Biennial Assessment of Ohio River Water Quality Conditions

for Water Years 2006 and 2007

September 2008

The Ohio River Valley Water Sanitation Commission
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Cincinnati, Ohio 45228-1112

EXECUTIVE SUMMARY

The Ohio River is one of the nation's great natural resources. It provides drinking water to nearly five million people; is a warm water habitat for aquatic life; provides numerous recreational opportunities; is used as a major transportation route; and is a source of water for manufacturing and power generation. The Ohio River forms in Pittsburgh, Pennsylvania at the confluence of the Allegheny and Monongahela rivers and flows in a southwesterly direction for 981 miles to join the Mississippi River near Cairo, Illinois. The first 40 miles of the Ohio River stay within the state of Pennsylvania. The remaining 941 miles form the state boundaries between Illinois, Indiana, and Ohio to the north, and Kentucky and West Virginia to the south.

The Ohio River Valley Water Sanitation Commission (ORSANCO; the Commission) is an interstate agency charged with abating existing pollution in the Ohio River Basin, and preventing future degradation of its waters. ORSANCO was created in 1948 with the signing of the Ohio River Valley Water Sanitation Compact. This report fulfills the following requirements of the Ohio River Valley Water Sanitation Compact:

1. To survey the district to determine water pollution problems.
2. To identify instances in which pollution from a state(s) injuriously affects waters of another state(s).

This report is a biennial assessment of Ohio River water quality conditions in terms of the degree to which the river supports each of its four designated uses: warm water aquatic life, public water supply, contact recreation, and fish consumption. The Ohio River Valley Water Sanitation Compact commits "...each state to place and maintain the waters of the basin in a satisfactory sanitary condition, available for safe and satisfactory use by public and industrial water supplies after reasonable treatment, suitable for recreation, capable of maintaining fish and other aquatic life...."

This assessment uses three classifications to describe the attainment of Ohio River designated uses: fully supporting (good water quality), partially supporting (fair water quality), and not supporting (poor water quality). ORSANCO conducts water quality monitoring and assessments on behalf of the Ohio River mainstem states (Illinois, Indiana, Kentucky, Ohio, Pennsylvania and West Virginia). This report provides a status of water quality from 2005-2007; however, in some cases data outside this range has been utilized in assessments. In addition, an Integrated List containing waters in need of Total Maximum Daily Loads (TMDLs) was completed (Table 10) in an effort to promote interstate consistency for Ohio River TMDLs.

Warm Water Aquatic Life Use Support

Ohio River warm water aquatic life use support was assessed based on chemical water quality data collected from ORSANCO's 17 clean metals and bimonthly sampling stations located on the mainstem, as well as direct measurements of fish communities from a large number of stream bank sites. Clean metals and bimonthly sampling, which occurred every other month at the 17 mainstem locations, detected no violations of ORSANCO's dissolved metals or bimonthly parameter criteria in relation to warm water aquatic life use support during this reporting period; therefore, no impairment designations resulted from this data.

Fish communities were assessed using ORSANCO's Ohio River Fish Index (ORFIn) for evaluating fish population data. Although numeric criteria have not yet been adopted into ORSANCO Pollution Control Standards, use of ORFIn allowed for the comprehensive assessment of Ohio River fish conditions. The Ohio River is divided into 20 assessment units based primarily on the locations of navigational dams. Using a random design, each assessment unit is assigned fifteen sampling locations to represent the fish community condition within a pool. This is being conducted on a rotating cycle with four pools sampled each year and the entire river sampled within five years. Sites are assessed as passing or failing when ORFIn scores are compared to expected values for a specific habitat type. Impairment is indicated when greater than 25 percent of sites within a pool have failing ORFIn scores. Sites sampled and data collected from July to October 2006 and 2007 were used for the 2008 report (Appendix K).

Sites are classified as fully supporting if fewer than 10 percent of water samples exceed the criteria for one or more pollutants and biological data do not indicate aquatic life impairment. Fair water quality is indicated by exceedances of criteria in 11-25 percent of the samples or biological data that suggested impairment. Sites are classified as not supporting if both water quality and biological data indicate impairment. No impairment was indicated from the biological data during the 2006-2007 sampling periods.

Dissolved oxygen and water temperature data were collected from thirteen stations (immediately upstream of 12 dams and at one power plant) on the Ohio River during months May through October 2006 and 2007 (Appendix E). *In situ* monitors are owned and operated by the US Army Corps of Engineers (seven locations), hydropower operators (five locations), and one coal-fired power plant operator. Hourly measurements are stored at each location, and ORSANCO electronically down-loads this data. For dissolved oxygen, stations with greater than 10% of days below 5 mg/L daily average have been identified as

partially supporting the Aquatic Life Use. Two pools, J.T. Myers and Smithland (ORM 776.1 – 918.5), have been classified as partially supporting and requiring a TMDL. Partial Support is also indicated for stations having more than 10% of the periods exceed the period average in relation to water temperature. Stations with more than 10% of the periods exceeding the period average for temperature include Cannelton, Newburgh, and J.T. Myers. Available biological data indicates full support for the Cannelton and Newburgh pools. Only the J.T. Myers pool will be listed as partially supporting (ORM 776.1 – 848.0) and requiring a TMDL, based on unavailable biological data for the J.T. Myers pool for this assessment period. A weight-of-evidence approach is used here because biological data is a more direct indicator of aquatic life conditions.

Public Water Supply Use Support

Ohio River public water supply use support was assessed based on chemical water quality data collected from the Bimonthly Sampling Program (Appendix D), bacteria monitoring (Appendix F, G), and questionnaires sent to water utilities to assess impacts on Ohio River drinking water utilities caused by source water conditions (Figure 10). Data included in this report were collected from October 2005 to October 2007. The river was designated as fully supporting this use if pollutant criteria were exceeded in less than 10 percent of the samples collected. The river is considered in fair condition (impaired, but partially supporting) if one or more pollutants exceeded the criteria in 11-25 percent of the samples collected, if frequent intake closures due to elevated levels of pollutants were necessary to protect water supplies, or frequent "non-routine" additional treatment was necessary to protect water supplies. Poor river conditions were indicated by exceedances of criteria in greater than 25 percent of the samples collected, or if source water quality caused finished water Maximum Contaminant Levels (MCL) violations, which resulted in noncompliance with provisions of the Safe Drinking Water Act (SDWA).

Approximately one-tenth of the river is classified as partially supporting the public water supply use. Surveys were received from 22 out of 29 water utilities that use the Ohio River as a source for drinking water. No utility indicated violations of the Safe Drinking Water Act for MCLs in finished water that could be attributable to Ohio River source water quality. Spills were not considered in the assessment. The partially supporting impairment identifications were made from Bimonthly Sampling data and Bacteria Sampling data. The Bimonthly Sampling data contain Phenol criterion exceedances of >5 mg/L in greater than 10% of samples for Newburgh and L&D 52 stations. This caused the use designation of partially supporting for the L&D 52 and 53 Pools (ORM 918.5 – 962.6), and the Newburgh Pool beginning at the Cannelton L&D to the confluence of the Green River (ORM 720.7 – 784.2). The Fecal coliform monthly geometric mean criterion of 2000 CFU/100 mL for the protection of water supplies was exceeded in greater than 10% of months at the Pittsburgh station ORM 1.4, but not at station 4.3. Therefore, the river is designated as partially supporting from ORM 0.0 – 4.0.

Contact Recreation Use Support

Bacteria data from longitudinal surveys completed since 2003 (Appendix F), as well as recreation season monitoring bacteria data (Appendix G) from the six largest CSO urban areas for 2006-2007 were used to assess the contact recreational use (Appendix H). Because bacteria data are so variable and influenced by precipitation, it was decided to use all the available longitudinal data (back to 2003) instead of just the results from 2006-2007. The result is that more of the river is designated as impaired than if only the recent data were used, since 2006-2007 data were generally collected under dry conditions.

Impairments are based on exceedances of ORSANCO's stream criteria for bacteria. For the longitudinal surveys, sites are designated Partially Supporting if 11-25% of samples exceed the single sample maximum criterion, and Not Supporting if greater than 25% of samples exceed the single sample maximum, or the geometric mean criterion is exceeded. For the recreation season monitoring, a month is considered to exceed criteria if the single sample maximum is exceeded in more than 10% of samples, or the geometric mean criterion is exceeded. Then, if 11-25% of months exceed criteria, the site is designated Partially Supporting, and Not Supporting if greater than 25% of months exceed criteria. Approximately 484 miles of the Ohio River are classified as impaired (fair or poor water quality) for the contact recreation use. Fifty percent of the Ohio River is classified as fully supporting this use.

Fish Consumption Use Support

Fish consumption use support is assessed based primarily on the states' issuance of fish consumption advisories (Appendix M) and ORSANCO fish tissue contaminants data (Appendix I, J, L). Sites are classified as fully supporting if there are no fish consumption advisories and if PCBs, dioxins, and mercury did not exceed criteria. If contaminants exceeded criteria or fish consumption advisories are in effect, sites were considered impaired with fair water quality. Poor water quality is indicated by "no consumption" advisories. Under these advisories, it is recommended that no fish from the river be consumed by any individuals. None of these types of advisories were observed during the reporting period.

Through the Ohio River Watershed Pollutant Reduction Program, ORSANCO collected "high volume" Ohio River water samples that were analyzed for dioxin and polychlorinated biphenyls (PCBs). These data sets were compared to applicable ambient water quality criteria established for the protection of human health due to water and fish ingestion. Dioxin and PCB

monitoring exceeded the applicable water quality criterion in every sample. Because of the widespread criteria violations for dioxin and PCBs, the entire river is assessed as impaired by these contaminants.

For mercury, a dual criterion, including water column and fish tissue data, is used in the assessment of fish consumption. The total mercury water column criterion was exceeded in greater than 10% of samples at five stations during the 2006 – 2007 sampling period; however there was only one fish tissue mercury criterion exceedance which occurred at Willow Island (ORM 161.7). Conclusions based on criteria violations conflict, and the fish tissue criterion is theoretically a more direct measure of impairment. So, a weight-of-evidence approach was employed and the river is not listed as impaired due to mercury. All 981 miles (100 percent) of the Ohio River are classified as partially supporting fish consumption use due to advisories for PCBs and widespread dioxin violations.

The following table is a state-by-state summary of impaired uses of the Ohio River.

State	River Miles	Aquatic Life Use Impairment	Contact Recreation Use Impairment	Public Water Supply Use Impairment	Fish Consumption Use Impairment
PA	0.0-40.2	0	40.2	4	40.2
OH-WV	40.2-317.1	0	176.0	0	276.9
OH-KY	317.1-491.1	0	18.7	0	174.2
IN-KY	491.1-848.0	71.9	243.5	63.5	356.7
IL-KY	848.0-981.0	70.5	5.2	44.1	133.0
TOTAL	981.0	142.4	483.6	111.6	981

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PART I: INTRODUCTION

The Ohio River Valley Water Sanitation Commission (ORSANCO; the Commission) is an interstate water pollution control agency for the Ohio River. ORSANCO was established in 1948 through the signing of the Ohio River Valley Water Sanitation Compact by representatives of the eight member states: Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia and West Virginia, and approved by Congress. Under the terms of the Compact, the states pledged to cooperate in the control of water pollution within the Ohio River Basin. Article VI of the Compact states that the guiding principal "shall be that pollution by sewage or industrial wastes originating in a signatory state shall not injuriously affect the various uses of the interstate waters." ORSANCO carries out a variety of programs, which primarily focus on the Ohio River mainstem, to address this principle. General program areas include water quality monitoring and assessment, emergency response, pollution control standards, and public information and education. The Commission also provides an excellent forum for information exchange and technology transfer among the states' water pollution control and natural resources agencies.

The Compact designates the Ohio River to be "available for safe and satisfactory use as public and industrial water supplies after reasonable treatment, suitable for recreational usage, capable of maintaining aquatic life…and adaptable to such other uses as may be legitimate." No degradation of Ohio River water quality, which would interfere with or become injurious to these uses, shall be permitted. ORSANCO monitors and assesses the Ohio River on behalf of the compact states. This report focuses on the water quality of the main stem of the Ohio River, though monitoring is conducted on tributaries as well. The Ohio River forms in Pittsburgh, Pennsylvania, at the confluence of the Allegheny and Monongahela Rivers. The river is 981 miles long and generally flows southwest to join the Mississippi River near Cairo, Illinois. The first 40 miles of the Ohio River are wholly within Pennsylvania. The remaining 941 miles form the state boundaries between Illinois, Indiana, and Ohio to the north, and Kentucky and West Virginia to the south.

This report generally covers the time between October, 2005 and October, 2007, although certain assessments use earlier data. The assessment methodologies and supporting data used to generate this assessment are contained within this report and its appendices. For this report, Ohio River water quality is determined by the degree of support for each of the following designated uses: warm water aquatic life habitat, public water supply, contact recreation, and fish consumption. Each designated use is evaluated using specific numeric water quality criteria, the existence of advisories against consuming fish, surveys and questionnaires, and a direct measure of biological communities within the Ohio River. Based on water quality conditions, the Ohio River is classified as fully, partially or not supporting each of the designated uses. Fully supporting indicates minor or no water quality problems. A designation of "partial support" indicates impairment, but data suggest fair water quality. A designation of "not supporting" also indicates impairment; however, in this case data indicate poor water quality.

Contained in this report are assessments of Ohio River designated use attainment, as well as an "Integrated List" of waters requiring Total Maximum Daily Loads (TMDLs). ORSANCO's role in completing Ohio River use attainment assessments and an Integrated List is to facilitate interstate consistency. However, the states' are not obligated to incorporate any or all of this assessment into their own reports. Specifically, the United States Environmental Protection Agency (USEPA) has prepared "Guidance for 2006 Assessment, Listing, and Reporting Requirements Pursuant to Sections 303(d), 305(B) and 314 of the Clean Water Act." This guidance states that "data and information in an interstate commission 305(b) report should be considered by the states as one source of readily available data and information when they prepare their Integrated Report and make decisions on segments to be placed in Category 5; however, data in a 305(b) Interstate Commission Report should not be automatically entered in a state Integrated Report or 303(d) list without consideration by the state about whether such inclusion is appropriate."

PART II: BACKGROUND

Chapter 1: Ohio River Watershed

Basin Characteristics

The Ohio River drains 203,940 square miles, which is approximately five percent of the contiguous United States (Figure 1). Although the river is 981 miles in length and flows through or borders 6 states, only five percent of the basin actually drains directly into the Ohio River. Instead the river is fed by numerous tributaries, including the Allegheny, Monongahela, Kanawha, Wabash, Green, Cumberland, and Tennessee rivers. These are only a few of the watersheds that make up the Ohio River Basin, which covers portions of 15 states. Over 25 million people, approximately ten percent of the United States' population, reside in the Ohio River Basin. An estimated 3.6 million people live in cities and towns adjacent to the Ohio River.

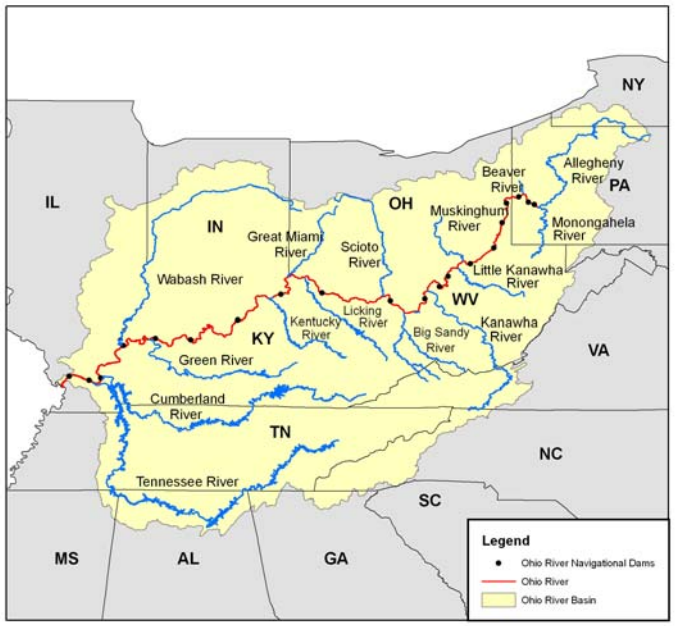


Figure 1. The Ohio River is fed by numerous tributaries. Twenty lock and dam systems regulate the water levels and allow navigation on the river.

The Ohio River watershed is comprised of a number of different land use types, including agricultural, industrial, urban, and forested areas (Figure 2). Land use is a significant factor in determining both the runoff characteristics of a drainage basin and the water quality of its streams. Land uses such as agriculture, industry, and mining can lead to impairments in water quality. Due to the high concentration of people in the watershed, urban runoff is a large contributor to degraded water quality as well. For example, in paved areas, water is conveyed to streams and rivers more quickly, transporting pollutants directly to the water bodies. In contrast, runoff is conveyed more slowly in forested areas where water can infiltrate the soil.

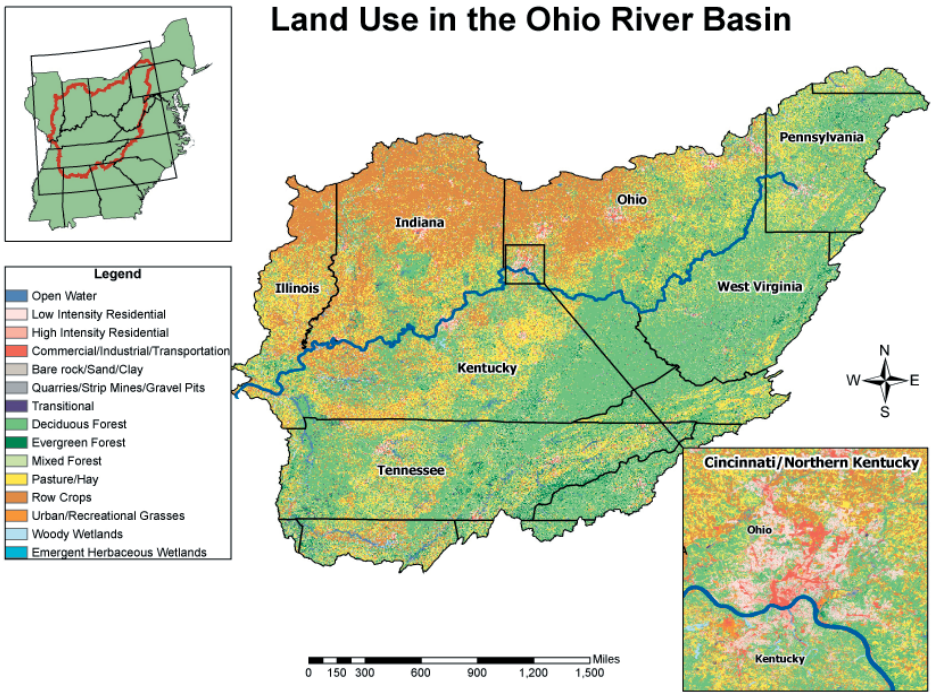


Figure 2 The Ohio River Valley supports a variety of land use types. Like most of the Midwest, states such as Ohio and Indiana are dominated by agriculture. As shown in the inset (Cincinnati/Northern Kentucky), highly populated regions of the river are characterized by residential, commercial, and industrial land use types.

Description of Ohio River Pools

The Ohio River is divided into 21 segments by 20 navigational dams (Figure 1). These dams have a significant impact on the flow, water quality and aquatic communities of the river. The modern high lift dams have resulted in a deeper, slower moving river than existed prior to their construction. Because each pool has its own unique characteristics, these water bodies often have been used for assessment and reporting purposes in the past. For this 2008 Biennial Assessment, aquatic life use attainment is determined using the navigational pools as separate assessment units; however, the degree of use support for the remaining uses is assessed for each river mile. It was determined that this method provided a more accurate description of the river. The following descriptions include the boundaries of each water body as well as other relative information.

- **Pittsburgh Point-Emsworth** (mile point 0-6.2) This water body is bounded by the confluence of the Allegheny and Monongahela rivers (the origin of the Ohio River) on the upstream end and by the Emsworth Locks & Dam on the downstream end. Chartiers Creek, with a drainage area of 277 square miles, intersects this water body at mile point 2.5.

- **Emsworth-Dashields** (mile point 6.2-13.3) This 7.1-mile-long water body encompasses the entire Dashields Pool and is bounded by the Emsworth Locks & Dam upstream and the Dashields Locks & Dam on the downstream end.

- **Dashields-Montgomery** (mile point 13.3-31.7) This 18.4-mile-long water body is bounded by the Dashields Locks & Dam upstream and the Montgomery Locks & Dam on the downstream end. Two tributaries that enter this navigational pool include the Beaver and Raccoon rivers at river miles 25.4 and 29.6 respectively.

- **Montgomery-New Cumberland** (mile point 31.7-54.4) This 22.7-mile-long water body is bounded by the Montgomery Locks & Dam upstream and New Cumberland Locks & Dam downstream. At mile point 40.2 the Ohio River leaves Pennsylvania to be bordered by Ohio to the north and West Virginia to the south. The Little Beaver River, with a drainage area of 510 square miles, intersects this water body at mile point 39.5. Yellow Creek, with a drainage area of 240 square miles, intersects this water body at mile point 50.4.

- **New Cumberland-Pike Island** (mile point 54.4-84.2) This 29.8-mile-long water body encompasses the entire Pike Island Pool and is bounded by the New Cumberland Locks & Dam upstream and the Pike Island Locks & Dam on the downstream end. The following tributaries intersect this water body: Buffalo Creek at mile point 74.7 with a drainage area of 160 square miles, and Short Creek at mile point 81.4 with a drainage area of 147 square miles.

- **Pike Island-Hannibal** (mile point 84.2-126.4) This 42.2-mile-long water body encompasses the entire Hannibal Pool and is bounded by the Pike Island Locks & Dam upstream and the Hannibal Locks & Dam on the downstream end. The following tributaries intersect this water body: Wheeling Creek in Ohio at mile point 91.0 with a drainage area of 108 square miles, Wheeling Creek in West Virginia at mile point 91.0 with a drainage area of 300 square miles, McMahon Creek at mile point 94.7 with a drainage area of 91 square miles, Grave Creek at mile point 102.5 with a drainage area of 75 square miles, Captina Creek at mile point 109.6 with a drainage area of 181 square miles, Fish Creek at mile point 113.8 with a drainage area of 250 square miles, and Sunfish Creek at mile point 118.0 with a drainage area of 114 square miles.

- **Hannibal-Willow Island** (mile point 126.4-161.7) This 35.3-mile-long water body encompasses the entire Willow Island Pool and is bounded by the Hannibal Locks & Dam upstream and the Willow Island Locks & Dam on the downstream end. The following tributaries intersect this water body: Fishing Creek at mile point 128.3 with a drainage area of 220 square miles, Middle Island Creek at mile point 154.0 with a drainage area of 560 square miles, and Little Muskingum River at mile point 168.3 with a drainage area of 315 square miles.

- **Willow Island-Belleville** (mile point 161.7-203.9) This 42.2-mile-long water body is bounded by Willow Island Locks & Dam on the upstream side and Belleville Locks & Dam on the downstream side. Duck Creek, with a drainage area of 228 square miles, intersects this water body at mile point 170.7. The Muskingum River has a drainage area of 8,040 square miles and enters the Ohio River at mile point 172.2. Other tributaries intersecting this water body include the Little Kanawha River at mile point 184.6 with a drainage area of 2,320 square miles, Little Hocking River at mile point 191.8 with a drainage area of 103 square miles, and Hocking River at mile point 199.3 with a drainage area of 1,190 square miles.

- **Belleville-Racine** (mile point 203.9-237.5) This 33.6-mile-long water body encompasses the entire Racine Pool and is bounded by the Belleville Locks & Dam upstream and the Racine Locks & Dam on the downstream end. The following tributaries intersect this water body: Shade River at mile point 210.6 with a drainage area of 221 square miles, Shady Creek at mile point 220.6 with a drainage area of 115 square miles, and Mill Creek at mile point 231.5 with a drainage area of 230 square miles.

- **Racine-Kanawha** (mile point 237.5-265.7) This 28.2-mile-long water body is bounded by the Racine Locks & Dam upstream and Kanawha River on the downstream end. Leading Creek, with a drainage area of 151 square miles, intersects this water body at mile point 254.2.

- **Kanawha-Robert C. Byrd** (mile point 265.7-279.2) This 13.5-mile-long water body is bounded by the Kanawha River upstream and the Robert C. Byrd (R.C. Byrd, formerly Gallipolis) Locks & Dam on the downstream end. The Kanawha River has a drainage area of 12,200 square miles. Raccoon Creek, with a drainage area of 684 square miles, intersects this water body at mile point 276.0.

- **Robert C. Byrd-Greenup** (mile point 279.2-341.0) This 61.8-mile-long water body is bounded by the RC Byrd Locks & Dam on the upstream and the Greenup Locks & Dam downstream. The following tributaries intersect this water body: Guyandotte River at mile point 305.2 with a drainage area of 1,670 square miles, Symmes Creek at mile point 308.7 with a drainage area of 356 square miles, and Twelvepole Creek at mile point 313.2 with a drainage area of 440 square miles. The Big Sandy River, forming the border between West Virginia and Kentucky, enters the Ohio River at mile point 317.1 with a drainage area of 4,280 square miles. The Little Sandy River, with a drainage area of 724 square miles, enters the Ohio River at mile point 336.4.

- **Greenup-Meldahl** (mile point 341.0-436.2) This 95.2-mile-long water body is bounded by the Greenup Locks & Dam upstream and Meldahl Lock & Dam on the downstream end. The following tributaries intersect this water body: Pine Creek at mile point 346.9 with a drainage area of 185 square miles, Little Scioto River at mile point 349.0 with a drainage area of 233 square miles, Tygarts Creek at mile point 353.3 with a drainage area of 336 square miles, the Scioto River at mile point 356.5 with a drainage area of 6,510 square miles, Kinniconnick Creek at mile point 368.1 with a drainage area of 253 square miles, Ohio Brush Creek at mile point 388.0 with a drainage area of 435 square miles, Eagle Creek at mile point 415.7 with a drainage area of 154 square miles, and White Oak Creek at mile point 423.9 with a drainage area of 234 square miles.

- **Meldahl-Markland** (mile point 436.2-531.5) This 95.3-mile-long water body is bounded by the Meldahl Lock & Dam upstream and the Markland Locks & Dam on the downstream end. Major tributaries intersecting this water body include the Little Miami River (river mile 464.1, drainage area 1,670 square miles), Licking River (river mile 470.2, drainage area 3,670 square miles), and Great Miami River (river mile 491.1, drainage area 5,400 square miles).

- **Markland-McAlpine** (mile point 531.5-604.4) This 72.9-mile-long water body is bounded by the Markland Locks & Dam upstream and the McAlpine Locks & Dam on the downstream end. The Kentucky River, which empties into this navigational pool, has a drainage area of 6,970 square miles. Other tributaries include the following: Little Kentucky River at mile point 546.5 with a drainage area of 147 square miles; Indian Kentucky River at mile point 550.5 with a drainage area of 150 square miles; and Silver Creek at mile point 606.5 with a drainage area of 225 square miles.

- **McAlpine-Cannelton** (mile point 604.4-720.7) This 113.9-mile-long water body is bounded by the McAlpine Locks & Dam upstream and the Cannelton Locks & Dam on the downstream end. Several tributaries intersect this portion of the Ohio River. The Salt River has a drainage area of 2,890 square miles. Other tributaries intersecting this water body include Big Indiana Creek at mile point 657 with a drainage area of 249 square miles, Blue River at mile point 663 with a drainage area of 466 square miles, and Sinking Creek at mile point 700.9 with a drainage area of 276 square miles.

- **Cannelton-Newburgh** (mile point 720.7-776.1) This 55.4-mile-long water body is bounded by the Cannelton Locks & Dam upstream and the Newburgh Locks & Dam on the downstream end. The following tributaries intersect this water body: Anderson River at mile point 731.5 with a drainage area of 276 square miles, Blackford Creek at mile point 742.2 with a drainage area of 124 square miles, and Little Pigeon Creek at mile point 773 with a drainage area of 415 square miles.

- **Newburgh-John T. Myers** (mile point 776.1-846.0) This 69.9-mile-long water body is bounded by the Newburgh Locks & Dam upstream and John T. Myers Locks & Dam (J.T. Myers, formerly Uniontown) on the downstream end. The Green River empties into this pool at river mile 784.2 and has a drainage area of 9,230 square miles. Pigeon Creek, with a drainage area of 375 square miles, intersects this water body at mile point 792.9.

- **John T. Myers-Smithland** (mile point 846.0-918.5) This 72.5-mile-long water body is bounded by the J.T. Myers Locks & Dam upstream and the Smithland Locks & Dam on the downstream end. The Wabash River has a drainage area of 33,100 square miles and enters the Ohio River at river mile 848. The Saline River, with a drainage area of 1,170 square miles, intersects this water body at mile point 867.3. The Tradewater River, with a drainage area of 1,000 square miles, intersects this water body at mile point 873.5.

- **Smithland-Lock & Dam 52** (mile point 918.5-938.9) This 20.4-mile-long water body is bounded by the Smithland Locks & Dam upstream and Lock & Dam 52 on the downstream end. The Cumberland River drains into the Ohio River at river mile 920.4 and has a drainage area of 17,920 square miles. The Tennessee River also empties into the Ohio River in this pool at river mile 932.5 with a drainage area of 40,910 square miles.

- **Lock & Dam 52-Cairo** (mile point 938.9-981) This 42.1-mile-long water body is bounded by Lock & Dam 52 upstream and the Mississippi River on the downstream end (the mouth of the Ohio River). Lock & Dam 52 as well as Lock & Dam 53 are currently being replaced by a single lock and dam facility called Olmsted Locks & Dam at river mile 964.4.

Appendix A contains additional data on basin characteristics including locations of locks and dams, locations of tributaries, and hydrologic data for water years 2005-2007.

Uses of the Ohio River

The Ohio River Basin encompasses 15 states. As such, the Ohio River is known for a variety of different uses. Specifically, through 29 public drinking water utilities and numerous industries, the river provides drinking water to approximately five million people. Forty-nine electric power-generating facilities located along the river provide greater than five percent of the United States' power generating capacity. In addition, the river serves as a transportation highway for commercial navigation. Each year, barges carry in excess of 150 million tons of cargo along the Ohio River. The majority of the commercial cargo consists of coal, oil and petroleum. Finally, the Ohio River serves as a source of recreation for many individuals throughout the basin. The river provides warm water habitat for over 129 species of fish, drawing fishermen and nature enthusiasts to the banks of the river. It also provides recreational opportunities for boaters and a natural setting for dining and festivals. According to the Clean Water Act, states must assess the degree to which state waters meet their designated uses. Designated uses for the Ohio River include contact recreation, aquatic life, public water supply, and fish consumption.

Flows

A series of locks and dams, operated and maintained by the United States Army Corps of Engineers, regulates pool elevation on the Ohio River. These dams create 20 pools with guaranteed, regulated minimum flows to assure commercial navigation at all times. Long-term average flows in the Ohio River, depending on location and time of year, range from 14,000 to 497,000 cubic feet per second (cfs). Hydrologic conditions varied considerably over the reporting period. Flow data, reported on a monthly basis by the National Weather Service, are contained in Appendix A. Figure 3 provides a comparison of flow over the reporting period compared to long-term average flows at three locations: Wheeling, WV; Markland, KY; and Smithland, KY. At all three locations the average monthly flows tended to be lower than the long-term average. Both high and low flow conditions can affect the various uses of the Ohio River adversely. Aquatic biota, for example, may experience lower dissolved oxygen levels during low flow periods. During high flow conditions, bacteria levels often increase due to combined sewer overflows (CSOs).

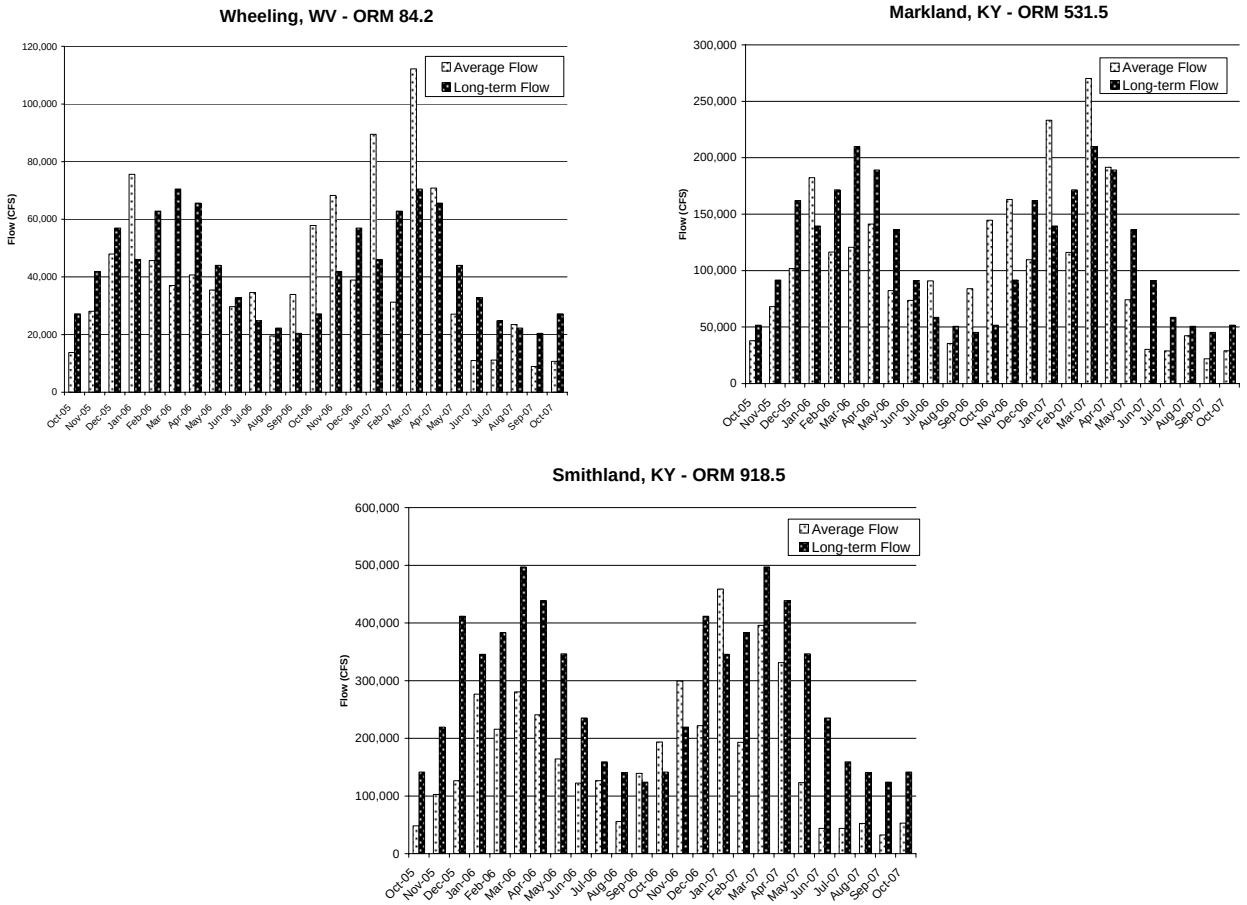


Figure 3 Flow data from the Ohio River at Wheeling, WV; Markland, KY; and Smithland, KY. Monthly average flows are compared to long-term flows. Flows in 2006-2007 tended to be lower than the long-term average. Wheeling, WV (the upper most site shown) had the highest percentage of flows greater than the long-term average**.**

Chapter 2: General Water Quality Conditions

Figure 4 presents box and whisker plots of all the Ohio River Bimonthly and Clean Metals monitoring data for the period July 2005 through July 2007. The data represents 13 sampling events conducted over the two year period, consisting of one round of sampling every other month beginning in January. Data are presented from upstream to downstream stations, which is left to right on the graphs. River mile points for each station can be found in the data tables in Appendix C and D.

Several general conclusions about the data are outlined in this chapter. A common occurrence in many of the data sets is a significant decrease in concentration between the Belleville and R.C. Byrd stations. This would be explained by the dilution caused by the Kanawha River whose flow is generally about 25 percent of the Ohio River flow. Many of the pollutant concentrations tend to increase in a downstream direction, while much fewer tend to decrease in a downstream direction which would be indicative of dilution of pollutants from upstream sources. Many of the total metals concentrations increase in a downstream direction because they are associated with (adsorbed to) suspended sediments which also increase in a downstream direction. As a general rule, West Point tends to have the highest concentrations for many of the parameters.

Ammonia concentrations are fairly consistent along the entire river, with the exception of spikes at Anderson Ferry, Louisville and West Point. West Point has the highest ammonia levels in the river with a maximum concentration of 0.5 mg/L, which is well below ORSANCO's criteria for the protection of aquatic life.

Median chloride concentrations tend to be fairly consistent along the length of the river, although slightly higher in the upper river. Median concentrations tend to be less than 40 mg/L and most of the data is below 60 mg/L, while all the data remains well below ORSANCO's water quality criterion of 250 mg/L.

Hardness increases steadily and consistently in a downstream direction. Median concentrations range from 100 mg/L in the upper river to 170 mg/L in the lower river, which would generally be considered moderately hard to hard. These concentrations would be considered "middle of the road" for river water quality.

Nitrate-Nitrite Nitrogen tends to increase consistently in a downstream direction beginning between the Greenup and Meldahl stations. Upstream of Greenup, concentrations remain consistently below 1 mg/L. All data is significantly below the stream criterion of 10 mg/L.

Very few detections of Phenolics occur, but were more prevalent at the Newburgh and L&D 52 stations, which resulted in impairments to the public water supply use. Any detection represents an exceedance of the water quality criterion of 5 ug/L.

Sulfate concentrations in the upper river increase steadily from New Cumberland to Belleville, decreases between Belleville and R.C. Byrd due to dilution from the Kanawha River, and then remains fairly consistent throughout the lower two-thirds of the river. All concentrations are well below the water quality criterion of 250 mg/L.
Total Kjeldahl Nitrogen (TKN) concentrations increase slightly in a downstream direction in the middle of the river, from the RC Byrd station to the West point station. West Point has the highest concentrations on the river with its median concentration around 0.8 mg/L. ORSANCO does not have a criterion for TKN.

Total Organic Carbon concentrations remain fairly consistent throughout the river with median concentrations in the 3 mg/L range and maximum concentrations only once exceeding 10 mg/L.

Median Total Phosphorus concentrations are consistently around 0.5 mg/L for the entire upper half of the river, then steadily increase from Meldahl to a high of 0.2 mg/L at West Point, then remain consistently at 0.1 mg/L from Cannelton and downstream (the lowest quarter of the river). Maximum concentrations reach 0.6 mg/L at Louisville and West Point. There currently is no stream criterion for Total Phosphorus.

Total Suspended Solids hold fairly constant in the upper Ohio River at a mean concentration of 12 mg/L, then gradually increase beginning with the R.C. Byrd station to a maximum mean concentration at West Point of over 100 mg/L. Mean concentrations then drop off from Cannelton and downstream.

Dissolved Aluminum is one of a few pollutants that consistently decrease in a downstream direction, with the highest median concentration of 15 ug/L occurring at Pike Island, and decreasing to 5 mg/L at L&D 52. In contrast, Total Aluminum generally increases in a downstream direction. The Commission does not have a criterion for Aluminum.

Arsenic concentrations, both dissolved and total, tend to increase in a downstream direction. The maximum median concentration occurs at the lowest station on the river at L&D 52, and is 1.4 ug/L for total Arsenic. Arsenic criteria are never exceeded, with a maximum concentration for Total Arsenic of 3 ug/L occurring at Anderson Ferry, which compares to the most stringent criterion for Total Arsenic of 10 ug/L.

Barium concentrations tend to be fairly consistent over the length of the river, with the highest median concentration occurring at West Point. No samples exceeded the water quality criterion of 1 mg/L; the maximum concentration of Total Barium being 115 ug/L occurred at Anderson Ferry.

Cadmium is detected more frequently in the lower third of the Ohio River, with the highest concentration of dissolved cadmium occurring at West Point and the highest concentration of Total Cadmium occurring at Anderson Ferry. The most stringent criterion for Dissolved Cadmium is 2.2 ug/L (at typical hardness) and this criterion is never exceeded.

Both total and dissolved Calcium concentrations tend to increase in a downstream direction, with a decrease at the R.C. Byrd station due to dilution from the Kanawha River. Maximum median concentrations for both total and dissolved Calcium occur at West Point. Almost all calcium found in the river is in the dissolved phase, as is noted by the total and dissolved concentrations being almost equal. There is no water quality criterion for Calcium.

Total and dissolved Chromium concentrations remain fairly consistent throughout the river, with the maximum dissolved concentration of 2.9 ug/L occurring at Louisville. The dissolved criterion of 74 ug/L is never exceeded.

Copper concentrations are highest in the upper river with maximum median concentrations occurring at the New Cumberland station. The maximum dissolved concentration of 6 ug/L also occurred at New Cumberland. The dissolved criterion of 9 ug/L was never exceeded.

Iron tends to be found predominantly in the solid phase as can be noted by the lack of detections of dissolved Iron. Total Iron concentrations are fairly consistent from New Cumberland to Belleville, then increase slightly downstream from the R.C. Byrd station. ORSANCO does not have an Iron criterion.

Lead is found predominantly in the particulate phase. Median concentrations of Total Lead remain relatively consistent throughout the river, while maximum concentrations tend to be higher in the lower half of the river. The maximum Total Lead concentration of 19 ug/L occurred at Anderson Ferry. The maximum dissolved Lead concentration of 0.16 ug/L occurred at the R.C. Byrd station. No dissolved concentrations exceeded the dissolved criterion of 2.5 ug/L (at typical hardness).

Both total and dissolved Magnesium concentrations significantly increase in a downstream direction. Magnesium, similar to Calcium, remains predominantly in the dissolved phase as is noted by nearly equal dissolved and total concentrations. Maximum median concentrations can be found at West Point, Smithland, and L&D 52 stations. There is no criterion for Magnesium.

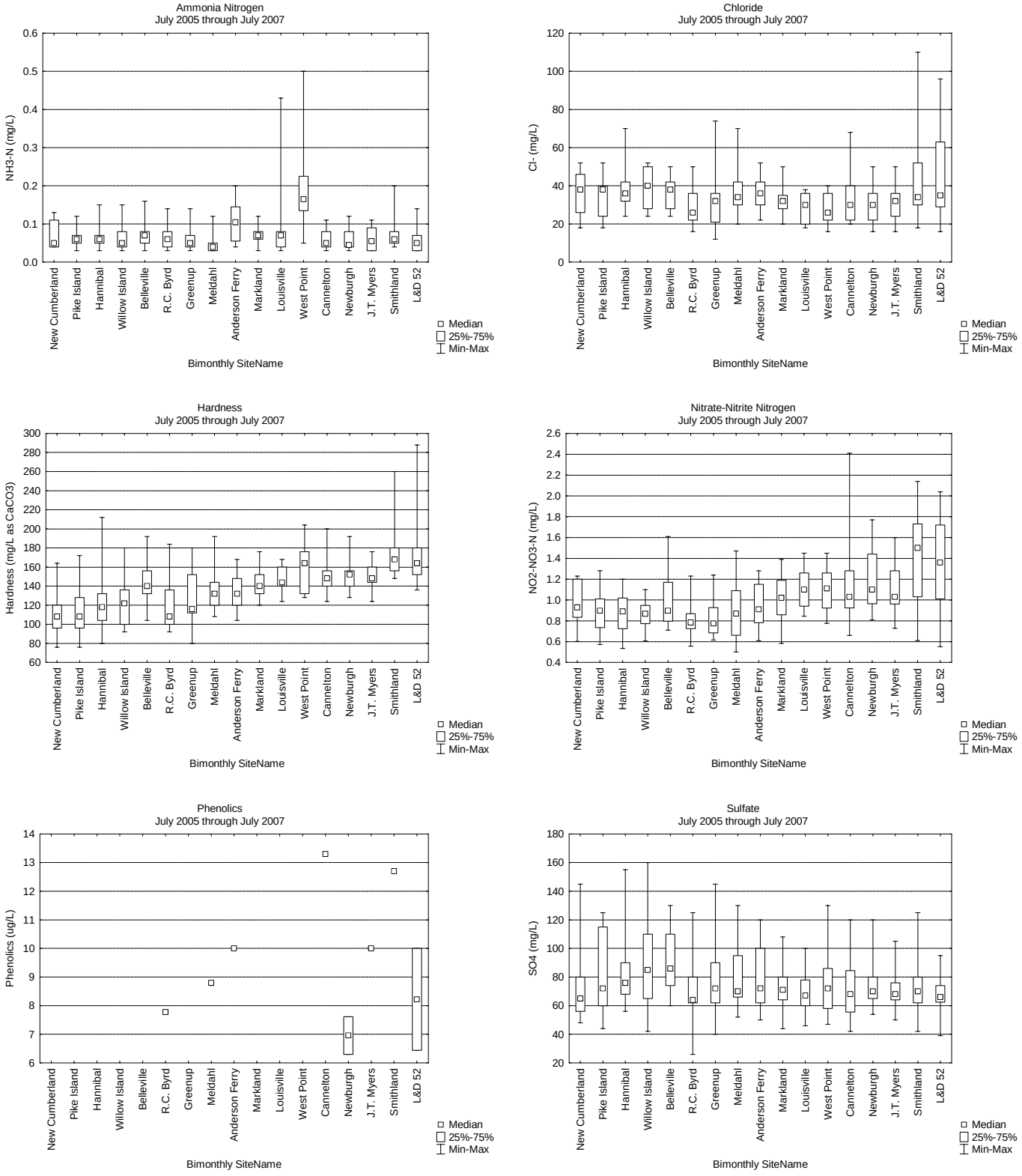
There are relatively few detections of Dissolved Mercury; however Total Mercury concentrations frequently exceed the water quality criterion of 0.012 ug/L. Total Mercury median concentrations tend to be relatively consistent in the upper half of the river, and are significantly higher in the lower river. The highest concentrations of Total Mercury occur at West Point. The median concentration of approximately 0.024 ug/L at West Point is almost twice the criterion value. Other stations with maximum concentrations exceeding the criterion include Anderson Ferry, Louisville, Cannelton, Newburgh, J.T. Myers, Smithland, and L&D 52.

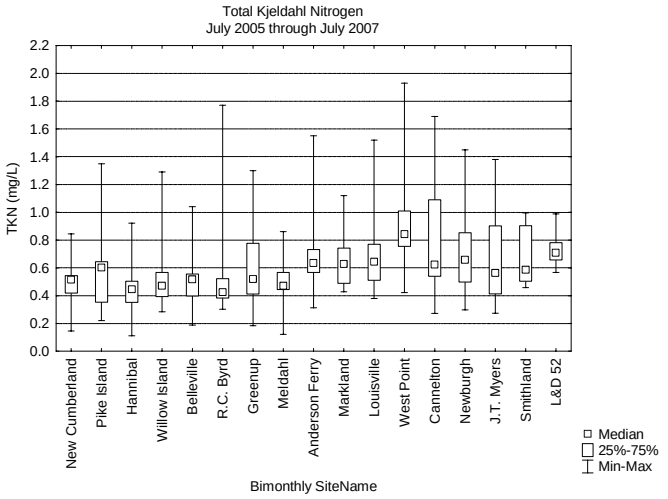
Dissolved Nickel is one of the few parameters which decrease in a downstream direction with the exception of a spike at West Point, while dissolved concentrations remain fairly consistent throughout the river. The maximum dissolved concentration of almost 8 ug/L occurred at the Greenup Station. The dissolved criterion of 52 ug/L (at typical hardness) was never exceeded.

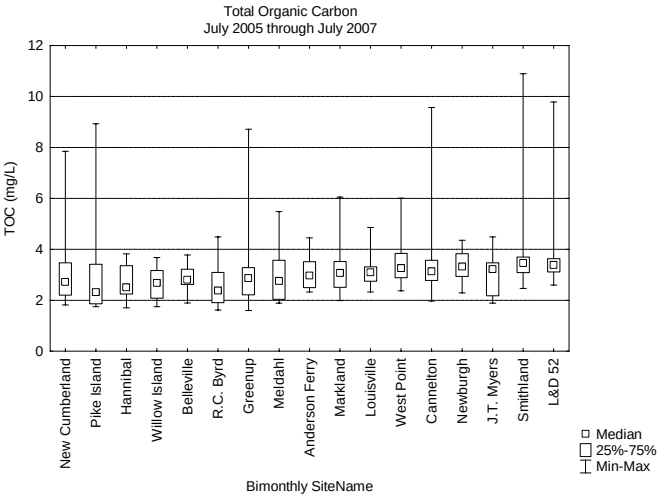
Dissolved and Total Selenium concentrations are fairly consistent and equal throughout the entire river with the exception of a spike at West Point. Total selenium concentrations never exceeded the criterion of 5 ug/L.

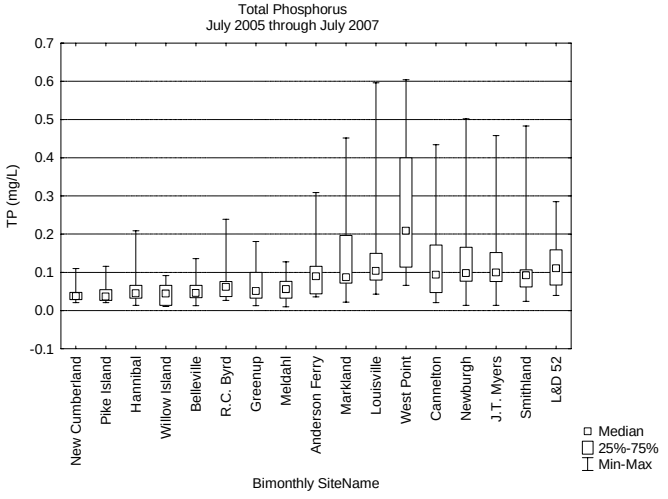
Dissolved and Total Zinc concentrations remain fairly consistent along the entire length of the Ohio River, with the maximum concentration of approximately 90 ug/L occurring at Anderson Ferry. The dissolved criterion of 117 ug/L (at typical hardness) is never exceeded throughout the entire river.

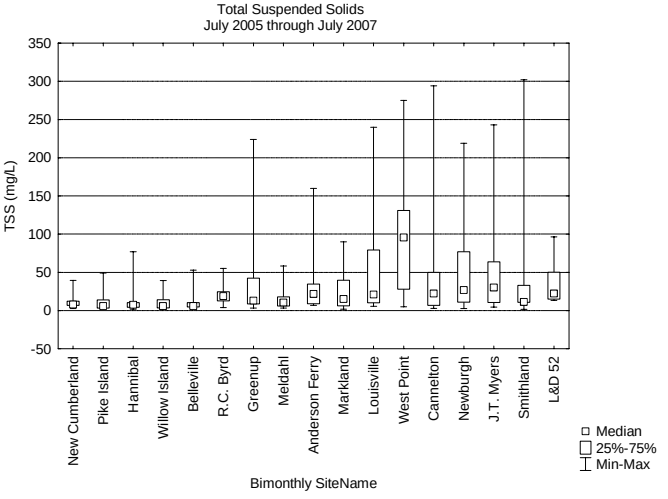
Figure 4 – Boxplots: Median 25th, 75th Maximum, Minimum All Bimonthly and Metals Data July 2005-July 2007

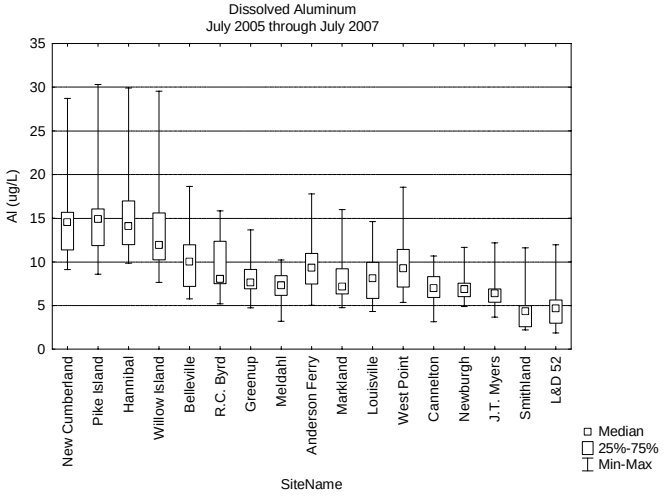


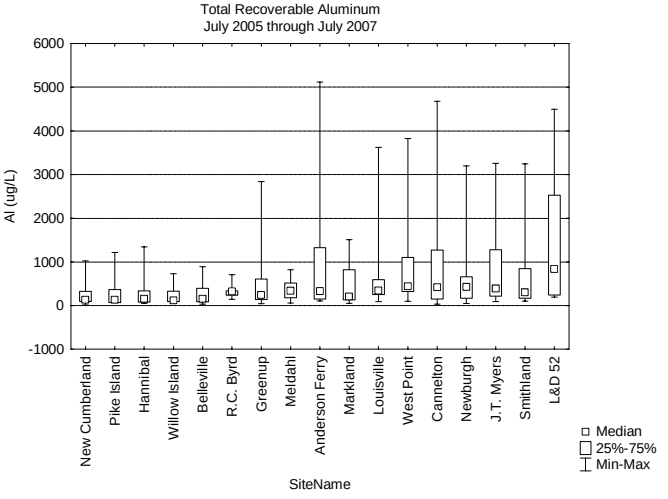

Total Kjeldahl Nitrogen
July 2005 through July 2007
TKN (mg/L)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
Median
25%-75%
Min-Max
Bimonthly SiteName

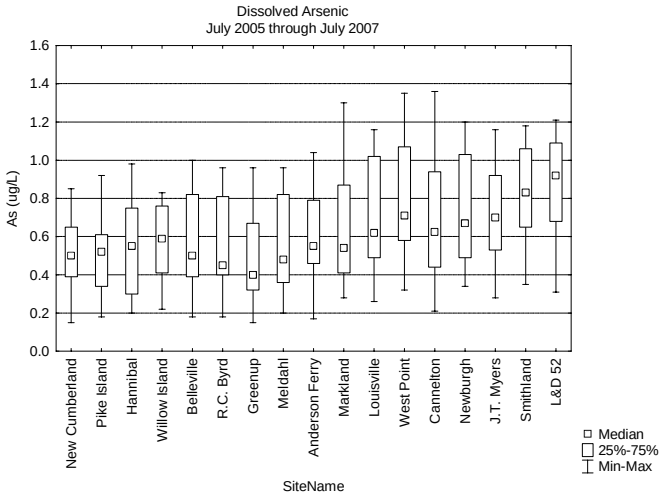

Total Organic Carbon
July 2005 through July 2007
TOC (mg/L)
12
10
8
6
4
2
0
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
Median
25%-75%
Min-Max
Bimonthly SiteName

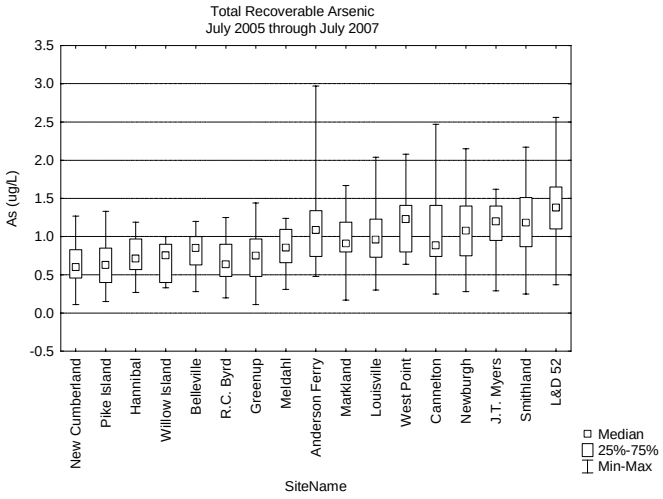

Total Phosphorus
July 2005 through July 2007
TP (mg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
Median
25%-75%
Min-Max
Bimonthly SiteName

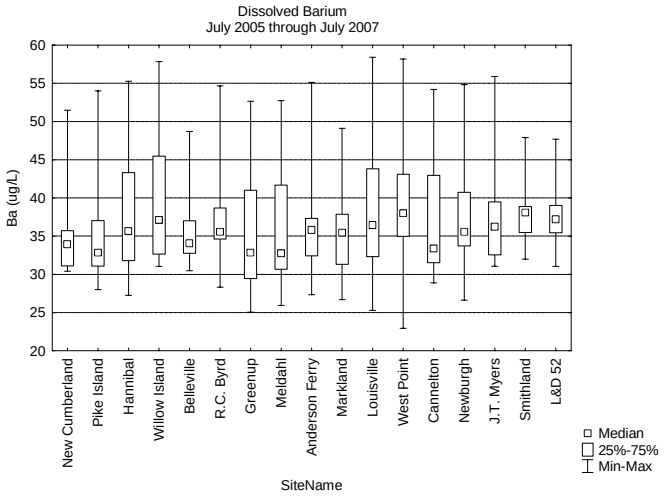

Total Suspended Solids
July 2005 through July 2007
TSS (mg/L)
350
300
250
200
150
100
50
0
-50
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
Median
25%-75%
Min-Max
Bimonthly SiteName

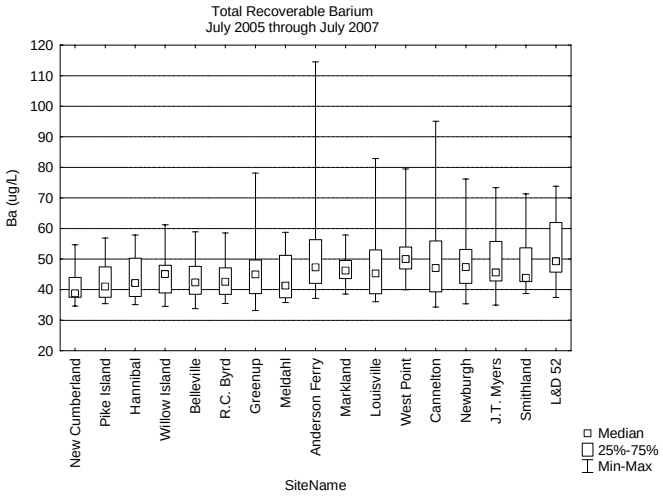

Dissolved Aluminum
July 2005 through July 2007
Al (ug/L)
35
30
25
20
15
10
5
0
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
Median
25%-75%
Min-Max
SiteName

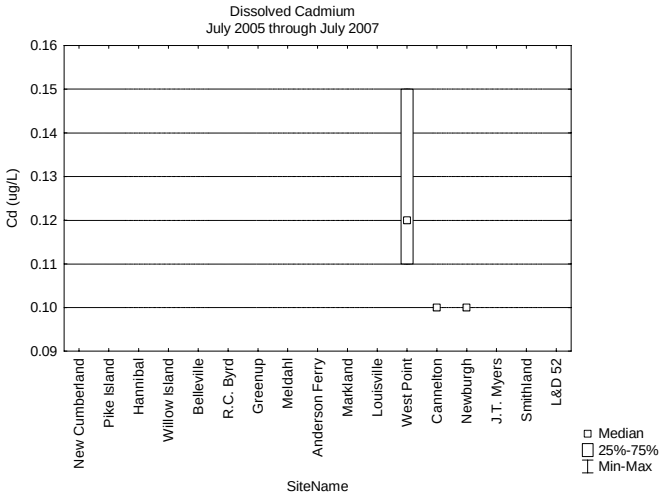

Total Recoverable Aluminum
July 2005 through July 2007
Al (ug/L)
6000
5000
4000
3000
2000
1000
0
-1000
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
Median
25%-75%
Min-Max
SiteName

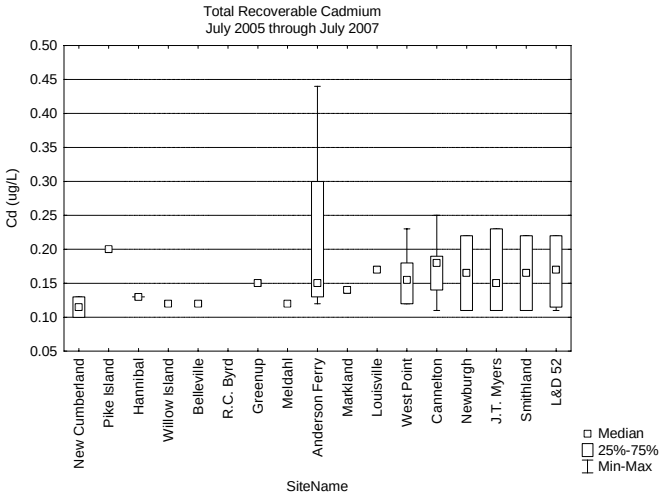

Dissolved Arsenic
July 2005 through July 2007
As (ug/L)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

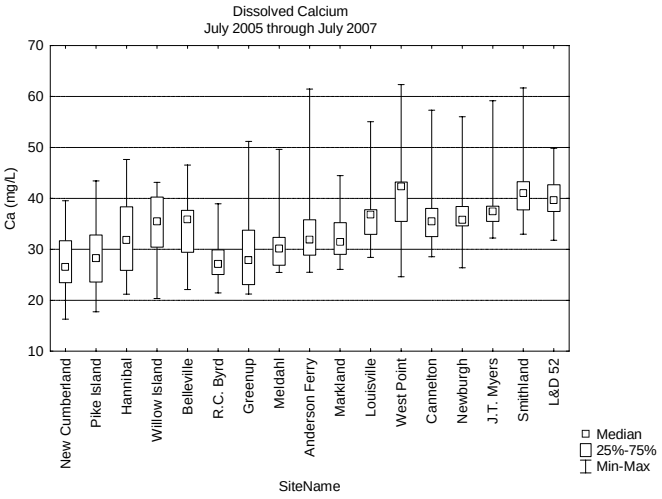

Total Recoverable Arsenic
July 2005 through July 2007
As (ug/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

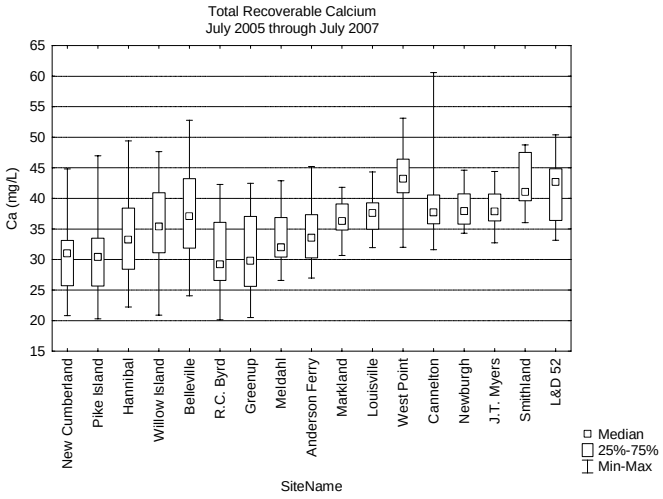

Dissolved Barium
July 2005 through July 2007
Ba (ug/L)
60
55
50
45
40
35
30
25
20
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

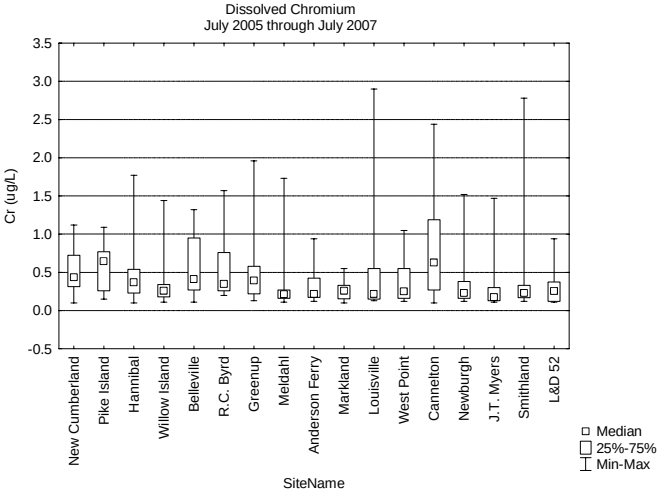

Total Recoverable Barium
July 2005 through July 2007
Ba (ug/L)
120
110
100
90
80
70
60
50
40
30
20
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

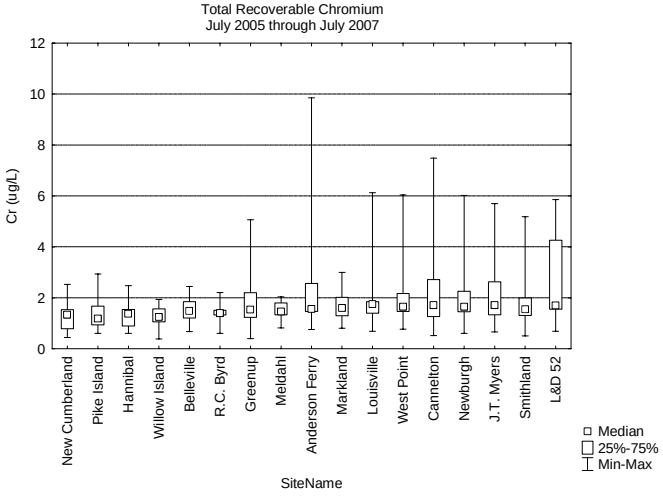

Dissolved Cadmium
July 2005 through July 2007
Cd (ug/L)
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

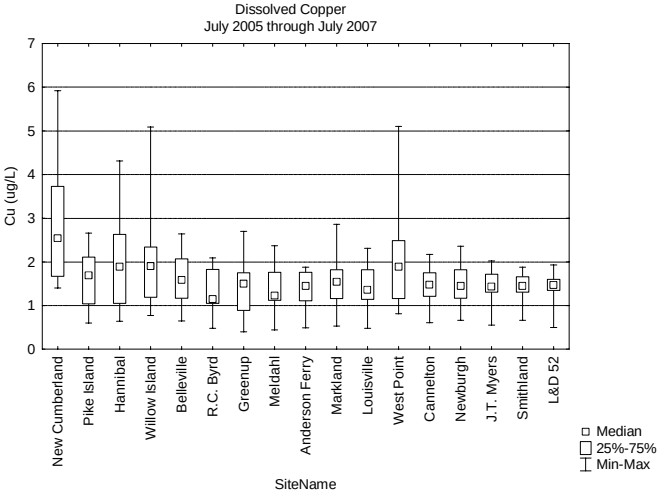

Total Recoverable Cadmium
July 2005 through July 2007
Cd (ug/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

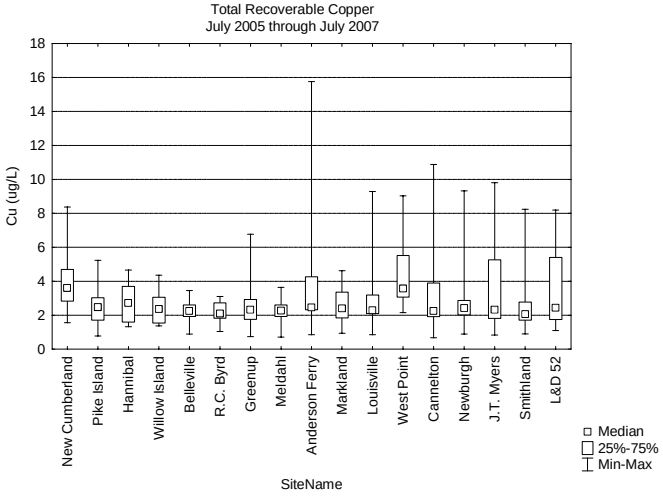

Dissolved Calcium
July 2005 through July 2007
Ca (mg/L)
70
60
50
40
30
20
10
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

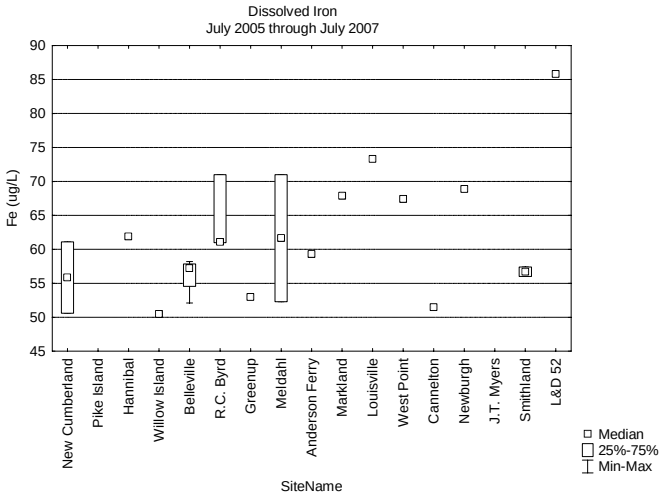

Total Recoverable Calcium
July 2005 through July 2007
Ca (mg/L)
65
60
55
50
45
40
35
30
25
20
15
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

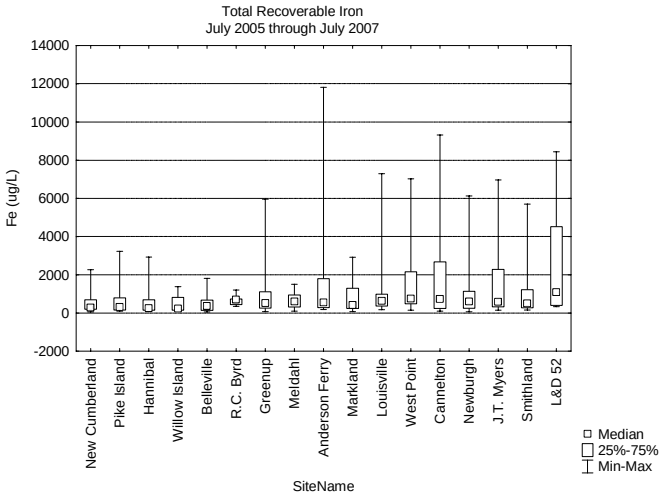

Dissolved Chromium
July 2005 through July 2007
Cr (ug/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

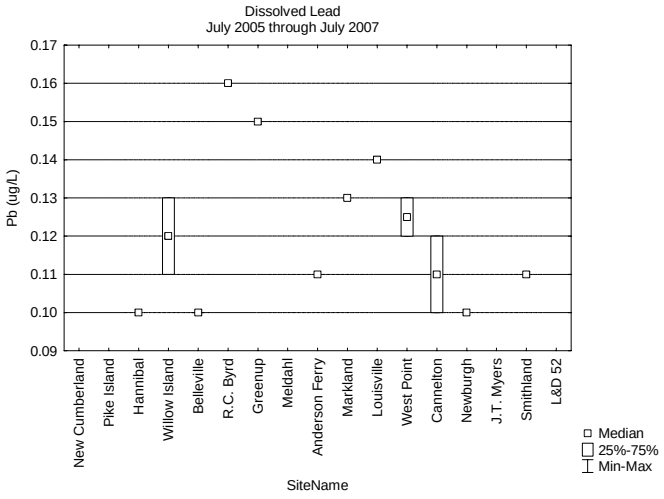

Total Recoverable Chromium
July 2005 through July 2007
Cr (ug/L)
12
10
8
6
4
2
0
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

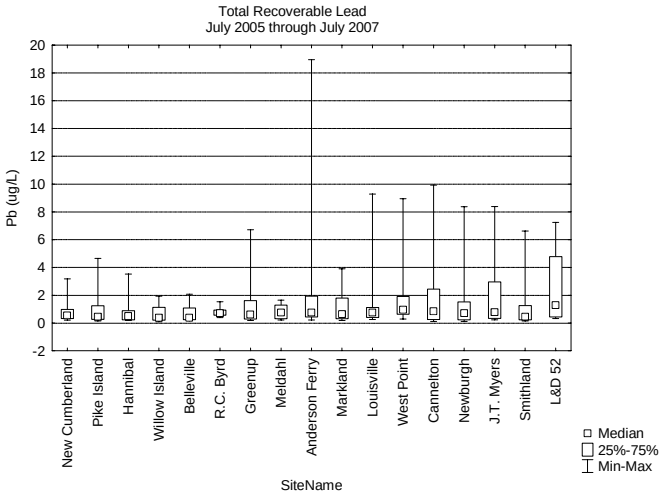

Dissolved Copper
July 2005 through July 2007
Cu (ug/L)
7
6
5
4
3
2
1
0
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

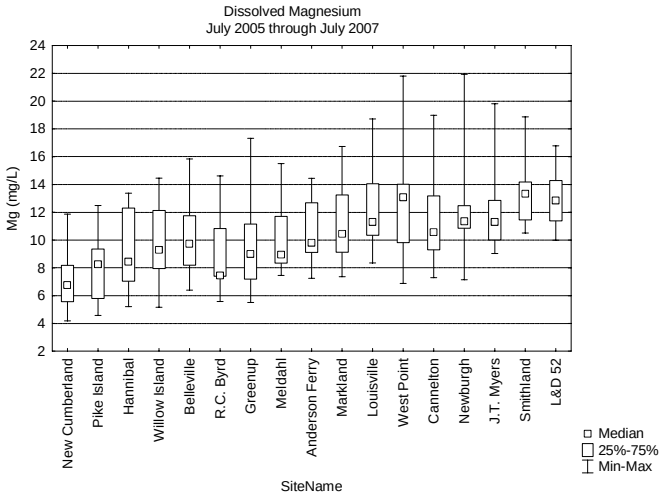

Total Recoverable Copper
July 2005 through July 2007
Cu (ug/L)
18
16
14
12
10
8
6
4
2
0
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

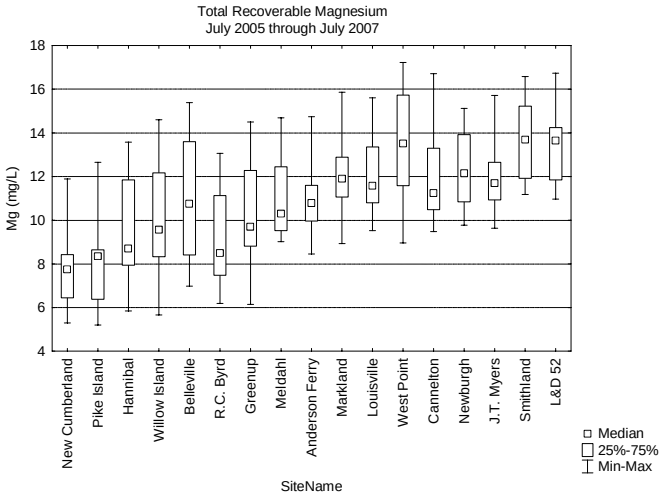

Dissolved Iron
July 2005 through July 2007
Fe (ug/L)
90
85
80
75
70
65
60
55
50
45
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

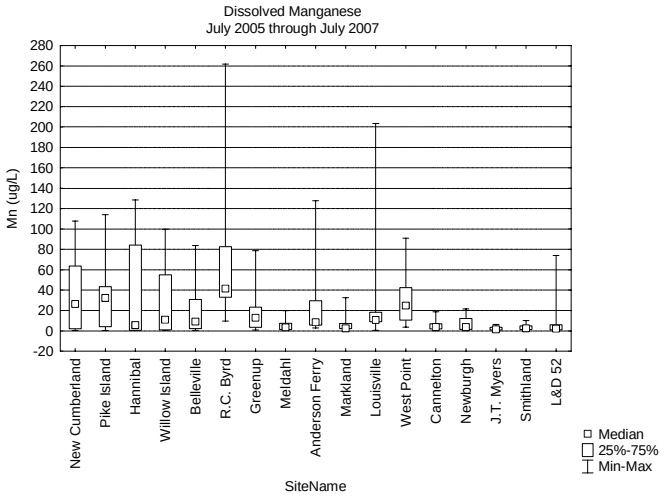

Total Recoverable Iron
July 2005 through July 2007
Fe (ug/L)
14000
12000
10000
8000
6000
4000
2000
0
-2000
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

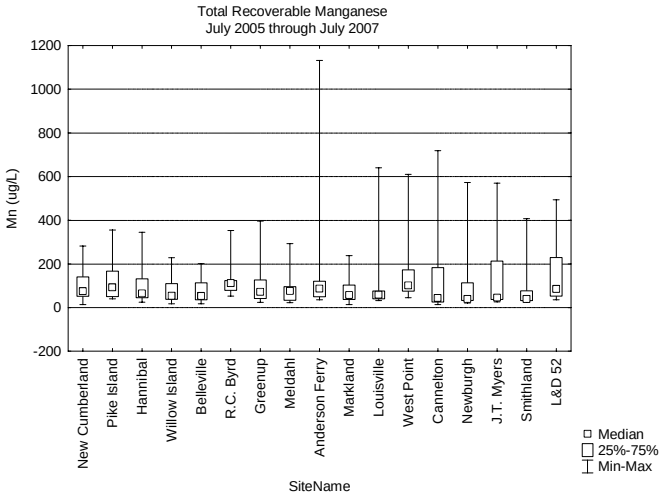

Dissolved Lead
July 2005 through July 2007
Pb (ug/L)
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

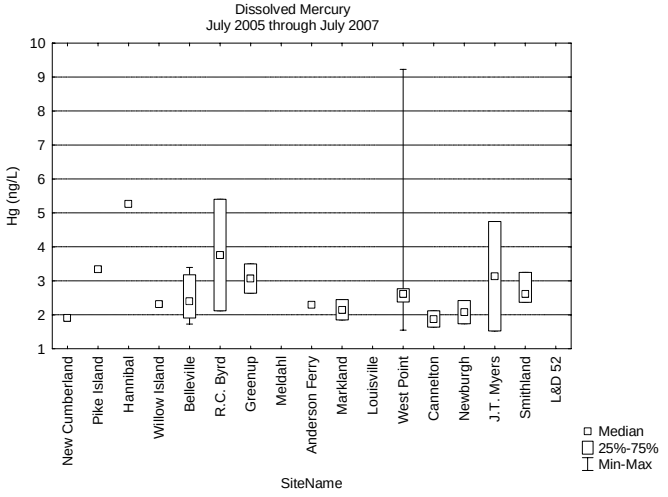

Total Recoverable Lead
July 2005 through July 2007
Pb (ug/L)
20
18
16
14
12
10
8
6
4
2
0
-2
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

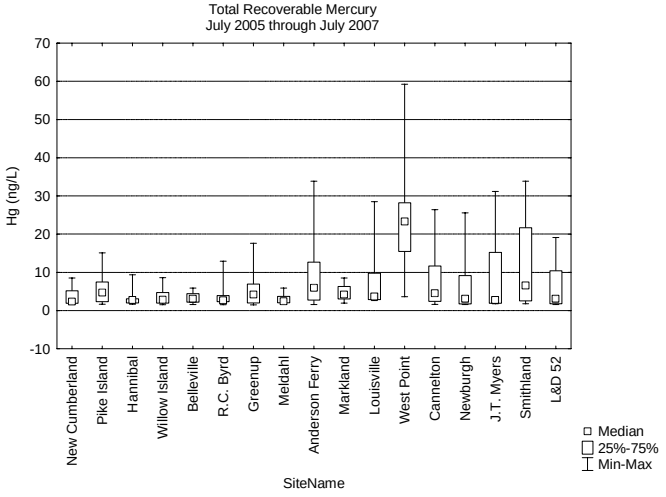

Dissolved Magnesium
July 2005 through July 2007
Mg (mg/L)
24
22
20
18
16
14
12
10
8
6
4
2
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

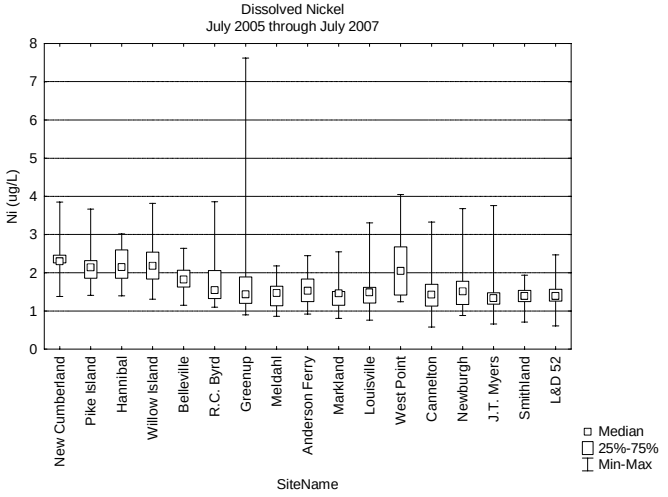

Total Recoverable Magnesium
July 2005 through July 2007
Mg (mg/L)
18
16
14
12
10
8
6
4
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

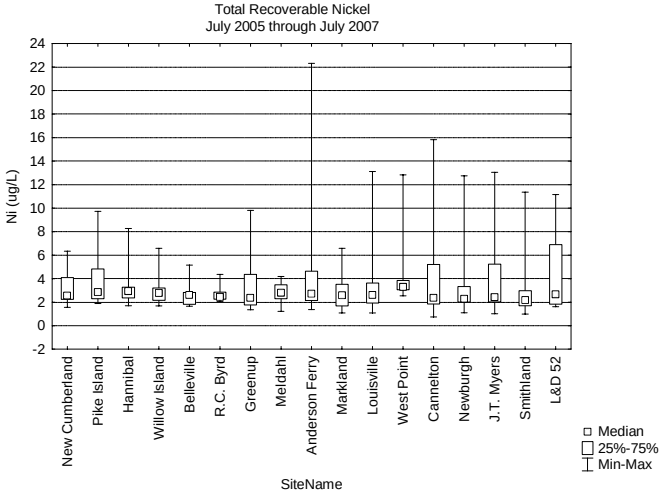

Dissolved Manganese
July 2005 through July 2007
Mn (ug/L)
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

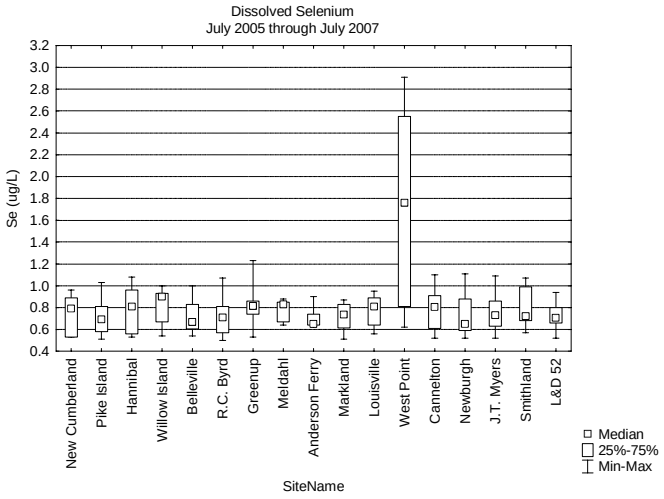

Total Recoverable Manganese
July 2005 through July 2007
Mn (ug/L)
1200
1000
800
600
400
200
0
-200
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

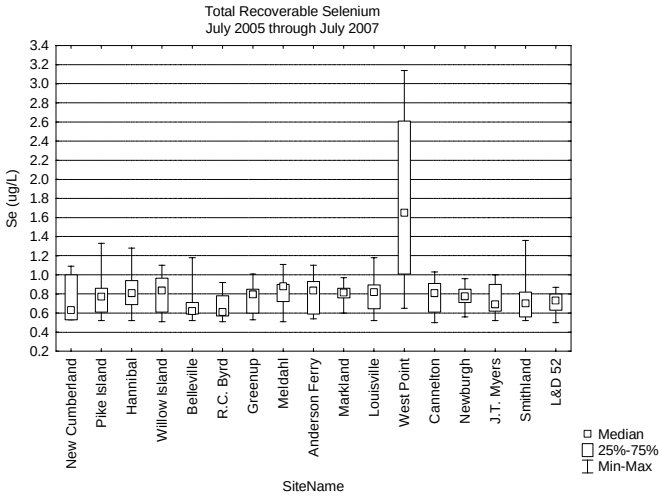

Dissolved Mercury
July 2005 through July 2007
Hg (ng/L)
10
9
8
7
6
5
4
3
2
1
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

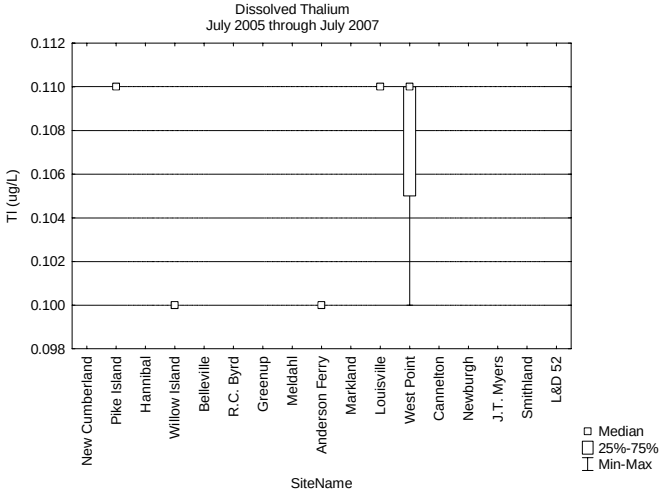

Total Recoverable Mercury
July 2005 through July 2007
Hg (ng/L)
70
60
50
40
30
20
10
0
-10
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

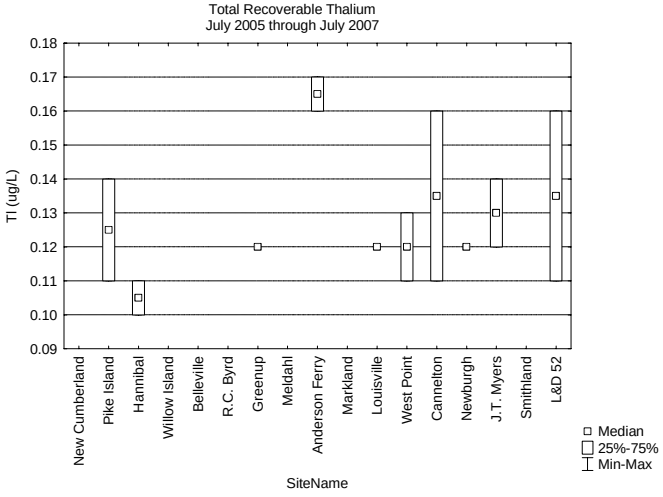

Dissolved Nickel
July 2005 through July 2007
Ni (ug/L)
8
7
6
5
4
3
2
1
0
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

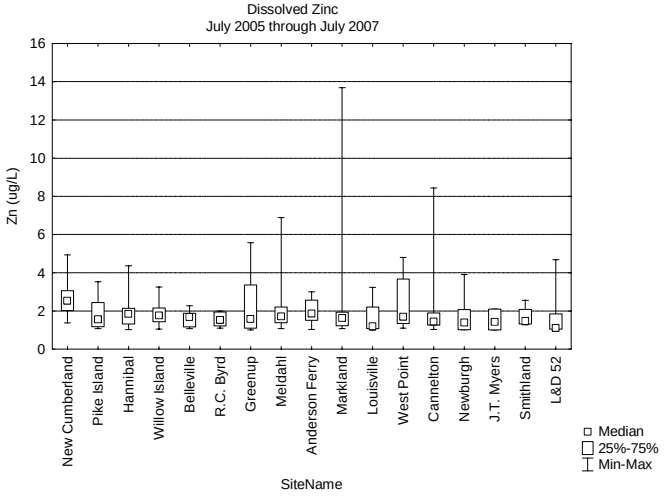

Total Recoverable Nickel
July 2005 through July 2007
Ni (ug/L)
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

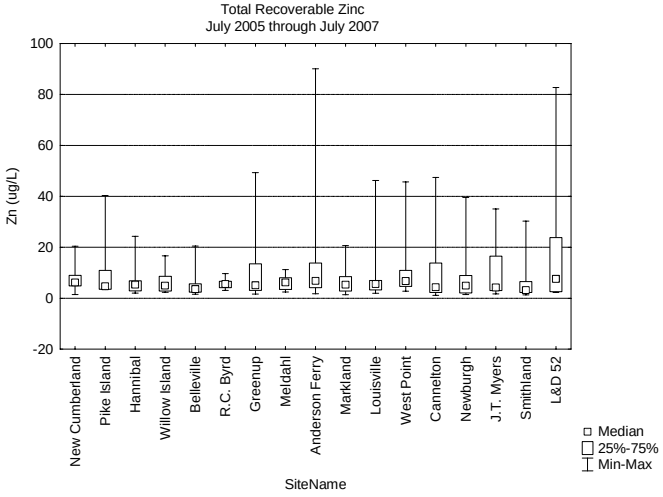

Dissolved Selenium
July 2005 through July 2007
Se (ug/L)
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max


Total Recoverable Selenium
July 2005 through July 2007
Se (ug/L)
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max


Dissolved Thalium
July 2005 through July 2007
Tl (ug/L)
0.112
0.110
0.108
0.106
0.104
0.102
0.100
0.098
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max


Total Recoverable Thalium
July 2005 through July 2007
Tl (ug/L)
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max


Dissolved Zinc
July 2005 through July 2007
Zn (ug/L)
16
14
12
10
8
6
4
2
0
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max


Total Recoverable Zinc
July 2005 through July 2007
Zn (ug/L)
100
80
60
40
20
0
-20
New Cumberland
Pike Island
Hannibal
Willow Island
Belleville
R.C. Byrd
Greenup
Meldahl
Anderson Ferry
Markland
Louisville
West Point
Cannelton
Newburgh
J.T. Myers
Smithland
L&D 52
SiteName
Median
25%-75%
Min-Max

PART III: SURFACE WATER MONITORING AND ASSESSMENT

Chapter 1: Monitoring Programs Designed To Assess Ohio River Designated Use Attainment

The Ohio River Valley Water Sanitation Compact requires that the Ohio River be capable of maintaining fish and other aquatic life, suitable for recreational usage, and in safe and satisfactory condition for public and industrial water supply. The Commission operates a number of monitoring programs to assess the degree of use support:

- Bimonthly Sampling
- Clean Metals Sampling
- Fish Population Monitoring
- Contact Recreation Bacteria Monitoring
- Longitudinal Bacteria Surveys
- Fish Tissue Sampling
- High Volume PCB and Dioxin Sampling

The first two are indirect chemical measures of biological health, while fish population surveys directly monitor biological integrity of one component (fish) of the aquatic community. Monitoring a large river system such as the Ohio River presents challenges related to spatial and temporal coverage. However, ORSANCO combines multiple monitoring programs to assess the attainment status of the Ohio River's designated uses (Figure 5). Water quality criteria used to assess use support are contained in the 2006 Revision of *Pollution Control Standards for Discharges to the Ohio River* (Appendix P).

Bimonthly & Clean Metals Sampling

Table 1 Table 1. Station Locations For Clean Metals And Bimonthly Sampling.

Station Name	River	Mile Point
New Cumberland	Ohio	54.4
Pike Island	Ohio	84.2
Hannibal	Ohio	126.4
Willow Island	Ohio	161.7
Belleville	Ohio	203.9
R.C. Byrd	Ohio	279.2
Greenup	Ohio	341.0
Meldahl	Ohio	436.2
Anderson Ferry	Ohio	477.5
Markland	Ohio	531.5
Louisville	Ohio	600.6
West Point	Ohio	625.9
Cannelton	Ohio	720.7
Newburgh	Ohio	776.1
J.T. Myers	Ohio	846.0
Smithland	Ohio	918.5
Lock & Dam 52	Ohio	938.9

The bimonthly and clean metals sampling programs are used to assess aquatic life and public water supply uses. These programs entail the collection of water column grab samples from 17 Ohio River stations once every other month (Appendix B, Table 1). The samples are collected by contract samplers and ORSANCO staff and analyzed for certain physical and chemical parameters by a contract laboratory. In October 2000, ORSANCO changed the aquatic life use criteria for metals from total recoverable metals to dissolved metals. This change was based on the conclusion that dissolved metals data were much more accurate and representative of metals dissolved in the water column, and therefore available to aquatic life. Dissolved metals criteria for the protection of aquatic life have very low concentrations, some in the single parts per billion range. Therefore, collection of uncontaminated samples and low-level analyses using clean techniques is essential. However, although dissolved criteria are used, every sample is analyzed for both total recoverable and dissolved metals. The Commonwealth of Virginia state laboratory provides the clean metals sampling equipment and analyses. Nonmetal parameters (Table 3) monitored in the Bimonthly Sampling Program as well as clean metals parameters (Table 2) are also used to determine the degree of support for aquatic life. Applicable results from mainstem stations are compared to established stream criteria. For this 2008 report, Bimonthly and Clean Metals data from July 2005 to July 2007 were used to make use assessments. Data from these programs also were used to assess the public water supply use.

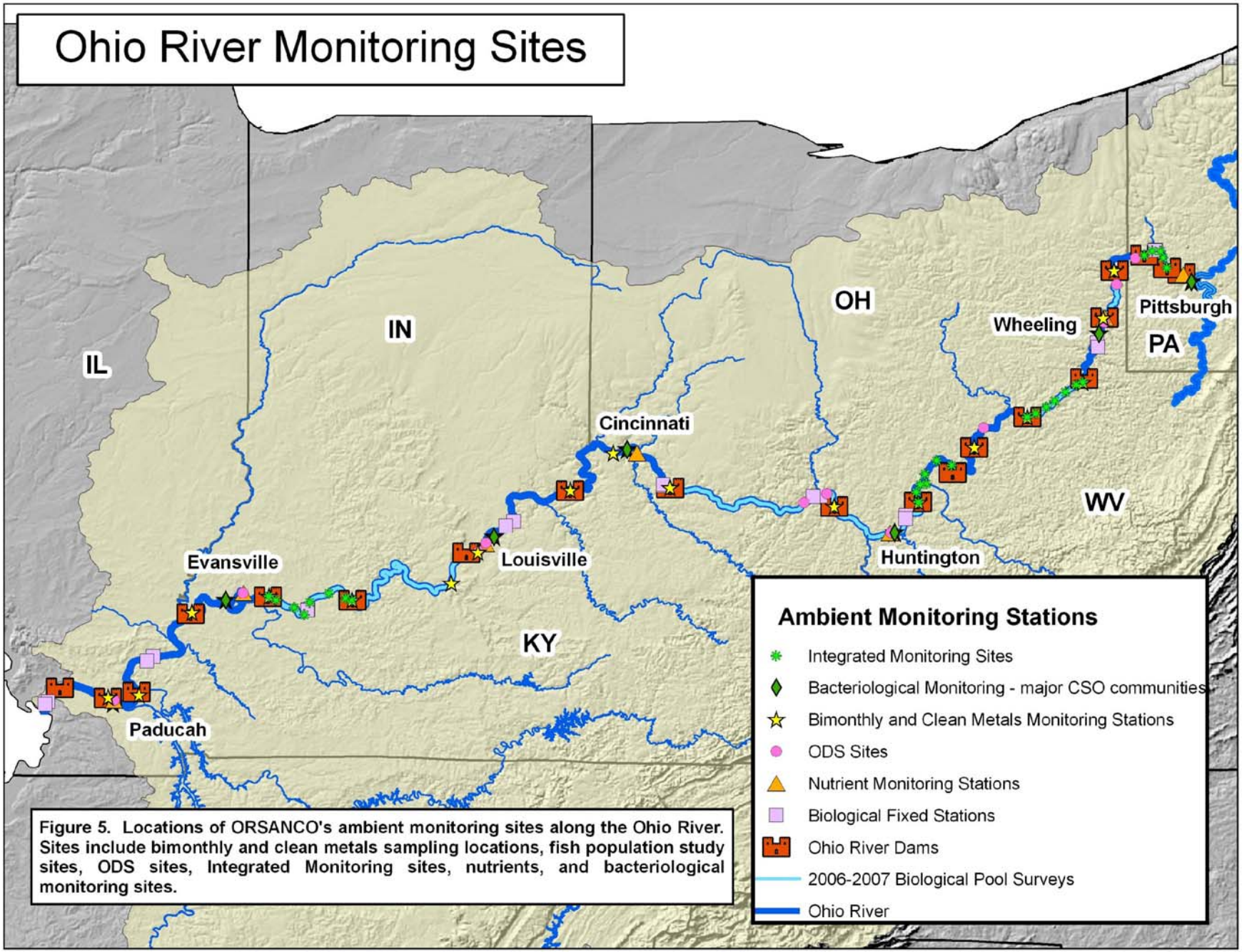


Figure 5. Locations of ORSANCO's ambient monitoring sites along the Ohio River. Sites include bimonthly and clean metals sampling locations, fish population study sites, ODS sites, Integrated Monitoring sites, nutrients, and bacteriological monitoring sites.

Table 2: Clean Metal Parameters.

Element	Analysis	Detection Limit (ug/L)
Aluminum	EPA 1638	1
Antimony	EPA 1638	0.1
Arsenic	EPA 1638	0.5
Barium	EPA 1638	10
Cadmium	EPA 1638	0.1
Calcium	EPA 1638	1,000
Copper	EPA 1638	0.1
Chromium	EPA 1638	0.1
Iron	EPA 1638	100
Lead	EPA 1638	0.1
Magnesium	EPA 1638	1,000
Manganese	EPA 1638	0.1
Mercury	EPA 1631	0.0002
Nickel	EPA 1638	0.1
Selenium	EPA 1638	0.5
Silver	EPA 1638	0.1
Thallium	EPA 1638	0.2
Zinc	EPA 1638	1

Table 3: Bimonthly Sampling Parameters.

Parameters	Analysis	Detection Limit
Ammonia Nitrogen	EPA 350.3	0.03 mg/L
Chloride	EPA 325.3	1.0 mg/L
Hardness	SM 2340C	1.0 mg/L
Nitrate + Nitrite	EPA 353.3	0.02 mg/L
Phenolics	EPA 420.1	0.005 mg/L
Total Kjeldahl Nitrogen	SM 4500	0.20 mg/L
Sulfate	HACH 8051	1.0 mg/L
Total Suspended Solids	EPA 160.2	1.0 mg/L
Total Phosphorus	EPA 365.3	0.01 mg/L
Total Organic Carbon	EPA 415.1	0.5 mg/L
Total Cyanide	EPA 335.2	5.0 ug/L

Table 2 and 3. Parameters, analytical methods and reporting levels for the Clean Metal Sampling Program and the Bimonthly Sampling Program (SM-Standard Methods).

Fish Population Monitoring

Fish population data from 2006 and 2007 were used to assess support of the aquatic life use. The Commission monitors the fish population annually from July through October, conducting between 100 and 200 surveys of the fish community. The monitoring strategy includes both fixed station and probability-based sampling. Samples consist of 500 meter shoreline zones that are electrofished by boat at night. The fish are netted, weighed, measured, species recorded, and any unusual abnormalities such as growths or lesions are noted. Habitat types within the zone also are recorded. Work usually is conducted in four pools throughout a field season, completing the entire length of the Ohio River (20 pools) in five years. Pools sampled in 2006 were Montgomery, Willow Island, Greenup, and Cannelton. In 2007, Emsworth, Pike Island, Meldahl, Cannelton, and Newburgh pools were sampled. Fifteen randomly selected zones are sampled in each pool to complete an assessment of the entire pool. If impairment is found, pools may be resampled the following year. Cannelton pool is listed in both 2006 and 2007 because fluctuating flows prohibited the sampling of all pool sites in 2006; sampling was completed in 2007. In past years, the sampling effort has focused on developing a numeric index to determine the integrity of fish communities. That index has been completed and includes a number of important factors such as number of fish, fish biomass, species diversity, and abundance of pollution tolerant and intolerant species. The Ohio River Fish Index (ORFIn) was based on the nationally used Index of Biotic Integrity (IBI), which was designed to assess smaller streams. The ORFIn, however, has been customized to assess the Ohio River, with expected values developed for the different habitats found in this large river system. Aquatic life use support is assessed by comparing measured, numeric index values to expected values. Pools with greater than 25 percent of sites scoring below the expected values for a specific habitat types were assessed as impaired.

Contact Recreation Bacteria Sampling

The Commission collects bacteria samples from May through October in six large urban communities with combined sewer systems to evaluate support of the contact recreation use. Locations include Pittsburgh, Wheeling, Huntington, Cincinnati, Louisville, and Evansville (Appendix B). Five rounds of sampling are completed monthly for each urban community sampling location and analyzed for fecal coliform and *E. coli*. There are at least three sites in each community sampled; one being upstream of the CSO community, one downtown, and one downstream. In addition to routine bacteria sampling, the Commission conducted longitudinal surveys for bacteria from May to

October in 2003-2007 under the Ohio River Watershed Pollutant Reduction Program (site list in Appendix B). For this work the Ohio was broken down into three segments: an upper, middle, and lower segment. For each segment five rounds of samples were collected, one round each week for five consecutive weeks. Sampling sites begin in Pittsburgh (Ohio River Mile 0) and end in Cairo (Ohio River Mile 981) with one river cross-section sample collected approximately every five miles. Each site was sampled fifteen times from 2003-2006, allowing for the calculation of three geometric means per site. In 2007 one round of sampling was completed for the entire river in a consecutive order beginning at mile 0 and ending at mile 981. Samples were analyzed for *E.coli* by the ORSANCO staff using Colilert, a Most Probable Number method. A minimum of ten percent duplicate samples were sent to a contract laboratory for analyses by the membrane filtration method for *E. coli* and fecal coliform. Through intensive longitudinal monitoring, the Commission has been able to monitor the entire river for bacteria and the contact recreation use.

Fish Tissue Sampling

The Commission collects fish tissue samples between July and October and analyzes them for certain contaminants to assess support of the fish consumption use (Appendix L). In 2005 and 2006, approximately 91 fish tissue samples are analyzed from various Ohio River locations depending on fish population monitoring efforts. Pollutant contamination in the tissue is based on a composite of up to five fillets from various species. Tissue contaminants analyzed include PCBs, chlordane, mercury, cadmium, lead and certain pesticides. The states use the data to develop and update public fish consumption advisories.

High Volume PCB and Dioxin Sampling

The Commission also conducted high volume sampling for dioxin (2,3,7,8-TCDD) and polychlorinated biphenyls (PCBs) to evaluate the fish consumption use (Appendix I, J). These chemicals have been known to bioaccumulate in fish tissue. High volume sampling is a method that concentrates 1,000 liters of water into a single sample, thereby lowering the detection level approximately 1,000 times. This achieves detection levels necessary to measure concentrations in the parts per quadrillion range. At least three rounds of sampling were completed at each of 35 Ohio River stations between 1997 and 2004. Filtered samples were analyzed by a contract laboratory, which generates results for dissolved and particulate fractions.

Other Sources of Data

Although many states rely on ORSANCO to monitor water quality in the Ohio River, most states collect some data on the Ohio River each year, though not as extensively as ORSANCO. To ensure the most comprehensive data set available to assess the quality of the Ohio River ORSANCO posted a public request for data on their website in addition to sending postcard requests to other government agencies, volunteer monitoring groups, and private industries.

Chapter 2: Aquatic Life Use Support Assessment

The Ohio River Valley Water Sanitation Compact calls for the Ohio River to be in a satisfactory sanitary condition capable of maintaining fish and other aquatic life. The Commission assesses the degree of use support every two years, as the states are required to do by section 305(b) of the federal Clean Water Act. Data from a number of monitoring programs are used in making use attainment assessments, including bimonthly and clean metals sampling, as well as biological data collected during electrofishing sampling events.

Aquatic Life Use Assessment Methodology

Bimonthly & Clean Metals Sampling

Both clean metals and nonmetal parameters are analyzed through ORSANCO's monitoring programs. Data are collected from 17 fixed stations along the river (Appendix B). Grab samples are collected from these stations once every other month, providing approximately 13 samples during the period between July 2005 and July 2007 at each station. Of the 20 lock and dam systems along the Ohio River, ORSANCO maintains monitoring locations in 15 of the pools, with two pools having two monitoring points. In the 2008 analysis, ORSANCO extrapolated data from these 17 sites to the entire river and considers all 981 miles assessed because no differences in impairment status were seen between monitoring locations.

Fish Population Monitoring

While monitoring chemical parameters is a common and valuable strategy used to determine impairment, it is also useful to expand the focus beyond water chemistry and directly examine the effects of pollution on aquatic life. To further understand the status of the river and the degree to which it is meeting its aquatic life use, ORSANCO also conducts biological assessments of the Ohio River using the Ohio River Fish Index (ORFIn) (Appendix K). The ORFIn combines various attributes of the fish community to give a score to the river based on its biology. The ORFIn is comprised of 13 metrics, which serve as surrogate measures of more complicated processes. Examples of metrics include the number of species, the number of pollution tolerant individuals, and the percent of top piscivores in the fish community. The values for each metric are compared to conditions found at the least disturbed locations in the Ohio River to derive a score. Metric scores are then combined to generate a single score for the site. A higher final score indicates a more desirable fish community, often having more species or fewer pollution-tolerant individuals in the fish community. The total score is compared to an expected score, which varies depending on the habitat type and location. Expected scores were developed using historical data collected from reference stations.

Since 2004, aquatic life has been assessed on a pool-by-pool basis. Four navigational pools are assessed each year, with the entire river (20 navigational pools) being fully assessed every five years. In 2006 and 2007, Emsworth, Montgomery, Pike Island, Willow Island, Greenup, Meldahl, Cannelton, and Newburgh pools were sampled (Appendix A), totaling 416.1 miles assessed. Fifteen sites were randomly selected to represent each pool as a whole. Sites were sampled using electrofishing between July and October. During each fish community assessment, biologists attempted to determine the fish community potential of that pool. A pool is designated as impaired when greater than 25 percent of those randomly selected sites have failing ORFIn scores.

Aquatic life use assessment was determined using the two types of monitoring programs described above. Attainment was assessed as either "fully supporting" indicating no impairment, "partially supporting" meaning the segment is impaired due to violations of chemical water quality criteria for the protection of aquatic life or biological data, or "not supporting" meaning biological and water quality data indicate impairment. A full description of each designation follows:

Assessment Methodology

Fully Supporting

- Fewer than ten percent of water samples exceed the criteria for one or more pollutants.
- Biological data does not indicate aquatic impairment (less than 25 percent of sites in a pool receive failing ORFIn scores).

Impaired-Partially Supporting

- One or more pollutants exceed the water quality criteria in 11-25 percent of the samples, **OR**
- Biological data indicates impairment (25 percent or more of sites in a pool receive failing ORFIn scores).

Impaired-Not Supporting

- One or more pollutants exceed the criteria in greater than 25 percent of the samples **AND**
- Biological data indicate impairment (25 percent or more of sites in a pool receive failing ORFIn scores).

Aquatic Life Use Assessment Summary

All sections of the river were designated as fully supporting the aquatic life use based on biological data (Table 4). This assessment was determined using biological data from eight navigational pools. Parameters such as dissolved oxygen, ammonia, and various dissolved metals have criteria that must be met to provide protection of warm water aquatic life. All of these parameters assessed through the bimonthly and clean metals programs were found to be fully supportive of aquatic life use. Dissolved oxygen and temperature parameters were measured from thirteen stations along the Ohio River (Appendix E). These stations are operated by the US Army Corps of Engineers at seven dams, hydropower operators at five locations, and one coal-fired power plant operator. ORSANCO acquires this data electronically as hourly measurements from each station, and then makes assessments from this information. Violations of dissolved oxygen were found within the J.T. Myers and Smithland pools (ORM 776.1 – 918.5); causing both pools to be classified as partially supporting and requiring a TMDL. Temperature data assessments found Cannelton, Newburgh, and J.T. Myers pools to have greater than ten percent of periods exceeding the period average. Biological data for this assessment period, indicating full support, was available for both Cannelton and Newburgh pools. Biological data is a direct measurement of aquatic life and carries greater weight when compared with water temperature and dissolved oxygen parameters. Because this additional biological information is available, and the weight-of evidence approach is being implemented, only J.T. Myers pool has been classified as partially supporting (ORM 776.1 – 848.0) and requiring a TMDL. No violations of the aquatic life criteria for clean metals or bimonthly parameters were observed (Appendix C, D).

Table 4. Summary of aquatic life use assessment for 2006-2007 based on 17 monitoring stations and fish population surveys. 838.6 miles of the Ohio River fully support warm-water aquatic life.

State	River Miles	Impaired Miles	Support Assessment	Causes of Impairment
PA	0-40.2	0.0	Full Support	None
OH-WV	40.2-317.1	0.0	Full Support	None
OH-KY	317.1-491.1	0.0	Full Support	None
IN-KY	491.1-848.0	776.1-848.0	Partial Support	Dissolved oxygen, Temperature
IN-IL	848.0-981.0	848.0-918.5	Partial Support	Dissolved oxygen
Total	981.0	142.4		

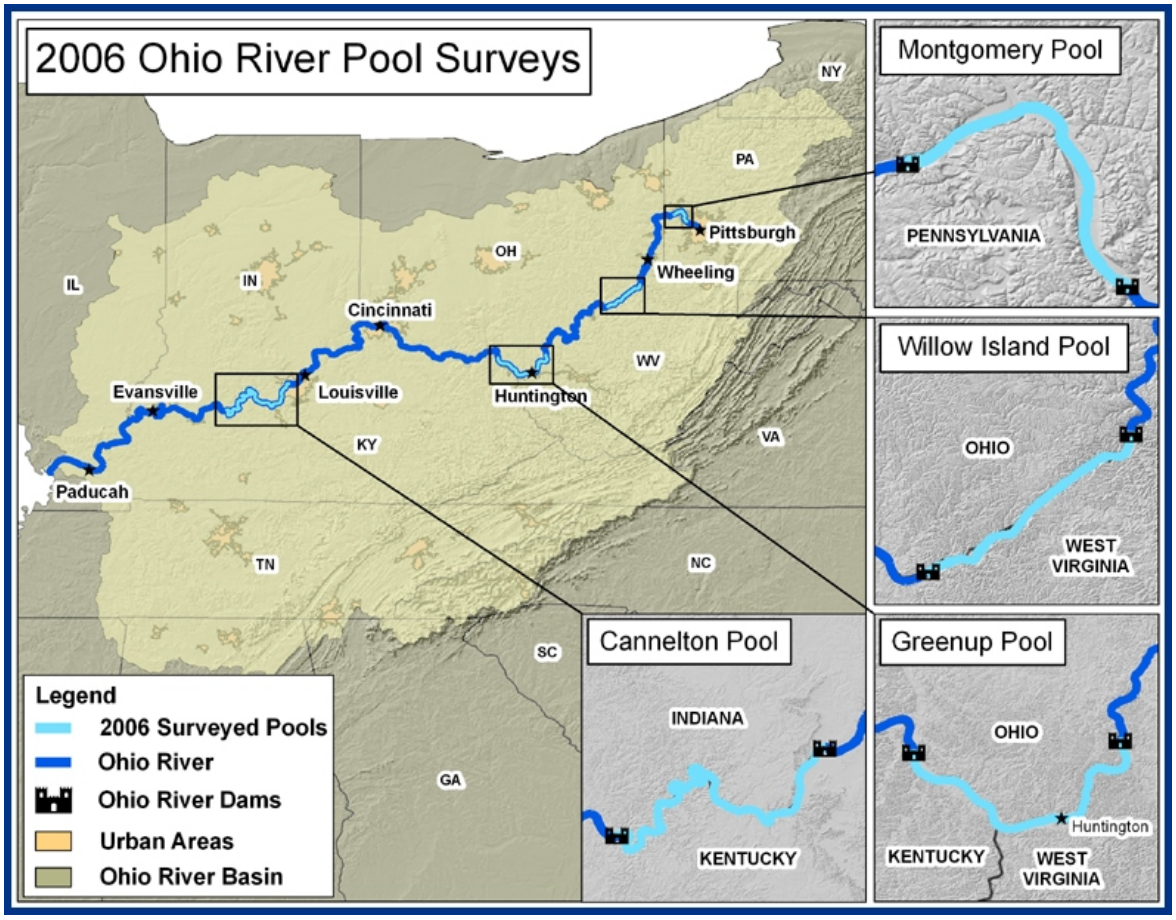


Figure 6. Location of Ohio River pools sampled during 2006 fish population surveys.

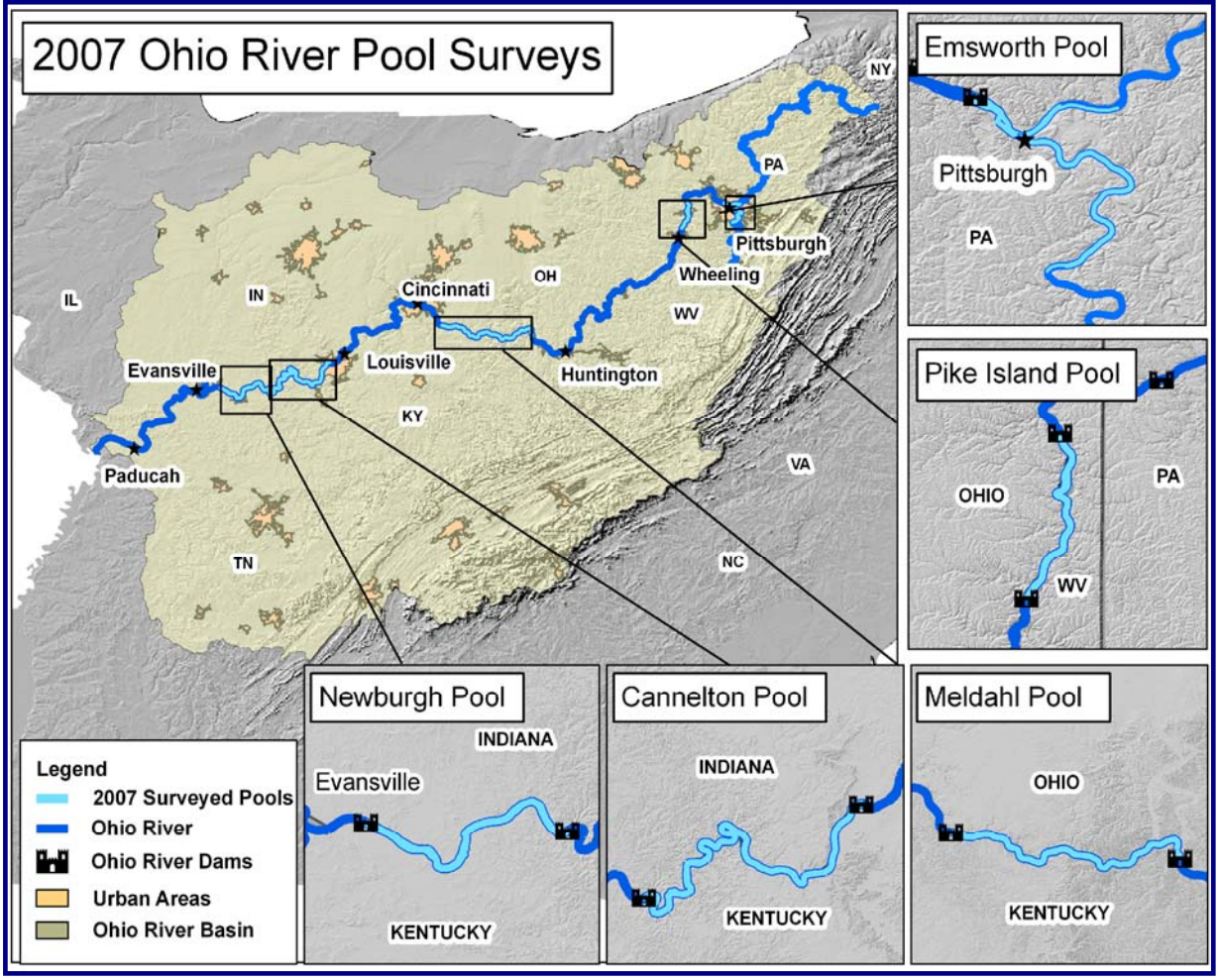


Figure 7. Location of Ohio River pools sampled during 2007 fish population surveys.

Figures 6 and 7 show the 2006 and 2007 pools surveyed for fish community assessment. In order to assess Ohio River fish communities ORSANCO has created a metrics system specialized for the Ohio River called the Ohio River Fish Index (ORFIn) for analysis; which is similar to the nationally used Index of Biotic Integrity (IBI) metrics system. ORFIn incorporates 13 attributes, or metrics, of the fish community that when compiled provide an accurate representation of the overall condition of the Ohio River fish community. Ohio River Pool Surveys are able to achieve a comprehensive analysis because each site is evaluated for habitat conditions, fish community, water quality, and substrate composition. Each site is assigned to one of three habitat classes; 'A', 'B', or 'C'. Habitat class 'A' sites are characterized by the presence of large substrates such as cobble and boulders. Sites that fall in habitat class 'C' are dominated by sand (small substrates), and habitat class 'B' describes sites that fall between 'A' and 'C' with a mix of large and small substrate materials. The three distinct habitat classes each exhibit different levels of ORFIn performance. Performance expectations for each habitat class were determined based on the statistical distribution of data (ORFIn scores) gathered from 'least impacted' (reference) sites within each habitat class. For a pool to be considered passing, 75 percent of the sites sampled within the pool must score above their criteria. Individual site scores were compared to expected values and the percentage of passing sites in the pool was then calculated (Table 5).

Table 5. Summary of 2006-2007 ORFIn score results.

Year	Mile Point	Pool	Result	% Passing
2006	13.7-30.4	MONTGOMERY	PASS	87%
2006	127.4-157.4	WILLOW ISLAND	PASS	100%
2006	281.6-338.9	GREENUP	PASS	80%
2007	0.0-5.1	EMSWORTH	PASS	100%
2007	55.5-79.8	PIKE ISLAND	PASS	100%
2007	356.2-431.2	MELDAHL	PASS	100%
2006&2007	612.1-720.3	CANNELTON	PASS	90%
2007	721.2-772.1	NEWBURGH	PASS	87%

Using several years of data, a possible relationship between ORFIn scores and Ohio River flow conditions was identified. Data from 1999 to 2007 indicated that as flow increases, the percentage of failing ORFIn scores increased. In both 2003 and 2004, two relatively wet years (Figure 8), less than 60 percent of the sites had passing ORFIn scores. Two dry years, 1999 and 2007 (Figure 8), resulted in passing ORFIn scores at over 90 percent of the sites.

Although 2007 could also be characterized as an "abnormal" flow year, it should be noted that fish are generally the most stressed when under low flow conditions, when dilution is reduced, thereby increasing instream concentrations of contaminants. Under these conditions, fish are additionally stressed by the higher temperatures and lower dissolved oxygen conditions naturally associated with low flows. In spite of these stressors, when only 2007 biological data are used, the pools sampled all fully support the aquatic life use.

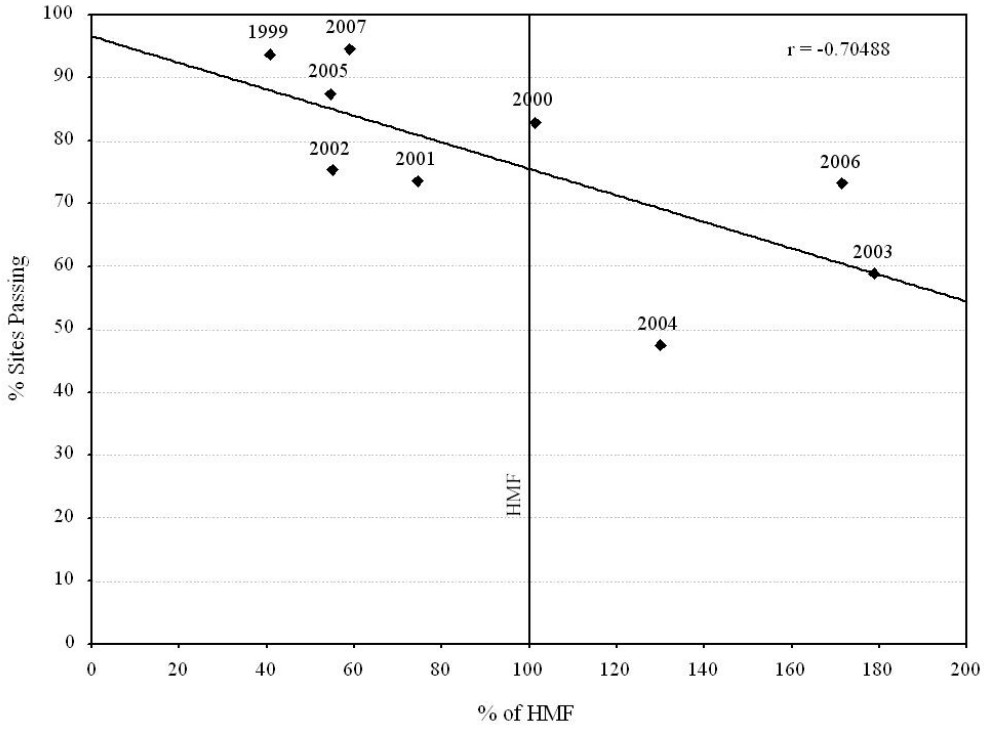


Figure 8. The percentage of sites passing in relation to harmonic mean flow (HMF) from 1999-2007. During wet years (higher % of HMF), a higher percentage of sites have failing ORFIn scores.

Chapter 3: Public Water Supply Use Support Assessment

The Ohio River Valley Water Sanitation Commission Compact requires that the Ohio River be available for safe and satisfactory use as public and industrial water supplies after reasonable treatment. The Ohio River serves as a drinking water source for over five million people within the Ohio River Basin. In order to ensure that this use is protected, the Commission operates a number of monitoring programs including bimonthly, clean metals, and bacteriological sampling.

Public Water Supply Use Assessment Methodology

The bimonthly and clean metals programs are comprised of 17 sampling stations along the Ohio River (Appendix B). Grab samples are collected from sites once every other month. Parameters monitored by ORSANCO for which there are human health criteria include arsenic, barium, silver, copper, nickel, selenium, thallium, total mercury, zinc, cyanide, chloride, fluoride, nitrates, nitrites, phenolics, dioxins, PCBs, and sulfates. Data included in this report were collected from July 2005 to July 2007. Bacteriological surveys are important to ensure that the fecal coliform criterion for drinking water—2,000 colonies/100 ml as a monthly geometric mean—is not exceeded. From 2005 through 2007, bacteria data were collected during the contact recreation season (May through October). In addition, the Commission mailed surveys to all Ohio River water utilities, requesting information about their source water quality. ORSANCO received responses from 22 utilities, approximately 75 percent of all utilities using the Ohio River as a drinking water source. Questionnaires asked utilities if there were frequent intake closures due to spills, whether violations of finished drinking water maximum contaminant levels (MCLs) occurred due to source water quality, or whether non-routine treatment due to source water quality was necessary to meet finished water MCLs (Figure 10). The designations are as follows:

Fully Supporting
- Pollutant criteria are exceeded in less than 10 percent of the samples collected.

Impaired-Partially Supporting
- One or more pollutants exceed the criteria in 11 to 25 percent of the samples collected.
- Frequent intake closures due to elevated levels of pollutants are necessary to protect water supplies.
- Frequent "non-routine" additional treatment is necessary to protect water supplies and comply with provisions of the Safe Drinking Water Act (SDWA).

Impaired-Not Supporting
- One or more pollutants exceed the criteria in greater than 25 percent of the samples collected.
- Source water quality causes finished water MCL violations which result in noncompliance with provisions of the SDWA.

Public Water Supply Use Assessment Summary

Twenty-eight public water utilities use the Ohio River as their drinking water source (Figure 9). Based on available data from various ORSANCO programs and outside data sources, 112 miles of the Ohio River partially support the public water supply use (Table 6). In the past, areas in West Virginia experienced recurring phenol violations; however between 2005 and 2007, phenol violations were found in Ohio, Kentucky, Indiana, and Illinois (Appendix D). One location in Pittsburgh has been designated as partially supporting the public water supply use due to multiple exceedances of the bacteria criterion. According to the Pollution Control Standards, the monthly geometric mean for fecal coliform should not exceed 2,000 colonies/ 100 ml. In June 2006 and August 2007, Pittsburgh reported geometric mean criterion exceedances at the ORM 1.4 fixed monitoring station (Appendix G). Wheeling and Louisville also reported monthly geometric mean exceedances for fecal coliform; however, this was less than 10 percent of the total number of monthly geometric means during the period between 2006 and 2007; therefore it earned a designation of fully supporting. Longitudinal bacteria survey data did not exceed the drinking water criterion at any point along the river (Appendix F), nor did metals levels threaten the public water supply (Appendix C).

Table 6. Summary of public water supply use assessment for 2005-2007 based on 17 monitoring stations, bacteriological sampling, and a survey of the public water utilities. All 112 miles of the Ohio River partially support the use of the Ohio River as a public water supply.

State	River Miles	Impaired Miles	Support Assessment	Causes of Impairment
PA	0-40.2	0.0-4.0	Partial Support	Fecal coliform
OH-WV	40.2-317.1	0	Full Support	None
OH-KY	317.1-491.1	0	Full Support	None
IN-KY	491.1-848.0	720.7-784.2	Partial Support	Phenol
IN-IL	848.0-981.0	918.5-962.6	Partial Support	Phenol
Total	981.0	111.6	Partial Support	

There was no indication of impairment based on the questionnaire surveys completed by water utilities (Table 7). However, although the river fully supports this use, surveys indicated that there are issues of concern. Three facilities reported intake closures due to chemical spills into the river. These closures did not result in an impairment designation because the conditions were temporary and related to single occurrences, but the occurrence of spills can temporarily suspend use of the Ohio River as a public water supply. Six respondents indicated that non-routine treatment was necessary. Much of the non-routine treatment conducted by utilities was related to preventing taste and odor problems caused by increases in algae. When algae are removed during the treatment process, some species leave behind metabolites that have an odor and can affect the taste of the water. Although taste and odor is considered a secondary standard, no MCL for taste and odor exists. Other instances of non-routine treatment were related to spills, non-point source pollution such as pesticides, or high levels of total organic carbon (TOC). TOC, a measure of organic matter, is removed during the treatment process, but interacts with the chlorine to produce disinfectant byproducts such as trihalomethanes (THMs) and haloacetic acids (HAA^5), which are regulated by the Safe Drinking Water Act. Therefore, even though TOC is not regulated, high levels can result in MCL violations in finished drinking water. Of the 22 returned surveys, five water utilities indicated they experienced MCL violations. Because THMs and HAA^5 were cited as the contaminants, rather than source water quality, these sites were not considered impaired because the contaminant was not directly caused by source water quality.

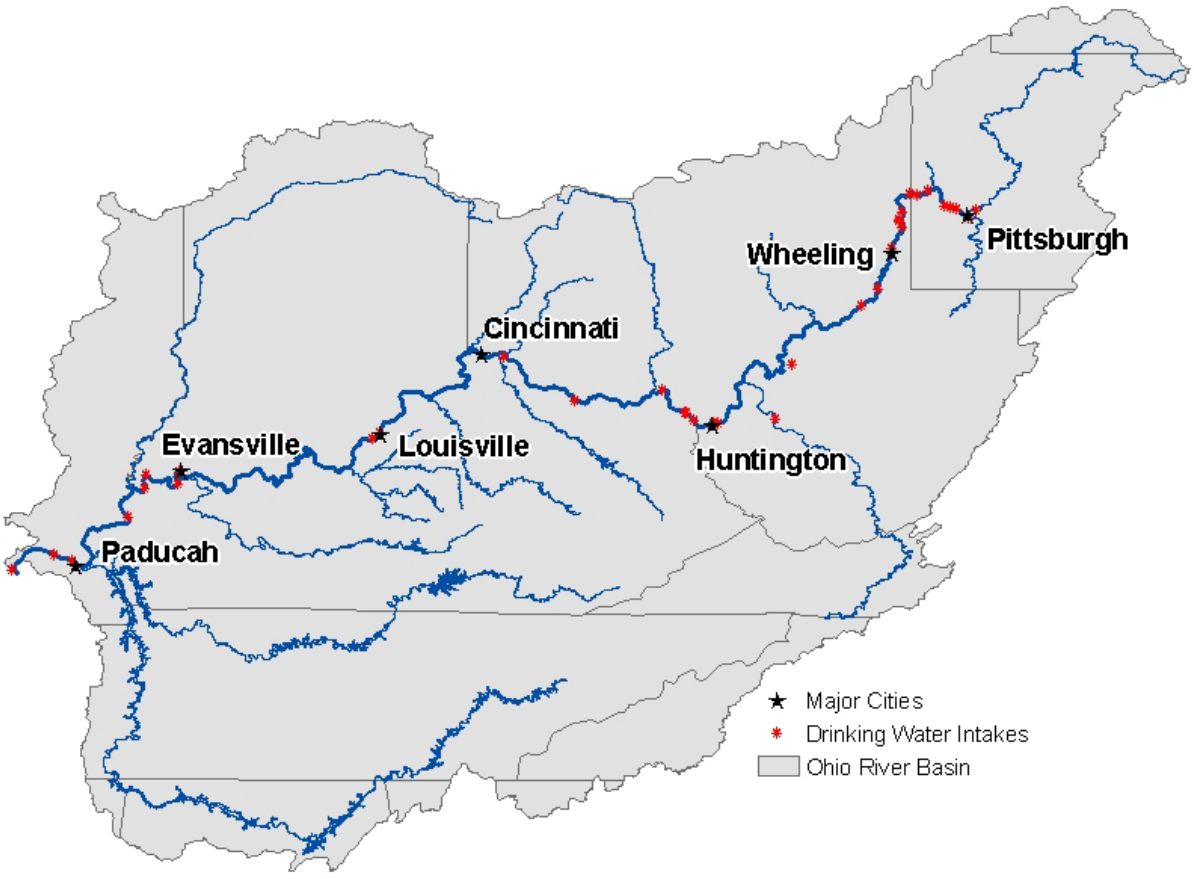


Figure 9. Map of Ohio River drinking water intakes. The 29 drinking water utilities provide drinking water to over three million people in the basin. The entire river fully supports use as a drinking water source.

Survey of the Ohio River Water Utilities for the 2008 Biennial Assessment of Ohio River Water Quality Conditions
(*For the period October 2005 – September 2007*)

Water Utility Name	Company/Facility

1. Your Name:		
Title:		
Phone Number:		
2. Between October 2005 and September 2007, was your intake closed as a result of Ohio River water quality conditions?	☐ Yes	☐ No
If so, how many times over the period was your intake closed?	How many days total over the period was your intake closed?	
What pollutants were involved?		
What sources were involved?		
3. Between October 2005 and September 2007, did your plant have any MCL violations?	☐ Yes	☐ No
If so, for what contaminants?		
Was it, in whole or part, caused by Ohio River water quality conditions?	☐ Yes	☐ No
4. Was "nonroutine" or additional treatment necessary to comply with SDWA MCLs during the period?	☐ Yes	☐ No
If so, for what contaminants? What was the source of the contaminants?		
How frequently was nonroutine/ additional treatment required?	How many days total was "nonroutine"/ additional treatment required?	

Figure 10. Ohio River Water Utility Questionnaire.

Table 7. Results from a survey of water utilities utilizing the Ohio River as a drinking water source indicated that the entire river (981 miles) fully supports use as a public water supply. MCL violations due to disinfection byproducts did not constitute impairment.

Utility Location	Mile Point	State	No. of Intake Closures due to Ohio River Water Quality	Causes of Intake Closures	MCL Violations	Contaminants causing MCL Violations	Non-routine Treatment Required	Contaminants resulting in Non-routine Treatment	Source of Contaminants	No. of Days*
West View	5.0	PA	0	-	-	-	-	-	-	-
Beaver Valley	29.0	PA	0	-	-	-	-	-	-	-
Midland	36.0	PA	0	-	X	TOC	-	-	-	-
East Liverpool	40.2	OH	0	-	-	-	X	Algae (taste and odor)		120
Toronto	59.2	OH	1	Ethylene Glycol	-	-	-	-	-	-
Weirton	62.5	WV	1	Spill into river	X	TOC, TTHM	X	TOC, TTHM	Spills and Non-point Sources	0
Follansbee	70.8	WV	0	-	-	-	-	-	-	-
Wheeling	86.8	WV	0	-	-	-	X	Petroleum, Algae, and Hexavalent Chromium	Point and Non-point sources, algal blooms	65
New Martinsville	121.9	WV	0	-	-	-	-	-	-	-
Huntington	304.0	WV	0	-	-	-	-	-	-	-
Ashland	319.7	KY	0	-	-	-	-	-	-	-
Ironton	327.0	OH	0	-	-	-	-	-	-	-
Russell	327.6	KY	0	-	X	THM	-	-	-	-
Portsmouth	350.8	OH	0	-	-	-	-	-	-	-
Louisville	600.0	KY	0	-	-	-	X	Organics from spills		30
Evansville	791.5	IN	0	-	-	-	X	Petroleum, Asphalt, Atrazine	Spills and Non-point Sources	9
Mt Vernon	829.3	IN	1	Petroleum	X	TTHM, HAA^5	-	-	-	-
Morganfield	842.5	KY	0	-	-	-	-	-	-	-
Sturgis	871.4	KY	0	-	X	TTHM, HAA^5	-	-	-	-
Paducah (WTP)	935.5	KY	0	-	-	-	-	-	-	-
Paducah (USEC)	945.9	KY	0	-	-	-	X	Benzene, Ethyl Benzene		6
Cairo	978.0	IL	0	-	-	-	-	-	-	-

THM- Trihalomethane, TOC- Total Organic Carbon, HAA^5- Haloacetic acids

* Total number of days during reporting period that non-routine treatment was required for one or more of contaminants listed.

Chapter 4: Contact Recreation Use Support Assessment Results

The Compact requires that the Ohio River remain in a satisfactory sanitary condition suitable for recreational usage. The Commission operates two bacteria monitoring programs to assess the degree of contact recreational use support during the contact recreation season (May-October): routine contact recreation bacteria sampling and longitudinal bacteria surveys conducted through the Watershed Pollutant Reduction Program. Contact recreation season data from May to October 2006 and May to October 2007 were used in making assessments, as well as longitudinal bacteria surveys conducted during the contact recreation season in 2003 - 2007.

Contact Recreation Use Assessment Methodology

There are 49 communities with combined sewer systems located along the Ohio. Combined sewer overflows (CSOs) and other non-point sources have been identified as significant causes of bacteria problems in the Ohio River, particularly during heavy rain events. Data is collected from six urban communities along the Ohio River with combined sewer systems to assess the degree of contact recreation use support in these areas (Appendix B). Five samples were collected monthly from three locations in these communities: Evansville, IN, Huntington, WV, and Louisville, KY. Sample locations included a site upstream and downstream of the community as well as a site within the major metropolitan area where combined sewer overflow (CSO) events are likely to occur. Four locations were monitored in Pittsburgh, PA, three of which created a cross-section where the Allegheny and Monongahela rivers meet to form the Ohio River in downtown Pittsburgh (river mile 1.4L, M, R), and one site downstream of the city (river mile 4.3). There were also four locations sampled in Wheeling, WV and five locations in Cincinnati, OH. Samples were analyzed for fecal coliform and *E. coli*.

Impairments are based on exceedances of ORSANCO's stream criteria for bacteria. This criteria for bacteria states that fecal coliform should not exceed 400/100mL in more than 10 percent of samples taken during a month, and should not exceed 200/100mL as a monthly geometric mean (at least 5 samples required). The standards for *E. coli* state that no single sample should be greater than 240/100mL, and should not exceed 130/100mL as a monthly geometric mean (at least 5 samples required). Using the geometric mean and instantaneous maximum bacteria values, sites were classified as having good (less than 10 percent of sites exceeded criteria), fair (11-25 percent of sites exceeded criteria), or poor (greater than 25 percent of sites exceeded criteria) water quality.

In 2003, ORSANCO expanded its bacteria monitoring program to include areas outside of the CSO communities. During the contact recreation season in 2003 - 2007, the entire length of the Ohio River was sampled fifteen times at five-mile intervals (Appendix F). Every five miles, three-point cross-sectional samples were collected and analyzed for *E. coli*. The river was divided into three sections (upper, middle, and lower) and each section was sampled weekly during a five-week period, allowing for the calculation of a monthly geometric mean. This was repeated for each section in a subsequent year, allowing for the calculation of three geometric means for each section of the river. Using ambient monitoring data collected during the contact recreation season at the fixed stations and longitudinal bacteria surveys, assessment categories were assigned based on the following criteria:

Assessment Methodology

Fully Supporting

- Monthly geometric mean or instantaneous maximum bacteria criteria are exceeded in not more than 10 percent of the time.

Impaired-Partially Supporting

- Monthly geometric mean or instantaneous maximum bacteria criteria are exceeded 11-25 percent of the time.

Impaired-Not Supporting

- Monthly geometric mean exceeds or instantaneous maximum bacteria criteria are exceeded greater than 25 percent of the time.

Contact Recreation Use Assessment Summary

All 981 miles of the Ohio River were assessed through bacteriological surveys to determine the degree of support for contact recreational usage. Based on available data, 426 miles (43 percent) were classified as impaired and not supporting use for contact recreation, 60 miles (6 percent) were impaired, but partially supporting the use, and 495 miles (50 percent) were classified as fully supporting contact recreation (Appendix H, Table 8). Approximately sixty samples were collected annually at each fixed sampling station (Appendix G). In 2006, 13 out of 20 sites exceeded the criteria in more than 25 percent of the samples (Figure 11). In contrast, 2007 was a drier year and had only 10 out of 22 monitoring sites with greater than 25 percent of the samples exceeding the criteria. Pittsburgh exceeded the stream criterion for the protection of contact recreation most frequently during 2006 and 2007. Municipalities such as Cincinnati, Evansville, and Wheeling experienced fewer violations in 2007 compared to 2006, likely as a result of dry conditions and fewer CSO (combined sewer overflow)

events. The upstream site in Cincinnati was the only fixed monitoring station at which the percentage of both the geometric mean and the individual sampling event exceedances were less than 25%, earning it a designation of "partial support." Overall, 2006 tended to have more violations than 2007, presumably due to increased precipitation in that year. The risk to public health following increased precipitation often comes from wet weather sources such as combined sewer systems. Heavy rains can cause the flow of rainwater and sewage carried in the combined sewer pipes to exceed the capacity, resulting in overflows to the river.

Although the fixed monitoring locations are useful in determining impairment near major metropolitan areas, longitudinal bacteria survey data are needed to fully assess the entire length of the river. During 2003 - 2007, the entire length of the Ohio River was sampled fifteen times through longitudinal bacteria surveys (Appendix F). Higher levels of *E. coli* were measured in major metropolitan areas along the river (Figure 12). As discussed previously, many of these same cities, such as Pittsburgh and Louisville, experienced violations based on fecal coliform at their fixed monitoring stations. The upper and lower sections of river exceeded the geometric mean and individual sample criterion more frequently than the middle section of the river. Specifically, from Pittsburgh to Wheeling, 86 of 105 miles exceeded the criteria in over 25% of the samples and were classified as "not supporting." In contrast, between Huntington and Cincinnati 105 of 177 miles were designated as "fully supporting" contact recreation.

The Ohio River is a large system that supports a variety of uses ranging from navigation to recreation. The basin also contains CSOs, which creates a risk associated with recreating in the river. Data described above show that the criterion for contact recreation use is often exceeded in the Ohio River, especially in major metropolitan areas. This risk of illness from bacteria increases after precipitation due to wet weather sources of pollution. Nonpoint sources of bacteria in the river include human waste from septic systems, urban stormwater runoff, and animal waste. In addition, point sources such as CSO events often lead to increased levels of human waste in the river. Currently, 15 percent of the CSO communities in the nation are found in the Ohio River Basin. Presently, criteria are in place to protect contact recreation. Through the development of Long Term Control Plans (LTCPs), facilities will begin to characterize, model, and monitor the combined sewer system, identify sensitive areas, and develop alternative plans to meet Clean Water Act requirements. Although facilities will continue to improve their practices of treating or storing wastewater, current evidence suggests that even after the requirements of the National CSO Control Policy are met by these treatment facilities, there may still be bacteria problems in the Ohio River with a corresponding health risk for swimming during wet weather.

Table 8. Summary of contact recreation use assessment for 2003-2007 based on fixed monitoring stations and longitudinal bacteria surveys. Of the 981 miles, 426 miles do not support contact recreation, 60 miles partially support contact recreation and 495 miles fully support contact recreation.

States	River Miles	Total Miles in Waterbody	Monitoring Station at River Mile Point (MP)	Support Assessment	Causes of Impairment
PA-OH-WV	0-68	68	*1.4L, 1.4M, 1.4R, 4.3, special survey*	Not supporting	bacteria
OH-WV	68-70	2	*special survey*	Partial support	bacteria
OH-WV	70-73	3	*special survey*	Not supporting	bacteria
OH-WV	73-82	9	*special survey*	Partial support	bacteria
OH-WV	82-85	3	*84.2, special survey*	Not supporting	bacteria
OH-WV	85-86	1	*special survey*	Full support	--
OH-WV	86-105	19	*86.8, 91.4, 92.8, special survey*	Not supporting	bacteria
OH-WV	105-177	72	*special survey*	Full support	--
OH-WV	177-182	5	*special survey*	Partial support	bacteria
OH-WV	182-203	21	*special survey*	Full support	--
OH-WV	203-228	25	*special survey*	Not supporting	bacteria
OH-WV	228-233	5	*special survey*	Partial support	bacteria
OH-WV	233-238	5	*special survey*	Not supporting	bacteria
OH-WV	238-243	5	*special survey*	Partial support	bacteria
OH-WV	243-299	56	*special survey*	Not supporting	bacteria
OH-WV	299-304	5	*special survey*	Full support	--
OH-WV	304-306	2	*305.1, special survey*	Not supporting	bacteria
OH-WV	306-308	2	*special survey*	Full support	--
OH-WV	308-311	3	*308.1, special survey*	Not supporting	bacteria
OH-WV	311-314	3	*special survey*	Partial support	bacteria
OH-WV	314-316	2	*314.8, special survey*	Not supporting	bacteria
OH-WV/KY	316-319	3	*special survey*	Partial support	bacteria
OH-KY	319-327	8	*special survey*	Full support	--
OH-KY	327-328	1	*special survey*	Partial support	bacteria
OH-KY	328-461	133	*special survey*	Full support	--
OH-KY	461-463	2	*462.6, special survey*	Not supporting	bacteria
OH-KY	463-465	2	*463.9, special survey*	Partial support	bacteria
OH-KY	465-469	4	*special survey*	Full support	--
OH-KY	469-471	2	*469.9, 470.0, special survey*	Not supporting	bacteria
OH-KY	471-475	4	*special survey*	Full support	--
OH-KY	475-478	3	*477.5, special survey*	Not supporting	bacteria
OH-KY	478-480	2	*special survey*	Full support	--
OH-KY	480-484	4	*special survey*	Partial support	bacteria
OH-KY	484-488	4	*special survey*	Not supporting	bacteria
OH/IN-KY	488-492	4	*special survey*	Full support	--
IN-KY	492-501	9	*special survey*	Not supporting	bacteria
IN-KY	501-593	92	*special survey*	Full support	--
IN-KY	593-596	3	*594.0, special survey*	Not supporting	bacteria
IN-KY	596-608	12	*special survey*	Full support	--
IN-KY	608-609	1	*608.7, special survey*	Not supporting	bacteria
IN-KY	609-611	2	*special survey*	Partial support	bacteria
IN-KY	611-709	98	*619.3, special survey*	Not supporting	bacteria
IN-KY	709-720	11	*special survey*	Partial support	bacteria
IN-KY	720-785	65	*special survey*	Not supporting	bacteria
IN-KY	785-789	4	*special survey*	Full support	--
IN-KY	789-798	9	*791.5, 793.7, 797.3, special survey*	Not supporting	bacteria
IN-KY	798-800	2	*special survey*	Partial support	bacteria
IN-KY	800-844	44	*special survey*	Not supporting	bacteria
IN/IL-KY	844-900	56	*special survey*	Full support	--
IL-KY	900-906	6	*special survey*	Partial support	bacteria
IL-KY	906-981	75	*special survey*	Full support	--
	Total Miles	**981**			

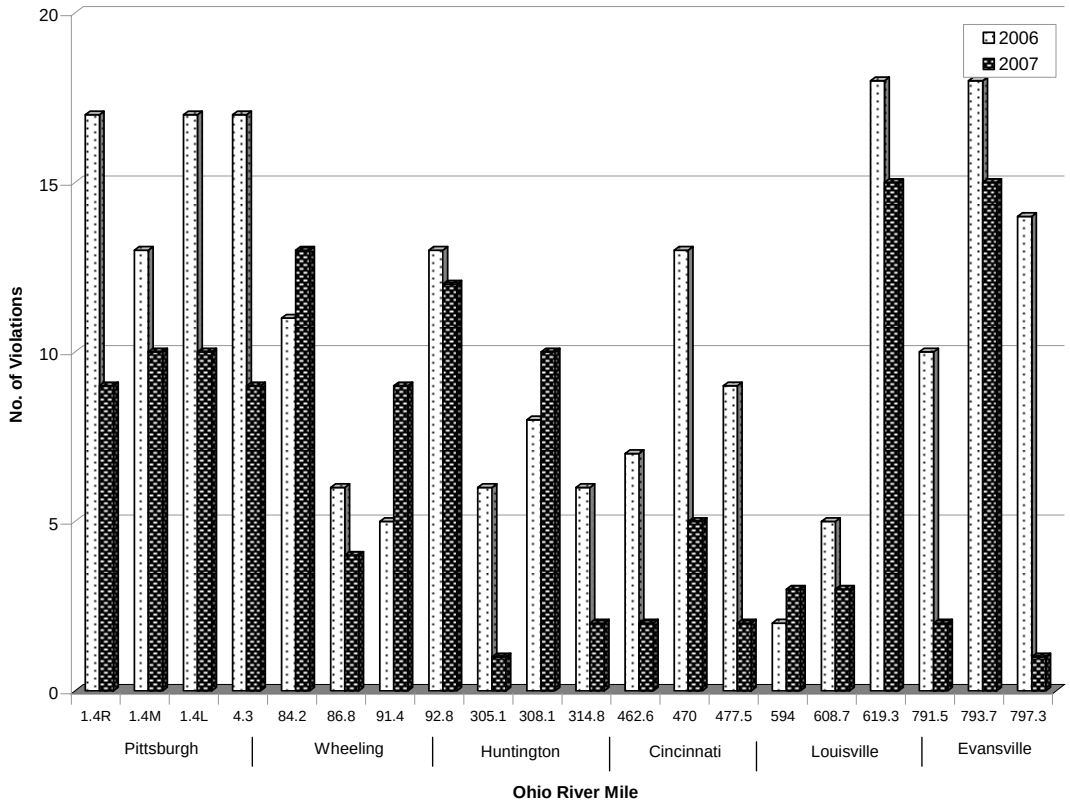


Figure 11. Number of samples, out of approximately 30 samples, exceeding the criteria at each contact recreation season monitoring location during 2006 and 2007. Sites with greater than 10 percent of the samples taken during the contact recreation season exceeding the 400 colonies/100 ml criterion are considered impaired.

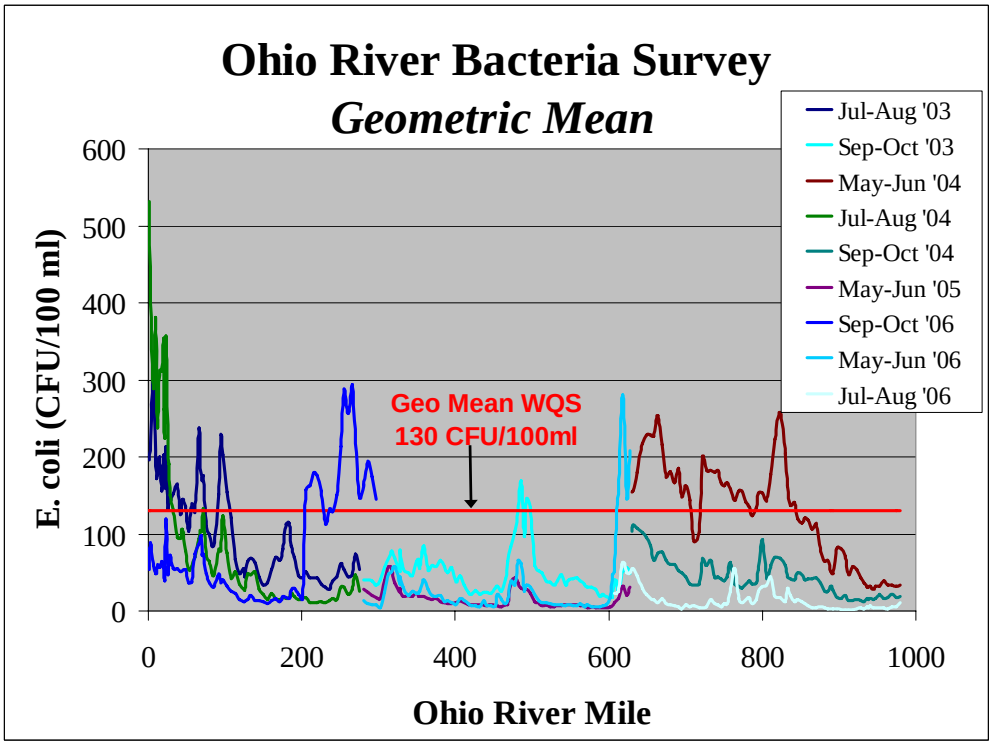


Figure 12. Between 2003 and 2006, the entire river was analyzed fifteen times through longitudinal bacteria surveys, allowing for the calculation of three monthly geometric means at each site. Peaks in *E. coli* levels often correspond with the location of major metropolitan areas such as Pittsburgh (river mile 1.4), Cincinnati (river mile 470), and Evansville (river mile 793.7).

Chapter 5: Fish Consumption Use Support Assessment

The Compact requires that the Ohio River be in a satisfactory sanitary condition and adaptable to such other uses as may be legitimate. The Commission maintains water quality criteria for the protection of human health from fish consumption and therefore evaluates this use in the Integrated Report.

Fish Consumption Use Assessment Methodology

The Commission generally collects and analyzes between 45 and 60 fish tissue samples annually. Samples, comprised of three- to five-fish composites, are analyzed for certain organics, pesticides, and metals. These data are then used by various agencies in each of the states bordering the river to issue fish consumption advisories to the public. Fish consumption advisories specific to the Ohio River are used in making impairment decisions. Statewide advisories not specific to the Ohio River are not used to classify the river as impaired. In addition to examining fish consumption advisories, levels of total mercury, PCBs, and dioxins (see note pg 41) in the water column, as well as methylmercury in fish tissue samples also were assessed against criteria for the protection of human health for fish consumption. Total mercury water column data were collected from 17 clean metals sites once every other month between July 2005 and July 2007. PCBs and dioxins were measured through high volume sampling. Collection of PCB and dioxin data was an ongoing process from 1997 through 2004; all data has been included in the assessment. Fish tissue samples were collected in 2005 and 2006 between July and October. These use designations are as follows:

Assessment Methodology

Fully Supporting

- No fish consumption advisories are in effect, **AND**
- PCB, dioxin, and mercury data do not exceed criteria

Impaired: Partially Supporting

- PCB, dioxin, or mercury criteria exceeded in greater than 10 percent of samples, **OR**
- Restricted fish consumption advisories are in effect

Impaired: Not Supporting

- "No Consumption" advisories are in effect for all commonly consumed species. Under these advisories, it is recommended that no fish from the river be consumed by any individuals.

Due to the prevalence of statewide consumption advisories for mercury and the differences in states' procedures for issuing these fish advisories, the Commission compared mercury fish tissue data against its criterion (0.3 mg/kg) in making impairment decisions.

Fish Consumption Use Assessment Summary

Fish consumption use was assessed based on the states' issuance of fish consumption advisories (Appendix M), mercury fish tissue data, PCB, dioxin, and mercury water column data. The entire Ohio River was assessed and classified as partially supporting based on fish consumption advisories as well as exceedances of the water quality criterion for PCBs and dioxin (Table 9). There was also a single occurrence of mercury fish tissue levels exceeding 0.3 mg/kg within the Willow Island pool (Appendix L). Dioxin water concentration data were compared against the Commission's water quality criterion of 0.000000005 µg/L (0.5 fg/L) (Appendix I). Every dioxin sample, riverwide, exceeded the water quality criterion (Figure 13). Similarly, PCB levels were compared against the 64 pg/L human health criteria set forth in the Pollution Control Standards (Appendix P). All samples were in violation of the PCB criterion as well (Appendix J, Figure 14). PCB and dioxin data were extrapolated to the entire river because data showed that all samples, at all locations along the river, exceeded the criteria for human health. Restricted fish consumption advisories are in effect in all states; however, no states had "no consumption" advisories in place in which no fish from a section of the river could be consumed by the general population, therefore the partial support classification.

Table 9. Summary of fish consumption use assessment for 2006-2007 based on 17 monitoring stations, high-volume sampling, and a fish tissue analyses. All 981 miles partially support the fish consumption use.

States	River Miles	Total Miles in Waterbody	Support Assessment	Causes of Impairment
PA-OH-WV-KY-IN-IL	0-981	981	Partial Support	PCBs, Dioxins

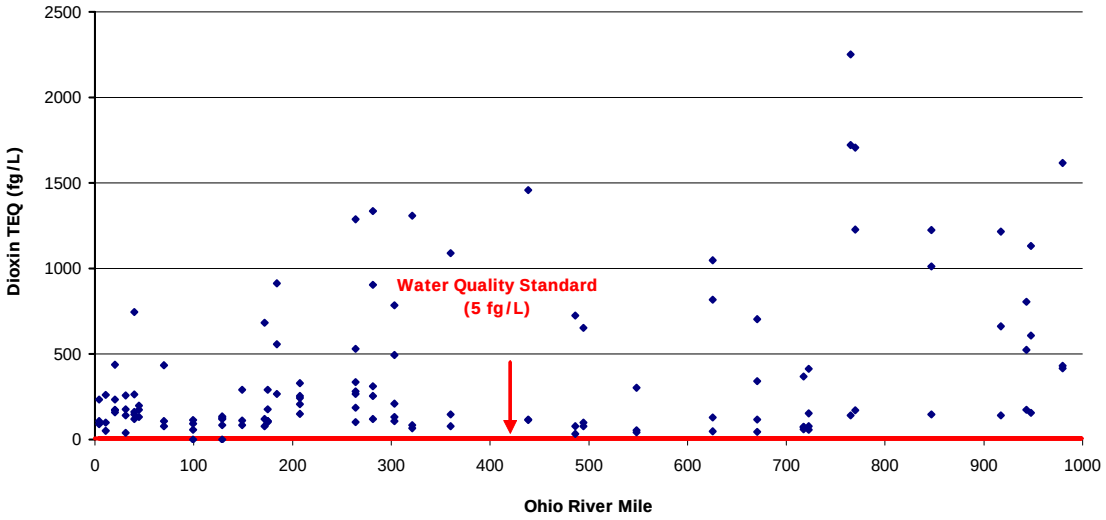


Figure 13. Dioxin TEQ concentrations in the Ohio River (1997-2004). All Ohio River samples analyzed for dioxins using high volume sampling techniques exceeded the water quality criteria for human health. As a result, the entire river was designated as impaired and "partially supporting" the fish consumption use.

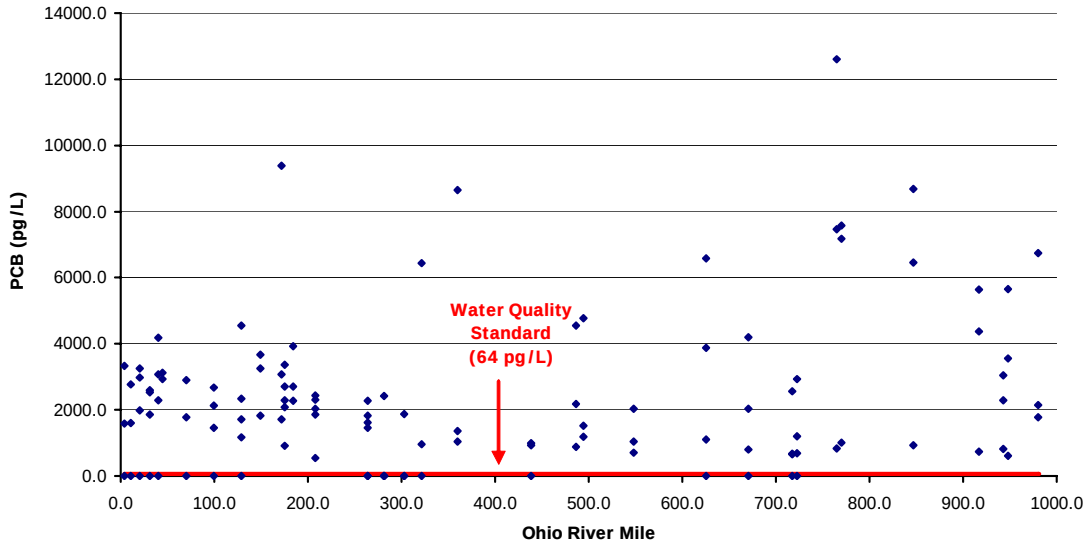


Figure 14. PCB data from the Ohio River collected from 1997-2004. All water samples analyzed for PCBs along the Ohio River exceeded ORSANCO's human health criteria for PCBs.

Based on fish tissue data, no segments were impaired due to exceedances of the methlymercury criterion (Appendix L, Figure 15). There was one exceedance of the criteria in fish tissue samples. Although many states issue statewide consumption advisories for mercury, there are distinct differences in states' procedures for issuing these advisories. As a result, the Commission compared mercury fish tissue data against its criterion (0.3 mg/kg) to make impairment decisions. ORSANCO also has a criterion of 0.012 µg/L for mercury in the water column to prevent the bioaccumulation of mercury in fish tissue. Clean metals data from 2005 through 2007 indicate that 503.5 miles of the Ohio had multiple exceedances of the mercury criteria (Appendix C). These exceedances were found to be greater than 10 percent of the samples at 7 (Anderson Ferry, West Point, Cannelton, Newburgh, J.T. Myers, Smithland, and Lock and Dam 52) out of 17 sites. However, because levels of mercury in over 90 fish tissue samples for 2005-2006 did not indicate impairment, segments were not listed based on the in-stream water column mercury criteria. Through discussion of the conflicting results, it was determined that the fish tissue mercury levels were more applicable in this use assessment than the levels of total mercury found in the water column because fish tissue is a more direct measure than water quality. The weight-of-evidence approach allows for biological data to have a greater impact in the assessment than water quality data. Fish tissue data were used because the tissue levels would directly impact individuals consuming fish from the Ohio River, while total mercury water column data is used as an indicator of potential bioaccumulation.

* Note: The term dioxin refers to a complex array of 210 polychlorinated dibenzodioxins and dibenzofurans. Seventeen of these 210 compounds have dioxin-like toxicity, the most toxic of which is 2, 3, 7, 8-tetrachlordibenzodioxin (2, 3, 7, 8-TCDD). EPA developed a method to quantify the dioxin toxicity of these compounds, which is now reported as 2, 3, 7, 8-TCDD TEQ (toxicity equivalency), an estimated sum of the toxicity of the 17 dioxin compounds. According to ORSANCO's Pollution Control Standards, the human health criterion for 2, 3, 7, 8-TCDD (dioxin) TEQ is 5 fg/L. This standard is based on EPA's Human Health Criteria for priority pollutants; however, an explanation of the way in which this criteria was derived was not included in ORSANCO's standards.

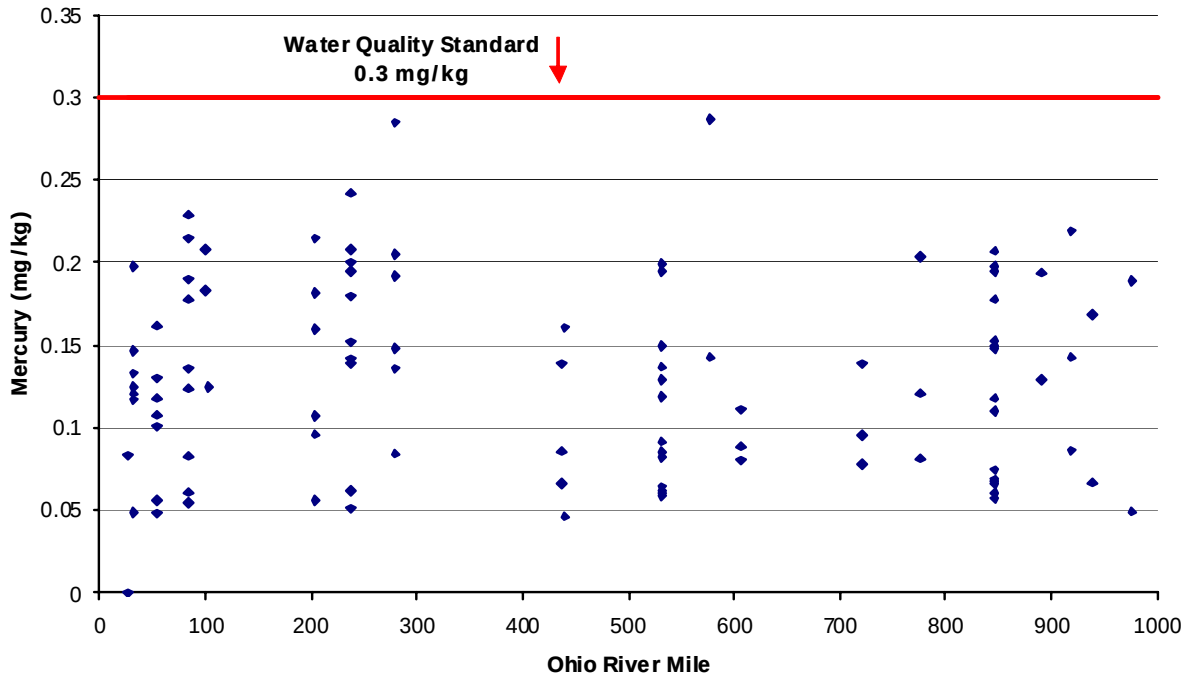


Figure 15. Mercury levels detected in Ohio River fish tissue (2003-2006). All fish tissue samples analyzed had mercury levels below the criteria for human health. No segments were assessed as impaired based on mercury levels in fish tissue.

Chapter 6: Ohio River Trends Analysis

ORSANCO first undertook a study of long-term temporal trends using the agency's own monitoring data in 1990, with 10-15 years of record at most monitoring stations. ORSANCO has since built another 18-year record to be tested for temporal trends. This study presents the results of that analysis and a comparison with the trends discovered in the earlier data set.

The Commission collects water quality samples at 17 locations on the Ohio River and near the mouth of 14 major Ohio River tributaries. Since 1990 the Commission has maintained a minimum of six sample events per year at each location. This study covers the 18-year period from January 1990 to December 2007, picking up where the previous ORSANCO trend analyses ended.

Sufficient data was available to test 18-year trends in seven non-metal water quality parameters: ammonia nitrogen, chloride, total hardness, nitrate-nitrite nitrogen, sulfate, total phosphorus, and total suspended solids. The introduction of a new sampling technique for metals in 2002 sufficiently changed the resulting data set such that this study examines only the 12-year record of total recoverable metals analysis through the end of 2002. The metals aluminum, magnesium, manganese, iron, and zinc have sufficient records for a 12-year trend test with a period ending in 2002.

A nonparametric test, the Seasonal Kendall, was performed both on direct concentrations and on a flow-adjusted basis to facilitate comparison with the Commission's earlier trend assessments. A nonparametric estimator of trend magnitude was calculated for all significant trends ($p < 0.10$).

Of 372 tests for trend (31 locations, 12 water quality parameters) 222 statistically significant ($p < 0.10$) trends were found. Analysis for the current period shows 54% increasing trends while the vast majority of trends (94%) discovered in the 1977 to 1990 studies were in the decreasing direction. One difference between the periods not indicated by that summary is that some parameters, for example copper and phenols, with decreases in the earlier period have apparently experienced declines such that infrequency of pollutant detections in the current period invalidates a test for continuing trends.

Important trends detected include increasing phosphorus concentrations at most Ohio River monitoring stations and increases in chloride concentrations at nearly all stations including tributaries. Sulfate concentrations in the Big Sandy River at the border of West Virginia and Kentucky have steadily increased and are reaching the level of the ORSANCO Water Quality Criterion of 250 milligrams per liter (mg/L).

Table 10 - Seasonal Kendall Test on Direct Concentrations

Bimonthly SiteName	River	Al	Cl-	Fe	Hardness	Mg	Mn	NH3-N	NO2-NO3-N	SO4	TP	TSS	Zn
Pittsburgh	Allegheny	O	INC	DEC	INC	INC	DEC	O	INC	O	O	O	dec
South Pittsburgh	Monongahela	O	INC	O	O	INC	DEC	O	inc	O	O	O	DEC
Beaver Falls	Beaver	O	INC	DEC	O	INC	DEC	O	dec	O	INC	O	O
New Cumberland	Ohio	DEC	INC	DEC	INC	INC	DEC	O	INC	O	DEC	DEC	DEC
Pike Island	Ohio	DEC	INC	DEC	O	inc	DEC	DEC	O	O	DEC	DEC	DEC
Hannibal	Ohio	O	INC	DEC	INC	INC	dec	O	O	O	O	O	DEC
Willow Island	Ohio	dec	INC	DEC	inc	INC	DEC	DEC	O	O	DEC	DEC	O
Marietta	Muskingum	DEC	O	DEC	O	INC	DEC	O	O	O	INC	DEC	DEC
Belleville	Ohio	DEC	INC	DEC	inc	INC	DEC	O	O	O	inc	DEC	DEC
Winfield	Kanawha	O	INC	O	INC	INC	inc	O	INC	INC	DEC	O	DEC
R.C. Byrd	Ohio	O	INC	O	O	INC	O	O	O	O	INC	inc	DEC
Louisa	Big Sandy	dec	O	dec	INC	INC	dec	INC	O	INC	O	DEC	DEC
Greenup	Ohio	DEC	INC	O	INC	INC	O	O	INC	O	INC	O	DEC
Lucasville	Scioto	O	inc	O	INC	INC	O	INC	DEC	O	INC	DEC	DEC
Meldahl	Ohio	O	INC	O	DEC	O	O	DEC	DEC	INC	O	O	DEC
Newtown	Little Miami	O	INC	O	inc	INC	O	inc	DEC	O	INC	DEC	dec
Covington	Licking	O	DEC	O	DEC	O	O	DEC	DEC	DEC	O	DEC	DEC
Anderson Ferry	Ohio	dec	INC	O	O	INC	O	INC	O	O	INC	O	O
Elizabethtown	Great Miami	O	O	O	O	inc	O	O	DEC	DEC	O	DEC	O
Markland	Ohio	O	INC	DEC	DEC	O	DEC	O	DEC	inc	INC	DEC	DEC
Louisville	Ohio	O	O	O	O	INC	O	dec	O	INC	INC	O	DEC
West Point	Ohio	DEC	INC	DEC	INC	INC	O	O	O	INC	INC	O	DEC
Cannelton	Ohio	O	INC	DEC	INC	INC	DEC	O	O	INC	INC	O	DEC
Newburgh	Ohio	O	INC	O	INC	INC	O	O	INC	INC	INC	O	DEC
Sebree	Green	dec	INC	O	INC	INC	O	O	INC	INC	INC	O	DEC
J.T. Myers	Ohio	O	INC	dec	INC	INC	DEC	O	O	INC	INC	O	DEC
Route 62 Bridge	Wabash		O	O	O	O	O	O	O	O	O	O	O
Smithland	Ohio	DEC	INC	DEC	INC	INC	dec	O	O	INC	INC	O	O
Pinkneyville	Cumberland	O	INC	inc	INC	INC	O	O	O	INC	INC	O	O
Paducah	Tennessee	DEC	INC	DEC	INC	INC	DEC	O	INC	INC	DEC	O	DEC
L&D 52	Ohio	DEC	INC	DEC	INC	INC	DEC	O	inc	INC	INC	O	DEC

INC - Strong significant increasing trend ($p < 0.05$, $Z_{0.025} = 1.96$)
inc - Significant increasing trend ($p < 0.10$, $Z_{0.05} = 1.6449$))
O - No significant trend found
dec - Significant decreasing trend ($p < 0.10$, $Z_{0.05} = 1.6449$)
DEC - Strong significant decreasing trend ($p < 0.05$, $Z_{0.025} = 1.96$)

Chapter 7: Integrated List

The Integrated Report combines requirements of both section 305(b) and 303(d) of the federal Clean Water Act. Each state completes an Integrated List, which then becomes available for public comment and is approved by the US EPA. While the Commission is not required to prepare a section 303(d) list, the preparation of a 305(b) report facilitates interstate consistency between states' Integrated Lists. The Integrated List contains a list of waters requiring Total Maximum Daily Loads (TMDLs). The Commission itself is not required to complete an Integrated List or TMDLs; therefore its Integrated List does not contain a schedule for establishment of TMDLs as is required of the states.

The Integrated List contains five assessment categories as follows:

Category 1 Data indicates that the designated use is met.

Category 2 Not Applicable ("available data and/or information indicated that some, but not all of the designated uses are supported").

Category 3 There is insufficient available data and/or information to make a use support determination.

Category 4 Water is impaired but a TMDL is not needed.

- **Category 4a** A TMDL is not needed because it has already been completed.
- **Category 4b** A TMDL is not needed because other required control measures are expected to result in the support of all designated uses in a reasonable period of time.
- **Category 4c** A TMDL is not needed because the impairment is not caused by a pollutant.

Category 5 The designated use is impaired and a TMDL is needed.

The entire length of the Ohio River was assessed for each use. Eight hundred and thirty-nine miles fully support the warm water aquatic life use. (Table 10). Bacteria TMDLs for the protection of the contact recreation use are required for 484 miles of the Ohio River. The remaining 497 miles fully support contact recreation. There were 112 miles impaired based on exceedances of the bacteria and phenol criterion for the public water supply use. The remaining 869 miles fully support the public water supply use. The full length of the river has been designated as impaired for the fish consumption use and requiring a TMDL for PCBs and dioxins. A TMDL for PCBs has been completed for river miles 0-238, the entire 40 miles of the Ohio River in Pennsylvania, and areas of the Ohio River bordering West Virginia and Ohio. TMDLs for both PCBs and dioxins have been completed for river miles 238-317.

Table 10. Ohio River integrated assessment summary for 2006-2007. Impaired uses include contact recreation and fish consumption. Category 5* Indicates that a PCB TMDL has been completed. A dioxin TMDL is still needed.

States	River Miles	Total Miles in Water Body	Warm Water Aquatic Life Use Support	Public Water Supply Use Support	Contact Recreation Use Support	Fish Consumption Use Support
PA	0-4	4	1	5	5	5*
PA-OH-WV	5-78	73	1	1	5	5*
OH-WV	78-83	5	1	1	5	5*
OH-WV	83-85	2	1	1	5	5*
OH-WV	85-86	1	1	1	1	5*
OH-WV	86-105	19	1	1	5	5*
OH-WV	105-131	26	1	1	1	5*
OH-WV	131-177	46	1	1	1	5*
OH-WV	177-182	5	1	1	5	5*
OH-WV	182-203	35	1	1	1	5*
OH-WV	203-238	35	1	1	5	5*
OH-WV	238-299	61	1	1	5	4a
OH-WV	299-304	5	1	1	1	4a
OH-WV	304-306	2	1	1	5	4a
OH-WV	306-308	2	1	1	1	4a
OH-WV	308-317	9	1	1	5	4a
OH-KY	317-319	2	1	1	5	5
OH-KY	319-327	8	1	1	1	5
OH-KY	327-328	1	1	1	5	5
OH-KY	328-397	96	1	1	1	5
OH-KY	397-461	64	1	1	1	5
OH-KY	461-465	4	1	1	5	5
OH-KY	465-469	4	1	1	1	5
OH-KY	469-471	2	1	1	5	5
OH-KY	471-475	4	1	1	1	5
OH-KY	475-478	3	1	1	5	5
OH-KY	478-480	2	1	1	1	5
OH-KY	480-488	8	1	1	5	5
OH/IN-KY	488-492	4	1	1	1	5
IN-KY	492-501	9	1	1	5	5
IN-KY	501-593	92	1	1	1	5
IN-KY	593-596	3	1	1	5	5
IN-KY	596-608	12	1	1	1	5
IN-KY	608-721	113	1	1	5	5
IN-KY	721-776	55	1	5	5	5
IN-KY	776-784	8	5	5	5	5
IN-KY	784-785	1	5	1	5	5
IN-KY	785-789	4	5	1	1	5
IN-KY	789-844	55	5	1	5	5
IN/IL-KY	844-900	56	5	1	1	5
IL-KY	900-906	6	5	1	5	5
IL-KY	906-919	13	5	1	1	5
IL-KY	919-981	62	1	1	1	5

Chapter 8: Summary Analysis for Surface Waters

ORSANCO's biennial assessment is generated through the coordination of the Commission's 305(b) Workgroup, which is composed of representatives from each of the mainstem states as well as US EPA Regions 3, 4, and 5. This workgroup communicates via meetings and teleconferences multiple times during the report preparation process. Through these conversations, the assessment parameters, methodology, and schedule are established. This group, along with ORSANCO staff, review Ohio River monitoring data and provide input into the generation of this report. Monitoring data from ORSANCO's bimonthly sampling, clean metals sampling, bacteria monitoring, watershed protection, fish population and fish contaminants programs, along with information from public drinking water facilities and outside data sources, provide the information needed to generate this assessment. The involvement of state personnel during the development of this report is essential to promote consistency among the states as they assess Ohio River water quality.

Most Ohio River states incorporate ORSANCO's biennial assessment into their own Integrated Report. This either occurs directly as an attachment to their reports or by reference within their reports. Most states do not conduct water quality monitoring on the Ohio River as extensively as ORSANCO, so this opportunity to share resources and promote consistency among the states that border the Ohio River is extremely valuable. ORSANCO also completes an Integrated List of waters requiring TMDLs. The purpose of developing this list is to promote consistency in Ohio River segments listed for TMDL development. The states submit their own Integrated Lists and otherwise have no requirement to complete TMDLs as contained in the Commission's report. However, the state listings in general are consistent with ORSANCO's 305(b) and Integrated List.

Aquatic Life

The aquatic life use assessment employed a new methodology for making assessments in the 2006 report. In 2004, ORSANCO began using a multimetric index to assess the fish community and aquatic life use. The Ohio River Fish Index (ORFIn) was compared against expected values from sites with good, representative fish communities. Locations with multiple ORFIn scores below the 25th percentile of expected scores were assessed as not supporting the aquatic life use. During the 2006 report cycle, biologists and members of the Biological Water Quality Subcommittee designed a monitoring schedule in which four navigational pools will be sampled each year, with the entire river (20 navigational pools) being sampled every five years. Fixed monitoring locations, which are visited yearly, enable biologists to track changes in the fish community over time. For the 2008 report, all Ohio River miles within eight separate segments were assessed as fully supporting aquatic life using biological data. Bimonthly and Clean metal data from 17 mainstem monitoring locations likewise indicated no impairment. One hundred and forty two miles of the Ohio River were found to be partially supporting due to violations of ORSANCO's dissolved oxygen and temperature criteria. Violations were found in the J.T. Myers pool (ORM 776.1 – 848.0) for both dissolved oxygen and temperature, while the Smithland pool (ORM 848.0 – 918.5) was found impaired due to low dissolved oxygen levels. The 142 miles with temperature and dissolved oxygen violations are listed under category 5.

Public Water Supply

Currently, there are 28 water utilities using the Ohio River as a source of drinking water. These water utilities provide drinking water to nearly 5 million people, and as such, it is important that the source water be evaluated for its suitability as drinking water after treatment. The public water supply use was assessed using Ohio River water quality data as well as results of a survey sent to each utility. Approximately three-fourths of the utilities responded to the survey, which asked whether finished drinking water standards (Maximum Contaminant Levels) were violated as a result of Ohio River water quality, whether non-routine treatment was necessary to meet finished water MCLs, or whether frequent intake closures were necessary as a result of poor source water conditions. No impairments to Ohio River water quality were designated based on responses to the water utility questionnaires. Several water utilities indicated on surveys that non-routine treatment was necessary due to contaminants such as toluene, oil, and pesticides such as atrazine. While the total number of non-routine treatment days and types of contamination may indicate some impairment of the public water supply use, this is not the case. Communication with water utilities confirmed that non-routine treatment was implemented to provide a better product to water utility customers and not to comply with the Safe Drinking Water Act's minimum requirements. Bimonthly sampling data did show impairment caused by phenol exceedances in greater than 10 percent of samples. As a result, the public water supply use has been designated as partially supporting for ORM 720.7-784.2 and ORM 918.5-962.6. There were also

fecal coliform monthly geometric mean criterion exceedances found amongst contact recreation sampling data. At station ORM1.4, greater than ten percent of months exceeded 2000 CFU/100 mL of fecal coliform. Therefore, the Ohio River is designated as partially supporting at ORM 0.0-4.0. The length of the river not affected by violations was designated as Category 1, fully supporting public water use. The length of the river including miles 0.0-4.0, 720.7-784.2, and 918.5-962.6 are allocated as partially supporting, and so placed in category 5. In addition, it is important to recognize that spill events on the river can impact the use of the Ohio River as a public water supply but were not used in making use assessments.

Contact Recreation

The Ohio River is used extensively for contact recreation by boaters and swimmers alike. Bacteria data are used to determine the status of attainment of the contact recreational use. Contact recreation bacteriological monitoring is conducted in the six largest communities with combined sewer systems along the Ohio River: Cincinnati, Evansville, Huntington, Louisville, Pittsburgh and Wheeling. In 2003, the Commission initiated longitudinal bacteria surveys in an effort to characterize bacteria levels along the entire Ohio River, including sampling in remote locations. The 2006 report had been the first to report the extensive bacteria data collection for the entire length of the Ohio River. The length of the river has been sampled fifteen times at five-mile intervals, the most comprehensive of ORSANCO monitoring programs. Based on the six routine urban sites, all locations, with the exception of one upstream site in Cincinnati, are classified as not supporting the contact recreational use. These impairments have been documented since the initiation of the monitoring sites in the early 1990's. With the addition of the longitudinal surveys, ORSANCO can now provide a more comprehensive assessment of the river, locating those areas outside the influence of major metropolitan areas that fully support this use. Although over half of the Ohio River fully supports contact recreation usage, violations occurred along the entire length. The violations are being addressed within a bacteria TMDL which is currently under development for the entire river.

Fish Consumption

The entire Ohio River is designated as impaired and listed as requiring a TMDL (page 45) for the fish consumption use due to elevated levels of dioxin and PCBs. The states base their fish consumption advisories on the Commission's fish tissue contaminants program. All states have Ohio River fish consumption advisories for PCBs. In addition, the Commission has operated a dioxin sampling program since 1997 and has collected samples in many segments and all regions of the Ohio River. Every sample collected exceeds the Commission's water quality criterion for human health protection from consumption of fish. Therefore, the entire Ohio River is classified as impaired for both dioxin and PCBs. Many states have statewide fish consumption advisories for mercury. However, only one Ohio River fish tissue contaminant sample exceeded the Commission's criterion, despite total mercury exceedances of the water column criterion at five monitoring locations. This water column mercury criterion is designed to prevent the bioaccumulation of mercury in fish tissue, but since only one impairment was indicated for mercury in fish tissue, the use was not designated as impaired from mercury contamination as measured in the water column.

TMDL Development

The Commission completed an Integrated List containing waters requiring Total Maximum Daily Loads (TMDLs) for the purpose of promoting interstate consistency in TMDL-listed waters. States are not required to implement TMDLs based solely on ORSANCO's recommendations; however this list should be consistent with the states' lists. Riverwide TMDLs are indicated for PCBs and dioxin except for segments which already have a TMDL completed. A PCB TMDL has been completed for the upper 238 miles of the Ohio River. TMDLs for both dioxin and PCBs have been completed for the section of the river between river mile 238 and 317. Bacteria TMDLs are needed for 484 miles of the Ohio River, and the Commission is currently assisting US EPA Region 5 complete a bacteria TMDL for the entire river.

Chapter 9: Recommendations

From this 2008 edition of the Biennial Assessment of Ohio River Water Quality, recommendations can be suggested from detailed analysis of the data contained in this report. The first recommendation pertains to dissolved oxygen and temperature impairments. We would suggest follow-up monitoring to determine if aquatic life impairments and to better define dissolved oxygen levels within the Smithland and JT Myers pools, and determine causes and sources of criteria violations for these two parameters. The second recommendation is to update dioxin monitoring data. No new monitoring has been performed since 2003, therefore existing data is becoming outdated for use in future assessments.

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