7.39	7.12	390	11:05:00 AM
		M	13		28.23	7.37	6.95	390	11:08:00 AM
		R	2	3.0	28.16	7.42	7.33	392	11:15:00 AM
610	New Albany Boat Club	L	2	2.0	28.21	7.38	6.92	391	11:20:00 AM
		M	2	2.5	28.29	7.39	6.89	387	11:25:00 AM
		R	2	3.0	28.14	7.44	7.13	393	11:30:00 AM
612	PSI Company	L	2	3.0	29.20	7.46	7.07	392	11:32:00 AM
		M	2	2.5	28.62	7.43	6.99	388	11:37:00 AM
		M	18		28.40	7.40	6.76	389	11:39:00 AM
		R	2	3.0	29.50	7.49	7.26	391	11:45:00 AM
614	Gulf Oil Company	L	2	3.0	29.22	7.34	7.13	421	11:50:00 AM
		M	2	2.75	28.69	7.35	7.02	403	11:53:00 AM
		R	2	3.5	29.07	7.41	7.25	402	11:56:00 AM
616	Kerr-McGee Terminal, Inc.	L	2	2.75	29.21	7.38	7.25	408	12:05:00 PM
		M	2	3.0	28.90	7.01	7.37	401	12:08:00 PM
		M	22		28.60	7.26	6.48	414	12:10:00 PM
		R	2	3.25	29.21	7.44	7.44	397	12:20:00 PM
618	Hughes Bar Light & Day Marks	L	2	3.0	30.86	7.42	7.32	402	12:28:00 PM
		M	2	2.5	30.37	7.40	7.14	404	12:30:00 PM
		R	2	2.5	29.91	7.40	7.07	400	12:32:00 PM
620	Duplicate	L	2	2.75	29.41	7.43	7.28	400	12:52:00 PM
		M	2	2.5	29.00	7.40	7.95	399	12:55:00 PM
		M	17		29.01	7.38	6.86	398	12:57:00 PM
		R	2	3.0	29.43	7.39	7.03	397	1:05:00 PM
622	Jeffersonville Riverport	L	2	3.0	29.39	7.42	7.23	395	1:10:00 PM
		M	2	2.5	28.80	7.39	6.83	395	1:12:00 PM
		R	2	4.0	29.43	7.41	6.91	394	1:14:00 PM
624	Sun Refining & Marketing Company	L	2	2.5	29.25	7.45	7.17	394	1:20:00 PM
		M	2	3.0	28.62	7.43	6.95	393	1:25:00 PM
		M	19		28.60	7.39	6.72	394	1:27:00 PM
		R	2	4.0	29.97	7.45	7.75	391	1:32:00 PM
626	Sheet piling on LDB	L	2	3.5	29.03	7.44	7.10	395	1:38:00 PM
		M	2	3.25	28.71	7.40	6.80	393	1:41:00 PM
		R	2	3.5	29.49	7.50	7.34	393	1:43:00 PM
628	Eversole Creek	L	2	3.5	29.28	7.46	7.25	399	1:50:00 PM
		M	2	3.0	29.12	7.44	7.04	397	1:04:00 PM
		M	26		28.71	7.39	6.67	397	1:56:00 PM
		R	2	3.0	29.72	7.46	7.16	397	1:59:00 PM
630	Louisville Gas & Electric	L	2	3.5	29.53	7.49	7.40	399	2:08:00 PM
		M	2	3.0	29.15	7.45	7.13	397	2:11:00 PM
		R	2	3.5	29.56	7.48	7.24	395	2:14:00 PM

Note: L = Left Bank; M = Midstream; R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 8/17/98

Sampling Mile Point	Transect Description	Downriver Bank	Sample Depth (Feet)	Coliert *Escherichia coli* (CFU/100 mL)	Chromocult Score	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Chromocult Score	Fecal coliform (CFU/100 mL)	Chromocult Score	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Time
589	Beige Daymark	L	2	<2	2			<20	20										11:06
		M	2	<2				<20		<2.0		11.0	0.08	1.00	0.51	0.04	111	179	11:10
		M								<2.0									11:30
		R	2	2															11:36
590	Martin Marietta Company	L	2	<2	4														11:44
		M	2	<2															11:46
		R	2	4															11:48
592	Twelve Mile Island	L	2	<2	2			<20	20										11:54
		M	2	<2				<20		<2.0		3.7		1.40	0.57	<0.03	104	163	11:59
		M								<2.0									12:03
		R	2	2															12:08
594	Pipeline Crossing	L	2	<2	2														12:14
		M	2	<2															12:26
		R	2	<2															12:30
596	Rubiyat Boat Club	L	2	<2	2			<20	20										12:36
		M	2	<2				20		<2.0		7.5	0.08	1.20	0.28	<0.03	108	160	12:41
		M								<2.0									12:44
		R	2	2															12:49
598	Six Mile Island Light & Day Marks	L	2	<2	2														12:55
		M	2	2															13:01
		R	2	26															13:07
600	Federal Mooring Buoys	L	2	6	4			<20	20										13:15
		M	2	2				<20		<2.0		11.0	0.08	1.10	0.15	<0.03	103	172	13:36
		M								<2.0									13:40
		R	2	4															13:47
602	Beargrass Creek	L	2	22	4														13:55
		M	2	2															13:58
		R	2	2															14:00
604	George Rogers Clark Bridge	L	2	15	8	<20	20	<20	20										14:09
		M	2	4		<20		<20		<2.0	<2.0	5.7		1.10	0.48	<0.03	102	155	14:17
		M								<2.0	<2.0								14:23
		R	2	4		<20													14:28
604	Duplicate	L	2	22	8							9.0		1.20	0.28	<0.03	104	162	14:09
		M	2	10				<20		<2.0									14:17
		M								<2.0									14:23
		R	2	2															14:28
608	New Albany Boat Club	L	2	<2	0			20	30			21.0		1.40	0.37	0.05	103	196	11:00
		M	2	4				<20											11:03
		M	13																11:08
		R	2	10															11:15
610	PSI Company	L	2	<2	10														11:20
		M	2	10															11:25
		R	2	10															11:30
612	Gulf Oil Company	L	2	4	4			<20	30										11:32
		M	2	2				<20		<2.0		12.0		1.40	0.38	0.04	105	164	11:37
		M	18							<2.0									11:39
		R	2	9															11:45
614	Kem-McGee Terminal, Inc	L	2	4	3														11:50
		M	2	4															11:53
		R	2	2															11:56
616	Hughes Bar Light & Day Marks	L	2	31	24	<20	20	20	30										12:05
		M	2	6		<20		<20		<2.0	<2.0	7.0		1.10	0.45	0.18	106	169	12:08
		M	22							<2.0	<2.0								12:10
		R	2	<2		<20													12:20
616	Duplicate	L	2	<2	2														12:05
		M	2	<2				<20		<2.0		8.0		1.20	0.64	0.17	110	165	12:08
		M	22							<2.0									12:10
		R	2	2															12:20
618	Jeffersonville Riverport	L	2	2	2														12:28
		M	2	6															12:30
		R	2	13															12:32
620	Sun Refining & Marketing Company	L	2	8	4			<20	30										12:52
		M	2	15				<20		<2.0		12.0		1.50	0.44	0.11	104	154	12:55
		M	17							<2.0									12:57
		R	2	4															13:05
622	Sheet piling on LDH	L	2	4	4														13:10
		M	2	10															13:12
		R	2	6															13:14
624	Eversole Creek	L	2	4	3			<20	30										13:20
		M	2	13				20		<2.0		9.0		1.40	0.35	0.09	107	165	13:25
		M	19							<2.0									13:27
		R	2	<2															13:32
626	Louisville Gas & Electric	L	2	4	4														13:38
		M	2	10															13:41
		R	2	<2															13:43
628	Louisville Environmental Service	L	2	41	26			<20	30										13:50
		M	2	10				20		<2.0		7.0	0.08	1.40	0.51	0.09	104	158	13:04
		M	26							<2.0									13:56
		R	2	<2															13:59
630	Salt River	L	2	10	3														14:08
		M	2	6															14:11
		R	2									1.0	<0.01	<0.1	<0.1	<0.03	12	12	14:14
	Crew 1 Equipment Blank			<2				<20		<2.0		<1.0		<0.1	<0.1	<0.03	9	18	10:36
	Crew 1 Field Blank			<2				<20		<2.0									14:34
	Crew 1 Method Blank											<1.0		<0.1	<0.1	<0.03	18	8	14:34
	Crew 1 Equipment Blank									<2.0		<1.0		<0.1	<0.1	<0.03	9	16	14:34
	Crew 2 Equipment Blank			<2		<20		<20		<2.0		<1.0	<0.01	<0.1	<0.1	<0.03	7	8	10:45
	Crew 2 Field Blank			<2				<20		<2.0	<2.0								14:20
	Crew 2 Method Blank											<1.0	<0.01	<0.1	<0.1	<0.03	11	15	14:23
	Crew 2 Equipment Blank									<2.0									14:30

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Tributary Physical Parameter Data

Survey Start Date: 8/17/98

Confluence Mile Point	Tributary	Site Description	State	Descending Bank	Surface Readings				
					Temperature (°C)	pH	D.O. (mg/L)	Conductivity (uS/cm)	Sample Time
595.9	Harrods Creek	Prospect	KY	L		7.58		2,460	10:15:00 AM
				M		7.54		2,472	
				R		7.53		2,445	
596.3	Lentzier Creek	Utica Pike	IN	M	22.7	7.7	7.6		2:30:00 PM
596.9	Goose Creek	River Road	KY	L		7.60		1,998	9:30:00 AM
				M		7.57		1,905	
				R		7.53		1,953	
597.8	Lancassange Creek	Utica Pike	IN	M	21.7	7.3	7.7		2:13:00 PM
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue	KY	M	21.06	7.49	8.06	672	10:30:00 AM
602.1	Beargrass Creek Mid/South Fork	Brownsboro	KY	M	23.50	7.49	3.19	579	9:46:00 AM
606.1	Mill Creek	Frontage Road	IN	M	23.6	7.5	8.2		3:00:00 PM
607.0	Silver Creek	Route 62	IN	L		7.96	6.10	1,990	11:15:00 AM
				M		7.97	6.12	1,985	
				R		9.98	6.10	1,989	
609.3	Falling Run	New Albany Pump Station	IN	M	24.0	7.20	2.0		2:00:00 PM
616.4	Mill Creek Cutoff	Cane Run	KY	M	22.52	6.93	6.07	650	9:30:00 AM
625.1	Mill Creek	Orell Road	KY	M	24.05	7.80	6.85	642	9:56:00 AM

Note: L = Left Bank; M = Midstream; R = Right Bank

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 8/17/98

Confluence Mile Point	Tributary	Site Description	State	Coliform Escherichia coli (CFU/100 mL)	Membrane Filtration Escherichia coli (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrite-Nitrate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Time
595.9	Harrods Creek	Prospect	KY	52		20	<2.0	89	283	0.29	1.10	0.45	0.12	10:15
596.5	Floodgate Creek	Utica Pike	IN	160			2.0		510	0.06	1.90	0.27	<0.03	14:30
596.9	Goose Creek Duplicate	River Road	KY	24 30	107	30.8 20	2.0 <2.0	8 10	283 283	0.07 0.07	0.80 1.30	0.44 0.21	0.04 0.05	9:30 9:30
597.8	Floodgate Creek	Utica Pike	IN	604			<2.0		343	0.06	1.80	0.46	<0.03	14:15
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue	KY	378		200	<2.0	8	410	0.16	1.90	0.18	<0.03	10:30
602.1	Beargrass Creek Middle/South Fork	Brownsboro Road	KY	3,700		280	2.0	7	350	0.07	0.97	0.41	0.14	9:51
606.1	Mill Creek	Frontage Road	IN	229			2.0		649	0.14	0.89	0.37	0.06	13:00
607.0	Silver Creek Duplicate	Route 62	IN	230 298	143		2.0 <2.0	33 36	295 260	0.08 0.08	0.50 0.68	0.37 0.22	0.04 0.04	11:10 11:10
609.3	Falling Run	New Albany Pump Station	IN	14,100			2.0		353	0.85	0.42	3.50	2.90	14:00
616.4	Mill Creek Cutoff	Dixie Run	KY	8		<20	<2.0		393	0.02	<0.1	0.36	0.03	9:20
623.1	Mill Creek	Dwell Road	KY	141		40	2.0		410	0.09	0.25	0.34	0.09	10:05
	Louisville MSD	Equipment Blank		<2		<20	<2.0		<10	<0.01	<0.1	<0.1	<0.03	9:10
	Louisville MSD	Equipment Blank		1		<20	<2.0		<10	<0.01	<0.1	<0.1	<0.03	10:00
	Jeffersonville/Clarksville	Equipment Blank		<2			2.0		<10	<0.01	<0.1	0.11	<0.03	14:30
	Jeffersonville/Clarksville	Equipment Blank		<2			2.0		<10	<0.01	<0.1	<0.1	<0.03	13:00
	New Albany	Equipment Blank		<2			2.0		<10	<0.01	<0.1	<0.1	<0.03	15:40
	Louisville MSD	Equipment Blank		<2		<20	2.0	1	<10	<0.01	<0.1	<0.1	<0.03	9:48
	Louisville MSD	Field Blank		<2		<20	<2.0	<1.0	<10	<0.01	<0.1	<0.1	<0.03	10:10
	Louisville MSD	Equipment Blank		5		<20	<2.0	3	<10	<0.01	<0.1	0.12	<0.03	10:25
	Strand & Associates	Equipment Blank		<2		<20	<2.0	<1.0	<10	0.01	<0.1	<0.1	<0.03	9:00
	Strand & Associates	Field Blank		<2	<20	<20	<2.0	<1.0	<10	<0.01	<0.1	0.13	<0.03	12:00
	Strand & Associates	Equipment Blank		<2		<20	2.0	2	<10	<0.01	<0.1	0.13	<0.03	12:00

Note: Harrods Creek, Goose Creek and Silver Creek samples are composited from the left descending bank, midstream, and right descending bank.
Nutrient samples from Falling Run and Mill Creek Cutoff were received at the laboratory unpreserved (pH 7).

APPENDIX D

WATER QUALITY DATA

October 1998 Wet Weather Event

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 10/7/98

Confluence Mile Point	Tributary	Site Description	Sample ID	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
595.9	Harrods Creek	Prospect	HR0	51		40	1.8	22	385	0.56	1.20	1.80	0.16	10/07/98	11:00
			HR2	40		40			410					10/07/98	15:45
			HR4	772		660	1.8	48	400	0.68	1.40	2.00	0.15	10/07/98	17:50
			HR6	539		40			430					10/07/98	19:00
			HR8	1,780		460			316					10/07/98	21:20
			HR12	15,300	14,500	4,400	<1	47	296	0.80	0.99	0.71	0.12	10/08/98	2:05
			Duplicate	10,500		4,600	1.4	40	293	0.87	1.10	0.58	0.14	10/08/98	2:05
			HR16	3,010		1,400			313					10/08/98	5:35
596.9	Goose Creek	River Road	HR0	63		40	1.6	8.5	325	0.12	0.64	0.55	0.1	10/07/98	10:30
			HR2	124		40			295					10/07/98	15:25
		Highway 42	HR4	18500		1,360	3.2	390	175	0.79	0.43	1.60	0.12	10/07/98	17:35
			HR6	17,300		780			280					10/07/98	19:00
			HR8	12,600		3,100			133					10/07/98	20:15
			HR12	5,800	4,000	1,540	1.8	57	158	0.45	2.35	0.72	0.09	10/08/98	0:50
			Duplicate	25,000		1,500	1.8	52	196	0.34	1.90	0.88	0.08	10/08/98	0:50
			HR16	12,400		940			173					10/08/98	5:55
602.1	Muddy Fork	Mockingbird	HR0	3,950		140	<1	2.0	395	0.23	1.30	0.67	0.05	10/07/98	13:10
			HR2	34,500		8,200			295					10/07/98	15:25
			HR4	81,600		32,000	3.0	1,610	200	0.34	0.58	3.40	0.17	10/07/98	17:20
			HR6	77,000		11,800			153					10/07/98	19:05
			HR8	51,700		13,000			156					10/07/98	21:08
			HR12	29,100		10,000	2.2	30	202	0.33	2.10	0.46	0.1	10/08/98	1:35
			Duplicate	30,800		5,400	1.8	27	208	0.34	1.70	0.43	< 03	10/08/98	1:35
			HR16	14,000		5,200			239					10/08/98	5:00
602.1	Mid/South Fork	Brownsboro	HR0	2,310		400	1.1	7.5	285	0.24	0.49	0.81	0.23	10/07/98	12:19
			HR2	1,650		720			290					10/07/98	14:53
			HR4	199,000		3,000	6.2	455	110	1.06	0.68	3.50	0.41	10/07/98	16:55
			HR6	68,700		4,600			139					10/07/98	18:49
			HR8	34,400		11,800			113					10/07/98	20:45
			HR12	21,400		8,200	2.5	183	122	0.48	1.20	1.30	0.11	10/08/98	0:55
			Duplicate	20,500		5,600	1.9	195	124	0.55	0.99	1.20	0.16	10/08/98	0:55
			HR16	34,500		12,600			139					10/08/98	4:40
			HR20	20,100		3,000	1.4	52	168	0.37	1.15	0.67	0.17	10/08/98	8:39
607.0	Silver Creek	Route 62	HR0	1,880			<1	15	300	0.09	0.12	3.30	0.05	10/07/98	11:55
			HR2	2,980					280					10/07/98	13:05
			HR4	17,200			2.2	320	182	0.45	0.21	<0.1	0.08	10/07/98	16:45
			HR6	14,400					142					10/07/98	18:45
			HR8	12,200					166					10/07/98	21:00
			HR12	3,900	4,200		1.6	57	330	0.22	0.24	0.46	0.12	10/08/98	0:50
			Duplicate	3,500	3,800		1.7	57	334	0.17	0.20	0.59	0.12	10/08/98	0:50
			HR16	5,800					398					10/08/98	6:15
	STRAND	Equipment Blank	BEB 1	<2		<20	<1.0	<1.0	30/<10	<10	<0.1	<0.1	<0.03	10/07/98	10:30
	STRAND	Equipment Blank	AEB 1	12		<20	<1.0	<1.0	26	<10	<0.1	<0.1	<0.03	-	-
	STRAND	Field Blank	AFB 1	<2		<20	<1.0	<1.0	29	<10	<0.1	<0.1	<0.03	-	-
	LMSD	Equipment Blank	BEB 1	<2		<20	<1.0	1.5	45/10	<10	<0.1	<0.1	<0.03	10/07/98	13:10
	LMSD	Equipment Blank	AEB 1	<2		<20	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/07/98	21:10
	LMSD	Equipment Blank	BEB 1	<2		<20	<1.0	1.5	<10	10	<0.1	0.46	<0.03	10/07/98	12:10
	LMSD	Equipment Blank	AEB 1	<2		<20	<1.0	<1.0	19	<10	<0.1	<0.1	<0.03	10/07/98	20:50
	STRAND	Equipment Blank	BEB 1	2			<1.0	1.0	<10	<10	<0.1	<0.1	<0.03	10/07/98	10:55
	STRAND	Equipment Blank	AEB 1	<2			<1.0	1.5	<10	<10	0.1	<0.1	<0.03	10/07/98	21:05

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 10/7/98

Confluence Mile Point	Tributary	Site Description	Sample ID	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous 10/05 (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
595.9	Harmon Creek	Prospect	HR20	2,880		1,600	2.2	48	346	1.24	2.30	0.89	0.14	10/08/98	9:50
			HR24	2,190		8,400			352					10/08/98	14:35
			HR32	1,260		960	3.3	72	290	0.92	0.69	1.15	0.14	10/08/98	22:00
			HR40	2,490		1,360			237					10/09/98	5:50
			HR48	1,310		1,180	3.6	68	215	0.73	0.62	1.00	0.15	10/09/98	14:30
			D3	271		4,600	2.2	49	244	0.45	0.49	0.78	0.18	10/10/98	10:42
			D4	204		120	1.7	98	258	0.47	1.10	0.90	0.16	10/11/98	10:35
			Duplicate	229		160	1.6	49	256	0.45	1.10	0.90	0.21	10/11/98	10:35
596.9	Gunny Creek	Highway 42	HR20	5,040		200	1.6	27	226	0.19	2.00	0.59	0.06	10/08/98	9:10
			HR24	2,760		1,300			264					10/08/98	14:00
			HR32	1,850		2,800	2.9	17	294	0.23	0.93	1.18	0.04	10/08/98	22:30
			HR40	1,540		3,600			300					10/09/98	6:30
			HR48	620		440	1.9	16	298	0.22	1.50	0.48	0.04	10/09/98	14:00
			D3	486		460	2.7	16	334	0.17	0.88	0.33	0.04	10/10/98	10:20
			D4	215		20	1.3	6.6	356	0.18	2.00	0.52	0.06	10/11/98	11:47
			Duplicate	291		60	1.0	9.0	362	0.17	1.00	0.26	0.06	10/11/98	11:47
602.1	Muddy Fork	Mockingbird	HR20	11,300		6,800	1	10	322	0.24	2.25	0.42	0.11	10/08/98	9:03
			HR24	3,730		2,800			285					10/08/98	12:56
			HR32	2,100		780	2.7	5.0	244	0.14	2.10	0.41	0.05	10/08/98	21:15
			HR40	1,620		980			298					10/09/98	5:16
			HR48	909		360	2.1	5.0	360	0.12	2.70	0.35	0.05	10/09/98	13:20
			D3			4,600	1.8	2.5	418	0.11	1.80	0.35	0.04	10/10/98	13:25
			D4	620		20	1	<1	446	0.11	2.10	0.21	0.06	10/11/98	13:35
			Duplicate	745		140	1.3	1.0	444	0.09	1.70	0.28	0.06	10/11/98	13:35
602.1	Mid/South Fork	Brownshoro	HR20	20,100		3,000	1.4	52	168	0.37	1.15	0.67	0.17	10/08/98	8:39
			HR24	20,500		13,800			174					10/08/98	12:40
			HR32	13,700		13,800	3.0	38	284	0.24	0.54	0.91	0.15	10/08/98	20:40
			HR40	5,400		1,040			182					10/09/98	4:50
			HR48	8,860		2,200	3.5	23	230	0.18	1.40	0.72	0.17	10/09/98	12:30
			D3	8,130		460	2.4	8.0	304	0.14	0.95	0.71	0.18	10/10/98	12:45
			D4	6,570		100	1.5	3.5	342	0.12	0.54	0.67	0.19	10/11/98	12:34
			Duplicate	7,000		200	1.3	5.5	344	0.13	1.50	0.64	0.19	10/11/98	12:34
607.0	Silver Creek	Route 62	HR20	2,220			2.1	24	398	0.09	0.32	0.75	0.07	10/08/98	10:15
			HR24	3,130					388					10/08/98	13:20
			HR32	4,820			1.7	84	250	0.27	0.18	0.83	0.06	10/08/98	21:26
			HR40	2,280					274					10/09/98	7:15
			HR48	648			2.7	35	326	0.17	0.35	0.69	0.08	10/09/98	13:15
			D3	358			2.3	21	368	0.12	0.22	0.52	0.07	10/10/98	9:45
			Duplicate	556			2.6	22	382	0.11	0.14	0.52	0.06	10/10/98	9:45
			D4	396			1.1	18	386	0.10	0.20	0.61	0.07	10/11/98	13:15
	STRAND	Equipment Blank	BEB D3	<2		<20	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/10/98	9:45
	LMSD	Equipment Blank	BEB D3	2		<20	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/10/98	13:10
	LMSD	Equipment Blank	AEB 2	<2		<20	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/09/98	12:40
	LMSD	Field Blank	AFB 1	<2			<1.0	2.0	<10	<10	<0.1	<0.1	0.33/<0.03	10/09/98	12:33
	LMSD	Equipment Blank	AEB D3	<2		<20	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/10/98	12:45
	LMSD	Equipment Blank	AEB D4	<2		<20	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/11/98	-
	LMSD	Field Blank	AFB D4	<2		<20	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/11/98	-
	STRAND	Equipment Blank	AEB 2	<2		<20	<1.0	3.0	<10	<10	<0.1	<0.1	<0.03	10/09/98	14:40
	STRAND	Field Blank	AFB 2	<2	53	<20	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/09/98	14:40
	STRAND	Equipment Blank	AEB D3	2		<20	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/10/98	11:05
	STRAND	Equipment Blank	AEB D4	<2		40	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/11/98	-
	STRAND	Field Blank	AFB D4	<2		60	<1.0	<1.0	<10	<10	<0.1	<0.1	<0.03	10/11/98	-

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 10/7/98

Confluence Mile Point	Tributary	Site Description	State	Sample ID	Coliert *Escherichia coli* (CFU/100 ml)	Membrane Filtration *Escherichia coli* (CFU/100 ml)	Fecal Coliform (CFU/100 ml)	Carbonaceous BOD5 (mg/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
596.3	Lentzner	Utica Pike	IN	M1	52			1.4		314	0.09	0.16	0.28	0.04	10/07/98	12:20
				M2	41,100					195					10/07/98	17:30
				M3	3,270			2.2		632	0.19	1.70	0.65	0.09	10/08/98	8:35
				Duplicate	3,050			2.8		324	0.18	1.20	0.72	0.11	10/08/98	8:35
				M4	2,600					266					10/08/98	10:30
				M5	2,090	3,110		1.7		284	0.15	1.10	0.51	0.07	10/08/98	13:15
				M6	479					286					10/09/98	10:30
596.9	Little Goose Creek	Barbour Lane	KY	HR4	7,940		18,800	2.0	2.450	270	1.47	1.70	5.60	0.12	10/07/98	17:05
				HR6	15,500		20,000			130					10/07/98	18:30
				HR8	9,870		5,000			175					10/07/98	21:45
				HR12	3,690		1,360	1.9	40	212	0.17	2.10	0.56	0.05	10/08/98	1:45
				Duplicate	3,040		1,380	1.6	53	220	0.27	1.80	0.59	0.05	10/08/98	1:45
				HR16	4,600		1,810			268					10/08/98	5:45
				HR20	2,600		1,860	2.4	26	245	0.17	1.80	0.33	0.09	10/08/98	9:30
				HR24	1,100		1,600			266					10/08/98	14:15
				HR32	1,790		540	2.9	12.5	136	0.05	1.40	0.25	0.03	10/08/98	22:00
				HR40	898		520			246					10/09/98	6:00
				HR48	523		480	2.0	5.0	302	0.05	1.00	0.28	< 0.03	10/09/98	14:15
				D3			340	2.3	1.5	378	0.05	1.40	0.20	< 0.03	10/10/98	11:00
				D4	331			< 1	5.0	380	0.05	1.50	0.22	0.05	10/11/98	11:08
				Duplicate	290			1.2	2.0	392	0.03	1.80	0.28	0.04	10/11/98	11:08
597.8	Lancaasenge Creek	Utica Pike	IN	M1	5,460			1.1		385	0.13	2.00	0.24	0.05	10/07/98	14:00
				M2	19,900					165					10/07/98	17:45
				M3	9,080			1.9		568	0.33	3.4 / 2.2	0.75	0.31	10/08/98	8:45
				Duplicate	6,910			1.6		588	0.30	2.2 / 1.1	0.75	0.32	10/08/98	8:45
				M4	6,440					558					10/08/98	10:40
				M5	3,170	4,400		1.7		574	0.28	2.20	0.59	0.22	10/08/98	13:35
				M6	1,560					482					10/09/98	10:50
600.1	Mill Creek (IN)	Frontage Road	IN	M1	36,100			3.0		215	1.10	0.39	1.30	0.16	10/07/98	15:20
				M2	12,700					376					10/07/98	18:05
				M3	4,570			1.8		364	0.42	0.44	0.92	0.23	10/08/98	9:45
				Duplicate	3,990			1.9		374	0.45	0.64	0.93	0.22	10/08/98	9:45
				M4	4,030					355					10/08/98	11:15
				M5	3,050	1,410		1.9		348	0.40	0.36	0.86	0.18	10/08/98	14:00
				M6	627					622					10/09/98	11:30
609.3	Falling Run	New Albany Pump Station	IN	M1	2,010			3.9		400	0.48	1.40	1.10	0.15	10/07/98	11:30
				M2	35,400					250					10/08/98	9:30
				M3	10,200	11,200		1.6		270	0.43	1.90	0.72	0.09	10/08/98	12:40
				M4	7,890					294					10/08/98	16:29
				M5	801					382					10/09/98	9:30
				M6	820			1.9		346	0.34	1.50	0.52	0.05	10/09/98	13:30
				Duplicate	1,210			2.2		364	0.33	1.80	0.44	0.04	10/09/98	13:30
616.4	Mill Creek Cutoff	Cane Run Road	KY	M1	1,690		780	2.2		246	0.25	0.29	0.55	0.11	10/07/98	14:20
				M2	26,000		11,600	3.2		78	0.73	0.79	0.85	0.13	10/07/98	17:35
				M3	9,800		1,800			132					10/08/98	7:50
				M4	4,620	3,110	5,200	1.8		164	0.29	0.42 / 0.5	0.68	0.1	10/08/98	12:30
				Duplicate	4,880		3,400	1.9		164	0.32	0.45 / 1.1	0.75	0.1	10/08/98	12:30
				M5	2,350		13,000			166					10/08/98	16:05
				M6	274		220			248					10/09/98	9:15
625.1	Mill Creek (KY)	Orell Road	KY	M1	2,430		720	1.1		220	0.17	0.18	0.60	0.48	10/07/98	14:50
				M2	14,800		13,600	3.0		150	0.01	0.44	2.10	0.13	10/07/98	18:10
				M3	5,480		1,200			154					10/08/98	8:10
				M4	5,370	1,970	5,000	2.1		138	0.30	0.38	0.56	0.09	10/08/98	13:00
				Duplicate	5,170		1,900	2.7		132	0.32	0.44	0.56	0.1	10/08/98	13:00
				M5	1,580		1,400			142					10/08/98	16:25
				M6	293		260			138					10/09/98	8:50
	NEW ALBANY	EQUIPMENT BLANK		BEB	<2			< 1.0		12	< 10	< 0.1	0.20	< 0.03	10/07/98	11:05
	NEW ALBANY	EQUIPMENT BLANK		AEB 1	<2			2.3 / 2.1		< 10	< 10	< 0.1	< 0.1	< 0.03	10/07/98	17:15
	NEW ALBANY	EQUIPMENT BLANK		AEB 2	<2			5.6		< 10	< 10	< 0.1	< 0.1	< 0.03	-	-
	JEFFERSONVILLE	EQUIPMENT BLANK		BEB				< 1.0		< 10	< 10	< 0.1	< 0.1	< 0.03	10/07/98	12:20
	JEFFERSONVILLE	EQUIPMENT BLANK		AEB 1	<2			< 1.0		< 10	< 10	< 0.1	< 0.1	< 0.03	10/08/98	9:45
	JEFFERSONVILLE	EQUIPMENT BLANK		AEB 2	36			< 1.0		< 10	< 10	< 0.1	< 0.1	< 0.03	10/09/98	11:30
	LMSD	EQUIPMENT BLANK		AEB 1	<2		< 20	< 1.0		< 10	< 10	< 0.1	< 0.1	< 0.03	10/07/98	14:55
	LMSD	EQUIPMENT BLANK		AEB 2	<2		< 20	< 1.0		< 10	< 10	< 0.1	< 0.1	< 0.03	10/08/98	16:30
	LMSD	EQUIPMENT BLANK		BEB 1	<2		< 20	< 1		< 10	< 10	< 0.1	< 0.1	< 0.03	10/07/98	14:25

Wet Weather Impact Study
Ohio River Analytical Data

Start Date: 10/7/98

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Coliert *Escherichia coli* (CFU/100 mL)	Geomeans	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Geomeans	Fecal coliform (CFU/100 mL)	Geomeans	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
588	Delga Daymark	L	2	<2	4			<20	<20										10/07/98	17:43
		M	2	<2				<20											10/07/98	17:45
		M	38																10/07/98	17:45
		R	2	8															10/07/98	17:49
590	Martin Marietta Company	L	2	8	8			<20	<20										10/07/98	17:33
		M	2	<2				<20											10/07/98	17:36
		R	2	<2															10/07/98	17:38
592	Twelve Mile Island	L	2	10	16			<20	<20										10/07/98	17:27
		M	2	<2				<20											10/07/98	17:25
		M	32																10/07/98	17:25
		R	2	<2															10/07/98	17:22
594	Pipeline Crossing	L	2	4	6			<20	<20										10/07/98	17:13
		M	2	4				<20											10/07/98	17:16
		R	2	42															10/07/98	17:18
596	Robyat Boat Club	L	2	10	16			<20	<20										10/07/98	17:01
		M	2	<2				<20											10/07/98	17:05
		M	37																10/07/98	17:05
		R	2	<2															10/07/98	17:07
598	Six Mile Island Light & Day Marks	L	2	4	17														10/07/98	16:45
		M	2	<2															10/07/98	16:49
		R	2	75															10/07/98	16:53
600	Federal Mooring Buoys	L	2	4	4			<20	<20										10/07/98	16:30
		M	2	2				<20											10/07/98	16:33
		M	44																10/07/98	16:33
		R	2	6															10/07/98	16:39
602	Deergrass Creek	L	2	106	56														10/07/98	16:20
		M	2	6															10/07/98	16:24
		R	2	6															10/07/98	16:28
604	George Rogers Clark Bridge	L	2	26	40	36	39	<20	<20										10/07/98	16:00
		M	2	10		18		<20											10/07/98	16:04
		M	22																10/07/98	16:04
		R	2	242		196													10/07/98	16:15
604	Duplicate	L	2	15	22			<20	<20										10/07/98	16:00
		M	2	8				<20											10/07/98	16:08
		M	22																10/07/98	16:08
		R	2	72															10/07/98	16:15
	Crew 1 Equipment Blank																		10/07/98	
	Crew 1 Method Blank			<2				<20											10/07/98	17:55
	Crew 1 Equipment Blank																		10/07/98	
	Crew 1 Field Blank			<2		<20		<20											10/07/98	17:54

Note: L = Left Bank; M = Midstream; R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/7/98

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (feet)	Colilert *Escherichia coli* (CFU/100 mL)	Geomean Alert	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Geomean Alert	Fecal coliform (CFU/100 mL)	Geomean 30-day	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorus (mg/L)	Nitrite-Nitrate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
588	Beige Daymark	L	2	10															10/08/98	11:15
		M	2	6						4.2		6.5	0.10	1.40	0.33	0.07	100	167	10/08/98	11:15
		M	11							3.9									10/08/98	11:27
		R	2	<2															10/08/98	11:18
590	Martin Marietta Company	L	2	4	3														10/08/98	11:40
		M	2	2															10/08/98	11:42
		R	2	4															10/08/98	11:44
592	Twelve Mile Island	L	2	6	6			<20	<20										10/08/98	11:52
		M	2	<2				<20		3.2		5.0		0.40	0.45	0.09	93	176	10/08/98	11:55
		M	11							2.9									10/08/98	11:55
		R	2	6															10/08/98	12:03
594	Pipeline Crossing	L	2	15	6														10/08/98	12:11
		M	2	4															10/08/98	12:14
		R	2	4															10/08/98	12:16
596	Rubbyat Boat Club	L	2	<2	6			<20	<20										10/08/98	12:25
		M	2	10				20		4.0		5.5		1.10	0.39	0.12	97	175	10/08/98	12:35
		M	15							4.0									10/08/98	12:35
		R	2	4															10/08/98	12:43
598	Six Mile Island Light & Day Marks	L	2	39	66														10/08/98	12:52
		M	2	22															10/08/98	12:54
		R	2	334															10/08/98	13:00
600	Federal Mooring Buoys	L	2	52	46			<20	80										10/08/98	13:15
		M	2	53				80		2.5		6.0		0.67	0.31	0.11	98	172	10/08/98	13:18
		M	40							2.1									10/08/98	13:18
		R	2	58															10/08/98	13:25
602	Hourgrass Creek	L	2	79	78														10/08/98	13:34
		M	2	60															10/08/98	13:37
		R	2	99															10/08/98	13:40
604	George Rogers Clark Bridge	L	2	326	282	520	379	100	115										10/08/98	13:50
		M	2	217		267		140		2.9 / 3	3	4.5		0.96	0.31	0.1	97	179	10/08/98	13:55
		M	18							2.1 / 3	2.4								10/08/98	13:55
		R	2	318		392													10/08/98	14:12
606	Duplicate	L	2	336	395														10/08/98	13:50
		M	2	228				20		2.5		5.5		0.87	0.38/0.26	0.1	97	163	10/08/98	13:55
		M	18							3.6									10/08/98	13:55
		R	2	336															10/08/98	14:12
608	New Albany Boat Club	L	2	863	738			1,040	930										10/08/98	10:28
		M	2	758				600		3.6		85.0		0.74	0.55	0.11	95	171	10/08/98	10:35
		M	14							3.2									10/08/98	10:35
		R	2	666															10/08/98	10:45
610	PSI Company	L	2	576	496														10/08/98	10:50
		M	2	617															10/08/98	10:53
		R	2	320															10/08/98	10:56
612	Gulf Oil Company	L	2	2,170	5,227			660	932										10/08/98	11:01
		M	2	1,600				1,180		3.7		11.0		0.84	0.38	0.09	95	171	10/08/98	11:05
		M	18							2.9									10/08/98	11:05
		R	2	1,130															10/08/98	11:15
614	Kem-McGee Terminal, Inc	L	2	2,330	1,772														10/08/98	11:20
		M	2	1,860															10/08/98	11:23
		R	2	549															10/08/98	11:25
616	Hughes Bar Light & Day Marks	L	2	4,760	3,832	8,000	2,398	11,400	6,928										10/08/98	11:33
		M	2	2,660		2,300		4,200		2.4 / 3	2.3	10.0		0.84 / 0.52	0.53	0.18	96	167	10/08/98	11:36
		M	25							2.7	2.1								10/08/98	11:36
		R	2	592		720													10/08/98	11:49
618	Duplicate	L	2		1,225			1,400	618										10/08/98	11:33
		M	2	2,360				20		1.9		9.5		1.4 / 1.4	0.55	0.17	97	165	10/08/98	11:36
		M	25							2.0									10/08/98	11:36
		R	2	637															10/08/98	11:49
618	Jeffersonville Riverport	L	2	37,900	27,248														10/08/98	11:58
		M	2	18,700															10/08/98	12:00
		R	2	9,330															10/08/98	12:03
620	Sun Refining & Marketing Company	L	2	24,800	15,955			61,000	68,599										10/08/98	12:25
		M	2	16,500				75,000		2.9		10.0		0.95	0.60	0.29	95	164	10/08/98	12:29
		M	17							2.2									10/08/98	12:29
		R	2	7,060															10/08/98	12:39
622	Sheet Piling on LDD	L	2	68,700	27,184														10/08/98	12:44
		M	2	15,000															10/08/98	12:46
		R	2	7,940															10/08/98	12:49
624	Iverside Creek	L	2	86,600	34,121			75,000	63,939										10/08/98	12:54
		M	2	72,700				56,000		2.2		8.0		0.95	0.66	0.29	94	164	10/08/98	12:56
		M	23							2.2									10/08/98	12:56
		R	2	6,310															10/08/98	13:06
626	Louisville Gas & Electric	L	2	242	85														10/08/98	13:13
		M	2	109															10/08/98	13:16
		R	2	22															10/08/98	13:19
628	Louisville Environmental Service	L	2	84	96			100	91										10/08/98	13:26
		M	2	75				80		2.4		15.5	0.09	1.10	0.63	0.12	96	171	10/08/98	13:30
		M	26							2.4									10/08/98	13:30
		R	2	15															10/08/98	13:37
630	Salt River	L	2	112	63														10/08/98	13:43
		M	2	46															10/08/98	13:46
		R	2	49															10/08/98	13:52
	Crew 1 Equipment Blank									<1.0		1.5	10	<0.1	<0.1	<0.03	18	5	10/08/98	
	Crew 1 Method Blank			<2				<20											10/08/98	14:35
	Crew 1 Equipment Blank									1.6 / 1		<1.0		0.1	<0.1	<0.03	11	9	10/08/98	14:26
	Crew 1 Field Blank			<2				<20		<1.0		<1.0		<0.1	0.13	<0.03	11	7	10/08/98	14:20
	Crew 2 Equipment Blank									<1.0		<1.0		<0.1	0.16	<0.03	7	5	10/08/98	9:55
	Crew 2 Method Blank			<2				<20											10/08/98	14:05
	Crew 2 Equipment Blank									<1.0		9.0	10	<0.1	<0.1	<0.03	8	11	10/08/98	14:10
	Crew 2 Field Blank			<2		<20		<20		<1.0	<1.0	5.0	10	<0.1	<0.1	<0.03	7	6	10/08/98	14:00

Note: L - Left Bank, M - Midstream, R - Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/7/98

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Coliform *Escherichia coli* (CFU/100 mL)	Geometric Mean	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Geometric Mean	Fecal coliform (CFU/100 mL)	Geometric Mean	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
588	Ohio Daymark	L	2	<2	<2			<20	<20										10/09/98	11:51
		M	2	<2				<20		1.8		10.5	0.08	1.00	0.54	0.05	92	136	10/09/98	11:56
		M	30							3.0									10/09/98	11:56
		R	2	<2															10/09/98	12:01
590	Martin Marietta Company	L	2	10	10														10/09/98	12:16
		M	2	<2															10/09/98	12:20
		R	2	<2															10/09/98	12:24
592	Twelve Mile Island	L	2	<2	<2			<20	<20										10/09/98	12:30
		M	2	<2				<20		3.0		5.0		1.90	0.15	0.05	93	168	10/09/98	12:35
		M	15							2.6									10/09/98	12:35
		R	2	<2															10/09/98	12:44
594	Pipeline Crossing	L	2	<2	10														10/09/98	12:53
		M	2	<2															10/09/98	12:56
		R	2	10															10/09/98	13:00
596	Rubiyat Boat Club	L	2	10	20			<20	<20										10/09/98	13:10
		M	2	<2				<20		2.4		4.5		1.80	0.19	0.07	93	168	10/09/98	13:14
		M	19							2.6									10/09/98	13:14
		R	2	<2															10/09/98	13:20
598	Six Mile Island Light & Day Marks	L	2	10	25														10/09/98	13:35
		M	2	<2															10/09/98	13:38
		R	2	63															10/09/98	13:45
600	Federal Mooring Buoys	L	2	<2	<2			<20	<20										10/09/98	14:10
		M	2	<2				<20		2.8		6.0		1.20	0.19	0.07	95	168	10/09/98	14:15
		M	44							2.2									10/09/98	14:15
		R	2	<2															10/09/98	14:28
602	Hargrass Creek	L	2	<2	20														10/09/98	14:45
		M	2	<2															10/09/98	14:47
		R	2	10															10/09/98	14:51
604	George Rogers Clark Bridge	L	2	134	43	18	12	20	30										10/09/98	15:02
		M	2	30		<20		<20		1.0	1.2	13.5		0.46	0.42	0.08	97	177	10/09/98	15:08
		M	21							3.0	3.4								10/09/98	15:08
		R	2	20		<20													10/09/98	15:20
604	Duplicate	L	2	97	27														10/09/98	15:02
		M	2	10				40		3.1		14.0		0.36	0.45	0.08	96	167	10/09/98	15:08
		M	21							3.0									10/09/98	15:08
		R	2	20															10/09/98	15:20
608	New Albany Boat Club	L	2	74	30			400	333										10/09/98	10:55
		M	2	41				80		3.2		14.5		0.80	0.42	0.1	96	169	10/09/98	11:00
		M	15							1.7									10/09/98	11:00
		R	2	41															10/09/98	11:11
610	PSI Company	L	2	31	44														10/09/98	11:17
		M	2	41															10/09/98	11:19
		R	2	41															10/09/98	11:21
612	Gulf Oil Company	L	2	109	61			220	155										10/09/98	11:28
		M	2	51				60		3.1		20.5		0.60	0.49	0.1	97	178	10/09/98	11:30
		M	26							2.7									10/09/98	11:30
		R	2	41															10/09/98	11:45
614	Kerr-McGee Terminal, Inc.	L	2	272	164														10/09/98	11:52
		M	2	134															10/09/98	11:54
		R	2	122															10/09/98	11:56
616	Hughes Bar Light & Day Marks	L	2	520	455	580	209	780	555										10/09/98	12:04
		M	2	63		89		180		2.4	2.8	24.0		1.4 1.4	0.41	0.1	96	170	10/09/98	12:08
		M	27							1.3	1.8								10/09/98	12:08
		R	2	120		178													10/09/98	12:20
616	Duplicate	L	2	496	293														10/09/98	12:04
		M	2	120				320		2.5		26.5		0.45 0.43	0.43	0.14	97	164	10/09/98	12:08
		M	27							3.3									10/09/98	12:08
		R	2	121															10/09/98	12:20
618	Jeffersonville Riverport	L	2	428	265														10/09/98	12:27
		M	2	259															10/09/98	12:29
		R	2	160															10/09/98	12:31
620	Sun Refining & Marketing Company	L	2	706	224			60	77										10/09/98	12:48
		M	2	364				190		3.7		29.5		0.76	0.49	0.15	92	175	10/09/98	12:52
		M	19							3.5									10/09/98	12:52
		R	2	132															10/09/98	13:00
622	Sheet Piling on 1190	L	2	1,280	470														10/09/98	13:07
		M	2	309															10/09/98	13:09
		R	2	262															10/09/98	13:11
624	Eversole Creek	L	2	933	770			480	333										10/09/98	13:26
		M	2	275				140		3.3		26.5		0.84	0.49	0.14	95	170	10/09/98	13:28
		M	20							1.8									10/09/98	13:28
		R	2	197															10/09/98	13:38
626	Louisville Gas & Electric	L	2	911	368														10/09/98	13:44
		M	2	359															10/09/98	13:46
		R	2	393															10/09/98	13:48
628	Louisville Environmental Service	L	2	2,710	5,082			1,140	1,957										10/09/98	13:52
		M	2	601				980		3.7		8.7		0.82	0.50	0.28	96	164	10/09/98	13:56
		M	25							3.6									10/09/98	13:56
		R	2	776															10/09/98	14:02
630	Salt River	L	2	2,300	1,450														10/09/98	14:06
		M	2	1,500															10/09/98	14:09
		R	2	959															10/09/98	14:11
	Crew 1 Equipment Blank									<1.0		<1.0	<10	<0.1	<0.1	<0.03	8	8	10/09/98	11:45
	Crew 1 Method Blank			<2				<20											10/09/98	15:49
	Crew 1 Equipment Blank									<1.0		1.0		<0.1	<0.1	<0.03	8	25	10/09/98	13:35
	Crew 1 Field Blank			<2				<20		<1.0		1.0		<0.1	<0.1	<0.03	6	5	10/09/98	15:40
	Crew 2 Equipment Blank									<1.0		1.0		<0.1	<0.1	<0.03	7	6	10/09/98	10:10
	Crew 2 Method Blank			<2				<20											10/09/98	15:05
	Crew 2 Equipment Blank									<1.0		<1.0	<10	<0.1	<0.1	<0.03	8	10	10/09/98	15:10
	Crew 2 Field Blank			<2		<20		<20		<1.0		<1.0	<10	<0.1	<0.1	0.03/<0.03	8	12	10/09/98	15:60

Note: L = Left Bank; M = Midstream; R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/7/98

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (feet)	Coliert *Escherichia coli* (CFU/100 ml)	Organics Notes	Membrane Filtration *Escherichia coli* (CFU/100 ml)	Organics Notes	Fecal coliform (CFU/100 ml)	Organics Notes	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Date	Sample Time
588	Paige Daymark	L	2	4	0			<20	<20										10/10/98	10:35
		M	2	8				40		1.7		6.4	0.11	1.40	0.35	0.05	94	163	10/10/98	10:44
		M	28							1.9									10/10/98	10:44
		R	2	2															10/10/98	10:54
590	Martin Marietta Company	L	2	13	23														10/10/98	11:00
		M	2	17															10/10/98	11:04
		R	2	10															10/10/98	11:06
592	Twelve Mile Island	L	2	6	7			<20	<20										10/10/98	11:13
		M	2	6				<20		1.7		6.0		0.76	0.33	0.07	90	170	10/10/98	11:15
		M	21							1.4									10/10/98	11:15
		R	2	10															10/10/98	11:23
594	Pipeline Crossing	L	2	2	3														10/10/98	11:34
		M	2	<2															10/10/98	11:38
		R	2	2															10/10/98	11:40
596	Ruthyat Boat Club	L	2	2	2			<20	<20										10/10/98	11:50
		M	2	<2				<20		1.9		5.0		1.20	0.30	0.06	94	168	10/10/98	11:51
		M	19							1.9									10/10/98	11:51
		R	2	<2															10/10/98	12:00
598	Six Mile Island Light & Day Marks	L	2	2	0														10/10/98	12:06
		M	2	<2															10/10/98	12:11
		R	2	29															10/10/98	12:17
600	Federal Mooring Buoys	L	2	<2	35			<20	<20										10/10/98	12:36
		M	2	<2				<20		2.3		9.0		0.67	0.33	0.06	94	169	10/10/98	12:40
		M	44							1.7									10/10/98	12:40
		R	2	37															10/10/98	12:52
602	Beargrass Creek	L	2	<2	22														10/10/98	13:00
		M	2	<2															10/10/98	13:02
		R	2	22															10/10/98	13:04
604	George Rogers Clark Bridge	L	2	4	19	<20	36	<20	40										10/10/98	13:10
		M	2	10		<20		20		1.7	2.1	10.5		1.0 1.2	0.29	0.06	94	166	10/10/98	13:15
		M	23							<1	1.2								10/10/98	13:15
		R	2	168		36													10/10/98	13:27
606	Duplicate	L	2	20	25			<20	30										10/10/98	13:39
		M	2	8				20		<1		6.0		0.5 1.1	0.37	0.08	95	168	10/10/98	13:15
		M	23							<1									10/10/98	13:15
		R	2	79															10/10/98	13:27
608	New Albany Boat Club	L	2	26	28			<20	<20										10/10/98	10:33
		M	2	6				<20		6.1		14.0		0.72	0.48	0.1	90	166	10/10/98	10:36
		M	16							6.1									10/10/98	10:36
		R	2	24															10/10/98	10:42
610	PSI Company	L	2	11	14														10/10/98	10:52
		M	2	12															10/10/98	10:54
		R	2	8															10/10/98	10:56
612	Gulf Oil Company	L	2	17	14			<20	30										10/10/98	11:02
		M	2	10				20		<1		13.0		1.00	0.48	0.1	94	172	10/10/98	11:05
		M	24							<1									10/10/98	11:05
		R	2	15															10/10/98	11:10
614	Kerr-McGee Terminal, Inc	L	2	43	22														10/10/98	11:16
		M	2	8															10/10/98	11:18
		R	2	32															10/10/98	11:20
616	Hughes Bar Light & Day Marks	L	2	196	98	125	87	60	60										10/10/98	11:23
		M	2	4		<20		<20		<1	1.0	14.2		1.20	0.53	0.08	93	172	10/10/98	11:28
		M	27							<1	<1								10/10/98	11:28
		R	2	35		36													10/10/98	11:38
618	Duplicate	L	2	243	38														10/10/98	11:23
		M	2	15				<20		1.1		13.5		1.10	0.51	0.11	92	171	10/10/98	11:28
		M	27							1.4									10/10/98	11:28
		R	2	15															10/10/98	11:38
619	Jeffersonville Riverport	L	2	67	69														10/10/98	11:44
		M	2	58															10/10/98	11:46
		R	2	24															10/10/98	11:48
620	Sun Refining & Marketing Company	L	2	61	46			<20	80										10/10/98	12:05
		M	2	49				60		<1		20.0		0.76	0.48	0.12	93	164	10/10/98	12:09
		M	18							<1									10/10/98	12:09
		R	2	32															10/10/98	12:14
622	Sheet Piling on LDB	L	2	181	59														10/10/98	12:18
		M	2	34															10/10/98	12:20
		R	2	32															10/10/98	12:22
624	Eversole Creek	L	2	129	51			<20	<20										10/10/98	12:28
		M	2	29				<20		1.5		14.0		1.00	0.48	0.15	94	173	10/10/98	12:32
		M	26							<1									10/10/98	12:32
		R	2	36															10/10/98	12:36
626	Louisville Gas & Electric	L	2	164	90														10/10/98	12:42
		M	2	37															10/10/98	12:44
		R	2	21															10/10/98	12:46
629	Louisville Environmental Service	L	2	198	85			<20	>20										10/10/98	12:32
		M	2	35				<20		1.0		17.0		0.88	0.51	0.15	96	170	10/10/98	12:56
		M	23							2.0									10/10/98	12:56
		R	2	40															10/10/98	12:59
630	Salt River	L	2	119	88														10/10/98	13:04
		M	2	49															10/10/98	13:06
		R	2	55															10/10/98	13:08
	Crew 1 Equipment Blank									1.0		<1.0	<10	<0.1	<0.1	<0.01	8	14	10/10/98	10:30
	Crew 1 Method Blank			<2				<20											10/10/98	14:10
	Crew 1 Equipment Blank									<1.0		<1.0		0.1	0.04<0.05		8	5	10/10/98	14:02
	Crew 1 Field Blank			<2				<20		<1.0		<1.0		0.1	0.03<0.05		8	4	10/10/98	13:55
	Crew 2 Equipment Blank									<1.0		1.2		0.1	0.03<0.05		7	10	10/10/98	10:00
	Crew 2 Method Blank			<2				<20											10/10/98	13:55
	Crew 2 Equipment Blank									<1.0		<1.0	<10	0.1	<0.1	0.06<0.05	7	4	10/10/98	14:00
	Crew 2 Field Blank			<2		<20		<20		<1.0	<1.0	<1.0	<10	<0.1	<0.1	0.06<0.05	8	6	10/10/98	13:50

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Combined Sewer Outfall Analytical Data

Site Description	Event Time (Hours)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
Louisville CSO #125	HR0	19.2		125	0.03	<0.1	<0.1	0.03	10/07/98	14:15
	HR1	9.8		80					10/07/98	14:30
	HR2	6.8 / <3	10.4	65	.093 / <0.01	0.11 / <0.1	0.2 / <0.1	0.03 / 0.03	10/07/98	14:45
	Duplicate	3.3 / <3		60	<0.01 / <0.01	<0.1 / <0.1	<0.1 / <0.1	0.03 / 0.03	10/07/98	14:45
	HR3	3.7		35					10/07/98	15:15
	HR4	3.7		65	0.03	<0.1	0.12	0.03	10/07/98	15:45
	HR5	4		75					10/07/98	16:15
Louisville CSO #108	HR0	4		185	0.05	<0.1	<0.1	0.04	10/07/98	14:06
	HR1	>26 / 17.1		130					10/07/98	14:21
	HR2	11.6 / 8.2	18.8	65	.035 / <0.01	<0.1 / <0.1	0.6 / <0.1	0.04 / 0.03	10/07/98	14:36
	Duplicate	6.7 / 3.7		65	<0.01 / <0.01	<0.1 / <0.1	0.13 / <0.1	<0.03 / 0.03	10/07/98	14:36
	HR3	4		65					10/07/98	15:06
	HR4	5		20	<0.01	<0.1	0.12	0.03	10/07/98	15:36
	HR5	3.8		70					10/07/98	15:51
	HR6	2.7		75	0.03	<0.1	0.16	0.03	10/07/98	16:06
	HR7	2.1		135					10/07/98	16:21
Jeffersonville CSO #002	HR0	168		720	5.40	0.61	10.30	2.80	10/07/98	14:30
	HR1	63		190					10/07/98	16:00
Louisville MSD	Field Blank	<1.0		<10	<10	<0.1	<0.1	<0.03	10/07/98	

Wet Weather Impact Study
Waste Water Treatment Plant Influent Analytical Data

Site Description	Event Time (Hours)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date Time	Sample Time
Morris Foreman WWTP	HR0	270		72	2.60	0.29	14.90	5.10	10/07/98	16:00
	HR1	250		185					10/07/98	17:00
	HR2	265	180	129 / <60	4.00	0.79	12.50	3.50	10/07/98	18:00
	Duplicate	280		>260	4.70	0.77	12.80	3.20	10/07/98	18:00
	HR3	330		>84 / 51					10/07/98	19:00
	HR4	325		57	2.90	1.40	13.90	6.00	10/07/98	20:00
	HR5	375		58					10/07/98	21:00
	HR6	425		78 / 31	4.50	2.30	14.60	7.00	10/07/98	22:00
	HR7	470		>84 / 43.2					10/07/98	23:00
	HR8	490		>84 / 31	4.00	2.10	15.10	7.00	10/08/98	0:00
	HR9	385		>84 / 49					10/08/98	1:00
New Albany WWTP	HR0	385		>84 / 123	5.50	<0.1	34.10	10.00	10/07/98	15:00
	HR1	310		25					10/07/98	16:05
	HR2	330	56.5	32 / 52.2	4.20	0.17	16.60	5.80	10/07/98	17:05
	Duplicate	305		35	3.90	0.25	16.00	5.60	10/07/98	17:05
	HR3	390		17					10/07/98	18:00
	HR4	455		24	2.40	3.00	14.10	8.60	10/07/98	19:00
	HR5	430		47					10/07/98	20:05
	HR6	494		48	3.10	1.60	15.80	9.70	10/07/98	21:00
	HR7	591		55					10/07/98	22:00
	HR8	534		47	3.20	0.27 / 0.19	15.90	9.10	10/07/98	23:05
	HR9	538		56					10/08/98	0:00
Jeffersonville WWTP	HR0	860		58	4.20	0.66	13.10	5.60	10/07/98	15:00
	HR1	635		55					10/07/98	16:00
	HR2	450	214	133 / <60	4.14	0.86	15.90	4.50	10/07/98	17:00
	Duplicate	760		75	2.26	0.74	14.10	5.80	10/07/98	18:30
	HR3	778		108					10/07/98	19:00
	HR4	1915		77	2.50	0.62	12.90	5.80	10/07/98	20:00
	HR5	1040		74					10/07/98	20:30
	HR6	1220		51	3.00	0.23	12.90	7.60	10/07/98	21:00
	HR7	1210		57					10/07/98	21:30
	HR8	1040		93	3.50	0.39	4.80	7.60	10/07/98	22:00
	HR9	814		80					10/07/98	22:30
New Albany		<1.0	<1.0	31	<10	<0.1	<0.1	<0.03	10/07/98	

APPENDIX D

WATER QUALITY DATA

June 1999 Dry Weather Event

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 6/23/99

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Coliform *Escherichia coli* (CFU/100 ml)	Geometric Mean	Membrane Fekrium *Escherichia coli* (CFU/100 ml)	Geometric Mean	Fecal coliform (CFU/100 ml)	Geometric Mean	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate Nitrate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Chlorophyll-a (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Sample Time
588	Dredge Deptmark	L	2	0	0			0	0											10:32
		M	2	0				0		1.05		<5	0.044	0.94	0.45	0.03	11.8	78	144	10:35
		M	16.5							0.46										10:35
		R	2	0				0												10:45
590	Morton Migration Company	L	2	2	2															10:56
		M	2	0																11:00
		R	2	0																11:05
592	Twelve Mile Island	L	2	0	0			0	0											11:15
		M	2	0				0		1.44		<5		0.59	0.48	0.06	11.20	78	145	11:20
		M	14							0.42										11:20
		R	2	0				0												11:30
594	Pipeline Crossing	L	2	0	0															11:35
		M	2	0																11:39
		R	2	0																11:40
596	Kuhlgate Boat Club	L	2	0	0			0	0											11:47
		M	2	0				0		1.49		<5		1.00	0.37	0.04	14.70	77	145	11:50
		M	32							0.55										11:50
		R	2	0				0												11:59
598	Six Mile Island Light & Day Marks	L	2	0	18															12:05
		M	2	0																12:08
		R	2	19																12:18
600	Twisted Mooring Buoys	L	2	0	0			0	52											12:34
		M	2	0				0		2.93		5.5		1.00	0.57	0.04	14.10	78	145	12:36
		M	33.5							0.55										12:36
		R	2	0				10												12:45
602	Georgetown Creek	L	2	2	2															12:52
		M	2	0																12:56
		R	2	0																12:58
604	George Rogers Clark Bridge	L	2	2	2	54	4	10	77											13:06
		M	2	2	<4	0				1.85	2.60	5.5	0.114	1.00	0.63	0.05	17.40	76	154	13:10
		M	16							0.51	0.49									13:10
		R	2	2	<4	0														13:25
604	Duplicate	L	2	4	4															13:06
		M	2	0		0				1.86		<5	0.044	0.96	0.49	0.04	13.10	78	144	13:10
		M	16							0.50										13:10
		R	2	0																13:25
608	New Albany Boat Club	L	2	2	2			0	170											9:37
		M	2	0				10		1.26		<5	0.054	0.92	0.27	0.16		75	140	9:43
		M								0.58										9:43
		R	2	0				0												9:51
610	TSI Company	L	2	2	2															10:00
		M	2	0																10:03
		R	2	0																10:08
612	Ashl Oil Company	L	2	0	0			0	20											10:15
		M	2	0				10		1.14		<5		0.99	0.39	0.05		77	141	10:23
		M								0.99										10:23
		R	2	0				0												10:31
614	Kent Meltine Terminal, Inc.	L	2	1,270	994															10:40
		M	2	1,270																10:46
		R	2	345																10:49
616	Hughes Bar Light & Day Marks	L	2	598	760	120	205	4,000	5,000											10:56
		M	2	985		500		2,000		0.83	1.73	6.5		0.83	0.46	0.19		79	142	11:15
		M	25							0.22	0.65									11:15
		R	2	760		140		5,100												11:29
618	Duplicate	L	2	567	672															10:56
		M	2	687				1,780		1.04		5.5		0.84	0.51	0.20		79	142	11:15
		M	25							0.02										11:15
		R	2	788																11:29
618	Jeffersonville Riverport	L	2	206	217															11:39
		M	2	213																11:49
		R	2	304																11:44
620	Star Refining & Marketing Company	L	2	258	129			530	1,987											12:16
		M	2	177				3,400		0.98		6.5		0.83	0.44	0.14		80	140	12:19
		M								0.19										12:19
		R	2	46				740												12:27
622	Short piling on LDB	L	2	52	65															12:34
		M	2	83																12:37
		R	2	53																12:40
624	Evansville Creek	L	2	10	9			280	250											12:47
		M	2	17				0		0.59		6.0		0.42	0.59	0.15		79	140	13:02
		M								0.06										13:02
		R	2	4				0												12:53
626	Evansville Gas & Electric	L	2	13	14															13:13
		M	2	10																13:23
		R	2	8																13:26
628	Evansville Environmental Service	L	2	24	35			30	37											13:34
		M	2	28				10		1.21		5.0	0.052	0.41	0.57	0.22	9.45	81	144	13:37
		M								0.34										13:37
		R	2	14				0												13:44
630	Salt River	L	2	10	24															13:56
		M	2	56																13:59
		R	2	<2																14:04
	Crew 1 Equipment Blank			0				0				<5	0.010	<0.1	<0.1	<0.05	<0.50	5.3	8	10:29
	Crew 1 Field Blank			0				0		0.29		<5	<0.1	<0.1	0.05			5.8	4	13:50
	Crew 1 Method Blank																			13:35
	Crew 1 Equipment Blank									<0.05		<5		<0.1	<0.1	<0.05		6.1	5	13:35
	Crew 2 Equipment Blank					<2		0		<0.05		<5		<0.1	0.10	<0.05		5.3	2	9:55
	Crew 2 Field Blank			0				0		0.11	0.52	<5	0.010	<0.1	<0.1	<0.05	3.52	5.4	5	14:26
	Crew 2 Method Blank			0																14:30
	Crew 2 Equipment Blank									0.75		<5	0.010	<0.1	<0.1	<0.05	<0.50	5.7	6	14:27

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 6/23/99

Confluence Mile Point	Tributary	Site Description	State	Colilert *Escherichia coli* (CFU/100 ml)	Membrane Filtration *Escherichia coli* (CFU/100 ml)	Fecal Coliform (CFU/100 ml)	Carbonaceous BOD5 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate+ Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Time
595.9	Harrods Creek	Prospect	KY	49		88	3.2	270	0.37	0.80	1.20	0.06	11:45
596.3	Lentzier Creek	Utica Pike	IN	294		220	1.0	290	0.13	0.55	0.32	<0.03	8:55
596.9	Goose Creek	Route 42	KY	154		210	0.7	400	0.42	2.60	0.13	0.04	12:35
596.9	Little Goose Creek	Harbour Road	KY	403	210	320	0.4	410	0.10	1.00	0.13	<0.03	12:10
597.8	Lancassange Creek	Utica Pike	IN	288		320	1.1	410	0.11	2.10	0.34	<0.03	9:13
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue	KY	181		370	0.7	450	0.27	1.50	0.23	0.04	14:20
	Middle/South Fork	Mellwood Avenue	KY	192		640	1.9	390	0.33	0.50	0.74	0.20	14:00
	Duplicate			211		820	2.0	390	0.26	0.49	0.81	0.19	
606.1	Mill Creek	Frontage Road	IN	292		320	0.8	610	0.45	0.90	0.54	0.05	10:45
607.0	Silver Creek	Route 62	IN	46	<60	220	2.0	430	0.26	0.28	0.63	0.03	11:55
	Duplicate			86	120	200	1.8	420	0.21	0.27	0.70	0.04	
609.3	Falling Run	New Albany Pump Station	IN	829		1440	0.8	580	0.40	0.84	0.39	0.03	10:30
616.4	Mill Creek Cutoff	Cane Run	KY	244		320	0.9	410	0.21	<0.1	0.39	<0.03	9:00
623.1	Mill Creek	Orell Road	KY	63		56	1.1	270	0.30	0.57	0.23	0.05	10:00
	Louisville MSD	Equipment Blank		0		<2	0.0	<10	<0.010	<0.1	<0.1	<0.03	9:00
	Louisville MSD	Equipment Blank		0		<2	0.1	12	<0.010	<0.1	0.10	<0.03	10:00
	Jeffersonville/Clarksville	Equipment Blank		0		<2	0.2	<10	<0.010	<0.1	<0.1	<0.03	8:55
	Jeffersonville/Clarksville	Field Blank		0		<2	-0.1	12	<0.010	<0.1	<0.1	<0.03	9:13
	Jeffersonville/Clarksville	Equipment Blank		0		<2	0.1	<10	<0.010	<0.1	<0.1	<0.03	9:13
	New Albany	Equipment Blank		0		<2	0.4	18	<0.010	<0.1	<0.1	<0.03	9:40
	Louisville MSD	Equipment Blank		0		<2	0.3	<10	<0.010	<0.1	<0.1	<0.03	11:35
	Louisville MSD	Field Blank		0		<2	0.1	16	<0.010	<0.1	<0.1	<0.03	14:35
	Louisville MSD	Equipment Blank		0		<2	0.1	20	<0.010	<0.1	0.12	<0.03	14:30
	Strand & Associates	Equipment Blank		0		<2	0.0	20	<0.010	<0.1	<0.1	<0.03	10:45
	Strand & Associates	Field Blank		0		<2	-0.1	<10	<0.010	<0.1	0.20	<0.03	14:30
	Strand & Associates	Equipment Blank		0		<2	0.0	12	<0.010	<0.1	0.34	<0.03	14:30

Note: Beargrass (Mid/South and Muddy Forks) and Silver Creek samples are composited from the left descending bank, midstream, and right descending bank.

APPENDIX D

WATER QUALITY DATA

August 2000 Wet Weather Event

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 8/8/00

Confluence Mile Point	Tributary	Site Description	State	Sample ID	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue	KY	HR 0			2,400	2.7		400	0.24	0.59	0.52	0.11	08/08/00	14:40
				HR 2			100,000			80					08/08/00	16:41
				HR 4			240,000			220					08/08/00	18:37
				HR 6			65,500	2.8	5.6	320	0.4	0.98	0.91	0.35	08/08/00	20:33
				HR 8			140,000			230					08/08/00	23:55
				HR 10			61,000			180					08/09/00	0:40
				HR 12		9,000	47,000	5.1	9.6	300	0.28	0.98	0.82	0.25	08/09/00	2:15
				Duplicate			52,000	3		280	0.25	0.95	0.81	0.27	08/09/00	2:15
602.1	Beargrass Creek Middle/South Fork	Mellwood	KY	HR 0	4,260		8,400	2.8		330	0.5	2.3	0.86	0.4	08/08/00	15:15
				HR 2	10,400		33,000*			220					08/08/00	17:00
				HR 4			68,000			360					08/08/00	19:00
				HR 6	8,465		18,800	3.2	6.9	380	0.83	1.7	0.82	0.23	08/08/00	21:00
				HR 8	4,380		9,200			380					08/08/00	23:15
				HR 10	3,640		8,600			320					08/09/00	0:54
				HR 12	3,470	1,600	6,000	2.1	4.4	320	0.34	1.7	0.98	0.39	08/09/00	2:39
				Duplicate	2,442		7,200	3.1		340	0.34	1.5	0.7	0.39	08/09/00	2:39
606.1	Mill Creek (IN)	Frontage Road	IN	HR 0	11,000		34,000	4.5		220	0.33	0.52	0.74	0.46	08/08/00	16:35
				HR 2	8,430		24,000			220					08/08/00	18:32
				HR 4	1,780		6,200			410					08/08/00	20:09
				HR 6	1,360		5,200	2.5	4.3	930	0.26	0.84	1.1	0.23	08/08/00	22:10
				HR 8	2,060		2,400			390					08/09/00	0:02
				HR 10	5,680		25,000			380					08/09/00	1:55
				HR 12	10,900		31,000	1.9	4	400	0.63	1.2	0.75	0.21	08/09/00	4:00
				Duplicate	7,890		34,000	3.1	5.6	390	0.66	0.93	0.8	0.22	08/09/00	4:01
607.0	Silver Creek	Route 62	IN	HR 0	8,420		39,000	4		220	0.36	0.57	0.92	0.34	08/08/00	17:02
				HR 2	21,700		67,000			200					08/08/00	19:01
				HR 4	1,110		22,000			220					08/08/00	20:25
				HR 6	12,500		14,000	3.5	6.9	220	0.57	1.5	0.87	0.15	08/08/00	22:23
				HR 8	11,900		35,000			380					08/09/00	0:22
				HR 10	7,860		50,000			360					08/09/00	2:15
				HR 12	6,860	10,000	51,000	2.5	4.9	260	0.8	1.3	1.1	0.23	08/09/00	4:42
				Duplicate	7,840	9,800	29,000	2.5	5	250	0.76	1.2	0.87	0.19	08/09/00	4:43
609.3	Falling Run	New Albany Pump Station	IN	HR 0	32,500		110,000	4.9		95	0.83	1.8	1.1	0.19	08/08/00	15:15
				HR 2	17,400		53,000			120					08/08/00	17:15
				HR 4	2,190		69,000			160					08/08/00	19:15
				HR 6	11,600		67,000	3.1	5.8	180	0.7	1.5	1	0.46	08/08/00	21:15
				HR 8	9,570		75,000			180					08/08/00	23:15
				HR 10	9,750		46,000			180					08/09/00	1:15
				HR 12	5,850		50,000	2.1	4	220	0.54	1.3	1.1	0.37	08/09/00	0:00
				Duplicate	7,170		68,000	1.9		200	0.53	1.6	1	0.35	08/09/00	3:15
616.4	Mill Creek Cutoff	Cane Run	KY	HR 0	5,470		63,000	5.7		120	0.64	1.3	0.72	0.34	08/08/00	16:00
				HR 2	2,280		49,000			90					08/08/00	18:00
				HR 4	988		28,000			100					08/08/00	20:00
				HR 6	904		33,000	2.9	6.3	180	0.15	0.57	0.52	0.09	08/08/00	22:00
				HR 8	1,770		15,300			73					08/09/00	0:00
				HR 10	800		4,000			260					08/09/00	2:00
				HR 12	611	560	2,000	1.9	3	310	0.18	0.14	0.31	0.22	08/09/00	4:00
				Duplicate	654		6,600	2.5		330	0.17	0.15	0.27	0.25	08/09/00	4:01
	Louisville MSD	Equipment Blank		BEB 1				2.3		<10	<0.01	<0.10	<0.10	0.09	08/08/00	14:33
	Strand & Associates	Equipment Blank		BEB 1				4		180	2.4	2.7	1.5	0.57	08/08/00	16:00
	New Albany	Equipment Blank		BEB 1	<1		<2	2.1		<10	<0.01	<0.10	<0.10	0.09	08/08/00	15:00
	Strand & Associates	Equipment Blank		BEB 1	4		16	1.4		<10	<0.01	<0.10	<0.10	0.08	08/08/00	15:45

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 8/8/00

Confluence Mile Point	Tributary	Site Description	State	Sample ID	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
602.1	Beargrass Creek Muddy Fork	Mockinghird Avenue	KY	HR 16			37,000			310					08/09/00	5:56
				HR 20			26,000	2.4		240	0.17	1.2	0.62	0.12	08/09/00	11:20
				HR 24			62,000			230					08/09/00	14:53
				HR 32				2.1		170	0.26	1	0.6	0.18	08/09/00	22:10
				HR 40						320					08/10/00	6:31
				HR 48				2.3	3.4	240	0.29	1	0.63	0.17	08/10/00	15:00
602.1	Beargrass Creek Middle/South Fork	Mellwood	KY	HR 16	1,100		3,000	5.3		280					08/09/00	6:10
				HR 20	414		43,000	1.6		240	0.18	1.7	0.59	0.1	08/09/00	11:40
				HR 24	374		11,000			248					08/09/00	15:20
				HR 32	453		500	2		230	0.32	1.6	0.43	0.15	08/09/00	22:39
				HR 40	408		10,000			320					08/10/00	6:45
				HR 48	139		100	<1.0	1.5	320	0.26	1.4	0.39	0.11	08/10/00	15:00
606.1	Mill Creek (IN)	Frontage Road	IN	HR 16	8,810		29,000			310					08/09/00	6:05
				HR 20	4,720		10,000	1.7		400	0.4	1.1	0.72	0.14	08/09/00	12:00
				HR 24	366		3,000			580					08/09/00	16:00
				HR 32	926		1,600	3.4		660	0.48	0.83	0.7	0.24	08/10/00	0:00
				HR 40	1,620		800			720					08/10/00	8:00
				HR 48	799		1,300	2.6	3.8	680	0.5	0.83	0.81	0.26	08/10/00	4:00:00 PM
607.0	Silver Creek	Route 62	IN	HR 16	5,010		51,000			310					08/09/00	6:36
				HR 20	1,510		10,300	1.6		360	0.47	0.86	0.79	0.14	08/09/00	12:01:00 PM
				HR 24	501		20,000			400					08/09/00	4:01:00 PM
				HR 32	702		2,000	2.9		420	0.22	1	0.7	0.19	08/10/00	0:01
				HR 40	200		3,000			520					08/10/00	8:00:00 AM
				HR 48	399		1,000	2.1	3	520	0.32	1	0.63	0.1	08/10/00	4:00:00 PM
609.3	Falling Run	New Albany Pump Station	IN	HR 16	4,560		35,000			240					08/09/00	6:15:00 AM
				HR 20	3,680		31,000	1.3		290	0.48	1.5	0.6	0.3	08/09/00	10:15:00 AM
				HR 24	2,100		12,000			310					08/09/00	2:15:00 PM
				HR 32	1,550		17,000	1.9		350	0.35	1.6	0.46	0.09	08/09/00	10:15:00 PM
				HR 40	1,380		6,000			360					08/10/00	6:15:00 AM
				HR 48	1,460		10,000	<1.0	1.9	380	0.38	1.7	0.43	0.08	08/10/00	2:15:00 PM
616.4	Mill Creek Cutoff	Cane Run	KY	HR 16	692		6,000			260					08/09/00	7:00
				HR 20	200		400	<1.0		440	0.1	0.15	0.39	0.16	08/09/00	12:00:00 PM
				HR 24	50		270			320					08/09/00	4:00:00 PM
				HR 32		No Data Collected										
				HR 40	14					210					08/10/00	8:00:00 AM
				HR 48	<2		100	1.7	3.3	220	0.07	0.12	0.52	0.08	08/10/00	4:00:00 PM
	Louisville MSD	Equipment Blank		AEB 1	2.0		>120	<1.0		<10	<0.01	<0.10	0.11	0.05	08/09/00	15:30
	Louisville MSD	Equipment Blank		AEB 2	<2		<1	<1.0		<10	<0.01	<0.10	0.13	0.06	08/10/00	3:00:00 PM
	Louisville MSD	Field Blank		AFB 2	<2		<1	<1.0		<10	<0.01	<0.10	<0.10	0.07	08/10/00	3:00:00 PM
	Strand & Associates	Equipment Blank		AEB 1	<1		<2	<1.0		15	<0.01	<0.10	0.43	0.06	08/09/00	4:02:00 PM
	Strand & Associates	Equipment Blank		AEB 2	<2		<1	<1.0		<10	<0.01	<0.10	<0.10	0.07	08/10/00	4:01:00 PM
	Strand & Associates	Field Blank		AFB 2	9		<1	<1.0		<10	<0.01	<0.10	0.15	0.06	08/10/00	4:00:00 PM
	New Albany	Equipment Blank		AEB 1	<1	<2	<2	2		<10	<0.01	<0.10	0.16	0.06	08/09/00	2:15:00 PM
	New Albany	Equipment Blank		AEB 2	325		49	<1.0		<10	<0.01	<0.10	<0.10	0.06	08/10/00	2:45:00 PM

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 8/8/00

Confluence Mile Point	Tributary	Site Description	State	Sample ID	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue	KY	D3			18,200	1.3		350	0.33	1.1	1	0.34	08/11/00
				D4		1500	2,380	1.1		340	0.33	0.56	0.97	0.25	08/12/00
				Duplicate			3,200	1.1		320	0.33	0.62	0.69	0.27	08/12/00
				D5		2000	6,400	1.5		320	0.23	<0.10	0.76	0.45	08/13/00
602.1	Beargrass Creek Middle/South Fork	Mellwood	KY	D3	175		460	<1.0		380	0.25	1.5	0.46	0.29	08/11/00
				Duplicate	92		207	<1.0		390	0.33	1.5	0.48	0.28	08/11/00
				D4	102			<1.0		370	0.2	0.98	0.24	0.04	08/12/00
				D5	135		210	<1.0		340	0.26	0.7	0.27	0.09	08/13/00
606.1	Mill Creek (IN)	Frontage Road	IN	D3	690		920	<1.0		910	0.64	0.55	0.58	0.37	08/11/00
				D4	241		660	<1.0		730	0.3	0.59	0.77	0.27	08/12/00
				Duplicate	260		800	1.2		710	0.3	0.57	0.73	0.3	08/12/00
607.0	Silver Creek	Route 62	IN	D3	122		250	<1.0		440	0.22	0.72	0.44	0.2	08/11/00
				Duplicate	129		440	<1.0		410	0.21	0.65	0.39	0.19	08/11/00
				D4	84	170	420	1.2		280	0.25	1.2	0.57	0.07	08/12/00
				D5	177	160	350	<1.0	<1.0	<10	<0.01	<0.10	0.14	0.08	08/13/00
609.3	Falling Run	New Albany Pump Station	IN	D3	488		620	<1.0		400	0.26	0.96	0.36	0.12	08/11/00
				Duplicate	330		1,600	<1.0		420	0.27	0.92	0.24	0.1	08/11/00
				D4	843	1080	1,670	<1.0		390	0.19	1.2	0.31	0.04	08/12/00
				D5	343		740	<1.0	1	480	0.4	0.76	0.36	0.09	08/13/00
616.4	Mill Creek Cutoff	Cane Run	KY	D3		No Data Collected									
				D4	101		168	1.1		200	0.11	<0.10	0.48	0.07	08/12/00
				Duplicate	87		128	<1.0		190	0.11	<0.10	0.36	0.07	08/12/00
				D5		No Data Collected									
	Louisville MSD	Equipment Blank		AEB D3	<2		<2*	<1.0		<10	<0.01	<0.10	<0.10	0.1	08/11/00
	Louisville MSD	Field Blank		AFB D3	<2		<2*	<1.0		<10	<0.01	<0.10	<0.10	0.08	08/11/00
	Louisville MSD	Equipment Blank		AEB D4	<2		<2*	<1.0		<10	<0.01	<0.10	<0.10	<0.03	08/12/00
	Louisville MSD	Field Blank		AFB D4	<2		<2*	<1.0		<10	<0.01	<0.10	<0.10	<0.03	08/12/00
	Louisville MSD	Equipment Blank		AEB D5	<2		<2	<1.0		<10	<0.01	<0.10	<0.10	0.06	08/13/00
	Louisville MSD	Field Blank		AFB D5	<2		<2	<1.0		<10	<0.01	<0.10	<0.10	0.06	08/13/00
	Strand & Associates	Equipment Blank		AEB D3	<2		<2*	<1.0		<10	<0.01	<0.10	<0.10	0.1	08/11/00
	Strand & Associates	Field Blank		AFB D3	<2		<2	<1.0		<10	<0.01	<0.10	<0.10	0.1	08/11/00
	Strand & Associates	Equipment Blank		AEB D4	<2		<2*	<1.0		<10	<0.01	<0.10	<0.10	<0.03	08/12/00
	Strand & Associates	Field Blank		AFB D4	<2										08/12/00
	Strand & Associates	Equipment Blank		AEB D5	<2		<2*	<1.0		<10	<0.01	<0.10	<0.10	0.1	08/13/00
	Strand & Associates	Field Blank		AFB D5	<2		<2	<2		420	0.32	0.88	0.38	0.11	08/13/00
	New Albany	Equipment Blank		AEB D3	<2		<2	1.6		<10	<0.01	<0.10	<0.10	0.1	08/11/00
	New Albany	Field Blank		AFB D3	<2		<2*	<1.0		<10	<0.01	<0.10	<0.10	0.04	08/11/00
	New Albany	Equipment Blank		AEB D4	<2		<2*	2.1		<10	<0.01	<0.10	<0.10	<0.03	08/12/00
	New Albany	Field Blank		AFB D4	<2		<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	08/12/00
	New Albany	Equipment Blank		AEB D5	<2		<2	1.9		<10	<0.01	<0.10	<0.10	0.07	08/13/00
	New Albany	Field Blank		AFB D5	<2		<2	<1.0		<10	<0.01	<0.10	<0.10	0.08	08/13/00
	Strand & Associates	Equipment Blank		AEB D3	<2		<2	<1.0		<10	<0.01	<0.10	<0.10	0.08	08/11/00
	Strand & Associates	Equipment Blank		AEB D4	2		<2*	<1.0		<10	<0.01	<0.10	<0.10	<0.03	08/12/00
	Strand & Associates	Equipment Blank		AEB D5	<2		<2*	<2		<10	<0.01	<0.10	<0.10	0.08	08/13/00

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 8/8/00

Confluence Mile Point	Tributary	Site Description	State	Sample ID	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date
595.9	Harrods Creek	Prospect	KY	M1	17,200		45,000	4.6	210	0.78	1.5	1.4	0.08	08/08/00
				M2	3,630		6,000		360					08/08/00
				M3	1,130		13,000	1.2	270	0.26	1.8	0.62	0.13	08/09/00
				M4	2,000		48,000		320					08/10/00
				M5	568	720	7,000	2	330	0.36	1.9	0.82	0.1	08/10/00
				Duplicate	804		4,000	1.7	320	0.35	1.8	0.75	0.1	08/10/00
				M6	643		1,300		320					08/10/00
596.3	Lentzier Creek	Utica Pike	IN	M1	14,900		60,000							08/08/00
				M2	7,600	80,000	40,000	<15*	160	1.4	1.2	1.1	0.1	08/08/00
				M3	487		70,000	1.2	300	0.13	1.5	0.48	0.13	08/09/00
				M4	1,410		11000		240					08/10/00
				M5	197	160	2000	1.9	310	0.26	0.95	0.47	0.15	08/10/00
				M6	160		48000		390					08/10/00
596.9	Goose Creek	Highway 42	KY	M1	8,410		11,600	2	270	0.31	1.9	0.5	0.06	08/08/00
				M2	5,890		11,400		340					08/08/00
				M3	2,220		5,200	1	230	0.32	1.7	0.79	0.13	08/09/00
				M4	1,320		2400		280					08/10/00
				M5	664	370	1200	1.2	310	0.22	1.5	0.33	0.1	08/10/00
				Duplicate	356	420	1000	<1.0	290	0.26	1.3	0.5	0.1	08/10/00
				M6	588		700		300					08/10/00
596.9	Little Goose Creek	Barbour Lane	KY	M1		Dry - No Sample								
				M2		Dry - No Sample								
				M3		Dry - No Sample								
				M4		Dry - No Sample								
				M5		Dry - No Sample								
				Duplicate		Dry - No Sample								
				M6		Dry - No Sample								
597.8	Lancassange	Utica Pike	IN	M1	23,200				150					08/08/00
				M2	25,300	200,000	60,000	<15*	120	0.87	1.8	1.4	0.11	08/08/00
				M3	11,200		50,000	1.4	280	0.84	1.8	0.79	0.2	08/09/00
				Duplicate	9,220		47,000	1.6	340	0.79	1.8	0.95	0.25	08/09/00
				M4	820		10000		NO DATA					08/10/00
				M5	91	300	5000	2.3	440	0.24	0.55	0.6	0.15	08/10/00
				M6	275		100		380					08/10/00
625.1	Mill Creek (KY)	Orell Road Bridge	KY	M1	246		567	2.6	94	0.32	0.37	0.36	0.11	08/08/00
				M2	199		300		310					08/08/00
				M3	78		130	<1.0	450	0.13	0.39	0.53	0.4	08/09/00
				M4	363				350					08/10/00
				M5	108	48		1.4	330	0.28	0.35	0.35	0.1	08/10/00
				Duplicate	90			1.2	340	0.23	0.51	0.5	0.12	08/10/00
				M6	48				380					08/10/00
	Strand & Associates	Equipment Blank		BEB D1	<1		>120	1.1	<10	<0.01	<0.10	<0.10	0.04	08/08/00
		Equipment Blank		AEB D1	1		<2	<1.0	<10	<0.01	<0.10	0.23	0.11	08/09/00
		Equipment Blank		AEB D2	<2		1	<1.0	<10	<0.01	<0.10	0.18	0.05	08/10/00
		Field Blank		AFB D2	<2		<1	<1.0	<10	<0.01	<0.10	0.29	0.06	08/10/00

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 8/8/00

Sampling Mile Point	Transect Description	Descending Stack	Sample Depth (Feet)	Coliert *Escherichia coli* (CFU/100 mL)	Enterolert Mpn	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Chlorophyll Mpn	Fecal coliform (CFU/100 mL)	Enterolert Mpn	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrite-Nitrate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
588	Dogs Chutemark	L	2	39	56															8/8/2000	11:15
		M	2	56				800		<1.0		18	0.11	1.6	0.52	0.06	83.0	132.0	0.162	8/8/2000	11:25
		M	48							<1.0										8/8/2000	11:32
		R	2	81																8/8/2000	11:38
590	Martin Marietta Company	L	2	46	92															8/8/2000	11:47
		M	2	46																8/8/2000	11:50
		R	2	114																8/8/2000	12:03
592	Twelve Mile Island	L	2	76	190															8/8/2000	12:08
		M	2	79				170		<1.0		41		1.8	0.75	0.08	82.0	134.0	0.152	8/8/2000	12:10
		M	9							<1.0										8/8/2000	12:13
		R	2	171																8/8/2000	12:16
594	Pipeline Crossing	L	2	27	80															8/8/2000	12:27
		M	2	22																8/8/2000	12:33
		R	2	194																8/8/2000	12:37
596	Ballyrat Boat Club	L	2	39	53															8/8/2000	12:44
		M	2	42				150		<1.0		13		1.6	0.52	0.05	83.0	130.0	0.183	8/8/2000	12:46
		M	42							<1.0										8/8/2000	12:50
		R	2	93																8/8/2000	12:53
598	Six Mile Island Light & Dwy Marks	L	2	39	95															8/8/2000	13:05
		M	2	20																8/8/2000	13:07
		R	2	54																8/8/2000	13:12
600	Federal Mooring Buoys	L	2	50	59															8/8/2000	13:29
		M	2	50				50		<1.0		27		1.5	0.41	0.12	82.0	134.0	0.199	8/8/2000	13:33
		M	40							<1.0										8/8/2000	13:36
		R	2	67																8/8/2000	13:40
602	Hourglass Creek	L	2	45	27															8/8/2000	13:58
		M	2	25																8/8/2000	14:00
		R	2	35																8/8/2000	14:04
604	George Rogers Clark Bridge	L	2	87	86	10	24													8/8/2000	14:08
		M	2	41		30				<1.0	<1.0	33	0.23	1.5	0.41	0.13	86.0	Lab accident	0.146	8/8/2000	14:12
		M	15							<1.0	<1.0									8/8/2000	14:15
		R	2	33		40														8/8/2000	14:29
606	Duplicate	L	2	51	27															8/8/2000	14:09
		M	2	18				180		<1.0		31	0.25	1.8	0.43	0.16	86.0	136.0	0.146	8/8/2000	14:13
		M	15							<1.0										8/8/2000	14:16
		R	2	21																8/8/2000	14:30
608	Portland Canal	L	2	497																8/8/2000	14:40
607	CSX Railroad Bridge	L	2	419																8/8/2000	11:26
607	Duplicate	L	2	472																8/8/2000	11:27
608	New Albany Boat Club	L	2	195	238															8/8/2000	11:36
		M	2	45				180		<1.0		42	0.29	1.7	0.63	0.28	85.0	140.0	0.184	8/8/2000	11:44
		M	26							<1.0										8/8/2000	11:44
		R	2	181																8/8/2000	11:41
610	PSI Company	L	2	250	146															8/8/2000	12:00
		M	2	128																8/8/2000	12:03
		R	2	84																8/8/2000	12:06
612	Gulf Oil Company	L	2	192	186															8/8/2000	12:14
		M	2	58				160		<1.0		37		1.6	0.48	0.19	86.0	142.0	0.203	8/8/2000	12:16
		M	36							<1.0										8/8/2000	12:16
		R	2	227																8/8/2000	12:16
614	Kerr McGee Terminal, Inc	L	2	717	206															8/8/2000	12:31
		M	2	115																8/8/2000	12:33
		R	2	106																8/8/2000	12:36
616	Hughes Bar Light & Dwy Marks	L	2	1,879	328	2200	233	280	206	<1.0	5.2	33		1.6	0.38	0.05	86.0	144.0	0.123	8/8/2000	12:40
		M	2	129		90				<1.0	3.9									8/8/2000	12:43
		M	12.5																	8/8/2000	12:43
		R	2	135		80														8/8/2000	12:55
616	Duplicate	L	2	1,990	815															8/8/2000	12:40
		M	2	99						<1.0		29		1.6	0.48	0.06	87.0	136.0		8/8/2000	12:44
		M	12.5							<1.0										8/8/2000	12:44
		R	2	153																8/8/2000	12:55
618	Jeffersonville Riverport	L	2	943	122															8/8/2000	13:02
		M	2	71																8/8/2000	13:03
		R	2	35																8/8/2000	13:05
620	Sun Refining & Marketing Company	L	2	1,280	185															8/8/2000	13:10
		M	2	77				150		<1.0		33		1	0.59	0.15	85.0	144.0	0.169	8/8/2000	13:12
		M	24							<1.0										8/8/2000	13:12
		R	2	78																8/8/2000	13:19
622	Short Pump on LDB	L	2	1,420	156															8/8/2000	13:25
		M	2	59																8/8/2000	13:26
		R	2	68																8/8/2000	13:29
624	Louisville Creek	L	2	1,250	750															8/8/2000	13:34
		M	2	48				210		<1.0		24		1.7	0.55	0.08	85.0	142.0	0.198	8/8/2000	13:37
		M	11.5							<1.0										8/8/2000	13:37
		R	2	56																8/8/2000	13:44
626	Louisville Gas & Electric	L	2	1,060	308															8/8/2000	13:51
		M	2	253																8/8/2000	13:53
		R	2	79																8/8/2000	13:55
628	Louisville Environmental Service	L	2	1,730	990															8/8/2000	14:01
		M	2	243				230		<1.0		25	0.27	1.7	0.56	0.13	87.0	142.0	0.122	8/8/2000	14:03
		M	21							<1.0										8/8/2000	14:03
		R	2	107																8/8/2000	14:15
630	Salt River	L	2	2,280	488															8/8/2000	14:23
		M	2	379																8/8/2000	14:24
		R	2	143																8/8/2000	14:27
	Crew 1 Equipment Blank									<1.0		5.0	0.01	<0.10	0.10	0.05	6.7	0.0		8/8/2000	10:45
	Crew 1 Equipment Blank			<1						<1.0		<5.0		<0.10	0.10	<0.05	6.2	0.0	<0.001	8/8/2000	15:00
	Crew 1 Method Blank							<2												8/8/2000	15:15
	Crew 1 Field Blank			<1				<2		<1.0		<5.0		<0.10	0.10	0.05	6.0	0.0		8/8/2000	15:10
	Crew 2 Equipment Blank									<1.0		5.0		0.10	0.10	0.04	4.8	0.0		8/8/2000	11:11
	Crew 2 Equipment Blank			<1						<1.0		<5.0	<0.01	<0.10	0.13	<0.05	5.8	3.4	<0.002	8/8/2000	14:39
	Crew 2 Method Blank							<2												8/8/2000	14:51
	Crew 2 Field Blank			<1		<2		<2		<1.0	<1.0	5.0	<0.01	<0.10	0.10	0.04	4.8	2.2	<0.002	8/8/2000	14:55

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 8-8-00

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Culert *Escherichia coli* (CFU/100 mL)	Chromocult Score	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Chromocult Score	Fecal coliform (CFU/100 mL)	Chromocult Score	Carbonaceous BOD5 (mg/L)	Carbonaceous 168 BOD (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
588	Dredge Drydock	L	2	531	100			400	100											8/10/2000	11:55
		M	2	505				100		<1.0		45	0.3	1.7	0.19	0.13	85.0	134.0	0.232	8/10/2000	14:02
		M	36							<1.0										8/10/2000	14:07
		R	2	48				30												8/10/2000	12:16
590	Martin Marietta Company	L	2	193	100															8/10/2000	12:25
		M	2	87																8/10/2000	12:27
		R	2	65																8/10/2000	12:58
592	Twelve Mile Island	L	2	256	100			180	100											8/10/2000	13:41
		M	2	140				70		<1.0		52		1.8	0.33	0.21	82.0	140.0	0.245	8/10/2000	13:44
		M								3.3										8/10/2000	13:48
		R	2	77				60												8/10/2000	13:51
594	Pipeline Crossing	L	2	264	100															8/10/2000	14:04
		M	2	75																8/10/2000	14:06
		R	2	120																8/10/2000	14:08
596	Ballyhoo Boat Club	L	2	217	100			100	100											8/10/2000	14:46
		M	2	193				100		1.0		42		1.7	0.41	0.15	83.0	132.0	0.199	8/10/2000	14:29
		M								<1.0										8/10/2000	14:20
		R	2	67				80												8/10/2000	14:26
598	Six Mile Island Light & Day Marks	L	2	180	100															8/10/2000	14:33
		M	2	283																8/10/2000	14:37
		R	2	251																8/10/2000	14:48
600	Federal Mooring Buoys	L	2	56	82			30	51											8/10/2000	14:59
		M	2	55				10		<1.0		29		1.6	0.31	0.11	80.0	132.0	0.238	8/10/2000	15:01
		M								<1.0										8/10/2000	15:05
		R	2	178				100												8/10/2000	15:08
602	Dongrass Creek	L	2	36	82															8/10/2000	15:18
		M	2	17																8/10/2000	15:22
		R	2	52																8/10/2000	15:23
604	George Rogers Clark Bridge	L	2	67	86	30	59	100	78											8/10/2000	15:31
		M	2	24		4		60		<1.0	1	35	0.2	1.7	0.43	0.09	82.0	134.0	0.22	8/10/2000	15:34
		M								<1.0	<1.0									8/10/2000	15:48
		R	2	74		60		70												8/10/2000	15:51
604	Duplicate	L	2	48	91				69											8/10/2000	15:52
		M	2	22				10		1		48	0.23	1.8	0.43	0.09	80.0	128.0	0.216	8/10/2000	15:55
		M								<1.0										8/10/2000	15:49
		R	2	27																8/10/2000	15:52
605	Portland Canal	L	2	57				20												8/10/2000	15:58
607	L&I Railroad Bridge	L																			
607	Duplicate	L																			
608	New Albany Boat Club	L	2	53	77			120	88											8/10/2000	15:30
		M	2	28				40		<1.0		38		1.8	0.43	0.13	81.0	134.0	0.238	8/10/2000	15:33
		M	25							<1.0										8/10/2000	15:35
		R	2	28				40												8/10/2000	15:42
610	PSI Company	L	2	45	96															8/10/2000	15:48
		M	2	25																8/10/2000	15:50
		R	2	19																8/10/2000	15:52
612	Gulf Oil Company	L	2	33	79			30	96											8/10/2000	15:00
		M	2	27				30		<1.0		52		2	0.46	0.13	82.0	134.0	0.233	8/10/2000	16:03
		M	31							<1.0										8/10/2000	16:08
		R	2	14				30												8/10/2000	16:10
614	Kaw-Mid-Ise Terminal, Inc	L	2	26	98															8/10/2000	16:15
		M	2	19																8/10/2000	16:17
		R	2	34																8/10/2000	16:20
616	Hughes Bar Light & Day Marks	L	2	133	96	140	82	250	92											8/10/2000	16:34
		M	2	10		20		30		<1.0	1	46		1.7	0.39	0.14	82.0	136.0	0.239	8/10/2000	16:36
		M	35							<1.0	1.0									8/10/2000	16:36
		R	2	20		30		30												8/10/2000	16:47
616	Duplicate	L	2	120	98				90											8/10/2000	16:34
		M	2	23				10		<1.0		65		1.7	0.41	0.18	81.0	140.0		8/10/2000	16:37
		M	35							<1.0										8/10/2000	16:37
		R	2	43																8/10/2000	16:47
618	Jeffersonville Riverport	L	2	201	92															8/10/2000	16:55
		M	2	26																8/10/2000	16:57
		R	2	27																8/10/2000	16:59
620	Sun Refining & Marketing Company	L	2	217	97			780	85											8/10/2000	17:13
		M	2	25				20		<1.0		54		1.7	0.43	0.14	82.0	144.0	0.311	8/10/2000	17:18
		M	30							<1.0										8/10/2000	17:18
		R	2	34				40												8/10/2000	17:27
622	Shell Piling on LDB	L	2	134	95															8/10/2000	17:40
		M	2	29																8/10/2000	17:42
		R	2	29																8/10/2000	17:44
624	Donnells Creek	L	2	136	96			290	98											8/10/2000	18:50
		M	2	30				20		<1.0		45		1.8	0.41	0.07	82.0	132.0	0.281	8/10/2000	18:55
		M	33							<1.0										8/10/2000	18:55
		R	2	31				50												8/10/2000	19:02
626	Louisville Gas & Electric	L	2	180	94															8/10/2000	19:06
		M	2	42																8/10/2000	19:08
		R	2	42																8/10/2000	19:10
628	Louisville Environmental Service	L	2	530	93			450	89											8/10/2000	19:17
		M	2	28				20		<1.0		43	0.19	1.8	0.51	0.08	84.0	144.0	0.246	8/10/2000	19:19
		M	33							<1.0										8/10/2000	19:19
		R	2	37				80												8/10/2000	19:25
630	Salt River	L	2	227	92															8/10/2000	19:29
		M	2	38																8/10/2000	19:30
		R	2	63																8/10/2000	19:36
	Crew 1 Equipment Blank									<1.0		<5.0	<0.01	<0.10	0.10	0.12	4.0	0.0		8/10/2000	11:30
	Crew 1 Equipment Blank			<2						<1.0		<5.0		<0.10	<0.10	0.07	3.0	0.0	<0.007	8/10/2000	16:05
	Crew 1 Method Blank							<1												8/10/2000	16:07
	Crew 1 Field Blank			<2				<1		<1.0		12		<0.10	<0.10	0.07	4.0	0.0		8/10/2000	16:03
	Crew 2 Equipment Blank									<1.0		5		<0.10	<0.10	0.1	5.0	0.0		8/10/2000	15:20
	Crew 2 Equipment Blank			<2						<1.0		<5.0	0.01	<0.10	0.10	0.09	5.0	0.0	<0.01	8/10/2000	19:55
	Crew 2 Method Blank							<1												8/10/2000	20:10
	Crew 2 Field Blank			<2				<1		<1.0	2.5	<5.0	<0.01	<0.10	<0.10	0.1	4.0	0.0	0.005	8/10/2000	19:59

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/8/01

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Coliform *Escherichia coli* (CFU/100 mL)	Chlorophyll-a (ug/L)	Membrane Fluorescence *Escherichia coli* (CFU/100 mL)	Chlorophyll-a (ug/L)	Fecal coliform (CFU/100 mL)	Enterococcus (ug/L)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
588	Dredge Depoment	L	2	274	336			500	342											8/31/2000	10:31
		M	2	207				400		<1.0		22	0.25	1.4	0.59	0.04	87.0	138.0	0.214	8/31/2000	10:36
		M	10							<1.0		23.5								8/31/2000	10:36
		R	2	160				290												8/31/2000	10:47
590	Martin Marietta Company	L	2	318	431															8/31/2000	10:50
		M	2	948																8/31/2000	10:52
		R	2	307																8/31/2000	11:00
592	Twelve Mile Island	L	2	476	466			770	649.6											8/31/2000	11:07
		M	2	331				1,800						1.7	0.65	0.04	87.0	140.0	0.192	8/31/2000	11:09
		M	10							<1.0										8/31/2000	11:09
		R	2	293				2,200												8/31/2000	11:15
594	Pipeline Crossing	L	2	495	816															8/31/2000	11:27
		M	2	542																8/31/2000	11:29
		R	2	543																8/31/2000	11:30
596	Ballyard Boat Club	L	2	403	530			440	920.4											8/31/2000	11:37
		M	2	594				900		<1.0		45		1.8	0.58	0.05	90.0	138.0	0.258	8/31/2000	11:39
		M								<1.0										8/31/2000	11:39
		R		700				6,000												8/31/2000	11:45
598	Ark Mor Island Light & Day Marks	L		473	525															8/31/2000	11:49
		M		520																8/31/2000	11:53
		R		227																8/31/2000	11:59
600	Tailrace Mooring Buoys	L		360	503			7,600	924											8/31/2000	12:15
		M		238				390		<1.0		14		1.5	0.53	0.05	86.0	140.0	0.296	8/31/2000	12:17
		M	40							<1.0										8/31/2000	12:17
		R		295				220												8/31/2000	12:29
602	Peregrine Creek	L		405	519															8/31/2000	12:33
		M		306																8/31/2000	12:39
		R		259																8/31/2000	12:41
604	George Rogers Clark Bridge	L		401	518	430	420	2,500	7,216											8/31/2000	12:49
		M		344		400		1,500		<1.0	5.2	32	0.34	1.7	1.1	0.04	87.0	136.0	0.221	8/31/2000	12:51
		M	14							<1.0	<1.0									8/31/2000	12:51
		R		330		440		480												8/31/2000	13:06
606	Duplicate	L		390	464				980											8/31/2000	12:50
		M		447				850		<1.0		44	0.34	1.7	1.2	0.05	88.0	144.0	0.219	8/31/2000	12:52
		M	14							1										8/31/2000	12:52
		R		379																8/31/2000	13:07
608	Portland Canal	L		348				470												8/31/2000	13:12
607	I-64 Railroad Bridge	L		337				3,900												8/31/2000	10:41
607	Duplicate	L		318				1,170												8/31/2000	10:42
608	New Albany Boat Club	L		230	319			210	291											8/31/2000	10:47
		M		400				500		<1.0		54	0.25	1.9	0.59	0.06	85.0	138.0	0.28	8/31/2000	10:50
		M	28							<1.0										8/31/2000	10:50
		R		262				360												8/31/2000	11:07
610	PSI Company	L		144	177															8/31/2000	11:09
		M		177																8/31/2000	11:11
		R		218																8/31/2000	11:13
612	Shell Oil Company	L		232	285			300	285											8/31/2000	11:18
		M		227				240		<1.0		38		2.5	0.62	0.05	85.0	140.0	0.258	8/31/2000	11:24
		M	34							<1.0										8/31/2000	11:24
		R		184				180												8/31/2000	11:20
614	River Mollene Terminal, Inc	L		120	136															8/31/2000	11:37
		M		169																8/31/2000	11:39
		R		124																8/31/2000	11:41
616	Hughes Bar Light & Day Marks	L		150	148	140	160	110	359											8/31/2000	11:47
		M		137		200		190		<1.0	1.5	34		1.7	0.62	0.05	85.0	138.0	0.27	8/31/2000	11:51
		M	17							<1.0	1.3									8/31/2000	11:51
		R		141		150		280												8/31/2000	12:01
618	Duplicate	L		118	156				95.0											8/31/2000	11:47
		M		271				310		<1.0		38		3.8	0.55	0.06	84.0	136.0		8/31/2000	11:52
		M	37							<1.0										8/31/2000	11:52
		R		171																8/31/2000	12:03
619	Jeffersonville Riverport	L		202	184															8/31/2000	12:06
		M		222																8/31/2000	12:08
		R		140																8/31/2000	12:10
620	Sun Refining & Marketing Company	L		174	218			340	291											8/31/2000	12:16
		M		233				250		<1.0		42		1.3	0.59	0.05	83.0	144.0	0.187	8/31/2000	12:18
		M	23							<1.0										8/31/2000	12:18
		R		156				230												8/31/2000	12:24
622	Howe Piling on LDM	L		182	188															8/31/2000	12:25
		M		238																8/31/2000	12:31
		R		133																8/31/2000	12:34
624	Eastside Creek	L		210	333			160	345											8/31/2000	12:39
		M		116				390		<1.0		53		1.5	0.51	0.05	85.0	140.0	0.24	8/31/2000	12:41
		M	29							<1.0										8/31/2000	12:41
		R		101				120												8/31/2000	12:50
626	Louisville Gas & Electric	L		190	538															8/31/2000	12:56
		M		123																8/31/2000	12:55
		R		50																8/31/2000	12:58
628	Louisville Environmental Service	L		310	345			190	291											8/31/2000	13:01
		M		107				400		<1.0		53	0.23	1.5	0.44	0.05	85.0	140.0	0.289	8/31/2000	13:03
		M	23							<1.0										8/31/2000	13:05
		R		89				160												8/31/2000	13:18
630	Salt River	L		206	329															8/31/2000	13:20
		M		99																8/31/2000	13:22
		R	2	92																8/31/2000	13:24
	Crew 1 Equipment Blank									<1.0		<5.0	<0.01	0.10	0.17	0.04	6.0	0.0		8/31/2000	9:46
	Crew 1 Equipment Blank			<2						<1.0		<5.0		0.10	0.23	0.03	5.0	0.0	0.006	8/31/2000	13:20
	Crew 1 Method Blank																			8/31/2000	13:30
	Crew 1 Field Blank			<2				<1		<1.0		<5.0		<0.10	<0.10	0.03	5.8	0.0		8/31/2000	13:25
	Crew 2 Equipment Blank									<1.0		<5.0		<0.10	<0.25	<0.04	6.8	0.0		8/31/2000	10:35
	Crew 2 Equipment Blank			<2						<1.0		5.0	<0.01	0.10	0.55	0.04	5.8	2.0	0.005	8/31/2000	13:41
	Crew 2 Method Blank							<1												8/31/2000	14:14
	Crew 2 Field Blank					<2		<1		<1.0	<1.0	<5.0	<0.01	0.10	0.52	0.03	6.2	0.0	0.002	8/31/2000	14:02

Note: L = Left Bank; M = Mid-stream; R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 8/8/00

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
610	PSI Company	M	2	255		156	<1.0		60	1.1	0.26	0.11	132.0	0.346	8/12/2000	10:27:00 AM
615	Stauffer Chemical	M	2	299		108	<1.0		59	0.79	0.44	0.1	140.0	0.27	8/12/2000	10:42:00 AM
620	Sun Refining and Marketing Company	M	2	252		108	<1.0		73	1.5	0.39	0.1	138.0	0.175	8/12/2000	10:56:00 AM
625	Fishtown Daymark	M	2	160		120	<1.0		67	1.3	0.58	0.11	140.0	0.373	8/12/2000	7:01:00 PM
630	Salt River	M	2	132		112	<1.0		62	1.3	0.54	0.04	140.0	0.335	8/12/2000	7:14:00 PM
635	Mosquito Daymark	M	2	234	280	204	<1.0	<1.0	88	0.98	0.27	<0.03	138.0	0.304	8/12/2000	7:40:00 PM
635	Duplicate	M	2	157		156	<1.0		100	0.9	0.44	<0.03	140.0	0.311	8/12/2000	7:40:00 PM
640	RDB Channel Markers	M	2	295		160	<1.0		87	1.3	0.51	0.04	140.0	0.214	8/12/2000	7:58:00 PM
645	Brandenburg Daymark	M	2	158		152	<1.0		76	1.5	0.51	<0.03	142.0	0.349	8/12/2000	8:11:00 PM
650	Haunted Hollow Daymark	M	2	154		250	<1.0		70	1.2	0.32	<0.03	146.0	0.461	8/12/2000	8:26:00 PM
655	New River Lime Company	M			No sample collected											
660	Cold Friday Daymark	M			No sample collected											
	Crew 1 Equipment Blank						<1.0		<5.0	<0.10	<0.10	0.05	0.0	-0.001	8/12/2000	10:01:00 AM
	Crew 1 Equipment Blank						<1.0		13	<0.10	<0.10	<0.03	0.0	-0.011	8/12/2000	8:56:00 PM
	Crew 1 Method Blank					<1									8/12/2000	9:02:00 PM
	Crew 1 Field Blank			<1	<2	<1	<1.0		<5.0	<0.10	<0.10	<0.03	0.0	-0.001	8/12/2000	9:00:00 PM

Note: M = Midstream

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 8/8/00

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Colilert *Escherichia coli* (CFU/100 mL)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
610	PSI Company	M	2	31		1600	<1.0		28	1.4	0.34	<0.03	130.0	0.733	8/13/2000	5:43:00 PM
615	Stauffer Chemical	M	2	21		1600	<1.0		33	1.6	0.32	<0.03	130.0	0.512	8/13/2000	5:29:00 PM
620	Sun Refining and Marketing Company	M	2	59		3200	<1.0		35	1	0.34	0.06	140.0	0.809	8/13/2000	5:15:00 PM
625	Fishtown Daymark	M	2	56		1060	<1.0		45	0.79	0.48	<0.03	140.0	0.535	8/13/2000	4:57:00 PM
630	Salt River	M	2	47		600	<1.0		34	1.6	0.48	0.05	134.0	0.408	8/13/2000	4:42:00 PM
635	Mosquito Daymark	M	2	32	36	200	<1.0		41	1.4	0.43	0.04	130.0	0.408	8/13/2000	4:02:00 PM
635	Duplicate	M	2	44		2000	<1.0		41	1.5	0.48	0.04	140.0	0.405	8/13/2000	4:03:00 PM
640	RDH Channel Markers	M	2	45		1600	<1.0		49	0.89	0.48	0.07	136.0	0.358	8/13/2000	3:41:00 PM
645	Brandenburg Daymark	M	2	51		600	<1.0		44	1.1	0.66	0.04	140.0	0.378	8/13/2000	3:09:00 PM
650	Haunted Hollow Daymark	M	2			1300	<1.0		41	1.1	0.63	0.05	140.0	0.366	8/13/2000	2:53:00 PM
655	New River Lime Company	M	2	35		800	<1.0		40	1.5	0.57	0.04	144.0	0.306	8/13/2000	2:40:00 PM
660	Cold Friday Daymark	M	2	34		400	<1.0		72	1.4	0.6	0.04	2.0	0.279	8/13/2000	2:17:00 PM
	Crew 1 Equipment Blank						<1.0		<5.0	<0.10	<0.10	<0.03	0.0	-0.002	8/13/2000	2:09:00 PM
	Crew 1 Equipment Blank			<2			<1.0		<5.0	<0.10	<0.10	0.11	0.0	-0.003	8/13/2000	5:48:00 PM
	Crew 1 Method Blank					<1									8/13/2000	5:48:00 PM
	Crew 1 Field Blank			<2		<1	<1.0		<5.0	<0.10	0.34	0.08	138.0	-0.002	8/13/2000	5:51:00 PM

Note: M - Midstream

Wet Weather Impact Study
Combined Sewer Outfall Analytical Data

Site Description	Sample ID	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
Louisville CSO#16	S0	54		100	1.5	1.8	4.1	1	08/08/00	3:00:00 PM
	S15	51		120					08/08/00	3:15:00 PM
	S30	63	155	100	1.7	1.8	4.1	0.97	08/08/00	3:30:00 PM
	Duplicate	53		90	1.6	1.6	4.3	0.97	08/08/00	3:31:00 PM
	S45	78		145					08/08/00	3:45:00 PM
	S60	140		150	8.6	1.9	12	5.8	08/08/00	4:00:00 PM
	S75	63		250					08/08/00	4:15:00 PM
	S90	83		140	1.6	1.5	4.5	1.4	08/08/00	4:30:00 PM
	S105	60		140					08/08/00	4:45:00 PM
	S120	47		120	1.4	1.3	6.3	1.9	08/08/00	5:00:00 PM
	S135	85		175					08/08/00	5:15:00 PM
	SH4	57		160	0.87	1.3	3.4	1.5	08/08/00	7:00:00 PM
Louisville CSO#19	S0	28		110	1.1	4.7	2.5	0.57	08/08/00	3:00:00 PM
	S15	37		110					08/08/00	3:15:00 PM
	S30	24	37	140	0.92	4.2	2.3	0.53	08/08/00	3:30:00 PM
	Duplicate	20		140	1	4.5	1.5	0.5	08/08/00	3:30:00 PM
	S45	17		90					08/08/00	3:45:00 PM
	S60	18		100	0.84	3.3	1.8	0.57	08/08/00	4:00:00 PM
	S75	17		110					08/08/00	4:15:00 PM
	S90	36		110	1.9	3.3	4.6	0.75	08/08/00	4:30:00 PM
	S105	12		160					08/08/00	4:45:00 PM
Louisville CSO#50	S0	15		100	0.98	1.1	1.8	0.85	08/08/00	3:16:00 PM
	S15	14		95					08/08/00	3:33:00 PM
	S30	14	22	100	0.93	1.3	1.7	0.85	08/08/00	3:48:00 PM
	Duplicate	13		95	0.9	1.1	1.7	0.82	08/08/00	3:48:00 PM
Louisville CSO#189	S0	70		160	0.8	2.1	3.4	0.68	08/08/00	2:30:00 PM
	S15	24		120					08/08/00	2:45:00 PM
	S30	46	140	160	1.5	1.1	4.7	0.82	08/08/00	3:00:00 PM
	Duplicate	44		95	1.5	1	4.4	0.75	08/08/00	3:05:00 PM
	S45	30		90					08/08/00	3:15:00 PM
	S60	21		83	0.88	1.8	2.6	0.5	08/08/00	3:30:00 PM
	S75	12		120					08/08/00	3:45:00 PM
	S90	20		80	0.67	1.2	1.5	0.6	08/08/00	4:00:00 PM
	S105	13		80					08/08/00	4:15:00 PM
	S120	19		150	0.8	1.2	1.9	0.63	08/08/00	4:30:00 PM
Louisville CSO#190	S0	<15		160	0.64	1.4	1.3	0.31	08/08/00	2:45:00 PM
	S15	<15		180					08/08/00	3:00:00 PM
	S30	<15	11	77	0.54	1.3	1.1	0.27	08/08/00	3:15:00 PM
	Duplicate	<15		81	0.5	1.2	1.2	0.27	08/08/00	3:16:00 PM
	S45	<15		170					08/08/00	3:30:00 PM
Louisville CSO#210	S0			80	0.9	1.2	2.6	0.46	08/08/00	3:00:00 PM
	S15			92					08/08/00	3:15:00 PM
	S30			96	1.6	1.9	6	0.75	08/08/00	3:30:00 PM
	Duplicate			85	1.6	1.8	6.3	0.89	08/08/00	3:31:00 PM
	S45			280					08/08/00	3:45:00 PM
	S60			350	3	6	30	10	08/08/00	4:00:00 PM
	S90			360					08/08/00	4:30:00 PM
	S120			240	1.6	1.6	19	7.3	08/08/00	5:00:00 PM
	150			280					08/08/00	5:30:00 PM
	180			350	1.8	2	22	7.3	08/08/00	6:00:00 PM
	SH4			55	1	1.3	6.7	3.3	08/08/00	7:00:00 PM
	SH5			140					08/08/00	8:00:00 PM
Louisville SO	S0			250	2.1	6.9	7.8	2.9	08/08/00	2:48:00 PM
	S15			240					08/08/00	3:03:00 PM
	S30			160	3.5	3.8	8.5	4.1	08/08/00	3:20:00 PM
	Duplicate			140	3.4	3.8	7.5	4.3	08/08/00	3:21:00 PM
	S45			340					08/08/00	3:34:00 PM
	S60			130	5	4.1	8.1	4.3	08/08/00	3:49:00 PM
	S90			300					08/08/00	4:19:00 PM
	S120			300	2	2.8	10	5.9	08/08/00	4:49:00 PM
	150			280					08/08/00	5:19:00 PM
	180			330	3.1	3.4	13	6.4	08/08/00	5:49:00 PM
	SH4			370	3.4	3.4	13	7	08/08/00	6:49:00 PM
	SH5			260					08/08/00	7:49:00 PM
	SH6			530	2	2.3	13	7.6	08/08/00	8:49:00 PM
Jeffersonville CSO#10	S0	33		180	1.2	1.3	4	1.1	08/08/00	2:50:00 PM
	S15	24		130					08/08/00	3:05:00 PM
	S30	41	89	130	1.1	1.8	3.2	1.1	08/08/00	3:20:00 PM
	Duplicate	190		110	1.3	1.9	7.9	1.3	08/08/00	3:35:00 PM
	S45	1100		290					08/08/00	3:50:00 PM
	S60	29		190	1.6	1	10	2.1	08/08/00	4:05:00 PM
Louisville MSD	Field Blank	<1.0		<10	<0.01	<0.10	<0.10	0.04	08/08/00	8:17:00 PM
Louisville MSD	Equipment Blank	2		<10	<0.01	<0.10	<0.10	0.05	08/08/00	8:18:00 PM
Louisville MSD	Field Blank			12	<0.01	<0.10	<0.10	<0.03	08/08/00	8:54:00 PM
Louisville MSD	Equipment Blank			<10	<0.01	<0.10	<0.10	<0.03	08/08/00	8:54:00 PM
EMC/EA2 Systems	Field Blank			<10	<0.01	<0.10	<0.10	<0.03	08/08/00	9:05:00 PM
EMC/EA2 Systems	Equipment Blank			<10	<0.01	<0.10	<0.10	<0.03	08/08/00	9:06:00 PM

Wet Weather Impact Study
Wastewater Treatment Plant Influent Analytical Data

Site Description	Sample ID	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
Morris Foreman WWTP	HR0	130		670	2.2	2	9	7.3	08/08/00	6:00:00 PM
	HR 1	150		640					08/08/00	7:00:00 PM
	HR2	180	280	720	2.7	1.9	13	9.5	08/08/00	8:00:00 PM
	Duplicate	160	260	730	2.8	1.6	14	9.1	08/08/00	8:00:00 PM
	HR 3	220		820					08/08/00	9:00:00 PM
	HR 4	170		850	2.1	1.7	15	8.9	08/08/00	10:00:00 PM
	HR 5	210		840					08/08/00	11:00:00 PM
	HR 6	250		880	2.5	2.1	17	10	08/08/00	12:00:00 AM
	HR 7	190		860					08/08/00	1:00:00 AM
	HR 8	210		810	3	2.6	19	9.6	08/08/00	2:00:00 AM
	HR 9	180		850					08/08/00	3:00:00 AM
Jeffersonville WWTP	HR 0	130		730	2.4	2	19	9.2	08/08/00	2:49:00 PM
	HR 1	160		580					08/08/00	3:45:00 PM
New Albany WWTP	HR 0	140		470	3.6	1.5	26	11.3	08/08/00	3:00:00 PM
	HR 1	120		350					08/08/00	4:00:00 PM
	HR2	120	290	380	2.5	1.6	14	4.8	08/08/00	5:00:00 PM
	Duplicate	120		420	2.3	1.2	15	4.8	08/08/00	5:00:00 PM
	HR 3	75		340					08/08/00	6:00:00 PM
	HR 4	61		450	1.8	0.67	15	8.2	08/08/00	7:00:00 PM
	HR 5	70		500					08/08/00	8:00:00 PM
	HR 6	70		510	1.9	2	12	8.2	08/08/00	9:00:00 PM
	HR 7	80		510					08/08/00	10:00:00 PM
	HR 8	110		540	2.6	0.76	14	11	08/08/00	11:00:00 PM
	HR 9	94		550					08/08/00	12:00:00 AM

APPENDIX D

WATER QUALITY DATA

May 2001 Wet Weather Event

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 5/7/01

Confluence Mile Point	Tributary	Site Description	State	Sample ID	*Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue Bridge	KY	HR 0	200	680	<1.0		464	0.207	3.7	0.6	0.46	05/07/01	5:50:00 PM
				HR 4	21,000	41,000			168					05/07/01	10:00:00 PM
				HR 6	20,000	37,000	3.9	14	192	1.27	1.6	2.8	0.37	05/08/01	12:01:00 AM
				HR 8	20,000	43,000			160					05/08/01	2:05:00 AM
				HR 10	12,000	56,000			160					05/08/01	3:55:00 AM
				HR 12	10,400	28,000	<1.9*	6.4	208	0.554	1.7	1	0.18	05/08/01	6:00:00 AM
				Duplicate	1,400	10,000	<2.2*		216	0.464	1.2	0.9	0.2	05/08/01	6:00:00 AM
602.1	Beargrass Creek Middle/South Fork	Mellwood	KY	HR 0	80,000	280,000	19.8		348	1.09	1.8	3.8	1.5	05/07/01	5:15:00 PM
				HR 4	60,000	220,000			136					05/07/01	9:40:00 PM
				HR 6	20,000	100,000	5	17	120	0.884	0.93	2.3	0.48	05/07/01	11:40:00 PM
				HR 8	17,000	71,000	3.8		92					05/08/01	1:45:00 AM
				HR 10	16,000	70,000			124					05/08/01	3:35:00 AM
				HR 12	13,700	61,000	2.7	7.3	116	0.644	0.99	1.3	0.26	05/08/01	5:39:00 AM
				Duplicate	10,600	52,000	2.9		132	0.524	1.3	0.9	0.3	05/08/01	5:45:00 AM
606.1	Mill Creek (IN)	Frontage Road	IN	HR 0	1,000	10,000	5.4		376	2.32	0.6	3.1	0.97	05/07/01	5:00:00 PM
				HR 2	28,000	240,000			226					05/07/01	7:30:00 PM
				HR 4	11,000	42,000			228					05/07/01	9:30:00 PM
				HR 6	9,000	30,000	3	3.8	260	0.744	1.4	2.5	0.75	05/07/01	11:30:00 PM
				HR 8	8,000	23,000			268					05/08/01	1:30:00 AM
				HR 10	1,400	14,000			312					05/08/01	3:30:00 AM
				HR 12	3,000	37,000	3	5.5	392	0.824	1	2.5	0.89	05/08/01	5:30:00 AM
				Duplicate	12,000	26,000	2.8	4.5	416	0.904	1	2.6	0.97	05/08/01	5:30:00 AM
607.0	Silver Creek	Route 62	IN	HR 0	1,000	9,000	<1.7*		264	0.119	0.26	0.83	0.3	05/07/01	5:00:00 PM
				HR 2	220	4,400			248					05/07/01	7:30:00 PM
				HR 4	12,000	31,000			272					05/07/01	9:30:00 PM
				HR 6	8,000	27,000	3.4	4	432	0.474	1.5	1.3	0.21	05/07/01	11:30:00 PM
				HR 8	17,000	150,000			236					05/08/01	1:30:00 AM
				HR 10	5,600	>100000			272					05/08/01	3:30:00 AM
				HR 12	11,800	90,000	2.7	5.7	260	0.344	0.8	1.1	0.34	05/08/01	5:30:00 AM
				Duplicate	13,700	70,000	3	3	226	0.264	0.65	1.1	0.24	05/08/01	5:30:00 AM
609.3	Falling Run	New Albany Pump Station	IN	HR 0	280	420		<1.0	520	0.243	0.75	0.54	0.12	05/07/01	5:25:00 PM
				HR 2	6,000	10,600			472					05/07/01	7:15:00 PM
				HR 4	110,000	200,000			224					05/07/01	9:20:00 PM
				HR 6	60,000	100,000	7.3	12	212	0.934	1.3	2.6	0.93	05/07/01	11:22:00 PM
				HR 8	50,000	98,200			220					05/08/01	1:18:00 AM
				HR 10	37,000	72,000			212					05/08/01	3:12:00 AM
				HR 12	13,000	46,000	<2.2*	3.5	212	0.374	0.47	1	0.32	05/08/01	5:20:00 AM
				Duplicate	10,000	60,000	<2.3*		236	0.354	0.49	0.92	0.25	05/08/01	5:31:00 AM
616.4	Mill Creek Cutoff	Cane Run	KY	HR 2	110,000	160,000			144					05/07/01	7:30:00 PM
				HR 4	130,000	180,000			156					05/07/01	9:30:00 PM
				HR 6	140,000	290,000	4.7	12	164	1.47	0.9	2.1	0.35	05/07/01	11:30:00 PM
				HR 8	39,000	100,000			192					05/08/01	1:30:00 AM
				HR 10	30,000	>100000			144					05/08/01	3:30:00 AM
				HR 12	41,000	<120000	3.2	6	152	0.764	0.32	1.5	0.23	05/08/01	5:30:00 AM
				Duplicate	50,000	<120000	4.5		152	0.694	0.33	1.4	0.28	05/08/01	5:30:00 AM
	Louisville MSD	Equipment Blank		BEB 1	<2	<2	1.8		<10	<0.01	<0.10	0.4	<0.03	05/07/01	5:15:00 PM
	Strand & Associates	Equipment Blank		BEB 1	2	4	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/07/01	5:00:00 PM
	Strand & Associates	Equipment Blank		BEB 1	24	40	<1.0		<10	<0.01	<0.10	0.12	0.04	05/07/01	2:59:00 PM
	New Albany	Equipment Blank		BEB 1	<2	<2	<1.0	<1.0	<10	<0.01	<0.10	<0.10	<0.03	05/07/01	4:50:00 PM

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 5/7/01

Confluence Mile Point	Tributary	Site Description	State	Sample ID	*Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue Bridge	KY	HR 16	4,400	28,000			276					05/08/01	9:30:00 AM
				HR 20	3,600	11,400	1.2		364	2.44	2	0.86	0.08	05/08/01	1:30:00 PM
				HR 24	1,440	10,400			388					05/08/01	5:34:00 PM
				HR 32	1,710	11,200	<1.0*		436	0.195	2.9	0.52	0.09	**05/09/01**	1:30:00 AM
				HR 40	6,800	10,000			348					**05/09/01**	9:45:00 AM
				HR 48	330	633	<1.0*	<1.0	484	0.145	1.5	0.44	0.14	05/09/01	5:10:00 PM
602.1	Beargrass Creek Middle/South Fork	Mellwood	KY	HR 16	7,600	35,000			176					05/08/01	9:00:00 AM
				HR 20	6,000	38,000			116	2.64	1.6	0.56	0.16	05/08/01	1:10:00 PM
				HR 24	10,000	29,000			228					05/08/01	5:00:00 PM
				HR 32	12,000	>60000	<1.1*		290	0.213	1.6	0.86	0.1	05/09/01	1:00:00 AM
				HR 40	NO DATA	1,450			460					05/09/01	9:30:00 AM
				HR 48	24,400	>60000	<1.0*	<1.0	332	0.097	1.5	0.55	0.26	05/09/01	4:40:00 PM
606.1	Mill Creek (IN)	Frontage Road	IN	HR 16	6,000	47,000			280					05/08/01	9:30:00 AM
				HR 20	3,600	15,000	<1.0*		316	0.454	0.72	1.1	0.34	05/08/01	1:30:00 PM
				HR 24	1,400	24,000			532					05/08/01	5:30:00 PM
				HR 32	2,200	8,800	<1.4*		388	0.107	0.28	1	0.05	05/09/01	1:30:00 AM
				HR 40	1,330	3,800			416					05/09/01	9:30:00 AM
				HR 48	540	1,080	4	4.4	552	0.324	0.68	0.94	0.44	05/09/01	4:30:00 PM
607.0	Silver Creek	Route 62	IN	HR 16	567	5,400			276					05/08/01	9:30:00 AM
				HR 20	200	3,400	2.1		312	0.194	0.26	0.7	0.04	05/08/01	1:30:00 PM
				HR 24	310	1,820			264					05/08/01	5:30:00 PM
				HR 32	820	1,420	<1.6*		352	0.344	0.34	0.7	0.39	05/09/01	1:30:00 AM
				HR 40	820	1,200			348					05/09/01	9:30:00 AM
				HR 48	190	400	<1.4*	1.1	300	0.173	0.12	0.44	0.17	05/09/01	4:30:00 PM
609.3	Falling Run	New Albany Pump Station	IN	HR 16	12,000	34,000			256					05/08/01	9:09:00 AM
				HR 20	4,600	23,000			288	0.274	0.64	0.63	0.1	05/08/01	1:15:00 PM
				HR 24	4,200	11,700			304					05/08/01	4:52:00 PM
				HR 32	780	1,930	<1.2*		408	0.211	0.85	0.42	0.15	05/09/01	1:10:00 AM
				HR 40	1,060	3,200			384					05/09/01	9:30:00 AM
				HR 48	533	840	<1.0*	2.2	412	0.151	2.6	0.44	0.12	05/09/01	3:30:00 PM
616.4	Mill Creek Cutoff	Cane Run	KY	HR 16	34,000	63,000			164					05/08/01	9:30:00 AM
				HR 20	13,500	75,000	2.4		180	0.324	0.69	1.1	0.15	05/08/01	1:30:00 PM
				HR 24	15,500	69,000			180					05/08/01	4:30:00 PM
				HR 32	10,400	16,800	2.4		182	0.205	0.36	0.94	0.18	05/09/01	1:30:00 AM
				HR 40	5,600	11,200	<1.0		184					05/09/01	9:30:00 AM
	Louisville MSD	Equipment Blank		AEB 1	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	0.05	05/08/01	**12:00:00 AM**
	Louisville MSD	Equipment Blank		AEB 2	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/09/01	5:10:00 PM
	Louisville MSD	Field Blank		AFB	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/09/01	5:10:00 PM
	Strand & Associates	Equipment Blank		AEB 1	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/08/01	4:30:00 PM
	Strand & Associates	Equipment Blank		AEB 2	<2	<2			<10	<0.01	0.13	<0.10	0.05	05/09/01	4:30:00 PM
	Strand & Associates	Equipment Blank		AEB 1	<2	<2	<1.0		<10	<0.01	<0.10	0.11	0.04	05/08/01	5:30:00 PM
	Strand & Associates	Field Blank		AFB	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	0.06	05/09/01	4:30:00 PM
	New Albany	Equipment Blank		AEB 1	PAST TIME	PAST TIME			<10	<0.01	0.11	0.11	<0.03	05/08/01	6:30:00 PM
	New Albany	Equipment Blank		AEB 2	<2	<2	<1.0*		<10	<0.01	<0.10	<0.10	0.06	05/09/01	3:40:00 PM
	New Albany	Field Blank		AFB	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	0.06	05/09/01	3:50:00 PM

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 5/7/01

Confluence Mile Point	Tributary	Site Description	State	Sample ID	*Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue Bridge	KY	D3	69	780	<1.0		460	0.157	2.1	0.42	0.12	05/10/01	5:30:00 PM
				Duplicate	188	740	<1.0		404	0.143	1.7	0.44	0.14	05/10/01	5:30:00 PM
				D4	140	200	<1.0		456	0.085	1.3	0.4	0.14	05/11/01	10:30:00 AM
602.1	Beargrass Creek Middle/South Fork	Mellwood	KY	D3	140	5,600	<1.0		356	0.131	1.9	0.44	0.11	05/10/01	5:00:00 PM
				D4	2,600	3,600	1.5		384	0.161	0.86	0.62	0.12	05/11/01	10:00:00 AM
				Duplicate	2,400	3,400	1.4		376	0.175	0.68	0.62	0.13	05/11/01	10:00:00 AM
606.1	Mill Creek (IN)	Frontage Road	IN	D3	88	593	1.3		604	0.271	0.29	0.85	0.31	05/10/01	10:15:00 AM
				D4	260	960	1.4		1,380	0.354	0.9	0.54	0.07	05/11/01	10:15:00 AM
				Duplicate	300	720	1.3		1,360	0.414	0.56	0.72	0.12	05/11/01	10:15:00 AM
607.0	Silver Creek	Route 62	IN	D3	112	300	<1.0		308	0.101	0.48	0.57	0.14	05/10/01	10:30:00 AM
				Duplicate	88	200	<1.0		356	0.085	0.71	0.57	0.13	05/10/01	10:30:00 AM
				D4	200	800	<1.0		356	0.053	0.77	0.59	0.18	05/11/01	10:30:00 AM
				D5	NO DATA	NO DATA	1.4	2.1	274	0.135	0.57	0.81	0.18	05/12/01	2:30:00 PM
609.3	Falling Run	New Albany Pump Station	IN	D3	152	440	<1.0		808	0.289	0.72	1.56	0.07	05/10/01	3:15:00 PM
				Duplicate	116	310	<1.0		450	0.283	0.82	0.48	0.06	05/10/01	3:15:00 PM
				D4	112	194	<1.0		480	0.207	0.77	0.44	0.09	05/11/01	10:21:00 AM
				D5	1,440	32,000	3.3	6.7	336	0.279	0.54	1.36	0.54	05/12/01	10:05:00 AM
616.4	Mill Creek Cutoff	Cane Run	KY	D5	9,800	>113,000	3.8	8.8	168	0.119	1.4	1	0.14	05/12/01	1:30:00 PM
	Louisville MSD	Equipment Blank		AEB D3	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	0.05	05/10/01	5:30:00 PM
	Louisville MSD	Field Blank		AFB D3	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/10/01	5:30:00 PM
	Louisville MSD	Equipment Blank		AEB D4	<2	4	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/11/01	10:30:00 AM
	Louisville MSD	Field Blank		AFB D4	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	0.04	05/11/01	10:30:00 AM
	Strand & Associates	Equipment Blank		AEB D5	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/12/01	1:30:00 PM
	Strand & Associates	Equipment Blank		AEB D3	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/10/01	10:30:00 AM
	Strand & Associates	Field Blank		AFB D3	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/10/01	10:30:00 AM
	Strand & Associates	Equipment Blank		AEB D4	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/11/01	10:31:00 AM
	Strand & Associates	Field Blank		AFB D4	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/11/01	10:31:00 AM
	Strand & Associates	Equipment Blank		AEB D5	<2	2	<0.1		<10	<0.01	<0.10	<0.10	<0.03	05/12/01	2:31:00 PM
	Strand & Associates	Field Blank		AFB D5	<2	<2	<0.1		<10	<0.01	<0.10	<0.10	<0.03	05/12/01	2:31:00 PM
	New Albany	Equipment Blank		AEB D3	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/10/01	3:20:00 PM
	New Albany	Field Blank		AFB D3	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/10/01	3:20:00 PM
	New Albany	Equipment Blank		AEB D4	<2	<2	<1.0		<10	<0.01	0.28	<0.10	0.05	05/11/01	10:30:00 AM
	New Albany	Field Blank		AFB D4	<2	<2	<1.0		<10	<0.01	0.21	<0.10	0.04	05/11/01	10:07:00 AM
	New Albany	Equipment Blank		AEB D5	<2	<2	<1.0		<10	<0.01	<0.10	<0.10	<0.03	05/12/01	10:12:00 AM
	New Albany	Field Blank		AFB D5	<2	<2	<1.0		<10	<0.01	0.1	<0.10	<0.03	05/12/01	9:50:00 AM

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 5/7/01

Confluence Mile Point	Tributary	Site Description	State	Sample ID	*Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
595.9	Harrods Creek	Prospect	KY	M1	9,400	22,000	3.4	300	1.23	1.3	2.1	0.31	05/07/01	5:45:00 PM
				M2	3,330	13,000		248					05/08/01	8:00:00 AM
				M3	12,000	37,000	1.7	280	0.544	<0.10	1.1	0.07	05/08/01	2:00:00 PM
				M4	10,000	15,600		202					05/08/01	4:00:00 PM
				M5 A	2,000	4,400	<1.4*	264	0.231	7.5	0.85	0.2	05/09/01	4:00:00 AM
				Duplicate	1,870	6,000	<1.4*	272	0.237	10	0.81	0.2	05/09/01	4:00:00 AM
				M6	520	760		276					05/09/01	3:30:00 PM
596.3	Lentzier Creek	Utica Pike	IN	M1	113	380	2.7	320	0.131	0.4	0.56	0.18	05/07/01	5:55:00 PM
				M2	1,400	7,200		256					05/08/01	1:15:00 PM
				M3	1,220	6,000	<1.0*	340	0.175	2.1	1	0.25	05/08/01	2:45:00 PM
				M4	1,000	1,800		496					05/08/01	3:30:00 PM
				M5	440	840	1.2	280	0.081	1.5	0.53	0.15	05/09/01	12:37:00 PM
				M6	180	580		278					05/09/01	**2:59:00 PM**
596.9	Goose Creek	Highway 42	KY	M1	7,800	17,500	3	332	0.234	0.85	1.1	0.18	05/07/01	5:30:00 PM
				M2	6,000	8,400		196					05/08/01	8:02:00 AM
				M3	3,600	15,000	<1.0*	212	0.175	1.5	0.66	0.08	05/08/01	2:02:00 PM
				M4	2,800	9,600		228					05/08/01	4:02:00 PM
				M5 A	2,000	3,000	<1.0	320	0.065	1.4	0.51	0.07	05/09/01	4:02:00 AM
				Duplicate	2,000	4,000	<1.0	364	0.077	1.1	0.53	0.31	05/09/01	4:02:00 AM
				M6	500	840		364					05/09/01	3:30:00 PM
596.9	Little Goose Creek	Barbour Lane	KY	M2	2,600	21,000		280					05/08/01	8:01:00 AM
				M3	1,200	7,400	<1.0*	240	0.067	2.8	0.48	0.06	05/08/01	2:01:00 PM
				M4	<2000	4,600		232					05/08/01	4:01:00 PM
				M5 A	1,360	2,400	<1.0*	300	0.053	1.6	0.4	0.11	05/09/01	4:01:00 AM
				Duplicate	1,670	3,200	<1.0	308	0.063	1.3	0.38	0.08	05/09/01	4:01:00 AM
				M6	387	800		276					05/09/01	3:30:00 PM
597.8	Lancassange	Utica Pike	IN	M1	1,400	6,800	<1.0	392	0.169	0.87	0.48	0.13	05/07/01	6:10:00 PM
				M2	8,400	28,000		260					05/08/01	1:00:00 PM
				M3 A	1,530	20,000	<1.0*	232	0.281	<0.10	0.9	0.15	05/08/01	2:15:00 PM
				M4	1,200	5,200		268					05/08/01	3:15:00 PM
				M5	320	1,840	<1.0	368	0.049	1.4	0.59	0.17	05/09/01	**12:51:00 PM**
				M6	240	1,140		360					05/09/01	**3:15:00 PM**
				M7			*NO DATA*	*400*	*0.055*	*<0.10*	*0.45*	*0.14*	*05/10/01*	*8:35:00 AM*
625.1	Mill Creek (KY)	Orell Road Bridge	KY	M1	4,600	8,800	2.7	300	0.744	0.43	1.4	0.3	05/07/01	5:00:00 PM
				M2	5,000	25,000		256					05/08/01	9:31:00 AM
				M3	5,800	11,800	<1.6*	244	0.243	1.4	0.81	0.24	05/08/01	12:00:00 PM
				M4	1,800	7,000		236					05/08/01	2:00:00 PM
				M5 A	2,200	6,800	<1.2*	212	0.253	0.57	0.71	0.21	05/09/01	3:00:00 AM
				M6	387	1,000		204					05/09/01	4:30:00 PM
	EMC/EA2 Systems	Equipment Blank		BEB D1	<2	<2	<1.0	<10	<0.01	<0.10	<0.10	<0.03	05/07/01	5:24:00 PM
		Equipment Blank		***BEB D2***	<2	<2							*05/10/01*	*8:40:00 AM*
	EMC/EA2 Systems	Equipment Blank		*AEB D1*	<2	<2							*05/10/01*	*8:35:00 AM*
		Equipment Blank		AEB D2	<2	<2	<1.0	<10	<0.01	<0.10	0.12	0.05	05/09/01	**3:19:00 PM**
		Field Blank		AFB D2	14	52	<1.0	<10	<0.01	<0.10	<0.10	0.06	05/09/01	**3:20:00 PM**
	Strand & Associates	Equipment Blank		AEB D1	<20	<2	<1.0	<10	<0.01	0.12	<0.10	<0.03	05/08/01	2:05:00 PM
		Equipment Blank		AEB D2	<2	<2	<1.0	<10	<0.01	<0.10	0.11	0.04	05/09/01	3:30:00 PM
		Field Blank		AFB D2	<2	<2	<1.0	<10	<0.01	<0.10	<0.10	0.04	05/09/01	3:30:00 PM

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 5/7/01

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Detection Limit	Fecal coliform (CFU/100 mL)	Detection Limit	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
588	Beige Deepwork	L	2	4		50												5/8/2001	13:10
		M	2	4		4		1.2		5	0.029	0.83	0.45	<0.03	1.8	136	12.264	5/8/2001	13:05
		M	30															5/8/2001	13:07
		R	2	<4		<4												5/8/2001	12:50
590	Marine Marietta Company	L	2	<4	4													5/8/2001	13:21
		M	2	4														5/8/2001	13:25
		R	2	4														5/8/2001	13:30
592	Twelve Mile Island	L	2	<2	4	<4	4											5/8/2001	13:42
		M	2	<2		<4		1.2		8	1.9	0.39	<0.03	2	136	12.218		5/8/2001	13:50
		M	17					1.1										5/8/2001	13:52
		R	2	4		4												5/8/2001	13:57
594	Pipeline Crossing	L	2	<4	<4													5/8/2001	14:12
		M	2	<4														5/8/2001	14:14
		R	2	<4														5/8/2001	14:18
596	Rubyat Boat Club	L	2	<20	<20	20	20											5/8/2001	14:30
		M	2	<20		<20		1.3		5	1.9	0.5	0.09	3	134	11.673		5/8/2001	14:33
		M	30					<1.0										5/8/2001	14:35
		R	2	<20		<20												5/8/2001	14:42
598	Six Mile Island Light & Day Marks	L	2	30	30													5/8/2001	14:55
		M	2	<10														5/8/2001	15:00
		R	2	20														5/8/2001	15:04
600	Federal Mooring Buoy	L	2	30	30	180	92											5/8/2001	15:18
		M	2	<10		40		1.5		8	1.5	0.47	<0.03	3.4	134	11.840		5/8/2001	15:20
		M	37					<1.0										5/8/2001	15:22
		R	2	<10		20												5/8/2001	15:30
602	Bourgeois Creek	L	2	20	16													5/8/2001	15:35
		M	2	20														5/8/2001	15:38
		R	2	10														5/8/2001	15:46
604	George Rogers Clark Bridge	L	2	507	110	4,200	810											5/8/2001	15:56
		M	2	20		90		1.1	1.9	10	0.023	1.1	0.41	<0.03	4.3	134	10.798	5/8/2001	16:00
		M	13					<1.0	1.5									5/8/2001	16:05
		R	2	20		160												5/8/2001	16:15
604	Duplicate	L	2	600	550	4,400	860											5/8/2001	15:56
		M	2	<10		115		1.0		6	0.025	0.82	0.53	0.04	3.8	136	11.263	5/8/2001	16:00
		M	13					1										5/8/2001	16:05
		R	2	20														5/8/2001	16:15
605	Portland Canal	L	2	NO DATA		2,200												5/8/2001	16:20
607	L&I Railroad Bridge	L	2	290		4,800												5/8/2001	12:56
607	Duplicate	L	2	320		3,400												5/8/2001	12:56
608	New Albany Boat Club	L	2	147	60	3,800	460											5/8/2001	13:08
		M	2	<10		60		<1.0		12	0.041	1.4	0.41	0.05	3.6	136	11.180	5/8/2001	13:10
		M	14					1.0										5/8/2001	13:16
		R	2	30		440												5/8/2001	13:15
610	PSI Company	L	2	330	85													5/8/2001	13:31
		M	2	93														5/8/2001	13:27
		R	2	10														5/8/2001	13:35
612	Gulf Oil Company	L	2	90	160	5,600	2,760											5/8/2001	13:39
		M	2	140		2,400		<1.0		10		1.6	0.47	0.05	2.6	136	11.053	5/8/2001	13:41
		M	21					1										5/8/2001	13:44
		R	2	90		660												5/8/2001	13:48
614	Kerr McGee Terminal Inc	L	2	720	85													5/8/2001	13:54
		M	2	120														5/8/2001	13:56
		R	2	10														5/8/2001	13:59
616	Hughes Bar Light & Day Marks	L	2	880	585	10,400	2,203											5/8/2001	14:05
		M	2	147		2,400		<1.0	1	12		1.7	0.43	0.03	2.7	138	10.617	5/8/2001	14:13
		M	27					<1.0	2.1									5/8/2001	14:20
		R	2	<10		980												5/8/2001	14:08
616	Duplicate	L	2	NO DATA	210													5/8/2001	14:05
		M	2	290		1,820		<1.0		8		1.5	0.49	0.05	2.6	136		5/8/2001	14:13
		M	27					<1.0										5/8/2001	14:20
		R	2	40														5/8/2001	14:08
618	Jeffersonville Boatyard	L	2	1,420	225													5/8/2001	14:50
		M	2	147														5/8/2001	14:55
		R	2	47														5/8/2001	14:38
620	Sun Refining & Marketing Company	L	2	8,400	558	43,000	7,334											5/8/2001	14:36
		M	2	370		8,000		<1.0		10		2.3	0.31	0.06	2.7	136	10.108	5/8/2001	14:48
		M	[illegible]					<1.0										5/8/2001	14:54
		R	2	50		1,400												5/8/2001	14:56
622	Sheet Piling no 1330	L	2	11,600	281													5/8/2001	15:27
		M	2	20														5/8/2001	15:29
		R	2	50														5/8/2001	15:32
624	Shemaide Creek	L	2	17,800	3,987	40,000	22,225											5/8/2001	15:47
		M	2	<10		346		1.0		11		1.8	0.43	0.14	2	136	11.076	5/8/2001	15:49
		M	25					1										5/8/2001	[illegible]
		R	2	500		13,000												5/8/2001	15:59
626	Louisville Gas & Electric	L	2	1,200	220													5/8/2001	16:07
		M	2	120														5/8/2001	16:10
		R	2	80														5/8/2001	16:14
628	Louisville Environmental Service	L	2	8,000	733	68,000	10,735											5/8/2001	16:22
		M	2	600		18,500		<1.0		10	0.077	1.5	0.5	0.06	2.6	134	11.928	5/8/2001	16:25
		M	[illegible]					1.1										5/8/2001	16:27
		R	2	100		1,320												5/8/2001	16:33
630	Salt River	L	2	2,000	600													5/8/2001	16:38
		M	2	180														5/8/2001	16:40
		R	2	<10														5/8/2001	16:43
	Crew 1 Equipment Blank							1.0	<1.0	<5	0.01	<0.10	<0.10	<0.05	<1	0		5/8/2001	12:07
	Crew 1 Equipment Blank							<1.0		<5		<0.10	0.13	<0.05	<1	0	0.000	5/8/2001	16:28
	Crew 1 Field Blank			<2		<2		<1.0		<5		<0.10	<0.10	<0.05	<1	0		5/8/2001	16:24
	Crew 2 Equipment Blank							<1.0		<5		<0.10	<0.10	0.04	<1	0		5/8/2001	12:43
	Crew 2 Equipment Blank							1.0		<5	0.01	0.24	<0.10	<0.05	<1	0	0.008	5/8/2001	17:01
	Crew 2 Method Blank			<2		<2												5/8/2001	17:07
	Crew 2 Field Blank			<2		<2		1.0	<1.0	<5	0.01	0.17	<0.10	<0.05	<1	0	0.002	5/8/2001	17:09

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 5/7/01

Sampling Mile Point	Transect Description	Descending Stack	Sample Depth (Feet)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Geometric Mean	Fecal coliform (CFU/100 mL)	Geometric Mean	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
588	Braga Drydock	L	2	8	9	16	23											5/9/2001	11:30
		M	2	8		32		1.4		5	0.057	1.4	0.51	0.06		133	10.097	5/9/2001	11:35
		M	33					<1.0										5/9/2001	11:37
		R	2	12		24												5/9/2001	11:40
590	Martin Marietta Greenway	L	2	16	8													5/9/2001	11:50
		M	2	4														5/9/2001	12:00
		R	2	8														5/9/2001	12:03
592	Twelve Mile Island	L	2	<4	7	<4	<5											5/9/2001	12:12
		M	2	4		8		1		9		1.5	0.44	0.05	<1	134	14.291	5/9/2001	12:15
		M	10															5/9/2001	12:17
		R	2	12		20												5/9/2001	12:21
594	Pipeline Crossing	L	2	4	8													5/9/2001	12:35
		M	2	<4														5/9/2001	12:38
		R	2	16														5/9/2001	12:42
596	Rabbyat Boat Club	L	2	16	35	28	39											5/9/2001	12:50
		M	2	8		8		1		9		1.4	0.36	<0.05	<1	130	12.955	5/9/2001	12:53
		M	23					<1.0										5/9/2001	12:55
		R	2	8		16												5/9/2001	13:00
598	Six Mile Island Light & Day Marks	L	2	16	10													5/9/2001	13:13
		M	2	16														5/9/2001	13:15
		R	2	16														5/9/2001	13:18
600	Federal Mooring Buoys	L	2	4	4	4	8											5/9/2001	13:23
		M	2	4		4		1.5		8		1.1	0.34	0.03	2	134	14.439	5/9/2001	13:27
		M	35					<1.0										5/9/2001	13:29
		R	2	<4		8												5/9/2001	13:42
602	Georgetown Creek	L	2	4	5													5/9/2001	13:44
		M	2	8														5/9/2001	13:46
		R	2	12														5/9/2001	13:49
604	George Rogers Clark Bridge	L	2	144	45	280	82											5/9/2001	14:02
		M	2	40		52		1	1.5	8	0.029	1.1	0.35	0.04	3.4	132	12.816	5/9/2001	14:03
		M	15					<1.0	<1.0									5/9/2001	14:07
		R	2	12		16												5/9/2001	14:13
604	Duplicate	L	2	160	52													5/9/2001	14:02
		M	2	24		108		1.0		8	0.025	1.6	0.36	0.03	2.4	134	13.059	5/9/2001	14:05
		M	15					<1.0										5/9/2001	14:07
		R	2	20														5/9/2001	14:15
605	Portland Canal	L	2	100		173												5/9/2001	14:25
608	New Albany Boat Club	L	2	113	68	160	108											5/9/2001	16:06
		M	2	20		80		1.0		13	0.029	0.34	0.4	<0.05	1.8	133	12.676	5/9/2001	16:09
		M	12					<1.0										5/9/2001	16:09
		R	2	49		120												5/9/2001	16:17
610	ISR Company	L	2	10	23													5/9/2001	16:24
		M	2	87														5/9/2001	16:26
		R	2	10														5/9/2001	16:29
612	Gulf Oil Company	L	2	133	28	340	154											5/9/2001	16:33
		M	2	40		70		<1.0		13		0.86	0.35	<0.05	2	134	13.821	5/9/2001	16:37
		M	19					<1.0										5/9/2001	16:37
		R	2	<10		100												5/9/2001	16:42
614	Kerr-McGee Terminal, Inc	L	2	700	196													5/9/2001	16:46
		M	2	<10														5/9/2001	16:51
		R	2	<10														5/9/2001	16:54
616	Hughes Bar Light & Day Marks	L	2	1650	1858	16,600	5,376											5/9/2001	17:04
		M	2	<10				<1.0	2.2	11		1.6	0.33	0.05	<1	134	13.719	5/9/2001	17:07
		M	23					<1.0	<1.0									5/9/2001	17:07
		R	2	<10		133												5/9/2001	17:15
616	Duplicate	L	2	280	206													5/9/2001	17:04
		M	2	<10		250		<1.0		12		1.2	0.39	0.06	1.8	136		5/9/2001	17:07
		M	23					<1.0										5/9/2001	17:07
		R	2	<10														5/9/2001	17:15
618	Jeffersonville Riverport	L	2	860	458													5/9/2001	17:23
		M	2	880														5/9/2001	17:27
		R	2	810														5/9/2001	17:29
620	Sun Refining & Marketing Company	L	2	220	203	19,000	12,078											5/9/2001	17:36
		M	2	NO DATA		10,900		<1.0		13		0.98	0.33	0.06	1	136	13.057	5/9/2001	17:53
		M	15					<1.0										5/9/2001	17:53
		R	2	320		8,400												5/9/2001	17:39
622	Sheet Piling on LPP	L	2	960	312													5/9/2001	18:03
		M	2	455														5/9/2001	18:06
		R	2	70														5/9/2001	18:09
624	Twomile Creek	L	2	780	886	13,300	5,420											5/9/2001	18:18
		M	2	460		6,000		1		11		0.93	0.35	0.06	<1	136	14.388	5/9/2001	18:20
		M	19			1,360		1										5/9/2001	18:20
		R	2	100														5/9/2001	18:25
626	Louisville Gas & Electric	L	2	960	925													5/9/2001	18:33
		M	2	860														5/9/2001	18:33
		R	2	40														5/9/2001	18:39
628	Louisville Environmental Service	L	2	NO DATA	366	5,400	4,623											5/9/2001	18:46
		M	2	175		7,200		1.1		11	0.055	<0.10	0.59	0.12	2.9	138	20.645	5/9/2001	18:48
		M	23					1.2										5/9/2001	18:48
		R	2	160		1,680												5/9/2001	18:53
630	Salt River	L	2	175	111													5/9/2001	18:59
		M	2	100														5/9/2001	19:02
		R	2	200														5/9/2001	19:10
	Crew 1 Equipment Blank							<1.0	<1.0	<5		<0.10	0.10	<0.05	<1	0		5/9/2001	11:25
	Crew 1 Equipment Blank							<1.0		<5		0.18	0.10	<0.05	<1	0	<0.002	5/9/2001	14:35
	Crew 1 Method Blank			<2		<2												5/9/2001	14:45
	Crew 1 Field Blank			<2		<2		<1.0		<5		<0.10	0.10	<0.05	<1	0		5/9/2001	14:30
	Crew 2 Equipment Blank							<1.0		<5		0.12	<0.10	<0.05	<1	0		5/9/2001	15:57
	Crew 2 Equipment Blank							<1.0		<5	<0.01	0.17	<0.10	0.06	<1	0	<0.002	5/9/2001	19:23
	Crew 2 Method Blank			<2		<2												5/9/2001	19:27
	Crew 2 Field Blank			<2		<2		<1.0	<1.0	<5	<0.01	<0.10	<0.10	0.05	<1	0	<0.002	5/9/2001	19:25

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 5/7/01

Sampling Mile Point	Transect Description	Downriver Bank	Sample Depth (Feet)	Membrane Filtration Fecal coliform (CFU/100 mL)	Qualifier	Fecal coliform (CFU/100 mL)	Qualifier	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
588	Pleigh Overmark	L	2	<4		<4		<1										5/10/2001	11:36
		M	5	<4		<4		1.1		<5	0.064	1	0.48	<0.01	4.8	114	16.012	5/10/2001	12:02
		M	20					<1.0										5/10/2001	12:05
		R		<4		<4												5/10/2001	12:08
590	Mather Marietta Company	L		<4	<4													5/10/2001	12:23
		M		<4														5/10/2001	12:27
		R		<4														5/10/2001	12:30
592	Twelve Mile Island	L		<4	60	<4	49											5/10/2001	12:35
		M	2	<4		<4		1.1		<5		1.8	0.41	<0.01	4.2	116	11.781	5/10/2001	12:40
		M	10					<1.0										5/10/2001	12:41
		R		<4		<4												5/10/2001	12:45
594	Pipeline Crossing	L		4	4													5/10/2001	12:55
		M		4														5/10/2001	12:59
		R		<4														5/10/2001	13:00
596	Raboyn Boat Club	L		<4	8	16	20											5/10/2001	13:06
		M		8		40		1.1		7		1.3	0.32	<0.01	4	116	12.281	5/10/2001	13:08
		M	15				8	<1.0										5/10/2001	13:10
		R		8		16												5/10/2001	13:15
598	Six Mile Island Light & Day Marker	L		<4	<4													5/10/2001	13:24
		M		<4														5/10/2001	13:26
		R		<4														5/10/2001	13:30
600	Federal Mooring Dunes	L		<4	<4	<4	52											5/10/2001	13:37
		M		<4		<4		1.3		8		1.5	0.43	<0.01	4	114	11.889	5/10/2001	13:39
		M	10					<1.0										5/10/2001	13:42
		R		<4		16												5/10/2001	13:46
602	Pennypack Creek	L		4	4													5/10/2001	13:55
		M		<4														5/10/2001	13:57
		R		<4														5/10/2001	14:02
604	George Rogers Clark Dredge	L		12	12	137	48											5/10/2001	14:15
		M		<4		40		1.4	2.1	8	0.081	1.4	0.41	<0.01	5	114	12.491	5/10/2001	14:16
		M						<1.0	1.2									5/10/2001	14:19
		R		<4		16												5/10/2001	14:23
606	Duplicate	L		12	12													5/10/2001	14:33
		M		20		233		1.2		4.5	0.071	1.1	0.41	<0.01	4.1		12.108	5/10/2001	14:36
		M						<1.0										5/10/2001	14:39
		R		<4														5/10/2001	14:23
605	Pattison Canal	L		90		140												5/10/2001	14:18
607	Ltd Railroad Bridge	L		8		56												5/10/2001	10:54
607	Duplicate	L		12		60												5/10/2001	10:54
608	New Albany Boat Club	L		NO DATA	60	100	10											5/10/2001	11:00
		M	2	<4		20		<1.0		8	0.045	1.7	0.48	<0.01	1.8	142	10.448	5/10/2001	11:03
		M	18															5/10/2001	11:06
		R		<4		20												5/10/2001	11:09
610	PSI Company	L		20	16													5/10/2001	11:16
		M		8														5/10/2001	11:18
		R		<4														5/10/2001	11:20
612	Cliff's Mt Company	L		8	8	66	36											5/10/2001	11:26
		M		8		54		1.0		11		1.8	0.41	<0.01	2.1	110	11.527	5/10/2001	11:28
		M	18					<1.0										5/10/2001	11:28
		R		8		28												5/10/2001	11:33
614	Kurt Mellon Terminal, Inc	L		124	72													5/10/2001	11:38
		M		<4														5/10/2001	11:41
		R		4														5/10/2001	11:45
616	Hughes Pier Light & Day Marker	L		531	76	6,200	220											5/10/2001	11:48
		M		4		49		<1.0	1.8	10		1.4	0.4	0.06	1	110	11.527	5/10/2001	11:56
		M	22					<1.0	<1.0									5/10/2001	11:56
		R		4		56												5/10/2001	11:52
618	Duplicate	L		491	496													5/10/2001	11:48
		M		<4		96		1.4		7		1.4	0.48	0.05	1	116		5/10/2001	11:56
		M	22					<1.0										5/10/2001	11:56
		R		<4														5/10/2001	11:52
618	Jeffersonville Riverport	L		500	504													5/10/2001	12:12
		M		560														5/10/2001	12:15
		R		640														5/10/2001	12:15
620	Sun Refining & Marketing Company	L		720	880	2,400	1,320											5/10/2001	12:22
		M	14	531		1,160		1.3		9		1.1	0.48	0.05	2.9	118	14.699	5/10/2001	12:24
		M						<1.0										5/10/2001	12:24
		R		440		520												5/10/2001	12:29
622	Shaw Filing on 1109	L		360	376													5/10/2001	12:36
		M		240														5/10/2001	12:38
		R		250														5/10/2001	12:41
624	Evansville Creek	L		1,060	592	1,400	448											5/10/2001	12:48
		M		108		490		1.6		13		1.6	0.43	0.05	1	114	16.010	5/10/2001	12:36
		M	22					<1.0										5/10/2001	12:36
		R		217		1,040												5/10/2001	12:50
626	Louisville Gas & Electric	L		850	624													5/10/2001	13:08
		M		440														5/10/2001	13:10
		R		208														5/10/2001	13:12
628	Louisville Environmental Service	L		460	336	2,400	1,600											5/10/2001	13:19
		M		260		2,160		1.2		16		1.7	0.43	<0.01	1	118	15.518	5/10/2001	13:22
		M	22					<1.0										5/10/2001	13:22
		R		1,200		1,980												5/10/2001	13:27
630	Salt River	L		214	336													5/10/2001	14:18
		M		185														5/10/2001	14:40
		R		460														5/10/2001	14:41
	New 1 Equipment Blank							<1.0	<1.0	<5	<0.01	0.11	<0.10	<0.01	<1	0		5/10/2001	11:36
	New 1 Equipment Blank			<2		<2		<1.0		<5		<0.10	<0.10	0.02	<1	0	<0.001	5/10/2001	13:20
	New 1 Method Blank			<2		<2												5/10/2001	13:24
	New 1 Field Blank							<1.0		<5		<0.10	<0.10	<0.01	<1	0		5/10/2001	15:29
	New 2 Equipment Blank							<1.0		<5		<0.10	<0.10	<0.01	<1	0		5/10/2001	10:49
	New 2 Equipment Blank							<1.0		<5	<0.01	0.11	<0.10	<0.01	<1	0	<0.002	5/10/2001	15:23
	New 2 Method Blank			<2		<2												5/10/2001	15:36
	New 2 Field Blank			<2		<2		<1.0	<1.0	<5	<0.01	<0.10	<0.1	<0.01	<1	0	<0.001	5/10/2001	15:29

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 5/7/01

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Date	Sample Time
610	PSI Company	M	2	16	86	<1.0		11	0.6	0.37	0.07	136	12.731	5/11/2001	5/12/2001	15:58
615	Stauffer Chemical	M	2	16	120	1.1		10	0.6	0.37	0.05	140	14.759	5/11/2001	5/12/2001	15:44
620	Sun Refining and Marketing Company	M	2	36	186	<1.0		11	0.95	0.47	0.06	136	14.007	5/11/2001	5/12/2001	15:31
625	Fishtown Daymark	M	2	74	250	<1.0		13	1.1	0.45	0.05	140	15.234	5/11/2001	5/12/2001	15:14
630	Salt River	M	2	92	400	1.7		12	0.99	0.63	0.09	142	17.041	5/11/2001	5/12/2001	15:00
635	Mosquito Daymark	M	2	69	220	1	2.4	12	1.8	0.46	0.06	140	19.557	5/11/2001	5/12/2001	14:31
635	Duplicate	M	2	98	480	1.3		11	1.4	0.49	0.05	138	19.536	5/11/2001	5/12/2001	14:31
640	RDB Channel Markers	M	2	74	367	1.2		11	2	0.57	0.04	140	18.972	5/11/2001	5/12/2001	14:17
645	Brandenburg Daymark	M	2	83	340	1.2		9.5	2.7	0.42	<0.03	142	17.486	5/11/2001	5/12/2001	13:43
650	Haunted Hollow Daymark	M	2	54	330	<1.0		11	1.9	0.4	<0.03	140	15.881	5/11/2001	5/12/2001	13:29
655	New River Lime Company	M	2	80	232	1.2		8	2	0.35	<0.03	140	15.888	5/11/2001	5/12/2001	13:17
660	Cold Friday Daymark	M	2	100	233	<1.0		7	1.8	0.4	0.05	138	16.170	5/11/2001	5/12/2001	12:57
	Crew 1 Equipment Blank					<1.0		<5	<0.10	<0.10	<0.03	0	-0.001	5/11/2001	5/12/2001	12:50
	Crew 1 Equipment Blank					<1.0		<5	<0.10	<0.10	<0.03	0	-0.007	5/11/2001	5/12/2001	16:36
	Crew 1 Method Blank			<2	<2									5/11/2001	5/12/2001	16:39
	Crew 1 Field Blank			<2	<2	<1.0		<5	<0.10	<0.10	<0.03	0	-0.004	5/11/2001	5/12/2001	16:41

Note: M Midstream

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 5/7/01

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Time
610	PSI Company	M	2	267	960	1.3		5	0.95	0.43	0.06	138	11.276	3:44:00 PM
615	Stauffer Chemical	M	2	560	1,760	1.4		10	0.75	0.53	0.12	140	11.556	3:30:00 PM
620	Sun Refining and Marketing Company	M	2	8,400	23,000	1.5		9	0.88	0.51	0.1	136	12.940	3:08:00 PM
625	Fishtown Daymark	M	2	380	540	1.3		12	0.82	0.43	0.07	140	12.754	2:51:00 PM
630	Salt River	M	2	136	217				1.4	0.45	0.08	142	13.812	2:37:00 PM
635	Mosquito Daymark	M	2	350	960	1.6	2.6	23	1.1	0.53	0.12	154	13.634	2:08:00 PM
635	Duplicate	M	2	NO DATA	480	1		24	0.8	0.59	0.13	156	13.660	2:08:00 PM
640	RDB Channel Markers	M	2	77	136	1.5		13	1.5	0.48	0.08	138	15.370	1:52:00 PM
643	Brandenburg Daymark	M	2	66	128	1.8		10	1.2	0.39	0.05	142	16.728	1:19:00 PM
650	Haunted Hollow Daymark	M	2	52	100	1.4		10	1	0.41	0.05	144	16.865	1:03:00 PM
655	New River Lime Company	M	2	43	80	1.6		12	1.6	0.43	0.05	140	19.537	12:52:00 PM
660	Cold Friday Daymark	M	2	77	104	2		9	1.9	0.45	0.05	144	19.791	12:29:00 PM
	Crew 1 Equipment Blank					<1.0		<5	<0.10	<0.10	<0.03	0	-0.002	12:20:00 PM
	Crew 1 Equipment Blank					<1.0		<5	0.13	<0.10	<0.03	0	-0.003	4:11:00 PM
	Crew 1 Method Blank			<2	<2									4:13:00 PM
	Crew 1 Field Blank			<2	<2	<1.0		<5	0.11	<0.10	<0.03	0	-0.003	4:15:00 PM

Note: M = Midstream

Wet Weather Impact Study
Combined Sewer Outfall Analytical Data

Site Description	Sample ID	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
Louisville CSO#16	S0	218		340	3.27	1.2	20	3.45	05/07/01	7:35:00 PM
	S15	104		268					05/07/01	7:50:00 PM
	S30	89.8	672	244	2.42	0.9	14.6	3.16	05/07/01	8:05:00 PM
	Duplicate	74.8		256	2.87	1.1	14.6	3.16	05/07/01	8:06:00 PM
	S45	81.2		248					05/07/01	8:20:00 PM
	S60	72.8		252	1.62	1.3	9.7	3.03	05/07/01	8:35:00 PM
	S90	65.4		188					05/07/01	9:05:00 PM
	S120	41.8		144	1.16	1	7	2.33	05/07/01	9:35:00 PM
	S150	34.8		124					05/07/01	8:05:00 PM
	S180	28.2		104	1	0.79	4.6	1.71	05/07/01	10:35:00 PM
	SH4	25.4		172	0.884	1	3	1.26	05/07/01	11:35:00 PM
	SH5	19.9		168					05/08/01	12:35:00 AM
	SH6	24.5		176	0.424	0.67	1.8	0.89	05/08/01	1:35:00 AM
Louisville CSO#19	S0	90.7		304	2.97	1.1	9.7	2.23	05/07/01	7:00:00 PM
	S15	71.1		332					05/07/01	7:15:00 PM
	S30	77.4	170	260	2.02	1.5	7	2.04	05/07/01	7:30:00 PM
	Duplicate	63.1		224	1.67	1.8	6.7	2.13	05/07/01	7:30:00 PM
	S45	69		156					05/07/01	7:45:00 PM
	S60	67.6		280	1.03	1.4	4.9	1.79	05/07/01	8:00:00 PM
	S75	51.1		176					05/07/01	8:15:00 PM
	S90	57.7		244	0.904	1.2	4.6	2.04	05/07/01	8:30:00 PM
	S105	36.7		196					05/07/01	8:45:00 PM
	S120	33.2		160	0.804	1.3	4.2	1.57	05/07/01	9:00:00 PM
	S135	24.7		196					05/07/01	9:15:00 PM
Louisville CSO#50	S0	48.7		160	1.04	0.58	4.9	2.9	05/07/01	7:04:00 PM
	S15	37.3		116					05/07/01	7:19:00 PM
	S30	24.1		116	0.854	0.98	3.5	1.95	05/07/01	7:34:00 PM
	Duplicate	35.8		96	0.924	0.81	3.7	2.13	05/07/01	7:34:00 PM
	S45	30.5		128					05/07/01	7:49:00 PM
	S60	<8*		82	0.554	0.98	2.2	1.11	05/07/01	8:04:00 PM
	S75	<7.1*		24					05/07/01	8:19:00 PM
	S90	<7.6*		40	0.534	0.94	2.1	0.97	05/07/01	8:34:00 PM
	S105	25.5		76					05/07/01	8:49:00 PM
	S120	<17.3*		80	0.754	1	3.9	1.26	05/07/01	9:04:00 PM
	S135	<12.3*		76					05/07/01	9:19:00 PM
Louisville CSO#189	S0	72		136	1.62	1.2	9.6	2.04	05/07/01	7:15:00 PM
	S15	58.3		156					05/07/01	7:30:00 PM
	S30	45.9	77	176	1.12	1.1	7	2.13	05/07/01	8:00:00 PM
	Duplicate	39.6		172	1.16	1.5	7.3	2.23	05/07/01	8:00:00 PM
	S45	40.8		172					05/07/01	8:15:00 PM
	S60	39.7		180	0.874	1.5	6.4	2.13	05/07/01	8:30:00 PM
	S75	<19.1		96					05/07/01	8:45:00 PM
	S90	23.5		112	0.634	1.3	4	1.21	05/07/01	9:15:00 PM
	S105	21		108					05/07/01	9:30:00 PM
	S120	19.3		80	0.694	0.91	4	1.15	05/07/01	9:45:00 PM
	S135	34.2		76					05/07/01	10:00:00 PM
Louisville CSO#100	S0	30		120	0.834	1.1	3.5	1.11	05/07/01	7:00:00 PM
	S15	<14.9*		84					05/07/01	7:15:00 PM
	S30	<14.1*	96	128	0.584	1.2	2.8	1.06	05/07/01	7:45:00 PM
	Duplicate	<14.4*		112	0.554	1.6	3	1.01	05/07/01	7:46:00 PM
	S45	<12.9*		92					05/07/01	8:30:00 PM
	S60	17.7		60	0.304	0.57	1.6	0.57	05/07/01	9:30:00 PM
	S60	<12.4*		144					05/07/01	9:45:00 PM
	S90	<10.5*		80	0.344	0.59	1.6	0.52	05/07/01	10:00:00 PM
	S105	<8.8*		72					05/07/01	10:15:00 PM
	S120	<4.9*		64	0.294	0.53	1.6	0.44	05/07/01	10:30:00 PM
	S135	<4.7*		48					05/07/01	10:45:00 PM
Louisville CSO#210	S0	216		448	7.34	0.43	41	8.66	05/07/01	7:20:00 PM
	S15	185		368					05/07/01	7:40:00 PM
	S30	101	612	260	6.52	0.73	28.6	5.59	05/07/01	7:55:00 PM
	Duplicate	100		240	6.47	0.73	21.9	5.35	05/07/01	7:56:00 PM
	S45	85.2		224					05/07/01	8:10:00 PM
	S60	64		204	2.82	1.1	12.3	3.61	05/07/01	8:25:00 PM
	S90	61.4		168					05/07/01	8:55:00 PM
	S120	79		260	2.72	0.63	15.3	4.11	05/07/01	9:25:00 PM
	S150	64.8		216					05/07/01	9:55:00 PM
	S180	41.8		200	1.07	0.6	10.2	2.77	05/07/01	10:25:00 PM
	SH4	43		192	3.52	0.64	11.7	3.45	05/07/01	11:25:00 PM
	SH5	40		184					05/08/01	12:25:00 AM
	SH6	35.1		232	4.82	0.58	6.7	3.03	05/08/01	1:25:00 AM
Louisville SO	S0	114		284	2.52	0.63	22	5.12	05/07/01	7:10:00 PM
	S15	181		408					05/07/01	7:25:00 PM
	S30A	150	798	320	3.92	0.66	25.6	6.1	05/07/01	7:40:00 PM
	Duplicate	113		324	4.27	0.64	21.4	6.37	05/07/01	7:41:00 PM
	S45	95.3		276					05/07/01	7:55:00 PM
	S60	81.7		248	2.77	1.9	16.8	3.94	05/07/01	8:10:00 PM
	S90	80.1		260					05/07/01	8:40:00 PM
	S120	87.5		248	3.27	0.31	12.8	3.94	05/07/01	9:10:00 PM
	S150	87.6		236					05/07/01	9:40:00 PM
	S180	67.6		224	2.57	1.7	11.5	3.77	05/07/01	10:10:00 PM
	SH4	39.4		160	1.62	0.85	7.4	2.77	05/07/01	11:10:00 PM
	SH5	42.6		196					05/08/01	12:10:00 AM
	SH6	60.8		228	1.97	1.8	7.5	1.79	05/08/01	1:10:00 AM
Jeffersonville CSO#10	S0	48		244	1.33	0.54	7.6	3.03	05/07/01	7:00:00 PM
	S15	73.8		284					05/07/01	7:15:00 PM
	S30	51.2	145	100	0.824	1.1	6.6	3.94	05/07/01	7:30:00 PM
	Duplicate	41.1		100	0.844	0.97	6.4	1.64	05/07/01	8:30:00 PM
	S45	32.6		180					05/07/01	8:45:00 PM
	S60	37.4		196	1.09	1.2	4	1.64	05/07/01	9:00:00 PM
	S75	31		204					05/07/01	9:15:00 PM
	S90	23.8		216	0.854	0.63	14.3	1.71	05/07/01	9:30:00 PM
	S105	25.9		120					05/07/01	9:45:00 PM
	S120	22.6		96	0.554	1.2	4	1.64	05/07/01	10:00:00 PM
	S135	22.8		172					05/07/01	10:15:00 PM
Louisville MSD	Field Blank	<1.0		<10	<0.01	<0.10	0.18	0.03	05/08/01	1:40:00 AM
Louisville MSD	Equipment Blank	<1.0		<10	<0.01	<0.10	0.1	0.03	05/08/01	1:40:00 AM
Louisville MSD	Field Blank	<1.0		<10	<0.01	<0.10	<0.10	0.03	05/08/01	1:30:00 AM
Louisville MSD	Equipment Blank	<1.0		<10	<0.01	<0.10	<0.10	0.03	05/08/01	1:30:00 AM
Louisville MSD	Field Blank	<1.0		<10	<0.01	<0.10	0.17	<0.03	05/08/01	1:14:00 AM
Louisville MSD	Equipment Blank	<1.0		<10	<0.01	<0.10	0.2	<0.03	05/08/01	1:16:00 AM
EMC/EA2 Systems	Field Blank	<1.0		<10	<0.01	<0.10	<0.10	0.04	05/07/01	10:20:00 PM

Wet Weather Impact Study
Wastewater Treatment Plant Influent Analytical Data

Site Description	Sample ID	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
Jeffersonville WWTP	HR0	93.6		936	2.72	1.1	11.4	5.12	05/07/01	7:20:00 PM
	HR1	105		944					05/07/01	8:20:00 PM
	HR2	101	427	640	3.32	0.87	14.3	7.27	05/07/01	9:20:00 PM
	Duplicate	95.2		548	2.92	0.67	15.1	6.65	05/07/01	9:20:00 PM
	HR3	88		606					05/07/01	10:30:00 PM
	HR4	50		524	1.32	0.86	7.7	3.94	05/07/01	11:25:00 PM
	HR5	47.6		608					05/08/01	12:20:00 AM
	HR6	49.2		624	2.22	0.6	5.5	3.61	05/08/01	1:20:00 AM
	HR7	79.2		936					05/08/01	2:20:00 AM
	HR8	75.6		972	6.32	1.1	12.7	5.59	05/08/01	3:20:00 AM
	HR9	71.8		960					05/08/01	4:00:00 AM

APPENDIX D

WATER QUALITY DATA

October 2001 Wet Weather Event

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 10/5/01

Confluence Mile Point	Tributary	Site Description	State	Sample ID	*Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue Bridge	KY	HR 0	200	300	1.3		388	0.12	0.21	0.51	0.1	10/05/2001	2:40:00 PM
				HR 2	28,000	78,000			372					10/05/2001	4:45:00 PM
				HR 4	100,000	100,900			156					10/05/2001	6:40:00 PM
				HR 6	42,000	79,100	7	27	164	0.9	0.2	1.8	0.58	10/05/2001	8:35:00 PM
				HR 8	31,000	57,000			172					10/05/2001	10:30:00 PM
				HR 10	14,000	40,000			116					10/06/2001	12:30:00 AM
				HR 12	30,000	35,000	1.6	3.9	124	0.7	0.19	0.68	0.13	10/06/2001	2:30:00 AM
				Duplicate	24,000	36,000	1.2		128	0.9	0.18	0.83	0.13	10/06/2001	2:30:00 AM
602.1	Beargrass Creek Middle/South Fork	Mellwood	KY	HR 0	100	200	1.2		552	0.13	0.31	0.35	0.05	10/05/2001	3:15:00 PM
				HR 2	3,400	4,200			465					10/05/2001	5:20:00 PM
				HR 4	37,000	84,500			132					10/05/2001	7:25:00 PM
				HR 6	32,000	48,000	2.8	12	236	1.6	0.18	1.3	0.28	10/05/2001	9:15:00 PM
				HR 8	27,000	44,000			140					10/05/2001	11:00:00 PM
				HR 10	11,000	22,000			232					10/06/2001	1:00:00 AM
				HR 12	11,600	34,000	1.3	3.9	184	0.29	0.88	0.6	0.09	10/06/2001	3:00:00 AM
				Duplicate	7,600	12,000	1		178	0.34	0.95	0.71	0.08	10/06/2001	3:00:00 AM
606.1	Mill Creek (IN)	Frontage Road	IN	HR 0	200	800	2.1		584	0.3	0.12	0.4	0.07	10/05/2001	2:55:00 PM
				HR 2	15,700	25,000			340					10/05/2001	5:35:00 PM
				HR 4	13,200	16,700			144					10/05/2001	7:00:00 PM
				HR 6	No Data Collected	32,000	2.2	9.1	156	0.29	<0.10	0.31	0.09	10/05/2001	9:30:00 PM
				HR 8	13,100	32,000			200					10/05/2001	10:50:00 PM
				HR 10	29,000	43,000			196					10/06/2001	12:30:00 AM
				HR 12	6,600	24,000	1.1	4	252	0.39	<0.10	0.83	0.08	10/06/2001	2:30:00 AM
				Duplicate	7,800	19,000	1.3	4.3	252	0.38	<0.10	0.65	0.09	10/06/2001	2:30:00 AM
607.0	Silver Creek	Route 62	IN	HR 0	270	430	1.6		116	0.08	0.12	0.48	0.07	10/05/2001	3:30:00 PM
				HR 2	1,400	2,600			328					10/05/2001	6:00:00 PM
				HR 4	24,000	35,000			184					10/05/2001	7:30:00 PM
				HR 6	13,700	20,500	1.6	7.2	160	0.55	<0.10	0.71	0.08	10/05/2001	10:10:00 PM
				HR 8	7,000	10,200			264					10/05/2001	11:10:00 PM
				HR 10	4,200	10,000			340					10/06/2001	1:00:00 AM
				HR 12	1,800	2,400	<1	2.7	376	0.3	<0.10	0.79	0.07	10/06/2001	2:55:00 AM
				Duplicate	2,800	3,200	<1	2.6	364	0.31	0.1	0.57	0.05	10/06/2001	2:55:00 AM
609.3	Falling Run	New Albany Pump Station	IN		No Data Collected										
616.4	Mill Creek Cutoff	Cane Run	KY	HR 0	40	133	1.5		464	0.088	1.3	0.66	0.16	10/05/2001	2:50:00 PM
				HR 2	600	3,200			222					10/05/2001	5:00:00 PM
				HR 4	14,000	39,000			128					10/05/2001	7:00:00 PM
				HR 6	22,000	25,000	3.4	12	140	0.61	0.6	0.98	0.1	10/05/2001	9:00:00 PM
				HR 8	9,800	19,000			144					10/05/2001	11:00:00 PM
				HR 10	25,000	34,000			92					10/06/2001	1:00:00 AM
				HR 12	13,500	39,000	1.1	3.5	112	0.55	0.66	1.5	0.07	10/06/2001	3:00:00 AM
				Duplicate	13,700	35,000	1.3		124	0.58	0.67	1.2	0.23	10/06/2001	3:00:00 AM
	Louisville MSD	Equipment Blank		BEB 1	<2	<2	<1		<10	<0.01	<0.10	0.11	<0.03	10/05/2001	2:40:00 PM
	Strand & Associates	Equipment Blank		BEB 1	<2	<2	1.6		<10	<0.01	<0.10	<0.10	<0.03	10/05/2001	2:45:00 PM
	Strand & Associates	Equipment Blank		BEB 1	<2	4	<1		<10	<0.01	<0.10	<0.10	<0.03	10/05/2001	2:45:00 PM

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 10/5/01

Confluence Mile Point	Tributary	Site Description	State	Sample ID	*Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
602.1	Beargrass Creek	Mockingbird Avenue Bridge	KY	HR 16	11,400	28,000			150					10/06/2001	6:30:00 AM
	Muddy Fork			HR 20	6,600	33,000	1		152	0.268	0.72	0.29	0.03	10/06/2001	10:30:00 AM
				HR 24	7,000	12,700			176					10/06/2001	2:30:00 PM
				HR 32	7,400	17,200	1.2		216	0.21	0.25	0.88	0.14	10/06/2001	10:30:00 PM
				HR 40	6,200	15,800			244					10/07/2001	6:35:00 AM
				HR 48	6,800	13,400	<1	1.2	252	0.76	0.5	0.65	0.04	10/07/2001	1:30:00 PM
602.1	Beargrass Creek	Mellwood	KY	HR 16	8,000	9,600			300					10/06/2001	7:00:00 AM
	Middle/South Fork			HR 20	5,200	11,400	1.2		280	0.208	0.61	0.23	0.03	10/06/2001	11:00:00 AM
				HR 24	3,200	5,600			316					10/06/2001	3:00:00 PM
				HR 32	2,400	2,600	<1		404	0.222	0.47	0.59	0.07	10/06/2001	11:00:00 PM
				HR 40	2,000	3,600			480					10/07/2001	7:15:00 AM
				HR 48	660	1,040	<1	1.7	452	1.04	0.51	0.28	0.03	10/07/2001	12:45:00 PM
606.1	Mill Creek (IN)	Frontage Road	IN	HR 16	7,400	15,500			336					10/06/2001	7:01:00 AM
				HR 20	8,600	11,800	2.1		340	0.4	0.53	0.48	0.03	10/06/2001	11:01:00 AM
				HR 24	5,400	11,400			428					10/06/2001	3:00:00 PM
				HR 32	6,600	15,200	1.1		508	0.35	1.2	0.38	0.04	10/06/2001	11:01:00 PM
				HR 40	9,600	11,800			572					10/07/2001	7:00:00 AM
				HR 48	9,000	7,800	1.3	7.4	616	2.18	0.72	0.97	0.07	10/07/2001	3:00:00 PM
607.0	Silver Creek	Route 62	IN	HR 16	6,800	10,600			264					10/06/2001	7:00:00 AM
				HR 20	7,200	7,600	<1		296	0.45	0.58	0.51	<0.03	10/06/2001	11:00:00 AM
				HR 24	5,400	6,800			<10					10/06/2001	3:01:00 PM
				HR 32	5,200	10,800	1.7		280	0.424	0.88	0.4	0.04	10/06/2001	11:00:00 PM
				HR 40	2,400	3,800			464					10/07/2001	7:01:00 AM
				HR 48	920	1,200	<1	2.6	444	0.224	0.79	0.42	0.06	10/07/2001	3:01:00 PM
609.3	Falling Run	New Albany Pump Station	IN		No Data Collected										
616.4	Mill Creek Cutoff	Cane Run	KY	HR 16	11,000	45,000			141					10/06/2001	7:00:00 AM
				HR 20	12,000	27,000	1.1		104	0.5	0.66	0.29	<0.03	10/06/2001	11:00:00 AM
				HR 24	7,000	11,200			164					10/06/2001	3:00:00 PM
				HR 32	3,400	5,800	1.2		180	0.532	0.57	0.42	0.11	10/06/2001	11:00:00 PM
				HR 40	1,800	3,600			228					10/07/2001	7:00:00 AM
				HR 48	660	1,200	<1	2.9	256	0.872	0.72	0.47	0.21	10/07/2001	3:00:00 PM
	Louisville MSD	Equipment Blank		AEB 1	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/06/2001	7:00:00 PM
	Louisville MSD	Equipment Blank		AEB 2	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/07/2001	12:45:00 PM
	Louisville MSD	Field Blank		AFB	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/07/2001	12:45:00 PM
	Strand & Associates	Equipment Blank		AEB 1	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/06/2001	3:15:00 PM
	Strand & Associates	Equipment Blank		AEB 2	<2	<2	<1		<10	<0.01	0.1	<0.10	<0.03	10/07/2001	3:15:00 PM
	Strand & Associates	Equipment Blank		AEB 1	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/06/2001	3:15:00 PM
	Strand & Associates	Field Blank		AEB 2	<2	2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/07/2001	3:15:00 PM

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 10/5/01

Confluence Mile Point	Tributary	Site Description	State	Sample ID	*Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
602.1	Beargrass Creek Muddy Fork	Mockingbird Avenue Bridge	KY	D3	2,400	8,200	<1		340	0.14	1	0.17	0.04	10/08/2001	1:15:00 PM
				D4	1,080	1,654	<1		416	0.162	0.52	0.43	0.03	10/09/2001	1:20:00 PM
				Duplicate	1,040	2,400	<1		364	0.166	1.6	0.72	0.03	10/09/2001	1:20:00 PM
602.1	Beargrass Creek Middle/South Fork	Mellwood	KY	D3	172	473	1.3		524	0.464	0.76	0.59	<0.03	10/08/2001	12:30:00 PM
				Duplicate	206	493	1		524	0.456	0.74	0.68	<0.03	10/08/2001	12:30:00 PM
				D4	320	393	<1		484	0.088	2.4	0.46	0.03	10/09/2001	12:30:00 PM
606.1	Mill Creek (IN)	Frontage Road	IN	D3	Dry - No Sample										
				D4	Dry - No Sample										
				Duplicate											
607.0	Silver Creek	Route 62	IN	D3	307	600	1.1		444	0.216	0.67	0.28	<0.03	10/08/2001	1:00:00 PM
				Duplicate	280	900	1.2		464	0.228	0.64	0.46	<0.03	10/08/2001	1:00:00 PM
				D4	370	390	<1		484	0.188	0.71	0.43	0.03	10/09/2001	11:45:00 AM
				D5	120	413	<1	2.1	392	0.154	0.66	0.57	0.08	10/10/2001	2:00:00 PM
609.3	Falling Run	New Albany Pump Station	IN		No Data Collected										
616.4	Mill Creek Cutoff	Cane Run	KY	D3	477	740	<1		400	0.188	0.73	0.54	0.23	10/08/2001	1:30:00 PM
				D4	140	229	<1		484	0.184	1.3	0.55	0.72	10/09/2001	11:00:00 AM
				Duplicate	128	350	<1		472	0.194	1.2	0.7	0.66	10/09/2001	11:00:00 AM
				D5	16	250	<1	1.7	490	0.024	0.71	0.6	0.58	10/10/2001	1:00:00 PM
	Louisville MSD	Equipment Blank		AEB D3	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/08/2001	12:30:00 PM
	Louisville MSD	Field Blank		AFB D3	<2	<2	<1		<10	<0.01	0.64	0.11	<0.03	10/08/2001	12:30:00 PM
	Louisville MSD	Equipment Blank		AEB D4	<2	<2	<1		<10					10/09/2001	12:30:00 PM
	Louisville MSD	Field Blank		AFB D4	<2	<2	<1		<10	<0.01	<0.10	0.66	<0.03	10/09/2001	12:30:00 PM
	Strand & Associates	Equipment Blank		AEB D3	<2	2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/08/2001	1:00:00 PM
	Strand & Associates	Field Blank		AFB D3	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/08/2001	1:00:00 PM
	Strand & Associates	Equipment Blank		AEB D4	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/09/2001	12:00:00 PM
	Strand & Associates	Field Blank		AFB D4	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/09/2001	12:00:00 PM
	Strand & Associates	Equipment Blank		AEB D5	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/10/2001	2:15:00 PM
	Strand & Associates	Field Blank		AFB D5	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/10/2001	2:15:00 PM
	Strand & Associates	Equipment Blank		AEB D3	<2	2	<1		<10	<0.01	<0.10	0.1	<0.03	10/08/2001	1:30:00 PM
	Strand & Associates	Equipment Blank		AEB D4	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/09/2001	11:15:00 AM
	Strand & Associates	Equipment Blank		AEB D5	<2	<2	<1		<10	<0.01	<0.10	<0.10	<0.03	10/10/2001	1:15:00 PM

Wet Weather Impact Study
Tributary Analytical Data

Survey Start Date: 10/5/01

Confluence Mile Point	Tributary	Site Description	State	Sample ID	*Escherichia coli* (CFU/100 mL)	Fecal Coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
595.9	Harrods Creek	Prospect	KY	M1	40	80	3.1	340	0.564	0.35	0.76	<0.03	10/05/2001	3:00:00 PM
				M2	120	1,100		316					10/05/2001	5:00:00 PM
				M3	360	1,100	<3	312	0.46	0.65	0.31	<0.03	10/05/2001	7:00:00 PM
				M4	5,400	8,400		360					10/06/2001	6:30:00 AM
				M5	4,000	8,000	2.3	288	0.89	0.7	0.99	0.06	10/06/2001	4:45:00 PM
				Duplicate	3,000	10,400	2.4	292	0.84	0.68	0.95	0.04	10/06/2001	4:45:00 PM
				M6	1,600	3,400		272					10/07/2001	8:30:00 AM
596.3	Lentzier Creek	Utica Pike	IN	M1	12,700	13,800	4.5	320	0.26	0.5	<0.10	<0.03	10/05/2001	3:00:00 PM
				M2	12,000	21,000		336					10/05/2001	5:00:00 PM
				M3	11,600	11,200	1.1	212	0.44	0.75	0.82	0.03	10/06/2001	8:00:00 AM
				M4	6,000	12,600		208					10/06/2001	10:20:00 AM
				M5	6,200	12,000	1.6	224	0.45	0.72	0.4	0.04	10/06/2001	1:50:00 PM
				M6	1,180	3,000		356					10/07/2001	9:15:00 AM
596.9	Goose Creek	Highway 42	KY	M1	280	380	1	476	0.376	1.4	0.15	0.03	10/05/2001	3:02:00 PM
				M2	16,200	24,000		244					10/05/2001	5:01:00 PM
				M3	24,000	26,000	3.4	164	0.42	0.33	1.14	0.03	10/06/2001	7:02:00 PM
				M4	8,000	14,600		172					10/06/2001	6:32:00 AM
				M5	3,600	6,000	1.3	260	0.208	1.4	0.47	0.03	10/06/2001	4:47:00 PM
				Duplicate	2,800	3,200	1	264	0.204	1.2	0.42	0.03	10/06/2001	4:47:00 PM
				M6	1,380	1,600		396					10/07/2001	8:32:00 AM
596.9	Little Goose Creek	Barbour Lane	KY	M1	800	1,060	2.8	432	0.124	1.1	0.19	0.04	10/05/2001	3:01:00 PM
				M2	38,000	47,000		272					10/05/2001	5:02:00 PM
				M3	19,000	36,000	4.3	108	0.43	0.64	0.71	0.03	10/05/2001	7:01:00 PM
				M4	2,800	9,600		212					10/06/2001	6:31:00 AM
				M5	5,800	6,600	<1	260	0.096	1.1	0.25	0.05	10/06/2001	4:46:00 PM
				Duplicate	1,340	2,600	<1	228	0.084	1	0.25	0.04	10/06/2001	4:46:00 PM
				M6	840	1,320		308					10/07/2001	8:31:00 AM
597.8	Lancassange	Utica Pike	IN	M1	15,800	16,200	4.4	288	0.65	<0.10	<0.10	<0.03	10/05/2001	3:00:00 PM
				M2	11,000	24,000		232					10/05/2001	5:00:00 PM
				M3	13,300	28,000	2.1	204	0.26	1.1	0.64	0.04	10/06/2001	8:00:00 AM
				M4	20,000	40,000		216					10/06/2001	10:40:00 AM
				M5	13,600	40,000	3	244	0.432	0.66	0.84	0.04	10/06/2001	1:30:00 PM
				M6	1,120	3,200		336					10/07/2001	9:30:00 AM
625.1	Mill Creek (KY)	Orell Road Bridge	KY	M1	80	100	<1	504	0.248	0.49	0.12	<0.03	10/05/2001	2:51:00 PM
				M2	20,000	37,000		144					10/05/2001	10:00:00 PM
				M3	9,600	11,800	1.2	300	0.48	0.71	0.26	0.06	10/06/2001	6:40:00 AM
				M4	8,800	16,800		168					10/06/2001	11:30:00 AM
				M5	5,200	6,600	1.6	120	0.44	0.53	0.5	0.03	10/06/2001	4:30:00 PM
				Duplicate	3,600	6,800	1.7	140	0.46	0.53	0.5	0.03	10/07/2001	4:30:00 PM
				M6	760	2,800		124					10/07/2001	7:30:00 AM
	Strand & Associates	Equipment Blank		BEB D1	6	6	<1	<10	<0.01	<0.10	<0.10	<0.03	10/05/2001	2:45:00 PM
		Equipment Blank		AEB D1	<2	<2	<1	<10	<0.01	<0.10	<0.10	<0.03	10/06/2001	6:15:00 AM
		Field Blank		AFB D2	<2	<2	<1	<10	0.06	<0.10	0.26	0.04	10/07/2001	2:30:00 AM

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/4/01

Sampling Mile Point	Transect Description	Describing Bank	Sample Depth (Feet)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Duplicate	Fecal coliform (CFU/100 mL)	Duplicate	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
388	Diego Drydock	L	3	<10	4	10	2											10/6/2001	14:20
		M	3	<10		10		<1		5	<0.03	0.61	0.10	0.05	106		2.282	10/6/2001	14:30
		M	16					<1										10/6/2001	14:30
		R	3	4		4												10/6/2001	14:25
390	Martin Marietta Company	L	3	4	4													10/6/2001	14:50
		M	3	4														10/6/2001	14:55
		R	3	<4														10/6/2001	15:00
392	Twelve Mile Island	L	3	4	4	8	8											10/6/2001	15:05
		M	3	4		4		<1		9		0.45	0.3	0.05	107	176	1.609	10/6/2001	15:10
		M	14					<1										10/6/2001	15:10
		R	3	<4		4												10/6/2001	15:15
394	Pipeline Crossing	L	3	10	16													10/6/2001	15:30
		M	3	<10														10/6/2001	15:32
		R	3	<10														10/6/2001	15:35
396	Rubyat Boat Club	L	3	<10	16	<10	32											10/6/2001	15:45
		M	3	<10		20		<1		8		0.51	0.16	0.05	108	174	1.132	10/6/2001	15:44
		M	49					<1										10/6/2001	15:48
		R	3	10		50												10/6/2001	15:55
398	Six Mile Island Light & Day Marks	L	3	20	32													10/6/2001	16:05
		M	3	30														10/6/2001	16:07
		R	3	30														10/6/2001	16:17
600	Federal Mooring Buoys	L	3	10	18	80	336											10/6/2001	16:30
		M	3	60		250		<1		9		0.57	0.25	0.05	107	172	1.378	10/6/2001	16:32
		M	42					<1										10/6/2001	16:32
		R	3	50		260												10/6/2001	16:45
602	Newgrass Creek	L	3	80	52													10/6/2001	16:55
		M	3	80														10/6/2001	16:57
		R	3	87														10/6/2001	16:59
604	George Rogers Clark Dredge	L	3	150	58	180	376											10/6/2001	17:30
		M	3	50		110		<1	<1	9	0.084	1.3	0.3	0.05	108	175	1.213	10/6/2001	17:13
		M	22					<1	<1									10/6/2001	17:13
		R	3	20		130												10/6/2001	17:11
604	Duplicate	L	3	120	76	340	340											10/6/2001	17:30
		M	3	80		340		<1		8	0.088	1.2	0.45	0.05	111	176	1.182	10/6/2001	17:15
		M	22					<1										10/6/2001	17:13
		R	3	80														10/6/2001	17:11
605	Portland Canal	L	3	330	150													10/6/2001	17:46
607	L&I Railroad Dredge	L	2	360	360	3,400	4,800											10/6/2001	13:47
607	Duplicate	L	2	493	493	3,800	5,400											10/6/2001	13:47
608	New Albany Boat Club	L	2	547	608	2,600	2,822											10/6/2001	13:54
		M	2	660		2,400		<1		10	0.108	1.4	0.58	0.05	109	172	1.588	10/6/2001	13:39
		M	17					<1										10/6/2001	14:02
		R	2	600		3,600												10/6/2001	14:08
610	PSI Company	L	2	1,400	1,662													10/6/2001	14:13
		M	2	920														10/6/2001	14:15
		R	2	1,220														10/6/2001	14:17
612	Quif Oil Company	L	2	3,040	3,358	10,800	3,067											10/6/2001	14:23
		M	2	1,820		8,600		<1		12		0.64	0.3	0.05	109	176	1.469	10/6/2001	14:25
		M	23					<1										10/6/2001	14:27
		R	2	1,260		5,800												10/6/2001	14:31
614	Kerr Marine Terminal, Inc	L	2	2,200	1,993													10/6/2001	14:36
		M	2	3,166														10/6/2001	14:38
		R	2	1,120														10/6/2001	14:40
616	Hughes Dw Light & Dwy Marks	L	2	620,000	27,835	120,000	9,935											10/6/2001	14:45
		M	2	12,000		2,600		<1	<1	11		0.58	0.42	0.04	114	180	1.448	10/6/2001	14:47
		M	28					<1	<1									10/6/2001	14:49
		R	2	2,800		740												10/6/2001	15:00
616	Duplicate	L	2			36,000	9,800											10/6/2001	14:45
		M	2	9,200		1,800		<1		11		0.55	0.45	0.04	113	176		10/6/2001	14:47
		M	28					<1										10/6/2001	14:49
		R	2			720												10/6/2001	15:00
618	Jeffersonville Riverport	L	2	49,000	10,063													10/6/2001	15:06
		M	2	33,000														10/6/2001	15:07
		R	2	16,000														10/6/2001	15:09
620	Sun Refining & Marketing Company	L	2	190,000	44,536	300,000	240,858											10/6/2001	15:15
		M	2	44,000		170,000		<1		10		0.61	0.5	0.06	114	176	1.420	10/6/2001	15:34
		M	16					<1										10/6/2001	15:36
		R	2	10,000		61,800												10/6/2001	15:42
622	Shell Piling on I 10	L	2	23,000	11,669													10/6/2001	15:48
		M	2	33,000														10/6/2001	15:51
		R	2	7,000														10/6/2001	15:56
624	Portside Dock	L	2	87,000	28,197	150,000	49,661											10/6/2001	16:01
		M	2	46,000		100,000		3		11		0.62	0.48	0.04	114	182	1.724	10/6/2001	16:05
		M	19					<1										10/6/2001	16:18
		R	2	6,000		47,000												10/6/2001	16:09
626	Louisville Gas & Electric	L	2	98,000	25,260													10/6/2001	16:22
		M	2	34,000														10/6/2001	16:23
		R	2	3,830														10/6/2001	16:23
628	Louisville Environmental Service	L	2	32,000	13,836	110,000	52,379											10/6/2001	16:34
		M	2	28,000		120,000		<1		10	0.194	1.6	0.62	0.13	115	176	1.905	10/6/2001	16:36
		M	25					<1										10/6/2001	16:38
		R	2	5,200		9,800												10/6/2001	16:42
630	Salt River	L	2	3,830	3,905													10/6/2001	16:47
		M	2	1,200														10/6/2001	16:50
		R	2	4,800														10/6/2001	16:54
	Crew 1 Equipment Blank							<1		5	<0.01	<0.10	0.05	0.05	0			10/6/2001	14:15
	Crew 1 Equipment Blank							<1		5		0.10	0.14	0.05	4	0	0.006	10/6/2001	18:45
	Crew 1 Method Blank			<2		<2												10/6/2001	18:55
	Crew 1 Field Blank			<2		<2		<1		<5		<0.10	<0.10	0.05	4	0		10/6/2001	18:50
	Crew 2 Equipment Blank							<1		5		<0.10	<0.10	0.05	4	0		10/6/2001	13:21
	Crew 2 Equipment Blank							<1		5	<0.01	<0.10	<0.10	0.05	4	0	<0.001	10/6/2001	17:10
	Crew 2 Method Blank			<2		<2												10/6/2001	17:15
	Crew 2 Field Blank			<2		<2		<1	<1	5	0.01	<0.10	<0.10	0.05	5	0	0.006	10/6/2001	17:05

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/5/01

Sampling Mile Point	Transect Description	Descending Dock	Sample Depth (Feet)	Membrane Filtration Escherichia coli (CFU/100 mL)	Ordinance Value	Fecal coliform (CFU/100 mL)	Ordinance Value	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorous (mg/L)	Nitrate Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
588	Bridge Daymark	L	3	<4		4		<1		4	0.124	1.1	0.45	<0.03	110	174	1.931	10/7/2001	10:51
		M	3	4		12		1										10/7/2001	10:53
		M	35					<1										10/7/2001	10:53
		R	3	<4		16												10/7/2001	10:33
589	Marion Marietta Company	L	3	8	52													10/7/2001	11:05
		M	3	16														10/7/2001	11:11
		R	3	12														10/7/2001	11:15
592	Twelve Mile Island	L	3	<4	52	8	26											10/7/2001	11:24
		M	3	10		40		1		8		1.1	0.47	<0.03	113	174	1.133	10/7/2001	11:26
		M	16					<1										10/7/2001	11:27
		R	3	<10		30												10/7/2001	11:35
594	Pipeline Crossing	L	3	4	4													10/7/2001	11:42
		M	3	4														10/7/2001	11:44
		R	3	4														10/7/2001	11:46
596	Rubeye Boat Club	L	3	<10	10	10	32											10/7/2001	11:55
		M	3	<10		10		1		7		1.4	0.4	0.07	111	168	1.234	10/7/2001	11:57
		M	44					<1										10/7/2001	11:57:00 AM
		R	3	<10		20												10/7/2001	12:10
599	Six Mile Island Light & Day Marks	L	3	20	25													10/7/2001	12:45
		M	3	12														10/7/2001	12:47
		R	3	68														10/7/2001	12:47
600	Federal Mooring Buoys	L	3	28	35	24	28											10/7/2001	12:49
		M	3	10		24		1		7		1.3	0.23	0.06	108	168	1.499	10/7/2001	13:00
		M	40					<1										10/7/2001	13:02
		R	3	16		28												10/7/2001	13:04
602	Bonegrass Creek	L	3	20	28													10/7/2001	13:07
		M	3	28														10/7/2001	13:17
		R	3	29														10/7/2001	13:19
604	George Rogers Clark Bridge	L	3	72	72	470	196											10/7/2001	13:30
		M	3	40		120		<1	1.4	9	0.102	0.87	0.19	0.04	109	168	1.211	10/7/2001	13:32
		M	22					<1	<1									10/7/2001	13:32
		R	3	130		140												10/7/2001	13:36
604	Duplicate	L	3	120	145													10/7/2001	13:30
		M	3	100		186		<1		9	0.104	0.89	0.22	0.03	108	170	1.144	10/7/2001	13:32
		M	22					<1										10/7/2001	13:32
		R	3	96														10/7/2001	13:36
605	Portland Canal	L	3	133		340												10/7/2001	14:10
607	L&N Railroad Bridge	L	2	171		820												10/7/2001	11:02
607	Duplicate	L	2	300		420												10/7/2001	11:02
608	New Albany Boat Club	L	2	240	140	460	284											10/7/2001	11:07
		M	2	87		162		1		11	0.118	1.1	0.43	0.05	109	170	1.080	10/7/2001	11:07
		M	15					<1										10/7/2001	11:11
		R	2	133		330												10/7/2001	11:17
610	PSI Company	L	2	230	316													10/7/2001	11:23
		M	2	140														10/7/2001	11:25
		R	2	113														10/7/2001	11:25
612	Shell Oil Company	L	2	200	275	320	522											10/7/2001	11:35
		M	2	167		260		1		11		1.1	0.41	<0.03	111	174	1.291	10/7/2001	11:38
		M	25					<1										10/7/2001	11:40
		R	2	160		400												10/7/2001	11:44
614	Kurt-McKee Terminal, Inc	L	2	160	316													10/7/2001	11:51
		M	2	487														10/7/2001	11:54
		R	2	330														10/7/2001	11:58
616	Hughes Bar Light & Day Marks	L	2	14,890	>2416	3,200	1,530											10/7/2001	12:04
		M	2	2,200		660		1	1	14		1.4	0.45	0.05	112	178	1.331	10/7/2001	12:12
		M	25					<1	1.1									10/7/2001	12:14
		R	2	1,800		1,140												10/7/2001	12:08
616	Duplicate	L	2			3,600	1,960											10/7/2001	12:06
		M	2	3,400		1,000		1		13		1.4	0.72	0.07	114	174		10/7/2001	12:12
		M	25					<1										10/7/2001	12:14
		R	2			1,270												10/7/2001	12:08
618	Jeffersonville Riverport	L	2	4,200	>2416													10/7/2001	12:28
		M	2	1,800														10/7/2001	12:28
		R	2	960														10/7/2001	12:31
620	Sun Refining & Marketing Company	L	2	5,400	>2416	13,800	9,524											10/7/2001	15:20
		M	2	1,600		10,200		1		10		0.64	0.79	0.03	113	182	1.580	10/7/2001	15:23
		M						<1										10/7/2001	15:24
		R	2	1,250		4,400												10/7/2001	13:31
622	Sheet Piling on LDH	L	2	5,000	3,173													10/7/2001	13:37
		M	2	4,000														10/7/2001	13:40
		R	2	1,600														10/7/2001	13:44
624	Evansville Creek	L	2	7,000	3,897	49,000	23,418											10/7/2001	13:51
		M	2	2,800		12,000		1		8		1.1	0.63	0.06	116	180	1.566	10/7/2001	13:53
		M	25					<1										10/7/2001	13:54
		R	2	3,000		22,000												10/7/2001	14:00
626	Louisville Gas & Electric	L	2	6,800	4,626													10/7/2001	14:05
		M	2	4,800														10/7/2001	14:07
		R	2	2,000														10/7/2001	14:11
628	Louisville Environmental Service	L	2	21,000	>2416	67,000	10,866											10/7/2001	14:19
		M	2	1,200		5,900		1		9	0.116	0.64	0.76	0.05	115	184	1.871	10/7/2001	14:21
		M	24					<1										10/7/2001	14:22
		R	2	7,400		2,900												10/7/2001	14:27
630	Salt River	L	2	13,000	>2416													10/7/2001	14:33
		M	2	13,000														10/7/2001	14:38
		R	2	3,000														10/7/2001	14:39
	Crew 1 Equipment Blank							<1		<5	<0.01	<0.10	<0.10	<0.03	3	0		10/7/2001	10:45
	Crew 1 Equipment Blank								<3			<0.10	<0.10	<0.03	3	0	<0.005	10/7/2001	14:50
	Crew 1 Method Blank			<2	<2													10/7/2001	14:45
	Crew 2 Equipment Blank							<1		<5		<0.10	<0.10	<0.03	3	0		10/7/2001	10:49
	Crew 2 Equipment Blank							<1		<5	<0.01	<0.10	0.42	<0.03	4	0	0.003	10/7/2001	14:53
	Crew 2 Method Blank			<2	<2													10/7/2001	15:02
	Crew 2 Field Blank			<2	<2			<1	<3	<5	<0.01	<0.10	0.53	<0.03	3	0	0.000	10/7/2001	14:59

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/5/01

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Membrane Filtration Escherichia coli (CFU/100 mL)	Geometric Mean	Fecal coliform (CFU/100 mL)	Geometric Mean	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
589	Delga Dayspark	L	3	<1		4		<2										10/8/2001	10:31
		M	3	<4		4		<1		9	0.154	0.53	0.51	0.05	116	176	1.690	10/8/2001	10:35
		M	40					<1										10/8/2001	10:35
		R	3	<4		<4												10/8/2001	10:45
590	Marian Marietta Company	L	3	<4	4													10/8/2001	10:54
		M	3	<4														10/8/2001	10:56
		R	3	<4														10/8/2001	10:58
592	Twelve Mile Island	L	3	<4	4	4	4											10/8/2001	11:08
		M	3	<4		<4		<1		7		0.42	0.27	<0.05	107	164	1.663	10/8/2001	11:10
		M	29					<1										10/8/2001	11:10
		R	3	<4		<4												10/8/2001	11:20
594	Pipeline Crossing	L	3	<4	4													10/8/2001	11:23
		M	3	<4														10/8/2001	11:25
		R	3	<4														10/8/2001	11:27
596	Rubyat Boat Club	L	3	<4	4	4	4											10/8/2001	11:34
		M	3	<4		8		<1		9		0.74	0.23	<0.05	108	174	1.652	10/8/2001	11:36
		M	40					<1										10/8/2001	11:36
		R	3	<4		<4												10/8/2001	11:42
598	Six Mile Island Light & Day Marks	L	3	<4	4													10/8/2001	11:49
		M	3	<4														10/8/2001	11:51
		R	3	8														10/8/2001	11:53
600	Federal Mooring Buoys	L	3	<4	4	12	8											10/8/2001	12:50
		M	3	<4		8		<1		6		1.3	0.48	<0.05	109	178	1.159	10/8/2001	12:52
		M	40					<1										10/8/2001	12:52
		R	3	8		8												10/8/2001	12:57
602	Bourgeois Creek	L	3	<4	4													10/8/2001	13:03
		M	3	8														10/8/2001	13:07
		R	3	8														10/8/2001	13:09
604	George Rogers Clark Bridge	L	3	<4	20	12	35											10/8/2001	13:16
		M	3	20		20		<1	1.3	7	0.144	0.97	0.23	0.05	107	175	1.284	10/8/2001	13:20
		M	29					<1	1.4									10/8/2001	13:20
		R	3	<4		64												10/8/2001	13:33
604	Duplicate	L	3	16	12													10/8/2001	13:38
		M	3	20		60		<1		8	0.154	1	0.61	0.1	107	174	1.282	10/8/2001	13:20
		M	20					<1										10/8/2001	13:20
		R	3	4														10/8/2001	3:53
605	Portland Canal	L	3	12		15												10/8/2001	13:42
607	L&E Railroad Bridge	L	3	<10		80												10/8/2001	10:28
607	Duplicate	L	3	40		190												10/8/2001	10:28
608	New Albany Boat Club	L	3	10	10	107	99											10/8/2001	10:32
		M	3	<10		135		<1		9	0.138	1	0.48	0.05	107	188	0.892	10/8/2001	10:34
		M	15					<1										10/8/2001	10:33
		R	3	<10		70												10/8/2001	10:39
610	PSI Company	L	3	20	20													10/8/2001	10:52
		M	3	10														10/8/2001	10:55
		R	3	40														10/8/2001	10:58
612	Gulf Oil Company	L	3	40	28	147	88											10/8/2001	11:04
		M	3	30		70		<1		6		0.58	0.51	0.04	107	170	0.773	10/8/2001	11:07
		M	23					<1										10/8/2001	11:08
		R	3	20		60												10/8/2001	11:13
614	Kerr-McGee Terminal, Inc	L	3	1,000	598													10/8/2001	11:18
		M	3	90														10/8/2001	11:20
		R	3	80														10/8/2001	11:23
616	Hughes Bar Light & Day Marks	L	3	7,400	840	333	222											10/8/2001	11:30
		M	3	280		70		<1	1.1	9		0.8	0.59	0.04	106	174	0.977	10/8/2001	11:32
		M	22					<1	<1									10/8/2001	11:33
		R	3	340		50												10/8/2001	11:42
616	Duplicate	L	3			960	333											10/8/2001	11:30
		M	3	280		60		<1		9		0.9	0.45	0.04	106	173		10/8/2001	11:32
		M	22					<1										10/8/2001	11:33
		R	3			60												10/8/2001	11:42
618	Jeffersonville Riverport	L	3	740	405													10/8/2001	11:48
		M	3	300														10/8/2001	11:50
		R	3	340														10/8/2001	11:55
620	Sun Refining & Marketing Company	L	3	500	253	7,800	5,213											10/8/2001	12:40
		M	3	270		5,800		<1		15		1.2	0.66	<0.05	107	176	1.345	10/8/2001	12:42
		M	17					<1										10/8/2001	12:43
		R	3	50		960												10/8/2001	12:49
622	Shell Pilot no 1 (4)	L	3	500	223													10/8/2001	12:55
		M	3	135														10/8/2001	12:07
		R	3	140														10/8/2001	12:59
624	Twosale Creek	L	3	80	44	5,000	3,618											10/8/2001	13:07
		M	3	70		1,800		<1		8		1.1	0.4	0.05	110	176	1.317	10/8/2001	13:09
		M	22					<1										10/8/2001	13:10
		R	3	20		900												10/8/2001	13:15
626	Louisville Gas & Electric	L	3	360	252													10/8/2001	13:20
		M	3	620														10/8/2001	13:23
		R	3	90														10/8/2001	13:26
628	Louisville Environmental Service	L	3	30	34	3,600	2,843											10/8/2001	13:34
		M	3	40		3,456		<1		7	0.174	1.3	0.52	0.06	108	178	1.844	10/8/2001	13:37
		M	24					<1										10/8/2001	13:38
		R	3	80		1,360												10/8/2001	13:43
630	Salt River	L	3	207	144													10/8/2001	13:48
		M	3	120														10/8/2001	13:49
		R	3	120														10/8/2001	13:53
	Crew 1 Equipment Blank							<1		<3	<0.01	<0.10	0.51	0.05	0	0		10/8/2001	
	Crew 1 Equipment Blank							<1		<3		<0.10	0.12	<0.05	4	0	0.001	10/8/2001	14:22
	Crew 1 Method Blank			<2		<2												10/8/2001	14:26
	Crew 1 Field Blank			<2		<2		<1		<3		<0.10	<0.10	<0.05	3	0		10/8/2001	14:24
	Crew 2 Equipment Blank							<1		<3		<0.10	<0.10	0.05	4	0		10/8/2001	10:10
	Crew 2 Equipment Blank							<1			<0.01	<0.10	<0.10	<0.05	4	0	0.002	10/8/2001	14:02
	Crew 2 Method Blank			<2		<2												10/8/2001	14:10
	Crew 2 Field Blank			<2		<2		<1	<1	<3	<0.01	<0.10	<0.10	0.05	4	0	<0.002	10/8/2001	14:08

Note: L = Left Bank, M = Midstream, R = Right Bank

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/5/01

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	Membrane Filtration *Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Total Hardness (mg/L)	Chlorophyll-a (mg/L)	Sample Date	Sample Time
610	PSI Company	M	2	32	40	<1		11	1.9	0.46	0.08	172	0.903	10/9/2001	11:00
615	Stauffer Chemical	M	2	74	116	<1		23	0.92	0.38	0.08	174	1.086	10/9/2001	11:09
620	Sun Refining and Marketing Company	M	2	240	553	<1		12	1.5	0.22	0.09	177	1.133	10/9/2001	11:18
625	Fishtown Daymark	M	2	260	660	<1		11	1.6	0.7	0.09	183	1.125	10/9/2001	11:28
630	Salt River	M	2	480	720	<1		9	2	0.43	0.05	178	1.861	10/9/2001	11:36
635	Mosquito Daymark	M	2	260	780	<1	<1	8	0.99	0.36	0.06	182	2.604	10/9/2001	12:04
635	Duplicate	M	2	310	920	<1		8	0.9	0.39	0.07	178	2.619	10/9/2001	12:04
640	RDB Channel Markers	M	2	147	600	<1		7	0.95	0.39	0.08	184	2.645	10/9/2001	12:14
645	Brandenburg Daymark	M	2	270	940	<1		<5	1.2	0.29	0.07	188	2.613	10/9/2001	12:27
650	Haunted Hollow Daymark	M	2	270	600	<1		5	1.1	0.27	0.08	186	3.025	10/9/2001	12:37
655	New River Lime Company	M	2	120	320	<1		7	1.9	0.32	0.1	172	2.944	10/9/2001	12:44
660	Cold Friday Daymark	M	2	12	40	<1		6	1	0.6	0.11	178	2.958	10/9/2001	12:55
	Crew 1 Equipment Blank					<1		<5	<0.10	<0.10	0.04	0	-0.001	10/9/2001	10:44
	Crew 1 Equipment Blank			<2	<2	<1		<5	1.1	<0.10	<0.03	0	-0.001	10/9/2001	12:59
	Crew 1 Method Blank													10/9/2001	
	Crew 1 Field Blank			<2	<2	<1		<5	<0.10	<0.10	<0.03	0	-0.001	10/9/2001	13:00

Note: M = Midstream

Wet Weather Impact Study
Ohio River Analytical Data

Survey Start Date: 10/5/01

Sampling Mile Point	Transect Description	Descending Bank	Sample Depth (Feet)	*Escherichia coli* (CFU/100 mL)	Fecal coliform (CFU/100 mL)	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Suspended Solids (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Total Hardness (mg/L)	Chlorophyl-a (mg/L)	Sample Time
610	PSI Company	M	2	<2	<2	<1		8	0.63	0.32	0.06	174	1.038	10:14:00 AM
615	Stauffer Chemical	M	2	16	300	<1		8	0.67	0.39	0.17	180	1.098	10:23:00 AM
620	Sun Refining and Marketing Company	M	2	88	400	<1		10	0.7	0.3	0.18	174	1.178	10:33:00 AM
625	Fishtown Daymark	M	2	64	560	<1		9	0.66	0.36	0.29	180	1.154	10:43:00 AM
630	Salt River	M	2	116	820	<1		6	1.1	0.34	0.1	180	1.104	10:52:00 AM
635	Mosquito Daymark	M	2	300	620	<1	<1	11	0.81	0.32	0.13	182	1.186	11:27:00 AM
635	Duplicate	M	2	250	540	<1		10	0.73	0.41	0.15	160	1.206	11:27:00 AM
640	RDB Channel Markers	M	2	116	500	<1		6	0.64	0.39	0.12	186	2.372	11:37:00 AM
645	Brandenburg Daymark	M	2	86	380	<1		<5	0.66	1	0.13	180	2.633	11:49:00 AM
650	Haunted Hollow Daymark	M	2	54	500	<1		5	0.7	0.82	0.08	174	2.887	11:59:00 AM
655	New River Lime Company	M	2	96	600	<1		<5	0.95	0.86	0.21	180	2.668	12:04:00 PM
660	Cold Friday Daymark	M	2	52	148	<1		5	1.3	0.39	0.22	182	2.761	12:14:00 PM
	Crew 1 Equipment Blank					<1		<5	<0.10	0.1	<0.03	0	0.001	9:42:00 AM
	Crew 1 Equipment Blank					<1		<5	<0.10	<0.10	<0.03	0	0.001	12:20:00 PM
	Crew 1 Method Blank			<2	<2									12:20:00 PM
	Crew 1 Field Blank			<2	<2	<1		<5	<0.10	<0.10	<0.03	0	-0.001	12:19:00 PM

Note: M = Midstream

Wet Weather Impact Study
Combined Sewer Outfall Analytical Data

Site Description	Sample ID	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
Louisville CSO#16	S0	93.8		196	2.55	1	11.8	2.19	10/05/2001	4:30:00 PM
	S15	105		128					10/05/2001	4:45:00 PM
	S30	96.2	160	168	2.55	0.91	11.3	2.84	10/05/2001	5:00:00 PM
	Duplicate	97.1		156	2.5	0.63	11.8	2.97	10/05/2001	5:01:00 PM
	S45	45.4		108					10/05/2001	5:15:00 PM
	S60	37.4		104	1.09	0.22	4.9	1.24	10/05/2001	5:30:00 PM
	S90	27		96					10/05/2001	6:00:00 PM
	S120	31.9		64	1.33	0.15	5.9	1.48	10/05/2001	6:30:00 PM
	S150	27.9		84					10/05/2001	7:00:00 PM
	S180	19.6		84	0.9	0.24	3.88	1	10/05/2001	7:30:00 PM
	SH4	10.7		76	0.47	0.23	1.98	0.5	10/05/2001	8:30:00 PM
	SH5	18.3		100	0.49	1.3	3.28	0.81	10/05/2001	9:30:00 PM
	SH6	32.8		168	0.88	0.27	4.48	1.24	10/05/2001	10:30:00 PM
Louisville CSO#19	S0	193		208	5.7	0.91	23.8	3.54	10/05/2001	5:00:00 PM
	S15	83.6		132					10/05/2001	5:15:00 PM
	S30	101	154	152	5.7	0.86	20	3.39	10/05/2001	5:30:00 PM
	Duplicate	110		144	5.5	0.91	20.9	2.97	10/05/2001	5:40:00 PM
	S45	9.7		48					10/05/2001	6:00:00 PM
	S60	14.7		88	0.87	0.49	1.87	0.44	10/05/2001	6:15:00 PM
	S75	7.7		76					10/05/2001	6:30:00 PM
	S90	11		80	0.54	0.48	1.33	0.3	10/05/2001	6:45:00 PM
	S105	9.8		64					10/05/2001	7:00:00 PM
	S120	10		92	0.44	0.48	1.4	0.3	10/05/2001	7:15:00 PM
	S135	10.1		84					10/05/2001	7:30:00 PM
Louisville CSO#50	S0	153		424	0.47	0.66	0.9	0.28	10/05/2001	4:15:00 PM
	S15	49.5		116					10/05/2001	4:30:00 PM
	S30	26	100	64	0.43	0.32	0.78	0.26	10/05/2001	4:45:00 PM
	Duplicate	26		68	0.44	0.31	1.17	0.31	10/05/2001	4:45:00 PM
	S45	41.2		104					10/05/2001	5:00:00 PM
	S60	19		68	1.12	0.51	0.85	0.26	10/05/2001	5:15:00 PM
	S75	47.8		116					10/05/2001	5:30:00 PM
	S90	76.5		168	1.05	1.9	5.85	2.1	10/05/2001	5:45:00 PM
	S105	50.8		136					10/05/2001	6:00:00 PM
	S120	11.9		64	0.81	0.31	2.5	1.36	10/05/2001	6:15:00 PM
	S135	16.2		68					10/05/2001	6:30:00 PM
Louisville CSO#189	S0	154		208	6.2	0.68	31	4.79	10/05/2001	3:50:00 PM
	S15	108		148					10/05/2001	4:05:00 PM
	S30	103	134	140	1.9	0.67	13	2.31	10/05/2001	4:20:00 PM
	Duplicate	74		160	1.6	0.68	12	2.19	10/05/2001	4:22:00 PM
	S45	25		92					10/05/2001	4:35:00 PM
	S60	20		68	0.35	0.61	3.3	0.84	10/05/2001	4:50:00 PM
	S75	14		60					10/05/2001	5:05:00 PM
	S90	14		52	0.23	0.67	2	0.38	10/05/2001	5:20:00 PM
	S105	9.1		52					10/05/2001	5:35:00 PM
	S120	5.8		52	0.58	0.34	1.4	0.32	10/05/2001	5:50:00 PM
	S135	5		56					10/05/2001	6:05:00 PM
Louisville CSO#190	S0	15		88	0.24	0.34	1.7	0.44	10/05/2001	4:10:00 PM
	S15	9.3		80					10/05/2001	4:25:00 PM
	S30	13	<20	100	0.84	0.39	1.5	0.44	10/05/2001	4:40:00 PM
	Duplicate	9.5		100	0.87	0.41	1.5	0.46	10/05/2001	4:40:00 PM
	S45	7.5		52					10/05/2001	4:55:00 PM
	S60	5.5		48	0.77	0.35	1.3	0.24	10/05/2001	5:10:00 PM
	S75	5.5		48					10/05/2001	5:25:00 PM
	S90	4		52	0.5	0.36	0.74	0.16	10/05/2001	5:40:00 PM
	S105	<3		64					10/05/2001	5:55:00 PM
	S120	3.7		72	0.43	0.31	0.63	0.21	10/05/2001	6:10:00 PM
	S135	5.2		60					10/05/2001	6:25:00 PM
Louisville CSO#210	S0	60		124	1.48	0.63	5.7	1.3	10/05/2001	4:15:00 PM
	S15	34		104					10/05/2001	4:30:00 PM
	S30	15	<20	80	0.94	0.38	2.7	0.62	10/05/2001	4:45:00 PM
	Duplicate	33		80	0.9	0.39	2.4	0.57	10/05/2001	4:46:00 PM
	S45	19		112					10/05/2001	5:00:00 PM
	S60	18		112	1.44	0.47	4.4	1.48	10/05/2001	5:15:00 PM
	S90	27		116					10/05/2001	5:45:00 PM
	S120	16		104	0.77	0.42	2.34	0.74	10/05/2001	6:15:00 PM
	S150	21		112					10/05/2001	6:45:00 PM
	S180	26		144	1.22	0.55	4.9	1.43	10/05/2001	7:15:00 PM
	SH4	23		136	1.16	0.46	3.4	1.31	10/05/2001	8:15:00 PM
	SH5	23		136					10/05/2001	9:15:00 PM
	SH6	24		148	0.7	0.71	2.9	1.06	10/05/2001	10:15:00 PM
Louisville SO	S0	230		568	9.6	0.43	23	6.92	10/05/2001	4:15:00 PM
	S15	120		428					10/05/2001	4:30:00 PM
	S30	110	131	392	8.2	0.47	18	6.64	10/05/2001	4:45:00 PM
	Duplicate	170		388	7.6	0.57	21	6.36	10/05/2001	4:45:00 PM
	S45	100		296					10/05/2001	5:00:00 PM
	S60	150		366	5.7	0.38	19	4.33	10/05/2001	5:15:00 PM
	S90	62		124					10/05/2001	5:45:00 PM
	S120	23		156	1.66	0.37	4.3	1.84	10/05/2001	6:15:00 PM
	S150	34		144					10/05/2001	6:45:00 PM
	S180	19		128	1.35	0.38	3.9	1.15	10/05/2001	7:15:00 PM
	SH4	24		152	1.55	0.3	4.1	1.06	10/05/2001	8:15:00 PM
	SH5	29		192					10/05/2001	9:15:00 PM
	SH6	77		412	1.8	0.21	9.6	2.19	10/05/2001	10:15:00 PM
Louisville MSD	Field Blank	<1		<10	<0.01	<0.10	<0.10	<0.03	10/05/2001	10:35:00 PM
Louisville MSD	Equipment Blank	<1		<10	<0.01	<0.10	<0.10	<0.03	10/05/2001	10:40:00 PM
Louisville MSD	Field Blank	<1		<10	<0.01	0.21	<0.10	0.04	10/05/2001	10:20:00 PM
Louisville MSD	Equipment Blank	<1		<10	<0.01	0.22	<0.10	<0.03	10/05/2001	10:25:00 PM
Louisville MSD	Field Blank	<1		<10	<0.01	<0.10	<0.10	<0.03	10/05/2001	10:17:00 PM
Louisville MSD	Equipment Blank	<1		<10	<0.01	<0.10	<0.10	<0.03	10/05/2001	10:18:00 PM

Wet Weather Impact Study
Wastewater Treatment Plant Influent Analytical Data

Site Description	Sample ID	Carbonaceous BOD5 (mg/L)	Carbonaceous BOD20 (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate-Nitrite (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia (mg/L)	Sample Date	Sample Time
Morris Foreman WWTP	HR0	280		348	4.8	0.61	19	7.87	10/05/2001	6:00:00 PM
	HR1	170		328					10/05/2001	7:00:00 PM
	HR2	77	294	228	4.5	0.34	15	3.65	10/05/2001	8:00:00 PM
	Duplicate	51		272	3.4	0.34	8.6	4.15	10/05/2001	9:00:00 PM
	HR3	45		276					10/05/2001	10:00:00 PM
	HR4	71		320	3.9	0.3	11	4.92	10/05/2001	11:00:00 PM
	HR5	60		344					10/06/2001	12:00:00 AM
	HR6	81		324	2.4	0.45	8.6	3.97	10/06/2001	1:00:00 AM
	HR7	66		368					10/06/2001	2:00:00 AM
	HR8	65		382	2.5	1	8.7	4.33	10/06/2001	3:00:00 AM

APPENDIX E

CALCULATED AND ESTIMATED EVENT MEAN CONCENTRATIONS (EMCS)

	Calculated EMC	Estimated EMC	River Mile
1997X08 - 1997X09			
14 mile Ck	20		589.3
Lentzier Ck		27	596.3
Silver Creek		19	607.0
Falling Run		132	609.3
Fourmile Ck		4	628.3
Harrods Ck		15	595.9
Upper Ohio River Tribs KY		4	598.0
Goose Ck	20		596.9
Beargrass Ck	26,465		602.1
Mill Ck Cutoff	40		616.4
Mill Ck KY	120		625.1
Lower Ohio River Tribs KY		4	629.0
1997XI13 - 1997XI16			
14 mile Ck	53		589.3
Lentzier Ck		2,054	596.3
Silver Creek		2,220	607.0
Falling Run		2,883	609.3
Fourmile Ck		303	628.3
Harrods Ck		1,910	595.9
Upper Ohio River Tribs KY		303	598.0
Goose Ck	379		596.9
Beargrass Ck	9,683		602.1
Mill Ck Cutoff	3,738		616.4
Mill Ck KY	1,309		625.1
Lower Ohio River Tribs KY		303	629.0
1998VIII17 - 1998VIII17			
14 mile Ck		0	589.3
Lentzier Ck		37	596.3
Silver Creek		26	607.0
Falling Run		178	609.3
Fourmile Ck		5	628.3
Harrods Ck	54		595.9
Upper Ohio River Tribs KY		5	598.0
Goose Ck	130		596.9
Beargrass Ck	271		602.1
Mill Ck Cutoff	0		616.4
Mill Ck KY	40		625.1
Lower Ohio River Tribs KY		5	629.0

	Calculated EMC	Estimated EMC	River Mile
1998X07 - 1998X10			
14 mile Ck		63	589.3
Lentzier Ck		2,411	596.3
Silver Creek		2,605	607.0
Falling Run		3,383	609.3
Fourmile Ck		356	628.3
Harrods Ck	1,612		595.9
Upper Ohio River Tribs KY		356	598.0
Goose Ck	3,229		596.9
Beargrass Ck	4,651		602.1
Mill Ck Cutoff	5,143		616.4
Mill Ck KY	3,154		625.1
Lower Ohio River Tribs KY		356	629.0
1999VI23 - 1999VI23			
14 mile Ck		1	589.3
Lentzier Ck	295		596.3
Silver Creek	210		607.0
Falling Run	1,440		609.3
Fourmile Ck		27	628.3
Harrods Ck	88		595.9
Upper Ohio River Tribs KY		27	598.0
Goose Ck	271		596.9
Beargrass Ck	691		602.1
Mill Ck Cutoff		1	616.4
Mill Ck KY	56		625.1
Lower Ohio River Tribs KY		27	629.0
2000VIII08 - 2000VIII13			
14 mile Ck		1,144	589.3
Lentzier Ck	113,480		596.3
Silver Creek	53,240		607.0
Falling Run	55,119		609.3
Fourmile Ck		6,507	628.3
Harrods Ck	89,661		595.9
Upper Ohio River Tribs KY		6,507	598.0
Goose Ck	10,021		596.9
Beargrass Ck	185,788		602.1
Mill Ck Cutoff	12,254		616.4
Mill Ck KY	960		625.1
Lower Ohio River Tribs KY		6,507	629.0

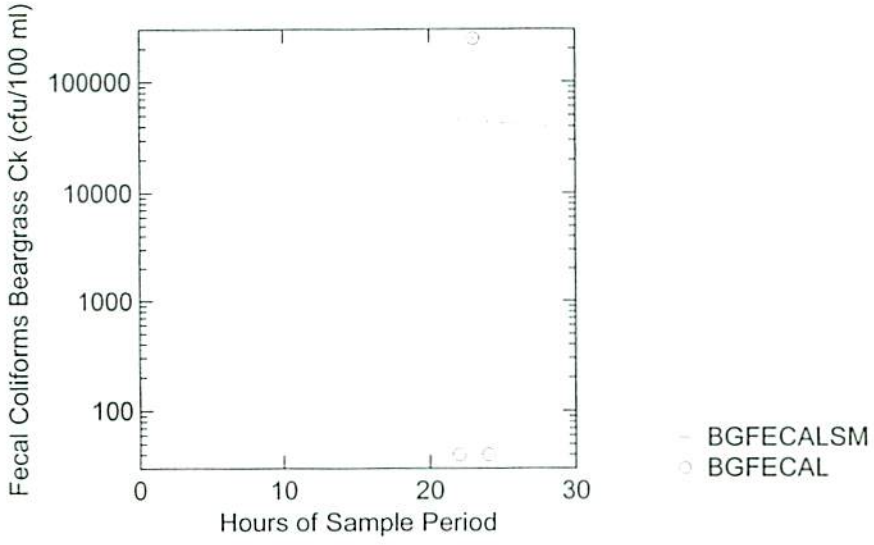
	Calculated EMC	Estimated EMC	River Mile
2001V07 - 2001V12			
14 mile Ck		429	589.3
Lentzier Ck	11,821		596.3
Silver Creek	19,854		607.0
Falling Run	25,735		609.3
Fourmile Ck		2,440	628.3
Harrods Ck	9,138		595.9
Upper Ohio River Tribs KY		2,440	598.0
Goose Ck	3,442		596.9
Beargrass Ck	51,614		602.1
Mill Ck Cutoff	67,577		616.4
Mill Ck KY	6,041		625.1
Lower Ohio River Tribs KY		2,440	629.0
2001X05 - 2001X10			
14 mile Ck		153	589.3
Lentzier Ck	18,186		596.3
Silver Creek	4,902		607.0
Falling Run		8,259	609.3
Fourmile Ck		869	628.3
Harrods Ck	2,727		595.9
Upper Ohio River Tribs KY		869	598.0
Goose Ck	6,806		596.9
Beargrass Ck	10,358		602.1
Mill Ck Cutoff	10,354		616.4
Mill Ck KY	7,466		625.1
Lower Ohio River Tribs KY		869	629.0

APPENDIX F

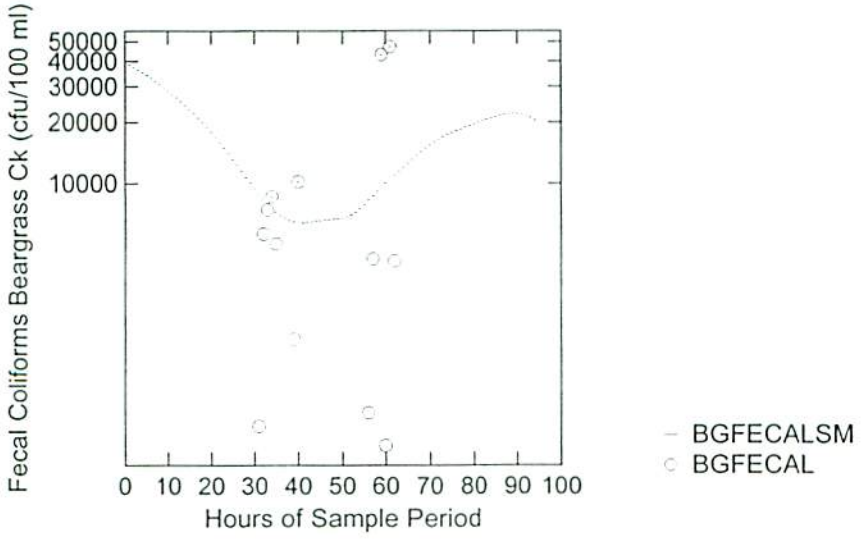
EVENT DATA PLOTS FOR LOCATIONS WITH OBSERVED DATA

Dotted Line = Simulated Data
Circles = Observed Data

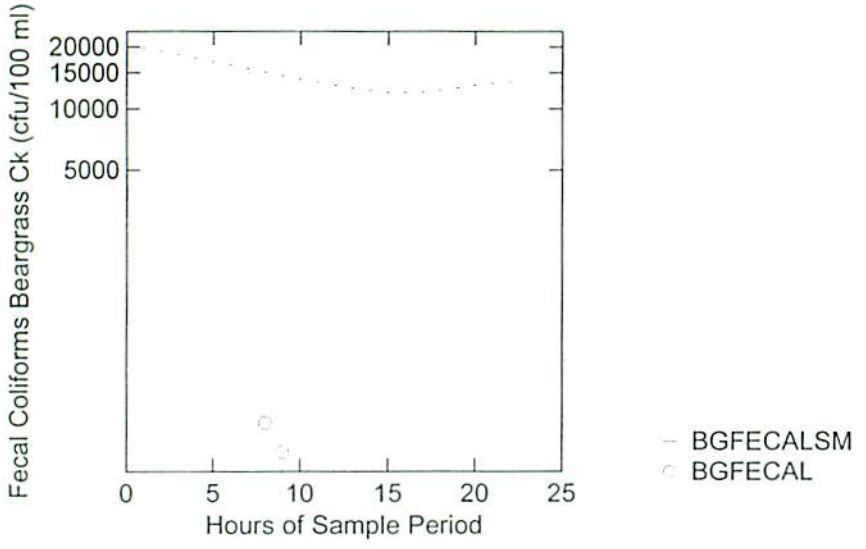
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1997X08 - 1997X09



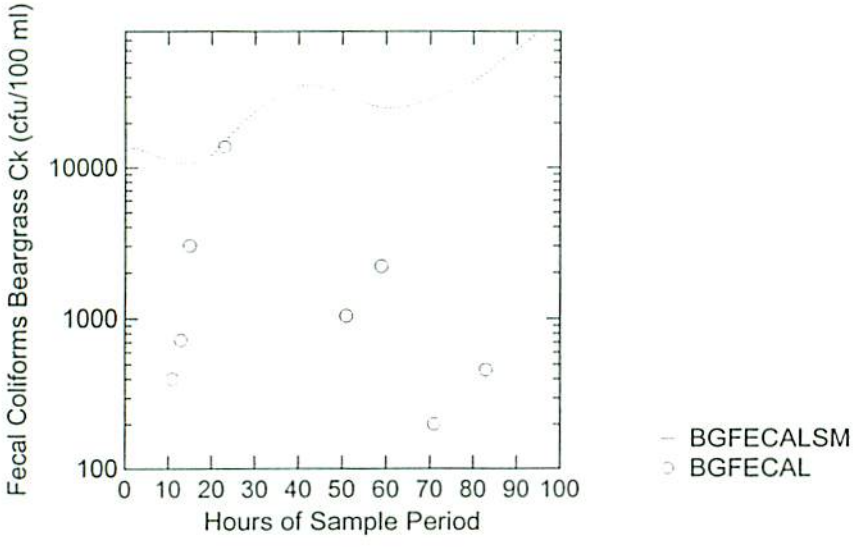
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1997XI13 - 1997XI16



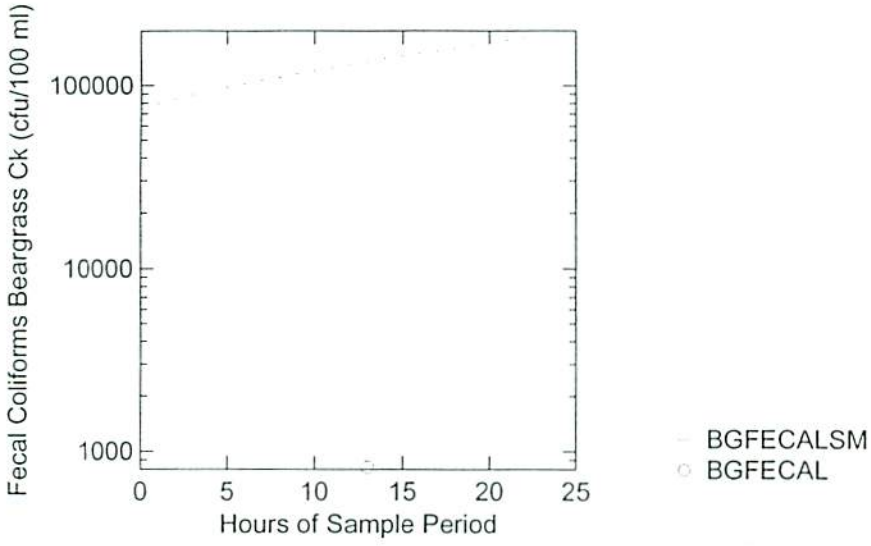
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1998VIII17 - 1998VIII17



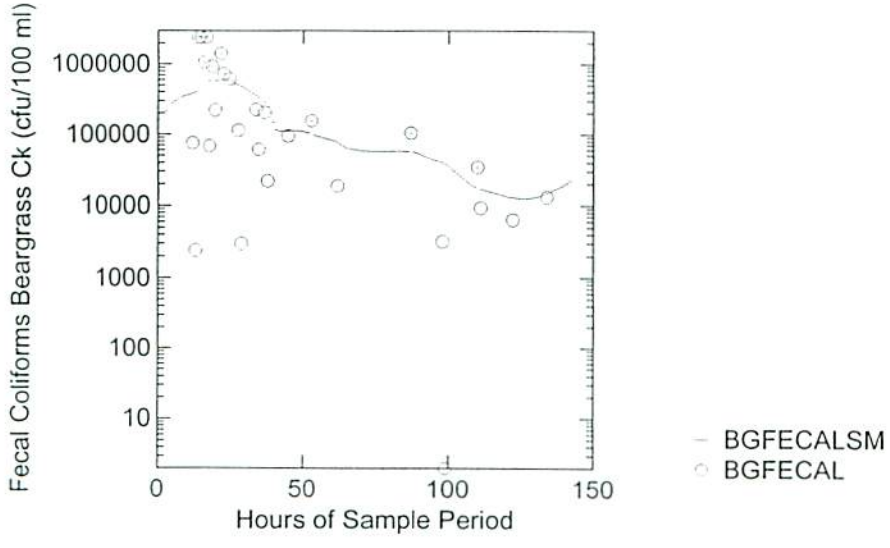
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1998X07 - 1998X10



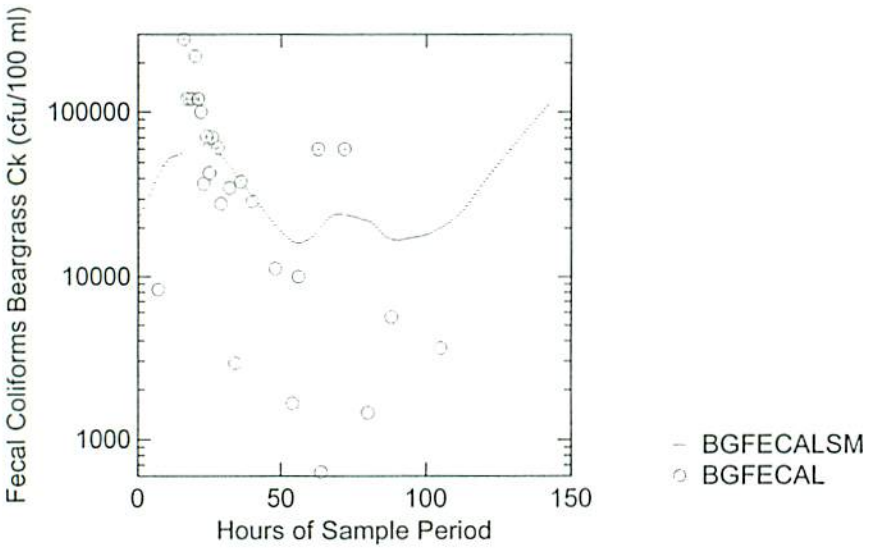
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1999VI23 - 1999VI23



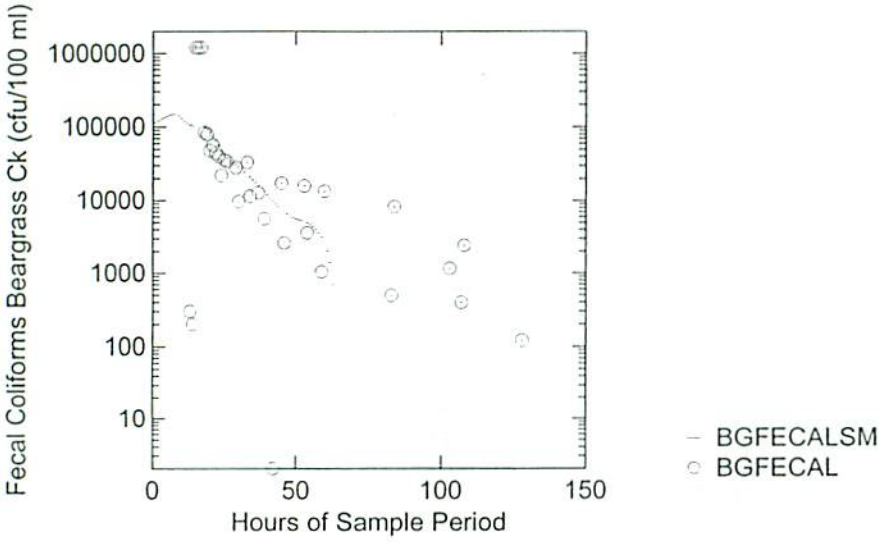
The following results are for:
2000VIII08 - 2000VIII13



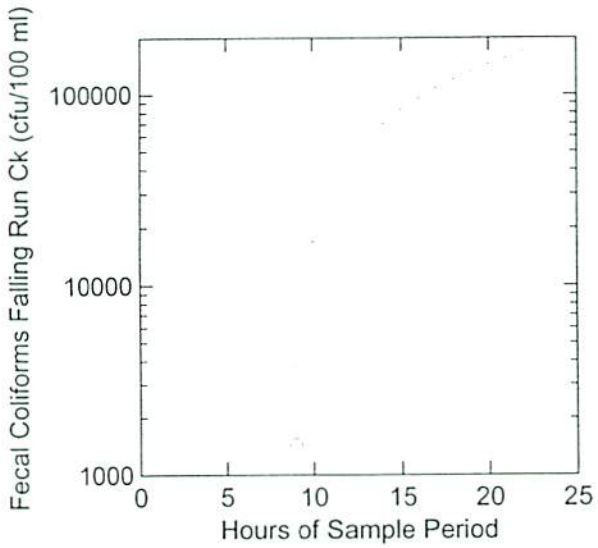
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2001V07 - 2001V12



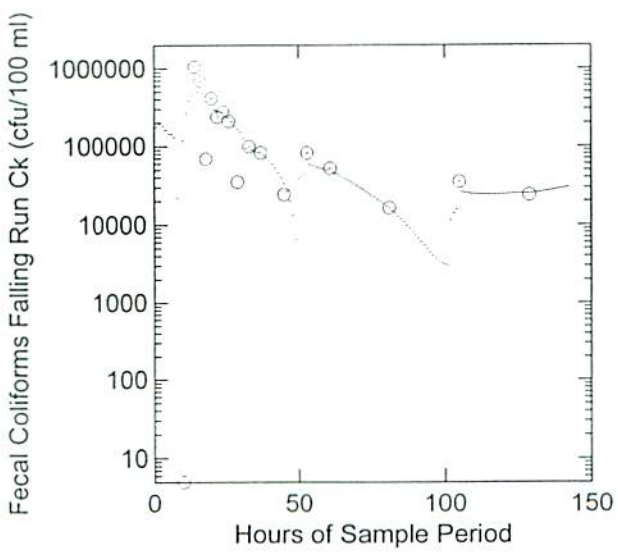
The following results are for:
2001X05 - 2001X10



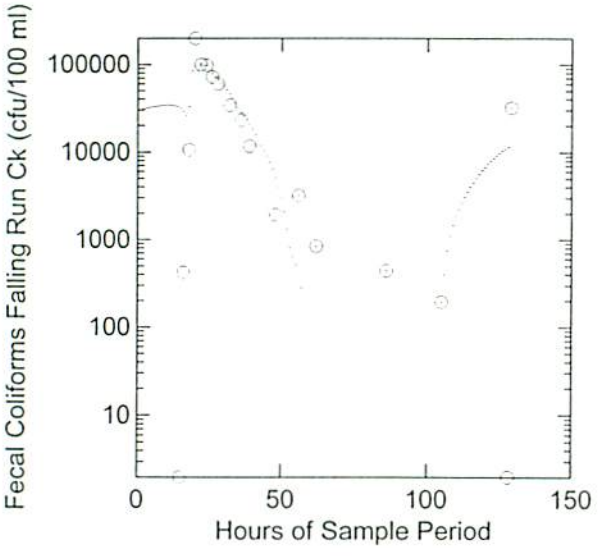
The following results are for:
1999VI23 - 1999VI23



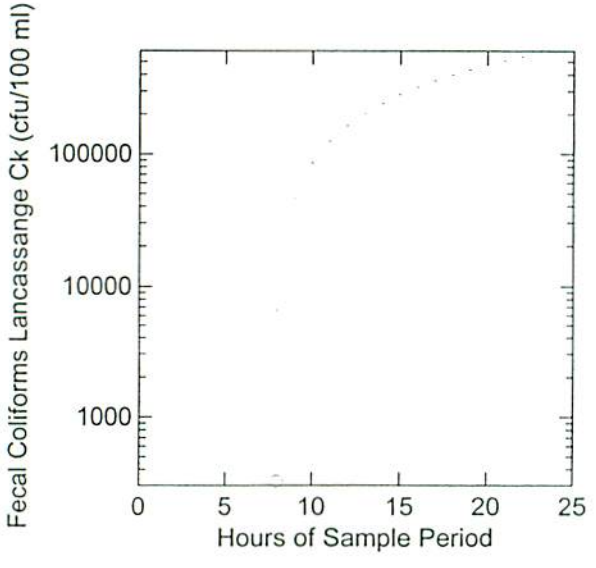
The following results are for:
2000VIII08 - 2000VIII13



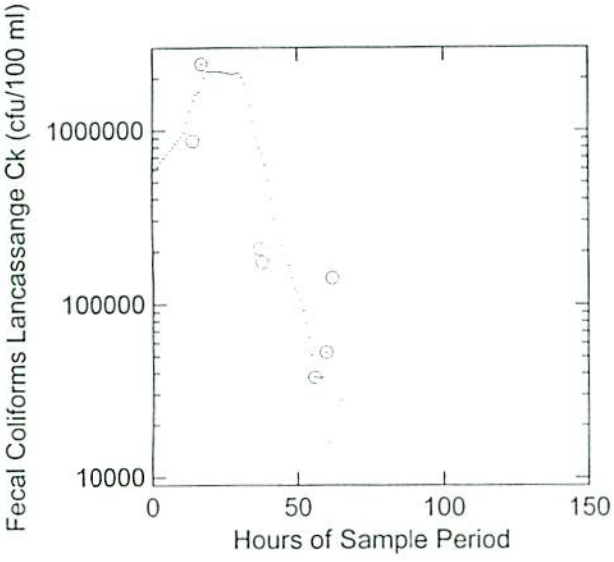
The following results are for:
2001V07 - 2001V12



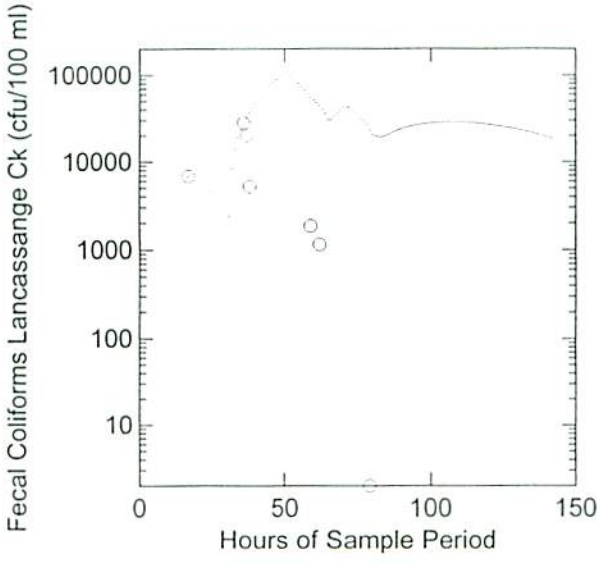
The following results are for:
1999VI23 - 1999VI23



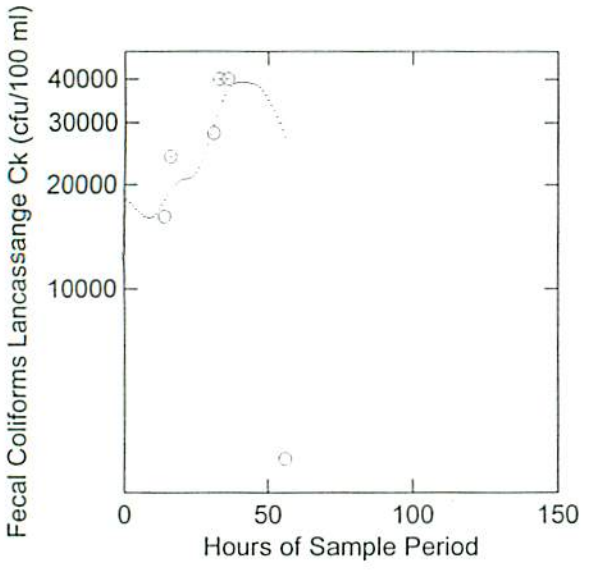
The following results are for:
2000VIII08 - 2000VIII13



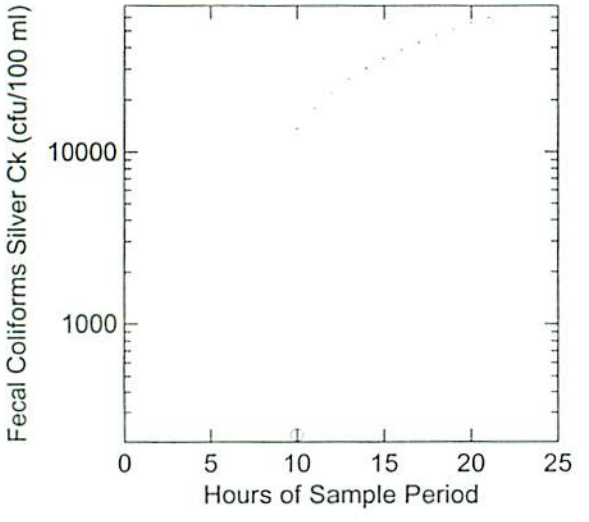
The following results are for:
2001V07 - 2001V12



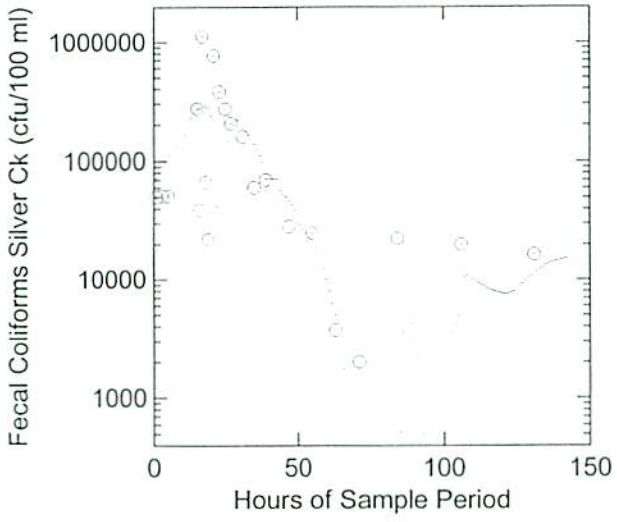
The following results are for:
2001X05 - 2001X10



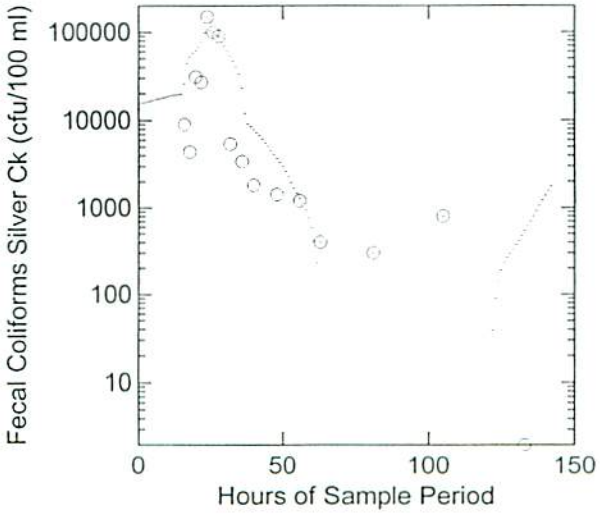
The following results are for:
1999VI23 - 1999VI23



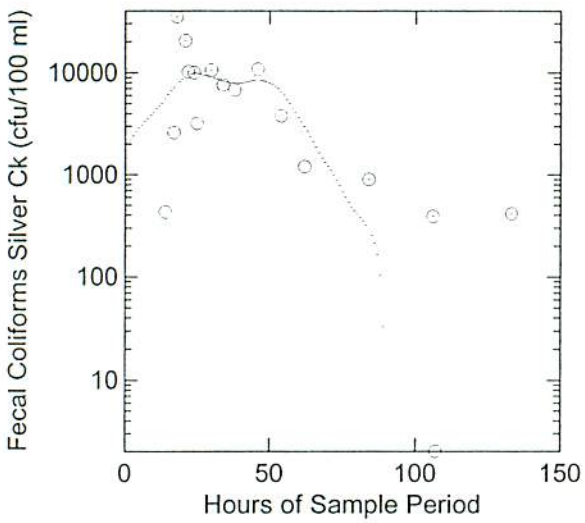
The following results are for:
2000VIII08 - 2000VIII13



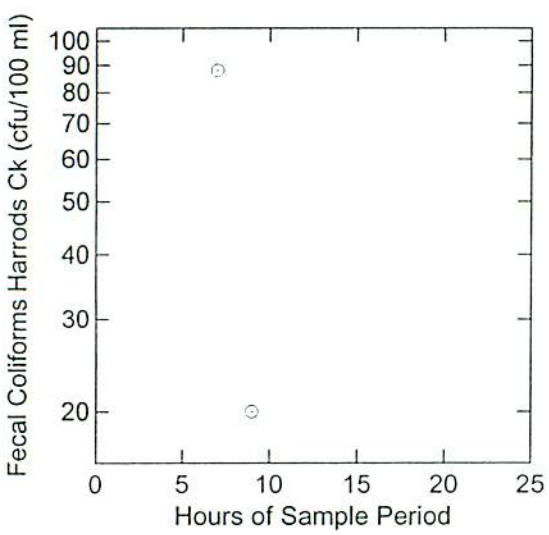
The following results are for:
2001V07 - 2001V12



The following results are for:
2001X05 - 2001X10

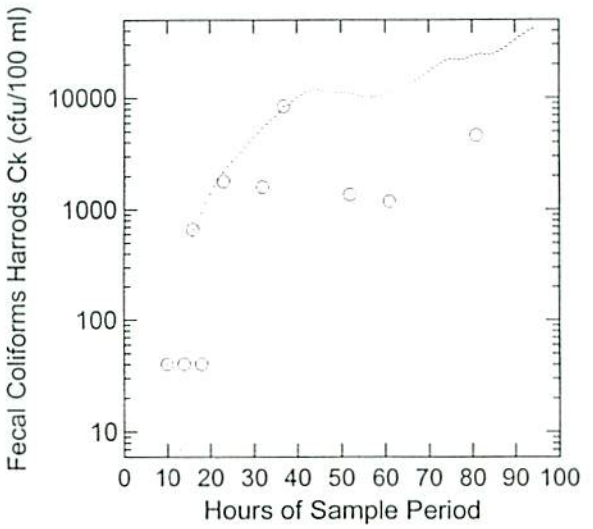


The following results are for:
1998VIII17 - 1998VIII17

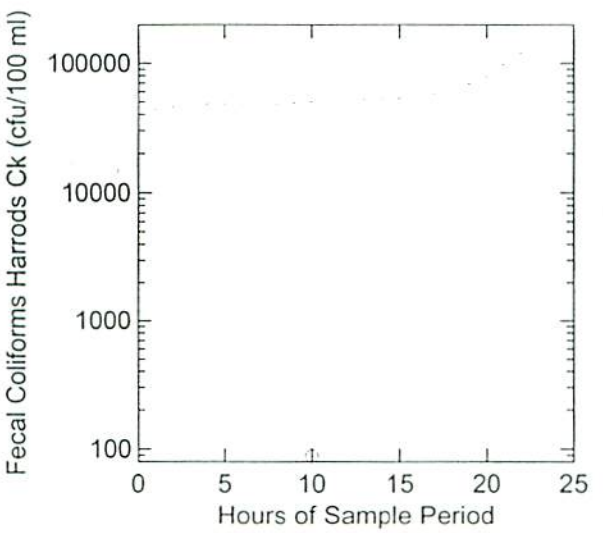


The following results are for:

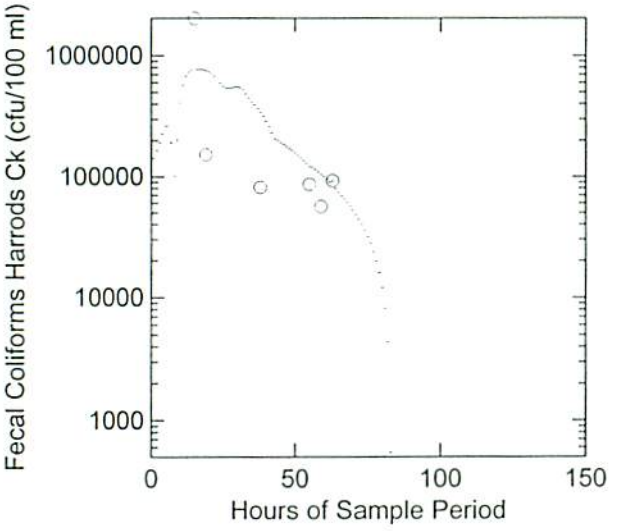
1998X07 - 1998X10



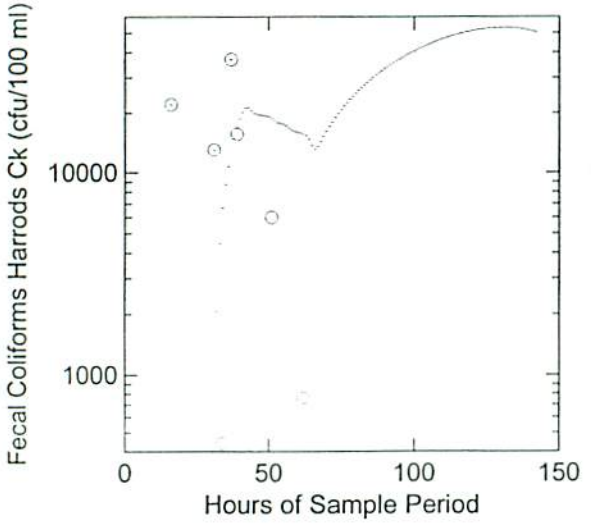
The following results are for:
1999VI23 - 1999VI23



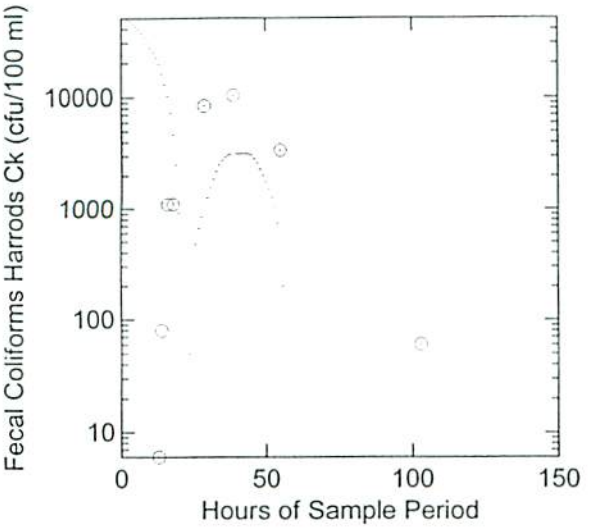
The following results are for:
2000VIII08 - 2000VIII13



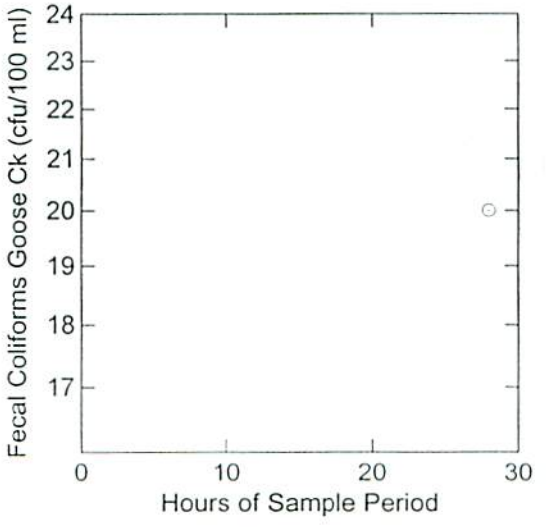
The following results are for:
2001V07 - 2001V12



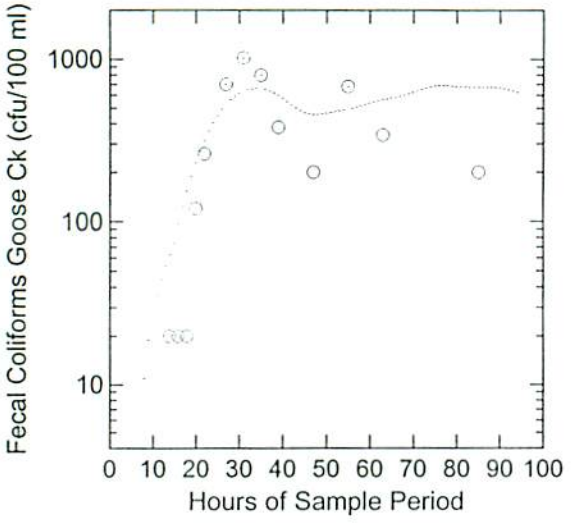
The following results are for:
2001X05 - 2001X10



The following results are for:
1997X08 - 1997X09

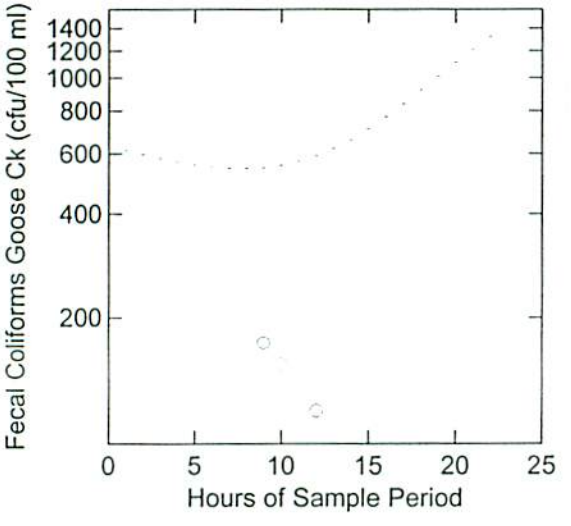


The following results are for:
1997XI13 - 1997XI16

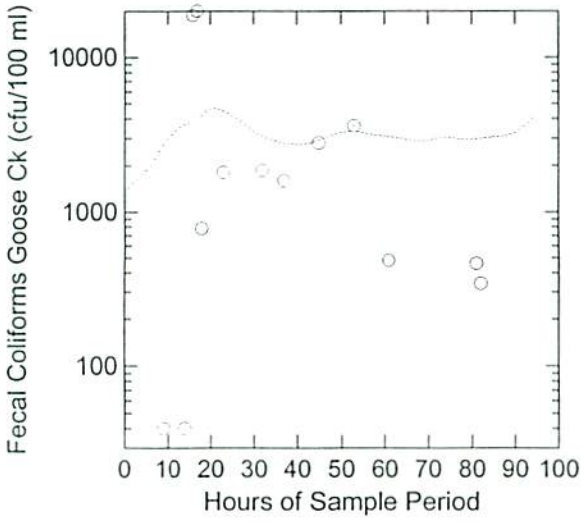


The following results are for:
1998VIII17 - 1998VIII17

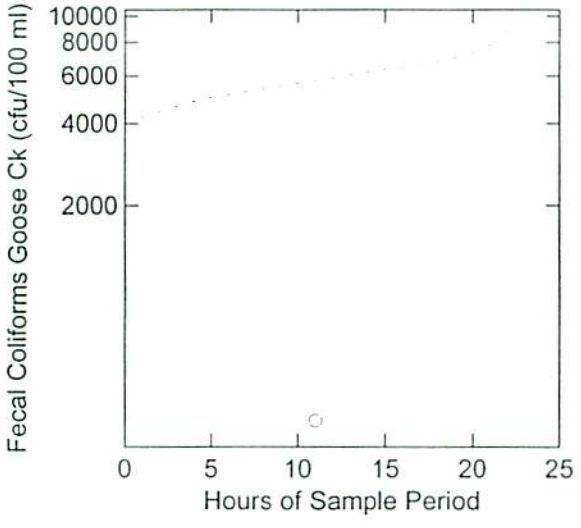
Of 22 cases, 1 were excluded by logging or powering negative values.



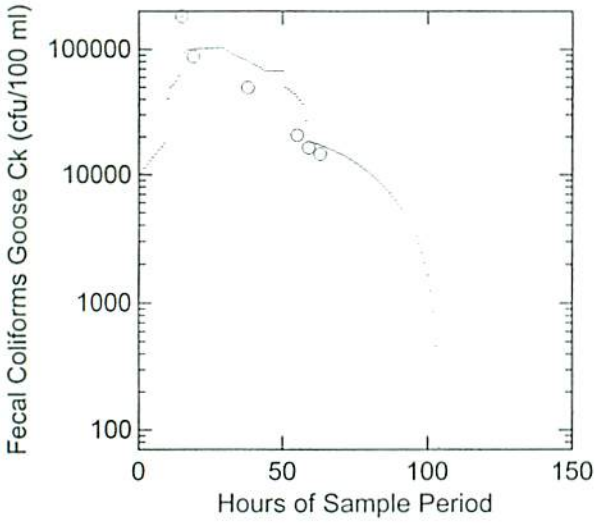
The following results are for:
1998X07 - 1998X10



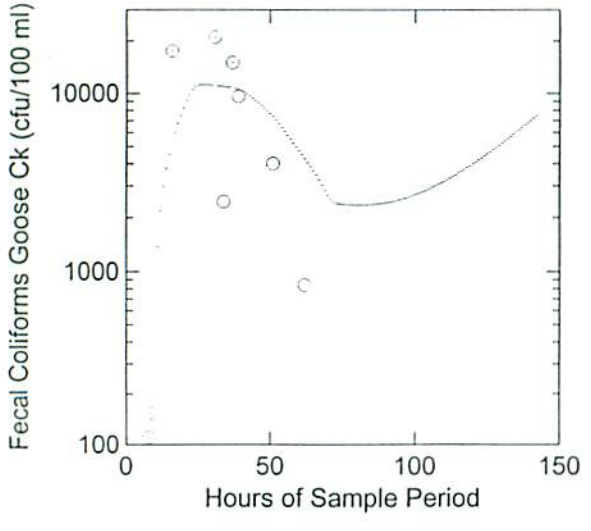
The following results are for:
1999VI23 - 1999VI23



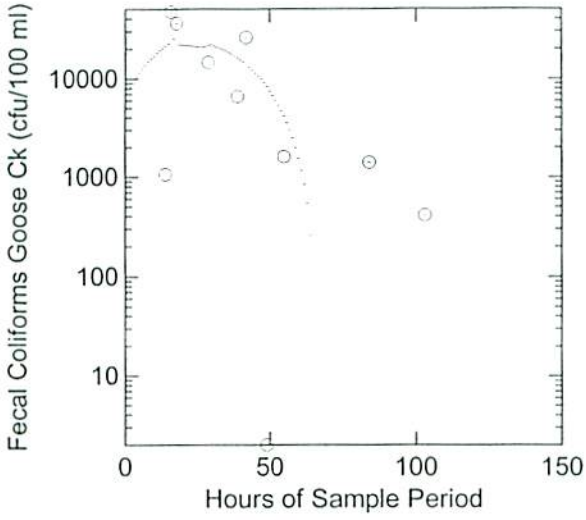
The following results are for:
2000VIII08 - 2000VIII13



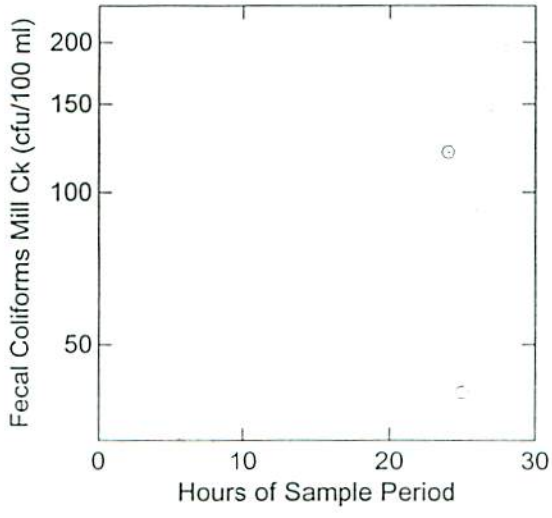
The following results are for:
2001V07 - 2001V12



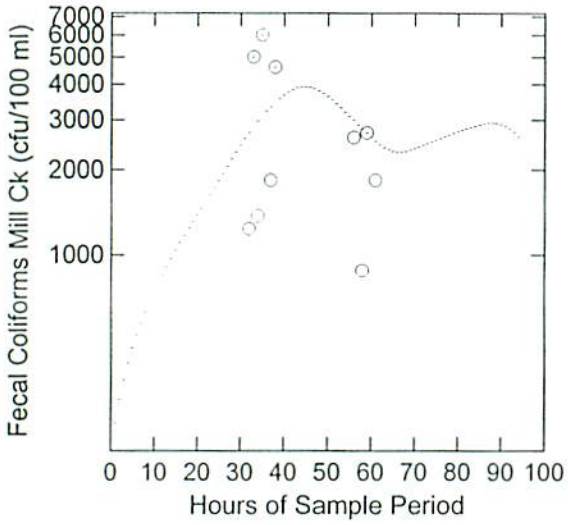
The following results are for:
2001X05 - 2001X10



The following results are for:
1997X08 - 1997X09

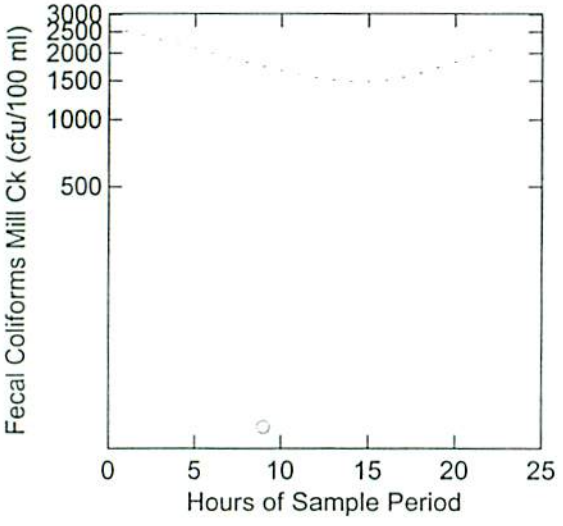


The following results are for:
1997XI13 - 1997XI16

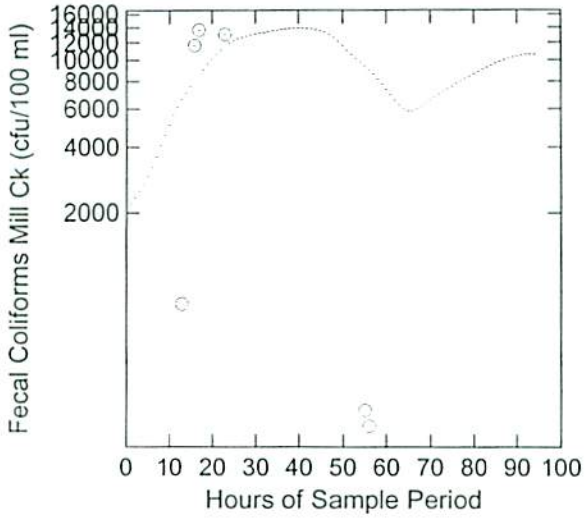


The following results are for:
1998VIII17 - 1998VIII17

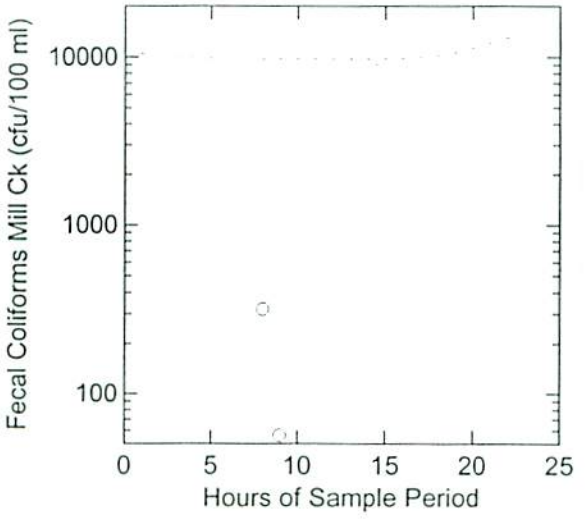
Of 22 cases, 1 were excluded by logging or powering negative values.



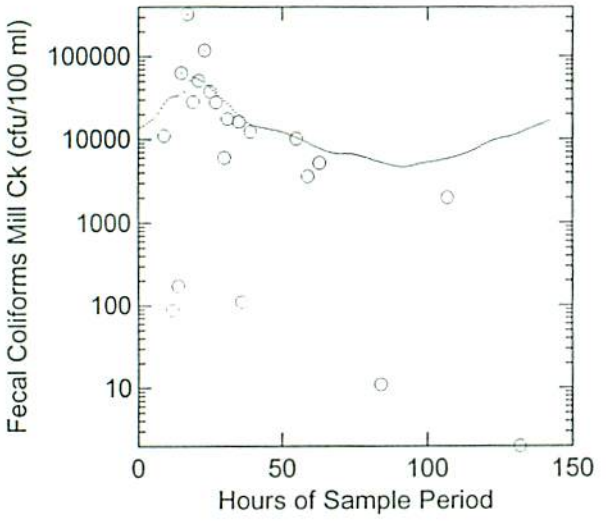
The following results are for:
1998X07 - 1998X10



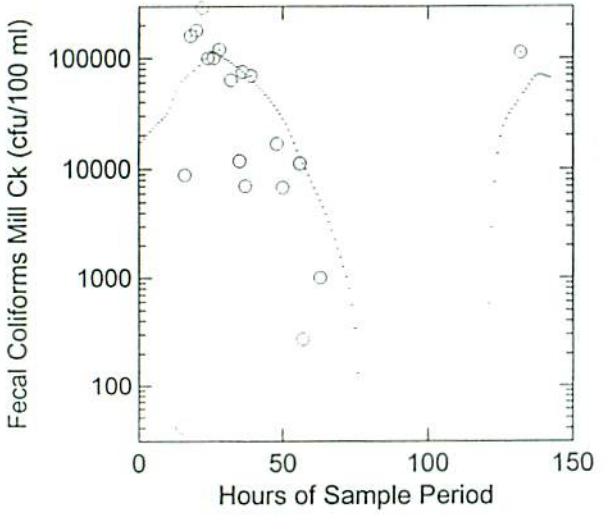
The following results are for:
1999VI23 - 1999VI23



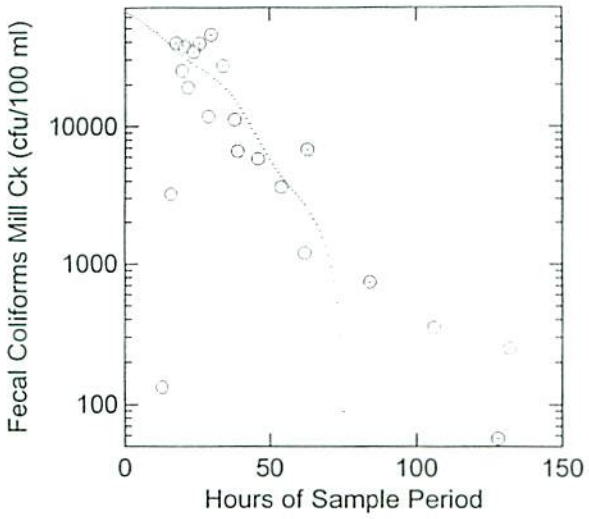
The following results are for:
2000VIII08 - 2000VIII13



The following results are for:
2001V07 - 2001V12



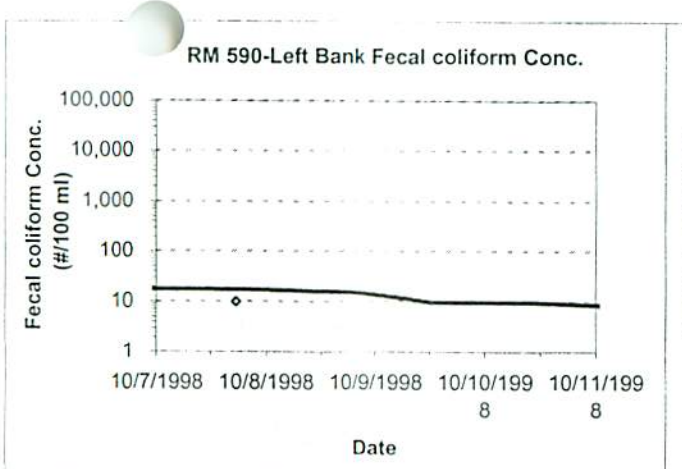
The following results are for:
2001X05 - 2001X10

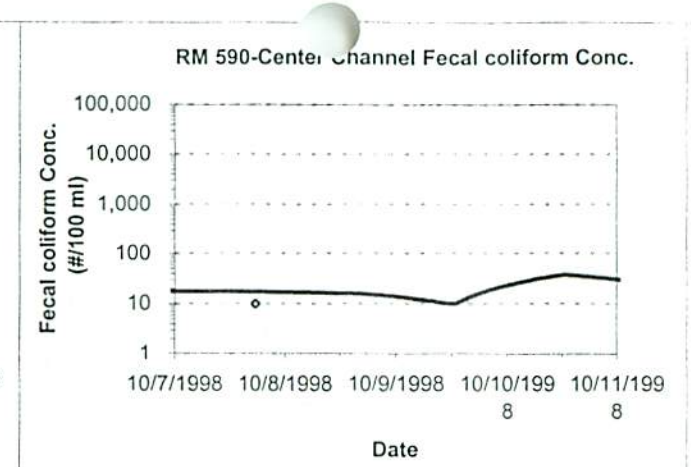


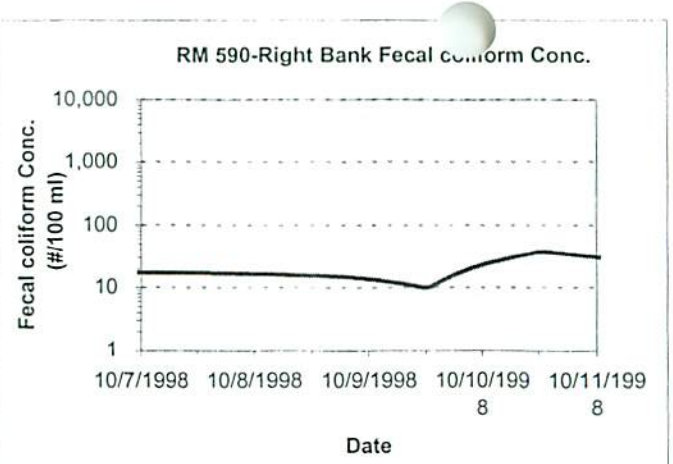
APPENDIX G

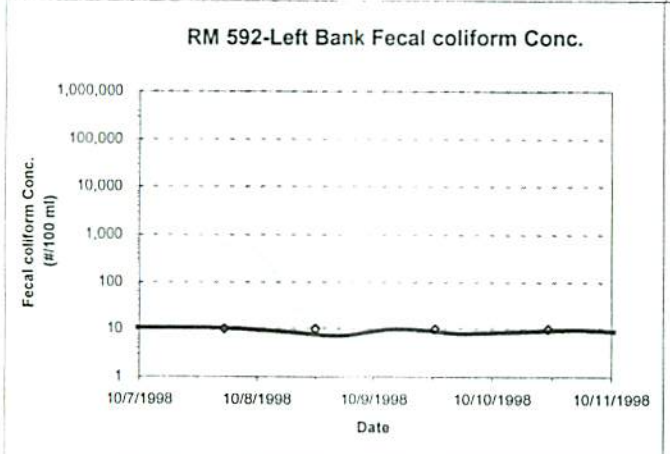
TEMPORAL PLOTS OF MODEL AND OBSERVED DATA BY AREA OF RIVER

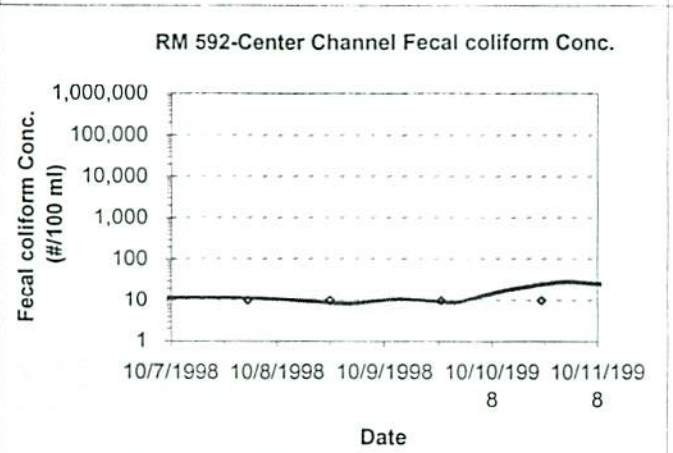
October 1998 Wet Weather Event Fecal Coliform

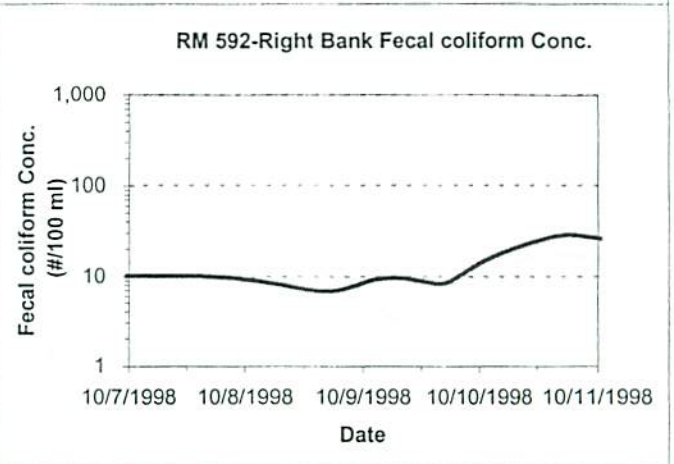

RM 590-Left Bank Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

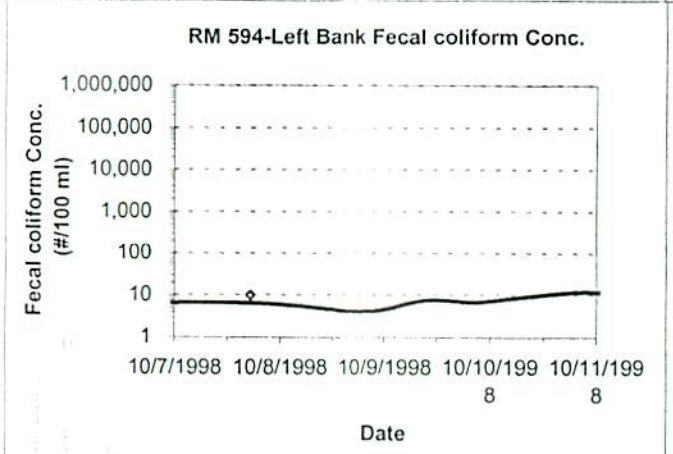

RM 590-Center Channel Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

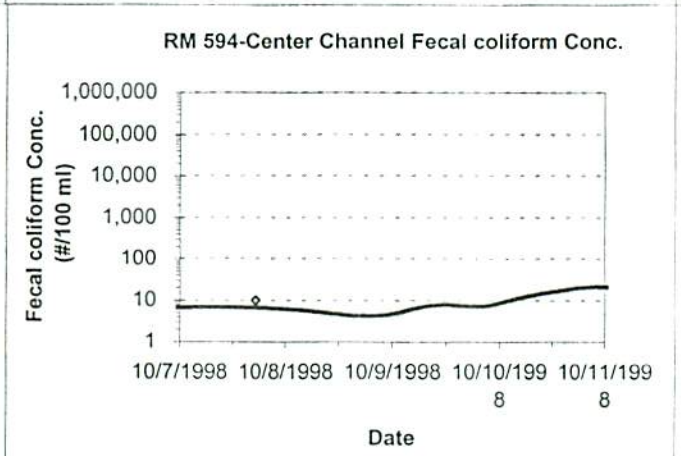

RM 590-Right Bank Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

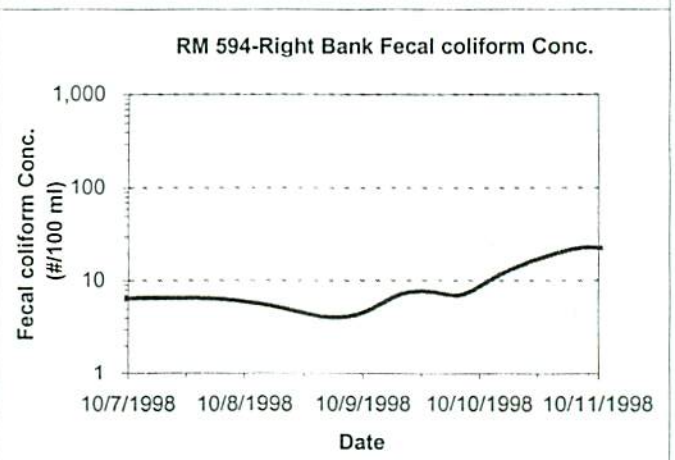

RM 592-Left Bank Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

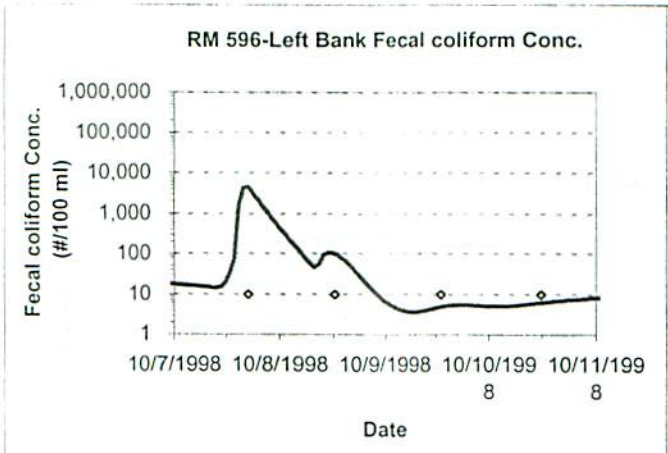

RM 592-Center Channel Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

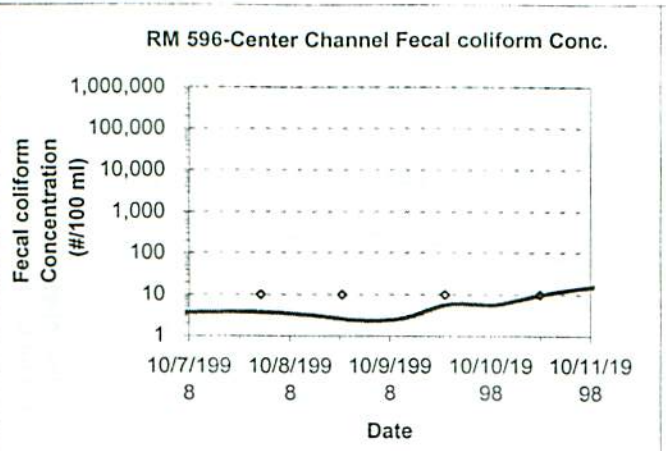

RM 592-Right Bank Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

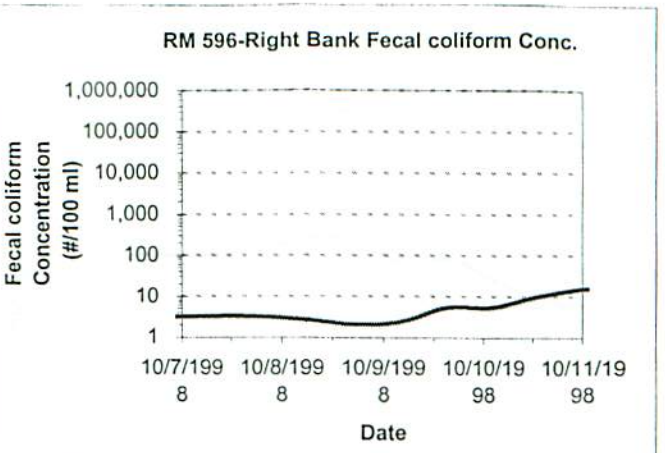

RM 594-Left Bank Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

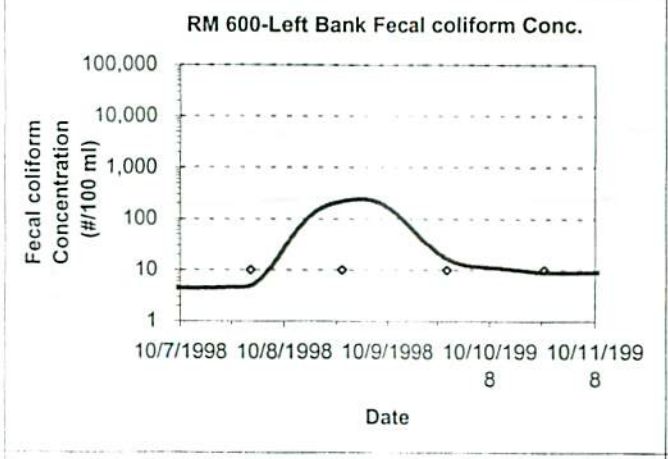

RM 594-Center Channel Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

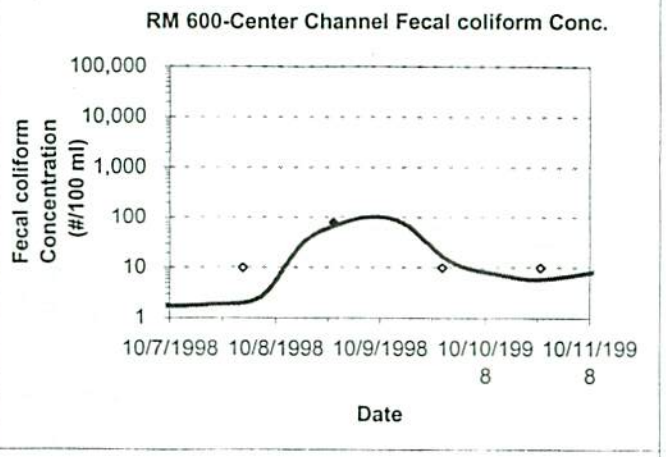

RM 594-Right Bank Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

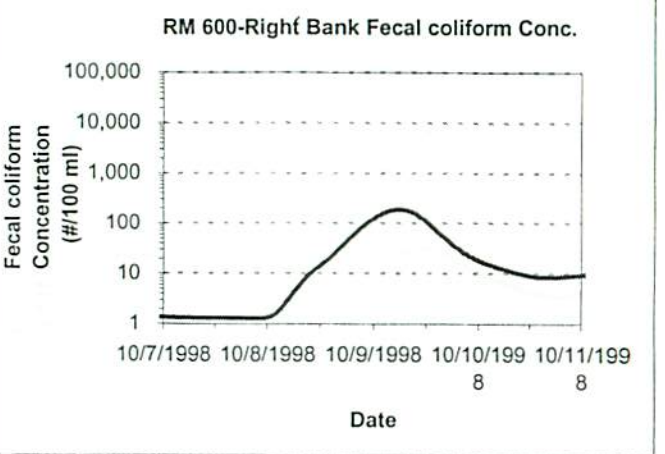

RM 596-Left Bank Fecal coliform Conc.
Fecal coliform Conc. (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

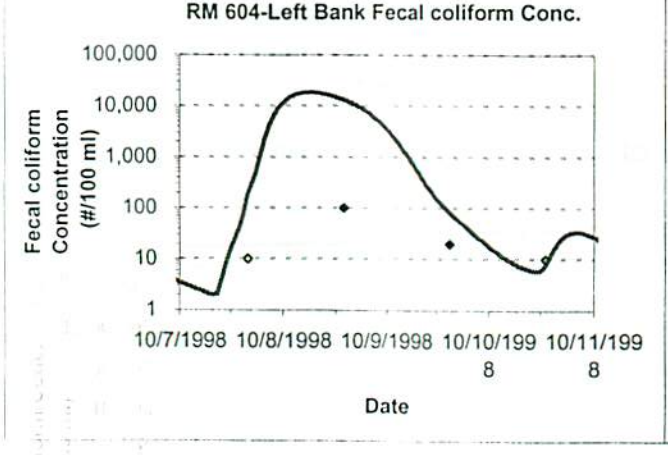

RM 596-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

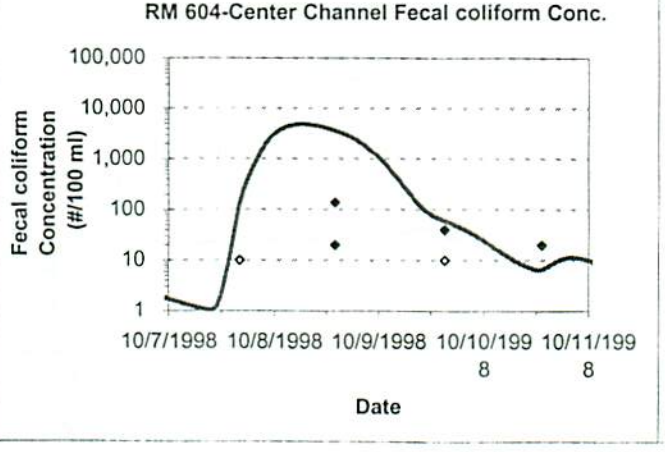

RM 596-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

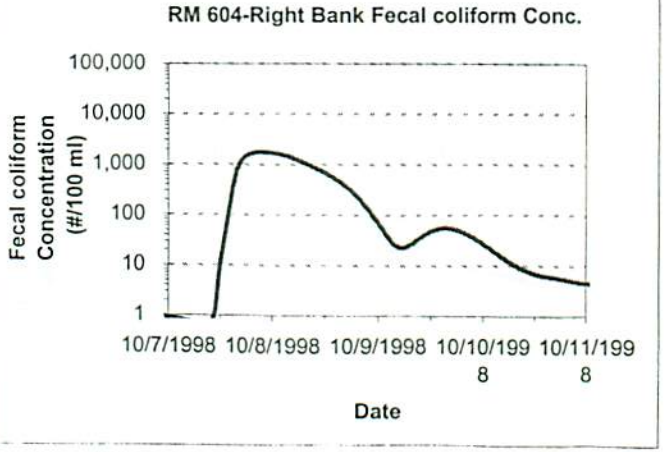

RM 600-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

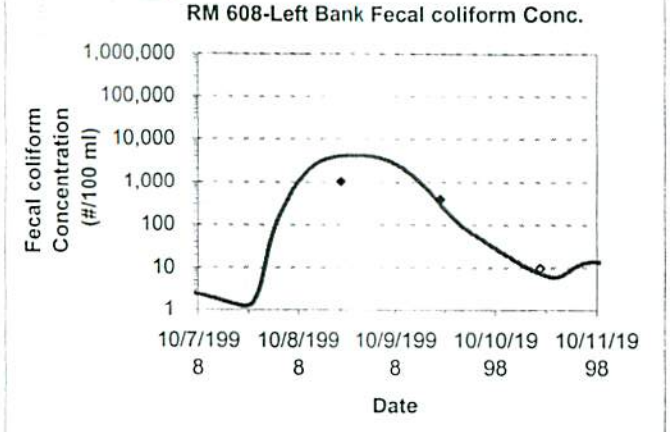

RM 600-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

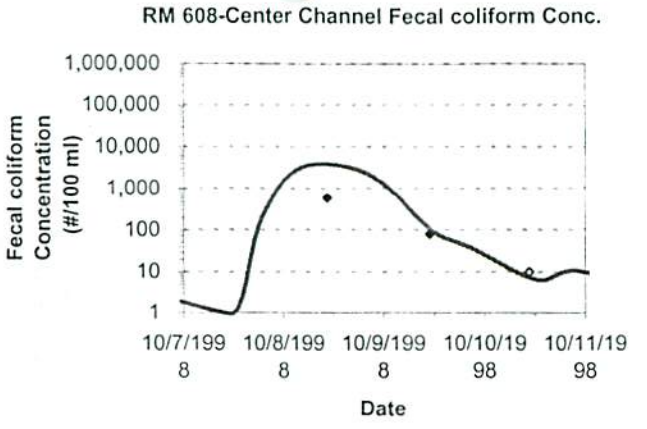

RM 600-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

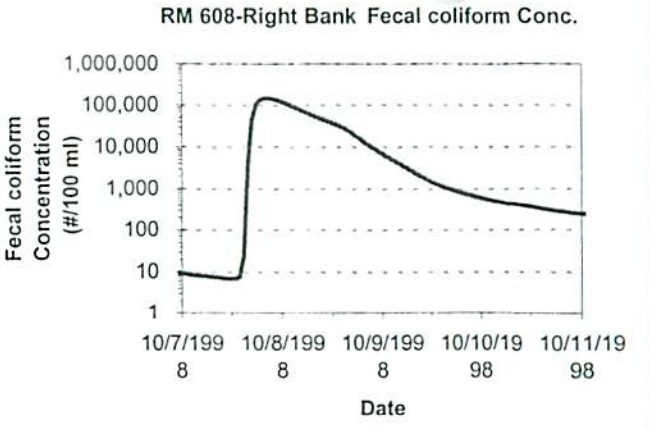

RM 604-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

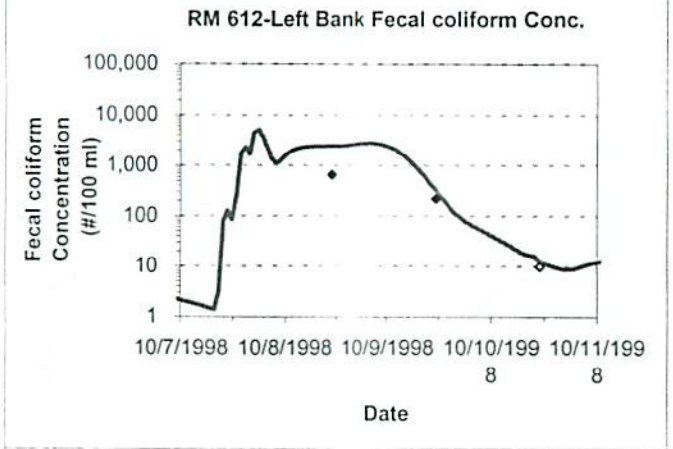

RM 604-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

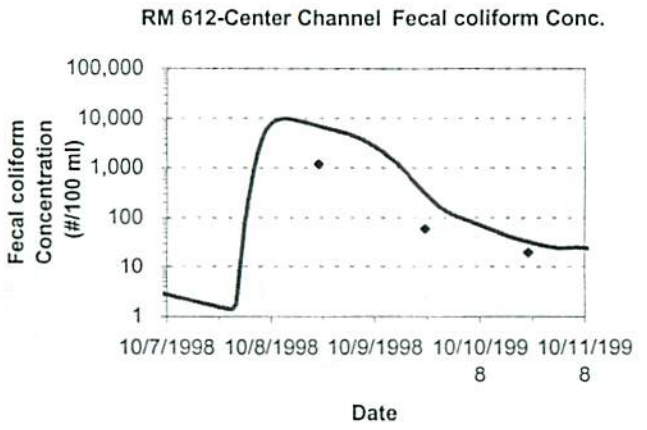

RM 604-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

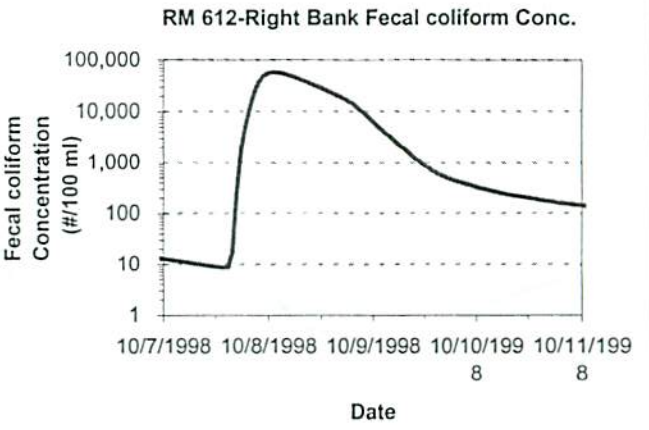

RM 608-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

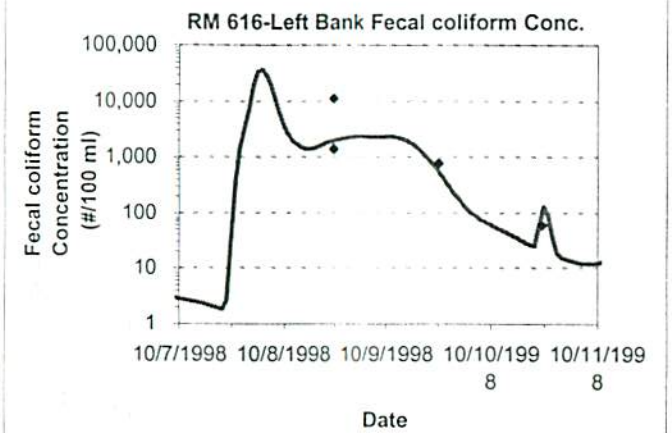

RM 608-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

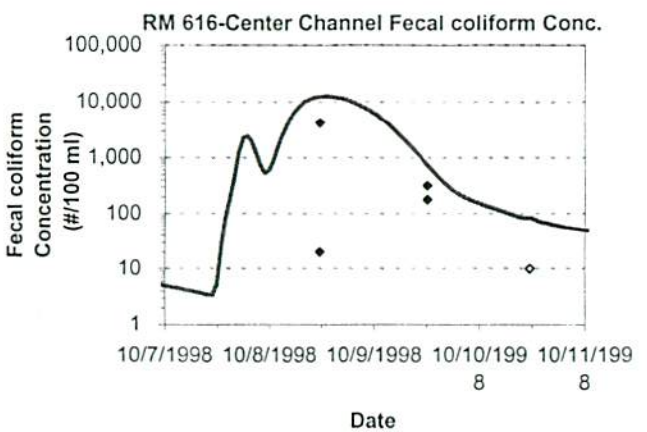

RM 608-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

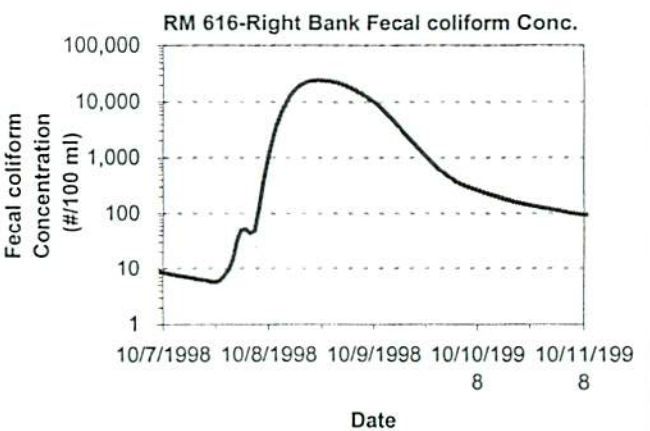

RM 612-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

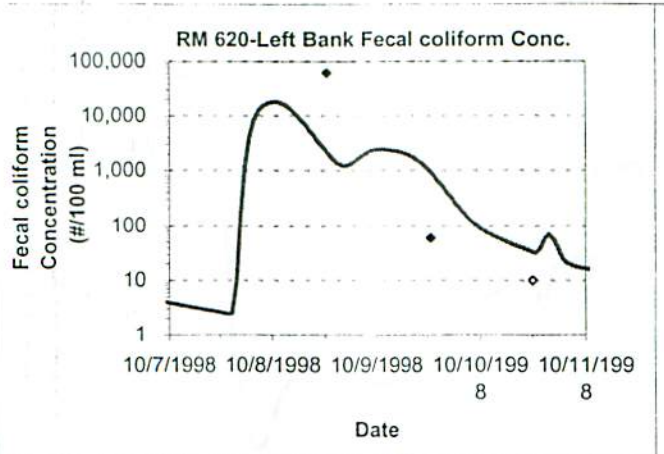

RM 612-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

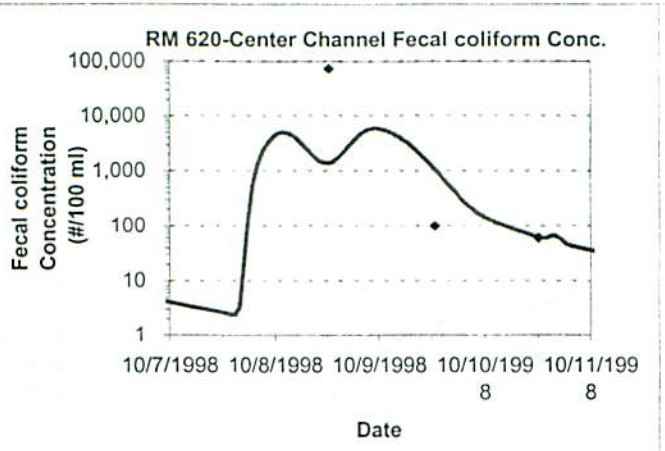

RM 612-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

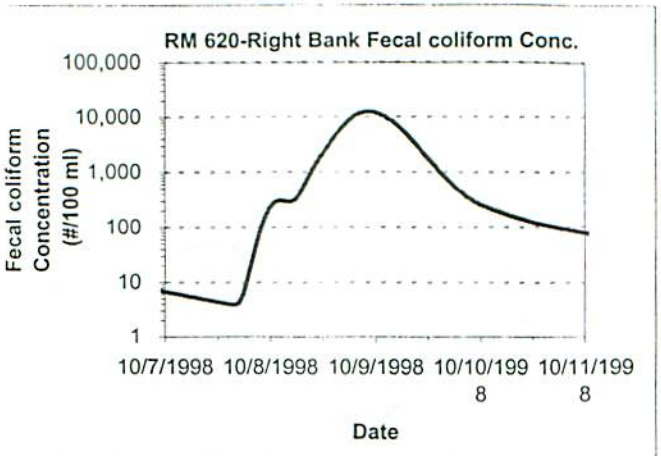

RM 616-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

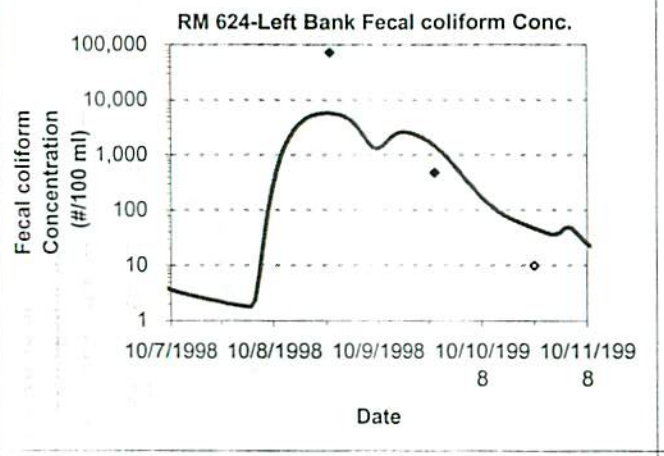

RM 616-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

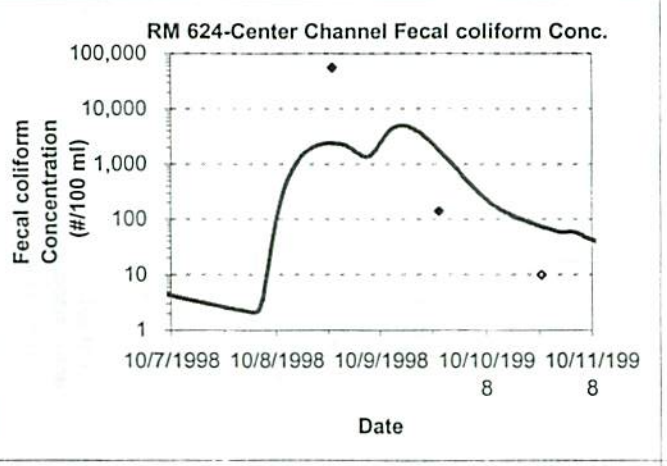

RM 616-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

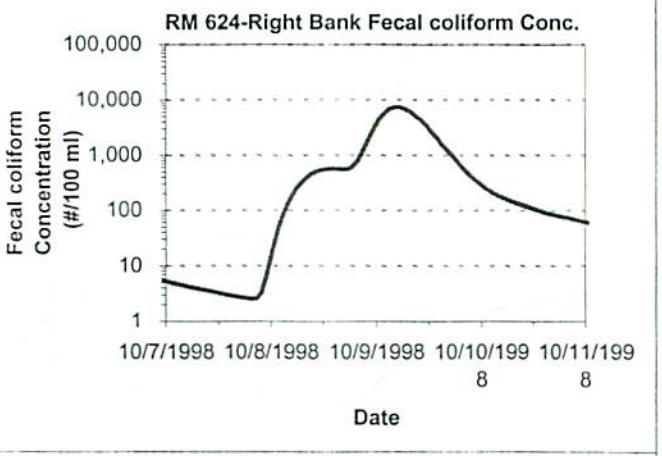

RM 620-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

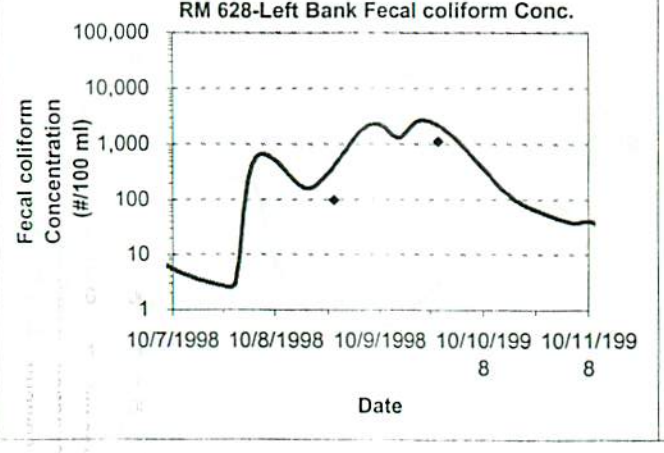

RM 620-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

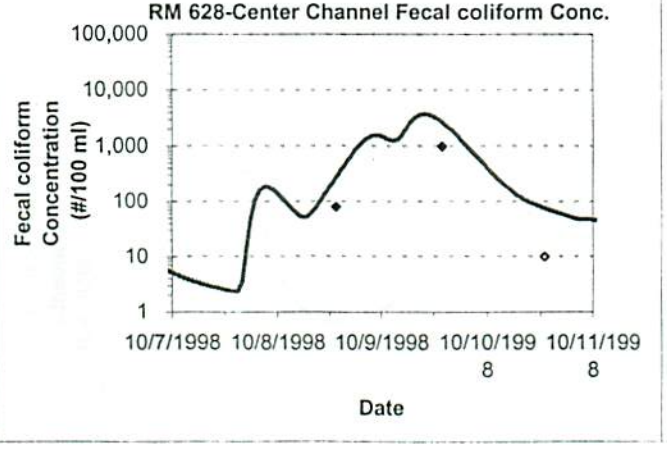

RM 620-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

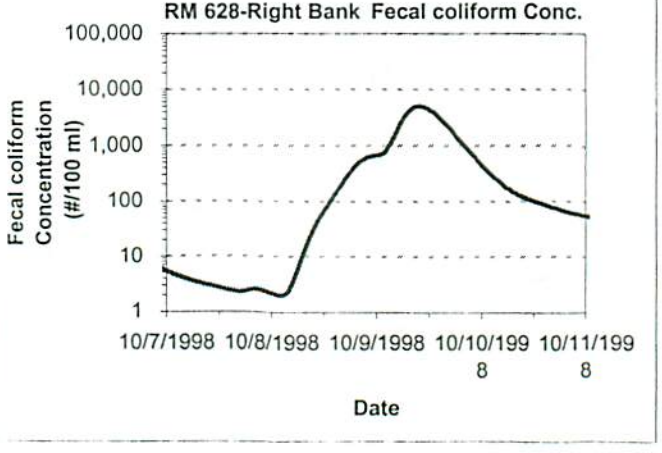

RM 624-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date


RM 624-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date


RM 624-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date


RM 628-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

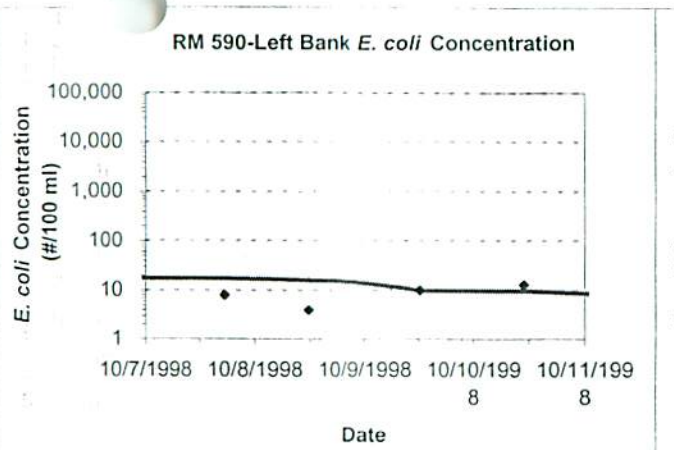

RM 628-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

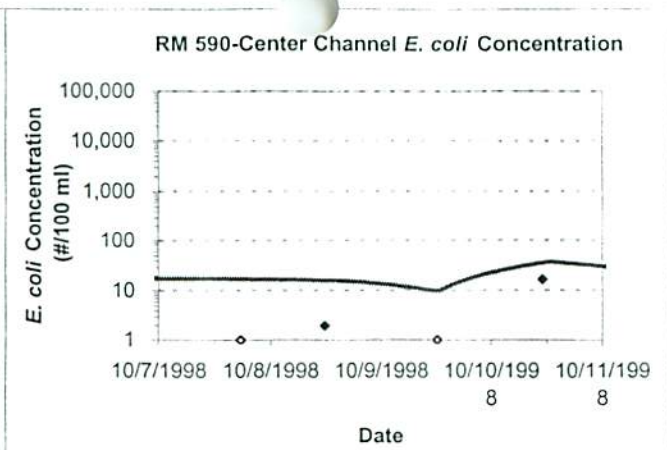

RM 628-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

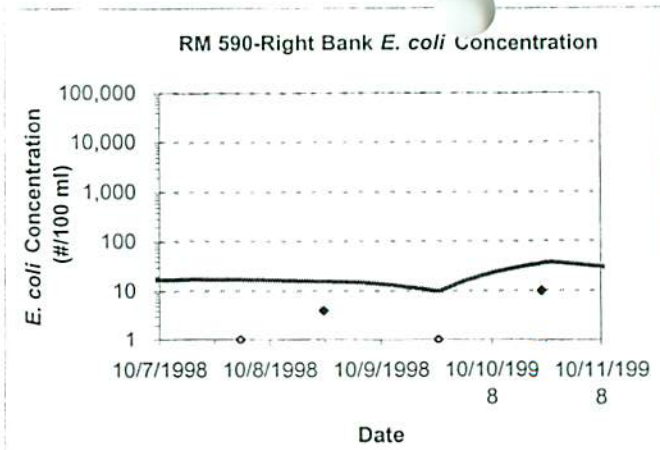
APPENDIX G

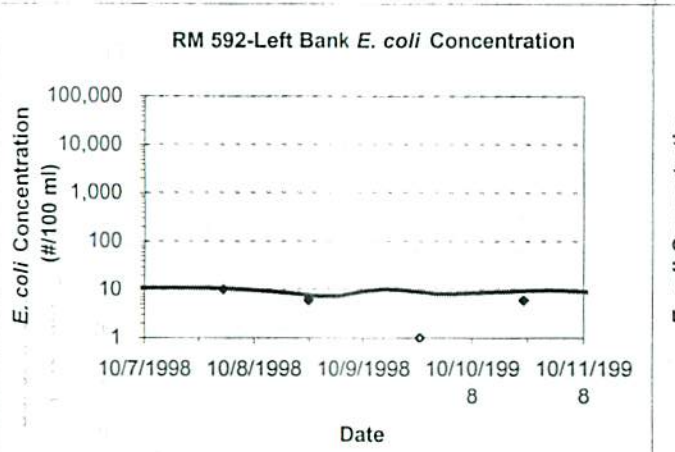
TEMPORAL PLOTS OF MODEL AND OBSERVED DATA BY AREA OF RIVER

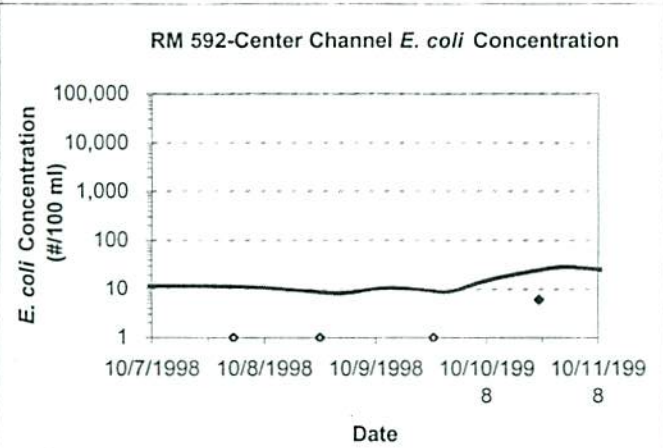
October 1998 Wet Weather Event *E. Coli*

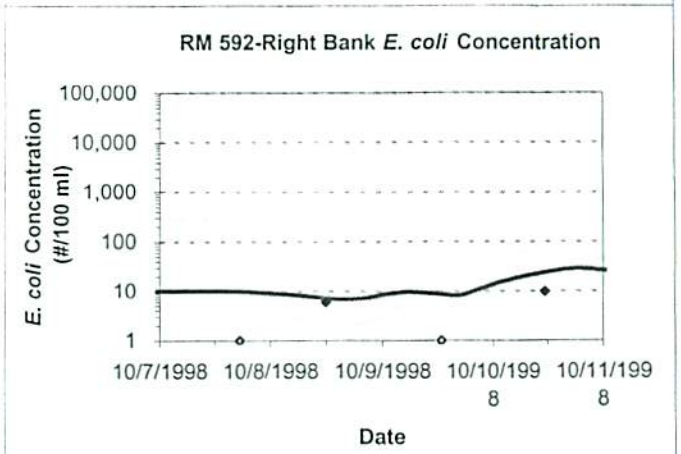

RM 590-Left Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

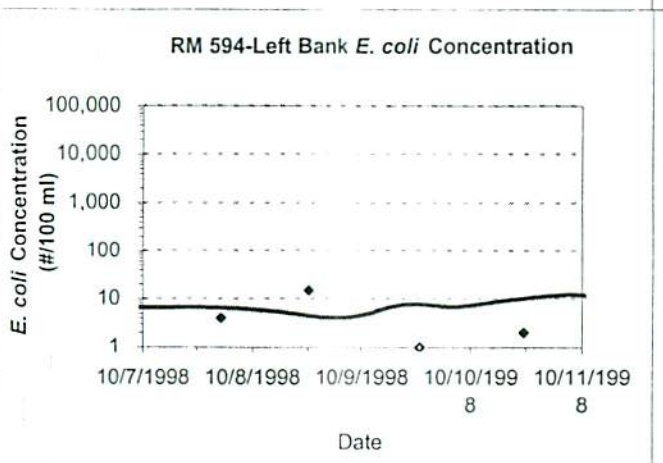

RM 590-Center Channel E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

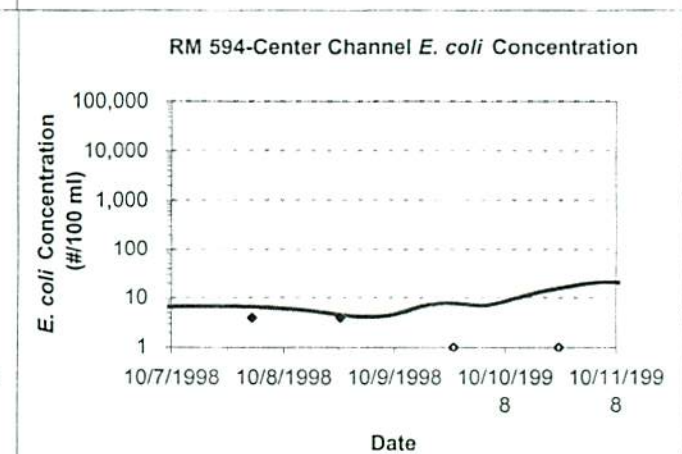

RM 590-Right Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

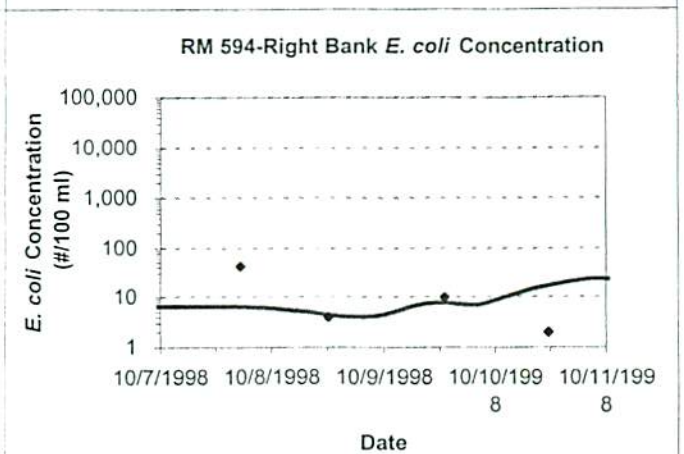

RM 592-Left Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date


RM 592-Center Channel E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

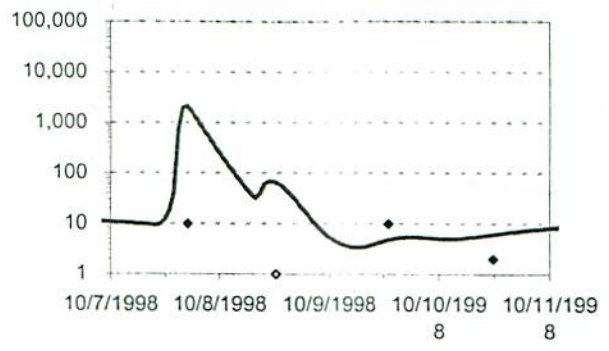

RM 592-Right Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date


RM 594-Left Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

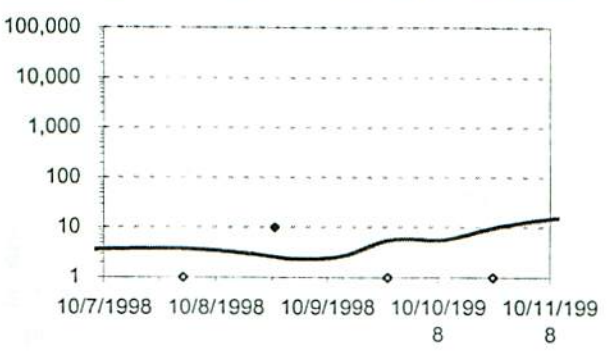

RM 594-Center Channel E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date


RM 594-Right Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998
Date

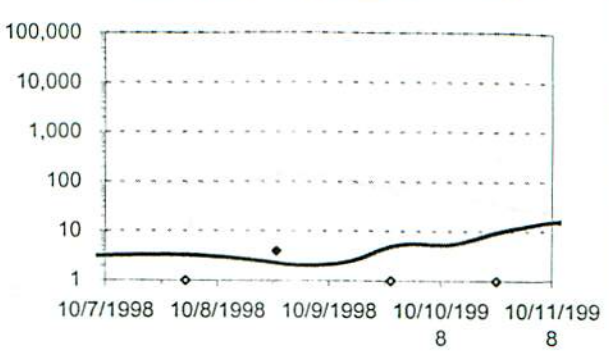
RM 596-Left Bank *E. coli* Concentration



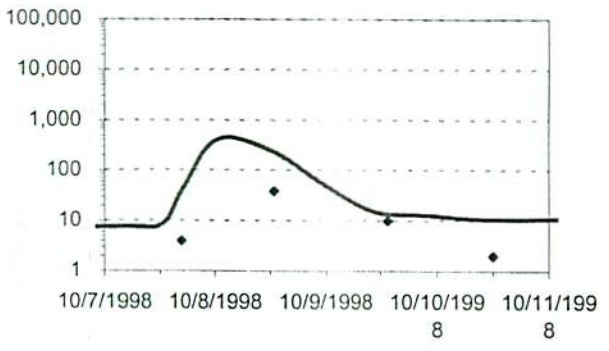
RM 596-Center Channel *E. coli* Concentration



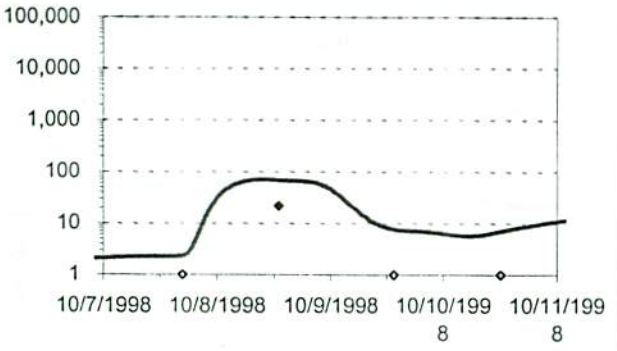
RM 596-Right Bank *E. coli* Concentration



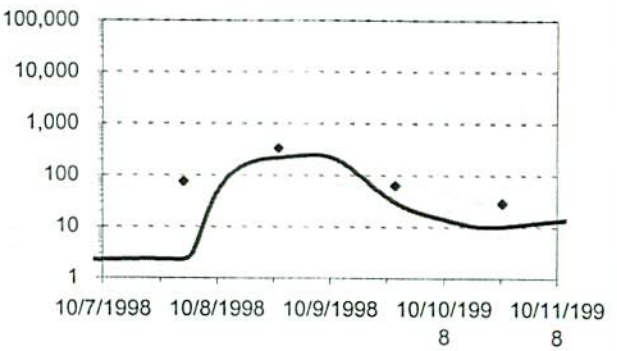
RM 598-Left Bank *E. coli* Concentration



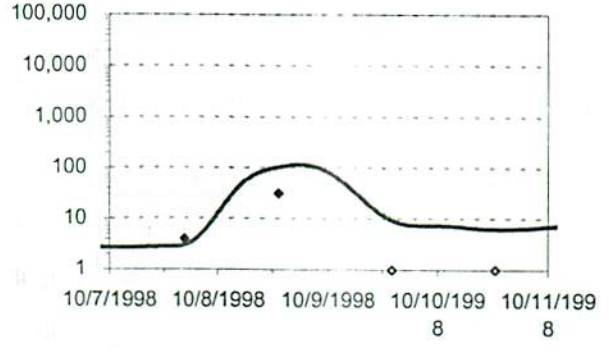
RM 598-Center Channel *E. coli* Concentration



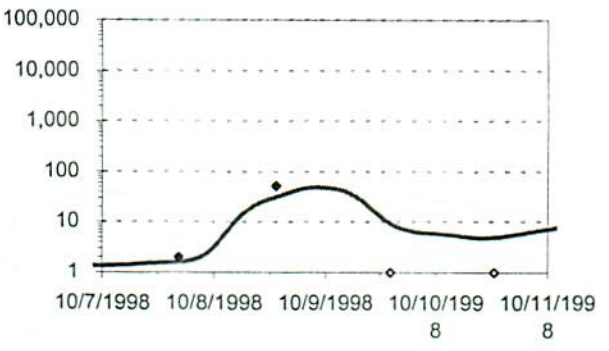
RM 598-Right Bank *E. coli* Concentration



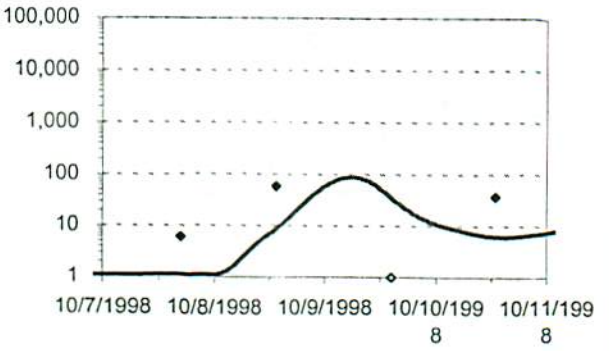
RM 600-Left Bank *E. coli* Concentration



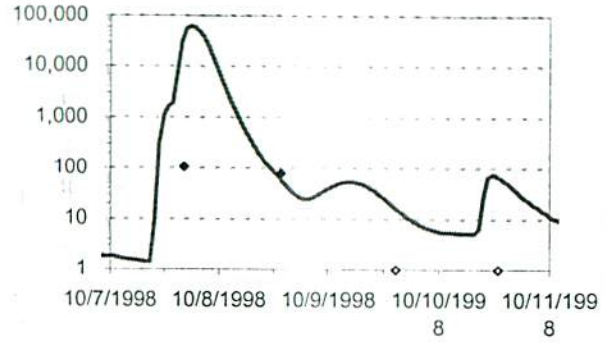
RM 600-Center Channel *E. coli* Concentration



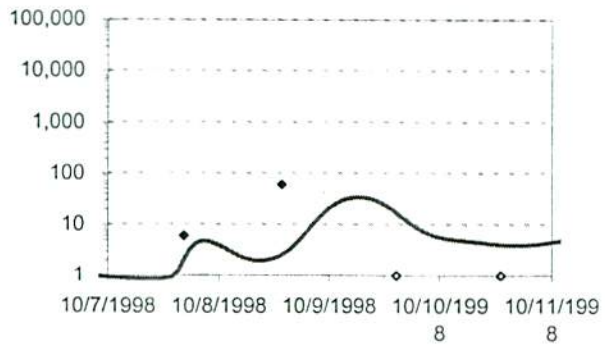
RM 600-Right Bank *E. coli* Concentration



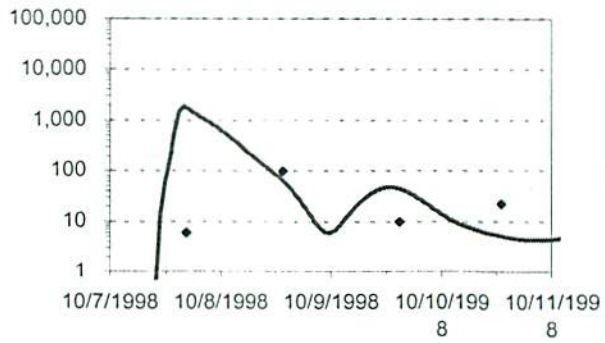
RM 602-Left Bank *E. coli* Concentration



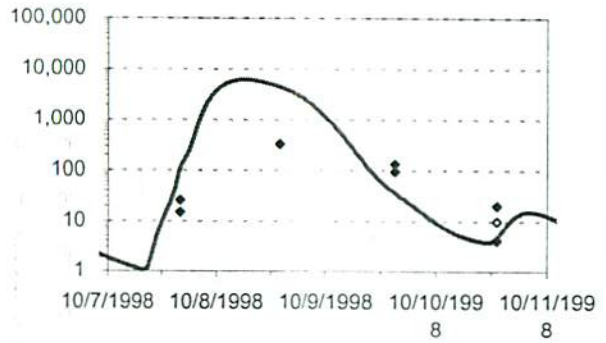
RM 602-Center Channel *E. coli* Concentration



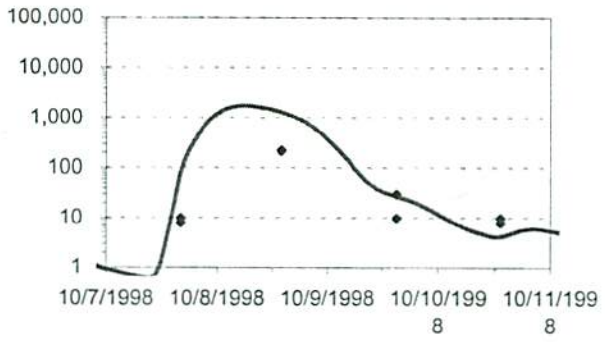
RM 602-Right Bank *E. coli* Concentration



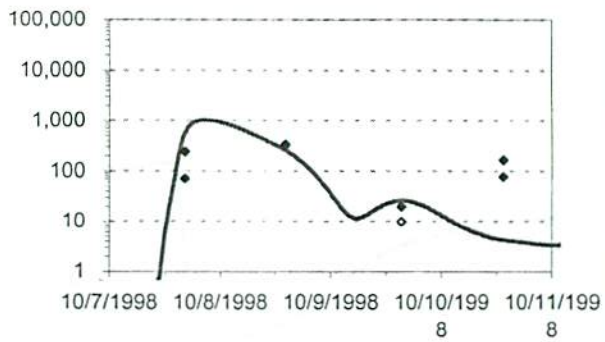
RM 604-Left Bank *E. coli* Concentration



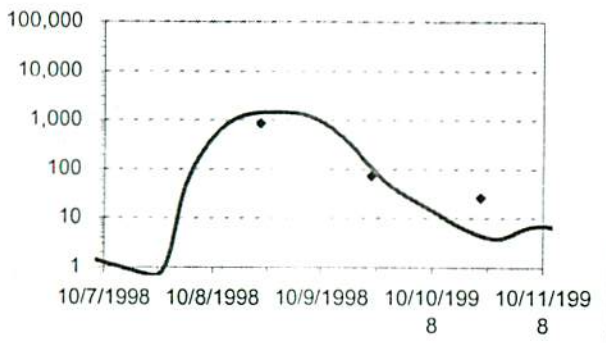
RM 604-Center Channel *E. coli* Concentration



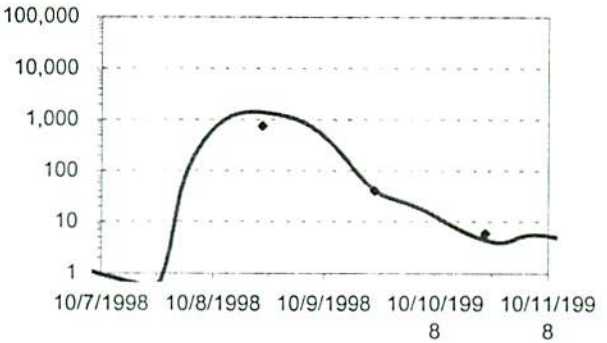
RM 604-Right Bank *E. coli* Concentration



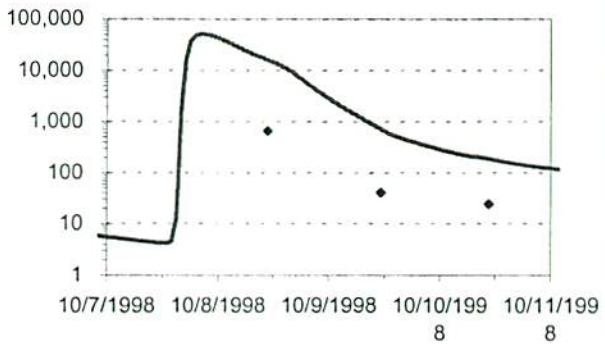
RM 608-Left Bank *E. coli* Concentration



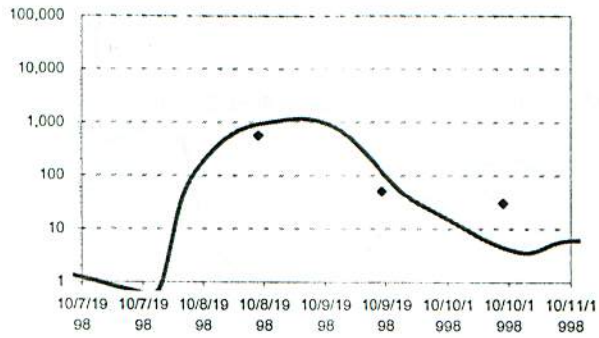
RM 608-Center Channel *E. coli* Concentration



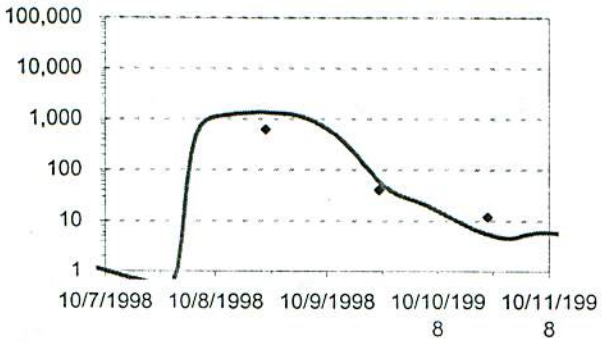
RM 608-Right Bank *E. coli* Concentration



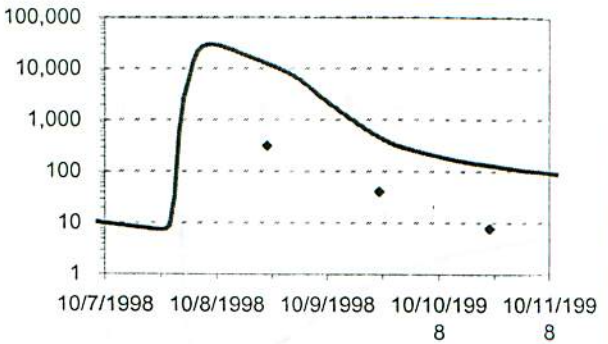
RM 610-Left Bank *E. coli* Concentration



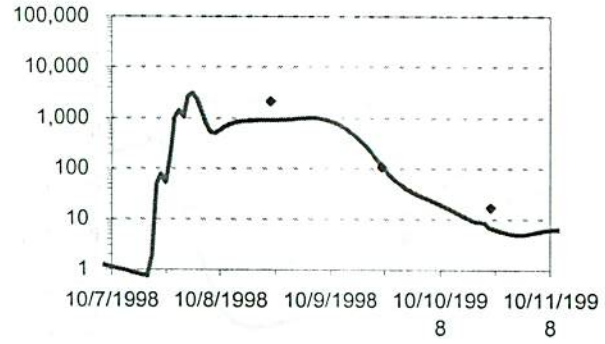
RM 610-Center Channel *E. coli* Concentration



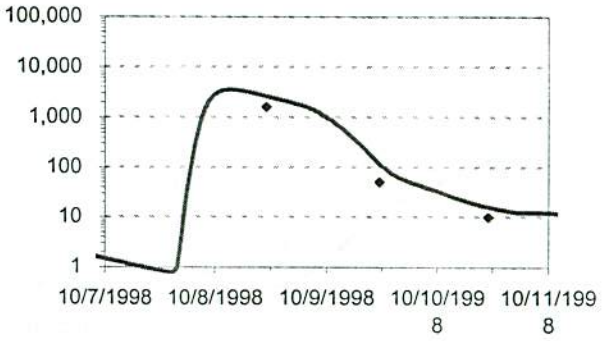
RM 610-Right Bank *E. coli* Concentration



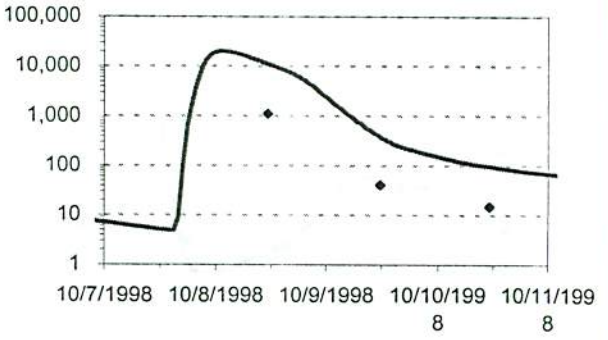
RM 612-Left Bank *E. coli* Concentration



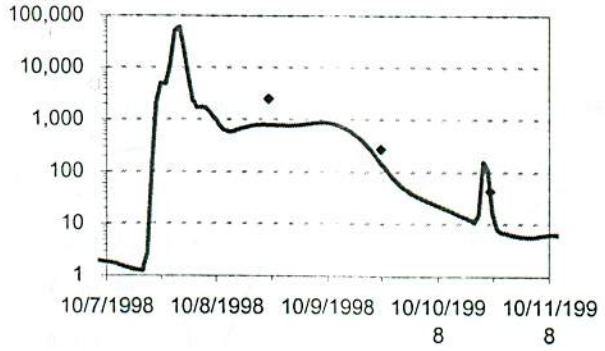
RM 612-Center Channel *E. coli* Concentration



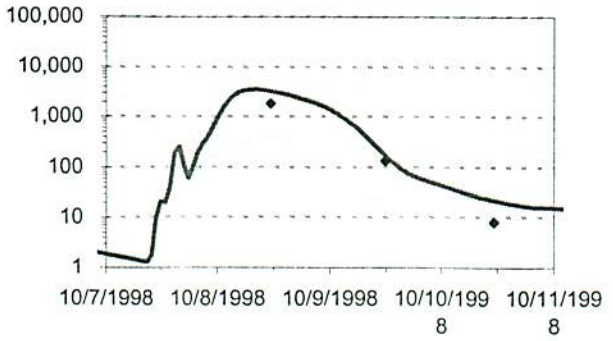
RM 612-Right Bank *E. coli* Concentration



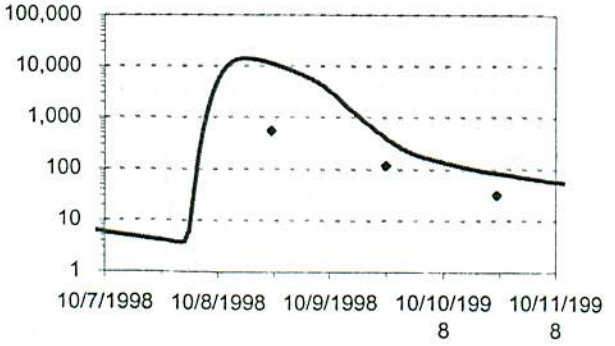
RM 614-Left Bank *E. coli* Concentration



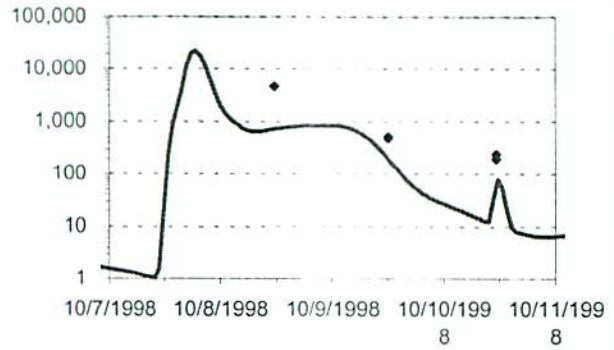
RM 614-Center Channel *E. coli* Concentration



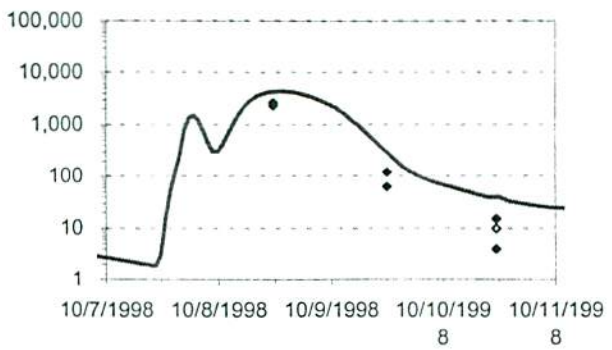
RM 614-Right Bank *E. coli* Concentration



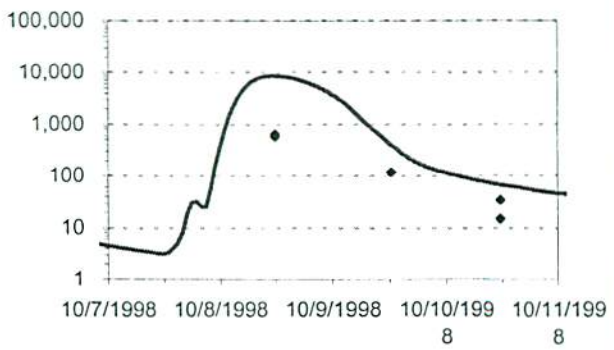
RM 616-Left Bank *E. coli* Concentration



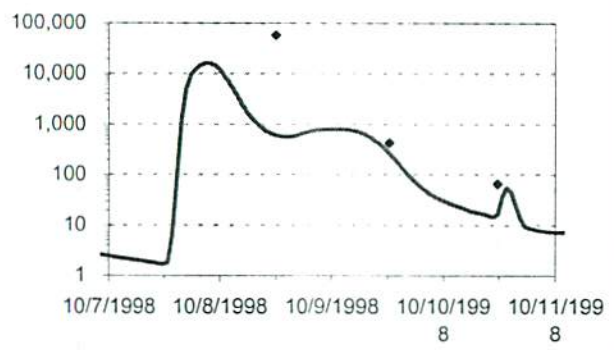
RM 616-Center Channel *E. coli* Concentration



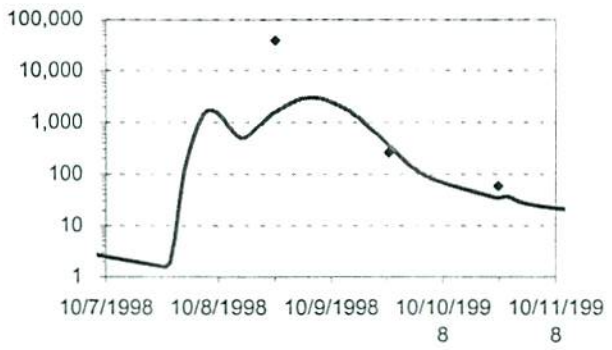
RM 616-Right Bank *E. coli* Concentration



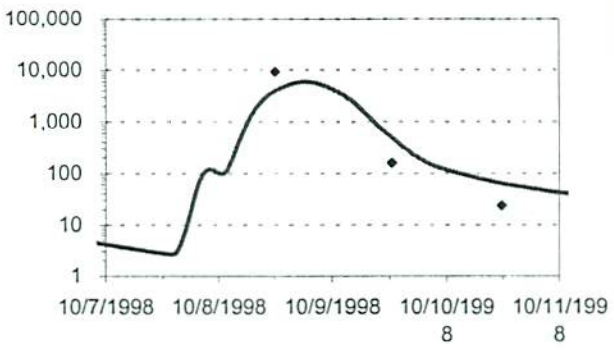
RM 618-Left Bank *E. coli* Concentration



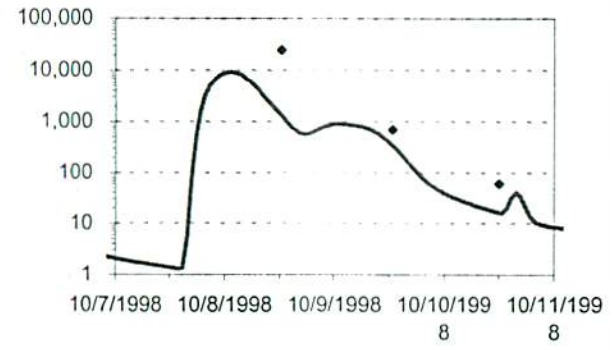
RM 618-Center Channel *E. coli* Concentration



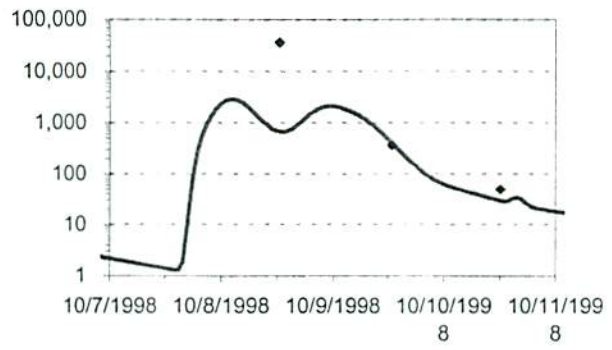
RM 618-Right Bank *E. coli* Concentration



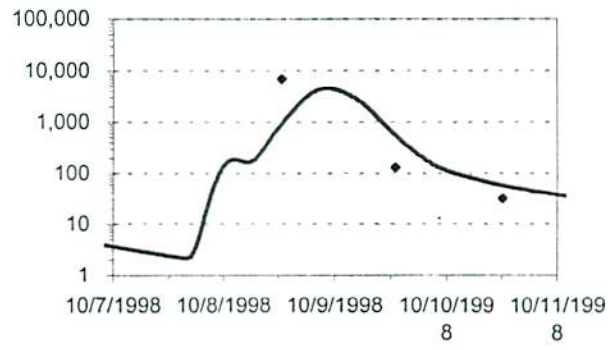
RM 620-Left Bank *E. coli* Concentration

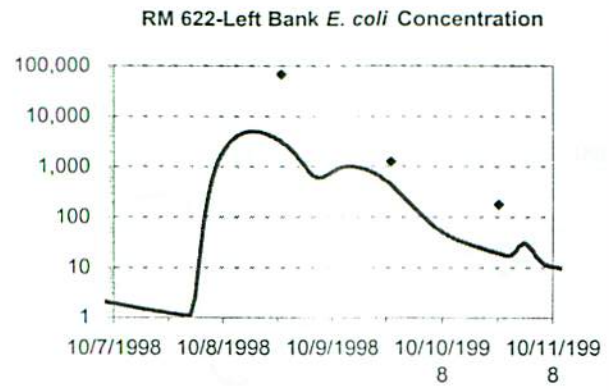


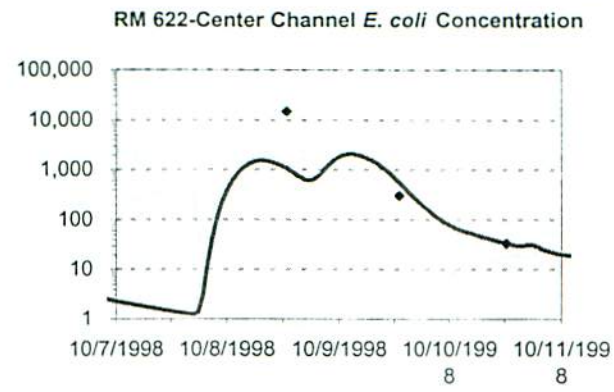
RM 620-Center Channel *E. coli* Concentration

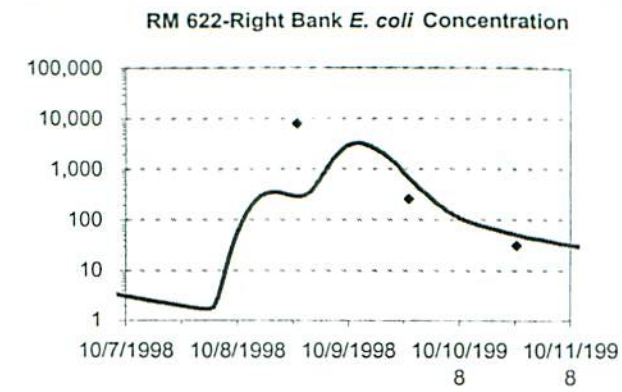


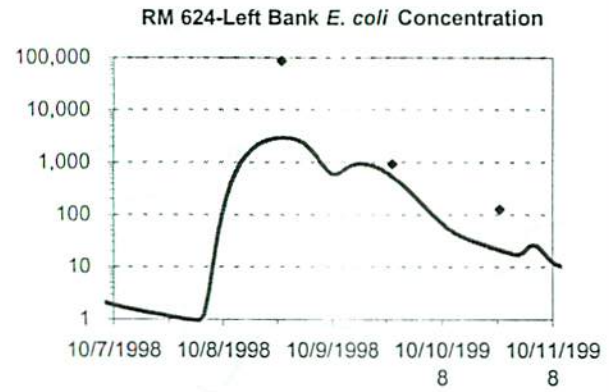
RM 620-Right Bank *E. coli* Concentration

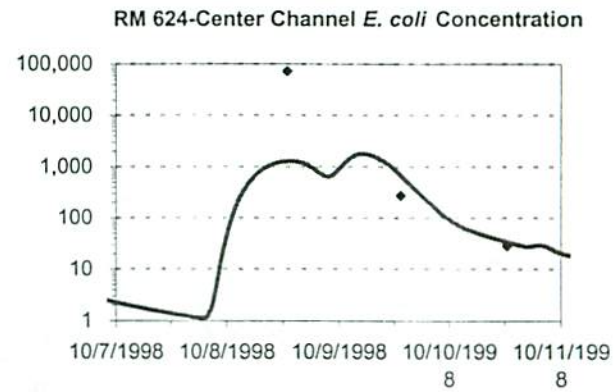


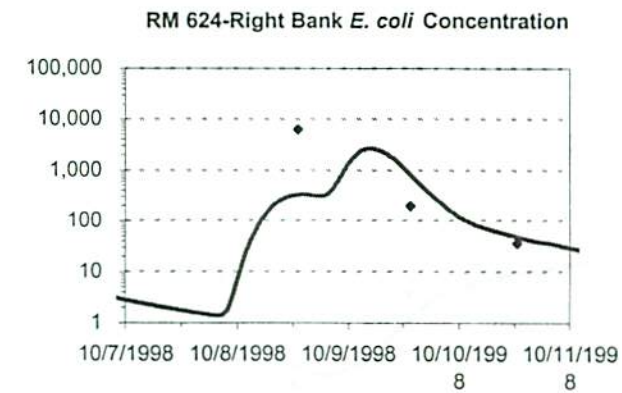

RM 622-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998


RM 622-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998

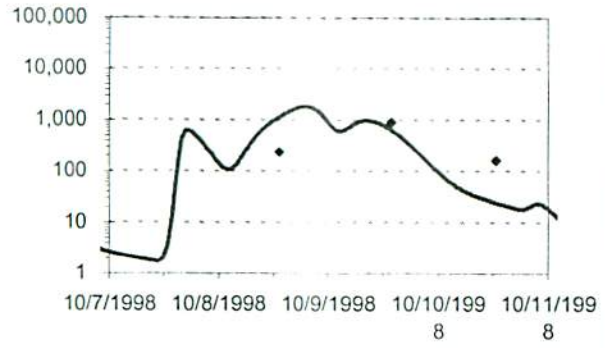

RM 622-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998


RM 624-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998

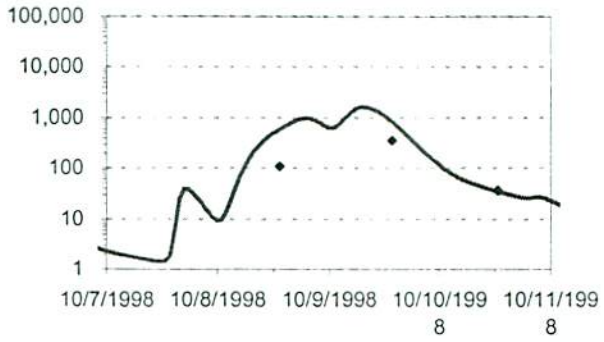

RM 624-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998


RM 624-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
10/7/1998
10/8/1998
10/9/1998
10/10/1998
10/11/1998

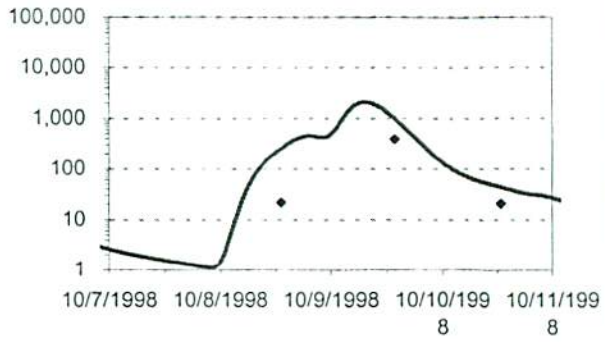
RM 626-Left Bank *E. coli* Concentration



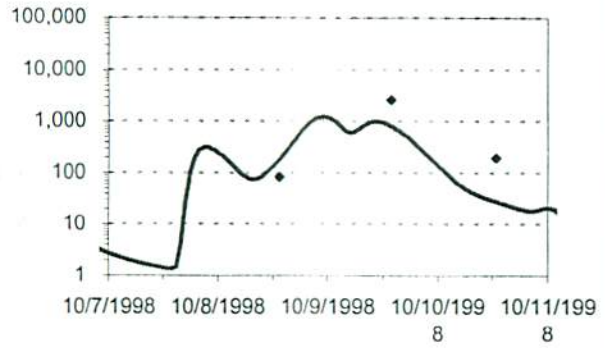
RM 626-Center Channel *E. coli* Concentration



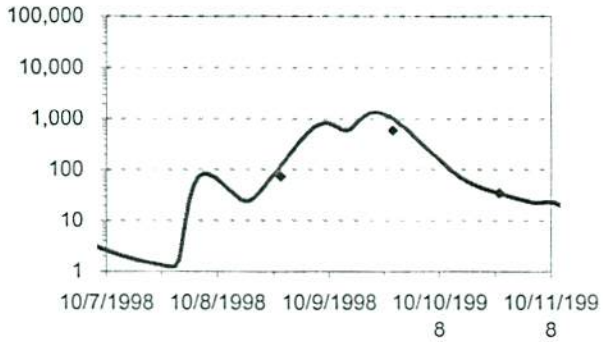
RM 626-Right Bank *E. coli* Concentration



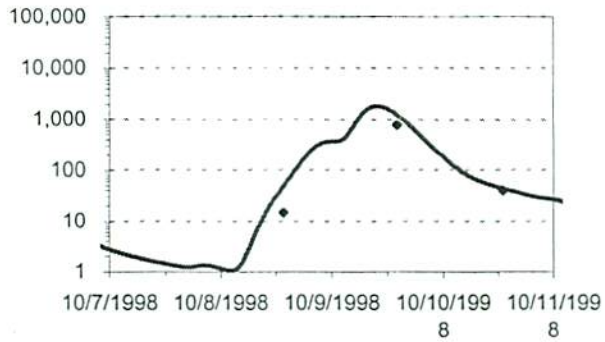
RM 628-Left Bank *E. coli* Concentration



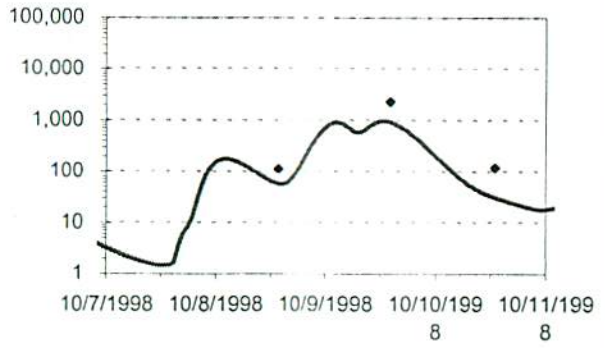
RM 628-Center Channel *E. coli* Concentration



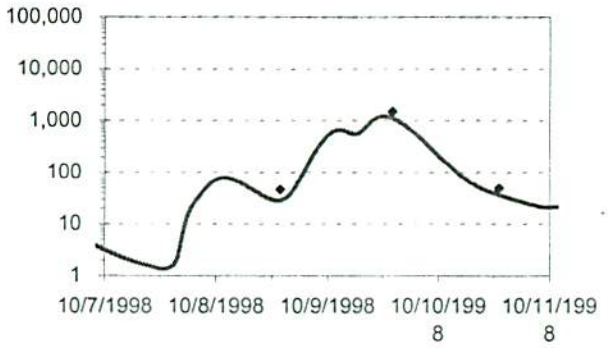
RM 628-Right Bank *E. coli* Concentration



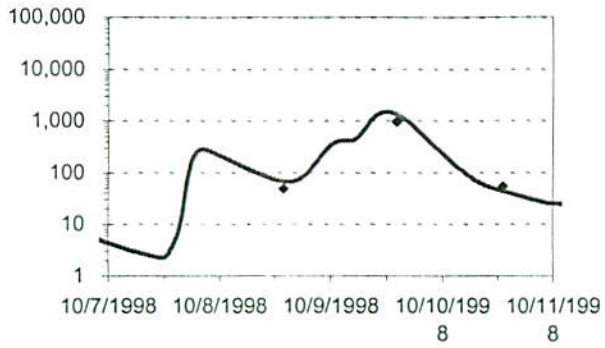
RM 629.9-Left Bank *E. coli* Concentration



RM 629.9-Center Channel *E. coli* Concentration



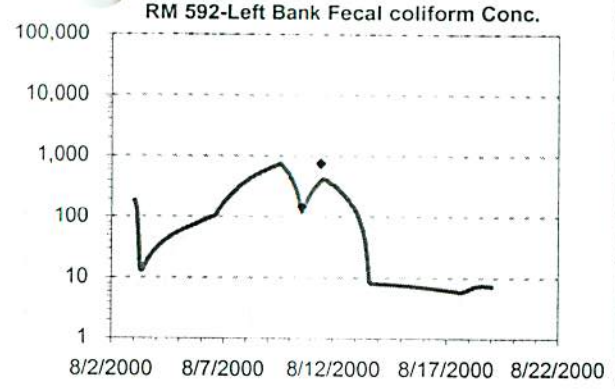
RM 629.9-Right Bank *E. coli* Concentration

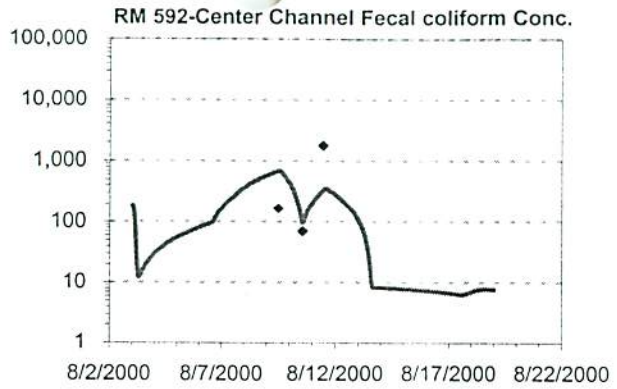


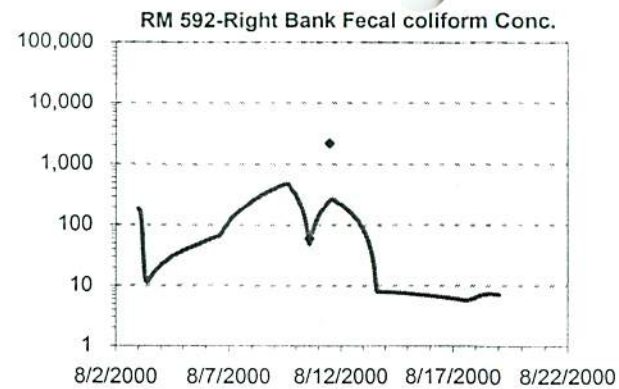
APPENDIX G

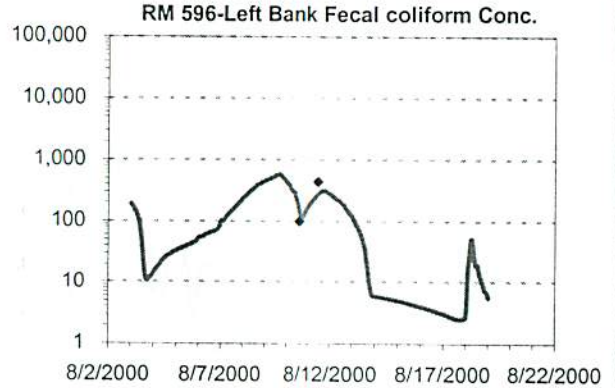
TEMPORAL PLOTS OF MODEL AND OBSERVED DATA BY AREA OF RIVER

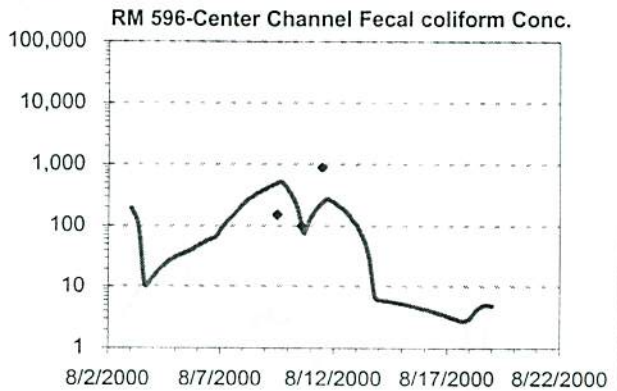
August 2000 Wet Weather Event Fecal Coliform

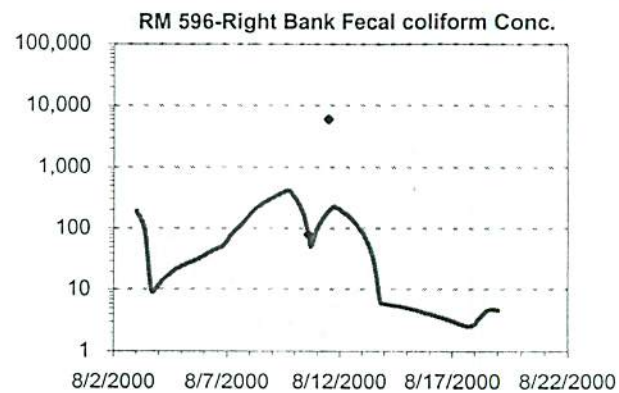

RM 592-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

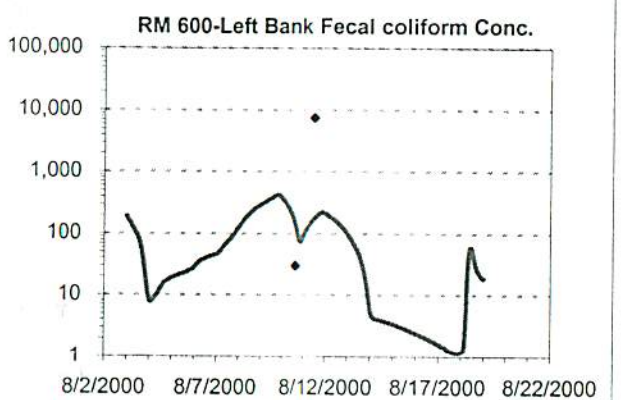

RM 592-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

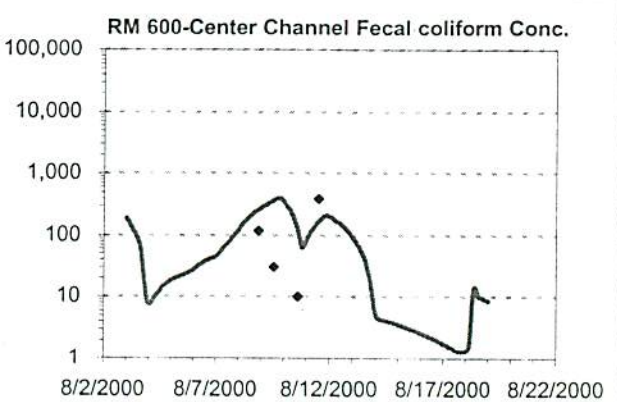

RM 592-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

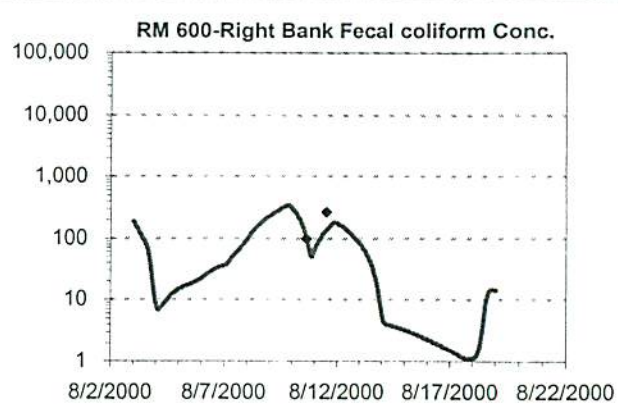

RM 596-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

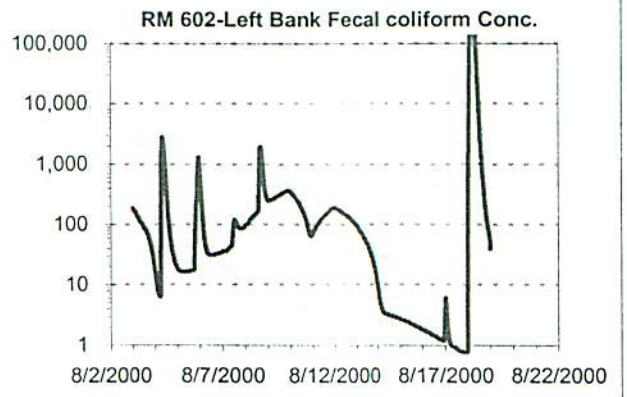

RM 596-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

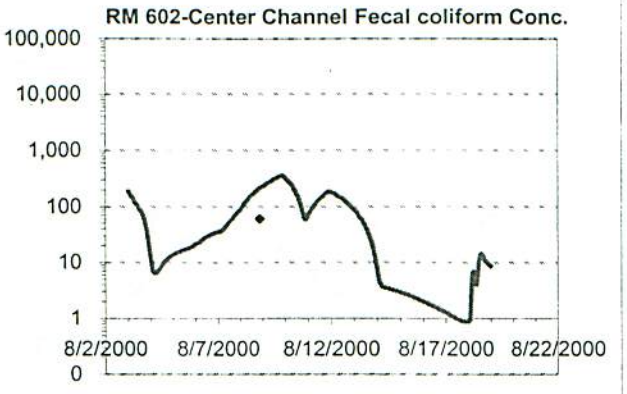

RM 596-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

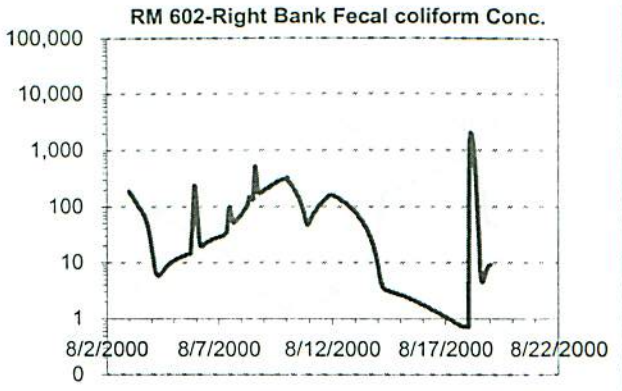

RM 600-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

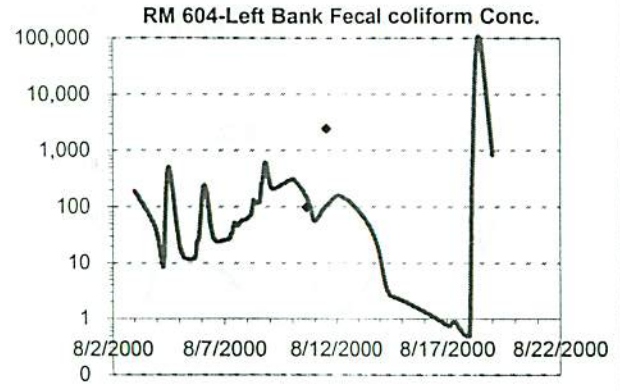

RM 600-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

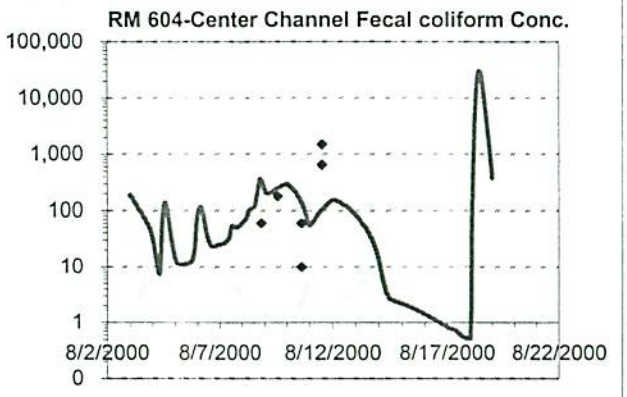

RM 600-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

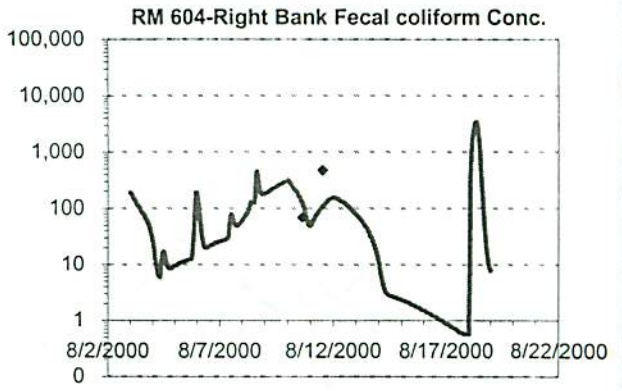

RM 602-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

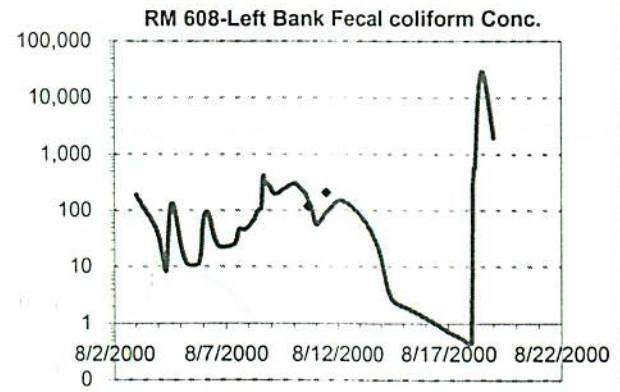

RM 602-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

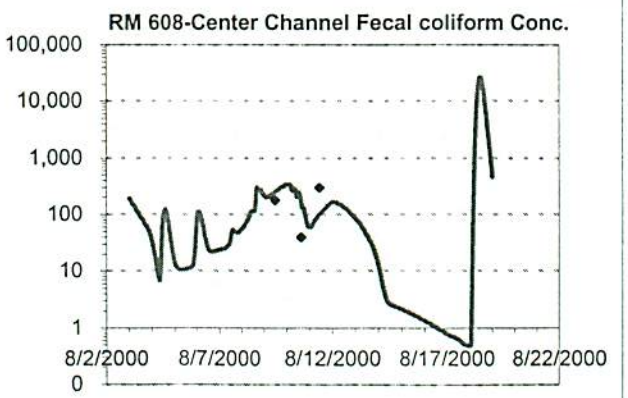

RM 602-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

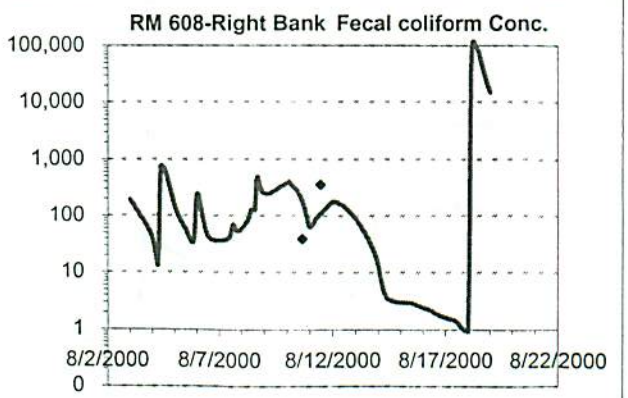

RM 604-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

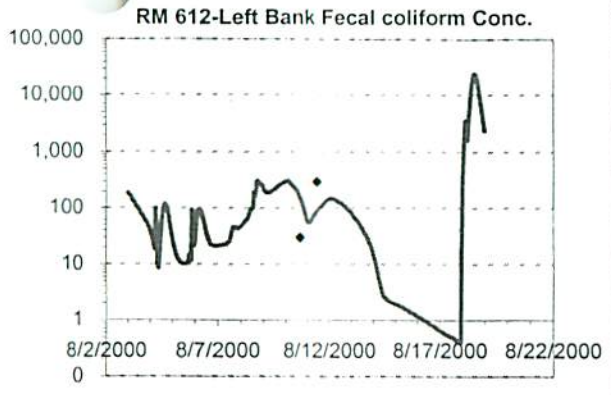

RM 604-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

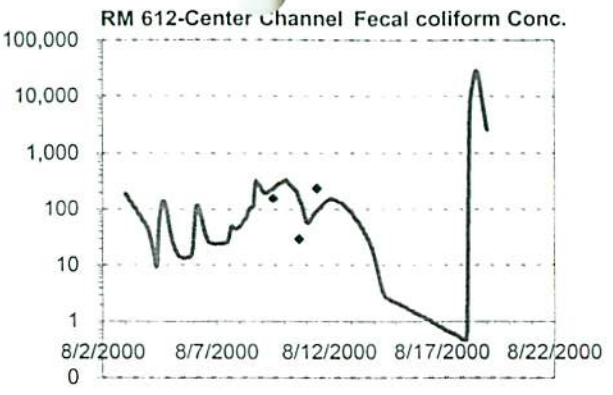

RM 604-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

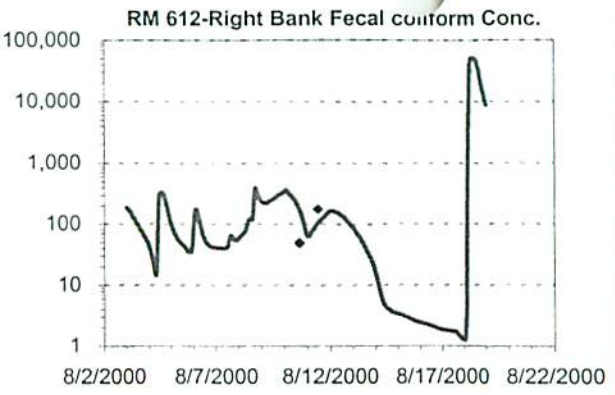

RM 608-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

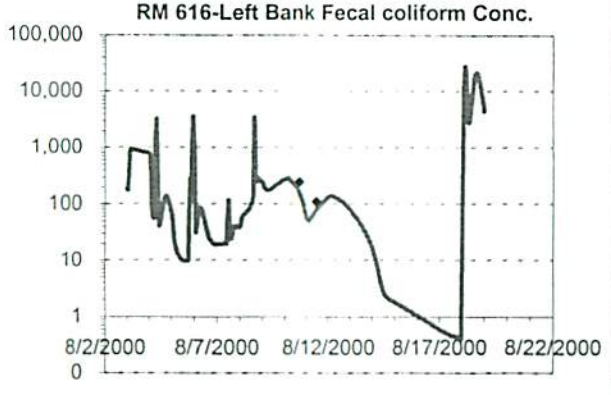

RM 608-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

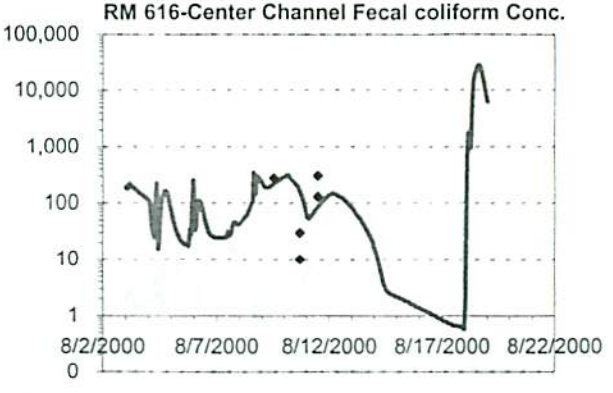

RM 608-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

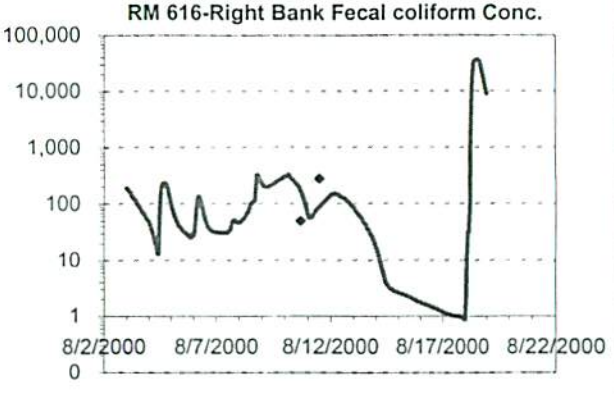

RM 612-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

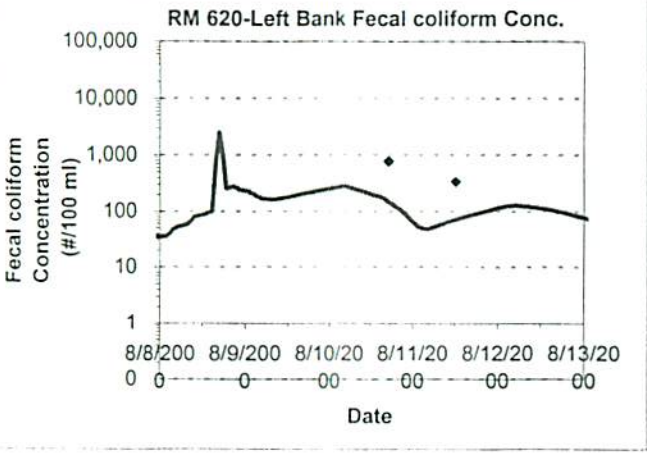

RM 612-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

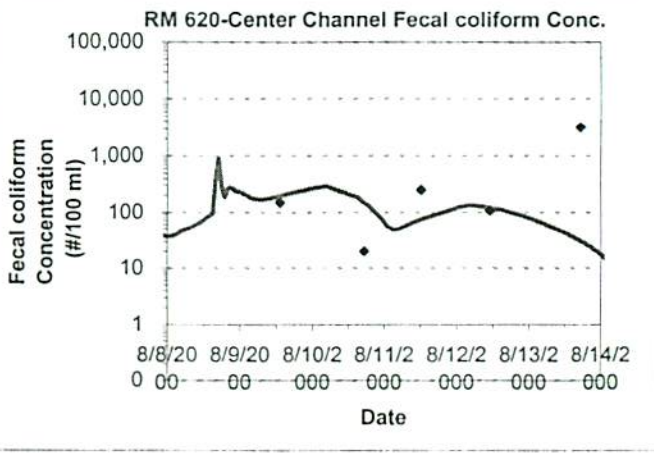

RM 612-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

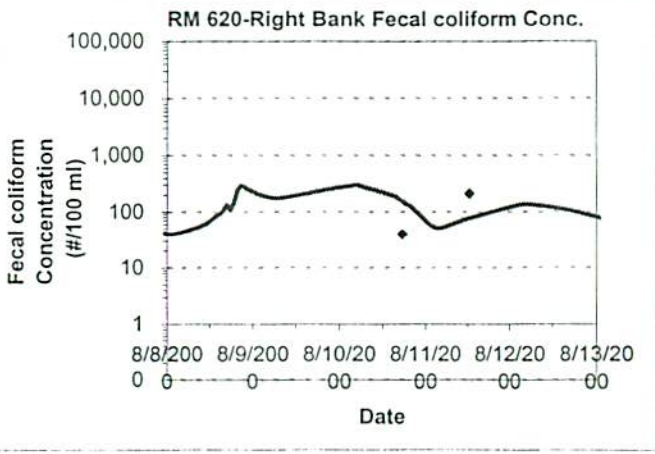

RM 616-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

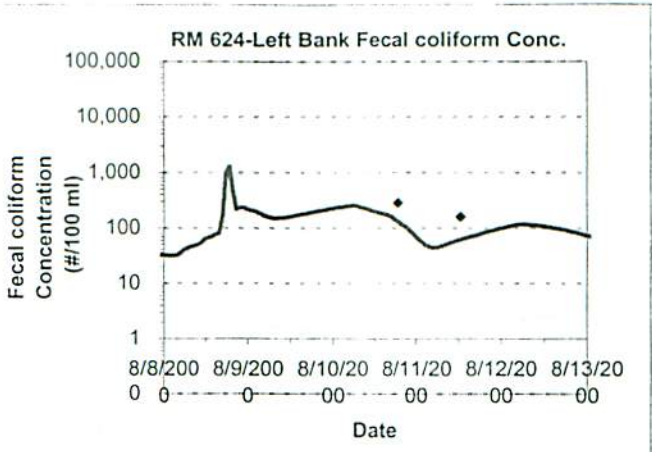

RM 616-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

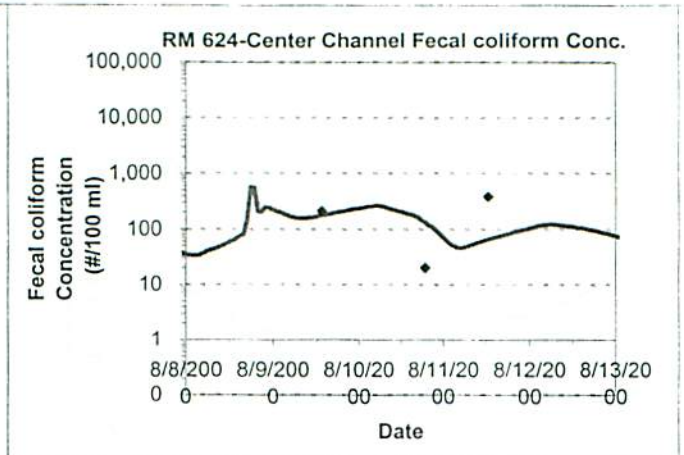

RM 616-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

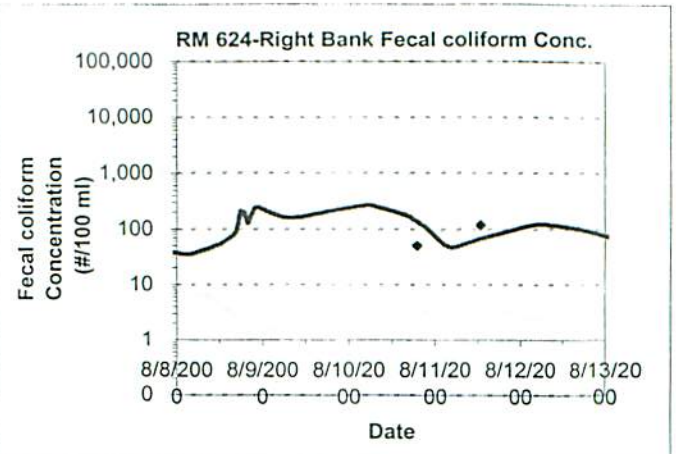

RM 620-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
0
8/8/200 8/9/200 8/10/20 8/11/20 8/12/20 8/13/20
0 0 0 00 00 00 00
Date

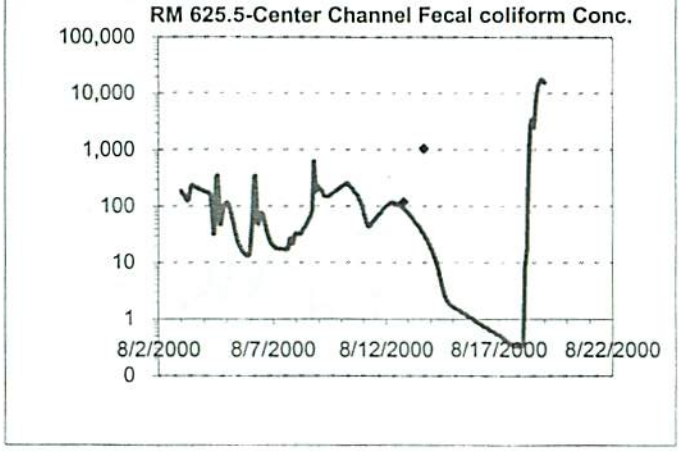

RM 620-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
0
8/8/20 8/9/20 8/10/2 8/11/2 8/12/2 8/13/2 8/14/2
00 00 000 000 000 000 000
Date

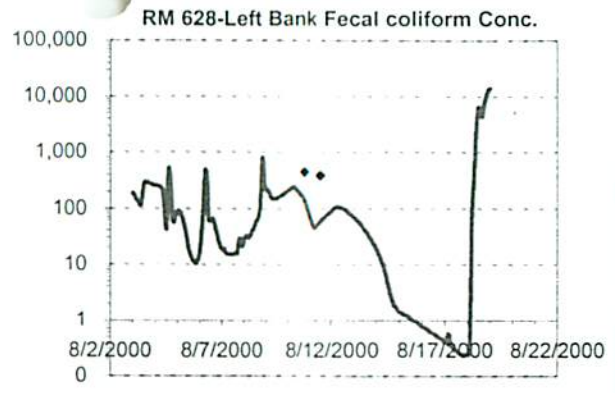

RM 620-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
0
8/8/200 8/9/200 8/10/20 8/11/20 8/12/20 8/13/20
0 0 0 00 00 00 00
Date

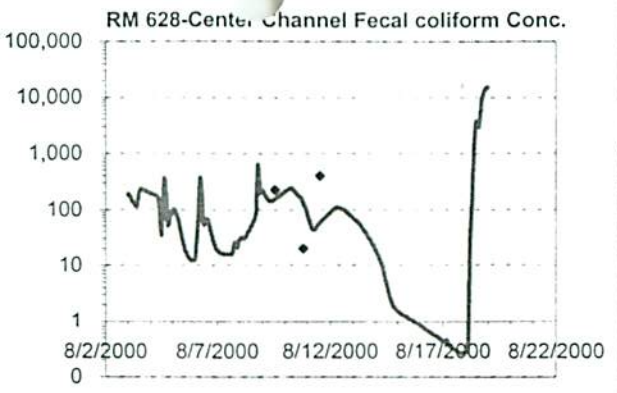

RM 624-Left Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
0
8/8/2000
8/9/2000
8/10/2000
8/11/2000
8/12/2000
8/13/2000
Date

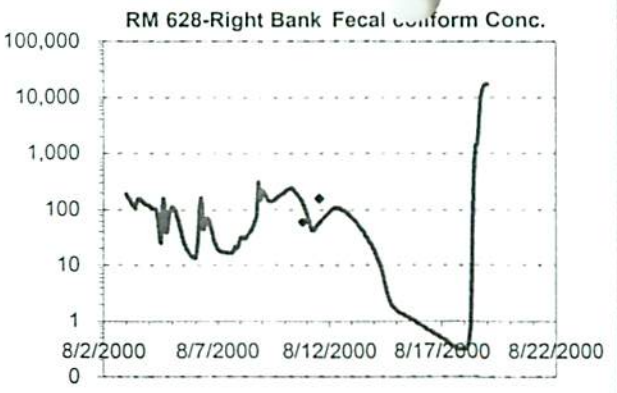

RM 624-Center Channel Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
0
8/8/2000
8/9/2000
8/10/2000
8/11/2000
8/12/2000
8/13/2000
Date

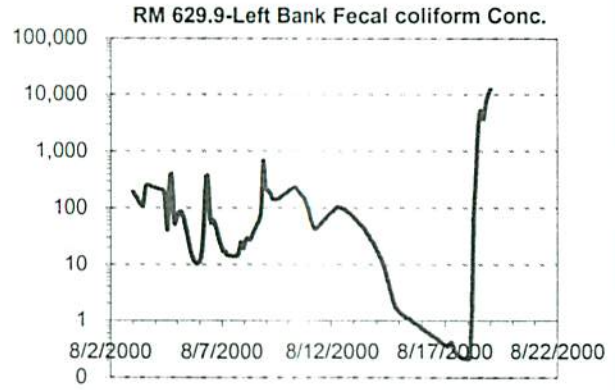

RM 624-Right Bank Fecal coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
0
8/8/2000
8/9/2000
8/10/2000
8/11/2000
8/12/2000
8/13/2000
Date

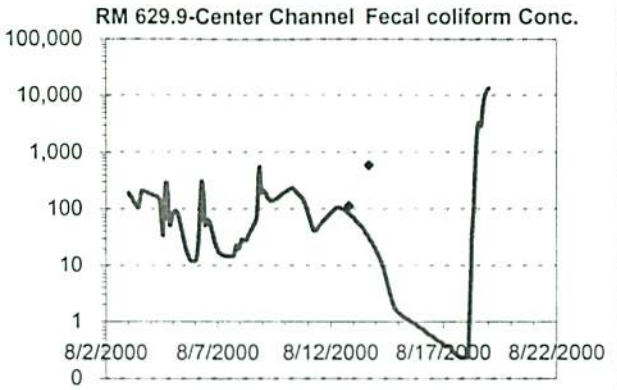

RM 625.5-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

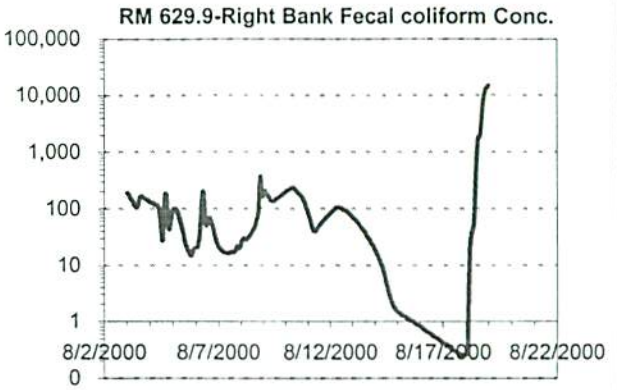

RM 628-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

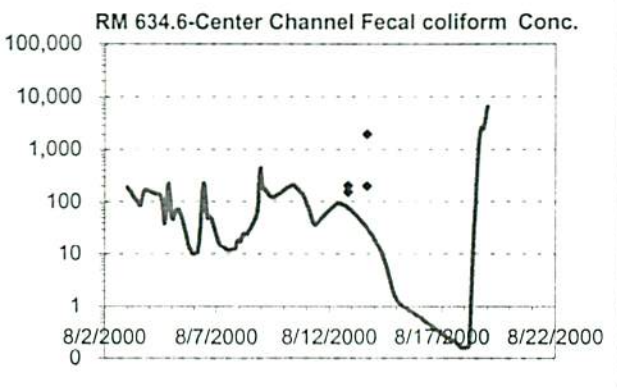

RM 628-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000


RM 628-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000


RM 629.9-Left Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000


RM 629.9-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

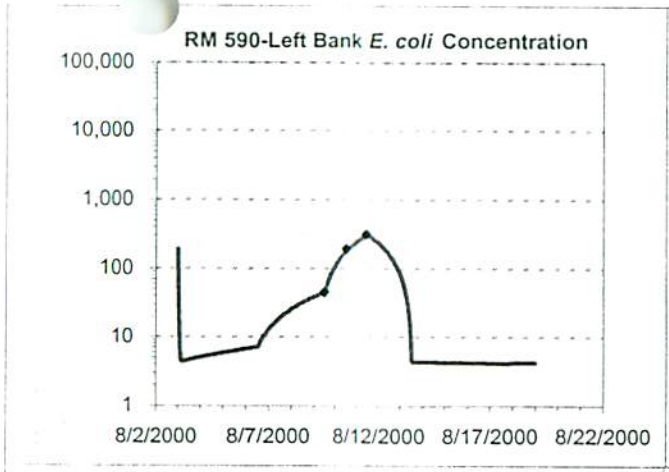

RM 629.9-Right Bank Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

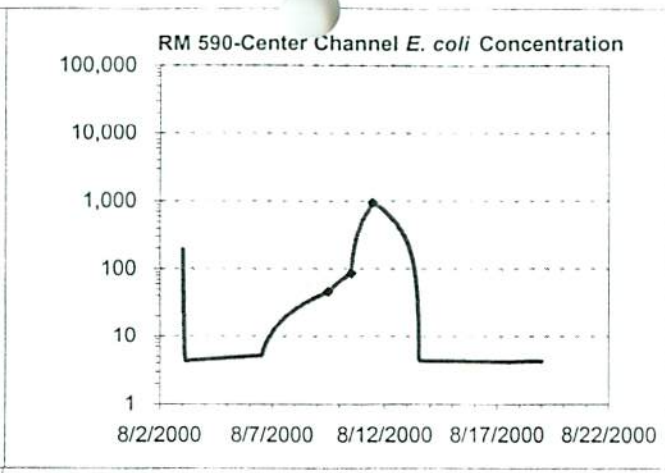

RM 634.6-Center Channel Fecal coliform Conc.
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

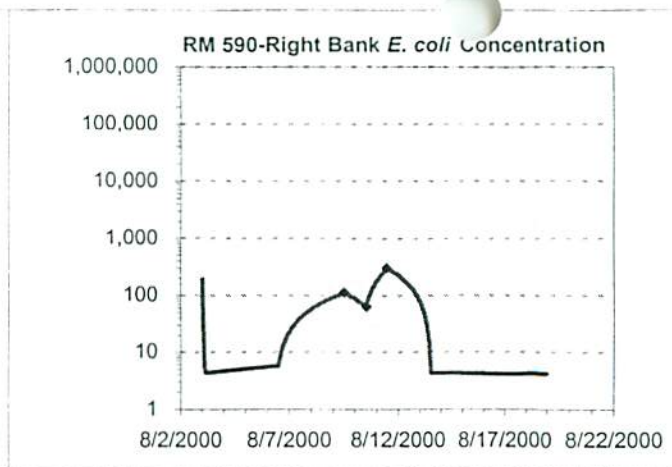
APPENDIX G

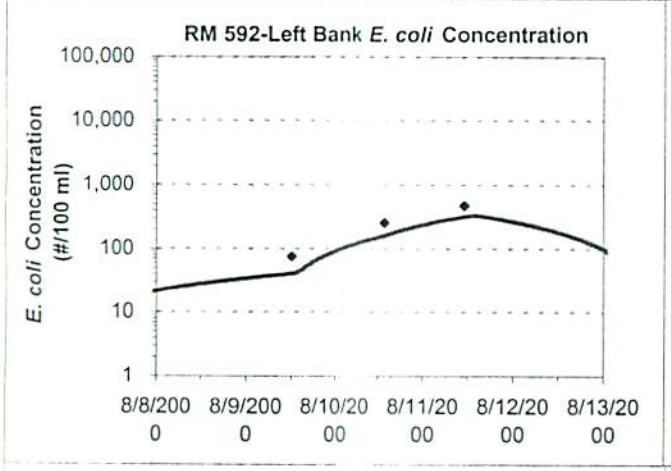
TEMPORAL PLOTS OF MODEL AND OBSERVED DATA BY AREA OF RIVER

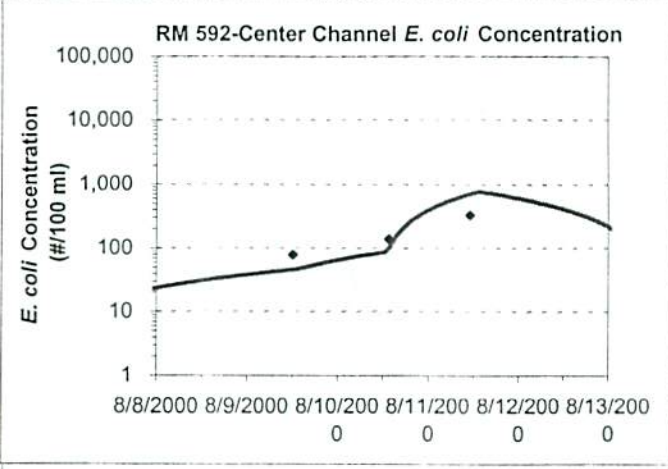
August 2000 Wet Weather Event *E. Coli*

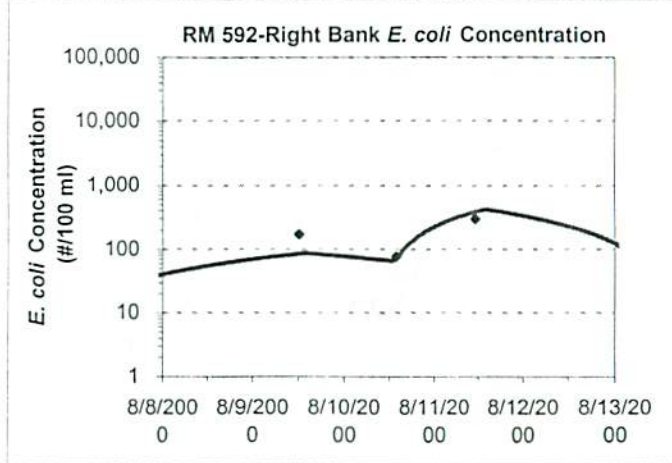

RM 590-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

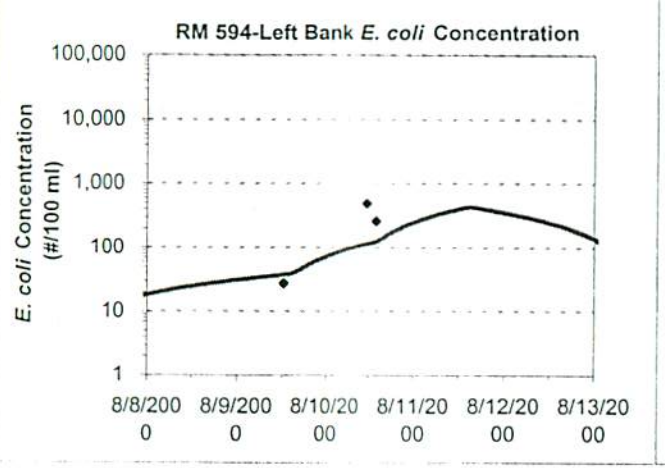

RM 590-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

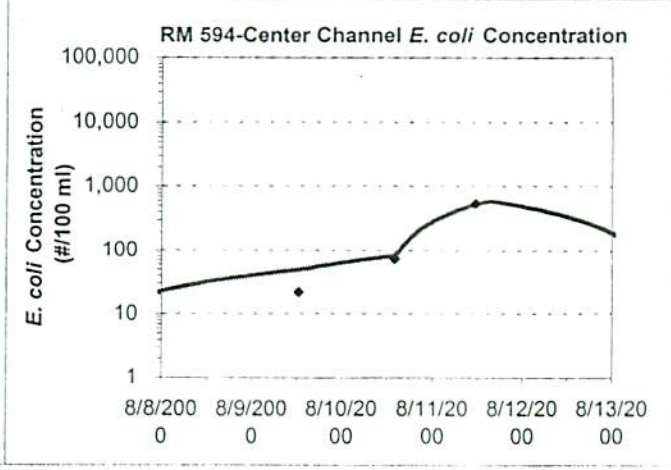

RM 590-Right Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

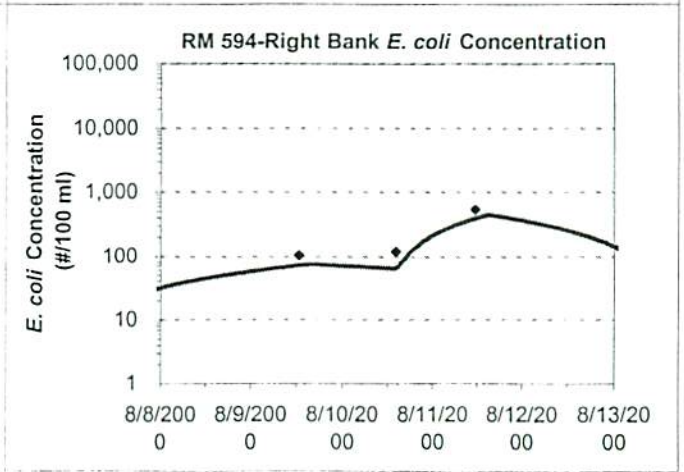

RM 592-Left Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
8/8/2000
8/9/2000
8/10/2000
8/11/2000
8/12/2000
8/13/2000

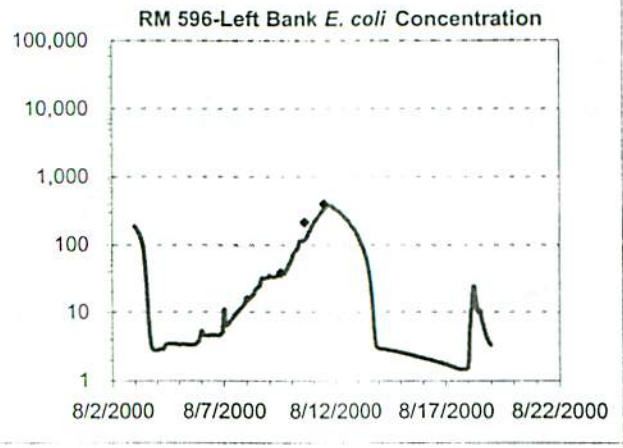

RM 592-Center Channel E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
8/8/2000
8/9/2000
8/10/2000
8/11/2000
8/12/2000
8/13/2000

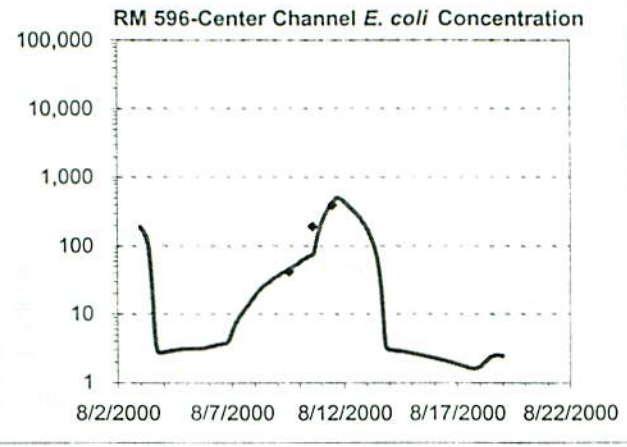

RM 592-Right Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
8/8/2000
8/9/2000
8/10/2000
8/11/2000
8/12/2000
8/13/2000

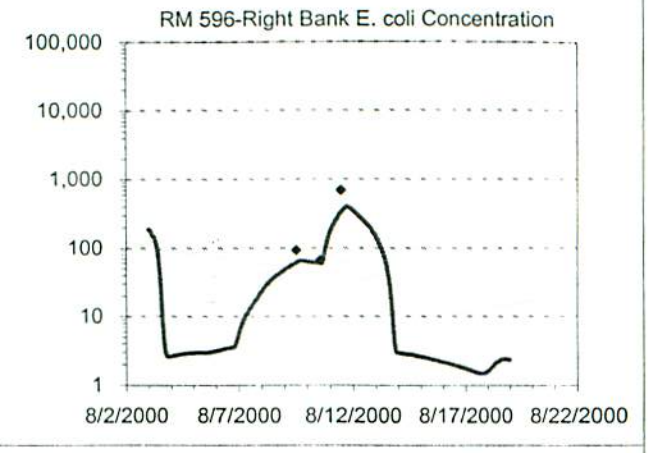

RM 594-Left Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
8/8/2000
8/9/2000
8/10/2000
8/11/2000
8/12/2000
8/13/2000

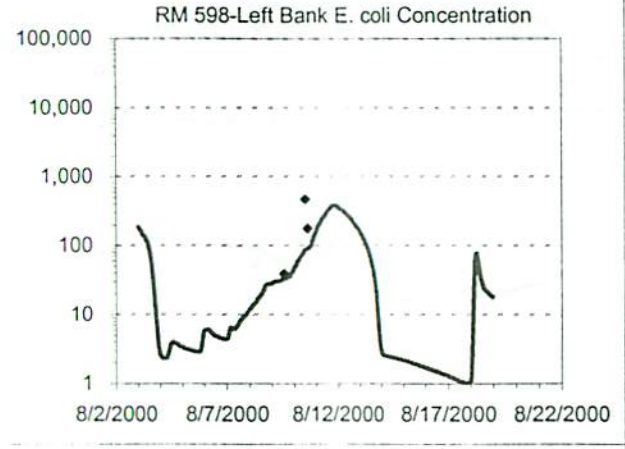

RM 594-Center Channel E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
8/8/2000
8/9/2000
8/10/2000
8/11/2000
8/12/2000
8/13/2000

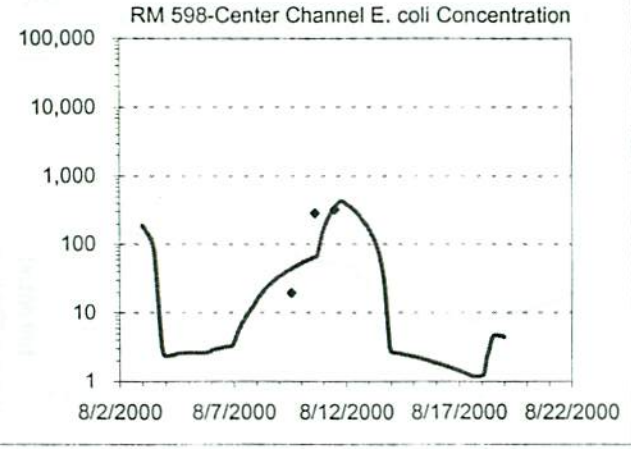

RM 594-Right Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
8/8/2000
8/9/2000
8/10/2000
8/11/2000
8/12/2000
8/13/2000

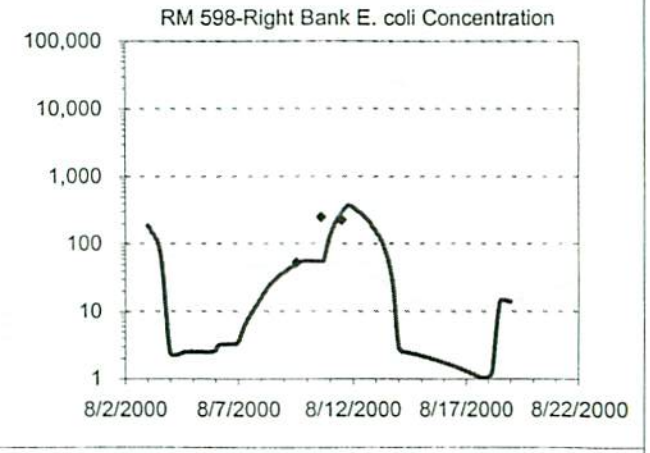

RM 596-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

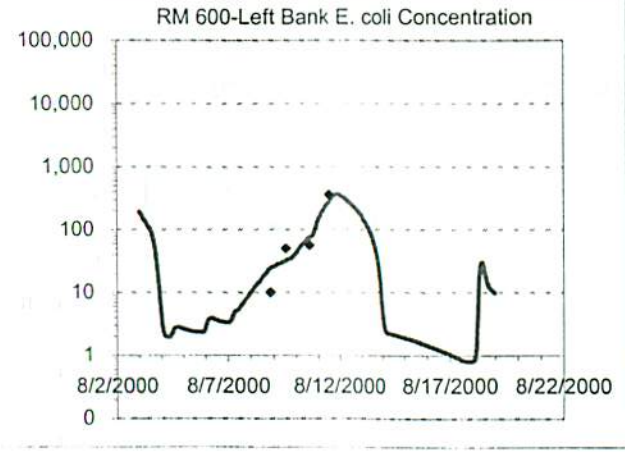

RM 596-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

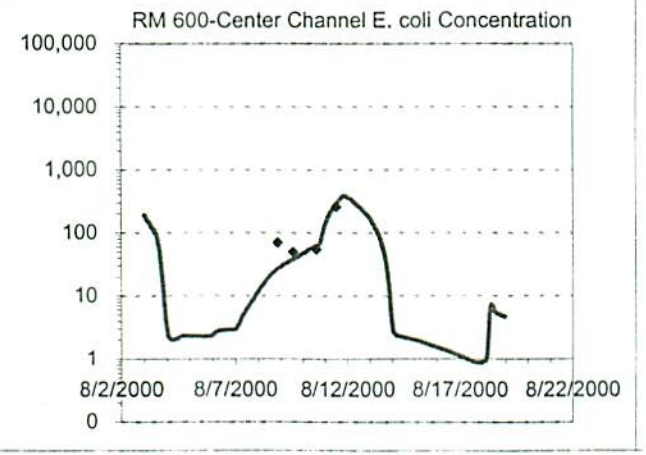

RM 596-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

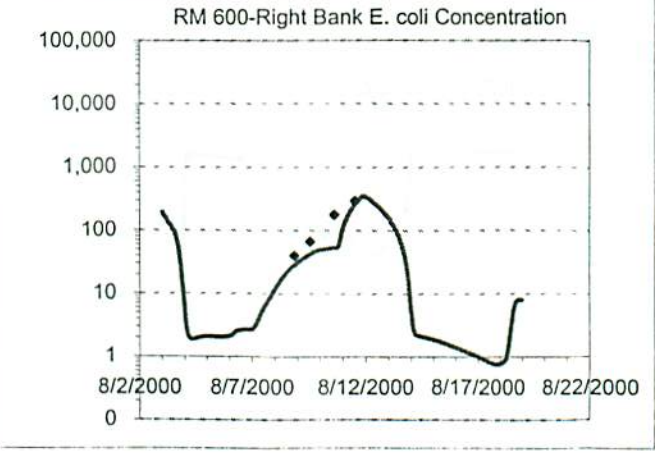

RM 598-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

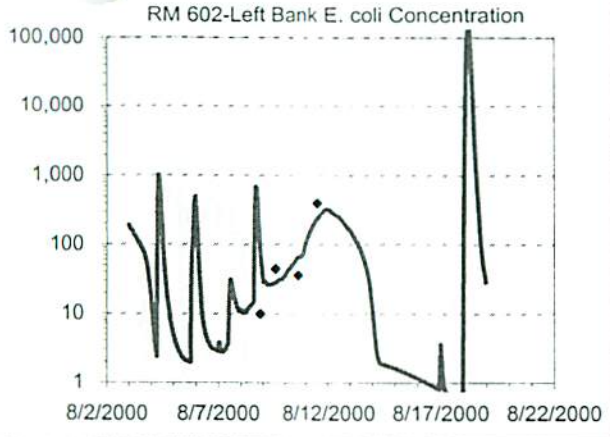

RM 598-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

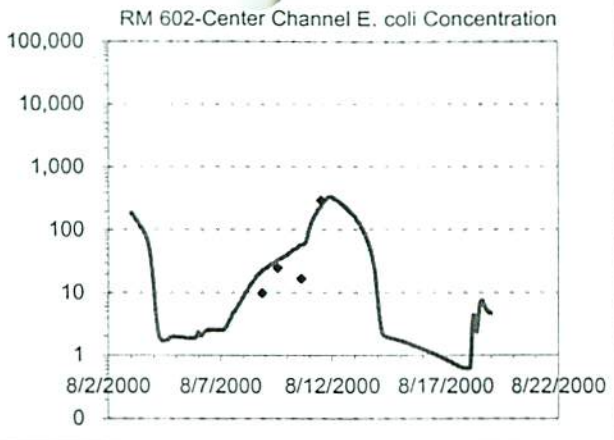

RM 598-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

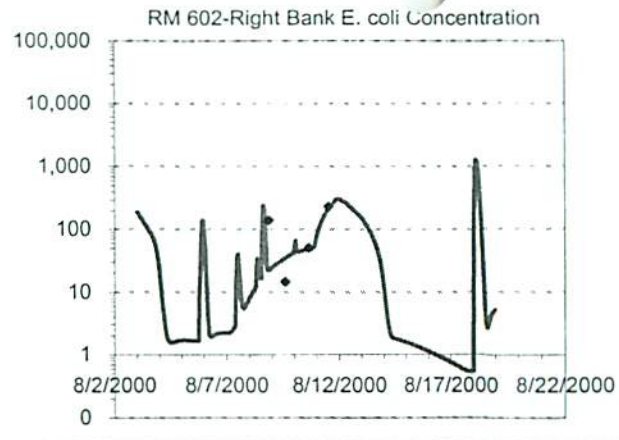

RM 600-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

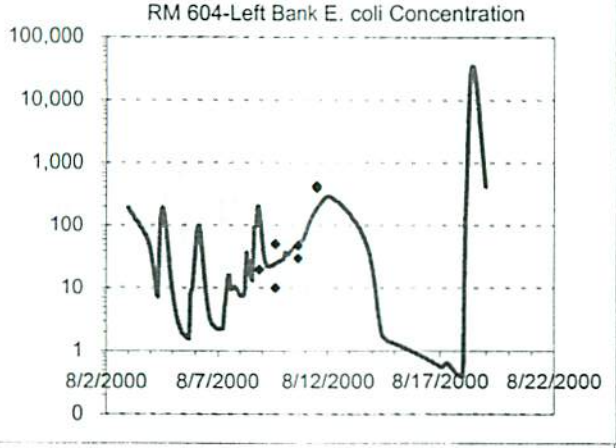

RM 600-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

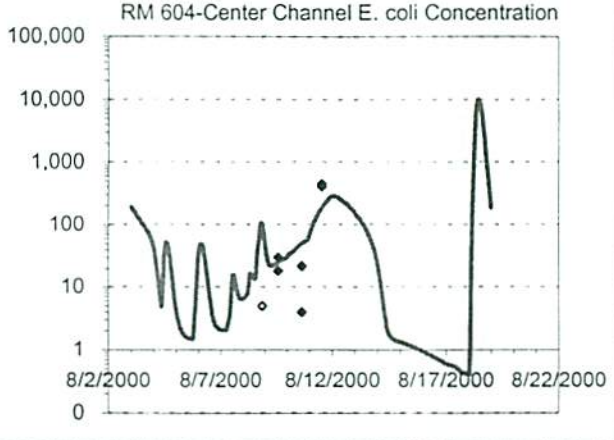

RM 600-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

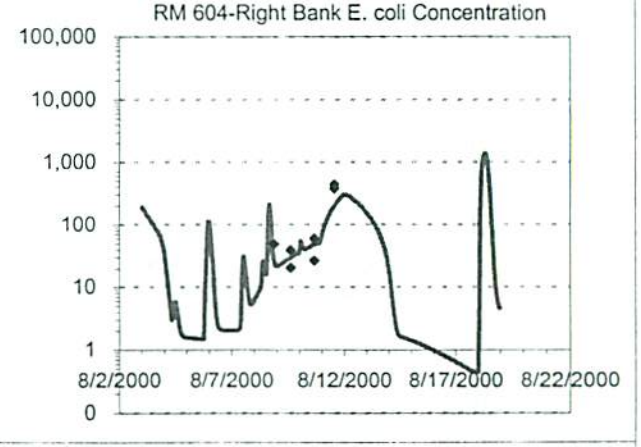

RM 602-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

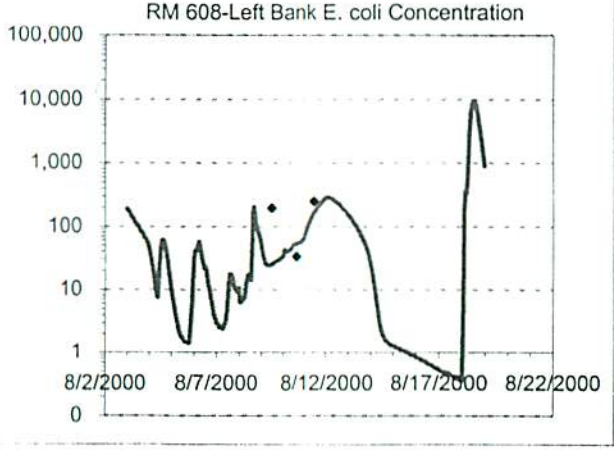

RM 602-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

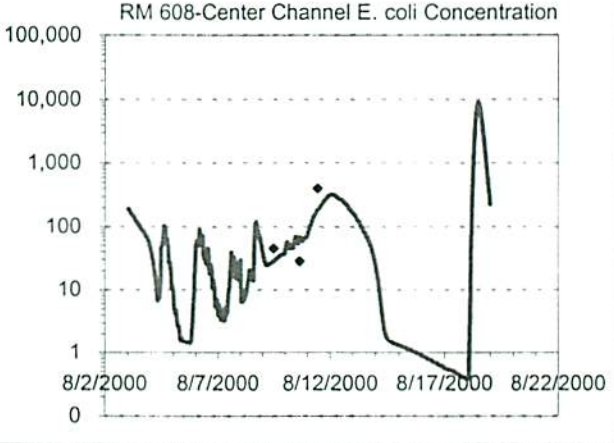

RM 602-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

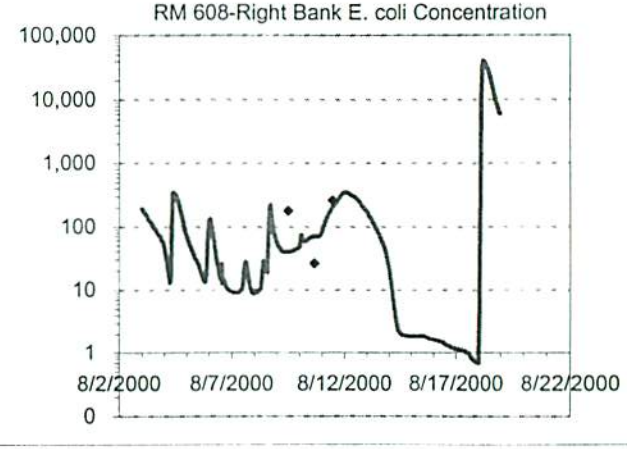

RM 604-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

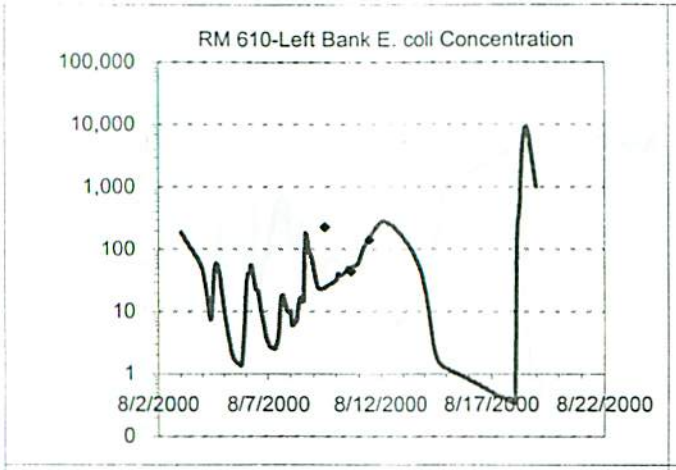

RM 604-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

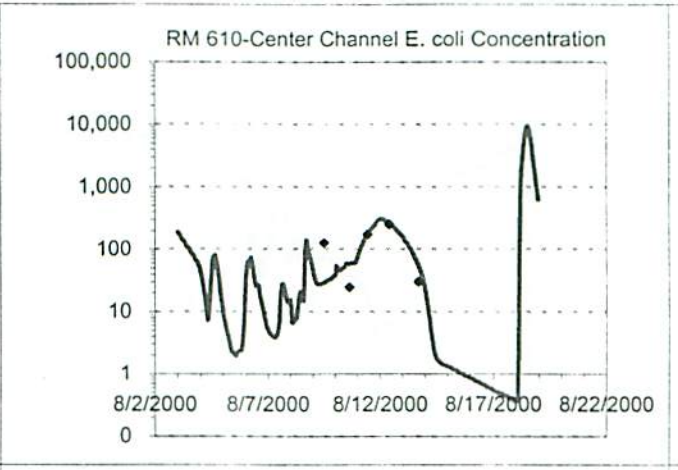

RM 604-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

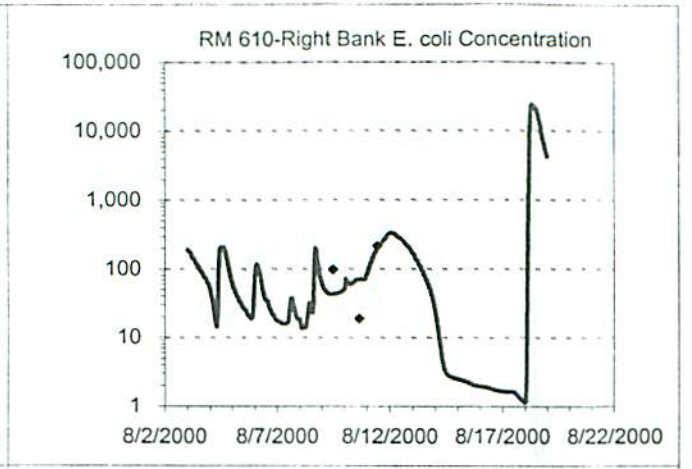

RM 608-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

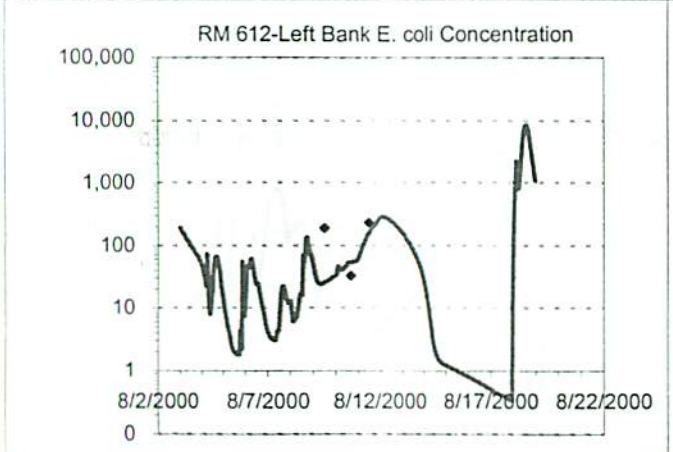

RM 608-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

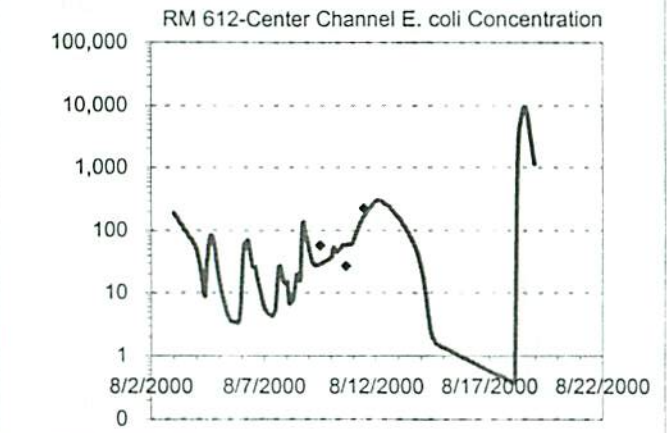

RM 608-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

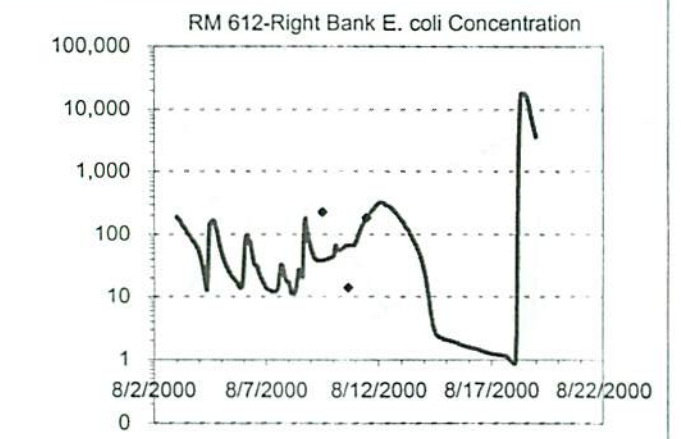

RM 610-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

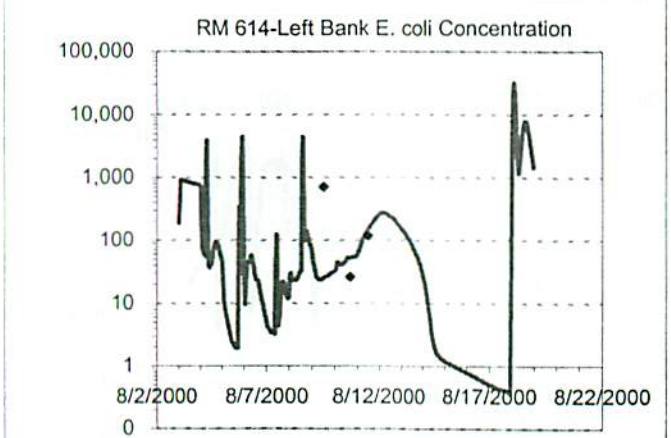

RM 610-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

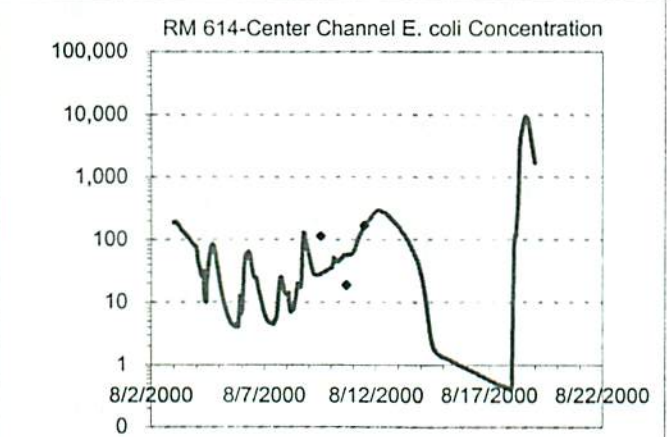

RM 610-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

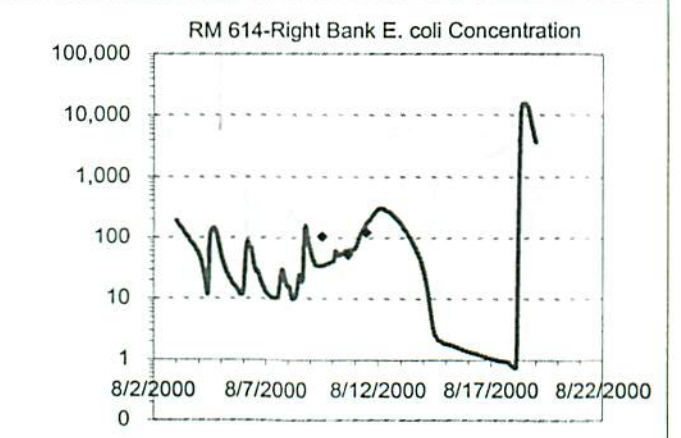

RM 612-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

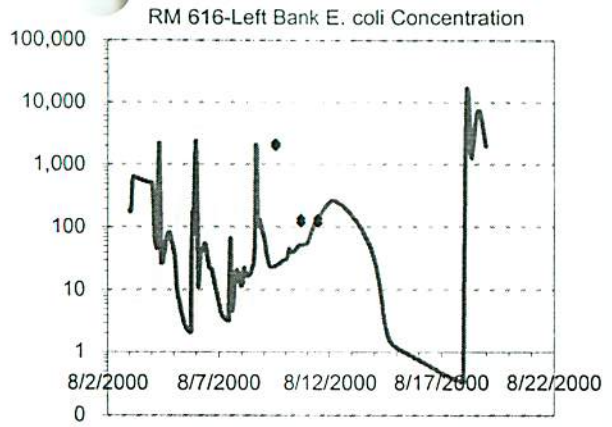

RM 612-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

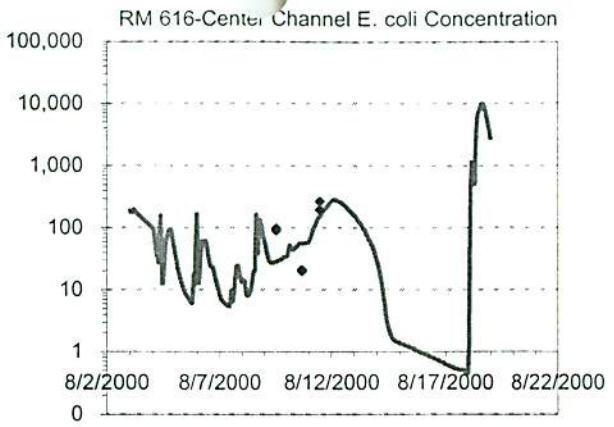

RM 612-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

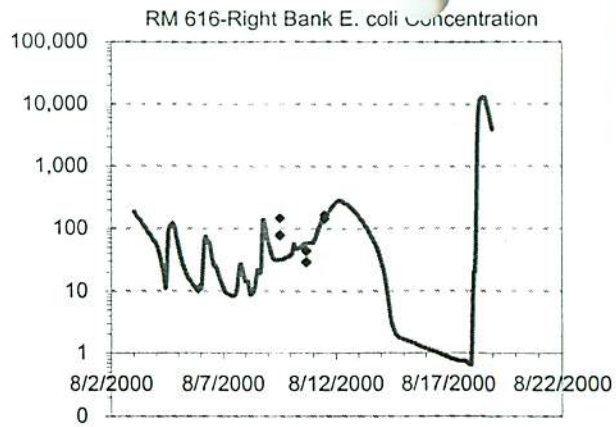

RM 614-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

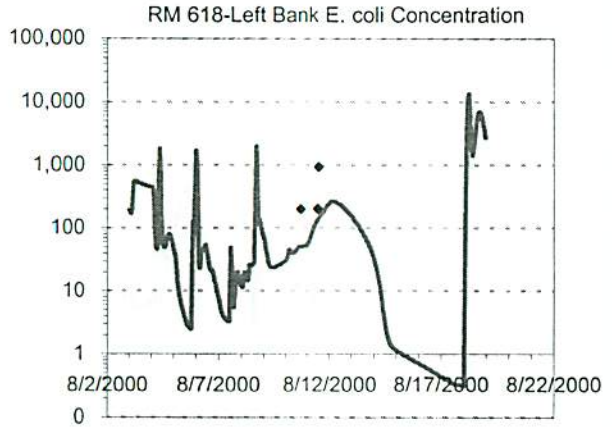

RM 614-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

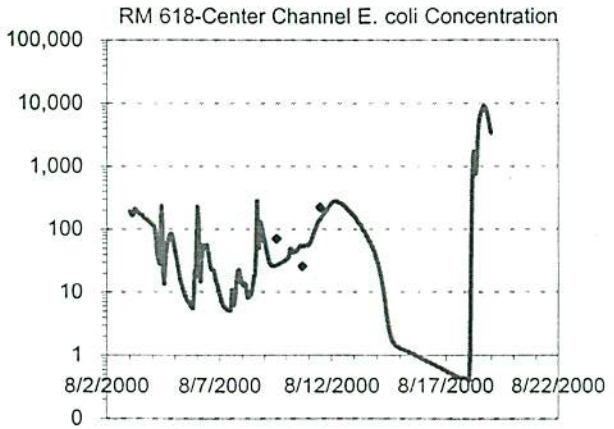

RM 614-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

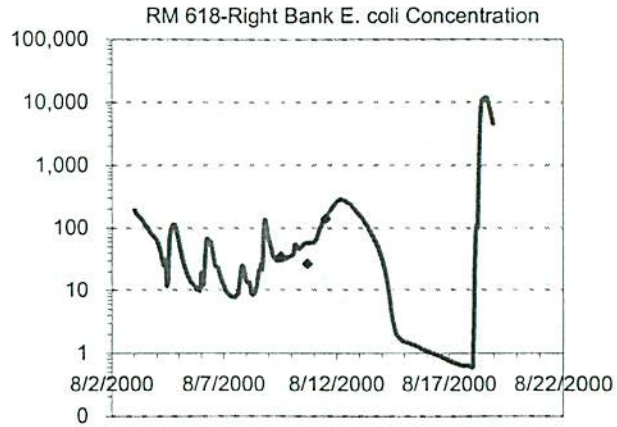

RM 616-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

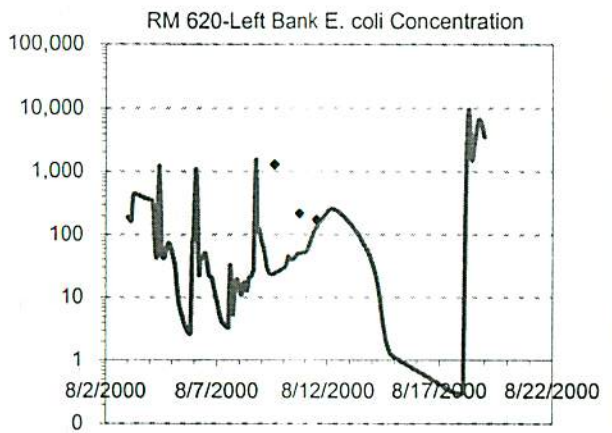

RM 616-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

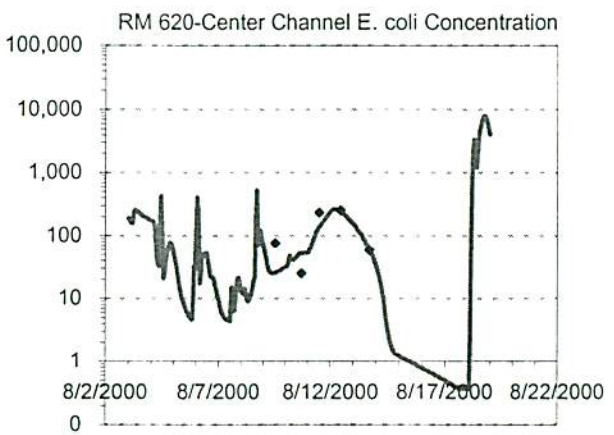

RM 616-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

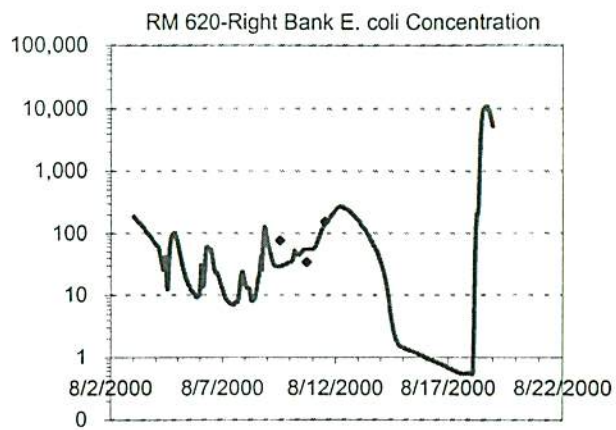

RM 618-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

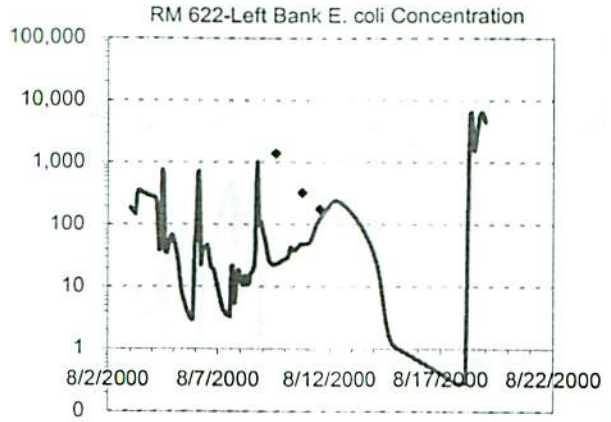

RM 618-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

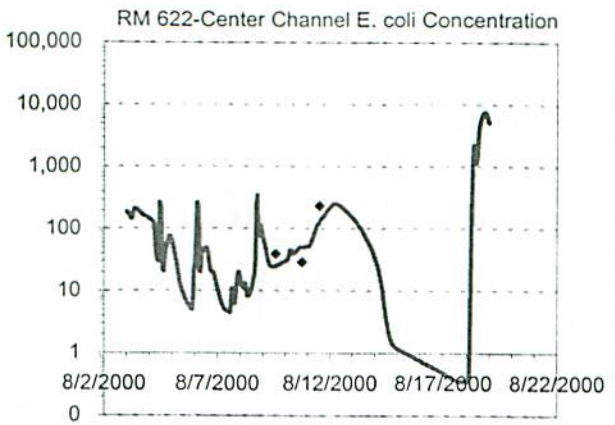

RM 618-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

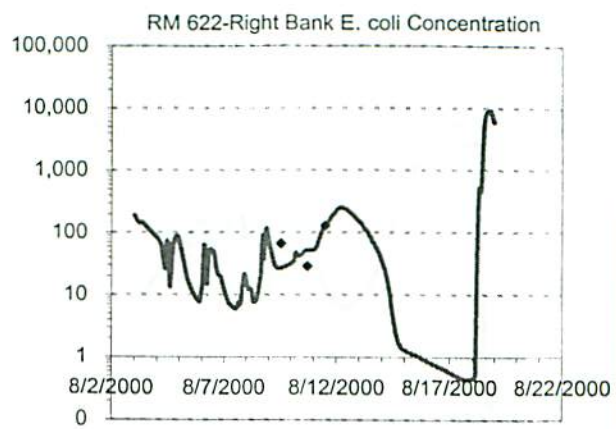

RM 620-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

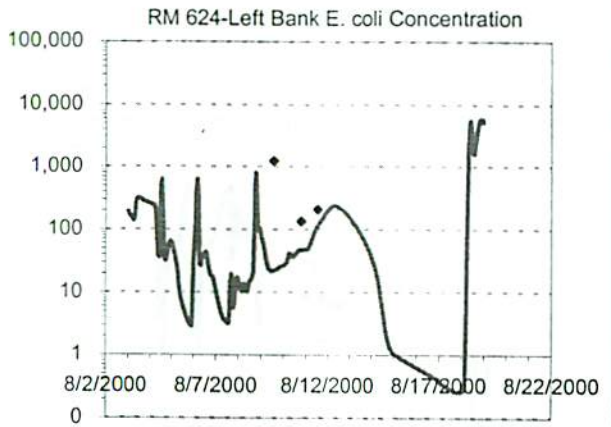

RM 620-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

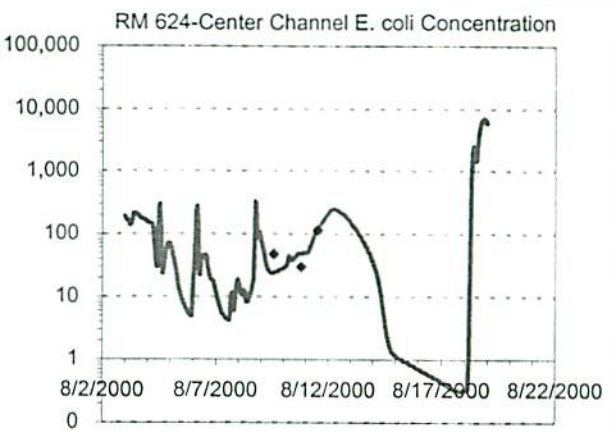

RM 620-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

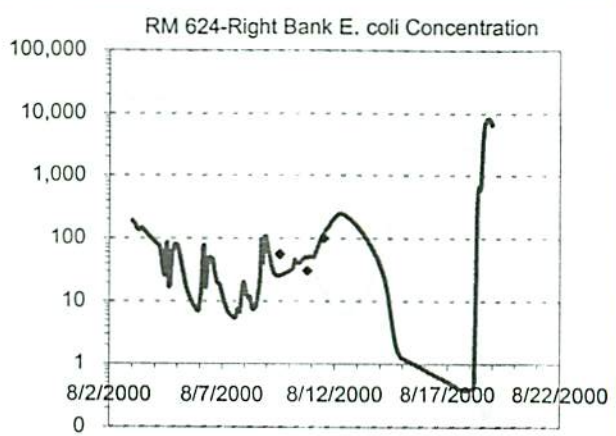

RM 622-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

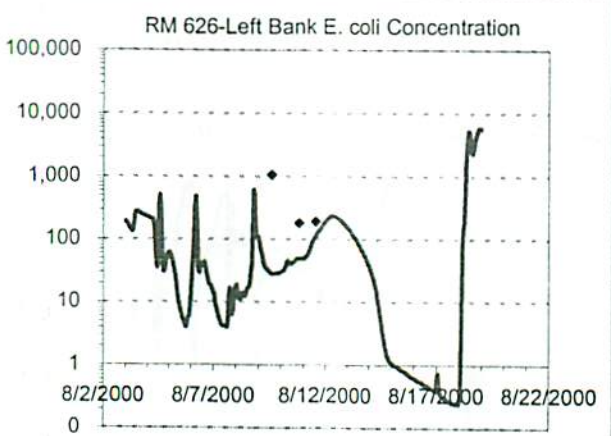

RM 622-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

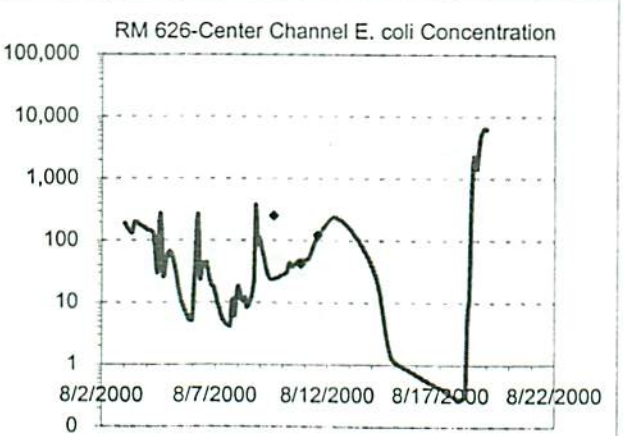

RM 622-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

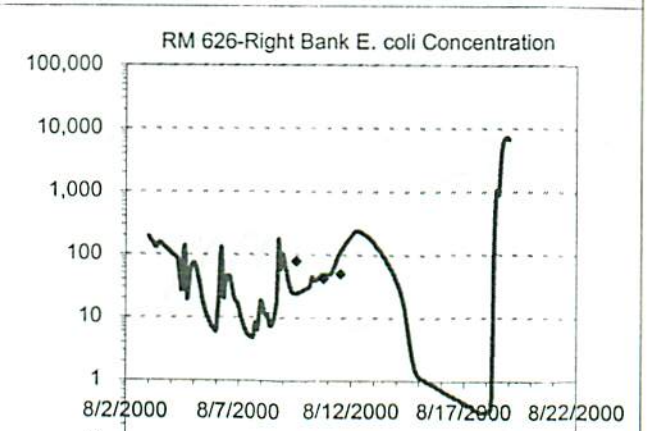

RM 624-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

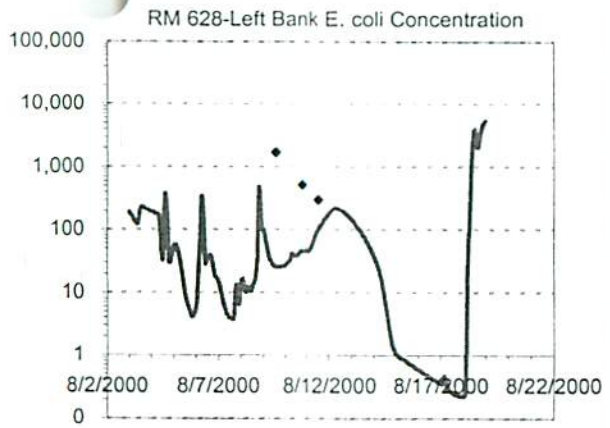

RM 624-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

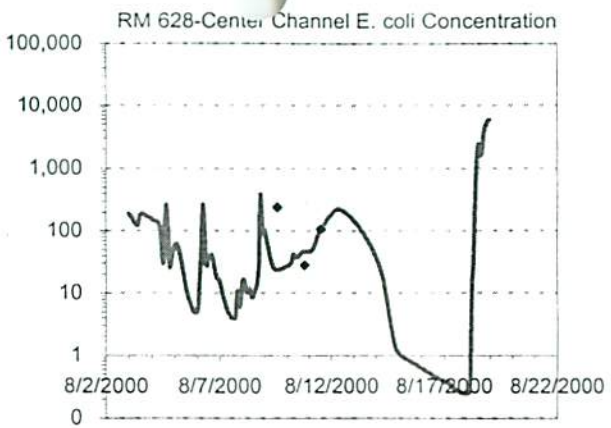

RM 624-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

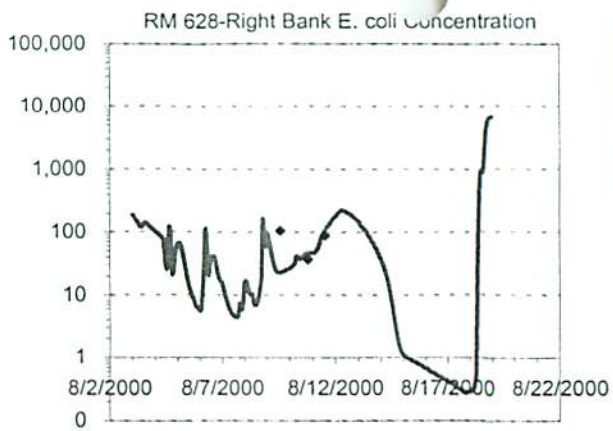

RM 626-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

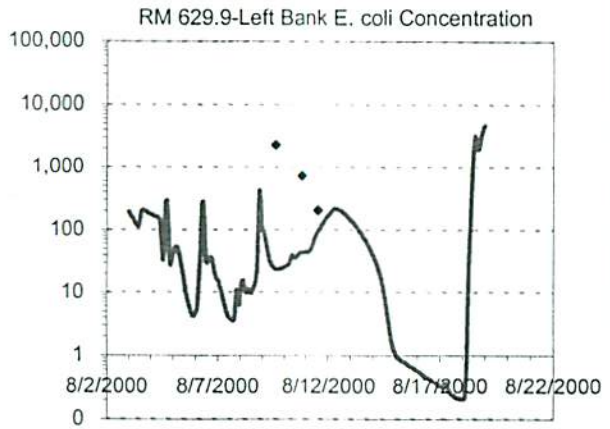

RM 626-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

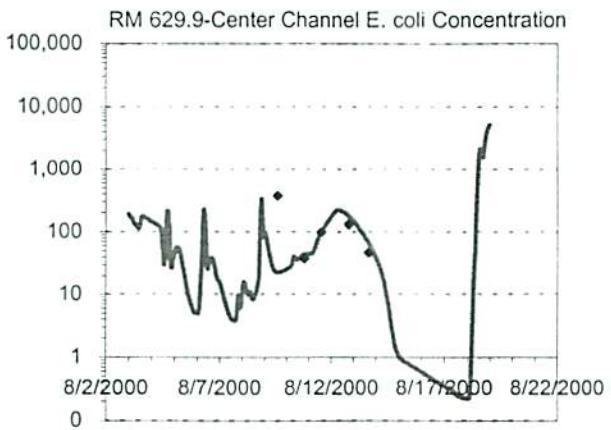

RM 626-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

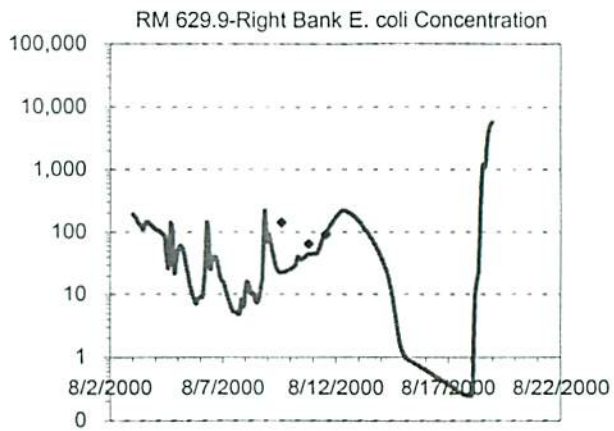

RM 628-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

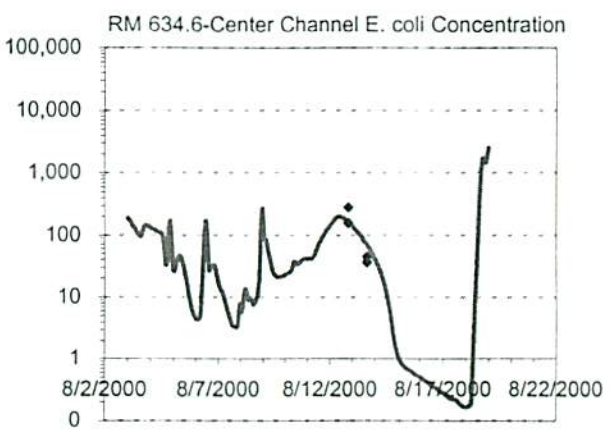

RM 628-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000


RM 628-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000


RM 629.9-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000


RM 629.9-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

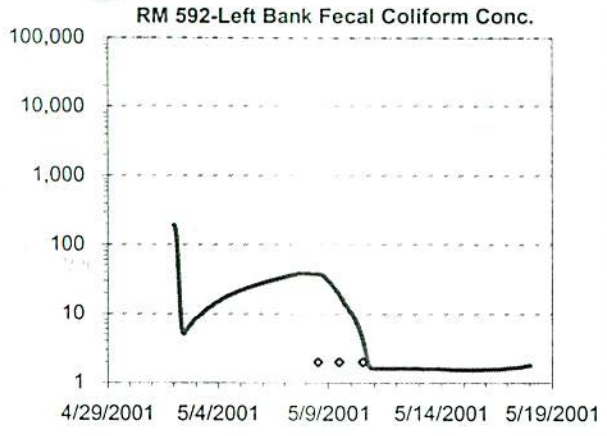

RM 629.9-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

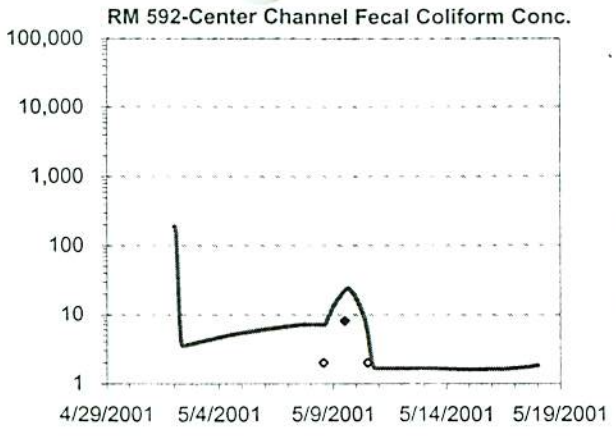

RM 634.6-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
8/2/2000
8/7/2000
8/12/2000
8/17/2000
8/22/2000

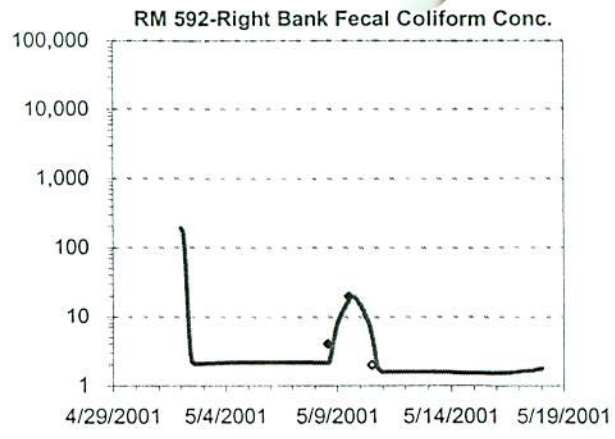
APPENDIX G

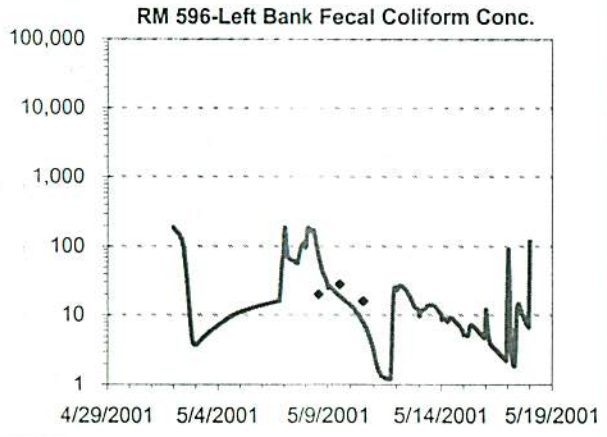
TEMPORAL PLOTS OF MODEL AND OBSERVED DATA BY AREA OF RIVER

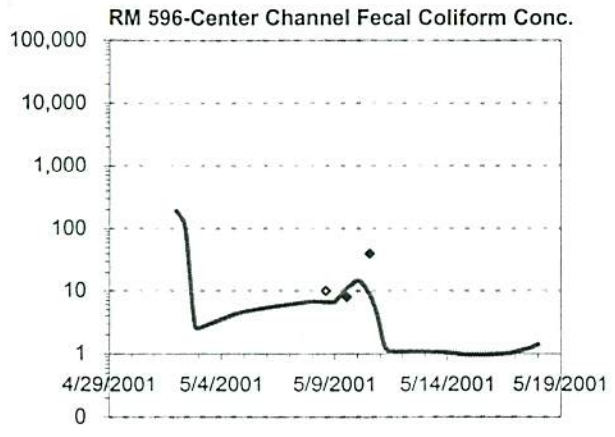
May 2001 Wet Weather Event Fecal Coliform

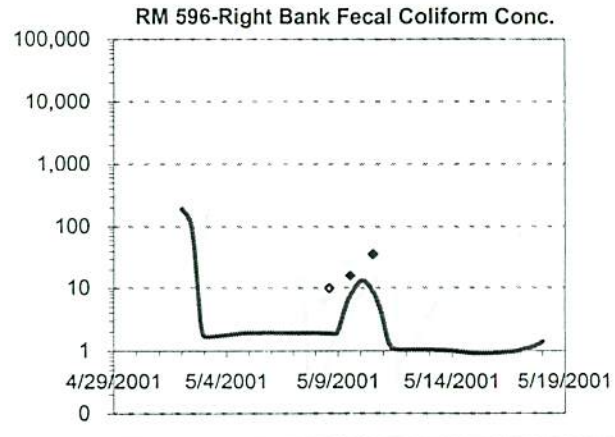

RM 592-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

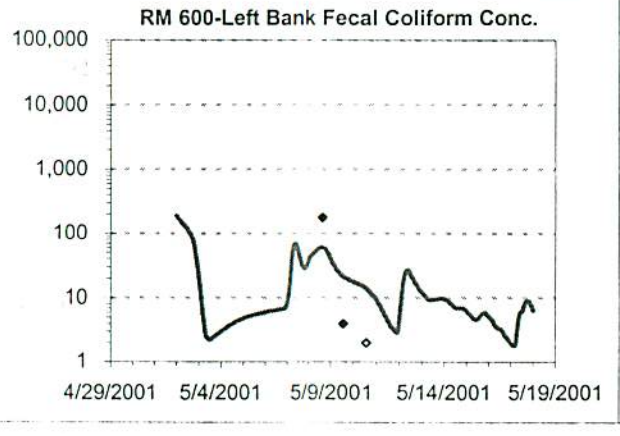

RM 592-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

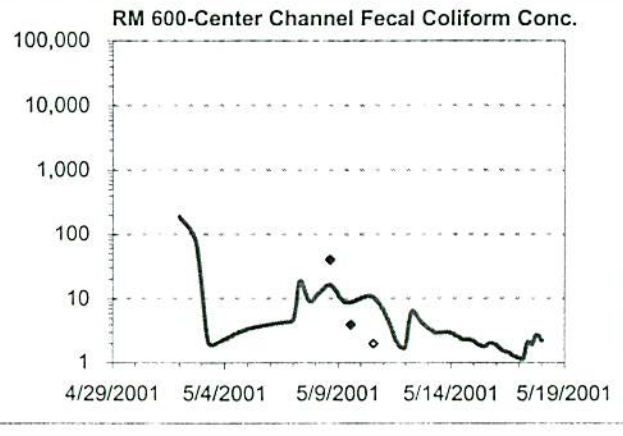

RM 592-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

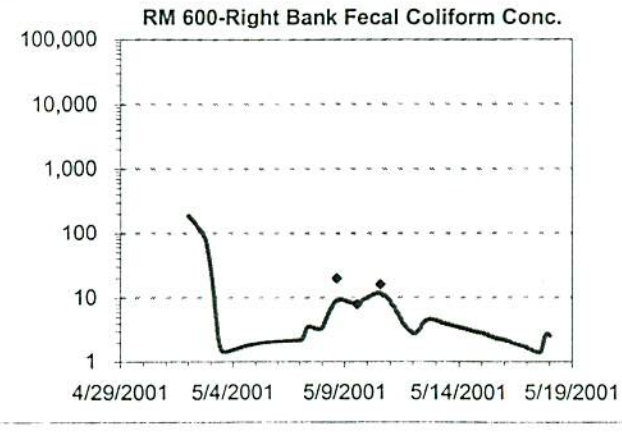

RM 596-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

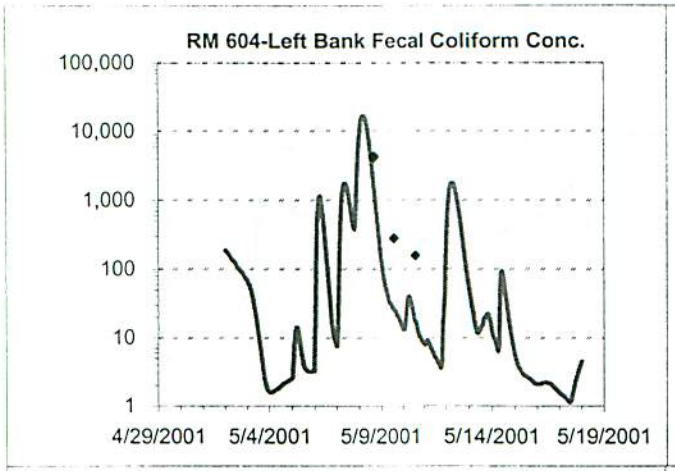

RM 596-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

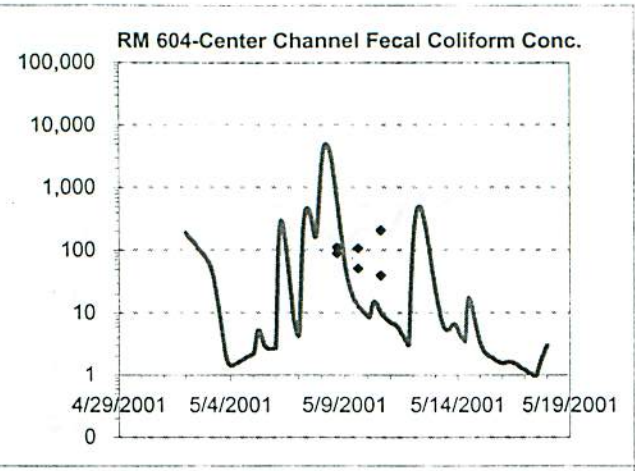

RM 596-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

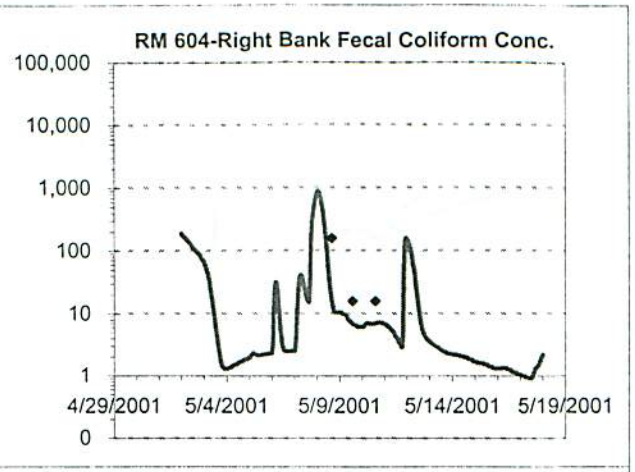

RM 600-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

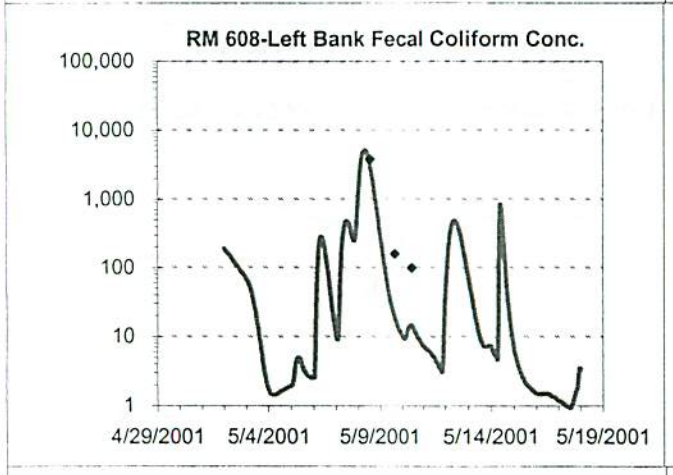

RM 600-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

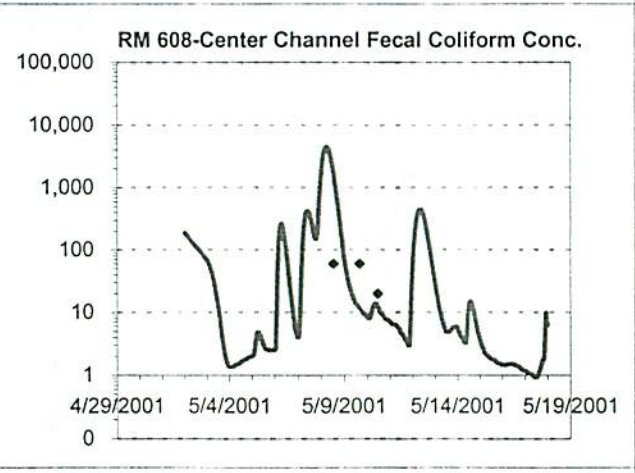

RM 600-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

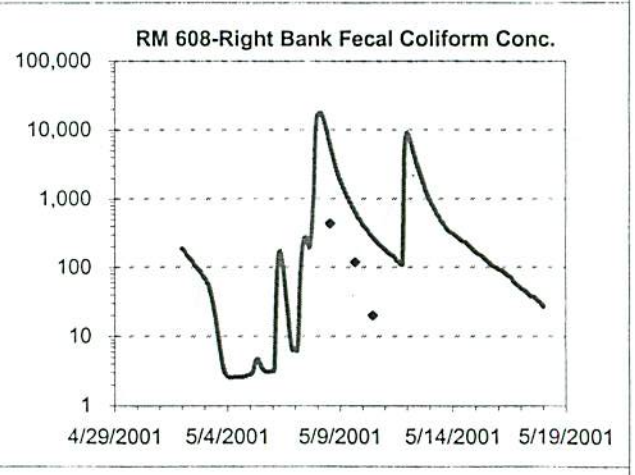

RM 604-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

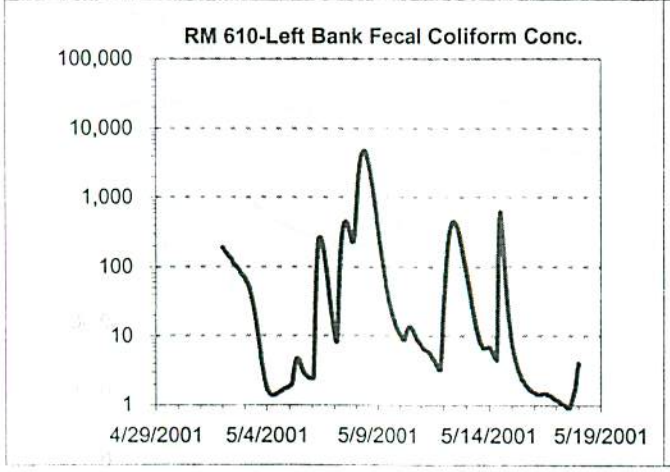

RM 604-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

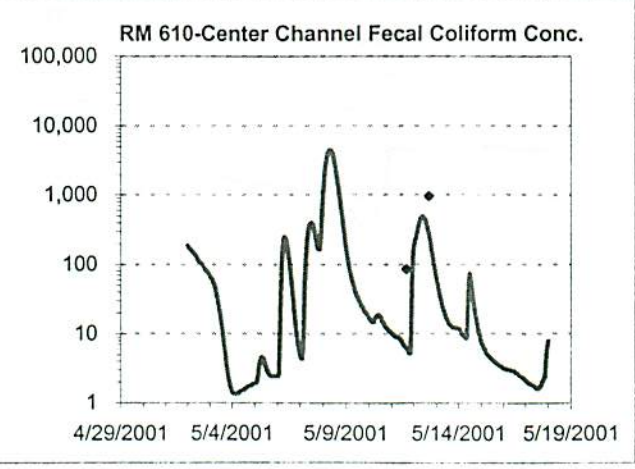

RM 604-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

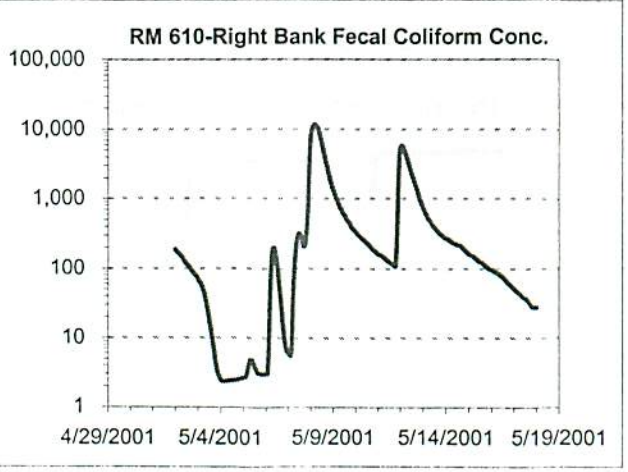

RM 608-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

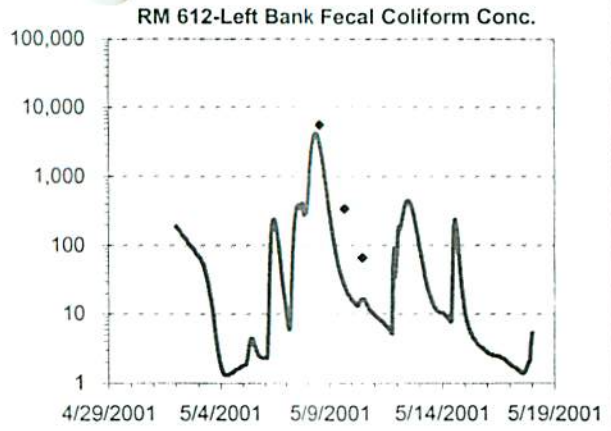

RM 608-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

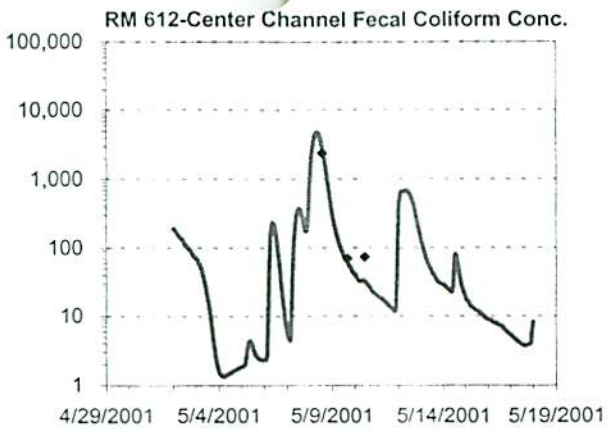

RM 608-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

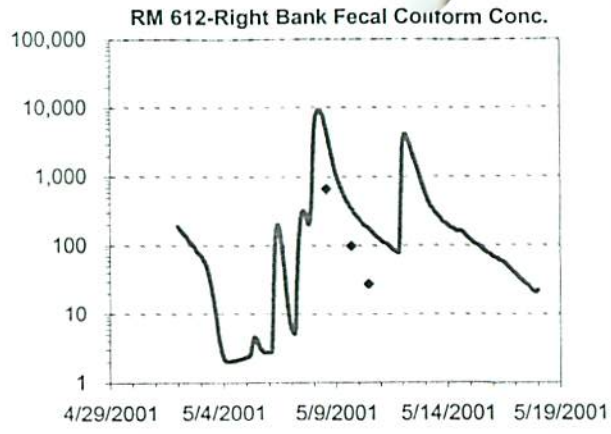

RM 610-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

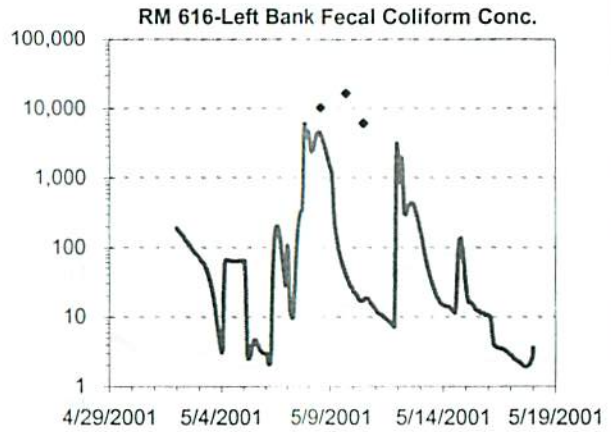

RM 610-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

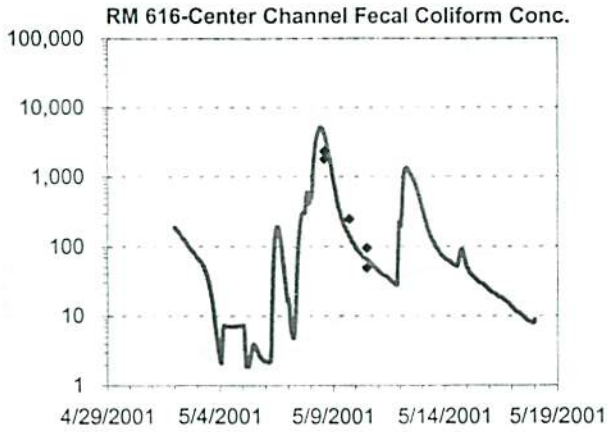

RM 610-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

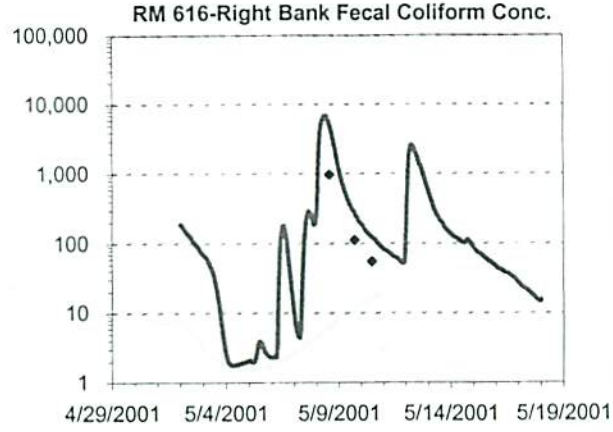

RM 612-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

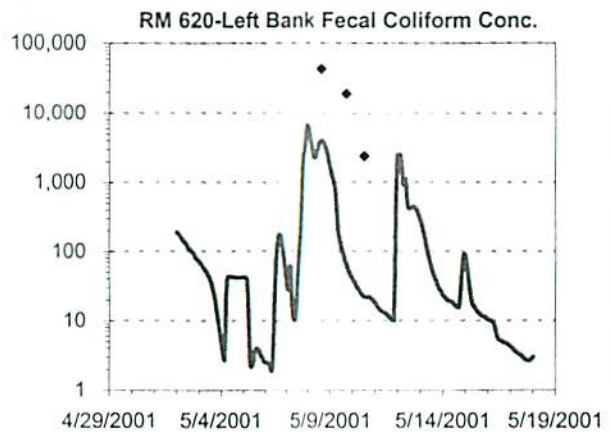

RM 612-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

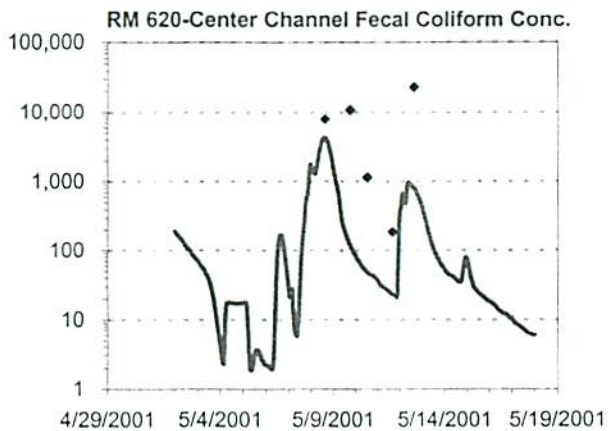

RM 612-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

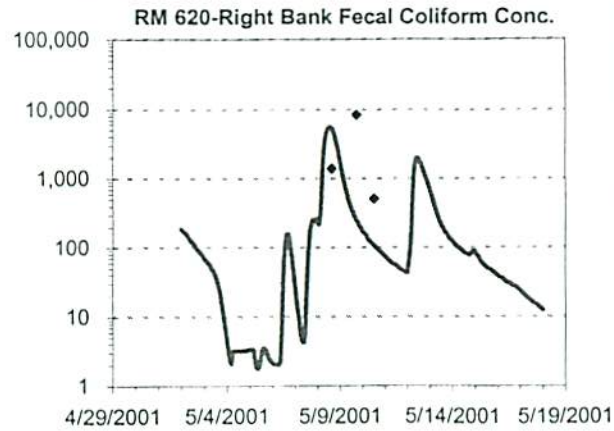

RM 616-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

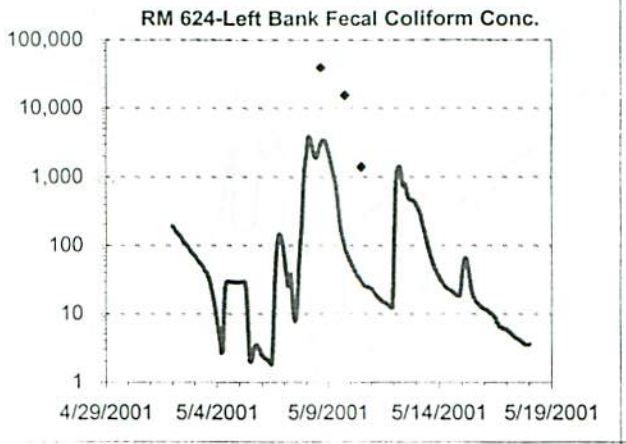

RM 616-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

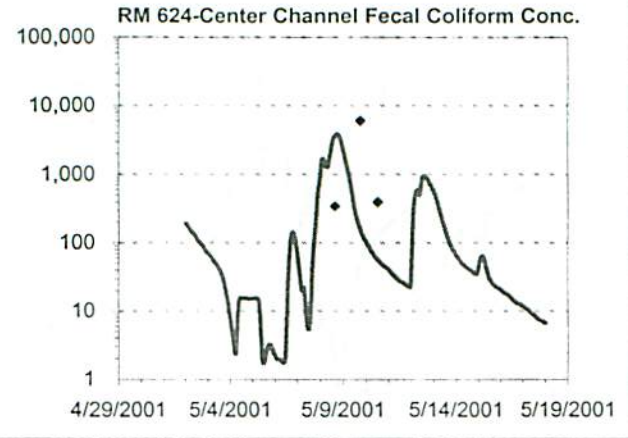

RM 616-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

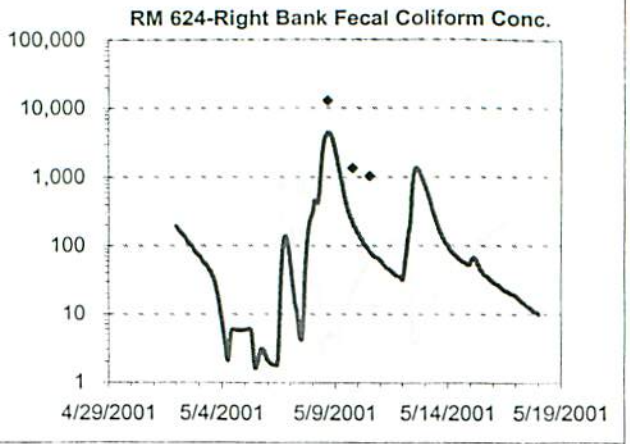

RM 620-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

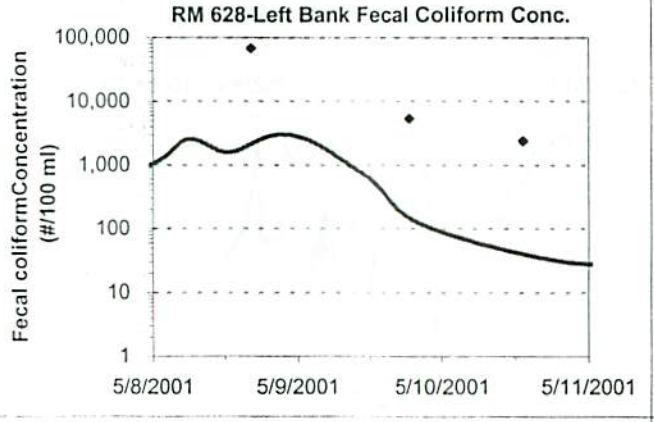

RM 620-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

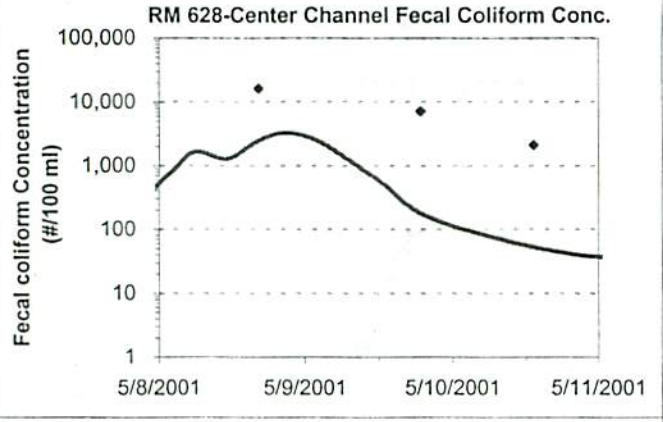

RM 620-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

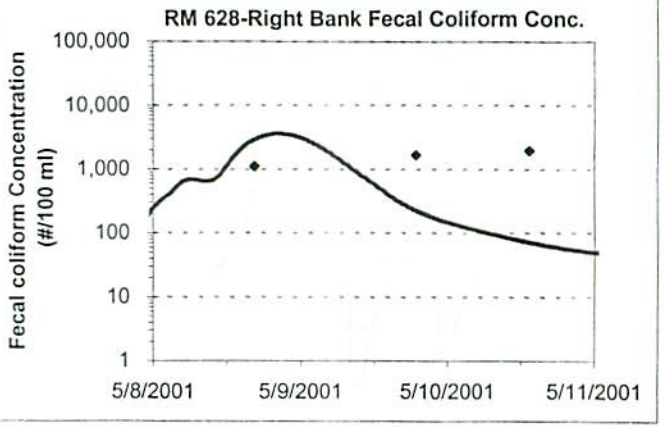

RM 624-Left Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

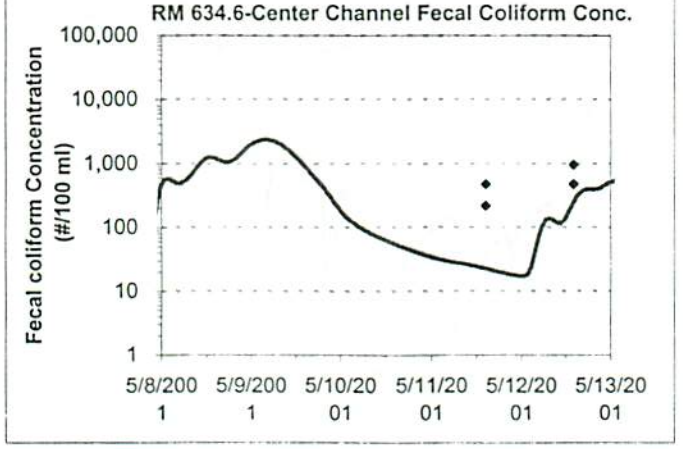

RM 624-Center Channel Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001


RM 624-Right Bank Fecal Coliform Conc.
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001


RM 628-Left Bank Fecal Coliform Conc.
Fecal coliformConcentration (#/100 ml)
100,000
10,000
1,000
100
10
1
5/8/2001
5/9/2001
5/10/2001
5/11/2001


RM 628-Center Channel Fecal Coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
5/8/2001
5/9/2001
5/10/2001
5/11/2001

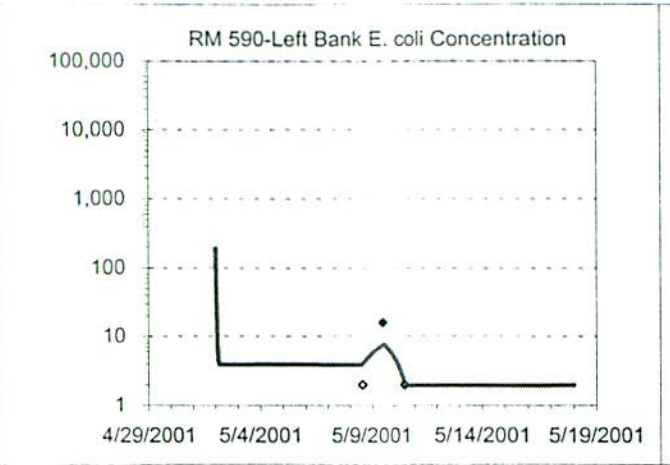

RM 628-Right Bank Fecal Coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
5/8/2001
5/9/2001
5/10/2001
5/11/2001

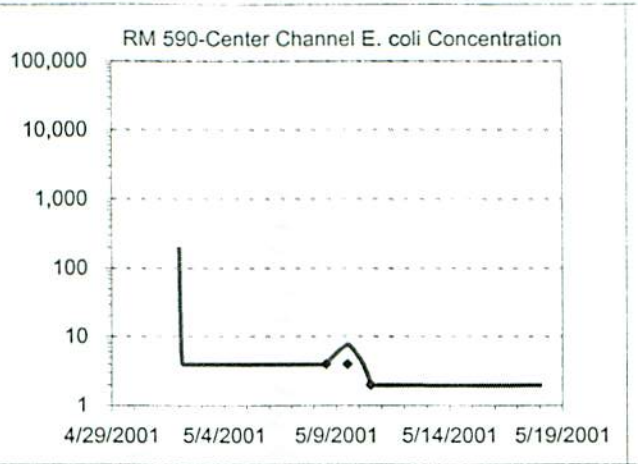

RM 634.6-Center Channel Fecal Coliform Conc.
Fecal coliform Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
5/8/2001
5/9/2001
5/10/2001
5/11/2001
5/12/2001
5/13/2001

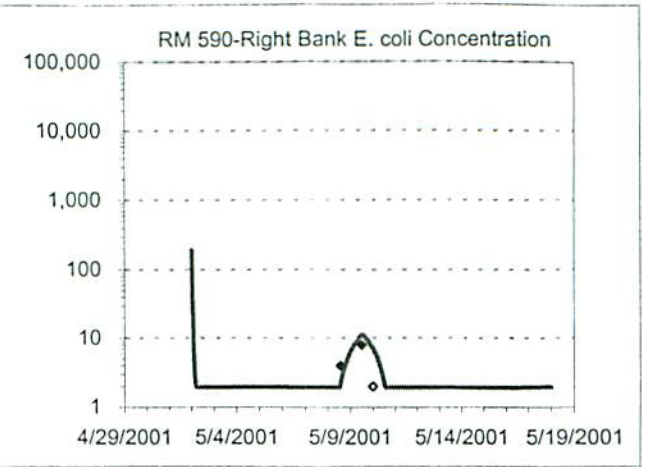
APPENDIX G

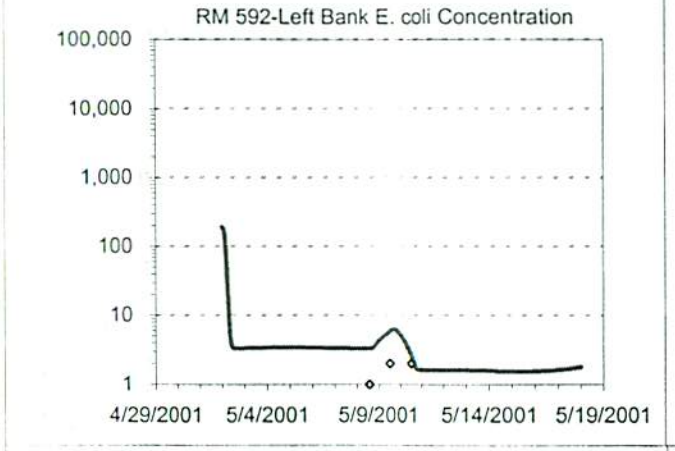
TEMPORAL PLOTS OF MODEL AND OBSERVED DATA BY AREA OF RIVER

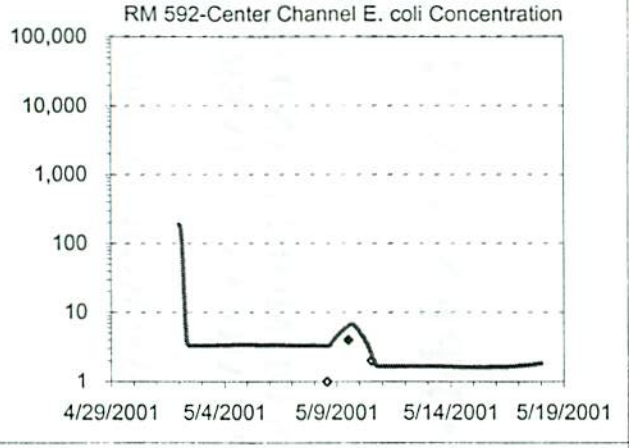
May 2001 Wet Weather Event *E. Coli*

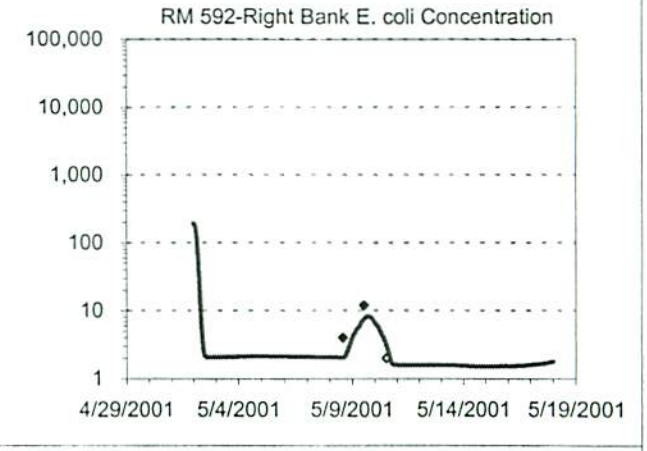

RM 590-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

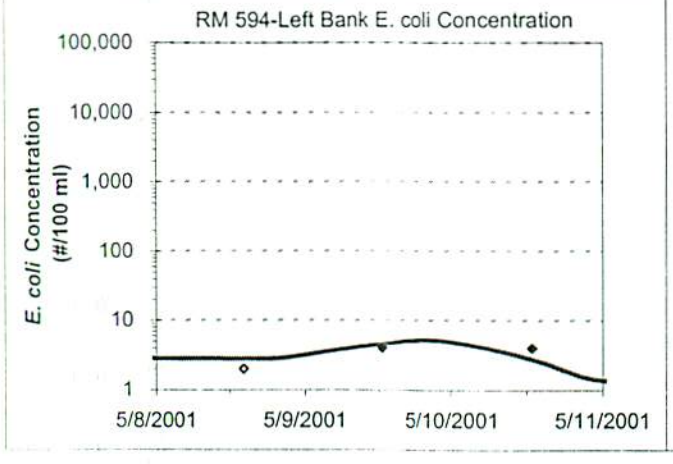

RM 590-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

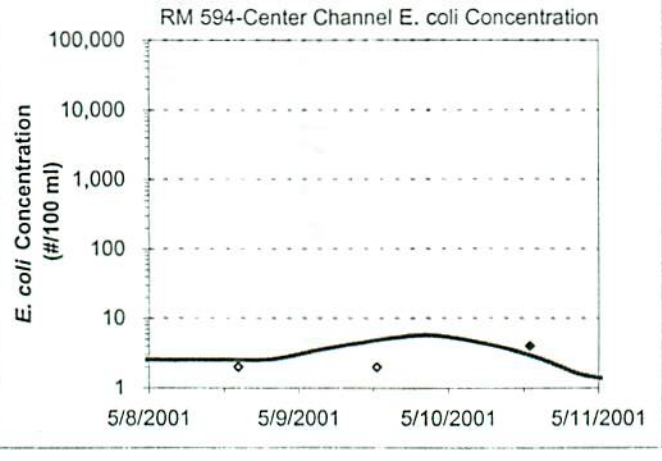

RM 590-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

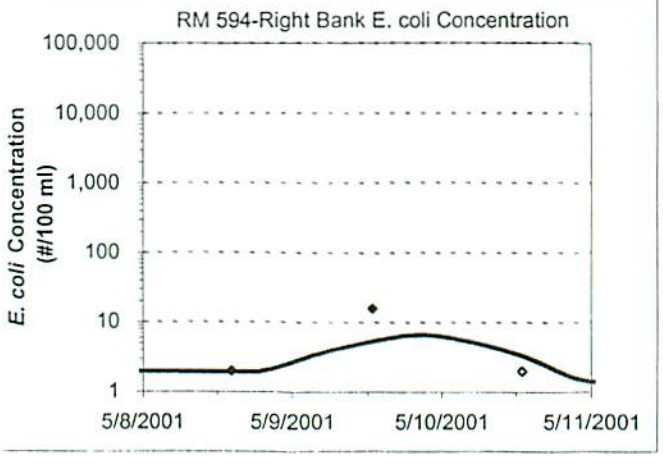

RM 592-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

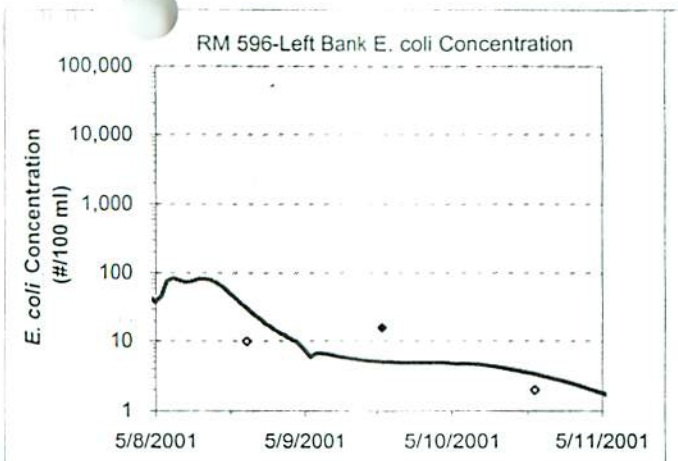

RM 592-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

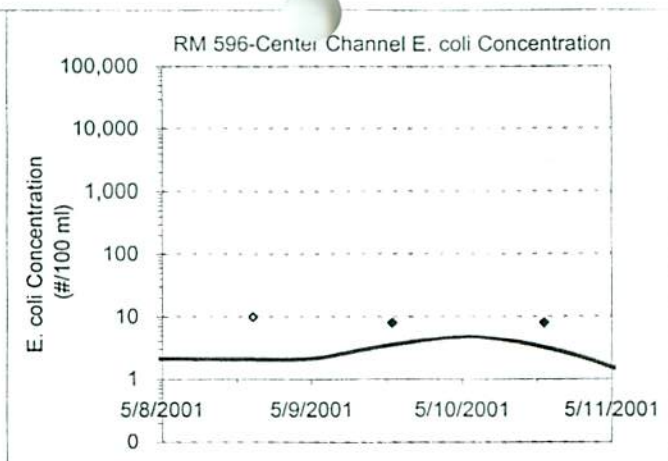

RM 592-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

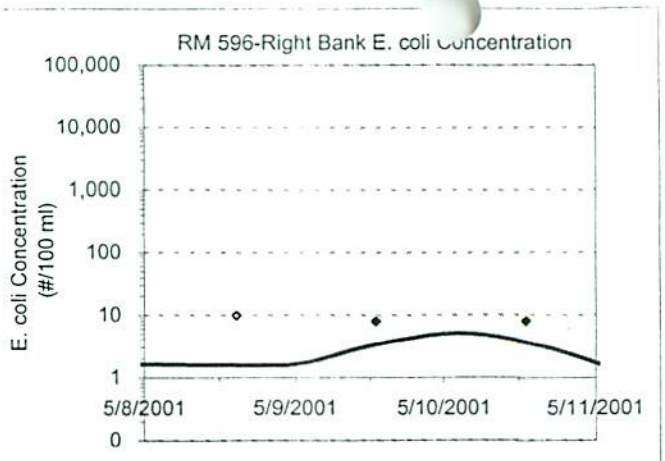

RM 594-Left Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
5/8/2001
5/9/2001
5/10/2001
5/11/2001

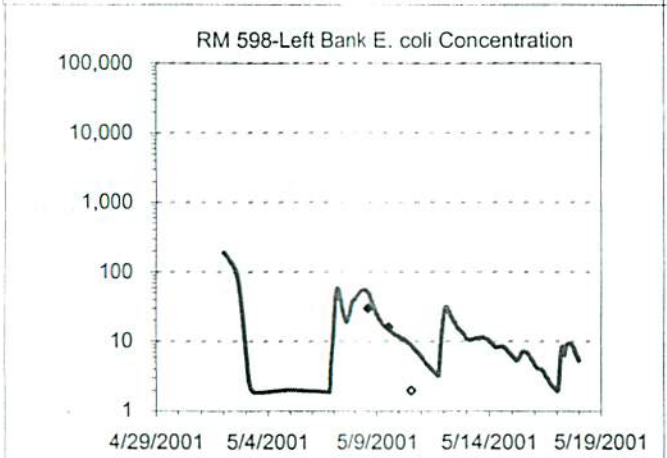

RM 594-Center Channel E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
5/8/2001
5/9/2001
5/10/2001
5/11/2001

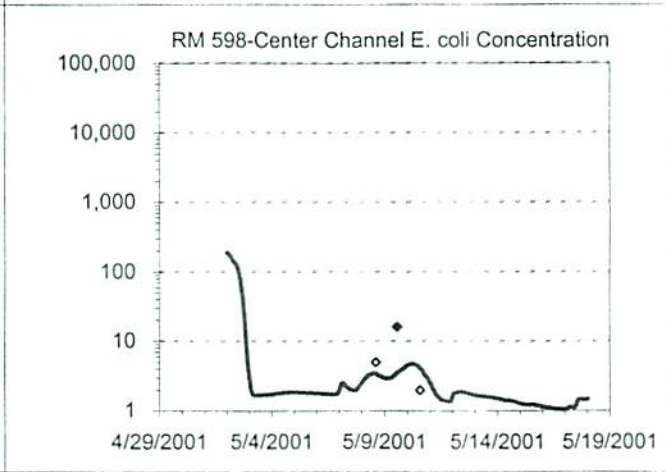

RM 594-Right Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
5/8/2001
5/9/2001
5/10/2001
5/11/2001

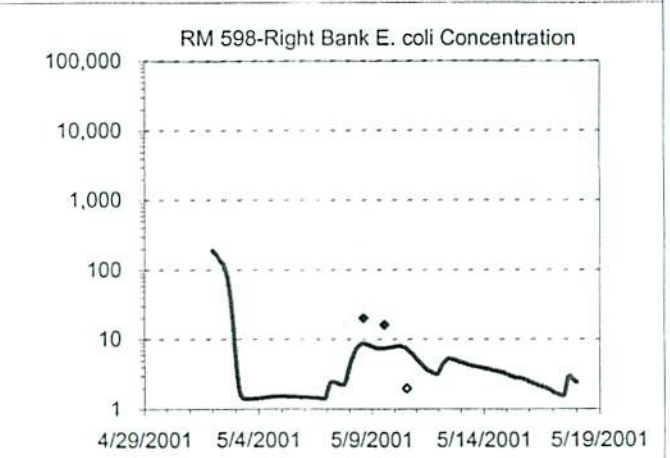

RM 596-Left Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
5/8/2001
5/9/2001
5/10/2001
5/11/2001

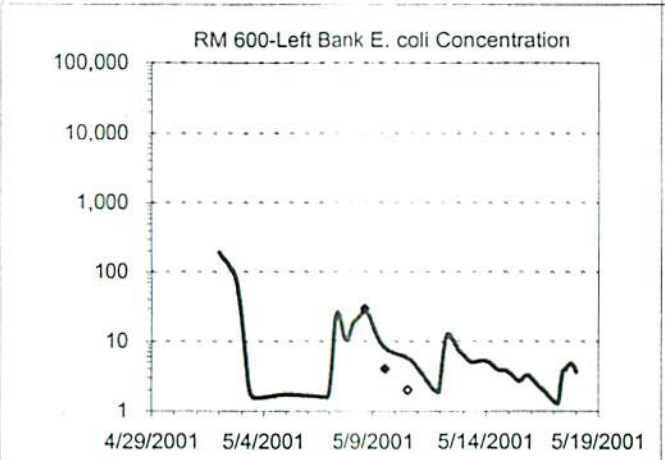

RM 596-Center Channel E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
0
5/8/2001
5/9/2001
5/10/2001
5/11/2001

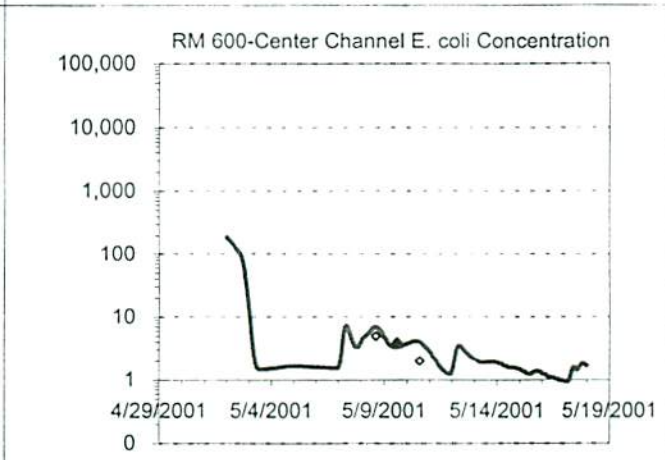

RM 596-Right Bank E. coli Concentration
E. coli Concentration (#/100 ml)
100,000
10,000
1,000
100
10
1
0
5/8/2001
5/9/2001
5/10/2001
5/11/2001

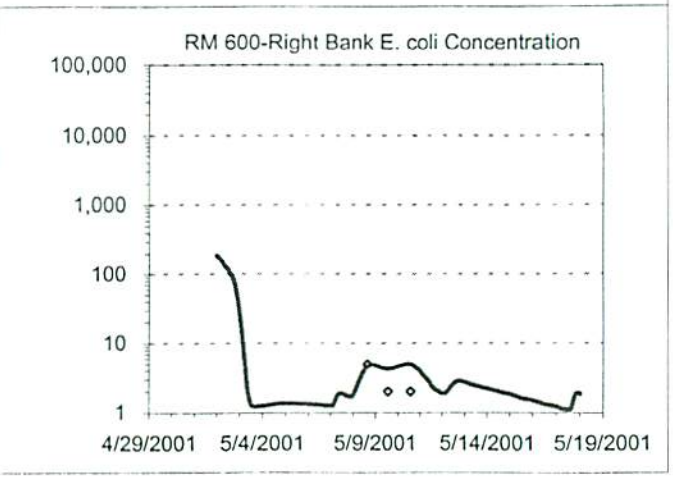

RM 598-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

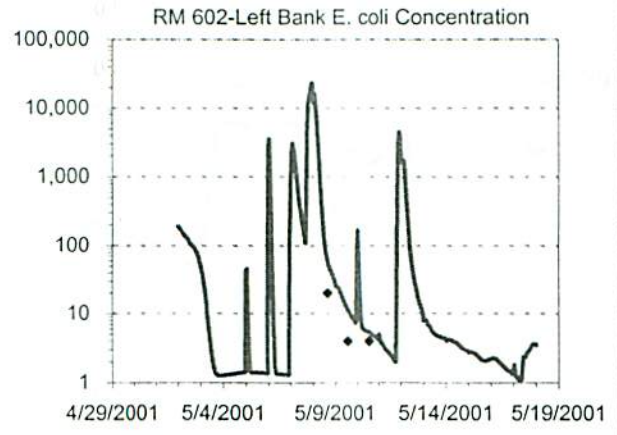

RM 598-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

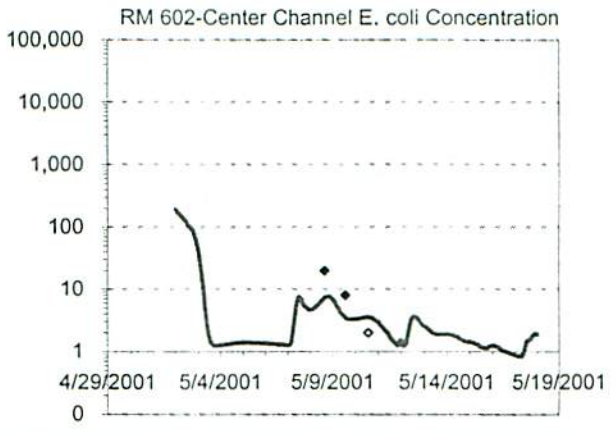

RM 598-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

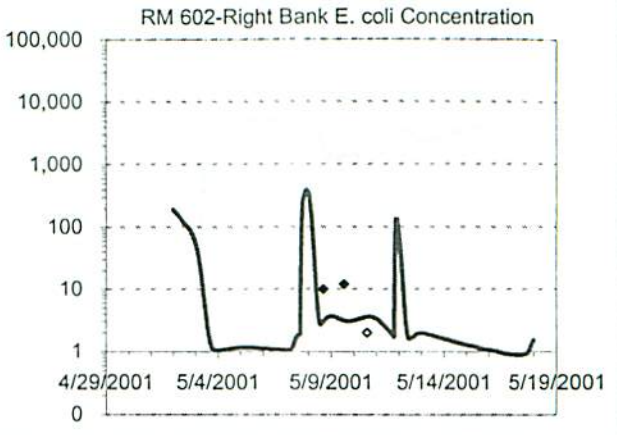

RM 600-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

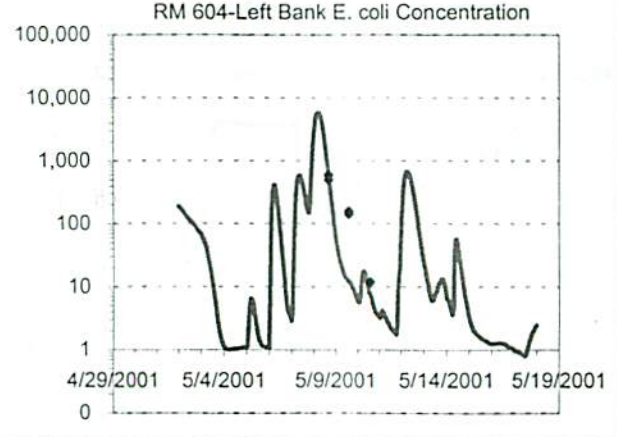

RM 600-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

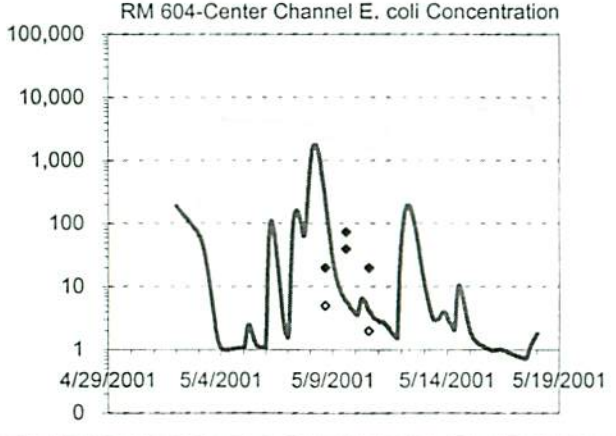

RM 600-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

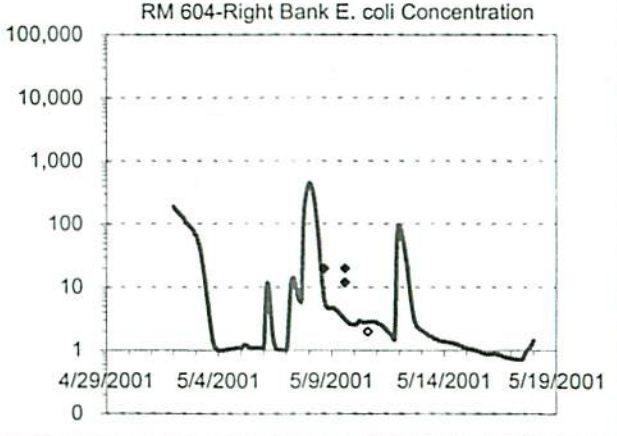

RM 602-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

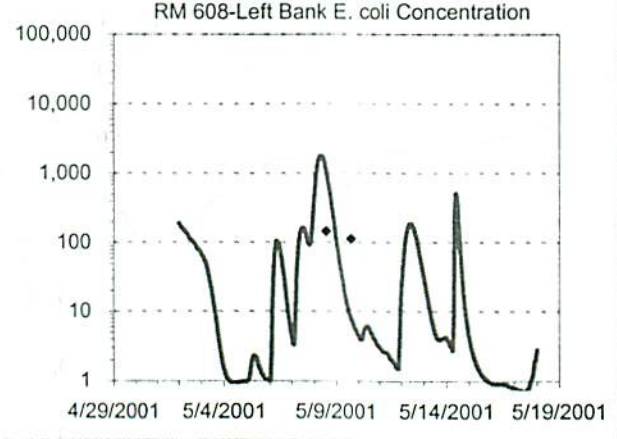

RM 602-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

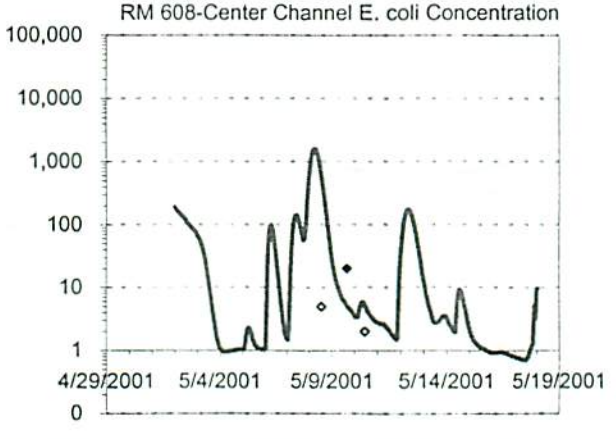

RM 602-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

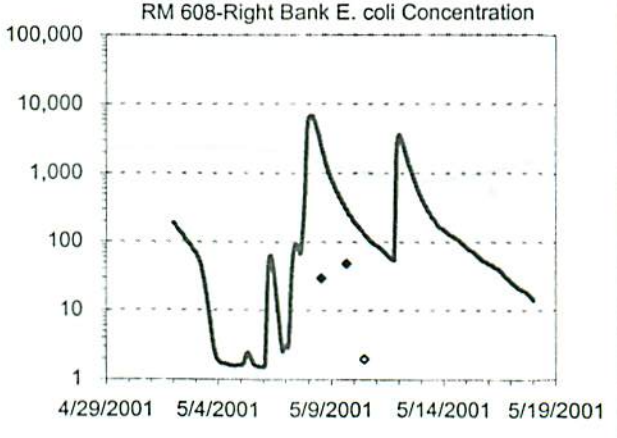

RM 604-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

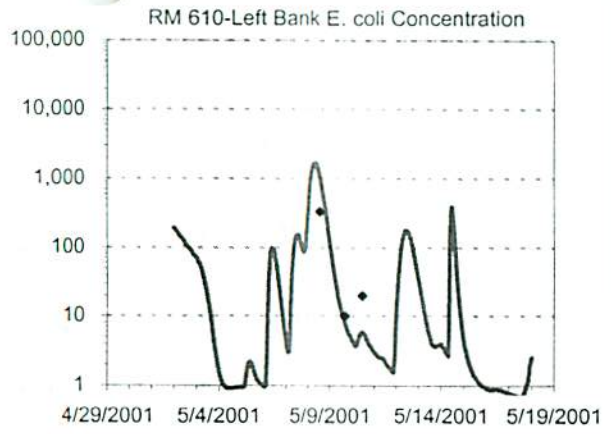

RM 604-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

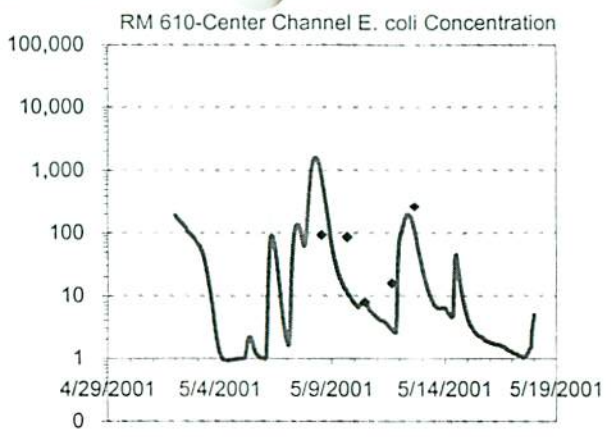

RM 604-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

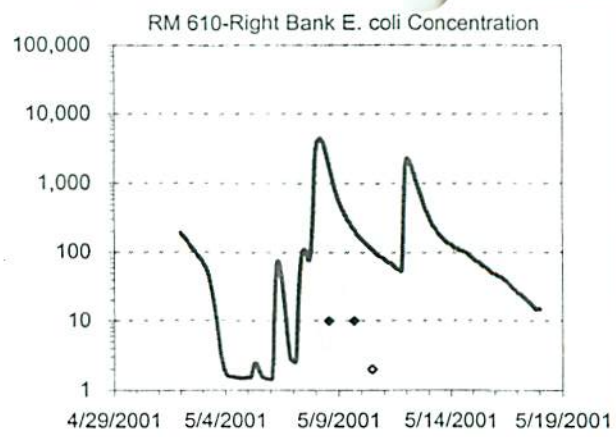

RM 608-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

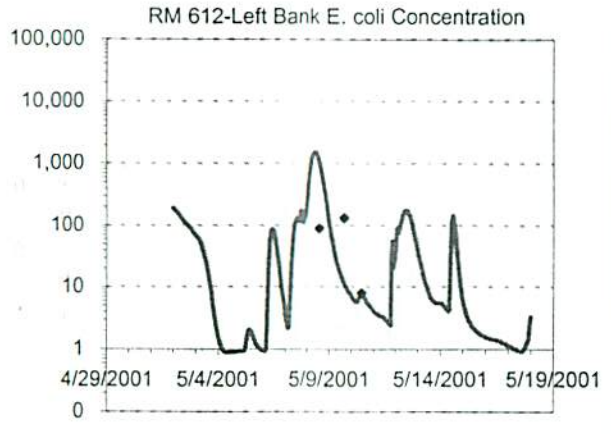

RM 608-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

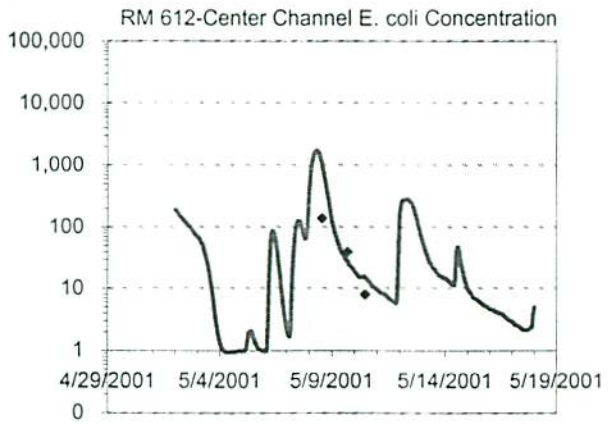

RM 608-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

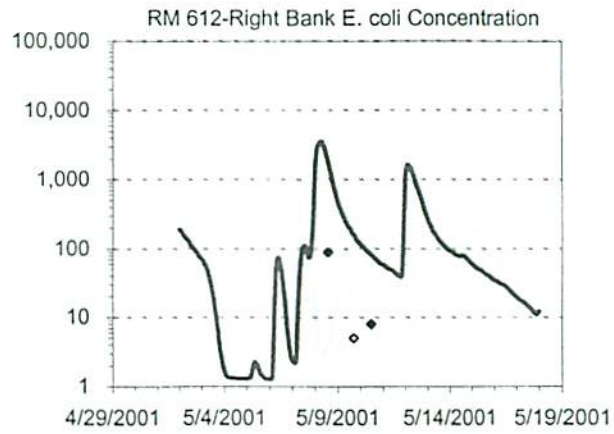

RM 610-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

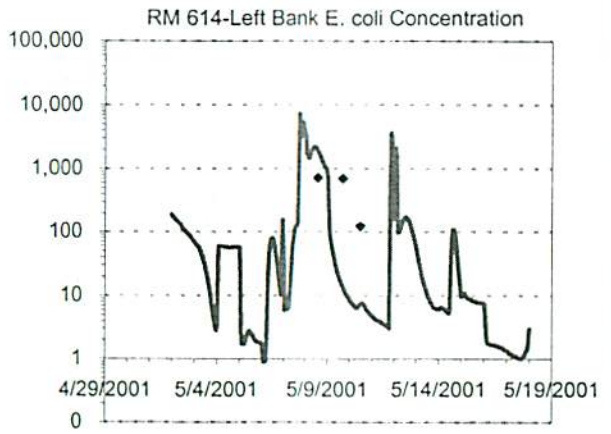

RM 610-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

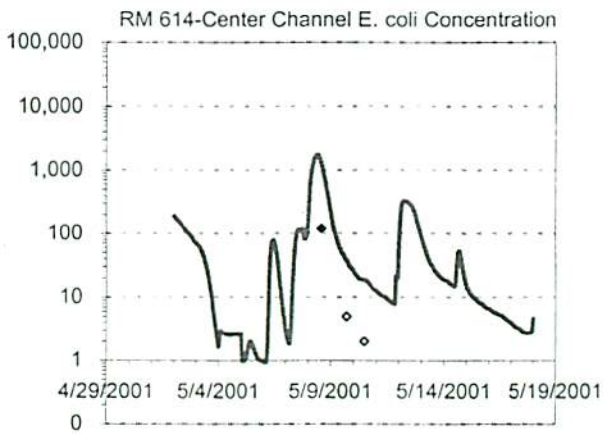

RM 610-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

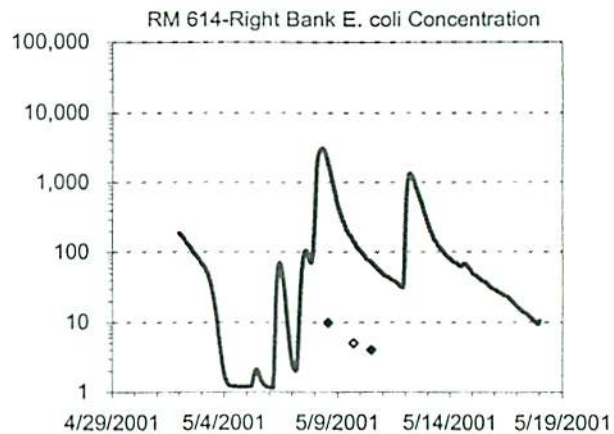

RM 612-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

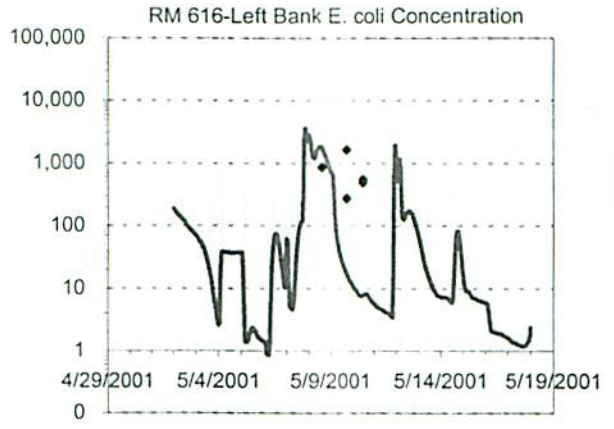

RM 612-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

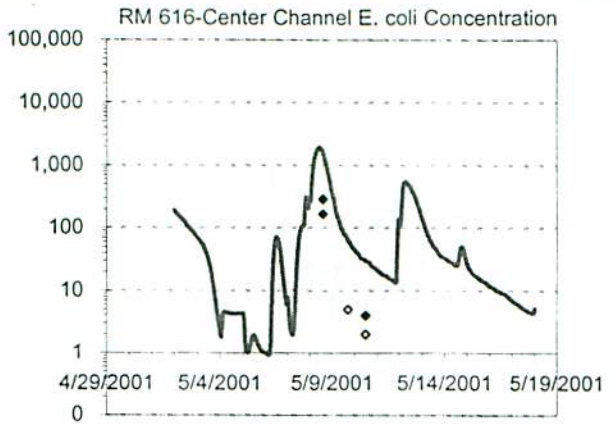

RM 612-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

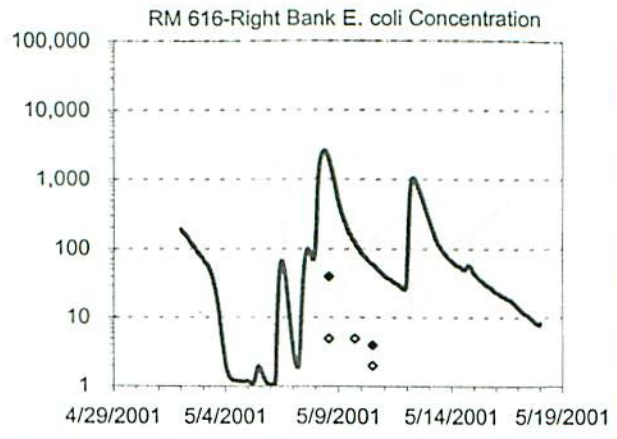

RM 614-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

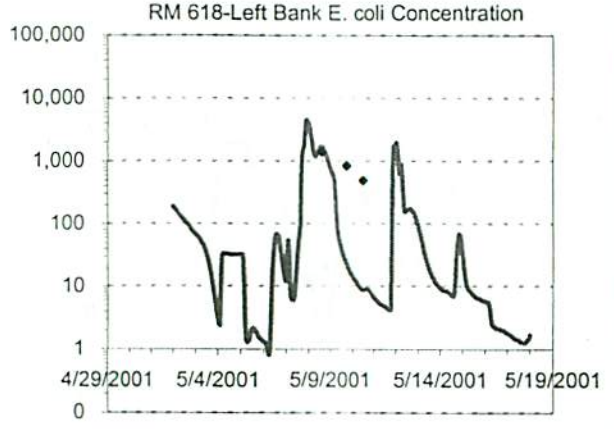

RM 614-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

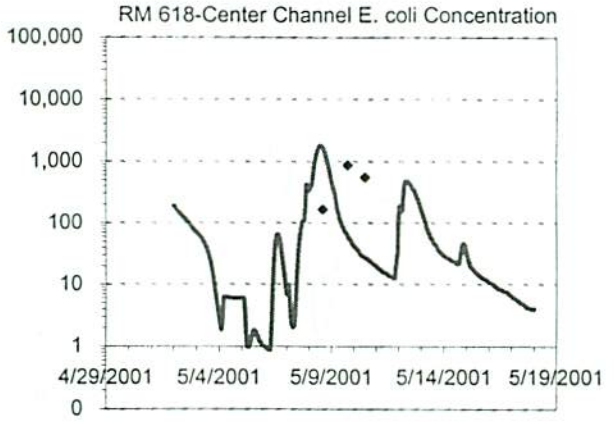

RM 614-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

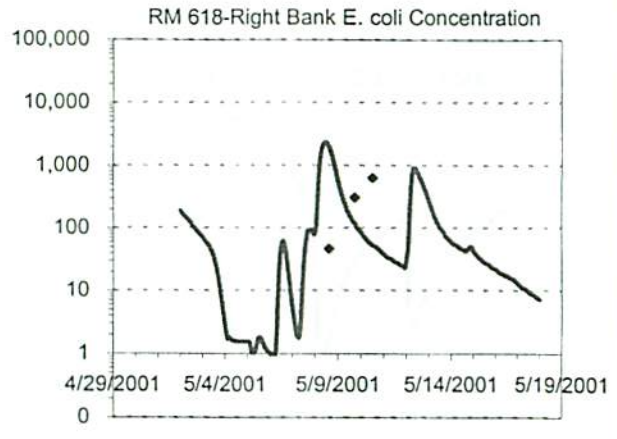

RM 616-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

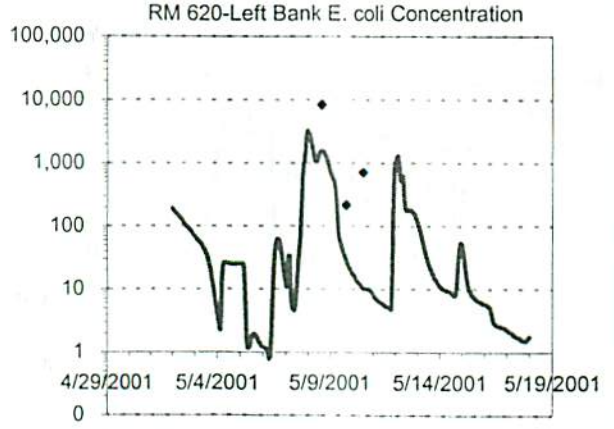

RM 616-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

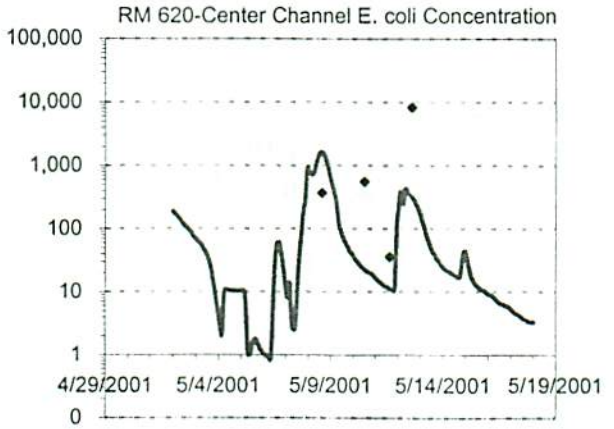

RM 616-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

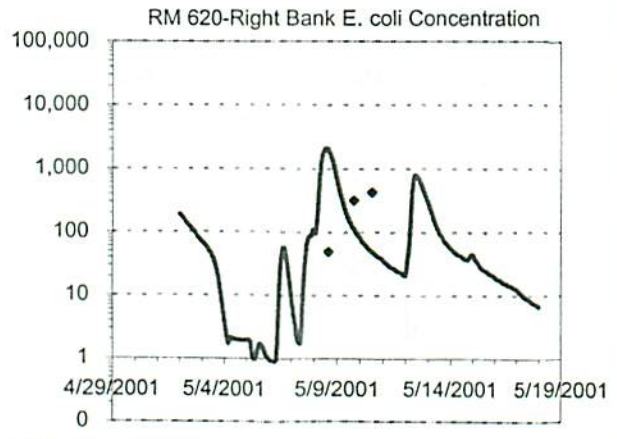

RM 618-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

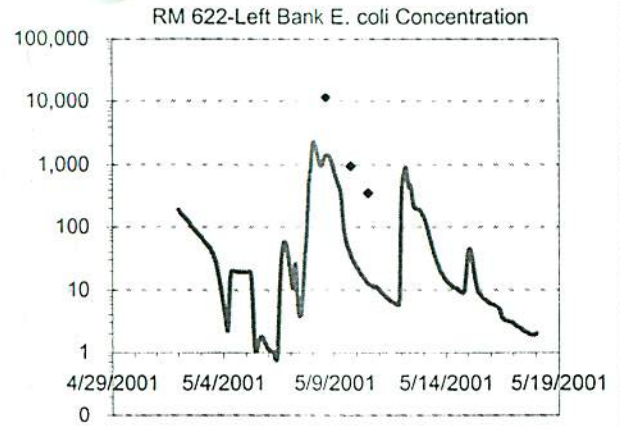

RM 618-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

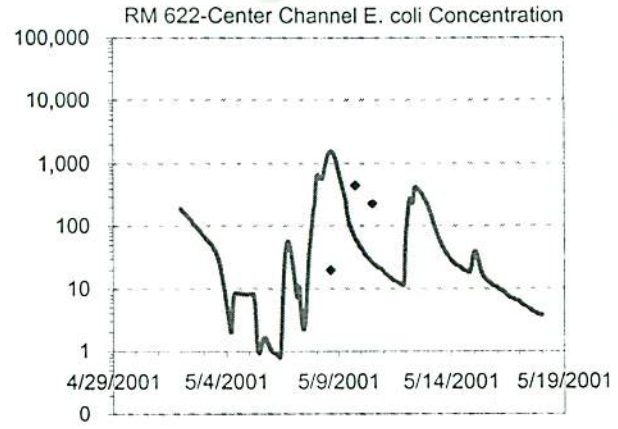

RM 618-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

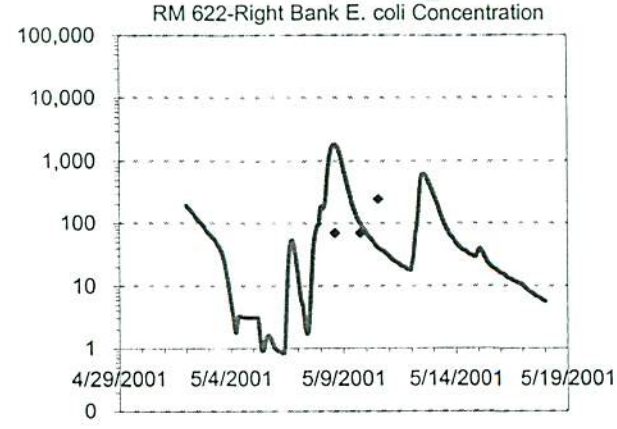

RM 620-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

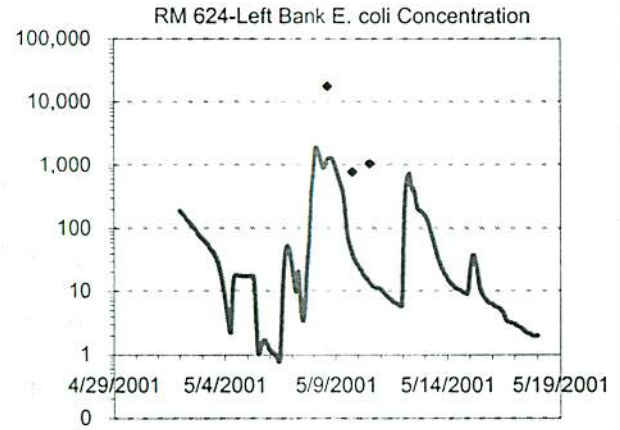

RM 620-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

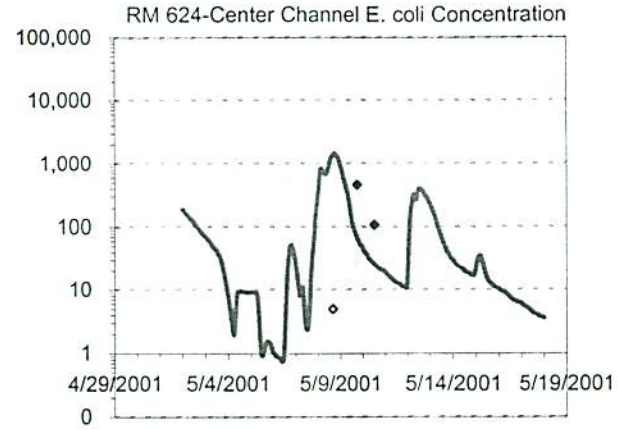

RM 620-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

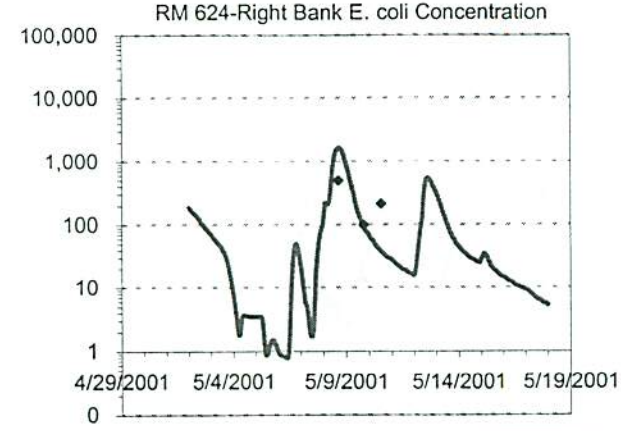

RM 622-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

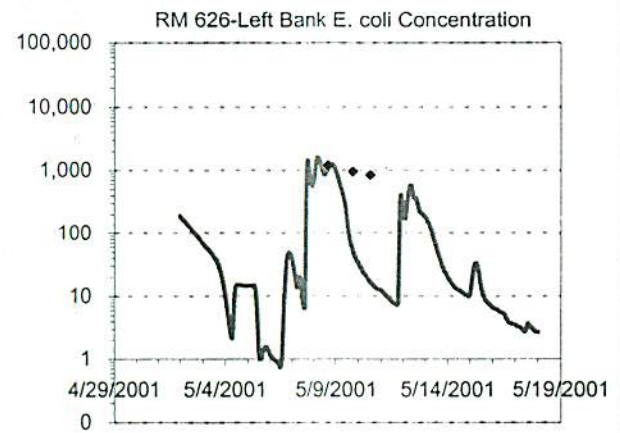

RM 622-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

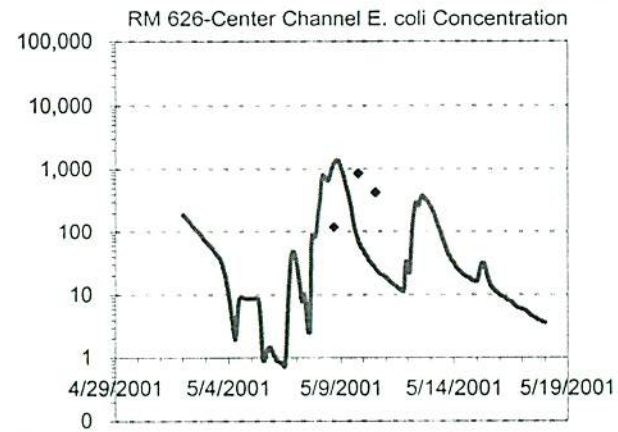

RM 622-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

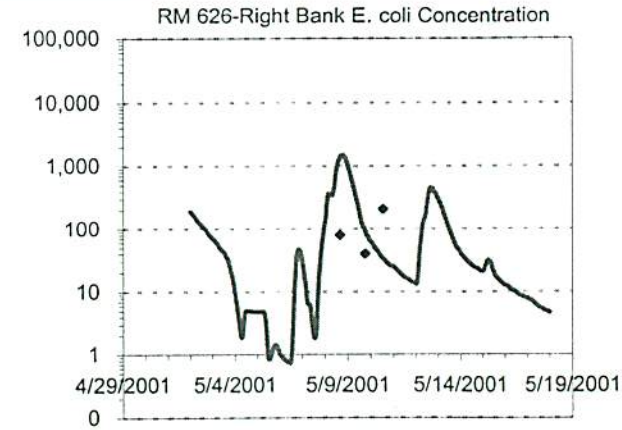

RM 624-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

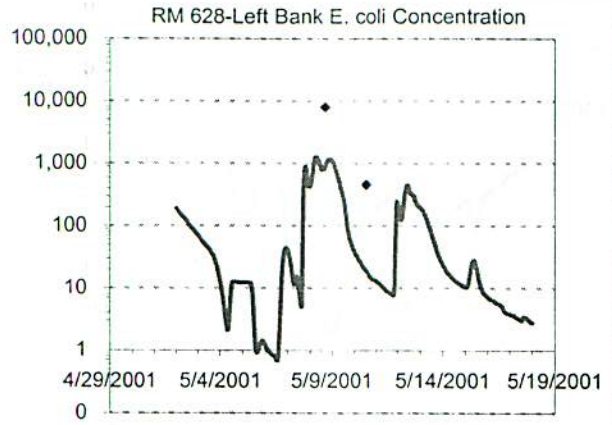

RM 624-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

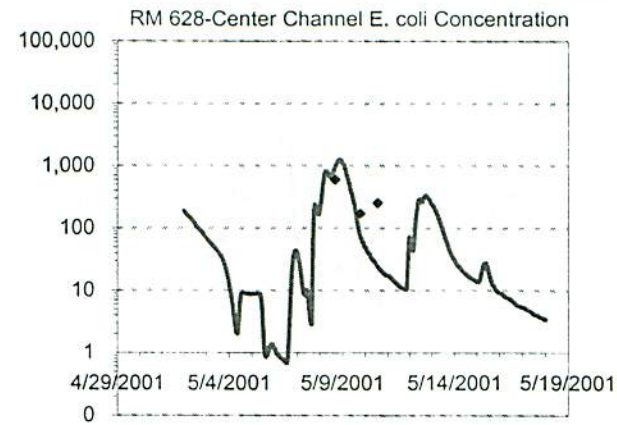

RM 624-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

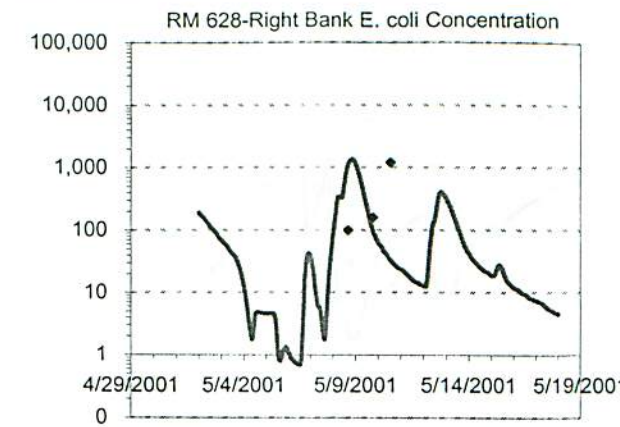

RM 626-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

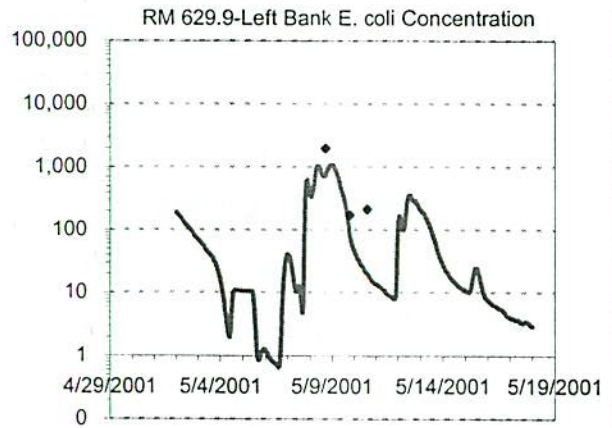

RM 626-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

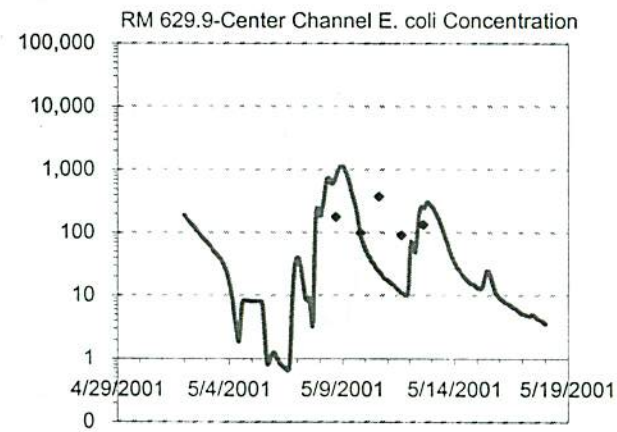

RM 626-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

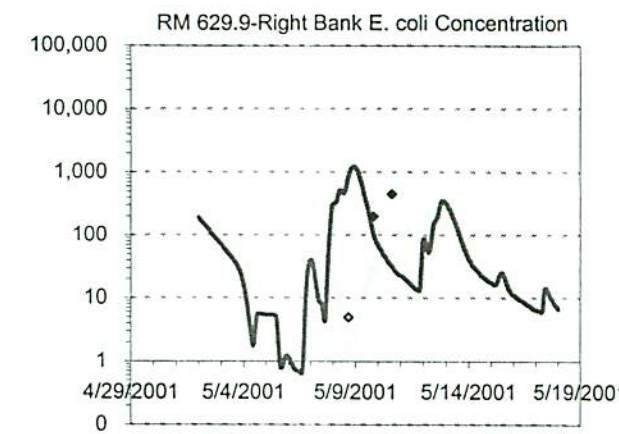

RM 628-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

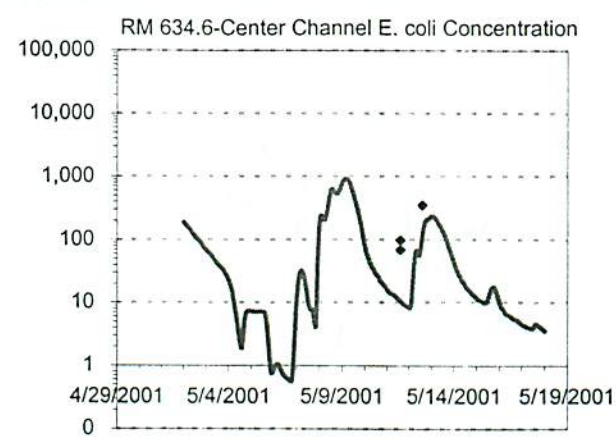

RM 628-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001


RM 628-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001


RM 629.9-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001


RM 629.9-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

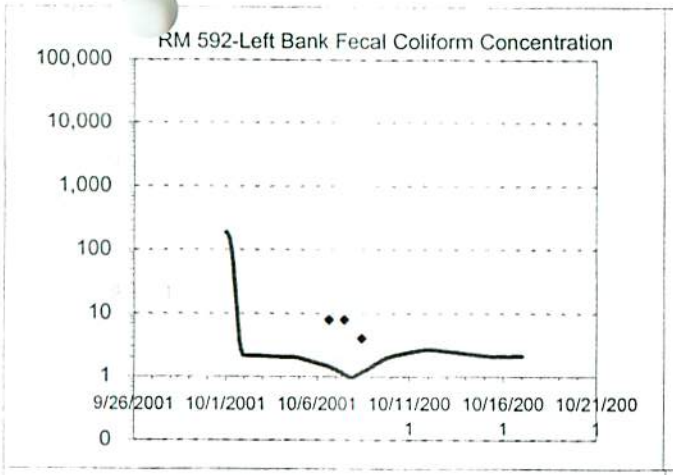

RM 629.9-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

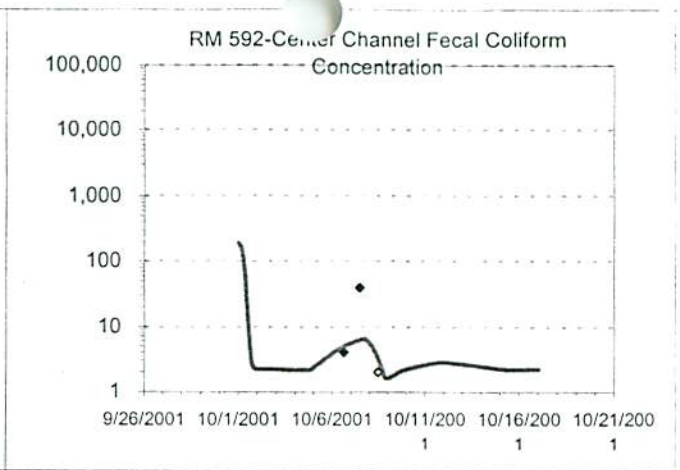

RM 634.6-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
4/29/2001
5/4/2001
5/9/2001
5/14/2001
5/19/2001

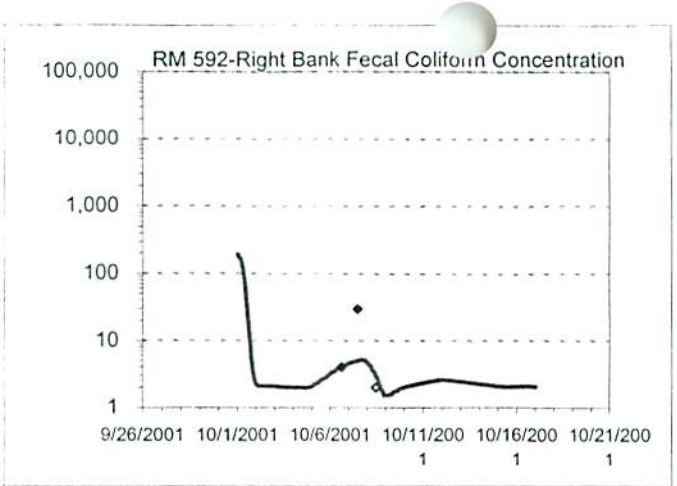
APPENDIX G

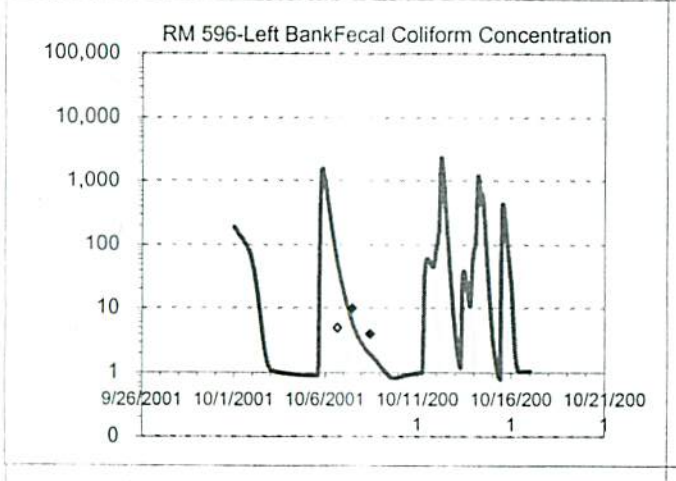
TEMPORAL PLOTS OF MODEL AND OBSERVED DATA BY AREA OF RIVER

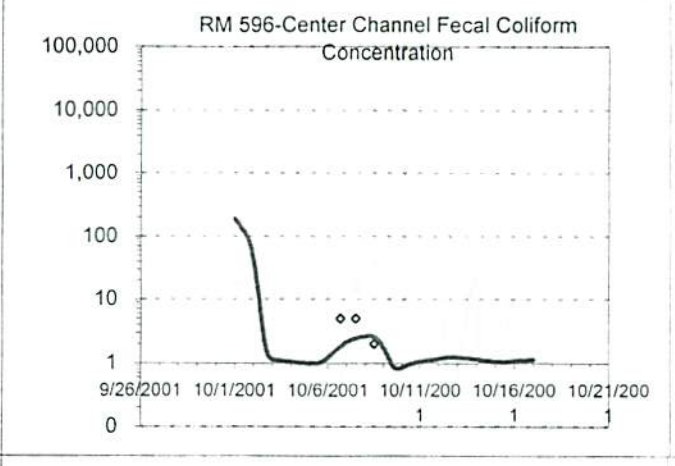
October 2001 Wet Weather Event Fecal Coliform

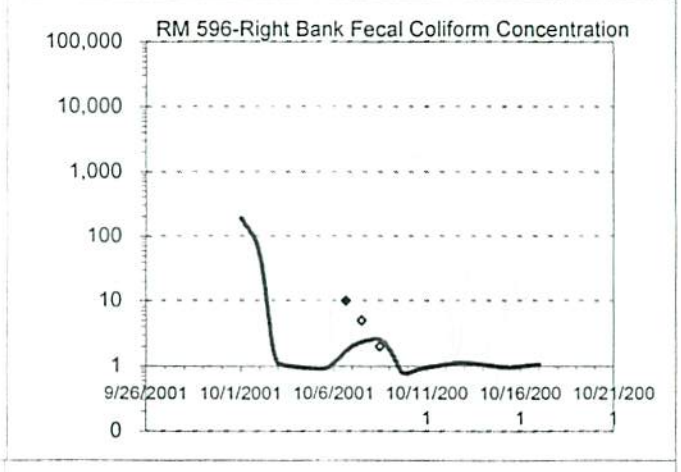

RM 592-Left Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

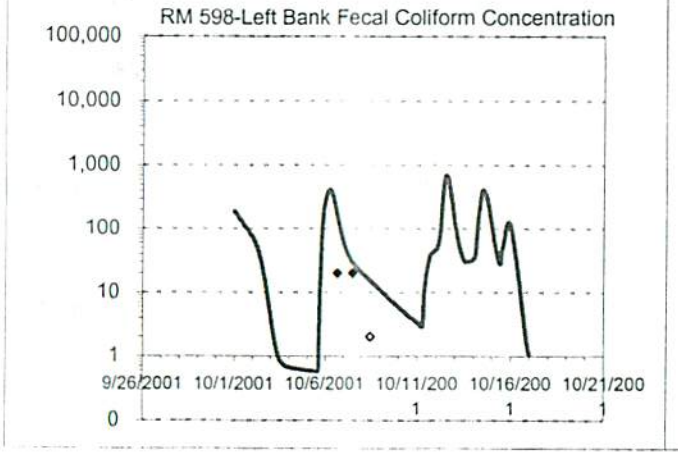

RM 592-Center Channel Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

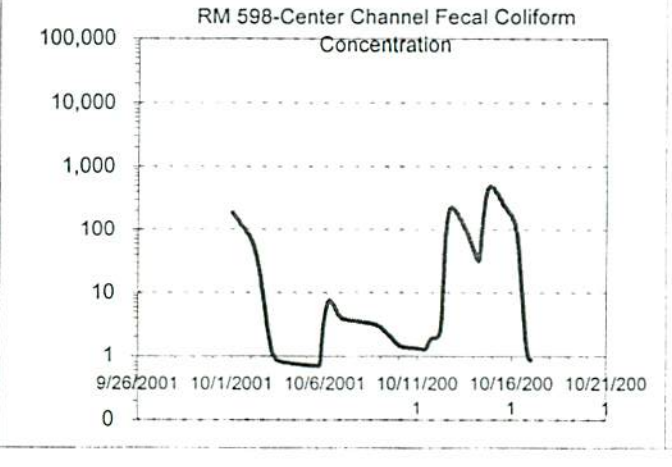

RM 592-Right Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

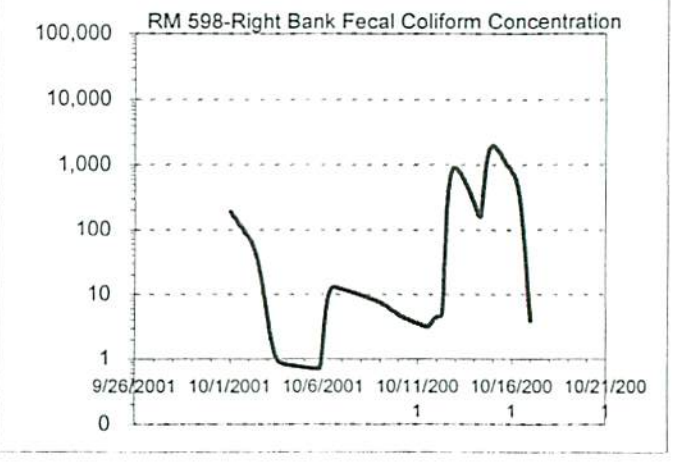

RM 596-Left BankFecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

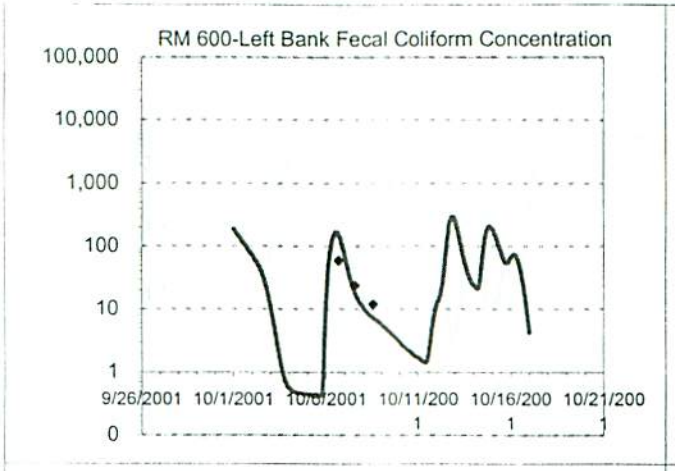

RM 596-Center Channel Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

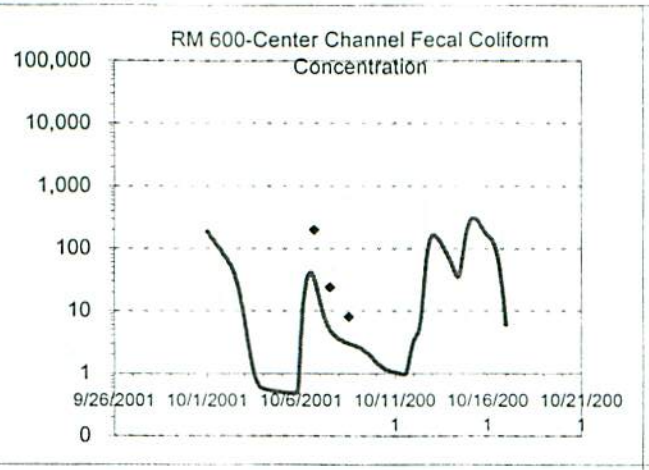

RM 596-Right Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

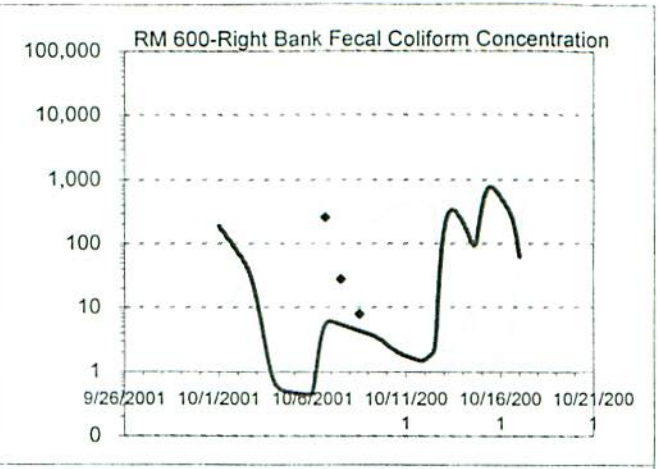

RM 598-Left Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

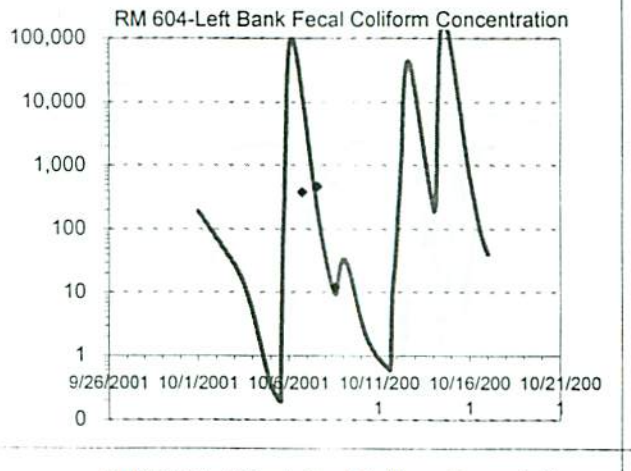

RM 598-Center Channel Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

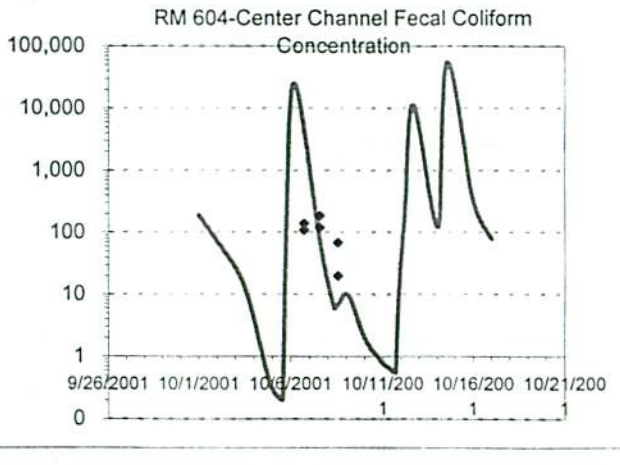

RM 598-Right Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

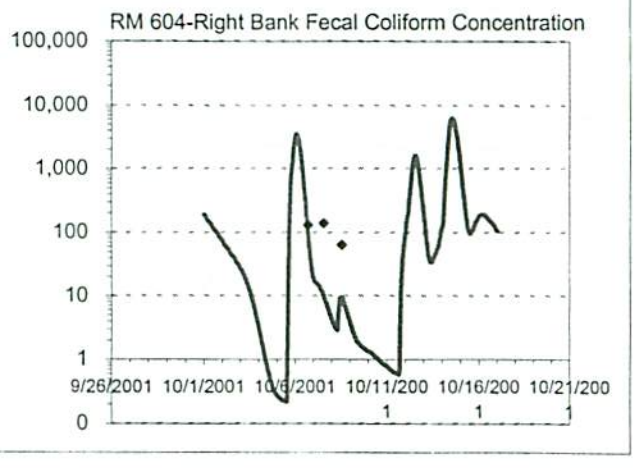

RM 600-Left Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

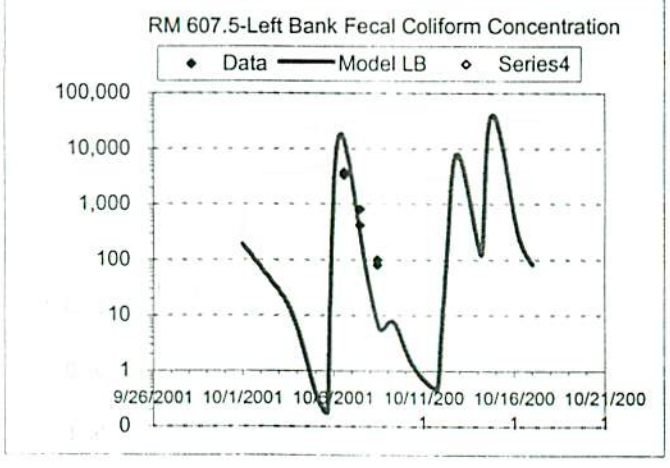

RM 600-Center Channel Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

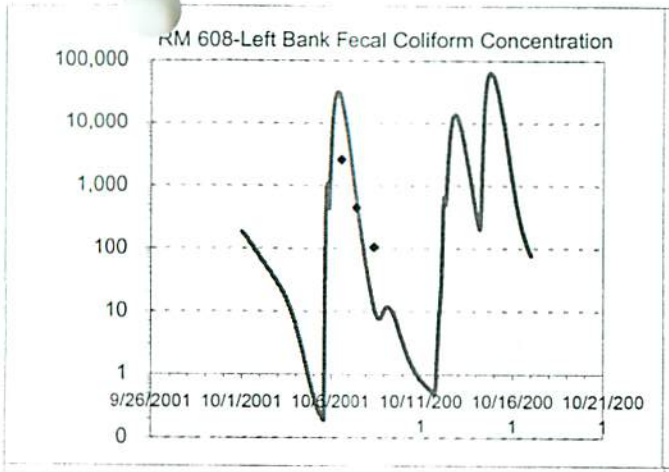

RM 600-Right Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

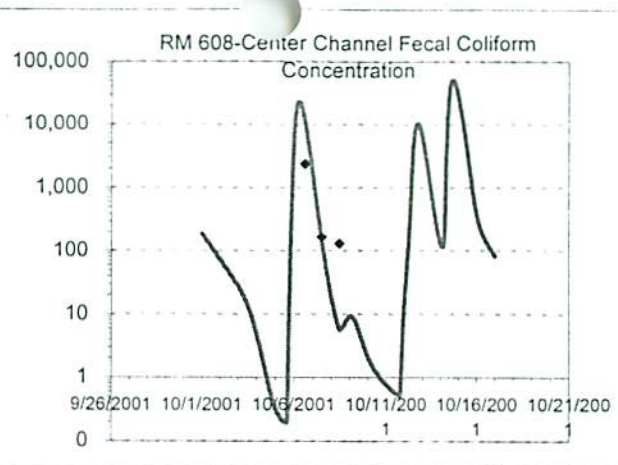

RM 604-Left Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

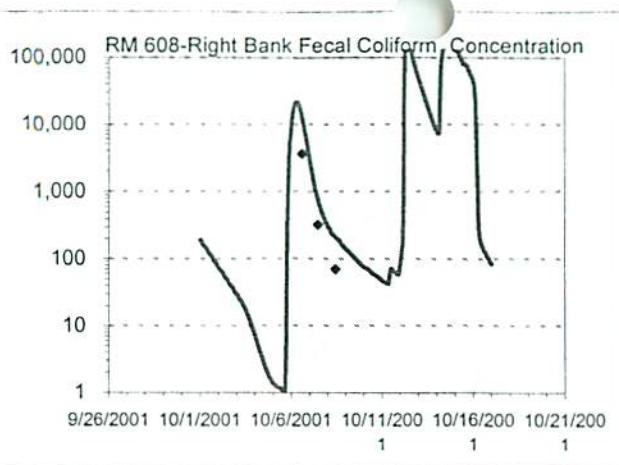

RM 604-Center Channel Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

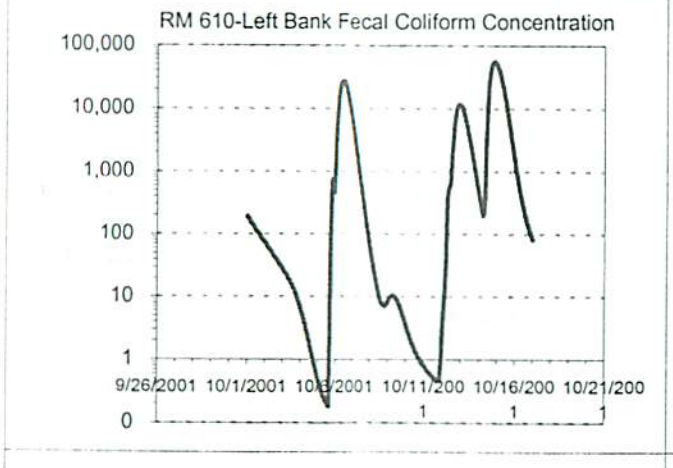

RM 604-Right Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

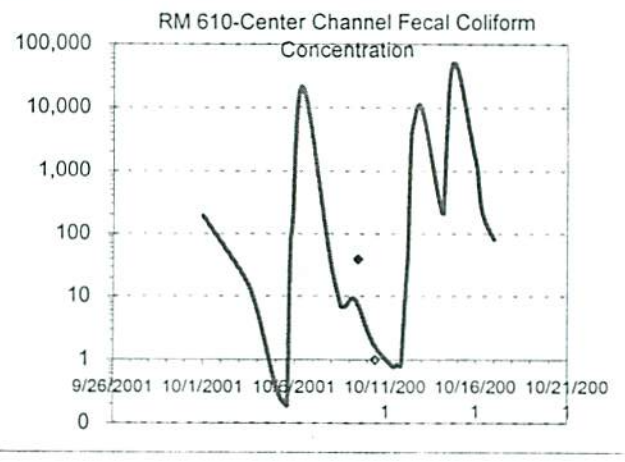

RM 607.5-Left Bank Fecal Coliform Concentration
Data
Model LB
Series4
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

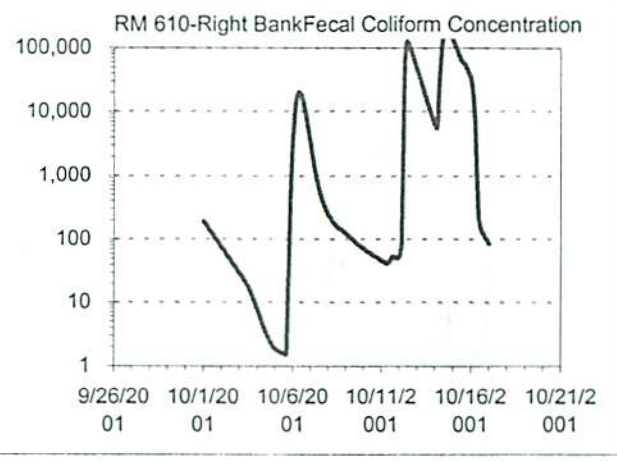

RM 608-Left Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

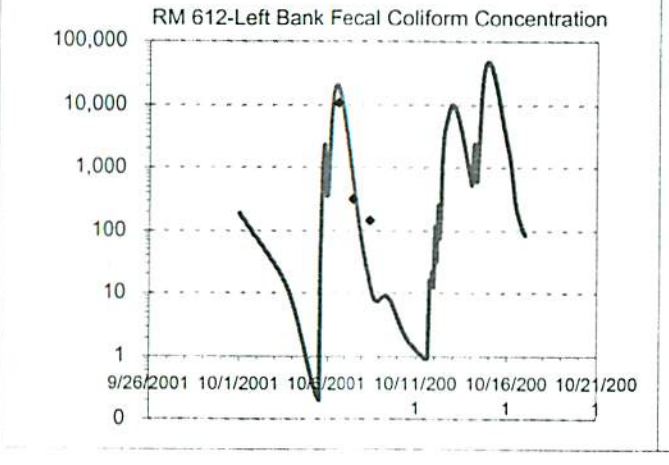

RM 608-Center Channel Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

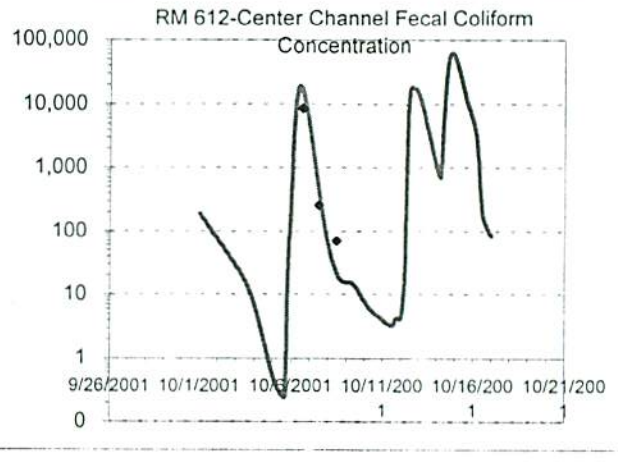

RM 608-Right Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

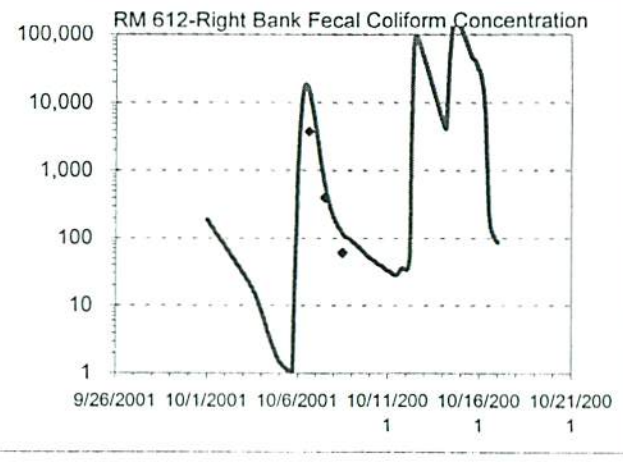

RM 610-Left Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

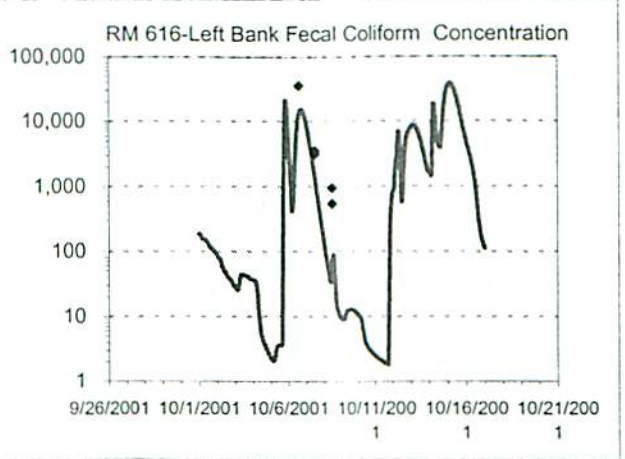

RM 610-Center Channel Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

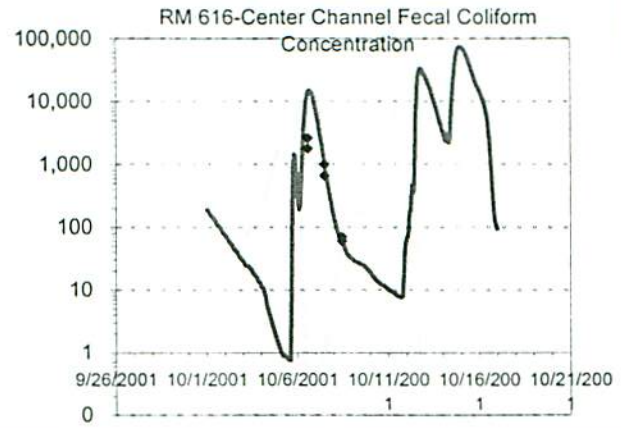

RM 610-Right BankFecal Coliform Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

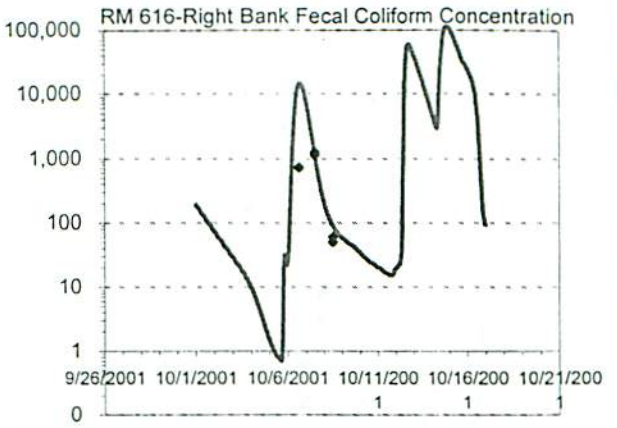

RM 612-Left Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

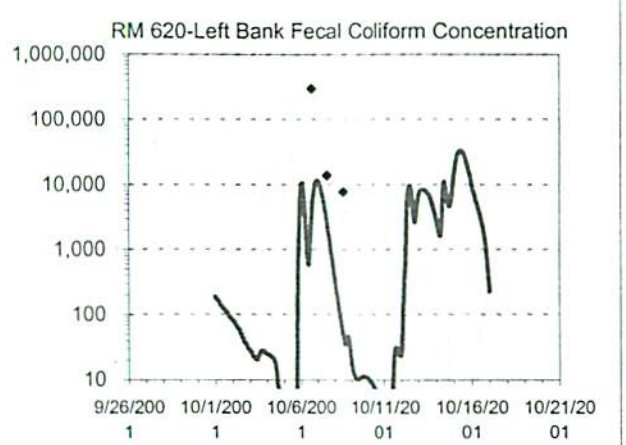

RM 612-Center Channel Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

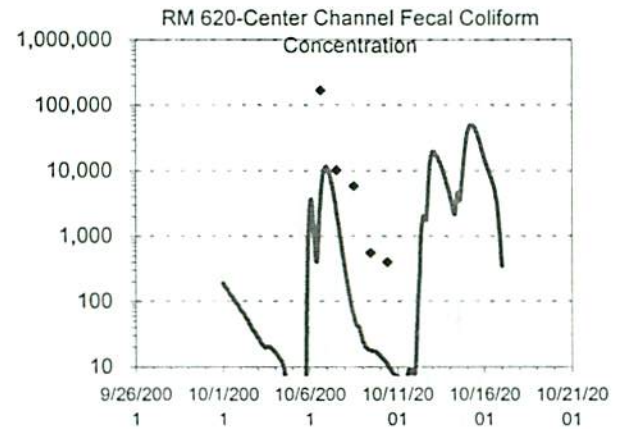

RM 612-Right Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

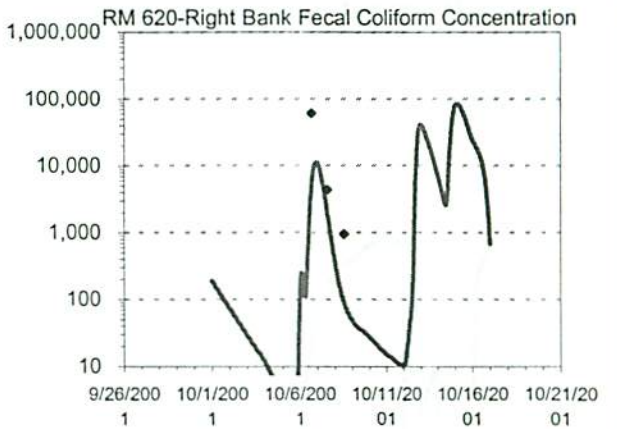

RM 616-Left Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

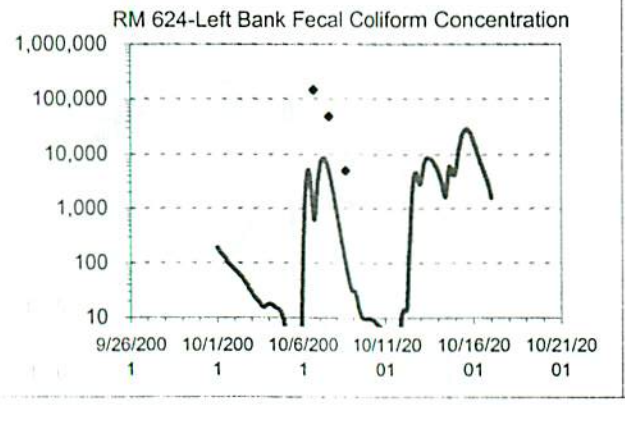

RM 616-Center Channel Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

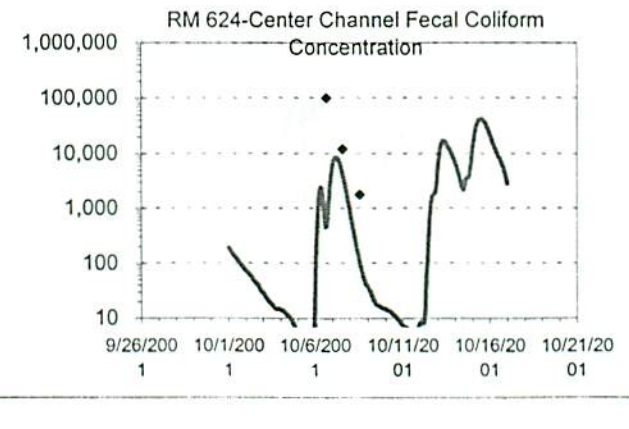

RM 616-Right Bank Fecal Coliform Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

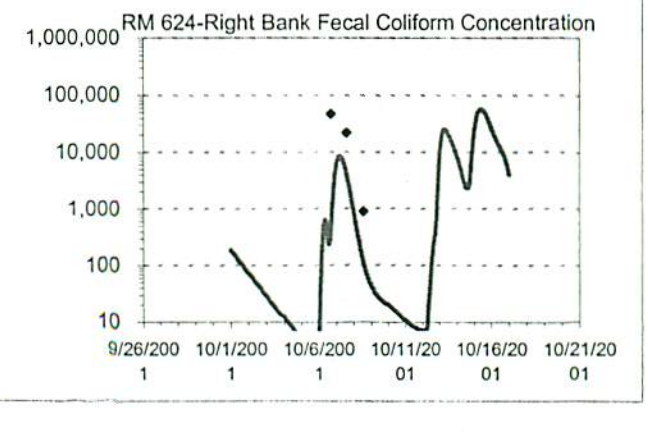

RM 620-Left Bank Fecal Coliform Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

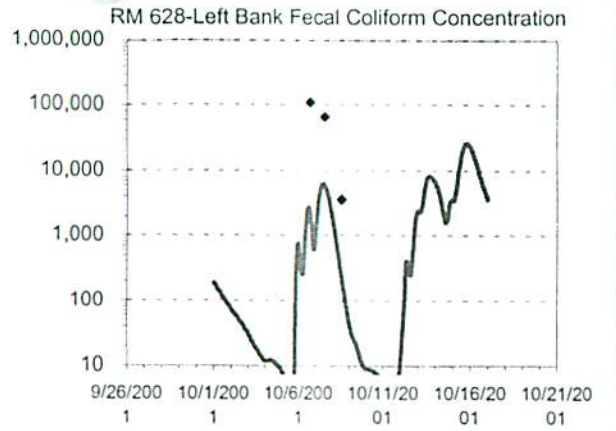

RM 620-Center Channel Fecal Coliform Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

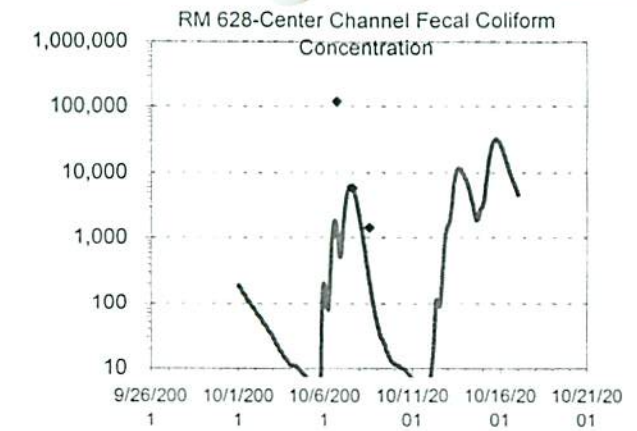

RM 620-Right Bank Fecal Coliform Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

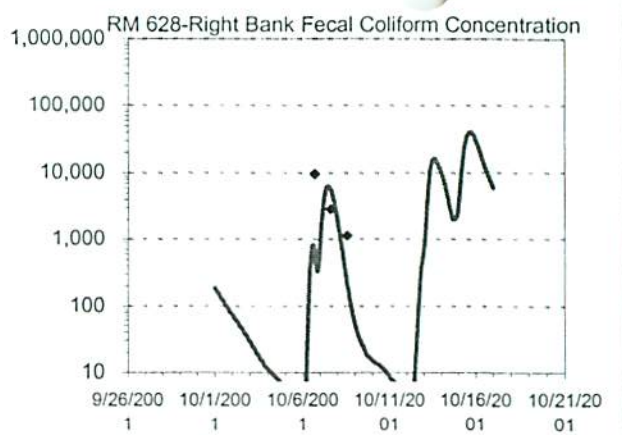

RM 624-Left Bank Fecal Coliform Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

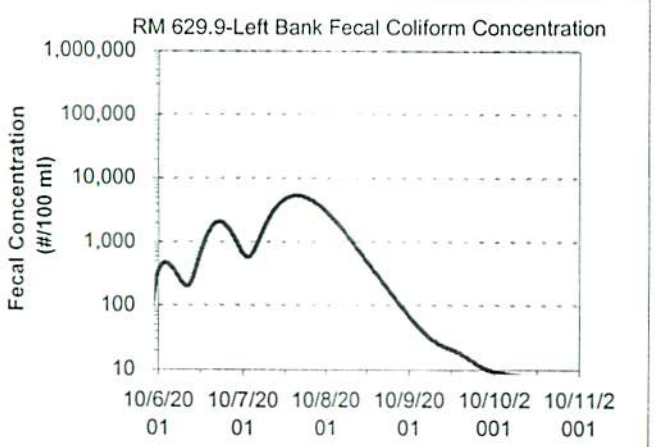

RM 624-Center Channel Fecal Coliform Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

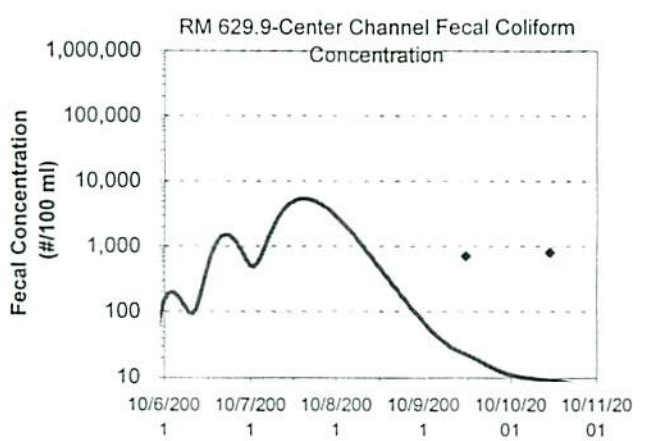

RM 624-Right Bank Fecal Coliform Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

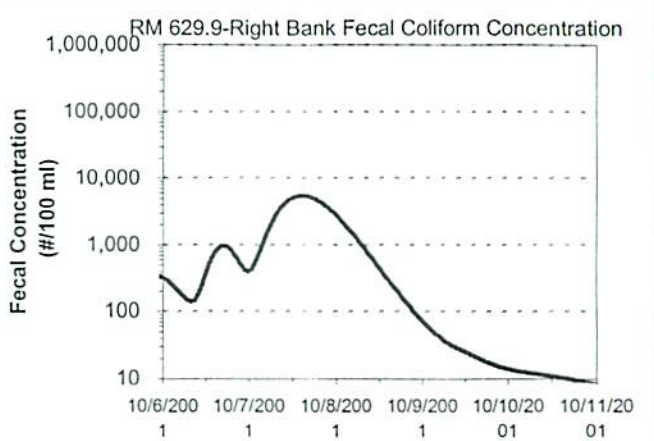

RM 628-Left Bank Fecal Coliform Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

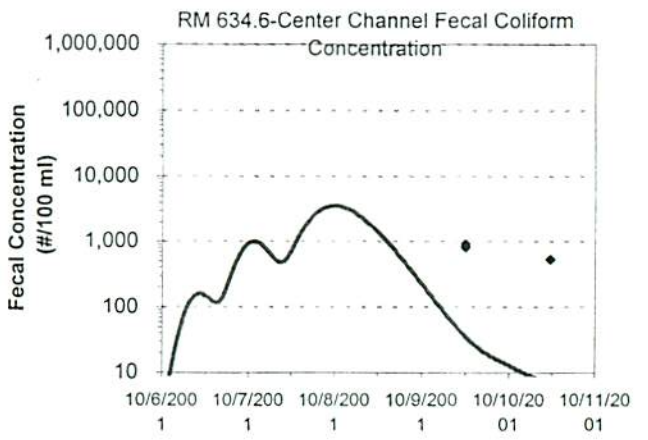

RM 628-Center Channel Fecal Coliform Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001


RM 628-Right Bank Fecal Coliform Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001


RM 629.9-Left Bank Fecal Coliform Concentration
Fecal Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
10/6/2001
10/7/2001
10/8/2001
10/9/2001
10/10/2001
10/11/2001


RM 629.9-Center Channel Fecal Coliform Concentration
Fecal Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
10/6/2001
10/7/2001
10/8/2001
10/9/2001
10/10/2001
10/11/2001

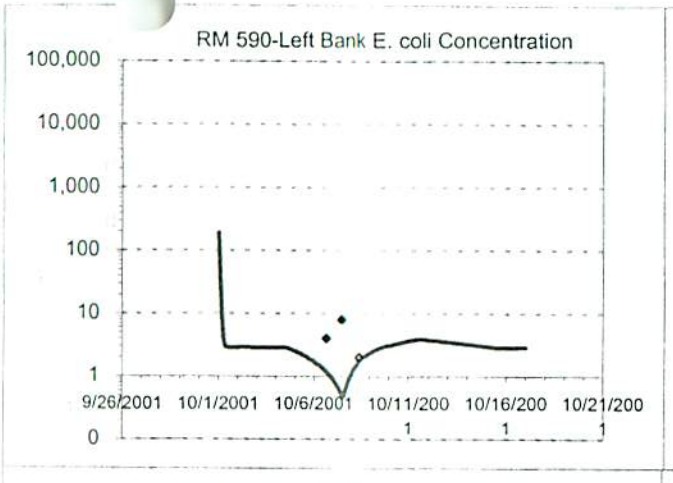

RM 629.9-Right Bank Fecal Coliform Concentration
Fecal Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
10/6/2001
10/7/2001
10/8/2001
10/9/2001
10/10/2001
10/11/2001

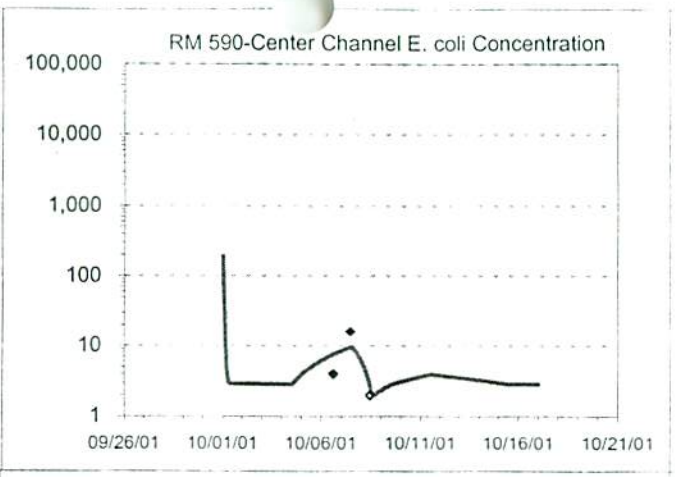

RM 634.6-Center Channel Fecal Coliform Concentration
Fecal Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
10/6/2001
10/7/2001
10/8/2001
10/9/2001
10/10/2001
10/11/2001

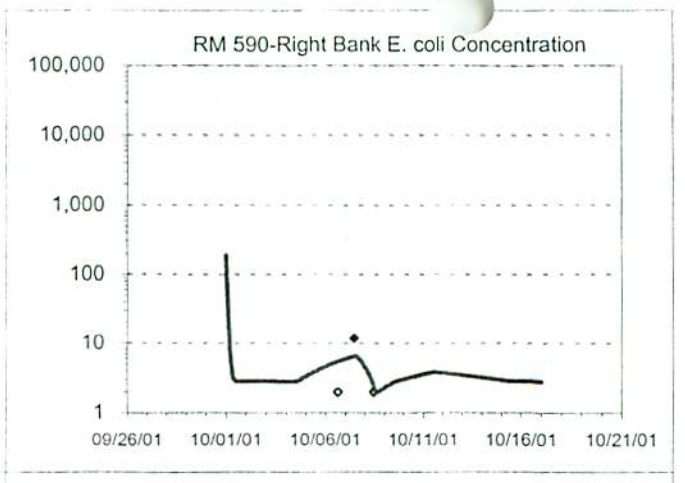
APPENDIX G

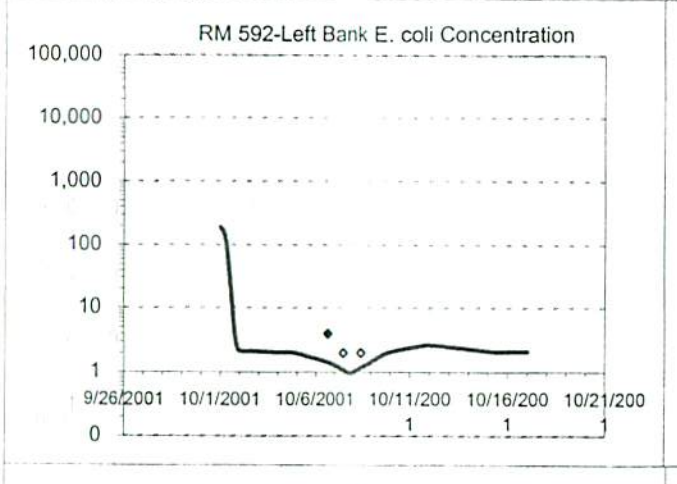
TEMPORAL PLOTS OF MODEL AND OBSERVED DATA BY AREA OF RIVER

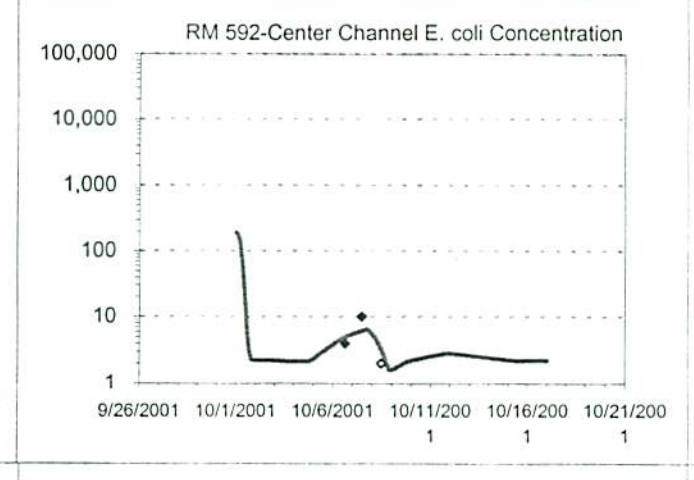
October 2001 Wet Weather Event *E. Coli*

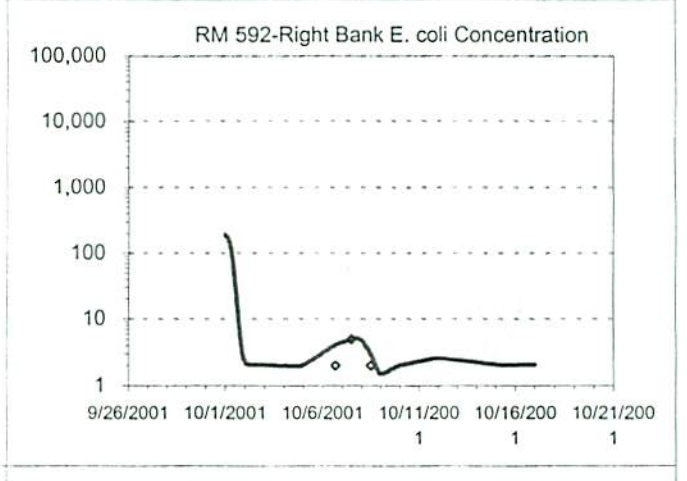

RM 590-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

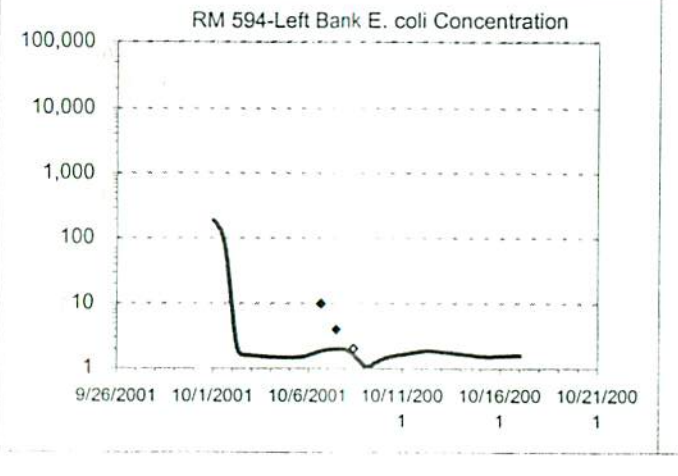

RM 590-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
09/26/01
10/01/01
10/06/01
10/11/01
10/16/01
10/21/01

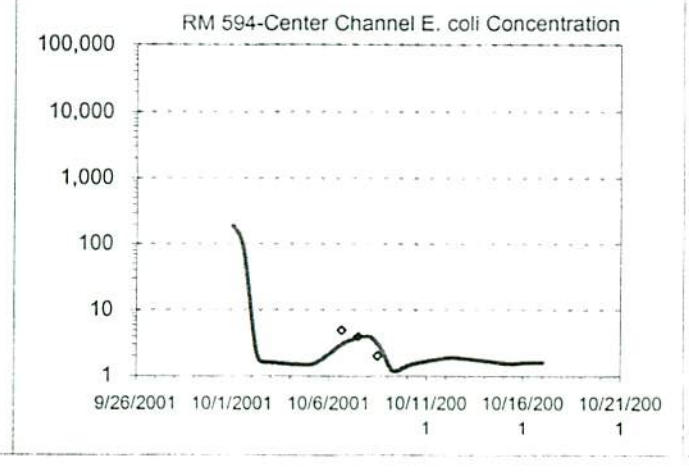

RM 590-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
09/26/01
10/01/01
10/06/01
10/11/01
10/16/01
10/21/01

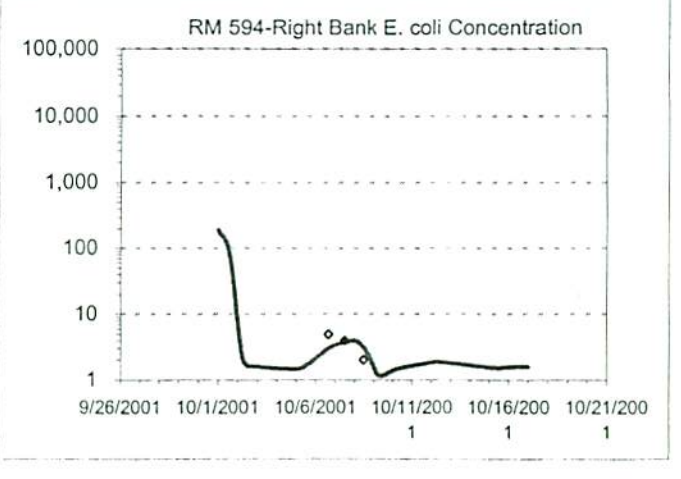

RM 592-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

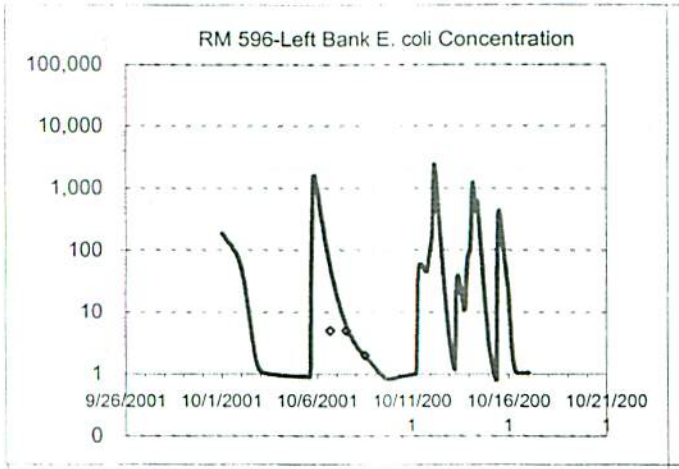

RM 592-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

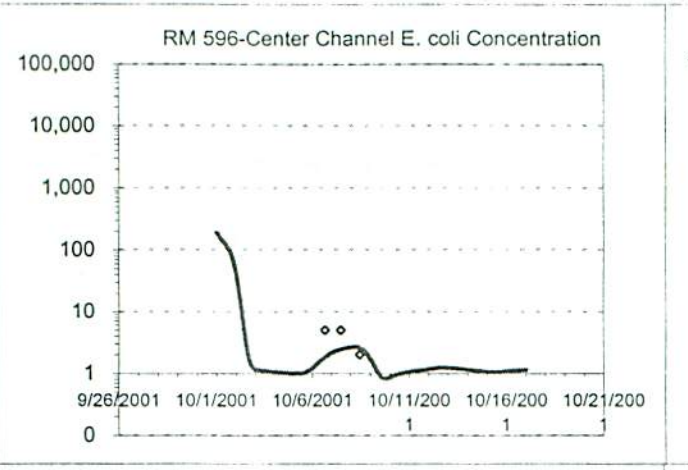

RM 592-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

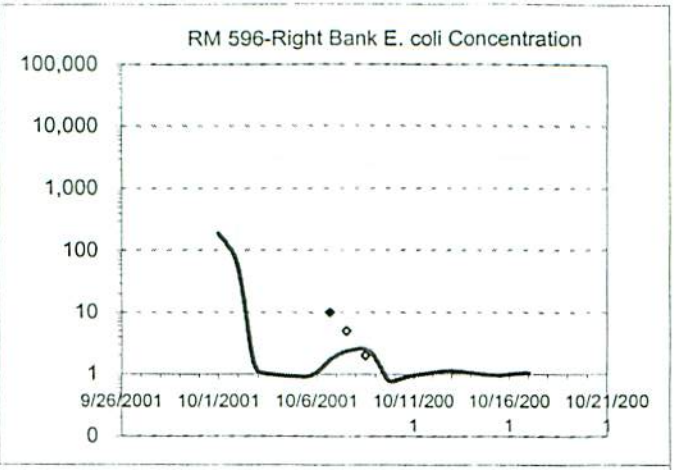

RM 594-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

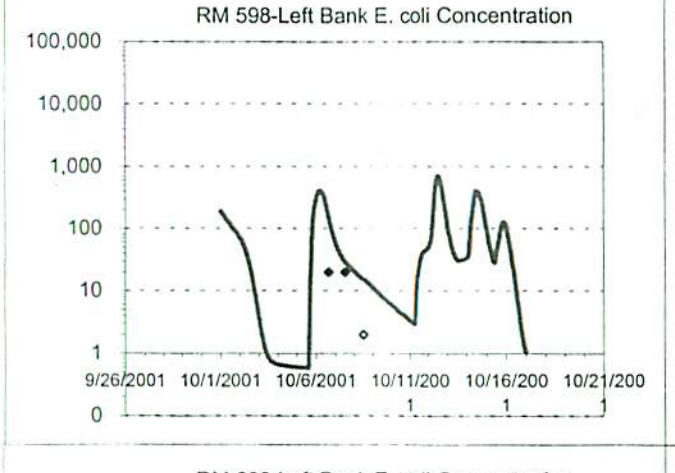

RM 594-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

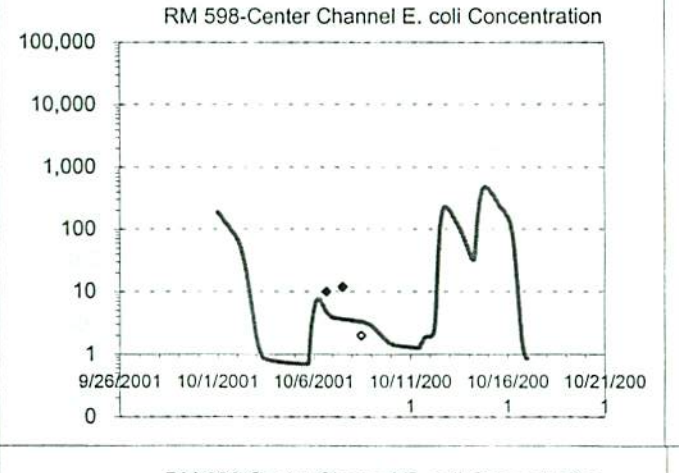

RM 594-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

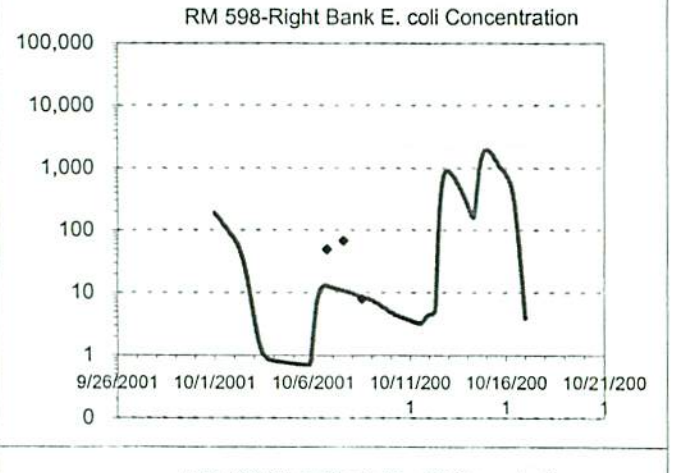

RM 596-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

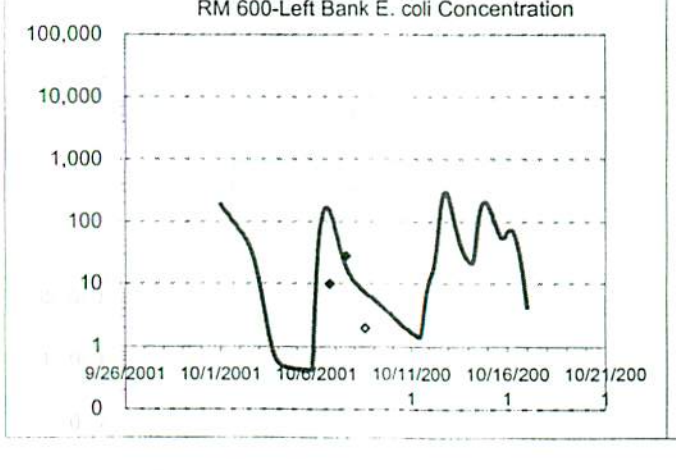

RM 596-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

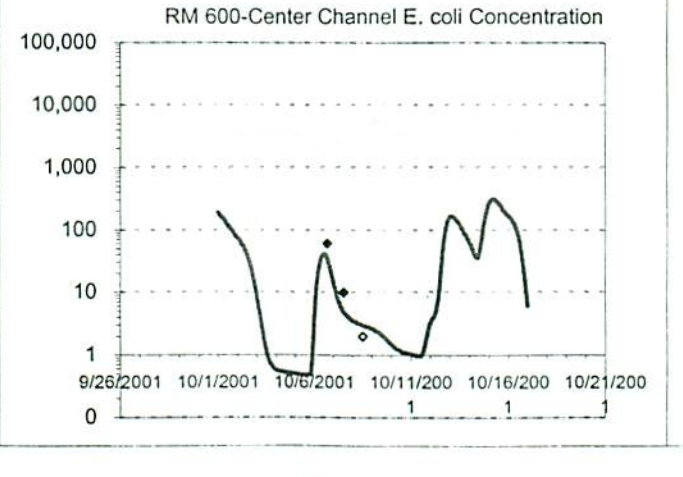

RM 596-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

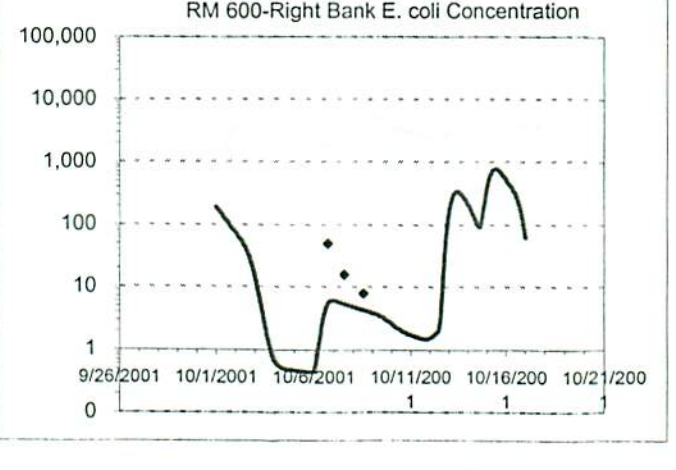

RM 598-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

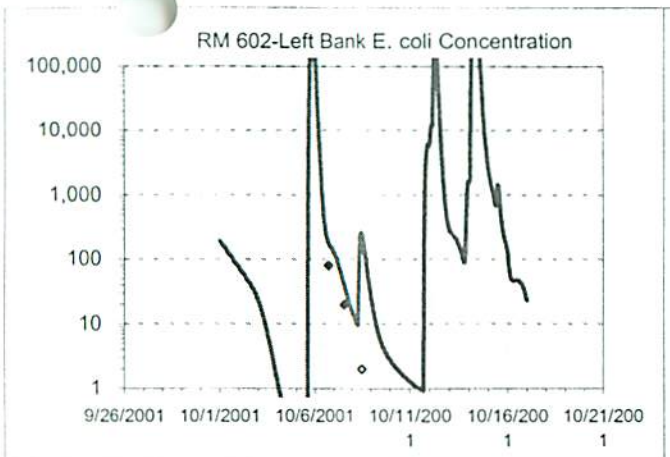

RM 598-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

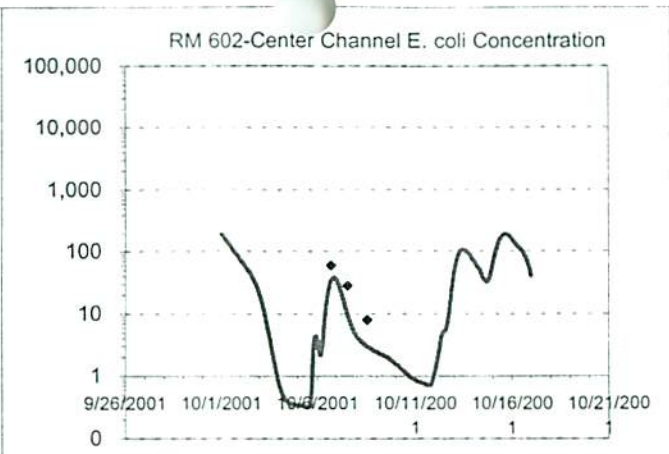

RM 598-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

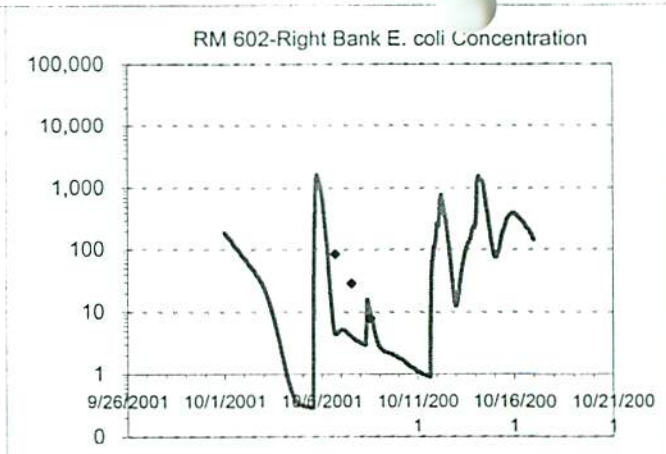

RM 600-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

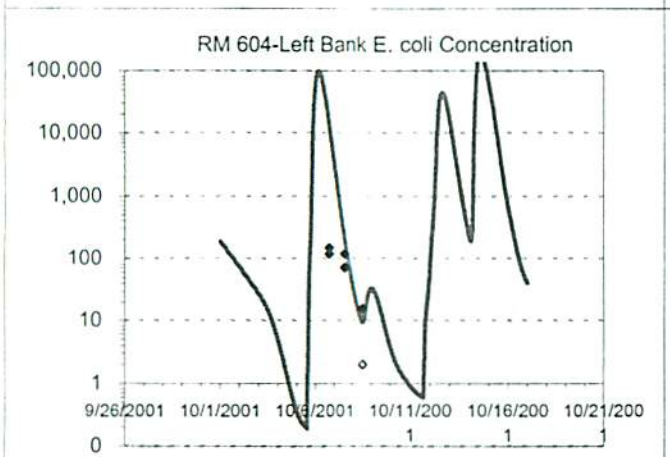

RM 600-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

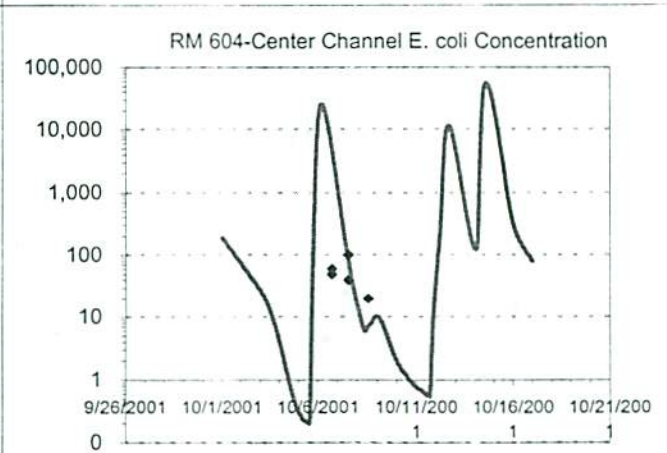

RM 600-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

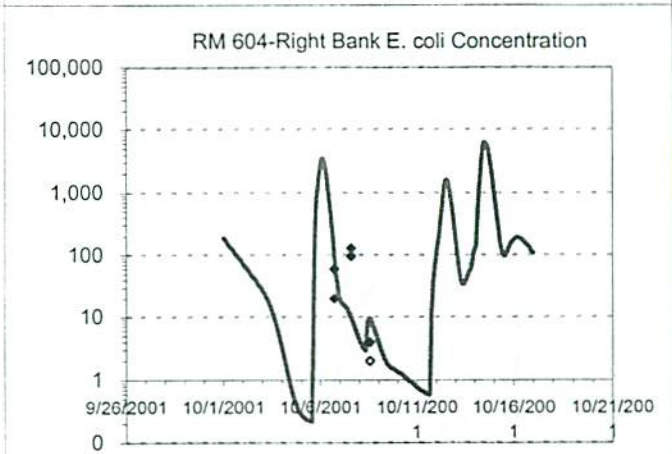

RM 602-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/200 1
10/16/200 1
10/21/200 1

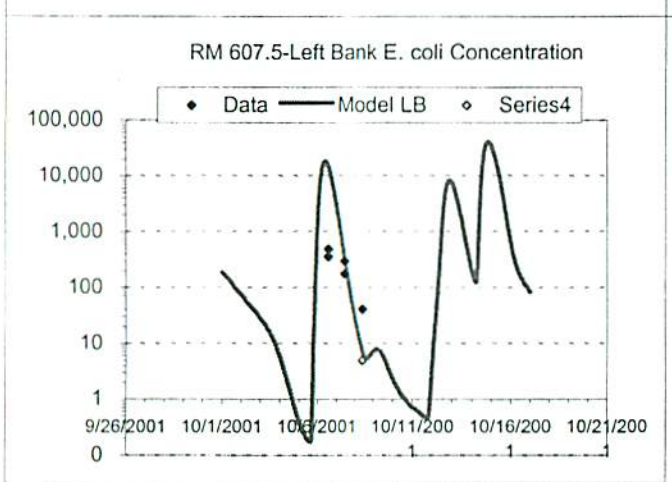

RM 602-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/11/200 1
10/16/200 1
10/21/200 1

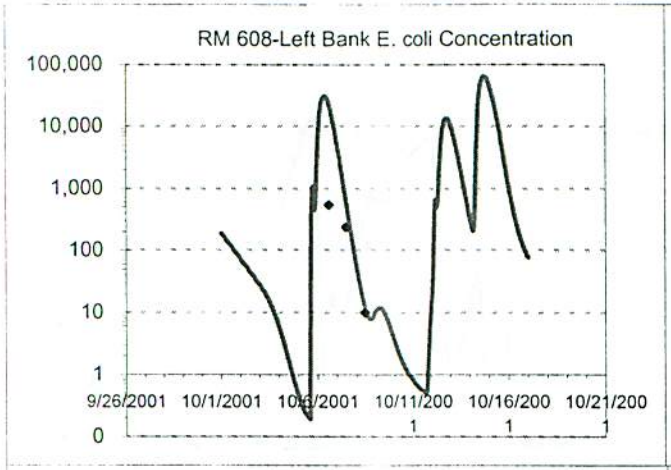

RM 602-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/11/200 1
10/16/200 1
10/21/200 1

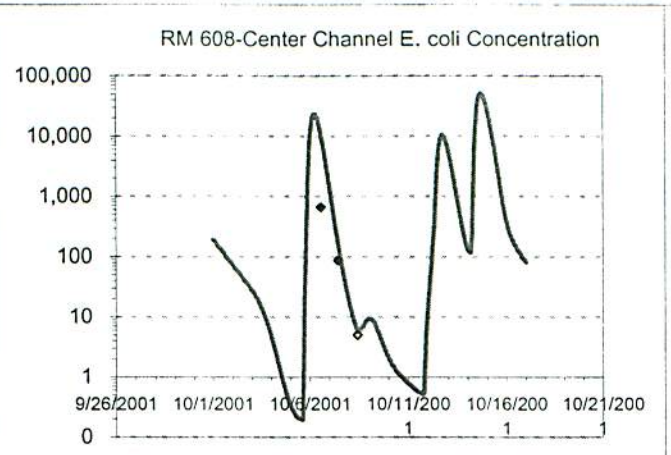

RM 604-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/11/200 1
10/16/200 1
10/21/200 1

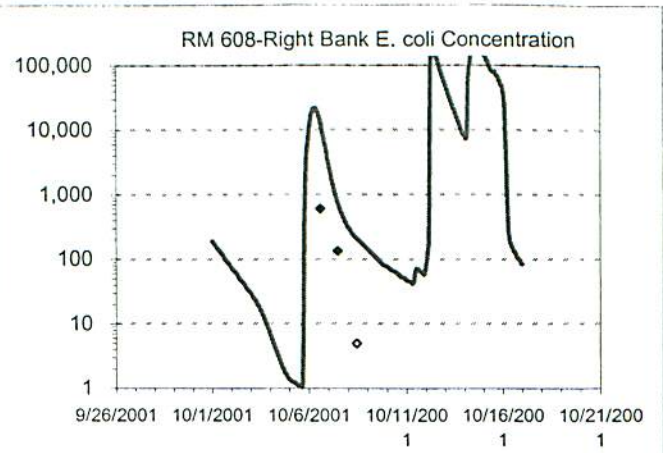

RM 604-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/11/200 1
10/16/200 1
10/21/200 1

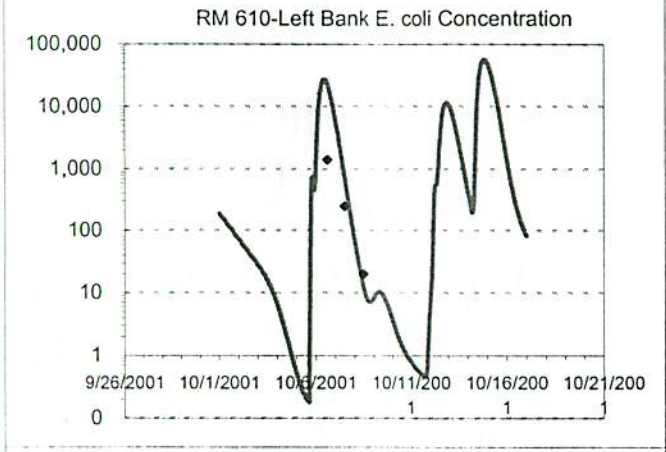

RM 604-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/11/200 1
10/16/200 1
10/21/200 1

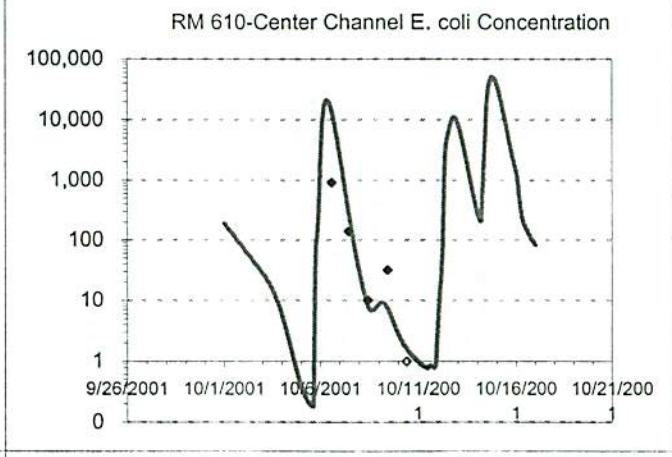

RM 607.5-Left Bank E. coli Concentration
Data
Model LB
Series4
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/11/200 1
10/16/200 1
10/21/200 1

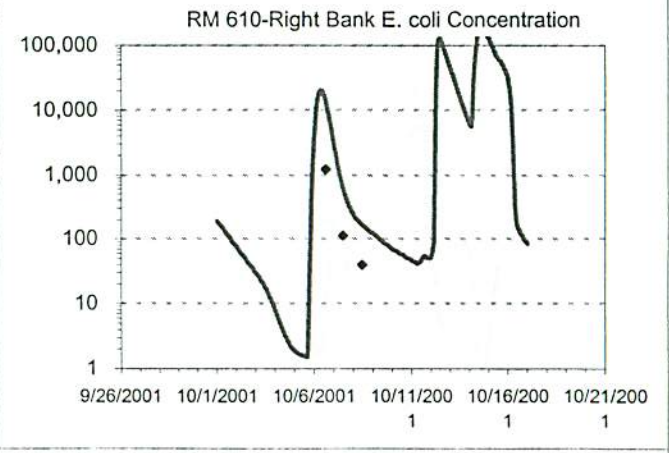

RM 608-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

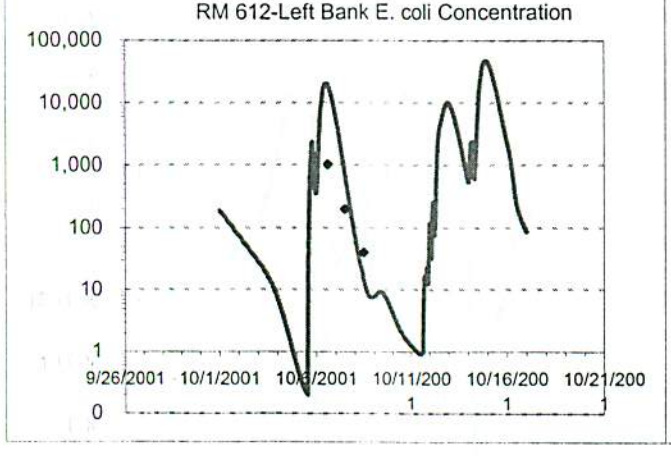

RM 608-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

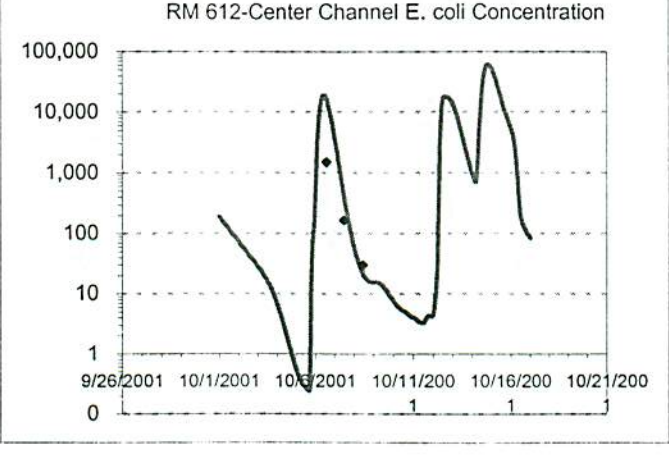

RM 608-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

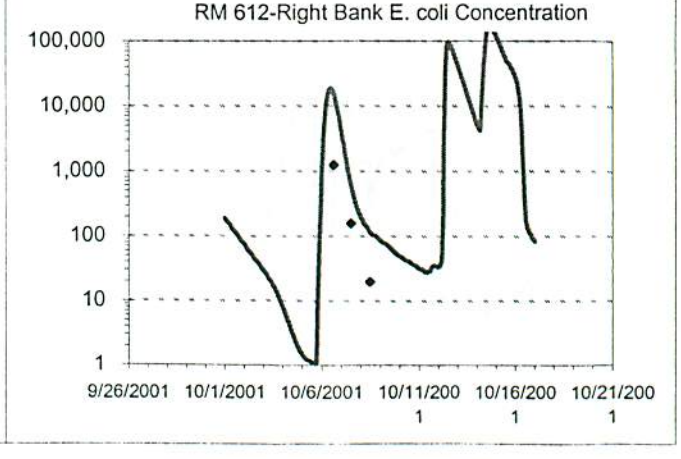

RM 610-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

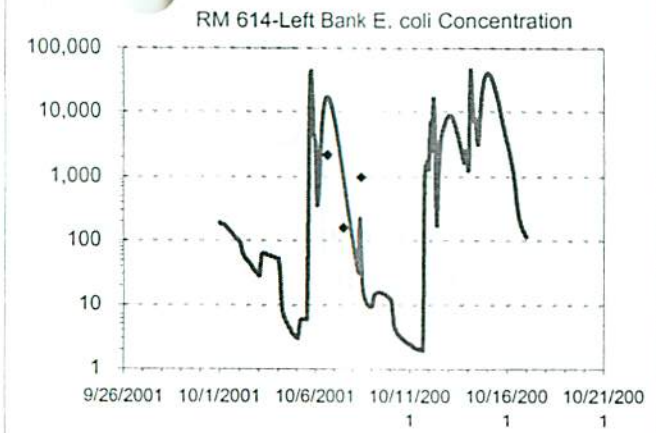

RM 610-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

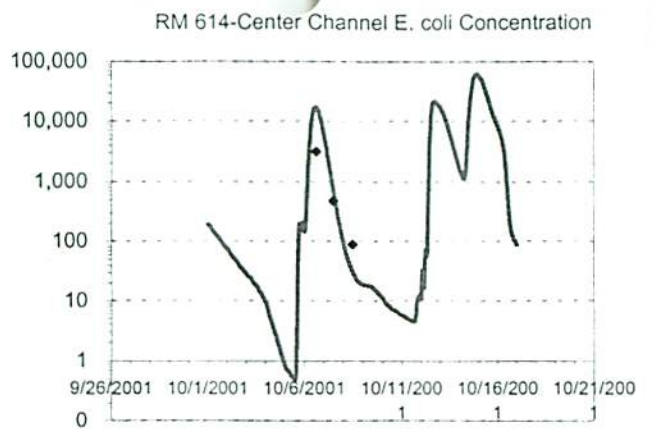

RM 610-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

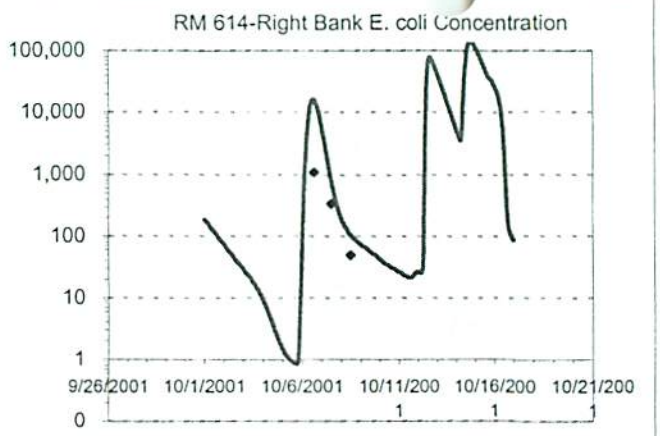

RM 612-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

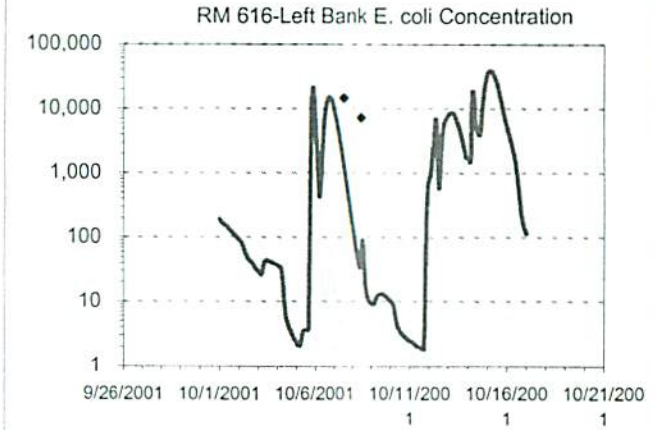

RM 612-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

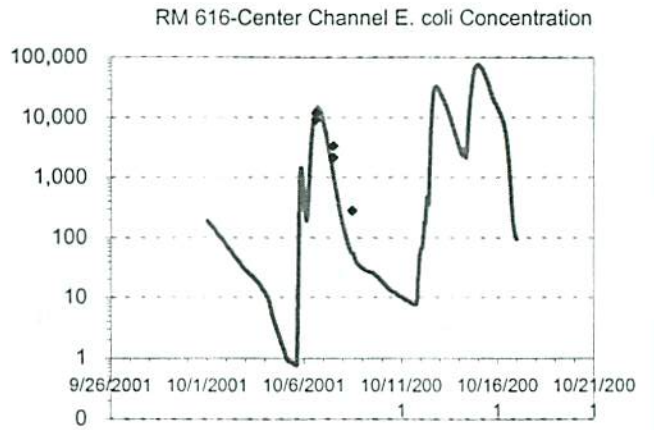

RM 612-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

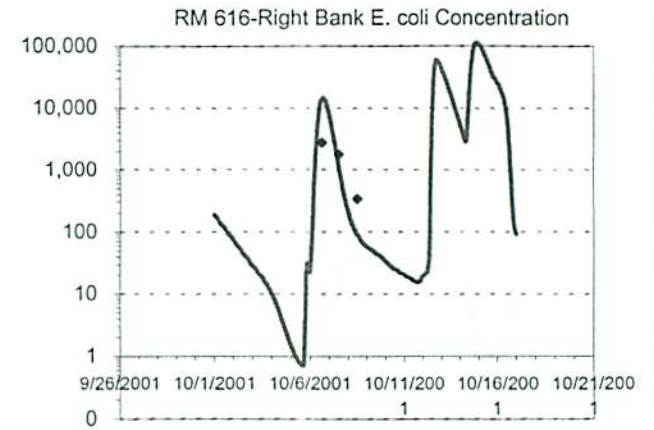

RM 614-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

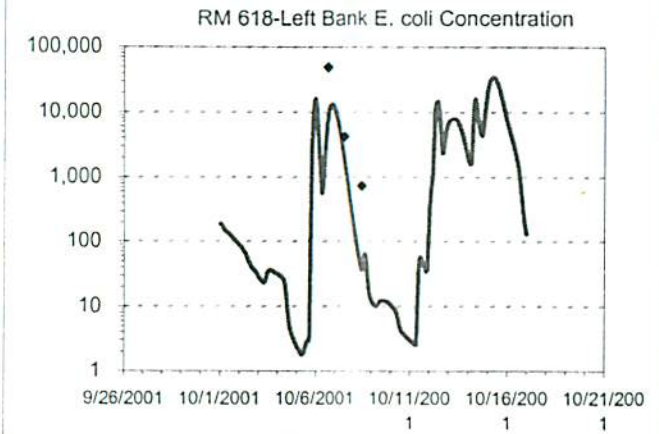

RM 614-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

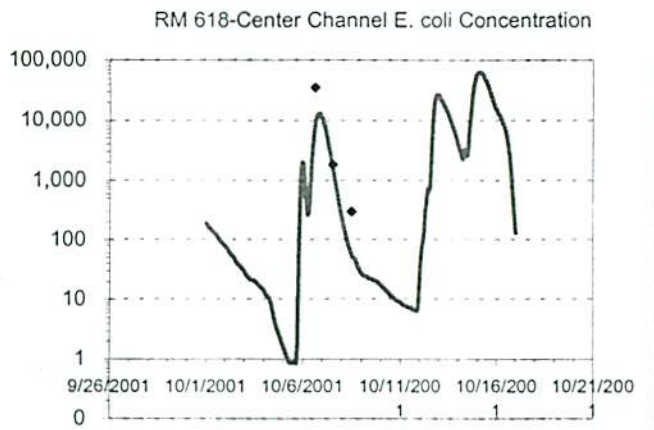

RM 614-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

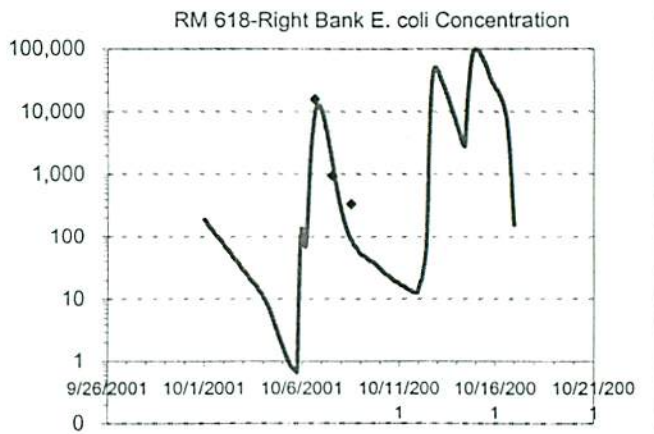

RM 616-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

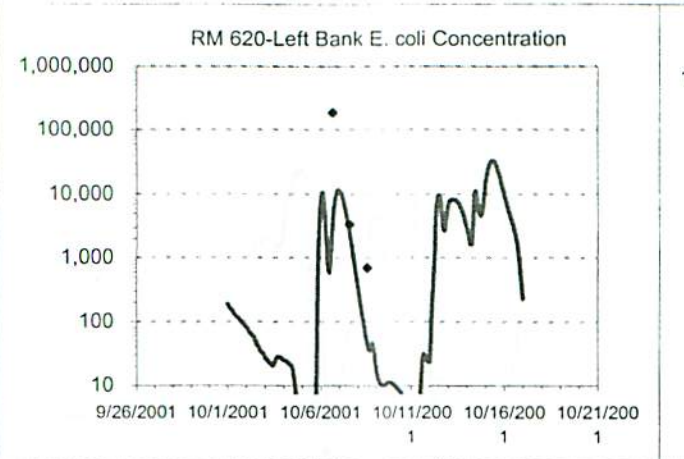

RM 616-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

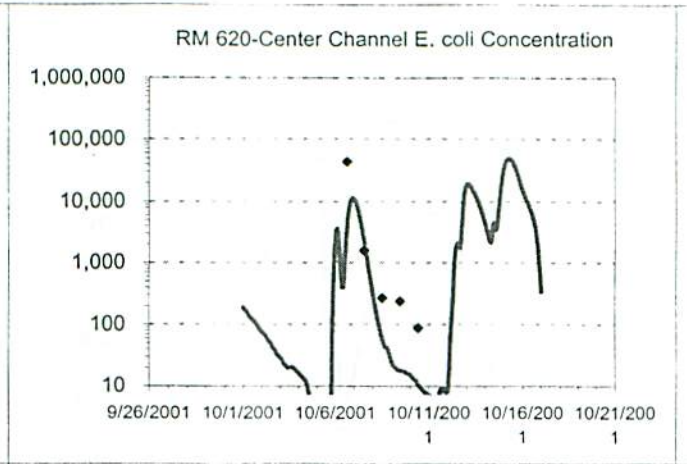

RM 616-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

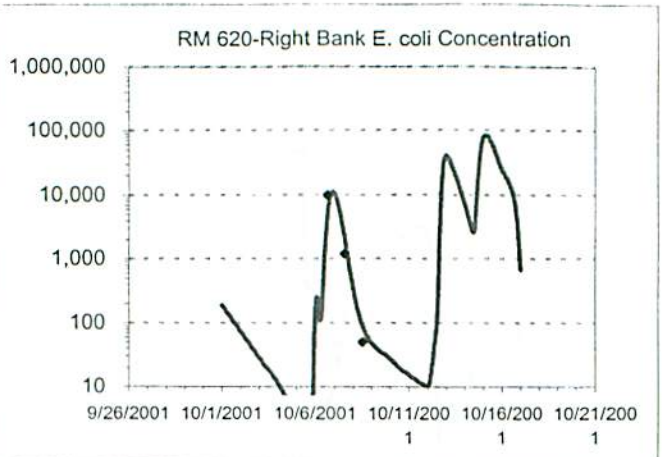

RM 618-Left Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

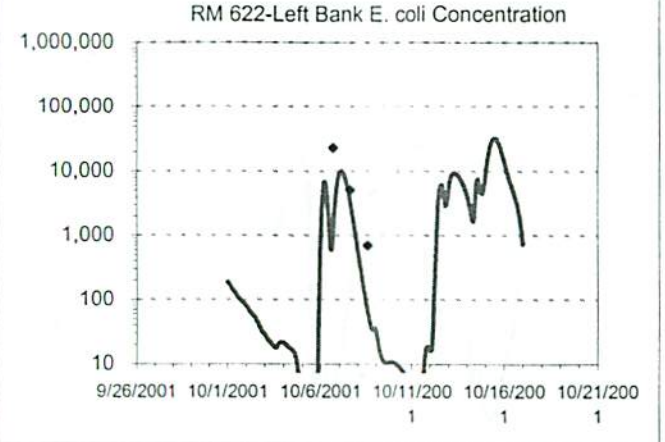

RM 618-Center Channel E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

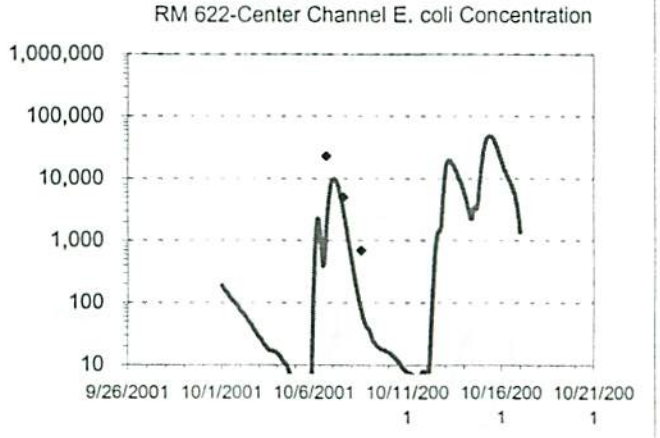

RM 618-Right Bank E. coli Concentration
100,000
10,000
1,000
100
10
1
0
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

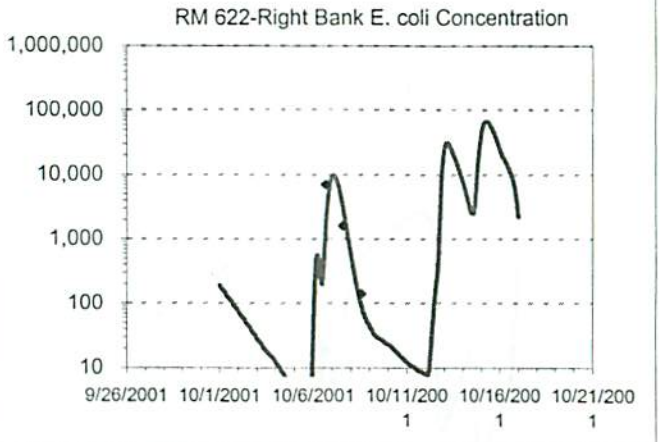

RM 620-Left Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

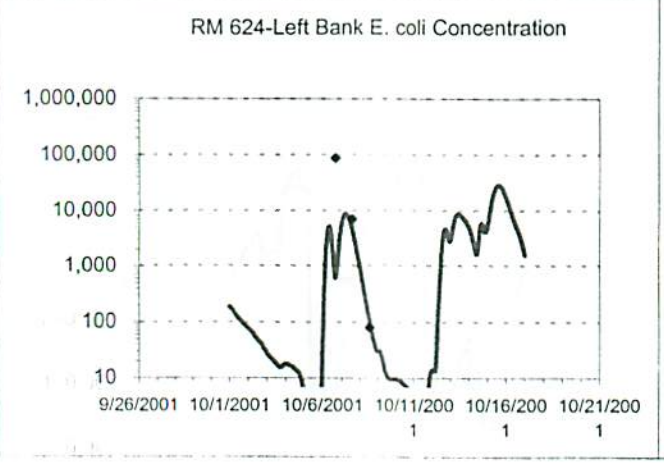

RM 620-Center Channel E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

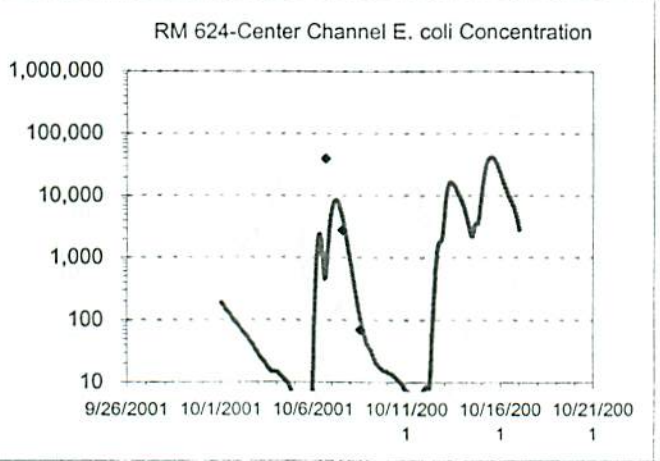

RM 620-Right Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

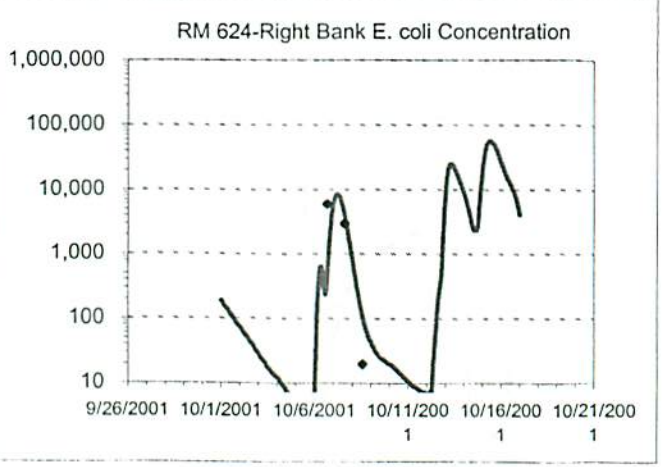

RM 622-Left Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

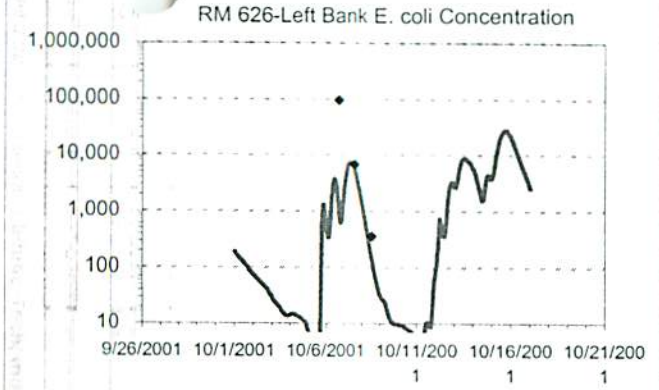

RM 622-Center Channel E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

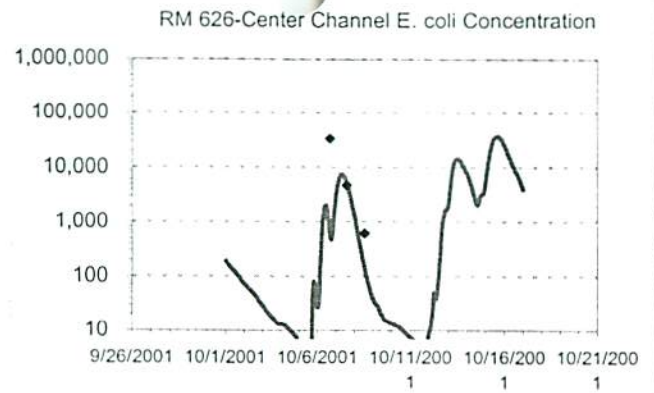

RM 622-Right Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

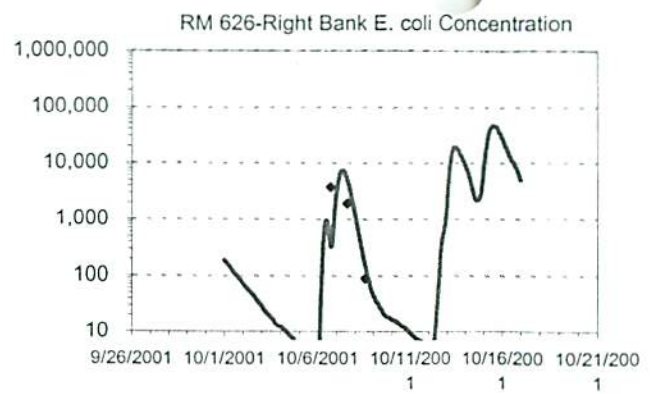

RM 624-Left Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

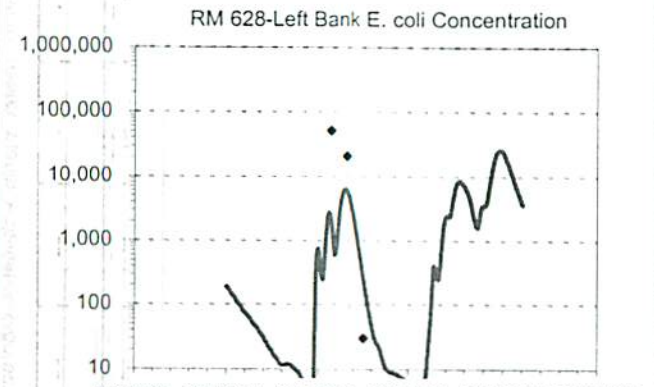

RM 624-Center Channel E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

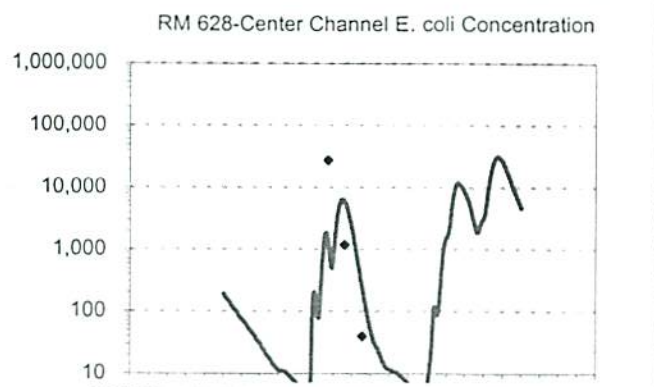

RM 624-Right Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

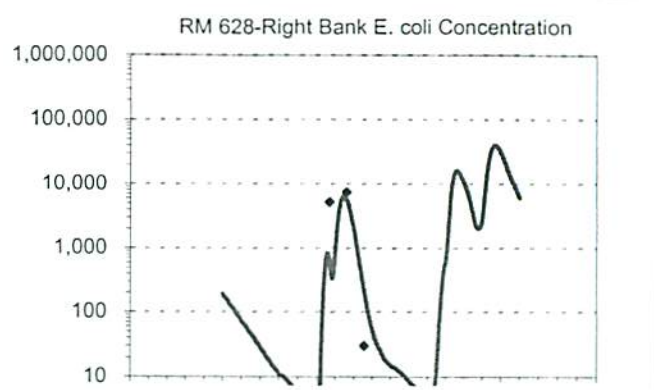

RM 626-Left Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

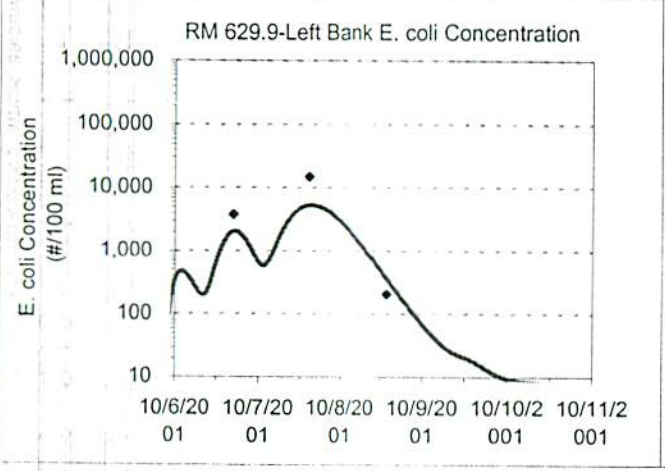

RM 626-Center Channel E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

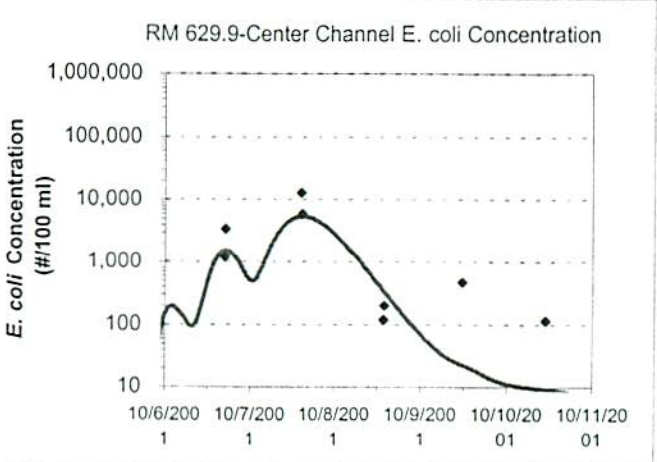

RM 626-Right Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

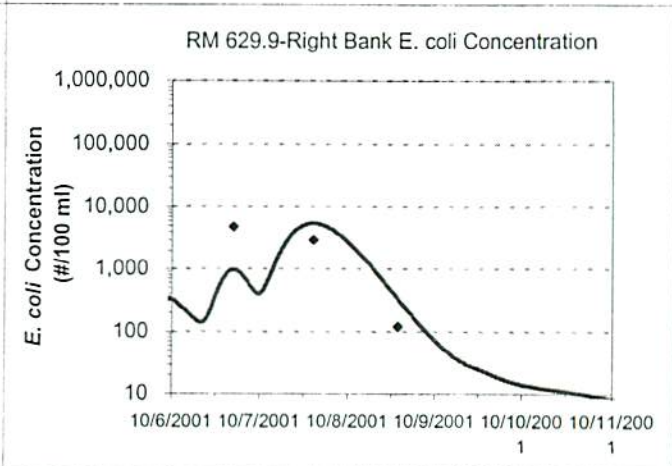

RM 628-Left Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001

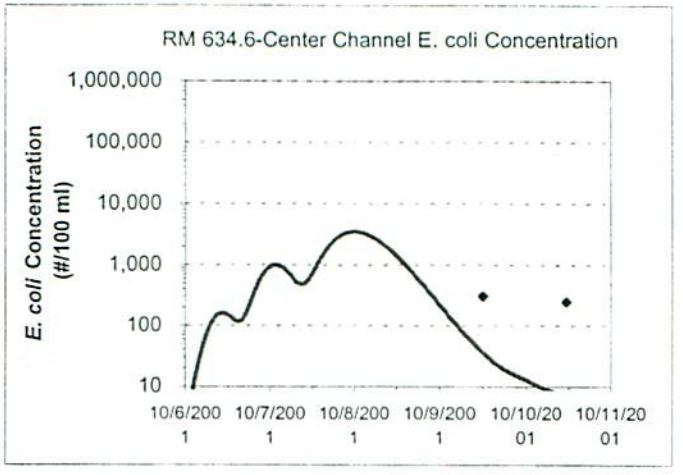

RM 628-Center Channel E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001


RM 628-Right Bank E. coli Concentration
1,000,000
100,000
10,000
1,000
100
10
9/26/2001
10/1/2001
10/6/2001
10/11/2001
10/16/2001
10/21/2001


RM 629.9-Left Bank E. coli Concentration
E. coli Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
10/6/2001
10/7/2001
10/8/2001
10/9/2001
10/10/2001
10/11/2001


RM 629.9-Center Channel E. coli Concentration
E. coli Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
10/6/2001
10/7/2001
10/8/2001
10/9/2001
10/10/2001
10/11/2001


RM 629.9-Right Bank E. coli Concentration
E. coli Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
10/6/2001
10/7/2001
10/8/2001
10/9/2001
10/10/2001
10/11/2001

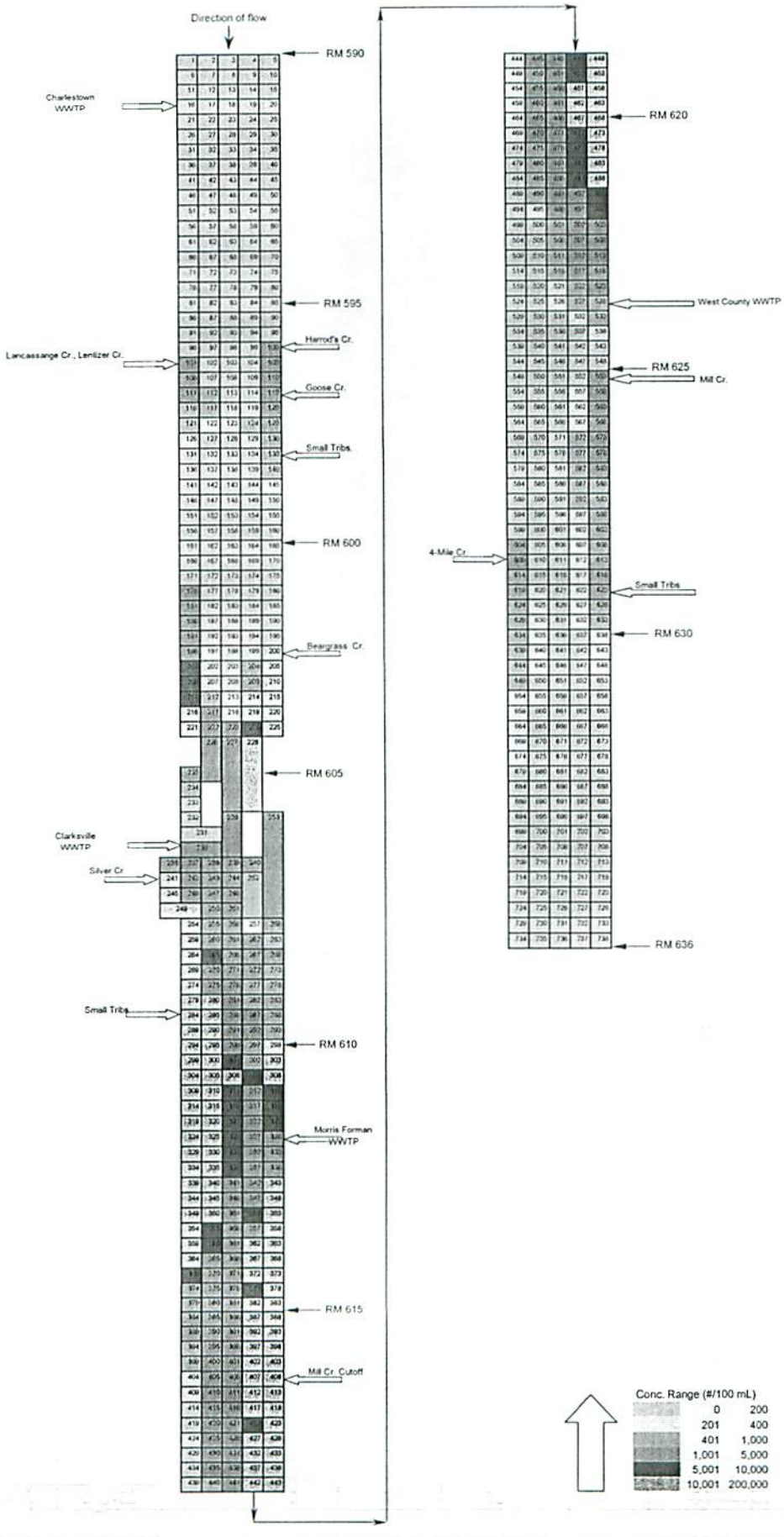

RM 634.6-Center Channel E. coli Concentration
E. coli Concentration (#/100 ml)
1,000,000
100,000
10,000
1,000
100
10
10/6/2001
10/7/2001
10/8/2001
10/9/2001
10/10/2001
10/11/2001

APPENDIX H

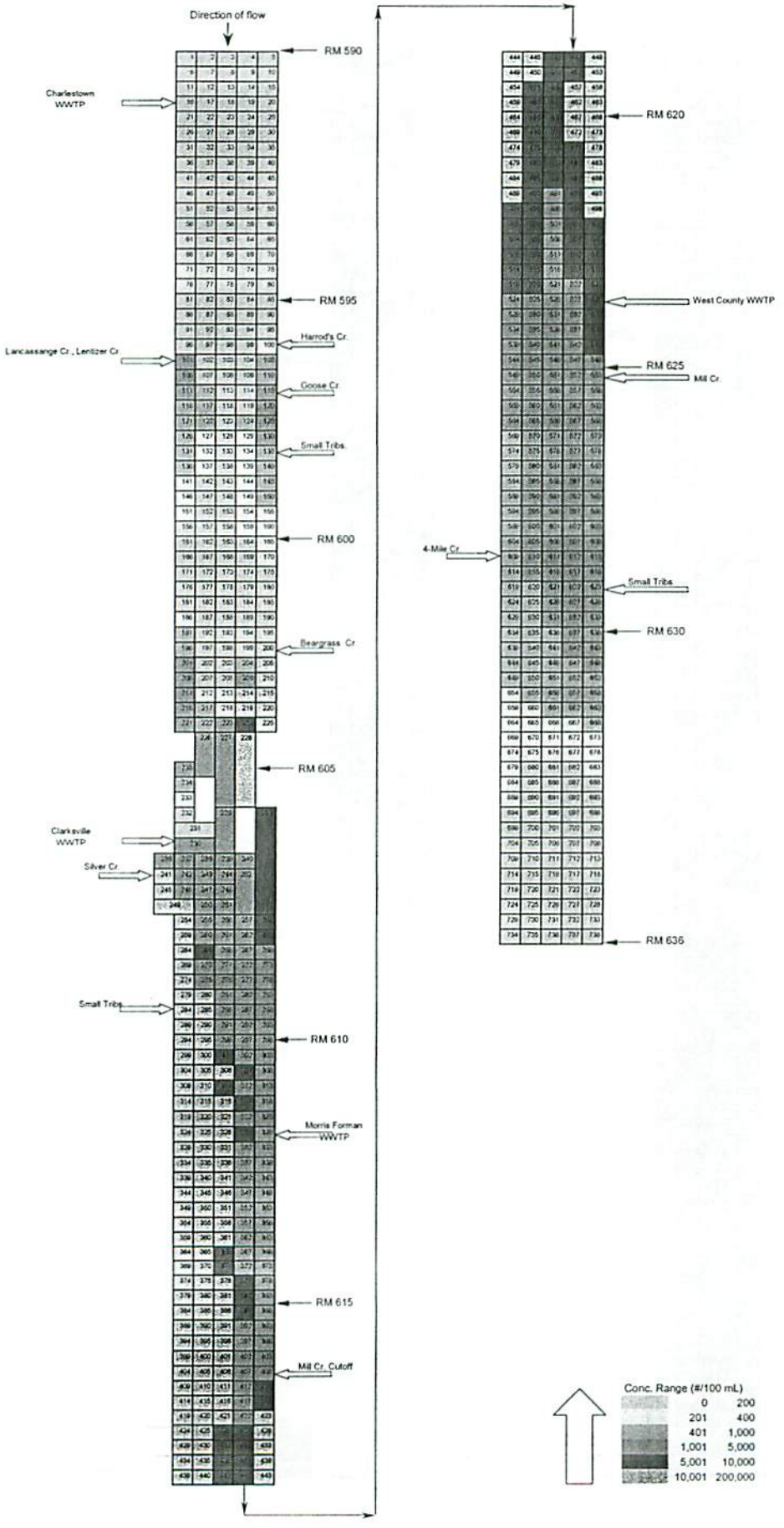
SCHEMATIC OF MAXIMUM CONCENTRATION IN EACH MODEL SEGMENT

October 1998 Wet Weather Event

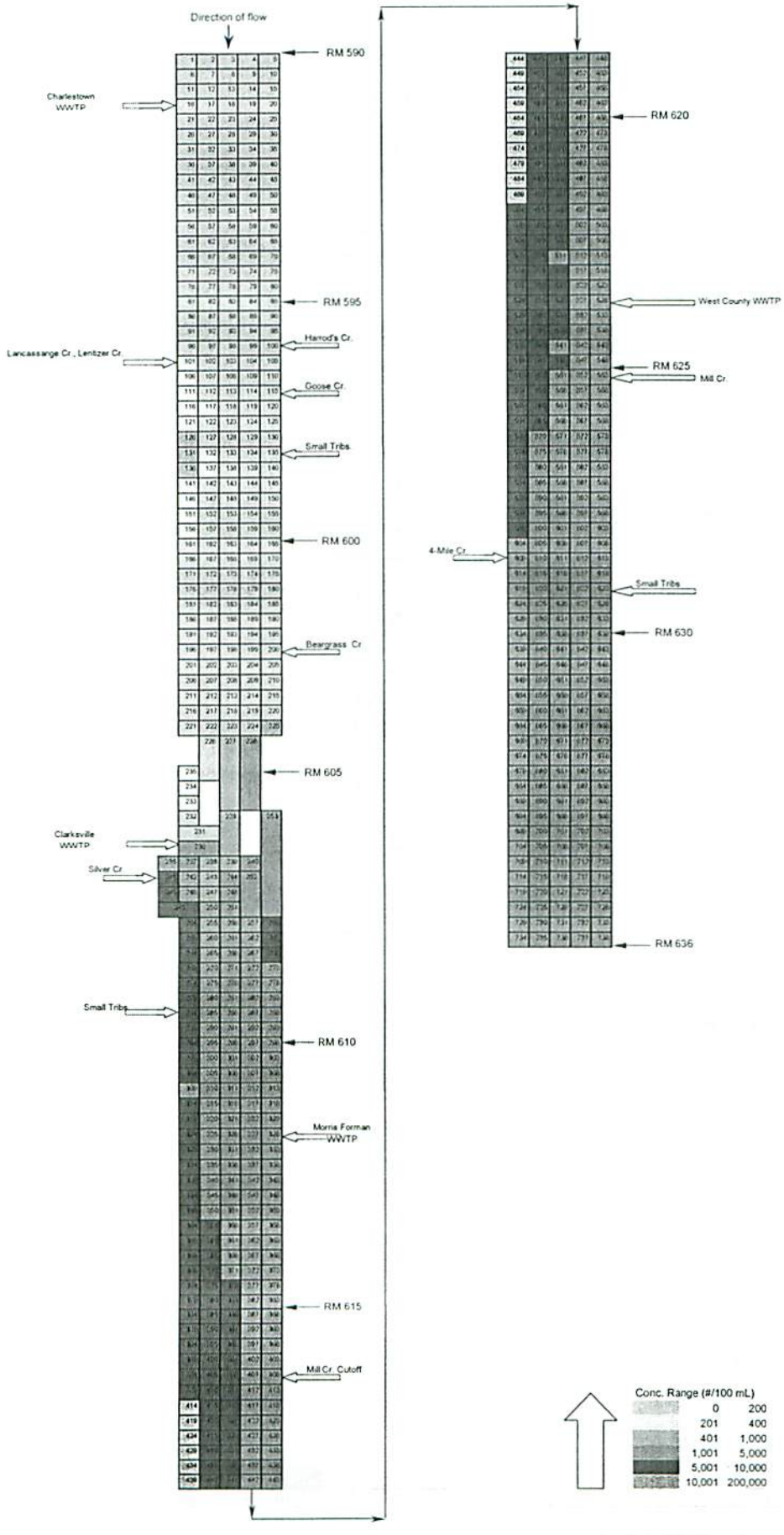
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/7/98



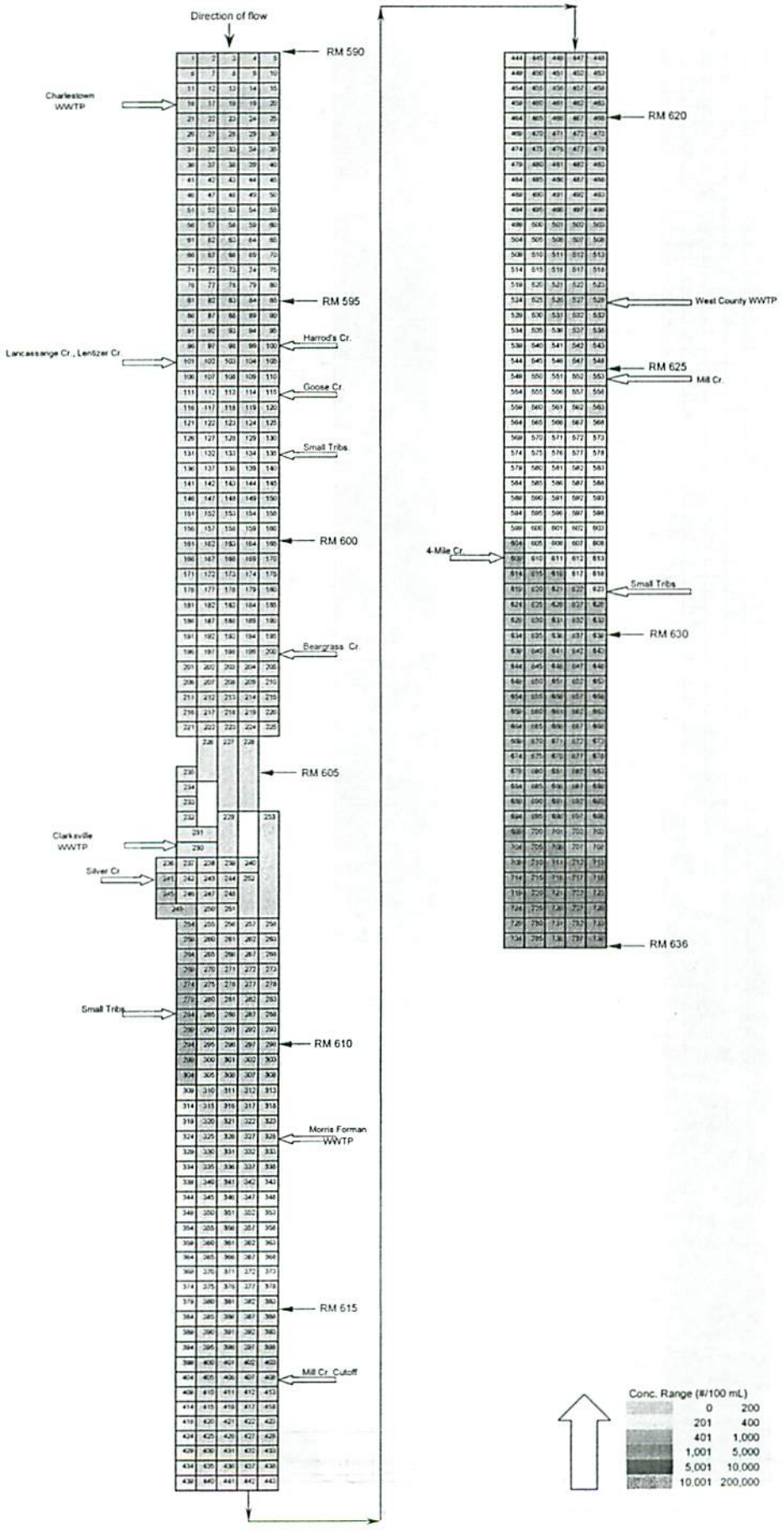
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/8/98



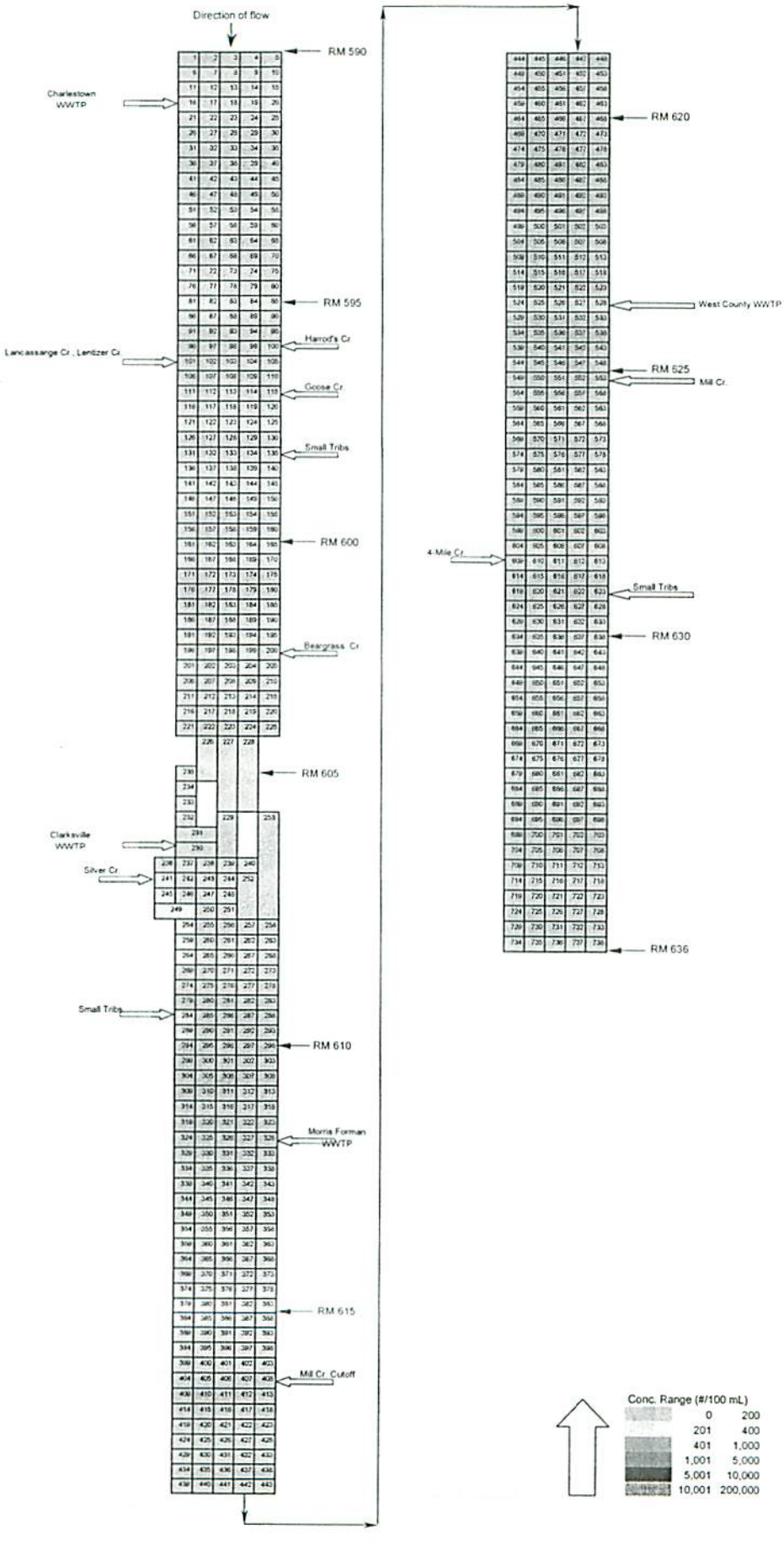
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/9/98



Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/10/98



Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/11/98

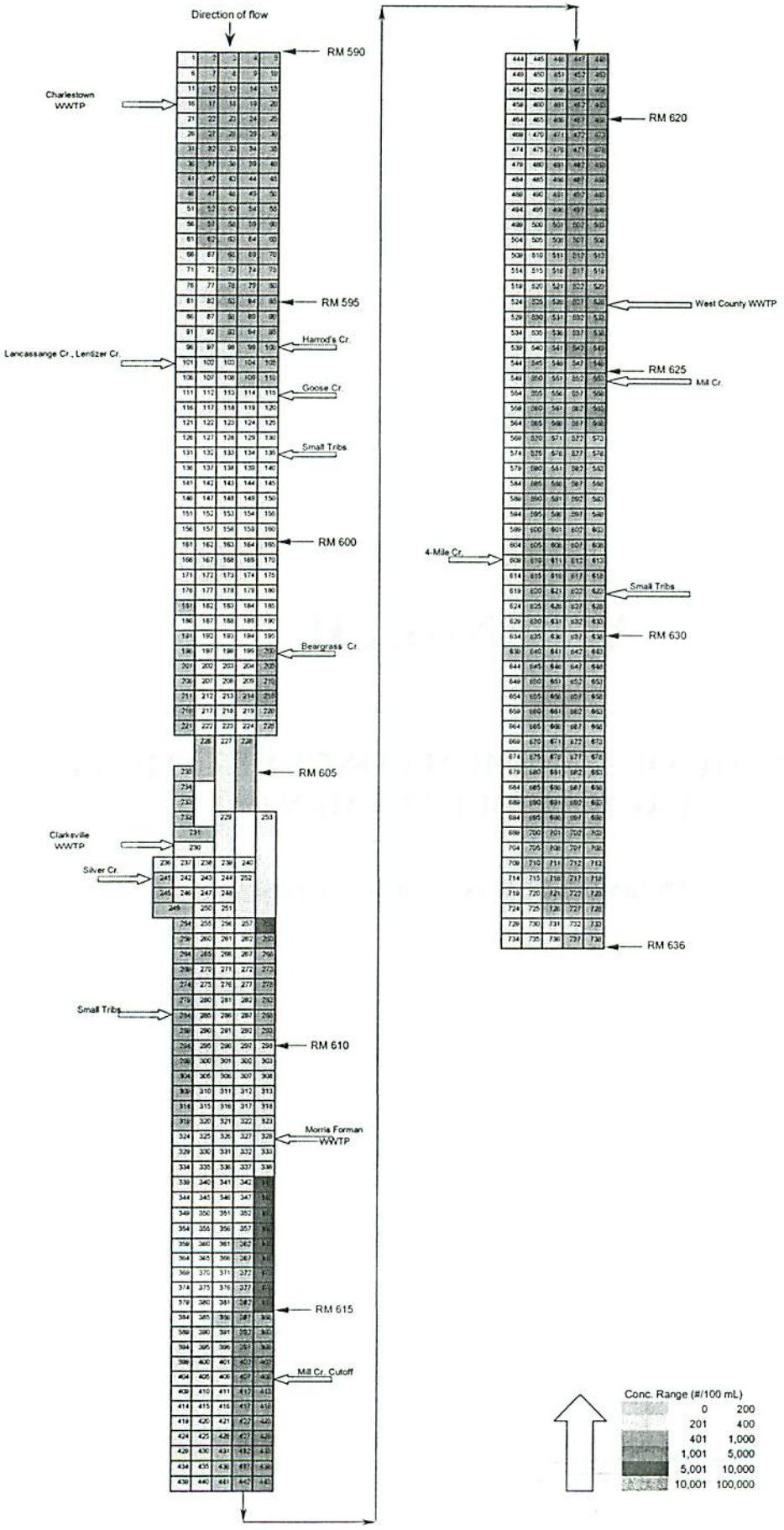


APPENDIX H

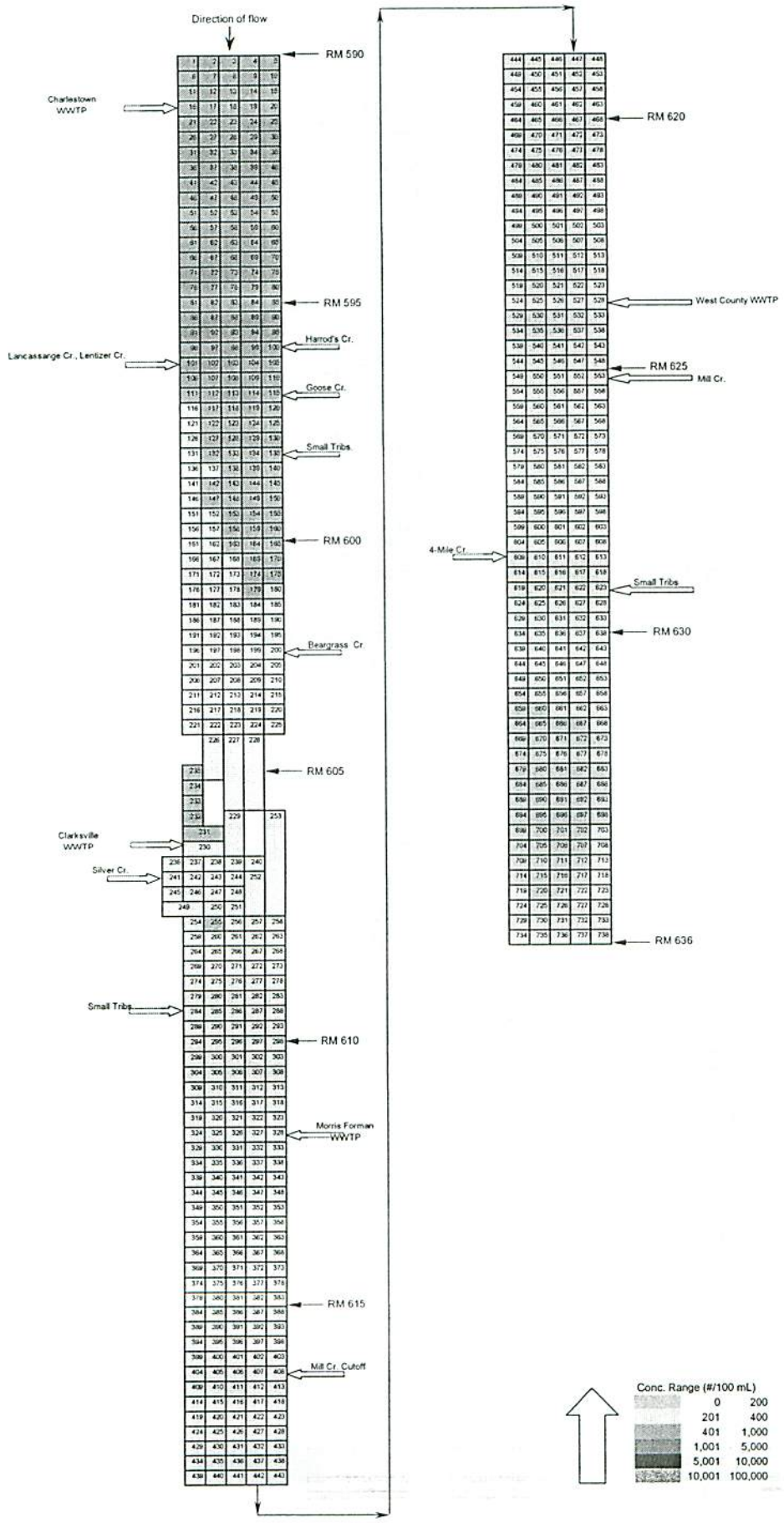
SCHEMATIC OF MAXIMUM CONCENTRATION IN EACH MODEL SEGMENT

August 2000 Wet Weather Event

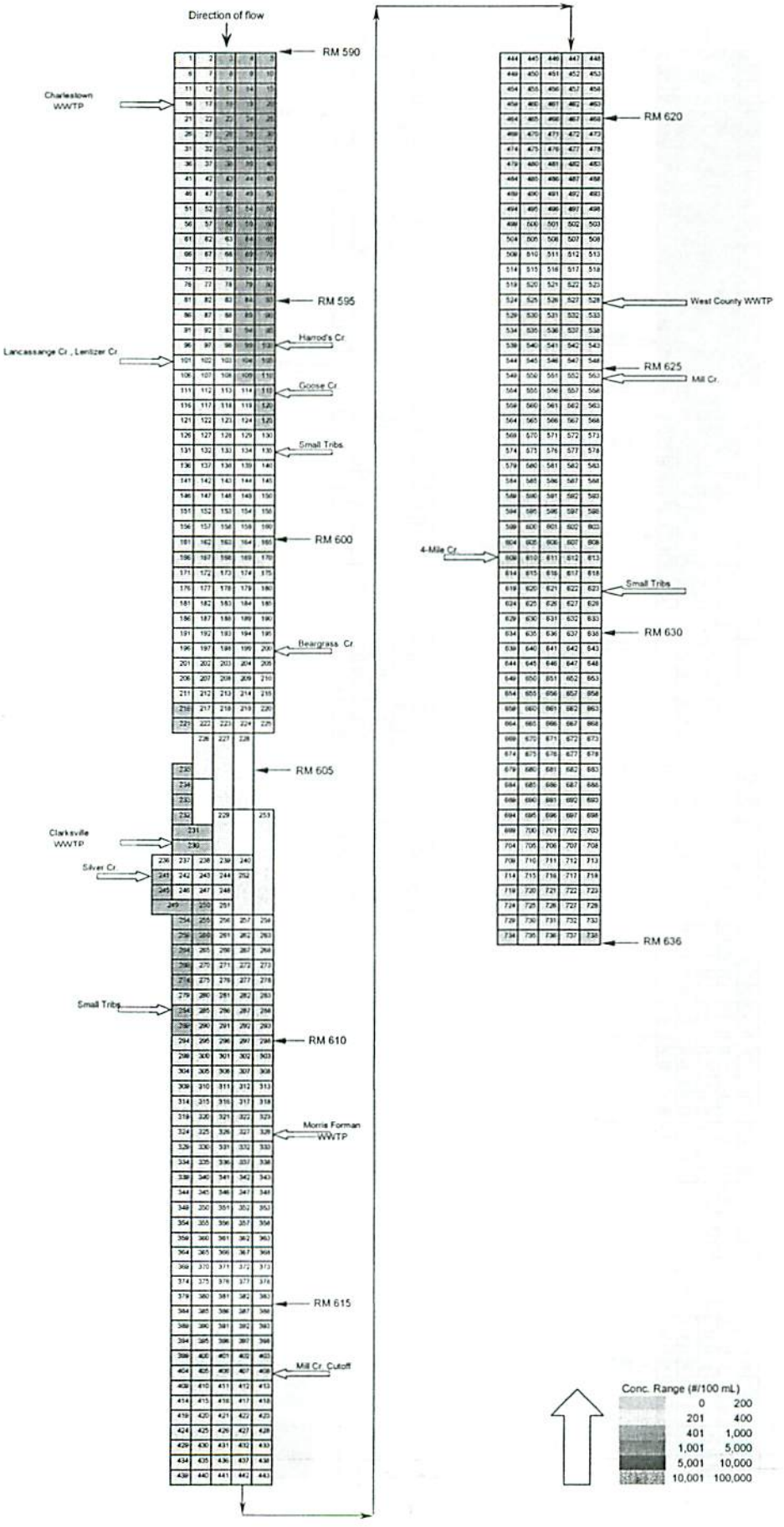
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 8/8/00



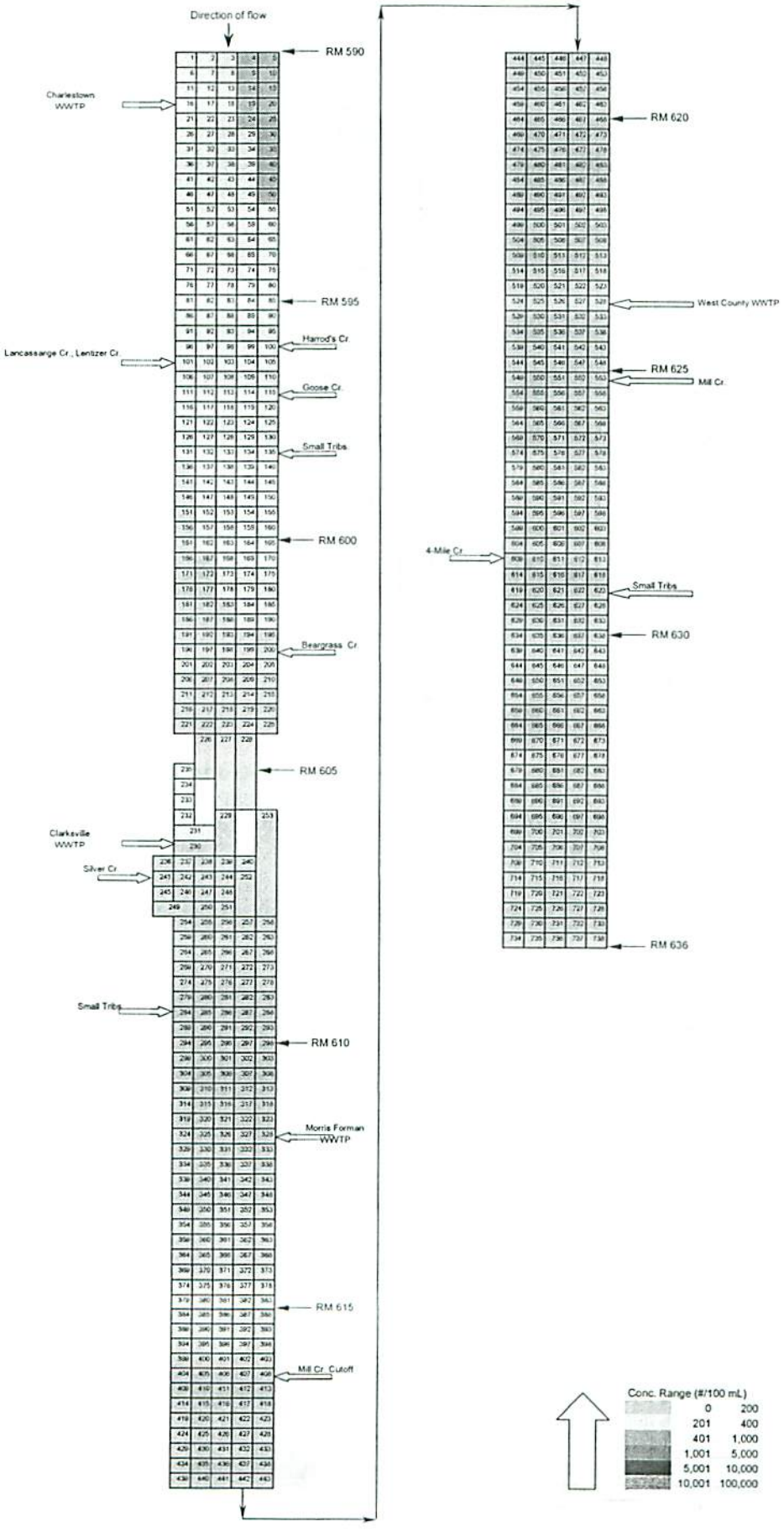
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 8/9/00



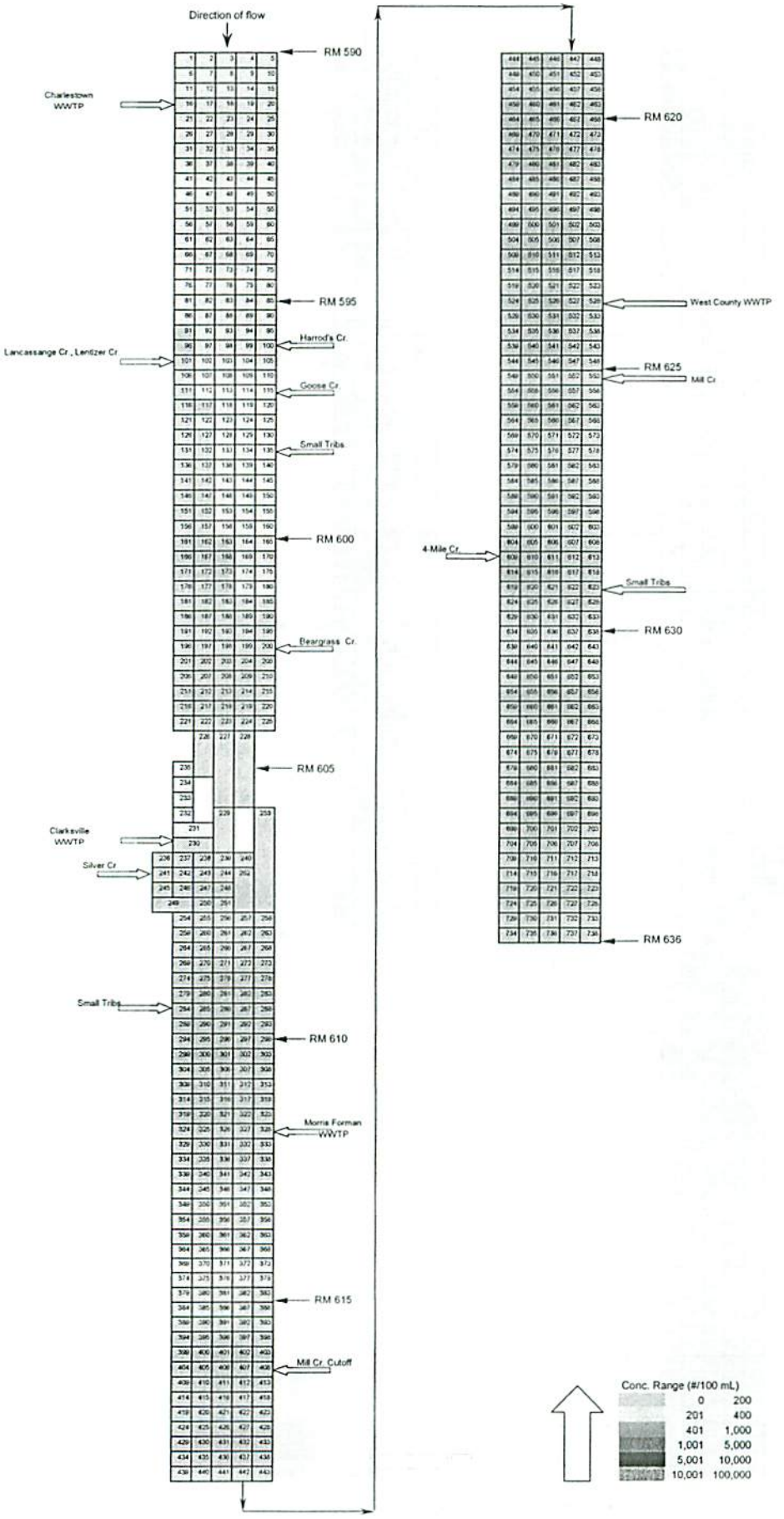
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 8/10/00



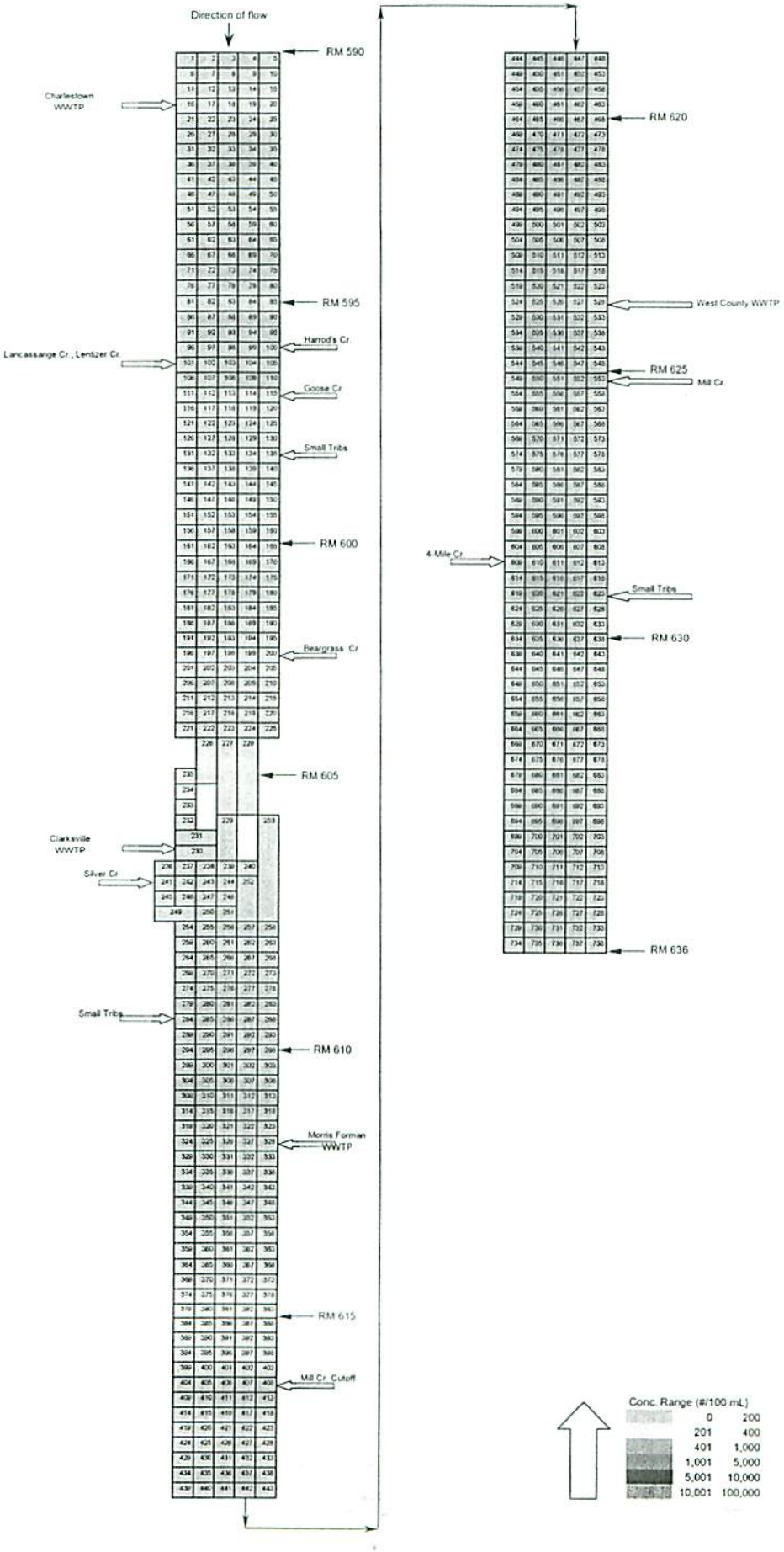
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 8/11/00



Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 8/12/00



Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 8/13/00

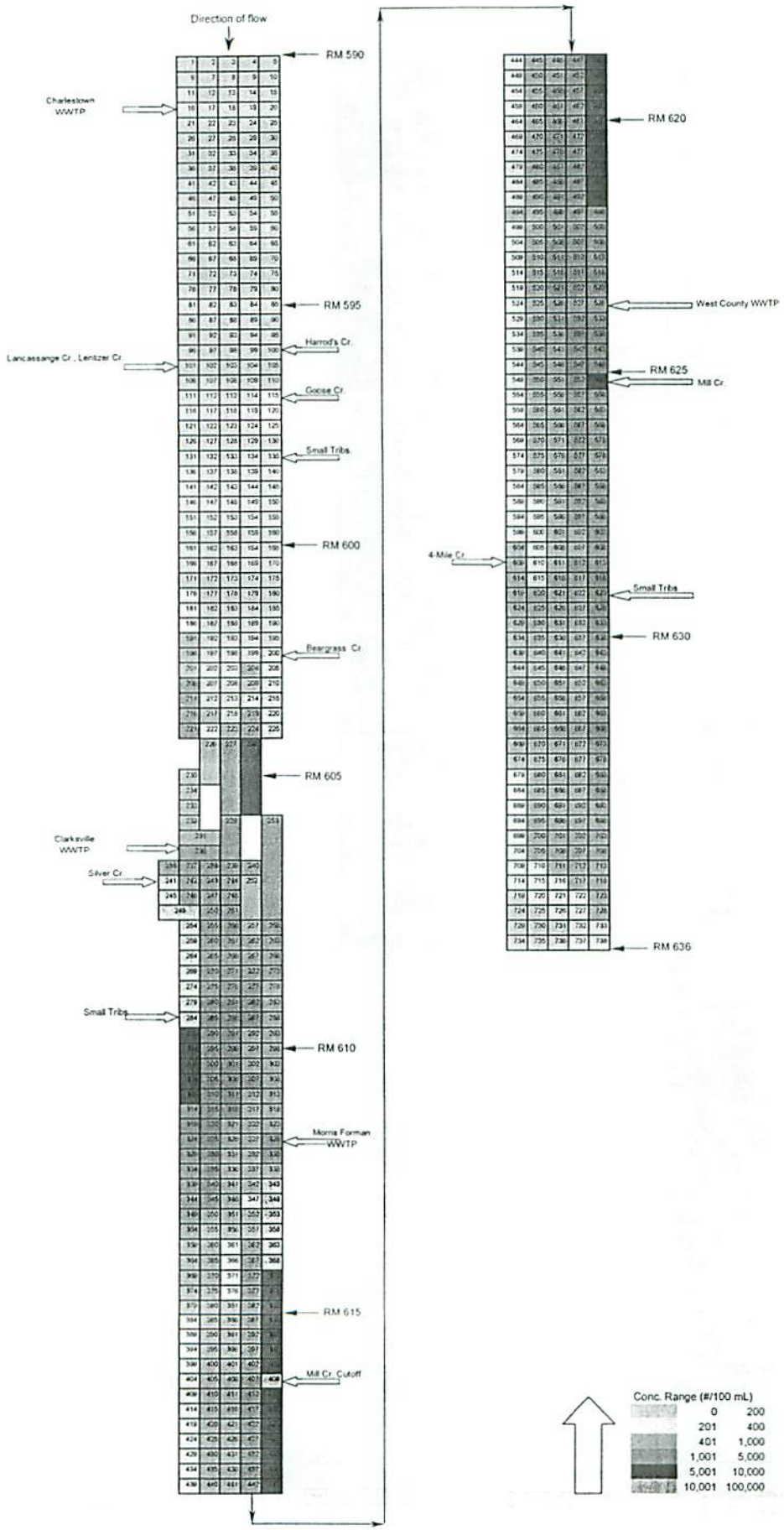


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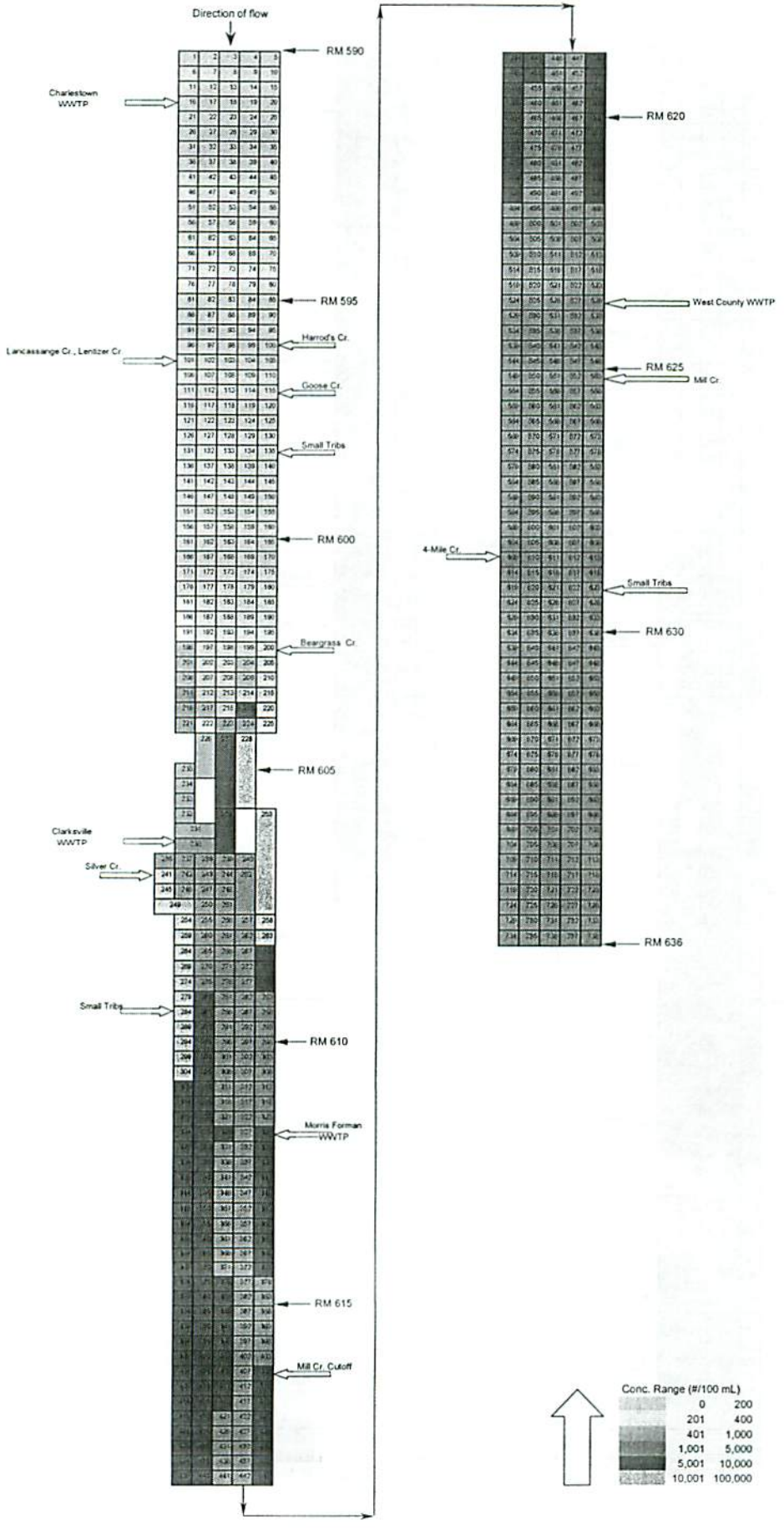
SCHEMATIC OF MAXIMUM CONCENTRATION IN EACH MODEL SEGMENT

May 2001 Wet Weather Event

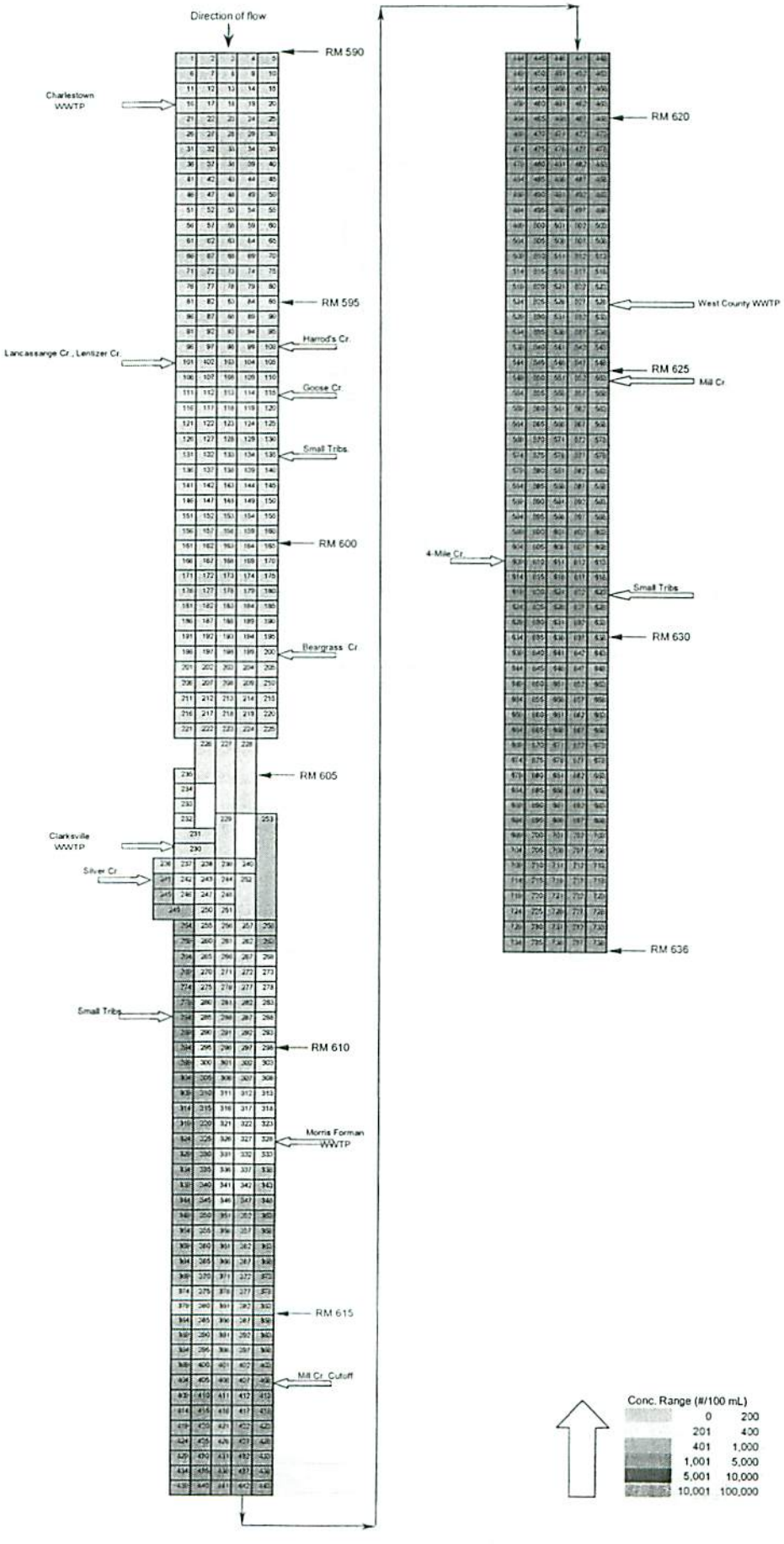
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 5/7/01



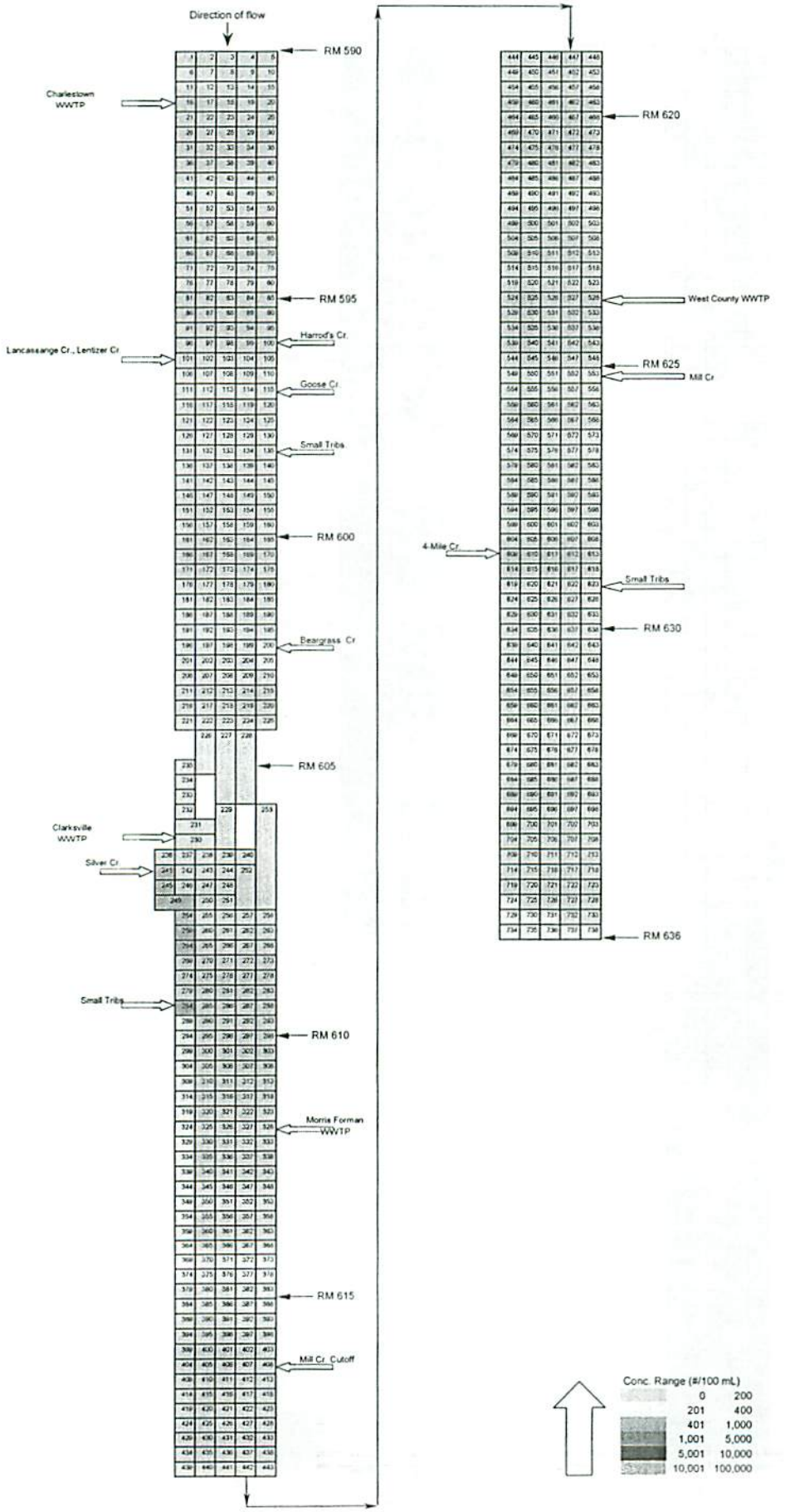
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 5/8/01



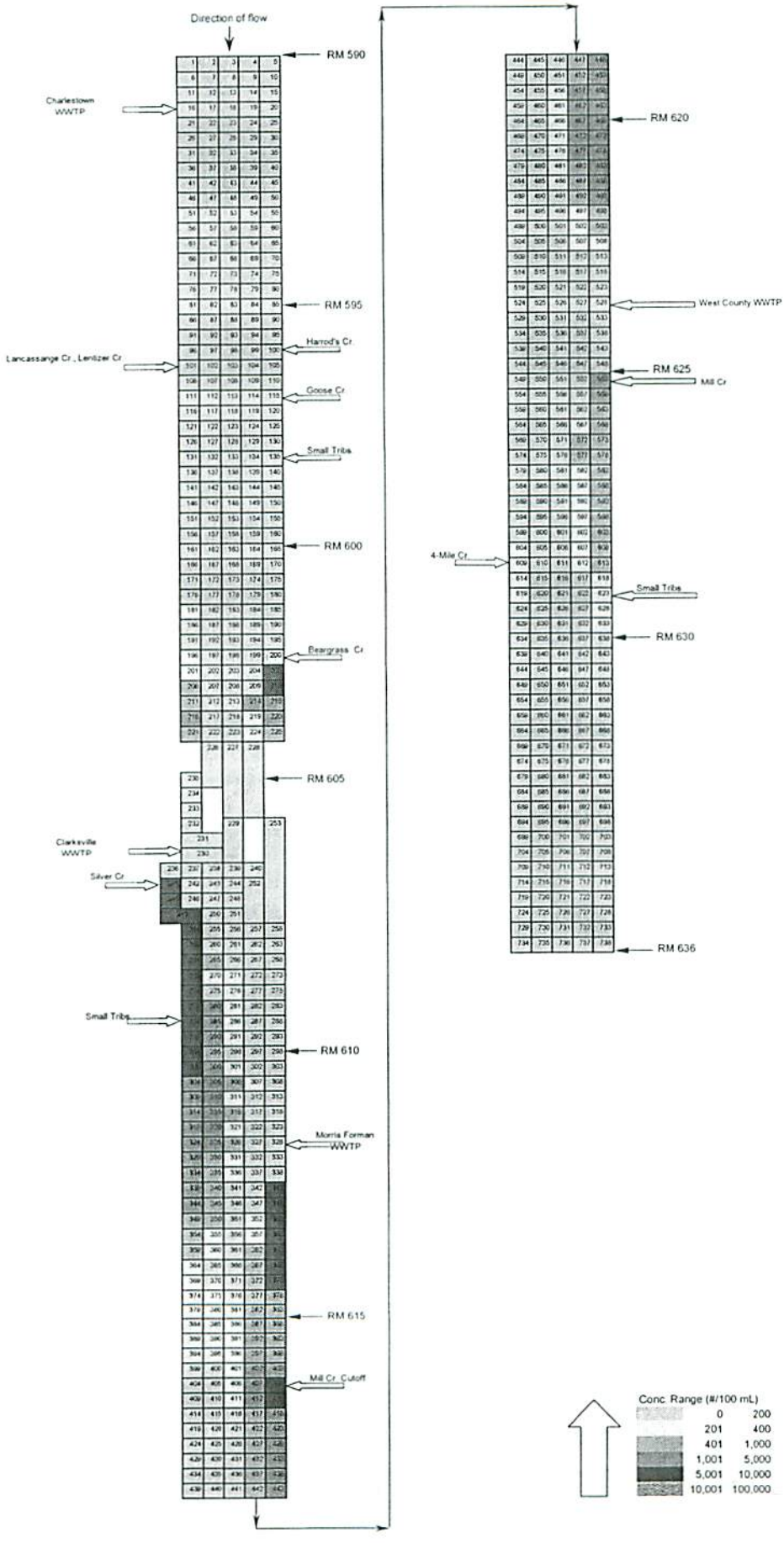
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 5/9/01



Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 5/10/01



Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 5/11/01

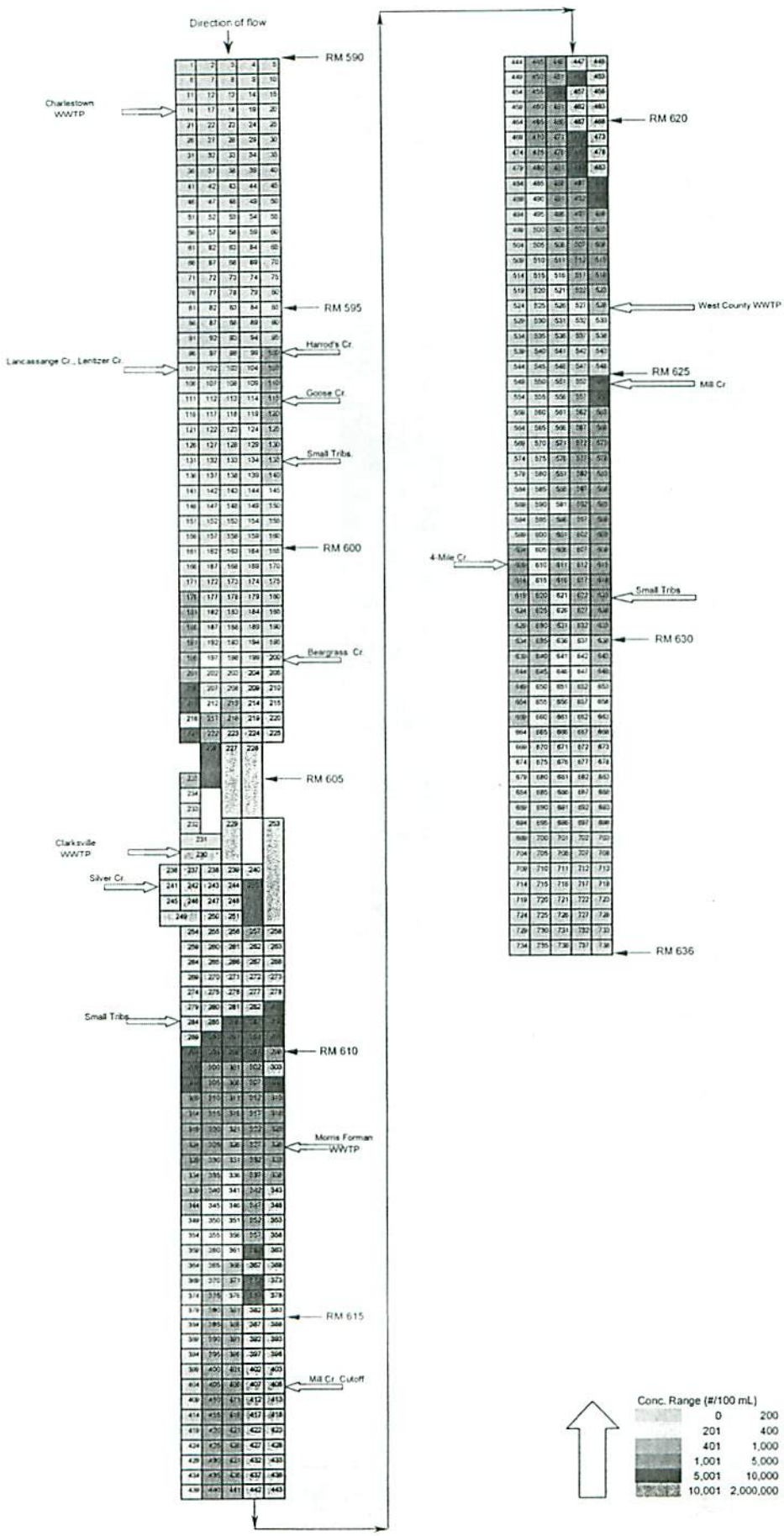


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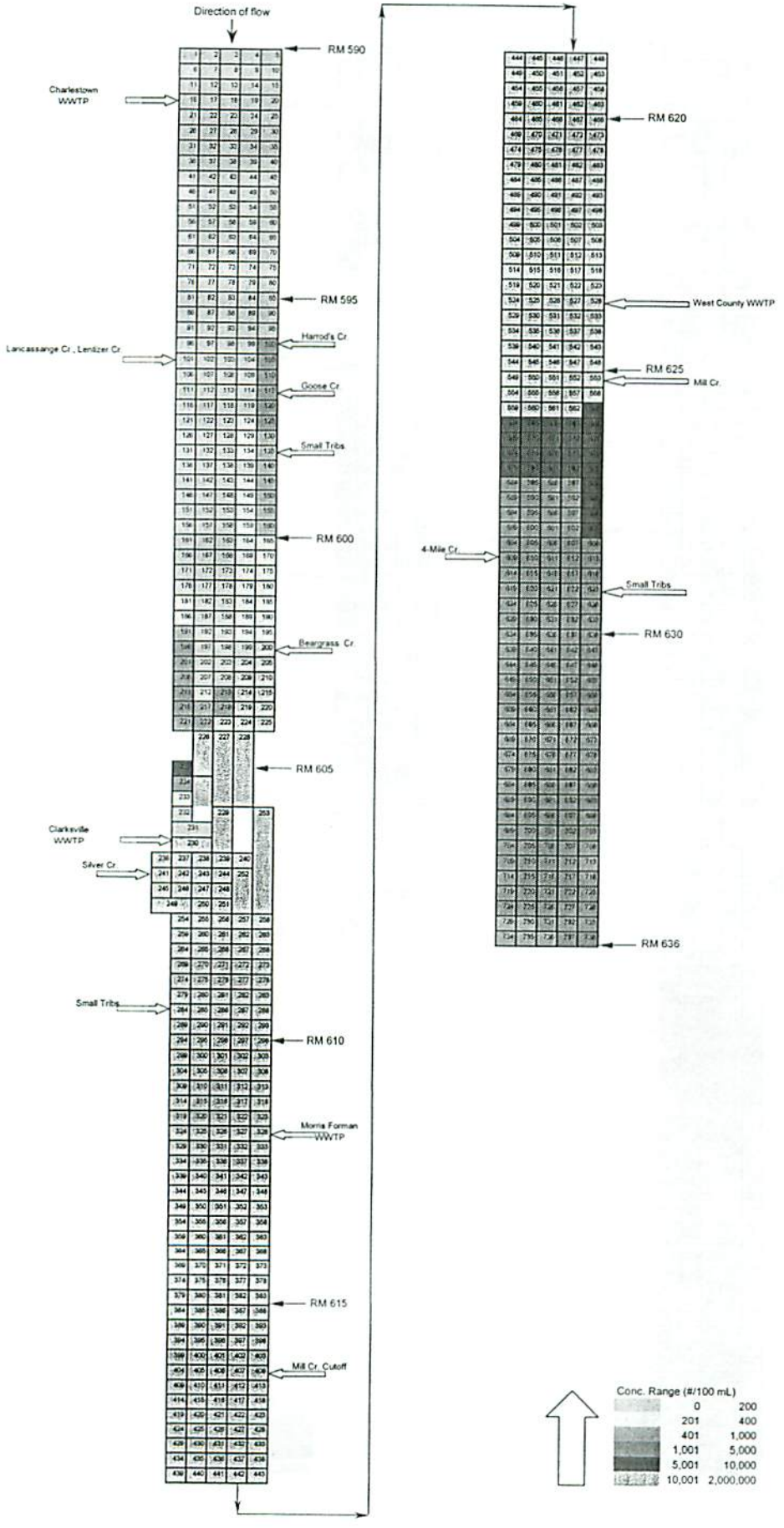
SCHEMATIC OF MAXIMUM CONCENTRATION IN EACH MODEL SEGMENT

October 2001 Wet Weather Event

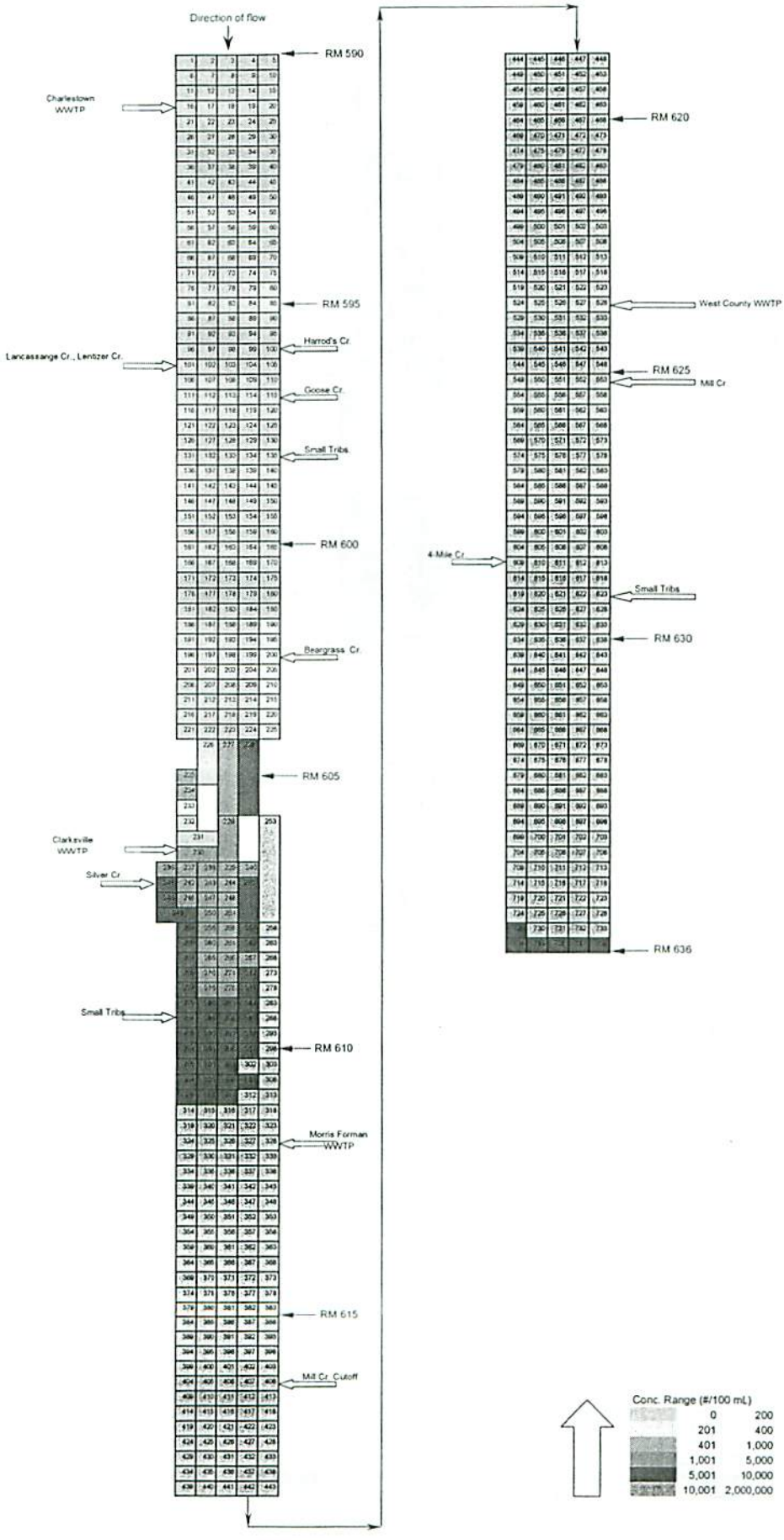
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/5/01



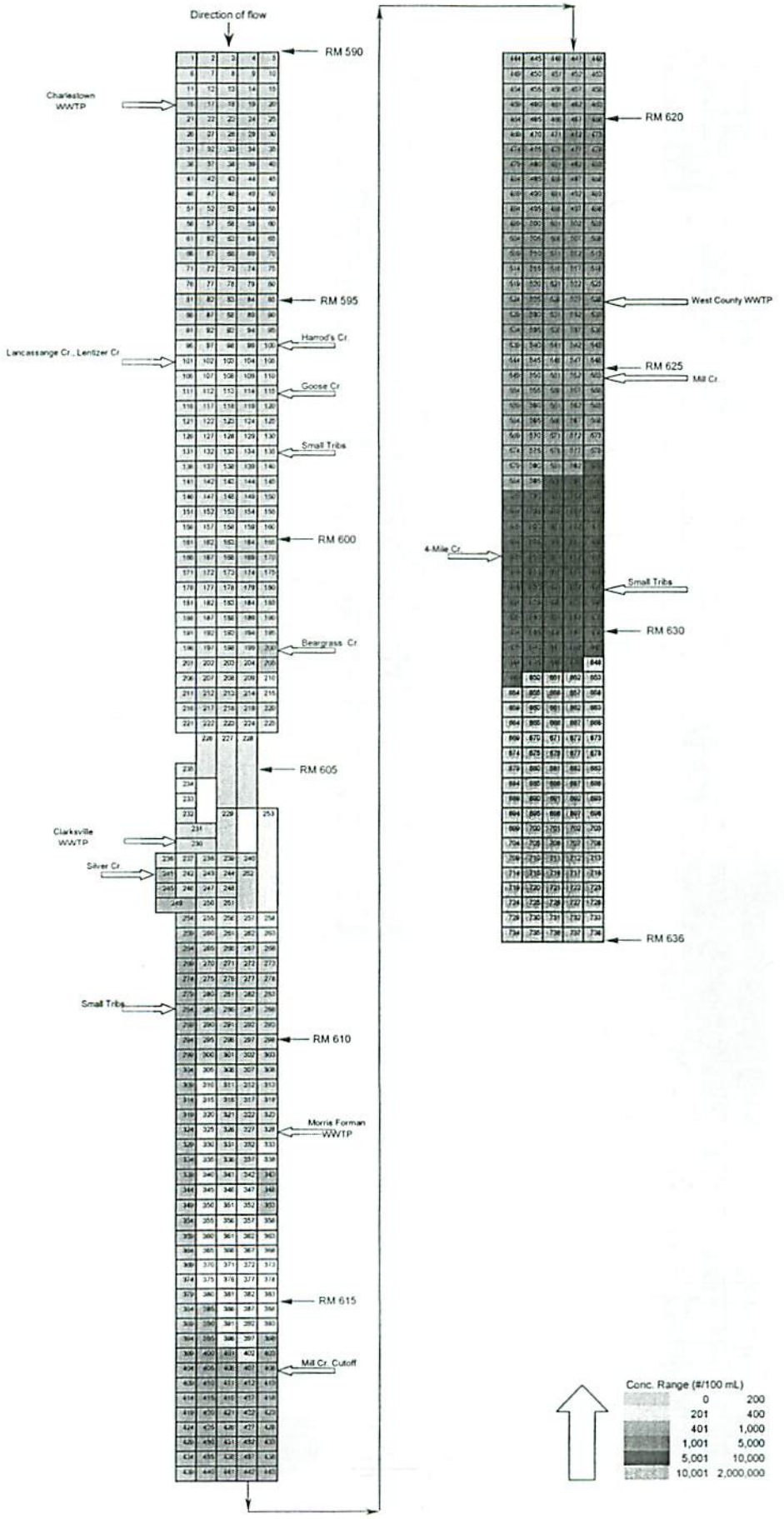
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/6/01



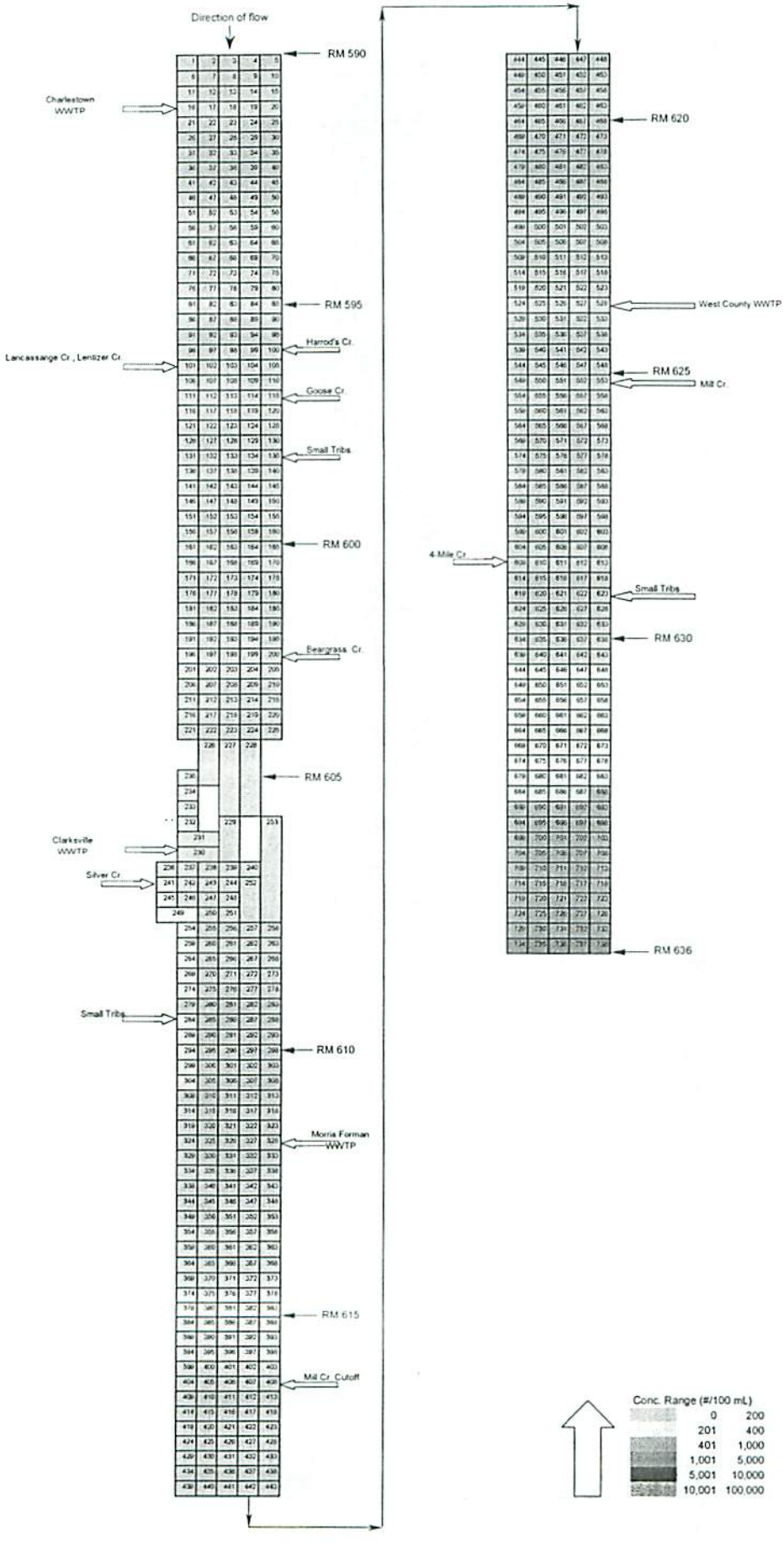
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/7/01



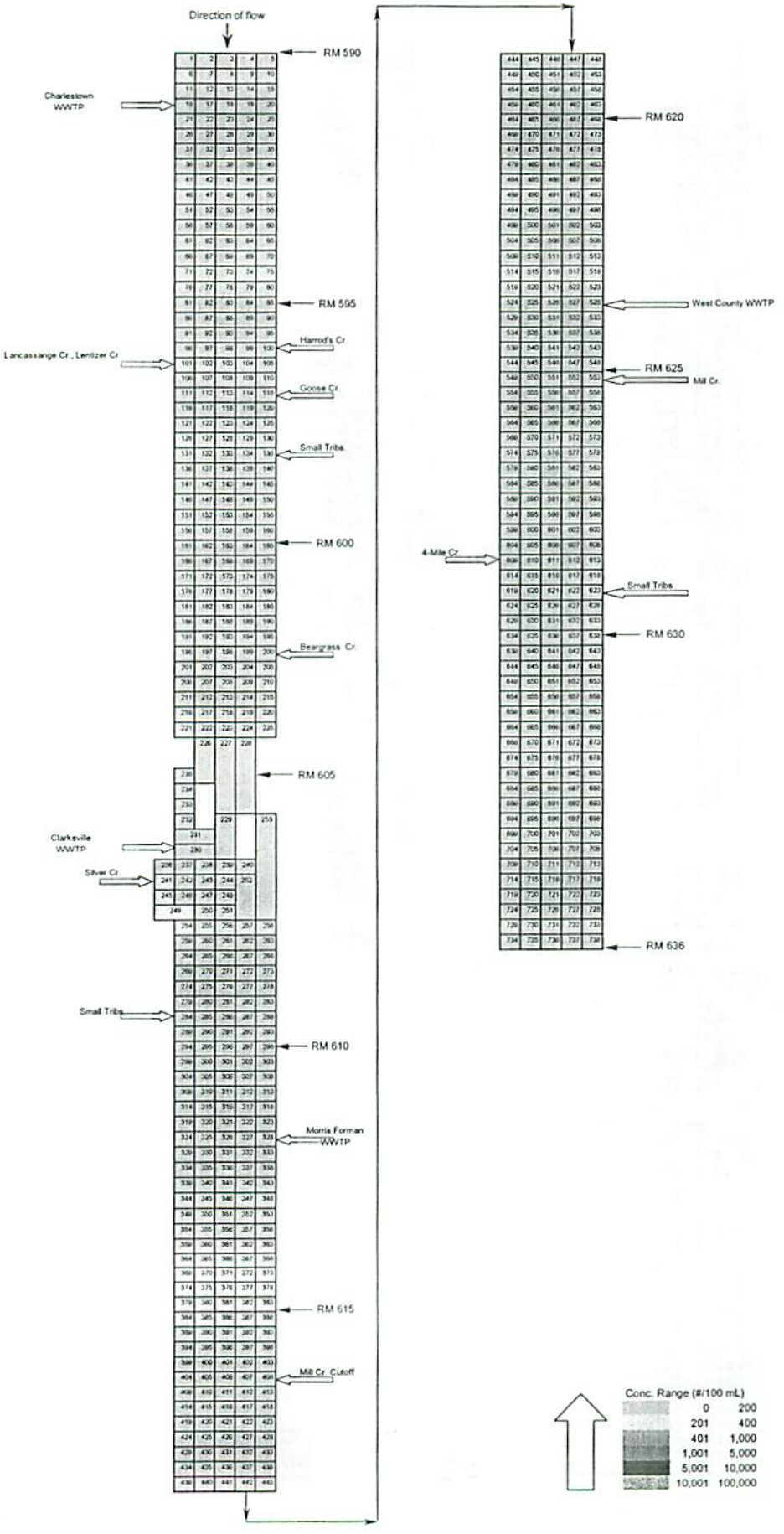
Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/8/01



Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/9/01



Model Simulated Maximum Fecal Coliform Concentration in Ohio River - 10/10/01



APPENDIX I

BACTERIA DILUTIONS AND COLONY COUNT REPORTING

Calculation Procedure for Determining Bacteria Densities

The following procedures will be followed for determining plate counts for bacteria samples.

1) Report coliform density as CFU/100mL.

Compute the density using membrane filters with counts of 20 to 60 (ideal range) fecal coliform (FC) or *E. coli* (EC) colonies (and not more than 200 colonies of all types) by the following equation.

$$\text{CFU/100mL} = \frac{\text{FC or EC colonies counted} \times 100}{\text{mL sample filtered}}$$

Calculated densities less than 100 CFU/100mL will be reported with no more than two significant figures, while densities greater than 100 CFU/100mL will be reported with no more than 3 significant figures.

If more than 200 colonies of all bacteria types are present on a plate or if the colonies are not distinct enough for counting, the result should be reported as "too numerous to count" (TNTC) on the bench sheet for the specific dilution. If a count can not be achieved for a specific dilution due to confluent growth, it should be reported as "confluent growth" (CG) on the bench sheet. If all dilutions for a particular sample are reported as TNTC or CG the sample density is reported as TNTC or CG.

2) If one or more dilutions has a FC or EC count in the acceptable range, use only those in the calculation. These calculated densities will not contain any qualifiers.

example:

filter	count
25mL	45
10mL	20
1mL	3

$$\frac{\text{CFU}}{100\text{mL}} = \frac{(45 + 20) \times 100)}{(25 + 10)} = 190 \text{ CFU/100ml}$$

3) If none of the dilutions has a FC or EC count in the acceptable range, use one of the following calculations. Do not include any colony counts less than 5 during the calculation procedures. Any data determined using calculations 3a, 3b, or 3c will be flagged as estimated densities.

a) If all the filters for a particular sample have counts less than the ideal range, total the FC or EC counts on all filters which contain colonies and report as CFU/100mL.

example:

filter	count
25mL	17
10mL	6
1mL	0

$$\frac{\text{CFU}}{100\text{mL}} = \frac{(17 + 6) \times 100)}{(25 + 10)} = 66 \text{ CFU/100ml}$$

b) If all the filters for a particular sample have some counts less than and some counts greater (but <100) than the ideal range, total the FC or EC counts on all filters and report as CFU/100mL.

example:

filter	count
10mL	80
1mL	10
0.1mL	2

$$\frac{\text{CFU}}{100\text{mL}} = \frac{(80 + 10) \times 100)}{(10 + 1)} = 820 \text{ CFU/100ml}$$

c) If all the filters for a particular sample have more than 60 colonies and at least one dilution with a count below 100, use the dilution with the lowest count of FC or *EC* colonies in calculating the density.

example:

filter	count
10mL	TNTC
1mL	110
0.1mL	68

$$\frac{\text{CFU}}{100\text{mL}} = \frac{(68) \times 100)}{(0.1)} = 68{,}000 \text{ CFU/100ml}$$

d) If all the filters for a particular sample have less than 5 colonies, use the highest dilution which has a count of FC or *EC* colonies in calculating the density.

example:

filter	count
10mL	3
1mL	1
0.1mL	0

$$\frac{\text{CFU}}{100\text{mL}} = \frac{(3) \times 100)}{(10)} = 30 \text{ CFU/100ml}$$

4) If no FC or EC colonies are observed on any of the dilutions, select the largest sample dilution and report as "less than" the computed CFU/100mL as if 1 colony were observed. One colony on the 25mL dilution would be 4 CFU/100mL, so report as <4 CFU/100mL

example:

filter	count
25mL	0
10mL	0
1mL	0

$$\frac{\text{CFU}}{100\text{mL}} = \frac{(1) \times 100)}{(25)} = <4 \text{ CFU/100ml}$$

5) Under circumstances when an estimated density is more useful than a TNTC (i.e. utilizing dilution counts that are greater than 100 and/or dilutions that contain greater than 200 colonies of all types of bacteria in order to calculate densities), the following calculations may be utilized. Any data determined using calculations 5a, 5b, or 5c will be flagged as estimated densities.

a) If a density is desired even though all dilutions have counts above 100, use the dilution with the lowest count of FC or EC colonies and report as "greater than" in calculating the density.

example:

filter	count	total
10mL	CG	
1mL	TNTC	
0.5mL	122	(<200)

$$\frac{\text{CFU}}{100\text{mL}} = \frac{(122) \times 100)}{(0.5)} = >24{,}400 \text{ CFU/100ml}$$

b) If a density is desired even though the dilution to be used in the calculation has a count greater than 200 colonies of all types of bacteria, report as "greater than" in calculating the density.

example:

filter	count	total
10mL	TNTC	
1mL	31	(>200)
0.1mL	3	

$$\frac{\text{CFU}}{100\text{mL}} = \frac{(31) \times 100)}{(1)} = >3{,}100 \text{ CFU/100ml}$$

c) If an approximate density is desired and all dilutions are reported as TNTC or CG, select the smallest sample dilution and report as "greater than" the computed CFU/100mL as if 60 colonies were observed. Sixty colonies on the 0.1mL dilution would be 60,000 CFU/100mL, so report as >60,000 CFU/100mL

example:

filter	count	total
10mL	CG	
1mL	TNTC	
0.1mL	TNTC	

$$\frac{\text{CFU}}{100\text{mL}} = \frac{(60) \times 100)}{(0.1)} = >60{,}000 \text{ CFU/100ml}$$

APPENDIX J

"TYPICAL" YEAR STORM EVENTS

Appendix J. Scenario Year Storm Events (Total Rainfall > 0.1")

EventNo	Start Date	End Date	Total Rainfall (in)	Max Intensity (in/hr)	Duration (hrs)	Time Since Last Rainfall (hrs)	Season	Year
1	12/10/00 2:00	12/10/00 5:00	0.1	0.05	3	327	Winter	2000
2	12/11/00 11:00	12/11/00 21:00	0.42	0.2	10	30	Winter	2000
3	12/13/00 9:00	12/13/00 11:00	0.13	0.08	2	36	Winter	2000
4	12/13/00 17:00	12/14/00 0:00	0.4	0.22	7	6	Winter	2000
5	12/16/00 3:00	12/16/00 23:00	2.5	0.39	20	51	Winter	2000
6	12/29/00 13:00	12/29/00 21:00	0.11	0.02	8	64	Winter	2000
7	1/18/01 20:00	1/19/01 9:00	0.42	0.08	13	92	Winter	2001
8	1/19/01 16:00	1/20/01 18:00	0.29	0.04	26	7	Winter	2001
9	1/29/01 18:00	1/30/01 0:00	0.39	0.15	6	67	Winter	2001
10	2/9/01 16:00	2/9/01 21:00	0.56	0.2	5	111	Winter	2001
11	2/13/01 16:00	2/13/01 20:00	0.1	0.06	4	91	Winter	2001
12	2/14/01 12:00	2/15/01 17:00	1.29	0.18	29	16	Winter	2001
13	2/16/01 0:00	2/16/01 18:00	0.51	0.09	18	7	Winter	2001
14	2/25/01 1:00	2/25/01 6:00	0.86	0.38	5	66	Winter	2001
15	3/4/01 1:00	3/4/01 18:00	1.13	0.18	17	47	Winter	2001
16	3/13/01 2:00	3/13/01 3:00	0.15	0.15	1	200	Winter	2001
17	3/15/01 7:00	3/15/01 11:00	0.1	0.04	4	52	Winter	2001
18	3/16/01 1:00	3/16/01 11:00	0.2	0.09	10	14	Winter	2001
19	3/20/01 15:00	3/20/01 20:00	0.21	0.09	5	91	Winter	2001
20	3/30/01 14:00	3/31/01 0:00	0.3	0.06	10	33	Winter	2001
21	4/1/01 3:00	4/1/01 6:00	0.2	0.17	3	27	Winter	2001
22	4/2/01 23:00	4/3/01 9:00	0.39	0.1	10	41	Winter	2001
23	4/23/01 20:00	4/24/01 0:00	0.25	0.14	4	83	Winter	2001
24	5/7/01 15:00	5/8/01 4:00	2.03	0.4	13	327	Rec. Season	2001
25	5/11/01 19:00	5/12/01 2:00	0.67	0.39	7	87	Rec. Season	2001
26	5/18/01 17:00	5/19/01 4:00	0.65	0.24	11	27	Rec. Season	2001
27	5/21/01 5:00	5/21/01 9:00	0.44	0.19	4	49	Rec. Season	2001
28	5/21/01 20:00	5/22/01 7:00	0.51	0.15	11	11	Rec. Season	2001
29	5/24/01 2:00	5/24/01 7:00	0.23	0.14	5	17	Rec. Season	2001
30	5/26/01 22:00	5/27/01 1:00	0.43	0.17	3	48	Rec. Season	2001
31	5/31/01 20:00	6/1/01 0:00	0.15	0.07	4	8	Rec. Season	2001
32	6/3/01 21:00	6/4/01 10:00	0.47	0.32	13	33	Rec. Season	2001
33	6/7/01 8:00	6/7/01 15:00	0.33	0.18	7	70	Rec. Season	2001
34	6/15/01 16:00	6/15/01 19:00	0.72	0.4	3	193	Rec. Season	2001
35	6/21/01 14:00	6/21/01 19:00	0.16	0.05	5	25	Rec. Season	2001
36	6/23/01 17:00	6/23/01 18:00	0.15	0.15	1	46	Rec. Season	2001
37	6/29/01 17:00	6/29/01 19:00	0.6	0.47	2	22	Rec. Season	2001
38	7/3/01 17:00	7/3/01 19:00	0.23	0.22	2	94	Rec. Season	2001
39	7/8/01 20:00	7/9/01 7:00	0.58	0.19	11	121	Rec. Season	2001
40	7/18/01 3:00	7/18/01 7:00	0.62	0.32	4	212	Rec. Season	2001
41	7/20/01 13:00	7/20/01 15:00	0.82	0.64	2	54	Rec. Season	2001
42	7/21/01 18:00	7/21/01 21:00	0.84	0.69	3	27	Rec. Season	2001
43	7/22/01 16:00	7/22/01 20:00	0.5	0.39	4	19	Rec. Season	2001
44	7/24/01 14:00	7/24/01 16:00	0.26	0.22	2	42	Rec. Season	2001
45	7/25/01 21:00	7/26/01 8:00	0.51	0.28	11	29	Rec. Season	2001

EventNo	Start Date	End Date	Total Rainfall (in)	Max Intensity (in/hr)	Duration (hrs)	Time Since Last Rainfall (hrs)	Season	Year
46	7/28/01 16:00	7/29/01 9:00	0.21	0.06	17	56	Rec. Season	2001
47	8/3/01 4:00	8/3/01 5:00	0.26	0.26	1	115	Rec. Season	2001
48	8/3/01 17:00	8/3/01 23:00	0.71	0.54	6	12	Rec. Season	2001
49	8/9/01 18:00	8/10/01 1:00	0.14	0.09	7	139	Rec. Season	2001
50	8/11/01 15:00	8/11/01 18:00	0.83	0.78	3	38	Rec. Season	2001
51	8/19/01 0:00	8/19/01 2:00	0.23	0.18	2	14	Rec. Season	2001
52	8/23/01 14:00	8/23/01 16:00	0.24	0.2	2	108	Rec. Season	2001
53	8/26/01 13:00	8/26/01 22:00	0.62	0.28	9	19	Rec. Season	2001
54	8/31/01 11:00	9/1/01 0:00	0.33	0.16	13	56	Rec. Season	2001
55	9/7/01 13:00	9/7/01 15:00	0.4	0.39	2	94	Rec. Season	2001
56	9/7/01 21:00	9/7/01 23:00	0.94	0.83	2	6	Rec. Season	2001
57	9/9/01 11:00	9/9/01 14:00	0.34	0.28	3	36	Rec. Season	2001
58	9/9/01 20:00	9/9/01 23:00	1.23	0.75	3	6	Rec. Season	2001
59	9/19/01 3:00	9/19/01 16:00	0.38	0.12	13	18	Rec. Season	2001
60	9/23/01 21:00	9/24/01 5:00	0.69	0.26	8	101	Rec. Season	2001
61	10/5/01 14:00	10/6/01 0:00	1.43	0.39	10	273	Rec. Season	2001
62	10/11/01 18:00	10/12/01 8:00	1.54	0.63	14	10	Rec. Season	2001
63	10/13/01 19:00	10/14/01 11:00	1.59	0.42	16	11	Rec. Season	2001
64	10/16/01 1:00	10/16/01 4:00	0.22	0.16	3	38	Rec. Season	2001
65	10/23/01 15:00	10/23/01 22:00	0.46	0.33	7	179	Rec. Season	2001
66	10/24/01 4:00	10/24/01 9:00	0.51	0.21	5	6	Rec. Season	2001
67	10/24/01 19:00	10/24/01 22:00	0.59	0.48	3	10	Rec. Season	2001
68	11/19/01 7:00	11/19/01 20:00	0.28	0.06	13	396	Winter	2001
69	11/24/01 13:00	11/24/01 17:00	0.55	0.4	4	11	Winter	2001
70	11/27/01 2:00	11/27/01 10:00	1.09	0.48	8	57	Winter	2001
71	11/28/01 5:00	11/30/01 3:00	3.15	0.34	46	19	Winter	2001

APPENDIX K

DAYS OF EXCEEDANCE OF SINGLE SAMPLE MAXIMUM CRITERION DURING RECREATION SEASON

Appendix K. Days of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) On Left Bank (KY side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	14	14	14	14	14	14	0	14	14	14
596.30	12	12	12	12	12	12	0	12	12	12
596.65	10	10	10	10	10	10	0	10	10	10
596.95	13	13	13	13	13	13	0	13	13	13
597.25	11	11	11	11	11	11	0	11	11	11
597.55	11	11	11	11	11	11	0	11	11	11
597.85	10	10	10	10	10	10	0	10	10	10
598.15	10	10	10	10	10	10	0	10	10	10
598.45	8	8	8	8	8	8	0	8	8	8
598.75	8	8	8	8	8	8	0	8	8	8
599.05	8	8	8	8	8	8	0	8	8	8
599.35	7	7	7	7	7	7	0	7	7	7
599.65	7	7	7	7	7	7	0	7	7	7
599.95	7	7	7	7	7	7	0	7	7	7
600.25	6	6	6	6	6	6	0	6	6	6
600.60	6	6	6	6	6	6	0	6	6	6
600.90	5	5	5	5	5	5	0	5	5	5
601.15	5	5	5	5	5	5	0	5	5	5
601.45	4	4	4	4	4	4	0	4	4	4
601.75	4	4	4	4	4	4	0	4	4	4
602.05	69	73	69	73	69	73	68	69	77	77
602.35	69	73	69	72	69	73	69	69	75	75
602.70	61	71	61	68	61	71	65	61	71	71
603.05	59	71	59	67	59	70	66	59	73	73
603.40	53	67	53	59	53	65	63	53	68	68
603.75	50	65	50	56	50	63	63	50	68	68
604.81	47	57	47	50	47	57	52	47	65	65
606.65	46	55	46	51	46	54	45	46	64	64
607.05	45	66	45	61	45	64	59	45	71	71
607.55	44	67	44	60	44	65	58	44	71	71
608.10	49	58	49	54	49	58	56	49	65	66
608.50	50	60	50	55	50	59	57	50	67	67
608.85	50	60	50	55	50	59	57	50	67	67
609.15	50	60	50	55	50	61	57	50	67	67
609.45	49	61	49	53	50	59	57	50	66	66
609.80	47	61	47	53	47	60	57	47	66	66
610.10	47	60	47	51	47	60	57	47	66	66
610.40	47	65	47	57	47	64	61	47	70	70
610.85	49	63	49	60	49	61	59	49	68	68
611.30	54	63	54	60	54	62	58	54	69	69
611.65	54	63	54	60	54	62	58	54	68	68
611.95	53	64	53	60	53	63	59	54	70	70
612.30	68	99	68	91	68	97	92	68	101	101
612.60	69	100	69	90	69	97	92	69	102	102

Appendix K. Days of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) On Left Bank (KY side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
612.80	70	101	70	89	70	98	94	70	103	103
613.05	69	104	69	99	69	101	98	69	107	107
613.30	68	104	68	99	68	102	98	68	105	105
613.55	68	104	68	100	68	102	99	68	107	107
613.80	66	102	66	98	66	101	97	66	104	104
614.00	66	101	66	98	66	101	98	66	105	105
614.30	67	103	67	98	67	100	97	67	105	105
614.65	67	103	67	97	67	101	99	67	105	105
614.95	66	101	66	96	66	98	98	66	104	104
615.20	65	100	65	96	65	100	96	66	102	102
615.45	65	100	65	97	65	99	97	65	104	104
615.75	64	101	64	95	64	101	97	64	104	104
616.05	64	102	64	94	64	100	97	64	104	104
616.35	64	102	64	94	64	100	97	64	104	104
616.65	88	106	88	100	88	103	95	88	107	107
616.90	87	105	87	101	87	102	95	87	107	107
617.10	87	105	87	101	87	103	95	87	107	107
617.40	88	104	88	101	88	103	95	88	107	107
617.75	88	103	88	101	88	103	94	88	107	107
618.05	88	102	88	101	88	102	94	88	107	107
618.35	88	103	88	99	88	102	94	88	106	106
618.60	88	104	88	99	88	103	93	88	106	106
618.85	86	102	86	98	86	101	93	86	105	105
619.10	84	103	84	98	84	101	91	84	104	104
619.35	83	101	83	96	83	100	91	83	103	103
619.65	83	103	83	96	83	100	91	83	103	103
619.95	83	102	83	96	83	101	90	83	103	103
620.25	83	102	83	97	83	101	90	83	103	103
620.55	83	102	83	97	83	101	89	83	103	103
620.85	82	100	82	96	82	99	87	82	102	102
621.10	82	100	82	96	82	99	85	82	101	101
621.35	81	99	81	96	81	98	84	81	100	100
621.70	77	96	77	88	77	94	84	78	99	99
622.00	75	95	75	87	75	93	84	75	98	98
622.25	74	94	74	85	74	90	83	74	96	96
622.55	73	91	73	83	73	88	82	73	94	94
622.85	73	91	73	83	73	88	81	73	92	92
623.15	73	90	73	81	73	87	81	73	91	91
623.45	72	89	72	80	72	86	81	72	90	90
623.75	71	87	71	80	71	84	78	71	90	90
624.05	70	85	70	79	70	83	77	70	89	89
624.35	69	85	69	78	69	83	76	69	87	87
624.65	69	85	69	78	69	83	77	69	86	86
624.95	90	101	90	96	90	99	78	90	103	103
625.25	88	99	88	94	88	97	78	88	100	100
625.60	86	99	86	92	86	97	77	86	100	100
625.90	86	99	86	92	86	97	77	86	99	99
626.15	86	99	86	92	86	98	75	86	99	99
626.50	84	97	84	89	84	96	75	84	97	97
626.85	83	97	83	89	83	95	75	83	97	97
627.10	83	96	83	88	83	95	75	83	97	97
627.35	83	96	83	88	83	94	74	83	97	97
627.70	82	95	82	87	82	94	73	82	96	96
628.00	81	94	81	86	81	93	73	81	96	96
628.25	81	95	81	86	81	93	74	81	97	97
628.55	81	94	81	85	81	91	74	81	96	96
628.85	78	93	78	81	78	89	73	78	95	95
629.10	78	93	78	80	78	87	73	78	94	94
629.40	76	92	76	80	76	86	73	76	93	93
629.75	75	91	75	80	75	85	73	75	94	94
630.05	70	86	70	74	70	78	71	70	90	90
630.35	69	85	69	74	69	79	71	69	90	90
630.70	67	84	67	73	67	78	69	67	89	89

Appendix K. Days of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) On Left Bank (KY side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
631.00	66	82	66	72	66	78	67	66	89	89
631.25	67	82	67	70	67	78	65	67	88	88
631.55	66	81	66	69	66	77	65	66	88	88
631.85	65	78	65	67	65	76	65	65	85	85
632.10	65	78	65	67	65	76	65	65	83	83
632.35	65	78	65	67	65	76	65	65	82	82
632.70	63	75	63	64	63	70	62	63	81	81
633.00	63	75	63	64	63	69	61	63	80	80
633.25	59	72	59	63	59	67	59	59	77	77
633.55	59	72	59	64	59	67	59	59	76	76
633.85	60	73	60	65	60	68	58	60	75	75
634.15	60	73	60	64	60	67	58	60	75	75
634.45	59	71	59	63	59	66	57	59	74	74
634.75	58	70	58	63	58	66	58	58	74	74
635.05	56	66	56	61	56	64	57	56	73	73
635.40	56	65	56	60	56	64	56	56	71	71
635.75	56	65	56	59	56	64	56	56	71	71
636.05	55	64	55	58	55	63	55	55	70	70

Appendix K. Days of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) in Center Channel of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.10	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	5	5	5	5	5	5	0	5	5	5
597.55	2	2	2	2	2	2	0	2	2	2
597.85	6	6	6	6	6	6	0	6	6	6
598.15	7	7	7	7	7	7	0	7	7	7
598.45	7	7	7	7	7	7	0	7	7	7
598.75	7	7	7	7	7	7	0	7	7	7
599.05	7	7	7	7	7	7	0	7	7	7
599.35	7	7	7	7	7	7	0	7	7	7
599.65	6	6	6	6	6	6	0	6	6	6
599.95	6	6	6	6	6	6	0	6	6	6
600.25	5	5	5	5	5	5	0	5	5	5
600.60	4	4	4	4	4	4	0	4	4	4
600.90	4	4	4	4	4	4	0	4	4	4
601.15	4	4	4	4	4	4	0	4	4	4
601.45	4	4	4	4	4	4	0	4	4	4
601.75	4	4	4	4	4	4	0	4	4	4
602.05	4	4	4	4	4	4	0	4	4	4
602.35	4	4	4	4	4	4	0	4	4	4
602.70	4	4	4	4	4	4	0	4	4	4
603.05	11	11	11	11	11	11	7	11	11	11
603.40	11	11	11	11	11	11	4	11	11	11
603.75	21	22	21	21	21	22	15	21	23	23
604.81	30	34	30	30	30	33	30	30	39	40
605.80	44	47	44	44	44	47	44	44	51	52
606.05	44	47	44	44	44	47	44	44	51	52
606.30	44	47	44	44	44	47	44	44	51	52
606.50	44	47	44	44	44	47	44	44	51	52
606.75	43	48	43	43	43	47	44	43	50	52
607.05	55	57	55	55	55	56	54	55	61	62
607.55	55	58	55	55	55	56	54	55	60	62
608.10	56	59	56	57	56	58	54	56	61	63
608.50	61	64	61	62	61	64	54	61	65	67
608.85	61	64	61	62	61	63	51	61	65	67
609.15	60	64	60	62	60	62	52	60	65	67
609.45	60	64	60	61	60	62	52	60	65	67
609.80	59	62	59	60	59	60	50	59	64	64
610.10	60	62	60	61	60	61	49	60	64	64
610.40	61	64	61	63	61	63	48	61	64	65
610.85	64	67	64	65	64	66	49	64	67	67
611.30	61	64	61	61	61	62	49	61	64	65

Appendix K. Days of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) in Center Channel of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
611.65	62	64	62	62	62	63	49	62	65	65
611.95	62	64	62	62	62	63	49	62	64	64
612.30	62	64	62	62	62	63	48	62	65	65
612.60	62	63	62	62	62	63	49	62	64	65
612.80	62	63	62	62	61	63	49	61	64	64
613.05	61	63	61	61	61	63	49	61	65	65
613.30	61	62	61	61	61	62	48	61	66	66
613.55	60	62	60	60	60	61	48	60	66	66
613.80	60	62	60	61	60	61	48	60	65	65
614.00	63	67	63	63	63	64	56	63	72	72
614.30	62	70	62	63	62	66	58	62	74	74
614.65	62	68	62	64	62	66	58	62	74	74
614.95	62	66	62	64	62	66	46	62	68	68
615.20	65	80	65	70	65	77	69	65	86	86
615.45	67	82	67	72	67	77	73	67	89	89
615.75	67	79	67	71	67	77	72	67	89	89
616.05	67	79	67	71	67	77	69	67	87	87
616.35	66	78	66	69	66	76	70	66	85	86
616.65	67	79	67	70	67	77	70	67	86	87
616.90	66	78	66	69	66	74	68	66	84	84
617.10	66	77	66	69	66	74	67	66	83	83
617.40	66	77	66	69	66	74	67	66	83	83
617.75	67	82	67	72	67	78	74	67	87	87
618.05	67	84	67	74	67	79	76	67	89	89
618.35	67	84	67	73	67	78	74	67	87	87
618.60	68	85	68	73	68	79	75	68	87	87
618.85	68	82	68	73	68	79	74	68	88	88
619.10	68	83	68	72	68	78	74	68	88	88
619.35	69	92	69	76	69	88	82	69	95	95
619.65	70	89	70	78	70	84	81	70	95	95
619.95	72	93	72	81	72	87	82	72	98	98
620.25	73	91	73	81	73	87	78	73	96	96
620.55	72	90	72	79	72	85	78	72	94	94
620.85	69	89	69	75	69	83	78	69	92	92
621.10	69	89	69	74	69	83	77	69	89	89
621.35	70	89	70	75	70	84	77	70	89	89
621.70	69	87	69	73	69	80	77	69	89	89
622.00	69	83	69	73	69	77	75	69	87	87
622.25	70	86	70	75	70	81	77	70	87	87
622.55	72	87	72	77	72	82	77	72	89	89
622.85	72	86	72	77	72	82	77	72	87	87
623.15	70	86	70	76	70	80	73	70	86	86
623.45	68	84	68	74	68	78	72	68	85	85
623.75	68	84	68	74	68	78	72	68	84	84
624.05	67	83	67	73	67	77	72	67	84	84
624.35	67	82	67	72	67	77	72	67	84	84
624.65	67	81	67	71	67	75	71	67	84	84
624.95	67	81	67	72	67	76	71	67	84	84
625.25	68	82	68	72	68	77	73	68	84	84
625.60	67	81	67	71	67	74	72	67	84	84
625.90	68	82	68	73	68	75	73	68	85	85
626.15	72	86	72	75	72	82	74	72	87	87
626.50	72	85	72	75	72	81	74	72	87	87
626.85	71	86	71	75	71	81	74	71	87	87
627.10	70	85	70	73	70	77	72	70	87	87
627.35	68	82	68	69	68	75	69	68	86	86
627.70	70	85	70	72	70	76	71	70	87	87
628.00	69	81	69	70	69	75	69	69	86	86
628.25	69	79	69	70	69	75	69	69	86	86
628.55	67	77	67	69	67	74	69	67	85	85
628.85	66	77	66	69	66	74	69	66	85	85
629.10	65	75	65	68	65	72	66	65	81	81
629.40	65	75	65	68	65	72	65	65	81	81

Appendix K. Days of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) in Center Channel of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
629.75	63	74	63	67	63	72	68	63	83	83
630.05	61	74	61	66	61	70	64	61	81	81
630.35	60	73	60	64	60	71	63	60	78	78
630.70	60	74	60	63	60	72	62	60	78	78
631.00	60	74	60	64	60	71	61	60	78	78
631.25	60	72	60	63	60	67	58	60	77	77
631.55	60	73	60	63	60	67	58	60	76	76
631.85	59	73	59	63	59	67	58	59	76	76
632.10	59	72	59	63	59	67	57	59	75	75
632.35	58	71	58	62	58	65	57	58	74	74
632.70	57	68	57	61	57	63	55	57	72	72
633.00	58	69	58	62	58	64	55	58	75	75
633.25	57	67	57	61	57	63	55	57	73	73
633.55	57	65	57	62	57	64	52	57	72	72
633.85	58	65	58	62	58	65	52	58	71	71
634.15	58	66	58	62	58	66	54	58	72	72
634.45	56	65	56	60	56	64	54	56	70	70
634.75	57	64	57	60	57	62	54	57	70	70
635.05	57	64	57	60	57	61	54	57	68	68
635.40	57	64	57	60	57	61	53	57	67	67
635.75	56	64	56	58	56	61	52	56	67	67
636.05	56	64	56	58	56	61	52	56	66	66

Appendix K. Days of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) in Right Bank (IN side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	10	10	10	10	10	10	0	10	10	10
596.65	9	9	9	9	9	9	0	9	9	9
596.95	9	9	9	9	9	9	0	9	9	9
597.25	8	8	8	8	8	8	0	8	8	8
597.55	8	8	8	8	8	8	0	8	8	8
597.85	8	8	8	8	8	8	0	8	8	8
598.15	8	8	8	8	8	8	0	8	8	8
598.45	8	8	8	8	8	8	0	8	8	8
598.75	7	7	7	7	7	7	0	7	7	7
599.05	7	7	7	7	7	7	0	7	7	7
599.35	7	7	7	7	7	7	0	7	7	7
599.65	6	6	6	6	6	6	0	6	6	6
599.95	6	6	6	6	6	6	0	6	6	6
600.25	6	6	6	6	6	6	0	6	6	6
600.60	5	5	5	5	5	5	0	5	5	5
600.90	5	5	5	5	5	5	0	5	5	5
601.15	5	5	5	5	5	5	4	9	5	9
601.45	6	6	6	6	6	6	1	7	6	7
601.75	6	6	6	6	6	6	0	6	6	6
602.05	4	4	4	4	4	4	0	4	4	4
602.35	5	5	5	5	8	5	8	12	5	12
602.70	5	5	5	5	5	5	6	10	5	10
603.05	5	5	10	5	13	5	17	21	5	21
603.40	5	5	20	5	26	5	25	29	5	29
603.75	4	4	17	4	21	4	25	28	4	28
604.30	14	15	14	15	15	15	15	19	18	22
604.51	14	15	14	15	14	15	15	19	18	22
604.85	14	15	14	15	14	15	15	18	17	20
605.09	14	15	14	14	14	15	15	18	16	20
605.29	13	15	13	14	13	15	15	17	16	21
605.55	13	15	13	14	13	14	14	17	15	21
605.80	33	36	34	35	34	36	32	35	40	42
606.05	31	35	36	33	37	34	32	37	36	41
606.30	68	70	70	70	70	70	33	70	70	73
606.50	67	69	69	69	69	69	33	69	69	72
606.75	66	69	68	69	68	69	33	68	70	73
607.05	65	68	67	67	67	67	32	67	69	72
607.55	65	67	67	67	67	67	32	68	69	71
608.10	66	68	68	67	68	67	32	68	69	71
608.50	79	81	80	81	80	81	48	80	82	84
608.85	74	78	75	77	75	78	47	75	78	79
609.15	74	78	75	77	75	77	47	75	78	79
609.45	82	85	83	85	83	85	48	83	86	87

Appendix K. Days of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) in Right Bank (IN side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
609.80	77	81	78	80	78	81	48	78	82	83
610.10	76	79	77	77	77	79	49	77	79	80
610.40	76	79	77	77	77	79	49	77	79	80
610.85	74	78	75	75	75	77	49	76	78	80
611.30	74	76	74	75	74	76	49	75	78	79
611.65	73	75	73	74	73	75	49	74	75	77
611.95	71	75	72	74	72	75	47	73	75	76
612.30	70	74	70	72	70	74	48	71	74	75
612.60	69	72	70	71	70	73	48	71	73	75
612.80	69	72	69	71	68	73	48	69	73	74
613.05	68	72	68	70	68	73	47	69	73	74
613.30	68	72	68	69	68	72	46	69	73	74
613.55	68	72	68	69	68	71	46	69	73	74
613.80	67	71	67	68	67	70	46	68	72	73
614.00	66	70	66	67	66	68	45	66	71	73
614.30	66	70	66	67	66	67	45	66	71	71
614.65	66	70	66	67	66	67	45	66	71	71
614.95	66	68	66	67	66	68	45	66	71	71
615.20	64	67	64	66	64	67	45	64	71	71
615.45	64	67	64	67	64	67	44	64	70	70
615.75	63	66	63	65	63	66	43	63	69	69
616.05	64	66	64	65	64	66	43	64	69	69
616.35	64	66	64	65	64	66	43	64	69	69
616.65	64	66	64	65	64	65	43	64	68	68
616.90	64	65	64	64	64	65	43	64	68	68
617.10	64	65	64	64	64	65	43	64	69	69
617.40	64	65	64	64	64	65	44	64	68	68
617.75	63	65	63	63	63	64	43	63	66	66
618.05	63	65	63	63	63	65	43	63	66	66
618.35	63	65	63	64	63	65	43	63	66	66
618.60	63	65	63	64	63	65	43	63	66	66
618.85	64	65	64	64	64	65	43	64	67	67
619.10	64	66	64	64	64	65	43	64	67	67
619.35	64	66	64	64	64	66	44	64	67	67
619.65	64	66	64	65	64	66	43	64	67	67
619.95	64	66	64	65	65	66	44	65	67	67
620.25	63	67	63	64	63	66	45	64	68	68
620.55	63	66	63	63	63	65	46	63	67	69
620.85	63	65	63	63	63	64	45	63	68	68
621.10	63	65	63	63	64	65	44	64	66	66
621.35	64	66	64	65	65	66	46	65	67	68
621.70	64	67	64	65	64	65	50	64	70	70
622.00	64	67	64	65	64	65	50	64	70	71
622.25	65	68	65	66	65	66	51	65	71	72
622.55	65	68	65	66	65	66	51	66	71	71
622.85	65	67	65	65	65	66	51	65	70	70
623.15	65	67	65	65	65	66	50	65	69	69
623.45	66	69	67	67	67	68	52	67	72	72
623.75	66	71	66	67	67	68	53	67	72	72
624.05	64	70	64	65	65	68	52	65	72	72
624.35	64	68	64	64	64	67	52	64	72	72
624.65	63	69	63	63	63	64	54	63	70	70
624.95	63	69	63	64	63	65	54	63	71	71
625.25	63	68	63	64	63	65	54	63	71	71
625.60	62	67	62	64	62	65	53	62	70	70
625.90	62	67	62	63	62	66	55	62	71	71
626.15	62	67	62	63	62	65	54	62	70	70
626.50	62	67	62	63	62	64	54	62	69	69
626.85	62	68	62	63	62	65	55	62	70	70
627.10	63	68	63	64	63	65	56	63	70	70
627.35	63	68	63	64	63	65	56	63	70	70
627.70	63	68	63	63	63	65	56	63	69	69
628.00	63	68	63	63	63	65	55	63	69	69

Appendix K. Days of Exceedance of Fecal Coliform Single Sample Maximum Criterion (400 cfu/100 ml) in Right Bank (IN side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
628.25	70	73	70	70	70	72	57	70	76	76
628.55	69	73	69	70	69	71	57	69	76	76
628.85	69	73	69	70	69	71	56	69	76	76
629.10	67	72	67	68	67	71	56	67	75	75
629.40	67	72	67	68	67	70	55	67	75	75
629.75	66	72	66	68	66	70	54	66	74	74
630.05	66	72	66	68	66	69	54	66	75	75
630.35	64	70	64	67	64	69	55	64	74	74
630.70	64	70	64	66	64	69	54	64	75	75
631.00	63	71	63	66	63	69	52	63	74	74
631.25	62	70	62	64	62	69	52	62	73	73
631.55	62	70	62	63	62	65	52	62	73	73
631.85	60	68	60	63	60	65	52	60	73	73
632.10	59	67	59	62	59	64	51	59	73	73
632.35	59	66	59	61	59	64	51	59	72	72
632.70	58	65	58	60	58	62	51	58	70	70
633.00	58	65	58	60	58	62	51	58	69	69
633.25	57	64	57	59	57	61	51	57	68	68
633.55	57	64	57	58	57	62	51	57	68	68
633.85	56	65	56	58	56	62	50	56	67	67
634.15	57	65	57	57	57	62	50	57	66	66
634.45	56	65	56	56	56	61	49	56	68	68
634.75	57	64	57	57	57	60	52	57	66	66
635.05	57	64	57	57	57	60	52	57	65	65
635.40	57	63	57	57	57	60	52	57	64	64
635.75	56	63	56	57	56	60	52	56	64	64
636.05	56	63	56	57	56	60	51	56	64	64

Appendix K. Days of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) On Left Bank (KY side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	9	9	9	9	9	9	0	9	9	9
596.30	8	8	8	8	8	8	0	8	8	8
596.65	8	8	8	8	8	8	0	8	8	8
596.95	9	9	9	9	9	9	0	9	9	9
597.25	8	8	8	8	8	8	0	8	8	8
597.55	8	8	8	8	8	8	0	8	8	8
597.85	7	7	7	7	7	7	0	7	7	7
598.15	6	6	6	6	6	6	0	6	6	6
598.45	6	6	6	6	6	6	0	6	6	6
598.75	5	5	5	5	5	5	0	5	5	5
599.05	5	5	5	5	5	5	0	5	5	5
599.35	4	4	4	4	4	4	0	4	4	4
599.65	4	4	4	4	4	4	0	4	4	4
599.95	4	4	4	4	4	4	0	4	4	4
600.25	4	4	4	4	4	4	0	4	4	4
600.60	3	3	3	3	3	3	0	3	3	3
600.90	2	2	2	2	2	2	0	2	2	2
601.15	2	2	2	2	2	2	0	2	2	2
601.45	2	2	2	2	2	2	0	2	2	2
601.75	2	2	2	2	2	2	0	2	2	2
602.05	55	69	55	60	55	68	60	55	70	70
602.35	54	69	54	61	54	64	58	54	70	70
602.70	50	58	50	55	50	57	52	50	66	66
603.05	48	57	48	55	48	57	54	48	66	66
603.40	40	54	40	47	40	52	48	40	58	58
603.75	40	52	40	45	40	47	47	40	57	57
604.81	37	42	37	39	37	41	39	37	48	48
606.65	33	41	33	36	33	39	33	33	44	44
607.05	34	53	34	49	34	52	47	34	58	58
607.55	34	54	34	48	34	53	47	34	59	59
608.10	30	40	30	36	30	41	37	30	46	47
608.50	30	40	30	36	30	39	39	30	45	46
608.85	30	38	30	36	30	39	39	30	45	46
609.15	30	38	30	35	30	39	39	30	44	46
609.45	30	39	30	35	30	39	38	30	44	45
609.80	30	39	30	33	30	39	38	30	43	44
610.10	30	38	30	33	30	38	37	30	42	43
610.40	30	42	30	38	30	42	41	30	45	46
610.85	33	44	33	40	33	43	39	34	46	47
611.30	37	45	37	43	38	45	40	38	48	49
611.65	37	46	37	44	38	46	40	38	49	50
611.95	38	47	38	44	39	46	43	39	52	53
612.30	50	80	50	76	52	80	77	52	82	83
612.60	50	79	50	74	51	79	78	51	83	84

Appendix K. Days of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) On Left Bank (KY side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
612.80	52	81	52	74	53	81	77	53	82	83
613.05	50	87	50	84	51	85	85	51	90	90
613.30	50	88	50	85	51	86	83	51	89	89
613.55	50	88	50	85	51	86	86	51	91	91
613.80	50	87	50	85	51	86	85	51	89	89
614.00	49	85	49	83	50	85	85	50	89	89
614.30	49	87	49	83	50	84	84	50	89	89
614.65	49	86	49	81	50	85	85	50	90	90
614.95	50	87	50	80	51	85	84	51	90	90
615.20	49	86	49	80	50	86	82	50	88	88
615.45	49	86	49	82	50	85	84	50	90	90
615.75	49	87	49	82	50	87	84	50	91	91
616.05	49	87	49	80	50	87	83	50	90	90
616.35	49	87	49	80	50	85	83	50	90	90
616.65	70	87	70	83	71	85	81	71	92	92
616.90	66	87	66	81	67	85	81	67	89	89
617.10	67	88	67	81	68	86	81	68	89	89
617.40	68	88	68	81	69	86	81	69	89	89
617.75	68	87	68	82	69	86	80	69	89	89
618.05	68	86	68	81	69	86	80	69	88	88
618.35	68	86	68	81	69	86	81	69	88	88
618.60	67	85	67	80	68	85	80	68	88	88
618.85	68	85	68	80	69	84	81	69	89	89
619.10	67	86	67	79	68	84	80	68	89	89
619.35	66	87	66	79	67	83	78	67	89	89
619.65	66	87	66	79	67	84	78	67	89	89
619.95	66	88	66	79	67	86	78	67	89	89
620.25	66	88	66	79	67	85	78	67	89	89
620.55	66	88	66	81	67	84	77	67	89	89
620.85	65	86	65	80	66	82	75	66	89	89
621.10	65	86	65	80	66	82	74	66	88	88
621.35	66	87	66	79	67	82	72	67	88	88
621.70	60	80	60	73	61	79	71	61	85	85
622.00	57	79	57	71	58	77	70	59	83	83
622.25	56	78	56	71	57	74	70	57	82	82
622.55	56	76	56	70	57	74	68	57	80	80
622.85	54	74	54	67	55	72	67	55	76	76
623.15	54	74	54	66	55	72	67	55	76	76
623.45	53	74	53	66	54	72	67	54	76	76
623.75	52	73	52	65	53	70	64	53	76	76
624.05	52	71	52	65	53	68	64	53	74	74
624.35	53	70	53	64	54	68	62	54	73	73
624.65	53	70	53	62	54	67	61	54	72	73
624.95	69	83	69	78	70	80	63	70	86	86
625.25	70	84	70	78	71	81	63	71	87	87
625.60	68	80	68	74	69	79	62	69	83	83
625.90	68	80	68	74	69	79	62	69	83	83
626.15	65	79	65	72	66	78	61	66	82	82
626.50	65	79	65	72	66	79	60	66	82	82
626.85	65	79	65	71	66	79	60	66	82	82
627.10	65	79	65	71	66	77	59	66	82	82
627.35	63	77	63	70	64	76	57	64	80	80
627.70	62	77	62	68	63	76	57	63	80	80
628.00	59	77	59	65	60	76	58	60	81	81
628.25	59	77	59	65	60	73	57	60	81	81
628.55	60	77	60	65	61	72	58	61	80	80
628.85	58	75	58	62	59	67	58	59	78	78
629.10	57	76	57	62	58	67	58	58	78	78
629.40	54	76	54	61	55	67	58	55	78	78
629.75	52	74	52	58	53	64	57	53	76	76
630.05	50	69	50	55	51	63	56	51	73	74
630.35	48	67	49	54	50	62	55	51	73	75
630.70	48	67	48	53	49	61	54	49	72	73

Appendix K. Days of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) On Left Bank (KY side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
631.00	47	65	47	51	48	58	52	48	69	70
631.25	45	61	45	48	46	56	52	46	68	69
631.55	44	61	44	47	45	56	51	45	68	69
631.85	44	59	44	47	45	56	51	45	65	66
632.10	44	59	44	47	45	56	52	45	65	66
632.35	43	60	43	46	44	53	52	44	65	66
632.70	43	58	43	46	44	51	50	44	65	66
633.00	44	57	44	47	45	51	48	45	66	67
633.25	43	56	43	46	44	51	46	44	63	64
633.55	43	55	43	47	44	51	46	44	62	63
633.85	45	55	45	48	45	52	45	46	61	62
634.15	45	55	45	47	45	52	45	46	60	61
634.45	43	53	43	45	44	50	44	44	57	58
634.75	42	52	42	45	43	50	43	43	56	57
635.05	40	51	41	43	42	48	41	42	56	57
635.40	40	48	41	43	42	48	41	42	53	55
635.75	40	48	41	41	42	48	41	42	54	56
636.05	40	49	41	41	42	46	40	42	53	55

Appendix K. Days of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) in Center Channel of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	2	2	2	2	2	2	0	2	2	2
597.55	0	0	0	0	0	0	0	0	0	0
597.85	3	3	3	3	3	3	0	3	3	3
598.15	3	3	3	3	3	3	0	3	3	3
598.45	4	4	4	4	4	4	0	4	4	4
598.75	4	4	4	4	4	4	0	4	4	4
599.05	2	2	2	2	2	2	0	2	2	2
599.35	2	2	2	2	2	2	0	2	2	2
599.65	2	2	2	2	2	2	0	2	2	2
599.95	2	2	2	2	2	2	0	2	2	2
600.25	2	2	2	2	2	2	0	2	2	2
600.60	2	2	2	2	2	2	0	2	2	2
600.90	2	2	2	2	2	2	0	2	2	2
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	1	1	1	1	1	1	0	1	1	1
602.35	1	1	1	1	1	1	0	1	1	1
602.70	1	1	1	1	1	1	0	1	1	1
603.05	9	9	9	9	9	9	5	9	9	9
603.40	7	7	7	7	7	7	2	7	7	7
603.75	17	20	17	19	17	20	11	17	20	20
604.81	24	29	25	28	25	29	22	25	31	31
605.80	24	29	25	27	25	29	22	25	31	31
606.05	25	29	25	27	26	27	22	26	31	31
606.30	25	31	25	27	26	28	24	26	34	34
606.50	28	32	28	30	29	31	26	29	34	34
606.75	28	33	28	30	28	31	27	29	34	34
607.05	35	37	35	37	35	37	29	36	39	40
607.55	35	37	34	37	36	37	30	35	41	41
608.10	33	38	33	37	34	38	31	35	40	40
608.50	39	44	39	41	39	44	30	39	45	45
608.85	38	43	39	40	39	43	31	39	45	45
609.15	38	43	39	41	39	43	30	39	44	44
609.45	39	43	40	41	40	42	29	40	44	44
609.80	39	42	40	40	40	42	29	40	44	44
610.10	36	41	37	38	38	41	30	38	43	43
610.40	39	42	40	40	40	42	30	40	43	43
610.85	40	43	41	41	41	43	29	42	44	44
611.30	39	42	40	40	40	42	29	40	42	42

Appendix K. Days of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) in Center Channel of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
611.65	40	43	41	41	41	42	28	41	43	43
611.95	40	43	41	41	41	42	28	41	43	43
612.30	42	45	43	43	43	44	28	44	45	46
612.60	41	45	42	43	42	44	28	44	46	47
612.80	41	43	42	42	42	43	28	43	44	46
613.05	41	43	42	42	42	43	29	43	44	45
613.30	41	43	42	42	42	43	29	43	44	45
613.55	41	43	42	42	43	43	29	43	45	46
613.80	40	43	42	41	42	43	30	42	44	46
614.00	42	47	43	43	43	45	39	44	51	52
614.30	42	50	42	43	43	47	41	44	53	54
614.65	42	49	42	43	43	46	41	44	53	54
614.95	46	48	46	46	47	47	29	47	50	50
615.20	48	62	48	52	49	57	51	49	67	67
615.45	49	66	49	54	50	60	55	50	70	70
615.75	49	62	50	53	50	59	54	50	70	70
616.05	49	62	50	52	50	59	52	50	67	67
616.35	48	61	49	51	49	58	52	49	67	67
616.65	49	62	50	52	50	58	53	50	70	70
616.90	48	61	49	51	49	58	53	49	69	69
617.10	49	63	50	52	50	57	50	50	68	68
617.40	50	64	51	53	51	58	50	51	68	68
617.75	49	69	49	53	50	62	60	51	73	73
618.05	49	70	49	54	50	63	61	50	74	74
618.35	49	71	49	54	50	62	59	50	73	73
618.60	49	71	49	54	50	63	59	50	72	72
618.85	49	69	49	54	50	63	59	50	73	73
619.10	49	69	49	54	50	62	59	50	73	73
619.35	51	74	51	61	52	69	67	52	79	79
619.65	50	73	50	60	51	67	67	51	78	78
619.95	53	75	53	62	54	69	67	54	80	80
620.25	53	73	53	62	54	70	64	54	78	78
620.55	52	73	52	62	53	69	64	53	77	77
620.85	50	73	50	56	51	69	64	51	76	76
621.10	49	74	49	57	50	69	64	50	75	75
621.35	50	74	50	58	51	70	64	51	76	76
621.70	49	72	49	58	50	67	64	50	76	76
622.00	52	73	52	59	53	66	61	53	76	76
622.25	52	73	52	59	53	68	62	53	75	75
622.55	51	73	51	63	52	69	62	52	75	75
622.85	53	73	53	63	54	68	61	54	76	76
623.15	52	72	52	59	53	68	58	53	74	74
623.45	53	72	53	58	54	67	58	54	74	74
623.75	53	72	53	58	54	67	57	54	73	73
624.05	53	72	53	57	54	66	57	54	73	73
624.35	53	71	53	57	54	63	57	54	73	73
624.65	51	68	51	56	52	60	55	52	72	72
624.95	51	67	51	56	52	61	56	52	72	72
625.25	52	69	52	56	53	62	57	53	72	72
625.60	51	66	51	56	52	59	56	52	71	71
625.90	52	68	52	57	53	60	57	53	72	72
626.15	54	72	54	58	55	64	58	55	75	75
626.50	53	70	53	57	54	61	58	54	72	73
626.85	54	73	54	58	55	63	58	55	74	75
627.10	52	70	52	55	53	61	57	53	71	72
627.35	52	66	52	55	53	60	53	53	71	72
627.70	54	70	54	57	55	62	54	55	72	73
628.00	52	66	52	56	53	61	52	53	72	72
628.25	52	63	52	55	53	61	52	53	72	72
628.55	49	62	49	54	50	60	52	50	71	71
628.85	49	62	49	53	50	60	53	50	71	71
629.10	48	61	48	51	49	58	52	49	69	69
629.40	47	61	47	50	48	58	52	48	68	69

Appendix K. Days of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) in Center Channel of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
629.75	47	61	47	50	48	57	53	48	70	71
630.05	48	62	48	51	49	57	50	49	67	68
630.35	47	61	48	50	49	55	49	49	65	67
630.70	46	59	46	50	47	55	48	47	65	66
631.00	44	58	44	47	45	55	48	45	65	66
631.25	44	58	44	48	45	53	44	45	62	63
631.55	44	57	44	47	45	53	45	45	62	63
631.85	44	57	44	47	45	52	45	45	60	61
632.10	44	56	44	47	45	51	45	45	60	61
632.35	44	56	44	47	45	50	45	45	60	61
632.70	42	52	43	46	44	49	44	44	59	60
633.00	43	53	43	46	44	49	44	44	60	61
633.25	41	50	41	43	42	47	43	42	58	59
633.55	41	49	41	43	42	48	41	42	56	57
633.85	42	49	42	44	42	47	41	43	56	57
634.15	43	50	43	45	43	49	43	44	56	57
634.45	42	50	42	44	43	49	42	43	54	55
634.75	42	49	42	43	43	47	39	43	53	54
635.05	41	49	41	43	42	47	39	42	52	53
635.40	41	49	41	42	42	45	39	42	52	53
635.75	41	49	41	41	42	44	37	42	52	53
636.05	41	50	41	41	42	44	37	42	51	52

Appendix K. Days of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) On Right Bank (IN side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	9	9	9	9	9	9	0	9	9	9
596.65	8	8	8	8	8	8	0	8	8	8
596.95	7	7	7	7	7	7	0	7	7	7
597.25	7	7	7	7	7	7	0	7	7	7
597.55	7	7	7	7	7	7	0	7	7	7
597.85	7	7	7	7	7	7	0	7	7	7
598.15	7	7	7	7	7	7	0	7	7	7
598.45	7	7	7	7	7	7	0	7	7	7
598.75	5	5	5	5	5	5	0	5	5	5
599.05	4	4	4	4	4	4	0	4	4	4
599.35	3	3	3	3	3	3	0	3	3	3
599.65	3	3	3	3	3	3	0	3	3	3
599.95	3	3	3	3	3	3	0	3	3	3
600.25	3	3	3	3	3	3	0	3	3	3
600.60	3	3	3	3	3	3	0	3	3	3
600.90	3	3	3	3	3	3	0	3	3	3
601.15	3	3	3	3	3	3	4	7	3	7
601.45	3	3	3	3	3	3	1	4	3	4
601.75	3	3	3	3	3	3	0	3	3	3
602.05	2	2	2	2	2	2	0	2	2	2
602.35	2	2	2	2	4	2	8	9	2	9
602.70	2	2	2	2	2	2	6	7	2	7
603.05	2	2	8	2	10	2	15	16	2	16
603.40	1	1	15	1	22	1	23	24	1	24
603.75	2	2	14	2	20	2	23	25	2	25
604.30	11	13	11	12	12	13	12	15	13	16
604.51	11	13	11	12	11	13	12	16	13	16
604.85	12	13	12	12	12	13	11	15	13	15
605.09	12	13	12	12	12	13	11	15	13	15
605.29	11	12	11	11	12	12	11	15	12	15
605.55	11	12	11	11	11	11	11	14	12	14
605.80	20	23	20	21	20	22	17	21	26	27
606.05	20	23	23	20	23	21	21	25	27	31
606.30	53	56	54	54	54	55	21	54	58	60
606.50	53	55	54	54	54	55	21	55	57	59
606.75	53	55	54	54	54	55	22	55	56	58
607.05	54	56	55	55	55	55	22	56	57	59
607.55	54	55	55	55	55	55	22	56	57	59
608.10	53	54	54	53	54	54	21	55	57	59
608.50	56	57	57	56	57	57	30	58	61	64
608.85	56	57	57	57	57	57	29	58	61	62
609.15	56	57	57	56	57	57	29	58	59	62
609.45	58	60	59	59	59	59	29	60	63	66

Appendix K. Days of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) On Right Bank (IN side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
609.80	58	59	59	59	60	59	29	60	61	63
610.10	57	58	58	58	59	58	29	59	60	62
610.40	56	57	58	57	59	57	28	59	59	62
610.85	56	57	57	57	58	57	29	59	58	62
611.30	53	54	53	54	54	54	28	55	56	57
611.65	53	54	53	54	54	54	28	55	56	57
611.95	53	54	53	54	54	54	28	55	56	57
612.30	52	53	53	53	54	53	28	55	55	57
612.60	52	53	52	53	53	53	28	55	55	57
612.80	52	53	52	53	53	53	28	54	55	56
613.05	52	54	52	53	53	53	28	54	56	57
613.30	53	54	53	53	54	54	27	55	56	57
613.55	52	53	52	52	53	53	27	54	55	56
613.80	51	52	51	51	52	52	27	53	54	55
614.00	51	53	51	51	52	52	26	52	54	54
614.30	51	53	51	51	52	52	26	52	54	54
614.65	50	52	50	50	51	51	26	51	52	53
614.95	48	51	48	49	49	50	28	49	51	52
615.20	48	51	48	49	49	50	27	49	51	51
615.45	48	51	48	49	49	50	27	49	51	51
615.75	48	51	48	48	49	50	27	49	51	51
616.05	48	51	48	48	49	50	27	49	51	51
616.35	48	51	48	48	49	50	27	49	51	51
616.65	48	50	48	48	49	50	27	49	51	51
616.90	48	50	48	48	49	49	27	49	52	52
617.10	47	50	47	48	49	49	26	49	52	52
617.40	47	50	47	47	48	49	26	49	52	52
617.75	47	50	47	47	48	48	26	48	52	52
618.05	47	50	47	47	48	48	26	48	52	52
618.35	47	49	47	47	48	49	26	48	51	52
618.60	47	49	47	47	48	48	26	48	50	52
618.85	47	49	47	47	48	48	26	48	51	51
619.10	47	49	47	48	48	48	26	48	51	51
619.35	47	49	47	48	48	48	26	48	51	51
619.65	47	49	47	48	48	48	26	48	51	51
619.95	47	50	47	48	48	48	27	48	52	52
620.25	47	51	47	48	48	49	28	48	53	53
620.55	46	52	46	48	47	48	28	47	53	53
620.85	46	51	46	48	47	49	28	47	53	53
621.10	46	50	46	48	47	49	27	47	52	52
621.35	47	51	47	49	48	50	28	48	53	53
621.70	46	53	46	48	47	51	34	48	58	58
622.00	46	52	46	47	47	50	34	47	57	57
622.25	46	54	46	47	47	51	35	47	57	57
622.55	47	51	47	47	48	50	34	48	57	57
622.85	47	51	47	48	48	49	34	48	57	57
623.15	48	51	48	48	49	49	33	49	57	57
623.45	49	55	49	49	50	51	35	51	59	59
623.75	49	55	49	49	50	50	36	50	59	59
624.05	50	54	50	50	51	51	35	51	59	60
624.35	50	54	50	50	51	51	35	51	58	58
624.65	50	56	50	50	51	51	39	51	59	59
624.95	49	56	49	50	50	52	38	50	59	59
625.25	49	56	49	49	50	52	37	50	59	59
625.60	49	55	49	49	50	51	37	50	59	59
625.90	49	55	49	50	50	52	37	50	60	60
626.15	49	55	49	50	50	52	37	50	59	59
626.50	49	55	49	49	50	52	37	50	57	58
626.85	49	55	49	49	50	52	38	50	57	58
627.10	50	56	50	50	51	53	38	51	57	58
627.35	50	56	50	50	51	52	38	51	57	58
627.70	50	56	50	50	51	52	38	51	57	58
628.00	48	55	48	49	49	52	38	49	58	59

Appendix K. Days of Exceedance of *E. coli* Single Sample Maximum Criterion (240 cfu/100 ml) On Right Bank (IN side) of Ohio River

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
628.25	55	61	55	56	56	58	39	56	65	65
628.55	55	61	55	55	56	58	40	56	65	65
628.85	54	60	54	54	55	57	39	55	64	64
629.10	53	60	53	54	54	57	40	54	64	64
629.40	53	60	53	54	54	57	40	54	64	64
629.75	52	59	52	54	53	57	40	53	63	64
630.05	52	59	52	53	53	57	40	53	62	63
630.35	51	58	51	52	52	55	41	52	63	64
630.70	50	57	51	51	52	54	41	52	60	62
631.00	47	54	47	48	48	52	39	50	59	61
631.25	45	53	45	46	46	51	39	46	57	58
631.55	45	53	45	46	46	51	39	46	57	58
631.85	44	52	44	45	45	50	39	45	56	57
632.10	44	52	44	44	45	49	39	45	56	57
632.35	44	51	44	44	45	49	39	45	55	56
632.70	44	50	44	44	45	47	39	45	55	56
633.00	44	50	44	44	45	47	39	45	54	55
633.25	41	49	42	43	43	46	39	43	53	54
633.55	41	49	41	41	42	46	39	42	53	55
633.85	40	49	40	42	40	45	38	41	51	53
634.15	41	49	41	41	41	43	38	42	50	51
634.45	42	49	42	42	43	44	37	43	51	52
634.75	41	49	41	42	42	44	37	42	49	50
635.05	41	49	41	42	42	44	37	42	49	50
635.40	41	49	41	42	42	44	37	42	49	50
635.75	41	48	41	41	42	43	37	42	50	51
636.05	41	48	41	41	42	43	36	42	50	51

APPENDIX L

COMPARISON OF DAYS OF EXCEEDANCE OF SINGLE SAMPLE MAXIMUM ALTERNATIVE CRITERIA (DURING RECREATION SEASON)

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	14	14	14	14	14	14	0	14	14	14
596.30	12	12	12	12	12	12	0	12	12	12
596.65	10	10	10	10	10	10	0	10	10	10
596.95	13	13	13	13	13	13	0	13	13	13
597.25	11	11	11	11	11	11	0	11	11	11
597.55	11	11	11	11	11	11	0	11	11	11
597.85	10	10	10	10	10	10	0	10	10	10
598.15	10	10	10	10	10	10	0	10	10	10
598.45	8	8	8	8	8	8	0	8	8	8
598.75	8	8	8	8	8	8	0	8	8	8
599.05	8	8	8	8	8	8	0	8	8	8
599.35	7	7	7	7	7	7	0	7	7	7
599.65	7	7	7	7	7	7	0	7	7	7
599.95	7	7	7	7	7	7	0	7	7	7
600.25	6	6	6	6	6	6	0	6	6	6
600.60	6	6	6	6	6	6	0	6	6	6
600.90	5	5	5	5	5	5	0	5	5	5
601.15	5	5	5	5	5	5	0	5	5	5
601.45	4	4	4	4	4	4	0	4	4	4
601.75	4	4	4	4	4	4	0	4	4	4
602.05	69	73	69	73	69	73	68	69	77	77
602.35	69	73	69	72	69	73	69	69	75	75
602.70	61	71	61	68	61	71	65	61	71	71
603.05	59	71	59	67	59	70	66	59	73	73
603.40	53	67	53	59	53	65	63	53	68	68
603.75	50	65	50	56	50	63	63	50	68	68
604.81	47	57	47	50	47	57	52	47	65	65
606.65	46	55	46	51	46	54	45	46	64	64
607.05	45	66	45	61	45	64	59	45	71	71
607.55	44	67	44	60	44	65	58	44	71	71
608.10	49	58	49	54	49	58	56	49	65	66

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
608.50	50	60	50	55	50	59	57	50	67	67
608.85	50	60	50	55	50	59	57	50	67	67
609.15	50	60	50	55	50	61	57	50	67	67
609.45	49	61	49	53	50	59	57	50	66	66
609.80	47	61	47	53	47	60	57	47	66	66
610.10	47	60	47	51	47	60	57	47	66	66
610.40	47	65	47	57	47	64	61	47	70	70
610.85	49	63	49	60	49	61	59	49	68	68
611.30	54	63	54	60	54	62	58	54	69	69
611.65	54	63	54	60	54	62	58	54	68	68
611.95	53	64	53	60	53	63	59	54	70	70
612.30	68	99	68	91	68	97	92	68	101	101
612.60	69	100	69	90	69	97	92	69	102	102
612.80	70	101	70	89	70	98	94	70	103	103
613.05	69	104	69	99	69	101	98	69	107	107
613.30	68	104	68	99	68	102	98	68	105	105
613.55	68	104	68	100	68	102	99	68	107	107
613.80	66	102	66	98	66	101	97	66	104	104
614.00	66	101	66	98	66	101	98	66	105	105
614.30	67	103	67	98	67	100	97	67	105	105
614.65	67	103	67	97	67	101	99	67	105	105
614.95	66	101	66	96	66	98	98	66	104	104
615.20	65	100	65	96	65	100	96	66	102	102
615.45	65	100	65	97	65	99	97	65	104	104
615.75	64	101	64	95	64	101	97	64	104	104
616.05	64	102	64	94	64	100	97	64	104	104
616.35	64	102	64	94	64	100	97	64	104	104
616.65	88	106	88	100	88	103	95	88	107	107
616.90	87	105	87	101	87	102	95	87	107	107
617.10	87	105	87	101	87	103	95	87	107	107
617.40	88	104	88	101	88	103	95	88	107	107
617.75	88	103	88	101	88	103	94	88	107	107
618.05	88	102	88	101	88	102	94	88	107	107
618.35	88	103	88	99	88	102	94	88	106	106
618.60	88	104	88	99	88	103	93	88	106	106
618.85	86	102	86	98	86	101	93	86	105	105
619.10	84	103	84	98	84	101	91	84	104	104
619.35	83	101	83	96	83	100	91	83	103	103
619.65	83	103	83	96	83	100	91	83	103	103
619.95	83	102	83	96	83	101	90	83	103	103
620.25	83	102	83	97	83	101	90	83	103	103
620.55	83	102	83	97	83	101	89	83	103	103
620.85	82	100	82	96	82	99	87	82	102	102
621.10	82	100	82	96	82	99	85	82	101	101
621.35	81	99	81	96	81	98	84	81	100	100
621.70	77	96	77	88	77	94	84	78	99	99
622.00	75	95	75	87	75	93	84	75	98	98
622.25	74	94	74	85	74	90	83	74	96	96
622.55	73	91	73	83	73	88	82	73	94	94
622.85	73	91	73	83	73	88	81	73	92	92

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
623.15	73	90	73	81	73	87	81	73	91	91
623.45	72	89	72	80	72	86	81	72	90	90
623.75	71	87	71	80	71	84	78	71	90	90
624.05	70	85	70	79	70	83	77	70	89	89
624.35	69	85	69	78	69	83	76	69	87	87
624.65	69	85	69	78	69	83	77	69	86	86
624.95	90	101	90	96	90	99	78	90	103	103
625.25	88	99	88	94	88	97	78	88	100	100
625.60	86	99	86	92	86	97	77	86	100	100
625.90	86	99	86	92	86	97	77	86	99	99
626.15	86	99	86	92	86	98	75	86	99	99
626.50	84	97	84	89	84	96	75	84	97	97
626.85	83	97	83	89	83	95	75	83	97	97
627.10	83	96	83	88	83	95	75	83	97	97
627.35	83	96	83	88	83	94	74	83	97	97
627.70	82	95	82	87	82	94	73	82	96	96
628.00	81	94	81	86	81	93	73	81	96	96
628.25	81	95	81	86	81	93	74	81	97	97
628.55	81	94	81	85	81	91	74	81	96	96
628.85	78	93	78	81	78	89	73	78	95	95
629.10	78	93	78	80	78	87	73	78	94	94
629.40	76	92	76	80	76	86	73	76	93	93
629.75	75	91	75	80	75	85	73	75	94	94
630.05	70	86	70	74	70	78	71	70	90	90
630.35	69	85	69	74	69	79	71	69	90	90
630.70	67	84	67	73	67	78	69	67	89	89
631.00	66	82	66	72	66	78	67	66	89	89
631.25	67	82	67	70	67	78	65	67	88	88
631.55	66	81	66	69	66	77	65	66	88	88
631.85	65	78	65	67	65	76	65	65	85	85
632.10	65	78	65	67	65	76	65	65	83	83
632.35	65	78	65	67	65	76	65	65	82	82
632.70	63	75	63	64	63	70	62	63	81	81
633.00	63	75	63	64	63	69	61	63	80	80
633.25	59	72	59	63	59	67	59	59	77	77
633.55	59	72	59	64	59	67	59	59	76	76
633.85	60	73	60	65	60	68	58	60	75	75
634.15	60	73	60	64	60	67	58	60	75	75
634.45	59	71	59	63	59	66	57	59	74	74
634.75	58	70	58	63	58	66	58	58	74	74
635.05	56	66	56	61	56	64	57	56	73	73
635.40	56	65	56	60	56	64	56	56	71	71
635.75	56	65	56	59	56	64	56	56	71	71
636.05	55	64	55	58	55	63	55	55	70	70

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	5	5	5	5	5	5	0	5	5	5
596.30	4	4	4	4	4	4	0	4	4	4
596.65	4	4	4	4	4	4	0	4	4	4
596.95	4	4	4	4	4	4	0	4	4	4
597.25	4	4	4	4	4	4	0	4	4	4
597.55	3	3	3	3	3	3	0	3	3	3
597.85	1	1	1	1	1	1	0	1	1	1
598.15	1	1	1	1	1	1	0	1	1	1
598.45	1	1	1	1	1	1	0	1	1	1
598.75	1	1	1	1	1	1	0	1	1	1
599.05	1	1	1	1	1	1	0	1	1	1
599.35	1	1	1	1	1	1	0	1	1	1
599.65	1	1	1	1	1	1	0	1	1	1
599.95	1	1	1	1	1	1	0	1	1	1
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	44	52	44	49	44	52	46	44	54	54
602.35	38	47	38	42	38	46	44	38	52	52
602.70	36	42	36	38	36	40	39	36	45	45
603.05	35	41	35	36	35	40	36	35	46	46
603.40	29	33	29	31	29	33	29	29	35	35
603.75	27	31	27	27	27	30	27	27	35	35
604.81	27	29	27	28	27	28	22	27	31	31
606.65	22	25	22	23	22	24	21	22	28	28
607.05	22	31	22	30	22	32	35	22	38	38
607.55	23	33	23	30	23	33	34	23	39	39
608.10	34	36	34	35	34	36	33	34	40	40

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
608.50	32	35	32	34	32	35	32	32	39	39
608.85	32	34	32	33	32	33	32	32	39	39
609.15	31	33	31	32	31	32	30	31	36	36
609.45	33	35	33	34	33	34	30	33	37	37
609.80	33	34	33	34	33	34	29	33	36	36
610.10	33	34	33	34	33	34	28	33	36	36
610.40	33	40	33	40	33	40	37	33	43	43
610.85	33	39	33	35	33	39	34	34	41	42
611.30	34	38	34	35	34	37	35	35	41	42
611.65	34	37	34	35	34	36	33	35	40	41
611.95	34	36	34	35	34	35	32	35	40	41
612.30	43	62	43	52	43	58	61	44	66	67
612.60	43	61	43	52	43	57	61	44	65	66
612.80	42	59	42	50	43	54	60	43	65	65
613.05	41	73	41	65	42	71	74	42	78	78
613.30	41	73	41	65	41	73	73	42	77	77
613.55	41	73	41	64	41	72	73	42	77	77
613.80	41	73	41	63	42	70	73	42	77	77
614.00	41	74	41	63	41	70	73	42	77	77
614.30	41	73	41	63	41	70	73	42	77	77
614.65	40	72	40	61	40	68	71	41	76	76
614.95	42	72	42	58	43	66	69	43	75	75
615.20	42	72	42	60	43	64	67	43	73	73
615.45	42	71	42	58	43	64	68	43	74	74
615.75	42	71	42	56	43	64	69	43	75	75
616.05	41	72	41	55	42	64	68	42	74	74
616.35	41	72	41	55	42	63	70	42	76	76
616.65	54	76	55	62	55	73	69	55	77	77
616.90	53	76	54	62	54	71	68	54	76	76
617.10	54	74	55	63	55	71	68	55	76	76
617.40	53	74	53	63	54	70	67	54	76	76
617.75	52	73	52	63	53	69	69	53	76	76
618.05	53	74	53	63	54	70	68	54	77	77
618.35	53	75	53	63	54	70	68	54	77	77
618.60	52	75	52	63	53	72	67	53	77	77
618.85	54	73	54	63	55	72	65	55	76	76
619.10	53	72	53	60	54	70	65	54	74	74
619.35	52	71	52	58	53	63	63	53	73	73
619.65	51	69	51	57	52	64	62	52	73	73
619.95	53	68	53	56	54	65	60	54	71	71
620.25	52	68	52	56	53	65	60	53	70	70
620.55	50	67	50	54	51	64	60	51	69	69
620.85	50	68	50	54	51	63	60	51	71	71
621.10	50	67	50	55	51	61	60	51	72	72
621.35	49	62	49	53	50	59	58	50	69	69
621.70	43	55	43	46	44	52	49	44	62	62
622.00	43	56	43	46	44	51	49	44	60	60
622.25	42	56	42	44	43	50	46	43	59	59
622.55	42	54	42	44	43	49	46	43	56	56
622.85	42	54	42	43	43	49	46	43	56	56

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
623.15	41	55	41	43	42	50	46	42	56	56
623.45	41	55	41	43	42	49	46	42	56	56
623.75	40	52	40	42	41	49	45	41	56	56
624.05	40	49	40	42	41	47	42	41	53	53
624.35	40	49	40	42	41	47	41	41	52	52
624.65	39	49	39	42	40	47	40	41	52	52
624.95	46	56	46	48	47	51	40	47	60	60
625.25	44	53	44	46	45	49	39	45	58	58
625.60	41	51	41	44	42	46	35	42	51	51
625.90	40	49	40	43	41	44	34	41	50	50
626.15	39	46	39	41	40	43	32	40	49	49
626.50	40	45	40	41	41	43	32	41	49	49
626.85	40	45	40	41	41	42	32	41	49	49
627.10	40	44	40	41	41	42	32	41	49	49
627.35	40	44	40	42	41	42	31	41	49	49
627.70	39	44	39	41	40	42	29	40	48	48
628.00	39	43	39	39	40	41	29	40	46	46
628.25	39	43	39	39	40	41	29	40	46	46
628.55	37	42	37	38	37	39	28	38	45	45
628.85	37	40	37	37	37	38	28	38	44	44
629.10	37	40	37	37	37	37	27	38	44	44
629.40	35	38	35	36	35	36	26	36	42	42
629.75	35	37	35	35	35	36	26	36	41	41
630.05	35	36	35	35	35	35	24	36	40	40
630.35	35	35	35	35	35	35	23	36	39	40
630.70	35	35	35	35	35	35	23	36	38	39
631.00	35	35	35	35	35	35	23	36	37	38
631.25	35	35	35	35	35	35	23	36	37	38
631.55	34	35	34	35	34	35	23	35	35	36
631.85	34	35	34	35	34	35	22	35	35	36
632.10	34	35	34	35	34	35	22	35	35	36
632.35	33	35	33	34	33	35	22	34	35	36
632.70	33	35	33	34	33	35	22	34	35	36
633.00	33	35	33	34	33	35	22	34	35	36
633.25	34	36	34	34	34	36	22	35	36	37
633.55	34	36	34	34	34	35	22	35	36	37
633.85	34	35	34	34	34	34	22	35	36	37
634.15	33	34	33	34	33	34	21	35	35	36
634.45	33	34	33	34	33	34	21	34	35	36
634.75	32	34	32	34	32	34	21	33	35	36
635.05	32	34	32	33	32	34	21	33	35	36
635.40	32	33	32	33	32	33	21	33	34	35
635.75	30	32	30	32	30	32	22	31	32	33
636.05	30	32	30	32	30	32	22	31	33	34

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	7	7	7	7	7	7	0	7	7	7
596.30	7	7	7	7	7	7	0	7	7	7
596.65	4	4	4	4	4	4	0	4	4	4
596.95	5	5	5	5	5	5	0	5	5	5
597.25	5	5	5	5	5	5	0	5	5	5
597.55	5	5	5	5	5	5	0	5	5	5
597.85	5	5	5	5	5	5	0	5	5	5
598.15	5	5	5	5	5	5	0	5	5	5
598.45	5	5	5	5	5	5	0	5	5	5
598.75	3	3	3	3	3	3	0	3	3	3
599.05	2	2	2	2	2	2	0	2	2	2
599.35	1	1	1	1	1	1	0	1	1	1
599.65	1	1	1	1	1	1	0	1	1	1
599.95	1	1	1	1	1	1	0	1	1	1
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	43	56	43	50	43	55	43	43	57	57
602.35	42	53	42	47	42	49	44	42	55	55
602.70	37	46	37	39	37	43	37	37	50	50
603.05	35	40	35	37	35	39	36	35	46	46
603.40	29	34	29	31	29	34	29	29	36	36
603.75	30	35	30	31	30	33	30	30	37	37
604.81	30	33	30	30	30	32	29	30	37	37
606.65	26	32	26	29	26	30	26	26	33	33
607.05	25	37	25	30	25	35	35	25	43	43
607.55	26	36	26	29	26	35	34	26	43	43
608.10	41	44	41	43	41	44	40	41	47	47

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
608.50	41	44	41	43	41	44	40	41	47	47
608.85	41	44	41	43	41	43	40	41	45	45
609.15	41	43	41	43	41	43	40	41	45	45
609.45	41	43	41	43	41	43	40	41	45	45
609.80	41	43	41	43	41	43	40	41	45	45
610.10	41	43	41	43	41	43	37	41	45	45
610.40	41	47	41	46	41	48	44	41	49	49
610.85	42	47	42	44	42	46	42	42	49	49
611.30	43	45	43	44	43	45	41	43	48	49
611.65	43	46	43	45	43	45	41	43	50	51
611.95	44	48	44	46	44	47	41	44	50	51
612.30	52	65	52	58	52	64	63	52	71	71
612.60	52	65	52	58	52	63	63	52	71	71
612.80	53	65	53	58	53	63	62	53	72	72
613.05	53	83	53	74	53	78	78	53	85	85
613.30	53	83	53	73	53	78	78	53	85	85
613.55	53	83	53	72	53	78	79	53	85	85
613.80	52	79	52	71	52	76	78	52	84	84
614.00	52	79	52	71	52	76	78	52	84	84
614.30	53	79	53	72	53	77	79	53	86	86
614.65	53	79	53	72	53	76	77	53	84	84
614.95	54	77	54	66	54	76	72	55	79	79
615.20	54	77	54	66	54	76	72	55	79	79
615.45	54	76	54	65	54	75	72	55	79	79
615.75	53	75	53	64	53	74	72	54	78	78
616.05	53	74	53	64	53	72	71	54	78	78
616.35	53	74	53	64	53	70	70	54	78	78
616.65	66	81	66	74	66	77	71	66	82	82
616.90	65	79	65	72	65	76	72	65	82	82
617.10	63	77	63	70	63	74	70	64	81	81
617.40	63	77	63	70	63	75	70	63	80	80
617.75	64	76	64	69	64	76	69	64	80	80
618.05	64	76	64	69	64	76	69	64	80	80
618.35	64	76	64	70	64	76	68	64	78	78
618.60	64	76	64	70	64	75	68	64	78	78
618.85	63	76	63	70	63	75	68	64	79	79
619.10	61	74	61	69	61	72	67	61	75	75
619.35	60	74	60	66	60	71	66	60	75	75
619.65	59	74	59	67	59	71	65	59	75	75
619.95	59	72	59	66	59	71	65	59	75	75
620.25	59	70	59	65	59	68	62	59	72	72
620.55	57	68	57	63	57	66	62	57	70	70
620.85	58	69	58	64	58	67	62	58	69	69
621.10	57	69	57	64	57	68	62	57	69	69
621.35	57	68	57	65	57	68	61	57	69	69
621.70	56	69	56	62	56	67	59	56	69	69
622.00	56	68	56	62	56	66	58	56	68	68
622.25	57	68	57	62	57	66	58	57	68	68
622.55	56	68	56	61	56	65	58	56	68	68
622.85	56	66	56	61	56	63	58	56	69	69

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
623.15	56	65	56	60	56	63	55	56	67	67
623.45	56	65	56	60	56	63	55	56	67	67
623.75	56	64	56	60	56	63	53	56	68	68
624.05	55	65	55	58	55	61	53	55	68	68
624.35	55	66	55	58	55	62	53	55	68	68
624.65	55	66	55	59	55	62	53	55	68	68
624.95	61	72	61	65	61	70	52	61	75	75
625.25	62	73	62	65	62	70	52	62	74	74
625.60	61	72	61	65	61	67	50	61	74	74
625.90	60	70	60	64	60	66	49	60	73	73
626.15	59	66	59	61	59	65	49	59	72	72
626.50	59	66	59	61	59	65	48	59	71	71
626.85	58	66	58	61	58	65	49	58	71	71
627.10	58	65	58	61	58	65	48	58	70	70
627.35	57	65	57	59	57	65	48	57	68	68
627.70	56	64	56	58	56	64	48	56	66	66
628.00	54	64	54	59	54	64	46	54	66	66
628.25	54	64	54	59	54	64	45	54	66	66
628.55	53	64	53	58	53	63	44	53	66	66
628.85	53	65	53	58	53	63	44	53	66	66
629.10	54	65	54	57	54	62	44	54	66	66
629.40	54	65	54	57	54	61	44	54	66	66
629.75	53	63	53	55	53	58	44	53	65	66
630.05	53	60	53	55	53	56	44	53	63	63
630.35	52	60	52	55	52	56	44	52	63	63
630.70	51	59	51	54	51	56	43	51	61	61
631.00	51	58	51	54	51	55	42	51	60	60
631.25	51	57	51	53	51	55	42	51	60	60
631.55	51	57	51	53	51	55	41	51	61	61
631.85	50	57	50	52	50	55	40	50	62	62
632.10	50	56	50	51	50	55	39	50	61	61
632.35	50	55	50	51	50	53	39	50	61	61
632.70	50	54	50	51	50	53	38	50	59	59
633.00	49	53	49	50	49	50	38	49	57	57
633.25	49	52	49	50	49	50	38	49	57	57
633.55	49	51	49	49	49	50	36	49	56	56
633.85	48	49	48	48	48	49	36	48	53	55
634.15	48	49	48	48	48	49	36	48	52	52
634.45	48	49	48	48	48	49	36	48	52	52
634.75	48	49	48	48	48	49	36	48	52	52
635.05	48	49	48	48	48	48	36	48	52	52
635.40	47	47	47	47	47	47	34	47	50	50
635.75	47	47	47	47	47	47	34	47	48	48
636.05	46	48	46	47	46	48	34	46	48	48

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	7	7	7	7	7	7	0	7	7	7
596.30	6	6	6	6	6	6	0	6	6	6
596.65	5	5	5	5	5	5	0	5	5	5
596.95	8	8	8	8	8	8	0	8	8	8
597.25	6	6	6	6	6	6	0	6	6	6
597.55	6	6	6	6	6	6	0	6	6	6
597.85	5	5	5	5	5	5	0	5	5	5
598.15	6	6	6	6	6	6	0	6	6	6
598.45	5	5	5	5	5	5	0	5	5	5
598.75	5	5	5	5	5	5	0	5	5	5
599.05	5	5	5	5	5	5	0	5	5	5
599.35	4	4	4	4	4	4	0	4	4	4
599.65	3	3	3	3	3	3	0	3	3	3
599.95	3	3	3	3	3	3	0	3	3	3
600.25	2	2	2	2	2	2	0	2	2	2
600.60	2	2	2	2	2	2	0	2	2	2
600.90	2	2	2	2	2	2	0	2	2	2
601.15	2	2	2	2	2	2	0	2	2	2
601.45	2	2	2	2	2	2	0	2	2	2
601.75	3	3	3	3	3	3	0	3	3	3
602.05	44	50	44	48	44	48	40	44	50	50
602.35	41	49	41	47	41	49	40	41	49	49
602.70	35	46	35	41	35	46	36	35	46	46
603.05	36	43	36	41	36	42	38	36	45	45
603.40	34	40	34	36	34	39	33	34	42	42
603.75	33	42	33	37	33	39	35	33	44	44
604.81	32	38	32	35	32	37	32	32	44	44
606.65	32	37	32	34	32	37	32	32	41	41
607.05	32	46	32	43	32	46	39	32	47	47
607.55	31	45	31	41	31	42	38	31	46	46
608.10	41	50	41	46	41	50	44	41	52	52

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
608.50	42	48	42	46	42	49	44	42	52	52
608.85	42	47	42	46	42	48	44	42	53	53
609.15	42	47	42	46	42	48	43	42	52	52
609.45	42	47	42	45	42	47	43	42	52	52
609.80	42	47	42	45	42	47	43	42	51	51
610.10	42	47	42	44	42	47	43	42	51	51
610.40	43	54	43	52	43	54	50	43	58	58
610.85	43	52	43	50	43	52	48	43	55	55
611.30	43	51	43	48	43	50	45	43	55	55
611.65	47	52	47	50	47	52	45	47	57	57
611.95	47	55	47	50	47	54	47	47	58	58
612.30	54	75	54	71	54	74	70	54	80	80
612.60	54	75	54	70	54	74	68	54	78	78
612.80	54	74	54	69	54	74	65	54	76	76
613.05	54	80	54	77	54	78	74	54	82	82
613.30	54	79	54	76	54	78	75	54	82	82
613.55	54	79	54	75	54	77	76	54	82	83
613.80	53	78	53	73	53	76	73	53	81	81
614.00	53	76	53	73	53	76	73	53	79	79
614.30	53	77	53	73	53	76	73	53	79	79
614.65	53	76	53	73	53	75	73	53	79	79
614.95	55	76	55	74	55	76	73	55	82	82
615.20	55	78	55	72	55	75	70	55	79	79
615.45	56	78	56	73	56	75	70	56	79	79
615.75	56	77	56	71	56	77	70	56	78	78
616.05	55	76	55	68	55	75	69	55	77	77
616.35	55	75	55	67	55	73	68	55	77	77
616.65	70	82	70	79	70	81	66	70	83	83
616.90	68	80	68	77	68	78	64	68	82	82
617.10	68	79	68	76	68	78	64	68	80	80
617.40	68	77	68	76	68	77	64	68	79	79
617.75	68	77	68	76	68	76	63	68	79	79
618.05	66	74	66	74	66	74	62	66	77	77
618.35	66	74	66	72	66	74	62	66	77	77
618.60	67	75	67	73	67	75	64	67	78	78
618.85	65	73	65	71	65	73	64	65	77	77
619.10	60	71	60	69	60	71	64	60	74	74
619.35	59	72	59	66	59	70	64	59	73	73
619.65	59	72	59	65	59	71	64	60	74	74
619.95	60	74	60	67	60	73	66	60	76	76
620.25	59	73	59	68	59	73	67	59	76	76
620.55	60	72	60	67	60	72	66	60	74	74
620.85	60	72	60	69	60	72	66	60	75	75
621.10	59	73	59	66	59	71	66	59	74	74
621.35	58	71	58	65	58	70	63	58	73	73
621.70	58	68	58	63	58	66	62	58	73	73
622.00	57	68	57	63	57	66	61	57	69	69
622.25	57	69	57	64	57	66	60	57	69	69
622.55	57	69	57	65	57	67	61	57	71	71
622.85	59	70	59	65	59	66	62	59	71	71

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
623.15	59	70	59	65	59	66	62	59	72	72
623.45	60	70	60	65	60	67	62	60	72	72
623.75	60	70	60	65	60	69	61	60	71	71
624.05	60	70	60	65	60	69	61	60	72	72
624.35	60	70	60	67	60	69	62	60	72	72
624.65	61	71	61	67	61	69	61	61	71	71
624.95	70	80	70	76	70	79	61	70	80	80
625.25	70	79	70	75	70	78	61	70	80	80
625.60	68	78	69	73	69	77	61	69	79	79
625.90	67	78	68	73	68	76	61	68	78	79
626.15	66	78	66	73	67	77	60	67	78	78
626.50	65	76	65	70	65	75	60	66	76	76
626.85	65	76	65	70	65	75	60	66	76	76
627.10	65	75	65	70	65	75	60	66	77	77
627.35	65	75	65	71	65	74	61	66	77	77
627.70	65	75	65	70	65	74	61	66	78	78
628.00	64	75	64	69	64	72	61	64	77	77
628.25	64	74	64	67	64	70	61	64	76	76
628.55	63	73	63	66	63	69	60	63	75	75
628.85	61	72	62	65	62	68	58	62	74	74
629.10	60	72	60	64	60	68	57	60	73	73
629.40	60	72	60	64	60	69	57	60	74	74
629.75	59	72	59	64	59	68	56	59	76	76
630.05	58	69	58	64	58	67	54	59	75	75
630.35	58	70	58	63	58	67	55	58	73	73
630.70	57	71	57	62	57	66	56	57	73	73
631.00	56	68	56	62	56	65	55	56	73	73
631.25	56	67	56	61	56	65	54	56	69	69
631.55	55	66	55	60	55	65	53	55	67	67
631.85	55	66	55	59	55	65	52	55	67	67
632.10	54	65	54	58	54	64	52	54	66	66
632.35	54	64	54	58	54	63	52	54	66	66
632.70	53	64	53	56	53	61	51	53	65	65
633.00	53	63	53	56	53	59	50	53	65	65
633.25	52	61	52	56	52	59	49	52	64	64
633.55	53	62	53	56	53	59	49	53	63	63
633.85	54	63	54	57	54	60	49	54	65	65
634.15	54	63	54	57	54	60	48	54	65	65
634.45	53	62	53	56	53	59	46	53	64	64
634.75	52	60	52	55	52	58	46	52	63	63
635.05	51	59	51	55	51	58	45	51	62	62
635.40	51	59	51	54	51	58	44	51	62	62
635.75	50	58	50	52	50	56	43	50	60	60
636.05	49	57	49	52	49	55	43	49	60	60

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	5	5	5	5	5	5	0	5	5	5
597.55	2	2	2	2	2	2	0	2	2	2
597.85	6	6	6	6	6	6	0	6	6	6
598.15	7	7	7	7	7	7	0	7	7	7
598.45	7	7	7	7	7	7	0	7	7	7
598.75	7	7	7	7	7	7	0	7	7	7
599.05	7	7	7	7	7	7	0	7	7	7
599.35	7	7	7	7	7	7	0	7	7	7
599.65	6	6	6	6	6	6	0	6	6	6
599.95	6	6	6	6	6	6	0	6	6	6
600.25	5	5	5	5	5	5	0	5	5	5
600.60	4	4	4	4	4	4	0	4	4	4
600.90	4	4	4	4	4	4	0	4	4	4
601.15	4	4	4	4	4	4	0	4	4	4
601.45	4	4	4	4	4	4	0	4	4	4
601.75	4	4	4	4	4	4	0	4	4	4
602.05	4	4	4	4	4	4	0	4	4	4
602.35	4	4	4	4	4	4	0	4	4	4
602.70	4	4	4	4	4	4	0	4	4	4
603.05	11	11	11	11	11	11	7	11	11	11
603.40	11	11	11	11	11	11	4	11	11	11
603.75	21	22	21	21	21	22	15	21	23	23
604.81	30	34	30	30	30	33	30	30	39	40
605.80	44	47	44	44	44	47	44	44	51	52
606.05	44	47	44	44	44	47	44	44	51	52
606.30	44	47	44	44	44	47	44	44	51	52
606.50	44	47	44	44	44	47	44	44	51	52

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
606.75	43	48	43	43	43	47	44	43	50	52
607.05	55	57	55	55	55	56	54	55	61	62
607.55	55	58	55	55	55	56	54	55	60	62
608.10	56	59	56	57	56	58	54	56	61	63
608.50	61	64	61	62	61	64	54	61	65	67
608.85	61	64	61	62	61	63	51	61	65	67
609.15	60	64	60	62	60	62	52	60	65	67
609.45	60	64	60	61	60	62	52	60	65	67
609.80	59	62	59	60	59	60	50	59	64	64
610.10	60	62	60	61	60	61	49	60	64	64
610.40	61	64	61	63	61	63	48	61	64	65
610.85	64	67	64	65	64	66	49	64	67	67
611.30	61	64	61	61	61	62	49	61	64	65
611.65	62	64	62	62	62	63	49	62	65	65
611.95	62	64	62	62	62	63	49	62	64	64
612.30	62	64	62	62	62	63	48	62	65	65
612.60	62	63	62	62	62	63	49	62	64	65
612.80	62	63	62	62	61	63	49	61	64	64
613.05	61	63	61	61	61	63	49	61	65	65
613.30	61	62	61	61	61	62	48	61	66	66
613.55	60	62	60	60	60	61	48	60	66	66
613.80	60	62	60	61	60	61	48	60	65	65
614.00	63	67	63	63	63	64	56	63	72	72
614.30	62	70	62	63	62	66	58	62	74	74
614.65	62	68	62	64	62	66	58	62	74	74
614.95	62	66	62	64	62	66	46	62	68	68
615.20	65	80	65	70	65	77	69	65	86	86
615.45	67	82	67	72	67	77	73	67	89	89
615.75	67	79	67	71	67	77	72	67	89	89
616.05	67	79	67	71	67	77	69	67	87	87
616.35	66	78	66	69	66	76	70	66	85	86
616.65	67	79	67	70	67	77	70	67	86	87
616.90	66	78	66	69	66	74	68	66	84	84
617.10	66	77	66	69	66	74	67	66	83	83
617.40	66	77	66	69	66	74	67	66	83	83
617.75	67	82	67	72	67	78	74	67	87	87
618.05	67	84	67	74	67	79	76	67	89	89
618.35	67	84	67	73	67	78	74	67	87	87
618.60	68	85	68	73	68	79	75	68	87	87
618.85	68	82	68	73	68	79	74	68	88	88
619.10	68	83	68	72	68	78	74	68	88	88
619.35	69	92	69	76	69	88	82	69	95	95
619.65	70	89	70	78	70	84	81	70	95	95
619.95	72	93	72	81	72	87	82	72	98	98
620.25	73	91	73	81	73	87	78	73	96	96
620.55	72	90	72	79	72	85	78	72	94	94
620.85	69	89	69	75	69	83	78	69	92	92
621.10	69	89	69	74	69	83	77	69	89	89
621.35	70	89	70	75	70	84	77	70	89	89
621.70	69	87	69	73	69	80	77	69	89	89

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
622.00	69	83	69	73	69	77	75	69	87	87
622.25	70	86	70	75	70	81	77	70	87	87
622.55	72	87	72	77	72	82	77	72	89	89
622.85	72	86	72	77	72	82	77	72	87	87
623.15	70	86	70	76	70	80	73	70	86	86
623.45	68	84	68	74	68	78	72	68	85	85
623.75	68	84	68	74	68	78	72	68	84	84
624.05	67	83	67	73	67	77	72	67	84	84
624.35	67	82	67	72	67	77	72	67	84	84
624.65	67	81	67	71	67	75	71	67	84	84
624.95	67	81	67	72	67	76	71	67	84	84
625.25	68	82	68	72	68	77	73	68	84	84
625.60	67	81	67	71	67	74	72	67	84	84
625.90	68	82	68	73	68	75	73	68	85	85
626.15	72	86	72	75	72	82	74	72	87	87
626.50	72	85	72	75	72	81	74	72	87	87
626.85	71	86	71	75	71	81	74	71	87	87
627.10	70	85	70	73	70	77	72	70	87	87
627.35	68	82	68	69	68	75	69	68	86	86
627.70	70	85	70	72	70	76	71	70	87	87
628.00	69	81	69	70	69	75	69	69	86	86
628.25	69	79	69	70	69	75	69	69	86	86
628.55	67	77	67	69	67	74	69	67	85	85
628.85	66	77	66	69	66	74	69	66	85	85
629.10	65	75	65	68	65	72	66	65	81	81
629.40	65	75	65	68	65	72	65	65	81	81
629.75	63	74	63	67	63	72	68	63	83	83
630.05	61	74	61	66	61	70	64	61	81	81
630.35	60	73	60	64	60	71	63	60	78	78
630.70	60	74	60	63	60	72	62	60	78	78
631.00	60	74	60	64	60	71	61	60	78	78
631.25	60	72	60	63	60	67	58	60	77	77
631.55	60	73	60	63	60	67	58	60	76	76
631.85	59	73	59	63	59	67	58	59	76	76
632.10	59	72	59	63	59	67	57	59	75	75
632.35	58	71	58	62	58	65	57	58	74	74
632.70	57	68	57	61	57	63	55	57	72	72
633.00	58	69	58	62	58	64	55	58	75	75
633.25	57	67	57	61	57	63	55	57	73	73
633.55	57	65	57	62	57	64	52	57	72	72
633.85	58	65	58	62	58	65	52	58	71	71
634.15	58	66	58	62	58	66	54	58	72	72
634.45	56	65	56	60	56	64	54	56	70	70
634.75	57	64	57	60	57	62	54	57	70	70
635.05	57	64	57	60	57	61	54	57	68	68
635.40	57	64	57	60	57	61	53	57	67	67
635.75	56	64	56	58	56	61	52	56	67	67
636.05	56	64	56	58	56	61	52	56	66	66

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	0	0	0	0	0	0	0	0	0	0
597.55	0	0	0	0	0	0	0	0	0	0
597.85	0	0	0	0	0	0	0	0	0	0
598.15	0	0	0	0	0	0	0	0	0	0
598.45	0	0	0	0	0	0	0	0	0	0
598.75	1	1	1	1	1	1	0	1	1	1
599.05	1	1	1	1	1	1	0	1	1	1
599.35	1	1	1	1	1	1	0	1	1	1
599.65	1	1	1	1	1	1	0	1	1	1
599.95	1	1	1	1	1	1	0	1	1	1
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	1	1	1	1	1	1	0	1	1	1
602.35	1	1	1	1	1	1	0	1	1	1
602.70	1	1	1	1	1	1	0	1	1	1
603.05	6	6	6	6	6	6	2	6	7	7
603.40	3	3	3	3	3	3	2	3	3	3
603.75	11	11	11	11	11	11	8	11	11	11
604.81	18	20	18	19	18	20	15	18	20	20
605.80	18	20	18	19	18	20	15	18	20	20
606.05	18	20	18	19	18	19	16	18	21	21
606.30	24	26	24	26	24	26	23	24	27	27
606.50	26	28	26	28	26	28	25	26	29	29

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
606.75	26	28	26	28	26	28	25	26	29	29
607.05	34	36	34	36	34	36	32	34	37	37
607.55	31	33	31	33	31	33	30	32	35	35
608.10	37	39	37	38	37	39	34	37	40	40
608.50	39	41	39	39	39	40	31	39	41	41
608.85	39	42	39	39	39	40	31	40	42	42
609.15	38	41	38	38	38	40	31	38	41	41
609.45	39	40	39	40	39	40	32	39	41	41
609.80	38	39	38	39	38	39	30	38	40	40
610.10	39	39	39	39	39	39	30	39	40	40
610.40	42	42	42	42	42	42	30	42	43	43
610.85	42	42	42	42	42	42	29	42	43	43
611.30	41	42	41	42	41	42	30	42	42	42
611.65	42	42	42	42	42	42	29	42	42	42
611.95	40	41	40	40	40	40	29	40	43	43
612.30	43	44	43	43	43	44	28	43	44	44
612.60	41	42	41	42	41	42	28	41	42	42
612.80	41	42	41	42	41	42	28	41	42	42
613.05	42	42	42	42	42	42	28	42	42	42
613.30	42	42	42	42	42	42	28	42	42	42
613.55	42	42	42	42	42	42	29	42	42	42
613.80	42	42	42	42	42	42	29	42	42	42
614.00	42	42	42	42	42	42	29	42	42	42
614.30	42	42	42	42	42	42	29	42	43	43
614.65	42	42	42	42	42	42	28	42	43	43
614.95	42	42	42	42	42	42	27	42	42	42
615.20	40	42	40	41	40	42	30	40	44	44
615.45	40	44	40	41	40	42	32	40	45	45
615.75	41	44	41	42	41	43	32	41	46	46
616.05	41	44	41	42	41	43	31	41	45	45
616.35	41	43	41	42	41	42	31	41	45	45
616.65	41	43	41	42	41	42	31	41	45	45
616.90	41	43	41	43	41	43	30	41	45	45
617.10	42	43	42	42	42	43	29	42	44	44
617.40	42	43	42	42	42	43	28	42	44	44
617.75	41	43	41	42	41	43	30	41	47	47
618.05	41	46	41	42	41	45	31	41	48	48
618.35	40	44	40	41	40	42	30	40	46	46
618.60	40	45	40	41	40	42	31	40	46	46
618.85	40	44	40	41	40	42	31	40	46	46
619.10	40	44	40	41	40	41	31	40	46	46
619.35	41	47	41	42	41	44	39	41	51	51
619.65	42	46	42	43	42	45	37	42	50	50
619.95	42	46	42	43	42	45	39	42	52	52
620.25	41	46	42	43	42	45	39	42	52	52
620.55	40	46	41	43	41	44	36	41	50	50
620.85	40	45	41	42	41	43	36	41	49	49
621.10	40	45	41	42	41	43	34	41	50	50
621.35	39	46	40	41	40	44	35	40	49	49
621.70	39	46	40	42	40	43	33	40	49	49

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
622.00	40	44	41	42	41	43	32	41	48	48
622.25	39	45	40	41	40	43	33	40	50	50
622.55	38	48	40	41	40	42	35	40	50	50
622.85	39	44	40	40	40	42	33	40	50	50
623.15	39	43	40	40	40	43	32	40	48	48
623.45	39	43	40	40	40	43	30	40	46	46
623.75	38	43	38	38	39	42	30	39	46	46
624.05	38	42	38	39	39	42	30	39	45	45
624.35	38	42	38	39	39	41	29	39	44	44
624.65	37	40	37	38	38	39	27	38	41	41
624.95	37	41	38	38	39	39	27	39	41	41
625.25	38	41	38	39	39	39	27	39	42	42
625.60	38	40	38	38	39	38	27	39	41	41
625.90	38	41	38	38	39	38	27	39	41	41
626.15	39	41	39	39	40	40	26	40	42	42
626.50	38	41	38	39	39	39	26	39	43	43
626.85	38	41	38	39	39	39	27	39	43	43
627.10	38	41	38	38	39	39	27	39	43	43
627.35	36	40	36	38	37	39	25	38	41	41
627.70	36	40	36	38	37	38	25	37	43	43
628.00	36	37	36	36	37	37	25	37	40	40
628.25	36	37	36	36	37	36	23	37	39	39
628.55	36	36	36	36	37	36	23	37	39	39
628.85	35	36	35	36	35	36	23	36	39	39
629.10	36	36	36	36	36	36	23	37	39	39
629.40	36	36	36	36	36	36	23	37	38	38
629.75	35	35	35	35	35	35	23	36	36	36
630.05	36	36	36	36	36	36	23	37	37	37
630.35	36	36	36	36	36	36	23	37	37	37
630.70	36	36	36	36	36	36	23	37	36	37
631.00	36	36	36	36	36	36	23	37	36	37
631.25	36	36	36	36	36	36	23	37	36	37
631.55	35	36	35	36	35	36	23	36	36	37
631.85	35	36	35	36	35	36	23	36	36	37
632.10	35	36	35	36	35	36	22	36	36	37
632.35	35	36	35	35	35	36	22	36	36	37
632.70	35	36	35	35	35	36	22	36	36	37
633.00	35	36	35	35	35	36	22	36	36	37
633.25	34	36	34	35	34	36	22	35	36	37
633.55	34	36	34	34	34	35	22	35	36	37
633.85	34	36	34	34	34	34	22	35	36	37
634.15	34	34	34	34	34	34	22	35	36	37
634.45	34	34	34	34	34	34	21	35	35	36
634.75	32	33	32	33	32	33	21	33	34	35
635.05	32	33	32	32	32	33	21	33	34	35
635.40	30	32	30	32	30	32	21	31	33	34
635.75	30	32	30	32	30	32	21	31	32	33
636.05	30	32	30	32	30	32	20	31	33	34

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	1	1	1	1	1	1	0	1	1	1
597.55	0	0	0	0	0	0	0	0	0	0
597.85	1	1	1	1	1	1	0	1	1	1
598.15	1	1	1	1	1	1	0	1	1	1
598.45	1	1	1	1	1	1	0	1	1	1
598.75	2	2	2	2	2	2	0	2	2	2
599.05	1	1	1	1	1	1	0	1	1	1
599.35	1	1	1	1	1	1	0	1	1	1
599.65	1	1	1	1	1	1	0	1	1	1
599.95	1	1	1	1	1	1	0	1	1	1
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	1	1	1	1	1	1	0	1	1	1
602.35	1	1	1	1	1	1	0	1	1	1
602.70	1	1	1	1	1	1	0	1	1	1
603.05	8	8	8	8	8	8	2	8	8	8
603.40	5	5	5	5	5	5	1	5	5	5
603.75	11	11	11	11	11	11	7	11	11	11
604.81	19	21	20	20	20	21	17	20	23	23
605.80	23	26	23	24	24	26	21	24	27	28
606.05	27	29	27	28	27	29	24	28	30	30
606.30	29	31	29	30	29	31	27	30	33	33
606.50	30	32	30	31	30	32	27	31	33	33

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
606.75	32	34	32	33	32	34	29	33	35	35
607.05	39	41	39	40	39	41	36	39	42	42
607.55	39	41	39	40	39	41	36	39	43	43
608.10	40	42	40	41	40	41	39	40	45	45
608.50	46	47	46	46	46	46	37	46	48	48
608.85	46	46	46	46	46	46	37	46	48	48
609.15	46	46	46	46	46	46	37	46	48	48
609.45	46	47	46	46	46	46	37	46	48	48
609.80	45	47	45	45	45	47	38	45	49	49
610.10	44	48	44	47	45	47	38	45	49	49
610.40	47	51	47	49	47	51	38	47	52	52
610.85	51	51	51	51	51	51	37	51	52	52
611.30	49	51	49	50	49	50	37	49	52	52
611.65	51	51	51	51	51	51	37	51	52	52
611.95	50	51	50	51	50	51	37	50	52	52
612.30	50	51	50	51	50	51	37	50	52	52
612.60	50	51	50	51	50	51	36	50	52	52
612.80	49	51	49	50	49	51	36	49	52	52
613.05	48	50	48	49	48	50	36	48	51	51
613.30	49	50	49	49	49	50	36	49	51	51
613.55	49	50	49	49	49	49	36	49	51	51
613.80	49	49	49	49	49	49	36	49	51	51
614.00	50	51	50	50	50	50	38	50	52	52
614.30	50	51	50	50	50	50	39	50	52	52
614.65	50	50	50	50	50	50	38	50	52	52
614.95	53	53	53	53	53	53	34	53	53	53
615.20	54	55	54	54	54	54	41	54	58	58
615.45	54	57	54	54	54	55	43	54	59	59
615.75	54	57	54	54	54	55	43	54	59	59
616.05	54	55	54	54	54	54	43	54	60	60
616.35	54	55	54	54	54	54	43	54	60	60
616.65	54	55	54	55	54	55	44	54	59	60
616.90	54	55	54	55	54	55	42	54	57	59
617.10	54	55	54	55	54	55	40	54	57	59
617.40	54	55	54	55	54	55	40	54	56	57
617.75	54	56	54	55	54	55	41	54	58	59
618.05	54	56	54	55	54	55	42	54	59	59
618.35	54	56	54	54	54	55	42	54	59	59
618.60	54	56	54	54	54	55	42	54	59	59
618.85	53	56	53	54	53	55	42	53	59	59
619.10	53	56	53	53	53	55	42	53	58	58
619.35	55	60	55	55	55	57	50	55	62	62
619.65	56	61	56	56	56	58	50	56	63	63
619.95	56	61	56	56	56	58	51	56	63	64
620.25	55	61	55	56	55	58	51	55	64	64
620.55	56	62	56	56	56	58	52	56	66	66
620.85	56	61	56	56	56	59	49	56	65	65
621.10	56	61	56	56	56	58	49	56	65	65
621.35	56	62	56	57	56	58	49	56	65	65
621.70	56	61	56	57	56	57	48	56	65	65

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
622.00	55	58	55	56	55	56	44	55	60	60
622.25	56	60	56	56	56	56	46	56	63	63
622.55	57	62	57	57	57	59	50	57	65	65
622.85	56	61	56	56	56	57	47	56	63	63
623.15	56	60	56	56	56	57	45	56	63	63
623.45	55	59	56	56	56	57	43	56	62	62
623.75	53	59	53	56	53	57	43	53	62	62
624.05	53	58	53	56	53	57	43	53	61	61
624.35	53	57	53	56	53	57	43	53	61	61
624.65	53	58	53	55	53	57	42	53	60	60
624.95	53	58	53	55	53	58	42	53	61	61
625.25	52	58	52	57	52	58	43	52	62	63
625.60	53	58	53	55	53	57	42	53	62	62
625.90	53	58	53	55	53	58	42	53	64	64
626.15	54	62	54	56	54	59	43	54	63	64
626.50	54	62	54	55	54	59	42	54	63	63
626.85	54	62	54	55	55	60	42	55	63	63
627.10	53	60	53	55	53	58	41	53	63	64
627.35	51	59	51	54	51	56	41	51	64	64
627.70	52	59	52	54	52	55	41	52	64	64
628.00	51	58	51	53	51	55	41	51	63	63
628.25	52	59	52	54	52	56	41	52	62	62
628.55	52	58	52	54	52	57	39	52	61	61
628.85	52	57	52	55	52	57	39	52	61	61
629.10	52	57	52	54	52	56	38	52	61	61
629.40	52	57	52	54	52	55	38	52	61	61
629.75	51	57	51	53	51	56	37	51	61	61
630.05	51	57	51	53	51	55	37	51	60	60
630.35	51	55	51	53	51	55	38	51	60	60
630.70	50	56	50	53	50	56	39	50	60	60
631.00	51	56	51	53	51	56	39	51	60	60
631.25	49	55	49	51	49	54	38	49	57	58
631.55	49	54	49	50	49	53	38	49	56	57
631.85	49	54	49	50	49	53	38	49	55	56
632.10	49	54	49	49	49	53	37	49	55	55
632.35	49	53	49	49	49	51	37	49	55	55
632.70	48	52	48	48	48	50	37	48	54	54
633.00	48	50	48	48	48	49	37	48	54	54
633.25	48	50	48	48	48	49	36	48	53	53
633.55	48	49	48	48	48	49	36	48	52	52
633.85	48	49	48	48	48	49	35	48	52	52
634.15	48	49	48	48	48	48	34	48	52	52
634.45	48	49	48	48	48	48	34	48	51	51
634.75	49	49	49	49	49	49	33	49	52	52
635.05	48	48	48	48	48	48	33	48	50	50
635.40	48	48	48	48	48	48	34	48	48	48
635.75	48	48	48	48	48	48	34	48	48	48
636.05	47	48	47	48	47	48	34	47	48	48

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	2	2	2	2	2	2	0	2	2	2
597.55	2	2	2	2	2	2	0	2	2	2
597.85	2	2	2	2	2	2	0	2	2	2
598.15	2	2	2	2	2	2	0	2	2	2
598.45	2	2	2	2	2	2	0	2	2	2
598.75	2	2	2	2	2	2	0	2	2	2
599.05	2	2	2	2	2	2	0	2	2	2
599.35	2	2	2	2	2	2	0	2	2	2
599.65	2	2	2	2	2	2	0	2	2	2
599.95	2	2	2	2	2	2	0	2	2	2
600.25	2	2	2	2	2	2	0	2	2	2
600.60	2	2	2	2	2	2	0	2	2	2
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	1	1	1	1	1	1	0	1	1	1
602.35	1	1	1	1	1	1	0	1	1	1
602.70	1	1	1	1	1	1	0	1	1	1
603.05	5	5	5	5	5	5	2	5	6	6
603.40	5	5	5	5	5	5	1	5	5	5
603.75	10	10	10	10	10	10	6	10	13	13
604.81	21	25	21	22	21	24	19	21	27	29
605.80	33	36	33	34	33	36	31	33	38	40
606.05	32	34	32	33	32	34	30	32	37	39
606.30	33	35	33	34	33	35	31	33	38	40
606.50	33	35	33	34	33	35	31	33	38	40

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
606.75	33	35	33	34	33	35	31	33	37	38
607.05	45	46	45	45	45	46	39	45	48	48
607.55	44	45	44	44	44	45	39	44	47	47
608.10	44	47	45	46	45	46	40	45	48	48
608.50	45	48	45	47	45	48	38	45	49	49
608.85	46	49	46	47	46	49	38	46	50	50
609.15	46	49	46	47	46	48	38	46	50	50
609.45	46	49	46	47	46	48	38	46	50	50
609.80	46	49	46	47	46	47	38	46	51	51
610.10	45	47	45	47	45	47	38	45	49	50
610.40	48	50	48	50	48	50	38	48	51	51
610.85	50	52	50	51	50	51	38	50	54	54
611.30	49	51	49	50	49	51	38	49	54	54
611.65	50	53	51	50	51	51	38	51	53	54
611.95	51	54	51	52	51	54	38	51	54	54
612.30	52	54	52	53	52	54	38	52	55	56
612.60	52	54	52	53	52	54	39	52	54	56
612.80	52	54	52	53	52	54	38	52	54	55
613.05	53	54	53	53	53	54	38	53	54	54
613.30	53	54	53	53	53	53	38	53	54	55
613.55	55	56	55	55	55	55	39	55	56	56
613.80	55	56	55	55	55	55	37	55	56	56
614.00	56	58	56	56	56	56	40	56	58	58
614.30	55	57	55	56	55	57	42	55	60	60
614.65	55	57	55	56	55	57	40	55	58	58
614.95	56	57	56	57	56	57	37	56	58	58
615.20	57	62	57	59	57	59	46	57	65	65
615.45	58	62	58	60	58	60	49	58	66	66
615.75	58	61	58	60	58	60	49	58	66	66
616.05	58	61	58	60	58	60	47	58	62	62
616.35	57	60	57	59	57	59	46	57	61	61
616.65	58	61	58	60	58	60	45	58	64	64
616.90	58	61	58	59	58	60	45	58	63	63
617.10	58	60	58	59	58	60	46	58	63	63
617.40	58	60	58	59	58	60	47	58	63	63
617.75	59	63	59	60	59	60	49	59	65	65
618.05	59	62	59	60	59	60	50	59	66	66
618.35	58	61	58	59	58	59	50	58	65	65
618.60	58	62	58	59	58	59	50	58	65	65
618.85	58	61	58	59	58	59	50	58	64	64
619.10	56	61	56	59	56	59	50	56	64	64
619.35	57	66	57	58	57	62	57	57	68	68
619.65	57	63	57	59	57	61	54	57	67	67
619.95	56	64	56	58	56	61	56	56	68	68
620.25	56	64	56	58	56	61	55	56	68	68
620.55	55	64	55	57	55	60	56	55	66	66
620.85	56	65	56	58	56	61	57	56	68	68
621.10	56	65	56	58	56	61	58	56	67	67
621.35	57	66	57	58	57	61	58	57	66	67
621.70	57	66	57	57	57	61	58	57	68	68

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
622.00	57	64	57	58	57	62	57	57	69	69
622.25	57	67	57	60	57	62	58	57	69	69
622.55	58	67	58	60	58	66	58	58	69	69
622.85	58	67	58	60	58	66	58	58	69	69
623.15	58	67	58	60	58	65	57	58	69	69
623.45	58	68	58	59	58	65	56	58	70	70
623.75	58	69	58	60	58	65	58	58	71	71
624.05	58	69	58	59	58	66	58	58	71	71
624.35	58	70	58	60	58	67	58	58	71	71
624.65	59	70	60	62	60	66	58	60	73	73
624.95	60	71	61	63	61	67	58	61	73	73
625.25	61	73	61	64	62	67	57	62	73	73
625.60	58	71	58	62	58	66	57	59	72	72
625.90	58	70	58	62	58	65	57	59	72	72
626.15	59	72	59	65	59	70	58	60	73	73
626.50	59	73	59	65	59	69	58	60	73	73
626.85	60	73	60	65	60	70	59	61	73	73
627.10	59	72	59	63	59	67	58	60	73	73
627.35	57	70	57	60	57	66	56	58	72	72
627.70	59	72	59	63	59	67	58	59	73	73
628.00	56	68	56	60	56	65	55	56	72	72
628.25	56	68	56	58	56	65	55	56	73	73
628.55	56	67	56	57	56	65	55	56	72	72
628.85	54	66	54	57	54	63	55	54	72	72
629.10	53	65	53	56	53	61	51	53	68	68
629.40	52	64	52	56	52	60	51	52	67	67
629.75	51	63	51	56	51	61	52	51	67	67
630.05	52	64	52	57	52	60	52	52	67	67
630.35	52	63	52	57	52	60	53	52	65	65
630.70	52	62	52	57	52	60	51	52	66	66
631.00	54	63	54	58	54	61	52	54	67	67
631.25	54	62	54	56	54	61	51	54	65	65
631.55	53	63	53	55	53	61	51	53	64	64
631.85	54	64	54	56	54	63	50	54	65	65
632.10	53	64	53	56	53	62	50	53	65	65
632.35	52	63	52	54	52	60	50	52	64	64
632.70	51	60	51	53	51	57	46	51	62	62
633.00	52	61	52	55	52	58	47	52	63	63
633.25	51	58	51	54	51	57	45	51	61	61
633.55	51	58	51	54	51	58	45	51	62	62
633.85	52	58	52	55	52	58	44	52	62	62
634.15	52	58	52	55	52	58	45	52	62	63
634.45	52	59	52	54	52	58	45	52	63	63
634.75	52	58	52	54	52	55	45	52	61	61
635.05	51	57	51	53	51	54	43	51	60	60
635.40	51	57	51	53	51	53	42	51	59	59
635.75	50	57	50	52	50	53	41	50	59	59
636.05	50	55	50	52	50	53	41	50	58	58

Appendix L. Days of Exceedance of Fecal Coliform Criterion In Center Channel of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	10	10	10	10	10	10	0	10	10	10
596.65	9	9	9	9	9	9	0	9	9	9
596.95	9	9	9	9	9	9	0	9	9	9
597.25	8	8	8	8	8	8	0	8	8	8
597.55	8	8	8	8	8	8	0	8	8	8
597.85	8	8	8	8	8	8	0	8	8	8
598.15	8	8	8	8	8	8	0	8	8	8
598.45	8	8	8	8	8	8	0	8	8	8
598.75	7	7	7	7	7	7	0	7	7	7
599.05	7	7	7	7	7	7	0	7	7	7
599.35	7	7	7	7	7	7	0	7	7	7
599.65	6	6	6	6	6	6	0	6	6	6
599.95	6	6	6	6	6	6	0	6	6	6
600.25	6	6	6	6	6	6	0	6	6	6
600.60	5	5	5	5	5	5	0	5	5	5
600.90	5	5	5	5	5	5	0	5	5	5
601.15	5	5	5	5	5	5	4	9	5	9
601.45	6	6	6	6	6	6	1	7	6	7
601.75	6	6	6	6	6	6	0	6	6	6
602.05	4	4	4	4	4	4	0	4	4	4
602.35	5	5	5	5	8	5	8	12	5	12
602.70	5	5	5	5	5	5	6	10	5	10
603.05	5	5	10	5	13	5	17	21	5	21
603.40	5	5	20	5	26	5	25	29	5	29
603.75	4	4	17	4	21	4	25	28	4	28
604.30	14	15	14	15	15	15	15	19	18	22
604.51	14	15	14	15	14	15	15	19	18	22
604.85	14	15	14	15	14	15	15	18	17	20
605.09	14	15	14	14	14	15	15	18	16	20
605.29	13	15	13	14	13	15	15	17	16	21

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
605.55	13	15	13	14	13	14	14	17	15	21
605.80	33	36	34	35	34	36	32	35	40	42
606.05	31	35	36	33	37	34	32	37	36	41
606.30	68	70	70	70	70	70	33	70	70	73
606.50	67	69	69	69	69	69	33	69	69	72
606.75	66	69	68	69	68	69	33	68	70	73
607.05	65	68	67	67	67	67	32	67	69	72
607.55	65	67	67	67	67	67	32	68	69	71
608.10	66	68	68	67	68	67	32	68	69	71
608.50	79	81	80	81	80	81	48	80	82	84
608.85	74	78	75	77	75	78	47	75	78	79
609.15	74	78	75	77	75	77	47	75	78	79
609.45	82	85	83	85	83	85	48	83	86	87
609.80	77	81	78	80	78	81	48	78	82	83
610.10	76	79	77	77	77	79	49	77	79	80
610.40	76	79	77	77	77	79	49	77	79	80
610.85	74	78	75	75	75	77	49	76	78	80
611.30	74	76	74	75	74	76	49	75	78	79
611.65	73	75	73	74	73	75	49	74	75	77
611.95	71	75	72	74	72	75	47	73	75	76
612.30	70	74	70	72	70	74	48	71	74	75
612.60	69	72	70	71	70	73	48	71	73	75
612.80	69	72	69	71	68	73	48	69	73	74
613.05	68	72	68	70	68	73	47	69	73	74
613.30	68	72	68	69	68	72	46	69	73	74
613.55	68	72	68	69	68	71	46	69	73	74
613.80	67	71	67	68	67	70	46	68	72	73
614.00	66	70	66	67	66	68	45	66	71	73
614.30	66	70	66	67	66	67	45	66	71	71
614.65	66	70	66	67	66	67	45	66	71	71
614.95	66	68	66	67	66	68	45	66	71	71
615.20	64	67	64	66	64	67	45	64	71	71
615.45	64	67	64	67	64	67	44	64	70	70
615.75	63	66	63	65	63	66	43	63	69	69
616.05	64	66	64	65	64	66	43	64	69	69
616.35	64	66	64	65	64	66	43	64	69	69
616.65	64	66	64	65	64	65	43	64	68	68
616.90	64	65	64	64	64	65	43	64	68	68
617.10	64	65	64	64	64	65	43	64	69	69
617.40	64	65	64	64	64	65	44	64	68	68
617.75	63	65	63	63	63	64	43	63	66	66
618.05	63	65	63	63	63	65	43	63	66	66
618.35	63	65	63	64	63	65	43	63	66	66
618.60	63	65	63	64	63	65	43	63	66	66
618.85	64	65	64	64	64	65	43	64	67	67
619.10	64	66	64	64	64	65	43	64	67	67
619.35	64	66	64	64	64	66	44	64	67	67
619.65	64	66	64	65	64	66	43	64	67	67
619.95	64	66	64	65	65	66	44	65	67	67
620.25	63	67	63	64	63	66	45	64	68	68

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
620.55	63	66	63	63	63	65	46	63	67	69
620.85	63	65	63	63	63	64	45	63	68	68
621.10	63	65	63	63	64	65	44	64	66	66
621.35	64	66	64	65	65	66	46	65	67	68
621.70	64	67	64	65	64	65	50	64	70	70
622.00	64	67	64	65	64	65	50	64	70	71
622.25	65	68	65	66	65	66	51	65	71	72
622.55	65	68	65	66	65	66	51	66	71	71
622.85	65	67	65	65	65	66	51	65	70	70
623.15	65	67	65	65	65	66	50	65	69	69
623.45	66	69	67	67	67	68	52	67	72	72
623.75	66	71	66	67	67	68	53	67	72	72
624.05	64	70	64	65	65	68	52	65	72	72
624.35	64	68	64	64	64	67	52	64	72	72
624.65	63	69	63	63	63	64	54	63	70	70
624.95	63	69	63	64	63	65	54	63	71	71
625.25	63	68	63	64	63	65	54	63	71	71
625.60	62	67	62	64	62	65	53	62	70	70
625.90	62	67	62	63	62	66	55	62	71	71
626.15	62	67	62	63	62	65	54	62	70	70
626.50	62	67	62	63	62	64	54	62	69	69
626.85	62	68	62	63	62	65	55	62	70	70
627.10	63	68	63	64	63	65	56	63	70	70
627.35	63	68	63	64	63	65	56	63	70	70
627.70	63	68	63	63	63	65	56	63	69	69
628.00	63	68	63	63	63	65	55	63	69	69
628.25	70	73	70	70	70	72	57	70	76	76
628.55	69	73	69	70	69	71	57	69	76	76
628.85	69	73	69	70	69	71	56	69	76	76
629.10	67	72	67	68	67	71	56	67	75	75
629.40	67	72	67	68	67	70	55	67	75	75
629.75	66	72	66	68	66	70	54	66	74	74
630.05	66	72	66	68	66	69	54	66	75	75
630.35	64	70	64	67	64	69	55	64	74	74
630.70	64	70	64	66	64	69	54	64	75	75
631.00	63	71	63	66	63	69	52	63	74	74
631.25	62	70	62	64	62	69	52	62	73	73
631.55	62	70	62	63	62	65	52	62	73	73
631.85	60	68	60	63	60	65	52	60	73	73
632.10	59	67	59	62	59	64	51	59	73	73
632.35	59	66	59	61	59	64	51	59	72	72
632.70	58	65	58	60	58	62	51	58	70	70
633.00	58	65	58	60	58	62	51	58	69	69
633.25	57	64	57	59	57	61	51	57	68	68
633.55	57	64	57	58	57	62	51	57	68	68
633.85	56	65	56	58	56	62	50	56	67	67
634.15	57	65	57	57	57	62	50	57	66	66
634.45	56	65	56	56	56	61	49	56	68	68
634.75	57	64	57	57	57	60	52	57	66	66
635.05	57	64	57	57	57	60	52	57	65	65

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
635.40	57	63	57	57	57	60	52	57	64	64
635.75	56	63	56	57	56	60	52	56	64	64
636.05	56	63	56	57	56	60	51	56	64	64

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	4	4	4	4	4	4	0	4	4	4
596.65	4	4	4	4	4	4	0	4	4	4
596.95	4	4	4	4	4	4	0	4	4	4
597.25	4	4	4	4	4	4	0	4	4	4
597.55	4	4	4	4	4	4	0	4	4	4
597.85	4	4	4	4	4	4	0	4	4	4
598.15	4	4	4	4	4	4	0	4	4	4
598.45	3	3	3	3	3	3	0	3	3	3
598.75	1	1	1	1	1	1	0	1	1	1
599.05	1	1	1	1	1	1	0	1	1	1
599.35	1	1	1	1	1	1	0	1	1	1
599.65	0	0	0	0	0	0	0	0	0	0
599.95	0	0	0	0	0	0	0	0	0	0
600.25	0	0	0	0	0	0	0	0	0	0
600.60	0	0	0	0	0	0	0	0	0	0
600.90	0	0	0	0	0	0	0	0	0	0
601.15	0	0	0	0	0	0	0	0	0	0
601.45	0	0	0	0	0	0	0	0	0	0
601.75	0	0	0	0	0	0	0	0	0	0
602.05	0	0	0	0	0	0	0	0	0	0
602.35	0	0	0	0	0	0	0	0	0	0
602.70	0	0	0	0	0	0	0	0	0	0
603.05	0	0	0	0	0	0	4	4	0	4
603.40	0	0	4	0	7	0	14	14	0	14
603.75	0	0	0	0	6	0	9	9	0	9
604.30	9	9	9	9	9	9	4	9	9	9
604.51	9	9	9	9	9	9	4	9	9	9
604.85	8	9	8	8	8	8	4	9	9	9
605.09	8	8	8	8	8	8	4	8	8	8
605.29	7	7	7	7	7	7	4	7	8	8

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
605.55	7	7	7	7	7	7	4	7	7	8
605.80	15	18	15	16	15	16	12	15	18	18
606.05	15	18	16	16	16	16	13	16	18	19
606.30	38	38	39	38	39	38	13	39	38	39
606.50	38	38	39	38	39	38	13	39	38	39
606.75	38	38	39	38	39	38	12	39	38	39
607.05	38	38	38	38	38	38	11	39	39	40
607.55	38	39	38	38	38	38	11	39	39	40
608.10	37	39	37	38	37	39	11	38	39	40
608.50	51	51	51	51	51	51	25	52	52	53
608.85	49	50	49	49	49	50	24	50	51	51
609.15	49	50	49	49	49	50	24	49	51	51
609.45	50	51	50	50	50	50	24	50	51	52
609.80	50	50	50	50	50	50	26	51	50	51
610.10	50	50	50	50	51	50	26	51	51	51
610.40	50	50	50	50	51	50	26	51	51	51
610.85	50	50	50	50	51	50	26	51	51	51
611.30	49	50	50	50	50	50	26	50	50	50
611.65	48	49	49	49	49	49	26	49	49	49
611.95	48	48	48	48	48	48	26	48	49	49
612.30	46	47	47	47	47	47	26	47	48	48
612.60	46	48	47	47	47	48	26	47	48	48
612.80	46	48	47	47	47	48	26	47	48	48
613.05	46	47	46	47	46	47	26	46	47	47
613.30	47	47	47	47	47	47	26	47	47	47
613.55	45	47	46	47	46	47	26	46	47	47
613.80	45	46	45	46	45	46	26	45	46	46
614.00	45	46	45	46	45	46	26	45	46	46
614.30	44	45	44	45	44	45	26	44	45	45
614.65	44	45	44	45	44	45	25	44	45	45
614.95	43	44	44	44	44	44	26	44	44	45
615.20	43	44	44	44	44	44	26	44	44	45
615.45	43	44	43	44	43	44	25	44	44	45
615.75	43	44	43	44	44	44	25	44	44	45
616.05	43	44	43	44	44	44	24	44	44	45
616.35	42	43	42	42	43	43	24	44	43	45
616.65	42	43	42	42	42	43	24	43	43	44
616.90	42	43	42	42	42	43	24	43	43	44
617.10	42	43	42	42	42	43	24	43	43	44
617.40	42	43	42	42	42	43	24	43	43	44
617.75	42	43	42	42	42	43	24	42	43	43
618.05	42	43	42	42	42	43	24	42	43	43
618.35	42	43	42	42	42	42	24	42	43	43
618.60	42	43	42	42	42	42	24	42	43	43
618.85	42	43	42	42	42	42	25	42	43	43
619.10	41	42	42	42	42	42	25	42	43	43
619.35	41	42	42	42	42	42	26	42	43	43
619.65	41	42	42	42	42	42	25	42	43	43
619.95	41	42	42	42	42	42	25	42	43	43
620.25	41	42	42	42	42	42	25	42	43	43

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
620.55	41	42	42	42	42	42	25	42	43	43
620.85	40	41	41	41	41	41	25	41	42	42
621.10	40	41	41	41	41	41	25	41	43	43
621.35	40	41	41	41	41	41	25	41	42	42
621.70	40	42	41	41	41	41	25	41	43	43
622.00	39	42	40	41	40	41	25	40	43	43
622.25	40	42	41	41	41	41	25	41	42	42
622.55	40	42	41	41	41	42	25	41	42	42
622.85	40	42	41	40	41	42	25	41	42	42
623.15	40	42	41	41	41	42	24	41	42	42
623.45	40	42	41	41	41	42	24	41	42	42
623.75	39	41	40	40	40	41	24	40	41	41
624.05	39	41	40	40	40	41	24	40	41	41
624.35	40	41	41	40	41	41	24	41	41	41
624.65	39	41	39	40	40	41	25	40	41	41
624.95	39	40	39	39	40	40	25	40	40	40
625.25	39	40	39	39	40	40	25	40	40	40
625.60	39	40	39	39	40	39	25	40	40	40
625.90	38	39	38	38	39	38	25	39	39	39
626.15	38	39	38	38	39	38	24	39	39	39
626.50	38	39	38	38	39	38	24	39	39	39
626.85	38	39	38	38	39	38	24	39	40	40
627.10	37	39	37	38	38	38	23	38	40	40
627.35	37	40	37	38	38	39	23	38	40	40
627.70	37	40	37	37	38	39	23	38	40	40
628.00	37	39	37	38	38	39	23	38	40	40
628.25	40	41	40	40	41	40	23	41	42	42
628.55	38	39	38	38	39	39	23	39	41	41
628.85	37	37	37	37	38	37	23	38	39	40
629.10	36	37	36	37	37	37	23	37	39	39
629.40	36	36	36	36	36	36	23	37	38	38
629.75	36	36	36	36	36	36	23	37	37	37
630.05	36	36	36	36	36	36	23	37	37	37
630.35	36	36	36	36	36	36	23	37	37	37
630.70	36	36	36	36	36	36	23	37	37	37
631.00	35	36	35	36	35	36	23	36	36	37
631.25	35	36	35	36	35	36	23	36	36	37
631.55	35	36	35	36	35	36	23	36	36	37
631.85	35	36	35	36	35	36	23	36	36	37
632.10	35	36	35	35	35	36	22	36	36	37
632.35	35	36	35	35	35	36	22	36	36	37
632.70	35	36	35	35	35	36	22	36	36	37
633.00	35	36	35	35	35	35	22	36	36	37
633.25	35	36	35	35	35	35	22	36	36	37
633.55	35	36	35	35	35	35	21	36	36	37
633.85	34	35	34	35	34	35	21	35	36	37
634.15	33	34	33	33	33	34	21	34	35	36
634.45	33	33	33	33	33	33	20	34	35	36
634.75	32	33	32	33	32	33	20	33	34	35
635.05	32	33	32	32	32	33	20	33	33	34

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (2,000 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
635.40	31	32	31	32	31	32	20	32	33	34
635.75	31	32	31	32	31	32	21	32	32	33
636.05	31	32	31	31	31	32	20	32	33	34

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	8	8	8	8	8	8	0	8	8	8
596.65	7	7	7	7	7	7	0	7	7	7
596.95	6	6	6	6	6	6	0	6	6	6
597.25	6	6	6	6	6	6	0	6	6	6
597.55	6	6	6	6	6	6	0	6	6	6
597.85	6	6	6	6	6	6	0	6	6	6
598.15	6	6	6	6	6	6	0	6	6	6
598.45	5	5	5	5	5	5	0	5	5	5
598.75	4	4	4	4	4	4	0	4	4	4
599.05	4	4	4	4	4	4	0	4	4	4
599.35	4	4	4	4	4	4	0	4	4	4
599.65	4	4	4	4	4	4	0	4	4	4
599.95	4	4	4	4	4	4	0	4	4	4
600.25	4	4	4	4	4	4	0	4	4	4
600.60	4	4	4	4	4	4	0	4	4	4
600.90	4	4	4	4	4	4	0	4	4	4
601.15	3	3	4	3	4	3	0	4	3	4
601.45	2	2	2	2	2	2	0	2	2	2
601.75	2	2	2	2	2	2	0	2	2	2
602.05	2	2	2	2	2	2	0	2	2	2
602.35	2	2	2	2	2	2	0	2	2	2
602.70	2	2	2	2	2	2	0	2	2	2
603.05	2	2	2	2	2	2	1	4	2	4
603.40	2	2	4	2	9	2	8	10	2	10
603.75	2	2	3	2	8	2	7	9	2	9
604.30	9	9	9	9	9	9	6	10	9	11
604.51	9	9	9	9	9	9	6	10	9	11
604.85	8	9	8	9	8	9	6	9	9	10
605.09	8	9	8	8	8	8	6	8	9	10
605.29	8	8	8	8	8	8	6	8	9	10

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
605.55	8	8	8	8	8	8	6	8	9	10
605.80	19	22	19	19	19	19	14	19	22	22
606.05	18	20	19	18	19	18	15	20	21	22
606.30	49	50	49	49	49	50	15	50	50	52
606.50	50	53	50	51	50	52	16	51	53	55
606.75	48	50	48	49	48	50	15	49	50	51
607.05	50	52	50	51	50	52	15	51	53	54
607.55	48	50	48	49	48	50	15	49	50	51
608.10	50	52	50	51	50	52	15	51	52	53
608.50	63	64	63	63	63	63	33	63	64	66
608.85	63	64	63	63	63	63	33	63	64	65
609.15	63	64	63	63	63	63	33	63	64	65
609.45	65	66	65	66	65	66	33	65	67	67
609.80	64	66	64	65	64	66	33	64	67	67
610.10	64	65	64	64	64	65	33	64	66	66
610.40	64	65	64	64	64	65	33	64	66	66
610.85	63	64	63	63	63	64	33	63	65	65
611.30	58	59	58	58	58	58	33	58	62	62
611.65	58	59	58	59	58	59	34	58	62	62
611.95	57	58	57	57	57	57	34	57	62	62
612.30	57	58	57	57	57	58	34	57	60	61
612.60	57	58	57	58	57	58	34	57	60	61
612.80	57	58	57	58	57	58	34	57	60	61
613.05	57	58	57	57	57	58	34	57	59	60
613.30	57	58	57	58	57	58	34	57	59	59
613.55	57	58	57	58	57	58	33	57	59	59
613.80	56	58	56	57	56	58	33	56	59	59
614.00	56	57	56	56	56	56	33	56	57	57
614.30	56	56	56	56	56	56	33	56	57	57
614.65	55	56	55	56	56	56	32	56	56	56
614.95	54	55	54	54	54	55	32	54	56	56
615.20	54	55	54	55	54	55	32	54	55	55
615.45	55	55	55	55	55	55	32	55	55	55
615.75	55	55	55	55	55	55	32	55	55	55
616.05	55	55	55	55	55	55	32	55	55	55
616.35	54	55	54	55	54	55	33	54	55	55
616.65	54	55	54	55	54	55	33	54	55	55
616.90	54	55	54	55	54	55	34	54	55	55
617.10	54	55	54	54	54	55	34	54	55	55
617.40	54	55	54	54	54	55	34	54	56	56
617.75	54	55	54	54	54	54	34	54	56	56
618.05	54	56	54	54	54	54	35	54	56	56
618.35	54	55	54	54	54	55	35	54	56	56
618.60	54	55	54	55	54	55	35	54	56	56
618.85	54	55	54	54	54	55	35	54	56	56
619.10	54	55	54	55	54	55	35	54	55	56
619.35	54	55	54	55	54	55	34	54	55	55
619.65	55	55	55	55	55	55	34	55	55	55
619.95	54	55	54	55	54	55	34	55	55	55
620.25	54	54	54	54	54	54	33	54	54	55

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
620.55	54	54	54	54	54	54	33	54	54	54
620.85	54	54	54	54	54	54	33	54	54	54
621.10	54	54	54	54	54	54	33	54	54	54
621.35	54	54	54	54	54	54	33	54	54	54
621.70	53	55	53	54	53	55	36	53	55	55
622.00	53	55	53	53	53	55	34	53	55	55
622.25	53	55	53	54	53	55	35	53	55	55
622.55	53	55	53	54	53	54	34	53	55	55
622.85	53	54	53	53	53	54	34	53	55	55
623.15	52	54	52	53	52	54	34	52	55	55
623.45	52	54	52	53	52	53	35	52	55	55
623.75	52	53	52	53	52	53	35	52	55	55
624.05	51	52	51	52	51	52	34	51	54	54
624.35	50	52	50	52	50	52	34	50	54	54
624.65	51	53	51	51	51	52	35	51	54	54
624.95	51	54	51	51	51	53	35	51	54	54
625.25	51	54	51	52	51	53	35	51	55	55
625.60	51	54	51	52	51	53	35	51	55	55
625.90	52	55	52	52	52	53	35	52	56	56
626.15	51	53	51	51	51	51	35	51	56	56
626.50	50	55	50	51	50	52	35	50	55	55
626.85	50	53	50	52	50	52	34	50	55	55
627.10	50	53	51	52	51	52	34	51	55	55
627.35	50	53	50	52	50	53	34	50	55	55
627.70	50	53	50	51	50	53	34	50	54	54
628.00	50	54	50	51	50	53	34	50	54	54
628.25	54	57	54	54	54	57	35	54	57	57
628.55	54	57	54	54	54	56	35	54	57	57
628.85	54	57	54	54	54	56	35	54	57	57
629.10	52	56	52	53	52	56	35	52	57	57
629.40	52	56	52	53	52	56	35	52	57	57
629.75	50	56	50	53	50	54	35	50	57	57
630.05	50	55	50	52	50	54	34	50	56	56
630.35	49	54	49	50	49	52	34	49	54	54
630.70	49	52	49	50	49	51	34	49	54	54
631.00	49	51	49	49	49	51	34	49	52	52
631.25	48	51	48	49	48	51	34	48	52	52
631.55	48	51	48	48	48	51	35	48	52	52
631.85	48	51	48	48	48	51	34	48	52	52
632.10	49	52	49	49	49	51	35	49	53	53
632.35	49	52	49	49	49	51	35	49	54	54
632.70	49	52	49	49	49	51	36	49	54	54
633.00	48	52	48	50	48	50	35	48	52	52
633.25	48	51	48	50	48	50	34	48	52	52
633.55	49	51	49	49	49	50	34	49	52	52
633.85	49	50	49	49	49	50	34	49	52	52
634.15	48	50	48	49	48	49	33	48	52	52
634.45	48	48	48	48	48	48	33	48	51	51
634.75	48	48	48	48	48	48	33	48	50	50
635.05	48	48	48	48	48	48	33	48	49	49

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
635.40	47	48	47	48	47	48	33	47	48	48
635.75	47	48	47	48	47	48	33	47	48	48
636.05	46	48	46	47	46	48	34	46	48	48

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	8	8	8	8	8	8	0	8	8	8
596.65	8	8	8	8	8	8	0	8	8	8
596.95	6	6	6	6	6	6	0	6	6	6
597.25	6	6	6	6	6	6	0	6	6	6
597.55	6	6	6	6	6	6	0	6	6	6
597.85	6	6	6	6	6	6	0	6	6	6
598.15	6	6	6	6	6	6	0	6	6	6
598.45	5	5	5	5	5	5	0	5	5	5
598.75	5	5	5	5	5	5	0	5	5	5
599.05	4	4	4	4	4	4	0	4	4	4
599.35	4	4	4	4	4	4	0	4	4	4
599.65	4	4	4	4	4	4	0	4	4	4
599.95	4	4	4	4	4	4	0	4	4	4
600.25	4	4	4	4	4	4	0	4	4	4
600.60	4	4	4	4	4	4	0	4	4	4
600.90	4	4	4	4	4	4	0	4	4	4
601.15	3	3	3	3	3	3	1	4	3	4
601.45	4	4	4	4	4	4	0	4	4	4
601.75	4	4	4	4	4	4	0	4	4	4
602.05	3	3	3	3	3	3	0	3	3	3
602.35	4	4	4	4	5	4	4	9	4	9
602.70	3	3	3	3	3	3	2	6	3	6
603.05	3	3	4	3	6	3	7	11	3	11
603.40	3	3	13	3	13	3	13	16	3	16
603.75	3	3	7	3	11	3	12	15	3	15
604.30	10	10	10	10	10	10	8	12	10	12
604.51	10	10	10	10	10	10	8	12	10	12
604.85	10	10	10	10	10	10	8	12	10	12
605.09	10	10	10	10	10	10	8	12	10	13
605.29	9	10	9	10	9	10	8	11	10	13

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
605.55	9	10	9	10	9	10	8	11	10	13
605.80	24	28	25	25	25	28	24	26	29	31
606.05	22	26	28	23	29	24	25	29	26	32
606.30	59	60	61	59	61	59	28	61	60	63
606.50	58	58	61	58	61	58	28	61	59	63
606.75	56	57	58	56	58	57	26	58	58	61
607.05	54	54	56	54	56	54	26	56	54	58
607.55	55	55	57	55	57	55	24	57	55	57
608.10	53	53	55	53	55	53	23	55	53	55
608.50	64	64	65	64	65	64	38	65	64	65
608.85	64	64	65	64	65	64	38	65	64	65
609.15	63	63	64	63	64	63	38	64	63	64
609.45	65	65	66	65	66	65	38	66	65	66
609.80	64	64	65	64	65	64	38	65	64	65
610.10	65	65	66	65	66	65	39	66	65	66
610.40	65	65	66	65	66	65	39	66	65	66
610.85	64	65	65	65	65	65	38	65	65	66
611.30	61	63	61	63	61	63	39	62	63	64
611.65	61	63	61	63	61	63	39	62	63	64
611.95	61	63	61	63	61	63	39	62	63	64
612.30	61	63	61	62	61	63	39	62	63	64
612.60	61	63	61	62	61	63	39	62	63	64
612.80	61	63	61	62	61	63	39	62	63	64
613.05	61	63	61	62	61	63	37	62	63	64
613.30	61	63	61	61	61	63	37	62	63	64
613.55	61	63	61	61	61	63	36	61	63	63
613.80	61	63	61	61	61	63	36	61	63	63
614.00	59	63	59	60	59	62	36	59	63	63
614.30	58	63	58	60	58	61	36	58	63	63
614.65	58	62	58	60	58	61	36	58	63	63
614.95	58	59	58	59	58	59	36	58	62	62
615.20	58	59	58	59	58	59	36	58	62	62
615.45	58	59	58	59	58	59	35	58	62	62
615.75	58	59	58	59	58	59	36	58	63	63
616.05	58	59	58	59	58	59	36	58	63	63
616.35	58	60	58	59	58	60	37	58	62	62
616.65	58	60	58	59	58	60	36	58	63	63
616.90	58	60	58	59	58	60	36	58	63	63
617.10	58	60	58	59	58	60	37	58	63	63
617.40	57	59	57	58	58	59	37	58	61	61
617.75	57	58	57	57	57	57	37	57	60	61
618.05	57	57	57	57	57	57	37	57	60	60
618.35	57	57	57	57	57	57	38	57	60	60
618.60	57	57	57	57	57	57	38	57	60	60
618.85	57	57	57	57	57	57	38	57	59	59
619.10	56	57	56	57	56	57	37	56	59	59
619.35	56	57	56	56	56	57	37	56	59	59
619.65	56	56	56	56	56	56	37	56	59	59
619.95	56	56	56	56	56	56	37	56	58	58
620.25	56	56	56	56	56	56	38	56	57	57

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
620.55	56	56	56	56	56	56	37	56	57	57
620.85	55	56	55	55	55	56	37	55	57	57
621.10	54	55	55	55	55	55	37	55	55	55
621.35	55	55	55	55	55	55	38	55	56	56
621.70	55	56	55	55	55	56	39	55	57	57
622.00	55	56	55	55	55	56	39	55	56	56
622.25	55	56	55	55	55	56	40	55	57	57
622.55	55	56	55	55	55	56	39	55	56	57
622.85	54	56	54	54	54	56	39	54	56	56
623.15	53	56	53	53	53	55	39	53	56	56
623.45	55	56	55	55	55	56	41	55	60	60
623.75	54	56	55	55	55	56	41	55	60	60
624.05	54	56	55	55	55	56	40	55	60	61
624.35	54	58	54	55	55	56	40	55	60	60
624.65	54	60	54	56	55	58	45	55	61	61
624.95	54	60	54	57	55	58	46	55	63	63
625.25	55	60	55	58	55	58	46	56	63	63
625.60	54	61	54	58	54	59	45	55	62	62
625.90	52	61	52	58	52	60	47	53	63	63
626.15	53	61	53	58	53	59	46	54	63	63
626.50	52	61	52	55	52	59	45	53	63	63
626.85	52	61	52	55	52	58	45	53	63	63
627.10	53	59	53	54	53	56	46	53	64	64
627.35	53	58	53	54	53	56	46	53	62	62
627.70	53	58	53	54	53	56	45	53	61	61
628.00	53	59	53	54	53	55	43	53	61	61
628.25	55	61	55	57	55	59	45	55	63	63
628.55	54	61	54	56	54	59	45	54	63	63
628.85	55	62	55	57	55	58	45	55	64	64
629.10	54	60	54	56	54	59	46	54	64	64
629.40	55	61	55	57	55	60	46	55	63	63
629.75	53	60	53	57	53	60	45	53	63	63
630.05	53	60	53	56	53	59	45	53	62	62
630.35	53	60	53	56	53	60	47	53	62	62
630.70	53	60	53	56	53	60	46	53	61	61
631.00	54	61	54	57	54	60	45	54	63	63
631.25	55	62	55	58	55	61	47	55	63	63
631.55	55	62	55	58	55	59	47	55	64	64
631.85	52	62	52	58	52	59	48	52	65	65
632.10	52	61	52	55	52	56	45	52	64	64
632.35	53	59	53	54	53	56	45	53	63	63
632.70	53	59	53	54	53	56	45	53	62	62
633.00	53	59	53	54	53	56	45	53	61	61
633.25	52	57	52	52	52	55	44	52	59	59
633.55	52	57	52	52	52	55	44	52	59	59
633.85	52	57	52	52	52	55	44	52	59	59
634.15	52	57	52	52	52	55	42	52	59	59
634.45	52	58	52	52	52	55	44	52	60	60
634.75	51	56	51	51	51	53	41	51	58	58
635.05	51	56	51	51	51	53	41	51	58	58

Appendix L. Days of Exceedance of Fecal Coliform Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (400 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
635.40	51	54	51	51	51	53	40	51	57	57
635.75	50	54	50	51	50	53	40	50	56	56
636.05	50	54	50	51	50	53	40	50	56	56

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	14	14	14	14	14	14	0	14	14	14
596.30	12	12	12	12	12	12	0	12	12	12
596.65	10	10	10	10	10	10	0	10	10	10
596.95	13	13	13	13	13	13	0	13	13	13
597.25	11	11	11	11	11	11	0	11	11	11
597.55	11	11	11	11	11	11	0	11	11	11
597.85	10	10	10	10	10	10	0	10	10	10
598.15	10	10	10	10	10	10	0	10	10	10
598.45	8	8	8	8	8	8	0	8	8	8
598.75	8	8	8	8	8	8	0	8	8	8
599.05	8	8	8	8	8	8	0	8	8	8
599.35	7	7	7	7	7	7	0	7	7	7
599.65	7	7	7	7	7	7	0	7	7	7
599.95	7	7	7	7	7	7	0	7	7	7
600.25	6	6	6	6	6	6	0	6	6	6
600.60	6	6	6	6	6	6	0	6	6	6
600.90	5	5	5	5	5	5	0	5	5	5
601.15	5	5	5	5	5	5	0	5	5	5
601.45	4	4	4	4	4	4	0	4	4	4
601.75	4	4	4	4	4	4	0	4	4	4
602.05	69	73	69	73	69	73	68	69	77	77
602.35	69	73	69	72	69	73	69	69	75	75
602.70	61	71	61	68	61	71	65	61	71	71
603.05	59	71	59	67	59	70	66	59	73	73
603.40	53	67	53	59	53	65	63	53	68	68
603.75	50	65	50	56	50	63	63	50	68	68
604.81	47	57	47	50	47	57	52	47	65	65
606.65	46	55	46	51	46	54	45	46	64	64
607.05	45	66	45	61	45	64	59	45	71	71
607.55	44	67	44	60	44	65	58	44	71	71
608.10	49	58	49	54	49	58	56	49	65	66

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
608.50	50	60	50	55	50	59	57	50	67	67
608.85	50	60	50	55	50	59	57	50	67	67
609.15	50	60	50	55	50	61	57	50	67	67
609.45	49	61	49	53	50	59	57	50	66	66
609.80	47	61	47	53	47	60	57	47	66	66
610.10	47	60	47	51	47	60	57	47	66	66
610.40	47	65	47	57	47	64	61	47	70	70
610.85	49	63	49	60	49	61	59	49	68	68
611.30	54	63	54	60	54	62	58	54	69	69
611.65	54	63	54	60	54	62	58	54	68	68
611.95	53	64	53	60	53	63	59	54	70	70
612.30	68	99	68	91	68	97	92	68	101	101
612.60	69	100	69	90	69	97	92	69	102	102
612.80	70	101	70	89	70	98	94	70	103	103
613.05	69	104	69	99	69	101	98	69	107	107
613.30	68	104	68	99	68	102	98	68	105	105
613.55	68	104	68	100	68	102	99	68	107	107
613.80	66	102	66	98	66	101	97	66	104	104
614.00	66	101	66	98	66	101	98	66	105	105
614.30	67	103	67	98	67	100	97	67	105	105
614.65	67	103	67	97	67	101	99	67	105	105
614.95	66	101	66	96	66	98	98	66	104	104
615.20	65	100	65	96	65	100	96	66	102	102
615.45	65	100	65	97	65	99	97	65	104	104
615.75	64	101	64	95	64	101	97	64	104	104
616.05	64	102	64	94	64	100	97	64	104	104
616.35	64	102	64	94	64	100	97	64	104	104
616.65	88	106	88	100	88	103	95	88	107	107
616.90	87	105	87	101	87	102	95	87	107	107
617.10	87	105	87	101	87	103	95	87	107	107
617.40	88	104	88	101	88	103	95	88	107	107
617.75	88	103	88	101	88	103	94	88	107	107
618.05	88	102	88	101	88	102	94	88	107	107
618.35	88	103	88	99	88	102	94	88	106	106
618.60	88	104	88	99	88	103	93	88	106	106
618.85	86	102	86	98	86	101	93	86	105	105
619.10	84	103	84	98	84	101	91	84	104	104
619.35	83	101	83	96	83	100	91	83	103	103
619.65	83	103	83	96	83	100	91	83	103	103
619.95	83	102	83	96	83	101	90	83	103	103
620.25	83	102	83	97	83	101	90	83	103	103
620.55	83	102	83	97	83	101	89	83	103	103
620.85	82	100	82	96	82	99	87	82	102	102
621.10	82	100	82	96	82	99	85	82	101	101
621.35	81	99	81	96	81	98	84	81	100	100
621.70	77	96	77	88	77	94	84	78	99	99
622.00	75	95	75	87	75	93	84	75	98	98
622.25	74	94	74	85	74	90	83	74	96	96
622.55	73	91	73	83	73	88	82	73	94	94
622.85	73	91	73	83	73	88	81	73	92	92

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
623.15	73	90	73	81	73	87	81	73	91	91
623.45	72	89	72	80	72	86	81	72	90	90
623.75	71	87	71	80	71	84	78	71	90	90
624.05	70	85	70	79	70	83	77	70	89	89
624.35	69	85	69	78	69	83	76	69	87	87
624.65	69	85	69	78	69	83	77	69	86	86
624.95	90	101	90	96	90	99	78	90	103	103
625.25	88	99	88	94	88	97	78	88	100	100
625.60	86	99	86	92	86	97	77	86	100	100
625.90	86	99	86	92	86	97	77	86	99	99
626.15	86	99	86	92	86	98	75	86	99	99
626.50	84	97	84	89	84	96	75	84	97	97
626.85	83	97	83	89	83	95	75	83	97	97
627.10	83	96	83	88	83	95	75	83	97	97
627.35	83	96	83	88	83	94	74	83	97	97
627.70	82	95	82	87	82	94	73	82	96	96
628.00	81	94	81	86	81	93	73	81	96	96
628.25	81	95	81	86	81	93	74	81	97	97
628.55	81	94	81	85	81	91	74	81	96	96
628.85	78	93	78	81	78	89	73	78	95	95
629.10	78	93	78	80	78	87	73	78	94	94
629.40	76	92	76	80	76	86	73	76	93	93
629.75	75	91	75	80	75	85	73	75	94	94
630.05	70	86	70	74	70	78	71	70	90	90
630.35	69	85	69	74	69	79	71	69	90	90
630.70	67	84	67	73	67	78	69	67	89	89
631.00	66	82	66	72	66	78	67	66	89	89
631.25	67	82	67	70	67	78	65	67	88	88
631.55	66	81	66	69	66	77	65	66	88	88
631.85	65	78	65	67	65	76	65	65	85	85
632.10	65	78	65	67	65	76	65	65	83	83
632.35	65	78	65	67	65	76	65	65	82	82
632.70	63	75	63	64	63	70	62	63	81	81
633.00	63	75	63	64	63	69	61	63	80	80
633.25	59	72	59	63	59	67	59	59	77	77
633.55	59	72	59	64	59	67	59	59	76	76
633.85	60	73	60	65	60	68	58	60	75	75
634.15	60	73	60	64	60	67	58	60	75	75
634.45	59	71	59	63	59	66	57	59	74	74
634.75	58	70	58	63	58	66	58	58	74	74
635.05	56	66	56	61	56	64	57	56	73	73
635.40	56	65	56	60	56	64	56	56	71	71
635.75	56	65	56	59	56	64	56	56	71	71
636.05	55	64	55	58	55	63	55	55	70	70

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	3	3	3	3	3	3	0	3	3	3
596.30	3	3	3	3	3	3	0	3	3	3
596.65	2	2	2	2	2	2	0	2	2	2
596.95	1	1	1	1	1	1	0	1	1	1
597.25	1	1	1	1	1	1	0	1	1	1
597.55	1	1	1	1	1	1	0	1	1	1
597.85	1	1	1	1	1	1	0	1	1	1
598.15	1	1	1	1	1	1	0	1	1	1
598.45	1	1	1	1	1	1	0	1	1	1
598.75	1	1	1	1	1	1	0	1	1	1
599.05	1	1	1	1	1	1	0	1	1	1
599.35	1	1	1	1	1	1	0	1	1	1
599.65	1	1	1	1	1	1	0	1	1	1
599.95	1	1	1	1	1	1	0	1	1	1
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	37	45	37	42	37	44	41	37	48	48
602.35	36	41	36	38	36	41	38	36	45	45
602.70	32	37	32	35	32	35	33	32	39	39
603.05	30	35	30	33	30	34	28	30	39	39
603.40	25	27	25	26	25	26	24	25	30	30
603.75	25	28	25	26	25	27	22	25	30	30
604.81	22	27	22	24	22	26	20	22	28	28
606.65	22	22	22	22	22	22	17	22	22	22
607.05	22	30	22	29	22	31	31	22	35	35
607.55	19	31	19	27	19	31	30	19	34	34
608.10	17	21	17	18	17	19	19	17	28	28

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
608.50	15	20	15	18	16	19	18	16	26	26
608.85	15	20	16	18	16	19	18	16	26	26
609.15	16	20	16	18	16	20	16	17	24	24
609.45	17	21	17	17	17	19	16	17	24	24
609.80	16	20	17	17	17	20	14	17	22	22
610.10	16	21	16	16	16	20	14	16	22	22
610.40	16	26	16	22	16	25	23	16	29	29
610.85	17	24	17	19	17	23	23	17	30	30
611.30	18	24	18	19	18	22	23	18	31	31
611.65	18	25	18	19	18	23	22	18	30	30
611.95	18	25	18	19	18	22	22	18	30	30
612.30	29	52	29	38	29	46	51	29	56	56
612.60	29	51	29	38	29	47	51	29	56	56
612.80	28	50	28	36	28	43	50	28	55	55
613.05	27	64	27	52	27	62	64	27	68	68
613.30	27	64	27	52	27	63	63	27	66	66
613.55	27	64	27	51	27	63	64	27	68	68
613.80	27	64	27	50	27	61	62	27	66	66
614.00	26	65	26	51	26	60	62	26	66	66
614.30	26	65	26	50	26	61	63	26	67	67
614.65	26	64	26	49	26	61	62	26	65	65
614.95	27	61	27	46	27	54	61	27	64	64
615.20	27	61	27	48	27	54	59	27	62	62
615.45	26	61	26	46	26	53	60	27	63	63
615.75	28	60	28	44	28	53	61	28	64	64
616.05	29	61	29	42	29	54	60	29	63	63
616.35	28	61	28	42	28	51	62	28	65	65
616.65	38	63	38	49	38	57	61	38	65	65
616.90	38	62	38	47	38	56	61	38	66	66
617.10	37	61	37	45	37	56	60	37	66	66
617.40	37	63	37	45	37	55	60	37	65	65
617.75	37	63	37	47	37	57	60	37	66	66
618.05	37	65	37	47	37	57	60	37	67	67
618.35	38	65	38	47	38	60	59	38	67	67
618.60	38	65	38	48	38	60	58	38	67	67
618.85	37	63	37	47	37	58	56	37	66	66
619.10	37	60	37	46	37	56	56	37	65	65
619.35	36	59	36	42	36	50	54	36	62	62
619.65	36	57	36	43	36	49	53	36	62	62
619.95	34	55	34	40	34	49	51	34	59	59
620.25	35	54	35	39	35	49	50	35	59	59
620.55	35	53	35	39	35	48	50	35	59	59
620.85	35	53	35	39	35	46	50	35	61	61
621.10	32	48	32	38	32	43	50	32	58	58
621.35	30	46	30	36	30	42	49	30	58	58
621.70	28	42	28	32	28	39	39	28	52	52
622.00	25	42	25	33	25	38	37	25	48	48
622.25	25	42	25	29	25	37	36	25	46	46
622.55	25	40	25	28	25	36	34	25	43	43
622.85	25	40	25	28	25	36	34	25	43	43

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
623.15	25	38	25	28	25	34	34	25	42	42
623.45	25	38	25	27	25	35	34	25	42	42
623.75	24	36	24	27	24	35	33	24	42	42
624.05	24	35	24	27	24	35	29	24	38	38
624.35	24	35	24	26	24	34	29	24	37	37
624.65	23	35	24	26	24	34	29	24	38	38
624.95	27	39	27	30	27	36	28	28	43	43
625.25	27	38	27	30	27	35	27	27	42	42
625.60	26	36	26	27	26	31	23	26	37	37
625.90	24	34	24	26	24	29	23	25	35	35
626.15	24	31	24	24	24	27	20	24	33	33
626.50	23	30	23	24	23	27	20	24	33	33
626.85	23	30	23	24	23	27	20	23	33	33
627.10	22	29	22	23	22	26	20	22	32	32
627.35	20	27	20	22	20	25	20	20	30	30
627.70	20	26	20	21	20	23	18	20	29	29
628.00	19	26	19	20	19	22	18	19	29	30
628.25	19	25	19	20	19	21	18	19	28	29
628.55	19	25	19	19	19	21	18	19	28	29
628.85	19	25	19	19	19	21	18	19	28	29
629.10	19	24	19	19	19	21	18	19	28	28
629.40	18	23	18	19	18	21	16	18	27	27
629.75	18	22	18	18	18	21	15	18	27	27
630.05	19	21	19	19	19	21	13	19	25	25
630.35	18	21	18	19	18	21	13	18	24	24
630.70	18	21	18	19	18	21	12	18	24	24
631.00	18	21	18	18	18	21	12	18	24	24
631.25	18	21	18	18	18	20	12	18	22	22
631.55	18	21	18	18	18	19	12	18	21	21
631.85	18	19	18	18	18	19	12	18	21	21
632.10	18	19	18	18	18	19	12	18	21	21
632.35	18	19	18	18	18	19	12	18	22	22
632.70	19	20	19	19	19	20	12	19	21	21
633.00	19	20	19	19	19	20	12	19	21	21
633.25	18	19	18	18	18	19	12	18	20	20
633.55	18	19	18	18	18	19	12	18	20	20
633.85	18	19	18	18	18	19	12	18	20	20
634.15	18	19	18	18	18	19	12	18	19	20
634.45	18	19	18	18	18	19	12	18	19	19
634.75	18	19	18	18	18	19	12	18	19	19
635.05	18	19	18	18	18	19	12	18	19	19
635.40	18	19	18	18	18	19	12	18	19	19
635.75	18	19	18	18	18	19	12	18	19	19
636.05	17	19	17	18	17	19	13	17	19	19

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	4	4	4	4	4	4	0	4	4	4
596.30	3	3	3	3	3	3	0	3	3	3
596.65	2	2	2	2	2	2	0	2	2	2
596.95	3	3	3	3	3	3	0	3	3	3
597.25	3	3	3	3	3	3	0	3	3	3
597.55	3	3	3	3	3	3	0	3	3	3
597.85	3	3	3	3	3	3	0	3	3	3
598.15	3	3	3	3	3	3	0	3	3	3
598.45	3	3	3	3	3	3	0	3	3	3
598.75	1	1	1	1	1	1	0	1	1	1
599.05	1	1	1	1	1	1	0	1	1	1
599.35	1	1	1	1	1	1	0	1	1	1
599.65	1	1	1	1	1	1	0	1	1	1
599.95	1	1	1	1	1	1	0	1	1	1
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	37	44	37	40	37	42	36	37	48	48
602.35	36	42	36	38	36	41	35	36	45	45
602.70	31	37	31	34	31	37	32	31	39	39
603.05	30	36	30	34	30	36	30	30	37	37
603.40	26	30	26	28	26	29	28	26	31	31
603.75	26	31	26	29	26	30	28	26	32	32
604.81	24	29	24	26	24	27	22	24	31	31
606.65	24	27	24	25	24	26	21	24	28	28
607.05	22	33	22	28	22	32	33	22	35	35
607.55	22	32	22	27	22	33	32	22	35	35
608.10	24	26	24	25	24	26	21	24	30	30

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
608.50	25	27	25	25	25	27	21	25	29	29
608.85	25	27	25	25	25	26	21	25	28	28
609.15	24	28	24	25	24	28	21	24	29	29
609.45	24	28	24	26	24	27	20	24	29	29
609.80	25	28	25	26	25	28	21	25	29	29
610.10	25	28	25	25	25	28	21	25	28	28
610.40	25	33	25	28	25	33	28	25	34	34
610.85	25	31	25	27	25	29	28	25	34	34
611.30	27	31	27	29	27	31	26	27	35	35
611.65	27	31	27	30	27	31	26	27	35	35
611.95	28	33	28	30	28	33	25	28	35	35
612.30	35	49	35	42	35	47	47	35	56	56
612.60	35	50	35	42	35	47	47	35	56	56
612.80	35	48	35	42	35	47	47	35	54	55
613.05	35	65	35	56	35	64	62	35	70	70
613.30	34	65	34	55	34	63	62	34	70	70
613.55	34	65	34	54	34	63	62	34	70	70
613.80	34	65	34	54	34	62	60	35	68	68
614.00	35	65	35	54	35	61	60	35	68	68
614.30	36	65	36	55	36	61	61	36	69	69
614.65	37	65	37	55	37	61	59	37	68	68
614.95	38	63	38	51	38	59	54	38	64	64
615.20	38	63	38	50	38	59	54	38	64	64
615.45	38	62	38	49	38	58	54	38	64	64
615.75	37	61	37	48	37	58	55	37	63	63
616.05	37	60	37	48	37	56	54	37	62	62
616.35	37	60	37	49	37	54	54	37	62	63
616.65	48	64	48	57	48	60	56	48	65	65
616.90	47	63	47	55	47	59	55	47	65	65
617.10	45	62	46	54	46	59	54	46	64	64
617.40	45	62	45	54	45	60	54	46	65	65
617.75	45	63	45	53	45	61	53	45	64	64
618.05	45	63	45	54	45	62	54	45	64	64
618.35	45	63	45	54	45	62	53	45	64	64
618.60	45	62	45	52	45	60	53	45	63	63
618.85	43	61	43	50	43	59	54	43	64	64
619.10	42	61	42	49	42	59	52	42	62	62
619.35	40	57	40	48	40	54	51	40	61	61
619.65	40	58	40	49	40	54	50	40	60	60
619.95	40	55	40	48	40	54	50	40	59	59
620.25	39	54	39	47	39	53	47	39	57	57
620.55	39	54	39	47	39	52	47	39	55	55
620.85	39	54	39	48	39	53	47	39	55	55
621.10	39	54	39	49	39	53	46	40	55	55
621.35	40	53	40	47	40	52	46	40	55	55
621.70	38	54	38	44	38	52	44	38	55	55
622.00	37	52	37	44	37	50	44	37	54	54
622.25	37	52	37	43	37	50	43	37	53	53
622.55	37	51	37	43	37	48	43	37	52	53
622.85	37	50	37	43	37	48	42	37	53	54

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
623.15	37	50	37	43	37	48	41	37	52	52
623.45	37	49	37	43	37	47	40	37	53	53
623.75	37	50	37	43	37	44	40	37	53	53
624.05	37	51	37	43	37	46	38	37	53	53
624.35	35	51	35	42	35	46	37	36	53	53
624.65	35	52	35	41	35	46	37	35	53	53
624.95	45	58	45	50	45	53	36	45	59	59
625.25	46	58	46	50	46	52	36	46	59	59
625.60	39	51	39	43	39	46	33	39	54	54
625.90	39	51	39	43	39	46	33	39	54	54
626.15	38	49	38	42	38	45	33	38	53	53
626.50	38	49	38	42	38	45	33	38	52	52
626.85	37	47	37	41	37	44	32	37	51	51
627.10	36	47	36	40	36	44	32	36	50	50
627.35	36	46	36	39	36	44	32	36	50	50
627.70	36	46	36	39	36	44	32	36	50	50
628.00	35	45	35	37	35	43	31	35	49	49
628.25	34	45	34	37	34	43	30	34	49	49
628.55	34	45	34	36	34	39	29	34	49	49
628.85	34	44	34	36	34	38	29	34	48	48
629.10	35	43	35	37	35	38	28	35	48	48
629.40	35	43	35	37	35	38	28	35	47	47
629.75	35	42	35	37	35	38	28	35	46	46
630.05	35	41	35	36	35	37	28	35	44	44
630.35	35	41	35	36	35	37	28	35	44	44
630.70	35	41	35	36	35	37	27	35	43	43
631.00	34	38	34	35	34	36	26	34	43	43
631.25	34	36	34	35	34	36	25	34	42	42
631.55	34	36	34	35	34	36	24	34	42	42
631.85	32	35	32	33	32	34	23	32	41	41
632.10	32	35	32	33	32	33	22	32	42	42
632.35	31	33	31	32	31	32	22	31	40	40
632.70	31	32	31	31	31	32	20	31	37	37
633.00	30	31	30	30	30	31	19	30	36	36
633.25	30	31	30	30	30	31	19	30	34	34
633.55	30	31	30	30	30	31	18	30	33	33
633.85	29	31	29	29	29	30	18	29	32	32
634.15	29	31	29	29	29	29	18	29	31	31
634.45	29	31	29	29	29	29	18	29	31	31
634.75	28	31	28	29	28	29	17	28	31	31
635.05	28	30	28	29	28	29	18	28	31	31
635.40	28	30	28	28	28	29	18	28	31	31
635.75	28	30	28	28	28	30	18	28	30	30
636.05	28	30	28	28	28	29	18	28	30	30

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	6	6	6	6	6	6	0	6	6	6
596.30	4	4	4	4	4	4	0	4	4	4
596.65	3	3	3	3	3	3	0	3	3	3
596.95	5	5	5	5	5	5	0	5	5	5
597.25	4	4	4	4	4	4	0	4	4	4
597.55	4	4	4	4	4	4	0	4	4	4
597.85	4	4	4	4	4	4	0	4	4	4
598.15	4	4	4	4	4	4	0	4	4	4
598.45	4	4	4	4	4	4	0	4	4	4
598.75	4	4	4	4	4	4	0	4	4	4
599.05	3	3	3	3	3	3	0	3	3	3
599.35	2	2	2	2	2	2	0	2	2	2
599.65	1	1	1	1	1	1	0	1	1	1
599.95	1	1	1	1	1	1	0	1	1	1
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	34	44	34	37	34	43	34	34	47	47
602.35	33	44	33	37	33	42	37	33	46	46
602.70	28	36	28	31	28	35	30	28	43	43
603.05	30	36	30	32	30	36	31	30	40	40
603.40	25	31	25	28	25	29	23	25	33	33
603.75	27	35	27	28	27	33	27	27	37	37
604.81	25	30	25	27	25	29	25	25	33	33
606.65	25	28	25	26	25	27	21	25	32	32
607.05	24	35	24	33	24	35	31	24	41	41
607.55	24	35	24	33	24	34	32	24	39	39
608.10	25	30	25	28	25	31	24	25	33	34

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
608.50	25	29	25	28	25	30	26	25	32	33
608.85	25	29	25	28	25	30	25	25	32	33
609.15	25	29	25	27	25	30	24	25	31	32
609.45	25	29	25	27	25	29	25	25	32	33
609.80	25	29	25	27	25	29	25	25	32	33
610.10	25	29	25	26	25	29	24	25	32	33
610.40	25	36	25	33	25	36	30	25	37	38
610.85	28	38	28	33	28	37	30	29	39	40
611.30	29	36	29	34	30	35	28	30	37	38
611.65	29	35	29	33	30	34	29	30	38	39
611.95	30	36	30	33	31	35	31	31	41	42
612.30	36	59	36	55	37	57	53	37	61	62
612.60	36	59	36	53	37	57	51	37	59	60
612.80	36	58	36	52	37	57	50	37	59	60
613.05	36	65	36	60	37	62	59	37	68	68
613.30	36	64	36	60	37	64	58	37	67	67
613.55	36	64	36	58	37	64	58	37	67	67
613.80	37	65	37	59	38	63	56	38	66	66
614.00	38	64	38	59	39	64	56	39	66	66
614.30	38	65	38	59	39	64	56	39	66	66
614.65	38	64	38	61	39	63	58	39	68	68
614.95	40	63	40	58	41	60	56	41	67	67
615.20	40	64	40	57	41	60	54	41	65	65
615.45	40	63	40	57	41	60	53	41	64	64
615.75	41	63	41	58	42	62	53	42	64	64
616.05	40	62	40	54	41	60	51	41	63	63
616.35	40	60	40	53	41	57	51	41	63	63
616.65	53	66	53	61	54	65	51	54	68	68
616.90	52	67	52	61	53	65	50	53	69	69
617.10	52	65	52	62	53	64	50	54	67	67
617.40	52	65	52	62	53	64	49	54	66	66
617.75	51	64	51	63	53	64	48	53	66	66
618.05	49	62	49	59	51	62	47	51	64	64
618.35	49	62	49	59	51	61	47	51	63	64
618.60	48	60	48	58	50	60	50	50	62	63
618.85	47	61	47	58	48	59	50	48	63	64
619.10	44	58	44	53	45	57	51	45	61	62
619.35	45	60	45	54	46	57	50	46	61	62
619.65	45	60	45	53	46	58	51	46	61	62
619.95	44	60	44	53	45	58	53	45	60	61
620.25	44	60	44	54	45	57	54	45	61	62
620.55	44	59	44	54	45	57	53	45	60	61
620.85	43	60	43	55	44	57	53	44	61	62
621.10	43	60	43	53	43	56	52	44	60	61
621.35	41	59	41	52	41	55	50	43	59	60
621.70	41	53	41	50	41	52	49	42	57	58
622.00	43	55	43	51	43	54	49	44	57	58
622.25	43	55	43	52	43	54	48	44	57	58
622.55	42	55	42	52	42	54	49	43	57	58
622.85	42	56	42	52	42	54	49	43	57	58

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
623.15	42	56	42	52	42	53	49	43	58	59
623.45	43	56	43	52	43	54	49	44	57	59
623.75	44	54	44	52	44	54	47	44	57	58
624.05	43	54	44	52	44	54	47	44	56	58
624.35	44	54	44	52	44	54	45	44	56	56
624.65	43	54	43	52	43	54	45	44	54	55
624.95	53	62	53	60	53	62	45	53	62	62
625.25	53	62	53	59	53	62	46	53	64	64
625.60	52	61	52	57	52	61	45	52	62	62
625.90	51	61	51	56	51	60	46	51	61	61
626.15	48	59	48	53	48	59	45	48	59	59
626.50	48	59	48	53	48	59	45	48	60	60
626.85	48	60	48	53	48	59	45	48	60	60
627.10	48	60	48	53	48	60	45	48	60	60
627.35	46	59	46	54	46	59	46	46	60	60
627.70	47	59	47	53	47	58	47	47	61	61
628.00	45	59	45	51	45	56	47	45	60	60
628.25	42	58	42	50	42	55	47	42	59	59
628.55	41	57	41	49	41	53	46	41	58	58
628.85	40	57	40	46	40	52	45	40	58	58
629.10	39	57	39	46	39	51	43	40	57	57
629.40	39	58	39	45	39	51	43	39	58	58
629.75	37	54	37	43	37	50	42	37	58	58
630.05	37	53	37	41	37	49	40	37	58	58
630.35	37	52	37	41	37	48	40	37	56	56
630.70	37	51	37	41	37	46	41	37	54	54
631.00	37	50	37	41	37	45	41	37	53	53
631.25	36	47	36	39	36	45	40	36	51	51
631.55	36	47	36	37	36	45	39	36	48	48
631.85	36	47	36	37	36	45	39	36	48	48
632.10	36	47	36	37	36	45	38	36	48	48
632.35	35	47	35	38	35	43	38	35	48	48
632.70	35	47	35	37	35	43	37	35	48	48
633.00	35	44	35	37	35	41	35	35	47	47
633.25	34	43	34	36	34	40	34	34	45	45
633.55	34	42	34	36	34	40	34	34	44	44
633.85	34	41	34	36	34	40	33	34	45	45
634.15	34	41	34	35	34	40	32	34	45	45
634.45	33	40	33	34	33	39	31	33	43	43
634.75	33	40	33	34	33	39	31	33	43	43
635.05	33	40	33	34	33	38	30	33	43	43
635.40	34	41	34	36	34	40	29	34	44	44
635.75	33	40	33	34	33	36	28	33	43	43
636.05	33	38	33	34	33	35	28	33	42	42

Appendix L. Days of Exceedance of *E. coli* Criterion On Left Bank (KY side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	2	2	2	2	2	2	0	2	2	2
597.55	0	0	0	0	0	0	0	0	0	0
597.85	3	3	3	3	3	3	0	3	3	3
598.15	3	3	3	3	3	3	0	3	3	3
598.45	4	4	4	4	4	4	0	4	4	4
598.75	4	4	4	4	4	4	0	4	4	4
599.05	2	2	2	2	2	2	0	2	2	2
599.35	2	2	2	2	2	2	0	2	2	2
599.65	2	2	2	2	2	2	0	2	2	2
599.95	2	2	2	2	2	2	0	2	2	2
600.25	2	2	2	2	2	2	0	2	2	2
600.60	2	2	2	2	2	2	0	2	2	2
600.90	2	2	2	2	2	2	0	2	2	2
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	1	1	1	1	1	1	0	1	1	1
602.35	1	1	1	1	1	1	0	1	1	1
602.70	1	1	1	1	1	1	0	1	1	1
603.05	9	9	9	9	9	9	5	9	9	9
603.40	7	7	7	7	7	7	2	7	7	7
603.75	17	20	17	19	17	20	11	17	20	20
604.81	24	29	25	28	25	29	22	25	31	31
605.80	24	29	25	27	25	29	22	25	31	31
606.05	25	29	25	27	26	27	22	26	31	31
606.30	25	31	25	27	26	28	24	26	34	34
606.50	28	32	28	30	29	31	26	29	34	34

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
606.75	28	33	28	30	28	31	27	29	34	34
607.05	35	37	35	37	35	37	29	36	39	40
607.55	35	37	34	37	36	37	30	35	41	41
608.10	33	38	33	37	34	38	31	35	40	40
608.50	39	44	39	41	39	44	30	39	45	45
608.85	38	43	39	40	39	43	31	39	45	45
609.15	38	43	39	41	39	43	30	39	44	44
609.45	39	43	40	41	40	42	29	40	44	44
609.80	39	42	40	40	40	42	29	40	44	44
610.10	36	41	37	38	38	41	30	38	43	43
610.40	39	42	40	40	40	42	30	40	43	43
610.85	40	43	41	41	41	43	29	42	44	44
611.30	39	42	40	40	40	42	29	40	42	42
611.65	40	43	41	41	41	42	28	41	43	43
611.95	40	43	41	41	41	42	28	41	43	43
612.30	42	45	43	43	43	44	28	44	45	46
612.60	41	45	42	43	42	44	28	44	46	47
612.80	41	43	42	42	42	43	28	43	44	46
613.05	41	43	42	42	42	43	29	43	44	45
613.30	41	43	42	42	42	43	29	43	44	45
613.55	41	43	42	42	43	43	29	43	45	46
613.80	40	43	42	41	42	43	30	42	44	46
614.00	42	47	43	43	43	45	39	44	51	52
614.30	42	50	42	43	43	47	41	44	53	54
614.65	42	49	42	43	43	46	41	44	53	54
614.95	46	48	46	46	47	47	29	47	50	50
615.20	48	62	48	52	49	57	51	49	67	67
615.45	49	66	49	54	50	60	55	50	70	70
615.75	49	62	50	53	50	59	54	50	70	70
616.05	49	62	50	52	50	59	52	50	67	67
616.35	48	61	49	51	49	58	52	49	67	67
616.65	49	62	50	52	50	58	53	50	70	70
616.90	48	61	49	51	49	58	53	49	69	69
617.10	49	63	50	52	50	57	50	50	68	68
617.40	50	64	51	53	51	58	50	51	68	68
617.75	49	69	49	53	50	62	60	51	73	73
618.05	49	70	49	54	50	63	61	50	74	74
618.35	49	71	49	54	50	62	59	50	73	73
618.60	49	71	49	54	50	63	59	50	72	72
618.85	49	69	49	54	50	63	59	50	73	73
619.10	49	69	49	54	50	62	59	50	73	73
619.35	51	74	51	61	52	69	67	52	79	79
619.65	50	73	50	60	51	67	67	51	78	78
619.95	53	75	53	62	54	69	67	54	80	80
620.25	53	73	53	62	54	70	64	54	78	78
620.55	52	73	52	62	53	69	64	53	77	77
620.85	50	73	50	56	51	69	64	51	76	76
621.10	49	74	49	57	50	69	64	50	75	75
621.35	50	74	50	58	51	70	64	51	76	76
621.70	49	72	49	58	50	67	64	50	76	76

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
622.00	52	73	52	59	53	66	61	53	76	76
622.25	52	73	52	59	53	68	62	53	75	75
622.55	51	73	51	63	52	69	62	52	75	75
622.85	53	73	53	63	54	68	61	54	76	76
623.15	52	72	52	59	53	68	58	53	74	74
623.45	53	72	53	58	54	67	58	54	74	74
623.75	53	72	53	58	54	67	57	54	73	73
624.05	53	72	53	57	54	66	57	54	73	73
624.35	53	71	53	57	54	63	57	54	73	73
624.65	51	68	51	56	52	60	55	52	72	72
624.95	51	67	51	56	52	61	56	52	72	72
625.25	52	69	52	56	53	62	57	53	72	72
625.60	51	66	51	56	52	59	56	52	71	71
625.90	52	68	52	57	53	60	57	53	72	72
626.15	54	72	54	58	55	64	58	55	75	75
626.50	53	70	53	57	54	61	58	54	72	73
626.85	54	73	54	58	55	63	58	55	74	75
627.10	52	70	52	55	53	61	57	53	71	72
627.35	52	66	52	55	53	60	53	53	71	72
627.70	54	70	54	57	55	62	54	55	72	73
628.00	52	66	52	56	53	61	52	53	72	72
628.25	52	63	52	55	53	61	52	53	72	72
628.55	49	62	49	54	50	60	52	50	71	71
628.85	49	62	49	53	50	60	53	50	71	71
629.10	48	61	48	51	49	58	52	49	69	69
629.40	47	61	47	50	48	58	52	48	68	69
629.75	47	61	47	50	48	57	53	48	70	71
630.05	48	62	48	51	49	57	50	49	67	68
630.35	47	61	48	50	49	55	49	49	65	67
630.70	46	59	46	50	47	55	48	47	65	66
631.00	44	58	44	47	45	55	48	45	65	66
631.25	44	58	44	48	45	53	44	45	62	63
631.55	44	57	44	47	45	53	45	45	62	63
631.85	44	57	44	47	45	52	45	45	60	61
632.10	44	56	44	47	45	51	45	45	60	61
632.35	44	56	44	47	45	50	45	45	60	61
632.70	42	52	43	46	44	49	44	44	59	60
633.00	43	53	43	46	44	49	44	44	60	61
633.25	41	50	41	43	42	47	43	42	58	59
633.55	41	49	41	43	42	48	41	42	56	57
633.85	42	49	42	44	42	47	41	43	56	57
634.15	43	50	43	45	43	49	43	44	56	57
634.45	42	50	42	44	43	49	42	43	54	55
634.75	42	49	42	43	43	47	39	43	53	54
635.05	41	49	41	43	42	47	39	42	52	53
635.40	41	49	41	42	42	45	39	42	52	53
635.75	41	49	41	41	42	44	37	42	52	53
636.05	41	50	41	41	42	44	37	42	51	52

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	0	0	0	0	0	0	0	0	0	0
597.55	0	0	0	0	0	0	0	0	0	0
597.85	0	0	0	0	0	0	0	0	0	0
598.15	0	0	0	0	0	0	0	0	0	0
598.45	0	0	0	0	0	0	0	0	0	0
598.75	0	0	0	0	0	0	0	0	0	0
599.05	1	1	1	1	1	1	0	1	1	1
599.35	1	1	1	1	1	1	0	1	1	1
599.65	1	1	1	1	1	1	0	1	1	1
599.95	1	1	1	1	1	1	0	1	1	1
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	1	1	1	1	1	1	0	1	1	1
602.35	1	1	1	1	1	1	0	1	1	1
602.70	1	1	1	1	1	1	0	1	1	1
603.05	3	4	3	4	3	4	2	3	6	6
603.40	2	2	2	2	2	2	1	2	2	2
603.75	9	10	9	10	9	10	8	9	10	10
604.81	14	17	14	16	14	16	12	14	18	18
605.80	14	17	14	16	14	16	12	14	18	18
606.05	14	17	14	16	14	16	12	14	18	18
606.30	14	16	14	16	14	16	12	14	18	18
606.50	14	16	14	16	14	16	12	14	18	18

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
606.75	14	16	14	15	14	16	12	14	19	20
607.05	18	21	18	19	18	21	16	18	22	22
607.55	18	21	18	20	18	21	16	18	22	22
608.10	22	24	22	22	22	24	17	22	25	25
608.50	23	26	23	24	23	26	15	24	26	26
608.85	22	25	22	23	22	25	15	22	25	25
609.15	23	25	23	23	23	25	15	23	25	25
609.45	23	25	23	23	23	25	15	23	25	25
609.80	23	25	23	23	23	24	15	23	25	25
610.10	20	24	20	21	20	23	16	20	24	24
610.40	23	26	23	24	23	25	16	24	26	26
610.85	24	26	24	26	24	26	16	24	28	28
611.30	23	24	23	24	23	24	16	23	26	27
611.65	23	26	23	25	23	26	16	23	29	29
611.95	23	26	23	25	23	26	16	23	28	28
612.30	24	27	24	25	24	27	16	24	28	28
612.60	25	27	25	26	25	27	16	25	28	28
612.80	25	27	25	27	25	27	16	25	28	28
613.05	24	27	24	27	24	27	16	24	27	27
613.30	24	27	24	27	24	27	16	25	27	27
613.55	26	27	26	27	26	27	16	26	27	27
613.80	26	27	26	27	26	27	16	26	27	27
614.00	26	27	26	27	26	27	15	26	27	27
614.30	24	27	24	27	24	27	15	25	27	27
614.65	24	27	24	27	24	27	15	24	28	28
614.95	27	29	27	29	27	29	14	27	29	29
615.20	26	30	26	28	26	29	18	26	33	33
615.45	26	33	26	29	26	31	20	26	34	34
615.75	26	32	26	28	26	31	20	26	34	34
616.05	26	32	26	29	26	31	19	26	33	33
616.35	27	32	27	28	27	30	19	27	33	33
616.65	27	32	27	28	27	30	19	27	33	33
616.90	27	30	27	28	27	29	19	27	33	33
617.10	27	29	27	28	27	29	18	27	31	31
617.40	27	29	27	28	27	29	18	27	31	31
617.75	27	30	27	28	27	29	21	27	34	34
618.05	27	32	27	28	27	31	22	27	35	35
618.35	27	30	27	28	27	29	21	27	34	34
618.60	27	31	27	28	27	29	21	27	34	34
618.85	27	31	27	28	27	29	21	27	34	34
619.10	27	31	27	28	27	29	21	27	33	33
619.35	27	35	27	28	27	31	29	27	39	39
619.65	28	34	28	29	28	31	28	28	39	39
619.95	27	34	27	28	27	30	29	27	39	39
620.25	27	34	27	28	27	30	30	27	40	40
620.55	26	33	26	29	26	30	27	26	38	38
620.85	26	33	26	27	26	29	26	26	37	37
621.10	26	31	26	27	26	29	25	26	36	36
621.35	26	33	26	27	26	29	24	26	36	36
621.70	26	32	26	27	26	28	22	26	36	36

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
622.00	26	29	26	27	26	28	20	26	33	33
622.25	26	29	26	27	26	28	22	26	36	36
622.55	24	32	24	27	24	28	23	24	36	36
622.85	24	29	24	27	25	28	21	25	36	36
623.15	25	28	25	27	25	28	19	25	34	34
623.45	25	28	25	27	25	28	18	25	33	33
623.75	24	28	24	26	24	28	18	25	33	33
624.05	24	28	24	26	24	28	17	24	32	32
624.35	23	28	23	26	24	26	17	24	31	31
624.65	22	26	23	25	23	25	14	23	27	27
624.95	21	27	21	25	21	25	14	21	27	27
625.25	22	27	22	25	22	26	15	22	29	29
625.60	21	26	21	24	21	25	14	21	27	27
625.90	21	27	21	23	21	25	14	21	27	27
626.15	23	27	23	24	23	25	15	23	29	29
626.50	22	26	22	24	22	25	15	22	29	29
626.85	22	26	22	23	22	25	15	22	28	28
627.10	21	26	21	22	21	23	15	21	27	27
627.35	21	23	21	22	21	23	14	21	25	25
627.70	20	24	20	21	20	22	14	20	27	27
628.00	20	22	20	21	20	21	14	20	25	25
628.25	20	22	20	21	20	21	14	20	26	26
628.55	21	22	21	22	21	22	12	21	26	26
628.85	21	22	21	21	21	22	12	21	25	25
629.10	21	22	21	21	21	22	12	21	24	24
629.40	21	22	21	21	21	22	12	21	24	24
629.75	20	22	21	21	21	22	12	21	24	24
630.05	20	22	20	21	20	22	12	21	24	24
630.35	19	22	19	21	20	22	12	20	24	24
630.70	19	22	19	21	19	22	12	19	24	24
631.00	19	22	19	21	19	22	12	19	22	22
631.25	19	22	19	20	19	22	12	19	22	22
631.55	19	22	19	19	19	22	12	19	22	22
631.85	19	22	19	19	19	21	12	19	22	22
632.10	19	21	19	19	19	21	12	19	22	22
632.35	19	21	19	19	19	21	12	19	22	22
632.70	19	21	19	19	19	20	12	19	21	21
633.00	18	20	18	18	18	19	12	18	20	20
633.25	18	19	18	18	18	19	12	18	20	20
633.55	18	19	18	18	18	19	12	18	20	20
633.85	18	19	18	18	18	19	12	18	20	20
634.15	18	19	18	18	18	19	12	18	20	20
634.45	18	19	18	18	18	19	12	18	20	20
634.75	18	19	18	18	18	19	12	18	19	20
635.05	18	19	18	18	18	19	12	18	19	19
635.40	18	19	18	18	18	19	12	18	19	19
635.75	18	19	18	18	18	19	11	18	19	19
636.05	18	19	18	18	18	19	11	18	19	19

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	0	0	0	0	0	0	0	0	0	0
597.55	0	0	0	0	0	0	0	0	0	0
597.85	0	0	0	0	0	0	0	0	0	0
598.15	0	0	0	0	0	0	0	0	0	0
598.45	0	0	0	0	0	0	0	0	0	0
598.75	0	0	0	0	0	0	0	0	0	0
599.05	1	1	1	1	1	1	0	1	1	1
599.35	0	0	0	0	0	0	0	0	0	0
599.65	1	1	1	1	1	1	0	1	1	1
599.95	1	1	1	1	1	1	0	1	1	1
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	1	1	1	1	1	1	0	1	1	1
602.35	1	1	1	1	1	1	0	1	1	1
602.70	1	1	1	1	1	1	0	1	1	1
603.05	4	4	4	4	4	4	1	4	5	5
603.40	1	2	1	2	1	2	1	1	2	3
603.75	9	10	9	10	9	10	7	9	10	10
604.81	19	20	19	19	19	20	13	19	20	20
605.80	19	20	19	19	19	20	13	19	20	20
606.05	19	20	19	19	19	20	13	19	20	20
606.30	19	20	19	19	19	19	13	19	20	20
606.50	19	20	19	19	19	19	13	19	20	20

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
606.75	18	20	18	19	18	19	13	18	20	20
607.05	24	26	24	25	24	25	19	24	27	27
607.55	24	24	24	24	24	24	19	24	25	25
608.10	27	27	27	27	27	27	21	27	28	28
608.50	30	30	30	30	30	30	20	30	30	30
608.85	30	30	30	30	30	30	21	30	30	30
609.15	29	30	29	29	29	30	21	29	30	30
609.45	30	31	30	31	30	31	21	30	32	32
609.80	28	29	28	29	28	29	20	28	29	29
610.10	28	29	28	28	28	29	20	28	29	29
610.40	30	31	30	30	30	31	20	30	31	31
610.85	31	32	31	31	31	31	20	31	34	34
611.30	30	30	30	30	30	30	20	30	31	31
611.65	32	33	32	32	32	32	20	32	34	34
611.95	31	33	31	32	31	33	20	31	33	33
612.30	33	34	33	34	33	34	21	33	36	36
612.60	32	35	32	34	32	35	21	32	37	37
612.80	32	36	32	34	32	35	21	32	36	36
613.05	32	36	32	33	32	36	21	32	37	37
613.30	33	36	33	35	33	36	20	33	37	37
613.55	35	36	35	35	35	36	20	35	37	37
613.80	35	36	35	35	35	36	20	35	37	37
614.00	35	38	35	37	35	37	21	35	38	38
614.30	35	38	35	36	35	37	22	35	38	38
614.65	35	37	35	36	35	36	22	35	38	38
614.95	37	37	37	37	37	37	19	37	38	38
615.20	38	38	38	38	38	38	24	38	41	41
615.45	38	40	38	39	38	39	26	38	43	43
615.75	38	40	38	39	38	39	26	38	42	42
616.05	38	40	38	39	38	39	25	38	42	42
616.35	38	39	38	39	38	39	25	38	42	42
616.65	38	40	38	40	38	40	24	38	43	43
616.90	39	40	39	40	39	40	24	39	42	42
617.10	39	40	39	40	39	40	24	39	42	42
617.40	39	40	39	40	39	40	24	39	42	42
617.75	39	41	39	39	39	40	25	39	42	42
618.05	39	42	39	39	39	40	27	39	43	43
618.35	38	42	38	39	38	40	26	38	42	42
618.60	38	42	38	39	38	40	26	38	42	42
618.85	37	42	37	39	37	40	26	37	42	42
619.10	37	41	37	38	37	40	26	37	42	42
619.35	39	45	39	41	39	43	35	39	47	47
619.65	39	44	39	41	39	43	34	39	47	47
619.95	40	46	40	42	40	44	35	40	49	49
620.25	39	45	39	42	39	44	35	39	49	50
620.55	39	44	39	41	39	42	35	39	48	50
620.85	38	44	39	41	39	42	34	39	48	48
621.10	38	44	38	41	38	41	34	38	48	48
621.35	38	45	38	40	38	41	34	38	48	48
621.70	37	43	37	40	37	41	32	37	47	47

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
622.00	36	41	36	39	36	40	30	36	44	44
622.25	36	41	36	39	36	40	31	36	44	44
622.55	37	44	37	41	37	42	35	37	49	49
622.85	35	43	35	39	35	41	32	35	47	48
623.15	35	42	35	38	35	41	30	35	45	45
623.45	35	41	35	38	35	41	28	35	45	45
623.75	35	42	35	38	35	41	28	35	45	45
624.05	35	42	35	37	35	41	28	35	45	45
624.35	35	42	35	38	35	41	28	35	45	45
624.65	35	41	35	37	35	40	27	35	44	44
624.95	35	41	36	37	36	41	27	36	44	44
625.25	35	41	35	37	35	41	28	35	44	44
625.60	34	41	34	37	34	38	27	34	44	44
625.90	34	41	34	37	34	39	27	34	43	44
626.15	35	41	35	37	35	41	28	35	44	44
626.50	34	41	34	37	34	40	27	34	45	45
626.85	34	41	34	35	34	40	27	34	44	44
627.10	34	40	34	35	34	36	26	34	44	44
627.35	34	39	34	35	34	36	26	34	43	43
627.70	34	40	34	35	34	36	26	34	44	44
628.00	33	39	33	35	33	37	26	33	42	42
628.25	32	38	32	35	32	36	26	33	42	42
628.55	33	37	33	35	33	36	24	33	42	42
628.85	33	37	33	35	33	35	24	33	42	42
629.10	33	35	33	35	33	35	23	33	41	41
629.40	33	35	33	34	33	35	23	33	41	41
629.75	33	35	33	34	33	35	22	33	42	42
630.05	33	35	33	34	33	35	22	33	39	39
630.35	33	35	33	34	33	35	22	33	40	40
630.70	33	36	33	34	33	36	23	33	40	40
631.00	33	36	33	35	33	36	23	33	41	41
631.25	32	35	32	32	32	33	21	32	36	36
631.55	31	33	31	31	31	32	21	31	35	35
631.85	31	33	31	31	31	32	20	31	34	34
632.10	31	33	31	31	31	32	18	31	34	34
632.35	31	33	31	31	31	32	18	31	34	34
632.70	30	32	30	30	30	31	18	30	32	33
633.00	29	31	29	29	29	30	18	29	31	31
633.25	29	31	29	29	29	30	18	29	31	31
633.55	29	31	29	29	29	29	17	29	31	31
633.85	29	31	29	29	29	29	17	29	31	31
634.15	29	31	29	29	29	30	17	29	31	31
634.45	29	30	29	29	29	30	16	29	31	31
634.75	28	30	28	29	28	30	16	28	31	31
635.05	28	30	28	28	28	30	16	28	30	30
635.40	28	30	28	28	28	30	16	28	30	30
635.75	29	31	29	29	29	30	16	29	31	31
636.05	28	31	28	29	28	30	17	28	31	31

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	0	0	0	0	0	0	0	0	0	0
596.65	0	0	0	0	0	0	0	0	0	0
596.95	0	0	0	0	0	0	0	0	0	0
597.25	2	2	2	2	2	2	0	2	2	2
597.55	0	0	0	0	0	0	0	0	0	0
597.85	2	2	2	2	2	2	0	2	2	2
598.15	1	1	1	1	1	1	0	1	1	1
598.45	1	1	1	1	1	1	0	1	1	1
598.75	2	2	2	2	2	2	0	2	2	2
599.05	2	2	2	2	2	2	0	2	2	2
599.35	2	2	2	2	2	2	0	2	2	2
599.65	2	2	2	2	2	2	0	2	2	2
599.95	2	2	2	2	2	2	0	2	2	2
600.25	1	1	1	1	1	1	0	1	1	1
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	1	1	1	1	1	1	0	1	1	1
602.35	1	1	1	1	1	1	0	1	1	1
602.70	1	1	1	1	1	1	0	1	1	1
603.05	4	4	4	4	4	4	1	4	4	4
603.40	2	2	2	2	2	2	0	2	2	2
603.75	7	8	7	8	7	8	6	7	8	8
604.81	17	21	18	19	18	19	15	18	21	21
605.80	17	21	18	19	18	19	15	18	21	21
606.05	17	21	18	18	18	20	15	18	22	22
606.30	17	22	17	18	18	19	16	18	22	22
606.50	18	22	18	19	19	21	16	19	23	23

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
606.75	19	23	19	20	19	22	16	20	23	23
607.05	27	30	27	28	27	28	24	28	31	32
607.55	26	28	25	27	27	28	24	26	31	31
608.10	28	30	28	29	29	29	26	29	33	33
608.50	29	31	29	30	29	30	25	29	33	33
608.85	28	31	29	29	29	31	25	29	32	32
609.15	28	31	29	30	29	31	25	29	32	32
609.45	30	33	31	32	31	33	24	31	34	34
609.80	28	31	29	29	29	31	24	29	32	32
610.10	28	31	29	29	29	31	24	29	31	31
610.40	30	33	31	31	31	33	24	31	33	33
610.85	32	35	33	33	33	35	23	33	36	36
611.30	31	34	32	32	32	34	23	32	34	34
611.65	32	36	33	33	33	35	23	33	36	36
611.95	32	35	33	34	33	35	23	34	37	37
612.30	34	38	35	36	35	37	22	35	39	39
612.60	33	38	34	35	35	38	23	35	39	39
612.80	34	38	36	36	36	38	23	36	39	39
613.05	35	38	36	37	36	38	23	37	40	40
613.30	36	38	37	37	37	38	23	37	40	40
613.55	36	38	37	37	37	38	23	37	39	39
613.80	36	39	37	37	37	38	23	37	39	39
614.00	38	41	39	39	39	40	26	39	43	43
614.30	38	42	38	39	39	42	27	39	44	44
614.65	38	42	38	39	39	41	25	39	42	42
614.95	39	42	39	40	40	41	22	40	42	42
615.20	42	47	42	44	43	44	32	43	50	50
615.45	43	48	43	45	44	46	34	44	51	51
615.75	43	47	44	44	44	45	33	44	51	51
616.05	43	47	44	44	44	45	29	44	48	48
616.35	42	46	43	43	43	44	29	43	47	47
616.65	43	47	44	44	44	45	28	44	48	48
616.90	43	47	44	44	44	45	29	44	48	48
617.10	43	47	44	44	44	45	29	44	48	48
617.40	43	45	44	44	44	45	30	44	48	48
617.75	42	48	42	44	43	46	32	44	50	50
618.05	42	47	42	43	43	46	33	43	50	50
618.35	42	47	42	43	43	44	34	43	50	50
618.60	42	47	42	43	43	44	34	43	49	50
618.85	42	47	42	43	43	44	34	43	49	50
619.10	41	46	41	42	42	44	34	42	48	49
619.35	43	50	43	45	44	48	40	44	53	54
619.65	42	49	42	45	43	47	42	43	53	54
619.95	41	51	41	44	42	47	42	43	53	54
620.25	41	51	41	44	42	48	42	42	53	54
620.55	41	51	41	43	42	47	42	42	52	53
620.85	42	52	42	43	43	48	45	43	54	55
621.10	42	52	42	43	43	48	45	43	54	55
621.35	42	53	42	44	42	48	44	43	53	54
621.70	41	52	41	43	41	48	45	42	54	55

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
622.00	41	50	41	43	41	48	43	42	54	55
622.25	43	52	43	44	43	48	44	44	54	55
622.55	43	54	43	46	43	51	45	44	54	55
622.85	43	53	43	46	43	51	45	44	54	55
623.15	43	53	43	44	43	51	45	44	54	55
623.45	43	54	43	43	43	51	46	44	55	56
623.75	42	54	42	45	42	51	45	42	55	56
624.05	43	54	43	45	43	51	44	43	55	56
624.35	42	54	42	45	42	49	44	43	55	56
624.65	40	53	40	44	40	48	43	40	55	55
624.95	39	53	39	43	39	48	44	39	55	55
625.25	39	54	39	42	39	49	43	39	55	55
625.60	37	51	37	40	37	45	42	37	53	53
625.90	37	52	37	41	37	46	44	37	54	54
626.15	38	54	38	41	38	48	44	38	54	54
626.50	38	54	38	41	38	45	44	38	55	55
626.85	37	54	37	41	37	46	44	37	55	55
627.10	37	55	37	40	37	47	44	37	55	55
627.35	37	52	37	40	37	47	42	37	55	55
627.70	37	54	37	41	37	47	43	37	55	55
628.00	38	50	38	40	38	47	40	38	56	56
628.25	37	49	37	40	37	46	40	37	57	57
628.55	36	47	36	40	36	45	40	36	56	56
628.85	36	46	36	37	36	45	40	36	56	56
629.10	35	43	35	36	35	41	37	35	52	52
629.40	35	44	35	37	35	41	37	35	49	49
629.75	35	45	35	37	35	42	37	35	49	49
630.05	35	46	35	37	35	41	37	35	49	49
630.35	35	45	35	37	35	43	39	35	49	49
630.70	35	43	35	36	35	42	36	35	48	48
631.00	35	43	35	36	35	43	37	35	48	48
631.25	35	43	35	36	35	41	35	35	45	45
631.55	35	44	35	36	35	41	37	35	46	46
631.85	35	44	35	36	35	41	37	35	46	46
632.10	34	44	34	36	34	40	37	34	46	46
632.35	34	43	34	35	34	39	37	34	46	46
632.70	33	39	33	34	33	38	33	33	44	44
633.00	34	40	34	35	34	39	34	34	45	45
633.25	33	39	33	33	33	38	32	33	44	44
633.55	34	40	34	34	34	39	30	34	44	44
633.85	34	40	34	35	34	38	29	34	44	44
634.15	34	40	34	35	34	38	29	34	43	43
634.45	34	40	34	35	34	38	30	34	43	43
634.75	34	40	34	35	34	38	29	34	42	42
635.05	33	39	33	34	33	35	28	33	41	41
635.40	33	40	33	34	33	35	27	33	42	42
635.75	33	39	33	33	33	34	26	33	41	41
636.05	33	38	33	33	33	34	26	33	39	39

Appendix L. Days of Exceedance of *E. coli* Criterion In Center Channel of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	9	9	9	9	9	9	0	9	9	9
596.65	8	8	8	8	8	8	0	8	8	8
596.95	7	7	7	7	7	7	0	7	7	7
597.25	7	7	7	7	7	7	0	7	7	7
597.55	7	7	7	7	7	7	0	7	7	7
597.85	7	7	7	7	7	7	0	7	7	7
598.15	7	7	7	7	7	7	0	7	7	7
598.45	7	7	7	7	7	7	0	7	7	7
598.75	5	5	5	5	5	5	0	5	5	5
599.05	4	4	4	4	4	4	0	4	4	4
599.35	3	3	3	3	3	3	0	3	3	3
599.65	3	3	3	3	3	3	0	3	3	3
599.95	3	3	3	3	3	3	0	3	3	3
600.25	3	3	3	3	3	3	0	3	3	3
600.60	3	3	3	3	3	3	0	3	3	3
600.90	3	3	3	3	3	3	0	3	3	3
601.15	3	3	3	3	3	3	4	7	3	7
601.45	3	3	3	3	3	3	1	4	3	4
601.75	3	3	3	3	3	3	0	3	3	3
602.05	2	2	2	2	2	2	0	2	2	2
602.35	2	2	2	2	4	2	8	9	2	9
602.70	2	2	2	2	2	2	6	7	2	7
603.05	2	2	8	2	10	2	15	16	2	16
603.40	1	1	15	1	22	1	23	24	1	24
603.75	2	2	14	2	20	2	23	25	2	25
604.30	11	13	11	12	12	13	12	15	13	16
604.51	11	13	11	12	11	13	12	16	13	16
604.85	12	13	12	12	12	13	11	15	13	15
605.09	12	13	12	12	12	13	11	15	13	15
605.29	11	12	11	11	12	12	11	15	12	15

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
605.55	11	12	11	11	11	11	11	14	12	14
605.80	20	23	20	21	20	22	17	21	26	27
606.05	20	23	23	20	23	21	21	25	27	31
606.30	53	56	54	54	54	55	21	54	58	60
606.50	53	55	54	54	54	55	21	55	57	59
606.75	53	55	54	54	54	55	22	55	56	58
607.05	54	56	55	55	55	55	22	56	57	59
607.55	54	55	55	55	55	55	22	56	57	59
608.10	53	54	54	53	54	54	21	55	57	59
608.50	56	57	57	56	57	57	30	58	61	64
608.85	56	57	57	57	57	57	29	58	61	62
609.15	56	57	57	56	57	57	29	58	59	62
609.45	58	60	59	59	59	59	29	60	63	66
609.80	58	59	59	59	60	59	29	60	61	63
610.10	57	58	58	58	59	58	29	59	60	62
610.40	56	57	58	57	59	57	28	59	59	62
610.85	56	57	57	57	58	57	29	59	58	62
611.30	53	54	53	54	54	54	28	55	56	57
611.65	53	54	53	54	54	54	28	55	56	57
611.95	53	54	53	54	54	54	28	55	56	57
612.30	52	53	53	53	54	53	28	55	55	57
612.60	52	53	52	53	53	53	28	55	55	57
612.80	52	53	52	53	53	53	28	54	55	56
613.05	52	54	52	53	53	53	28	54	56	57
613.30	53	54	53	53	54	54	27	55	56	57
613.55	52	53	52	52	53	53	27	54	55	56
613.80	51	52	51	51	52	52	27	53	54	55
614.00	51	53	51	51	52	52	26	52	54	54
614.30	51	53	51	51	52	52	26	52	54	54
614.65	50	52	50	50	51	51	26	51	52	53
614.95	48	51	48	49	49	50	28	49	51	52
615.20	48	51	48	49	49	50	27	49	51	51
615.45	48	51	48	49	49	50	27	49	51	51
615.75	48	51	48	48	49	50	27	49	51	51
616.05	48	51	48	48	49	50	27	49	51	51
616.35	48	51	48	48	49	50	27	49	51	51
616.65	48	50	48	48	49	50	27	49	51	51
616.90	48	50	48	48	49	49	27	49	52	52
617.10	47	50	47	48	49	49	26	49	52	52
617.40	47	50	47	47	48	49	26	49	52	52
617.75	47	50	47	47	48	48	26	48	52	52
618.05	47	50	47	47	48	48	26	48	52	52
618.35	47	49	47	47	48	49	26	48	51	52
618.60	47	49	47	47	48	48	26	48	50	52
618.85	47	49	47	47	48	48	26	48	51	51
619.10	47	49	47	48	48	48	26	48	51	51
619.35	47	49	47	48	48	48	26	48	51	51
619.65	47	49	47	48	48	48	26	48	51	51
619.95	47	50	47	48	48	48	27	48	52	52
620.25	47	51	47	48	48	49	28	48	53	53

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
620.55	46	52	46	48	47	48	28	47	53	53
620.85	46	51	46	48	47	49	28	47	53	53
621.10	46	50	46	48	47	49	27	47	52	52
621.35	47	51	47	49	48	50	28	48	53	53
621.70	46	53	46	48	47	51	34	48	58	58
622.00	46	52	46	47	47	50	34	47	57	57
622.25	46	54	46	47	47	51	35	47	57	57
622.55	47	51	47	47	48	50	34	48	57	57
622.85	47	51	47	48	48	49	34	48	57	57
623.15	48	51	48	48	49	49	33	49	57	57
623.45	49	55	49	49	50	51	35	51	59	59
623.75	49	55	49	49	50	50	36	50	59	59
624.05	50	54	50	50	51	51	35	51	59	60
624.35	50	54	50	50	51	51	35	51	58	58
624.65	50	56	50	50	51	51	39	51	59	59
624.95	49	56	49	50	50	52	38	50	59	59
625.25	49	56	49	49	50	52	37	50	59	59
625.60	49	55	49	49	50	51	37	50	59	59
625.90	49	55	49	50	50	52	37	50	60	60
626.15	49	55	49	50	50	52	37	50	59	59
626.50	49	55	49	49	50	52	37	50	57	58
626.85	49	55	49	49	50	52	38	50	57	58
627.10	50	56	50	50	51	53	38	51	57	58
627.35	50	56	50	50	51	52	38	51	57	58
627.70	50	56	50	50	51	52	38	51	57	58
628.00	48	55	48	49	49	52	38	49	58	59
628.25	55	61	55	56	56	58	39	56	65	65
628.55	55	61	55	55	56	58	40	56	65	65
628.85	54	60	54	54	55	57	39	55	64	64
629.10	53	60	53	54	54	57	40	54	64	64
629.40	53	60	53	54	54	57	40	54	64	64
629.75	52	59	52	54	53	57	40	53	63	64
630.05	52	59	52	53	53	57	40	53	62	63
630.35	51	58	51	52	52	55	41	52	63	64
630.70	50	57	51	51	52	54	41	52	60	62
631.00	47	54	47	48	48	52	39	50	59	61
631.25	45	53	45	46	46	51	39	46	57	58
631.55	45	53	45	46	46	51	39	46	57	58
631.85	44	52	44	45	45	50	39	45	56	57
632.10	44	52	44	44	45	49	39	45	56	57
632.35	44	51	44	44	45	49	39	45	55	56
632.70	44	50	44	44	45	47	39	45	55	56
633.00	44	50	44	44	45	47	39	45	54	55
633.25	41	49	42	43	43	46	39	43	53	54
633.55	41	49	41	41	42	46	39	42	53	55
633.85	40	49	40	42	40	45	38	41	51	53
634.15	41	49	41	41	41	43	38	42	50	51
634.45	42	49	42	42	43	44	37	43	51	52
634.75	41	49	41	42	42	44	37	42	49	50
635.05	41	49	41	42	42	44	37	42	49	50

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
635.40	41	49	41	42	42	44	37	42	49	50
635.75	41	48	41	41	42	43	37	42	50	51
636.05	41	48	41	41	42	43	36	42	50	51

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	4	4	4	4	4	4	0	4	4	4
596.65	4	4	4	4	4	4	0	4	4	4
596.95	2	2	2	2	2	2	0	2	2	2
597.25	2	2	2	2	2	2	0	2	2	2
597.55	2	2	2	2	2	2	0	2	2	2
597.85	1	1	1	1	1	1	0	1	1	1
598.15	1	1	1	1	1	1	0	1	1	1
598.45	1	1	1	1	1	1	0	1	1	1
598.75	0	0	0	0	0	0	0	0	0	0
599.05	0	0	0	0	0	0	0	0	0	0
599.35	0	0	0	0	0	0	0	0	0	0
599.65	0	0	0	0	0	0	0	0	0	0
599.95	0	0	0	0	0	0	0	0	0	0
600.25	0	0	0	0	0	0	0	0	0	0
600.60	0	0	0	0	0	0	0	0	0	0
600.90	0	0	0	0	0	0	0	0	0	0
601.15	0	0	0	0	0	0	0	0	0	0
601.45	0	0	0	0	0	0	0	0	0	0
601.75	0	0	0	0	0	0	0	0	0	0
602.05	0	0	0	0	0	0	0	0	0	0
602.35	0	0	0	0	0	0	0	0	0	0
602.70	0	0	0	0	0	0	0	0	0	0
603.05	0	0	0	0	0	0	5	5	0	5
603.40	0	0	4	0	8	0	14	14	0	14
603.75	0	0	0	0	6	0	9	9	0	9
604.30	5	5	5	5	5	5	3	6	8	8
604.51	5	5	5	5	5	5	3	6	7	8
604.85	4	5	5	5	5	5	3	5	5	7
605.09	4	5	5	5	5	5	3	5	5	6
605.29	4	5	5	5	5	5	2	5	5	5

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
605.55	4	5	4	4	4	5	2	4	5	5
605.80	13	14	13	13	13	14	9	13	14	14
606.05	13	14	14	13	14	13	10	14	14	15
606.30	34	35	35	34	35	34	10	35	35	36
606.50	34	34	34	34	34	34	10	35	35	36
606.75	34	34	35	34	35	34	10	35	35	36
607.05	34	34	34	34	34	34	10	35	35	36
607.55	34	34	34	34	34	34	10	35	35	36
608.10	34	34	34	34	34	34	10	35	34	35
608.50	37	39	37	37	37	38	15	38	39	40
608.85	36	38	36	36	36	37	14	36	38	38
609.15	36	38	36	36	36	37	14	36	38	38
609.45	36	38	36	36	36	38	14	36	38	38
609.80	37	39	37	38	37	39	15	37	39	39
610.10	37	37	37	37	37	37	14	37	38	38
610.40	36	38	36	37	36	38	15	36	38	38
610.85	36	38	36	37	36	37	15	36	38	38
611.30	34	35	34	35	34	35	15	35	35	36
611.65	33	35	33	34	33	35	15	33	35	35
611.95	30	33	30	32	30	33	15	30	33	33
612.30	30	33	30	31	30	33	15	30	34	34
612.60	29	33	29	30	29	32	16	29	33	33
612.80	29	33	29	30	29	33	16	29	33	33
613.05	29	33	29	31	29	33	16	29	33	33
613.30	28	33	28	30	28	32	16	29	33	33
613.55	29	32	29	30	29	32	16	29	32	32
613.80	29	32	29	30	29	32	15	29	32	32
614.00	28	31	28	29	28	31	14	28	31	31
614.30	28	31	28	29	28	31	14	28	31	31
614.65	28	31	28	29	28	30	14	28	31	31
614.95	29	31	29	29	29	30	14	29	31	31
615.20	29	30	29	29	29	30	14	29	32	32
615.45	29	30	29	29	29	30	14	29	32	32
615.75	29	31	29	29	29	30	14	29	33	33
616.05	29	32	29	29	29	32	14	29	33	33
616.35	29	31	29	30	29	31	14	29	32	32
616.65	30	31	30	30	30	31	14	30	32	32
616.90	30	31	30	30	30	31	14	30	32	32
617.10	30	31	30	30	30	31	14	30	31	31
617.40	30	31	30	30	30	31	14	30	31	31
617.75	30	31	30	30	30	31	15	30	31	31
618.05	30	31	30	30	30	31	15	30	31	31
618.35	30	31	30	30	30	31	15	30	31	31
618.60	29	31	29	30	29	31	14	29	31	31
618.85	30	31	30	30	30	31	15	30	31	31
619.10	29	31	29	30	29	31	15	29	31	31
619.35	29	31	29	30	29	30	15	29	31	31
619.65	29	31	29	30	29	30	15	29	31	31
619.95	29	31	29	30	29	30	15	29	31	31
620.25	29	31	29	30	29	30	15	29	31	31

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
620.55	28	31	28	29	28	30	15	29	31	31
620.85	28	31	28	29	28	29	15	28	31	31
621.10	28	31	28	29	28	29	14	28	31	31
621.35	27	30	27	28	27	28	13	27	30	31
621.70	27	30	27	28	27	29	13	27	30	30
622.00	27	29	27	28	27	29	12	27	30	30
622.25	27	29	27	28	27	29	12	27	30	30
622.55	26	28	26	27	26	27	12	26	29	30
622.85	26	28	26	27	26	27	12	26	29	29
623.15	26	27	26	27	26	27	11	26	29	29
623.45	25	27	25	26	25	26	11	25	28	28
623.75	25	26	25	26	25	26	11	25	27	27
624.05	25	26	25	26	25	26	11	25	27	27
624.35	24	25	24	25	24	25	11	24	25	25
624.65	24	25	24	25	24	25	11	24	25	25
624.95	24	25	24	25	24	25	12	24	25	25
625.25	24	25	24	25	24	25	12	24	25	25
625.60	24	25	24	25	24	25	12	24	25	25
625.90	24	25	24	25	24	25	12	24	25	25
626.15	24	25	24	25	24	25	12	24	25	25
626.50	23	25	23	25	23	25	12	24	26	26
626.85	23	25	23	24	23	25	12	23	26	26
627.10	23	24	23	24	23	24	12	23	26	26
627.35	22	24	22	24	23	24	12	23	25	25
627.70	21	24	21	24	21	24	12	22	25	25
628.00	21	24	21	23	21	24	11	21	25	25
628.25	21	23	21	23	21	23	12	21	25	25
628.55	21	23	21	23	21	23	12	21	24	24
628.85	21	23	21	22	21	23	12	21	24	24
629.10	21	23	21	22	21	23	12	21	24	24
629.40	21	23	21	22	21	23	12	21	24	24
629.75	21	23	21	22	21	23	12	21	24	24
630.05	21	23	21	21	21	22	12	21	24	24
630.35	21	23	21	21	21	22	12	21	24	24
630.70	20	22	20	21	20	22	12	20	24	24
631.00	20	22	20	21	20	22	12	20	24	24
631.25	20	22	20	20	20	22	12	20	24	24
631.55	20	22	20	20	20	22	12	20	24	24
631.85	19	22	19	20	19	21	12	20	23	23
632.10	19	21	19	20	19	21	12	19	22	23
632.35	19	21	19	20	19	21	12	19	22	22
632.70	19	21	19	19	19	21	12	19	21	22
633.00	18	20	18	18	18	20	11	18	20	20
633.25	18	20	18	18	18	20	11	18	20	20
633.55	18	20	18	18	18	19	11	18	20	20
633.85	18	20	18	18	18	19	11	18	20	20
634.15	18	19	18	18	18	19	11	18	20	20
634.45	18	19	18	18	18	19	11	18	20	20
634.75	18	19	18	18	18	19	11	18	20	20
635.05	18	19	18	18	18	19	11	18	20	20

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: Daily Maximum Concentration
Numeric Criteria: ***5*WQS (1,200 cfu/100 ml)***

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
635.40	18	19	18	18	18	19	11	18	19	20
635.75	18	19	18	18	18	19	11	18	19	19
636.05	18	19	18	18	18	19	11	18	19	19

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	6	6	6	6	6	6	0	6	6	6
596.65	5	5	5	5	5	5	0	5	5	5
596.95	4	4	4	4	4	4	0	4	4	4
597.25	4	4	4	4	4	4	0	4	4	4
597.55	4	4	4	4	4	4	0	4	4	4
597.85	4	4	4	4	4	4	0	4	4	4
598.15	4	4	4	4	4	4	0	4	4	4
598.45	3	3	3	3	3	3	0	3	3	3
598.75	3	3	3	3	3	3	0	3	3	3
599.05	3	3	3	3	3	3	0	3	3	3
599.35	3	3	3	3	3	3	0	3	3	3
599.65	3	3	3	3	3	3	0	3	3	3
599.95	3	3	3	3	3	3	0	3	3	3
600.25	3	3	3	3	3	3	0	3	3	3
600.60	1	1	1	1	1	1	0	1	1	1
600.90	1	1	1	1	1	1	0	1	1	1
601.15	1	1	1	1	1	1	0	1	1	1
601.45	1	1	1	1	1	1	0	1	1	1
601.75	1	1	1	1	1	1	0	1	1	1
602.05	1	1	1	1	1	1	0	1	1	1
602.35	1	1	1	1	1	1	0	1	1	1
602.70	1	1	1	1	1	1	0	1	1	1
603.05	1	1	1	1	1	1	2	3	1	3
603.40	1	1	3	1	8	1	8	9	1	9
603.75	1	1	1	1	7	1	7	8	1	8
604.30	6	6	6	6	6	6	5	6	6	6
604.51	6	6	6	6	6	6	5	6	6	6
604.85	6	6	6	6	6	6	5	6	6	6
605.09	6	6	6	6	6	6	4	6	6	6
605.29	6	6	6	6	6	6	4	6	6	6

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
605.55	5	6	5	5	5	6	4	6	6	6
605.80	16	18	16	17	16	18	10	16	18	20
606.05	15	18	16	17	16	18	12	18	18	21
606.30	44	45	44	45	44	45	10	45	45	46
606.50	44	45	44	45	44	45	10	45	45	46
606.75	44	45	44	45	44	45	10	45	45	46
607.05	44	45	44	45	44	45	10	45	45	46
607.55	44	45	44	45	44	45	10	45	45	46
608.10	44	45	44	45	44	45	10	45	45	46
608.50	47	47	47	47	47	47	15	47	48	48
608.85	46	47	46	47	46	47	17	46	47	47
609.15	45	47	45	47	45	47	17	45	47	47
609.45	51	51	51	51	51	51	17	51	51	51
609.80	51	51	51	51	51	51	18	51	51	51
610.10	47	47	48	47	48	47	19	48	47	48
610.40	47	47	47	47	47	47	19	47	47	47
610.85	46	46	46	46	46	46	19	46	46	46
611.30	43	44	43	44	43	44	20	43	44	44
611.65	43	44	43	44	43	44	20	43	44	44
611.95	43	44	43	44	43	44	20	43	44	44
612.30	42	44	42	44	42	44	20	42	44	44
612.60	42	44	42	42	42	44	20	42	44	44
612.80	42	43	42	42	42	43	20	42	44	44
613.05	41	43	42	41	42	43	19	42	43	43
613.30	40	43	40	41	42	42	18	42	43	43
613.55	40	42	40	40	40	41	18	41	43	43
613.80	40	41	40	40	40	40	18	41	42	43
614.00	40	40	40	40	40	40	18	40	41	41
614.30	40	40	40	40	40	40	19	40	41	41
614.65	40	40	40	40	40	40	18	40	41	41
614.95	40	40	40	40	40	40	19	40	41	41
615.20	40	40	40	40	40	40	18	40	40	40
615.45	40	40	40	40	40	40	17	40	40	40
615.75	40	40	40	40	40	40	17	40	40	40
616.05	40	40	40	40	40	40	16	40	40	40
616.35	40	40	40	40	40	40	16	40	40	40
616.65	40	40	40	40	40	40	16	40	40	40
616.90	40	40	40	40	40	40	17	40	40	40
617.10	40	40	40	40	40	40	16	40	40	40
617.40	39	40	39	40	39	40	16	39	40	40
617.75	38	40	39	40	39	40	17	39	40	40
618.05	38	39	38	39	38	39	16	38	40	40
618.35	38	39	38	39	38	39	15	38	39	39
618.60	38	39	38	39	38	39	15	38	39	39
618.85	37	38	37	38	37	38	17	37	38	38
619.10	37	38	37	38	37	38	17	37	38	38
619.35	37	38	37	37	37	38	16	37	38	38
619.65	37	38	37	37	37	38	15	37	38	38
619.95	36	37	36	36	36	37	17	37	37	38
620.25	35	36	35	35	35	36	17	35	36	36

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
620.55	35	36	35	35	35	36	17	35	36	36
620.85	36	37	36	36	36	37	17	36	37	37
621.10	35	37	35	35	35	36	16	35	38	38
621.35	34	36	34	34	34	34	17	34	37	37
621.70	33	37	33	34	33	37	20	33	38	38
622.00	33	37	33	34	33	34	19	33	39	39
622.25	32	37	32	35	32	35	20	32	39	39
622.55	32	37	32	33	32	35	20	32	39	39
622.85	32	35	32	32	32	35	19	32	39	39
623.15	32	35	32	33	32	34	19	32	38	38
623.45	32	35	32	33	32	35	20	32	38	38
623.75	31	34	31	32	31	34	20	31	37	37
624.05	31	34	31	32	31	33	20	31	37	37
624.35	31	33	31	32	31	32	19	31	36	36
624.65	32	34	32	32	32	32	20	32	36	36
624.95	32	34	32	32	32	32	20	32	36	36
625.25	32	33	32	32	32	32	20	32	36	36
625.60	31	32	31	32	31	32	20	32	36	36
625.90	31	33	31	32	31	32	20	31	36	36
626.15	31	33	31	31	31	32	20	31	35	35
626.50	31	32	31	31	31	32	20	31	35	35
626.85	31	32	31	31	31	31	20	31	35	35
627.10	31	32	31	31	31	31	19	31	35	35
627.35	31	32	31	31	31	31	19	31	34	34
627.70	31	32	31	31	31	31	18	31	34	34
628.00	30	33	30	31	30	31	18	30	33	33
628.25	33	37	33	33	33	36	20	33	38	38
628.55	33	37	33	34	33	36	20	33	38	38
628.85	33	37	33	34	33	36	19	33	37	37
629.10	33	36	33	34	33	34	20	33	37	37
629.40	32	35	32	33	32	34	20	32	36	36
629.75	31	34	31	31	31	33	19	31	35	35
630.05	30	34	30	31	30	32	18	30	34	34
630.35	30	34	30	30	30	32	19	30	34	34
630.70	30	33	30	30	30	33	18	30	33	33
631.00	30	33	30	30	30	32	18	30	33	33
631.25	30	33	30	30	30	32	18	30	33	33
631.55	29	31	29	29	29	31	17	29	32	32
631.85	29	31	29	29	29	31	16	29	32	32
632.10	29	31	29	29	29	30	16	29	31	31
632.35	29	32	29	29	29	30	16	29	32	32
632.70	29	32	29	29	29	31	17	29	32	32
633.00	29	33	29	30	29	32	17	29	33	33
633.25	29	32	29	30	29	31	17	29	32	32
633.55	29	31	29	30	29	31	16	29	32	32
633.85	29	31	29	30	29	31	16	29	32	32
634.15	29	31	29	30	29	31	16	29	32	32
634.45	30	31	30	30	30	31	16	30	32	32
634.75	29	31	29	30	29	31	16	29	31	31
635.05	29	31	29	29	29	31	16	29	31	31

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: Entire Day
Model Result: ***Daily Average Concentration***
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
635.40	27	31	27	29	27	30	16	27	31	31
635.75	27	31	27	28	27	30	16	27	31	31
636.05	27	30	27	28	27	29	16	27	31	31

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	0	0	0	0	0	0	0	0	0	0
590.45	0	0	0	0	0	0	0	0	0	0
590.75	0	0	0	0	0	0	0	0	0	0
591.05	0	0	0	0	0	0	0	0	0	0
591.35	0	0	0	0	0	0	0	0	0	0
591.65	0	0	0	0	0	0	0	0	0	0
591.95	0	0	0	0	0	0	0	0	0	0
592.30	0	0	0	0	0	0	0	0	0	0
592.60	0	0	0	0	0	0	0	0	0	0
592.85	0	0	0	0	0	0	0	0	0	0
593.15	0	0	0	0	0	0	0	0	0	0
593.45	0	0	0	0	0	0	0	0	0	0
593.80	0	0	0	0	0	0	0	0	0	0
594.15	0	0	0	0	0	0	0	0	0	0
594.45	0	0	0	0	0	0	0	0	0	0
594.75	0	0	0	0	0	0	0	0	0	0
595.05	0	0	0	0	0	0	0	0	0	0
595.40	0	0	0	0	0	0	0	0	0	0
595.75	0	0	0	0	0	0	0	0	0	0
596.00	0	0	0	0	0	0	0	0	0	0
596.30	8	8	8	8	8	8		8	8	8
596.65	6	6	6	6	6	6		6	6	6
596.95	5	5	5	5	5	5		5	5	5
597.25	5	5	5	5	5	5		5	5	5
597.55	5	5	5	5	5	5		5	5	5
597.85	5	5	5	5	5	5		5	5	5
598.15	5	5	5	5	5	5		5	5	5
598.45	4	4	4	4	4	4		4	4	4
598.75	3	3	3	3	3	3		3	3	3
599.05	3	3	3	3	3	3		3	3	3
599.35	3	3	3	3	3	3		3	3	3
599.65	3	3	3	3	3	3		3	3	3
599.95	3	3	3	3	3	3		3	3	3
600.25	3	3	3	3	3	3		3	3	3
600.60	3	3	3	3	3	3		3	3	3
600.90	2	2	2	2	2	2		2	2	2
601.15	2	2	2	2	2	2	1	3	2	3
601.45	2	2	2	2	2	2		2	2	2
601.75	2	2	2	2	2	2		2	2	2
602.05	1	1	1	1	1	1		1	1	1
602.35	1	1	1	1	1	1	4	6	1	6
602.70	1	1	1	1	1	1	2	3	1	3
603.05	1	1	3	1	5	1	5	7	1	7
603.40	1	1	9	1	11	1	12	13	1	13
603.75	2	2	5	2	9	2	11	13	2	13
604.30	7	8	7	8	8	8	6	9	8	9
604.51	7	8	7	8	7	8	6	9	8	9
604.85	7	8	7	7	7	8	6	9	8	9
605.09	7	8	7	7	7	8	6	9	8	9
605.29	7	8	7	7	7	8	6	9	8	9

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
605.55	7	8	7	7	7	7	6	9	8	9
605.80	15	16	15	15	15	15	12	15	17	17
606.05	15	16	19	15	19	15	16	20	17	22
606.30	45	47	47	45	47	46	16	47	48	51
606.50	44	46	47	44	47	45	16	48	47	51
606.75	42	45	44	42	44	43	16	45	46	49
607.05	42	44	44	42	44	43	16	45	45	48
607.55	41	42	43	41	43	42	15	44	44	47
608.10	40	41	42	40	42	41	12	43	43	46
608.50	44	45	45	44	45	45	20	46	49	52
608.85	44	45	45	45	45	45	20	46	48	49
609.15	44	45	45	44	45	45	20	46	47	50
609.45	48	51	49	49	49	50	20	50	52	54
609.80	49	51	50	50	51	51	21	51	52	54
610.10	48	51	49	49	50	51	22	50	52	54
610.40	47	49	48	48	49	49	21	49	51	53
610.85	47	50	48	48	49	49	21	49	51	53
611.30	44	46	44	45	45	45	22	46	47	48
611.65	44	46	44	45	45	45	22	46	47	48
611.95	44	45	44	45	45	45	22	46	48	49
612.30	44	46	44	45	45	45	21	46	48	49
612.60	44	46	44	45	45	46	21	46	48	49
612.80	44	46	44	46	45	46	21	46	48	49
613.05	44	46	44	46	45	46	22	46	47	48
613.30	45	46	45	45	46	46	21	47	47	48
613.55	45	46	45	45	46	46	20	46	47	47
613.80	44	45	44	44	45	45	20	45	46	46
614.00	44	46	44	44	45	45	20	45	46	46
614.30	44	46	44	44	45	45	20	45	46	46
614.65	44	46	44	44	45	45	20	45	46	46
614.95	44	46	44	44	45	45	21	45	46	46
615.20	44	46	44	44	45	45	20	45	46	46
615.45	44	46	44	44	45	45	20	45	46	46
615.75	44	46	44	44	45	45	20	45	46	46
616.05	44	46	44	44	45	45	20	45	46	46
616.35	44	46	44	44	45	45	20	45	46	46
616.65	43	45	43	43	44	44	20	44	46	46
616.90	43	44	43	43	44	44	20	44	45	46
617.10	43	44	43	43	44	44	20	44	45	45
617.40	42	44	42	43	43	44	20	43	45	45
617.75	42	44	42	43	43	44	20	43	45	45
618.05	42	44	42	42	43	44	21	43	44	45
618.35	42	43	42	42	43	43	21	43	44	45
618.60	42	43	42	42	43	42	20	43	43	44
618.85	42	43	42	42	43	42	20	43	43	44
619.10	42	43	42	42	43	42	20	43	43	44
619.35	42	43	42	42	43	42	20	43	43	44
619.65	42	43	42	42	43	42	20	43	43	44
619.95	42	43	42	42	43	42	20	43	43	44
620.25	42	43	42	42	43	42	21	43	43	44

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
620.55	41	43	41	41	42	42	21	42	43	44
620.85	40	42	40	40	41	40	21	42	42	43
621.10	40	40	40	40	41	40	22	41	42	43
621.35	41	42	41	41	42	41	22	42	43	44
621.70	40	42	40	40	40	41	23	41	43	44
622.00	40	41	40	40	40	41	24	41	42	43
622.25	38	40	38	39	38	40	25	40	42	43
622.55	38	40	38	38	38	40	24	39	42	44
622.85	38	40	38	38	38	40	24	39	43	44
623.15	38	40	38	39	38	40	24	39	43	44
623.45	36	39	36	38	36	39	27	37	43	45
623.75	39	42	39	40	39	41	28	39	46	47
624.05	39	42	39	40	39	41	26	39	45	48
624.35	38	42	38	39	38	42	26	38	45	46
624.65	36	42	36	37	36	39	31	36	44	44
624.95	35	43	35	36	35	38	31	35	44	44
625.25	35	42	35	36	35	38	31	35	44	44
625.60	35	43	35	36	35	39	31	35	45	45
625.90	34	42	34	35	34	38	31	34	45	45
626.15	34	41	34	34	34	38	31	34	44	44
626.50	35	41	35	36	35	39	30	35	44	44
626.85	35	41	35	36	35	39	29	35	45	45
627.10	36	41	36	36	36	39	30	36	44	44
627.35	36	42	36	36	36	40	30	36	44	44
627.70	36	42	36	37	36	38	30	36	44	44
628.00	36	42	36	37	36	38	29	36	44	44
628.25	39	45	39	39	39	42	30	39	48	48
628.55	39	45	39	39	39	41	30	39	48	48
628.85	39	44	39	39	39	42	30	39	46	46
629.10	38	44	38	38	38	42	30	38	47	47
629.40	38	44	38	38	38	42	30	38	47	47
629.75	38	44	38	38	38	42	31	38	47	47
630.05	38	44	38	38	38	42	30	38	46	46
630.35	38	44	38	38	38	42	31	38	46	46
630.70	38	44	38	38	38	43	30	38	45	45
631.00	37	44	37	37	37	41	29	37	45	45
631.25	37	44	37	37	37	41	30	37	45	45
631.55	37	43	37	37	37	41	30	37	46	46
631.85	36	42	36	36	36	41	33	36	46	46
632.10	36	42	36	36	36	39	31	36	46	46
632.35	36	42	36	36	36	39	32	36	44	44
632.70	36	41	36	36	36	38	31	36	43	43
633.00	36	41	36	36	36	38	31	36	43	43
633.25	34	40	34	35	34	37	29	34	42	42
633.55	34	40	34	34	34	37	30	34	42	43
633.85	34	40	34	34	34	36	30	35	42	43
634.15	34	39	34	34	34	35	29	35	41	42
634.45	34	39	34	34	34	35	28	34	40	40
634.75	33	38	33	33	33	34	27	33	39	39
635.05	33	37	33	33	33	34	26	33	39	39

Appendix L. Days of Exceedance of *E. coli* Criterion On Right Bank (IN side) of Ohio River

Time Period Considered: ***Daylight Only (8:30 a.m. - 9:30 p.m.)***
Model Result: Daily Maximum Concentration
Numeric Criteria: WQS (240 cfu/100 ml)

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
635.40	33	38	33	34	33	35	26	33	40	40
635.75	33	36	33	33	33	34	26	33	39	40
636.05	33	35	33	33	33	34	25	33	38	39

APPENDIX M

MODEL-SIMULATED PEAK CONCENTRATIONS DURING MAY 7, 2001 STORM EVENT

Appendix M. Peak Fecal Coliform Concentrations During May 7, 2001 Storm Event In Left Bank (KY side) of the Ohio River.

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	11	11	11	11	11	11	11	11	11	11
590.45	10	10	10	10	10	10	10	10	10	10
590.75	10	10	10	10	10	10	10	10	10	10
591.05	10	10	10	10	10	10	10	10	10	10
591.35	10	10	10	10	10	10	10	10	10	10
591.65	9	9	9	9	9	9	9	9	9	9
591.95	9	9	9	9	9	9	9	9	9	9
592.30	9	9	9	9	9	9	9	9	9	9
592.60	9	9	9	9	9	9	9	9	9	9
592.85	9	9	9	9	9	9	9	9	9	9
593.15	8	8	8	8	8	8	8	8	8	8
593.45	8	8	8	8	8	8	8	8	8	8
593.80	8	8	8	8	8	8	8	8	8	8
594.15	8	8	8	8	8	8	8	8	8	8
594.45	8	8	8	8	8	8	8	8	8	8
594.75	7	7	7	7	7	7	7	7	7	7
595.05	7	7	7	7	7	7	7	7	7	7
595.40	7	7	7	7	7	7	7	7	7	7
595.75	7	7	7	7	7	7	7	7	7	7
596.00	194	194	194	194	194	194	7	194	194	194
596.30	167	167	167	167	167	167	6	167	167	167
596.65	145	145	145	145	145	145	6	145	145	145
596.95	119	119	119	119	119	119	6	119	119	119
597.25	103	103	103	103	103	103	6	103	103	103
597.55	100	100	100	100	100	100	6	100	100	100
597.85	85	85	85	85	85	85	6	85	85	85
598.15	128	128	128	128	128	128	6	128	128	128
598.45	115	115	115	115	115	115	5	115	115	115
598.75	88	88	88	88	88	88	5	88	88	88
599.05	92	92	92	92	92	92	5	92	92	92
599.35	77	77	77	77	77	77	5	77	77	77
599.65	74	74	74	74	74	74	5	74	74	74
599.95	70	70	70	70	70	70	5	70	70	70
600.25	66	66	66	66	66	66	5	66	66	66
600.60	62	62	62	62	62	62	5	62	62	62
600.90	56	56	56	56	56	56	4	56	56	56
601.15	54	54	54	54	54	54	4	54	54	54
601.45	51	51	51	51	51	51	4	51	51	51
601.75	48	48	48	48	48	48	4	48	48	48
602.05	43,500	64,100	43,500	51,800	43,500	60,100	33,300	43,500	76,800	76,800
602.35	37,200	54,900	37,200	44,300	37,200	51,400	28,500	37,200	65,700	65,700
602.70	27,300	40,200	27,300	32,500	27,300	37,700	20,900	27,300	48,200	48,200
603.05	24,000	35,300	24,000	28,600	24,000	33,100	18,400	24,000	42,300	42,300
603.40	14,900	22,000	14,900	17,800	14,900	20,600	11,400	14,900	26,300	26,300
603.75	13,600	20,100	13,600	16,200	13,600	18,800	10,400	13,600	24,000	24,000
604.81	10,300	15,200	10,300	12,300	10,300	14,200	7,880	10,300	18,200	18,200
606.65	7,060	10,400	7,060	8,410	7,060	9,760	5,390	7,060	12,500	12,500
607.05	6,510	9,600	6,510	7,750	6,510	8,990	4,970	6,510	11,500	11,500
607.55	6,290	9,270	6,290	7,490	6,290	8,690	4,800	6,290	11,100	11,100
608.10	3,000	4,430	3,010	3,580	3,010	4,150	2,300	3,010	5,300	5,310
608.50	2,980	4,400	2,990	3,550	2,990	4,120	2,290	2,990	5,260	5,270
608.85	2,960	4,370	2,960	3,530	2,970	4,090	2,270	2,970	5,220	5,230
609.15	2,940	4,330	2,940	3,500	2,940	4,060	2,260	2,950	5,180	5,190

609.45	2,880	4,240	2,880	3,430	2,880	3,980	2,210	2,890	5,070	5,080
609.80	2,850	4,200	2,850	3,400	2,860	3,940	2,190	2,860	5,030	5,040
610.10	2,810	4,130	2,810	3,340	2,810	3,870	2,150	2,810	4,940	4,950
610.40	2,750	4,050	2,750	3,270	2,760	3,800	2,100	2,760	4,840	4,850
610.85	2,620	3,850	2,630	3,120	2,630	3,610	1,990	2,640	4,600	4,610
611.30	2,640	3,840	2,650	3,120	2,650	3,600	1,930	2,660	4,570	4,580
611.65	2,640	3,810	2,640	3,110	2,640	3,580	1,900	2,650	4,520	4,530
611.95	2,600	3,740	2,600	3,060	2,610	3,520	1,860	2,610	4,440	4,450
612.30	4,310	5,430	4,320	4,760	4,320	5,210	4,750	4,330	6,110	6,120
612.60	4,280	5,390	4,290	4,730	4,290	5,170	3,950	4,290	6,060	6,070
612.80	4,130	5,220	4,130	4,570	4,130	5,010	3,380	4,140	5,890	5,900
613.05	4,090	15,100	4,090	5,250	4,100	10,200	19,900	4,100	20,100	20,100
613.30	4,050	13,200	4,060	4,610	4,060	8,930	17,300	4,070	17,600	17,600
613.55	4,020	11,800	4,020	4,450	4,030	8,190	15,800	4,030	16,100	16,100
613.80	3,850	11,100	3,850	4,270	3,850	7,650	14,800	3,860	15,000	15,000
614.00	3,820	11,200	3,820	4,240	3,830	7,700	14,800	3,830	15,100	15,100
614.30	3,780	10,200	3,780	4,200	3,790	6,970	13,400	3,790	13,700	13,700
614.65	3,670	8,570	3,680	4,080	3,680	5,970	11,400	3,690	11,700	11,700
614.95	3,430	6,660	3,430	3,830	3,430	4,650	8,770	3,440	9,030	9,030
615.20	3,400	6,710	3,410	3,810	3,410	4,660	8,800	3,420	9,060	9,060
615.45	3,370	6,360	3,380	3,780	3,380	4,400	8,260	3,390	8,520	8,520
615.75	3,340	5,810	3,340	3,730	3,340	4,130	7,650	3,350	7,900	7,900
616.05	3,280	5,680	3,280	3,670	3,280	4,060	7,440	3,290	7,690	7,690
616.35	3,250	5,510	3,250	3,640	3,250	4,020	7,160	3,260	7,410	7,410
616.65	8,070	12,200	8,070	9,470	8,070	10,900	5,850	8,070	13,700	13,700
616.90	7,250	11,000	7,250	8,360	7,250	9,720	5,580	7,250	12,500	12,500
617.10	7,270	10,600	7,270	8,420	7,270	9,590	5,600	7,270	12,100	12,100
617.40	7,190	10,700	7,190	8,390	7,190	9,610	5,450	7,190	12,100	12,100
617.75	6,980	10,600	6,980	8,230	6,980	9,500	5,080	6,980	12,000	12,000
618.05	6,850	10,400	6,850	7,970	6,850	9,260	5,170	6,850	11,800	11,800
618.35	6,870	10,100	6,870	7,990	6,870	9,120	5,170	6,870	11,500	11,500
618.60	6,800	10,200	6,800	7,960	6,800	9,120	5,030	6,800	11,500	11,500
618.85	6,250	9,590	6,250	7,390	6,250	8,540	4,660	6,250	10,800	10,800
619.10	5,420	8,580	5,420	6,490	5,420	7,580	4,390	5,420	9,770	9,770
619.35	4,640	7,300	4,640	5,540	4,640	6,450	3,970	4,640	8,370	8,370
619.65	4,610	7,290	4,610	5,530	4,610	6,460	3,850	4,610	8,310	8,310
619.95	4,520	7,240	4,520	5,450	4,520	6,390	3,780	4,520	8,270	8,270
620.25	4,310	7,010	4,310	5,230	4,310	6,160	3,720	4,310	8,020	8,020
620.55	4,320	6,850	4,320	5,190	4,320	6,060	3,650	4,320	7,810	7,810
620.85	4,280	6,840	4,280	5,160	4,280	6,040	3,620	4,280	7,800	7,800
621.10	4,180	6,740	4,180	5,060	4,180	5,940	3,560	4,180	7,700	7,700
621.35	3,960	6,410	3,960	4,780	3,960	5,630	3,430	3,960	7,330	7,330
621.70	3,210	5,330	3,210	3,940	3,210	4,670	2,990	3,210	6,120	6,120
622.00	2,990	5,010	2,990	3,680	2,990	4,380	2,850	2,990	5,780	5,780
622.25	2,920	4,910	2,920	3,600	2,920	4,290	2,800	2,920	5,660	5,660
622.55	2,750	4,650	2,750	3,400	2,750	4,050	2,680	2,750	5,360	5,360
622.85	2,740	4,620	2,740	3,380	2,740	4,030	2,660	2,740	5,330	5,330
623.15	2,670	4,520	2,670	3,310	2,670	3,940	2,620	2,670	5,220	5,220
623.45	2,600	4,410	2,600	3,220	2,600	3,840	2,570	2,600	5,080	5,080
623.75	2,570	4,360	2,570	3,180	2,570	3,800	2,530	2,570	5,040	5,040
624.05	2,550	4,190	2,550	3,060	2,550	3,650	2,450	2,560	4,840	4,840
624.35	2,520	4,100	2,520	3,000	2,520	3,570	2,420	2,530	4,730	4,730
624.65	2,500	3,950	2,500	2,860	2,500	3,430	2,340	2,510	4,570	4,570
624.95	5,710	5,710	5,710	5,710	5,710	5,710	2,260	5,710	5,710	5,710
625.25	5,600	5,600	5,600	5,600	5,600	5,600	2,240	5,600	5,600	5,600
625.60	3,720	3,720	3,720	3,720	3,720	3,720	2,020	3,720	3,940	3,940
625.90	3,650	3,650	3,650	3,650	3,650	3,650	1,980	3,650	3,910	3,910
626.15	3,130	3,170	3,130	3,130	3,130	3,130	1,870	3,130	3,650	3,650
626.50	3,030	3,110	3,030	3,040	3,030	3,040	1,860	3,030	3,580	3,580

626.85	2,880	3,070	2,880	2,870	2,880	2,920	1,830	2,880	3,550	3,550
627.10	2,900	3,040	2,900	2,900	2,900	2,900	1,810	2,900	3,510	3,510
627.35	2,730	2,980	2,730	2,730	2,730	2,870	1,760	2,730	3,380	3,380
627.70	2,390	2,960	2,390	2,620	2,400	2,840	1,690	2,400	3,320	3,330
628.00	2,370	2,940	2,380	2,590	2,380	2,830	1,640	2,390	3,300	3,310
628.25	2,340	2,910	2,340	2,570	2,350	2,800	1,620	2,360	3,250	3,270
628.55	2,320	2,870	2,320	2,540	2,330	2,760	1,600	2,330	3,220	3,230
628.85	2,310	2,850	2,310	2,520	2,310	2,740	1,560	2,320	3,190	3,210
629.10	2,280	2,830	2,280	2,500	2,290	2,720	1,540	2,300	3,160	3,170
629.40	2,260	2,790	2,260	2,470	2,260	2,690	1,530	2,270	3,120	3,130
629.75	2,240	2,760	2,240	2,450	2,250	2,660	1,500	2,260	3,100	3,110
630.05	2,270	2,790	2,280	2,480	2,280	2,680	1,390	2,290	3,110	3,130
630.35	2,250	2,760	2,250	2,450	2,260	2,660	1,370	2,260	3,080	3,100
630.70	2,210	2,720	2,220	2,420	2,220	2,620	1,350	2,230	3,030	3,050
631.00	2,220	2,710	2,220	2,410	2,220	2,610	1,290	2,230	3,020	3,030
631.25	2,190	2,680	2,190	2,380	2,190	2,580	1,270	2,200	2,990	3,000
631.55	2,160	2,650	2,160	2,350	2,160	2,550	1,260	2,170	2,950	2,960
631.85	2,140	2,610	2,140	2,330	2,140	2,520	1,240	2,150	2,910	2,920
632.10	2,110	2,580	2,120	2,300	2,120	2,490	1,220	2,130	2,880	2,890
632.35	2,080	2,560	2,090	2,270	2,090	2,460	1,210	2,100	2,850	2,860
632.70	2,100	2,560	2,100	2,280	2,100	2,470	1,140	2,110	2,840	2,850
633.00	2,070	2,520	2,080	2,250	2,080	2,430	1,120	2,090	2,810	2,820
633.25	2,060	2,510	2,060	2,230	2,070	2,420	1,070	2,070	2,780	2,790
633.55	2,040	2,480	2,040	2,220	2,050	2,400	1,050	2,050	2,750	2,770
633.85	2,010	2,440	2,020	2,190	2,020	2,360	1,030	2,030	2,720	2,730
634.15	1,990	2,420	1,990	2,150	1,990	2,330	1,010	2,000	2,680	2,690
634.45	1,960	2,390	1,970	2,130	1,970	2,300	996	1,970	2,650	2,660
634.75	1,940	2,360	1,950	2,110	1,950	2,280	983	1,960	2,620	2,630
635.05	1,920	2,330	1,920	2,080	1,920	2,250	970	1,930	2,590	2,600
635.40	1,890	2,300	1,900	2,060	1,900	2,220	943	1,900	2,550	2,560
635.75	1,880	2,270	1,880	2,040	1,880	2,190	917	1,890	2,520	2,530
636.05	1,850	2,250	1,860	2,010	1,860	2,170	892	1,860	2,490	2,500

Appendix M. Peak Fecal Coliform Concentrations During May 7, 2001 Storm Event In Center Channel of the Ohio River.

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	11	11	11	11	11	11	11	11	11	11
590.45	10	10	10	10	10	10	10	10	10	10
590.75	10	10	10	10	10	10	10	10	10	10
591.05	10	10	10	10	10	10	10	10	10	10
591.35	10	10	10	10	10	10	10	10	10	10
591.65	10	10	10	10	10	10	10	10	10	10
591.95	9	9	9	9	9	9	9	9	9	9
592.30	9	9	9	9	9	9	9	9	9	9
592.60	9	9	9	9	9	9	9	9	9	9
592.85	9	9	9	9	9	9	9	9	9	9
593.15	9	9	9	9	9	9	9	9	9	9
593.45	9	9	9	9	9	9	9	9	9	9
593.80	8	8	8	8	8	8	8	8	8	8
594.15	8	8	8	8	8	8	8	8	8	8
594.45	8	8	8	8	8	8	8	8	8	8
594.75	8	8	8	8	8	8	8	8	8	8
595.05	7	7	7	7	7	7	7	7	7	7
595.40	7	7	7	7	7	7	7	7	7	7
595.75	7	7	7	7	7	7	7	7	7	7
596.00	7	7	7	7	7	7	7	7	7	7
596.30	7	7	7	7	7	7	7	7	7	7
596.65	7	7	7	7	7	7	7	7	7	7
596.95	6	6	6	6	6	6	6	6	6	6
597.25	9	9	9	9	9	9	6	9	9	9
597.55	8	8	8	8	8	8	6	8	8	8
597.85	9	9	9	9	9	9	6	9	9	9
598.15	9	9	9	9	9	9	6	9	9	9
598.45	10	10	10	10	10	10	6	10	10	10
598.75	13	13	13	13	13	13	6	13	13	13
599.05	17	17	17	17	17	17	5	17	17	17
599.35	16	16	16	16	16	16	5	16	16	16
599.65	19	19	19	19	19	19	5	19	19	19
599.95	19	19	19	19	19	19	5	19	19	19
600.25	20	20	20	20	20	20	5	20	20	20
600.60	19	19	19	19	19	19	5	19	19	19
600.90	19	19	19	19	19	19	5	19	19	19
601.15	20	20	20	20	20	20	5	20	20	20
601.45	25	25	25	25	25	25	5	25	25	25
601.75	24	24	24	24	24	24	4	24	24	24
602.05	20	20	20	20	20	20	4	20	20	20
602.35	21	21	21	21	21	21	4	21	21	21
602.70	19	19	19	19	19	19	4	19	19	19
603.05	90	127	90	105	90	120	63	91	150	150
603.40	37	50	37	42	38	48	27	39	58	60
603.75	666	978	667	792	667	918	508	668	1,170	1,170
604.81	2,950	4,350	2,950	3,510	2,950	4,070	2,270	2,960	5,200	5,220
605.80	2,940	4,340	2,940	3,500	2,950	4,060	2,270	2,960	5,190	5,200
606.05	2,930	4,320	2,930	3,490	2,930	4,050	2,260	2,940	5,170	5,180
606.30	2,910	4,290	2,910	3,470	2,920	4,020	2,240	2,930	5,140	5,150
606.50	2,900	4,270	2,900	3,450	2,910	4,010	2,230	2,910	5,110	5,130
606.75	2,860	4,220	2,870	3,410	2,870	3,960	2,200	2,880	5,050	5,060
607.05	2,760	4,070	2,760	3,280	2,760	3,810	2,120	2,770	4,860	4,880
607.55	2,740	4,050	2,750	3,270	2,750	3,790	2,110	2,760	4,840	4,860

608.10	2,610	3,850	2,610	3,110	2,620	3,610	2,010	2,630	4,600	4,620
608.50	2,880	4,090	2,890	3,370	2,890	3,860	1,970	2,900	4,830	4,850
608.85	2,850	4,040	2,850	3,330	2,860	3,810	1,940	2,870	4,770	4,790
609.15	2,810	3,990	2,820	3,280	2,820	3,760	1,930	2,830	4,710	4,730
609.45	2,870	4,040	2,870	3,330	2,880	3,810	1,920	2,890	4,760	4,770
609.80	2,780	3,970	2,790	3,260	2,790	3,740	1,930	2,800	4,690	4,710
610.10	2,740	3,910	2,740	3,210	2,750	3,680	1,910	2,760	4,630	4,650
610.40	3,040	4,170	3,040	3,490	3,050	3,950	1,860	3,060	4,860	4,880
610.85	3,210	4,320	3,220	3,660	3,220	4,110	1,850	3,240	5,000	5,020
611.30	3,060	4,170	3,070	3,500	3,070	3,950	1,830	3,080	4,860	4,870
611.65	3,200	4,290	3,210	3,630	3,210	4,070	1,790	3,230	4,950	4,970
611.95	3,180	4,250	3,180	3,610	3,190	4,040	1,770	3,200	4,900	4,920
612.30	3,440	4,460	3,440	3,850	3,450	4,260	1,730	3,460	5,090	5,110
612.60	3,360	4,360	3,360	3,760	3,370	4,160	1,710	3,380	5,000	5,010
612.80	3,330	4,340	3,340	3,730	3,340	4,130	1,700	3,350	4,970	4,990
613.05	3,250	4,270	3,260	3,660	3,270	4,070	1,700	3,280	4,900	4,920
613.30	3,290	4,290	3,290	3,690	3,300	4,090	1,680	3,310	4,900	4,920
613.55	3,360	4,340	3,370	3,760	3,370	4,150	1,660	3,390	4,940	4,960
613.80	3,370	4,330	3,380	3,760	3,390	4,140	1,640	3,400	4,930	4,950
614.00	3,290	4,260	3,300	3,670	3,310	4,060	1,670	3,320	4,860	4,880
614.30	3,240	4,210	3,240	3,630	3,250	4,020	1,680	3,260	4,800	4,820
614.65	3,220	4,170	3,220	3,600	3,230	3,980	1,660	3,240	4,740	4,770
614.95	4,570	5,370	4,570	4,890	4,580	5,210	1,500	4,600	5,860	5,890
615.20	4,130	4,960	4,140	4,450	4,150	4,790	1,580	4,170	5,490	5,520
615.45	4,020	4,860	4,020	4,350	4,030	4,690	1,590	4,050	5,370	5,400
615.75	4,040	4,850	4,050	4,370	4,050	4,690	1,570	4,070	5,370	5,400
616.05	4,030	4,830	4,040	4,350	4,050	4,660	1,540	4,060	5,350	5,370
616.35	3,990	4,790	4,000	4,290	4,000	4,630	1,530	4,020	5,290	5,320
616.65	3,930	4,730	3,940	4,250	3,950	4,570	1,520	3,960	5,220	5,240
616.90	3,900	4,670	3,910	4,210	3,910	4,520	1,500	3,930	5,180	5,200
617.10	3,900	4,670	3,910	4,200	3,920	4,510	1,480	3,930	5,160	5,180
617.40	3,900	4,660	3,910	4,190	3,920	4,510	1,470	3,930	5,140	5,160
617.75	3,750	4,510	3,750	4,050	3,760	4,360	1,490	3,770	4,990	5,010
618.05	3,670	4,430	3,670	3,960	3,680	4,270	1,490	3,690	4,910	4,930
618.35	3,670	4,430	3,680	3,960	3,690	4,270	1,470	3,700	4,900	4,920
618.60	3,620	4,370	3,620	3,920	3,630	4,220	1,470	3,640	4,830	4,850
618.85	3,580	4,310	3,590	3,870	3,590	4,170	1,460	3,600	4,790	4,810
619.10	3,570	4,300	3,580	3,860	3,590	4,150	1,440	3,600	4,770	4,790
619.35	3,300	4,060	3,310	3,610	3,310	3,910	1,550	3,320	4,540	4,550
619.65	3,340	4,080	3,350	3,640	3,350	3,930	1,520	3,370	4,550	4,570
619.95	3,260	4,010	3,270	3,550	3,270	3,860	1,530	3,290	4,480	4,490
620.25	3,220	3,960	3,220	3,510	3,230	3,820	1,520	3,240	4,420	4,440
620.55	3,220	3,940	3,230	3,510	3,230	3,800	1,490	3,240	4,400	4,410
620.85	3,240	3,940	3,250	3,520	3,250	3,800	1,460	3,260	4,400	4,420
621.10	3,210	3,920	3,220	3,480	3,220	3,770	1,440	3,240	4,360	4,380
621.35	3,140	3,850	3,150	3,430	3,150	3,710	1,440	3,170	4,280	4,300
621.70	3,180	3,870	3,190	3,460	3,190	3,730	1,410	3,200	4,300	4,310
622.00	3,260	3,920	3,260	3,520	3,270	3,790	1,370	3,280	4,340	4,360
622.25	3,170	3,830	3,170	3,420	3,180	3,700	1,380	3,190	4,250	4,270
622.55	3,060	3,740	3,060	3,330	3,070	3,600	1,490	3,080	4,150	4,170
622.85	3,100	3,760	3,110	3,370	3,110	3,630	1,390	3,120	4,170	4,190
623.15	3,120	3,760	3,120	3,370	3,130	3,620	1,360	3,140	4,170	4,190
623.45	3,140	3,770	3,150	3,390	3,160	3,640	1,320	3,170	4,170	4,190
623.75	3,100	3,730	3,100	3,340	3,110	3,600	1,320	3,120	4,120	4,130
624.05	3,060	3,680	3,070	3,310	3,070	3,560	1,310	3,080	4,070	4,090
624.35	3,040	3,650	3,050	3,280	3,050	3,520	1,290	3,060	4,040	4,060
624.65	3,120	3,710	3,130	3,350	3,130	3,590	1,250	3,140	4,090	4,110
624.95	3,040	3,630	3,040	3,270	3,050	3,510	1,250	3,060	4,000	4,020
625.25	2,940	3,520	2,950	3,180	2,950	3,410	1,260	2,960	3,910	3,920

625.60	2,990	3,560	2,990	3,210	3,000	3,440	1,220	3,010	3,930	3,940
625.90	2,910	3,490	2,920	3,140	2,930	3,380	1,220	2,940	3,850	3,870
626.15	2,790	3,360	2,790	3,020	2,800	3,250	1,280	2,810	3,730	3,750
626.50	2,760	3,330	2,760	2,980	2,770	3,220	1,270	2,780	3,700	3,710
626.85	2,720	3,290	2,720	2,940	2,730	3,180	1,270	2,740	3,640	3,660
627.10	2,720	3,280	2,720	2,940	2,730	3,170	1,210	2,740	3,630	3,640
627.35	2,730	3,270	2,730	2,940	2,730	3,160	1,170	2,740	3,620	3,630
627.70	2,650	3,200	2,660	2,860	2,660	3,090	1,200	2,670	3,540	3,560
628.00	2,640	3,190	2,650	2,860	2,650	3,080	1,150	2,660	3,520	3,530
628.25	2,620	3,150	2,630	2,830	2,630	3,040	1,130	2,640	3,490	3,500
628.55	2,600	3,130	2,610	2,810	2,610	3,020	1,110	2,620	3,460	3,470
628.85	2,580	3,100	2,580	2,780	2,590	3,000	1,100	2,600	3,420	3,440
629.10	2,590	3,110	2,600	2,800	2,600	3,000	1,080	2,610	3,420	3,430
629.40	2,560	3,050	2,560	2,750	2,560	2,950	1,070	2,570	3,380	3,390
629.75	2,490	2,990	2,490	2,680	2,500	2,890	1,070	2,510	3,310	3,320
630.05	2,480	2,980	2,480	2,680	2,490	2,880	1,060	2,500	3,290	3,300
630.35	2,440	2,930	2,450	2,640	2,450	2,840	1,050	2,460	3,240	3,250
630.70	2,430	2,910	2,430	2,610	2,430	2,810	1,030	2,440	3,220	3,230
631.00	2,370	2,850	2,370	2,560	2,380	2,760	1,040	2,380	3,150	3,170
631.25	2,390	2,860	2,390	2,580	2,400	2,770	1,000	2,400	3,150	3,170
631.55	2,350	2,810	2,360	2,540	2,360	2,720	994	2,370	3,110	3,130
631.85	2,310	2,770	2,310	2,490	2,310	2,680	986	2,320	3,060	3,070
632.10	2,290	2,750	2,300	2,480	2,300	2,660	971	2,310	3,030	3,040
632.35	2,270	2,710	2,270	2,450	2,280	2,620	959	2,280	3,000	3,010
632.70	2,240	2,680	2,240	2,410	2,240	2,590	946	2,250	2,960	2,970
633.00	2,190	2,630	2,190	2,370	2,190	2,540	945	2,200	2,900	2,920
633.25	2,170	2,600	2,180	2,340	2,180	2,510	928	2,190	2,880	2,890
633.55	2,150	2,580	2,160	2,320	2,160	2,490	907	2,170	2,850	2,860
633.85	2,110	2,540	2,120	2,280	2,120	2,450	899	2,130	2,800	2,810
634.15	2,070	2,480	2,070	2,230	2,080	2,400	893	2,080	2,750	2,760
634.45	2,030	2,450	2,040	2,200	2,040	2,370	880	2,050	2,710	2,720
634.75	2,030	2,430	2,030	2,190	2,030	2,350	863	2,040	2,680	2,690
635.05	2,000	2,400	2,010	2,160	2,010	2,320	850	2,010	2,650	2,660
635.40	1,970	2,370	1,980	2,130	1,980	2,290	839	1,990	2,610	2,630
635.75	1,960	2,340	1,960	2,110	1,960	2,270	828	1,970	2,590	2,600
636.05	1,930	2,310	1,930	2,080	1,940	2,230	818	1,940	2,560	2,570

Appendix M. Peak Fecal Coliform Concentrations During May 7, 2001 Storm Event In Right Bank (IN side) of the Ohio River.

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	11	11	11	11	11	11	11	11	11	11
590.45	10	10	10	10	10	10	10	10	10	10
590.75	10	10	10	10	10	10	10	10	10	10
591.05	10	10	10	10	10	10	10	10	10	10
591.35	10	10	10	10	10	10	10	10	10	10
591.65	9	9	9	9	9	9	9	9	9	9
591.95	9	9	9	9	9	9	9	9	9	9
592.30	9	9	9	9	9	9	9	9	9	9
592.60	9	9	9	9	9	9	9	9	9	9
592.85	9	9	9	9	9	9	9	9	9	9
593.15	8	8	8	8	8	8	8	8	8	8
593.45	8	8	8	8	8	8	8	8	8	8
593.80	8	8	8	8	8	8	8	8	8	8
594.15	8	8	8	8	8	8	8	8	8	8
594.45	8	8	8	8	8	8	8	8	8	8
594.75	7	7	7	7	7	7	7	7	7	7
595.05	7	7	7	7	7	7	7	7	7	7
595.40	7	7	7	7	7	7	7	7	7	7
595.75	7	7	7	7	7	7	7	7	7	7
596.00	7	7	7	7	7	7	7	7	7	7
596.30	36	36	36	36	36	36	6	36	36	36
596.65	31	31	31	31	31	31	6	31	31	31
596.95	23	23	23	23	23	23	6	23	23	23
597.25	22	22	22	22	22	22	6	22	22	22
597.55	22	22	22	22	22	22	6	22	22	22
597.85	21	21	21	21	21	21	6	21	21	21
598.15	20	20	20	20	20	20	6	20	20	20
598.45	19	19	19	19	19	19	5	19	19	19
598.75	15	15	15	15	15	15	5	15	15	15
599.05	14	14	14	14	14	14	5	14	14	14
599.35	13	13	13	13	13	13	5	13	13	13
599.65	13	13	13	13	13	13	5	13	13	13
599.95	12	12	12	12	12	12	5	12	12	12
600.25	12	12	12	12	12	12	5	12	12	12
600.60	11	11	11	11	11	11	4	11	11	11
600.90	11	11	11	11	11	11	4	11	11	11
601.15	10	10	10	10	12	10	17	19	10	19
601.45	10	10	10	10	10	10	12	14	10	14
601.75	10	10	10	10	10	10	10	12	10	12
602.05	10	10	10	10	10	10	8	10	10	10
602.35	9	9	66	9	127	9	245	248	9	248
602.70	9	9	47	9	88	9	167	170	9	170
603.05	9	9	41	9	77	9	147	149	9	149
603.40	9	14	228	9	450	9	893	896	9	896
603.75	9	12	177	9	348	9	689	691	9	691
604.30	235	343	249	278	263	322	257	305	409	468
604.51	233	341	247	277	262	320	255	304	407	464
604.85	231	338	242	274	259	317	250	301	402	460
605.09	226	330	239	267	253	309	246	293	393	450
605.29	222	324	233	263	249	304	239	289	387	441
605.55	212	310	225	252	239	291	230	276	370	422
605.80	1,790	2,640	1,800	2,130	1,810	2,480	1,400	1,820	3,160	3,190
606.05	1,770	2,610	1,780	2,110	1,780	2,450	1,380	1,790	3,120	3,140

606.30	19,200	19,400	19,200	19,300	19,200	19,400	1,210	19,200	19,600	19,700
606.50	19,100	19,300	19,100	19,200	19,100	19,300	1,200	19,100	19,500	19,500
606.75	18,900	19,100	18,900	19,000	18,900	19,100	1,190	19,000	19,300	19,300
607.05	18,700	19,000	18,800	18,800	18,800	18,900	1,180	18,800	19,200	19,200
607.55	18,600	18,900	18,600	18,700	18,700	18,800	1,170	18,700	19,100	19,100
608.10	18,500	18,800	18,500	18,600	18,500	18,700	1,160	18,600	18,900	19,000
608.50	14,500	14,800	14,500	14,600	14,500	14,700	1,330	14,500	15,100	15,200
608.85	13,700	14,100	13,700	13,800	13,700	14,000	1,350	13,700	14,400	14,500
609.15	13,600	14,000	13,600	13,800	13,600	13,900	1,350	13,600	14,300	14,400
609.45	13,700	14,200	13,700	13,900	13,700	14,100	1,330	13,800	14,500	14,600
609.80	12,400	12,900	12,400	12,600	12,400	12,800	1,380	12,500	13,300	13,400
610.10	11,300	11,800	11,300	11,500	11,300	11,700	1,420	11,300	12,200	12,300
610.40	11,200	11,800	11,200	11,400	11,200	11,600	1,410	11,200	12,100	12,200
610.85	11,100	11,600	11,100	11,300	11,100	11,500	1,400	11,100	12,000	12,000
611.30	8,980	9,650	8,990	9,220	9,010	9,510	1,490	9,030	10,100	10,100
611.65	8,870	9,550	8,890	9,140	8,900	9,410	1,470	8,920	9,950	10,000
611.95	8,630	9,260	8,650	8,890	8,660	9,140	1,460	8,680	9,670	9,710
612.30	8,550	9,170	8,560	8,780	8,570	9,030	1,450	8,590	9,600	9,640
612.60	8,470	9,110	8,480	8,710	8,500	8,980	1,430	8,520	9,530	9,570
612.80	8,350	9,010	8,370	8,620	8,380	8,880	1,420	8,400	9,400	9,450
613.05	8,190	8,810	8,200	8,440	8,210	8,690	1,420	8,240	9,190	9,240
613.30	8,130	8,730	8,140	8,370	8,160	8,610	1,410	8,180	9,150	9,190
613.55	8,070	8,680	8,080	8,300	8,090	8,540	1,400	8,110	9,090	9,130
613.80	7,860	8,490	7,870	8,100	7,880	8,360	1,390	7,900	8,890	8,930
614.00	7,400	8,040	7,410	7,660	7,430	7,910	1,400	7,450	8,420	8,460
614.30	7,140	7,750	7,150	7,380	7,160	7,620	1,400	7,180	8,180	8,220
614.65	6,980	7,620	6,990	7,210	7,000	7,490	1,390	7,020	8,030	8,070
614.95	6,380	7,050	6,390	6,650	6,400	6,910	1,400	6,420	7,460	7,490
615.20	6,340	6,970	6,350	6,590	6,360	6,840	1,390	6,380	7,410	7,440
615.45	6,270	6,910	6,280	6,510	6,290	6,770	1,380	6,310	7,340	7,370
615.75	6,190	6,850	6,200	6,450	6,210	6,720	1,370	6,230	7,250	7,290
616.05	6,120	6,750	6,130	6,370	6,130	6,620	1,350	6,150	7,150	7,180
616.35	6,050	6,660	6,060	6,290	6,070	6,530	1,340	6,090	7,080	7,110
616.65	5,960	6,590	5,970	6,190	5,980	6,450	1,330	6,000	6,990	7,020
616.90	5,790	6,420	5,800	6,040	5,810	6,300	1,330	5,830	6,810	6,840
617.10	5,750	6,350	5,760	5,990	5,760	6,230	1,310	5,780	6,760	6,790
617.40	5,690	6,290	5,700	5,920	5,710	6,160	1,300	5,730	6,690	6,720
617.75	5,570	6,190	5,580	5,810	5,590	6,060	1,290	5,610	6,570	6,600
618.05	5,520	6,120	5,530	5,760	5,540	6,000	1,280	5,550	6,500	6,530
618.35	5,470	6,050	5,480	5,700	5,490	5,930	1,260	5,510	6,450	6,480
618.60	5,420	6,000	5,420	5,630	5,430	5,870	1,250	5,450	6,380	6,410
618.85	5,210	5,810	5,220	5,450	5,230	5,690	1,260	5,250	6,180	6,210
619.10	5,160	5,740	5,170	5,390	5,180	5,620	1,240	5,190	6,120	6,150
619.35	5,120	5,690	5,130	5,340	5,130	5,560	1,230	5,150	6,070	6,100
619.65	5,070	5,640	5,070	5,280	5,080	5,520	1,220	5,100	6,010	6,040
619.95	4,940	5,530	4,950	5,180	4,960	5,410	1,220	4,970	5,880	5,910
620.25	4,830	5,390	4,840	5,060	4,850	5,280	1,210	4,860	5,780	5,800
620.55	4,780	5,350	4,790	5,000	4,800	5,230	1,200	4,820	5,720	5,750
620.85	4,730	5,300	4,740	4,950	4,750	5,180	1,190	4,760	5,650	5,680
621.10	4,680	5,230	4,690	4,900	4,690	5,120	1,180	4,710	5,590	5,620
621.35	4,560	5,110	4,570	4,780	4,580	4,990	1,170	4,590	5,480	5,510
621.70	4,240	4,820	4,250	4,470	4,260	4,710	1,200	4,270	5,180	5,210
622.00	4,200	4,750	4,200	4,420	4,210	4,640	1,180	4,220	5,130	5,150
622.25	4,110	4,670	4,110	4,320	4,120	4,550	1,180	4,130	5,040	5,060
622.55	4,060	4,630	4,070	4,280	4,080	4,510	1,170	4,090	4,980	5,010
622.85	4,020	4,580	4,020	4,240	4,030	4,470	1,160	4,040	4,930	4,950
623.15	3,990	4,530	4,000	4,210	4,000	4,420	1,150	4,020	4,900	4,920
623.45	3,880	4,430	3,880	4,090	3,890	4,310	1,150	3,900	4,790	4,810
623.75	3,810	4,370	3,820	4,030	3,820	4,250	1,140	3,840	4,710	4,730

624.05	3,770	4,310	3,780	3,990	3,780	4,210	1,130	3,800	4,670	4,690
624.35	3,730	4,260	3,740	3,930	3,740	4,150	1,110	3,760	4,610	4,630
624.65	3,560	4,110	3,570	3,780	3,580	4,000	1,120	3,590	4,450	4,470
624.95	3,500	4,030	3,510	3,720	3,520	3,930	1,120	3,530	4,390	4,410
625.25	3,450	3,990	3,460	3,660	3,470	3,870	1,110	3,480	4,330	4,350
625.60	3,410	3,940	3,410	3,610	3,420	3,830	1,090	3,430	4,270	4,290
625.90	3,320	3,840	3,320	3,530	3,330	3,740	1,100	3,340	4,180	4,200
626.15	3,280	3,800	3,290	3,480	3,300	3,690	1,090	3,310	4,140	4,160
626.50	3,240	3,760	3,250	3,440	3,250	3,660	1,080	3,260	4,090	4,110
626.85	3,200	3,720	3,210	3,410	3,210	3,610	1,060	3,220	4,040	4,060
627.10	3,180	3,680	3,180	3,370	3,190	3,570	1,060	3,200	4,010	4,030
627.35	3,150	3,650	3,150	3,330	3,160	3,540	1,050	3,170	3,970	3,990
627.70	3,110	3,610	3,120	3,310	3,120	3,510	1,030	3,130	3,920	3,940
628.00	3,080	3,560	3,080	3,270	3,090	3,470	1,020	3,090	3,880	3,900
628.25	3,030	3,510	3,030	3,210	3,040	3,410	1,030	3,050	3,830	3,850
628.55	2,990	3,480	3,000	3,180	3,000	3,380	1,020	3,010	3,790	3,800
628.85	2,960	3,440	2,960	3,150	2,970	3,350	1,000	2,980	3,750	3,760
629.10	2,880	3,360	2,890	3,070	2,890	3,260	1,010	2,900	3,670	3,680
629.40	2,850	3,330	2,850	3,030	2,860	3,230	1,000	2,870	3,630	3,640
629.75	2,810	3,280	2,810	3,000	2,820	3,190	993	2,820	3,580	3,590
630.05	2,780	3,250	2,790	2,970	2,790	3,160	982	2,800	3,550	3,570
630.35	2,710	3,170	2,710	2,890	2,720	3,080	986	2,730	3,470	3,490
630.70	2,670	3,140	2,680	2,860	2,680	3,050	974	2,690	3,430	3,440
631.00	2,640	3,100	2,650	2,820	2,650	3,010	959	2,660	3,390	3,400
631.25	2,600	3,050	2,600	2,770	2,610	2,960	953	2,620	3,340	3,350
631.55	2,550	3,010	2,560	2,730	2,560	2,920	945	2,570	3,280	3,300
631.85	2,510	2,950	2,510	2,680	2,520	2,860	932	2,530	3,230	3,250
632.10	2,470	2,910	2,470	2,640	2,480	2,820	924	2,490	3,190	3,200
632.35	2,420	2,860	2,430	2,600	2,430	2,780	916	2,440	3,130	3,140
632.70	2,390	2,810	2,390	2,560	2,400	2,730	901	2,410	3,090	3,100
633.00	2,360	2,780	2,360	2,520	2,370	2,700	893	2,380	3,050	3,070
633.25	2,320	2,740	2,320	2,490	2,330	2,660	880	2,340	3,000	3,010
633.55	2,290	2,690	2,290	2,450	2,290	2,610	866	2,300	2,960	2,970
633.85	2,250	2,660	2,260	2,410	2,260	2,580	858	2,270	2,920	2,930
634.15	2,220	2,620	2,220	2,380	2,230	2,540	845	2,230	2,870	2,890
634.45	2,160	2,560	2,160	2,310	2,160	2,470	846	2,170	2,810	2,820
634.75	2,100	2,490	2,100	2,260	2,110	2,420	826	2,110	2,740	2,750
635.05	2,080	2,460	2,080	2,230	2,080	2,380	818	2,090	2,710	2,720
635.40	2,050	2,430	2,050	2,200	2,050	2,350	810	2,060	2,670	2,680
635.75	2,020	2,400	2,020	2,170	2,030	2,320	800	2,030	2,630	2,640
636.05	2,000	2,370	2,000	2,140	2,000	2,290	788	2,010	2,610	2,620

Appendix M. Peak E. coli Concentrations During May 7, 2001 Storm Event In Left Bank (KY side) of the Ohio River.

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	5	5	5	5	5	5	5	5	5	5
590.45	5	5	5	5	5	5	5	5	5	5
590.75	5	5	5	5	5	5	5	5	5	5
591.05	5	5	5	5	5	5	5	5	5	5
591.35	5	5	5	5	5	5	5	5	5	5
591.65	4	4	4	4	4	4	4	4	4	4
591.95	4	4	4	4	4	4	4	4	4	4
592.30	4	4	4	4	4	4	4	4	4	4
592.60	4	4	4	4	4	4	4	4	4	4
592.85	4	4	4	4	4	4	4	4	4	4
593.15	4	4	4	4	4	4	4	4	4	4
593.45	4	4	4	4	4	4	4	4	4	4
593.80	4	4	4	4	4	4	4	4	4	4
594.15	4	4	4	4	4	4	4	4	4	4
594.45	4	4	4	4	4	4	4	4	4	4
594.75	4	4	4	4	4	4	4	4	4	4
595.05	3	3	3	3	3	3	3	3	3	3
595.40	3	3	3	3	3	3	3	3	3	3
595.75	3	3	3	3	3	3	3	3	3	3
596.00	92	92	92	92	92	92	3	92	92	92
596.30	80	80	80	80	80	80	3	80	80	80
596.65	72	72	72	72	72	72	3	72	72	72
596.95	59	59	59	59	59	59	3	59	59	59
597.25	51	51	51	51	51	51	3	51	51	51
597.55	49	49	49	49	49	49	3	49	49	49
597.85	39	39	39	39	39	39	3	39	39	39
598.15	60	60	60	60	60	60	3	60	60	60
598.45	55	55	55	55	55	55	3	55	55	55
598.75	41	41	41	41	41	41	3	41	41	41
599.05	39	39	39	39	39	39	2	39	39	39
599.35	32	32	32	32	32	32	2	32	32	32
599.65	31	31	31	31	31	31	2	31	31	31
599.95	29	29	29	29	29	29	2	29	29	29
600.25	28	28	28	28	28	28	2	28	28	28
600.60	27	27	27	27	27	27	2	27	27	27
600.90	25	25	25	25	25	25	2	25	25	25
601.15	24	24	24	24	24	24	2	24	24	24
601.45	23	23	23	23	23	23	2	23	23	23
601.75	22	22	22	22	22	22	2	22	22	22
602.05	15,100	22,300	15,100	18,000	15,100	20,900	11,600	15,100	26,700	26,700
602.35	12,800	18,800	12,800	15,200	12,800	17,700	9,780	12,800	22,500	22,500
602.70	9,420	13,900	9,420	11,200	9,420	13,000	7,210	9,420	16,600	16,600
603.05	8,270	12,200	8,270	9,850	8,270	11,400	6,330	8,270	14,600	14,600
603.40	5,140	7,580	5,140	6,120	5,140	7,100	3,930	5,140	9,070	9,070
603.75	4,690	6,920	4,690	5,590	4,690	6,490	3,600	4,690	8,290	8,290
604.81	3,560	5,260	3,560	4,240	3,560	4,920	2,730	3,560	6,290	6,290
606.65	2,450	3,630	2,450	2,920	2,450	3,390	1,880	2,450	4,330	4,330
607.05	2,260	3,340	2,260	2,700	2,260	3,130	1,730	2,260	3,990	3,990
607.55	2,190	3,230	2,190	2,600	2,190	3,020	1,670	2,190	3,860	3,860
608.10	1,040	1,540	1,050	1,240	1,050	1,440	805	1,050	1,840	1,850
608.50	1,040	1,530	1,040	1,240	1,040	1,430	799	1,040	1,830	1,840
608.85	1,030	1,520	1,030	1,230	1,030	1,420	794	1,030	1,820	1,820
609.15	1,020	1,510	1,020	1,220	1,020	1,410	788	1,030	1,800	1,810

609.45	1,000	1,480	1,000	1,190	1,000	1,380	772	1,010	1,760	1,770
609.80	991	1,460	992	1,180	994	1,370	765	997	1,750	1,750
610.10	976	1,440	977	1,160	978	1,350	751	981	1,720	1,730
610.40	956	1,410	958	1,140	959	1,320	735	962	1,680	1,690
610.85	914	1,340	915	1,090	917	1,260	695	920	1,600	1,610
611.30	924	1,340	926	1,090	928	1,260	676	931	1,590	1,600
611.65	923	1,330	925	1,090	927	1,250	665	931	1,580	1,590
611.95	909	1,310	912	1,070	914	1,230	651	919	1,550	1,560
612.30	1,960	2,350	1,960	2,110	1,960	2,270	2,930	1,960	3,020	3,020
612.60	1,940	2,330	1,940	2,100	1,950	2,250	2,530	1,950	2,620	2,620
612.80	1,850	2,230	1,850	2,000	1,850	2,150	1,950	1,850	2,460	2,470
613.05	1,830	9,270	1,830	3,180	1,840	6,260	12,300	1,840	12,400	12,400
613.30	1,820	8,380	1,820	2,870	1,820	5,640	11,100	1,820	11,200	11,200
613.55	1,800	7,160	1,800	2,520	1,800	4,950	9,700	1,810	9,800	9,800
613.80	1,700	6,750	1,700	2,370	1,700	4,640	9,080	1,700	9,180	9,180
614.00	1,680	6,900	1,690	2,400	1,690	4,710	9,230	1,690	9,320	9,320
614.30	1,670	6,390	1,670	2,220	1,670	4,330	8,480	1,670	8,570	8,570
614.65	1,610	5,200	1,610	1,850	1,610	3,610	7,030	1,610	7,120	7,120
614.95	1,450	4,040	1,450	1,590	1,450	2,800	5,420	1,460	5,510	5,510
615.20	1,440	4,110	1,440	1,580	1,440	2,830	5,480	1,450	5,570	5,570
615.45	1,430	3,930	1,430	1,570	1,430	2,700	5,210	1,440	5,300	5,300
615.75	1,410	3,520	1,410	1,550	1,420	2,450	4,730	1,420	4,810	4,810
616.05	1,380	3,470	1,380	1,510	1,380	2,400	4,630	1,390	4,710	4,710
616.35	1,370	3,390	1,370	1,500	1,370	2,340	4,500	1,370	4,580	4,580
616.65	3,250	5,790	3,250	4,120	3,250	5,000	3,710	3,250	6,750	6,750
616.90	2,860	5,300	2,860	3,640	2,860	4,510	3,460	2,860	6,240	6,240
617.10	2,870	5,140	2,870	3,580	2,870	4,330	3,490	2,870	6,080	6,080
617.40	2,840	5,010	2,840	3,590	2,840	4,340	3,420	2,840	5,840	5,840
617.75	2,770	5,040	2,770	3,550	2,770	4,330	3,220	2,770	5,890	5,890
618.05	2,700	4,990	2,700	3,460	2,700	4,260	3,210	2,700	5,860	5,860
618.35	2,710	4,870	2,710	3,400	2,710	4,130	3,230	2,710	5,750	5,750
618.60	2,690	4,770	2,690	3,400	2,690	4,120	3,160	2,690	5,550	5,550
618.85	2,470	4,540	2,470	3,180	2,470	3,890	2,890	2,470	5,320	5,320
619.10	2,140	4,110	2,140	2,810	2,140	3,490	2,720	2,140	4,850	4,850
619.35	1,830	3,540	1,830	2,380	1,830	2,980	2,470	1,830	4,210	4,210
619.65	1,820	3,470	1,820	2,390	1,820	2,960	2,410	1,820	4,100	4,100
619.95	1,780	3,470	1,780	2,360	1,780	2,940	2,320	1,780	4,100	4,100
620.25	1,700	3,380	1,700	2,280	1,700	2,850	2,310	1,700	4,010	4,010
620.55	1,700	3,280	1,700	2,240	1,700	2,770	2,280	1,700	3,900	3,900
620.85	1,690	3,270	1,690	2,230	1,690	2,770	2,190	1,690	3,860	3,860
621.10	1,650	3,240	1,650	2,190	1,650	2,740	2,180	1,650	3,830	3,830
621.35	1,560	3,090	1,560	2,080	1,560	2,610	2,120	1,560	3,670	3,670
621.70	1,260	2,560	1,260	1,710	1,260	2,160	1,810	1,260	3,050	3,050
622.00	1,180	2,430	1,180	1,600	1,180	2,040	1,720	1,180	2,900	2,900
622.25	1,150	2,390	1,150	1,570	1,150	2,000	1,700	1,150	2,850	2,850
622.55	1,080	2,250	1,080	1,480	1,080	1,880	1,620	1,080	2,680	2,680
622.85	1,080	2,240	1,080	1,480	1,080	1,880	1,610	1,080	2,680	2,680
623.15	1,050	2,200	1,050	1,440	1,050	1,840	1,580	1,050	2,620	2,620
623.45	1,030	2,140	1,030	1,410	1,030	1,790	1,560	1,040	2,560	2,560
623.75	1,020	2,110	1,020	1,390	1,020	1,770	1,530	1,030	2,530	2,530
624.05	1,010	2,030	1,020	1,330	1,020	1,700	1,480	1,020	2,430	2,430
624.35	1,000	1,990	1,000	1,310	1,010	1,670	1,470	1,010	2,380	2,380
624.65	993	1,920	995	1,250	998	1,600	1,420	1,000	2,300	2,300
624.95	2,400	2,390	2,400	2,390	2,400	2,390	1,370	2,400	2,400	2,400
625.25	2,370	2,370	2,370	2,370	2,370	2,370	1,360	2,370	2,370	2,370
625.60	1,590	1,670	1,590	1,590	1,590	1,590	1,220	1,590	1,990	1,990
625.90	1,540	1,650	1,540	1,540	1,540	1,540	1,200	1,540	1,970	1,970
626.15	1,320	1,540	1,320	1,320	1,320	1,320	1,130	1,320	1,840	1,840
626.50	1,290	1,510	1,290	1,290	1,290	1,290	1,120	1,290	1,810	1,810

626.85	1,210	1,500	1,210	1,210	1,210	1,250	1,110	1,210	1,790	1,790
627.10	1,230	1,480	1,230	1,220	1,230	1,240	1,090	1,230	1,770	1,770
627.35	1,160	1,430	1,160	1,160	1,160	1,200	1,070	1,160	1,710	1,710
627.70	1,010	1,360	1,010	1,020	1,010	1,140	1,020	1,010	1,630	1,630
628.00	964	1,320	964	1,010	964	1,100	994	964	1,580	1,580
628.25	943	1,290	943	997	943	1,080	980	943	1,550	1,550
628.55	910	1,280	912	987	914	1,070	970	918	1,540	1,540
628.85	904	1,250	906	978	908	1,050	948	913	1,490	1,490
629.10	895	1,230	897	968	899	1,050	937	904	1,470	1,470
629.40	884	1,220	886	960	888	1,030	925	893	1,460	1,460
629.75	878	1,190	880	951	883	1,020	908	887	1,430	1,430
630.05	887	1,090	889	958	891	1,030	842	896	1,300	1,300
630.35	878	1,080	880	947	883	1,020	831	887	1,300	1,300
630.70	864	1,060	866	936	869	1,010	820	874	1,270	1,270
631.00	864	1,040	866	933	868	1,000	783	872	1,210	1,210
631.25	853	1,020	855	919	857	988	769	862	1,190	1,190
631.55	842	1,010	844	909	846	978	761	851	1,170	1,170
631.85	833	999	835	899	837	966	752	841	1,160	1,160
632.10	824	987	826	888	828	953	740	832	1,140	1,140
632.35	813	977	816	878	818	944	732	822	1,120	1,120
632.70	815	977	817	880	820	945	693	824	1,070	1,080
633.00	807	963	809	870	811	932	682	815	1,060	1,070
633.25	801	955	803	860	805	923	649	809	1,050	1,060
633.55	793	947	795	854	797	916	635	802	1,040	1,050
633.85	783	932	785	842	787	902	622	790	1,030	1,030
634.15	773	921	775	830	777	891	614	781	1,010	1,020
634.45	762	911	764	822	767	881	605	771	1,000	1,010
634.75	756	900	757	813	759	871	595	763	990	995
635.05	746	888	747	801	749	859	588	753	977	984
635.40	735	878	737	792	739	850	572	744	964	971
635.75	730	867	731	784	733	839	556	737	953	959
636.05	719	856	721	772	723	828	541	727	940	947

Appendix M. Peak E. coli Concentrations During May 7, 2001 Storm Event In Center Channel of the Ohio River.

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	5	5	5	5	5	5	5	5	5	5
590.45	5	5	5	5	5	5	5	5	5	5
590.75	5	5	5	5	5	5	5	5	5	5
591.05	5	5	5	5	5	5	5	5	5	5
591.35	5	5	5	5	5	5	5	5	5	5
591.65	5	5	5	5	5	5	5	5	5	5
591.95	4	4	4	4	4	4	4	4	4	4
592.30	4	4	4	4	4	4	4	4	4	4
592.60	4	4	4	4	4	4	4	4	4	4
592.85	4	4	4	4	4	4	4	4	4	4
593.15	4	4	4	4	4	4	4	4	4	4
593.45	4	4	4	4	4	4	4	4	4	4
593.80	4	4	4	4	4	4	4	4	4	4
594.15	4	4	4	4	4	4	4	4	4	4
594.45	4	4	4	4	4	4	4	4	4	4
594.75	4	4	4	4	4	4	4	4	4	4
595.05	4	4	4	4	4	4	4	4	4	4
595.40	3	3	3	3	3	3	3	3	3	3
595.75	3	3	3	3	3	3	3	3	3	3
596.00	3	3	3	3	3	3	3	3	3	3
596.30	3	3	3	3	3	3	3	3	3	3
596.65	3	3	3	3	3	3	3	3	3	3
596.95	3	3	3	3	3	3	3	3	3	3
597.25	4	4	4	4	4	4	3	4	4	4
597.55	4	4	4	4	4	4	3	4	4	4
597.85	4	4	4	4	4	4	3	4	4	4
598.15	5	5	5	5	5	5	3	5	5	5
598.45	5	5	5	5	5	5	3	5	5	5
598.75	6	6	6	6	6	6	3	6	6	6
599.05	8	8	8	8	8	8	3	8	8	8
599.35	7	7	7	7	7	7	3	7	7	7
599.65	8	8	8	8	8	8	2	8	8	8
599.95	8	8	8	8	8	8	2	8	8	8
600.25	9	9	9	9	9	9	2	9	9	9
600.60	8	8	8	8	8	8	2	8	8	8
600.90	8	8	8	8	8	8	2	8	8	8
601.15	9	9	9	9	9	9	2	9	9	9
601.45	11	11	11	11	11	11	2	11	11	11
601.75	11	11	11	11	11	11	2	11	11	11
602.05	9	9	9	9	9	9	2	9	9	9
602.35	10	10	10	10	10	10	2	10	10	10
602.70	9	9	9	9	9	9	2	9	9	9
603.05	33	45	33	38	33	43	22	33	53	53
603.40	14	18	14	16	14	17	10	15	21	22
603.75	231	339	231	274	231	318	176	232	405	405
604.81	1,020	1,510	1,020	1,220	1,030	1,410	793	1,030	1,810	1,810
605.80	1,020	1,510	1,020	1,220	1,020	1,410	791	1,030	1,800	1,810
606.05	1,020	1,500	1,020	1,210	1,020	1,400	788	1,020	1,790	1,800
606.30	1,010	1,490	1,010	1,200	1,010	1,400	784	1,020	1,780	1,790
606.50	1,000	1,480	1,010	1,200	1,010	1,390	781	1,010	1,770	1,780
606.75	994	1,470	996	1,180	998	1,370	770	1,000	1,750	1,760
607.05	957	1,410	959	1,140	961	1,320	742	965	1,690	1,700
607.55	952	1,410	954	1,130	956	1,320	739	961	1,680	1,690

608.10	905	1,340	908	1,080	910	1,250	704	915	1,600	1,610
608.50	1,010	1,430	1,020	1,180	1,020	1,350	688	1,030	1,690	1,700
608.85	1,000	1,420	1,000	1,170	1,010	1,330	679	1,010	1,670	1,680
609.15	987	1,400	990	1,150	993	1,320	676	1,000	1,650	1,660
609.45	1,010	1,420	1,010	1,170	1,020	1,340	670	1,020	1,670	1,680
609.80	978	1,390	980	1,140	983	1,310	674	988	1,640	1,650
610.10	961	1,370	963	1,120	966	1,290	668	972	1,620	1,630
610.40	1,080	1,470	1,080	1,240	1,080	1,400	651	1,090	1,710	1,720
610.85	1,150	1,530	1,150	1,300	1,150	1,460	646	1,160	1,770	1,780
611.30	1,090	1,480	1,090	1,240	1,100	1,400	640	1,100	1,710	1,720
611.65	1,150	1,520	1,150	1,300	1,150	1,450	625	1,160	1,750	1,770
611.95	1,140	1,510	1,140	1,290	1,150	1,440	619	1,150	1,740	1,750
612.30	1,240	1,600	1,240	1,380	1,250	1,530	604	1,260	1,810	1,830
612.60	1,210	1,560	1,210	1,350	1,220	1,490	599	1,220	1,780	1,790
612.80	1,200	1,550	1,200	1,340	1,210	1,480	595	1,220	1,770	1,780
613.05	1,170	1,530	1,180	1,320	1,180	1,460	598	1,190	1,740	1,760
613.30	1,190	1,540	1,190	1,330	1,190	1,470	591	1,200	1,750	1,760
613.55	1,220	1,560	1,220	1,350	1,220	1,490	583	1,230	1,760	1,780
613.80	1,220	1,560	1,230	1,360	1,230	1,490	576	1,240	1,760	1,770
614.00	1,200	1,530	1,200	1,330	1,210	1,470	596	1,220	1,740	1,750
614.30	1,180	1,520	1,190	1,320	1,190	1,450	600	1,200	1,720	1,740
614.65	1,170	1,500	1,180	1,310	1,180	1,440	594	1,190	1,700	1,720
614.95	1,690	1,970	1,700	1,800	1,700	1,910	527	1,720	2,140	2,160
615.20	1,540	1,820	1,540	1,650	1,550	1,760	569	1,560	2,010	2,020
615.45	1,500	1,790	1,500	1,610	1,510	1,730	577	1,520	1,970	1,980
615.75	1,500	1,790	1,510	1,620	1,510	1,730	569	1,520	1,960	1,980
616.05	1,500	1,780	1,510	1,610	1,510	1,720	561	1,520	1,960	1,970
616.35	1,490	1,760	1,490	1,590	1,500	1,710	557	1,510	1,940	1,950
616.65	1,470	1,740	1,470	1,580	1,480	1,690	553	1,490	1,910	1,930
616.90	1,450	1,720	1,460	1,560	1,460	1,670	546	1,470	1,890	1,910
617.10	1,460	1,720	1,460	1,560	1,460	1,660	539	1,470	1,890	1,900
617.40	1,460	1,720	1,460	1,560	1,470	1,660	534	1,480	1,880	1,900
617.75	1,400	1,670	1,410	1,510	1,410	1,620	550	1,420	1,830	1,850
618.05	1,380	1,640	1,380	1,480	1,390	1,580	553	1,390	1,810	1,820
618.35	1,380	1,640	1,380	1,480	1,390	1,590	546	1,400	1,800	1,820
618.60	1,360	1,620	1,360	1,460	1,370	1,570	545	1,380	1,780	1,790
618.85	1,340	1,600	1,350	1,450	1,350	1,550	543	1,360	1,760	1,770
619.10	1,340	1,590	1,350	1,440	1,350	1,540	535	1,360	1,760	1,770
619.35	1,260	1,520	1,260	1,370	1,270	1,470	884	1,270	1,690	1,700
619.65	1,270	1,530	1,280	1,380	1,280	1,480	793	1,290	1,690	1,700
619.95	1,250	1,510	1,250	1,350	1,250	1,450	899	1,260	1,670	1,680
620.25	1,230	1,490	1,230	1,330	1,240	1,440	899	1,250	1,650	1,660
620.55	1,230	1,480	1,230	1,330	1,240	1,430	834	1,240	1,640	1,650
620.85	1,240	1,480	1,240	1,330	1,240	1,430	783	1,250	1,640	1,650
621.10	1,230	1,470	1,230	1,320	1,230	1,420	773	1,240	1,620	1,630
621.35	1,200	1,450	1,210	1,300	1,210	1,400	807	1,220	1,600	1,610
621.70	1,210	1,450	1,220	1,310	1,220	1,410	739	1,230	1,600	1,610
622.00	1,240	1,470	1,240	1,330	1,250	1,420	653	1,250	1,610	1,620
622.25	1,210	1,440	1,210	1,300	1,220	1,390	742	1,220	1,590	1,600
622.55	1,180	1,410	1,180	1,270	1,180	1,370	896	1,190	1,560	1,570
622.85	1,190	1,420	1,190	1,280	1,200	1,370	827	1,200	1,560	1,570
623.15	1,200	1,420	1,200	1,280	1,200	1,370	778	1,210	1,560	1,570
623.45	1,200	1,420	1,210	1,290	1,210	1,380	722	1,220	1,560	1,570
623.75	1,190	1,400	1,190	1,270	1,190	1,360	728	1,200	1,540	1,550
624.05	1,170	1,390	1,180	1,260	1,180	1,350	718	1,190	1,520	1,530
624.35	1,160	1,370	1,170	1,250	1,170	1,330	707	1,180	1,510	1,520
624.65	1,190	1,400	1,200	1,270	1,200	1,350	625	1,210	1,530	1,540
624.95	1,160	1,370	1,170	1,240	1,170	1,330	662	1,180	1,500	1,510
625.25	1,130	1,330	1,130	1,210	1,130	1,290	722	1,140	1,460	1,470

625.60	1,140	1,340	1,150	1,220	1,150	1,300	651	1,160	1,470	1,480
625.90	1,120	1,320	1,120	1,190	1,130	1,280	681	1,130	1,440	1,450
626.15	1,070	1,270	1,080	1,150	1,080	1,230	773	1,090	1,400	1,410
626.50	1,060	1,260	1,070	1,140	1,070	1,220	764	1,080	1,390	1,400
626.85	1,050	1,250	1,050	1,130	1,060	1,210	767	1,060	1,370	1,380
627.10	1,050	1,240	1,050	1,120	1,050	1,200	728	1,060	1,360	1,370
627.35	1,050	1,240	1,050	1,120	1,050	1,200	688	1,060	1,360	1,370
627.70	1,020	1,210	1,030	1,100	1,030	1,170	726	1,030	1,330	1,340
628.00	1,020	1,210	1,020	1,090	1,030	1,170	688	1,030	1,320	1,330
628.25	1,010	1,190	1,010	1,080	1,010	1,160	676	1,020	1,310	1,320
628.55	1,000	1,180	1,010	1,070	1,010	1,140	659	1,010	1,300	1,310
628.85	994	1,170	996	1,060	999	1,140	649	1,000	1,290	1,290
629.10	997	1,170	1,000	1,070	1,000	1,140	603	1,010	1,280	1,290
629.40	982	1,160	985	1,050	987	1,120	613	992	1,270	1,270
629.75	960	1,130	962	1,030	965	1,100	646	970	1,240	1,250
630.05	956	1,130	958	1,020	961	1,090	622	966	1,230	1,240
630.35	941	1,110	943	1,010	945	1,080	626	950	1,220	1,220
630.70	935	1,100	937	1,000	940	1,070	610	944	1,210	1,220
631.00	914	1,080	917	979	920	1,050	627	925	1,190	1,190
631.25	920	1,090	923	986	925	1,050	574	931	1,180	1,190
631.55	907	1,070	909	970	911	1,030	576	916	1,170	1,180
631.85	890	1,050	893	951	895	1,020	584	900	1,150	1,160
632.10	884	1,040	887	947	889	1,010	560	894	1,140	1,150
632.35	874	1,030	876	936	879	998	556	883	1,130	1,130
632.70	863	1,020	865	922	868	985	552	872	1,110	1,120
633.00	844	999	847	906	849	968	564	854	1,090	1,100
633.25	838	987	840	898	842	957	546	847	1,080	1,090
633.55	830	978	833	887	835	948	523	839	1,070	1,080
633.85	815	963	817	874	819	933	521	823	1,050	1,060
634.15	799	943	802	856	804	913	535	808	1,040	1,040
634.45	787	931	789	843	791	902	526	795	1,020	1,030
634.75	782	923	784	839	786	895	500	790	1,010	1,020
635.05	773	910	775	827	777	881	495	781	998	1,000
635.40	762	900	764	816	766	872	486	770	985	992
635.75	755	891	757	809	759	864	473	762	973	980
636.05	745	877	747	798	749	850	472	753	962	968

Appendix M. Peak E. coli Concentrations During May 7, 2001 Storm Event In Right Bank (IN side) of the Ohio River.

River Mile	Sc. 01	Sc. 02	Sc. 03	Sc. 04	Sc. 05	Sc. 06	Sc. 07	Sc. 08	Sc. 09	Sc. 10
590.00	5	5	5	5	5	5	5	5	5	5
590.45	5	5	5	5	5	5	5	5	5	5
590.75	5	5	5	5	5	5	5	5	5	5
591.05	5	5	5	5	5	5	5	5	5	5
591.35	5	5	5	5	5	5	5	5	5	5
591.65	4	4	4	4	4	4	4	4	4	4
591.95	4	4	4	4	4	4	4	4	4	4
592.30	4	4	4	4	4	4	4	4	4	4
592.60	4	4	4	4	4	4	4	4	4	4
592.85	4	4	4	4	4	4	4	4	4	4
593.15	4	4	4	4	4	4	4	4	4	4
593.45	4	4	4	4	4	4	4	4	4	4
593.80	4	4	4	4	4	4	4	4	4	4
594.15	4	4	4	4	4	4	4	4	4	4
594.45	4	4	4	4	4	4	4	4	4	4
594.75	4	4	4	4	4	4	4	4	4	4
595.05	3	3	3	3	3	3	3	3	3	3
595.40	3	3	3	3	3	3	3	3	3	3
595.75	3	3	3	3	3	3	3	3	3	3
596.00	3	3	3	3	3	3	3	3	3	3
596.30	19	19	19	19	19	19	3	19	19	19
596.65	16	16	16	16	16	16	3	16	16	16
596.95	12	12	12	12	12	12	3	12	12	12
597.25	12	12	12	12	12	12	3	12	12	12
597.55	11	11	11	11	11	11	3	11	11	11
597.85	11	11	11	11	11	11	3	11	11	11
598.15	10	10	10	10	10	10	3	10	10	10
598.45	10	10	10	10	10	10	3	10	10	10
598.75	8	8	8	8	8	8	2	8	8	8
599.05	7	7	7	7	7	7	2	7	7	7
599.35	7	7	7	7	7	7	2	7	7	7
599.65	6	6	6	6	6	6	2	6	6	6
599.95	6	6	6	6	6	6	2	6	6	6
600.25	6	6	6	6	6	6	2	6	6	6
600.60	6	6	6	6	6	6	2	6	6	6
600.90	5	5	5	5	5	5	2	5	5	5
601.15	5	5	5	5	6	5	10	11	5	11
601.45	5	5	5	5	5	5	7	8	5	8
601.75	5	5	5	5	5	5	6	7	5	7
602.05	5	5	5	5	5	5	5	6	5	6
602.35	5	5	39	5	76	5	149	150	5	150
602.70	5	5	29	5	55	5	106	107	5	107
603.05	5	5	25	5	47	5	91	92	5	92
603.40	4	8	147	4	292	4	580	581	4	581
603.75	4	7	108	4	213	4	421	423	4	423
604.30	82	120	90	97	103	112	121	137	142	185
604.51	81	119	90	96	103	111	120	137	141	185
604.85	80	117	89	95	101	110	120	135	140	183
605.09	79	115	87	93	99	108	116	131	136	178
605.29	77	113	86	92	97	106	114	129	134	175
605.55	74	108	82	88	93	101	107	123	128	168
605.80	621	917	626	740	630	859	493	638	1,100	1,110
606.05	615	907	618	732	621	850	485	627	1,080	1,100

606.30	7,280	7,370	7,290	7,320	7,300	7,350	425	7,310	7,430	7,470
606.50	7,240	7,330	7,250	7,270	7,250	7,310	423	7,270	7,380	7,410
606.75	7,180	7,260	7,190	7,210	7,190	7,240	420	7,210	7,320	7,360
607.05	7,110	7,210	7,120	7,140	7,130	7,180	415	7,140	7,270	7,310
607.55	7,080	7,180	7,080	7,120	7,090	7,160	413	7,110	7,240	7,280
608.10	7,030	7,130	7,040	7,070	7,050	7,110	409	7,060	7,180	7,220
608.50	5,480	5,610	5,490	5,530	5,500	5,580	468	5,520	5,710	5,740
608.85	5,180	5,330	5,190	5,240	5,200	5,300	476	5,210	5,430	5,460
609.15	5,150	5,300	5,160	5,210	5,170	5,270	473	5,190	5,400	5,430
609.45	5,240	5,400	5,240	5,290	5,250	5,360	469	5,270	5,510	5,540
609.80	4,730	4,910	4,740	4,800	4,750	4,880	485	4,770	5,020	5,050
610.10	4,280	4,470	4,290	4,350	4,300	4,420	498	4,320	4,600	4,630
610.40	4,250	4,440	4,260	4,320	4,270	4,400	495	4,290	4,570	4,600
610.85	4,210	4,410	4,210	4,280	4,220	4,360	492	4,240	4,520	4,560
611.30	3,400	3,610	3,410	3,480	3,420	3,570	523	3,430	3,760	3,790
611.65	3,360	3,580	3,370	3,440	3,380	3,540	515	3,390	3,720	3,750
611.95	3,260	3,480	3,270	3,350	3,280	3,440	513	3,290	3,610	3,640
612.30	3,230	3,440	3,240	3,320	3,250	3,400	508	3,260	3,580	3,610
612.60	3,210	3,410	3,210	3,290	3,220	3,370	504	3,240	3,560	3,580
612.80	3,160	3,380	3,170	3,240	3,180	3,330	500	3,190	3,520	3,540
613.05	3,090	3,310	3,100	3,180	3,100	3,270	498	3,120	3,440	3,470
613.30	3,070	3,280	3,080	3,160	3,090	3,240	495	3,100	3,410	3,430
613.55	3,050	3,250	3,060	3,130	3,070	3,210	491	3,080	3,390	3,410
613.80	2,970	3,180	2,980	3,050	2,990	3,130	489	3,000	3,320	3,340
614.00	2,790	3,010	2,790	2,880	2,800	2,960	491	2,810	3,140	3,170
614.30	2,690	2,900	2,700	2,770	2,700	2,860	491	2,720	3,040	3,060
614.65	2,630	2,840	2,640	2,710	2,650	2,800	488	2,660	2,990	3,010
614.95	2,390	2,630	2,400	2,490	2,410	2,580	493	2,420	2,760	2,790
615.20	2,380	2,600	2,390	2,470	2,390	2,560	488	2,400	2,740	2,760
615.45	2,360	2,570	2,360	2,440	2,370	2,520	485	2,380	2,720	2,740
615.75	2,330	2,550	2,340	2,410	2,340	2,500	480	2,360	2,690	2,710
616.05	2,290	2,520	2,300	2,380	2,310	2,470	475	2,320	2,650	2,670
616.35	2,270	2,480	2,280	2,360	2,280	2,440	470	2,300	2,620	2,640
616.65	2,240	2,450	2,250	2,320	2,250	2,400	467	2,270	2,590	2,610
616.90	2,180	2,390	2,180	2,260	2,190	2,350	468	2,200	2,530	2,550
617.10	2,160	2,370	2,160	2,240	2,170	2,330	462	2,180	2,500	2,520
617.40	2,140	2,340	2,140	2,220	2,150	2,300	458	2,160	2,480	2,500
617.75	2,100	2,300	2,100	2,170	2,110	2,260	457	2,120	2,440	2,460
618.05	2,070	2,280	2,080	2,160	2,090	2,240	452	2,100	2,410	2,430
618.35	2,060	2,260	2,060	2,140	2,070	2,220	446	2,080	2,390	2,410
618.60	2,040	2,230	2,040	2,110	2,050	2,190	443	2,060	2,370	2,380
618.85	1,960	2,170	1,970	2,040	1,970	2,120	446	1,980	2,290	2,310
619.10	1,940	2,140	1,940	2,020	1,950	2,100	442	1,960	2,270	2,280
619.35	1,920	2,120	1,930	2,000	1,930	2,080	437	1,940	2,250	2,270
619.65	1,910	2,100	1,910	1,980	1,920	2,060	434	1,930	2,230	2,250
619.95	1,860	2,060	1,870	1,940	1,870	2,020	433	1,880	2,180	2,200
620.25	1,820	2,010	1,820	1,890	1,820	1,970	432	1,830	2,140	2,150
620.55	1,800	1,990	1,800	1,870	1,810	1,950	428	1,820	2,120	2,140
620.85	1,780	1,970	1,790	1,850	1,790	1,930	424	1,800	2,100	2,110
621.10	1,760	1,950	1,760	1,830	1,770	1,910	420	1,780	2,070	2,090
621.35	1,720	1,900	1,720	1,790	1,730	1,860	419	1,730	2,030	2,040
621.70	1,600	1,800	1,600	1,670	1,610	1,760	433	1,620	1,920	1,940
622.00	1,580	1,770	1,580	1,660	1,590	1,730	428	1,590	1,900	1,910
622.25	1,550	1,740	1,550	1,620	1,550	1,700	428	1,560	1,870	1,880
622.55	1,530	1,720	1,540	1,600	1,540	1,680	423	1,550	1,850	1,860
622.85	1,510	1,710	1,520	1,590	1,520	1,670	420	1,530	1,820	1,840
623.15	1,500	1,690	1,500	1,580	1,510	1,650	416	1,520	1,810	1,830
623.45	1,460	1,650	1,460	1,530	1,470	1,610	418	1,480	1,770	1,790
623.75	1,440	1,630	1,440	1,510	1,450	1,590	415	1,450	1,750	1,760

624.05	1,420	1,610	1,420	1,500	1,430	1,570	412	1,440	1,730	1,740
624.35	1,410	1,590	1,410	1,480	1,410	1,550	407	1,420	1,710	1,720
624.65	1,350	1,540	1,350	1,420	1,360	1,500	414	1,360	1,650	1,660
624.95	1,320	1,510	1,330	1,400	1,330	1,470	414	1,340	1,630	1,640
625.25	1,310	1,490	1,310	1,380	1,310	1,450	412	1,320	1,610	1,620
625.60	1,290	1,470	1,290	1,360	1,300	1,430	406	1,300	1,590	1,600
625.90	1,250	1,440	1,260	1,330	1,260	1,400	410	1,270	1,550	1,560
626.15	1,240	1,420	1,250	1,310	1,250	1,380	406	1,260	1,540	1,550
626.50	1,230	1,410	1,230	1,290	1,240	1,370	402	1,240	1,520	1,530
626.85	1,210	1,390	1,220	1,280	1,220	1,350	397	1,230	1,500	1,510
627.10	1,200	1,380	1,210	1,270	1,210	1,340	395	1,220	1,490	1,500
627.35	1,190	1,360	1,190	1,260	1,200	1,330	391	1,200	1,480	1,490
627.70	1,180	1,350	1,180	1,240	1,190	1,320	387	1,190	1,460	1,470
628.00	1,160	1,330	1,170	1,230	1,170	1,300	382	1,180	1,440	1,450
628.25	1,150	1,320	1,160	1,220	1,160	1,280	388	1,170	1,430	1,440
628.55	1,140	1,310	1,140	1,200	1,150	1,270	383	1,150	1,410	1,430
628.85	1,130	1,300	1,130	1,190	1,130	1,260	378	1,140	1,400	1,410
629.10	1,100	1,260	1,100	1,160	1,100	1,230	392	1,110	1,370	1,380
629.40	1,090	1,250	1,090	1,150	1,090	1,220	388	1,100	1,360	1,370
629.75	1,070	1,240	1,070	1,140	1,080	1,200	393	1,080	1,340	1,350
630.05	1,060	1,220	1,060	1,130	1,070	1,190	390	1,070	1,330	1,330
630.35	1,030	1,200	1,040	1,100	1,040	1,160	420	1,050	1,300	1,310
630.70	1,020	1,180	1,030	1,080	1,030	1,150	415	1,030	1,280	1,290
631.00	1,010	1,170	1,010	1,070	1,010	1,140	410	1,020	1,270	1,280
631.25	994	1,150	996	1,050	999	1,120	414	1,000	1,250	1,260
631.55	977	1,130	980	1,040	983	1,100	417	988	1,230	1,240
631.85	959	1,110	962	1,020	964	1,080	421	969	1,210	1,220
632.10	946	1,100	948	1,000	951	1,060	421	956	1,190	1,200
632.35	929	1,080	931	988	934	1,050	424	939	1,170	1,180
632.70	915	1,060	917	974	920	1,030	421	924	1,160	1,160
633.00	904	1,050	907	960	909	1,020	416	914	1,140	1,150
633.25	890	1,040	892	948	895	1,010	409	900	1,120	1,130
633.55	876	1,020	878	932	881	988	409	885	1,110	1,120
633.85	864	1,010	866	917	868	976	403	873	1,090	1,100
634.15	851	991	853	907	855	963	398	859	1,080	1,080
634.45	829	967	831	883	833	937	427	837	1,060	1,060
634.75	807	944	809	862	811	917	414	815	1,030	1,030
635.05	798	930	800	851	802	904	417	806	1,020	1,020
635.40	787	920	789	837	791	893	410	795	1,000	1,010
635.75	776	909	778	829	780	882	406	784	989	996
636.05	768	896	770	819	772	870	400	776	979	985

APPENDIX N

COMPARISON OF ORIGINAL AND "TYPICAL" YEAR MODEL RESULTS TO DATA FROM MAY 2001 AND OCTOBER 2001 EVENTS

Memorandum

TO: Carrie Turner

DATE: June 7, 2004

PROJECT: LOUIS4

FROM: Jagjit Kaur

COPIES:

SUBJECT: Comparison of the revised model results with the original water quality model

INTRODUCTION

This memorandum presents the preliminary evaluation of the revised water quality model (described in Chapter 10) used to assess the water quality impacts of wet weather events, including nonpoint source runoff and combined sewer overflows (CSOs), on the Ohio River. Specifically, the results of the original model (used for calibration and confirmation purposes and described in Chapter 5) are compared with the revised model to assess the performance of the revised model. The revised model includes updated bacterial loads from CSOs, simplified flow routings and improvements to the model's computer code. The revised and the original model results are compared for fecal coliform and *Eschericha coli* (*E. coli*) with available data for two wet weather surveys: May 2001 and October 2001. The study area spanned from the portion of the Ohio River beginning at river mile (RM) 590, which is upstream of the Louisville metropolitan area, and extending downstream to just below the confluence with the Salt River, at RM 630.

MODEL REVISIONS

Differences between the original and revised models include bacterial loadings from CSOs, boundary conditions, flow routings, and model output intervals. Table 1 presents a summary of the changes made to the original model developed under the previous project conducted for the ORSANCO.

Table 1: Summary of changes to the water quality model.

Changes to the model	Original model	Revised model
Jeffersonville CSO Loadings	Used average Louisville CSO flow and load for each Jeffersonville CSO outfall.	Output from a SWMM model of the Jeffersonville collection system
Boundary conditions	Based on event-specific data	Average concentration based on statistical evaluation of all data (1998-2001)
Flow routings balance	Oct 2001: based on dam operations at low flow May 2001: based on dam operations at average flow	• Oct 2001: based on dam operations at average flow • May 2001: based on dam operations at average flow

Changes to the model	Original model	Revised model
Model output time step	24 outputs per day	25 outputs per day

RESULTS:

The revised model results are compared with the original model results for two events of 2001. Data collected by ORSANCO for the events are also plotted on the same graphs for evaluating model performance.

May 2001 Event

An average of 1.31 inches of rain fell on the study area on May 7, 2001, although the rainfall volume varied across the watershed. Flow in the Ohio River was approximately 40,000 cfs, which roughly corresponds to the long-term historical average summer flow. Smaller rainfall ($\leq$ 0.1 inches) occurred on subsequent days of the event. ORSANCO sampled the Ohio River over the period of May 7-11, 2001. Figures 1-1 and 1-2 show a comparison between the original model and the revised model results along with data for the May 2001 event for fecal coliform and *E. coli*, respectively. Comparisons for each area of the river, Kentucky near shore (left bank), mid-channel, and Indiana near shore (right bank) are shown for each day of the event.

In general, the model reproduces the concentration pattern observed in the stream data from upstream to downstream. The model seems to favorably reproduce the pattern in lateral transport across the river. The differences are simulated only in the upstream (at RM 590) concentrations, which are attributed to the revised boundary conditions. The models do not capture higher concentrations observed after RM 614. Revised loadings from CSOs show little impact on the revised model results.

October 2001 Event

An average of 1.29 inches of rain fell on the study area on October 5, 2001. Flow in the Ohio River was approximately 18,000 cfs, which is a very low flow condition for the river (20^{th} percentile flow based on historical flow records). ORSANCO monitored water quality in the Ohio River from October 6, 2001 through October 10, 2001. Figures 2-1 and 2-2 show a spatial comparison between the original model and the revised model results along with data for the monitored period for fecal coliform and *E. coli*, respectively. Spatial comparisons for each area of the river, Kentucky near shore (left bank), mid-channel, and Indiana near shore (right bank) are shown for each day of the event. Temporal plots showing model results and data are shown for RM 620 in Figure 2-3.

As Figures 2-1 and 2-2 illustrate, the revised model predicts slightly different bacterial concentrations at the upstream boundary (RM 590) when compared with the original

model results. This is because the boundary conditions in the revised model were different than those considered in the original model. However, the boundary concentrations were not significantly different and were in the same order of magnitude as in the original model. In general, the models (both original and revised) reproduce the spatial concentration patterns for *E. coli* and fecal coliform as those observed in the stream. The models also seem to reproduce the patterns of lateral transport reasonably. However, the model does not reproduce the elevated concentrations observed downstream from approximately RM 615 on 10/6/01.

The flow routing difference between the models seem to be responsible for the differences in the original and the revised model results. With average flow routings, travel time for a water parcel in the revised model is longer than in the original model. This is due to the fact that the water allowed to pass through additional model segments on the right bank. On the other hand, in the original model the low flows do not allow the flow diverted to right bank but rather it is allowed to follow only one channel (left bank), resulting in smaller travel times. As shown in Figure 2-3, the model results with low routings (original model) capture the peak concentrations better when compared with the average routings (revised model) but fails to follow the observed concentrations following the peak event days. On the other hand, the average flow routings captures concentrations better on the subsequent days of the peak event. As a result, the revised model performs better in producing trends in bacterial concentrations observed on 10/9/01 (Figures 2-1 and 2-2).

CONCLUSIONS

The revised model does not produce significantly different results as predicted by the original model for the May 2001 event. For the October 2001 event, however, the results of bacterial concentrations are significantly different produced by two models after the M^{c}Alpine Dam (located at RM 607). This is because in May 2001 both models consider average flow routings (hence the same travel time), however for the October 2001 event, the flow routings are different. The revised model considers average flow routings, which allows water to flow over the dam to the right bank, resulting in longer travel time. The revised model shows better performance of capturing the measurements during subsequent days of the event. Flow patterns seem to be significant contributor to changes in model predictions after the dam (RM 607).

Both models do not reproduce the elevated concentrations observed downstream of RM 614 during both events. The models under predict bacterial concentrations on 10/6/01 for the October 2001 event and most of the days during the May event. The sources of these elevated concentrations could not be identified and those do not seem to be included in the loading time series of the revised model.

Figure 1-1: Comparison between the original model and the revised model results along with data for fecal coliform in May 2001.

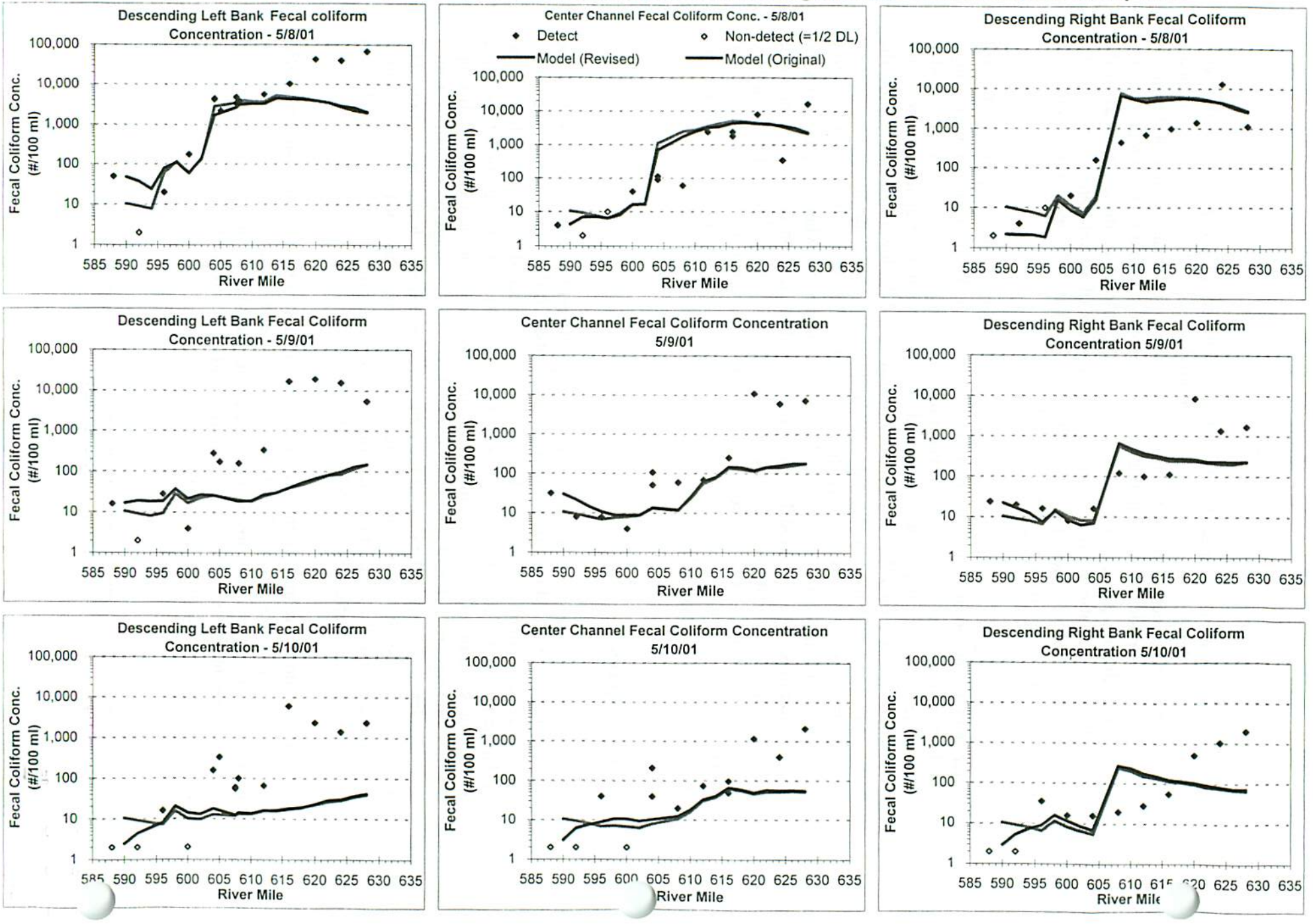


Figure 1-1: Comparison between the original model and the revised model results along with data for fecal coliform in May 2001.

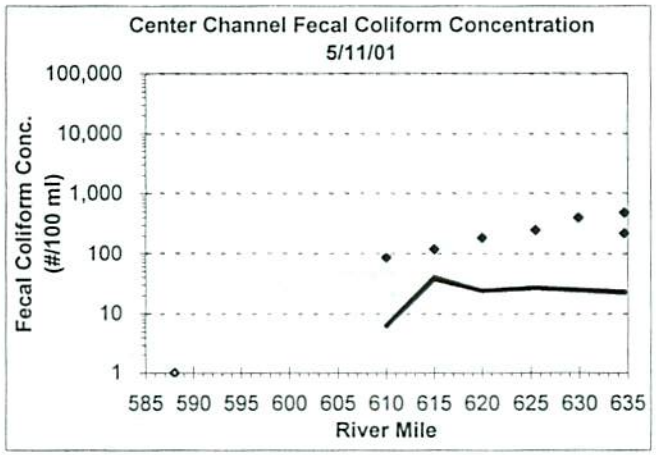


Figure 1-2: Comparison between the original model and the revised model results along with data for *E. coli.* in May 2001.

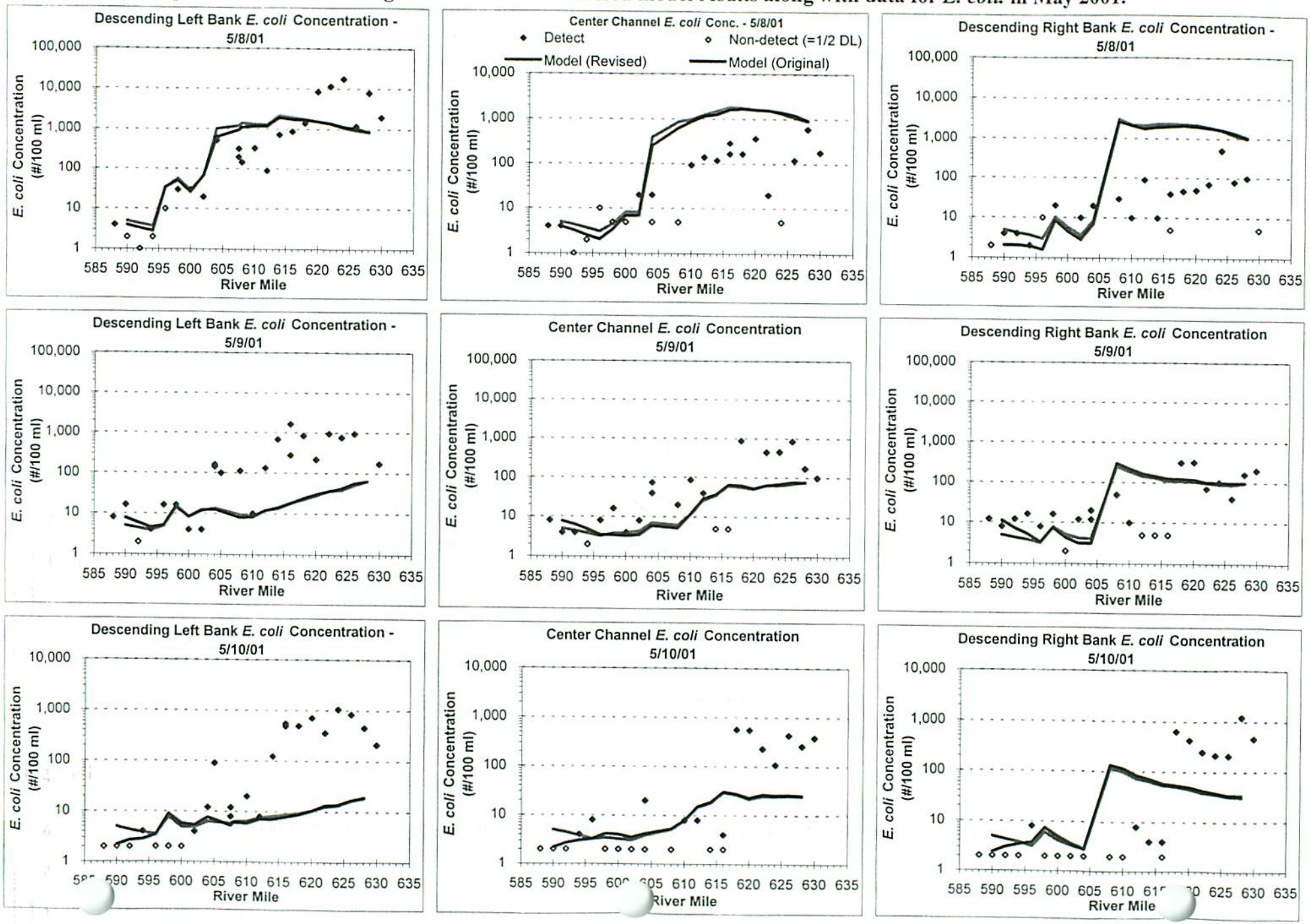


Figure 1-2: Comparison between the original model and revised model results along with data for *E. coli.* in May 2001.

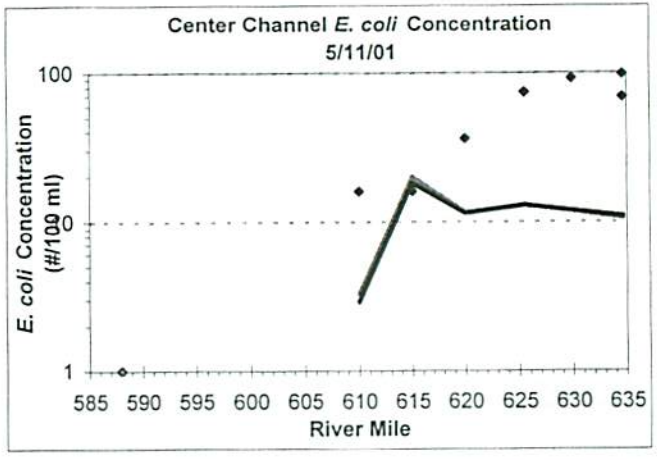
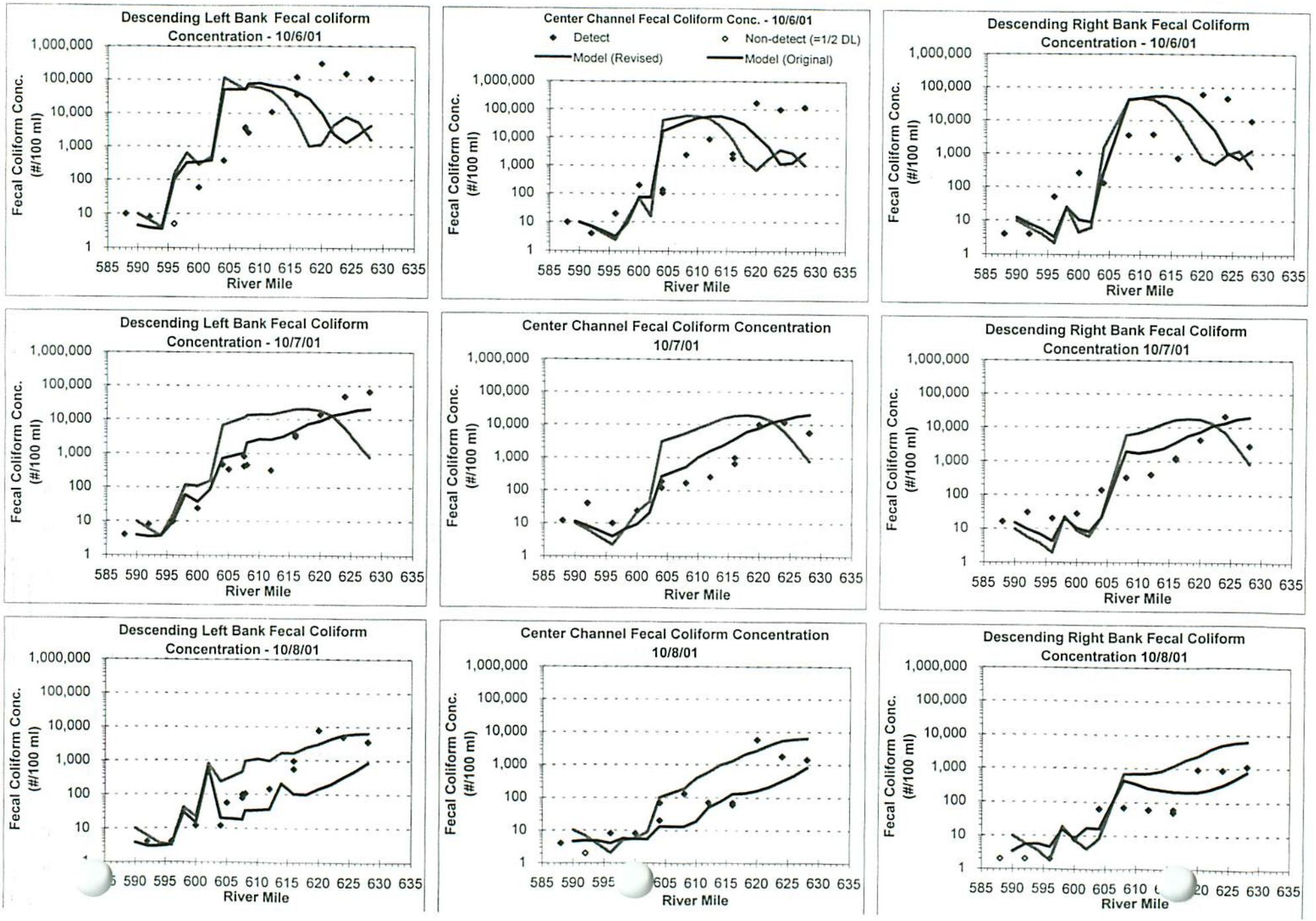


Figure 2-1: Comparison between the original model and revised model results along with data for fecal coliform in October 2001.



2-1: Comparison between the original model and revised model results along with data for fecal coliform in October 2001.

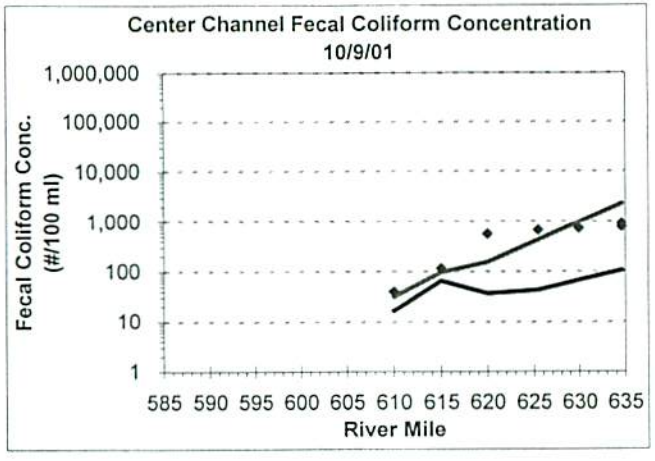


Figure 2-2: Comparison between the original model and the revised model results along with data for *E. coli.* in October 2001.

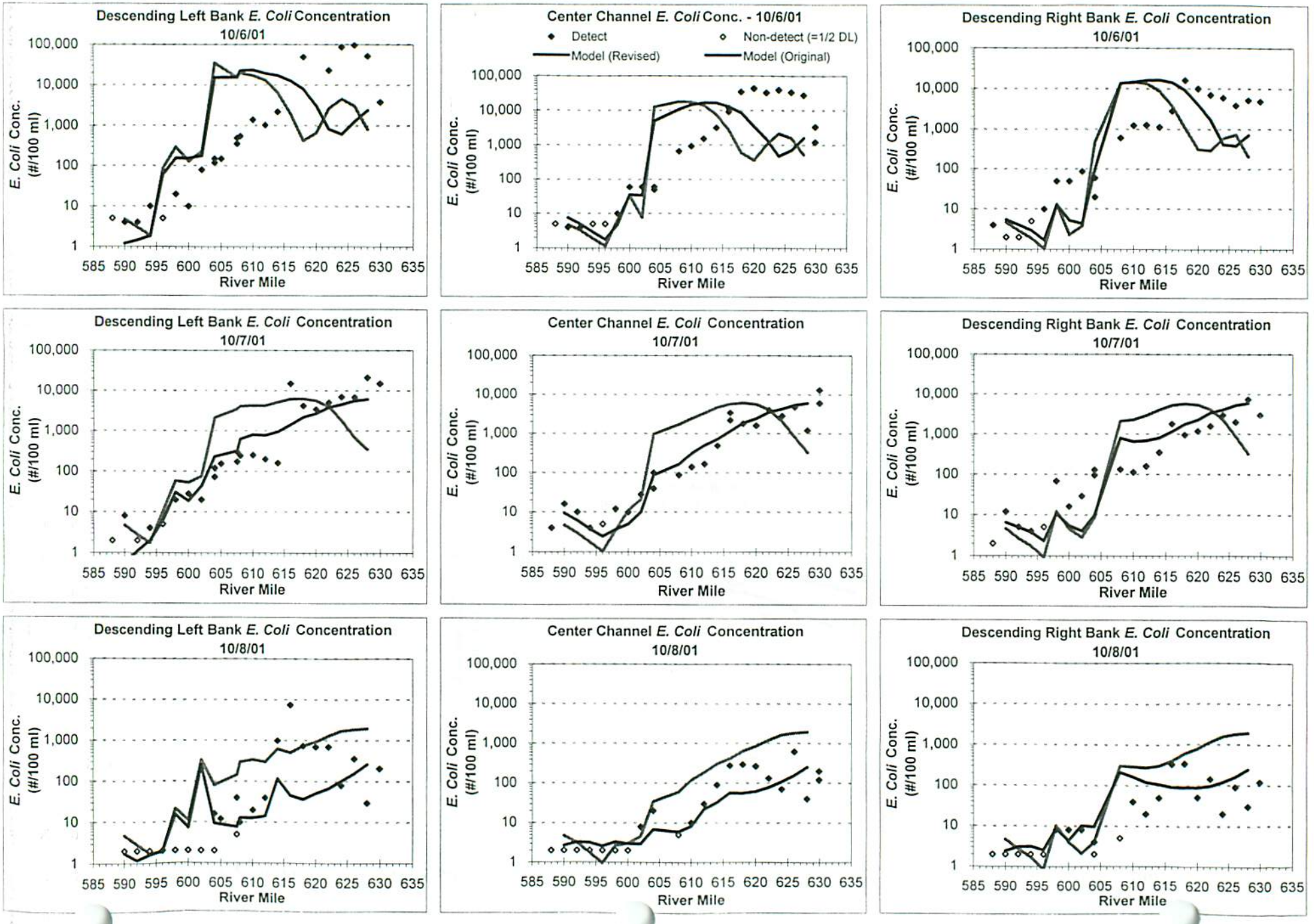


Figure 2-2: Comparison between the original model and the revised model results along with data for *E. coli.* in October 2001.

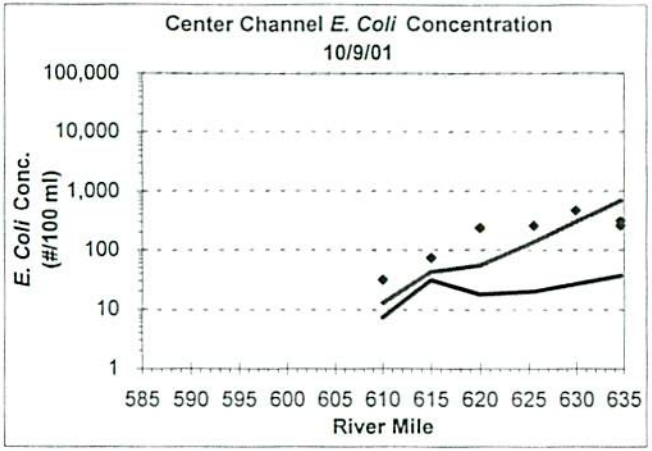


Figure 2-3: Temporal comparison between the original model and the revised model results along with data at RM 620 for fecal coliform in October 2001.

