FINAL REPORT

INVESTIGATING CSOs AND THEIR IMPACT ON THE OHIO RIVER

Volume 1

Identification of Longitudinal / Bacteria Impacts from CSOs

The Ohio River Valley Water Sanitation Commission

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Background

Combined sewer overflows (CSOs) are viewed as a particular problem in the Ohio River Basin. A national inventory of CSOs compiled by the U.S. EPA indicated that there were 10,770 individual CSOs, 7,250 (67 percent) of which are located within the eight member states of the Ohio River Valley Water Sanitation Commission (ORSANCO). Although many of these CSOs are located in portions of the states which are outside the Ohio River Valley, such as Chicago, Cleveland and New York City, early reports identified more than 1,200 CSOs in cities along the main stem of the Ohio River.

In 1991, ORSANCO convened a task force of representatives from state and federal regulatory agencies, as well as municipal sewer districts with CSOs, to consider the role of ORSANCO in CSO abatement. Due to the lack of existing information on CSO impacts on large rivers, it was decided that ORSANCO needed to develop a strategy for monitoring CSO impacts on the Ohio River. "A Strategy for Monitoring CSOs on the Ohio River" was adopted by the Commission in 1993, outlining the responsibilities of state regulatory agencies, municipal dischargers and ORSANCO in CSO monitoring activities along the Ohio River. Among the Commission's charges was the role of monitoring interstate clusters of CSOs along the main stem.

CSO Study Objectives

To accomplish the tasks outlined in the Strategy in a timely manner, ORSANCO solicited assistance from U.S. EPA. In October 1993, ORSANCO and U.S. EPA Regions III and IV entered into a cooperative agreement to conduct a study of the impacts of CSOs on the main stem of the Ohio River. A total of $160,000 was provided by the two regions through Section 104(b)(3) of the Clean Water Act, with an additional $29,000 supplied by ORSANCO. This study was comprised of three components:

1. Compilation of CSO-related information for Ohio River Communities
2. Identification of longitudinal/bacteria impacts from CSOs
3. Development of biological assessment methodologies

The following report presents the approach, findings and conclusions for the second component only – the longitudinal/bacteria study. This component was conducted in a 40-mile section (Ohio River mile points 301-341) of the Greenup Pool of the Ohio River, in the vicinity of Huntington, WV (See Figure 2). The purpose of this component was to attempt to develop a methodology for determining the physical limits of impacts from CSOs by examining certain field measurable parameters (dissolved oxygen, conductivity, pH and temperature), bacteria and BTEX (benzene, toluene, ethylbenzene, and xylene) compounds.

Study Approach

A total of 15 surveys were conducted under this component. Eight of the surveys were classified as dry weather surveys and seven were classified as wet weather – CSOs are expected to discharge during wet weather events and not during dry weather. Each survey was comprised of a longitudinal component and a cross-sectional component. The longitudinal component utilized a flow-through system which allowed field crews to develop water quality profiles of the study area without stopping the sampling vessel. The cross-sectional component utilized traditional stationary monitoring of five points across the stream (three points for tributaries) for horizontal profiles of the study area at eight main stem sites and two tributary sites.

Results

A comparison of the data collected in the dry weather surveys to that collected in the wet weather surveys reveals that there do not appear to be any impacts to either the physical parameters measured or to the BTEX levels in the river that would be attributable to local rainfall. As would be expected, the levels of fecal coliform bacteria demonstrated a consistent pattern of increased concentrations after rain events. However, of the 350 bacteria samples collected after precipitation events on the Ohio River, only six percent were greater than 600 CFU/100 mL and none exceeded 4,000 CFU/100 mL, while bacteria levels on the Guyandotte River (a major tributary in the study area) were consistently in the thousands range after rainfall and peaked at 24,000 CFU/100 mL.

Conclusions

Bacteria were the most telling of the parameters investigated in this study. The data collected indicate that the densities of fecal coliform bacteria in the River increase after local precipitation. Additional information on the volume, frequency, and duration of discharges from the combined systems in the study area would have allowed for a more definitive explanation of the elevated bacteria levels following wet weather. Consideration of various components of the available data does in fact point to CSOs as the likely source of the elevated bacteria levels. Specifically, the most upstream sampling site in the study area, which is located above all the local CSOs, consistently showed very low levels of fecal coliform in both dry and wet weather. This suggests that bacteria loadings are at the very least associated with the urban areas in the sampling zone, and not the result of high upstream background levels flowing into the study area.

This study represents the Commission's first attempt to quantify the extent and duration of water quality impacts attributable to CSOs. The study was able to demonstrate specific impacts from CSOs on tributaries. The size of the Ohio River, however, presents unique problems in terms of characterizing sources of pollution during storm events. The 40-mile study area discussed in this report included a 25-mile stretch of river which received discharges from 60 CSOs. It is difficult to isolate the impacts attributable to CSOs on the Ohio without extensive monitoring and modeling programs. One of the reasons for this is that most of the overflow structures are submerged and hence the impacts are not seen at the surface for some distance downstream.

In conclusion, the study was successful in quantifying the magnitude of the impacts on fecal coliform densities in the Ohio River resulting from local rainfall. Sampling methodologies utilized in this program proved extremely practical for wet weather applications and continue to be used in other wet weather studies along the Ohio River. It was established that BTEX compounds are not a good indicator of CSO/wet weather impacts. All future studies conducted on the Ohio River for the purpose of determining the water quality impacts associated with CSOs or wet weather in general, should include a strong emphasis on bacterial monitoring.

PREFACE

In October 1993, the Ohio River Valley Water Sanitation Commission (ORSANCO), received funding from U.S. EPA Regions III and IV to perform a study of the impacts of combined sewer overflows (CSOs) on the Ohio River. This study consisted of three major components: 1) compilation of CSO-related information, 2) identification of longitudinal/bacteria impacts from CSOs, and 3) development of biological assessment methodologies. In June 1994, ORSANCO received additional funding to perform a fourth component - Ohio River Basinwide Assessment.

Investigating CSOs and Their Impact on the Ohio River

The first component involved the collection of CSO related information for communities along the entire 981 miles of the Ohio River. From this effort it was determined that there are 60 municipalities with 1,061 permitted CSOs along or adjacent to the River. In addition, there are 40 *known* unpermitted CSOs from 12 different municipalities, and an *estimated* 447 unpermitted CSOs located in the Pittsburgh, PA area. If these estimates are correct, there could be as many as 1,548 CSOs in communities along the Ohio River. This number represents approximately 10 percent of the CSOs in the nation. ORSANCO has established a data base for pertinent information relating to CSO abatement along the Ohio. This data base includes latitude and longitude information where available for CSO outfall locations, status of CSO minimization plans, permit information including monitoring requirements, and the status of each state's CSO abatement program. In general, the CSO programs along the Ohio are well under way and hence, the information regarding CSOs will continue to change as abatement programs are developed and implemented.

The second component of the study – the longitudinal/bacteria study – was conducted in a 40-mile section (Ohio River mile points 301-341) of the Greenup Pool of the Ohio River, in the vicinity of Huntington, WV. The purpose of this component was to attempt to develop a methodology for determining the physical limits of impacts from CSOs by examining certain field measurable parameters (dissolved oxygen, conductivity, pH and temperature), bacteria and BTEX (benzene, toluene, ethylbenzene, and xylene) compounds. A total of 15 surveys were

conducted under this component. Eight of the surveys were classified as dry weather surveys and seven were classified as wet weather. A comparison of the data collected in the dry weather surveys to that collected in the wet weather surveys reveals that there do not appear to be any impacts to either the physical parameters measured or to the BTEX levels in the river. As would be expected, the levels of fecal coliform bacteria demonstrated a consistent pattern of increased concentrations after rain events. However, the bacteria concentrations measured in the main stem, although noticeably higher in the wet weather surveys, in general did not represent extremely high values, particularly when compared to the Guyandotte River – a tributary in the study area.

The third component – development of biological assessment methodologies – was conducted in a five-mile section of the Hannibal Pool of the Ohio River (Ohio River mile points 89-93) in the Wheeling, WV area. The objective of this component was to develop an assessment methodology for determining the impacts of CSOs, if any, on Ohio River biota. Potential impacts on the water quality of the main stem from five individual CSOs were investigated in the Wheeling system utilizing three different biological communities – macroinvertebrates, periphyton and benthic macroinvertebrates. Three rounds of sampling were conducted for each group over an 18 week period in the summer of 1994. Results indicated that of the three communities studied, macroinvertebrates seem to be the most useful in detecting impacts from the intermittent discharges of CSOs.

Ohio River Basinwide Assessment

An Intergovernmental Task Force on Monitoring Water Quality (ITFM) was created to develop and implement a strategic plan for effective collection, interpretation and presentation of water quality data, and to improve the availability of information for decision making at all levels of government. To this end, the Assessment and Reporting Task Group (ARTG) reviewed numerous water quality reports to identify features and information presentation techniques that should be used in reports to produce understandable interpretations of water quality conditions. The goal of the ARTG was to develop guidance for agencies and individuals preparing water quality reports.

U.S. EPA approached ORSANCO and the Tennessee Valley Authority (TVA) to produce a prototype basinwide assessment for the Ohio River Valley. An assessment chapter using the ITFM's findings has been generated which illustrates how information in the national 305(b) report might look in future years. It is a prototype for how states may prepare the information they provide to EPA to make it easier to put chapters together on conditions in major watersheds in the United States.

1.0 INTRODUCTION

1.1 Basin Description

The Ohio River Basin covers approximately 204,000 square miles, an area roughly the size of France, and constitutes six and a half percent of the continental United States. The Basin is located in the East Central part of the country and includes portions of 14 states (see Figure 1). Topography of the Basin varies from the Appalachian Mountains in the East to Midwestern prairies in the West. Land use varies similarly. While forests, agriculture and mining dominate the land use in the northeastern portion of the Basin, most of the land is forested in the south-eastern portion. Agricultural cropland dominates both the northwestern and southwestern areas. Almost three-quarters of the nation's identified coal reserves are found within the Basin. Due in part to this fact, there are a considerable number of electric power plants. Generating facilities along the Ohio River alone account for more than five percent of the nation's electricity. Other major industries in the Basin include manufactures of steel and petrochemicals.

The population of the Basin is more than 26 million. Large cities include Pittsburgh, Cincinnati and Louisville on the Ohio River main stem, as well as Columbus, Indianapolis, Chattanooga, and Nashville in other parts of the Basin. Major tributaries to the Ohio River include the Allegheny, Monongahela, Muskingum, Kanawha, Kentucky, Green, Wabash, Cumberland, and Tennessee Rivers (see Table 1 on page 3).

1.2 Water Use in the Ohio River Basin

The Ohio River Basin averages approximately 45 inches of precipitation per year. Rainfall is generally enough that irrigation of agriculture is not necessary. As a result of the abundant precipitation, the long-term average flow of the Ohio River is greater than that of the Mississippi River at their point of the confluence, even though the drainage area of the Mississippi River at this location is more than three times that of the Ohio River.

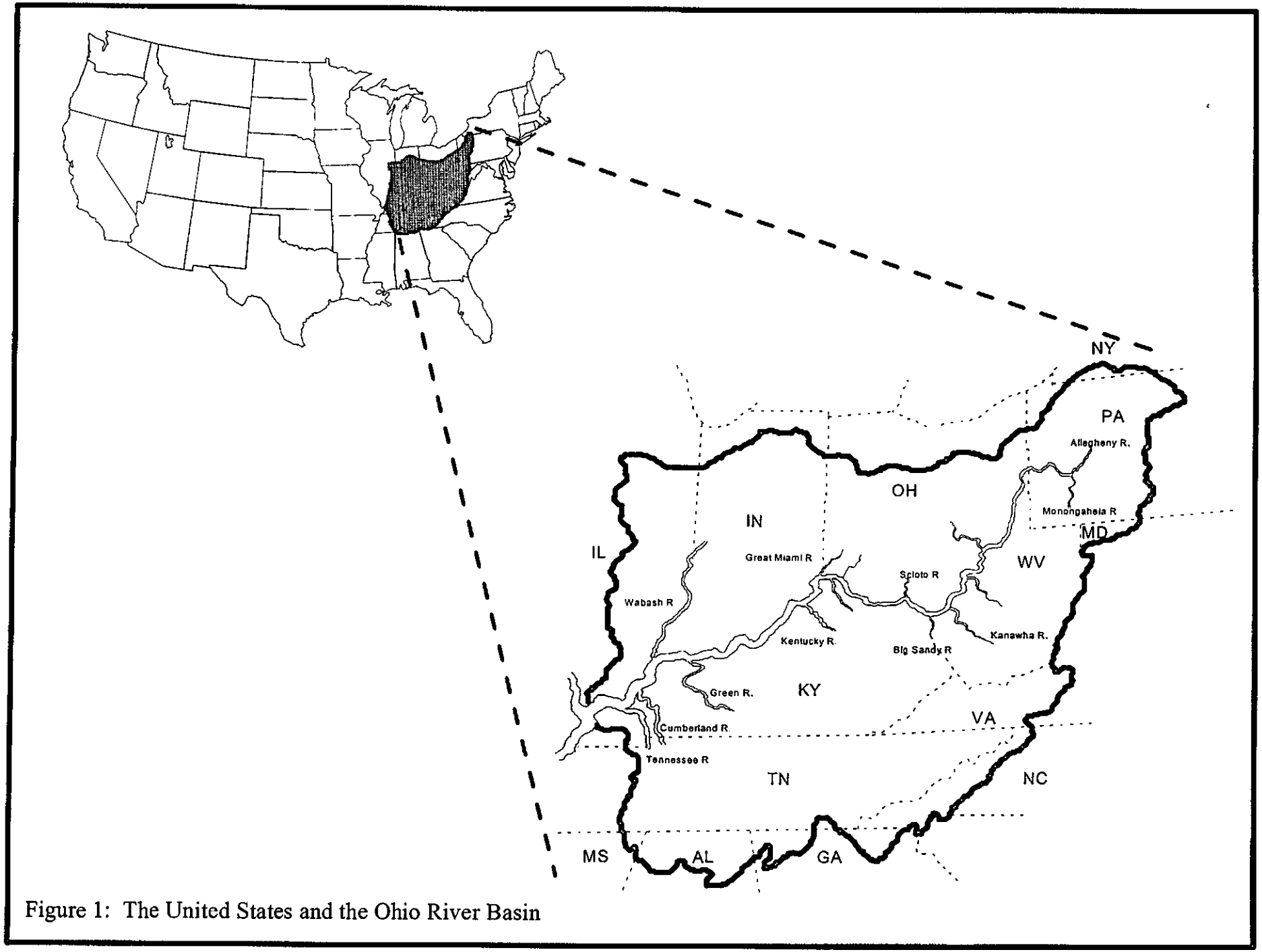


Figure 1: The United States and the Ohio River Basin

There are 2,584 miles of navigable waterways in the Basin, and over 40 percent of the nation's water-borne commerce is transported on this system. Coal and petroleum products comprise the largest share of the commodities carried by barge on the navigable waterways, which include all 981 miles of the Ohio River, 653 miles of the Tennessee River, 381 miles of the Cumberland River, 129 miles of the Monongahela River, and lesser portions of the Green, Kanawha, Kentucky, Allegheny, Clinch, and Little Tennessee Rivers.

The waters of the Basin are used for a variety of industrial purposes, including processing and cooling. In addition to the coal fired power plants noted above, electricity is produced at several nuclear facilities. Both coal fired and nuclear plants use large amounts of cooling water.

TABLE 1: STATES WITHIN THE OHIO RIVER BASIN

State	Drainage Area (sq. miles)	Major Rivers
Alabama	6,810	Tennessee
Georgia	1,500	Little Tennessee
Illinois	11,440	Ohio, Wabash
Indiana	29,135	Ohio, Wabash
Kentucky	39,375	Ohio, Licking, Kentucky, Green, Cumberland, Tennessee
Maryland	400	Youghiogheny
Mississippi	400	Tennessee
New York	1,900	Allegheny
North Carolina	6,260	Hiwassee, New, French Broad, Little Tennessee
Ohio	29,570	Ohio, Muskingum, Scioto, Great Miami
Pennsylvania	15,620	Allegheny, Monongahela, Ohio, Youghiogheny
Tennessee	33,645	Tennessee, Cumberland, Clinch, Holston, Hiwassee, French Broad, Little Tennessee
Virginia	7,175	New, Clinch, Holston
West Virginia	20,610	Ohio, Kanawha, Monongahela, New

There are also a number of hydropower facilities in the Basin, particularly on the Tennessee and Cumberland Rivers.

Water uses of primary concern are those which depend on good water quality conditions – public water supply, water contact recreation, aquatic life habitat, and fish consumption. Most of the rivers, streams, and lakes throughout the Ohio River Basin are classified for one or more of these uses. About 10 million people are served by public water supply systems that depend on surface waters of the Basin as their source, three million of which rely specifically on the Ohio River. Most of the waters of the Basin are classified as warm water aquatic habitat, and their use for sport fishing is steadily increasing. Some commercial fishing and mussel harvesting take place on the Tennessee and Lower Ohio Rivers. While designated swimming beaches are, for the most part, located on the many lakes and reservoirs in the Basin, water skiing and swimming also take place on the larger rivers. Several rivers such as the New and the Gauley in West Virginia, the Ocoee in Tennessee, and the Nantahala in North Carolina are widely used for whitewater canoeing, kayaking and rafting.

1.3 Ohio River Main Stem

The Ohio River extends 981 miles from Pittsburgh, PA southwest to Cairo, IL where it joins the Mississippi River. Along the way, the Ohio River forms the border between Ohio, Indiana, and Illinois to the north, and West Virginia and Kentucky to the south. The flow in the river is regulated by a series of locks and dams operated and maintained by the U.S. Army Corps of Engineers. The 20 dams on the river create a series of pools. The average flow in the river ranges from 35,000 cubic feet per second at Pittsburgh to 250,000 cubic feet per second at Cairo.

Many municipal and industrial discharges are located along the Ohio River. Of the 194 municipal waste water treatment facilities discharging directly to the River, 126 have flows of 40,000 gallons per day or greater; these 126 facilities serve 3.5 million people. Major dischargers of treated municipal waste water include the cities of Pittsburgh, PA, Cincinnati, OH, and Louisville, KY. There are a variety of industrial discharges to the River, including discharges from steel, chemical and power production facilities. Of the 383 industrial discharges, 114 are contaminated process discharges with flows of 40,000 gallons per day or greater. Regarding power production, there are 45 generating facilities on the River which constitute approximately five percent of the nation's installed generating capacity.

The River is also a major artery for the transportation of industrial materials. Freight on the River is dominated by coal traffic. In 1992, the U.S. Army Corps of Engineers estimated that more than 225 million tons of cargo were transported through barge traffic, 59 percent of which was coal. Other products which are transported along the River include aggregates (28 million tons in 1992), petroleum (13 million tons), grain (11 million tons), and chemicals (10 million tons).

In addition, because of improved water quality, the River is being used more for such recreational activities as boating, water skiing and fishing.

1.4 Ohio River Valley Water Sanitation Commission (ORSANCO)

The Ohio River Valley Water Sanitation Commission (ORSANCO) is an interstate water pollution control agency which was created in 1948 to administer an agreement among eight states. That agreement, the Ohio River Valley Water Sanitation Compact, established certain goals for the water quality of the Ohio River and its tributaries, and established the Commission as a body corporate to oversee its execution. The Compact was signed by the governors of the eight states – Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia – and was approved by the United States Congress (see Appendix 1).

It is clear from a reading of the Compact that its framers foresaw a cooperative effort by the states, rather than creation of a new level of authority, as the key to the success of their undertaking. In its key provisions, the Compact pledges the states to action, with the Commission providing information and a forum for the states to coordinate their activities. Programs carried out by the Commission are therefore designed to complement efforts by the states. Some activities, such as monitoring and assessment of the Ohio River main stem, have been delegated to the Commission by the member states. In other areas, such as the regulation of individual waste water dischargers, the states perform the primary role with the Commission providing oversight and coordination.

2.0 BACKGROUND

Combined sewer overflows (CSOs) are viewed as a particular problem in the Ohio River Basin. A national inventory of CSOs compiled by the U.S. EPA indicated that there were 10,770 individual CSOs, 7,250 (67 percent) of which are located within the eight member states of the Commission. Although many of these CSOs are located in portions of the states which are outside the Ohio Valley, such as Chicago, Cleveland and New York City, early reports identified more than 1,200 CSOs in cities along the main stem of the Ohio River.

2.1 Development of ORSANCO CSO Initiative

In 1991, ORSANCO convened a task force made up of representatives from state and federal regulatory agencies as well as municipal sewer districts with CSOs to consider the role ORSANCO should fulfill in CSO abatement. The task force developed a list of specific recommendations which fell into two general areas: coordination of states' abatement activities to assure compatibility between communities on opposite sides of the river, and determination of monitoring needs to identify CSO impacts on the Ohio River.

In 1992, efforts by ORSANCO staff to identify studies of CSO impacts on large rivers met with little success. While numerous studies of CSO impacts on estuaries had been completed, and lesser numbers on lakes and small streams, no large river case studies could be found. It was believed that results from studies of other types of waters could not be directly applied to the Ohio River for several reasons:

1. Due to tidal action, CSO discharges to estuaries remain in a relatively confined area for a period of time after the overflow event. On a large river, the combined sewage discharge moves downstream.

2. Accumulation of deposits in bottom sediments is an important CSO impact on estuaries, lakes and small streams. On the Ohio River, however, the bottom is highly transient and no such deposits have been observed.

3. Most early studies of CSO impacts focused on established beaches and swimming areas. There are no such areas on the Ohio River; most contact recreation consists of water skiing or swimming from boats.

4. Combined sewer overflows to most waterbodies are strictly the result of rainfall. On the Ohio River, however, overflows can be induced by rises in river stage. The older combined sewer systems along the Ohio River were built before the current system of high lift navigation dams were in place. The new dams resulted in higher river stages, which in turn, submerged many existing sewer systems and overflows. Thus, overflows from these systems can be triggered by river water entering the sewers.

Due to the lack of existing information, it was decided that ORSANCO would need to develop a strategy for monitoring CSO impacts on the Ohio River. To this end, the Commission hosted a workshop where experts from around the country were asked to assist in the development of monitoring protocols which would isolate impacts attributable to CSOs. The result of the workshop was the publication of ORSANCO's "A Strategy for Monitoring CSOs on the Ohio River" in 1993. This document outlines the responsibilities of state regulatory agencies, municipal dischargers and ORSANCO in CSO monitoring activities along the Ohio River. Among the Commission's charges was the role of monitoring interstate clusters of CSOs along the main stem.

2.2 Investigating CSOs and Their Impact on the Ohio River

To accomplish the tasks outlined in the Strategy in a timely manner, ORSANCO solicited assistance from U.S. EPA. In October 1993, ORSANCO and U.S. EPA Regions III and IV entered into a cooperative agreement to conduct a study of the impacts of CSOs on the main stem of the Ohio River. A total of $160,000 was provided by the two regions through Section 104(b)(3) of the Clean Water Act, with an additional $29,000 supplied by ORSANCO. This study was comprised of three components:

1. Compilation of CSO-related information for Ohio River Communities
2. Identification of longitudinal/bacteria impacts from CSOs
3. Development of biological assessment methodologies

This document presents results of the second component. A separate report is available on the third component.

3.0 LONGITUDINAL/BACTERIA STUDY

3.1 Objective

The objective of this study was to attempt to develop a methodology for determining the physical limits of impacts from CSOs by examining certain field measurable parameters, bacteria and BTEX (benzene, toluene, ethylbenzene, and xylene) compounds.

3.2 Study Area

The surveys were conducted in the Greenup Pool (Gallipolis L&D – Ohio River Mile Point (ORMP) 279 downstream to Greenup L&D – ORMP 341) of the Ohio River. A 40-mile section of this pool, Ohio River mile points 301 to 341, was used for the longitudinal and cross-sectional surveys. This area contains the boundaries of three states: Kentucky, Ohio, and West Virginia. The following CSO communities are represented in the study area:

ORMP	City	State	Number of CSOs
308	Huntington	WV	23
316	Kenova	WV	2
318	Catlettsburg	KY	13
322	Ashland	KY	9
326	Ironton	OH	10
329	Worthington	KY	3
		TOTAL:	**60**

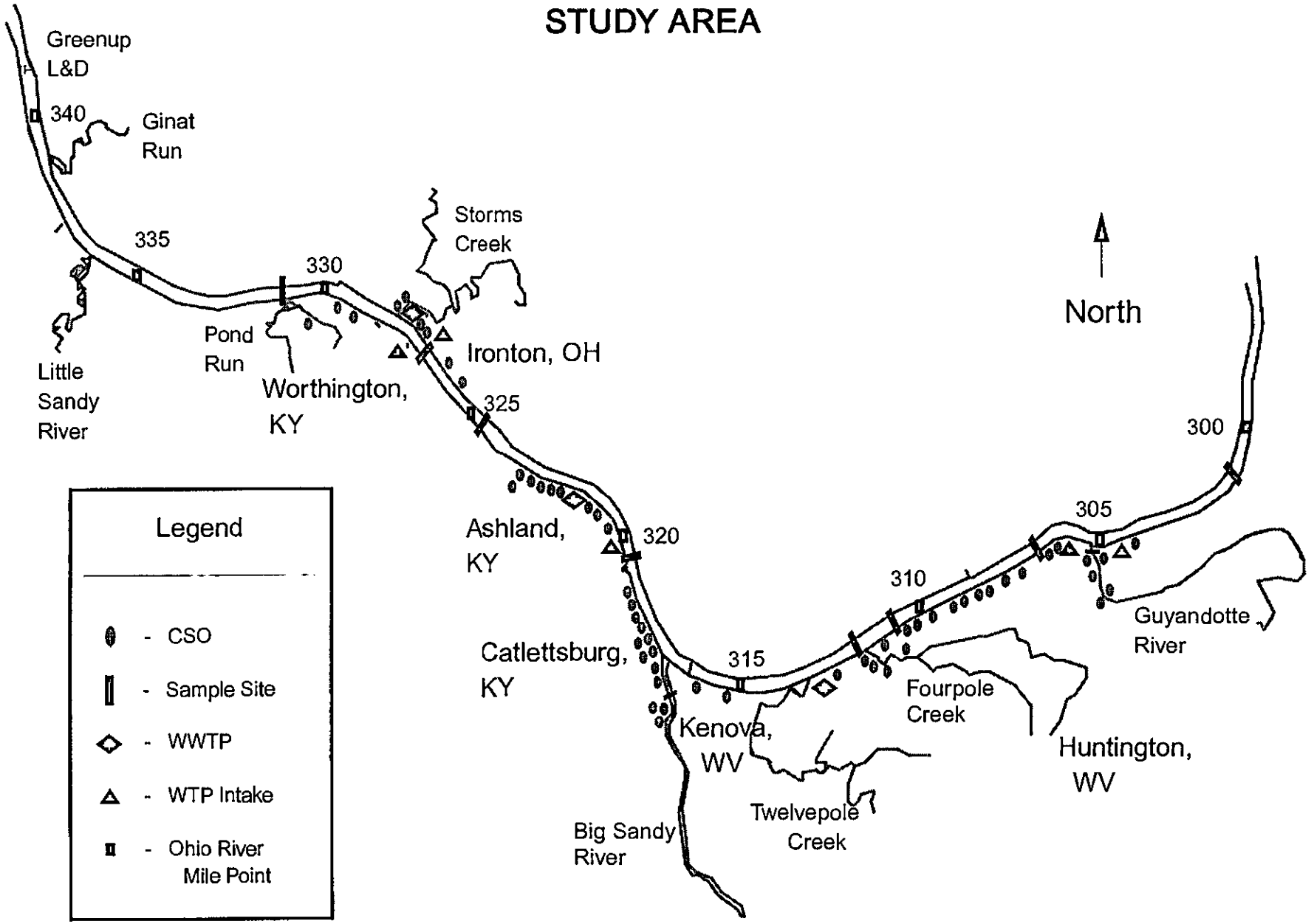
Table 2 displays mile points of existing ORSANCO bacteria monitoring stations, water treatment plant (WTP) intakes, publicly owned treatment work (POTW) discharges, and approximate Ohio River mile points of CSOs for the study area. Appendix 2 contains detailed ORSANCO Summary Sheets for each CSO community. Figure 2 displays the portion of the Greenup Pool which was used for the surveys. Locations of CSOs, WWTP discharges, WTP intakes, and cross-section survey sites for the area are all displayed.

TABLE 2
Greenup Pool Information

Existing Bacteria Monitoring Stations		
ORMP 306.9	Huntington WTP	
ORMP 314.8	ORSANCO (Kosmos Cement Co. - Barge Moor)	
WTP Intakes		
ORMP 304.2	Huntington, WV	
ORMP 306.9	Huntington (2nd Intake)	
ORMP 319.7	Ashland, KY	
ORMP 327.0	Ironton, OH	
ORMP 327.5	Russell, KY	
POTW Discharges		
		Design Flow
ORMP 313.1	Eastern Lawrence Co. R.S.D., OH	1.1 MGD
ORMP 313.2	Huntington, WV	17.0 MGD
ORMP 317.0	South Point, OH	1.2 MGD
ORMP 317.1	Catlettsburg, KY	0.5 MGD
ORMP 322.5	Ashland, KY	11.0 MGD
ORMP 324.0	Coal Grove, OH	0.3 MGD
ORMP 327.2	Ironton, OH	1.7 MGD
ORMP 327.3	Boyd/Greenup Co. S.D. #1, KY	0.8 MGD
ORMP 327.8	Flatwoods, KY	0.8 MGD
ORMP 327.9	Greenup County, KY	2.1 MGD
ORMP 328.9	Worthington, KY	0.2 MGD
ORMP 336.4	Greenup, KY	0.2 MGD
Approximate Ohio River Mile Points of CSOs		
		LAT/LON
ORMP 304 - 313	Huntington, WV (14 Ohio River CSOs)	Yes
*ORMP 305.2	Guyandotte River - Huntington (4 CSOs)	
*ORMP 311.9	Fourpole Creek - Huntington (4 CSOs)	
	Krout Creek - Huntington (1 CSO)	
ORMP 315 - 316	Kenova, WV (2 Ohio River CSOs)	Yes
ORMP 317 - 319	Catlettsburg, KY (8 Ohio River CSOs)	No
*ORMP 317.2	Big Sandy River - Catlettsburg (5 CSOs)	
ORMP 321 - 323	Ashland, KY (6 Ohio River CSOs)	Yes
*ORMP 323.7	Long Branch - Ashland (1 CSO)	
*ORMP 324.0	Hood Creek - Ashland (2 CSOs)	
ORMP 325 - 328	Ironton, OH (8 Ohio River CSOs)	Yes
*ORMP 328.0	Storms Creek - Ironton (2 CSOs)	
ORMP 329 - 331	Worthington, KY (2 Ohio River CSOs)	Yes
*ORMP 331.0	Pond Run - Worthington (1 CSO)	

*Indicates confluence mile point

FIGURE 2
STUDY AREA



3.3 Approach

Surveys were conducted in the Greenup Pool of the Ohio River to determine if the proposed methodologies could be used to characterize the longitudinal impacts of CSOs on water quality of the Ohio River. Investigations were conducted to develop and document longitudinal profiles for pH, conductivity, dissolved oxygen, temperature, fecal coliform bacteria, and BTEX compounds during dry weather and after rain/CSO discharge events.

3.3.1 Historical Hydrological Data for the Greenup Pool

The first step in designing the sampling program for this component involved the review of historical hydrological data for the study area. In addition to attempting to define optimum sampling conditions, consideration had to be given to crew safety.

Three forms of historical hydrologic data – river stage, river flow, and precipitation – were collected for the Huntington, WV area. Although this information represented historical data and might not have any bearing on the actual conditions which would be encountered during the sampling period, it was necessary to review this information for developing tentative sampling schedules.

River Stage Data

Both river stage and river flow data were collected, as there is not a linear correlation between them. High stage conditions on the Ohio River can be quite dangerous, and field crews should avoid going onto the river if possible during these periods. Therefore, historical river stage information was collected for the summer months to verify that stage elevation would not present a problem for the proposed sampling period.

Stage data were provided to ORSANCO by the U.S. Army Corps of Engineers, Huntington District. Five years of data, reported in one hour intervals, were compiled into a spreadsheet format where daily and monthly averages were computed.

Because all the sampling was to be conducted in the summer, averages were only computed for the months of May through September. A five-year average was also computed. From these data, it appears that over the last five years the average pool level during these months has been fairly constant at one to two feet over the normal flat pool level of 24.7 feet.

River Flow Data

Flow data were also used to determine when the river would be accessible to the sampling crews. Data were obtained from the National Weather Service Ohio River Forecast Center in Cincinnati, OH, which utilizes a predictive model to generate flow values. The average monthly flows from 1984 to 1993 were compiled and a 10-year average computed. The data shows that over the last 10 years, during the months of June through October, the average monthly river flow has been under 60,000 cfs. It has been ORSANCO's experience that during the months of June through October the Ohio River is usually accessible by small water craft and is conducive to water sampling. However, extreme weather conditions could have had profound effects in local or regional areas that would have suspended sampling due to safety concerns.

Precipitation Data

Precipitation data were gathered for the Huntington area to represent key periods of precipitation. This allowed the sampling activities to be scheduled during the highest probability of a rain event. Precipitation data were provided to ORSANCO by the Northeast Regional Climate Center and were reported in total inches of precipitation per day. The data were then imported into a spreadsheet where the total amount of precipitation per month was computed.

Based on a review of data for the last 10 years, the month of July appears to provide the most optimum conditions for sampling CSOs on the Ohio River. Of the summer months, July has the greatest amount of precipitation, the most numerous days of precipitation, and relatively low

flows. Figure 3 displays the average monthly precipitation and the average monthly flows for the Huntington area.

3.3.2 Sampling Program

Due to equipment integration setbacks, the project did not start in mid-June as anticipated, but rather was delayed until mid-July. Completion of the sampling was delayed in the fall due to weather patterns. As a result, the field sampling season did not end until the second week of November. A total of 15 surveys were completed from July 21 through November 10. Appendix 3 contains the hydrologic conditions at Huntington, WV for each survey.

Eight of these surveys were classified as dry weather surveys and seven were classified as wet weather. Each survey consisted of two phases. Phase 1 involved the development of longitudinal profiles of the study area for a number of parameters with the use of a flow-through system. Phase 2 consisted of a series of cross-sectional surveys at 10 locations in the sampling area (see Figure 2). For each of the 15 surveys, six pages of tables and figures were compiled. An example of the information generated from a single survey is included in Appendix 4.

Phase 1 - Longitudinal Surveys

Fifteen surveys were performed from mid-July through mid-November of 1994. For each survey, a longitudinal profile of the study area was generated for a number of parameters including fecal coliform bacteria, BTEX compounds and physical parameters including DO, pH, conductivity, and temperature. The sampling apparatus used for this component consisted of a fluorometer and multi-parameter probe attached to a flow-through system which allowed for instantaneous readouts of water quality conditions while the boat traversed the study area at 30 miles per hour (see Figures 4a and 4b).

A review of Figure 2 shows that the CSOs are concentrated on the left descending bank (Huntington, Kenova, Catlettsburg, and Ashland) from ORMP 304 - ORMP 324. Below

FIGURE 3
AVG MONTHLY FLOW vs. AVG MONTHLY PRECIPITATION
Huntington, WV 1984 - 1993

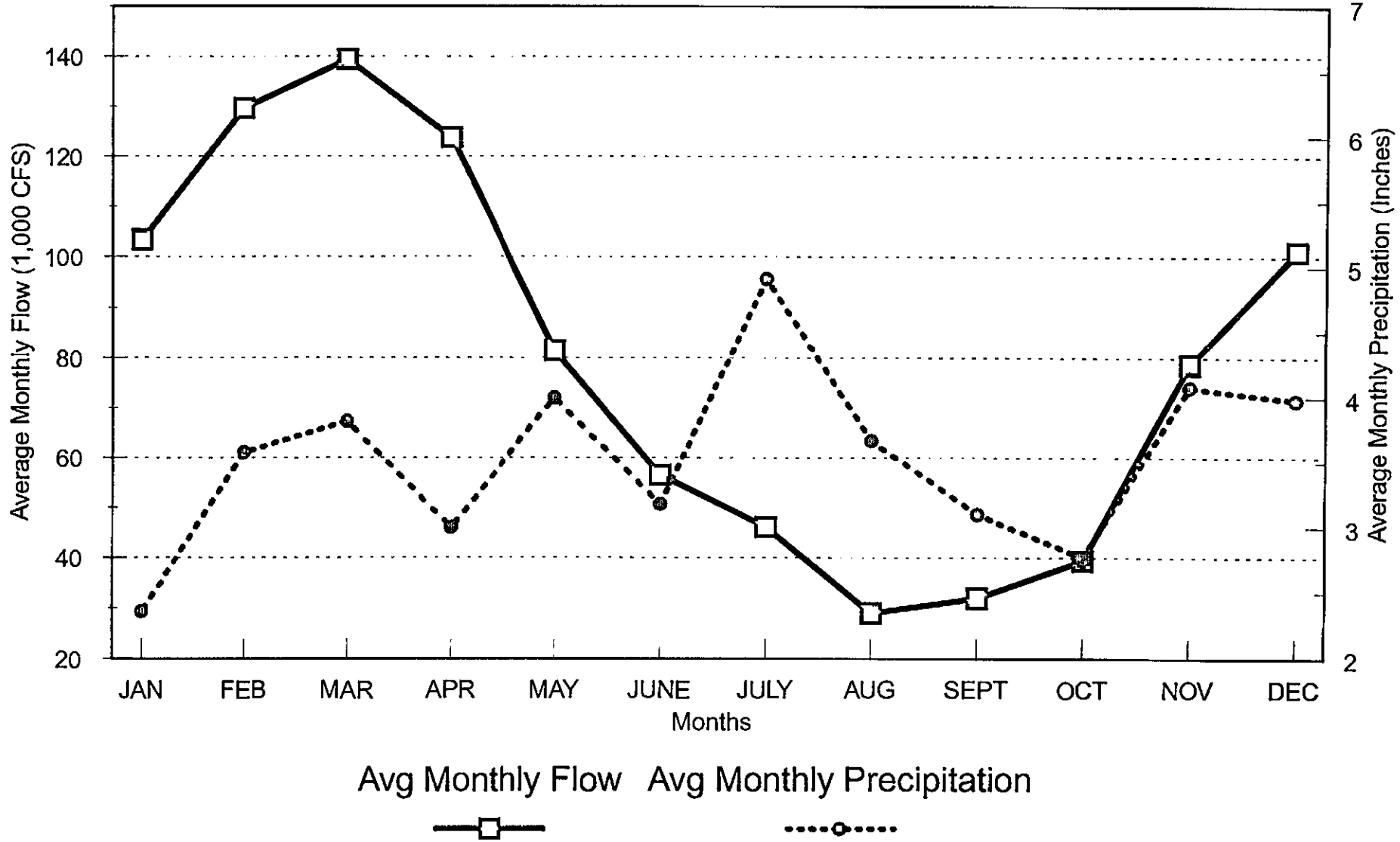


FIGURE 4a
MONITORING APPARATUS FOR LONGITUDINAL SURVEYS

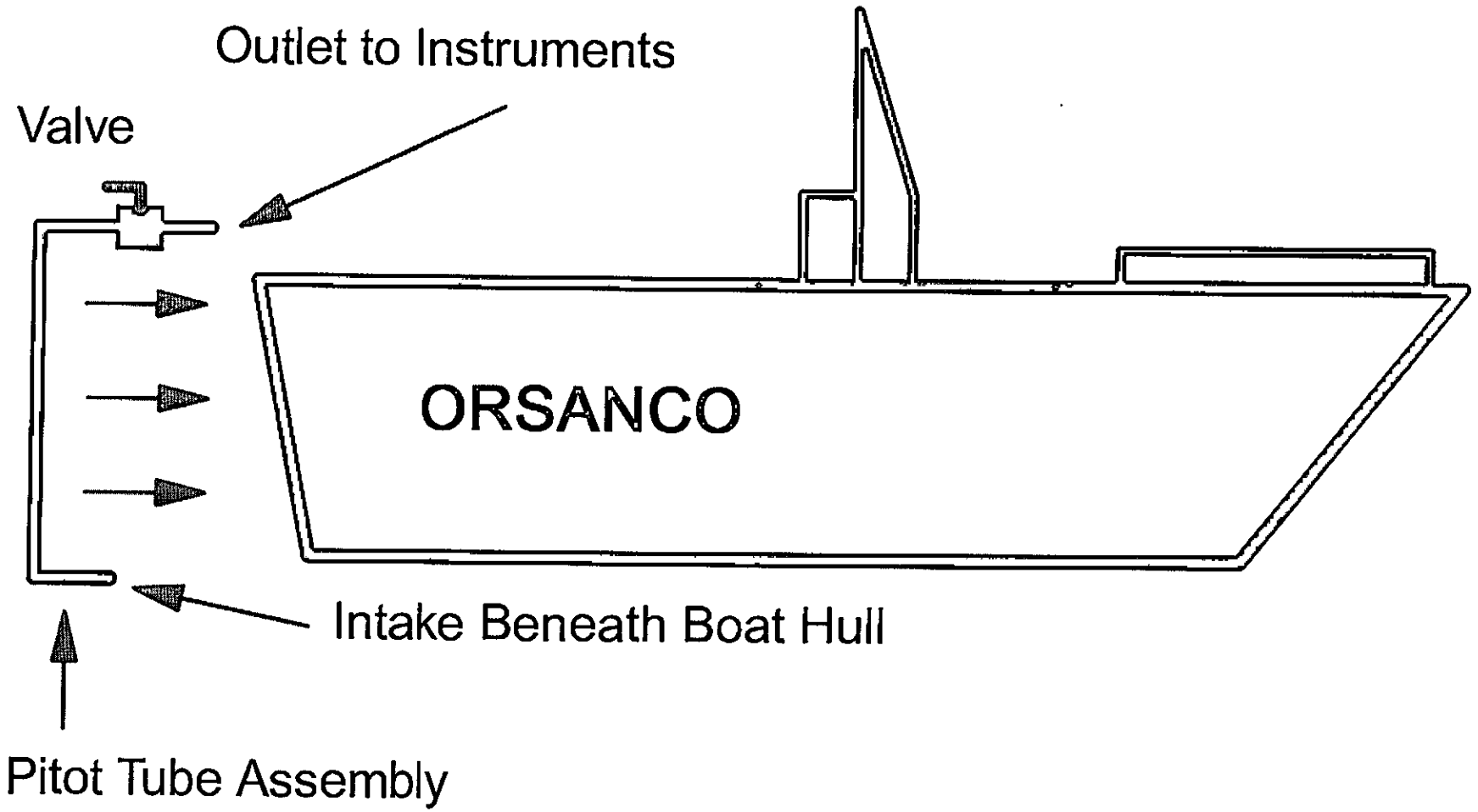
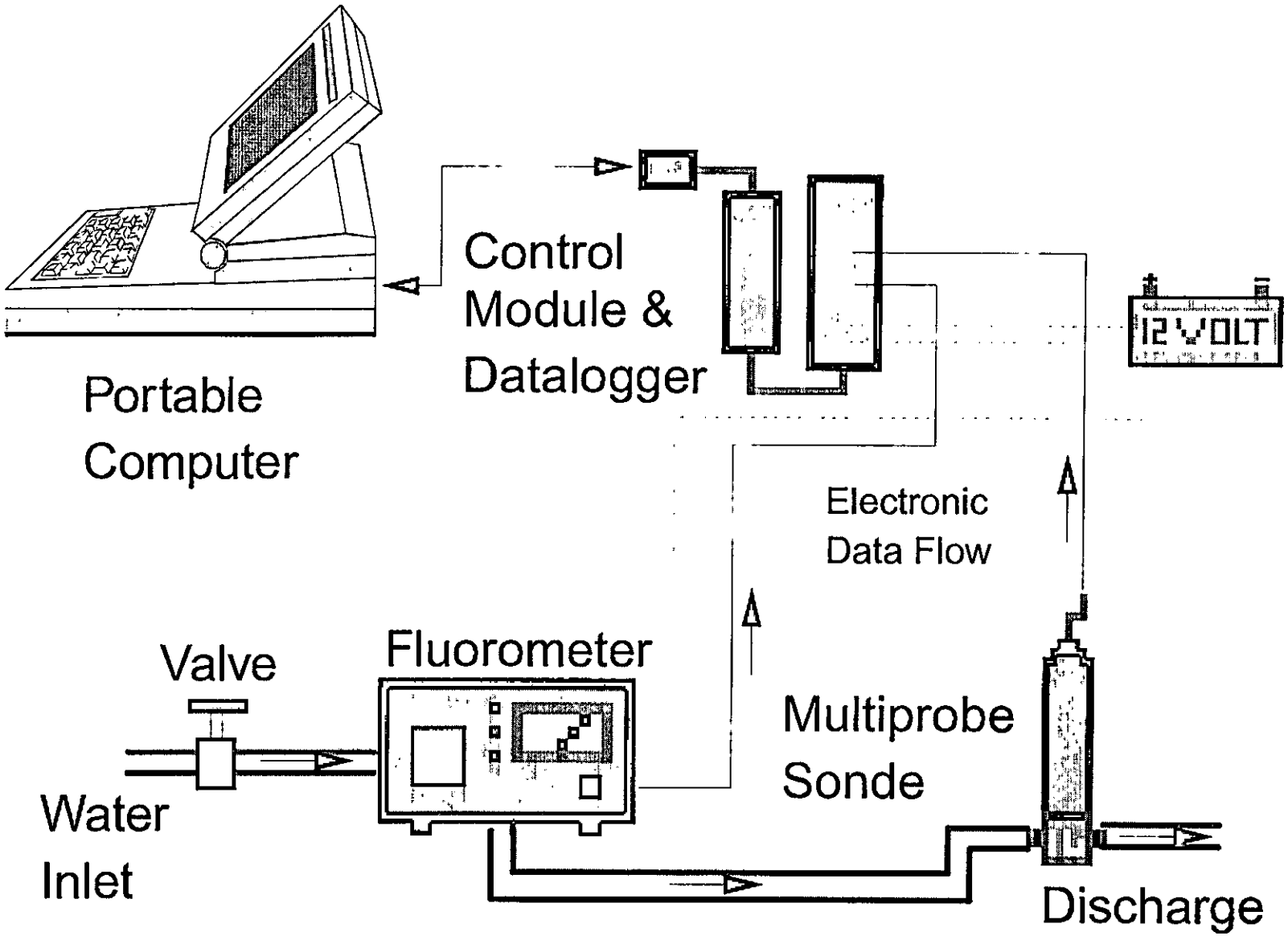


FIGURE 4b
MONITORING APPARATUS FOR LONGITUDINAL SURVEYS



Ashland, KY, however, most of the CSOs are located in Ironton, OH on the right descending bank. In an effort to capture possible near-field impacts from the CSO discharges, the boat traveled near the left descending bank in the upper area of the sampling zone before crossing over to the right descending bank near the Ironton WTP intake and continued near the right bank for the remainder of the survey.

The multi-parameter probe measured pH, conductivity, dissolved oxygen, and temperature. The instrument was both pre- and post-calibrated for each survey. The data logging equipment was programmed to record data at 10 second intervals while the boat traversed the 40-mile study segment. This resulted in approximately 1.6 hours of sampling time, 576 readings per parameter, and a resolution of 14.4 readings per parameter per mile. See Appendix 5 for a summary of these data. In an effort to investigate correlations between bacteria levels and the field measurable parameters, single-point grab samples were taken at 10 locations during the longitudinal survey to be analyzed for fecal coliform bacteria. This resulted in a total of 165 bacteria samples (including one field blank per survey) for all 15 longitudinal surveys. Table 3 lists the locations where the longitudinal samples were collected.

The fluorometer, which was incorporated into the flow-through system, allowed for continuous monitoring for the presence of BTEX compounds during the longitudinal surveys. However, the fluorometer was only sensitive to levels of BTEX greater than five parts per billion (ppb). In an effort to verify the readings of the fluorometer as well as to detect lower concentrations of BTEX compounds, 10 grab samples (collected in duplicate) were taken during each longitudinal survey to be analyzed using laboratory techniques. As an additional quality control, one of the 10 samples (e.g., 10 percent) collected during each survey was collected in quadruplicate with two samples being sent to a contract laboratory for gas chromatograph (GC) analysis.

Phase 2 - Cross-sectional Surveys

Upon completion of Phase 1, cross-sectional surveys were performed at 10 locations in the study area. The objective was to bracket urban areas as well as associated publicly owned treatment works (POTWs) to determine impacts of CSOs on bacteria levels in the River. Refer to Table 3

TABLE 3
Greenup Pool Longitudinal and Cross-Sectional Surveys
Sampling Site Locations

Sampling Mile Point	Number of Samples	Site Description	Sample Identification						Reason for Sampling Site
			L	LQ	M	RQ	R	G	
301 0	6	Public Launching Ramp	301L	301LQ	301M	301RQ	301R	301G	Above Huntington CSOs
305.2	1	Guyandotte River Confluence						305G	Receiving stream for 4 CSOs
	3	Guyandotte River @ 1st Bridge	305L		305M		305R		
306.9	6	Huntington WTP - Intake # 2	306L	306LQ	306M	306RQ	306R	306G	Downstream of Guyandotte R. & Huntington CSOs
310.8	6	West End Bridge	310L	310LQ	310M	310RQ	310R	310G	Downstream of Huntington CSOs & Above Fourpole Creek
311.9	6	Fourpole Creek Confluence	311L	311LQ	311M	311RQ	311R	311G	Downstream of Huntington CSOs & Receiving Stream for 4 CSOs
317.2	1	Big Sandy River Confluence						317G	*No CSOs - Determine non-CSO related bacteria levels in tributary
	3	Big Sandy River @ 1st Bridge	317L		317M		317R		
319.7	6	Ashland WTP Intake	319L	319LQ	319M	319RQ	319R	319G	Above Ashland CSOs
324.7	6	Submarine Crossing	324L	324LQ	324M	324RQ	324R	324G	Below Ashland CSOs & Above Ironton CSOs
327 0	6	Ironton WTP Intake	327L	327LQ	327M	327RQ	327R	327G	Below 2 Ironton CSOs & Above Worthington CSOs
331 0	6	Pond Run Confluence	331L	331LQ	331M	331RQ	331R	331G	Below Ironton and Worthington CSOs
Field Blanks	1	Longitudinal	341L						
	1	Cross-Section					341R		

*After the surveys were completed, ORSANCO was notified that Catlettsburg has 13 CSO's, 5 of which discharge to the Big Sandy River

Designation for cross-section grab samples (L = Left Bank, LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

Designation for longitudinal grab samples = G

for locations where the cross-sectional sampling was performed. At each of the eight main stem sampling locations, samples were collected at five points across the stream (left bank, left quarter, midstream, right quarter, and right bank). At the two tributary sampling locations – the Guyandotte and Big Sandy Rivers – samples were collected at three points across the stream (left third, midstream, and right third). Each sample, a grab sample collected one foot below the surface, was analyzed for fecal coliform bacteria. In addition, field measurable parameters including pH, conductivity, dissolved oxygen, and temperature, were recorded at each of the sampling points (see Appendix 6 for a summary of these data). As part of this component, 47 samples (including one field blank) were collected for each survey resulting in a total of 705 bacteria samples for all 15 surveys.

3.4 Data Assessment

The assessment of the longitudinal and cross-sectional survey data was completed by compiling all of the data (field measurable parameters, BTEX data, fecal coliform data, and any field notes) into spreadsheet and graphical form. Data were then evaluated for any relationships or correlations between wet weather and river water quality conditions.

It was imperative to obtain as much rainfall information as possible. Huntington WWTP has a network of nine rain gauges spread throughout the Huntington area. Additionally, precipitation data were obtained from both Ashland, KY and Ironton, OH. Huntington's rainfall data were collected on an hourly basis, whereas Ironton and Ashland collected theirs on a daily basis. See Appendix 7 for a summary of the precipitation data for the study area during the periods when sampling was conducted.

In reviewing the following information, recall that this sampling program was essentially comprised of two different phases, and therefore, there are two distinct types of samples referenced in the data – longitudinal grab samples and cross-sectional grab samples.

The longitudinal grab samples were obtained during the initial phase of each sampling event. As the boat traversed the 40-mile sampling zone, grab samples were obtained "on-the-move," via the flow through system, at 10 pre-established locations along the main stem. The 10 samples taken during this phase of each survey are designated as "longitudinal grab samples."

Upon completion of the first phase, the sampling crew would proceed back up the River to conduct five-across cross-sectional sampling (Phase 2) at eight of the 10 locations where the longitudinal grab samples had been taken during Phase 1. The two exceptions to the relationship between the Phase 1 and Phase 2 sampling locations occurred at Ohio River mile points 305.2 and 317.2 which represent the mile points of the confluences of two tributaries, the Guyandotte and Big Sandy Rivers, respectively. In these two instances, Phase 2 samples were obtained a short distance up the tributary, off the main stem, and therefore represent a different sampling location from Phase 1. Also, because of the significant difference in stream width between these two tributaries and the main stem, only three-across cross-sectional sampling was conducted at the sampling sites on the tributaries.

In summary, all of the longitudinal grab samples taken during Phase 1, were taken from the main stem of the Ohio River. Additionally, eight of the 10 cross-sections conducted under Phase 2 represent main stem sampling locations. The remaining two sets of cross-sectional sampling associated with Phase 2 were conducted on the Guyandotte and Big Sandy Rivers.

There were three surveys in which a "stage induced bypass" may have occurred (Surveys 5, 6, and 7). These three surveys were also classified as dry weather events and not wet weather events due to very little or no recorded precipitation 24 hours before sampling. The high stage was the direct result of large amounts of precipitation further upstream of the Greenup Pool (especially the Kanawha River Basin). Although the stage for all 15 surveys was above the normal flat pool of 24.7 feet (515 feet above sea level), the three previously mentioned surveys recorded the highest stages at greater than 27 feet (approximately 2.5 feet above normal flat pool).

Of the CSO communities in the Greenup Pool, ORSANCO could only gather outfall and weir elevations from Huntington. According to the document, "Report on Development of Combined Sewer System Operation Plan," there are four CSOs which may have experienced stage induced bypasses during the sampling surveys. These four CSOs have weir elevations between 518 to 520 feet above mean sea level (three to five feet above normal flat pool). The bacteria concentrations in the Huntington area were elevated on the left descending bank and the left quarter for each of these surveys when compared to the rest of the cross-section samples.

3.5 Results

3.5.1 Fecal Coliform Bacteria Data

The following section presents the results of the fecal coliform bacteria samples collected during the study. Appendix 8 contains the bacteria data in tabular form. ORSANCO's *Pollution Control Standards for Discharges to the Ohio River 1993 Revision* require that the "Maximum allowable level of fecal coliform bacteria for contact recreation (for the months of May through October) content shall not exceed 200/100mL as a monthly geometric mean based on not less than five samples per month; nor exceed 400/100mL in more than 10 percent of all samples taken during the month." In reference to these standards, fecal coliform bacteria data collected for this study have been divided into the following four categories:

a) 0-200 CFU/100mL
b) 201-400 CFU/100mL
c) 401-600 CFU/100mL
d) >600 CFU/100mL

Dry Weather Sampling

Dry weather sampling was in general, characterized by a 48-hour antecedent dry period. However, in some instances -- specifically, Surveys 5, 8 and 11 – there was some precipitation within the 48-hour period. In all three instances, the rain was limited in its area of coverage and ranged in magnitude from trace amounts to 0.15 inches.

Longitudinal Sampling

A total of 80 longitudinal samples were collected from the main stem during the eight dry weather surveys (10 samples/survey). Figure 5 presents the data in terms of the number of samples which fall within these various groupings. Of the 80 samples collected, 68 samples (or 85 percent) had levels of fecal coliform less than 200 CFU/100mL. Furthermore, bacteria levels were below 400 CFU/100mL in 99 percent of the samples collected. Only one sample was above 400 CFU/100mL. Of these dry weather surveys, mile point 310.8 had the fewest samples in the <200 group. However, the highest fecal coliform bacteria level occurred at mile point 305.2 (Guyandotte River confluence).

Cross-Sectional Sampling

A total of 320 main stem samples were collected for this component. Of these, 285 samples, or 89 percent of the samples collected, had levels of fecal coliform bacteria below 200 CFU/100mL with 98 percent below 400 CFU/100mL. Only two samples, or less than one percent, out of the 320 samples collected during the dry weather surveys exceeded 600 CFU/100mL. See Figure 6. The site with the most exceedances of the 200 CFU/100ml criteria occurred at mile point 306.9, where 17 percent of the samples collected were greater than the 200 level. The site selected to provide background conditions above the influences of the urban areas within the study zone was mile point 301. At this location 98 percent of the samples collected were 200 CFU/100mL or less. The one sample that did exceed the 200 level was a minor exceedance (220 CFU/100mL) which occurred during Survey 6.

Wet Weather Sampling

The initial criteria, as defined in the project workplan, for determining a wet weather event required 0.25 inches or more of precipitation in the study area within the 24-hour period preceding sampling. Information from 11 rain gauges in the study area has been compiled for the period when sampling was conducted.

Although it was necessary to establish a mechanism to trigger wet weather monitoring activities, the rainfall patterns in the study area required the use of best professional judgement in deciding

FIGURE 5: LONGITUDINAL SURVEYS
OHIO RIVER FECAL COLIFORM DENSITIES
8 Dry Weather Events (8 Samples / Site)

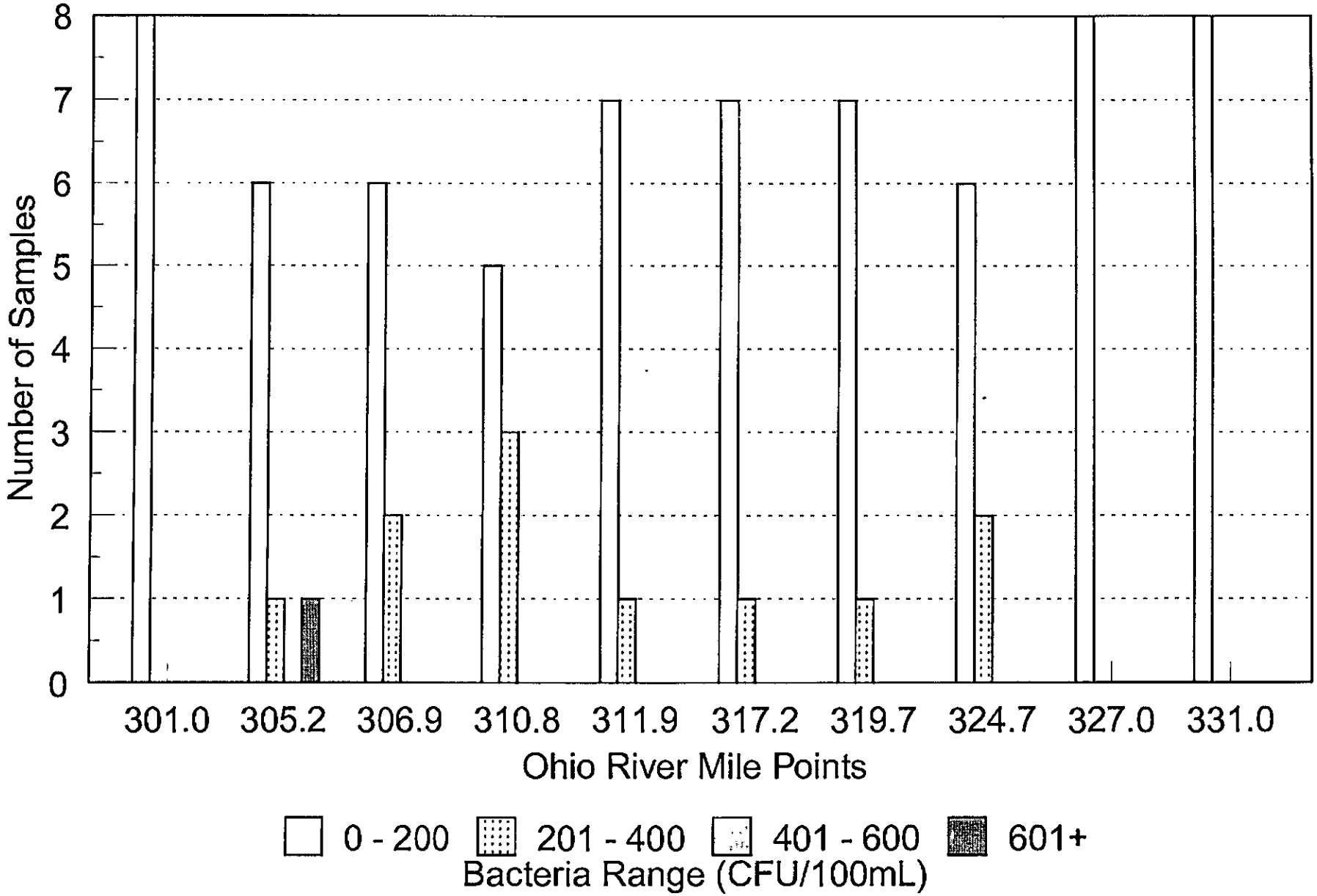
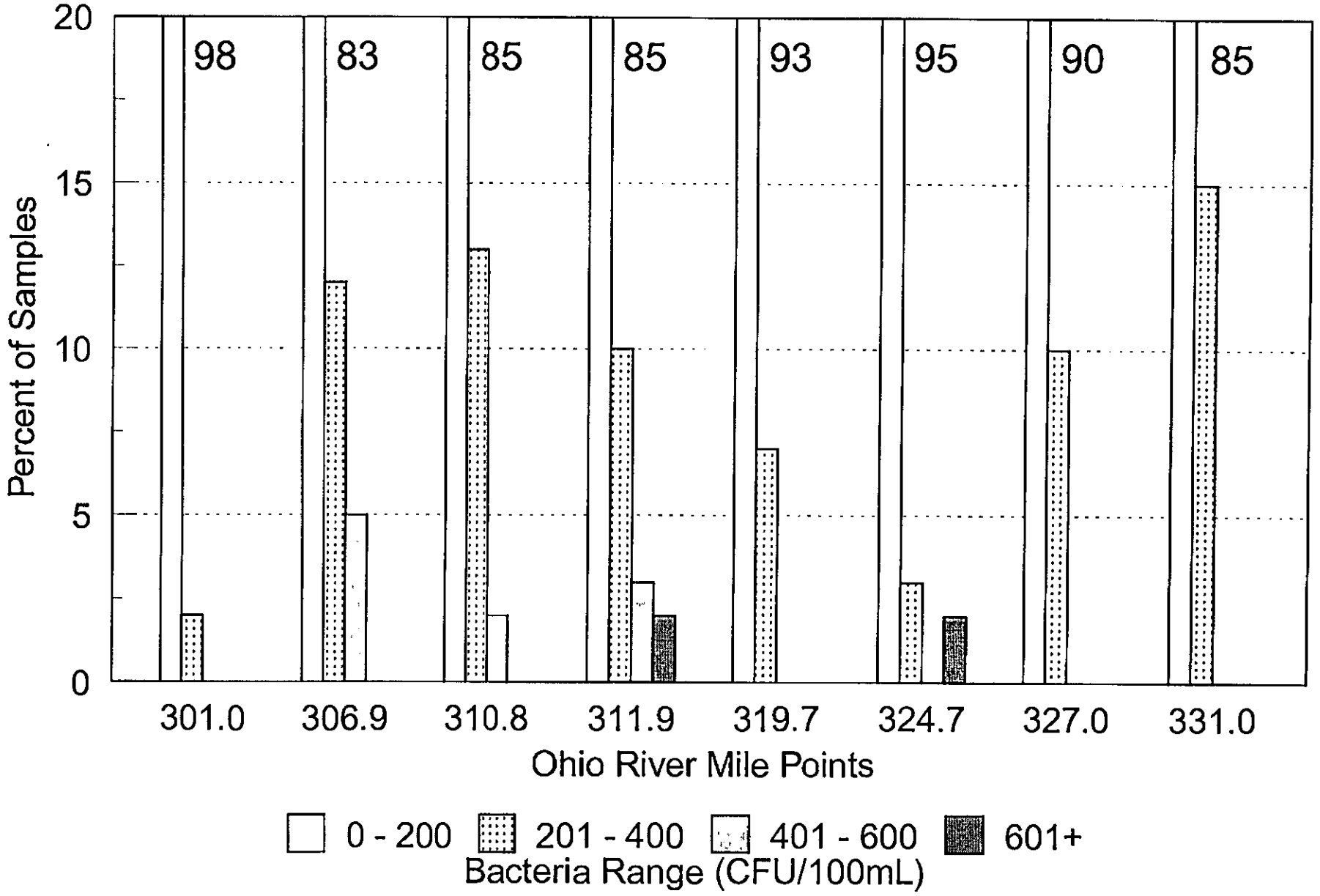


FIGURE 6: CROSS-SECTIONAL SURVEYS
OHIO RIVER FECAL COLIFORM DENSITIES
8 Dry Weather Events (40 Samples / Site)



when to monitor and how to classify each of the monitored events. As was expected, precipitation over the study area varied greatly for any given rain event (see Appendix 7). Simply taking the average of the gauge readings is not really appropriate, as in some instances the majority of the gauges recorded significant precipitation while a few of the gauges registered no rain. Therefore, the classification of wet and dry for any given monitoring event is more subjective than simply meeting an established criteria of so many inches of rain over a given period of time.

In general, a minimum of 0.2 inches of rain over the study area occurred within 24 hours of sampling for the surveys classified as "wet weather" surveys. The only real exception occurred with Survey 15 which has been classified as a wet weather survey despite the fact that only 0.12 inches of rain occurred prior to sampling. However, because the precipitation covered a large portion of the study area, and since the rain occurred the morning of the survey, it has been classified as a wet weather survey.

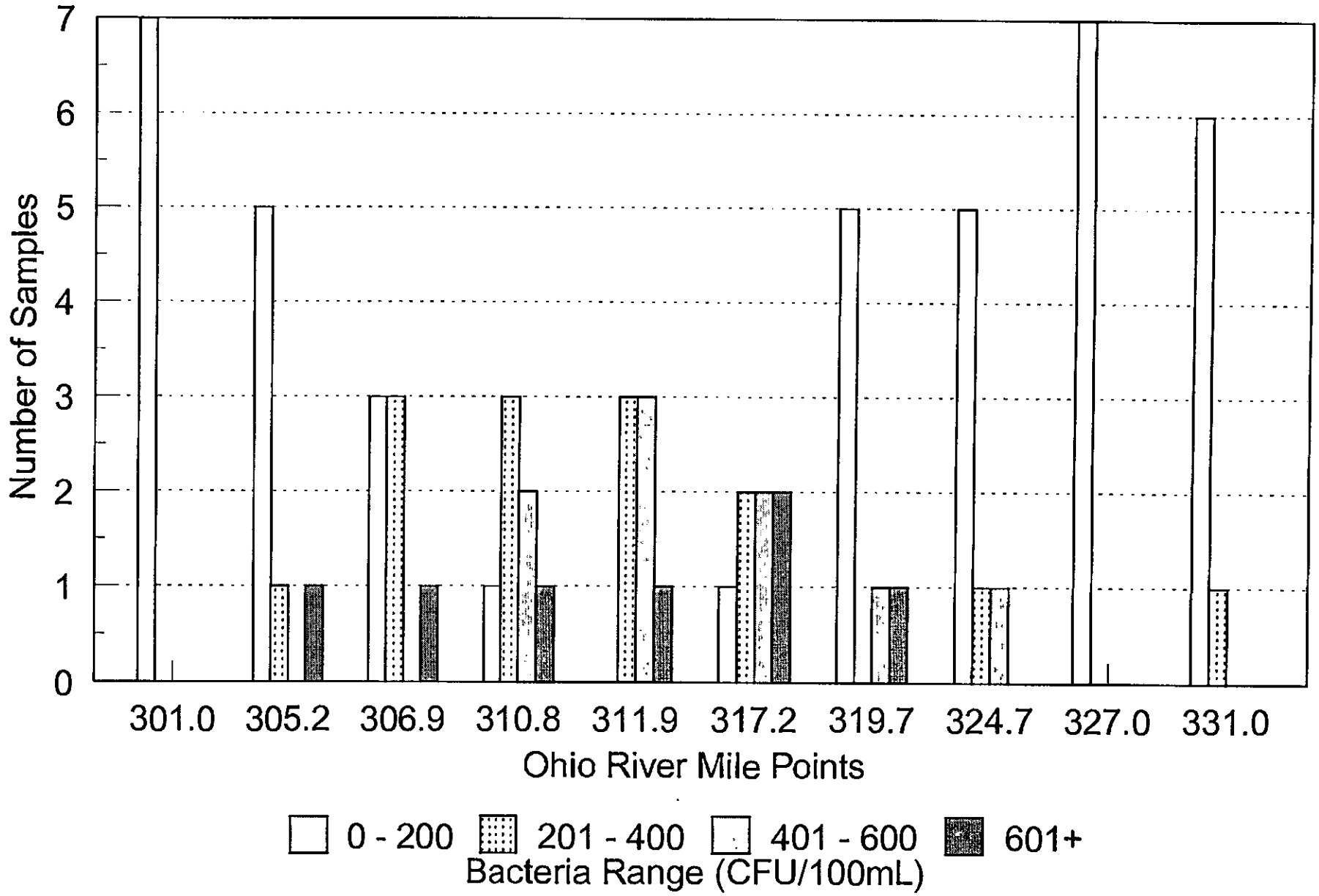
Longitudinal Sampling

A total of 70 longitudinal samples were collected from the main stem during the seven wet weather surveys (10 samples/survey). Of the 70 samples collected, 40 samples or 57 percent, had levels of fecal coliform less than 200 CFU/100mL. At least 54 samples, or 77 percent, had bacteria levels below 400 CFU/100mL. A total of seven samples exceeded the 600 CFU/100 mL bacteria level, with the highest fecal coliform bacteria level for any wet weather longitudinal sample reaching 3,300 CFU/100mL. See Figure 7.

Cross-Sectional Sampling

A total of 280 fecal coliform bacteria samples were collected on the main stem of the Ohio on days which were classified as wet weather events. Of the 15 surveys completed, seven were classified as wet weather. A total of 206 of the 280 samples collected, or 74 percent, had fecal coliform concentrations below the 200 CFU/100mL level, with 241 samples or 86 percent of the sample concentrations below 400 CFU/100mL. Forty-three of the collected samples, or 15 percent, had fecal coliform bacteria concentrations which exceeded 600 CFU/100mL, with the

FIGURE 7: LONGITUDINAL SURVEYS
OHIO RIVER FECAL COLIFORM DENSITIES
7 Wet Weather Events (7 Samples / Site)



highest fecal coliform bacteria level for any wet weather cross-section sample reaching 3,700 CFU/100mL (see Figure 8).

At the upstream reference site, mile point 301, selected to determine background conditions free from the influences of the local CSOs, all of the samples collected during the wet weather cross-sectional surveys were <200 CFU/100mL.

Tributary Surveys

Guyandotte River Investigation

The Guyandotte River enters the Ohio River at mile point 305.2, upstream of Huntington, WV. A review of data from the first seven surveys revealed that the Guyandotte River consistently had elevated levels of fecal coliform even during dry weather. The initial sampling location on the Guyandotte was located downstream of all the CSOs which discharge to that tributary. The results were discussed with representatives from the Huntington Sanitary Board. They believed the elevated levels were not from the CSOs but rather were representative of high background levels. A summary of the data collected from the initial sampling location for all 15 surveys is presented in Figure 9.

Beginning with the seventh survey, additional sampling was conducted on the Guyandotte River in an effort to determine if the CSOs were in fact the source of the high bacteria levels (appendix 9 contains the additional data). ORSANCO established sampling sites further upstream on the Guyandotte River which bracketed the known CSOs and provided a location above the influences of Huntington's combined sewer system which would represent background conditions. Four additional sites were sampled during three of the remaining surveys, while an additional two sites were sampled for the remaining six surveys.

The results of the more intensive sampling are presented in Figure 10. It appears that the fecal coliform levels increase significantly just below the last group of CSOs. However, despite the

FIGURE 8: CROSS-SECTIONAL SURVEYS
OHIO RIVER FECAL COLIFORM DENSITIES
7 Wet Weather Events (35 Samples / Site)

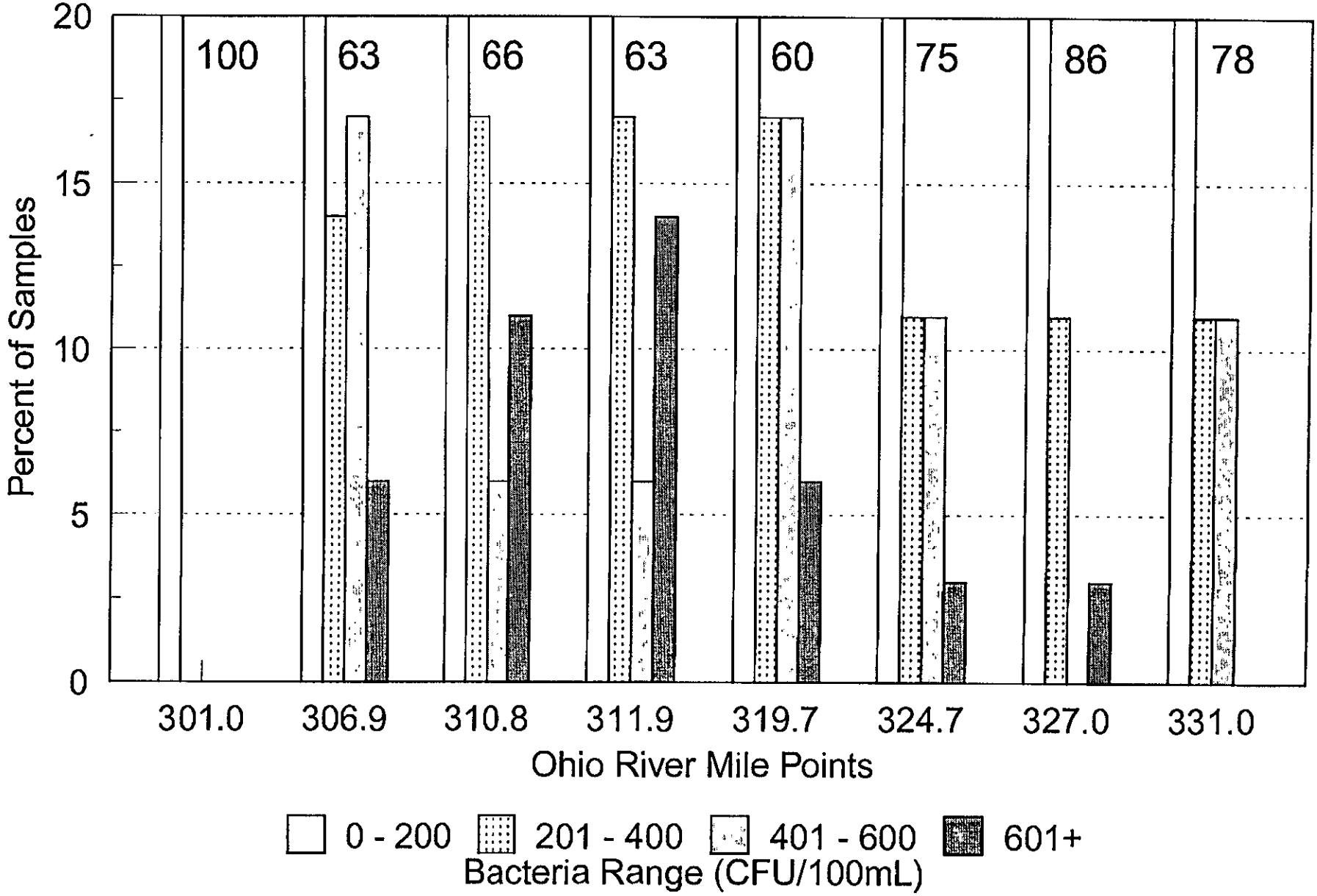


FIGURE 9: CROSS-SECTIONAL SURVEYS
GUYANDOTTE RIVER FECAL COLIFORM DENSITIES
Dry Weather vs. Wet Weather

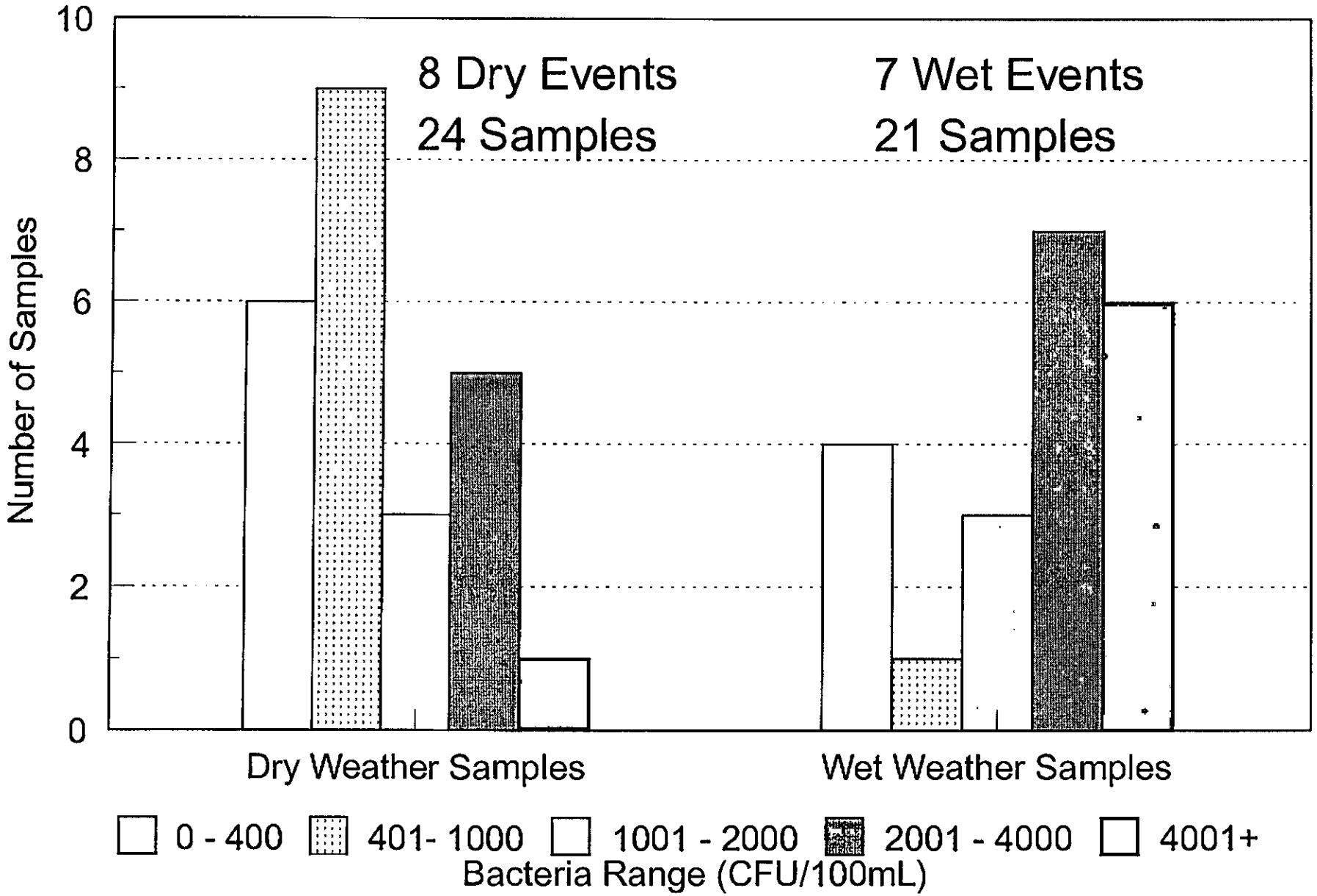
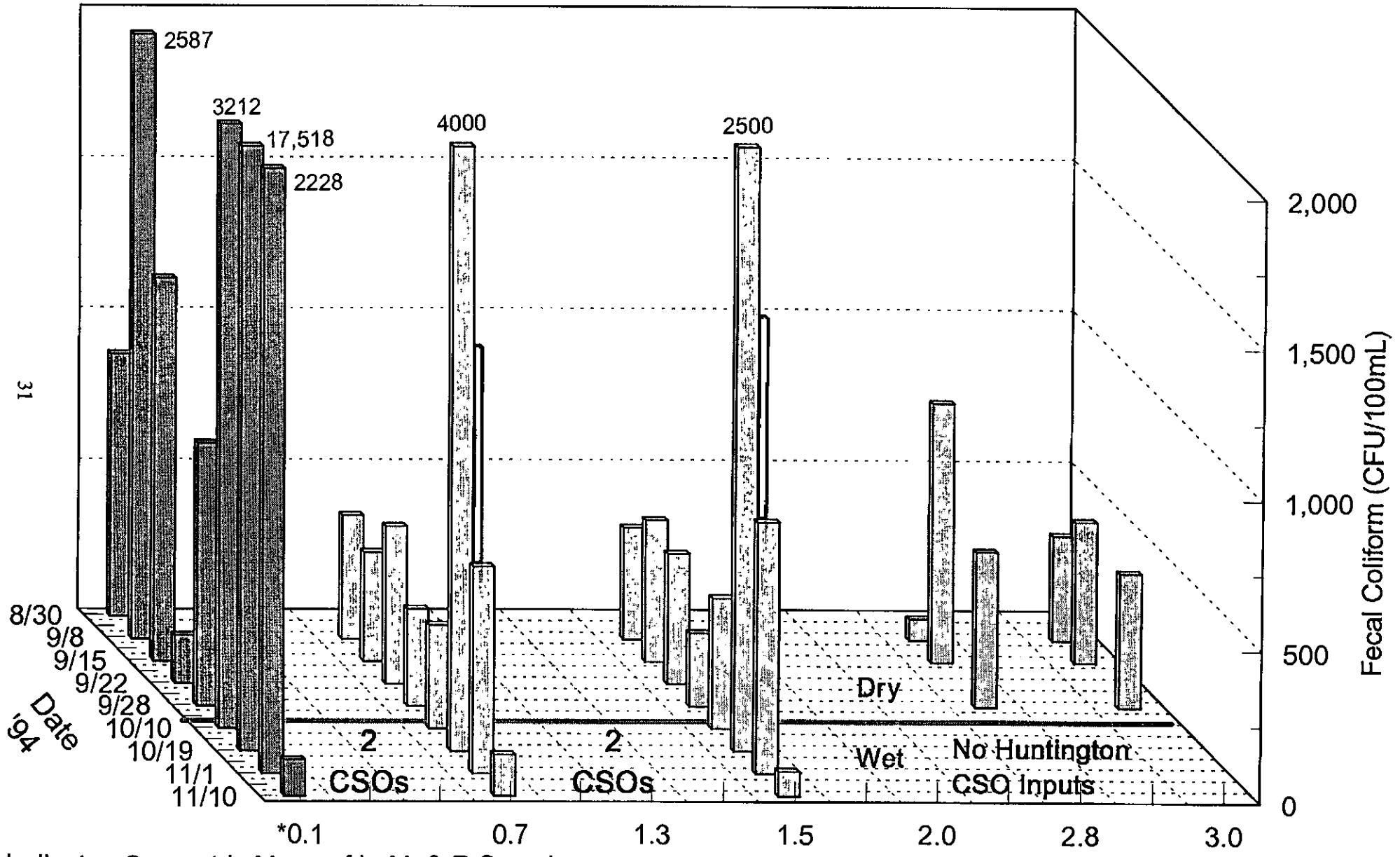


FIGURE 10: GUYANDOTTE RIVER INVESTIGATION
FECAL COLIFORM DENSITIES



* Indicates Geometric Mean of L, M, & R Samples

Note: Other GRMPs - Midstream Sample Only

apparent impact which these CSOs seem to be having on the bacteria levels, it also seems that the Guyandotte River does have elevated background concentrations of fecal coliform bacteria. Currently, the state of West Virginia Division of Environmental Protection is investigating this situation.

Big Sandy River Investigation

The Big Sandy River enters the Ohio River at mile point 317.1 just upstream of Cattletsburg, KY. When the sampling program was designed for this study, it was thought that the community of Cattletsburg did not have any CSOs. However, after the project was completed, it was discovered that Cattletsburg has five CSOs which discharge to the Big Sandy River and eight CSOs which discharge directly to the Ohio River.

Although it would have been preferable to know about the existence of the CSOs prior to the initiation of sampling, the later discovery did help to gain a better understanding of the data. For example, some samples collected from the main stem directly below the confluence with the Big Sandy River were much higher than the levels found in the tributary. Initially this did not make sense. However, once it was realized that the sampling site on the Big Sandy River was located upstream of a number of CSOs, and therefore did not capture the impacts of all five, these data became more clear. Secondly, a number of samples collected at the Ashland Water Treatment Plant intake (just downstream of Cattletsburg) showed elevated bacteria levels. Once it was realized that Cattletsburg has eight CSOs discharging to the main stem, these data were also more understandable.

Tributary Surveys Summary

A review of Figures 11 and 12 clearly demonstrate the difference in fecal coliform bacteria levels between the two tributaries sampled. The Big Sandy River, during both wet and dry weather conditions, consistently had fecal coliform levels below 400 CFU/100mL, while the Guyandotte River consistently showed levels above 600 CFU/100mL. It should be noted that, as mentioned

FIGURE 11: CROSS-SECTIONAL SURVEYS
TRIBUTARY FECAL COLIFORM DENSITIES
8 Dry Weather Events (24 Samples / Site)

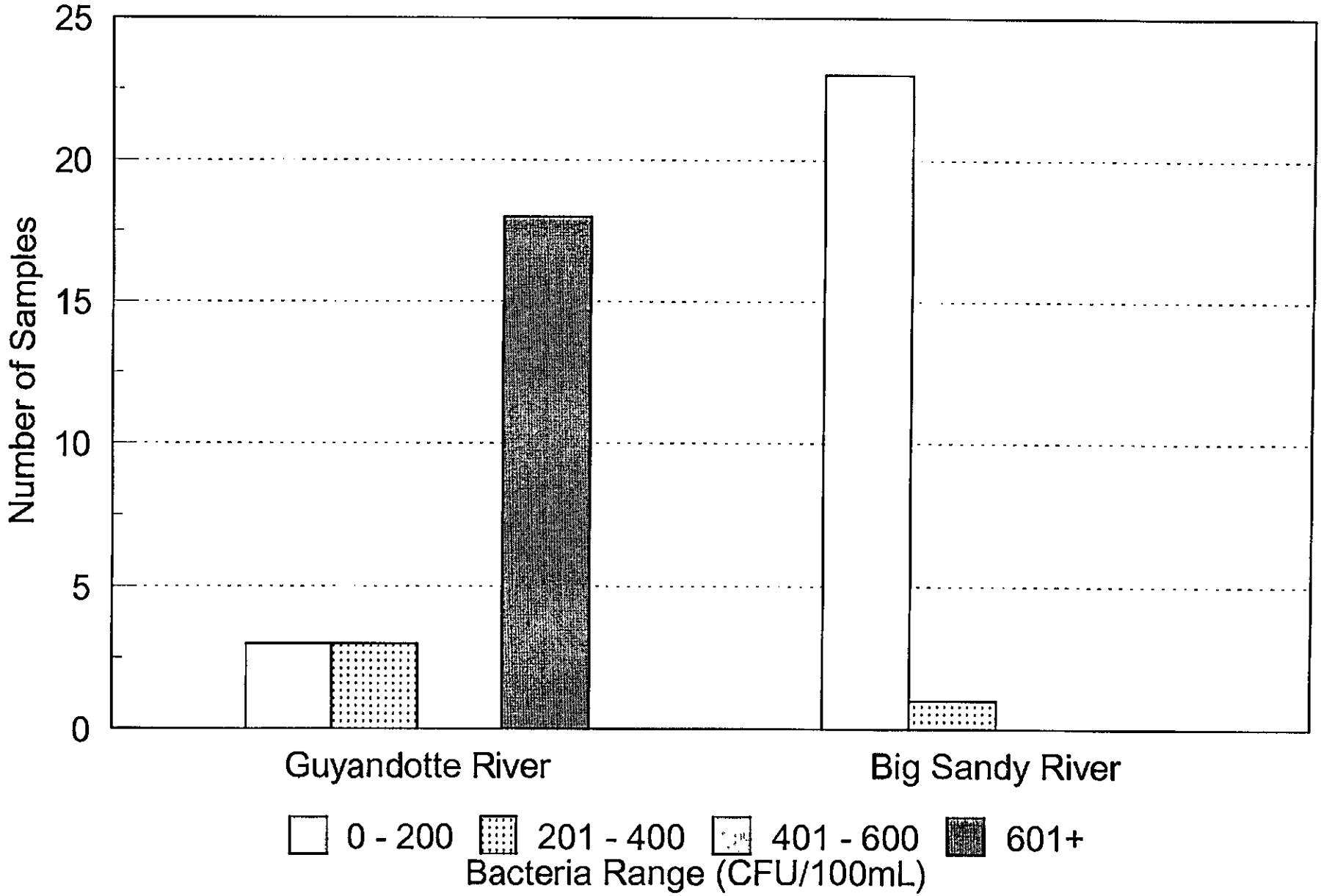
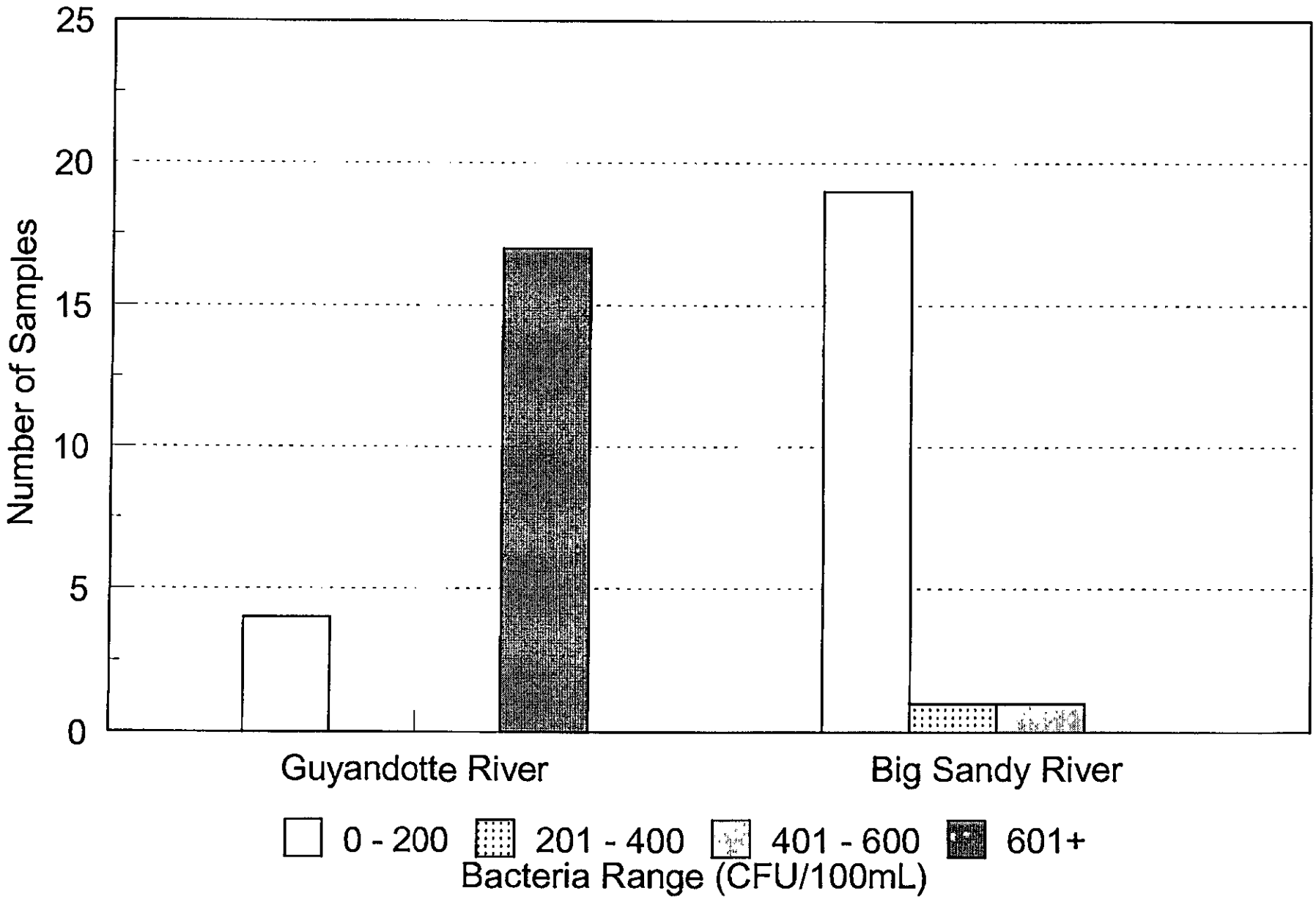


FIGURE 12: CROSS-SECTIONAL SURVEYS
TRIBUTARY FECAL COLIFORM DENSITIES
7 Wet Weather Events (21 Samples / Site)



earlier, the sampling location on the Big Sandy River was upstream of a number of the CSOs known to discharge to that tributary.

3.5.2 Wet Weather vs. Dry Weather Events

A total of 870 bacteria samples were obtained during the entire study. In addition, data for physical parameters including DO, pH, conductivity and temperature were collected at thousands of points in the river during these surveys. Of the data recorded or collected (fecal coliform, BTEX, and physical parameters), only fecal coliform appeared to display a difference between wet and dry weather events.

Physical Parameters

The physical parameters did not display any definite patterns which would allow for the differentiation between wet and dry weather. Refer to Appendices 5 and 6 for the physical parameter data collected for all 15 surveys.

BTEX

There were no significant BTEX concentrations found in the samples collected during the project. Only one of 150 samples analyzed on ORSANCO's gas chromatograph (GC) confirmed the presence of BTEX compounds. The remaining 149 samples were reported as below the detection limit of one ppb. There were two separate cases in which the confirmation sample analyzed by the contract laboratory reported the presence of BTEX compounds when ORSANCO had reported the sample as non-detect. This discrepancy was a result of the contract laboratory's ability to detect lower concentrations than ORSANCO (contract laboratory detection limit = 0.5 ppb). There was, however, a problem with contamination (in three instances) with the water that was used for blanks. When the flow-through system was checked for contamination, three samples were taken: 1) from blank water container, 2) from a large container into which seven gallons of water were poured, and then pumped through the system, and 3) from the flow-through system discharge point. Each time there was contamination in the discharge sample blank, it was traced back to the blank water container, and therefore, although this contamination

existed, it did not affect the samples collected from the river. Appendix 10 presents the results of the BTEX analyses.

Longitudinal Sampling

Figure 13 presents a summary of the bacteria data collected during the longitudinal surveys. In general, the highest levels of fecal coliform bacteria occurred during the sampling events which were classified as wet weather events.

Cross-Sectional Sampling

Cross-sectional sampling was conducted at eight sites on the main stem of the River during 15 events – eight dry and seven wet. Figure 14 presents a summary of geometric means for the cross-sectional surveys. Once again, the highest elevations of bacteria generally occurred in the wet weather surveys.

The cross-section data collected during seven wet weather events are presented in Figure 8. As expected, the wet weather surveys show higher levels of fecal coliform bacteria represented by many more exceedances of the 200 CFU/100mL. The site with the most exceedances of the 200 CFU/100ml occurred at mile point 319.7, where only 60 percent of the samples were less than or equal to the 200 level. This is a significant difference compared to the dry weather surveys, where for any specified cross-section site, no fewer than 83 percent of the samples collected did not exceed 200 CFU/100mL.

The wet weather surveys also had far more exceedances of the 600 CFU/100mL level compared to the dry weather surveys (15 exceedances vs. 2). Figure 8, which summarizes the wet weather cross-sectional surveys, shows that exceedances of the 600 level occurred more frequently (14 percent of the time) at mile point 311.9 than at any other cross-section.

FIGURE 13: LONGITUDINAL SURVEYS
OHIO RIVER FECAL COLIFORM DENSITIES
Dry Weather vs. Wet Weather

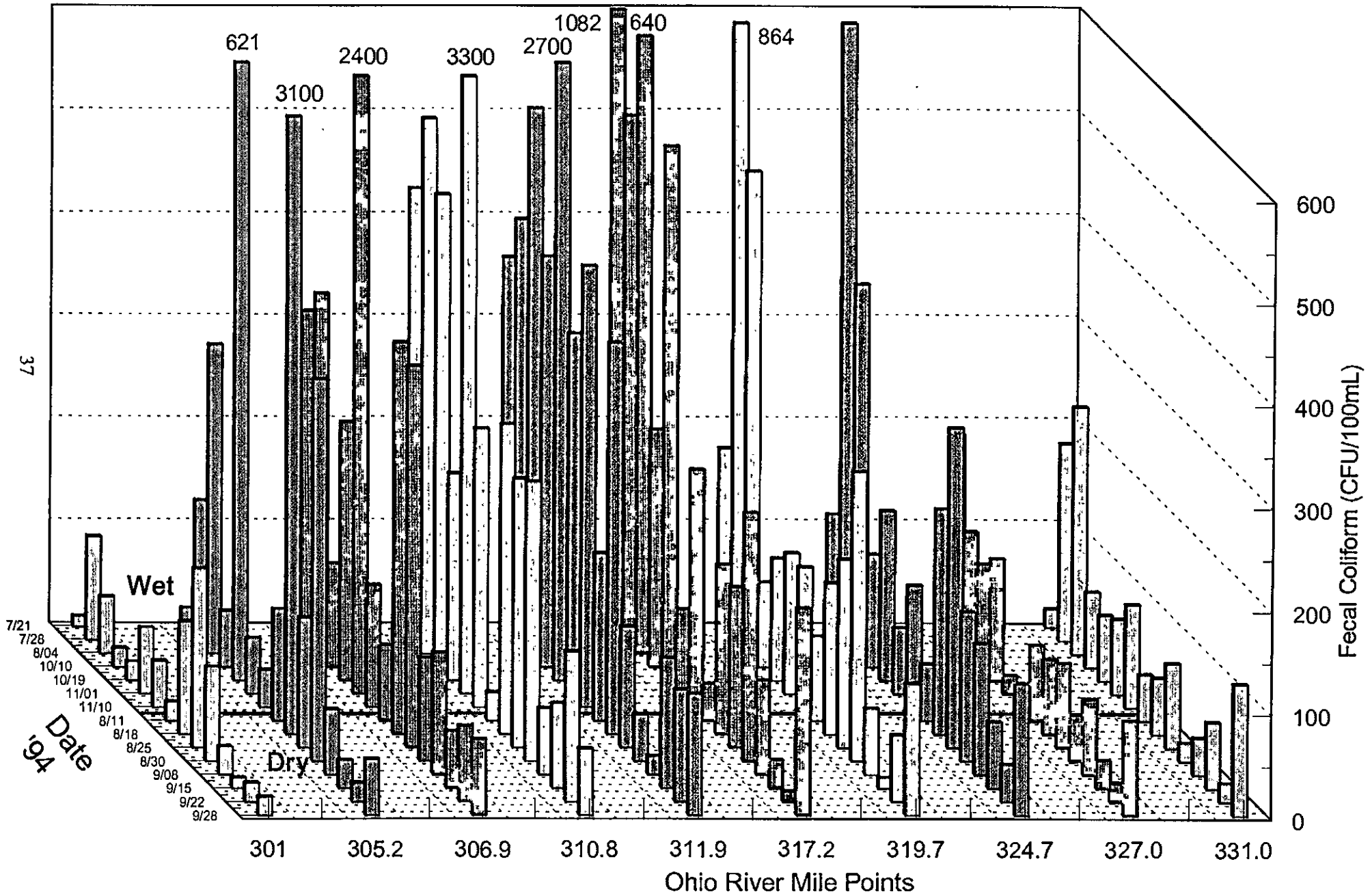
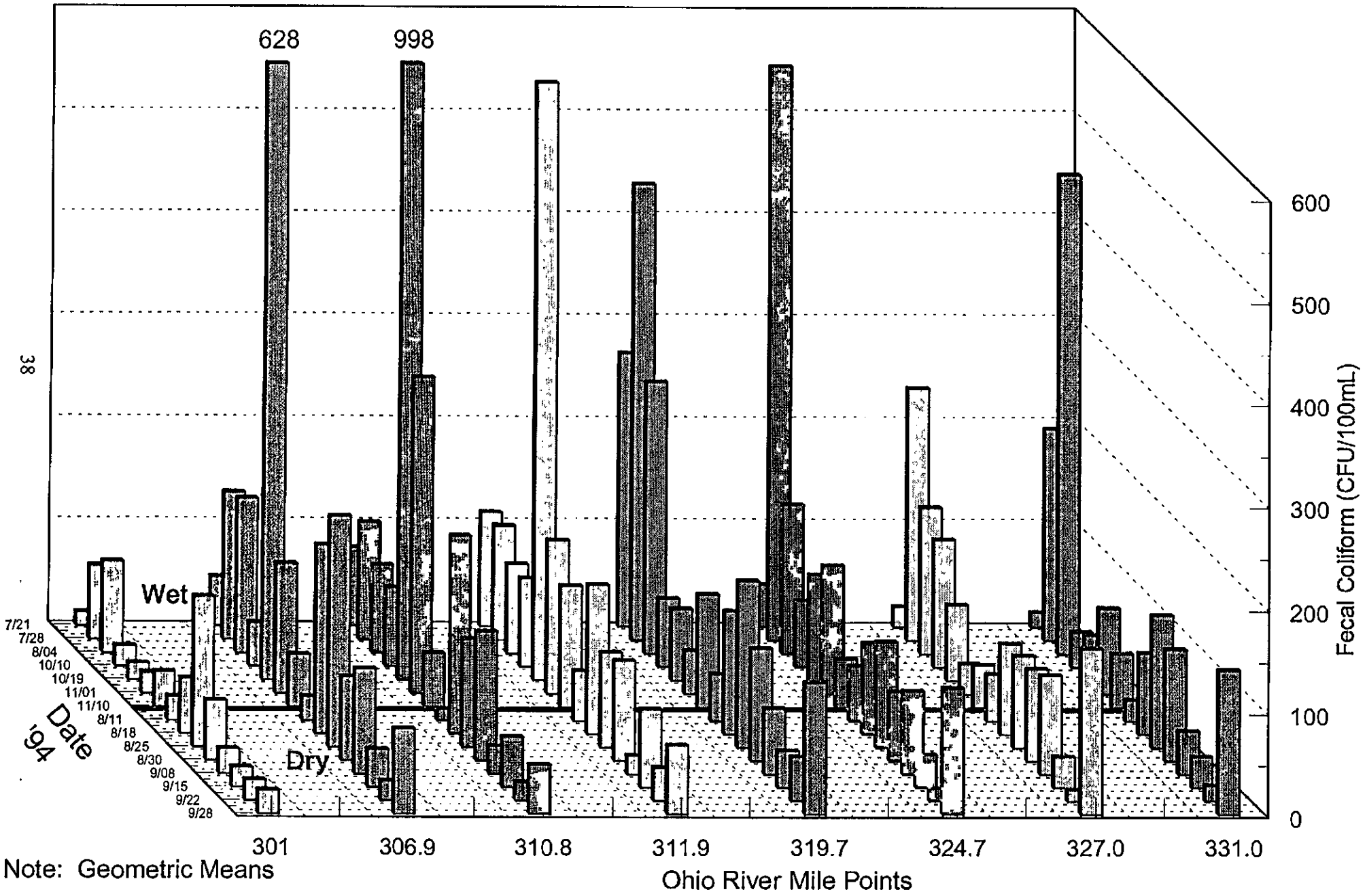


FIGURE 14: CROSS-SECTIONAL SURVEYS
OHIO RIVER FECAL COLIFORM DENSITIES
Dry Weather vs. Wet Weather



Note: Geometric Means

3.6 Discussion of Methodologies

As stated earlier, there were two different kinds of sampling techniques used for the 15 surveys – longitudinal and cross-sectional. Each sampling technique involved the collection of similar data (physical parameters, fecal coliform, and BTEX compounds) but utilized different methodologies to obtain the data.

Longitudinal Surveys

Longitudinal surveys were the more unique of the two survey types because they involved collection of data while the boat transversed the study area at approximately 30 miles per hour. The sampling system consisted of a pitot tube that directed river water into the boat for sample collection (bacteria and BTEX) and physical parameter determination. The ability to collect information continuously without stopping proved to be very advantageous. Not only did it drastically reduce sampling time, but it also allowed for a larger area to be studied. This system was used by ORSANCO in three other situations (mixing zone characterization of tributaries, thermal plume characterization and spill tracking) during summer of 1994, and proved extremely useful for this project.

Cross-Sectional Surveys

Cross-sectional surveys have been conducted by ORSANCO in the past and proved to be the most valuable for showing water quality impacts. The only difference between this type of survey and past cross-sectional surveys was the use of a five-point cross-section on the main stem instead of a three-point cross-section. The extra samples displayed a gradient of fecal coliform levels across the stream in many cases. In the area from Huntington to downstream of Catlettsburg, the higher bacteria levels were confined from the left descending bank to mid-stream. However, the downstream sites generally displayed more complete mixing of the bacteria levels.

3.7 CONCLUSIONS

As stated in the report, three categories of water quality parameters were investigated in this program. They included physical parameters – dissolved oxygen, temperature, and conductivity – BTEX compounds, and fecal coliform bacteria.

Although the physical parameter data showed no fluctuation between wet and dry weather surveys and consistently remained in compliance with water quality standards, the measurements for pH, conductivity, temperature and dissolved oxygen can provide extremely important insight into the physical characteristics of the system being studied and hence should continue to be a significant component of future wet weather related work. Specifically, conductivity and temperature are helpful in understanding the mixing characteristics of the River, particularly at the confluences of tributaries with the main stem and therefore valuable in selecting sampling locations and interpreting data. Wet weather associated pollution has the potential to contribute significant oxygen demanding loads to the receiving stream. When the study was initially designed, it was expected that a decrease in dissolved oxygen levels would occur following a rain event as a result of CSO discharges. This sag was expected to occur near the next downstream dam (Greenup Lock and Dam); however, the data did not support this theory.

The BTEX data indicate that levels remain consistently low in both dry and wet weather. Of the 150 samples collected all were below detection (1 ppb). These results clearly demonstrate that BTEX is not a problem in the study area during either wet or dry conditions.

On the other hand, fecal coliform bacteria densities demonstrated a significant difference between wet and dry weather periods. The data collected indicate that the densities of fecal coliform bacteria in the River increase after local precipitation. Figures 15 and 16 present a comparison of the fecal coliform concentrations in wet and dry weather for both the longitudinal and the cross-sectional components.

FIGURE 15: LONGITUDINAL SURVEYS
OHIO RIVER FECAL COLIFORM DENSITIES
Dry Weather vs. Wet Weather

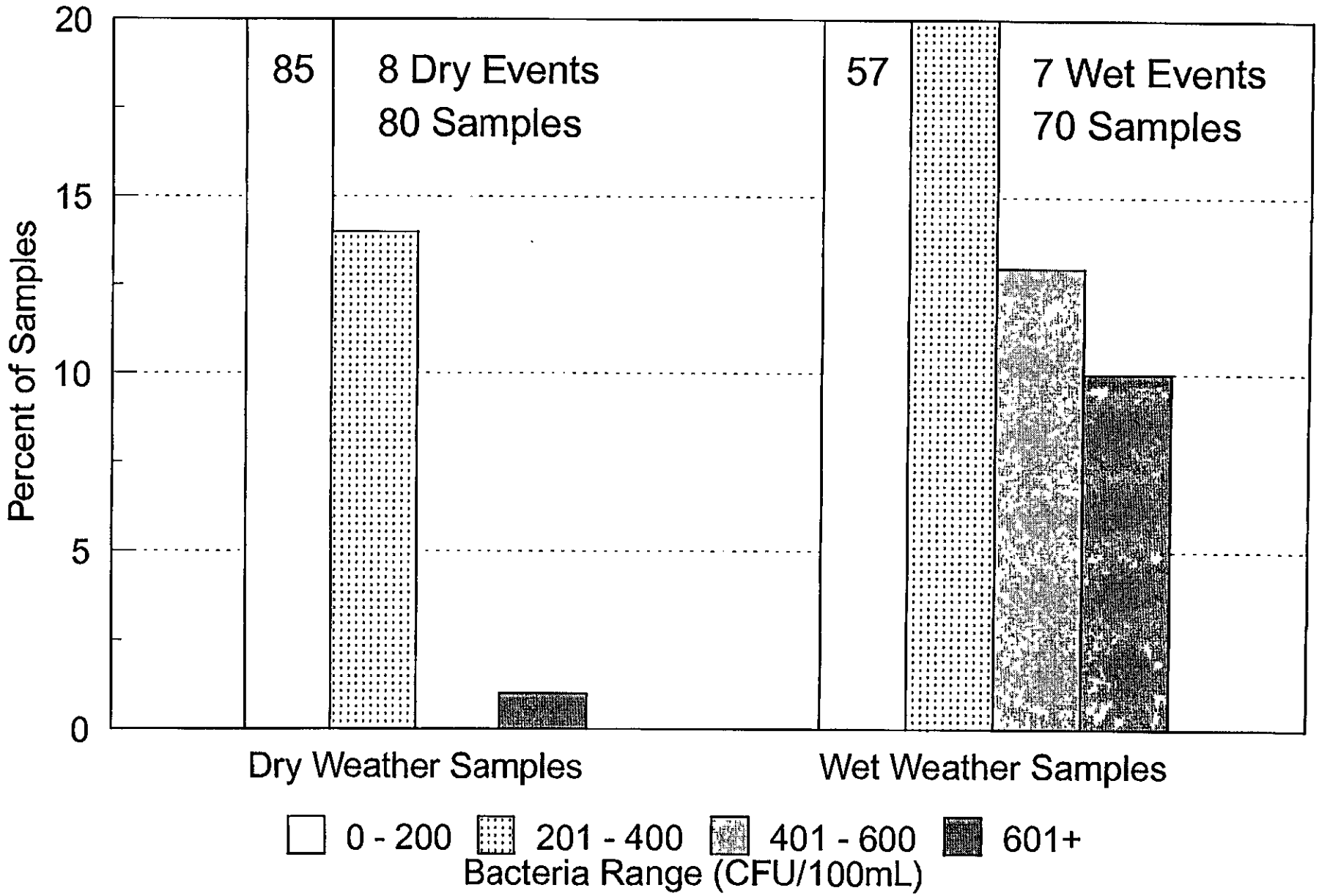
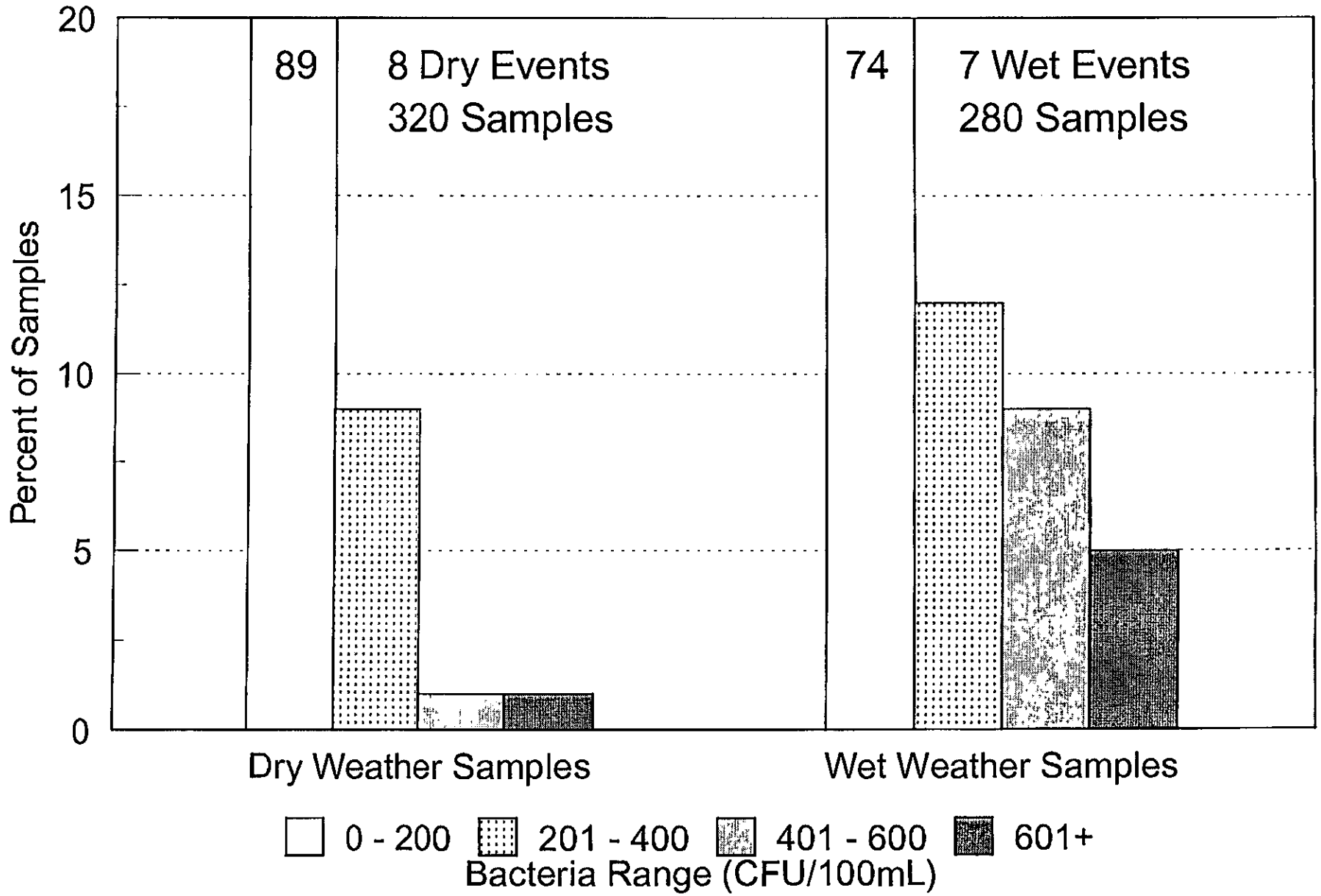


FIGURE 16: CROSS-SECTIONAL SURVEYS
OHIO RIVER FECAL COLIFORM DENSITIES
Dry Weather vs. Wet Weather



Although there is a definite increase in the percentage of samples with elevated fecal coliform densities during wet weather, it is important to note that a majority of the samples collected, in both dry periods and after rainfall, remained below 200 CFU/100ml. Additionally, all of the fecal coliform samples collected on the main stem of the Ohio River were less than 4,000 CFU/100mL. It should be assumed that locations with greater numbers of CSOs may in fact have a more significant impact on water quality during wet weather.

Additional information on the volume, frequency, and duration of discharges from the combined systems in the study area would have allowed for a more definitive explanation of the elevated bacteria levels following wet weather. Consideration of various components of the available data, does in fact point to CSOs as the likely source of the elevate bacteria levels. Specifically, the most upstream sampling site in the study area, which is located above all the local CSOs, consistently showed very low levels of fecal coliform in both dry and wet weather. This suggests that bacteria loadings are at the very least associated with the urban areas in the sampling zone, and not the result of high upstream background levels flowing into the study area.

Additionally, the bacteria data collected on the Big Sandy River upstream of the CSOs consistently showed relatively low concentrations; however, the data collected on the Ohio River immediately downstream of the confluence with the Big Sandy often times revealed elevated densities of fecal coliform. The differences in bacteria levels between these two sites, which bracketed a number of CSOs, strongly suggests discharges from the combined system as the source of the elevated levels.

Another example occurred on the Guyandotte River. The City of Huntington, WV had installed a flow monitor in CSO No. 16 which discharges to the Guyandotte River upstream of the ORSANCO sampling site. The information provided by representatives from the Huntington WWTP indicates that CSO No. 16 discharged prior to every wet weather survey except one - Survey 15. Not surprisingly, Survey 15 had the lowest bacteria concentrations of any wet survey. All of the fecal coliform densities were less than 200 CFU/100mL. The inactivity of the CSOs and the corresponding low bacteria levels seem to indicate that CSOs are a significant

contributor to the elevated fecal coliform densities during wet weather. This is further supported by the data generated from the more intensive sampling program initiated on the Guyandotte during the last nine surveys which bracketed groups of CSOs. These data indicate that despite elevated background concentrations, fecal coliform levels increased significantly below the CSOs.

This study represents the Commission's first attempt to quantify the extent and duration of water quality impacts attributable to CSOs. The study was able to demonstrate specific impacts from CSOs on tributaries. The size of the Ohio River, however, presents unique problems in terms of characterizing sources of pollution during storm events. The 40-mile study area discussed in this report included a 25-mile stretch of river which received discharges from 60 CSOs. It is difficult to isolate the impacts attributable to CSOs on the Ohio without extensive monitoring and modeling programs. One reason for this is that most of the overflow structures are submerged and hence the impacts are not seen at the surface for some distance downstream.

In conclusion, the study was successful in quantifying the magnitude of the impacts on fecal coliform densities in the River resulting from local rainfall. Sampling methodologies utilized in this program proved extremely practical for wet weather applications and continue to be used in other wet weather studies along the Ohio River. It was established that BTEX compounds are not a good indicator of CSO/wet weather impacts. Physical parameter data should continue to be collected, as the affect on dissolved oxygen levels instream may not be realized for many miles below the point of discharge, and therefore dissolved oxygen monitoring should continue for as many days as it takes for the loading to pass through the study area. All future studies conducted on the Ohio River for the purpose of determining the water quality impacts associated with CSOs or wet weather in general, should include a strong emphasis on bacterial monitoring.

APPENDIX 1

ORSANCO Compact

OHIO RIVER VALLEY
WATER SANITATION COMPACT

JUNE 30, 1948

OHIO RIVER VALLEY WATER SANITATION COMPACT

THIS COMPACT, Made and entered into by and between the States of Indiana, West Virginia, Ohio, New York, Illinois, Kentucky, Pennsylvania, Virginia and such additional States as may join in its execution,

WITNESSETH THAT:

WHEREAS, Pursuant to authority of the 74th Congress of the United States, granted by Public Resolution 104, approved June 8, 1936, duly appointed Commissioners respectively representing the States of Indiana, West Virginia, Ohio, New York, Illinois, Kentucky, Pennsylvania and Tennessee have heretofore negotiated a proposed Compact in form as hereinafter set forth and as approved by the 76th Congress of the United States by Public Act No. 739, effective July 11, 1940; and

WHEREAS, By legislation duly enacted, each of said negotiating States, with the exception of Tennessee, has caused said Compact to be approved, ratified, adopted and enacted into law and has authorized its execution; and

WHEREAS, By legislation duly enacted, the Commonwealth of Virginia, although not participating in the original negotiation thereof, has authorized and requested its Governor to execute said Compact on behalf of the Commonwealth and thereby to bind the Commonwealth and to indicate its assent to and acceptance of the terms and conditions of the Compact; and

WHEREAS, Since all conditions upon which the effectiveness of the Compact or the ratification and approval thereof by any of the signatory States was contingent have been met and satisfied, it is now appropriate that the signatory States duly execute the OHIO RIVER VALLEY WATER SANITATION COMPACT, which, as specifically set out in the legislation hereinabove referred to, reads as follows:

> WHEREAS, A substantial part of the territory of each of the signatory States is situated within the drainage basin of the Ohio River; and
>
> WHEREAS, The rapid increase in the population of the various metropolitan areas situated within the Ohio drainage basin, and the growth in industrial activity within that area, have resulted in recent years in an increasingly serious pollution of the waters and streams within the said drainage basin, constituting a grave menace to the health, welfare and recreational facilities of the people living in such basin, and occasioning great economic loss; and

WHEREAS, The control of future pollution and the abatement of existing pollution in the waters of said basin are of prime importance to the people thereof, and can best be accomplished through the cooperation of the States situated therein, by and through a joint or common agency;

Now, therefore, The States of Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Tennessee and West Virginia do hereby covenant and agree as follows:

ARTICLE I

Each of the signatory States pledges to each of the other signatory States faithful cooperation in the control of future pollution in and abatement of existing pollution from the rivers, streams and water in the Ohio River basin which flow through, into or border upon any of such signatory States, and in order to effect such object, agrees to enact any necessary legislation to enable each such State to place and maintain the waters of said basin in a satisfactory sanitary condition, available for safe and satisfactory use as public and industrial water supplies after reasonable treatment, suitable for recreational usage, capable of maintaining fish and other aquatic life, free from unsightly or malodorous nuisances due to floating solids or sludge deposits, and adaptable to such other uses as may be legitimate.

ARTICLE II

The signatory States hereby create a district to be known as the "Ohio River Valley Water Sanitation District," hereinafter called the District, which shall embrace all territory within the signatory States, the water in which flows ultimately into the Ohio River, or its tributaries.

ARTICLE III

The signatory States hereby create the "Ohio River Valley Water Sanitation Commission," hereinafter called the Commission, which shall be a body corporate, with the powers and duties set forth herein, and such additional powers as may be conferred upon it by subsequent action of the respective legislatures of the signatory States or by act or acts of the Congress of the United States.

ARTICLE IV

The Commission shall consist of three commissioners from each State, each of whom shall be a citizen of the State from which he is appointed, and three commissioners representing the United States Government. The commissioners from each State shall be chosen in the manner and for the terms provided by the laws of the State from which they shall be appointed, and any commissioner may be removed or suspended from office as provided by

the law of the State from which he shall be appointed. The commissioners representing the United States shall be appointed by the President of the United States, or in such other manner as may be provided by Congress. The commissioners shall serve without compensation, but shall be paid their actual expenses incurred in and incident to the performance of their duties; but nothing herein shall prevent the appointment of an officer or employee of any State or of the United States Government.

ARTICLE V

The Commission shall elect from its number a chairman and vice chairman, and shall appoint, and at its pleasure remove or discharge, such officers and legal, clerical, expert and other assistants as may be required to carry the provisions of this Compact into effect, and shall fix and determine their duties, qualifications and compensation. It shall adopt a seal and suitable by-laws, and shall adopt and promulgate rules and regulations for its management and control. It may establish and maintain one or more offices within the District for the transaction of its business, and may meet at any time or place. One or more commissioners from a majority of the member States shall constitute a quorum for the transaction of business.

The Commission shall submit to the Governor of each State, at such time as he may request, a budget of its estimated expenditures for such period as may be required by the laws of such State for presentation to the legislature thereof.

The Commission shall keep accurate books of account, showing in full its receipts and disbursements, and said books of account shall be open at any reasonable time to the inspection of such representatives of the respective signatory States as may be duly constituted for that purpose.

On or before the first day of December of each year, the Commission shall submit to the respective governors of the signatory States a full and complete report of its activities for the preceding year.

The Commission shall not incur any obligations of any kind prior to the making of appropriations adequate to meet the same; nor shall the Commission pledge the credit of any of the signatory States, except by and with the authority of the legislature thereof.

ARTICLE VI

It is recognized by the signatory States that no single standard for the treatment of sewage or industrial wastes is applicable in all parts of the District due to such variable factors as size, flow, location, character, self-purification, and usage of waters within the District. The guiding principle of this Compact shall be that pollution by sewage or industrial wastes origi-

nating within a signatory State shall not injuriously affect the various uses of the interstate waters as hereinbefore defined.

All sewage from municipalities or other political subdivisions, public or private institutions, or corporations, discharged or permitted to flow into these portions of the Ohio River and its tributary waters which form boundaries between, or are contiguous to, two or more signatory States, or which flow from one signatory State into another signatory State, shall be so treated, within a time reasonable for the construction of the necessary works, as to provide for substantially complete removal of settleable solids, and the removal of not less than forty-five per cent of the total suspended solids; provided that, in order to protect the public health or to preserve the waters for other legitimate purposes, including those specified in Article I, in specific instances such higher degree of treatment shall be used as may be determined to be necessary by the Commission after investigation, due notice and hearing.

All industrial wastes discharged or permitted to flow into the aforesaid waters shall be modified or treated, within a time reasonable for the construction of the necessary works, in order to protect the public health or to preserve the waters for other legitimate purposes, including those specified in Article I, to such degree as may be determined to be necessary by the Commission after investigation, due notice and hearing.

All sewage or industrial wastes discharged or permitted to flow into tributaries of the aforesaid waters situated wholly within one State shall be treated to that extent, if any, which may be necessary to maintain such waters in a sanitary and satisfactory condition at least equal to the condition of the waters of the interstate stream immediately above the confluence.

The Commission is hereby authorized to adopt, prescribe and promulgate rules, regulations and standards for administering and enforcing the provisions of this article.

ARTICLE VII

Nothing in this Compact shall be construed to limit the powers of any signatory State, or to repeal or prevent the enactment of any legislation or the enforcement of any requirement by any signatory State, imposing additional conditions and restrictions to further lessen or prevent the pollution of waters within its jurisdiction.

ARTICLE VIII

The Commission shall conduct a survey of the territory included within the District, shall study the pollution problems of the District, and shall make a comprehensive report for the prevention or reduction of stream pollution therein. In preparing such report, the Commission shall confer with any national or regional planning body which may be established, and any depart-

ment of the Federal Government authorized to deal with matters relating to the pollution problems of the District. The Commission shall draft and recommend to the governors of the various signatory States uniform legislation dealing with the poliution of rivers, streams and waters and other pollution problems within the District. The Commission shall consult with and advise the various States, communities, municipalities, corporations, persons, or other entities with regard to particular problems connected with the pollution of waters, particularly with regard to the construction of plants for the disposal of sewage, industrial and other waste. The Commission shall, more than one month prior to any regular meeting of the legislature of any State which is a party thereto, present to the governor of the State its recommendations relating to enactments to be made by any legislature in furthering the intents and purposes of this Compact.

ARTICLE IX

The Commission may from time to time, after investigation and after a hearing, issue an order or orders upon any municipality, corporaiion, person, or other entity discharging sewage or industrial waste into the Ohio River or any other river, stream or water, any part of which constitutes any part of the boundary line between any two or more of the signatory States, or into any stream any part of which flows from any portion of one signatory State through any portion of another signatory State. Any such order or orders may prescribe the date on or before which such discharge shall be wholly or partially discontinued, modified or treated or otherwise disposed of. The Commission shall give reasonable notice of the time and place of the hearing to the municipality, corporation or other entity against which such order is proposed. No such order shall go into effect unless and until it receives the assent of at least a majority of the commissioners from each of not less than a majority of the signatory Staies; and no such order upon a municipality, corporation, person or entity in any State shall go into effect unless and until it receives the assent of not less than a majority of the commissioners from such State.

It shall be the duty of the municipality, corporation, person or other entity to comply with any such order issued against it or him by the Commission, and any court of general jurisdiction or any United States District Court in any of the signatory States shall have the jurisdiction, by mandamus, injunction, specific performance or other form of remedy, to enforce any such order against any municipality, corporation or other entity domiciled or located within such State or whose discharge of the waste takes place within or adjoining such State, or against any employee, department or subdivision of such municipality, corporation, person or other entity; provided, however, such court may review the order and affirm, reverse or modify the same upon any of the grounds customarily applicable in proceedings for court review of administrative decisions. The Commission or, at its request, the Attorney General or other law enforcing official, shall have power to institute in such court any action for the enforcement of such order.

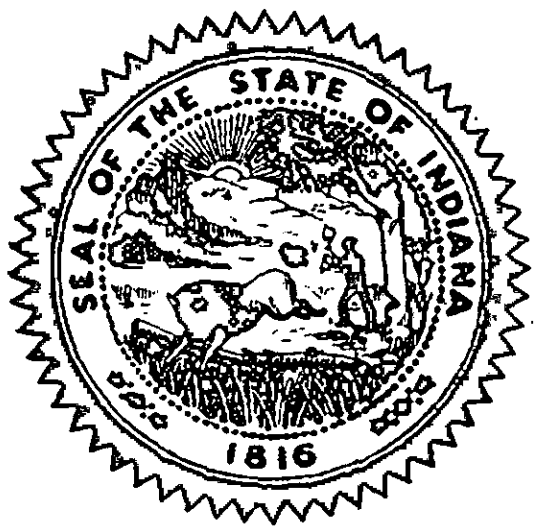
ARTICLE X

The signatory States agree to appropriate for the salaries, office and other administrative expenses, their proper proportion of the annual budget as determined by the Commission and approved by the Governors of the signatory States, one-half of such amount to be prorated among the several States in proportion to their population within the District at the last preceding Federal census, the other half to be prorated in proportion to their land area within the District.

ARTICLE XI

This Compact shall become effective upon ratification by the legislatures of a majority of the States located within the District and upon approval by the Congress of the United States; and shall become effective as to any additional States signing thereafter at the time of such signing.

NOW, THEREFORE, IN WITNESS OF their ratification, adoption and enactment into law of the foregoing Compact, and in witness of their assent to and acceptance of the terms, conditions and obligations therein contained, the signatory States have caused this OHIO RIVER VALLEY WATER SANITATION COMPACT to be executed by their respective Governors and by their respective Compact Commissioners and have caused their respective seals to be hereunto affixed this 30th day of June, 1948.



STATE OF INDIANA

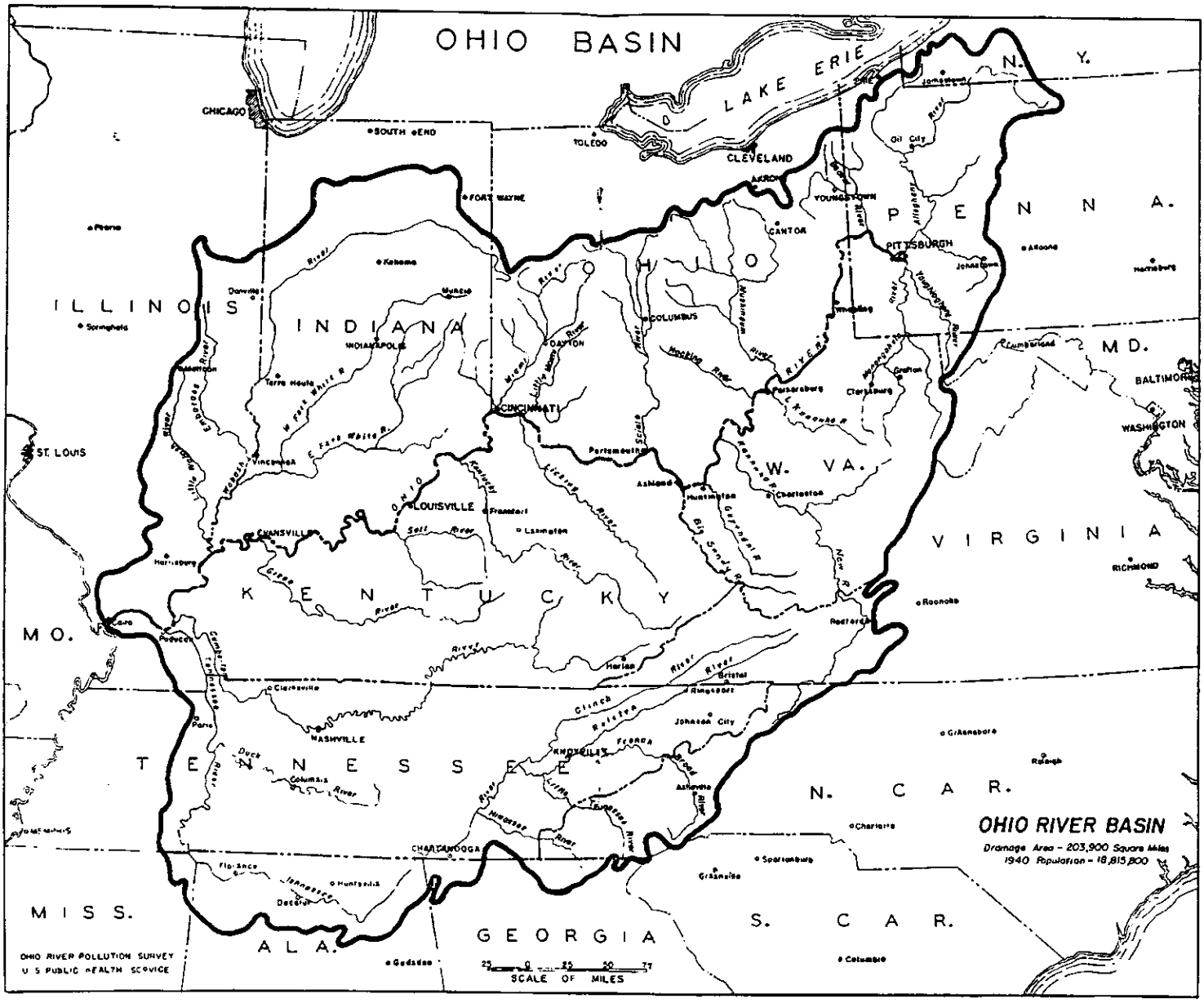
By _____
RALPH F. GATES,
Governor

_____
L. E. BURNEY,
Commissioner

_____
BLUCHER A. POOLE,
Commissioner

_____
JOSEPH L. QUINN,
Commissioner

ATTEST: _____
THOMAS E. BATH,
Secretary of State


OHIO BASIN
LAKE ERIE
N. Y.
CHICAGO
SOUTH END
TOLEDO
CLEVELAND
AKRON
YOUNGSTOWN
PENNA.
CANTON
PITTSBURGH
ILLINOIS
INDIANA
OHIO
COLUMBUS
DAYTON
CINCINNATI
MD.
BALTIMORE
WASHINGTON
ST. LOUIS
W. VA.
VIRGINIA
LOUISVILLE
KENTUCKY
RICHMOND
MO.
NASHVILLE
TENNESSEE
KNOXVILLE
CHATTANOOGA
N. CAR.
MISS.
ALA.
GEORGIA
S. CAR.
OHIO RIVER BASIN
Drainage Area - 203,900 Square Miles
1940 Population - 18,815,800
OHIO RIVER POLLUTION SURVEY
U S PUBLIC HEALTH SERVICE
SCALE OF MILES

STATE OF WEST VIRGINIA

By _____

CLARENCE W. MEADOWS,
Governor

_____

KENNETH S. WATSON,
Commissioner

_____

W. W. JENNINGS,
Commissioner

_____

N. H. DYER,
Commissioner

ATTEST: _____

WILLIAM S. O'BRIEN,
Secretary of State

STATE OF OHIO

By _____

THOS. J. HERBERT,
Governor

_____

HUDSON BIERY,
Commissioner

_____

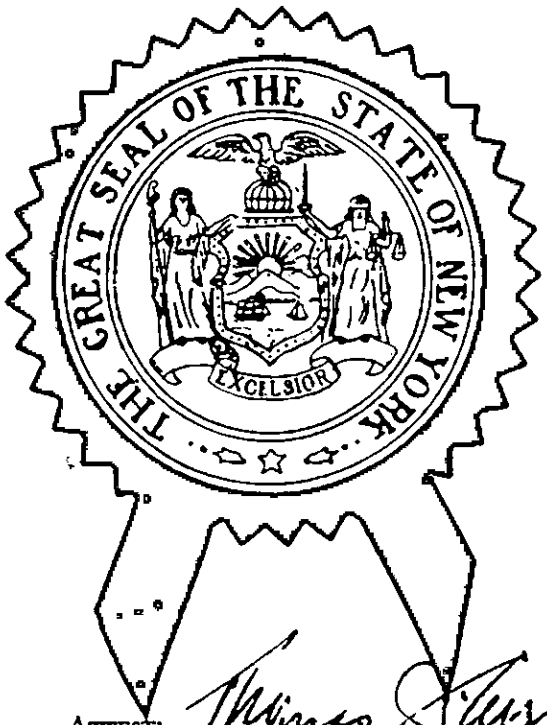
KENNETH M. LLOYD,
Commissioner

_____

JOHN D. PORTERFIELD,
Commissioner

ATTEST: _____

EDWARD J. HUMMEL,
Secretary of State



STATE OF NEW YORK

By _____
THOS. E. DEWEY,
Governor

_____
MARTIN F. HILFINGER,
Commissioner

_____
CHARLES B. MCCABE,
Commissioner

_____
HERMAN E. HILLEBOE,
Commissioner

ATTEST: _____
THOMAS J. CURRAN,
Secretary of State

STATE OF ILLINOIS

By _____
DWIGHT H. GREEN,
Governor

_____
C. W. KLASSEN,
Commissioner

_____
J. J. WOLTMANN,
Commissioner

_____
ROLAND R. CROSS,
Commissioner

ATTEST: _____
EDWARD J. BARRETT,
Secretary of State

COMMONWEALTH OF KENTUCKY

By _____
EARLE C. CLEMENTS,
Governor

_____
HENRY WARD,
Commissioner

_____
~~P. E. BLACKERBY~~,
acting Commissioner

_____
EARL WALLACE,
Commissioner

ATTEST: _____
GEORGE GLENN HATCHER,
Secretary of State

COMMONWEALTH OF PENNSYLVANIA

By _____
JAMES H. DUFF,
Governor

_____
HERBERT P. SORG,
Commissioner

_____
E. A. HOLBROOK,
Commissioner

_____
NORRIS W. VAUX,
Commissioner

ATTEST: _____
C. M. MORRISON,
Secretary of the Commonwealth

COMMONWEALTH OF VIRGINIA

By _____
WILLIAM M. TUCK,
Governor

_____
E. BLACKBURN MOORE,
Commissioner

_____
ROSS H. WALKER,
Commissioner

_____
T. BRADY SAUNDERS,
Commissioner

ATTEST: _____
THELMA Y. GORDON,
Secretary of the Commonwealth

APPENDIX

Approval by the Congress of the United States of America

Authority to enter into the foregoing Compact was initially granted by act of the 74th Congress of the United States by Public Resolution No. 104, approved June 8, 1936, and subsequent consent to and approval thereof was expressly granted by the Congress of the United States by the following legislation:

Public—No. 739—76th Congress
Chapter 581—3rd Session
S. 3617, approved July 11, 1940

Approval by the Signatory States

The foregoing Compact was expressly ratified and approved and its execution authorized by the respective legislatures of the signatory States by the following Acts:

INDIANA

Enrolled Act No. 337, House
Approved March 4, 1939

No reservations were contained in this legislation.

WEST VIRGINIA

H. B. No. 369 of the Legislature of 1939 of the State of West Virginia; passed March 11, 1939 and effective 90 days thereafter.

This Act was expressly to become effective after the approval, ratification, adoption and entering into thereof by the States of New York, Pennsylvania, Ohio and Virginia.

OHIO

Amended Senate Bill No. 33; passed by the Regular Session of the 93rd General Assembly of Ohio on May 24, 1939; approved by the Governor on May 29, 1939; effective August 31, 1939.

This Act was expressly conditioned to become effective and become operative and Compact executed for and on behalf of the State of Ohio only from and after the approval, ratification, adoption and entering into thereof by the States of New York, Pennsylvania and West Virginia.

NEW YORK

Chapter 945 of the Laws of 1939 of the State of New York; passed by the Legislature, approved by the Governor and became effective July 11, 1939.

No reservations were contained in this legislation.

This Act was expressly conditioned to become effective as to Sections 1 to 6 thereof as of June 8, 1939.

ILLINOIS

H. B. 891 D of the General Assembly of 1939 of the State of Illinois; approved July 22, 1939.

No reservations were contained in this legislation.

KENTUCKY

Chapter 150 (H. B. 172) of the Acts of 1940 Regular Session of the General Assembly of Kentucky; approved March 16, 1940; effective June 30, 1940.

No reservations were contained in this legislation.

PENNSYLVANIA

Act No. 50 of the General Assembly of the Commonwealth of Pennsylvania; approved April 2, 1945.

This Act expressly provided that the Compact shall be executed for and on behalf of the Commonwealth of Pennsylvania only after the approval, ratification and entering into thereof of the States of New York, Ohio, and West Virginia.

VIRGINIA

Chapter 117 (H. B. 15) of the Acts of the 1948 Regular Session of the General Assembly of the Commonwealth of Virginia; approved March 5, 1948; effective 90 days after adjournment of the General Assembly which took place on March 13, 1948.

This Act contains no reservations except that it shall become effective in due course provided the Governor signs the Compact therein referred to on behalf of the Commonwealth.

APPENDIX 2

CSO Summary Sheets

CSO Summary Sheet

Municipality: Huntington, WV — Ohio River Mile: 313.2

Date of Last Revision: October 1, 1996

Address: City of Huntington
Sanitary Board
P.O. Box 1659
Huntington, WV 25717

Contact: Luke Richmond
Phone: (304) 696-5917

NPDES Permit #: WV0023159
Expiration Date: 3/07/00

Plant Design Flow: 17.0 MGD — CSO Plan of Action: Approved
Number of CSOs: 23 — Implementation of NMC: Due 5/15/95
Lat/Long: Yes
Discharge Point(s): 14 to Ohio River, 4 to Guyandotte River, 4 to Fourpole Creek, 1 to Krout Creek.

Comments: The NPDES permit for the City of Huntington contains the following requirements:

Requirement	Due Date	Status
Submit a final CSO Plan of Action	11/15/93	Approved
Complete planned minimization of discharges	5/15/95	Unknown
Complete planned evaluation of water quality impacts	5/15/96	Unknown
Develop long term control plan	5/15/97	N/A

The CSO Operational Plan for the City of Huntington was received by ORSANCO. There are five stages to the plan:

- Phase I - Description of the existing physical system.
- Phase II - Description of the current maintenance and management program.
- Phase III - Assembly and calibration of a mathematical model.
- Phase IV - Evaluation of CSO abatement alternatives.
- Phase V - Final CSO Plan with recommendations.

Phases I and II are complete. Data required for the model in Phase III has been obtained and processed into usable form. Monitoring equipment will be installed by 1/1/94. Sampling will be conducted for a 4-month period during Spring, 1994. Phase IV is due to be completed by 5/15/95. Phase V will be completed on or before 5/15/96.

There are 23 CSOs with 26 diversion structures. Outfalls 009, 017 and 018 have two diversion structures per outfall. Each diversion structure show little signs of wear and appear to be operating as designed. Four diversion structures are very highly susceptible to submergence and 10 are highly susceptible to submergence. Descriptions of each overflow are given in the CSO Plan.

Huntington CSO Summary Sheet cont...

A lift station light maintenance program will be developed, along with a "Deep Clean" program (clean solids from regulators, diversion chambers, wet well chambers and sewage station pumps on a regular basis). Also, planned force main/interceptor flushing will be done.

Huntington Sanitary Board maintains a pretreatment program. There are 20 Significant Industrial Users with industrial discharge permits. The sewer use ordinance is being reviewed. A draft copy is included in the CSOP. Four outfalls (013,016,018 and ???) have the potential for discharging industrial type pollutants.

Six overflows will be monitored during Phase III. Parameters to be measured include bypassed flow, sanitary flow, CSO quality (TSS, BOD_5, oil and grease, pH, hardness, ammonia as NH_3-N, selected metals, fecal coliform, E. coli, and DO), hourly rainfall data, river stage, and treatment plant and industrial flows and quality. Flow weighted composite samples (not first flush) will be taken. As of 1/4/94, five flow meters are in place (East Road, West 13th, 16th Street (one on bypass and one on sanitary sewer) and 5th Avenue. One is to be put in at James River Road. There are nine rain gauges throughout the City of Huntington. Data from each is available to ORSANCO as needed.

The overflows that discharge the greatest volumes are the 20th Street regulator (013) to the Ohio River, and the 5th Avenue Pump Station (016) and Pat's Branch Pump Station (018) to the Guyandotte River. Overflow 018 will contain the greatest concentration of metals. A very small amount of rain will trigger an overflow due to major CSOs being built on very steep sewer lines. Increasing the weir levels will not help.

Huntington has had problems with dry weather overflows at the Richmond St. CSO (020) and the 35th St. CSO (021) in the past. These problems are being addressed by the Sanitary Board.

ORSANCO conducted an intensive longitudinal/bacterial study on the Greenup Pool (ORM 301 to 341) during the 1994 recreational season. Bacteria and BTEX samples were taken and field measurable parameters were measured above and below Huntington's collection system at river mile points 301 (above Huntington's collection system), 305.2 (mouth of the Guyandotte River), 306.9 (Huntington WTP water intake), 310.8 (West End Bridge) and 311.9 (West End Bridge). Sampling was also conducted further downstream at mile points 317.2, 319.7, 324.7, 327.0 and 331.0. A report was submitted to US EPA Regions III and IV in Sept. 1995 and subsequently approved.

CSO Summary Sheet

Municipality:	Kenova, WV	Ohio River Mile: 313.2	
Date of Last Revision:	October 1, 1996		
Address:	City of Kenova P.O. Box 268 Kenova, WV 25530		
Contact:	Roger Caldwell		
Phone:	(304) 453-1081		
NPDES Permit #:	WV0035912		
Expiration Date:	6/9/96		
Plant Design Flow:	Wastewater pumped to Huntington	CSO Plan of Action:	Approved
Number of CSOs:	2	Implementation of NMC:	Due 1/1/97
Lat/Long:	Yes		
Discharge Point(s):	Both discharge to Ohio River		

Comments: Kenova's combined sewers utilize gravity flow to one of two pumping stations. The sewage pumping stations direct flow into a 16" force main, which flows eastward along the Ohio River. The force main terminates at a pumping station owned by Ceredo, WV, where it joins with Ceredo's flow and is directed to the Huntington WWTP. A map of the collection system area and detailed drawings of the diversion chambers, regulator stations and lift stations are included in the plan. The diversion chambers, regulators and lift stations were all constructed in 1991 and are in good working order. Each lift station is supplied with a backup generator to ensure continuous operation during power outages.

The city has two overflows - the 19th Street Lift Station CSO (#001) and the 9th Street Lift Station CSO (#002). Signs are posted at each outfall. Each CSO drains an area of over 300 acres. Adjustable weirs have been constructed in each diversion chamber. The influent pipe is screened by an aluminum grating, which requires periodic cleaning. Weir elevations are available for each overflow. Both are only slightly susceptible to submergence by river backflow (less than 10 days per year). Additional controls to prevent submergence are not thought to be necessary.

The sewer system operation and maintenance program is carried out by the city's Public Works Superintendent. The superintendent inspects the lift stations and diversion structures daily, performs preventive maintenance, inspects and maintains overflow weirs and regulator chamber gates, and coordinates volunteer groups for street sweeping activities.

One industrial user has been issued an industrial discharge permit. Mississippi Chemical Express performs cleaning operations for truck tankers. A package treatment facility has been installed to pretreat the wastewater. Mississippi Chemical is responsible for sampling and analyzing the effluent semi-annually. The Huntington Sanitary Board, which administers Kenova's pretreatment program, collects a compliance sample once a year.

ORSANCO conducted an intensive longitudinal/bacterial study on the Greenup Pool (ORM 301 to 341) during the 1994 recreational season. Bacteria and BTEX grab samples and were taken above Kenova's overflows at five river mile points. Grab samples were taken downstream of the CSOs at five points. Cross section sampling for bacteria and field measurable parameters were conducted at each of the above points. A report was submitted to US EPA Regions III and IV in Sept. 1995 and subsequently approved.

Kenova CSO Summary Sheet cont...

The following additional activities are planned prior to January 1, 1997:

- Develop a light preventive maintenance program for the lift stations, regulators and diversion chambers.
- Create a "Deep Clean" program for the regulators, diversion chambers, wet well chambers, catch basins and sewer mains. (The city is considering the purchase of a jet rodding machine.)
- Develop a force main/interceptor flushing program and schedule.
- Develop and implement a street sweeping and catch basin cleaning program.
- Review and modify where necessary measures for enforcing the sewer use ordinance and regulations, and the industrial pretreatment program.
- Identify subdrainage areas with excessive inflow/infiltration.

West Virginia conditionally approved the Operational Plan in May 1996. The City of Kenova is required to submit additional information describing the sewer system operational and maintenance program, and document the implementation of the planned activities listed above. The City must also provide results of any CSO monitoring.

CSO Summary Sheet

Municipality:	Catlettsburg, KY	Ohio River Mile: 317.1
Date of Last Revision:	January 30, 1997	
Address:	Catlettsburg Wastewater Treatment Plant 3701 Park Street Catlettsburg, KY 41129	
Contact:	Fred Childers	
Phone:	(606) 739-5145	
NPDES Permit #:	KY0035467	
Expiration Date:	3/31/98	
Plant Design Flow:	0.5 MGD	CSO Operational Plan: On hold
Number of CSOs:	14	
Lat/Long:	No	
Discharge Point(s):	9 to Ohio River, 5 to Big Sandy River	
Design Flow of WWTP	0.5 MGD	

Comments: The City of Catlettsburg is currently in the planning stages of a major sewer renovation project, which will include renovating the treatment plant, adding sludge disposal facilities, replacing the eight existing pump stations, extending sewer services to areas south of Catlettsburg (260-300 houses), and separating the collection system. The city currently as approximately $5.2 million to complete the project ($1.4 million grant, $1 million contribution from city, remainder from a KIA loan). Projects will be prioritized in case funds should run short. The requirement to submit a CSO Operational Plan has been suspended, pending KY DOW's approval of the sewer separation plan.

At this time, the combined sewer system experiences several problems. The pump stations are old and malfunction occasionally. The overflow regulators and pipes tend to become clogged, resulting in dry weather overflows. There are also rows of houses from which sewer pipes do not lead to the interceptor, but directly to the river. These will be the highest priority of the sewer renovation project. Maps of the sewer system have been received by ORSANCO. Lat/long information is not available at this time.

ORSANCO conducted an intensive longitudinal/bacterial study on the Greenup Pool (ORM 301 to 341) during the 1994 recreational season. Bacteria and BTEX grab samples were taken above Catlettsburg overflows at river mile points 301 (above Huntington's collection system), 305.2 (mouth of the Guyandotte River), 306.9 (Huntington WTP water intake), 310.8 (West End Bridge) and 311.9 (West End Bridge). Grab samples were also taken at Catlettsburg at mile point 317.2 (Big Sandy confluence), and downstream of the overflows at 319.7 (Ashland water intake), 324.7 (Allied Chemical), 327.0 (Ironton water intake) and 331.0 (Pond Run confluence). Cross section sampling for bacteria and field measurable parameters were also conducted at each of the above points. A final report was submitted to US EPA Regions III and IV in September, 1995.

CSO Summary Sheet

Municipality:	Ashland, KY	Ohio River Mile: 322.5	
Date of Last Revision:	January 15, 1997		
Address:	City of Ashland Department of Utilities P.O. Box 1839 Ashland, KY 41105		
Contact:	Joe Harris		
Phone:	(606) 327-2007		
NPDES Permit #:	KY0022373		
Expiration Date:	12/31/99		
Plant Design Flow:	11.0 MGD	CSO Operational Plan:	Approved
Number of CSOs:	9 permitted, 1 eliminated	Annual Report:	Due Nov. 1
Lat/Long:	Yes		
Discharge Point(s):	6 to Ohio River, 2 to Hoods Creek (1 eliminated), 1 to Long Branch		

Comments: Flow is transported to the Ashland treatment plant via a force main from the 26th Street pump station. The WWTP effectively treats about 4.0 MGD of dry weather flow. Flows that exceed 7.0 MGD cause settled solids in the final; clarifier to resuspend and escape over the clarifier's weir. Average monthly flows for 1995 and 1996 are provided.

Proper Operation and Maintenance: A regular program for lift station inspection and maintenance is in place. The program is corrective in nature; a preventative maintenance schedule is being developed. Street cleaning is performed daily, with all downtown streets being cleaned once a week and outlying areas once a month. A catch basin cleaning and repair program is being developed and will be implemented in 1997. Guidelines for a preventative maintenance program is included in the CSO Plan. The plan also recommends that the regulators be checked and cleaned at least every other month. Very little information regarding the cleaning of sewer lines is provided.

Maximize System Storage: Leaping weirs are in place at CSOs 002 (above the WWTP) and 014 (Roberts Drive). The weir at CSO 014 has been raised eight inches with no complaints of basement backups. It will be raised an additional three inches. The height of the weir at CSO 002 will remain the same until modifications are made at the treatment plant. In recent years, storm lines have been separated from combined sewers and downspouts have been disconnected from sanitary lines. Work will continue in these areas. Residents with downspout connections must either disconnect them or face fines from the City, in accordance with the sewer use ordinance. All flap gates are in good working order except at CSO 014. Mud and debris that has built up over time prevents this flap gate from closing.

Pretreatment Program: There are six industries covered by the city's pretreatment program, all of which are generally in compliance except the AK Steel Coke Plant. AK Steel is often in significant non-compliance, and is a source of concern for ammonia, BOD/COD, cyanide, explosive gases, high temperature, oil and grease, thiocyanate and sulfide. Currently, AK Steel is under a compliance schedule and has constructed a wastewater treatment facility. Additionally, they have applied for a permit to discharge directly to the Ohio River, which would eliminate CSO concerns. Two outlying districts discharge to the Ashland sewer system. There are plans to enact multi-jurisdictional agreements, with the City performing required pretreatment functions for the districts.

Ashland CSO Summary Sheet cont...

Maximize Flow to WWTP: The current recommendation is to construct two circular 12 MGD clarifiers, convert the existing clarifiers into sludge holding facilities, and construct a return/waste activated sludge pumping station. Additionally, satellite treatment facilities will be constructed at CSOs 004, 010 and 012 (and 002 if necessary). Each facility will include mechanical bar screens, swirl concentrators or vortex separators, and disinfection. Construction costs for the treatment plant upgrade and the satellite facilities will range from $11.3 to 14.2 million. This will be implemented in three phases, with the construction of the new clarifiers occurring in Phase 1 (estimated cost - $2 million).

Eliminate Dry Weather Overflows: Recently, dry weather overflows were observed at CSOs 004 and 006. The bypassing at CSO 004 was most probably the result of a calcified gravity sewer. Ashland is investigating the potential replacement of this line. The elimination of dry weather overflows at CSO 004 will also be helped once AK Steel puts its new treatment plant on line. Overflows at CSO 006 were the result of a malfunctioning pump station. The variable speed drives of the pumps were replaced and dry weather bypasses have ceased.

Control of Solids and Floatables: The solids and floatable materials problem is being addressed through source controls, primarily street sweeping.

Pollution Prevention: Current programs include regular street sweeping, garbage collection and grease trap inspections. The City is discussing the possibility of implementing a recycling program with Rumpke, Inc. Additionally, a catch basin cleaning program should be established in early 1997.

Public Notification: There are plans to install notification signs at all CSO locations. Additionally, a bulletin will be published explaining CSOs and giving their location. A CSO public information committee will also be established.

Monitoring: Flow monitoring at four CSOs was conducted for a one month period in the Spring of 1996. Results indicate that:

- It takes approximately a 0.1 inch rainfall to activate CSOs 002, 004, 006, 010 and 012. The CSOs overflow on average 85 times a year.
- The impacts of overflows from CSO 006 are minimal, since the outfall has a reverse grade, which results in wastewater flowing back from the outfall to the main sewer.
- CSOs 008 and 009 are activated by a rainfall exceeding 0.2 inches, and overflows on average 60 times a year.
- CSO 014 did not overflow during the study, and has not discharged since the pump station was upgraded.

Water quality samples were also taken at four overflows. Fecal coliform levels exceeded 200/100 mL in all samples. Acceptable limits for suspended solids and BOD were also exceeded. A complete list of parameters exceeding recommended levels are listed in Table X.2 of the CSO Plan. All raw data are included in Appendix A of the CSO Plan. This work is in addition to the Greenup Pool intensive longitudinal/bacterial study conducted by ORSANCO in 1994.

CSO Summary Sheet

Municipality:	Ironton, OH	Ohio River Mile:	327.2
Date of Last Revision:	March 19, 1996		
Address:	Ironton WWTP 810 N. Fourth Street P.O. Box 704 Ironton, OH 45638		
Contact:	Mike Betz		
Phone:	(614) 532-8425		
NPDES Permit #:	OH0025852		
Expiration Date:	4/1/97		
Plant Design Flow:	1.7 MGD	CSS Operational Plan:	Submitted
Number of CSOs:	9 permitted, 1 unpermitted		
Lat/Long:	Yes, except for #006		
Discharge Point(s):	8 to Ohio River, 2 to Storms Creek		

Comments: Only nine CSOs are listed in the current permit, but Mr. Betz mentioned the Orchard Street Pump Station Overflow (#006) still exists. This was to be removed during the 1988 remodeling, but it wasn't. Discharges from 006 are still being reported to the Ohio EPA. No lat/long information is available for this overflow; however, it is located approximately 100 feet from the Orchard Street Overflow (#018). Both 006 and 018 discharge to Storms Creek. The permit calls for a plan for removal of inflow sources by 4/30/93 and complete removal by 9/1/94. All bypasses and overflows are to be removed from the separate sanitary sewer by 12/31/93.

NPDES Permit requires monitoring for peak flow rate, occurrences, duration, $CBOD_5$, and TSS at stations 002, 004, 007, 011, 017 and 018. The flow rate is estimated using a maximum indicator staff gauge, which measures water depth. A computer formula estimates rate based on the height of the water, weir length and duration. The duration of the bypass is difficult to measure, so rainfall duration is used instead. At best, the flow rate is over-estimated, according to Mr. Betz. Grab samples are taken for $CBOD_5$ and TSS during the first 30 minutes of each storm event. Mr. Betz estimates that it takes 3/10 inch rain to cause an overflow at some points. To the best of his knowledge, CSO 007 discharges most frequently, followed by 009 and 010 (about equal), then 011, which is in a tough position to sample. However, a study to determine actual overflow volumes has not been conducted.

ORSANCO conducted an intensive bacterial/longitudinal study of the Greenup Pool (ORM 301 to 341) during dry and wet weather periods from July to November 1994. A full report on the results of this study was submitted to U.S. EPA Regions III and IV in September 1995.

The CSO Operation and Maintenance plan was submitted to Ohio EPA on 2/8/94. The plan was prepared by BBS Corporation of Columbus, OH. ORSANCO submitted comments on Ironton's CSO plan to Ohio EPA's Southeast office on 8/23/94.

Sewer System Description - A detailed map of the sewer system is included in Ironton's CSO plan. The system is connected to the WWTP by 12" and 24" interceptor sewers which join at a junction box east of the WWTP. There is a sewage flow regulator at the head of the plant which diverts flows in excess of 3.4 MGD, the peak

Ironton CSO Summary Sheet cont...

design capacity of the WWTP, back into the sewer system for overflow at CSO #007. The actual peak hydraulic flow of the plant exceeds 4.0 MGD. The plant can adequately treat this flow. No improvements to the plant are anticipated.

A Sewer System Evaluation Survey was conducted in 1982. The sewers were estimated to transport six times the dry weather flow prior to an overflow occurrence. According to a 12/13/82 meeting held between the City and Ohio EPA, "any sewer transporting at least six times the dry weather flow is doing the job adequately."

There are three pump stations in the Ironton sewer system. Only the Orchard St. pump station discharges combined flow. Each pump station is equipped with high-level alarms for the detection of dry weather overflows. There is a portable emergency generator for each pump station.

Each CSO is briefly described in the CSO plan. Two CSOs have automated regulators while five have inverted weir diversion structures. The remaining overflows originate at the Orchard St. Pump Station, the head of the treatment plant, and a manhole near the railroad. The Fifth and Pearl St. CSO (#011) functions when a 12" sewer under the railroad is plugged or surcharged. Overflows from the manhole discharge onto the surrounding surface of the undeveloped area adjacent to the railroad. The sewer is rodded and cleaned regularly to reduce the number of overflows. The Hecla St CSO (#007) is normally the first CSO to overflow, thereby governing the maximum flow to the treatment plant. A flow meter is used to monitor this overflow, but is currently malfunctioning. The WWTP CSO (#002) discharges only if the Hecla St. CSO becomes plugged and does not overflow. No overflows have been recorded at the WWTP CSO.

Collection System Operation and Maintenance - Currently, "routine" inspections and cleaning of the sewer system are conducted. The regulators and diversion structures are inspected monthly and after all rain events. Manholes are cleaned when necessary. Maintenance on the regulators and the pump stations is performed in accordance with the manufacturer's recommendations. The operations and maintenance manual for the regulators is included in the CSO plan.

Industrial Dischargers - There are two industries which discharge to Ironton's sewer system. There is no pretreatment program in place for either industry. Waste from Ironton Iron would overflow at CSO #010. Wastes typically contain small amounts of foundry sand. Wastes from Cabletron would overflow at CSO #009. The city noted an increase in biosolids zinc after Cabletron started production. Testing of the WWTP effluent and biosolids has not revealed any significant amounts of metals.

Future Improvements - Sedimentation manholes will be placed in areas where sewer cleaning is difficult due to inaccessibility or where there has been a history of plugging. Locations include Vesuvius St., east of the railroad, and downstream of the Hecla St. regulator. the Fifth and Pearl St. manholes will be rehabilitated and larger diameter sewer pipes will be installed. The bypass pump at the Orchard St. Pump Station will be modified to discharge to the sanitary force main. No time line was given in the plan for these improvements.

In a January 6, 1996 letter, Ohio EPA listed problems discovered during a Compliance Evaluation Inspection, including a plant bypass, which resulted from grit accumulation in the sewer between the Hecla Street junction box and the plant. Apparently this is a chronic problem. Removal of inflow sources and elimination of dry weather overflows from the CSS in South Ironton are to be completed by September 1996.

CSO Summary Sheet

Municipality:	Worthington, KY	Ohio River Mile: 328.9	
Date of Last Revision:	May 21, 1997		
Address:	City of Worthington P.O. Box 366 Worthington, KY 41183		
Contact:	Joe Moore/Dennis Gumbert		
Phone:	(606) 836-0523 (606) 836-6821 (City Hall)		
NPDES Permit #:	KY0022926		
Expiration Date:	5/31/02		
Plant Design Flow:	0.2 MGD	CSO Operational Plan:	Requirement Suspended
Number of CSOs:	3		
Lat/Long:	Yes		
Discharge Point(s):	2 to Ohio River, 1 to Pond Run		

Comments: The permit requires that the City maintain an approved Combined Sewer Operational Plan (CSOP) which shall include mechanisms and procedures to ensure the implementation of the nine minimum controls. However, the overflows in Worthington's system are inactive for the most part, and the requirement to complete a CSOP has been suspended. The City regularly updates the Kentucky DOW on improvements made to the collection system and overflows.

CSO 002 (Prospect Avenue at Edsel Street) - The two pumps at the lift station (80 gpm capacity) were renovated in 1992. Only one storm drain goes to the lift station, which the city plans to eliminate. A total of 48 homes are served by the lift station. The wet well has a storage capacity of 1500 gal. and the manhole can store 100 gal. of wastewater.

CSO 003 (Prospect Avenue at Ferry Street) - The two pumps at the lift station (250 gpm capacity) were installed in 1964 and are in poor repair. A total of 148 homes are served by the lift station, plus the force main from the west end of the city. This CSO is more likely to be a problem than any of the others. The city is discussing the possibility of eliminating one of the storm drains going to the lift station.

CSO 004 (Riverside Drive at Third Avenue) - This CSO discharges to Pond Run, not the Ohio River as stated in the city's NPDES permit. According to WWTP personnel, this lift station has never overflowed due to excessive storm water entering the system. The city is considering using this lift station for storage of excess flow.

The City of Worthington has recently obtained a $340,000 CDBG grant and KIA funding has been approved. The city is in the process of conducting an environmental assessment and developing the plans and specifications for the sewer renovation project. The environmental assessment is scheduled for completion in 12/94; the plans and specifications for the sewer renovation project should be completed by 6/95. Construction is scheduled to begin in 10/95 and be completed in 6/96. Among the plans being considered are an increase in pumping capacity of the main lift station and the construction of a holding facility at the plant.

Worthington CSO Summary Sheet cont...

ORSANCO conducted an intensive longitudinal/bacterial study on the Greenup Pool (ORM 301 to 341) from July to November 1994. Bacteria and BTEX grab samples were taken above Worthington's overflows at river mile points 301 (above Huntington's collection system), 305.2 (mouth of the Guyandotte River), 306.9 (Huntington water intake), 310.8 (West End Bridge), 311.9 (West End Bridge), 317.2 (Big Sandy confluence), 319.7 (Ashland water intake), 324.7 (Allied Chemical) and 327.0 (Ironton water intake). Grab samples were also taken downstream of the overflows at mile point 331.0 (Pond Run confluence). Cross section sampling for bacteria and field measurable parameters were also conducted at each of the above points. A final report was submitted to U.S. EPA Regions III and IV in September, 1995.

The city has a pretreatment agreement with Ashland-Boyd County airport. The city is trying to reach an agreement with the railroad.

All outfalls are above normal pool level. Due to the elevation of the diversion structures, Worthington does not experience stage-induced bypassing.

APPENDIX 3

Ohio River at Huntington, WV – Hydrologic & Precipitation Data

CSO LONGITUDINAL / BACTERIA SURVEY

Ohio River at Huntington, WV - Hydrologic & Precipitation Data

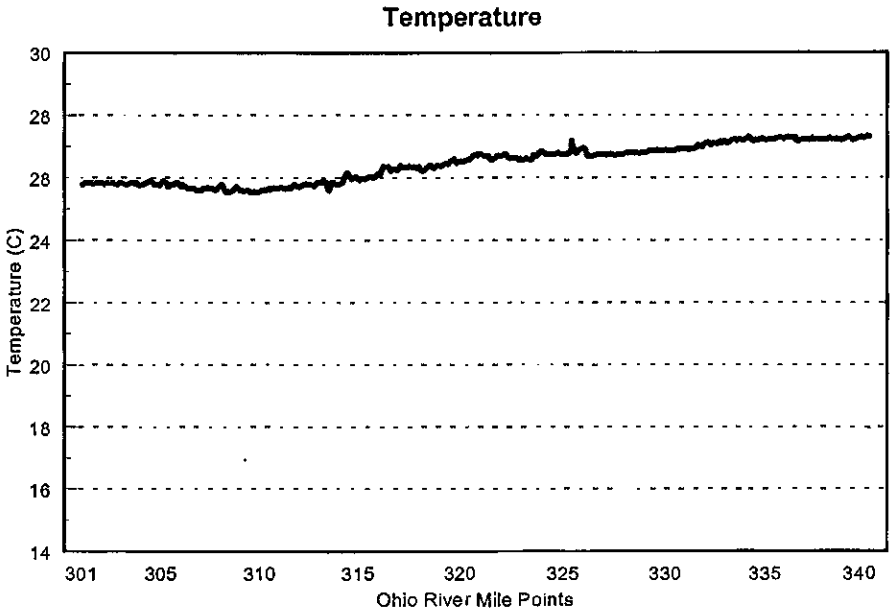
			Huntington, WV					
Survey #	Date	Event	Rainfall - 1	Rainfall - 2	Rainfall - 3	Flow	Velocity	Stage
1	07/21/94	Wet	0.00	**0.56**	0.00	40.8	0.82	26.13
2	07/28/94	Wet	0.00	**0.94**	**0.06**	48.0	0.95	26.33
3	08/04/94	Wet	0.00	**0.37**	**0.14**	43.1	0.86	26.58
4	08/11/94	Dry	0.00	0.00	0.00	44.3	0.88	25.92
5	08/18/94	Dry	0.00	**0.12**	0.00	121.9	2.13	27.65
6	08/25/94	Dry	0.00	0.00	0.00	85.2	1.55	27.20
7	08/30/94	Dry	0.00	**Trace**	0.00	67.1	1.25	27.30
8	09/08/94	Dry	0.00	0.00	0.00	29.2	0.58	26.10
9	09/15/94	Dry	0.00	0.00	0.00	20.2	0.40	26.60
10	09/22/94	Dry	0.00	0.00	0.00	18.0	0.36	25.98
11	09/28/94	Dry	0.00	0.00	**0.03**	39.5	0.79	25.93
12	10/10/94	Wet	0.00	**0.21**	0.00	24.3	0.49	26.58
13	10/19/94	Wet	**0.52**	0.00	0.00	18.3	0.37	25.59
14	11/01/94	Wet	**0.29**	0.00	0.00	31.5	0.63	26.35
15	11/10/94	Wet	**0.13**	**0.08**	0.00	54.4	1.05	27.05

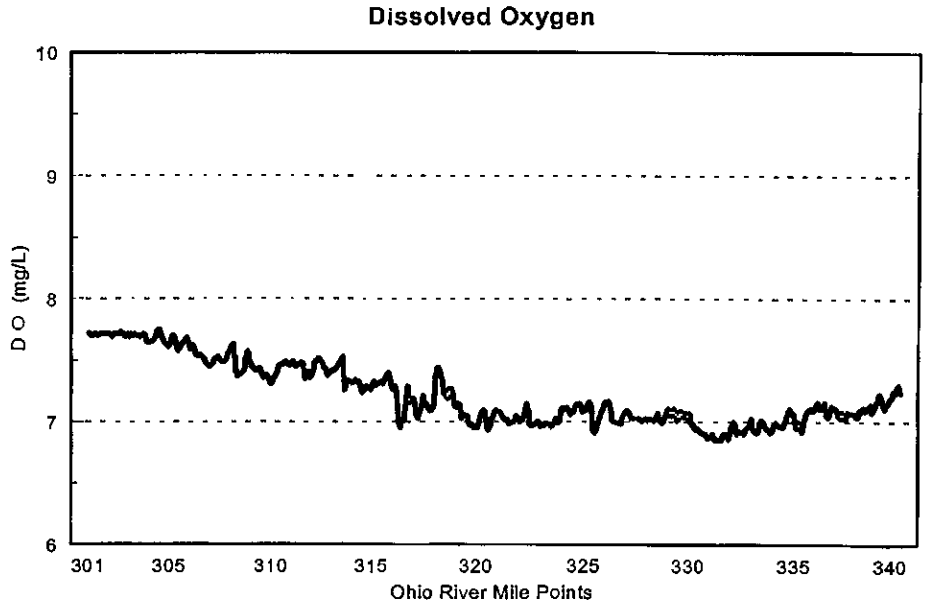
Note: Rainfall data were computed from nine local rain gauges.
Rainfall - 1 = average precipitation (in.) on day of survey from 1:00 am to 5:00 pm
Rainfall - 2 = average precipitation (in.) 1 day before survey
Rainfall - 3 = average precipitation (in.) 2 days before survey
Flows (kCFS) - from the NWSORFC predictive model
Velocity (mph) - from the NWSORFC predictive model
Stage (feet) - from the NWSORFC (NFP = 24.7 feet)

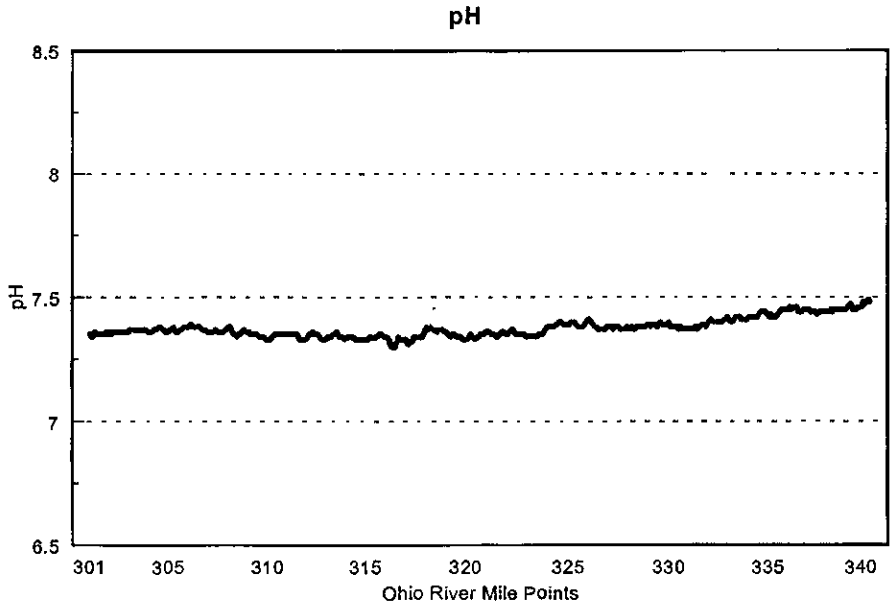
APPENDIX 4

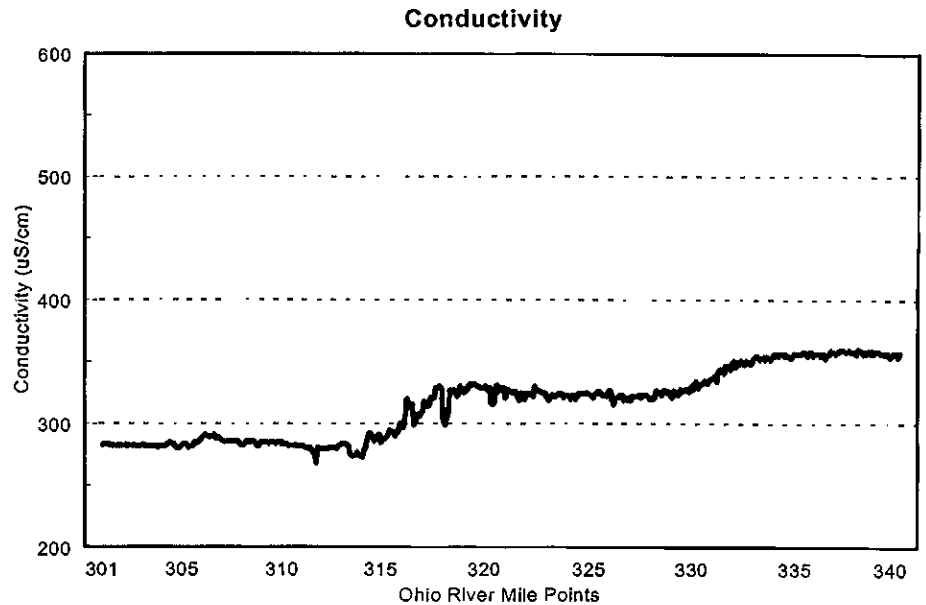
Example Data Packet

CSO LONGITUDINAL SURVEY
SURVEY #3 - 8/04/94 - Wet Weather Event









CROSS-SECTIONAL SURVEY

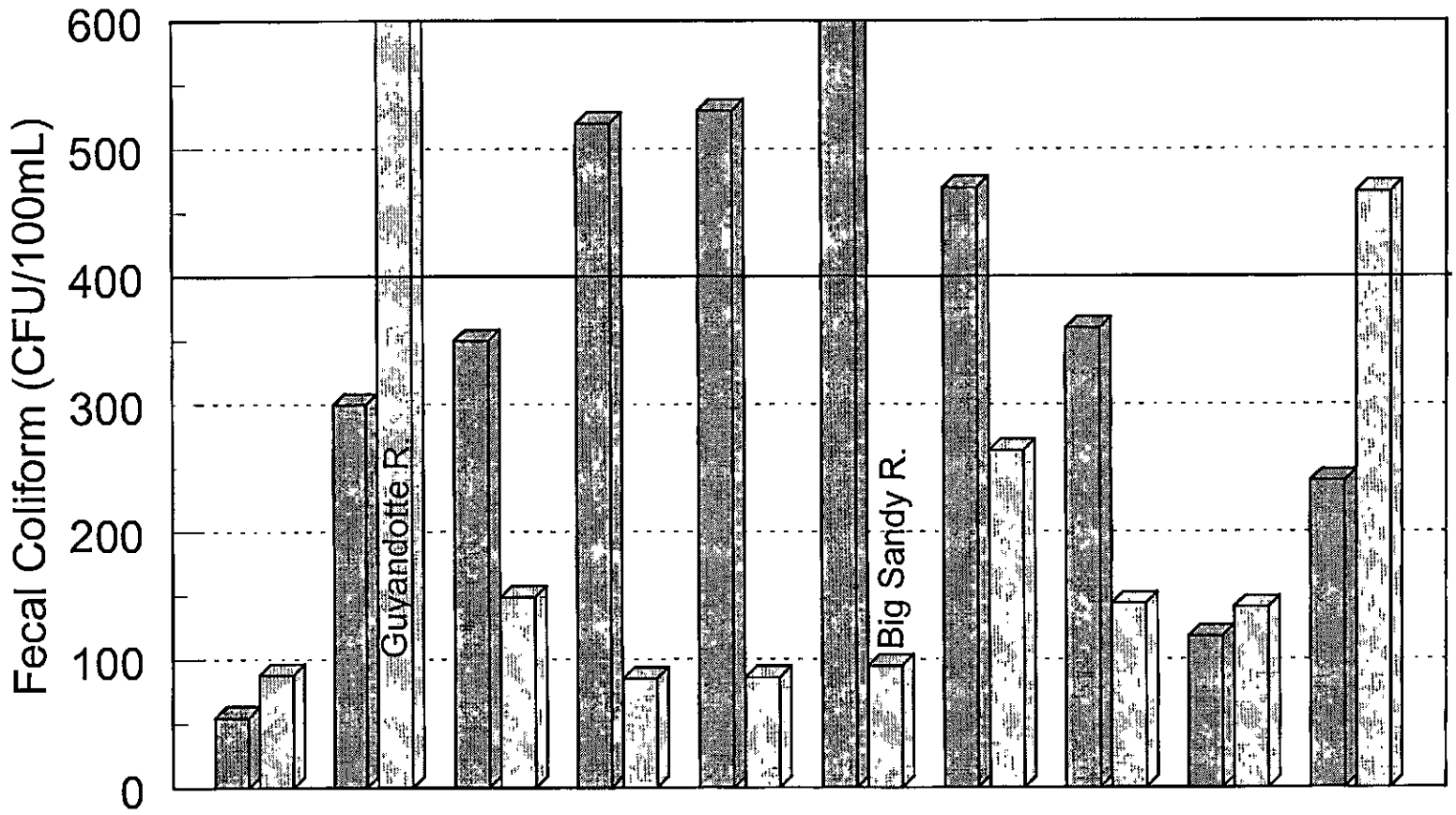
Physical Parameter Data

Survey #3 - 8/04/94 - Wet Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	26.38	7 80	8.33	299		16:20
		Left Quarter	26.21	7.69	8.25	297		16:22
		Midstream	26.14	7.65	8.17	300		16:24
		Right Quarter	26.29	7.69	8.39	299		16:26
		Right	26.30	7.67	8.40	296		16:28
*305.2	Guyandotte River	Left	26 07	7.66	6 95	464		15.28
	@ 1st Bridge	Midstream	26.26	7.68	7.13	466		15:32
		Right	26.12	7.71	7.39	467		15:35
306.9	Huntington WTP	Left	26.14	7.64	7.93	299	P	15:05
	Intake #2	Left Quarter	26.20	7.59	7.99	298	r	15:10
		Midstream	26.16	7.58	8.06	290	o	15:13
		Right Quarter	26 32	7.63	8.27	290	b	15:17
		Right	26.52	7.68	8.43	290	e	15:20
310.8	West End Bridge	Left	26.38	7.59	7.95	291	M	14:40
		Left Quarter	26.29	7.58	8.04	291	a	14:42
		Midstream	26.07	7.51	7.76	288	l	14.45
		Right Quarter	26.25	7.56	8.00	288	f	14.48
		Right	26 37	7.64	8.28	286	u n	14:50
311.9	Fourpole Creek Confluence	Left	26.10	7.72	7.54	289	c	14:27
		Left Quarter	25.88	7.55	7.59	289	t	14:29
		Midstream	26 00	7.56	7.72	287	i	14:31
		Right Quarter	26.20	7.60	8.00	285	o	14:34
		Right	26.43	7.61	8.16	282	n	14:36
*317.2	Big Sandy River	Left	25.71	7.67	7.08	508		13:11
	@ 1st Bridge	Midstream	25.72	7.60	7.14	509		13:13
		Right	25.55	7.58	7.08	507		13:15
319.7	Ashland WTP Intake	Left	26.69	7.42	6.90	335		12:38
		Left Quarter	26.47	7.42	7.38	323		12:40
		Midstream	26.65	7.43	7.41	327		12:42
		Right Quarter	26.66	7.42	7.34	317		12:45
		Right	26.73	7.41	7.31	317		12:49
324.7	Submarine Crossing	Left	27.03	7.42	7.15	331		12:16
		Left Quarter	26.76	7.38	7.10	332		12:19
		Midstream	26.77	7.36	7.24	331		12:21
		Right Quarter	26.76	7.38	7.20	326		12:23
		Right	26.95	7.38	7 16	326		12:25
327.0	Ironton WTP Intake	Left	27.07	7.49	7.15	332		11:59
		Left Quarter	27.11	7.45	7.23	332		12:01
		Midstream	27.15	7.47	7.45	331		12:03
		Right Quarter	26.93	7.42	7.28	329		12:06
		Right	26.93	7.42	7.20	329		12:09
331.0	Pond Run Confluence	Left	27.12	7.51	6.87	352		11:35
		Left Quarter	27.16	7.42	7 07	343		11:38
		Midstream	27.06	7.39	7 03	344		11:40
		Right Quarter	27.10	7.41	7.12	342		11:43
		Right	27.16	7.40	7.06	350		11:45

* Indicates confluence mile point

LONGITUDINAL & CROSS-SECTIONAL SURVEYS
FECAL COLIFORM DENSITIES
Survey #3 - 8/04/94 - Wet Weather Event



Ohio River Mile Points	301.0	*305.2	306.9	310.8	311.9	*317.2	319.7	324.7	327.0	331.0
Longitudinal Grab Sample	55	300	350	520	530	640	470	360	118	240
Cross-Section Mean	88	1,576	149	85	86	95	264	144	141	467

*Cross-Section Samples Collected in Tributary

LONGITUDINAL & CROSS-SECTIONAL SURVEYS

Bacteria Data

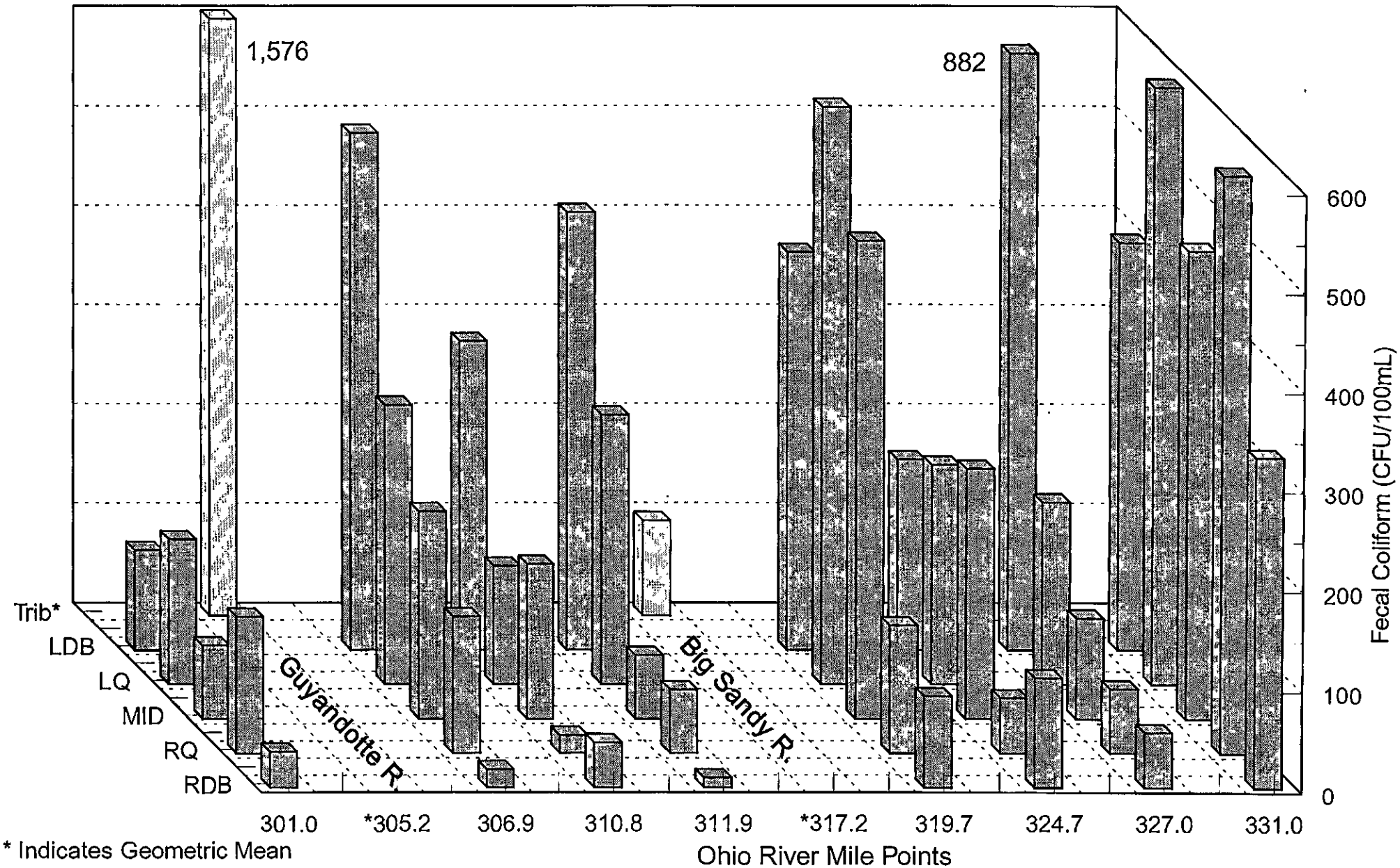
Survey #3 - 8/04/94 - Wet Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	100	145	73	136	36	88	55
305.2	Guyandotte River Confluence							300
	Guyandotte River @ 1st Bridge	4500		145		6000	1576	
306.9	Huntington WTP - Intake #2	520	280	207	136	18	149	350
310.8	West End Bridge	310	118	154	18	45	85	520
311.9	Fourpole Creek Confluence	440	270	63	63	< 10	86	530
317.2	Big Sandy River Confluence							640
	Big Sandy River @ 1st Bridge	100		64		136	95	
319.7	Ashland WTP Intake	400	580	480	127	91	264	470
324.7	Submarine Crossing	191	220	250	55	109	144	360
327.0	Ironton WTP Intake	882	182	100	64	55	141	118
331.0	Pond Run Confluence	410	600	470	580	330	467	240
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CROSS-SECTIONAL SURVEY
FECAL COLIFORM DENSITIES
Survey #3 - 8/04/94 - Wet Weather Event



* Indicates Geometric Mean

LONGITUDINAL SURVEY

BTEX Data

Survey #3 - 8/04/94 - Wet Weather Event

Sampling Mile Points	Site Description	Analysis Method*	Sample Result
301.0	Public Launching Ramp	EPA Method 602 M	< 1 PPB
305.2	Guyandotte River Confluence	EPA Method 602 M	< 1 PPB
306.9	Huntington WTP - Intake #2	EPA Method 602 M	< 1 PPB
310.8	West End Bridge	EPA Method 602 M	< 1 PPB
311.9	Fourpole Creek Confluence	EPA Method 602 M	< 1 PPB
317.2	Big Sandy River Confluence	EPA Method 602 M	< 1 PPB
319.7	Ashland WTP Intake	EPA Method 602 M	< 1 PPB
324.7	Submarine Crossing	EPA Method 602 M	< 1.PPB
327.0	Ironton WTP Intake	EPA Method 602 M	< 1 PPB
331.0	Pond Run Confluence	EPA Method 602 M	< 1 PPB
319.7	GC Confirmation	EPA Method 602	< 0.5 & < 1.5 PPB
	Longitudinal Blank	EPA Method 602 M	< 1 PPB

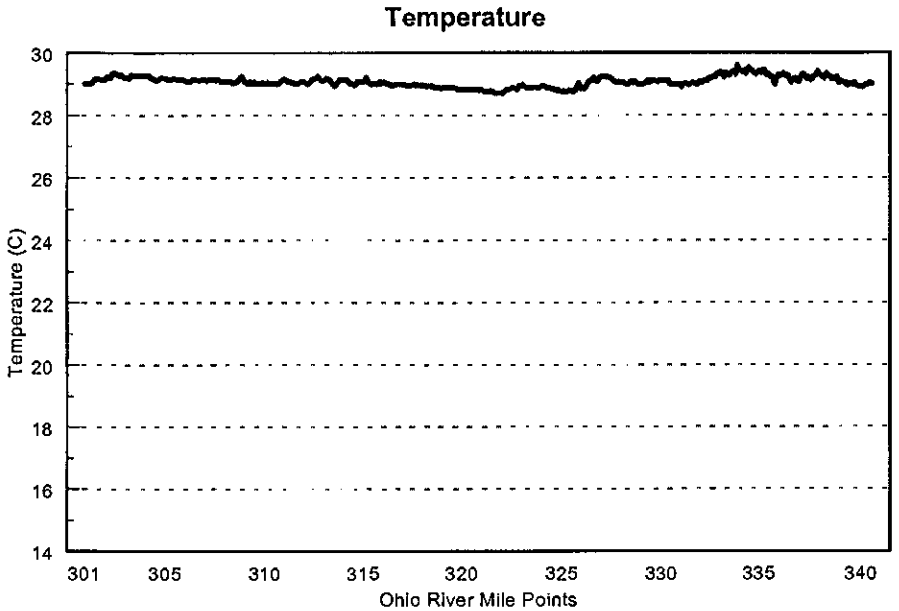
*Methods - EPA Method 602 Modified = Benzene, Toluene, Ethylbenzene, & Xylene
Detection Level = 1 PPB
- EPA Method 602 = Benzene, Toluene, & Ethylbenzene - Detection Level = 0.5 PPB
Xylene - Detection Level = 1.5 PPB

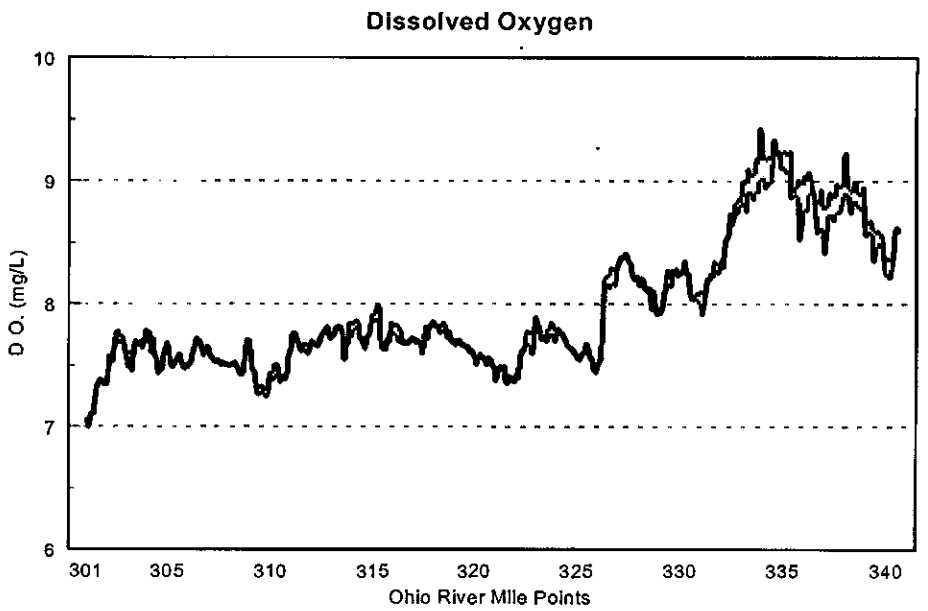
APPENDIX 5

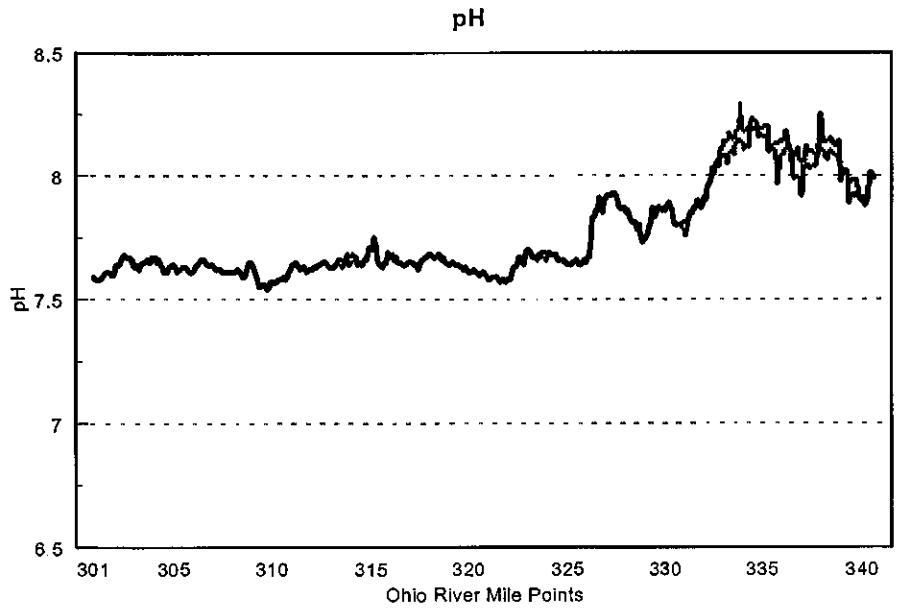
Physical Parameters - Longitudinal

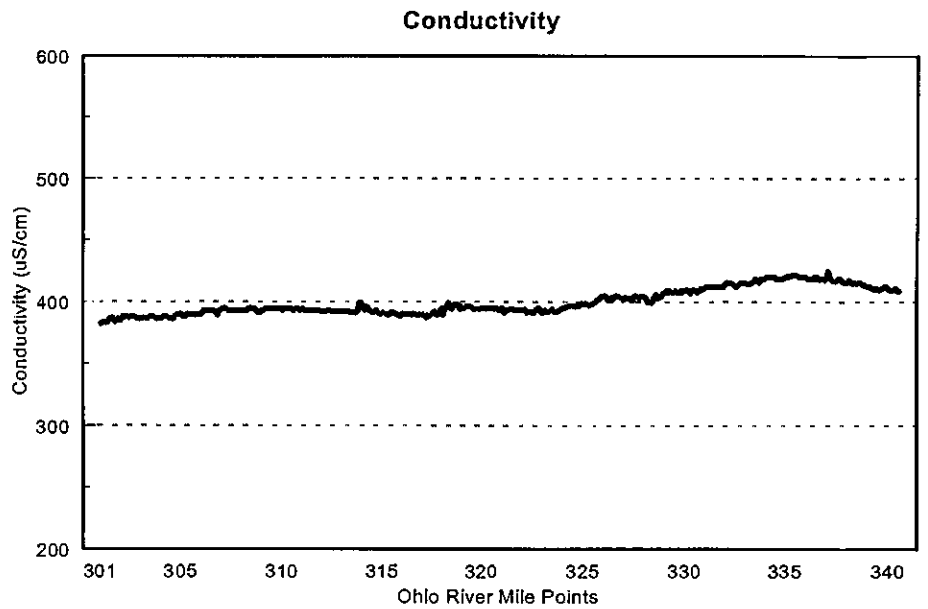
LONGITUDINAL SURVEY

Survey #1 - 7/21/94 - Wet Weather Event



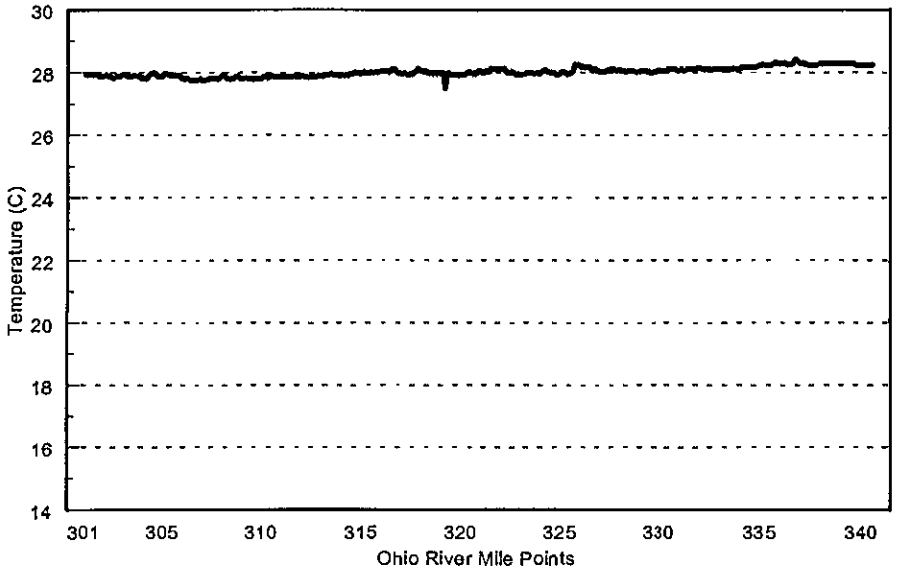




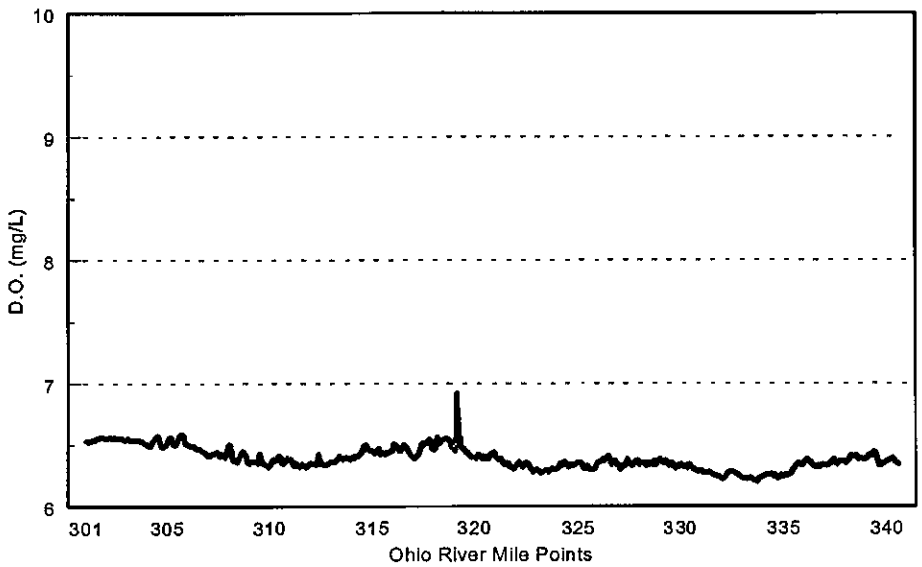


LONGITUDINAL SURVEY
SURVEY #2 - 7/28/94 - Wet Weather Event

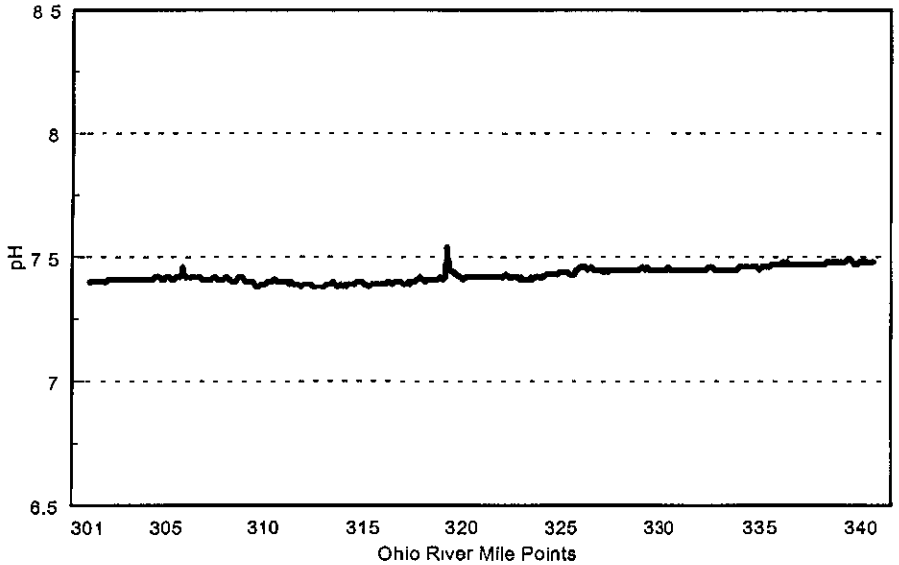
Temperature



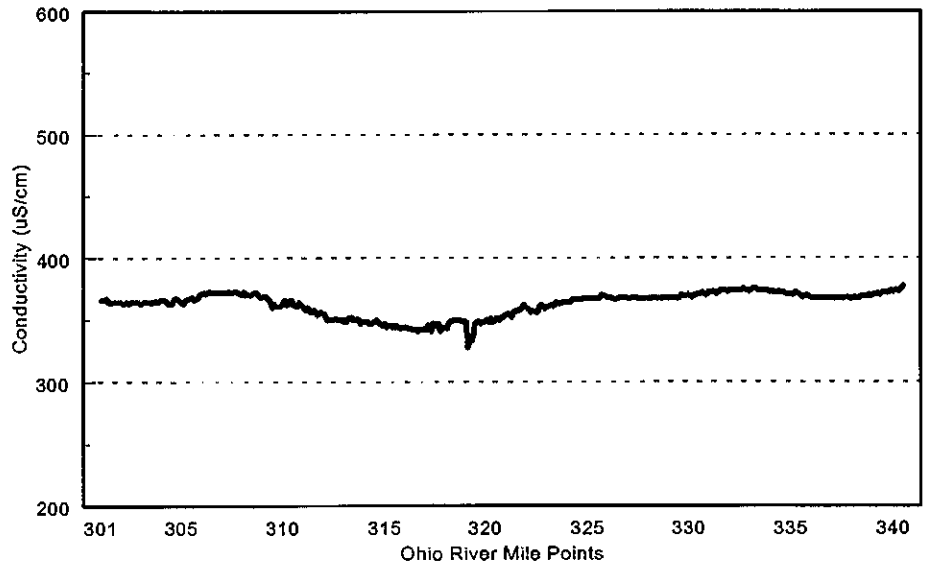
Dissolved Oxygen



pH

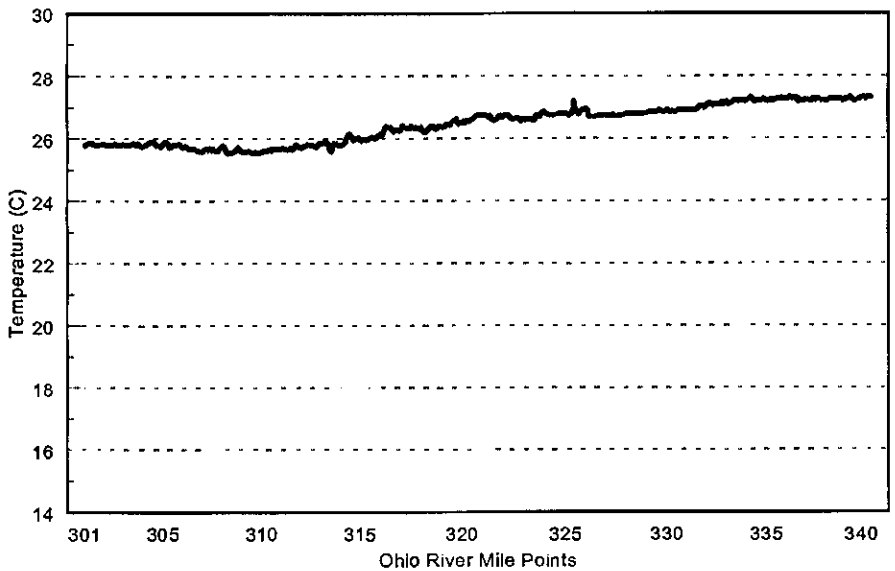


Conductivity

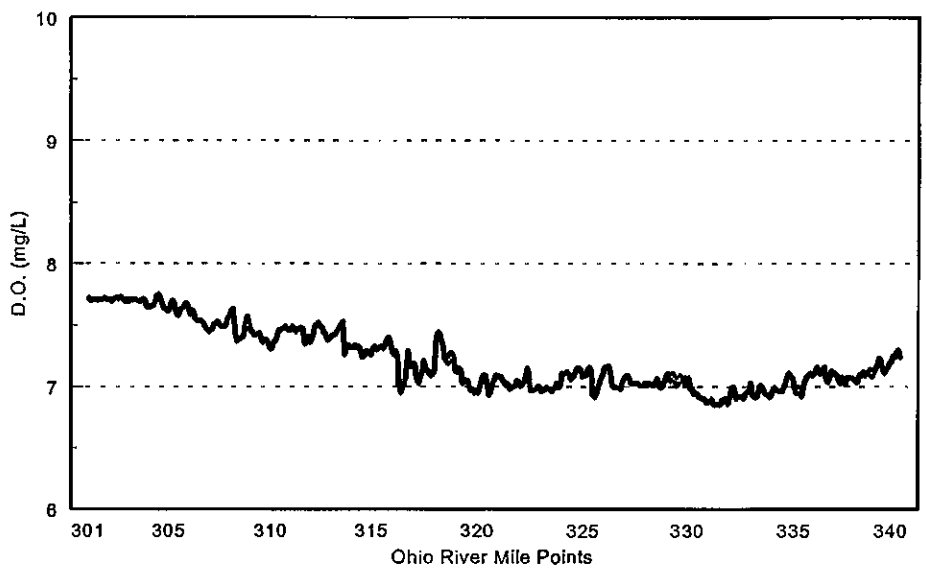


LONGITUDINAL SURVEY
SURVEY #3 - 8/04/94 - Wet Weather Event

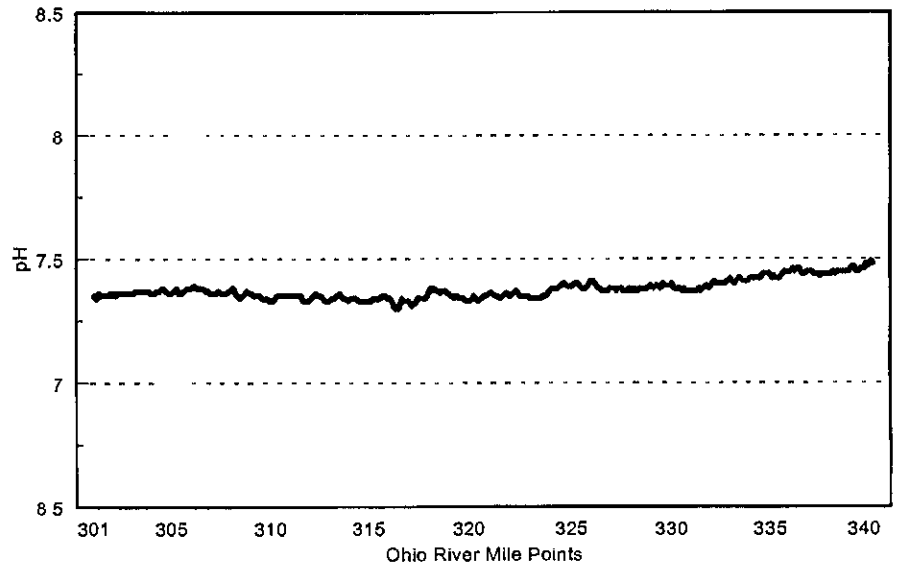
Temperature



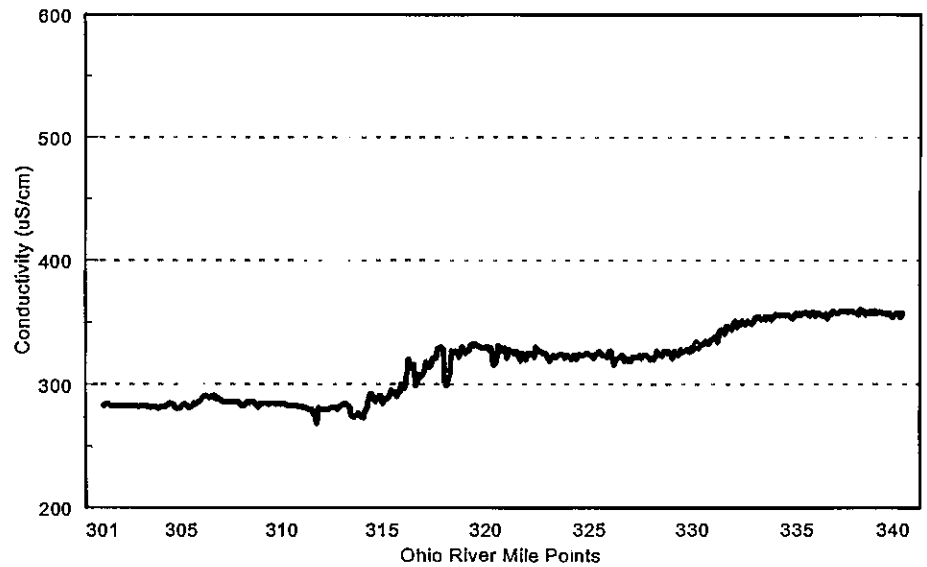
Dissolved Oxygen



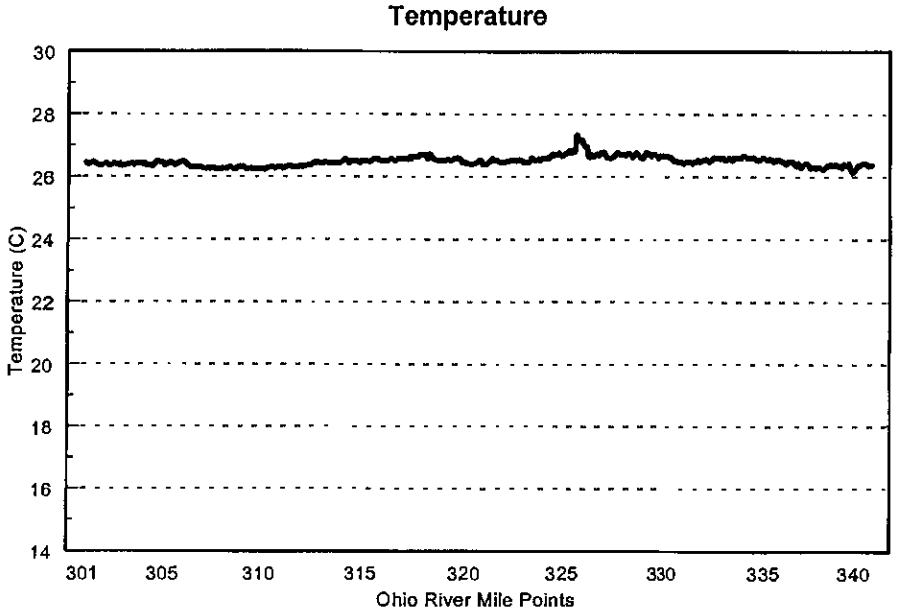
pH

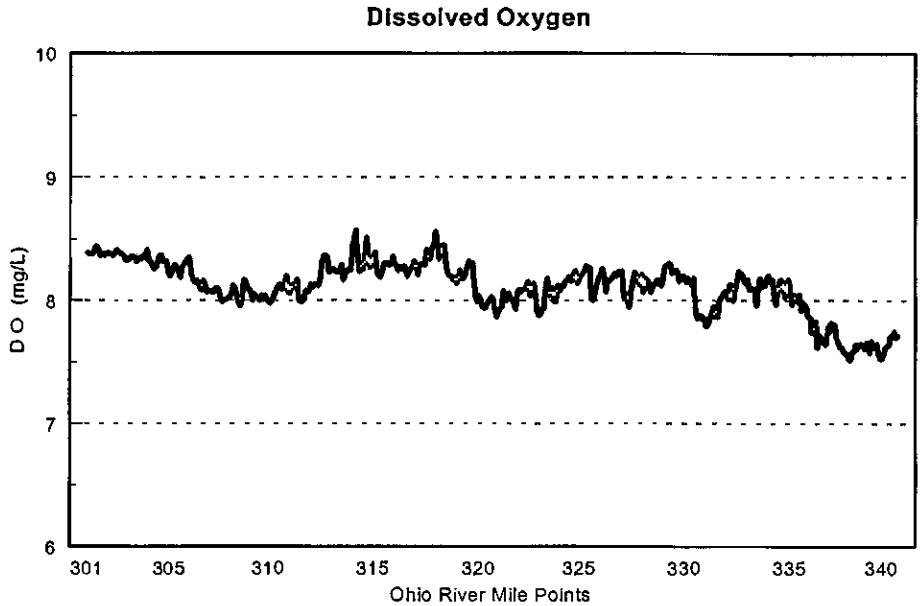


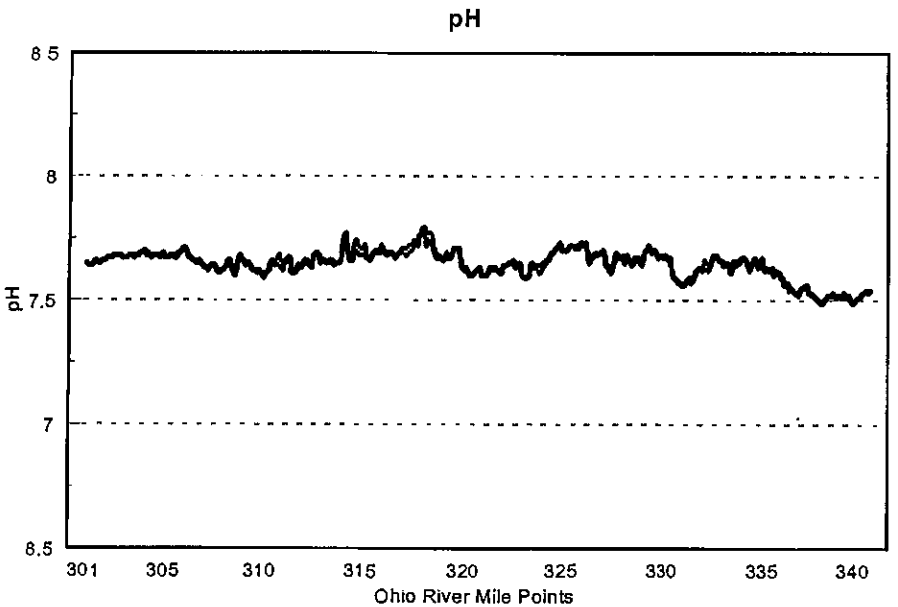
Conductivity

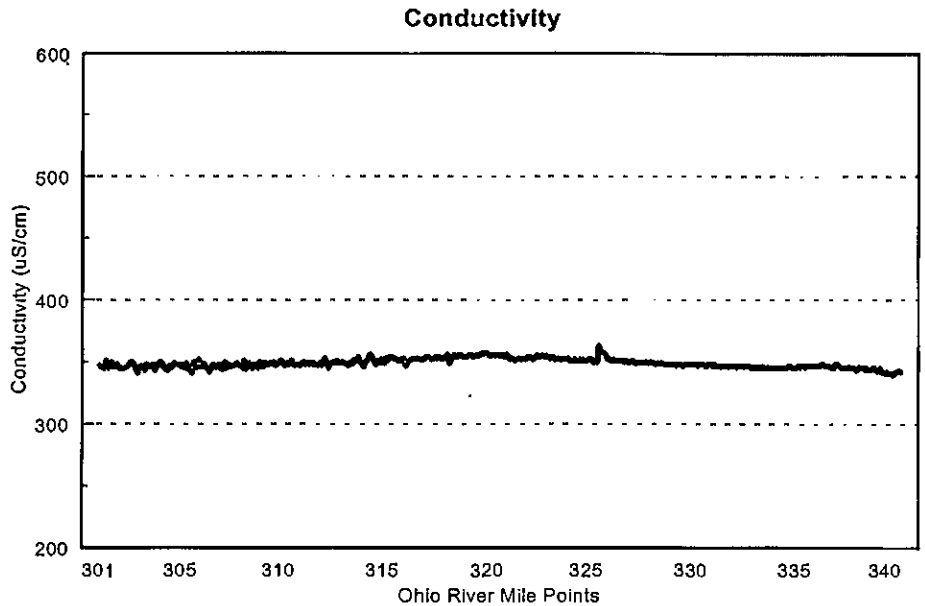


LONGITUDINAL SURVEY
SURVEY #4 - 8/11/94 - Dry Weather Event

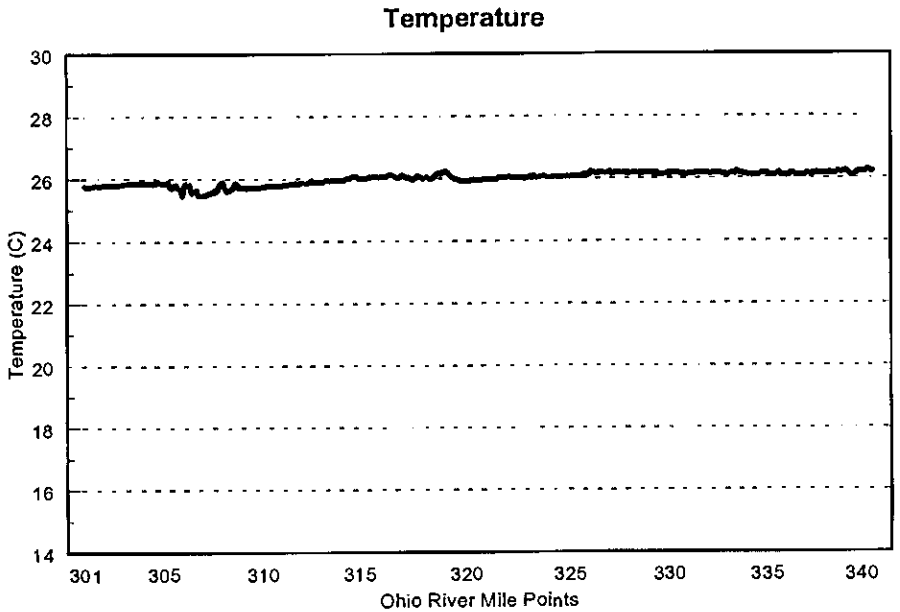


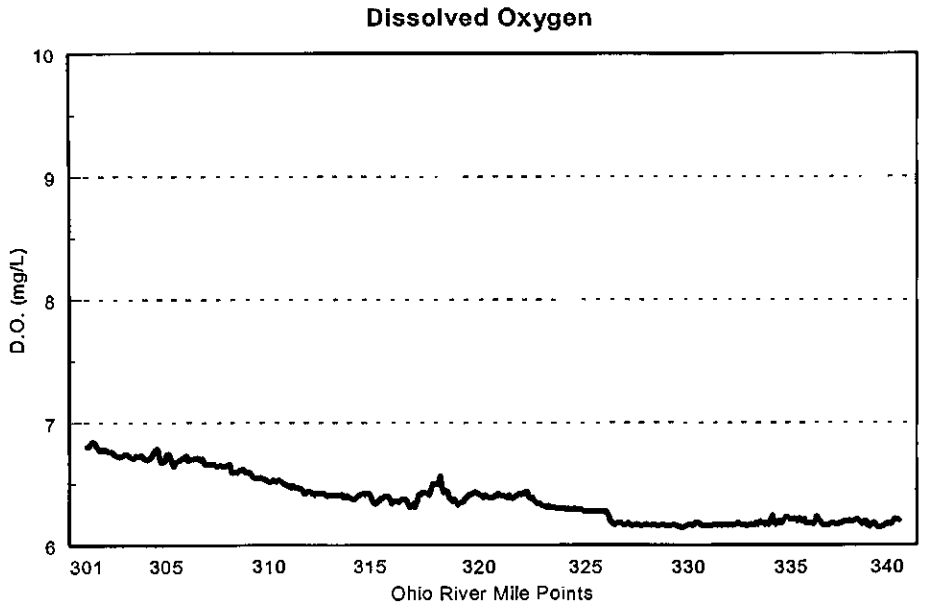


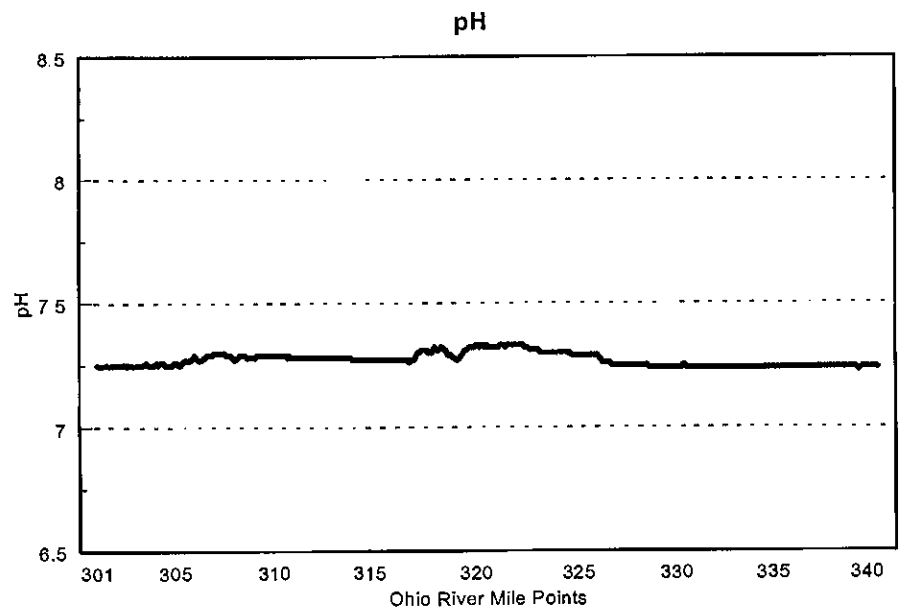


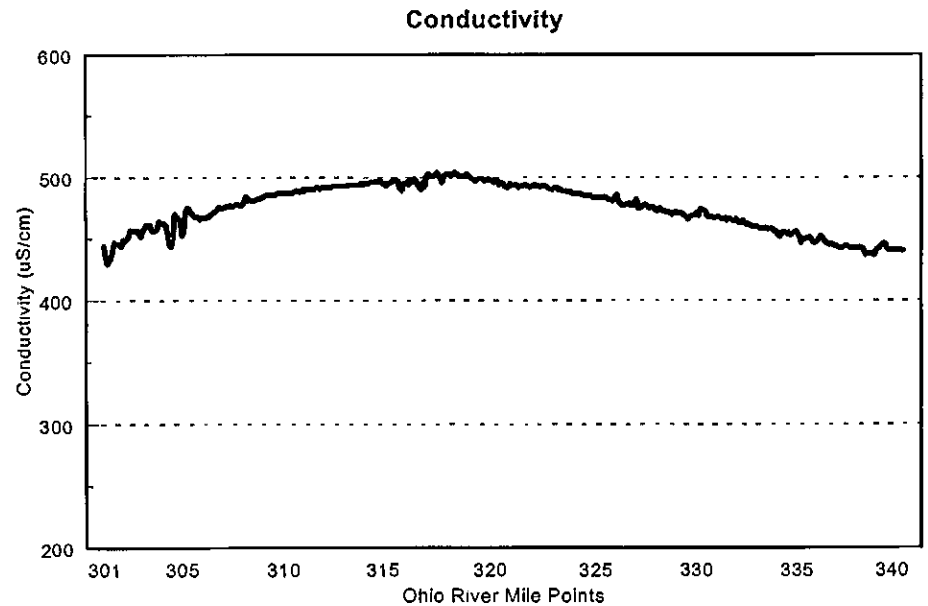


LONGITUDINAL SURVEY
SURVEY #5 - 8/18/94 - Dry Weather Event

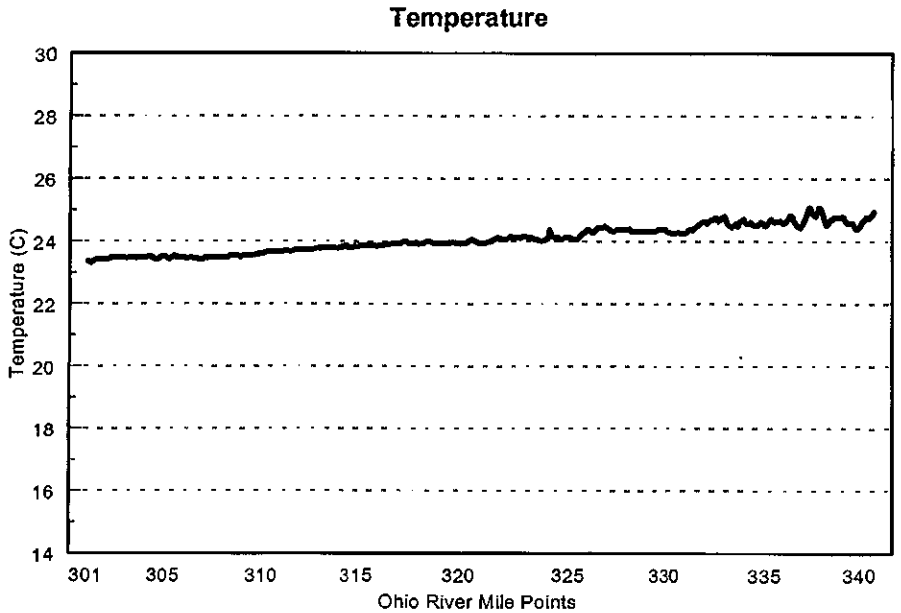


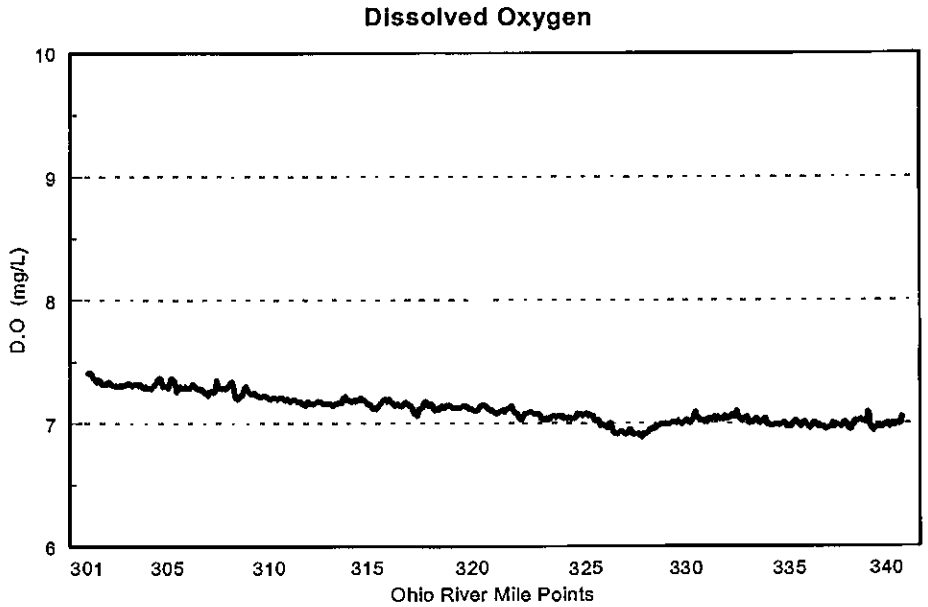


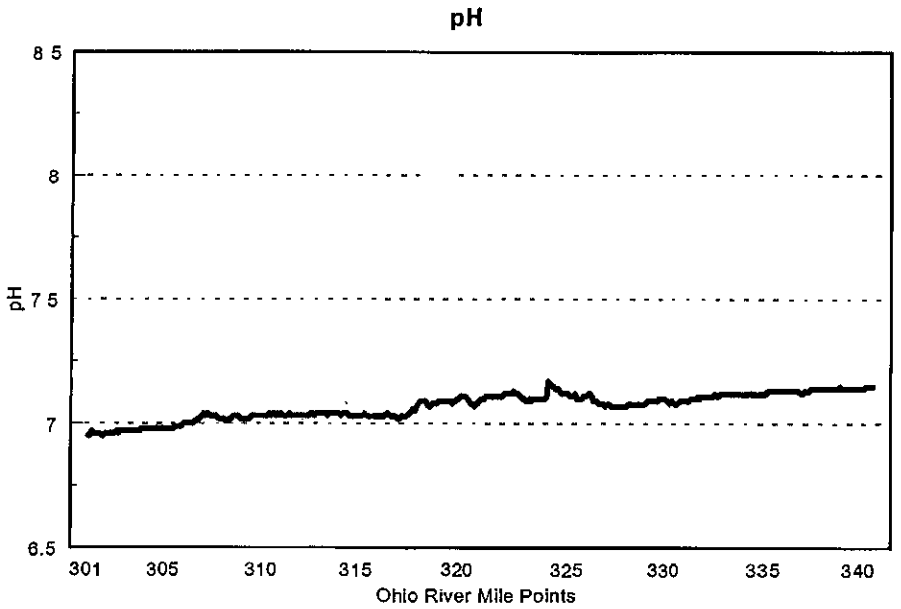


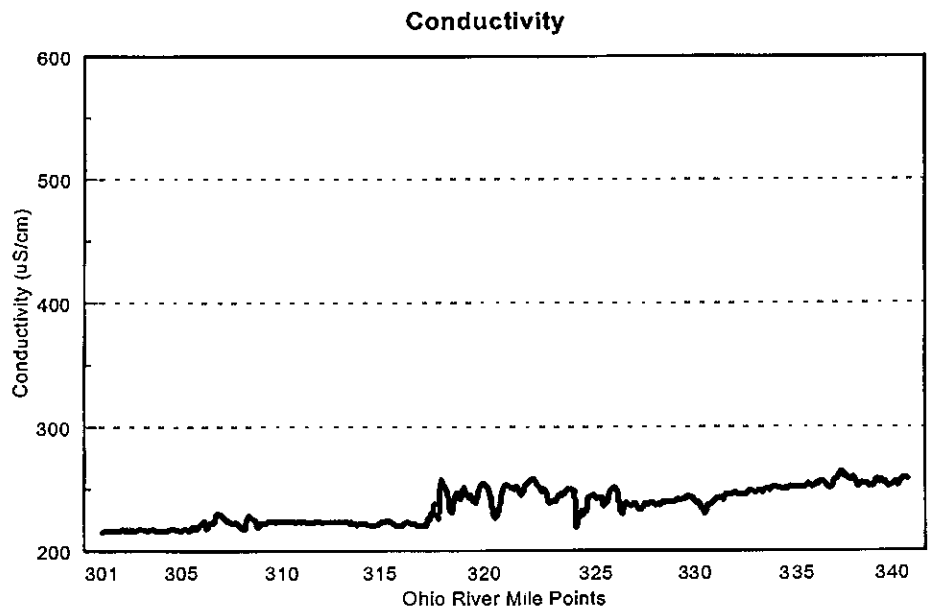


LONGITUDINAL SURVEY
SURVEY #6 - 8/25/94 - Dry Weather Event

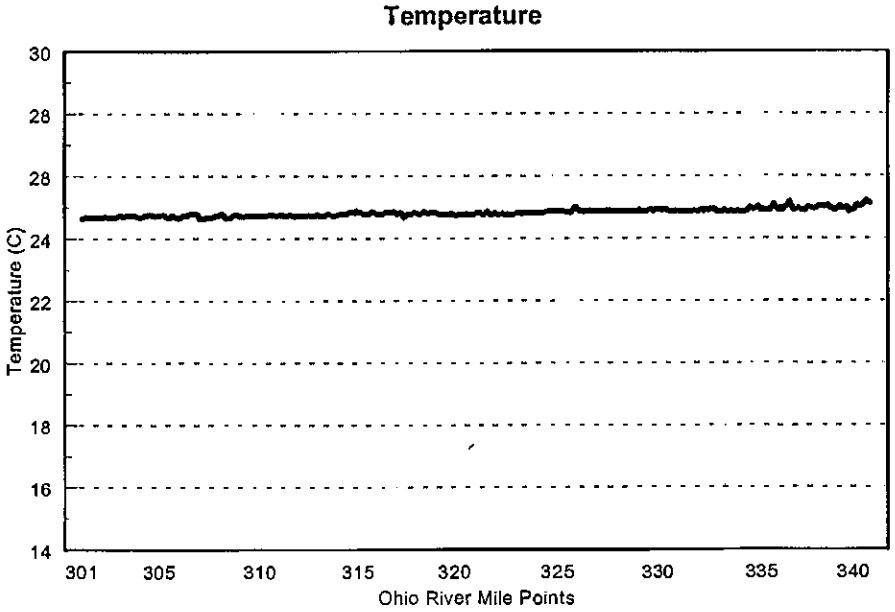


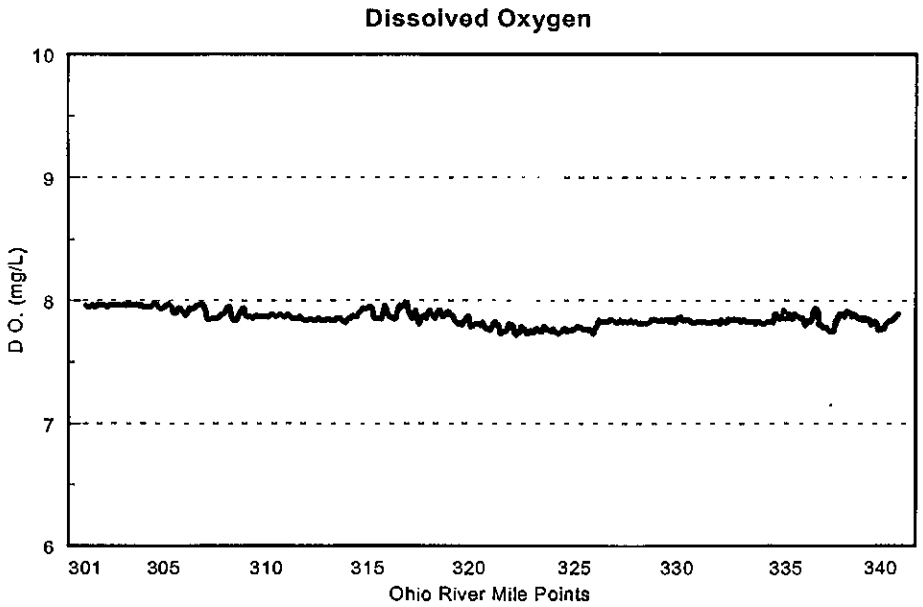


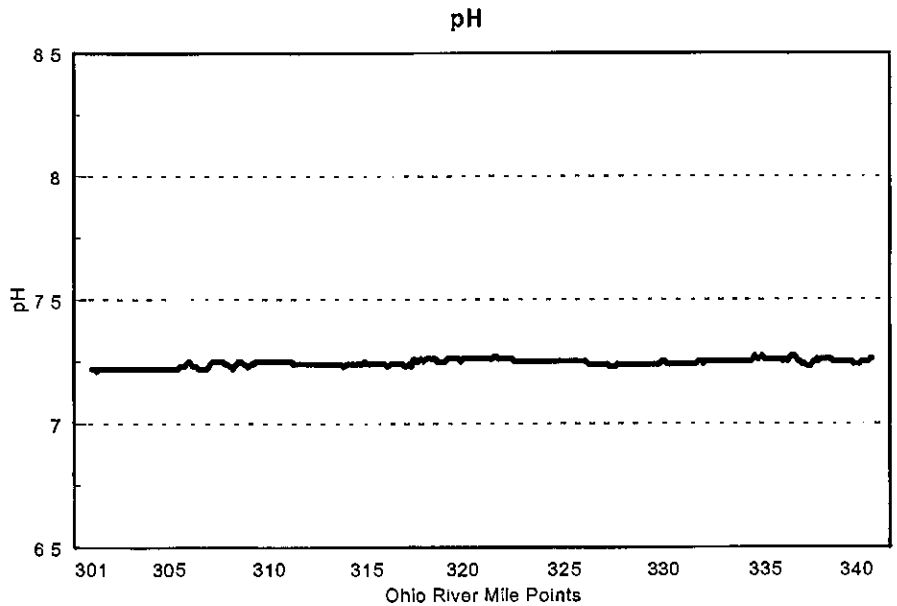


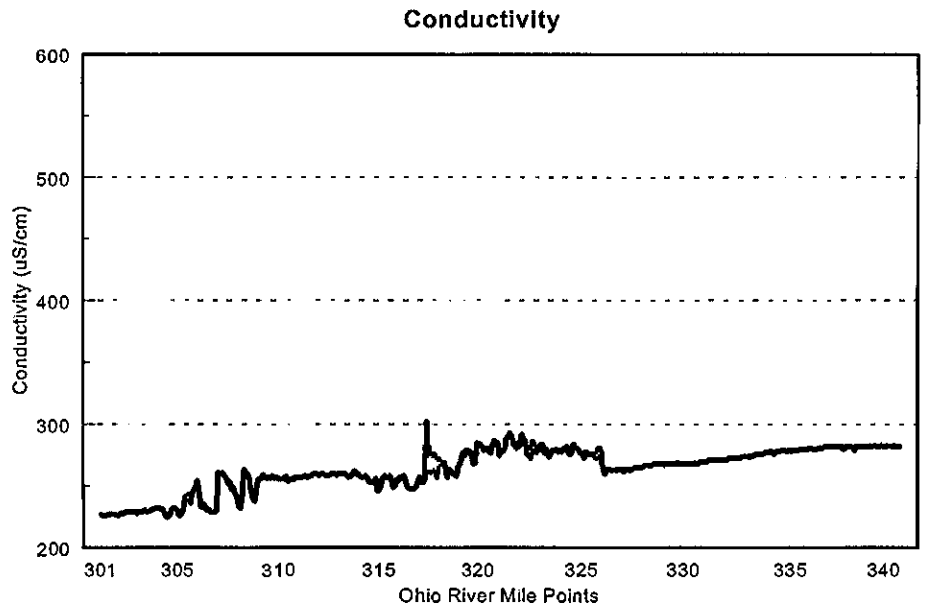


LONGITUDINAL SURVEY
SURVEY #7 - 8/30/94 - Dry Weather Event

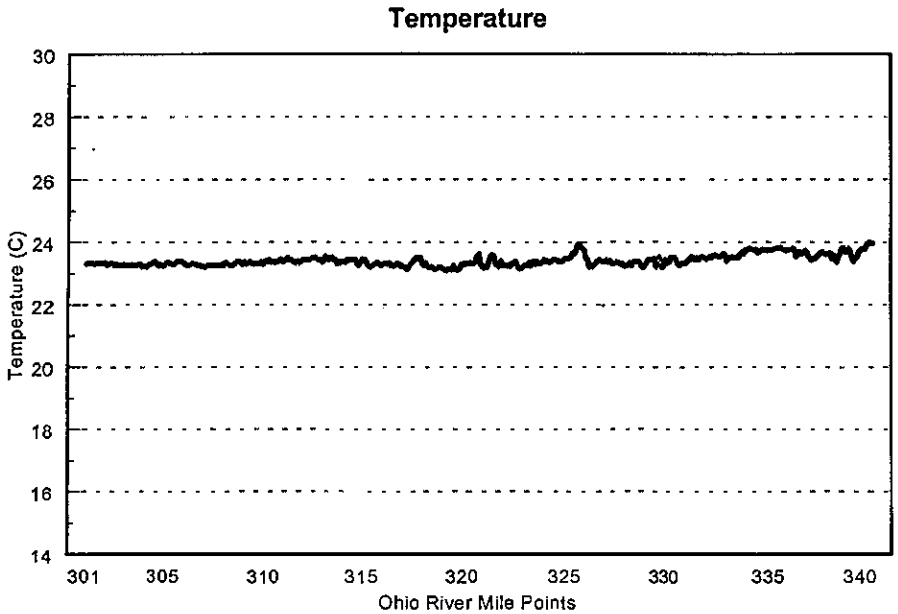


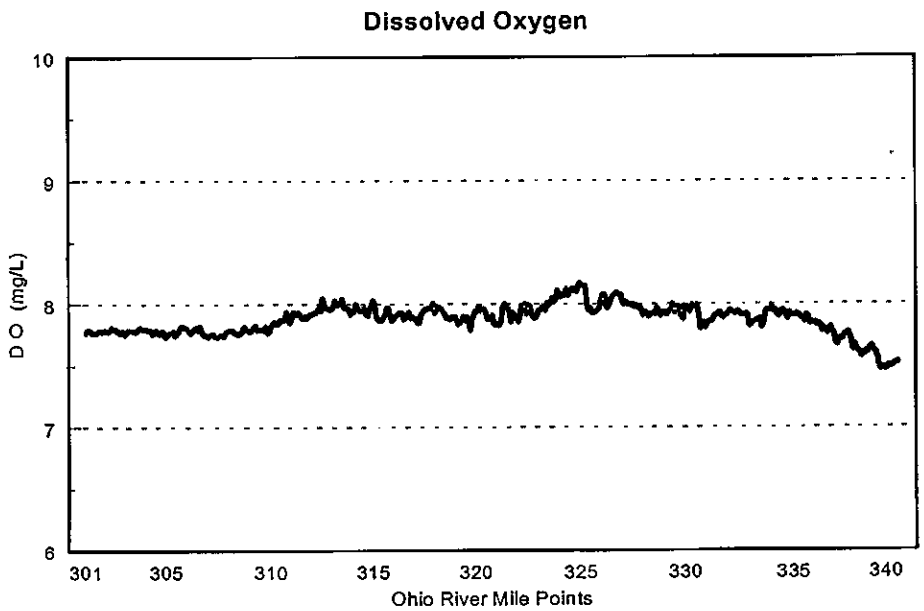


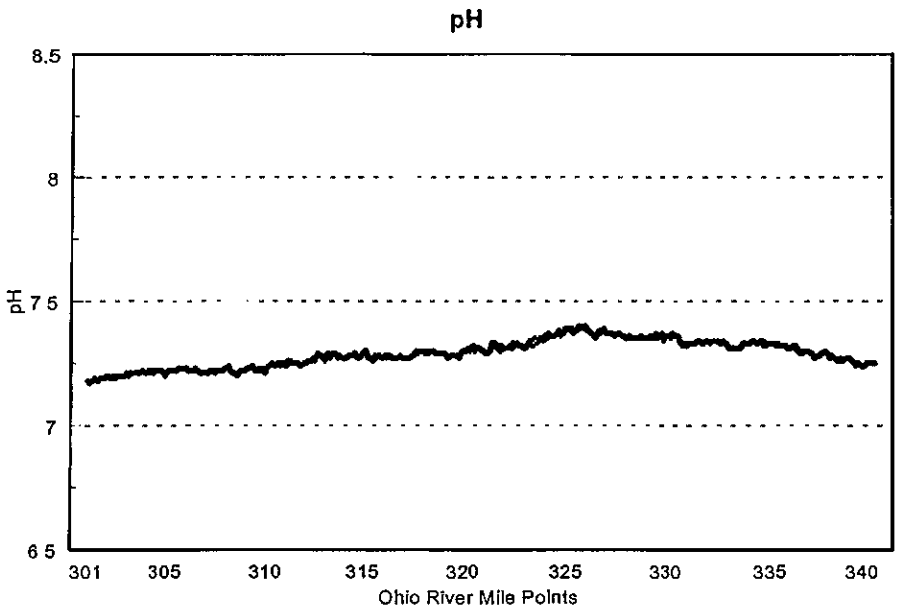


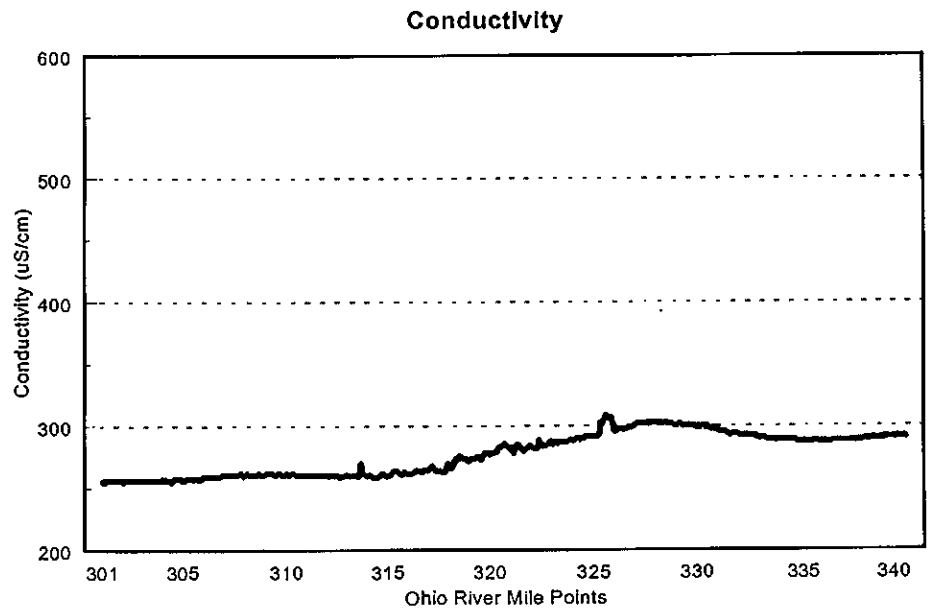


LONGITUDINAL SURVEY
SURVEY #8 - 9/08/94 - Dry Weather Event



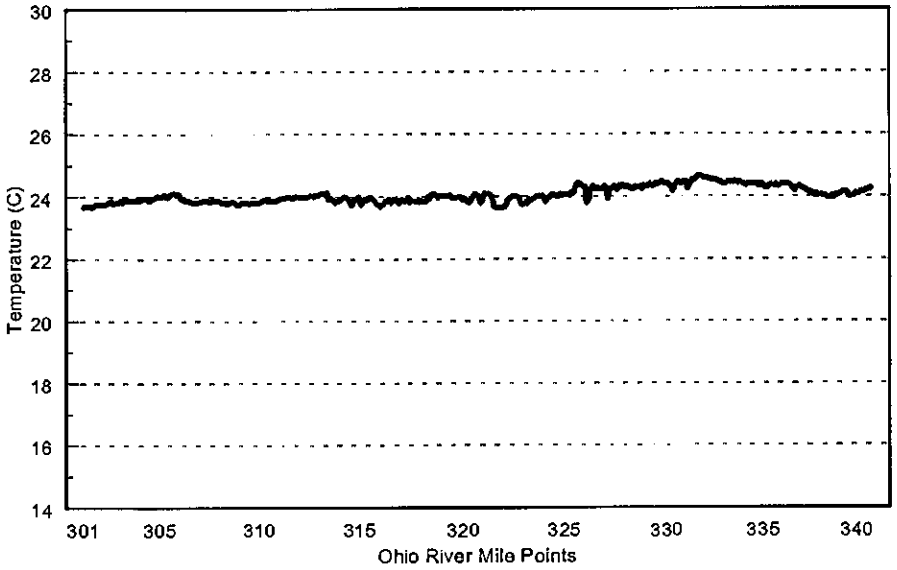




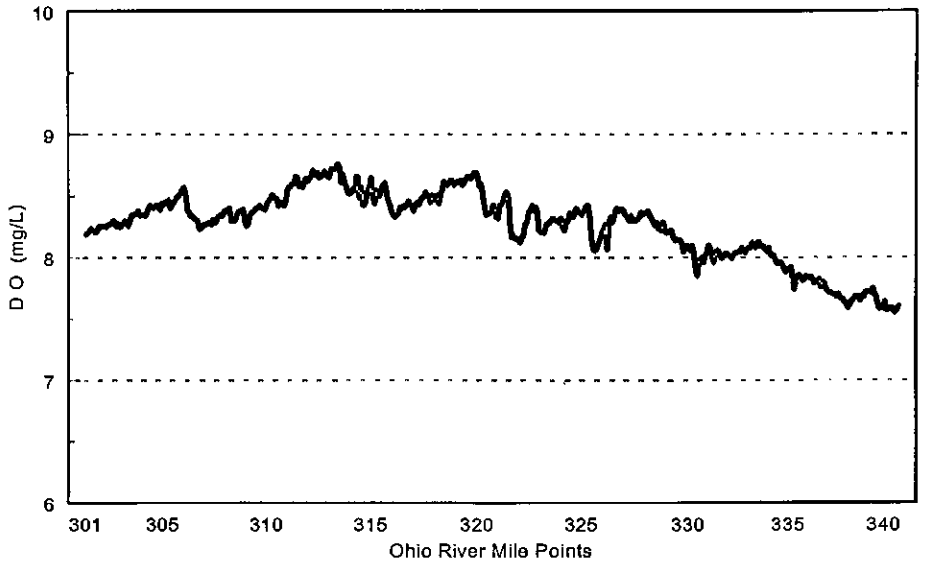


LONGITUDINAL SURVEY
SURVEY #9 - 9/15/94 - Dry Weather Event

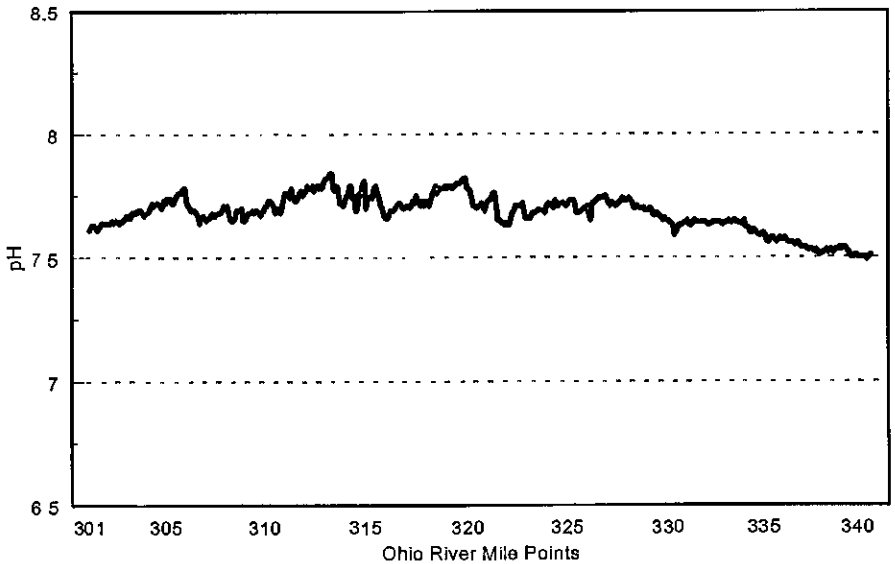
Temperature



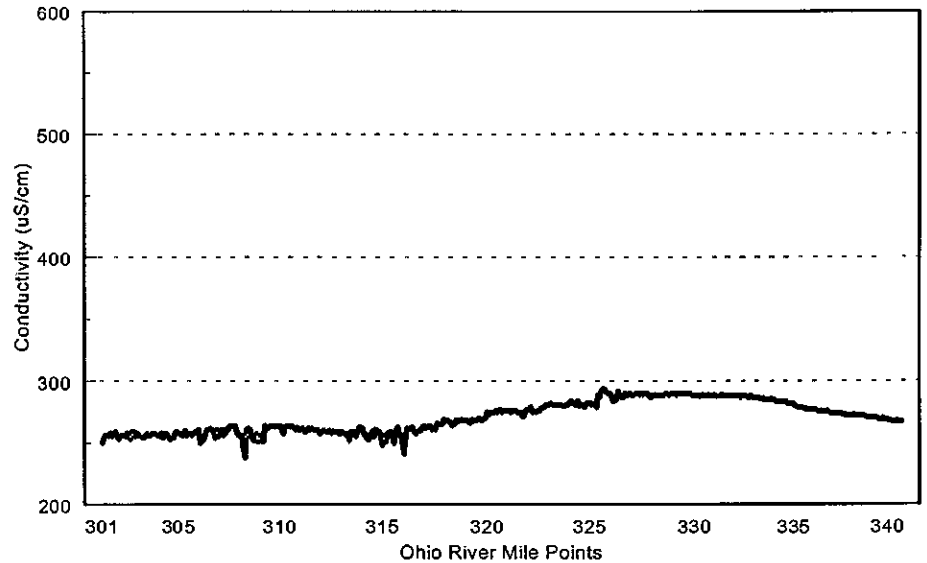
Dissolved Oxygen



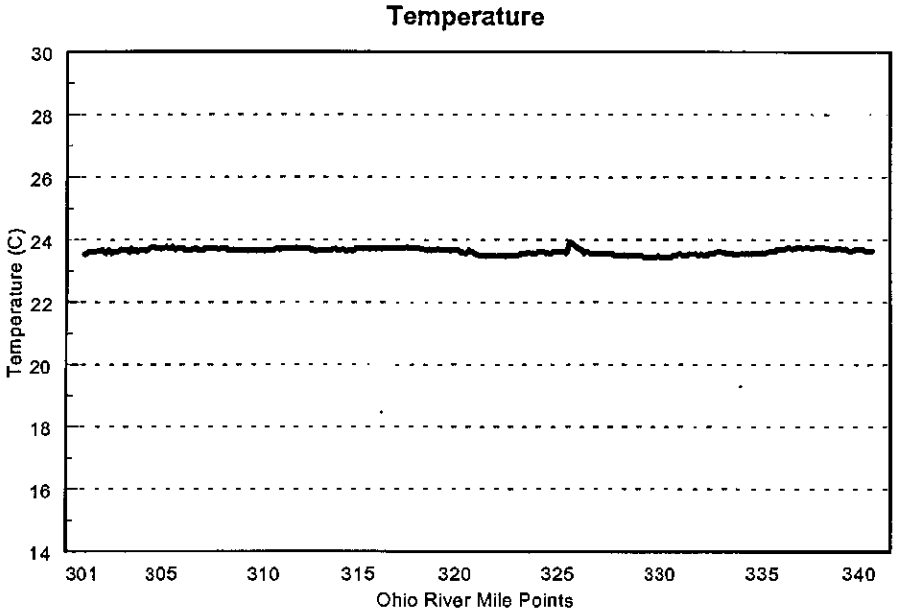
pH

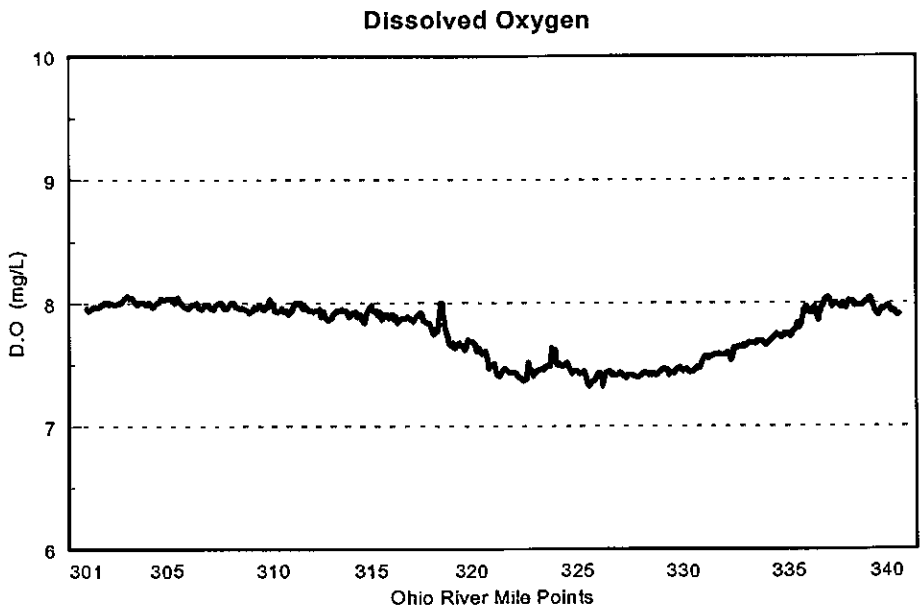


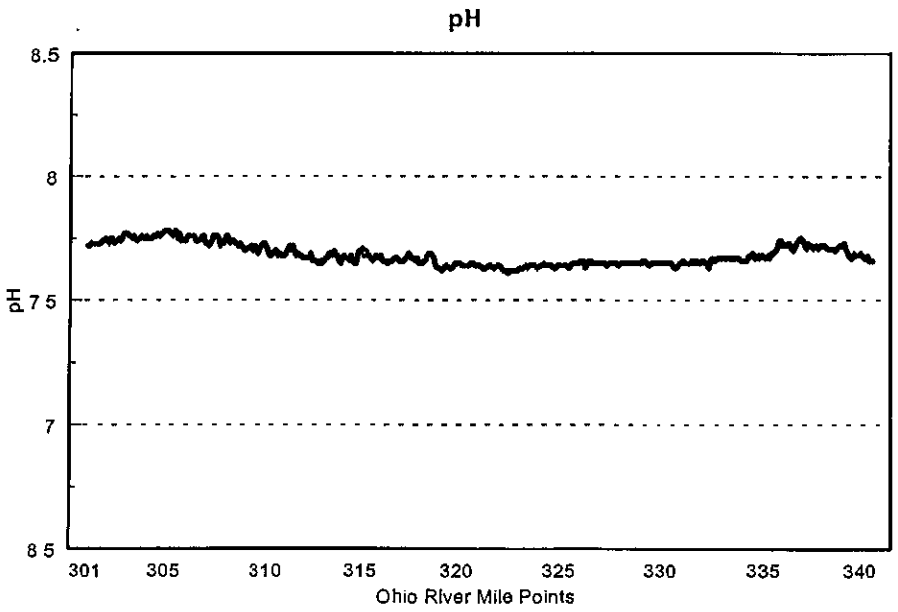
Conductivity

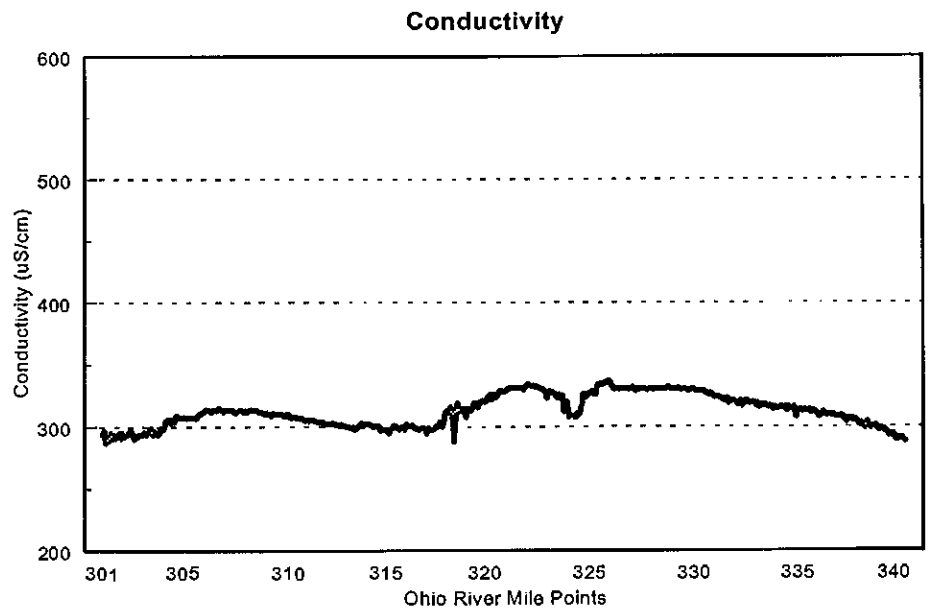


LONGITUDINAL SURVEY
SURVEY #10 - 9/22/94 - Dry Weather Event



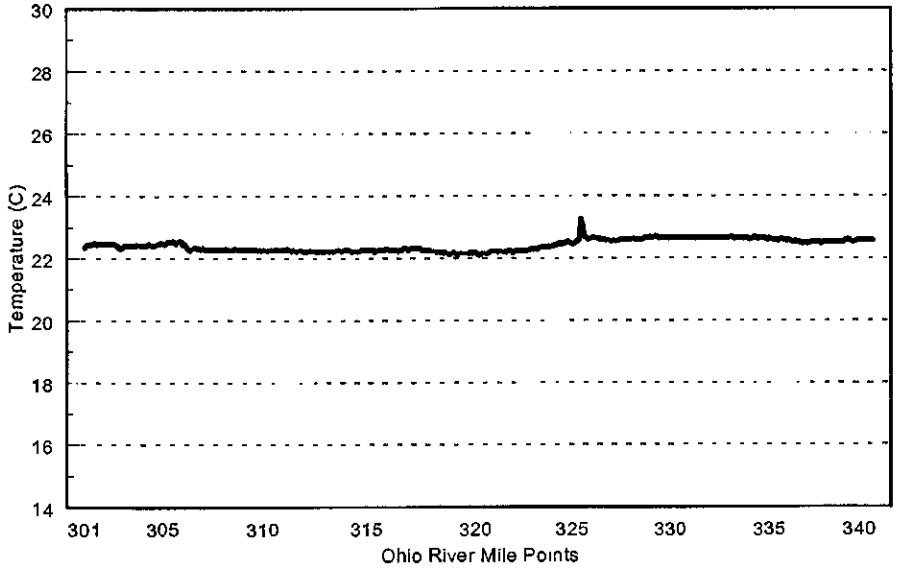




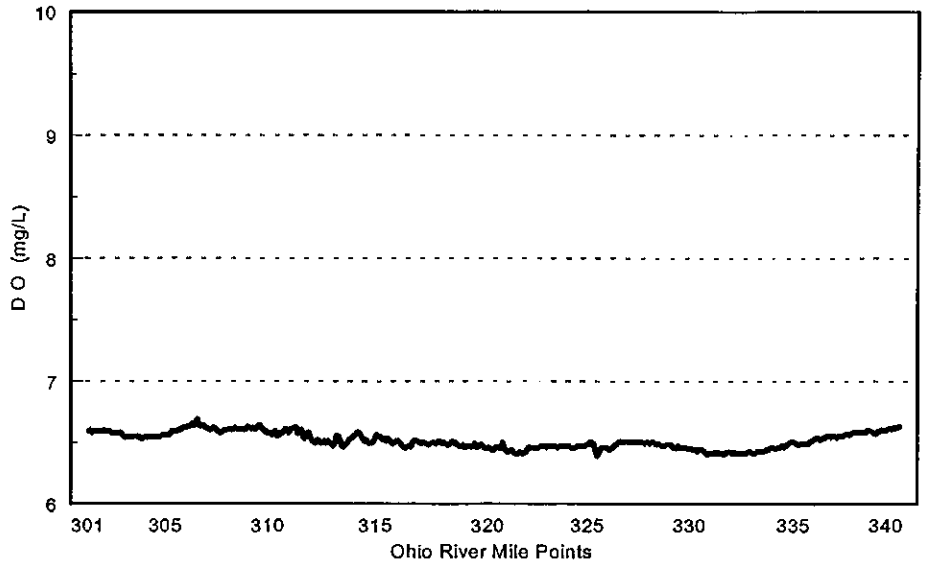


LONGITUDINAL SURVEY
SURVEY #11 - 9/28/94 - Dry Weather Event

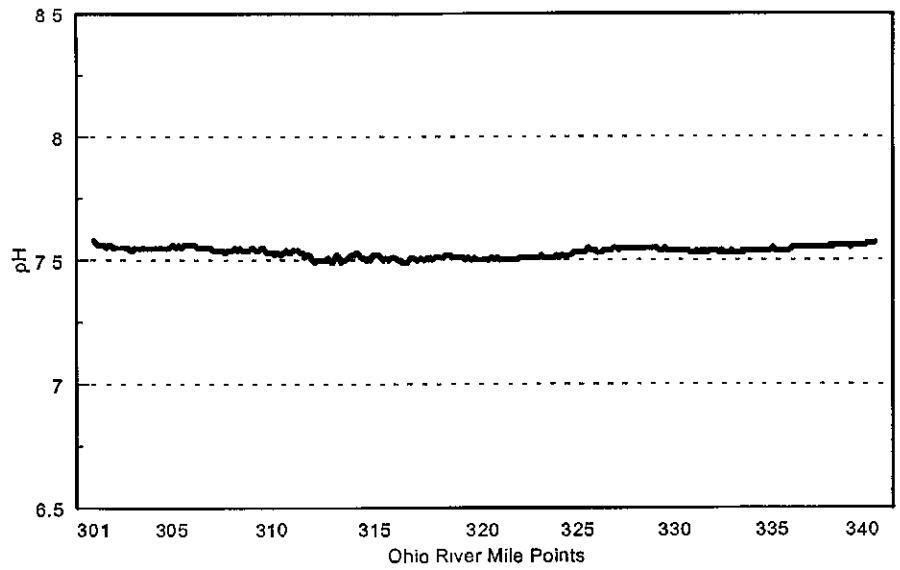
Temperature



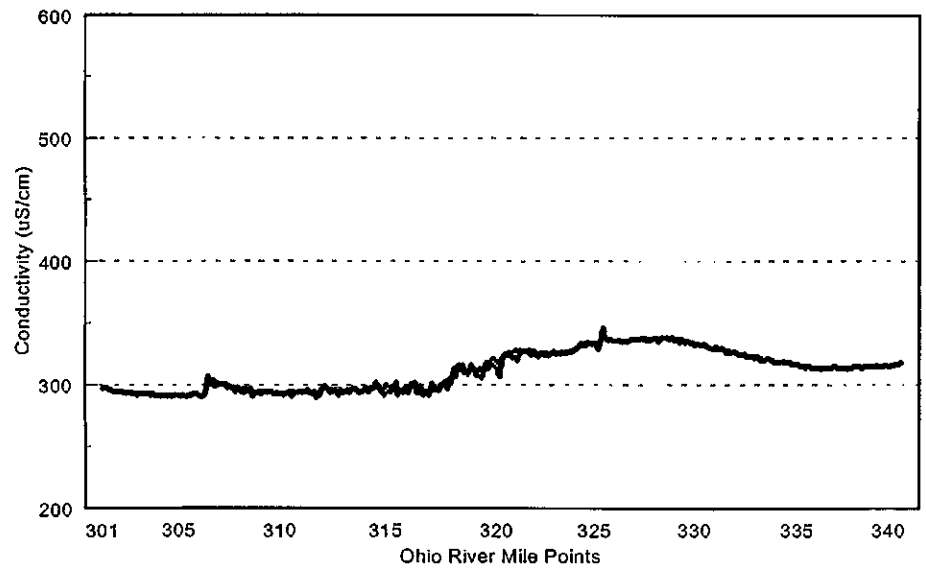
Dissolved Oxygen



pH

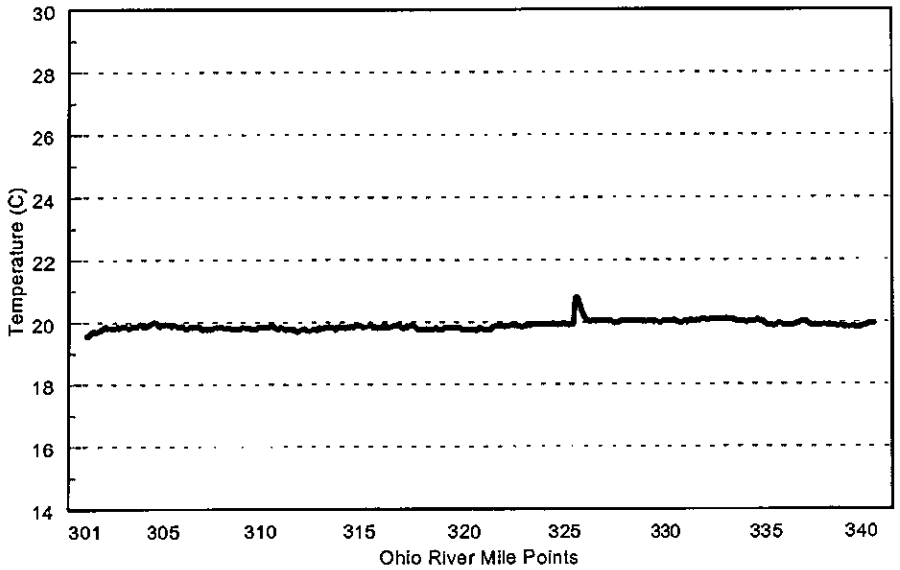


Conductivity

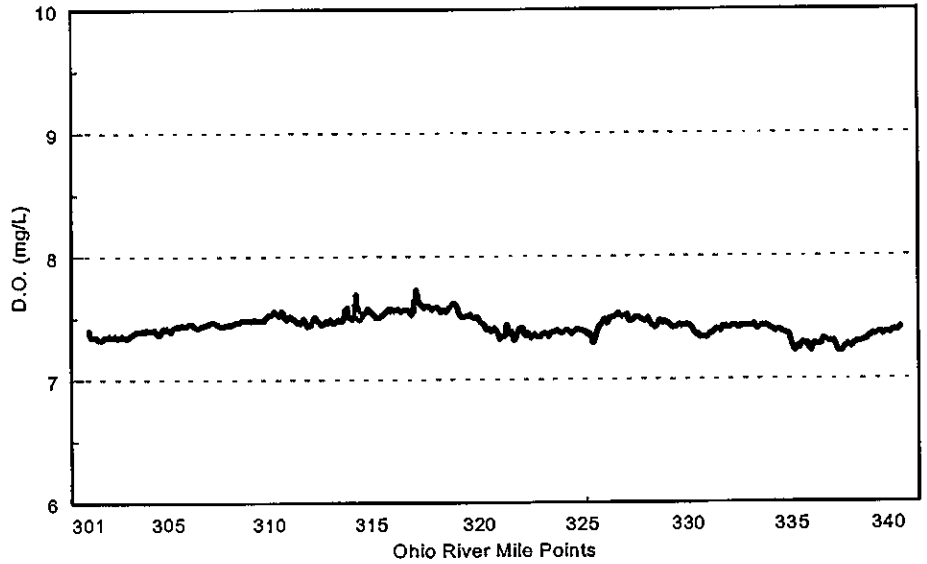


LONGITUDINAL SURVEY
SURVEY #12 - 10/10/94 - Wet Weather Event

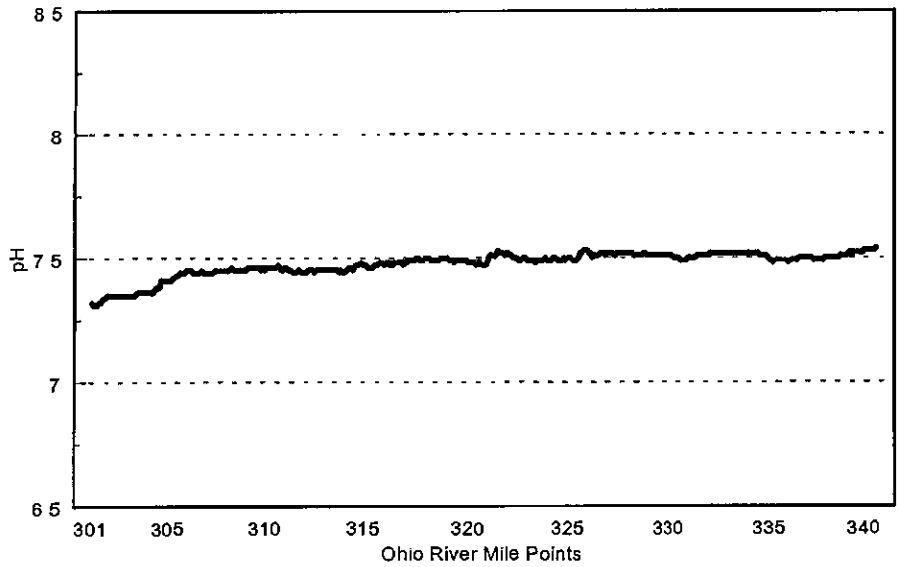
Temperature



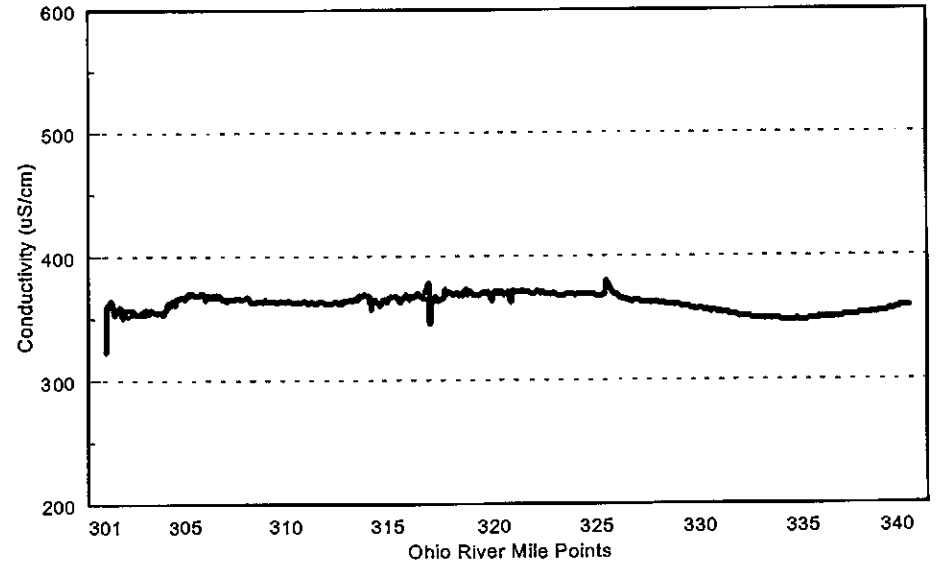
Dissolved Oxygen



pH

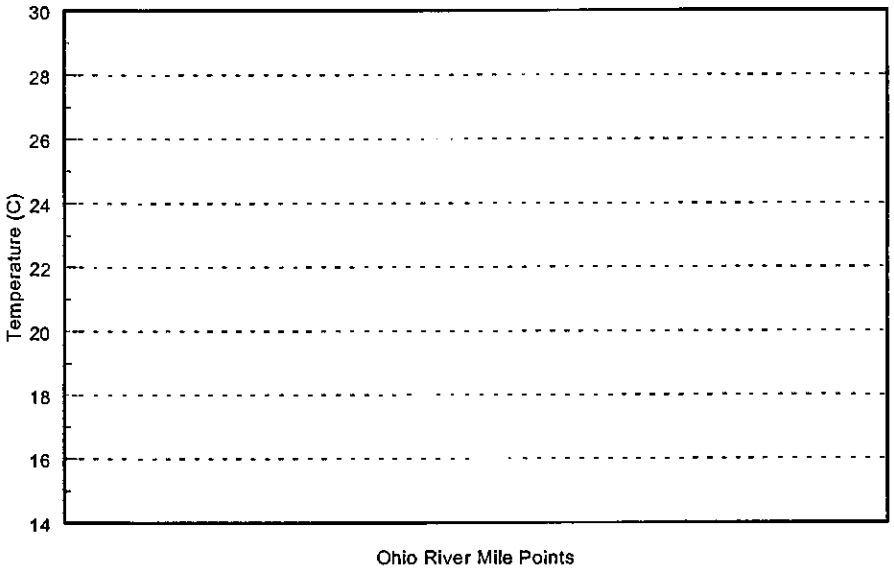


Conductivity

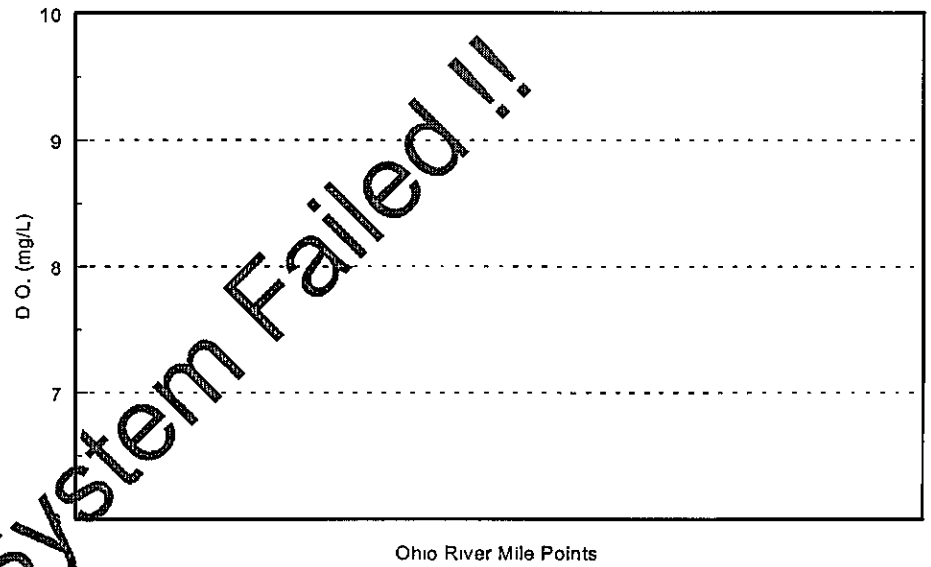


LONGITUDINAL SURVEY
SURVEY #13 - 10/19/94 - Wet Weather Event

Temperature

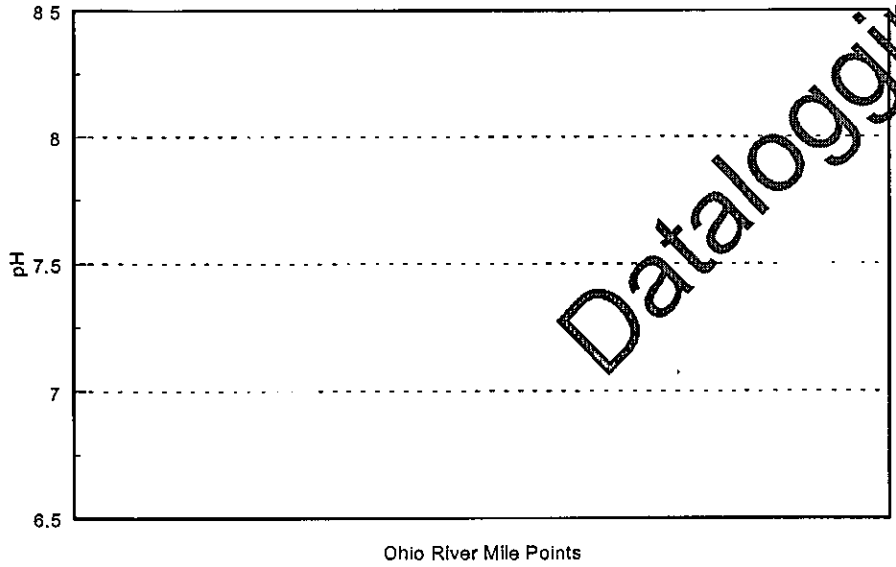


Dissolved Oxygen

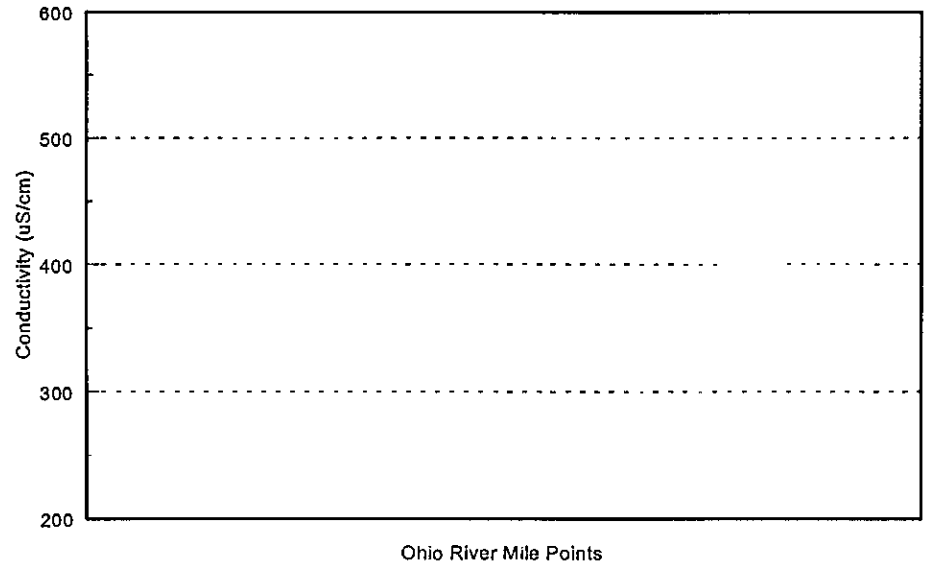


Datalogging System Failed !!

pH

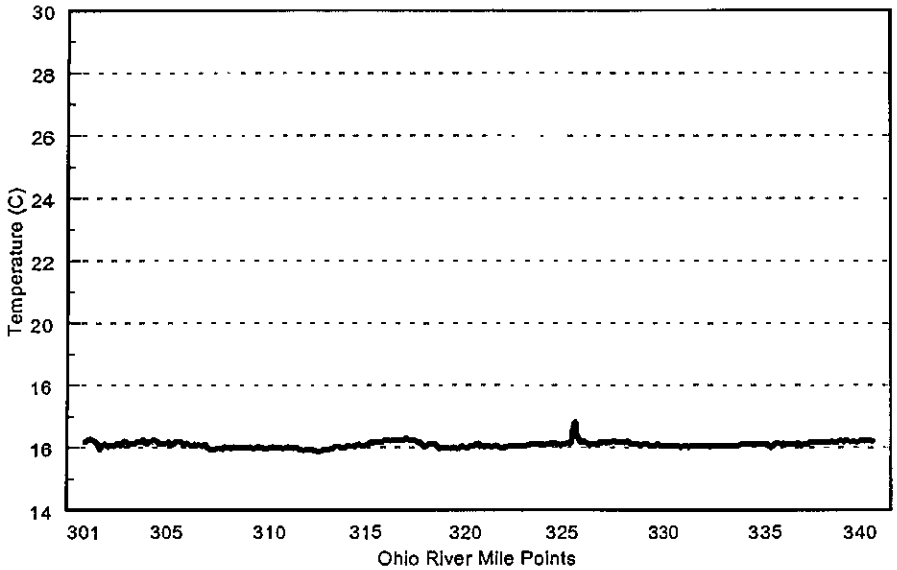


Conductivity

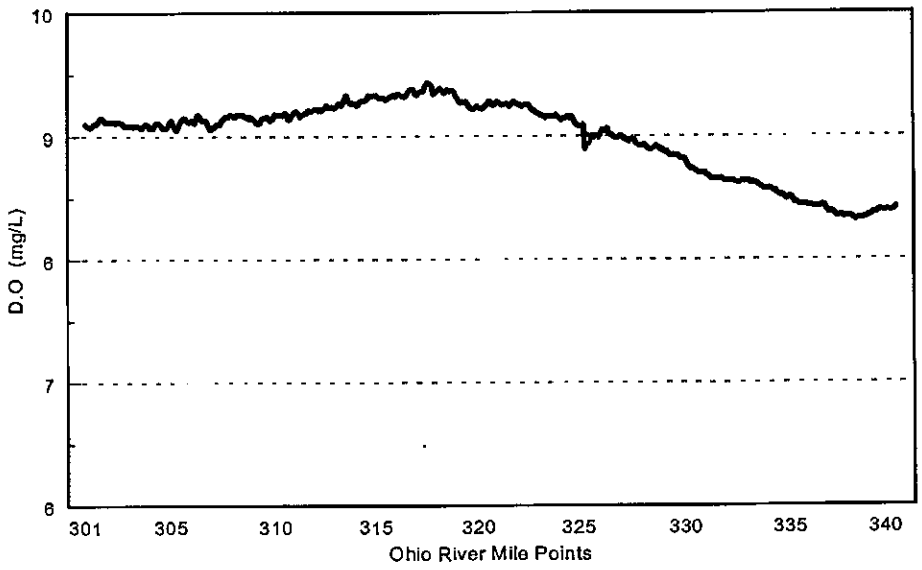


LONGITUDINAL SURVEY
SURVEY #14 - 11/01/94 - Wet Weather Event

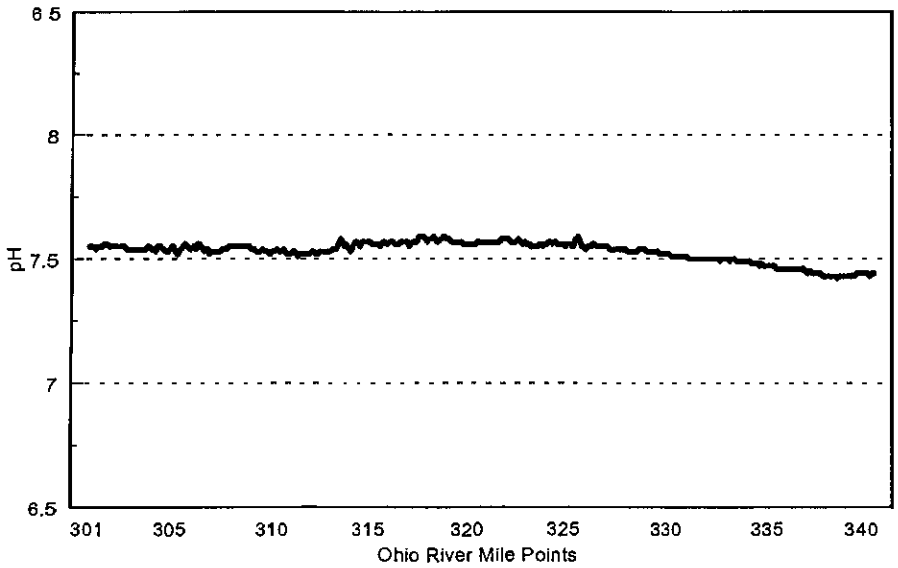
Temperature



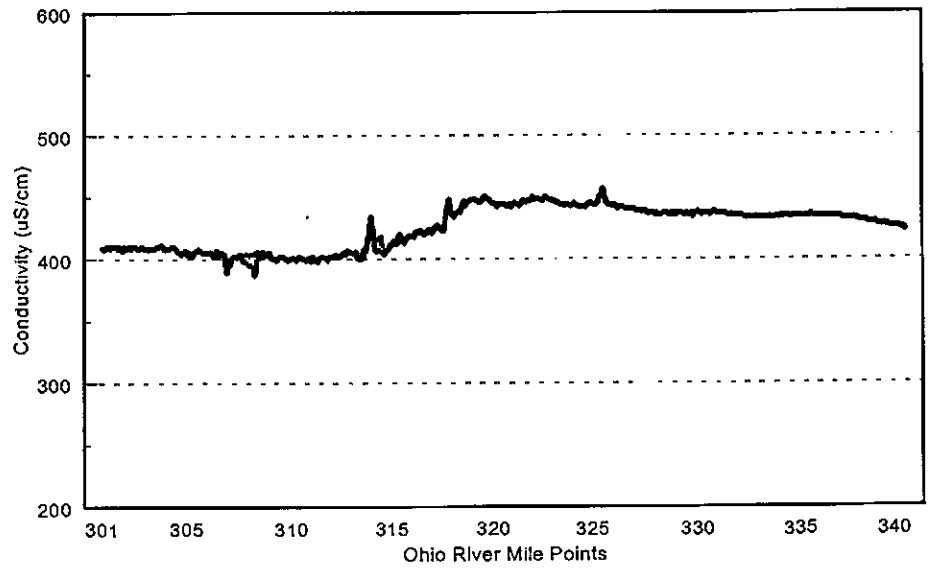
Dissolved Oxygen



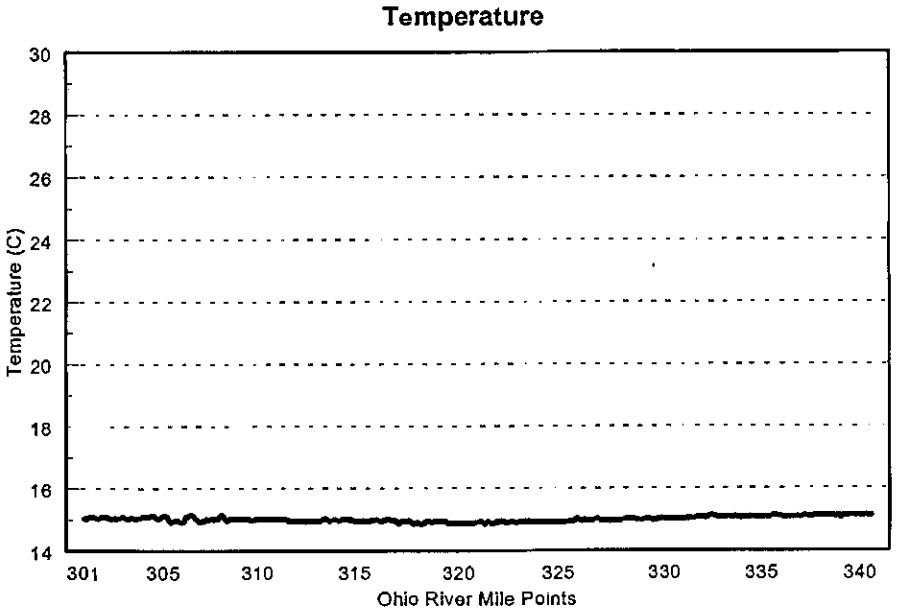
pH

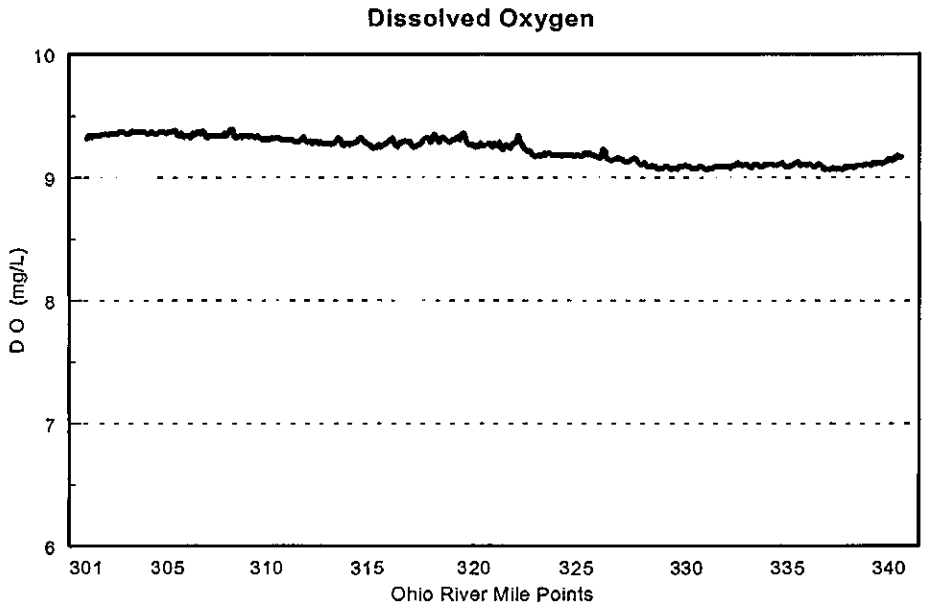


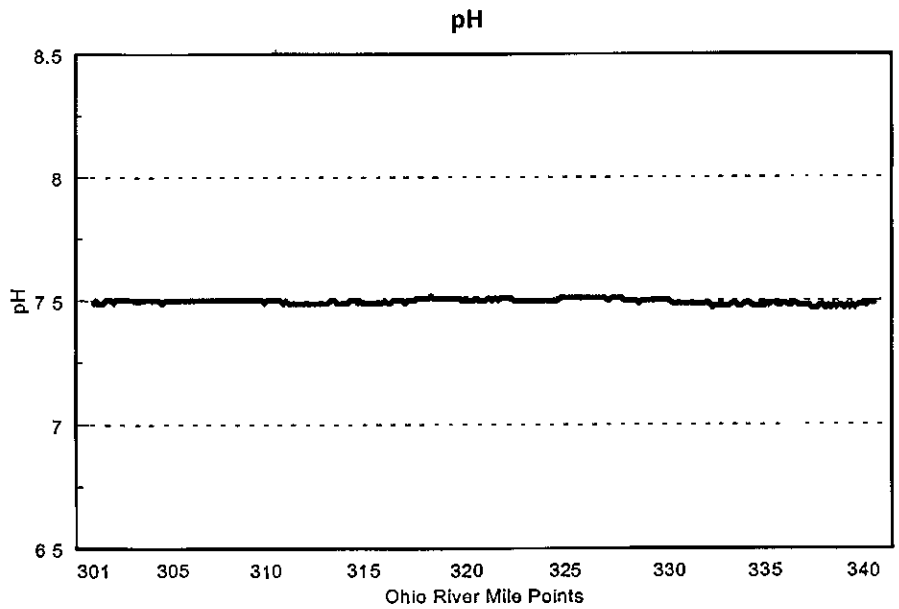
Conductivity

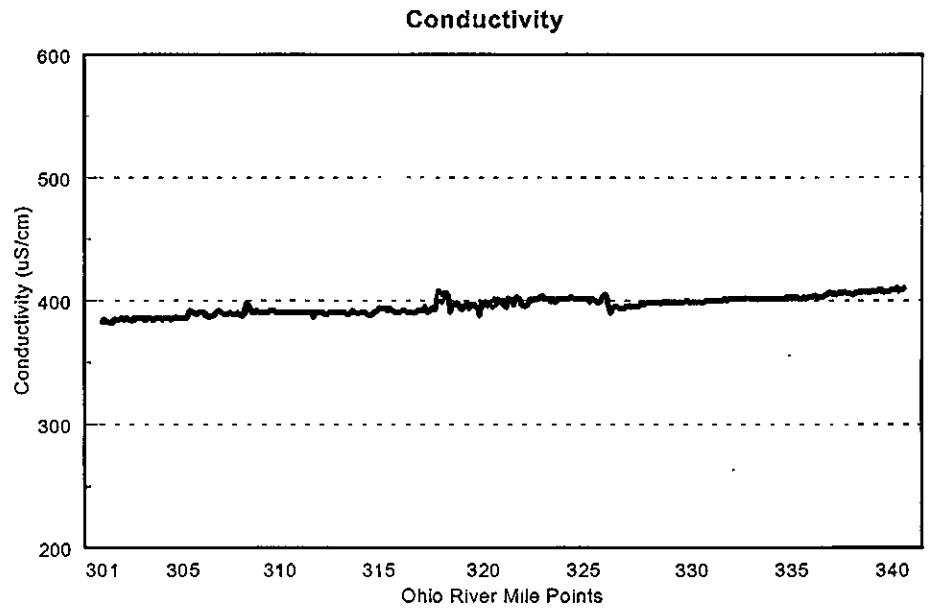


LONGITUDINAL SURVEY
SURVEY #15 - 11/10/94 - Wet Weather Event









APPENDIX 6

Physical Parameters - Cross-Sections

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #1 - 7/21/94 - Wet Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	29.75	7.68	7.92	396		16:00
		Left Quarter	29.15	7.56	7.23	395		16:01
		Midstream	29.20	7.56	7.20	394		16:03
		Right Quarter	29.43	7.65	7.70	396		16:05
		Right	29.30	7.65	7.57	396		16:08
*305.2	Guyandotte River	Left	27.21	7.59	6.80	495		15:43
	@ 1st Bridge	Midstream	27.10	7.60	6.85	492		15:45
		Right	27.29	7.63	6.90	491		15:48
306.9	Huntington WTP	Left	29.09	7.60	7.24	400	P	15:28
	Intake #2	Left Quarter	29.03	7.56	7.30	401	r	15:30
		Midstream	29.15	7.60	7.43	401	o	15:32
		Right Quarter	29.29	7.63	7.60	397	b	15:35
		Right	29.56	7.71	7.89	398	e	15:37
310.8	West End Bridge	Left	29.40	7.67	7.83	398	M	15:09
		Left Quarter	29.22	7.68	7.72	399	a	15:11
		Midstream	29.20	7.67	7.65	399	l	15:14
		Right Quarter	29.69	7.71	7 80	396	f	15:16
		Right	29.30	7.75	8.80	395	u n	15:18
311.9	Fourpole Creek Confluence	Left	29.96	7.82	8.17	398	c	14:55
		Left Quarter	30.07	7.87	8.40	399	t	14:58
		Midstream	29.14	7.68	7.65	398	i	14:59
		Right Quarter	29.20	7.72	7.80	396	o	15:03
		Right	29.59	7.80	8.12	395	n	15:05
*317.2	Big Sandy River	Left	27.90	8.18	9.66	603		14:39
	@ 1st Bridge	Midstream	28.68	8.24	10.03	603		14:36
		Right	28.18	8.20	9.90	603		14:34
319.7	Ashland WTP Intake	Left	28.93	7.60	7.56	399		14:12
		Left Quarter	29.37	7.76	8.16	403		14:14
		Midstream	28.98	7.67	7.72	401		14:17
		Right Quarter	29.22	7.67	7.78	394		14:20
		Right	29.27	7.70	7.84	394		14:23
324.7	Submarine Crossing	Left	29.42	7.82	8.17	426		13:44
		Left Quarter	29.35	7.85	8.25	412		13:47
		Midstream	29.18	7.80	8.14	412		13:49
		Right Quarter	29.53	7.95	8.56	412		13.52
		Right	29.44	7.80	8.83	413		13:53
327.0	Ironton WTP Intake	Left	29.20	7.85	8.20	430		13:22
		Left Quarter	29.51	7.92	8.47	418		13:24
		Midstream	29.40	7.80	8.10	417		13:27
		Right Quarter	29.50	7.88	8.33	417		13:29
		Right	29.56	7.88	8.35	417		13.32
331.0	Pond Run Confluence	Left	29.67	8.05	8.94	419		12:48
		Left Quarter	29.49	7.89	8.29	420		12:53
		Midstream	28.99	7.76	7.89	421		12.55
		Right Quarter	29.50	7.90	8.40	422		12:58
		Right	29.68	7.97	8.52	421		13.00

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #2 - 7/28/94 - Wet Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	28.95	7.55	6.97	379		15:18
		Left Quarter	28.35	7.46	6.62	389		15:20
		Midstream	28.38	7.44	6.58	396		15:22
		Right Quarter	28.31	7.47	6.62	390		15:26
		Right	28.33	7.48	6.77	384		15:28
*305.2	Guyandotte River	Left	24.30	7.56	6.73	476		15:01
	@ 1st Bridge	Midstream	24.62	7.56	6.80	479		15.03
		Right	24.36	7.57	6.81	479		15.05
306.9	Huntington WTP	Left	28.16	7.68	6.74	371	P	14:45
	Intake #2	Left Quarter	28.29	7.48	6.75	373	r	14:48
		Midstream	28.35	7.46	6.66	374	o	14:50
		Right Quarter	28.38	7.46	6.72	372	b	14:52
		Right	28.43	7.47	6.88	372	e	14:54
310.8	West End Bridge	Left	28.06	7.43	6.51	374	M	14:24
		Left Quarter	28.12	7.46	6.63	377	a	14:26
		Midstream	28.25	7.47	6.71	375	l	14:29
		Right Quarter	28.20	7.47	6.65	373	f	14:31
		Right	28.26	7.45	6.66	372	u n	14.33
311.9	Fourpole Creek Confluence	Left	28.05	7.52	6.52	365	c	14:06
		Left Quarter	28.09	7.47	6.53	374	t	14:09
		Midstream	28.23	7.46	6.64	376	i	14:12
		Right Quarter	28.20	7.45	6.61	373	o	14:15
		Right	28.29	7.47	6.72	367	n	14·18
*317.2	Big Sandy River	Left	26.65	7.80	7.43	636		13·46
	@ 1st Bridge	Midstream	26.47	7.75	7.25	637		13:49
		Right	26.48	7.75	7.26	636		13:51
319.7	Ashland WTP Intake	Left	28.13	7.45	6.51	355		13.27
		Left Quarter	28.16	7.44	6.56	350		13:29
		Midstream	28.19	7.44	6.61	349		13:32
		Right Quarter	28.17	7.44	6.52	347		13 34
		Right	28.27	7.45	6.60	349		13:36
324.7	Submarine Crossing	Left	28.16	7.46	6.50	372		13:05
		Left Quarter	28.14	7.44	6.46	369		13:07
		Midstream	28.10	7.44	6.40	366		13:09
		Right Quarter	28.21	7.48	6.62	369		13:11
		Right	28.14	7.48	6.44	378		13:15
327.0	Ironton WTP Intake	Left	28.24	7.48	6.43	374		12:45
		Left Quarter	28.47	7.52	6.73	374		12:47
		Midstream	28.42	7.51	6.68	375		12:51
		Right Quarter	28.27	7.45	6.56	375		12:54
		Right	28.29	7.48	6.56	375		12:56
331.0	Pond Run Confluence	Left	28.39	7.45	6.42	379		12:25
		Left Quarter	28.38	7.48	6.38	379		12.26
		Midstream	28.41	7.51	6.56	379		12:29
		Right Quarter	28.35	7.48	6.48	377		12:31
		Right	28.25	7.48	6.44	378		12:34

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #3 - 8/04/94 - Wet Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	26.38	7.80	8.33	299		16:20
		Left Quarter	26.21	7.69	8.25	297		16:22
		Midstream	26.14	7.65	8.17	300		16:24
		Right Quarter	26.29	7.69	8.39	299		16:26
		Right	26.30	7.67	8.40	296		16:28
*305.2	Guyandotte River	Left	26.07	7.66	6.95	464		15:28
	@ 1st Bridge	Midstream	26.26	7.68	7.13	466		15:32
		Right	26.12	7.71	7.39	467		15:35
306.9	Huntington WTP	Left	26.14	7.64	7.93	299	P	15.05
	Intake #2	Left Quarter	26.20	7 59	7.99	298	r	15:10
		Midstream	26.16	7.58	8.06	290	o	15:13
		Right Quarter	26.32	7.63	8.27	290	b	15 17
		Right	26.52	7.68	8.43	290	e	15.20
310.8	West End Bridge	Left	26.38	7.59	7.95	291	M	14:40
		Left Quarter	26.29	7.58	8.04	291	a	14:42
		Midstream	26.07	7.51	7.76	288	l	14.45
		Right Quarter	26.25	7.56	8.00	288	f	14:48
		Right	26.37	7.64	8.28	286	u n	14:50
311.9	Fourpole Creek Confluence	Left	26.10	7.72	7.54	289	c	14:27
		Left Quarter	25.88	7.55	7.59	289	t	14:29
		Midstream	26 00	7.56	7.72	287	ı	14:31
		Right Quarter	26.20	7.60	8.00	285	o	14:34
		Right	26 43	7 61	8.16	282	n	14:36
*317.2	Big Sandy River	Left	25.71	7.67	7.08	508		13:11
	@ 1st Bridge	Midstream	25.72	7.60	7.14	509		13·13
		Right	25.55	7.58	7.08	507		13:15
319.7	Ashland WTP Intake	Left	26.69	7.42	6 90	335		12:38
		Left Quarter	26.47	7.42	7.38	323		12.40
		Midstream	26.65	7.43	7.41	327		12:42
		Right Quarter	26 66	7.42	7.34	317		12:45
		Right	26.73	7.41	7.31	317		12:49
324.7	Submarine Crossing	Left	27.03	7.42	7.15	331		12:16
		Left Quarter	26.76	7.38	7.10	332		12:19
		Midstream	26.77	7.36	7.24	331		12:21
		Right Quarter	26.76	7.38	7.20	326		12:23
		Right	26.95	7.38	7.16	326		12:25
327.0	Ironton WTP Intake	Left	27.07	7.49	7.15	332		11:59
		Left Quarter	27.11	7.45	7.23	332		12·01
		Midstream	27.15	7.47	7.45	331		12:03
		Right Quarter	26 93	7.42	7.28	329		12:06
		Right	26.93	7.42	7.20	329		12:09
331.0	Pond Run Confluence	Left	27.12	7.51	6.87	352		11:35
		Left Quarter	27.16	7.42	7.07	343		11:38
		Midstream	27.06	7.39	7.03	344		11:40
		Right Quarter	27.10	7.41	7.12	342		11:43
		Right	27.16	7.40	7.06	350		11:45

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #4 - 8/11/94 - Dry Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	27.20	7.95	9.19	359		15:06
		Left Quarter	27.19	8.17	9.85	357		15:08
		Midstream	26.72	7.87	8.93.	344		15:10
		Right Quarter	26.85	8.07	9.55	353		15:12
		Right	27.10	8.07	9.48	362		15·14
*305.2	Guyandotte River	Left	24.26	7.69	7.40	377		14:50
	@ 1st Bridge	Midstream	24.23	7.64	7.45	378		14:51
		Right	24.29	7.64	7.42	377		14.54
306.9	Huntington WTP	Left	27.28	7.88	8.99	364	P	14:32
	Intake #2	Left Quarter	26.76	7.90	8.90	365	r	14:34
		Midstream	27.00	7.98	9.04	366	o	14:37
		Right Quarter	27.05	8.00	9.16	364	b	14:39
		Right	27.02	7.98	9.10	364	e	14:43
310.8	West End Bridge	Left	27.33	7.95	8.90	360	M	14:06
		Left Quarter	26.80	8.05	9.10	360	a	14:08
		Midstream	26.55	7.78	8.26	360	l	14:16
		Right Quarter	26.53	7.79	8.31	359	f	14:09
		Right	28.23	8.11	9.20	360	u n	14:12
311.9	Fourpole Creek Confluence	Left	26.89	7.90	8.79	365	c	13:53
		Left Quarter	27.45	8.03	9.05	360	t	13:56
		Midstream	26.65	7.80	8.40	359	i	13:58
		Right Quarter	27.45	8.20	9.60	358	o	14.00
		Right	27.47	8.08	9.17	358	n	14:02
*317.2	Big Sandy River	Left	24.80	7.64	7.40	539		13:33
	@ 1st Bridge	Midstream	25.20	7.64	7.40	539		13:35
		Right	24.38	7.62	7.40	539		13:37
319.7	Ashland WTP Intake	Left	27.13	7.78	8.51	361		13:15
		Left Quarter	26.86	7 92	8.76	362		13·17
		Midstream	27.20	7.95	8.92	364		13.19
		Right Quarter	26.84	7.87	8.70	367		13.21
		Right	26.74	7.74	8.38	367		13.24
324.7	Submarine Crossing	Left	27.25	7.93	8.59	358		12:56
		Left Quarter	27.17	7.79	8.42	360		12:58
		Midstream	27.28	7.84	8.62	359		13:00
		Right Quarter	26.98	7.87	8.61	359		13:02
		Right	27.14	7.82	8.48	360		13:04
327.0	Ironton WTP Intake	Left	27.60	7.94	8.75	357		12:41
		Left Quarter	26.77	7.79	8.35	356		12:44
		Midstream	27.07	7.78	8.42	357		12:46
		Right Quarter	27.07	7.82	8 42	358		12:48
		Right	26.95	7.79	8.41	357		12:49
331.0	Pond Run Confluence	Left	26.54	7.60	7.95	353		12:20
		Left Quarter	26.79	7.75	8.44	354		12:24
		Midstream	26.65	7.70	8.08	354		12:27
		Right Quarter	26.80	7.73	8 30	353		12:29
		Right	26 64	7.68	8.20	353		12:31

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #5 - 8/18/94 - Dry Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	26.05	7.28	7.16	382		14:49
		Left Quarter	25.74	7.31	7.15	363		14:50
		Midstream	25.78	7.28	7.13	369		14:52
		Right Quarter	25.90	7.27	7.05	390		14:54
		Right	26.03	7.26	6.99	403		14:56
*305.2	Guyandotte River	Left	22.00	7.31	6.86	377		14:34
	@ 1st Bridge	Midstream	21.98	7.29	6.87	374		14:36
		Right	21.99	7.29	6.85	376		14.38
306.9	Huntington WTP	Left	25.41	7.30	6.89	415	P	14:20
	Intake #2	Left Quarter	25.65	7.28	6.98	406	r	14:22
		Midstream	25.90	7.29	7.02	401	o	14:24
		Right Quarter	26.05	7.26	6.89	425	b	14:26
		Right	26.20	7.31	6.86	437	e	14:28
310.8	West End Bridge	Left	25.72	7.31	6.79	452	M	14:03
		Left Quarter	25.76	7.31	6.85	435	a	14:05
		Midstream	26.01	7.31	6.94	420	l	14:08
		Right Quarter	26.08	7.28	6.84	436	f	14:10
		Right	26.26	7.28	6.72	467	u n	14:11
311.9	Fourpole Creek Confluence	Left	25.81	7.46	6.70	469	c	13:53
		Left Quarter	25.78	7.35	6.80	451	t	13:55
		Midstream	26.01	7.32	6.85	431	ı	13:56
		Right Quarter	26.08	7.28	6.78	446	o	13:58
		Right	26.24	7.30	6.77	475	n	14.00
*317.2	Big Sandy River	Left	25.23	7.80	8.32	595		13:33
	@ 1st Bridge	Midstream	24.96	7.79	8.17	598		13.35
		Right	25.05	7.81	8.11	598		13:38
319.7	Ashland WTP Intake	Left	26.07	7.31	6.56	511		13:15
		Left Quarter	26.24	7.31	6.51	500		13:16
		Midstream	26.28	7.26	6.49	498		13:17
		Right Quarter	26.26	7.28	6.46	500		13:22
		Right	26.33	7.28	6.32	507		13:24
324.7	Submarine Crossing	Left	26.20	7.40	6.43	505		12:58
		Left Quarter	26.27	7.36	6.40	508		13:00
		Midstream	26.35	7.32	6.33	510		13:01
		Right Quarter	26.41	7.33	6.27	506		13:02
		Right	26.46	7.32	6.27	496		13:03
327.0	Ironton WTP Intake	Left	26.32	7.33	6.33	493		12:41
		Left Quarter	26.24	7.33	6.32	500		12.43
		Midstream	26.31	7.33	6.34	503		12:45
		Right Quarter	26.38	7.31	6.28	501		12:50
		Right	26.34	7.30	6.24	493		12:51
331.0	Pond Run Confluence	Left	26.34	7.32	6.22	474		12:18
		Left Quarter	26.34	7.34	6.27	481		12:25
		Midstream	26.30	7.30	6.28	487		12.27
		Right Quarter	26.31	7.30	6.23	485		12:30
		Right	26.31	7.29	6.28	481		12:31

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #6 - 8/25/94 - Dry Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	23.79	7.21	7.46	216		15:34
		Left Quarter	23.60	7.08	7.45	214		15:37
		Midstream	23 61	7.05	7.46	215		15:39
		Right Quarter	23.63	7.03	7.44	219		15:43
		Right	23.79	7.04	7.44	221		15:46
*305.2	Guyandotte River @ 1st Bridge	Left	22.53	7 33	7.38	325		15:17
		Midstream	22 57	7.41	7.40	326		15:20
		Right	22 59	7.42	7.40	327		15:22
306.9	Huntington WTP Intake #2	Left	23.53	7.07	7.41	234	P	14:59
		Left Quarter	23 54	7.06	7.46	220	r	15:01
		Midstream	23.52	7.04	7.48	218	o	15:04
		Right Quarter	23.60	7.02	7.45	222	b	15:06
		Right	23.77	7.02	7.41	226	e	15:09
310.8	West End Bridge	Left	23.61	7.08	7.34	228	M	14:40
		Left Quarter	23 57	7.04	7.44	223	a	14:42
		Midstream	23.54	7.02	7.47	221	l	14:44
		Right Quarter	23.56	7.02	7.43	224	f	14:46
		Right	23 79	7.02	7.33	230	u n	14:48
311.9	Fourpole Creek Confluence	Left	23.72	7.57	7.29	228	c	14:23
		Left Quarter	23.62	7.24	7.33	227	t	14:25
		Midstream	23.60	7.10	7.47	222	i	14:27
		Right Quarter	23.59	7.04	7.44	224	o	14:30
		Right	23.73	7.04	7.32	228	n	14:33
*317.2	Big Sandy River @ 1st Bridge	Left	24.28	7.42	7.57	482		14:00
		Midstream	23.91	7.52	7.44	482		14:02
		Right	23.21	7.53	7.51	477		14:04
319.7	Ashland WTP Intake	Left	24.08	7.11	7 21	255		13:40
		Left Quarter	23.81	7.09	7.32	236		13:43
		Midstream	23.75	7.06	7.36	224		13:45
		Right Quarter	23.83	7.04	7.28	228		13:47
		Right	23.93	7.03	7.19	231		13:49
324.7	Submarine Crossing	Left	23.97	7.10	7.20	252		13:15
		Left Quarter	23.87	7.12	7.23	245		13:17
		Midstream	23.92	7.11	7.27	232		13:20
		Right Quarter	24.12	7.09	7 19	235		13:22
		Right	24.14	7.07	7.08	240		13:25
327.0	Ironton WTP Intake	Left	24.11	7.13	7 13	256		12:58
		Left Quarter	24.01	7.13	7.21	245		13:00
		Midstream	24.17	7.11	7.26	234		13:03
		Right Quarter	24.16	7.08	7 19	234		13:06
		Right	24.08	7.08	7.08	241		13:08
331.0	Pond Run Confluence	Left	24.32	7.05	7 12	259		12:36
		Left Quarter	24.27	7.12	7.11	253		12:38
		Midstream	24.27	7.12	7.19	247		12:41
		Right Quarter	24.10	7.10	7.18	241		12:44
		Right	24.17	7.11	7.15	244		12:47

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #7 - 8/30/94 - Dry Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	25.27	7.50	8.27	235		15:09
		Left Quarter	25.07	7.36	8.12	242		15:10
		Midstream	25.11	7.31	8.13	247		15:12
		Right Quarter	25.12	7 30	8.10	251		15:15
		Right	25.28	7.32	8.20	247		15:17
*305.2	Guyandotte River	Left	23.84	7.52	7.17	433		15:28
	@ 1st Bridge	Midstream	23.92	7.51	7.18	430		15:30
		Right	23.98	7.50	7.16	431		15:32
306.9	Huntington WTP	Left	25.04	7.50	8 00	259	P	14·46
	Intake #2	Left Quarter	25.04	7.34	8.03	244	r	14:49
		Midstream	25 14	7.30	8.08	238	o	14:50
		Right Quarter	25.13	7 30	8.07	238	b	14:52
		Right	25.28	7.32	8.17	238	e	14:56
310.8	West End Bridge	Left	24.99	7.35	7.95	260	M	14:29
		Left Quarter	25.00	7.31	7.94	240	a	14·30
		Midstream	25 07	7 31	8 04	230	l	14:32
		Right Quarter	25.08	7.30	8 03	234	f	14·34
		Right	25.32	7.31	8 17	247	u n	14:35
311.9	Fourpole Creek Confluence	Left	25.03	7.53	7 97	259	c	14:15
		Left Quarter	25.00	7.39	7.96	253	t	14·17
		Midstream	25.08	7.34	8.05	232	i	14:20
		Right Quarter	25.16	7.31	8 07	236	o	14·22
		Right	26.17	7.31	8.14	246	n	14.26
*317.2	Big Sandy River	Left	25.77	7.60	7.91	533		13:55
	@ 1st Bridge	Midstream	24.86	7.58	7 75	526		13:57
		Right	24.99	7 59	7.82	528		14:00
319.7	Ashland WTP Intake	Left	24.95	7.37	7.87	284		13:37
		Left Quarter	24.99	7.31	7.94	279		13·39
		Midstream	24.99	7.30	7.95	270		13:41
		Right Quarter	25.02	7.26	7.99	251		13:43
		Right	24.99	7.25	7.96	253		13.45
324.7	Submarine Crossing	Left	24.97	7.28	7.81	285		13:16
		Left Quarter	24.91	7.26	7.83	271		13:19
		Midstream	24.97	7.25	7.92	257		13:21
		Right Quarter	25.07	7.25	7.95	256		13.23
		Right	25.04	7.24	7.92	263		13.25
327.0	Ironton WTP Intake	Left	25.08	7.19	7.80	284		12:57
		Left Quarter	24.97	7.22	7.84	278		12:59
		Midstream	24.87	7.19	7.81	267		13:01
		Right Quarter	24.97	7.20	7.92	260		13:06
		Right	25.06	7.19	7.95	265		13:09
331.0	Pond Run Confluence	Left	25.07	7.12	7.82	289		12:35
		Left Quarter	25.07	7.19	7.86	279		12.40
		Midstream	25.03	7.19	7.85	272		12:42
		Right Quarter	24.98	7.19	7.85	271		12:45
		Right	25.06	7.19	7.95	272		12.46

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #8 - 9/08/94 - Dry Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	24.06	7.51	8.10	259		15:54
		Left Quarter	24.50	7.41	8.26	260		15:57
		Midstream	23.71	7.27	7.74	259		15:59
		Right Quarter	24.16	7.32	7.96	259		16:01
		Right	23.70	7.29	7.80	260		16:03
*305.2	Guyandotte River	Left	20.37	7.50	7.97	370		16:14
	@ 1st Bridge	Midstream	20.41	7.48	8.06	371		16:16
		Right	20.58	7.46	8.05	372		16:19
306.9	Huntington WTP	Left	23.47	7.35	7.87	264	P	15:32
	Intake #2	Left Quarter	23.72	7.37	8.22	263	r	15:34
		Midstream	23.60	7.31	7.90	263	o	15:37
		Right Quarter	23.64	7.32	7.94	261	b	15:39
		Right	24.16	7.40	8.27	261	e	15:41
310.8	West End Bridge	Left	23.73	7.31	8.10	266	M	15:11
		Left Quarter	24.06	7.34	8.21	266	a	15:15
		Midstream	23.50	7.29	7.84	265	l	15:17
		Right Quarter	23.78	7.32	8.04	264	f	15:19
		Right	24.39	7.35	8.14	265	u n	15:22
311.9	Fourpole Creek Confluence	Left	23.99	7.45	8.16	266	c	14:56
		Left Quarter	23.97	7.39	8 16	266	t	14:59
		Midstream	24.02	7.38	8.12	264	i	15:01
		Right Quarter	24.12	7.39	8.24	264	o	15:03
		Right	24.53	7.41	8.28	264	n	15.05
*317.2	Big Sandy River	Left	21.79	7.65	8.22	638		14:35
	@ 1st Bridge	Midstream	21.20	7.66	8.13	642		14:38
		Right	20.87	7.65	8.14	642		14:40
319.7	Ashland WTP Intake	Left	23.55	7.44	8.05	282		14:15
		Left Quarter	23.34	7.37	7.96	276		14:17
		Midstream	23.20	7.32	7.82	282		14:25
		Right Quarter	23.60	7.39	8.17	282		14·19
		Right	23.51	7.39	8.09	284		14:22
324.7	Submarine Crossing	Left	23.78	7.50	8.10	296		13:53
		Left Quarter	23.63	7.47	8.36	291		13:56
		Midstream	23.80	7.43	8.08	290		13:58
		Right Quarter	23.51	7.45	8.20	288		14:00
		Right	23.51	7.44	8.20	293		14.03
327.0	Ironton WTP Intake	Left	23.43	7.49	7.94	309		13:37
		Left Quarter	23.97	7.49	8.22	308		13:39
		Midstream	23.30	7.42	8.05	300		13:41
		Right Quarter	23.16	7.37	7.89	299		13:44
		Right	23.72	7.42	8.23	301		13:46
331.0	Pond Run Confluence	Left	23.40	7.38	7.76	301		13:13
		Left Quarter	23.76	7.42	7.99	302		13:15
		Midstream	23 67	7.38	7.81	304		13:17
		Right Quarter	23 47	7.44	8.17	304		13.19
		Right	23.67	7.43	8.07	302		13·22

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #9 - 9/15/94 - Dry Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	24.62	7.87	8.55	270		15:11
		Left Quarter	25.18	7.99	8.84	270		15:13
		Midstream	25.25	7.96	8.75	270		15:15
		Right Quarter	25.20	8 00	8.85	270		15:19
		Right	25.17	7.95	8.72	270		15:21
*305.2	Guyandotte River	Left	23.73	7.85	8.51	452		15:34
	@ 1st Bridge	Midstream	22.72	7.82	8.30	461		15:38
		Right	23.21	7.83	8.40	462		15:41
306.9	Huntington WTP	Left	24.05	7.77	8.40	269	P	14:47
	Intake #2	Left Quarter	24.33	7.78	8.37	269	r	14:50
		Midstream	25.51	7.92	8.74	268	o	14.53
		Right Quarter	25.15	8.02	9.01	267	b	14:55
		Right	24.56	7.98	8.94	266	e	14:57
310.8	West End Bridge	Left	24 82	7.87	8.83	270	M	14:27
		Left Quarter	24.21	7.86	8.69	269	a	14.29
		Midstream	25.35	7.88	8.63	270	l	14:32
		Right Quarter	24.75	7.84	8.60	270	f	14 34
		Right	25.01	8.06	9.14	268	u n	14·36
311.9	Fourpole Creek Confluence	Left	24.20	7.86	8.73	268	c	14:11
		Left Quarter	24.85	8.01	9.04	269	t	14·14
		Midstream	24.81	7.88	8.58	268	i	14.17
		Right Quarter	25.14	8.12	9.17	266	o	14:19
		Right	25.61	8.10	9.35	267	n	14·22
*317.2	Big Sandy River	Left	24.18	8.08	8.87	620		13:57
	@ 1st Bridge	Midstream	23 64	8.01	8.39	681		13:55
		Right	23.05	7.88	7.90	694		13:53
319 7	Ashland WTP Intake	Left	24.99	7.85	8.63	275		13:33
		Left Quarter	23.83	7.68	8.34	273		13:36
		Midstream	24.32	7.77	8.50	275		13·39
		Right Quarter	24.12	7.77	8.55	274		13.42
		Right	24.45	7.82	8.67	274		13:44
324.7	Submarine Crossing	Left	25.30	7.84	8.56	287		13:08
		Left Quarter	24.23	7.68	8.23	285		13.11
		Midstream	24.23	7 71	8.38	285		13:13
		Right Quarter	24.67	7.72	8.37	285		13·17
		Right	24.02	7.69	8 29	287		13.20
327.0	Ironton WTP Intake	Left	24.38	7.78	8.47	297		12.50
		Left Quarter	24.40	7.82	8.57	296		12:53
		Midstream	24.71	7.82	8.61	290		12:55
		Right Quarter	24.79	7.76	8.41	292		12:58
		Right	24.60	7.78	8.46	294		13:01
331.0	Pond Run Confluence	Left	23.87	7.63	7.77	292		12.30
		Left Quarter	24.07	7.67	8.11	295		12:32
		Midstream	24.40	7.68	8.20	293		12:35
		Right Quarter	24.19	7.70	8.13	293		12:37
		Right	23.98	7.60	7.80	293		12:39

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #10 - 9/22/94 - Dry Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	24.04	7.83	8.16	311		14:17
		Left Quarter	24.33	7.85	8.19	312		14:19
		Midstream	24.26	7.81	8.10	312		14:21
		Right Quarter	24.42	7.91	8.33	312		14:22
		Right	24.25	7.84	8.25	311		14:25
*305.2	Guyandotte River	Left	23.55	7.81	8.17	389		14:35
	@ 1st Bridge	Midstream	23.87	7.84	8.38	358		14:38
		Right	22.84	7.75	8.13	444		14:40
306.9	Huntington WTP	Left	24.36	7.84	8.25	320	P	13:52
	Intake #2	Left Quarter	24.18	7.82	8.24	319	r	13:55
		Midstream	24.25	7.90	8.37	317	o	13:59
		Right Quarter	24.46	7.93	8.45	317	b	14:02
		Right	24.32	7.91	8.39	317	e	14:04
310.8	West End Bridge	Left	24.21	7.82	8.26	317	M	13:24
		Left Quarter	24.09	7.82	8.27	317	a	13:27
		Midstream	24.66	7.90	8.42	318	l	13:30
		Right Quarter	24.77	7.98	8.60	318	f	13:32
		Right	24.44	7.81	8.31	314	u n	13:35
311.9	Fourpole Creek Confluence	Left	24.56	7.93	8.27	316	c	13:08
		Left Quarter	24.42	7.83	8.25	315	t	13:10
		Midstream	24.46	7.76	8.12	314	i	13:13
		Right Quarter	24.40	7.90	8.42	313	o	13:16
		Right	24.56	7.92	8.60	311	n	13:19
*317.2	Big Sandy River	Left	21.98	7.84	7.69	737		12:48
	@ 1st Bridge	Midstream	22.02	7.85	7.74	730		12:51
		Right	22.11	7.89	7.65	731		12:54
319.7	Ashland WTP Intake	Left	24.32	7.67	7.75	324		12:32
		Left Quarter	23.90	7.63	7.69	325		12:35
		Midstream	24.04	7.63	7.74	324		12:37
		Right Quarter	24.16	7.71	8.02	331		12:39
		Right	24.19	7.73	7.93	330		12:40
324.7	Submarine Crossing	Left	24.07	7.68	7.70	328		12:13
		Left Quarter	24.02	7 63	7.62	330		12:14
		Midstream	24.03	7.62	7.51	330		12:16
		Right Quarter	24.36	7.65	7.67	331		12:18
		Right	23.99	7.66	7.69	333		12:20
327.0	Ironton WTP Intake	Left	24.17	7.74	7.78	338		11.54
		Left Quarter	24.23	7.70	7.63	339		11:58
		Midstream	24.04	7.62	7.46	338		12:02
		Right Quarter	23.92	7.65	7.48	338		12:04
		Right	23.88	7.64	7.58	338		12:06
331.0	Pond Run Confluence	Left	23.76	7.67	7.59	335		11:35
		Left Quarter	23.70	7.62	7.40	334		11:38
		Midstream	23 66	7.62	7 54	334		11:39
		Right Quarter	23.72	7.61	7.45	333		11:42
		Right	23.79	7 67	7.66	334		11:44

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #11 - 9/28/94 - Dry Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	22.70	7.57	6.65	327		15:21
		Left Quarter	22.74	7.55	6.61	331		15:25
		Midstream	22.87	7.55	6.57	332		15:27
		Right Quarter	22.86	7.55	6.52	329		15:29
		Right	22.83	7.55	6.53	328		15:31
*305.2	Guyandotte River	Left	18.04	7.57	6.77	377		15:45
	@ 1st Bridge	Midstream	18.08	7.54	6.81	375		15:48
		Right	18.17	7.51	6.76	375		15:50
306.9	Huntington WTP	Left	22.62	7.51	6.56	313	P	14:58
	Intake #2	Left Quarter	22.56	7.51	6.53	315	r	15:00
		Midstream	22.57	7.53	6.56	318	o	15:02
		Right Quarter	22.66	7.54	6.60	317	b	15:05
		Right	22.69	7.56	6.66	314	e	15:07
310.8	West End Bridge	Left	22.47	7.49	6.56	305	M	14 29
		Left Quarter	22.49	7.51	6.56	305	a	14:30
		Midstream	22.52	7.53	6 60	305	l	14.32
		Right Quarter	22.52	7.54	6.61	305	f	14:34
		Right	22.46	7.55	6.65	304	u n	14:36
311.9	Fourpole Creek Confluence	Left	21 91	7 42	6.30	311	c	14:07
		Left Quarter	22.46	7.51	6.57	302	t	14:11
		Midstream	22.48	7.53	6 62	303	ı	14:15
		Right Quarter	22.46	7.54	6.61	303	o	14.17
		Right	22.38	7 56	6.74	304	n	14:20
*317.2	Big Sandy River	Left	20.39	7.81	7.00	719		13:42
	@ 1st Bridge	Midstream	20.29	7.81	6.98	720		13:45
		Right	20.34	7.82	6.96	724		13.47
319.7	Ashland WTP Intake	Left	22 29	7 49	6 36	327		13:17
		Left Quarter	22.32	7.49	6.41	327		13:21
		Midstream	22.34	7.52	6.41	335		13:24
		Right Quarter	22.33	7.53	6.49	335		13:26
		Right	22.26	7.53	6.48	337		13:29
324.7	Submarine Crossing	Left	22.57	7 51	6.39	337		12:53
		Left Quarter	22.50	7 52	6.44	335		12:55
		Midstream	22.41	7.52	6.47	333		12:57
		Right Quarter	22.48	7.52	6.44	334		12:59
		Right	22.47	7.52	6.43	334		13:01
327.0	Ironton WTP Intake	Left	22.74	7.53	6.40	343		12:37
		Left Quarter	22.75	7.53	6.45	343		12.39
		Midstream	22.69	7.53	6.47	341		12:41
		Right Quarter	22.67	7.54	6.47	340		12:43
		Right	22.61	7.55	6.50	340		12:46
331.0	Pond Run Confluence	Left	22.76	7.53	6.31	336		12:20
		Left Quarter	22.82	7.53	6.30	336		12:21
		Midstream	22.84	7.53	6.36	338		12:22
		Right Quarter	22.80	7.54	6.41	331		12:24
		Right	22.80	7.54	6.40	339		12:26

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #12 - 10/10/94 - Wet Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D O (mg/L)	COND (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	20.33	7 50	7.77	399		15:32
		Left Quarter	20.25	7.49	7.63	402		15:34
		Midstream	20.24	7.46	7.57	401		15:37
		Right Quarter	20.27	7.48	7.61	402		15:39
		Right	20.30	7.51	7.76	402		15:41
*305.2	Guyandotte River	Left	16.90	7.58	7.58	542		13:52
	@ 1st Bridge	Midstream	17.41	7 61	7.75	552		13:54
		Right	17.69	7 60	7.75	545		13:56
306.9	Huntington WTP	Left	20.25	7.50	7.56	403	P	15:11
	Intake #2	Left Quarter	20.31	7.47	7.57	401	r	15:13
		Midstream	20.31	7.47	7.57	401	o	15.15
		Right Quarter	20.38	7.48	7.59	399	b	15:17
		Right	20.49	7.52	7 81	397	e	15:19
310.8	West End Bridge	Left	20.26	7.51	7.77	395	M	14:50
		Left Quarter	20.35	7.47	7.71	396	a	14:52
		Midstream	20.34	7.48	7.70	397	l	14:54
		Right Quarter	20.44	7.50	7.80	394	f	14.57
		Right	20.47	7.52	7.88	392	u n	14:59
311.9	Fourpole Creek Confluence	Left	20.15	7 54	7.73	392	c	14:36
		Left Quarter	20.27	7.49	7.71	393	t	14:39
		Midstream	20.26	7.46	7 69	391	i	14:41
		Right Quarter	20.28	7 49	7.75	391	o	14:44
		Right	20.42	7.53	8.05	391	n	14:46
*317.2	Big Sandy River	Left	18.50	7 70	8.18	570		13:52
	@ 1st Bridge	Midstream	18.32	7.76	8.33	595		13:54
		Right	17.75	7.76	8.19	672		14:02
319.7	Ashland WTP Intake	Left	20.31	7.51	7.82	391		13:33
		Left Quarter	20.29	7.49	7.81	399		13:37
		Midstream	20.28	7.47	7.84	400		13:39
		Right Quarter	20 22	7.45	7.75	403		13.41
		Right	20.20	7.39	7.61	401		13.43
324.7	Submarine Crossing	Left	20 30	7.51	7.60	394		13.13
		Left Quarter	20.18	7.42	7.43	395		13·16
		Midstream	20.33	7.46	7.65	393		13.18
		Right Quarter	20.27	7.45	7.46	393		13:20
		Right	20.30	7.45	7.64	395		13:22
327.0	Ironton WTP Intake	Left	20.48	7.51	7.66	392		12:59
		Left Quarter	20 50	7.50	7.69	392		13:01
		Midstream	20.27	7.43	7.40	391		13:03
		Right Quarter	20.33	7.47	7.43	391		13:05
		Right	20.40	7.50	7.62	391		13:07
331.0	Pond Run Confluence	Left	20.22	7.47	7.30	383		12:35
		Left Quarter	20.25	7.45	7.54	382		12:39
		Midstream	20.16	7.43	7.48	382		12:42
		Right Quarter	20.21	7.37	7.31	383		12:45
		Right	20.30	7.41	7.47	381		12:48

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #13 - 10/19/94 - Wet Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface TEMP. (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	19.29	7.57	8.66	393		16:36
		Left Quarter	19.31	7.54	8.62	397		16:38
		Midstream	19.31	7.54	8.61	397		16:39
		Right Quarter	19.30	7.54	8.63	396		16:41
		Right	19.29	7.55	8.66	397		16:42
*305.2	Guyandotte River	Left	14.90	7.49	8.01	441		16:52
	@ 1st Bridge	Midstream	14.87	7.48	8.24	445		16:54
		Right	14.91	7.47	8.14	447		16:55
306.9	Huntington WTP	Left	19.18	7.53	8.67	387	P	16:18
	Intake #2	Left Quarter	19.18	7.54	8.71	390	r	16:20
		Midstream	19.22	7.56	8.76	389	o	16:21
		Right Quarter	19.22	7.56	8.79	388	b	16:23
		Right	19.20	7.58	8.86	388	e	16:24
310.8	West End Bridge	Left	19.12	7.53	8.70	386	M	15:47
		Left Quarter	19.12	7.57	8.78	384	a	15:57
		Midstream	19.16	7.58	8.87	384	l	15:59
		Right Quarter	19.16	7.57	8.83	384	f	16:01
		Right	19.16	7.59	8.91	384	u n	16:02
311.9	Fourpole Creek Confluence	Left	19.18	7.61	8.91	385	c	15:37
		Left Quarter	19.17	7.59	8.85	383	t	15:38
		Midstream	19.18	7.60	8.92	383	ı	15:40
		Right Quarter	19.16	7.59	8.88	384	o	15:41
		Right	19.16	7.61	8.98	384	n	15:43
*317.2	Big Sandy River	Left	16.31	7.68	8.83	683		15:20
	@ 1st Bridge	Midstream	16.21	7.68	8.89	690		15:22
		Right	16.21	7.67	8.82	687		15:23
319.7	Ashland WTP Intake	Left	19.03	7.61	8.87	424		14:49
		Left Quarter	19.03	7.63	8.94	426		14:50
		Midstream	19.05	7.63	8.95	425		14:52
		Right Quarter	19.07	7.64	8.94	424		14:54
		Right	19.08	7.61	8.89	423		14:56
324.7	Submarine Crossing	Left	19.02	7.63	8.84	425		14.31
		Left Quarter	19.03	7.64	8.92	423		14.33
		Midstream	19.02	7.60	8.83	423		14·34
		Right Quarter	19.03	7.60	8.86	423		14:35
		Right	19.05	7.60	8.83	421		14:36
327.0	Ironton WTP Intake	Left	19.12	7.64	8.88	416		14·19
		Left Quarter	19.14	7.61	8.80	416		14:21
		Midstream	19.15	7.62	8.92	417		14.22
		Right Quarter	19.12	7.60	8.83	417		14·24
		Right	19.13	7.62	8.92	417		14:26
331.0	Pond Run Confluence	Left	19.02	7.57	8.72	405		14.01
		Left Quarter	19.06	7.55	8.61	405		14·04
		Midstream	19.08	7.56	8.67	405		14.05
		Right Quarter	19.09	7.56	8.70	405		14.06
		Right	19.11	7.56	8.73	405		14:08

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #14 - 11/01/94 - Wet Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP (°C)	pH	D.O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	16.04	7.56	9.25	415		15:34
		Left Quarter	16.28	7.54	9.19	415		15:33
		Midstream	16.39	7.52	9.16	416		15:31
		Right Quarter	16.46	7.50	9.08	415		15:30
		Right	16.36	7.47	9.26	415		15:28
*305.2	Guyandotte River	Left	11.43	7.52	9.68	459		15:45
	@ 1st Bridge	Midstream	12.00	7.54	9.61	463		15:46
		Right	11.96	7.54	9.55	463		15:48
306.9	Huntington WTP	Left	16.00	7.48	9.13	413	P	15:07
	Intake #2	Left Quarter	16.04	7.53	9.30	415	r	15:08
		Midstream	16.07	7.56	9.31	415	o	15:10
		Right Quarter	16.03	7.57	9.34	414	b	15:12
		Right	15.89	7.59	9.34	412	e	15:14
310.8	West End Bridge	Left	16.02	7.53	9.26	409	M	14:48
		Left Quarter	16.07	7.56	9.31	408	a	14:50
		Midstream	16.11	7.56	9.33	408	l	14:53
		Right Quarter	16.04	7.57	9.32	400	f	14:55
		Right	15.90	7.59	9.44	407	u	14:56
							n	
311.9	Fourpole Creek Confluence	Left	15.44	7.52	9.32	408	c	14:33
		Left Quarter	16.01	7.52	9.31	408	t	14:36
		Midstream	16.04	7.56	9.44	407	i	14:37
		Right Quarter	16.04	7.56	9.44	406	o	14:40
		Right	15.90	7.58	9.39	405	n	14:45
*317.2	Big Sandy River	Left	12.33	7.70	10.21	696		14:15
	@ 1st Bridge	Midstream	12.33	7.72	10.10	703		14:16
		Right	12.24	7.73	10.07	704		14:17
319.7	Ashland WTP Intake	Left	16.08	7.52	9.32	456		13:59
		Left Quarter	16.08	7.57	9.49	454		14:01
		Midstream	16.10	7.58	9.45	448		14:02
		Right Quarter	16.12	7.58	9.36	447		14:04
		Right	16.08	7.58	9.38	447		14:06
324.7	Submarine Crossing	Left	16.27	7.51	9.37	450		13:38
		Left Quarter	16.27	7.54	9.23	449		13:39
		Midstream	16.27	7.55	9 32	448		13:41
		Right Quarter	16.25	7.54	9.23	448		13:42
		Right	16.16	7.56	9.24	447		13:44
327.0	Ironton WTP Intake	Left	16.22	7.55	9.19	446		13:24
		Left Quarter	16.29	7.54	9.05	448		13:25
		Midstream	16.27	7.54	9.07	449		13:27
		Right Quarter	16.26	7.55	9.06	450		13:29
		Right	16.19	7.56	9.13	449		13:30
331.0	Pond Run Confluence	Left	16.20	7.48	8.77	444		13:06
		Left Quarter	16.24	7.49	8 68	445		13:09
		Midstream	16.23	7.49	8.69	444		13:11
		Right Quarter	16.20	7.50	8.71	445		13:12
		Right	16 19	7.50	8.77	445		13:13

* Indicates confluence mile point

CROSS-SECTIONAL SURVEYS

Physical Parameter Data

Survey #15 - 11/10/94 - Wet Weather Event

Sampling Mile Point	Transect Description	Bank Description (Descending)	Hydrolab Readings - 1 Foot Below the Surface					
			TEMP. (°C)	pH	D O. (mg/L)	COND. (uS/cm)	Turbidity (NTU)	Sample Time
301.0	Public Lauching Ramp	Left	15 22	7.53	9.41	387		14:00
		Left Quarter	15.18	7.47	9.33	382		14:02
		Midstream	15.26	7.45	9.28	387		14:04
		Right Quarter	15.24	7.45	9.27	391		14:06
		Right	15 25	7.47	9.23	394		14:09
*305.2	Guyandotte River	Left	12.49	7.53	8.64	505		14.20
	@ 1st Bridge	Midstream	12.63	7.46	8.50	505		14:23
		Right	12.93	7.46	8.72	504		14:25
306.9	Huntington WTP	Left	15.04	7.50	9.27	396	P	13:38
	Intake #2	Left Quarter	15.20	7.47	9.33	391	r	13.40
		Midstream	15.21	7 47	9.36	392	o	13.42
		Right Quarter	15.24	7.47	9.28	394	b	13:44
		Right	15 33	7.48	9.30	397	e	13:48
310.8	West End Bridge	Left	15.10	7.47	9.30	398	M	13:16
		Left Quarter	15.22	7.48	9.41	394	a	13:19
		Midstream	15.26	7.48	9.36	395	l	13:21
		Right Quarter	15.28	7.48	9.37	395	f	13:23
		Right	15.31	7.50	9.33	397	u n	13:25
311.9	Fourpole Creek Confluence	Left	15.04	7.59	9.30	397	c	13:04
		Left Quarter	15.18	7.50	9.40	396	t	13:06
		Midstream	15.27	7.48	9.28	395	i	13:08
		Right Quarter	15.27	7.49	9.41	396	o	13:10
		Right	15.25	7.48	9.33	396	n	13:12
*317.2	Big Sandy River	Left	13.54	7.60	9.12	710		12:49
	@ 1st Bridge	Midstream	13.45	7.59	9.17	708		12:47
		Right	13.45	7.58	9.27	711		12:45
319.7	Ashland WTP Intake	Left	15 05	7.46	9 31	402		12:27
		Left Quarter	15.12	7.47	9.31	398		12:29
		Midstream	15.19	7.47	9.33	395		12:31
		Right Quarter	15.23	7.47	9.25	395		12:32
		Right	15.22	7.46	9.22	396		12:34
324 7	Submarine Crossing	Left	15.07	7.43	9.21	406		12:08
		Left Quarter	15.10	7.45	9.25	401		12:09
		Midstream	15.17	7.47	9.27	395		12:11
		Right Quarter	15.17	7.45	9.16	394		12:14
		Right	15.14	7.47	9.09	396		12:15
327.0	Ironton WTP Intake	Left	15.11	7.46	9 04	412		11:53
		Left Quarter	15.05	7 47	9 21	406		11:55
		Midstream	15.11	7.48	9.19	401		11.58
		Right Quarter	15.13	7.46	9.24	398		12:00
		Right	15.12	7.46	9 20	399		12:01
331.0	Pond Run Confluence	Left	14.97	7.60	9 40	412		11:33
		Left Quarter	15.03	7.49	9.64	410		11:35
		Midstream	15.02	7.47	9.05	406		11:36
		Right Quarter	15.06	7.48	9.33	405		11.38
		Right	15.10	7.46	9.18	405		11:39

* Indicates confluence mile point

APPENDIX 7

Precipitation Data

PRECIPITATION DATA

Date	Survey Classification	Huntington									Ashland	Ironton
		13th Street	16th Street	4th Street	5th Avenue	Gallery	JMSRiver	POTW	ROBY	VA Hospital		
08/09/94	Dry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0 00	0 00
08/10/94		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
08/11/94		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08/16/94	Dry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
08/17/94		0 09	0.13	0.01	0.18	0.15	0.11	0.07	0.20	0.08	0.00	0.00
08/18/94		0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08/23/94	Dry	0 01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0 00
08/24/94		0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08/25/94		0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 02	0 00
08/28/94	Dry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 00	Trace	0.20
08/29/94		0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0 01	0 03	0.00
08/30/94		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 00	0 00	0.00
09/06/94	Dry	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0 00	0.00	0 00
09/07/94		0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0 00
09/08/94		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0 00
09/13/94	Dry	0.00	0 00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/14/94		0 00	0 00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/15/94		0.00	0 00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/20/94	Dry	0.00	0.00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/21/94		0.00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 00	0 00
09/22/94		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 00
09/26/94	Dry	0.03	0.03	0.02	0.01	0.04	0.03	0.03	0.03	0.03	0.00	0 00
09/27/94		0.00	0.00	0.00	0.00	0.00	0.00	0 00	0.00	0.00	0.00	0 00
09/28/94		0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 00

PRECIPITATION DATA

Date	Survey Classification	Huntington									Ashland	Ironton
		13th Street	16th Street	4th Street	5th Avenue	Gallery	JMSRiver	POTW	ROBY	VA Hospital		
07/19/94		0 00	0.00	0.00	0 00	0.00	0.00	0.00	0.00	0 04	0.00	0.90
0720/94	Wet	0 85	0.32	0.97	0 51	0.91	0.66	0.32	0.47	0.03	0.00	0.10
07/21/94		0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
07/26/94		0 13	0.04	0.13	0.05	0.03	0.00	0.06	0.02	0.01	0.00	0 00
07/27/94	Wet	1.11	0.98	1 00	1.09	1.27	1 34	1 02	0.66	0.01	0.62	0 20
07/28/94		0.00	0.00	0 00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0 60
08/02/94		0.17	0 02	0 05	0.00	0.05	0 24	0.31	0.00	0.00	0.00	2 50
08/03/94	Wet	0.14	0 00	0 14	0.23	0.76	0.46	0.07	0.78	0.00	0.22	0 00
08/04/94		0 00	0 00	0.00	0.00	0.00	0 01	0.00	0.01	0.00	0.00	0 00
10/08/94		0.00	0 00	0.00	0.00	0.00	0 00	0.00	0.00	0.00	0.00	0.00
10/09/94	Wet	0 20	0.20	0.22	0.21	0.22	0 21	0.21	0.21	0.24	0.22	0.30
10/10/94		0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
10/17/94		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 50	0.20
10/18/94	Wet	0 00	0.00	0.00	0.00	0.00	0 00	0.00	0.00	0.00	0 00	0.50
10/19/94		0 52	0.49	0.52	0.55	0.59	0.43	0.47	0.58	0.56	0 00	0 00
10/29/94		0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0 20	0 20
10/30/94	Wet	0.00	0 00	0.00	0.00	0.00	0.00	0 00	0.00	0.00	0.00	0.00
11/01/94		0.00	0.34	0.15	0.39	0.37	0.12	0.16	0.48	0.00	0.00	0.00
11/08/94		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00
11/09/94	Wet	0.00	0.08	0.10	0.09	0.09	0.07	0.08	0.08	0.00	0.00	0.50
11/10/94		0 00	0 12	0.12	0.14	0.12	0.16	0.12	0.14	0.00	0.00	0.00

APPENDIX 8

Bacteria Data

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #1 - 7/21/94 - Wet Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Crosss-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	< 10	< 10	18	< 10	18	13	< 10
305.2	Guyandotte River Confluence							18
	Guyandotte River @ 1st Bridge	1351		982		1604	1286	
306.9	Huntington WTP - Intake #2	164	164	82	< 10	< 10	47	100
310.8	West End Bridge	210	182	145	< 10	45	76	220
311.9	Fourpole Creek Confluence	230	180	135	45	63	110	360
317.2	Big Sandy River Confluence							1082
	Big Sandy River @ 1st Bridge	91		36		55	56	
319.7	Ashland WTP Intake	450	290	280	310	118	266	173
324.7	Submarine Crossing	73	45	55	18	36	41	109
327.0	Ironton WTP Intake	< 10	< 10	36	36	18	19	45
331.0	Pond Run Confluence	< 10	< 10	18	< 10	27	14	18
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #2 - 7/28/94 - Wet Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	155	55	109	109	18	71	100
305.2	Guyandotte River Confluence Guyandotte River @ 1st Bridge	4100		3400		3200	3547	135
306.9	Huntington WTP - Intake #2	260	300	164	55	82	142	320
310.8	West End Bridge	320	73	55	73	200	113	440
311.9	Fourpole Creek Confluence	260	210	60	70	70	110	410
317.2	Big Sandy River Confluence Big Sandy River @ 1st Bridge	173		73		28	71	510
319.7	Ashland WTP Intake	754	410	290	250	773	444	864
324.7	Submarine Crossing	500	540	500	745	550	560	600
327.0	Ironton WTP Intake	191	173	320	290	290	245	200
331.0	Pond Run Confluence	350	300	280	136	91	205	191
	Longitudinal Blank Cross-Section Blank	< 10 < 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #3 - 8/04/94 - Wet Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	100	145	73	136	36	88	55
305.2	Guyandotte River Confluence							300
	Guyandotte River @ 1st Bridge	4500		145		6000	1576	
306.9	Huntington WTP - Intake #2	520	280	207	136	18	149	350
310.8	West End Bridge	310	118	154	18	45	85	520
311.9	Fourpole Creek Confluence	440	270	63	63	< 10	86	530
317.2	Big Sandy River Confluence							640
	Big Sandy River @ 1st Bridge	100		64		136	95	
319.7	Ashland WTP Intake	400	580	480	127	91	264	470
324.7	Submarine Crossing	191	220	250	55	109	144	360
327.0	Ironton WTP Intake	882	182	100	64	55	141	118
331.0	Pond Run Confluence	410	600	470	580	330	467	240
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #4 - 8/11/94 - Dry Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section	Longitudinal
		L	LQ	M	RQ	R	*Mean	Grab Sample
301.0	Public Launching Ramp	27	<10	46	18	27	23	18
305.2	Guyandotte River Confluence							108
	Guyandotte River @ 1st Bridge	210		216		162	194	
306.9	Huntington WTP - Intake #2	55	64	18	< 10	< 10	23	73
310.8	West End Bridge	45	64	<10	46	<10	11	27
311.9	Fourpole Creek Confluence	260	54	18	18	54	48	162
317.2	Big Sandy River Confluence							36
	Big Sandy River @ 1st Bridge	100		109		155	119	
319.7	Ashland WTP Intake	36	55	27	46	73	45	82
324.7	Submarine Crossing	36	64	82	27	82	53	55
327.0	Ironton WTP Intake	36	36	46	46	64	45	73
331.0	Pond Run Confluence	73	46	< 10	< 10	<10	20	45
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #5 - 8/18/94 - Dry Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	73	36	27	82	73	53	109
305.2	Guyandotte River Confluence							3100
	Guyandotte River @ 1st Bridge	2800		2900		3000	2899	
306.9	Huntington WTP - Intake #2	340	440	73	118	155	182	380
310.8	West End Bridge	340	240	91	82	420	191	300
311.9	Fourpole Creek Confluence	189	171	90	108	198	144	380
317.2	Big Sandy River Confluence							164
	Big Sandy River @ 1st Bridge	55		36		118	62	
319.7	Ashland WTP Intake	182	136	91	91	118	119	146
324.7	Submarine Crossing	164	100	55	73	82	88	218
327.0	Ironton WTP Intake	200	136	64	55	55	88	73
331.0	Pond Run Confluence	340	220	18	82	27	79	55
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #6 - 8/25/94 - Dry Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	82	127	220	164	173	145	173
305.2	Guyandotte River Confluence							126
	Guyandotte River @ 1st Bridge	865		1000		1243	1024	
306.9	Huntington WTP - Intake #2	570	230	155	200	136	223	370
310.8	West End Bridge	191	109	82	64	118	105	260
311.9	Fourpole Creek Confluence	144	162	63	63	72	92	117
317.2	Big Sandy River Confluence							155
	Big Sandy River @ 1st Bridge	136		127		240	161	
319.7	Ashland WTP Intake	380	100	127	118	191	161	182
324.7	Submarine Crossing	182	145	91	64	73	102	310
327.0	Ironton WTP Intake	240	182	64	36	55	89	82
331.0	Pond Run Confluence	240	182	210	45	82	128	82
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #7 - 8/30/94 - Dry Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section	Longitudinal
		L	LQ	M	RQ	R	*Mean	Grab Sample
301.0	Public Launching Ramp	55	64	55	36	91	58	91
305.2	Guyandotte River Confluence Guyandotte River @ 1st Bridge	901		802		910	870	370
306.9	Huntington WTP - Intake #2	430	136	27	27	82	81	100
310.8	West End Bridge	360	300	109	36	73	125	270
311.9	Fourpole Creek Confluence	280	290	81	18	72	97	45
317.2	Big Sandy River Confluence Big Sandy River @ 1st Bridge	109		91		127	108	240
319.7	Ashland WTP Intake	270	200	145	55	36	109	280
324.7	Submarine Crossing	100	64	82	36	73	67	145
327.0	Ironton WTP Intake	250	82	109	55	45	89	45
331.0	Pond Run Confluence	340	270	109	55	27	108	18
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #8 - 9/08/94 - Dry Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	55	18	18	< 10	45	24	27
305.2	Guyandotte River Confluence							63
	Guyandotte River @ 1st Bridge	6909		2700		928	2587	
306.9	Huntington WTP - Intake #2	320	164	260	82	< 10	102	118
310.8	West End Bridge	127	36	18	< 10	18	27	64
311.9	Fourpole Creek Confluence	109	< 10	18	< 10	< 10	18	18
317.2	Big Sandy River Confluence							91
	Big Sandy River @ 1st Bridge	55		36		91	56	
319.7	Ashland WTP Intake	173	55	18	100	64	64	64
324.7	Submarine Crossing	973	18	55	36	100	81	127
327.0	Ironton WTP Intake	220	173	91	64	36	96	73
331.0	Pond Run Confluence	250	73	73	< 10	< 10	42	36
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #9 - 9/15/94 - Dry Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section	Longitudinal
		L	LQ	M	RQ	R	*Mean	Grab Sample
301.0	Public Launching Ramp	64	< 10	< 10	< 10	36	19	< 10
305.2	Guyandotte River Confluence							27
	Guyandotte River @ 1st Bridge	1036		2300		856	1268	
306.9	Huntington WTP - Intake #2	55	55	45	27	18	37	55
310.8	West End Bridge	118	73	45	27	27	49	82
311.9	Fourpole Creek Confluence	865	450	36	< 10	18	76	126
317.2	Big Sandy River Confluence							27
	Big Sandy River @ 1st Bridge	< 10		< 10		55	18	
319.7	Ashland WTP Intake	36	36	45	36	27	36	< 10
324.7	Submarine Crossing	64	45	< 10	27	45	32	64
327.0	Ironton WTP Intake	27	18	36	55	27	30	27
331.0	Pond Run Confluence	91	36	27	27	< 10	30	64
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #10 - 9/22/94 - Dry Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	55	18	< 10	< 10	36	20	18
305.2	Guyandotte River Confluence Guyandotte River @ 1st Bridge	117		135		250	158	18
306.9	Huntington WTP - Intake #2	45	27	< 10	< 10	18	19	73
310.8	West End Bridge	< 10	< 10	18	18	55	18	145
311.9	Fourpole Creek Confluence	45	36	54	< 10	36	32	108
317.2	Big Sandy River Confluence Big Sandy River @ 1st Bridge	< 10		27		< 10	14	< 10
319.7	Ashland WTP Intake	36	118	63	55	< 10	43	64
324.7	Submarine Crossing	< 10	27	< 10	< 10	< 10	12	36
327.0	Ironton WTP Intake	18	< 10	< 10	< 10	< 10	11	18
331.0	Pond Run Confluence	< 10	18	< 10	< 10	45	15	18
	Longitudinal Blank Cross-Section Blank	< 10 < 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #11 - 9/28/94 - Dry Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section	Longitudinal
		L	LQ	M	RQ	R	*Mean	Grab Sample
301.0	Public Launching Ramp	55	36	18	< 10	18	23	18
305.2	Guyandotte River Confluence							54
	Guyandotte River @ 1st Bridge	694		748		1270	870	
306.9	Huntington WTP - Intake #2	145	109	127	73	27	83	73
310.8	West End Bridge	260	100	< 10	36	27	48	64
311.9	Fourpole Creek Confluence	210	54	63	72	27	67	117
317.2	Big Sandy River Confluence							200
	Big Sandy River @ 1st Bridge	36		45		64	47	
319.7	Ashland WTP Intake	220	155	136	73	100	128	127
324.7	Submarine Crossing	240	109	136	109	73	123	127
327.0	Ironton WTP Intake	240	173	200	91	145	161	91
331.0	Pond Run Confluence	136	182	100	200	109	140	127
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #12 - 10/10/94 - Wet Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section	Longitudinal
		L	LQ	M	RQ	R	*Mean	Grab Sample
301.0	Public Launching Ramp	18	27	< 10	18	36	20	18
305.2	Guyandotte River Confluence							54
	Guyandotte River @ 1st Bridge	3700		2800		3200	3212	
306.9	Huntington WTP - Intake #2	109	73	64	< 10	27	42	100
310.8	West End Bridge	230	91	127	27	36	76	460
311.9	Fourpole Creek Confluence	300	162	72	72	18	85	400
317.2	Big Sandy River Confluence							230
	Big Sandy River @ 1st Bridge	250		118		145	162	
319.7	Ashland WTP Intake	45	82	91	100	36	66	82
324.7	Submarine Crossing	64	155	55	45	45	64	109
327.0	Ironton WTP Intake	280	136	182	91	45	123	100
331.0	Pond Run Confluence	73	36	55	18	18	34	73
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #13 - 10/19/94 - Wet Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section	Longitudinal
		L	LQ	M	RQ	R	*Mean	Grab Sample
301.0	Public Launching Ramp	< 10	18	< 10	36	18	16	18
305.2	Guyandotte River Confluence							621
	Guyandotte River @ 1st Bridge	24000		10182		22000	17518	
306.9	Huntington WTP - Intake #2	909	809	600	450	490	628	250
310.8	West End Bridge	3700	2000	250	2800	191	998	200
311.9	Fourpole Creek Confluence	3000	901	380	480	135	582	2700
317.2	Big Sandy River Confluence							520
	Big Sandy River @ 1st Bridge	560		36		73	114	
319.7	Ashland WTP Intake	109	73	82	55	45	69	118
324.7	Submarine Crossing	82	155	200	118	36	102	164
327.0	Ironton WTP Intake	55	91	64	91	73	73	118
331.0	Pond Run Confluence	36	55	73	64	18	44	64
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #14 - 11/01/94 - Wet Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	64	18	< 10	27	< 10	20	64
305.2	Guyandotte River Confluence Guyandotte River @ 1st Bridge	3900		1351		2100	2228	54
306.9	Huntington WTP - Intake #2	580	530	280	< 10	36	125	2400
310.8	West End Bridge	3600	320	480	136	36	307	3300
311.9	Fourpole Creek Confluence	1351	991	36	54	27	148	350
317.2	Big Sandy River Confluence Big Sandy River @ 1st Bridge	< 10		55		< 10	18	82
319.7	Ashland WTP Intake	173	82	27	18	18	42	136
324.7	Submarine Crossing	330	200	136	73	45	124	64
327.0	Ironton WTP Intake	27	27	45	36	18	29	18
331.0	Pond Run Confluence	36	100	91	109	109	83	73
	Longitudinal Blank Cross-Section Blank	< 10 < 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

CSO LONGITUDINAL & CROSS-SECTION SURVEYS

Bacteria Data

Survey #15 - 11/10/94 - Wet Weather Event

Sampling Mile Point	Site Description	Sample Locations (Fecal coliform colonies / 100mL)						
		Cross-Section Grab Samples					Cross-Section *Mean	Longitudinal Grab Sample
		L	LQ	M	RQ	R		
301.0	Public Launching Ramp	36	36	27	36	36	34	45
305.2	Guyandotte River Confluence							36
	Guyandotte River @ 1st Bridge	162		126		81	118	
306.9	Huntington WTP - Intake #2	109	55	64	91	< 10	51	118
310.8	West End Bridge	470	64	18	27	27	52	270
311.9	Fourpole Creek Confluence	694	189	63	36	73	117	430
317.2	Big Sandy River Confluence							230
	Big Sandy River @ 1st Bridge	18		< 10		< 10	12	
319.7	Ashland WTP Intake	560	290	173	55	< 10	109	136
324.7	Submarine Crossing	310	55	18	27	27	47	118
327.0	Ironton WTP Intake	64	100	36	18	27	41	18
331.0	Pond Run Confluence	73	36	27	64	82	52	100
	Longitudinal Blank	< 10						
	Cross-Section Blank	< 10						

* Indicates Geometric Mean

Designation for cross-section grab samples (L = Left Bank; LQ = Left Quarter; M = Midstream; RQ = Right Quarter; R = Right Bank)

APPENDIX 9

Guyandotte River Investigation
Bacteria Data

CSO GUYANDOTTE RIVER INVESTIGATION

Bacteria Data

Date	Event	Mile Point	Site Description	Fecal Coliform CFU/100 mL	Sampling Location	Collected By
08/30/94	Dry Weather	0.1	Third Ave. Highway Bridge	870	L, M, R	ORSANCO
		1.3	Robey Road Bridge	892	M	ORSANCO
		2.0	Submarine Crossing	991	M	ORSANCO
09/08/94	Dry Weather	0.1	Third Ave. Highway Bridge	2587	L, M, R	ORSANCO
		0.7	2nd RR Bridge from Confluence	410	M	ORSANCO
		1.5	Aerial Pipeline Crossing	370	M	ORSANCO
		2.8	Russell Creek Bridge	70	M	Huntington WWTP
		3.0	8th Street Boat Dock	347	M	Huntington WWTP
09/15/94	Dry Weather	0.1	Third Ave. Highway Bridge	1268	L, M, R	ORSANCO
		0.7	2nd RR Bridge from Confluence	360	M	ORSANCO
		1.5	Aerial Pipeline Crossing	470	M	ORSANCO
		2.8	Russell Creek Bridge	860	M	Huntington WWTP
		3.0	8th Street Boat Dock	467	M	Huntington WWTP
09/22/94	Dry Weather	0.1	Third Ave. Highway Bridge	158*	L, M, R	ORSANCO
		0.7	2nd RR Bridge from Confluence	520	M	ORSANCO
		1.5	Aerial Pipeline Crossing	430	M	ORSANCO
09/28/94	Dry Weather	0.1	Third Ave. Highway Bridge	870*	L, M, R	ORSANCO
		0.7	2nd RR Bridge from Confluence	320	M	ORSANCO
		1.5	Aerial Pipeline Crossing	240	M	ORSANCO
		2.8	Russell Creek Bridge	513	M	Huntington WWTP
		3.0	8th Street Boat Dock	443	M	Huntington WWTP
10/10/94	Wet Weather	0.1	Third Ave. Highway Bridge	3212	L, M, R	ORSANCO
		0.7	2nd RR Bridge from Confluence	340	M	ORSANCO
		1.5	Aerial Pipeline Crossing	430	M	ORSANCO
10/19/94	Wet Weather	0.1	Third Ave. Highway Bridge	17518	L, M, R	ORSANCO
		0.7	2nd RR Bridge from Confluence	4000	M	ORSANCO
		1.5	Aerial Pipeline Crossing	2500	M	ORSANCO
11/01/94	Wet Weather	0.1	Third Ave. Highway Bridge	2228	L, M, R	ORSANCO
		0.7	2nd RR Bridge from Confluence	680	M	ORSANCO
		1.5	Aerial Pipeline Crossing	830	M	ORSANCO
11/10/94	Wet Weather	0.1	Third Ave. Highway Bridge	118	L, M, R	ORSANCO
		0.7	2nd RR Bridge from Confluence	135	M	ORSANCO
		1.5	Aerial Pipeline Crossing	81	M	ORSANCO

*Designates Ohio River Backwater

Designation for grab samples (L = Left Descending Bank, M – Midstream, R = Right Descending Bank)

Note: Locations with L, M, R = Geometric Mean for Fecal Coliform Count

APPENDIX 10

BTEX Data

BTEX VALUES
(PPB)

Sample Identification	SURVEY NUMBER														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mile Point															
301.0	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
305.2	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
306.9	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
310.8	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
311.9	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
317.2	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
319.7	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
324.7	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
327.0	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
331.0	< 90	< 90	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
GC Confirmation															
319.7	Invalid	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1	< 0.5	0.6
Blanks															
Longitudinal	< 90	< 90	< 1	< 1	< 1	< 1	< 1	2.8	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Discharge	< 0.5							2.5							4.8
Bucket	< 0.5							2.6							4.7
Container	< 0.5							2.7							4.0