State of Ohio
Environmental Protection Agency

Division of Surface Water

Cuyahoga River Aquatic Life Use Attainment Following the Kent and Munroe Falls Dam Modifications

Portage and Summit Counties

Ohio EPA Biological and Water Quality Report NEDO/2008-08-01

August 6, 2008

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prepared by

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Cover Photos:

Top – Cuyahoga River in Kent upstream from Main Street and the Kent dam. This is the upstream limit of the fish sampling zone for Site F01P28 at River Mile (RM) 55.0

Bottom – Cuyahoga River downstream from Fish Creek and upstream from the Summit County Fishcreek WWTP. This is the fish sampling zone for Site F01W38 at RM 49.9.

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SUMMARY

Chemical/physical water quality and aquatic life community assessments were performed at seven locations in Portage and Summit Counties along the middle portion of the Cuyahoga River from 2005 to 2007. The primary purpose of the sampling was to determine the attainment status for the Warmwater Habitat (WWH) aquatic life use designation for the Cuyahoga River following implementation of the 2000 Middle Cuyahoga River total maximum daily load (TMDL) recommendations. Previous surveys of the Cuyahoga River had found that this reach of the river was not in full attainment of water quality standards due primarily to altered flow regime, altered habitat, lack of fish passage and low dissolved oxygen (Figure 1).

The aquatic community survey included assessments between river mile (RM) 55.6 and RM 48.7 (Figure 2). Survey results in Kent (RM 55.6, 55.0, and 54.6) for the Invertebrate Community Index (ICI), the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb) were in full attainment of the ecoregional aquatic life criteria in Ohio's Water Quality Standards. The sites in the former Munroe Falls dam pool (RMs 51.8, 51.0, 49.9) were in partial attainment of the ecoregional aquatic life criteria. The fish populations in Munroe Falls are in the process of changing from a lentic to a lotic community and have probably not had sufficient time to adapt to the new habitat conditions following the Munroe Falls dam removal. The site downstream from the Munroe Falls dam near Waterworks Park (RM 48.7) was in NON attainment. The scores at this site were not significantly different from previous Ohio EPA sampling (Table 1). Habitat quality for fish populations was assessed using the Qualitative Habitat Evaluation Index (QHEI). Habitat in the sample reaches was better than the WWH community target score of 60 except at the most downstream reach at RM 48.7. The QHEI score at that location was a 58. The QHEI score and river substrate composition at the RM 48.7 site were similar to those found in previous surveys.

A total of 30 fish species and one hybrid were collected during the 2007 survey. Three sites in Kent were in full attainment and supported robust populations of northern hogsucker (*Hypentelium nigricans*), greenside darters (*Etheostoma blennioides*), rock bass (*Ambloplites rupestris*) and smallmouth bass (*Micropterus dolomieui*). Northern pike (*Esox lucius)*, smallmouth bass and rock bass were large enough to support an excellent recreational fishery. The macroinvertebrate populations improved dramatically in all portions of the study area. All sites attained the established aquatic macroinvertebrate ICI index criterion and one site in the former Munroe Falls dam pool exceeded the exceptional criterion. The IBI and MIwb (fish) scores within the former Munroe Falls dam pool were not meeting the established WWH criteria and index scores were not significantly different from pre dam removal. However, all elements for a full recovery of the aquatic communities to WWH standards were present and full attainment is expected within the next few years.

Physical/chemical water quality monitoring was performed within the study reach to evaluate water quality and to update the water quality computer model developed prior to the TMDL implementation. All of the collected water samples, including dissolved oxygen, met the established water quality

standards for the river. The model was calibrated and verified using the 2007 water quality data and stream morphology measurements. The model predicts that all of Ohio's Water Quality Standards (WQS) criteria will be met at low flow conditions (Q1-10) and dischargers at their current and near future maximum permitted loadings. The model does indicate that instream temperatures at low flow conditions could approach the WQS criteria.

Table 1. Aquatic community index scores and attainment status prior to implementation of the Middle Cuyahoga River TMDL, 1996-2000

River Mile (Fish/Macroinvertebrate)	Attainment Status	IBI	MIwb	ICI	QHEI	Location Description
Cuyahoga River						
55.7 [a]	**NON**	28†	8.2 [ns]	Not Sampled	51.0	Grant Street (Dam Pool)
54.2/54.4	**PARTIAL**	28*	7.6*	44	70.0	Tannery Park (Free Flowing)
53.4/53.4 [a]	**PARTIAL**	31*	6.7*	38	38.0	Middlebury Road (Dam Pool)
53.0/52.6 [a]	**NON**	31*	7.7 [ns]	18†	64.0	Ust Fish Creek (Dam Pool)
51.00[a]	**NON**	30*	6.2*	Not Sampled	48.5	Dst Fishcreek WWTP (Dam Pool)
49.7/49.8 [a]	**PARTIAL**	34*	8.4	42	83.0	Dst Munroe Falls dam (Free Flowing)
48.7/48.4 [a]	**NON**	22†	5.0†	32 [ns]	56.0	Adjacent Silver Lake/Dst from Kent and Munroe Falls dams.

Table 2. Aquatic community index scores and attainment status in the 2007 study area following dam modifications

River Mile (Fish/Macroinvertebrate)	Attainment Status	IBI	MIwb	ICI	QHEI	Location Description
Cuyahoga River						
55.60/55.60	**FULL**	46	8.3	36	69.0	Grant Street (Former Dam Pool)
55.0/55.0	**FULL**	42	8.2	36	76.0	Brady's Leap (Former Dam Pool)
54.60/54.4	**FULL**	41	8.5	36	79.5	Tannery Park
51.80/52.0	**PARTIAL**	30*	7.5 [ns]	50	61.5	Dst Fish Creek/Ust WWTP (Former Dam Pool)
51.00[a]	**PARTIAL**	32*	8.4 [ns]	Not Sampled	71.0	Dst Fishcreek WWTP (Former Dam Pool)
49.90/50.0	**PARTIAL**	31*	8.7	44	66.5	Ust/Dst former Munroe Falls dam
48.70/48.7 [a]	**NON**	23†	6.4†	42	58.0	Adjacent Silver Lake/Dst from Kent and Munroe Falls dams.

EOLP WWH Biocriteria	
INDEX	Target Criteria
IBI (Wading/Boat)	38/40
MIwb (Wading/Boat)	7.9/8.7
ICI	34

[a] - Boat sampling site. All other locations are wading sites.

[ns] - Non-significant departure from biocriteria (<4 IBI units or <0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI units or >0.5 MIwb units).

† - Indicates poor results

Green Shading for QHEI indicates meeting or exceeding a score of 60 which is the threshold for conditions adequate to support WWH biological communities

FOREWORD

What is a Biological and Water Quality Survey? A biological and water quality survey, or "biosurvey," is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 4-5 watersheds study areas with an aggregate total of 250-300 sampling sites.

The Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation, water supply and human health concerns are also addressed.

The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by Ohio EPA (*e.g.*, NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1], Water Quality Permit Support Documents [WQPSDs]), and are eventually incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]).

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators consisting of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures (Figure 1). This integrated approach includes a hierarchical continuum from administrative to true environmental indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition. Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. Stressor indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. Exposure indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. Response indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.*, rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreation uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]), the Ohio Nonpoint Source Assessment, and other technical bulletins.

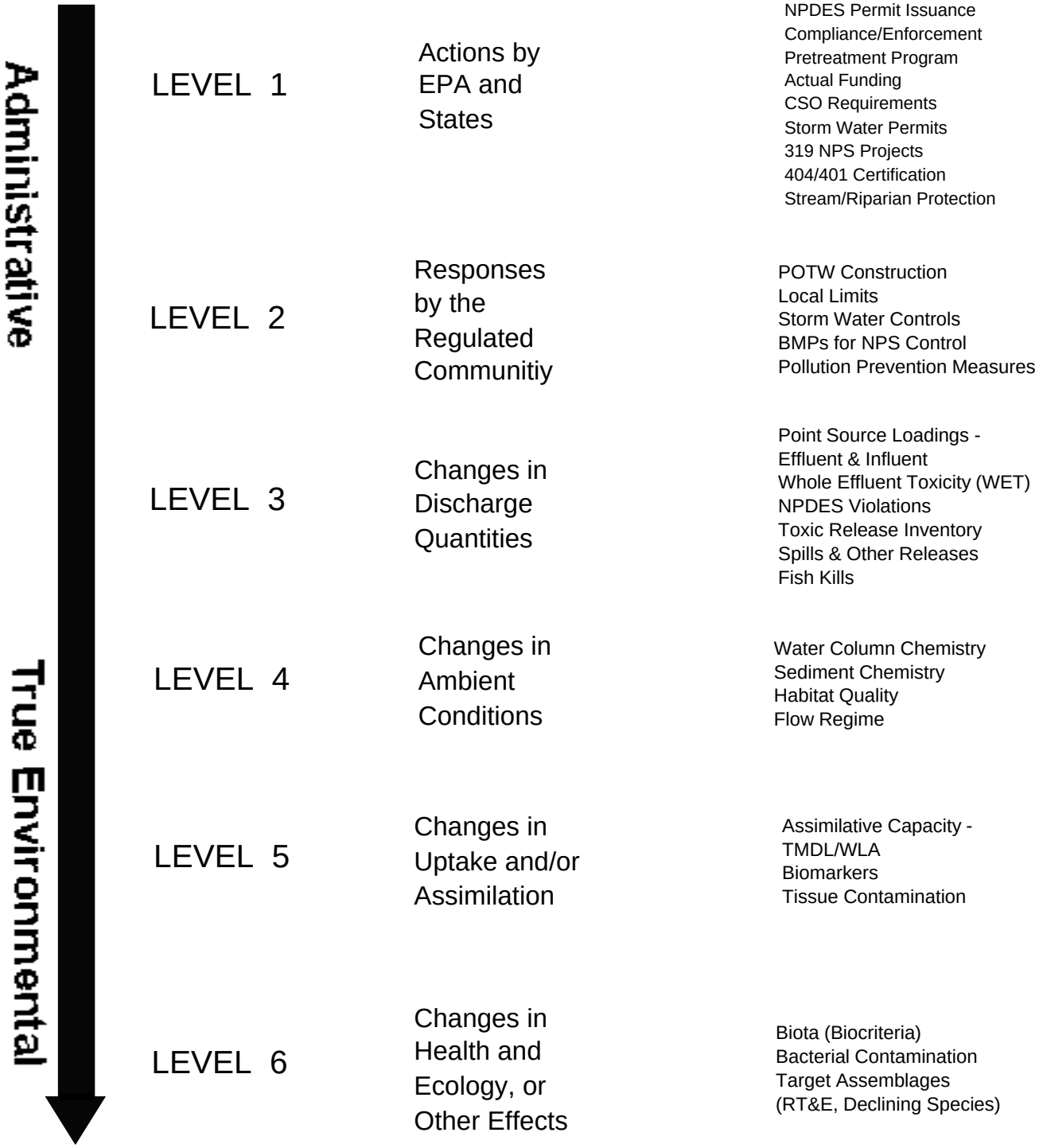

Figure 1. Hierarchy of the six "levels" of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

Ohio Water Quality Standards: Designated Aquatic Life Use

The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses. The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; this use represents the principal restoration target for the majority of water resource management efforts in Ohio.

2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.*, declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.*

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 mi^2 drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.*, true ephemeral streams), or other irretrievably altered waterways.

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a "tiered" approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria. For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same water quality criteria may apply to two or three different use designations.

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use can be having a water depth of at least one meter over an area of at least 100 square feet or, lacking this, where frequent human contact is a reasonable expectation. If a water body does not meet either criterion, the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.,* fecal coliform, *E. coli)* and the criteria for each are specified in the Ohio WQS.

Attainment of recreation uses are evaluated based on monitored bacteria levels. The Ohio Water Quality Standards state that all waters should be free from any public health nuisance associated with raw or poorly treated sewage (Administrative Code 3745-1-04, Part F). Additional criteria (Administrative Code 3745-1-07) apply to waters that are designated as suitable for full body contact such as swimming (PCR- primary contact recreation) or for partial body contact such as wading (SCR- secondary contact recreation). These standards were developed to protect human health, because even though fecal coliform bacteria are relatively harmless in most cases, their presence indicates that the water has been contaminated with fecal matter.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The AWS and IWS use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health.

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Loucek, Scott Winkler, Colum McKenna (Ohio EPA, NEDO), and college interns Sarah Allen and Kim Martin. Macroinvertebrate collections were performed by Jack Freda (Ohio EPA DSW – Ecological Assessment Section) and intern Amy Barret. Paul Gledhill (Ohio EPA DSW) managed the chemical physical water collections and performed the computer modeling. Dennis Mishne (Ohio EPA, DSW, Ecological Assessment Section) provided data management, calculation of biological indices, and QHEI scores. Jeff DeShon (DSW, Ecological Assessment Section) and Bill Zawiski (DSW, NEDO) reviewed the document and provided editorial comments.

INTRODUCTION

Previous evaluations of the water resources of the Cuyahoga River included chemical and physical (water column, effluents, sediment, flows), biological (fish and macroinvertebrate assemblages, fish tissue and bacteria), and habitat data collected by Ohio EPA pursuant to the five-year basin approach for monitoring and National Pollutant Discharge Elimination System (NPDES) permit reissuance. Ohio EPA relies on a tiered approach in attempting to link administrative activity indicators (*i.e.,* permitting, grants, enforcement) with true environmental indicators (*i.e.,* stressor, exposure, and response indicators). Stressor indicators generally include activities that have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. Exposure indicators include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to stressor or bioaccumulative agents. Response indicators include the more direct measures of community and population response and are represented here by the biological indices which comprise Ohio EPA's biological criteria. The key is in using the different types of indicators within the roles most appropriate for each. Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry, sediment, habitat, and effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment and an evaluation of the aquatic community represents the association of impairments (defined by response indicators) with stressor and exposure indicators.

Use attainment is a term describing the degree that environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (Ohio Administrative Code (OAC) 3745-1). Assessing use attainment status for aquatic life uses involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-15). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), which indicate the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Numerical endpoints are stratified by ecoregion, aquatic life use designation, and stream or river size. Three attainment status results are possible at each sampling location - full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects very poor or poor performance. An aquatic life use attainment table (see Table 2) was constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile (RM), the applicable biological indices, the use attainment status (*i.e.,* full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and comments and observations for each sampling location.

Previous biological and physical/chemical surveys from 1989 through 2000 in the middle portion of the Cuyahoga River revealed that the river was not meeting the designated WWH aquatic life use water quality standards. As such, the river segment was identified as a priority impaired water pursuant to Section 303(d) of the Clean Water Act. This section requires states to develop total maximum daily loads (TMDLs) for impaired waters. A TMDL is a written, quantitative assessment of water quality problems and contributing sources of pollution in a waterbody. The TMDL specifies the amount a specific pollutant needs to be reduced to meet water quality standards (WQS), allocates pollutant load reductions, and provides the basis for taking actions needed to restore a waterbody (Figure 2).

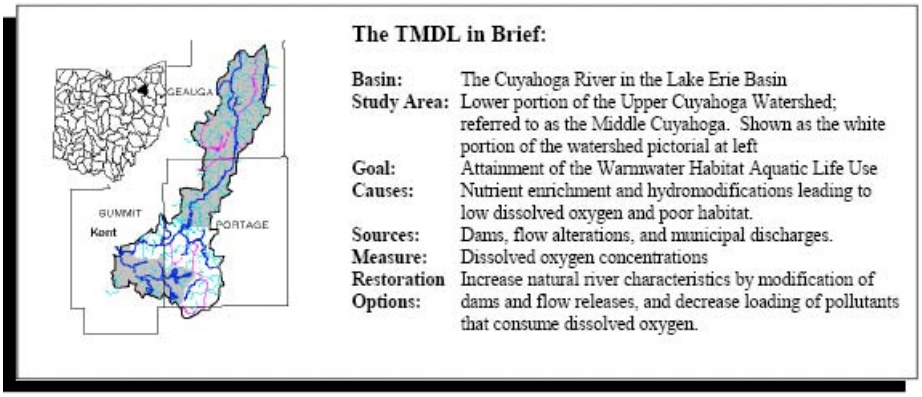

Figure 2. Summary of the Middle Cuyahoga River TMDL (Ohio EPA, 2000).

The TMDL process contains four broad, overlapping phases:

Assess waterbody health: biological, physical/chemical, and habitat
Develop a restoration target and a viable solution to meet the target
Implement the solution: inside/outside of Ohio EPA
Validate to monitor progress and then delist or relist.

The Middle Cuyahoga River TMDL report was prepared and became the first Ohio TMDL approved by U.S. EPA. The TMDL identified nutrient enrichment and hydromodifications that lead to low dissolved oxygen and poor habitat as the causes of non-attainment. Sources were attributed to flow alterations, dams, and municipal discharges. The restoration target was to improve the river assimilative capacity by modification of dams and flow releases, and to decrease loading of pollutants that consume dissolved oxygen. The recommendations have largely been implemented and this paper is a report on the effectiveness of these measures. Therefore, this report is the fourth, or validation phase, of the Middle Cuyahoga River TMDL.

STUDY AREA DESCRIPTION

The middle Cuyahoga River watershed is located northeast of Akron, Ohio and covers portions of Portage, Summit and Stark Counties. The river is within the Erie/Ontario Lake Plain (EOLP) ecoregion in HUC 04110002030. The EOLP is characterized by glacial formations and low to high stream gradient and velocities. Soils are mainly derived from glacial till and lacustrine deposits and tend to be light colored, acidic and moderately to highly erodible. The study area reach extends from near the northern

boundary of Kent and extends south and west through the urban areas of Kent and Stow/Munroe Falls (Table 3; Figures 3 and 4). The downstream boundary is Waterworks Park in the city of Cuyahoga Falls. The study area is upstream from the Little Cuyahoga River and the dams in Cuyahoga Falls. Significant tributaries within the study area include Plum Creek and Fish Creek.

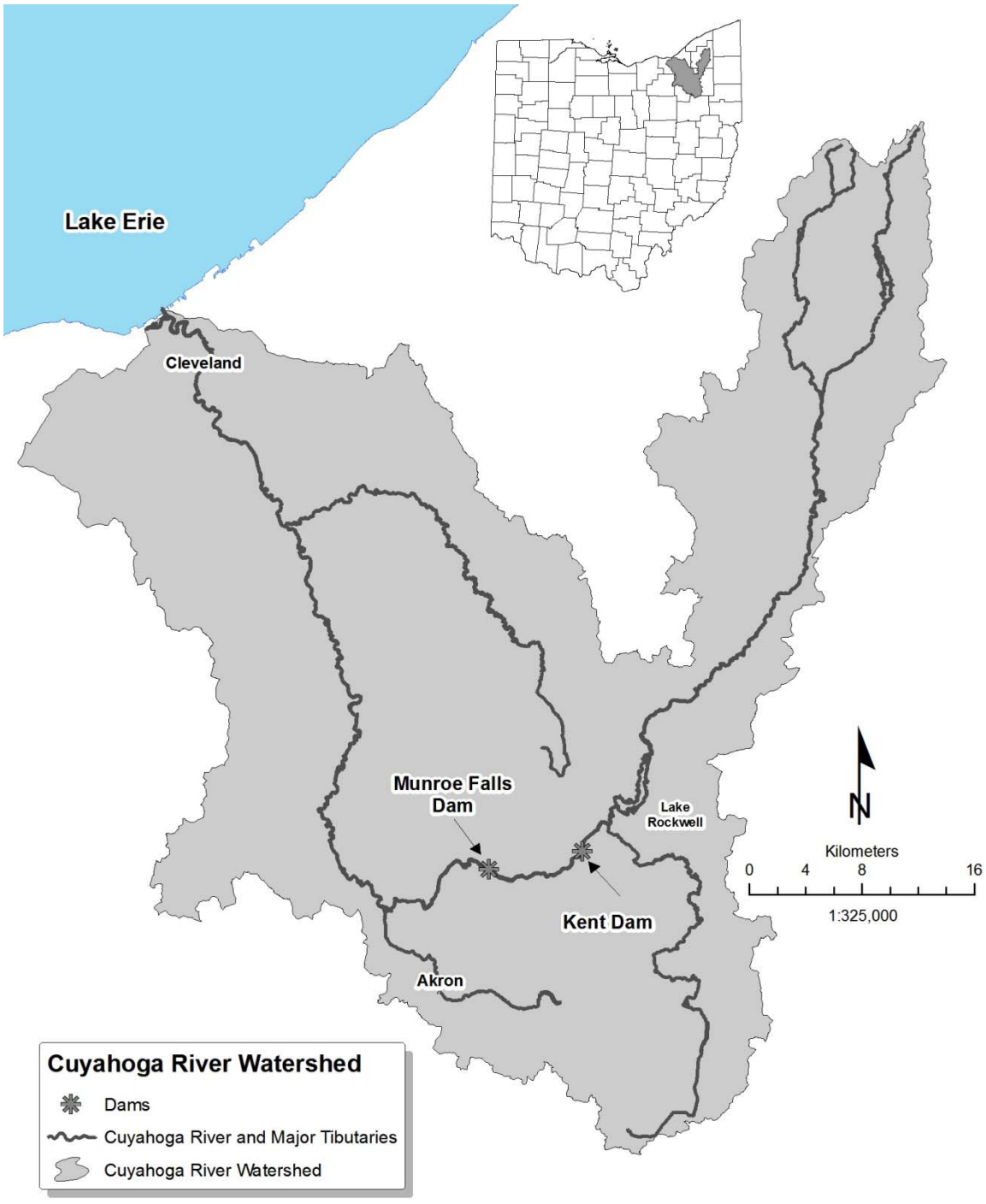

Figure 3. Cuyahoga River watershed and location of the two former dams.

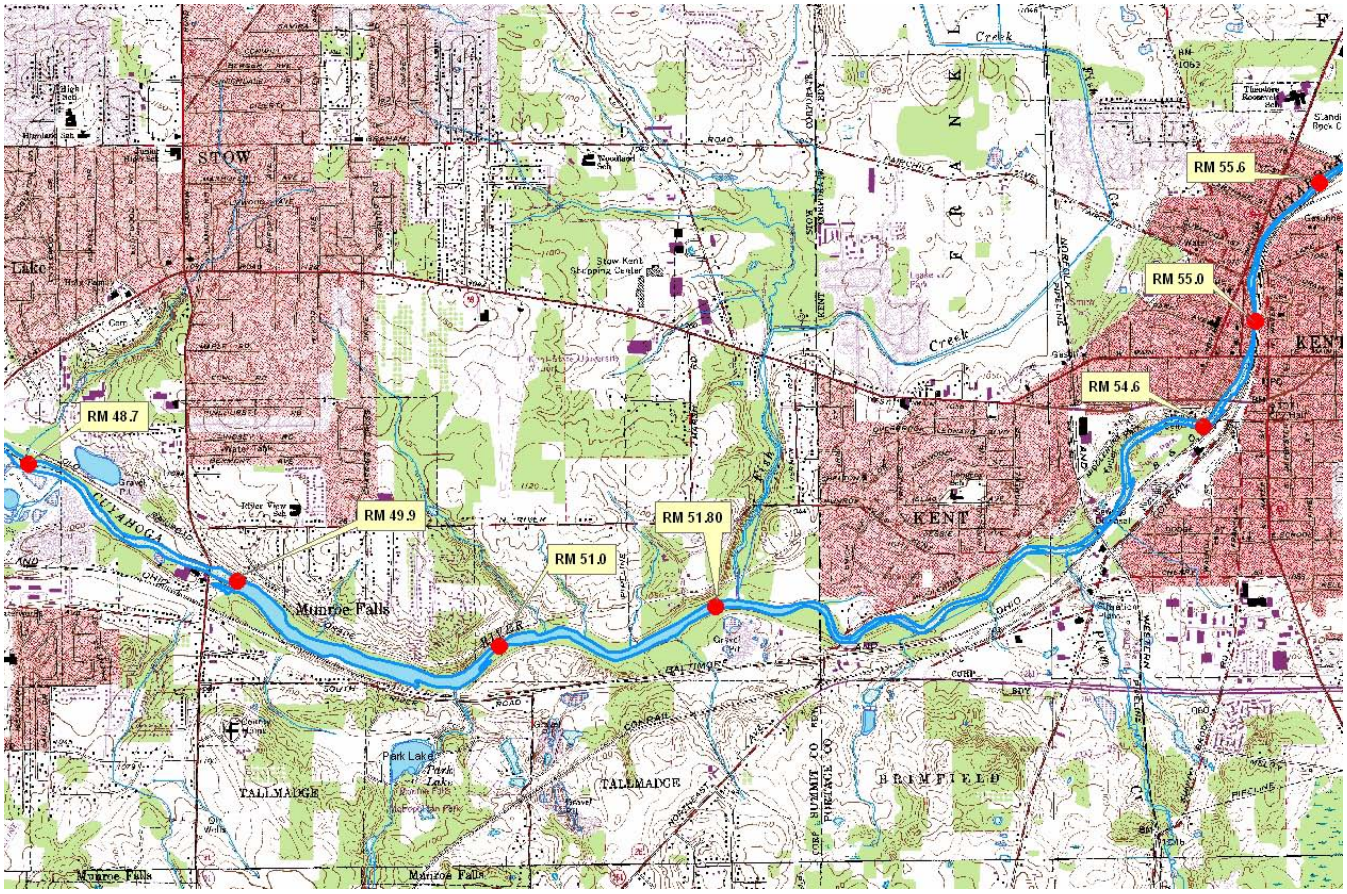

Figure 4. Middle Cuyahoga River aquatic community sampling locations.

Land use within the Cuyahoga River watershed is dominated by urban development, followed by agriculture, forest and wetland areas. Water quality standards for the river are derived from the EOLP warmwater habitat (WWH) aquatic life, industrial and agricultural water supply and primary contact recreation use designations. There are several municipal wastewater treatment plants both on the Cuyahoga mainstem and in the Breakneck Creek watershed, a major tributary upstream from the study area. The hydrology of the study area is influenced by impoundments and flow modifications. One Cuyahoga River impoundment, Lake Rockwell, is used as a public water supply reservoir for the City of Akron.

Prior to 1998, the city of Akron often completely eliminated flow from the Lake Rockwell dam during low stream flows. A recent Ohio Supreme Court ruling requires Akron to maintain a minimum flow of 8.5 million gallons per day (MGD) downstream from the dam. This minimum flow includes all Akron drinking water treatment plant wastewater discharges, “seepage” under and around the dam, flow over the dam and all other releases from the reservoir. Other minor water withdrawals in and near the study area include a surface water supply for the city of Ravenna at Lake Hodgson, irrigation for two golf

courses and diversions to groundwater recharge basins for the cities of Kent and Cuyahoga Falls. There are several minor and major wastewater discharges which occur in or near the study area. Table 4 lists the significant wastewater point sources.

Table 3. Site location information for the aquatic community survey for the middle Cuyahoga River mainstem, 2007.

River Mile	Station ID[1]	Location	Latitude	Longitude
55.6	F01W70	Grant St	41.16338	-81.35475
55.0	F01P28	Ust Main St	41.15560	-81.35920
54.6	F01W85	Dst Stow St	41.15000	-81.36300
51.8	F01W38	Ust WWTP	41.13950	-81.40146
51.0	F01W79	Dst WWTP	41.13693	-81.41826
49.9	F01S75	Ust Main St	41.14816	-81.45084
48.7	200037	Ust Silver Lk	41.14147	-81.43669

[1]Identification code for the site from the U.S. EPA STORET station code listing.

Table 4. Significant wastewater treatment plants in or near the study area.

Discharger	Receiving Stream	Discharge Location	Permitted Flow Rate
Portage Co Twin Lakes Wastewater Treatment Plant (WWTP)	Twin Lakes Trib	RM 0.52 to Cuyahoga River (RM 57.83)	0.5 MGD
Akron Drinking Water Treatment Plant (WTP)	Twin Lakes Trib	RM 0.15 to Cuyahoga River (RM 57.83)	1.6 MGD
Ravenna WWTP	Homan Avenue Ditch	RM 0.85 to Homan Ave Ditch to Wahoo Ditch (RM 0.5) to Breakneck Creek (RM 4.8) to Cuyahoga River (RM 56.82)	2.8 MGD
Portage Co Franklin Hills WWTP	Breakneck Creek	RM 2.52 to Breakneck Creek to Cuyahoga River (RM 56.82)	2.0 MGD
Kent WWTP	Cuyahoga River	RM 53.85	5.0 MGD
Summit Co Fishcreek WWTP	Cuyahoga River	RM 51.45	5.0 MGD

CONDITIONS PRIOR TO TMDL IMPLEMENTATION

Previous Studies

Water quality investigations prior to the dam modifications in Kent and Munroe Falls revealed non-attainment of Ohio Water Quality Standards. These surveys included biological and chemical/physical surveys in 1984, 1991, 1996, 2000 and 2005 (Munroe Falls area). Post dam modification sampling in the Kent area was performed in 2004, 2005 and 2007. In the Munroe Falls dam area, limited chemical/physical water quality monitoring occurred in 2005 during and immediately after dam removal. The only post removal biological sampling in the Munroe Falls area was performed in 2007 and is reported here.

Causes and Sources of Impairment Prior to Dam Modifications

Median total phosphorus concentrations generally exceeded the 0.12 mg/l median value for total phosphorus established for small river reference sites in the Erie-Ontario Lake Plain ecoregion. This indicates the middle Cuyahoga River was moderately enriched with respect to phosphorus. Nitrate-nitrite nitrogen concentrations increased downstream from Breakneck Creek compared to upstream values. Breakneck Creek enters the Cuyahoga River just upstream from the study area and receives the effluent from the Ravenna and Franklin Hills WWTPs. Median nitrate-nitrite nitrogen concentrations in the river increased nearly five-fold downstream from the Kent and Fishcreek WWTPs compared to upstream. There was little assimilation evident throughout the study area. The lack of assimilation indicates that nitrogen was present in concentrations saturating to algal growth. High algal productivity and subsequent respiration, combined with impounded conditions in the Munroe Falls dam pool resulted in dissolved oxygen concentrations falling below levels limiting to aquatic life, especially at night. Lake Rockwell also contributed to the enriched conditions by adding significant amounts of remineralized phosphorus and ammonia nitrogen to the Cuyahoga River. Water quality monitoring performed in 1996 and 2000 found exceedances of the dissolved oxygen criteria. The exceedances were attributed primarily to flow alteration from dams and low stream flow attributed primarily to water withdrawal by the City of Akron.

Index of Biotic Integrity (IBI) scores decreased downstream from Lake Rockwell relative to the free-flowing reach upstream. Further declines in IBI scores were measured in a short free flowing reach downstream from the Munroe Falls dam, and were believed to be related to nutrient enrichment and the resulting increased algal productivity from the Kent and Fishcreek WWTPs. A surface scum of what appeared to be blue-green algae was present in the Munroe Falls dam pool. Blue-green algae are favored by enriched conditions and low nitrogen to phosphorus ratios (*i.e.*, high phosphorus concentrations). The Modified Index of well-being (MIwb) scores also decreased in the reach downstream from Lake Rockwell. Consequently, neither of the two Ohio EPA fish indices met the respective WWH criteria. The invertebrate community sampled from the artificial substrates did not meet the WWH criterion at the station immediately downstream from Lake Rockwell. The habitat and water quality impairments in the reach downstream from Lake Rockwell to below Munroe Falls dam collectively resulted in

biological communities that were either in Partial or NON-attainment of the WWH aquatic life use designation (Table 1).

Impoundment Information Summary

Munroe Falls Dam

The Munroe Falls Dam was situated at river mile 49.9 and was formerly owned and maintained by Sonoco Paper Products Company. The purpose of the dam was to create a reservoir to supply process water for the manufacture of paper products. Sonoco closed the plant and later sold the dam to the City of Munroe Falls.

The low head dam was an arch-shaped broad crested weir constructed of sandstone block with stone and earth abutments. It was 350 feet long, 12 feet high, and supplied 100,000 to 130,000 gallons of water per day for Sonoco's paper processing needs. The dam was in need of several safety-related repairs with estimated costs near $500,000. The dam pool extended approximately 4 miles upstream and significantly impacted the hydraulics of the river. During the hot, dry summer months water in the pool became stagnant and resulted in documented dissolved oxygen levels as low as 2.66 mg/l. The dam pool greatly diminished the natural assimilative capacity of the river, created conditions for low dissolved oxygen concentrations, altered aquatic habitat conditions, and was a fish migration barrier. Populations of logperch darter (*Percina caprodes*) differed in genotypic frequencies above and below the Munroe Falls dam, with unique alleles occurring below the dam indicating that the Munroe Falls dam acted as a one-way barrier to gene flow (Haponski *et al.* 2007). The dam was removed in the fall of 2005.

Kent Dam

The first Kent Dam was originally a wooden structure constructed in 1834 to supply water power for a grist mill and is thought to have been constructed near what is now known as Brady's Leap. Later, an integrated stone arch dam/canal lock structure located at river mile 54.8 was constructed for the Pennsylvania and Ohio Canal. The canal dam/lock was destroyed by a flood in 1913. It was rebuilt in 1925 solely for aesthetic reasons. The current structure is an arch-shaped broad crested weir approximately 12 feet high constructed of sandstone blocks with a concrete cap prior to remediation. Sluice gates located on the east end of the dam could bottom-release water and drain the dam pool. The dam pool extended upstream about one mile to approximately Standing Rock Cemetery at RM 55.9. During the hot and dry summer months the water in the pool became stagnant and contributed to low dissolved oxygen concentrations. In 1996, Ohio EPA measured dissolved oxygen concentrations as low as 1.61 mg/l upstream from the dam. The river was diverted around the Kent dam in 2004. The dam is a historic structure and was retained and converted into a waterfall for mitigation as required in Section 106 of the National Historic Preservation Act.

Lake Rockwell Dam

The Lake Rockwell dam, located at river mile 57.97, is a 35 foot high, 490 foot wide concrete gravity dam with a 280 foot wide broad crested weir spillway. The structure was completed in 1914 and provides the primary water supply for the City of Akron. Removable eighteen inch wooden flash boards

can be installed on the dam crest to increase the storage capacity in the reservoir as needed. A withdrawal structure was installed in 1996 designed to discharge hypolimnetic water from the reservoir. Akron currently withdraws an average of 41 MGD from the reservoir for their drinking water needs. The peak water supply usage occurred in the 1960s and 1970s when the highest annual average withdrawal was 51 MGD. The current average annual withdrawal could increase by another 4.8 MGD to near 45 MGD over the next twenty years as a result of the Joint Economic Development Districts the city has formed with three neighboring communities. The City of Akron manages the Lake Rockwell reservoir and can control the vast majority of the outflow to the river during lower flow periods. When more water is needed in the reservoir, the dam can hold back all water except for some seepage. When this occurred, the flow of the Cuyahoga River in Kent was composed primarily of Breakneck Creek and treated wastewater from upstream dischargers. Historically, these conditions have occurred nearly every year with few exceptions. During the hot, dry summer months the lack of flow caused the river to become stagnant and resulted in dissolved oxygen violations. Dissolved oxygen concentrations as low as 0.0 mg/l have been recorded just downstream from the Lake Rockwell dam.

In April 1998, a civil lawsuit was filed against the City of Akron by five middle Cuyahoga River communities, the cities of Kent, Munroe Falls, Cuyahoga Falls, Silver Lake, and Portage County. The suit alleged that the city did not have the right to disrupt and divert the entire flow of the river. An Ohio EPA computer simulation model calculated that a minimum release of 32 MGD from Lake Rockwell would be required to maintain dissolved oxygen levels at or above the 5 mg/l standard if no modifications are made to the Kent and Munroe Falls dams or any changes to the existing permitted discharges. The 32 MGD flow is considerably higher than the estimated natural critical low flow conditions for the middle Cuyahoga with no Lake Rockwell dam. The release of more water alone would not address habitat impairments or fish migrations. Therefore, full attainment of the WQS would be unlikely.

THE MIDDLE CUYAHOGA RIVER TMDL

Previous Ohio EPA stream surveys have indicated that habitat alteration, excessive nutrient levels and low dissolved oxygen (D.O.) were the primary causes of impairment within the Cuyahoga River watershed. The main sources of impairment included flow modification, impoundments and municipal discharges. The river flows in the study area are modified mainly by Lake Rockwell, a Cuyahoga River reservoir used as a public water supply for the City of Akron. The release from Lake Rockwell is controlled by Akron and provides the upstream flow to the middle Cuyahoga River. The management of this flow was the subject of litigation that was resolved in the Ohio Supreme Court. The judgment of the courts was that Akron shall release 8.5 MGD of “reasonably clean” water from Lake Rockwell. Lowhead dams in Kent and Munroe Falls also contributed to water quality impairment through habitat alteration.

In the case of the middle Cuyahoga River, both the upstream flow (the Lake Rockwell release) and the physical characteristics of the river (the two lowhead dam pools) were major contributors to the stream

impairment and lay largely outside of Ohio EPA's regulatory authority. As a result, a two tiered approach was used incorporating both regulatory and non-regulatory options in the TMDL. The tiers included an Ohio EPA recommended option (summarized below) based primarily from increased releases from Lake Rockwell and modifications to the two lowhead dams. This preferred option was backed up by a second tier that would impose extremely stringent regulatory actions based upon the existing critical conditions (no release from Lake Rockwell and unmodified lowhead dams). Despite the recommended stringent permits (beyond Best Available Technology (BAT) and the most stringent proposed by the State of Ohio) in the second tier option, it was acknowledged that the water quality standards were not likely to be met. The tier one recommended components of the reduction strategy to meet Ohio's Water Quality Standards were:

- A minimum release from Lake Rockwell of at least 3.5 MGD unless the public water supply is at emergency levels and all other reasonable water conservation activities have been exhausted. The release should be aerated, be of reasonable water quality and not a hypolimnetic release.
- Modification or removal of the Kent Dam to reduce or eliminate the dam pool.
- Modification or removal of the Munroe Falls Dam to reduce or eliminate the dam pool.
- Summer limits of ammonia nitrogen no greater than 1.0 mg/l, summer limits of phosphorus no greater than 1.0 mg/l and summer total suspended solids limits no greater than 8 mg/l.
- Monitoring and, if necessary, permit limitations of Akron WTP outfalls 001 and 002 for nutrients, solids and dissolved oxygen.
- Improved method of sludge transport associated with the Akron WTP. Increased monitoring to assure these controls are sufficient and spills are minimized.
- Whole effluent toxicity testing of the Ravenna WWTP as appropriate.

Summary of the Implementation Plan

Special conditions were placed in the middle Cuyahoga River dischargers' National Pollutant Discharge Elimination System (NPDES) permits. The permits were self-implementing and contained two final tables - one to represent a change in assimilative capacity of the river (e.g. dams modified) and one assuming the existing stream conditions remain.

IMPLEMENTED TMDL RECOMMENDATIONS

The middle Cuyahoga River TMDL was approved in September 2000. The stakeholders in the middle Cuyahoga River watershed chose to implement the tier one recommended alternative that consisted of maintenance of a minimum flow from Lake Rockwell and modification or elimination of the dams at Kent and Munroe Falls. The City of Akron has maintained a flow in excess of the minimum flow recommended in the TMDL in the past several years. These flows will likely be maintained as the Ohio Supreme Court upheld a lower court ruling that the City of Akron must maintain a minimum flow of 8.5 MGD from all Lake Rockwell discharges (i.e. seepage, overflow, regulated releases and treated

backwash waters). The City of Akron states that the minimum regulated flow releases from the Lake Rockwell dam have been maintained at approximately 5 MGD. This flow rate is more than the TMDL recommended regulated release flow through the dam of 3.5 MGD.

The Kent dam bypass project was completed in 2005 and the Munroe Falls dam removal was essentially completed in 2006. Additional stream bank restoration in the former Munroe Falls dam pool took place in 2007 and was completed in 2008. Both dam projects have resulted in:

- Elimination of the impounded habitat upstream from the dams
- Elimination of the barriers to fish migration
- Improved instream habitat, and
- Improved instream re-aeration upstream from the former dams

Other implemented recommendations:

- Some of the NPDES authorized discharges were slightly reduced to meet the recommended loads in the TMDL.
- The Akron water treatment plant installed additional piping to improve their sludge management system. Akron also eliminated their small sewage “package plant” discharge in 2003.
- The Ravenna WWTP (2.8 MGD average design) treatment processes were upgraded in 2003. Upgrades included a new aeration tank, final settling tank, expand primary digester and refurbishment of other equipment.
- Fishcreek WWTP (8.0 MGD average design) expanded from 5.0 to 8.0 MGD.
- Twin Lakes WWTP (0.46 MGD average design) added post aeration equipment.
- Franklin Hills WWTP (1.5 MGD average design) expanded from 1.0 to 1.5 MGD and added flow splitting, grit removal and fine bubble diffusers.
- Improvements in storm water programs within the watershed as a result of the NPDES Phase II regulations.

METHODS

Fish, benthic macroinvertebrate collections, qualitative habitat evaluation (QHEI), chemical/physical water sampling and primary productivity analysis were performed at various locations in the Cuyahoga River watershed from Lake Rockwell at RM 57.97 to Cuyahoga Falls at RM 48.0 (Table 3).

Macroinvertebrate Community Assessment

Macroinvertebrates were collected in 2005 and 2007 from artificial substrates and from the natural habitats according to Ohio EPA methodology (Table 10). Macroinvertebrate collections near Munroe Falls in 2005 were performed prior to the removal of the Munroe Falls dam. The artificial substrate collections provided quantitative data and consisted of a composite sample of five modified Hester-

Dendy multiple-plate samplers set in the river for six weeks. Following the six week colonization period, the artificial substrates were retrieved and a qualitative multi-habitat composite sample was collected. This qualitative sampling effort consisted of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (*e.g.*, riffle, run, pool, and margins). Detailed discussion of macroinvertebrate field and laboratory procedures is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989a, 2006b).

Fish Community Assessment

An assessment of the fish community upstream from the Kent dam following the bypass began in 2004. Additional sampling occurred in 2005 and 2007. Fish collections near Munroe Falls in 2005 were performed prior to the removal of the Munroe Falls dam. Most fish collections for this study were made by wading a 200-300 meter river reach using a long-line or "sportyak" electrofishing unit. Due to deeper water in the dam pools, fish collections at two locations were made with an electrofishing boat in 500 meter zones. Attainment criteria have been calibrated for these two sampling methods and were applied accordingly. All collected fish were identified to species, counted, weighed, examined for external anomalies and returned to the river. Weights were taken on a representative sub-sample if more than 15 individuals of a species were captured except in the case of small fish where either all individuals captured were weighed together or a sub-sample of at least 50 individuals were weighed. Discussion of the fish community assessment methodology used in this report is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989a, 1989b).

Surface Water Quality

Chemical physical water quality samples and dissolved oxygen surveys were collected from surface water samples in 2004 and 2005 during the initial lowering of the Kent and Munroe Falls dam pools. Additional samples were collected in 2007 to assess current conditions and to develop and verify a new computer model simulation of the post modification conditions. Chemical/physical samples were collected from 20 stream and 2 effluent locations in the study area (Table 3, Appendix Tables 1 - 2). Surface water samples were analyzed for Total Barium, Five Day Biochemical Oxygen Demand (BOD_5), Twenty Day Carbonaceous Biochemical Oxygen Demand ($cBOD_{20}$), Dissolved Twenty Day Carbonaceous Biochemical Oxygen Demand ($dcBOD_{20}$), Dissolved Organic Carbon (DOC), Alkalinity as $CaCO_3$, Hardness, Total Aluminum, Total Arsenic, Total Cadmium, Total Calcium, Total Chromium, Total Copper, Total, Iron, Total Lead, Total Magnesium, Total Manganese, Total Nickel, Total Potassium, Total Selenium, Total Sodium, Total Strontium, Total Zinc, Sulfate, Chloride, Total Dissolved Solids, Total Suspended Solids, Volatile Suspended Solids, Nitrate + nitrite, Nitrite, Total Kjeldahl Nitrogen (TKN), Ammonia-Nitrogen, Total Phosphorus, and Orthophosphate. In addition,

physical measurements for pH, temperature, dissolved oxygen and conductivity were obtained at the time of water sample collections. Datasonde® continuous water recorders were placed near the thalweg in the stream for at least 24 hours. The instruments measured and recorded pH, temperature, dissolved oxygen, conductivity and river stage. Water sample collections and measurements were made in accordance with the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA, 1989a, 2006).

The new model examined low flow (7Q10) conditions for violations of water quality criteria and the total phosphorus target of the "existing conditions" (i.e. flow required by the Ohio Supreme Court ruling regarding the minimum amount of flow to be released from (and around) Lake Rockwell and the Akron water treatment plant discharges; current WWTP limits at design flows; and existing low flow calculations (used in the 2006 PSD modeling). The model also evaluated the low flow conditions for violations of water quality criteria and total phosphorus targets at expanded flows requested by wastewater treatment facilities in the study area.

Table 5. Significant existing WWTP flows and requested expanded flows in the Middle Cuyahoga River.

Treatment Plant	Existing Flow(MGD)	Expanded Flow(MGD)
Ravenna WWTP	2.8	2.8
Franklin Hills WWTP	1.5	1.5
Twin Lakes WWTP	0.456	0.75
Kent WWTP	5.0	6.0
Fishcreek WWTP	8.0	8.0

Stream Physical Habitat

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin, 1989). Habitat was evaluated at each fish sampling location (Table 7). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling site. As such, individual sites may have much poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. Mean QHEI values from rivers or river segments equal to or greater than 60.0 generally indicate a level of macrohabitat quality sufficient to support an assemblage of aquatic organisms fully consistent with the WWH aquatic life use designation. Average reach values at greater than 75.0 are generally considered adequate to support fully exceptional (EWH) communities (Rankin 1989 and Rankin 1995). Values between 55 and 45 indicate limiting components of physical habitat are present and may exert a negative influence upon ambient biological performance. However, due to the potential

for compensatory stream features (e.g., strong ground water influence) or other watershed variables, QHEI scores within this range do not necessarily exclude WWH or even EWH assemblages. Values below 45 indicate a higher probability of habitat derived aquatic life use impairment.

All physical and biological field, data processing, and analysis methodologies and procedures utilized in this study adhered to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 1989a, 2003) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III and updates (Ohio EPA 1987a, 1987b, 1989b, 1989c, 2006). Qualitative Habitat Evaluation Index (QHEI) scores used to assess the habitat to support fish communities were derived and interpreted using the methodologies found in Rankin (1989, 1995) and Ohio EPA guidance (Ohio EPA 2006c).

Determining Use Attainment

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria established in the Ohio Water Quality Standards (WQS) as promulgated in Chapter 3745-1 of the Ohio Administrative Code (OAC). Assessing aquatic life use attainment status involves a primary reliance upon biological water quality criteria developed by the Ohio EPA (Table 7-15 of OAC Rule 3745-1-07). These criteria are confined to ambient assessments and apply to rivers and streams outside of point source mixing zones. Numerical biological criteria are based upon multi-metric biological indices measuring the response of the lotic fish and macroinvertebrate communities. Indices used to assess the fish community condition include the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb), while the Invertebrate Community Index (ICI) is used to assess macroinvertebrate community condition.

Performance expectations for the basic aquatic life uses (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH] have been developed by the Ohio EPA using the regional reference site approach (Hughes et al., 1986; Omernik, 1987). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley, 1981). Attainment of an aquatic life use is FULL if all three indices (or those available) meet the applicable criteria, PARTIAL if at least one of the indices did not attain and performance did not fall below the fair category, and NON if all indices either fail to attain or any index indicates poor or very poor performance.

RESULTS and DISCUSION

The 2007 sampling effort was the first aquatic life sampling following the completion of both the Kent and the Munroe Falls dam projects. Datasonde® continuous monitors were placed in the river in 2006 after the two dams were modified. The results verified the computer model prediction of the elimination of low dissolved oxygen concentrations in the former dam pools. The Modeling and Assessment Section (MAS) created an updated low-flow water quality model. This field work was performed during the summer of 2007 and included extensive stream hydraulics and water quality measurements.

Physical Habitat for Aquatic Life

The response of the middle reach of the Cuyahoga River to dam removals and modifications made profound changes in the available habitat for aquatic life by changing sediment composition, stream morphology and hydrology. In the Kent stream reach, the largest change was a result of the installation and subsequent removal of the construction access road and stream restoration projects upstream from the dam. Stream restoration efforts included bank shaping, installation of wing deflectors and placement of large boulders. Downstream at Tannery Park (RM 54.60), a large pool was filled in with cobble and coarse gravel transported downstream from the dam construction/stream restoration area. Much of this material was delivered during flood conditions during construction and from remnants of two hurricanes that passed over Ohio in 2005. Although this pool was greatly diminished, the substrate composition and available habitat did not change appreciably from pre to post dam modification. In fact the highest QHEI (79.5) was measured at this location.

In the Munroe Falls reach, stream substrate changes included an increase in coarse substrates upstream, and increase in fine substrates downstream from the former dam. The greatest degree of coarsening occurred near the former dam site. Following dam removal, changes in channel morphology were characterized by approximately 1 m of bed aggradation downstream from the dam site. Upstream, the channel quickly incised to the pre-1817 (pre-dam) substrate within a month of dam removal. Once the pre-1817 substrate was reached, downcutting stopped, and channel-widening became the dominant morphologic response to flow fluctuations. Prior to dam removal, flow velocity within the impoundment limited sediment transport to suspended load in all but the largest flows of the year. Following removal, reduced cross-sectional area and greater slope, increased flow velocity by 4 to 15 times. Now the river erodes and transports sand-sized sediment as bed load even during the low-flow periods. (Rumschlag and Peck 2007). Obviously these changes have had profound impacts on the instream habitat available for aquatic communities.

Slump block erosion occurred principally near the dam. Rotational slumping primarily occurred where there were saturated soils, whereas desiccated banks eroded as vertical scarps. As expected, the river's ability to transport and erode sand-sized and larger sediment increased. Thus, a coarsening of the mean grain *size upstream and fining of the mean grain size down*stream from the former dam followed removal (ibid).

Habitat quality for fish populations was assessed using the Qualitative Habitat Evaluation Index (QHEI). A QHEI score of 60 indicates instream physical habitat is suitable for sustaining a WWH fish community. A score between 45 and 60 requires a professional assessment to determine whether habitat is a limiting factor for the fish community (Rankin, 1989). QHEI scores in the study area ranged between 58.0 and 79.5 (Table 6; Figure 7). The average score was 68.7 and the median was 71. The location of the 58.0 QHEI score was downstream from the dam projects and did not change appreciably

Figure 5. Cuyahoga River upstream from the Kent dam (RM 55.0).

Figure 6. Cuyahoga River at the former Munroe Falls dam (RM 49.9).

from pre dam modification evaluations. The river substrate composition at the RM 48.7 site were similar to those found in previous surveys even though the river had aggraded due to sediments transported downstream from the former Munroe Falls dam pool.

The QHEI scores were indicative of good stream habitat which is adequate for supporting WWH biological communities which differs from pre modification conditions (Figure 7). Natural channel conditions had been established at each location assessed. Cobble, bedrock, boulders and gravel were predominate bottom substrates at all of the sites except at RM 48.7 which was almost exclusively sand, the same as pre modification conditions. Silt and bottom embeddedness, the degree to which cobble, gravel and boulder substrates are surrounded or covered by fine materials, was elevated and considered moderate at most sites. The exceptions were in Kent and at the former Munroe Falls dam where the higher stream velocities precluded high sedimentation rates. The substrate metric average was 15.1. A narrow to wide riparian corridor had been established beyond the revegetated dam pools. Average riparian score was 5.4. Instream channel development was good, with a mixture of pool, riffle and run habitats. The most cover was found in the reach immediately upstream from the Kent dam as a result of the larger boulders placed in the stream during restoration. The remaining cover was generally sparse. Maximum pool depths at the sites varied between 70-100 and >100 centimeters.

Most sites contained a full complement of positive channel, substrate, and riparian features, displaying classic channel form and function typical of good quality lake plain streams of northeast Ohio. The channel configurations were generally recovered or were recovering to a natural state. Riffle, run and pool complexes were commonly observed throughout the study area. The process of natural restoration or recovery of complex channel features, although incomplete, appeared well underway despite low channel sinuosity. Trench and lateral scour pools were well formed in the Kent reach and were becoming established in the Munroe Falls reach. All sites contained pools greater than 40 cm deep. The higher slope and concurrent stream velocities in Kent resulted in a more narrow and deeper stream profile compared to the Munroe Falls reach. Favorable stream habitat in Kent was formed much more quickly than the Munroe Falls reach due to the greater stream power in Kent and the hands-on stream restoration that was required there due to the access road installation and removal.

Instream timber and woody debris were lacking at most sites as previously fallen trees had accumulated at the margins of the former dam pools and were generally not in the water under normal flows. The riparian areas at most sites were vegetated. Woody vegetation was closer to the stream's edge in Kent, attenuating sunlight. Woody vegetation was present throughout the Munroe Falls reach, but was set back from the stream margins. This lack of mature trees at the stream's edge did not allow instream structure in the form of woody debris and rootwads to form. Also, the river was not shaded and likely is a significant factor affecting primary productivity (algae) in this river reach. This and the youth of the channel resulted in sparse cover at several sites.

Dominant substrates were coarse glacial till or bedrock and generally unencumbered with extensive deposits of clayey silts. However, the reach near Munroe Falls was still processing sands from the former dam pool and the river substrates there were moderately embedded. Much of the processed sand in that reach is being transported downstream to the Cuyahoga Falls Waterworks Park. Interestingly, although the river bed had aggraded, the composition of the substrates as described in the QHEI substrate assessment had not changed appreciably from pre dam removal conditions at the site near Silver Lake. One stream transect taken by Rumschlag downstream from the dam showed that the predominant substrate had changed from gravel to coarse sand. The channel-floor elevation is relatively stable and the river is presently equilibrating to the new flow and slope conditions principally through widening. It appears that the dam pool from the next downstream dam in Cuyahoga Falls (RM 46.5) continues to exert a strong influence on the river habitat near the Silver Lake sampling site.

Table 6. Qualitative Habitat Evaluation Index (QHEI) scores and physical attributes for fish sampling sites in the Cuyahoga River, 2007.

			WWH Attributes											MWH Attributes																					
														High Influence						Moderate Influence																	
Key QHEI Components			No Channelizationor Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max. Depth >40 cm	Low-Normal Riffle Embeddedness	Total WWH Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/ No Cover	Max. Depth <40 cm (WD,HW sites)	Total High Influence Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total Moderate Influence Attributes	(MWH H.I.+1)/ (WWH+1) Ratio	(MWH M.I.+1)/ (WWH+1) Ratio
River Mile	**QHEI**	**Gradient (ft/mile)**																																	
(19-001)	-	Cuyahoga River																																	
Year: 2007																																			
55.6	69.0	4.61	■	■		■		■	■		■		6				◆		1		●			●	●				●	●		5	0.29	1.00
55.01	75.0	10.00		■		■		■	■	■	■	■	7	◆					1						●	●						2	0.25	0.50
54.6	79.5	6.12	■	■		■	■	■	■	■	■		8				◆		1		●								●	●		3	0.22	0.56
51.8	61.5	4.76		■				■	■		■		4				◆		1	●	●			●	●			●	●	●		7	0.4	0.18
51.0	65.0	0.10		■		■		■	■		■		5				◆		1	●	●			●	●				●	●		6	0.33	1.33
49.9	66.5	4.76		■		■		■	■	■	■		6				◆		1	●				●	●					●		4	0.29	0.86
48.7	58.0	1.00	■				■	■			■		4				◆		1		●			●	●			●	●	●		6	0.40	1.60

The highest QHEI score of 79.5 was at the Tannery Park site downstream from the dam in Kent. (RM 54.6). Cobble and gravel substrates were prevalent throughout the study area, with boulders, cobbles

and gravels providing suitable substrates for cover and riffle development. Warmwater Habitat attributes generally exceed the modified attributes within the entire study reach (Table 6).

The available fish cover within the river at all sites was deemed to be sparse to moderate. During high flow events, water energy cannot carve out deep pools in the hard bedrock. Woody debris has tended not to deposit within the low flow stream channel, but is instead deposited along the stream margins where it is unavailable as cover for the fish community under low flow conditions. Occasional *Valisenaria* aquatic macrophytes were observed upstream from the Fishcreek WWTP, but were not numerous enough to form beds that provided significant cover.

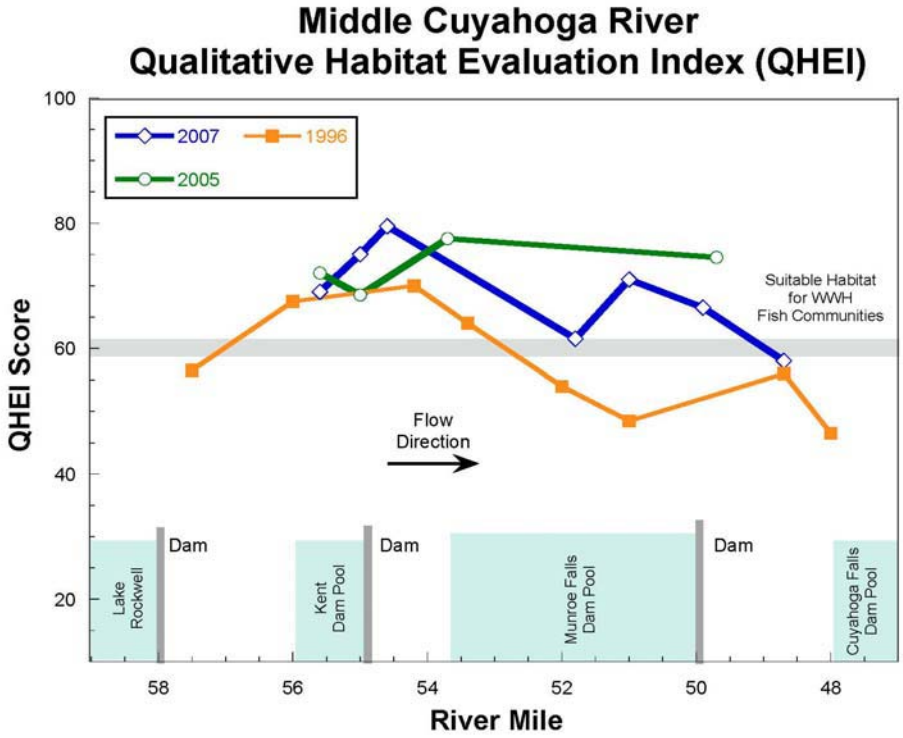

Figure 7. Middle Cuyahoga River QHEI scores 1996-2007.

Fish Community Assessment

A total of 4,565 fish representing 30 species and one hybrid were collected from the middle Cuyahoga River between June and August, 2007. The three full attainment sites supported robust populations of northern hogsucker (*Hypentelium nigricans*), greenside darters (*Etheostoma blennioides*), rock bass (*Ambloplites rupestris*) and smallmouth bass (*Micropterus dolomieui*). Northern pike (*Esox lucius)*, smallmouth bass and rock bass were large enough to support a recreational fishery. Only one carp

(*Cyprinus carpio*) was collected in the Kent area. Carp were more prevalent in the former Munroe Falls dam pool and were the predominant species (relative percentage = 32) collected downstream from the former dams at RM 48.7. The fish sampling effort included 12 sampling events at 7 stations, evaluating 7 miles of the mainstem between RM 55.6 (Grant Street) and RM 48.7 (near Silver Lake). Fish community statistics for electrofishing assessments conducted within the study area before and after the removal of the Kent and Munroe Falls dams are tabulated in Tables 7-9 and index score changes are depicted in Figures 8 and 9."

Assessments of the Cuyahoga River in 2007 using electrofishing methods found good to very good fish communities at all three of the sites monitored near Kent four years after the Kent dam remediation project was completed (Table 7). Index of Biotic Integrity and MIwb scores were in FULL attainment of the ecoregional biocriteria for the WWH aquatic life use at all of the sites. There were 28 species collected during the 2007 survey in the Kent reach. Based on aggregated catch statistics, numerically predominant species (number/0.3km) included northern hog sucker (20.28%), common shiner (18.42%), bluntnose minnow (13.40%), and greenside darter (13.18%). In terms of relative biomass (kg/0.3km), northern hog sucker (42.98%), smallmouth bass (12.17%), common shiner (7.70%), and white sucker (5.99%). IBI scores in Kent ranged from 41 to 46 and MIwb scores ranged from 8.2 to 8.5. The fish population was still not in equilibrium as some species expected to be there such as rainbow darters and spotted suckers were not collected. The relative weight of fish was also lower except at 49.9 where it increased.

Fish index scores in the former Munroe Falls dam pool were in the fair to poor range and were not significantly different from the pre removal scores. The fish community was not fully attaining the ecoregional biocriteria. The composition of the fish community in the former Munroe Falls dam pool however, did change significantly. In 2000 and 2005 there were 22 species collected prior to the dam removal. The numerically predominant species (No./0.3km) pre dam removal based upon aggregated catch statistics were bluegill (22.52%), pumpkinseed (17.56%), white sucker (14.89%), black crappie (7.63%) and rock bass (7.63%); In terms of relative biomass (kg/0.3km), predominant species were white sucker (46.46%), carp (20.26%), northern pike (10.44%), and largemouth bass (5.09%). There were 24 species captured in the post removal collections in 2007. The predominant species were bluntnose minnows (35.89%), northern hog suckers (11.48%), white suckers (11.21%), and central stoneroller minnows (7.19%); predominant species by weight were carp (54.76%), northern hog sucker (8.66%), smallmouth bass (8.24%), and northern pike (7.49%). New species collected included 13 river chubs, 47 johnny darters and 52 greenside darters. Bluntnose minnows which comprised the bulk of the collection are often found in large numbers in nutrient enriched waters downstream from WWTP discharges.

Fish collections were also made downstream from the disturbed areas at RM 48.7 to evaluate the impact from downstream sediment transport of the dam removal/modification projects. Fish index scores were in the poor range, not significantly different from the pre removal scores and were not fully attaining the

ecoregional biocriteria. The numerically predominant species (No./0.3km) based upon aggregated catch statistics were carp (32.37%), bluegill (17.99%), northern hog sucker (8.63%), smallmouth bass (7.19%), and pumpkinseed (7.19%); In terms of relative biomass (kg/0.3km), predominant species were carp (85.24%), northern hog sucker (3.47%), smallmouth bass (3.02%), and white sucker (2.87%) Northern pike were observed during the collection but were not captured. The IBI did not change significantly (26 in 1996 to 23 in 2007); however, the MIwb declined from 7.1 in 1996 to 6.4 in 2007. This decline can be attributed to the large percentage of carp which may have migrated from the former dam pool downstream to this site which has habitat more suitable for carp.

Information regarding the fish species collected, data collected for the calculation of the IBI and the MIwb, and the IBI metric scores are found in the Appendices to this report.

Table 7. Fish community summaries based on pulsed D.C. electrofishing sampling conducted by Ohio EPA in the Cuyahoga River from June - August, 2007. Relative numbers and relative weight are per 1.0 km for boat sites and 0.3 km for wading sites.

Stream River Mile	Sampling Method	Species (Mean)	Species (Total)	Relative Number	Relative Wt. (kg)	QHEI	MIwb	IBI	Narrative Evaluation
Cuyahoga River									
55.6	Wading	16	16	246	30.5	69.0	8.3	46	Very Good
55.01	Wading	13.0	15	373	41.4	76.0	8.2	42	Good
54.60	Wading	15.5	19	1263	42.9	79.5	8.5	41	Good
51.80	Wading	18.5	22	847	10.8	61.5	7.5	30	Fair
51.00	Boat	17	17	223	72.3	71.0	8.4	32	Fair
49.90	Wading	19	22	661	29.8	66.5	8.7	31	Fair
48.70	Boat	12	16	231	154.2	58.0	6.4	23	Very Poor

EOLP WWH Biocriteria – Cuyahoga River	
INDEX	Target Criteria
IBI (wading/Boat)	38/40
MIwb (wading/Boat)	7.9/8.7
ICI	34

^{ns} - Non-significant departure from biocriteria (<4 IBI units or <0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI units or >0.5 MIwb units).

† - Indicates poor results

Table 8. Fish community statistics for electrofishing assessments conducted prior to remediation of the Kent or Munroe Falls dams on the Cuyahoga River.

River Mile	Number of Species	Rel.No. (no./0.3 km)	Rel. Wt. (kg./0.3 km)	MIwb	IBI	Narrative Evaluation
Cuyahoga River 19-001 (2005)						
53.7	19	240	55.3	8.8	34	Fair
50.0	12	284	98.2	7.2	32	Poor
49.7	15	308	6.4	7.7	40	Fair/Good
Cuyahoga River 19-001 (2003)						
49.8	20	350	19.6	7.5	28	Poor
54.4	20	644	22.3	8.8	42	Good
Cuyahoga River 19-001 (2000)						
55.7	21	308	235.5	8.2	28	Fair/Poor
49.7	20	583	85.4	8.4	34	Fair
Cuyahoga River 19-001 (1999)						
55.2	17	758	--	5.3	30	Poor
Cuyahoga River 19-001 (1996)						
57.5	11	81	4.1	5.6	35	Poor
56.0	12	78	12	6.7	35	Poor
54.2	17	253	118	7.6	28	Poor
53.4	14	194	90.6	6.7	31	Poor
52.0	14	221	60.0	7.5	30	Poor
51.0	10	137	58.3	6.2	30	Poor
48.7	15.5	220	85.9	7.1	26	Very Poor
48.0	14	186	75.3	6.7	24	Very Poor
Cuyahoga River 19-001 (1991)						
54.6	20.5	1017	17.2	8.8	40	Good
49.8	19.7	1127	147.1	8.7	35	Fair
Cuyahoga River 19-001 (1984)						
57.6	14	273	56.8	7.5	29	Poor
56.0	21	334	98	9.0	33	Fair
54.6	14.3	216	47.9	7.6	30	Fair
53.0	14	196	38.2	7.7	31	Fair
51.0	12	278	59.5	7.4	23	Very Poor
48.7	9.7	166	41	5.0	22	Very Poor

Table 9. Fish community statistics for electrofishing assessments conducted after the remediation of the Kent and Munroe Falls dams on the Cuyahoga River.

River Mile	Number of Species	Rel. No. (no./0.3 km)	Rel. Wt. (kg./0.3 km)	MIwb	IBI	Narrative Evaluation
Cuyahoga River 19-001 (2007)						
55.6	16	246	30.5	8.3	46	Good/V. Good
55.0	12	142	13.8	7.4	40	Good
54.6	16	591	60.1	8.5	42	Good
51.8	18	693	12.7	7.8	30	Poor
51.0	17	223	72.3	8.4	32	Fair
49.9	20	618	21.5	8.5	30	Fair/Poor
48.7	11	226	135.5	6.3	22	Very Poor
Cuyahoga River 19-001 (2005)						
55.6	16	200	14.1	8.3	40	Good
55.0	12	171	6.1	6.7	34	Fair
54.4	20	408	10.9	8.9	44	Good/V. Good
Cuyahoga River 19-001 (2004)						
55.7	19	120	28.5	8.9	44	Good/V. Good

*Indicates a significant departure from the ecoregional biocriterion

[ns]Indicates a non-significant departure from the ecoregional biocriterion (>4 IBI units, >0.5 MIwb units)

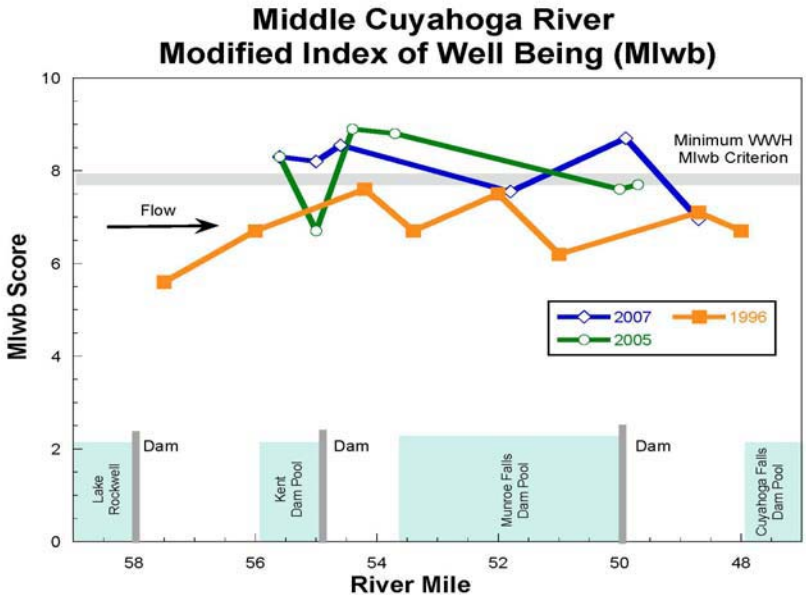

Figure 8. Middle Cuyahoga River MIwb scores 1996-2007.

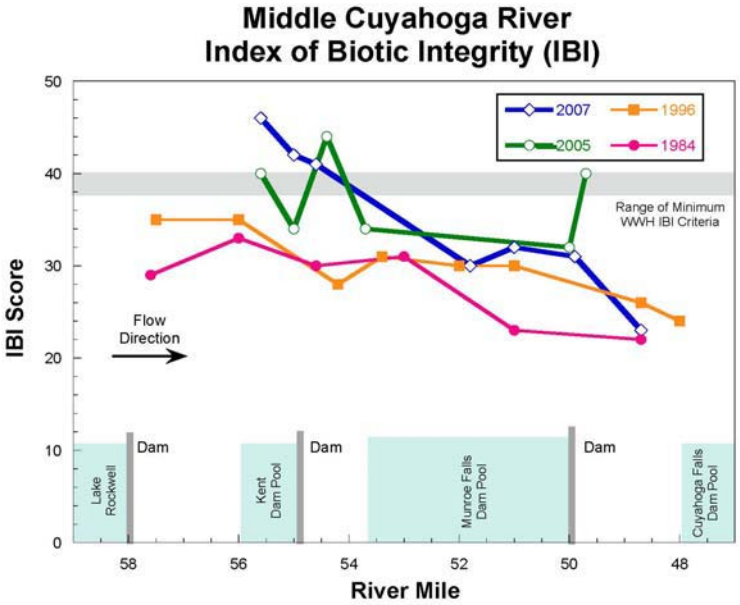

Figure 9. Middle Cuyahoga River IBI scores 1984-2007.

Aquatic Macroinvertebrates

Macroinvertebrate sample results in 2007 from the Kent area met the Invertebrate Community Index (ICI) water quality criterion and were similar to previous post dam modification results. There was a very significant improvement in community health in the former Munroe Falls Dam pool following dam removal with a substantial shift from lentic (impounded) to lotic (free-flowing) populations (Figure 10). ICI scores from once impounded sites at RMs 52.0 and 50.0 increased by an average 28 points; narrative evaluations in the same reach improved from the low fair (ICI = 14 at RM 50.0) to exceptional range (ICI = 50 at RM 52.0).

Improvements in macroinvertebrate communities following the Munroe Falls dam removal were characterized by sharp increases in mayfly, caddisfly, and sensitive taxa richness, both on the natural and artificial substrates. Percentages of flow dependent net-spinning caddisflies, mayflies, and Tanytarsini midges also increased sharply in the newly flowing reach. Concurrently, there was a large reduction in the percentage of "Other Dipterans and non-insects", a group of populations that are generally considered pollution tolerant and are often associated with siltation, low dissolved oxygen, and sluggish flow.

Remaining Cuyahoga River sites sampled upstream and downstream from the Munroe Falls Dam pool were of generally similar quality between the 2005 and 2007 surveys. Even though ICI scores exceeded the WWH criterion at all sites sampled, relatively large populations of hydra, flatworms, or oligochaetes at three sites in Kent upstream from the Munroe Falls pool in 2007 suggested a lingering enrichment influence downstream from the Lake Rockwell dam. .

Table 10. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Cuyahoga River, 2007.

Stream/ River Mile	Density Number/ft^2	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	ICI	Evaluation
Cuyahoga River (2007)							
55.6	2,864	58	35	45	12	36	Good
55.0	3,295	63	48	40	11	36	Good
54.40	2,610	72	52	58	15	36	Good
52.0	1,710	74	39	57	15	50	Excellent
50.0	1,525	67	47	38	16	44	Very Good
48.70	725	65	39	44	12	42	Good

EOLP WWH Biocriteria – Cuyahoga River	
INDEX	Target Criteria
ICI	34

[a] EPT=total Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa richness, a measure of pollution sensitive organisms.

Table 11. Macroinvertebrate community statistics for assessments conducted prior to remediation of the Kent or Munroe Falls dams on the Cuyahoga River.

Stream/ River Mile	Density Number/ft^2	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	ICI	Evaluation
Cuyahoga River (2005)							
55.6	1018	67	45	43	10	36	Good
55.0	1432	51	42	25	5	42	Very Good
54.40	1617	55	36	41	8	38	Good
52.0	486	47	38	32	5	24	Fair-dam pool
50.0	903	44	34	29	5	14	Low Fair-dam pool
49.80	1659	54	23	48	16	32	Marg. Good
Cuyahoga River (2000)							
48.7	1226	63	43	41	11	42	Very Good
Cuyahoga River (1996)							
57.6	641	51	37	35	5	24	Fair
56.1	411	66	39	51	10	32	Marg. Good
54.4	1492	67	41	51	11	44	Very Good
53.4	1654	60	32	45	9	38	Good
49.8	5435	50	25	42	11	42	Very Good
48.0	868	63	42	48	14	44	Very Good
Cuyahoga River (1991)							
54.4	-	53	-	53	10	-	Good
49.8	1727	50	34	36	7	32	Marg. Good
Cuyahoga River (1984)							
57.6	856	42	26	32	5	8	Poor
55.8	417	65	48	38	6	34	Good
54.3	1509	57	37	44	10	40	Good
52.6	534	44	33	21	4	18	Fair
48.4	962	47	35	35	4	32	Marg. Good

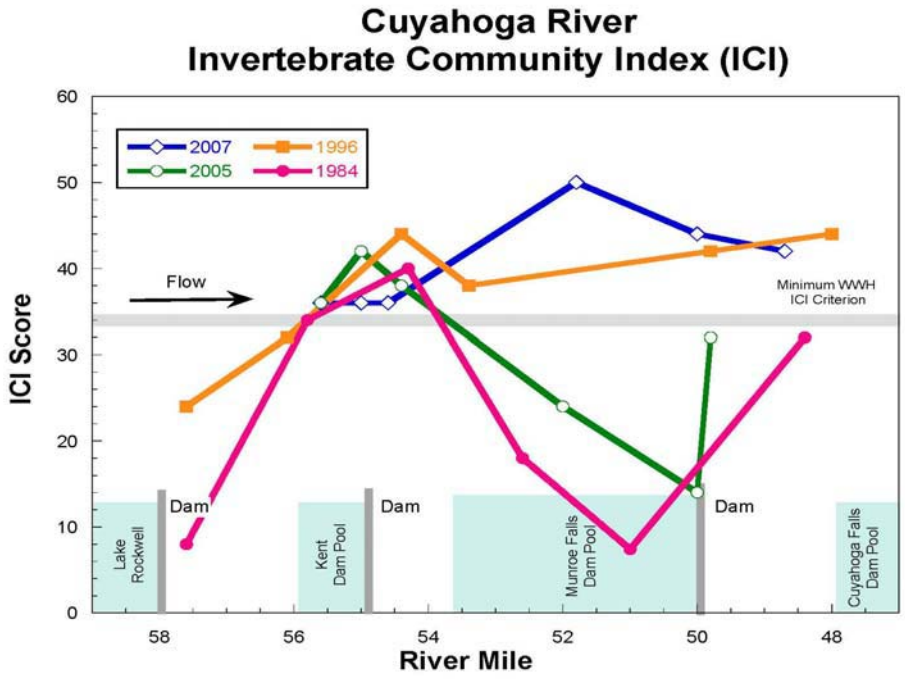

Figure 10. Middle Cuyahoga River Invertebrate Community Index (ICI) scores 1984-2007.

Chemical/Physical Water Quality

2004-5 Water quality sample results.
The 2004 and 2005 sample results indicated immediate water quality benefits from the elimination of the two dam pools. Dissolved oxygen concentrations met the WWH standards and closely matched the pre dam modification computer model predictions. All other sample results met Ohio's WQS criteria. Despite the exposure of dam pool sediments, total suspended solid concentrations during the initial lowering of the Munroe Falls dam increased only slightly and averaged 29 mg/l downstream from the dam compared to 23 mg/l upstream from the dam pool.

2007 Water quality sample results.
There were no violations or exceedances of Ohio chemical/physical water quality standards. However, total phosphorus concentrations were elevated compared to the 0.12 mg/l median EOLP ecoregion concentration and the statewide TMDL nutrient target concentration of 0.17 mg/l. Instream Nitrate + Nitrite concentrations also generally exceeded the EOLP median concentration of 1.0 mg/l and the proposed statewide target concentration of 1.5 mg/l.

Large diurnal fluctuations in dissolved oxygen concentrations occurred downstream from the Fishcreek WWTP in the former Munroe Falls dam pool. The large fluctuations are likely caused by the combination of elevated instream nutrients and prolonged sunlight due to the lack of tree canopy over the river. Such conditions are optimal for algae and macrophyte production. This high productivity causes the diurnal dissolved oxygen swings by the production of oxygen through photosynthesis during the day and the consumption of oxygen through respiration at night. The algae and macrophyte cause of the swings is supported by the concurrent fluctuation of instream pH values caused by the uptake and release of carbon dioxide and the subsequent affect on the carbon dioxide-carbonic acid equilibrium.

The relationship among instream nutrient concentrations and aquatic communities, however, is a complex interaction of land use, physiographic relief, soil types, and lotic habitat (Ohio EPA, 1999, Richards *et al.*1996, Allan *et al.* 1997, and Johnson *et al.* 1997). And although the dissolved oxygen fluctuations also coincide with non-attaining fish community scores, exceedances of the reference or target nutrient values should not be interpreted in a manner similar to toxicity criteria for other established water quality standards. Ohio EPA uses a tiered or multi-criteria approach especially when evaluating nutrient criteria. Therefore, an exceedance of the phosphorus target should not necessarily trigger a requirement for load reductions since high values of both nutrient loadings and biological integrity can co-occur. This argues for iterative sampling to address that possibility, and consideration of downstream uses. This is especially relevant for the middle Cuyahoga River where the habitat and stream biota have been significantly altered by the dam modifications and removals and the stream system has not had time to equilibrate.

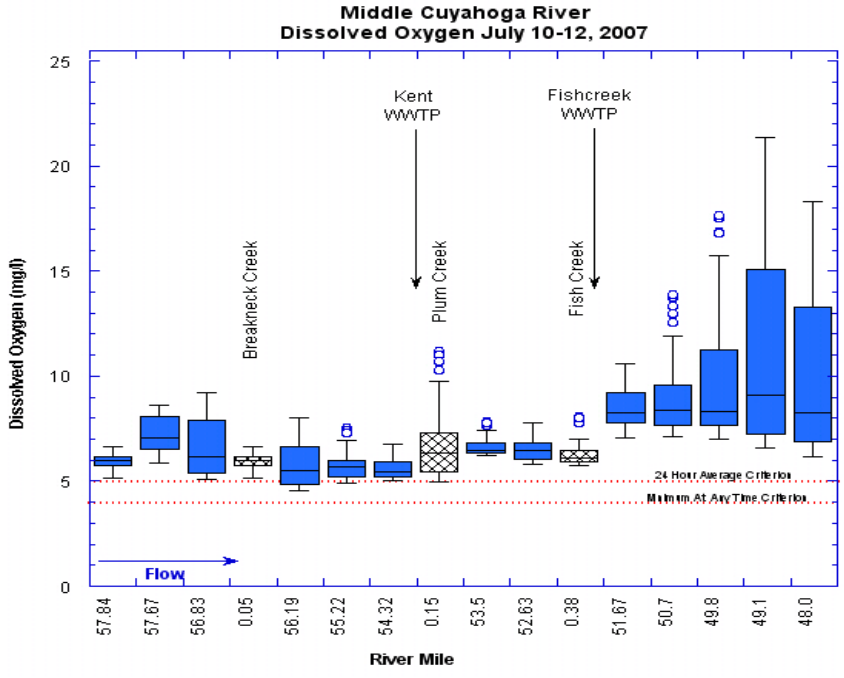

Figure 11. Dissolved oxygen concentrations in the middle Cuyahoga River July 10-12, 2007. Cross hatched boxes are tributary streams as labeled.

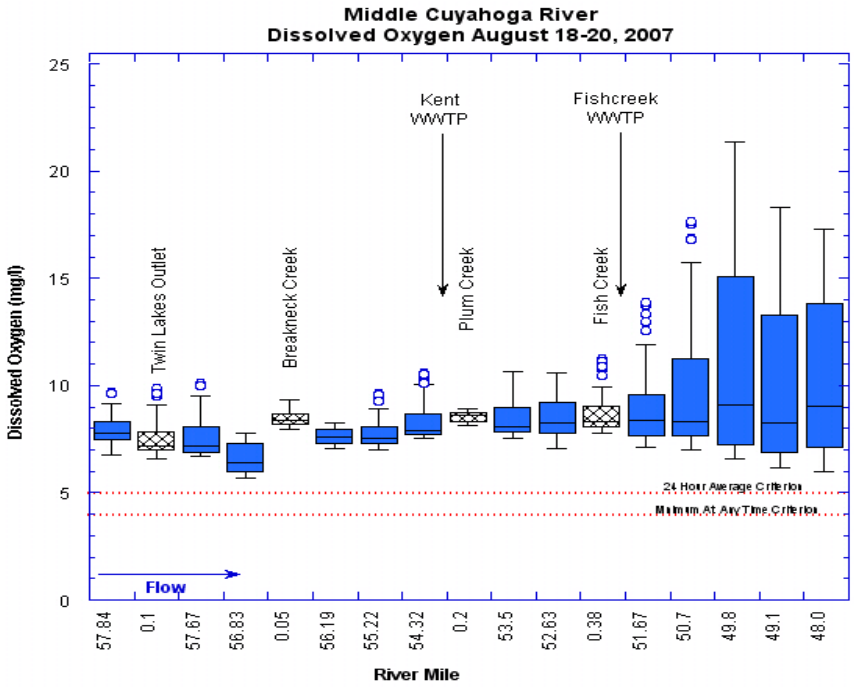

Figure 12. Dissolved oxygen concentrations in the middle Cuyahoga River in August 18-20, 2007. Cross hatched boxes are tributary streams as labeled.

Computer Model

A Qual2E computer simulation of the Cuyahoga River study area was developed, calibrated and verified by Ohio EPA computer modeling staff. The model verification results indicate a high level of confidence that the model accurately simulates the existing real world conditions and can be used to run "what if" scenarios (Figure 18). The verified computer model was run under critical low flows using the existing maximum permitted wastewater treatment plant loadings and the maximum loadings that may be requested in the near future.

The model results for critical conditions indicate that dissolved oxygen meets the appropriate criteria at critical low flow conditions and current pollutant loading limits. Total phosphorus loading is above the small river statewide TMDL nutrient target concentration of 0.17 mg/l at maximum loadings due to the WWTPs combined contributions. Temperature, due to lack of shading, is also borderline high, in the area downstream from Fishcreek WWTP. Several TP modeling scenarios, with various new WWTP limits have been modeled. Like the existing conditions, the river meets the dissolved oxygen criteria at all modelled scenarios including hypolimnetic Lake Rockwell water. Total phosphorus from Rockwell would add to the phosphorus exceedance of the target.

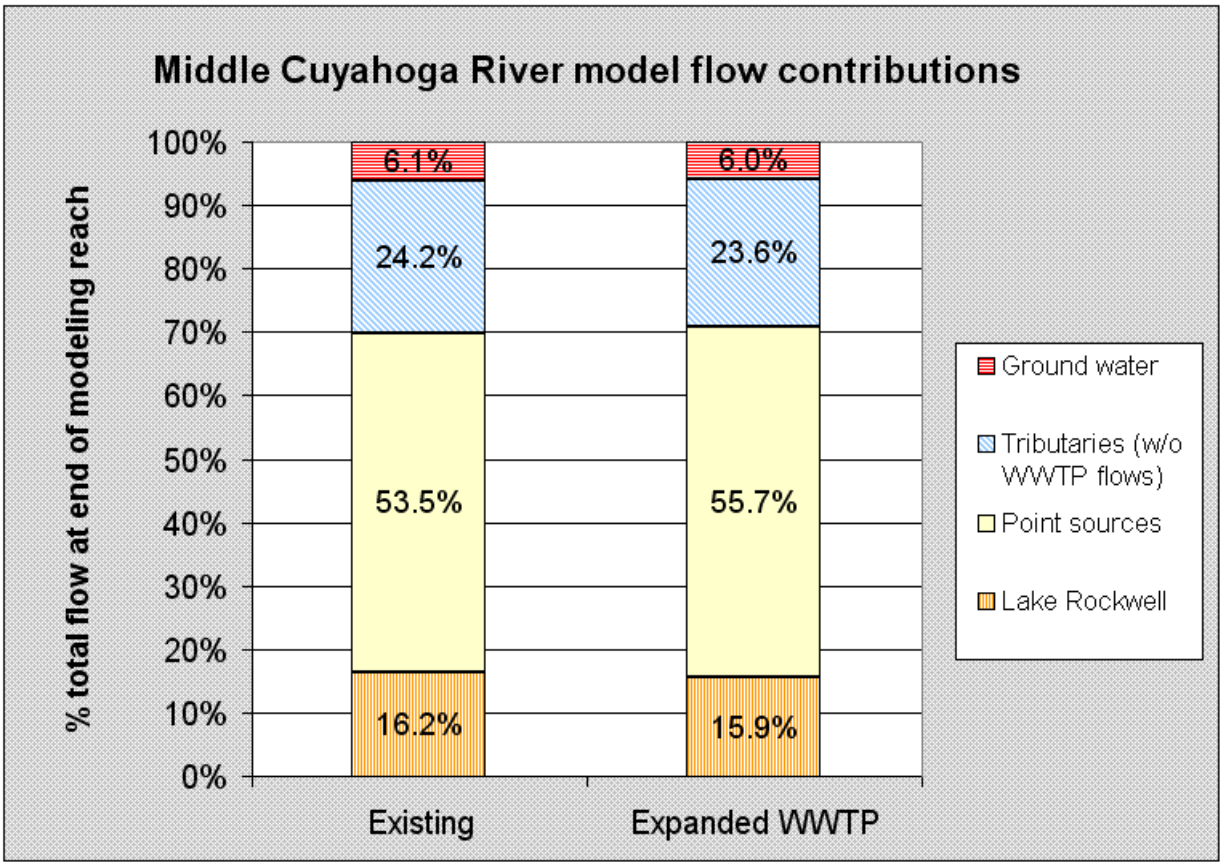

Figure 13. Computer Relative river flow contributions in the Middle Cuyahoga River during critical low stream flows (Q7-10).

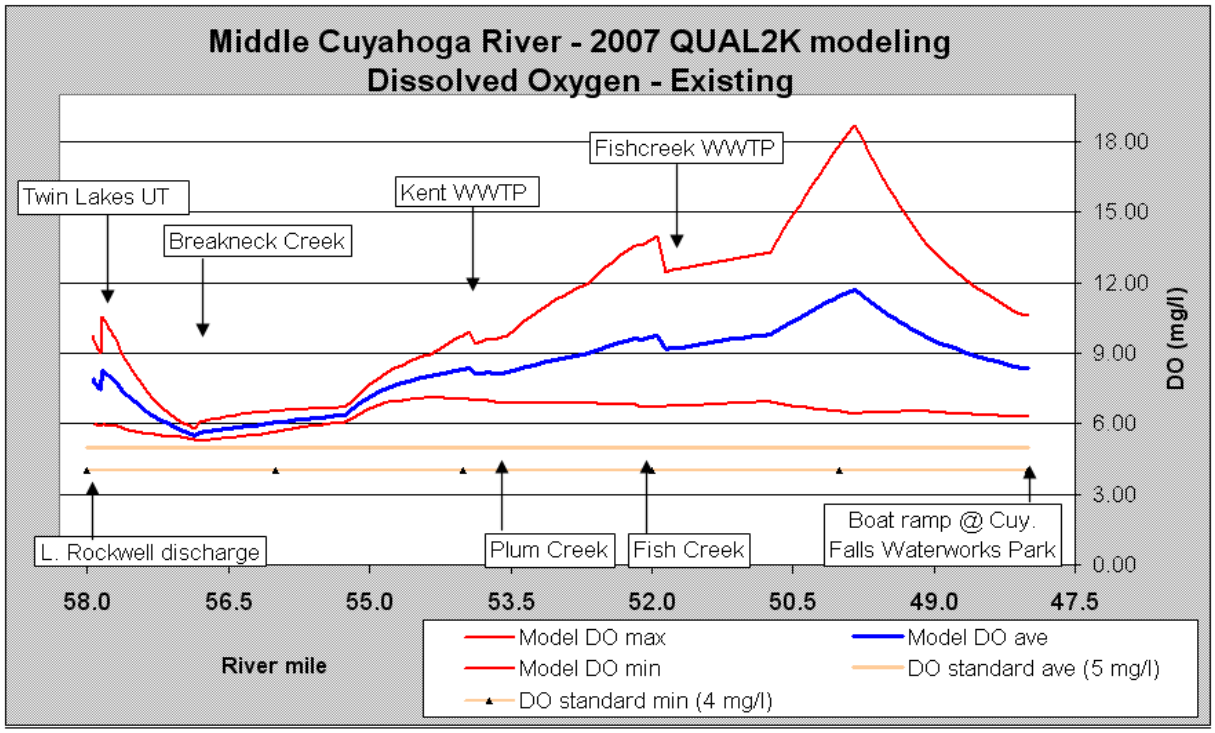

Figure 14. Computer model results for dissolved oxygen concentrations in the Middle Cuyahoga River.

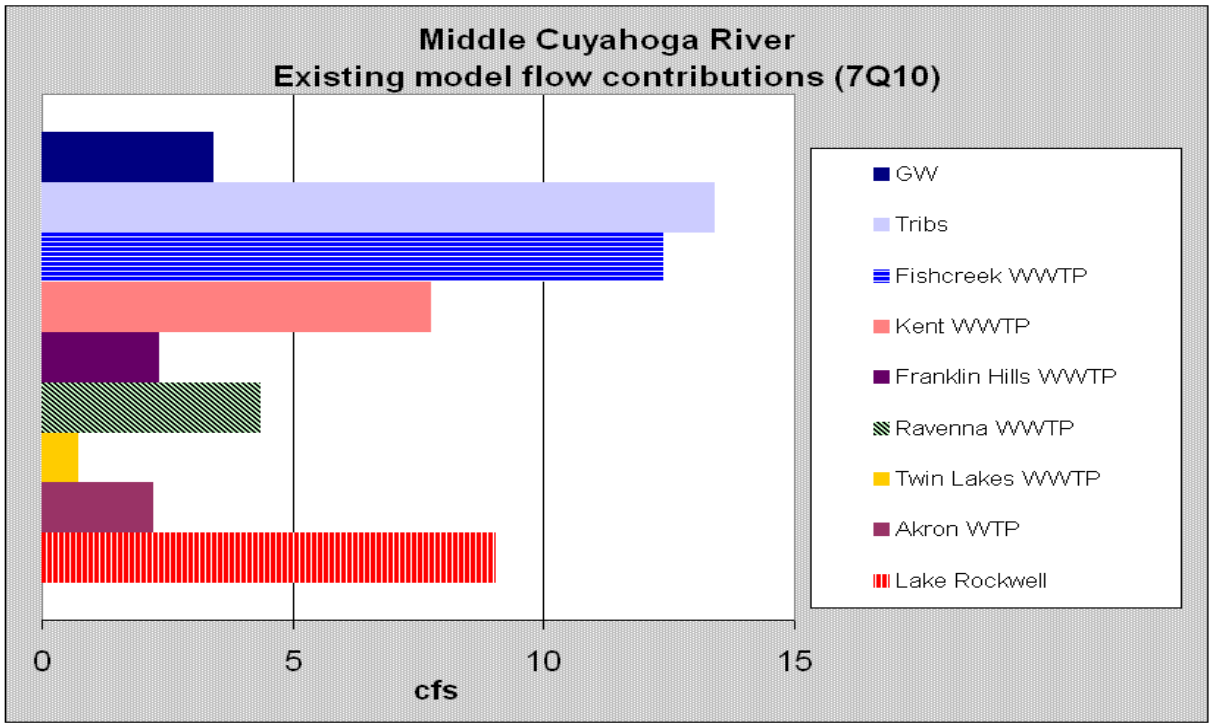

Figure 15. Relative river flow contributions in the Middle Cuyahoga River during critical low stream flows (Q7-10).

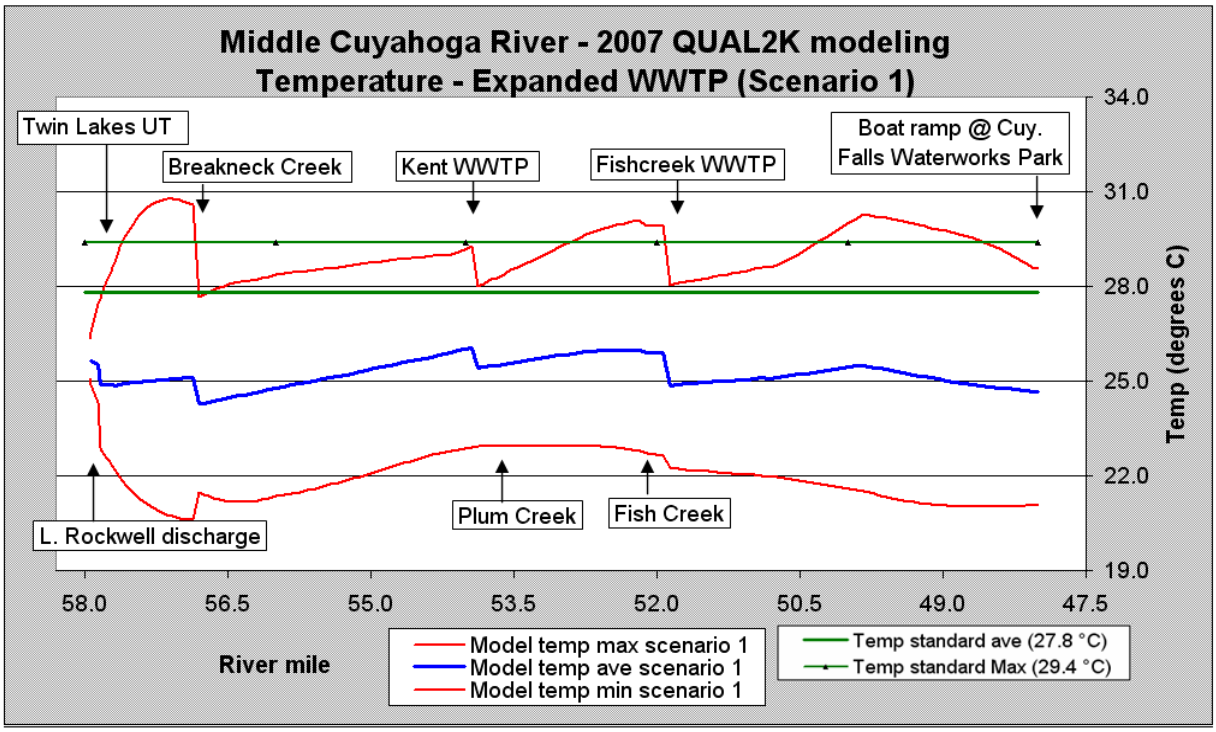

Figure 16. Computer model prediction of instream temperature in the middle Cuyahoga River at Q7-10 low flows.

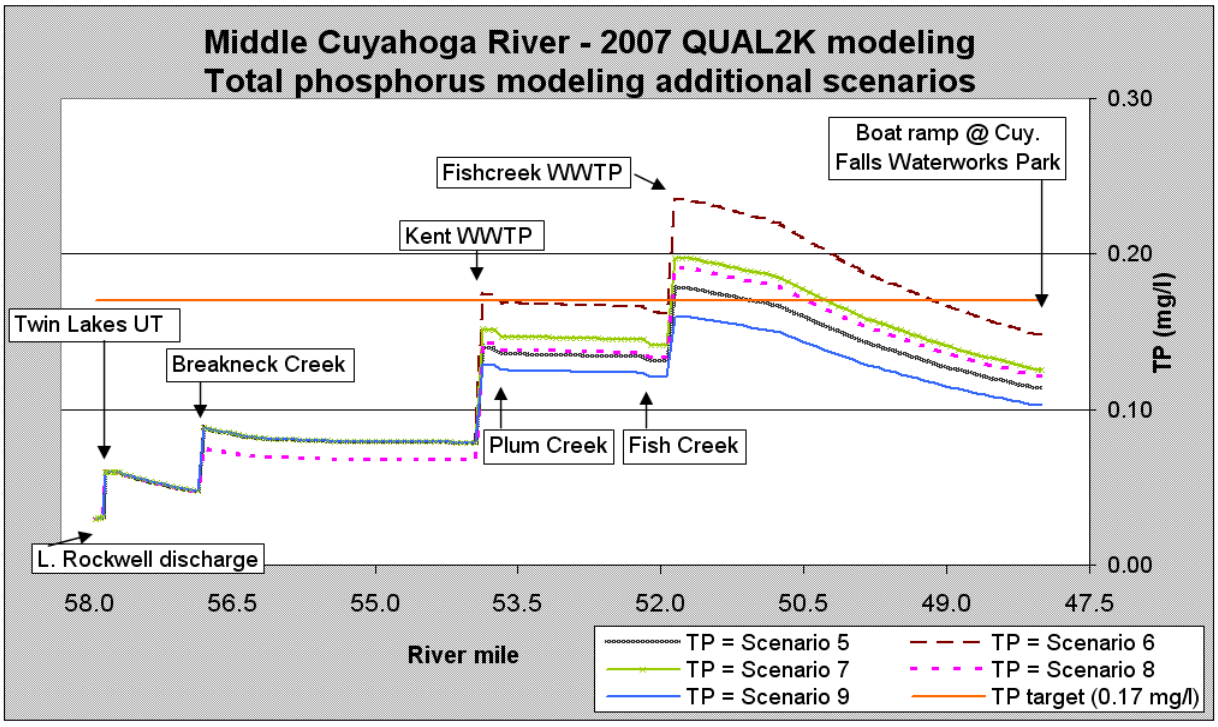

Figure 17. Computer model prediction of instream total phosphorus in the middle Cuyahoga River at Q7-10 low flows.

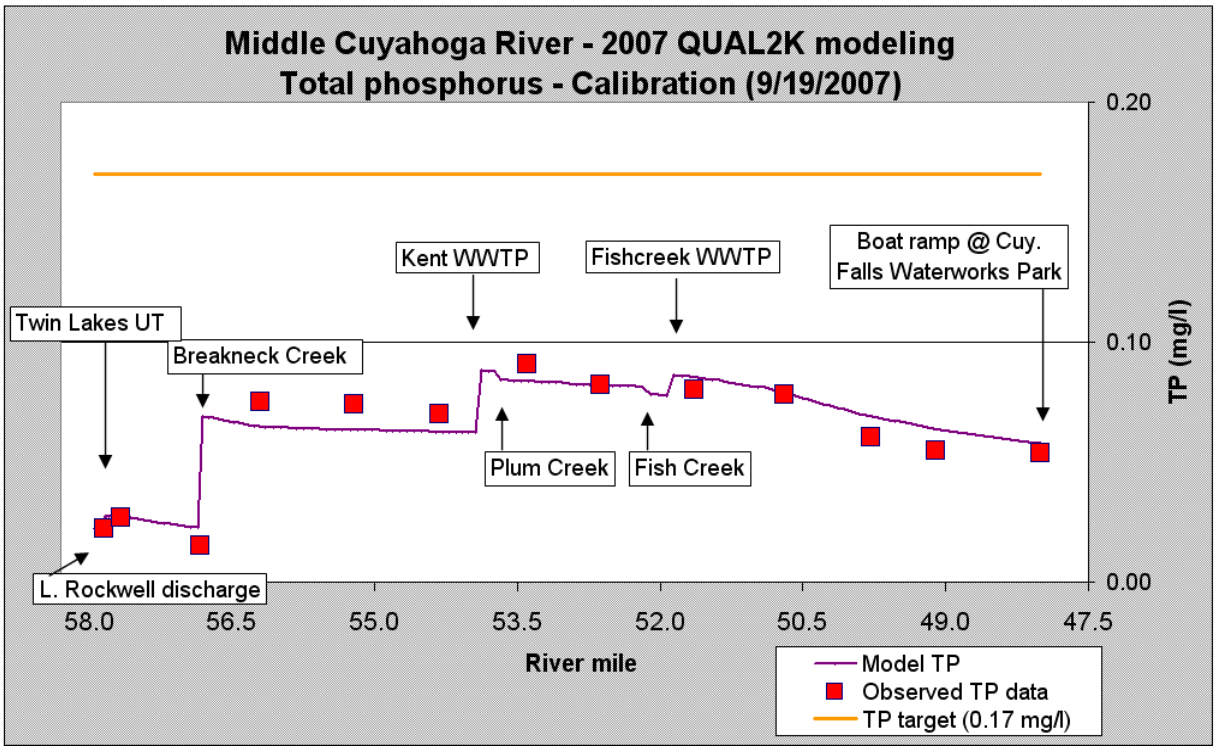

Figure 18. Computer model calibration of instream total phosphorus in the middle Cuyahoga September 19, 2007. Measured vs. predicted concentrations.

CONCLUSIONS AND RECOMMENDATIONS

The 2007 survey affirms that the portion of the Cuyahoga River in and near Kent is in FULL attainment of the aquatic life use biocriteria. The reach in the former Munroe Falls dam pool improved slightly from pre dam removal conditions and is in PARTIAL attainment. This reach was in NON attainment of the aquatic life use biocriteria prior to the dam removal. Habitat scores throughout the study area were more than adequate to support WWH fish communities. There were no exceedances or violations of chemical/physical water quality. Total phosphorus concentrations in the river exceed the statewide TMDL nutrient target concentration of 0.17 mg/l. The aquatic life attainment status in the river immediately downstream from the both the Kent and Munroe Falls dams did not change from pre-modification conditions which indicate that the dam projects did not have a significant adverse effect on downstream reaches. Verified computer model predictions indicate that, with the exception of total phosphorus, existing effluent permit concentrations at existing and requested expanded flows will meet current water quality chemical/physical standards or targets.

The predominant stream recovery pattern which Ohio EPA has observed statewide since the inception of biomonitoring more than 25 years ago, is that the macroinvertebrate community in a stream (as measured by the ICI) recovers first, followed later by fish abundance and biomass (MIwb), with structural and functional indicators (IBI) responding last. The time frame for recovery is complex but includes availability of recruitment stock, habitat, and physical energy of the river. The Munroe Falls dam area appears to be following this recovery pattern as the macroinvertebrate community is in full attainment of the ecoregional biocriterion in the former dam pool and MIwb scores improved significantly from an average of 7.6 to 8.7. The IBI score did not change significantly, but the composition of the fish community has changed significantly which will allow recovery to a robust fishery. As the former Munroe Falls dam pool matures, it is expected that there will be more instream cover, larger riparian vegetation, larger aquatic macrophyte beds which should ensure the structural and functional integrity of the fish community and subsequent full attainment of Ohio's water quality standards. It is recommended that Ohio EPA continue to periodically monitor the aquatic life in the middle Cuyahoga River and maintain existing NPDES permitted nutrient loading until there is no apparent improvement in IBI scores or nutrient water quality standards are established.

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These documents and this report may be obtained by writing to:
Ohio EPA, Division of Surface Water
Ecological Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8786
or
www.epa.state.oh.us/dsw/formspubs.html

APPENDICES

Appendix 1. Aquatic Life Use Summary for the Cuyahoga River Mainstem, 1984-2007.

River Mile Fish/Inverts (*Drainage mi*^{2})	IBI	MIwb	ICI	QHEI	Attainment Status	Comment
Cuyahoga River 19-001 (1984)						
57.6 (*208*)	29	7.5	8	--	NON	
56.0 (*292*)	33	9.0	--	--	NON	
55.8 (*291*)	--	--	34	--	NON	
54.6 (*293*)	30	7.6	--	--	NON	
54.3 (*293*)	--	--	40	--	FULL	
53.0 (*328*)	31	7.7	--	--	NON	
52.6 (*309*)	--	--	18	--	NON	
51.0 (*323*)	23	7.4	--	--	NON	
48.7 (327)	22	5.0	--	--	NON	
48.4 (*327*)	--	--	32	--	NON	
Cuyahoga River 19-001 (1991)						
54.6 (*293*)	40	8.8	--	--	FULL	
54.4 (*293*)	--	--	--	--		Qualitative Macroinvertebrates
49.8 (*328*)	35	8.7	32	--	FULL	
Cuyahoga River 19-001 (1996)						
57.6 (*208*)	--	--	24	--	NON	
57.5 (*208*)	35	5.6	--	56.5	NON	
56.1 (*291*)	--	--	32	--	PARTIAL	
56.0 (*291*)	35	6.7	--	67.5	PARTIAL	
54.4 (*293*)	--	--	44	--	PARTIAL	
54.2 (*293*)	28	7.6	--	70.0	PARTIAL	
53.4 (*307*)	31	6.7	38	64.0	PARTIAL	
52.0 (*320*)	30	7.5	--	54.0	NON	
51.0 (323)	30	6.2	--	48.5	NON	
49.8 (*327*)	--	--	42	--	FULL	
48.7 (327)	26	7.1	--	56.0	PARTIAL	
48.0 (331)	24	6.7	44	46.5	PARTIAL	
Cuyahoga River 19-001 (1999)						
55.2 (*293*)	30	5.3	--	--	NON	
Cuyahoga River 19-001 (2000)						
55.7 (*292*)	28	8.2	--	51.0	PARTIAL	
49.7 (*328*)	34	8.4	--	83.0	PARTIAL	
48.7 (*327*)	--	--	42	--	FULL	

Cuyahoga River 19-001 (2003)						
54.4 (*293*) [W]	42	8.8	38	--	FULL	Free Flowing
49.8 (331) [W]	28	7.5			PARTIAL	Free Flowing
Cuyahoga River 19-001 (2004)						
55.7 (*292*) [W]	44	8.9	--	79.5	FULL	Free Flowing
Cuyahoga River 19-001 (2005)						
55.6 (*290*) [W]	40	8.3	36	72.0	FULL	Former dam pool
55.0 (*293*) [W]	34	6.7	42	68.5	PARTIAL	Former dam pool
54.4 (*294*) [W]	44	8.9	38	--	FULL	Free Flowing
53.7/52.0 (*293*) [W]	34	8.8	24	77.5	PARTIAL	Dam Pool
50.0 (*326*) [W]	32	7.6	14	--	NON	Dam Pool
49.7/49.8 (*328*) [W]	40	7.7	32	74.5	FULL	Free Flowing
Cuyahoga River 19-001 (2007)						
55.6 (*292*) [W]	46	8.3	34	69.0	FULL	Former dam pool
55.0 (*293*) [W]	42	8.2	36	75.0	FULL	Former dam pool
54.6/54.4 (*293*) [W]	41	8.5	36	79.5	FULL	Downstream Dam
51.8/52.0 (*321*) [W]	30	7.5	50	61.5	PARTIAL	Former dam pool
51.0 (*323*)	32	8.4	--	65.0	PARTIAL	Former dam pool
49.9/50.0 (*328*) [W]	31	8.7	44	66.5	PARTIAL	Downstream Dam
48.7 (*331*)	23	6.4	42	58.0	NON	

[W] - Wading collection method. All other sampling by boat

Appendix 2. Fish collections from the middle Cuyahoga River, 2007.

Species List

River Code: **19-001**	Stream: **Cuyahoga River**	Sample Date: **2007**
River Mile: **55.60**	Location: Grant St.	Date Range: 06/20/2007
Time Fished: 3000 sec	Drainage: 292.0 sq mi	
Dist Fished: 0.20 km	Basin: Cuyahoga River No of Passes: 1	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Northern Hog Sucker	R	I	S	M	42	63.00	25.61	13.97	45.84	221.67
White Sucker	W	O	S	T	11	16.50	6.71	4.57	15.01	277.00
Spotted Sucker	R	I	S		1	1.50	0.61	0.21	0.70	142.00
River Chub	N	I	N	I	15	22.50	9.15	1.21	3.96	53.60
Common Shiner	N	I	S		4	6.00	2.44	0.49	1.61	81.50
Bluntnose Minnow	N	O	C	T	5	7.50	3.05	0.06	0.19	7.80
Yellow Bullhead		I	C	T	3	4.50	1.83	0.73	2.40	162.67
White Perch	E		M		29	43.50	17.68	4.62	15.16	106.13
Black Crappie	S	I	C		3	4.50	1.83	0.54	1.78	120.33
Rock Bass	S	C	C		9	13.50	5.49	1.15	3.79	85.44
Smallmouth Bass	F	C	C	M	6	9.00	3.66	0.49	1.60	54.00
Bluegill Sunfish	S	I	C	P	11	16.50	6.71	0.98	3.21	59.27
Pumpkinseed Sunfish	S	I	C	P	3	4.50	1.83	0.34	1.10	74.33
Yellow Perch			M		3	4.50	1.83	0.31	1.01	68.67
Logperch	D	I	S	M	14	21.00	8.54	0.70	2.29	33.21
Greenside Darter	D	I	S	M	5	7.50	3.05	0.11	0.37	15.00
	Mile Total				164	246.00		30.46		
	Number of Species				16					
	Number of Hybrids				0					

Species List

River Code: **19-001**	Stream: **Cuyahoga River**	Sample Date: **2007**
River Mile: **55.00**	Location: adj. Brady's Leap	Date Range: 06/20/2007
Time Fished: 8820 sec	Drainage: 293.0 sq mi	Thru: 09/21/2007
Dist Fished: 0.40 km	Basin: Cuyahoga River No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Northern Hog Sucker	R	I	S	M	114	85.50	22.89	19.16	46.33	224.12
White Sucker	W	O	S	T	5	3.75	1.00	0.53	1.28	141.40
River Chub	N	I	N	I	44	33.00	8.84	1.48	3.57	44.72
Common Shiner	N	I	S		18	13.50	3.61	1.47	3.56	109.19
Bluntnose Minnow	N	O	C	T	45	33.75	9.04	0.07	0.17	2.09
Yellow Bullhead		I	C	T	14	10.50	2.81	1.34	3.23	127.38
White Bass	F	P	M		6	4.50	1.20	0.42	1.02	93.33
Black Crappie	S	I	C		10	7.50	2.01	0.39	0.95	52.40
Rock Bass	S	C	C		77	57.75	15.46	4.39	10.62	76.07
Smallmouth Bass	F	C	C	M	85	63.75	17.07	10.96	26.50	171.92
Green Sunfish	S	I	C	T	2	1.50	0.40	0.03	0.07	18.50
Bluegill Sunfish	S	I	C	P	19	14.25	3.82	0.53	1.29	37.33
Pumpkinseed Sunfish	S	I	C	P	2	1.50	0.40	0.06	0.14	39.00
Logperch	D	I	S	M	16	12.00	3.21	0.29	0.70	24.06
Greenside Darter	D	I	S	M	41	30.75	8.23	0.23	0.56	7.59
	Mile Total				498	373.50		41.36		
	Number of Species				15					
	Number of Hybrids				0					

Species List

River Code: **19-001**	Stream: **Cuyahoga River**	Sample Date: **2007**
River Mile: **54.60**	Location: dst. Main St. (Kent)	Date Range: 06/22/2007
Time Fished: 7140 sec	Drainage: 293.0 sq mi	Thru: 09/21/2007
Dist Fished: 0.40 km	Basin: Cuyahoga River No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Redfin Pickerel		P	M	P	1	0.75	0.06	0.03	0.06	35.00
Northern Hog Sucker	R	I	S	M	396	297.00	23.50	26.40	61.62	88.89
White Sucker	W	O	S	T	34	25.50	2.02	0.52	1.21	20.38
Spotted Sucker	R	I	S		2	1.50	0.12	0.34	0.79	226.00
Common Carp	G	O	M	T	1	0.75	0.06	1.50	3.50	2,000.00
River Chub	N	I	N	I	76	57.00	4.51	2.75	6.42	48.27
Common Shiner	N	I	S		439	329.25	26.05	5.25	12.24	15.93
Bluntnose Minnow	N	O	C	T	318	238.50	18.87	0.55	1.29	2.32
Yellow Bullhead		I	C	T	14	10.50	0.83	0.57	1.32	53.93
Black Crappie	S	I	C		10	7.50	0.59	0.59	1.37	78.10
Rock Bass	S	C	C		30	22.50	1.78	1.31	3.06	58.36
Smallmouth Bass	F	C	C	M	21	15.75	1.25	1.80	4.19	114.01
Largemouth Bass	F	C	C		3	2.25	0.18	0.05	0.11	20.00
Green Sunfish	S	I	C	T	1	0.75	0.06	0.03	0.07	37.00
Bluegill Sunfish	S	I	C	P	20	15.00	1.19	0.22	0.52	14.90
Pumpkinseed Sunfish	S	I	C	P	2	1.50	0.12	0.07	0.17	48.50
Bluegill X Pumpkinseed					1	0.75	0.06	0.01	0.01	8.00
Logperch	D	I	S	M	26	19.50	1.54	0.32	0.75	16.50
Johnny Darter	D	I	C		3	2.25	0.18	0.01	0.03	5.00
Greenside Darter	D	I	S	M	287	215.25	17.03	0.54	1.26	2.52
	Mile Total				1,685	1,263.75		42.85		
	Number of Species				19					
	Number of Hybrids				1					

Species List

River Code: **19-001**	Stream: **Cuyahoga River**	Sample Date: **2007**
River Mile: **51.80**	Location: dst. Fish Creek, upst. WWTP	Date Range: 07/16/2007
Time Fished: 5820 sec	Drainage: 321.0 sq mi	Thru: 09/18/2007
Dist Fished: 0.40 km	Basin: Cuyahoga River No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Northern Hog Sucker	R	I	S	M	129	96.75	11.42	0.37	3.45	3.83
White Sucker	W	O	S	T	130	97.50	11.50	0.23	2.18	2.40
Common Carp	G	O	M	T	3	2.25	0.27	5.15	47.90	2,288.33
River Chub	N	I	N	I	10	7.50	0.88	0.12	1.10	15.80
Creek Chub	N	G	N	T	2	1.50	0.18	0.02	0.18	12.50
Common Shiner	N	I	S		46	34.50	4.07	0.39	3.60	11.20
Spottail Shiner	N	I	M	P	1	0.75	0.09	0.00	0.04	5.00
Fathead Minnow	N	O	C	T	1	0.75	0.09	0.01	0.07	10.00
Bluntnose Minnow	N	O	C	T	459	344.25	40.62	0.72	6.71	2.09
Central Stoneroller	N	H	N		92	69.00	8.14	0.08	0.73	1.15
Yellow Bullhead		I	C	T	15	11.25	1.33	0.42	3.86	36.87
Black Crappie	S	I	C		1	0.75	0.09	0.05	0.46	65.00
Rock Bass	S	C	C		23	17.25	2.04	1.10	10.23	63.74
Smallmouth Bass	F	C	C	M	3	2.25	0.27	0.08	0.78	37.00
Largemouth Bass	F	C	C		8	6.00	0.71	0.63	5.87	105.13
Warmouth Sunfish	S	C	C		1	0.75	0.09	0.01	0.07	10.00
Green Sunfish	S	I	C	T	29	21.75	2.57	0.06	0.54	2.68
Bluegill Sunfish	S	I	C	P	59	44.25	5.22	0.59	5.46	13.27
Pumpkinseed Sunfish	S	I	C	P	12	9.00	1.06	0.37	3.44	41.08
Logperch	D	I	S	M	11	8.25	0.97	0.19	1.80	23.45
Johnny Darter	D	I	C		45	33.75	3.98	0.05	0.49	1.56
Greenside Darter	D	I	S	M	50	37.50	4.42	0.12	1.08	3.09
Mile Total					1,130	847.50		10.75		
Number of Species					22					
Number of Hybrids					0					

Species List

River Code: **19-001**	Stream: **Cuyahoga River**	Sample Date: **2007**
River Mile: **51.00**	Location: 0.45 mi. dst. Fish Creek WWTP	Date Range: 06/24/2007
Time Fished: 2400 sec	Drainage: 323.0 sq mi	
Dist Fished: 0.30 km	Basin: Cuyahoga River No of Passes: 1	Sampler Type: A

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Redfin Pickerel		P	M	P	2	6.67	2.99	0.35	0.49	53.00
Northern Pike	F	P	M		4	13.33	5.97	7.03	9.72	527.00
Northern Hog Sucker	R	I	S	M	8	26.67	11.94	7.38	10.20	276.75
White Sucker	W	O	S	T	6	20.00	8.96	5.05	6.98	252.50
Common Carp	G	O	M	T	7	23.33	10.45	41.08	56.80	1,760.71
River Chub	N	I	N	I	3	10.00	4.48	0.31	0.43	31.00
Common Shiner	N	I	S		3	10.00	4.48	0.35	0.48	34.67
Black Crappie	S	I	C		3	10.00	4.48	0.55	0.76	55.00
Rock Bass	S	C	C		6	20.00	8.96	1.09	1.51	54.50
Smallmouth Bass	F	C	C	M	5	16.67	7.46	7.57	10.46	454.00
Warmouth Sunfish	S	C	C		1	3.33	1.49	0.22	0.30	65.00
Green Sunfish	S	I	C	T	3	10.00	4.48	0.22	0.30	21.67
Bluegill Sunfish	S	I	C	P	3	10.00	4.48	0.35	0.48	35.00
Pumpkinseed Sunfish	S	I	C	P	4	13.33	5.97	0.37	0.52	28.00
Logperch	D	I	S	M	5	16.67	7.46	0.30	0.42	18.20
Johnny Darter	D	I	C		2	6.67	2.99	0.03	0.05	5.00
Greenside Darter	D	I	S	M	2	6.67	2.99	0.07	0.10	11.00
Mile Total					67	223.33		72.32		
Number of Species					17					
Number of Hybrids					0					

Species List

River Code: **19-001**	Stream: **Cuyahoga River**	Sample Date: **2007**
River Mile: **49.90**	Location: upst. SR 91, formerly impounded	Date Range: 07/16/2007
Time Fished: 4860 sec	Drainage: 328.0 sq mi	Thru: 09/18/2007
Dist Fished: 0.40 km	Basin: Cuyahoga River No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Northern Hog Sucker	R	I	S	M	86	64.50	9.75	7.70	25.88	119.44
White Sucker	W	O	S	T	174	130.50	19.73	6.94	23.30	53.14
River Chub	N	I	N	I	76	57.00	8.62	2.26	7.60	39.66
Western Blacknose Dace	N	G	S	T	7	5.25	0.79	0.04	0.13	7.57
Creek Chub	N	G	N	T	12	9.00	1.36	0.12	0.39	13.01
Common Shiner	N	I	S		100	75.00	11.34	3.30	11.10	44.05
Spottail Shiner	N	I	M	P	9	6.75	1.02	0.07	0.24	10.44
Fathead Minnow	N	O	C	T	1	0.75	0.11	0.00	0.01	5.00
Bluntnose Minnow	N	O	C	T	157	117.75	17.80	0.38	1.27	3.22
Central Stoneroller	N	H	N		70	52.50	7.94	0.72	2.42	13.70
Yellow Bullhead		I	C	T	11	8.25	1.25	0.15	0.49	17.55
White Bass	F	P	M		1	0.75	0.11	0.06	0.20	80.00
Black Crappie	S	I	C		2	1.50	0.23	0.12	0.40	79.50
Rock Bass	S	C	C		11	8.25	1.25	0.79	2.65	95.45
Smallmouth Bass	F	C	C	M	16	12.00	1.81	4.77	16.04	397.79
Largemouth Bass	F	C	C		7	5.25	0.79	1.30	4.36	247.29
Green Sunfish	S	I	C	T	1	0.75	0.11	0.01	0.05	18.00
Bluegill Sunfish	S	I	C	P	2	1.50	0.23	0.06	0.20	40.50
Pumpkinseed Sunfish	S	I	C	P	4	3.00	0.45	0.17	0.57	56.75
Bluegill X Pumpkinseed					1	0.75	0.11	0.03	0.11	43.00
Logperch	D	I	S	M	24	18.00	2.72	0.31	1.05	17.32
Johnny Darter	D	I	C		17	12.75	1.93	0.04	0.13	3.02
Greenside Darter	D	I	S	M	93	69.75	10.54	0.42	1.42	6.07
Mile Total					882	661.50		29.77		
Number of Species					22					
Number of Hybrids					1					

Species List

River Code: **19-001**	Stream: **Cuyahoga River**	Sample Date: **2007**
River Mile: **48.70**	Location:	Date Range: 06/24/2007
Time Fished: 4920 sec	Drainage: 331.0 sq mi	Thru: 09/27/2007
Dist Fished: 0.60 km	Basin: Cuyahoga River No of Passes: 2	Sampler Type: A

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Northern Hog Sucker	R	I	S	M	12	20.00	8.63	5.35	3.47	267.33
White Sucker	W	O	S	T	5	8.33	3.60	4.43	2.87	531.40
Common Carp	G	O	M	T	45	75.00	32.37	131.44	85.24	1,752.47
Emerald Shiner	N	I	M		1	1.67	0.72	0.00	0.00	2.00
Spottail Shiner	N	I	M	P	3	5.00	2.16	0.01	0.01	2.00
Yellow Bullhead		I	C	T	7	11.67	5.04	1.59	1.03	136.14
White Perch	E		M		8	13.33	5.76	1.08	0.70	81.25
Black Crappie	S	I	C		3	5.00	2.16	0.44	0.29	88.67
Rock Bass	S	C	C		1	1.67	0.72	0.12	0.08	70.00
Smallmouth Bass	F	C	C	M	10	16.67	7.19	4.66	3.02	279.70
Largemouth Bass	F	C	C		5	8.33	3.60	2.23	1.44	267.00
Green Sunfish	S	I	C	T	1	1.67	0.72	0.04	0.03	24.00
Bluegill Sunfish	S	I	C	P	25	41.67	17.99	1.79	1.16	42.96
Pumpkinseed Sunfish	S	I	C	P	10	16.67	7.19	0.93	0.60	55.80
Bluegill X Pumpkinseed					1	1.67	0.72	0.05	0.03	30.00
Yellow Perch			M		1	1.67	0.72	0.02	0.01	10.00
Logperch	D	I	S	M	1	1.67	0.72	0.03	0.02	20.00
	Mile Total				139	231.67		154.20		
	Number of Species				16					
	Number of Hybrids				1					

Appendix 3. Macroinvertebrate collections from the middle Cuyahoga River, 2007.

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 09/04/2007 River Code: 19-001 RM: 55.60

Site: Cuyahoga River
Grant St.

Taxa Code	Taxa	Quant/Qual	
01320	*Hydra sp*	1065	
01801	*Turbellaria*	1312	+
03360	*Plumatella sp*	2	
03600	*Oligochaeta*	641	+
05800	*Caecidotea sp*		+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*		+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*		+
08601	*Hydrachnidia*	40	
11120	*Baetis flavistriga*	14	+
11130	*Baetis intercalaris*	652	+
13400	*Stenacron sp*	177	+
16700	*Tricorythodes sp*		+
17200	*Caenis sp*		+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*		+
50804	*Lype diversa*	64	
51300	*Neureclipsis sp*	1	+
52200	*Cheumatopsyche sp*	1282	+
52430	*Ceratopsyche morosa group*	2913	+
52450	*Ceratopsyche sparna*	2	
52530	*Hydropsyche depravata group*	58	+
52560	*Hydropsyche orris*	4	
53800	*Hydroptila sp*	32	+
57900	*Pycnopsyche sp*		+
59410	*Nectopsyche diarina*		+
68702	*Dubiraphia bivittata*		+
68901	*Macronychus glabratus*	423	+
69400	*Stenelmis sp*	94	+
70600	*Antocha sp*	9	+
71900	*Tipula sp*		+
74100	*Simulium sp*	88	+
77130	*Ablabesmyia rhamphe group*		+
77750	*Hayesomyia senata or Thienemannimyia norena*	149	+
77800	*Helopelopia sp*	50	
78600	*Pentaneura inconspicua*	50	+
80310	*Cardiocladius obscurus*		+
80430	*Cricotopus (C.) tremulus group*		+
81240	*Nanocladius (N.) distinctus*		+
81825	*Rheocricotopus (Psilocricotopus) robacki*	50	
82220	*Tvetenia discoloripes group*	895	
83040	*Dicrotendipes neomodestus*		+
83158	*Endochironomus nigricans*		+
83300	*Glyptotendipes (G.) sp*	50	+
83840	*Microtendipes pedellus group*		+
84010	*Parachironomus "abortivus" (sensu Simpson & Bode, 1980)*	149	+
84450	*Polypedilum (Uresipedilum) flavum*	2137	+
84460	*Polypedilum (P.) fallax group*	99	
84470	*Polypedilum (P.) illinoense*	99	+
84540	*Polypedilum (Tripodura) scalaenum group*		+
84700	*Stenochironomus sp*	99	
85625	*Rheotanytarsus sp*	1292	+
85800	*Tanytarsus sp*		+
85840	*Tanytarsus sepp*		+
87540	*Hemerodromia sp*	137	
92615	*Cipangopaludina japonica*		+
96900	*Ferrissia sp*	1	
97601	*Corbicula fluminea*	191	+

No. Quantitative Taxa: 35 Total Taxa: 58
No. Qualitative Taxa: 45 ICI: **36**
Number of Organisms: 14321 Qual EPT: 12

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Cuyahoga River
adj. Brady's Leap

Collection Date: 09/04/2007 River Code: 19-001 RM: 55.00

Taxa Code	Taxa	Quant/Qual	
01320	*Hydra sp*	4128	
01801	*Turbellaria*	960	+
03360	*Plumatella sp*	12	+
03600	*Oligochaeta*	672	
04964	*Mooreobdella microstoma*		+
05800	*Caecidotea sp*	4	+
06700	*Crangonyx sp*		+
08250	*Orconectes (Procericambarus) rusticus*		+
08601	*Hydrachnidia*	104	
11120	*Baetis flavistriga*	1	+
11130	*Baetis intercalaris*	320	+
13400	*Stenacron sp*	308	+
13561	*Maccaffertium pulchellum*	22	
14950	*Leptophlebia sp or Paraleptophlebia sp*	1	
17200	*Caenis sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*	1	+
50315	*Chimarra obscura*	2	
50906	*Psychomyia flavida*	5	+
51206	*Cyrnellus fraternus*	1	+
51300	*Neureclipsis sp*	6	+
52200	*Cheumatopsyche sp*	988	+
52430	*Ceratopsyche morosa group*	60	
52450	*Ceratopsyche sparna*	60	+
52530	*Hydropsyche depravata group*	599	+
52560	*Hydropsyche orris*	45	
53800	*Hydroptila sp*	57	
59100	*Ceraclea sp*	2	
59300	*Mystacides sp*		+
68601	*Ancyronyx variegata*	2	+
68901	*Macronychus glabratus*	780	+
69400	*Stenelmis sp*	75	+
70600	*Antocha sp*	10	
74100	*Simulium sp*	39	+
77800	*Helopelopia sp*		+
79100	*Thienemannimyia group*	288	
80310	*Cardiocladius obscurus*	72	+
80410	*Cricotopus (C.) sp*	72	+
80420	*Cricotopus (C.) bicinctus*		+
81231	*Nanocladius (N.) crassicornus or N. (N.) "rectinervis"*		+
81240	*Nanocladius (N.) distinctus*	144	
81825	*Rheocricotopus (Psilocricotopus) robacki*	72	
82141	*Thienemanniella xena*	32	
82220	*Tvetenia discoloripes group*	216	
83040	*Dicrotendipes neomodestus*		+
83300	*Glyptotendipes (G.) sp*	144	
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	216	
83840	*Microtendipes pedellus group*		+
84010	*Parachironomus "abortivus" (sensu Simpson & Bode, 1980)*	144	+
84040	*Parachironomus frequens*		+
84450	*Polypedilum (Uresipedilum) flavum*	863	+
84470	*Polypedilum (P.) illinoense*	72	+
84540	*Polypedilum (Tripodura) scalaenum group*		+
84700	*Stenochironomus sp*	288	
85263	*Cladotanytarsus vanderwulpi group Type 3*		+
85625	*Rheotanytarsus sp*	3884	+
85821	*Tanytarsus glabrescens group sp 7*	360	+
85840	*Tanytarsus sepp*	144	
87540	*Hemerodromia sp*	21	
93900	*Elimia sp*	1	+
96900	*Ferrissia sp*	48	
97601	*Corbicula fluminea*		+
98600	*Sphaerium sp*	128	

No. Quantitative Taxa: 48 Total Taxa: 63
No. Qualitative Taxa: 40 ICI: **36**
Number of Organisms: 16473 Qual EPT: 11

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Cuyahoga River
dst. Kramer Field Rd.

Collection Date: 09/04/2007 River Code: 19-001 RM: 54.40

Taxa Code	Taxa	Quant/Qual	
01200	*Cordylophora lacustris*	2	
01320	*Hydra sp*	4675	+
01801	*Turbellaria*	491	+
01900	*Nemertea*	1	+
03121	*Paludicella articulata*	1	
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	105	+
05800	*Caecidotea sp*	69	+
06700	*Crangonyx sp*	259	+
08200	*Orconectes sp*	1	+
08601	*Hydrachnidia*	48	+
11120	*Baetis flavistriga*	68	+
11130	*Baetis intercalaris*	282	+
11200	*Callibaetis sp*		+
13400	*Stenacron sp*	604	+
13561	*Maccaffertium pulchellum*	34	
16700	*Tricorythodes sp*	230	+
17200	*Caenis sp*	1	+
21300	*Hetaerina sp*	4	
22001	*Coenagrionidae*		+
22300	*Argia sp*	33	+
44501	*Corixidae*		+
50315	*Chimarra obscura*	15	+
51300	*Neureclipsis sp*	37	+
51600	*Polycentropus sp*		+
52200	*Cheumatopsyche sp*	505	+
52430	*Ceratopsyche morosa group*	87	+
52450	*Ceratopsyche sparna*	216	+
52530	*Hydropsyche depravata group*	437	+
53800	*Hydroptila sp*	1	
59310	*Mystacides sepulchralis*	8	+
59410	*Nectopsyche diarina*	8	+
60900	*Peltodytes sp*		+
68601	*Ancyronyx variegata*	33	
68708	*Dubiraphia vittata group*		+
68901	*Macronychus glabratus*	631	+
69400	*Stenelmis sp*	139	+
70600	*Antocha sp*	11	+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*		+
77130	*Ablabesmyia rhamphe group*		+
77500	*Conchapelopia sp*	118	+
77750	*Hayesomyia senata or Thienemannimyia norena*	197	+
78600	*Pentaneura inconspicua*	79	
80204	*Brillia flavifrons group*		+
80410	*Cricotopus (C.) sp*	39	+
80420	*Cricotopus (C.) bicinctus*	79	+
80430	*Cricotopus (C.) tremulus group*		+
81231	*Nanocladius (N.) crassicornus or N. (N.) "rectinervis"*	79	
81240	*Nanocladius (N.) distinctus*	157	
82220	*Tvetenia discoloripes group*	79	+
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*	39	+
83158	*Endochironomus nigricans*		+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*		+
84010	*Parachironomus "abortivus" (sensu Simpson & Bode, 1980)*	79	
84300	*Phaenopsectra obediens group*		+
84450	*Polypedilum (Uresipedilum) flavum*	590	+
84470	*Polypedilum (P.) illinoense*		+
84540	*Polypedilum (Tripodura) scalaenum group*	118	+
84700	*Stenochironomus sp*	39	
85263	*Cladotanytarsus vanderwulpi group Type 3*		+
85625	*Rheotanytarsus sp*	1653	+
85800	*Tanytarsus sp*	39	
85821	*Tanytarsus glabrescens group sp 7*	79	+
87540	*Hemerodromia sp*	34	+
93200	*Hydrobiidae*		+
93900	*Elimia sp*		+
95100	*Physella sp*		+
95900	*Gyraulus sp*	32	
96900	*Ferrissia sp*	427	+
97601	*Corbicula fluminea*	56	+

No. Quantitative Taxa: 52 Total Taxa: 72
No. Qualitative Taxa: 58 ICI: **36**
Number of Organisms: 13049 Qual EPT: 15

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 09/05/2007 River Code: 19-001 RM: 52.00

Site: Cuyahoga River
dst. Fish Creek

Taxa Code	Taxa	Quant/Qual
00401	*Spongillidae*	+
01320	*Hydra sp*	9
01801	*Turbellaria*	534 +
03600	*Oligochaeta*	20 +
04960	*Mooreobdella sp*	+
05800	*Caecidotea sp*	+
06201	*Hyalella azteca*	+
06700	*Crangonyx sp*	+
08601	*Hydrachnidia*	+
11120	*Baetis flavistriga*	62 +
11130	*Baetis intercalaris*	295 +
11200	*Callibaetis sp*	+
13400	*Stenacron sp*	96 +
13510	*Maccaffertium exiguum*	178 +
13561	*Maccaffertium pulchellum*	755 +
13570	*Maccaffertium terminatum*	46 +
16700	*Tricorythodes sp*	122 +
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
23704	*Anax junius*	+
24900	*Gomphus sp*	+
26700	*Macromia sp*	+
27001	*Corduliidae*	+
45100	*Palmacorixa sp*	+
48220	*Chauliodes rastricornis*	+
50315	*Chimarra obscura*	90 +
51300	*Neureclipsis sp*	9 +
52200	*Cheumatopsyche sp*	4285 +
52430	*Ceratopsyche morosa group*	108 +
52450	*Ceratopsyche sparna*	4 +
52530	*Hydropsyche depravata group*	152 +
59200	*Leptocerus americanus*	8
59410	*Nectopsyche diarina*	+
60800	*Haliplus sp*	+
68025	*Ectopria sp*	+
68700	*Dubiraphia sp*	1
68702	*Dubiraphia bivittata*	+
68707	*Dubiraphia quadrinotata*	+
68901	*Macronychus glabratus*	193 +
69400	*Stenelmis sp*	204 +
70600	*Antocha sp*	8
74100	*Simulium sp*	3
74501	*Ceratopogonidae*	+
77120	*Ablabesmyia mallochi*	+
77130	*Ablabesmyia rhamphe group*	+
77355	*Clinotanypus pinguis*	+
77500	*Conchapelopia sp*	24
77750	*Hayesomyia senata or Thienemannimyia norena*	168
78655	*Procladius (Holotanypus) sp*	+
81231	*Nanocladius (N.) crassicornus or N. (N.) "rectinervis"*	54 +
81270	*Nanocladius (N.) spiniplenus*	14
81825	*Rheocricotopus (Psilocricotopus) robacki*	14
82220	*Tvetenia discoloripes group*	69
82820	*Cryptochironomus sp*	+
83040	*Dicrotendipes neomodestus*	+
83158	*Endochironomus nigricans*	14
83410	*Harnischia curtilamellata*	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	27
84210	*Paratendipes albimanus or P. duplicatus*	+
84450	*Polypedilum (Uresipedilum) flavum*	410 +
84470	*Polypedilum (P.) illinoense*	+
84520	*Polypedilum (Tripodura) halterale group*	14
84540	*Polypedilum (Tripodura) scalaenum group*	41
85265	*Cladotanytarsus vanderwulpi group Type 5*	+
85625	*Rheotanytarsus sp*	371 +
85720	*Stempellinella fimbriata*	14
85800	*Tanytarsus sp*	54
85821	*Tanytarsus glabrescens group sp 7*	65 +
87540	*Hemerodromia sp*	2
93200	*Hydrobiidae*	+
95100	*Physella sp*	+
96900	*Ferrissia sp*	+
97601	*Corbicula fluminea*	14 +
98200	*Pisidium sp*	+

No. Quantitative Taxa: 39	Total Taxa: 74
No. Qualitative Taxa: 57	ICI: **50**
Number of Organisms: 8551	Qual EPT: 15

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Cuyahoga River
upst. Munroe Falls dam

Collection Date: 09/04/2007 River Code: 19-001 RM: 50.00

Taxa Code	Taxa	Quant/Qual
01320	*Hydra sp*	16
01801	*Turbellaria*	864 +
01900	*Nemertea*	32
03600	*Oligochaeta*	140
05800	*Caecidotea sp*	1
06201	*Hyalella azteca*	+
06700	*Crangonyx sp*	+
08601	*Hydrachnidia*	8
11014	*Acentrella turbida*	+
11120	*Baetis flavistriga*	30 +
11130	*Baetis intercalaris*	646 +
11250	*Centroptilum sp (w/o hindwing pads)*	+
13400	*Stenacron sp*	2 +
13510	*Maccaffertium exiguum*	29 +
13561	*Maccaffertium pulchellum*	42 +
13570	*Maccaffertium terminatum*	20 +
16700	*Tricorythodes sp*	34 +
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
42700	*Belostoma sp*	+
47600	*Sialis sp*	+
50315	*Chimarra obscura*	16
51300	*Neureclipsis sp*	+
52200	*Cheumatopsyche sp*	3714 +
52430	*Ceratopsyche morosa group*	206 +
52450	*Ceratopsyche sparna*	103 +
52530	*Hydropsyche depravata group*	342 +
53800	*Hydroptila sp*	+
59410	*Nectopsyche diarina*	+
60900	*Peltodytes sp*	+
63300	*Hydroporus sp*	16
67500	*Laccobius sp*	+
68601	*Ancyronyx variegata*	2
68901	*Macronychus glabratus*	88
69400	*Stenelmis sp*	33
70600	*Antocha sp*	12
71910	*Tipula abdominalis*	4
74100	*Simulium sp*	1 +
77500	*Conchapelopia sp*	11
77750	*Hayesomyia senata or Thienemannimyia norena*	334
77800	*Helopelopia sp*	+
78450	*Nilotanypus fimbriatus*	17
80310	*Cardiocladius obscurus*	+
80420	*Cricotopus (C.) bicinctus*	11 +
80430	*Cricotopus (C.) tremulus group*	11 +
81231	*Nanocladius (N.) crassicornus or N. (N.) "rectinervis"*	21
81690	*Paratrichocladius sp*	+
82220	*Tvetenia discoloripes group*	83 +
82820	*Cryptochironomus sp*	32
82881	*Cryptotendipes sp 1*	+
83040	*Dicrotendipes neomodestus*	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	11
84300	*Phaenopsectra obediens group*	62
84420	*Polypedilum (P.) n.sp 1*	32
84440	*Polypedilum (Uresipedilum) aviceps*	11
84450	*Polypedilum (Uresipedilum) flavum*	408 +
84460	*Polypedilum (P.) fallax group*	11
84470	*Polypedilum (P.) illinoense*	+
84520	*Polypedilum (Tripodura) halterale group*	11
84540	*Polypedilum (Tripodura) scalaenum group*	32
84700	*Stenochironomus sp*	+
85265	*Cladotanytarsus vanderwulpi group Type 5*	11
85615	*Rheotanytarsus pellucidus*	11
85625	*Rheotanytarsus sp*	11 +
85821	*Tanytarsus glabrescens group sp 7*	11
85840	*Tanytarsus sepp*	73
96900	*Ferrissia sp*	8

No. Quantitative Taxa: 47 Total Taxa: 67
No. Qualitative Taxa: 38 ICI: **44**
Number of Organisms: 7624 Qual EPT: 16

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

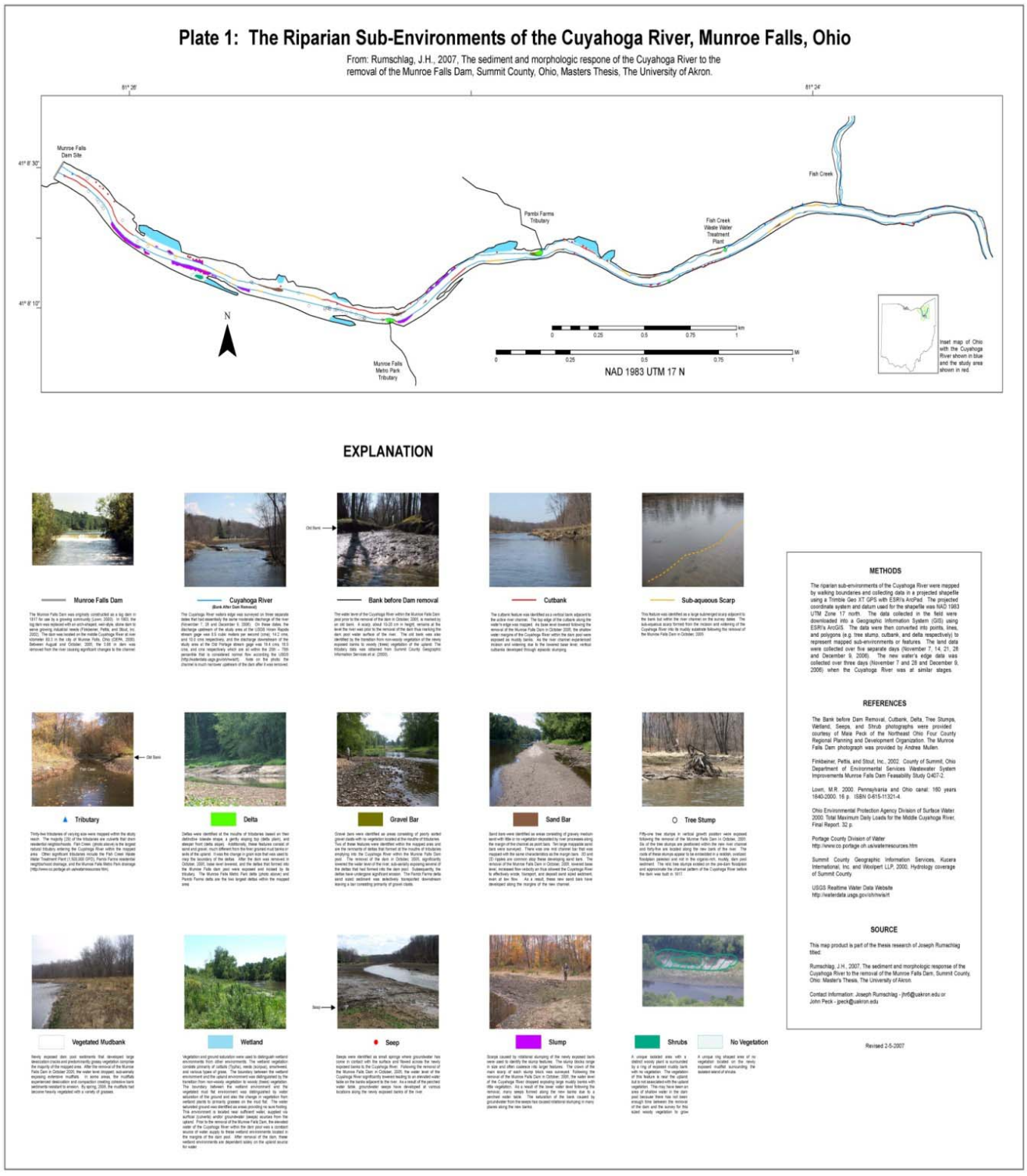
Site: Cuyahoga River

Collection Date: 09/05/2007 River Code: 19-001 RM: 48.70

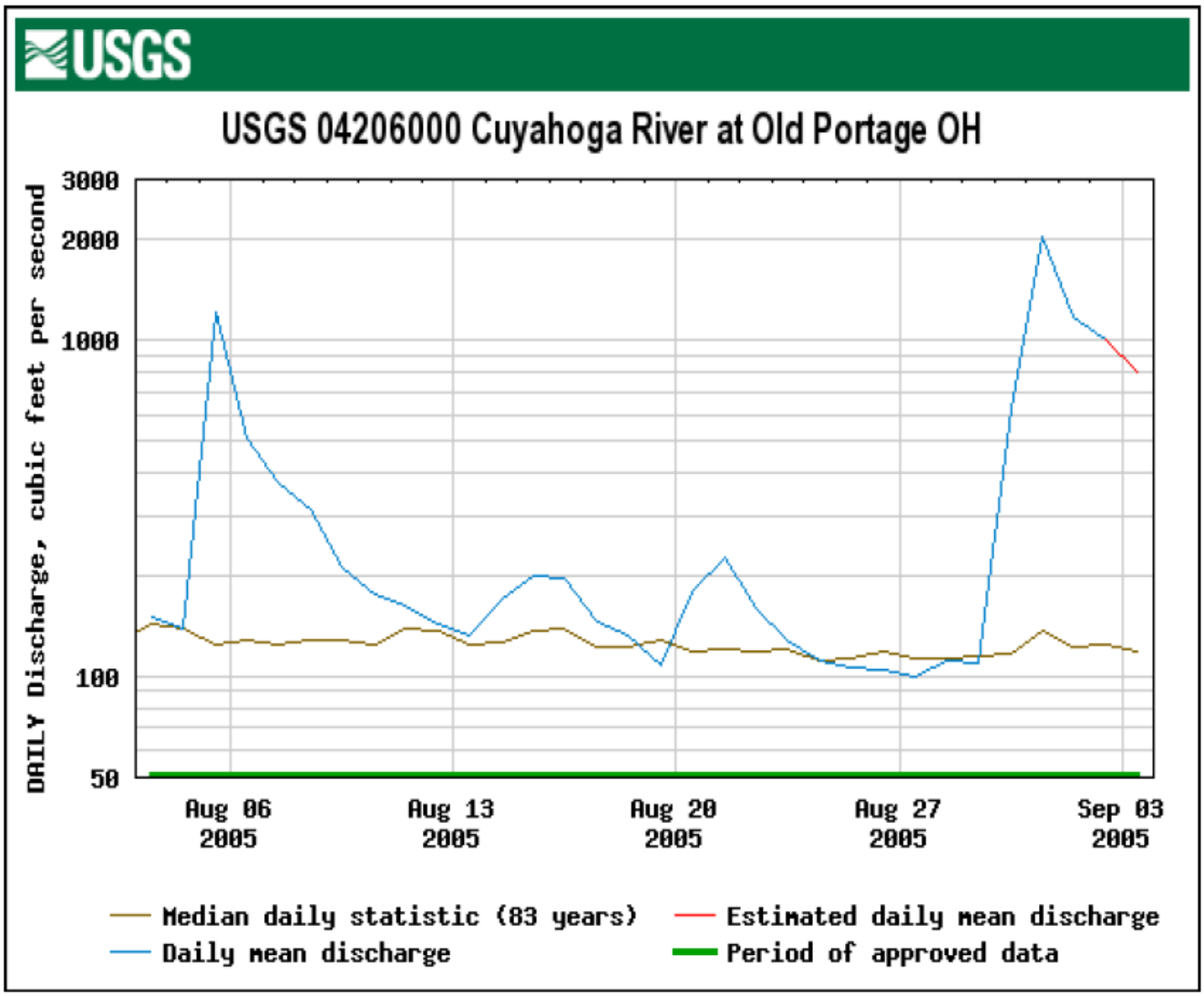
Taxa Code	Taxa	Quant	Qual
00401	*Spongillidae*		+
01320	*Hydra sp*	186	
01801	*Turbellaria*		+
01900	*Nemertea*	4	
03121	*Paludicella articulata*	1	+
03360	*Plumatella sp*	1	
03451	*Urnatella gracilis*		+
03600	*Oligochaeta*	24	+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*		+
08601	*Hydrachnidia*	25	
11130	*Baetis intercalaris*	65	+
13400	*Stenacron sp*		+
13510	*Maccaffertium exiguum*	110	+
13561	*Maccaffertium pulchellum*	413	+
13570	*Maccaffertium terminatum*	238	+
16700	*Tricorythodes sp*	396	+
17200	*Caenis sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*	82	+
24501	*Gomphidae*		+
25620	*Stylurus spiniceps*		+
47600	*Sialis sp*		+
51300	*Neureclipsis sp*	63	+
52200	*Cheumatopsyche sp*	875	+
52430	*Ceratopsyche morosa group*	6	
52450	*Ceratopsyche sparna*	2	
52530	*Hydropsyche depravata group*	26	+
59410	*Nectopsyche diarina*		+
59500	*Oecetis sp*		+
68025	*Ectopria sp*		+
68601	*Ancyronyx variegata*	1	+
68702	*Dubiraphia bivittata*		+
68708	*Dubiraphia vittata group*	8	+
68901	*Macronychus glabratus*	12	+
69400	*Stenelmis sp*		+
77120	*Ablabesmyia mallochi*		+
77130	*Ablabesmyia rhamphe group*	17	
77150	*Ablabesmyia simpsoni*		+
77500	*Conchapelopia sp*	100	
77750	*Hayesomyia senata or Thienemannimyia norena*	150	+
77800	*Helopelopia sp*		+
78655	*Procladius (Holotanypus) sp*		+
80430	*Cricotopus (C.) tremulus group*	17	
81231	*Nanocladius (N.) crassicornus or N. (N.) "rectinervis"*	25	
81240	*Nanocladius (N.) distinctus*	67	
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*		+
83158	*Endochironomus nigricans*		+
83300	*Glyptotendipes (G.) sp*	25	+
84000	*Parachironomus sp*		+
84060	*Parachironomus pectinatellae*	17	
84300	*Phaenopsectra obediens group*	8	
84450	*Polypedilum (Uresipedilum) flavum*	42	
84460	*Polypedilum (P.) fallax group*	17	
84470	*Polypedilum (P.) illinoense*		+
84540	*Polypedilum (Tripodura) scalaenum group*	50	
84700	*Stenochironomus sp*	17	
85625	*Rheotanytarsus sp*	217	+
85800	*Tanytarsus sp*	58	+
85821	*Tanytarsus glabrescens group sp 7*	25	
87540	*Hemerodromia sp*	9	
92600	*Cipangopaludina sp*		+
96120	*Menetus (Micromenetus) dilatatus*	33	
96900	*Ferrissia sp*	194	

No. Quantitative Taxa: 39 Total Taxa: 65
No. Qualitative Taxa: 44 ICI: **42**
Number of Organisms: 3626 Qual EPT: 12

Appendix 4. Erosion Areas of the Former Munroe Falls Dam Pool.



Appendix 5. Cuyahoga River flow hydrograph at Old Portage gage for the August 2005 floods. The late August flood was from the remnants of Hurricane Katrina.



Appendix 6. Monitoring performed in the Middle Cuyahoga River 2004-2007.

Site Description	Relative Location	STORET Number	RM*	Chemical/ Physical†	Data-sondes	Macro-invertebrates	Fish/ Habitat
Cuyahoga R From Dam Face-Part Siphon Part Overflow	At Dam	300335	57.97	2005	NS	NS	NS
Cuyahoga R 100' Dst Lake Rockwell Spillway Upst 2 Lew Pipes	Dst Dam	300335	57.95	2007	NS	NS	NS
1st Pipe To Lew Cuyahoga R Dst Lake Rockwell	Storm/Subsurface Discharge	300336	57.88	2007	NS	NS	NS
2nd Pipe Dst Dam Welling Up At Lew), Mid-Level Dam Release	Reservoir Discharge to meet Court Order	300337	57.86	2007	NS	NS	NS
Cuyahoga R. Dst Rckwll.Dam,50'upst. Twin Lks Outlt	Ust Twin Lakes Outlet	F01W80	57.84	2005, 2007	2005	NS	NS
Twin Lakes Outlet Nr Mouth,	Twin Lakes	F01W86	57.83	2005, 2007	2005	NS	NS
Cuyahoga R at Ravenna Rd	Dst dam and discharges	F01P29	57.67	2005	2005	NS	NS
Cuyahoga R Upst Breakneck Ck Dst Lake Rockwell	Ust Breakneck	F01W82	56.83‡	2007	NS	NS	NS
Breakneck Creek	Breakneck Creek	F01W83	56.82/0.5	2007	2005	NS	NS
Cuyahoga River at River Bend Road	Ust Dam Pool	F01W87	56.19	2007	2005	NS	NS
Cuyahoga R at Standing Rock	Start of Dam Pool	F01W70	55.8	2005, 2007	NS	NS	NS
Cuyahoga R at Grant Street	Former Dam Pool	F01W70	55.6	NS	NS	2005, 2007	2004,2005, 2007
Cuyahoga R at Crain Ave	Former Dam Pool	F01S18	55.22	2005, 2007	2005	NS	NS
Cuyahoga R Ust Main St – Brady's Leap	Ust Kent Dam	F01P28	55	NS	NS	2005, 2007	2005, 2007
Cuyahoga R Near Stow Street	Dst Kent Dam	F01W85	54.4	2005	NS	2005	2005, 2007
Cuyahoga R Near Fred Fuller Park	Ust Kent WWTP	F01S17	54.32‡	2007	2005	NS	NS

Kent WWTP 001 Outfall To Cuyahoga R. Bio Mix Zone	Kent WWTP	F01A33		2007	NS	NS	NS
Plum Creek	Plum Creek	F01P34	53.67/0.15	2007	2005	NS	NS
Cuyahoga R Ust Middlebury Rd	Dst Kent WWTP-Plum Creek	502060	53.4‡	2007	NS	NS	NS
Cuyahoga R Near Middlebury Rd	Dst Plum Creek	F01S02	52.63	2007	NS	NS	2005
Fish Creek	Fish Creek	F01W37	52.12/0.38	2007	2005	NS	NS
Cuyahoga R Just Upst Fish Ck WWTP Dst Fish Creek	Dst Fish Creek/Ust WWTP	F01W38	52	2005	NS	2005, 2007	2005, 2007
Fishcreek WWTP Effluent To Rew Cuyahoga R.	Fishcreek WWTP	F01E15	51.66‡	2007	NS	NS	NS
Cuyahoga R. Dst Fish Ck WWTP	Dst Fishcreek WWTP	300338	51.6	2007	2005	NS	2007
Cuyahoga R. At Munroe Falls Dam Pool (RM 50.0)	Ust Munroe Falls Dam	F01S75	50.0	2005, 2007	NS	2005	2005
Cuyahoga R. At Munroe Falls Dam (RM 49.9)	At Munroe Falls Dam		49.9	2007	2005	2007	2007
Cuyahoga R. SR 91	Dst Munroe Falls Dam	F01P27	49.78‡	2005, 2007	2005	2005	2005
Ust Water Works Park	Dst Footbridge	F01G53	49	2007	NS	2007	2007
At Water Works Park	Near Boat Launch	200038	48	2007	NS	NS	NS

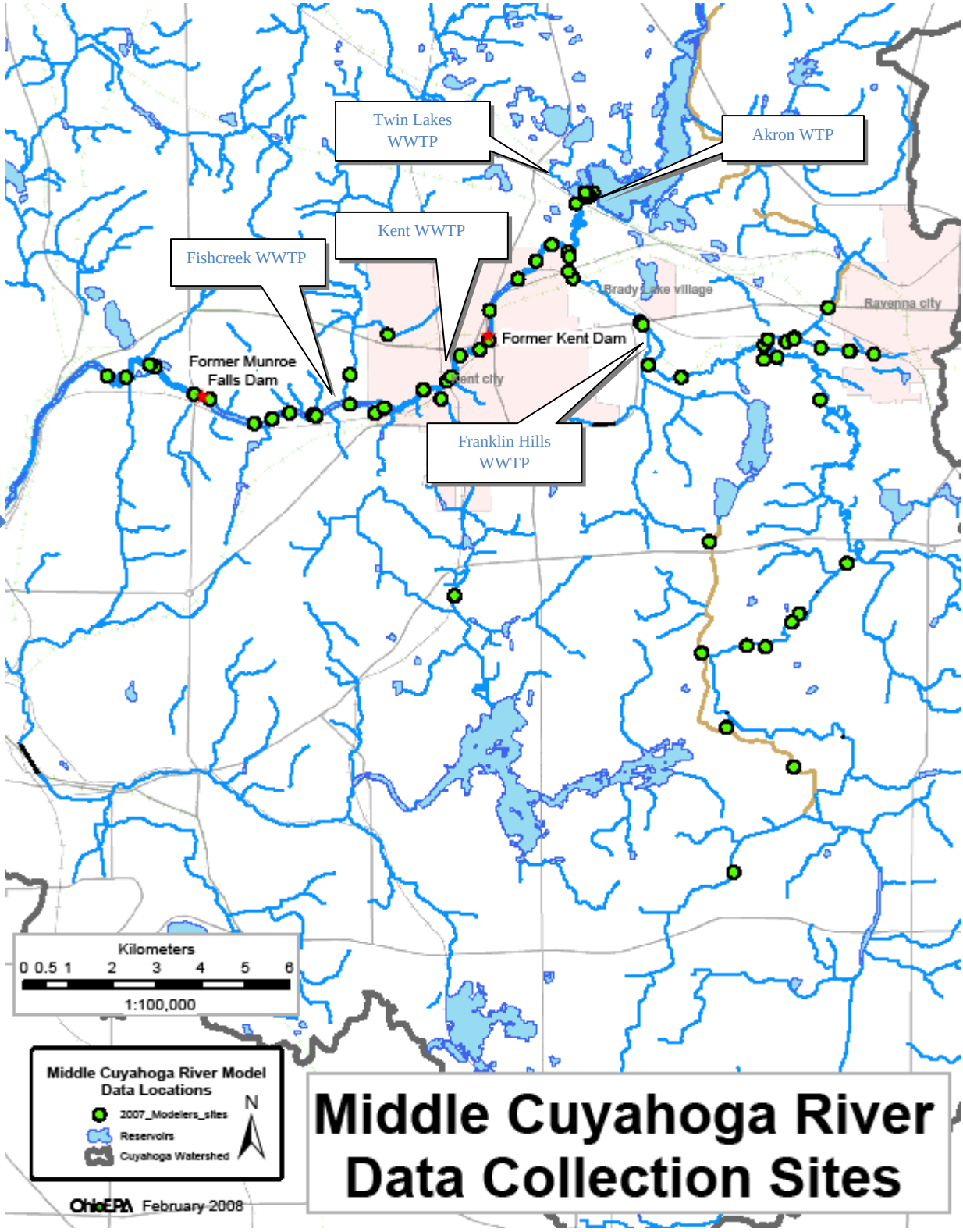
* River Miles are approximate. Macroinvertebrate and Fish collections determined in the field and may differ slightly.

‡ includes chlorophyll a and periphyton a. sampling.

†The analytical list includes: Alkalinity, Aluminum, Ammonia, Arsenic, Barium, BOD_5, Cadmium, Calcium, cBOD20, Chloride, Chromium, Copper, dcBOD20, DOC, Hardness, Total, Iron, Lead, Magnesium, Manganese, Nickel, Nitrate + nitrite, Nitrite, Orthophosphate,, Potassium, Selenium, Sodium, Strontium, Sulfate, TKN, Total Dissolved Solids, Total Phosphorus, Total Suspended Solids, Volatile Suspended Solids, Zinc, Temperature, pH, Dissolved Oxygen, Conductivity. Not all analyses were performed at each location.

NS - indicates no sampling performed

Appendix 7. Map of historical sampling locations in the Middle Cuyahoga River.



Appendix 8. Table of middle Cuyahoga River water sampling results 2000-2007.

RIVER MILE	LOCATION	DATE	ARSENIC AS,TOT UG/L	BARIUM BA,TOT UG/L	BOD 5 DAY MG/L	CHLORIDE TOTAL MG/L	CNDUCTVY AT 25C MICROMHO	CU, TOT UG/L	DISS ORG C MG/L	DO PROBE MG/L	DO SATUR %	PB, TOT UG/L	MN, TOT UG/L	NH3+NH4-N TOTAL MG/L	NO2&NO3 N-TOT MG/L	NO2-N TOTAL MG/L
	CUYAHOGA R @ CUYAHOGA ST	7/19/2000	2	46	2	63	513	10		6.1	68.5	2	158	0.1	1.1	0
		7/25/2000	3	49	2	81	638	10		9.6	111.4	2	95	0.1	1.2	0
		8/3/2000	2	57	2	99	724	10		7.8	93.9	2	79	0.1	1.4	0
		8/10/2000	3	44	2.7	49	432	10		8.4	100.3	2	123	0.1	0.5	0
42.6		9/14/2000	3	58	2	103	732	10		8.1	92.6	2	53	0.1	2	0
	CUYAHOGA R. AT CUYAHOGA FALLS @ WATERWORKS PARK	7/10/2007	3.3	60	4.3	120		10				3.4	169	0.1	3	0
		7/11/2007	4.3	66	4.6	97.9		10				9.8	370	0.1	2.1	0
		8/27/2007	3.1	59	2	68.4		10				2	168	0.1	0.9	0
		9/19/2007	2.6	59	2	130		10				2	85	0.1	4	0
48		9/20/2007	2.4	60	2	133		10				2	72	0.1	4.1	0
	CUYAHOGA R NR SHELTER @ N SIDE OF WATERWORKS PK	7/19/2000	3	49	2	43	441	10		6.2	70.6	2	235	0.1	1.3	0
		7/25/2000	3	58	2	78	686	10		7.8	86.8	2	186	0.1	1.8	0
		8/3/2000	3	60	2	83	685	10		6.2	73	2	177.5	0.1	1.8	0
		8/10/2000	3.5	48.5	2.8	44	416.5	10		7.9	92.3	2.5	190.5	0.1	0.6	0
48.38		9/14/2000	3	75	2	78	663	10		6.3	71.6	2	198	0.5	2	0.1
	CUYAHOGA R UPST BIKE TRAIL BRDG UPST UNNAMED TRIB (49.07)	9/19/2007	2.4	59	2	103		10				2	96	0.1	3.9	0
		9/20/2007	2.4	61	2	106		10				2	95	0.1	4.3	0
49.1																
	CUYAHOGA R @ SR 91 AT MUNROE FALLS	6/29/2005	3.1	52	2	81.1	663	10		7.7	93	2	184	0.1	1.7	0
		8/2/2005	4.2	56	2.2	74	571	10		8.2	100.8	2	183	0.1	1	0
		8/18/2005	6.2	74	2	79.6	663	10		7.7	89.1	4.8	480	0.2	1.8	0
		7/10/2007	2.9	53	4.9	106.5		10				2.3	142	0.1	4	0
		7/11/2007	2.6	47.5	3.6	95.1		10				2	111	0.1	2.6	0
		7/12/2007	2.8	50.5		110		10	5.1			2	95.5	0.1	2.9	0
		8/27/2007	3.8	53	2	67.7		10				2	188	0.1	0.9	0
		9/19/2007	2.4	57.5	2.1	102.5		10				2	82.5	0.1	5.5	0
49.78		9/20/2007	2.3	56	2.2	107		10				2	72	0.1	4.4	0
	CUYAHOGA R @ MUNROE FALLS DAM POOL	6/29/2005	3.2	50	2	81.6	666	10		5.4	64.9	2	185	0.1	1.8	0
		8/2/2005	4.4	56	2.2	73.6	566	10		6.6	80.2	2	190	0.1	0.9	0
50		8/18/2005	6.6	76	2	81.2	669	10		6.3	72.9	7.1	545	0.3	2.7	0
	CUYAHOGA R NR MUNROE FALLS	7/10/2007	3.8	64	2.8	109		10				9.5	293	0.1	5.8	0
		7/11/2007	3.8	60	2.9	102		10				5.7	230	0.1	3.3	0
		9/19/2007	2.5	57	2	105		10				2	79	0.1	4.3	0
50.7		9/20/2007	2.3	57	2	110		10				2	72	0.1	4.6	0
	CUYAHOGA R DST UNNAMED TRIB (51.66), 0.15 MI. DST WWTP	8/28/2007	3.3	56	2	77.5		10				2	220	0.1	1.2	0
		9/19/2007	2.4	55	2.6	114		10				2	74	0.1	4.3	0
51.64		9/20/2007	2.4	54	2.7	118		10				2	76	0.1	4.4	0
	FISH CK WWTP EFFLUENT TO CUYAHOGA R	7/10/2007	2.1	15	4	248		10				2	31	0.1	2.5	0
		7/11/2007	2	15.5	2.8	250.5		10	6.3			2	43	0.1	2.5	0.2
		8/28/2007	2.2	16	2	220		10				2	101	0.1	2.9	0
		9/19/2007	2.5	15	2.1	239.5		10				2	64.5	0.1	3.2	0
51.82		9/20/2007	2.6	15	2.2	245		10				2	41.5	0.1	3.4	0
	CUYAHOGA R JUST UPST FISH CK WWTP	6/29/2005	3.1	81	2.1	131	987	10		6.1	68.7	2	322	0.1	0.4	0
		8/2/2005	4.2	57	2.1	68.3	537	10		5.1	62.1	2	154	0.1	1.3	0
51.83		8/18/2005	4.9	65	2	71.5	624	10		6.7	77.1	2.1	349	0.2	1.6	0

Appendix 8. Table of middle Cuyahoga River water sampling results 2000-2007.

RIVER MILE	LOCATION	DATE	ARSENIC AS,TOT UG/L	BARIUM BA,TOT UG/L	BOD 5 DAY MG/L	CHLORIDE TOTAL MG/L	CNDUCTVY AT 25C MICROMHO	CU, TOT UG/L	DISS ORG C MG/L	DO PROBE MG/L	DO SATUR %	PB, TOT UG/L	MN, TOT UG/L	NH3+NH4-N TOTAL MG/L	NO2&NO3 N-TOT MG/L	NO2-N TOTAL MG/L
	CUYAHOGA R @ MIDDLEBURY RD AT KENT	7/10/2007	3.6	62	3.7	91.4		10				2.8	313	0.2	3.4	0
		7/11/2007	2.7	50	2.4	84.1		10				2	126	0.1	3.2	0
		9/19/2007	2.7	61	2	96.6		10				2	103	0.1	6	0
52.63		9/20/2007	2.5	59	2	92.6		10				2	97	0.1	5.1	0
	KENT WWTP 001 OUTFALL TO CUYAHOGA R	7/10/2007	2	15	3	217.5		10				2	16	0.1	25.4	0
		7/11/2007	2	15	3.1	204		10	5.1			2	13.5	0.1	23.2	0
		9/19/2007	2	15	3.2	62.6		10				2	18	0.1	38.2	0
53.85		9/20/2007	2.1	15	3.3	252.5		10				2	15	0.1	37.3	0
	CUYAHOGA R @ FULLER PARK UPST KENT WWTP	7/10/2007	4.8	70	4.6	82.7		10				5	836	0.1	1.8	0
		7/11/2007	4.5	76	3.8	87.4		10				5.7	756	0.1	2.9	0
		7/12/2007	3.1	60		94.6		10	5.6			2	194	0.1	2.6	0
		9/19/2007	2.7	65	2.3	81.9		10				2	177	0.1	3	0
54.32		9/20/2007	2.9	66	2.3	82.7		10				2	139	0.1	3	0
	CUYAHOGA R @ STOW ST	6/29/2005	3.1	55	2	67	586	12		8	95.7	2	178	0.1	1.5	0
		8/2/2005	5	65	2	63.1	500	10		6.8	80.5	2	235	0.1	0.8	0
54.59		8/18/2005	4.9	57	2	66.2	575	10		7.1	81.9	2	218	0.1	1.2	0
	CUYAHOGA R @ CRAIN AVE AT KENT	6/29/2005	3.1	53	2	65.8	581	13		7.2	86.1	2	183	0.1	1.6	0
		8/2/2005	4.4	68	2.1	61.2	491	10		5.7	67.4	2	247	0.1	1.2	0
		8/18/2005	3.6	56	2	64.6	569	10		6	68.8	2	242	0.1	1.4	0
		7/10/2007	3.1	57	4.2	77.6		10				2.8	246	0.1	2.5	0
		7/11/2007	5.6	86	4.5	86.3		10				5.7	1180	0.1	2.8	0
		9/19/2007	2.8	65	2.3	79.4		10				2	163	0.1	2.9	0
55.22		9/20/2007	2.7	64	2	79.8		10				2	150	0.1	2.7	0
	CUYAHOGA R @ STANDING ROCK CEMETERY DST AMETEK	6/29/2005	3.2	54	2	65.6	578	14		6.3	75	2	208	0.1	3.1	0
		8/2/2005	5	69	2	61.2	487	10		5.3	63.5	2	287	0.1	2.4	0
55.8		8/18/2005	4.9	57	2	64.4	566	10		5.4	62	2	288	0.1	2	0

Appendix 8. Table of middle Cuyahoga River water sampling results 2000-2007.

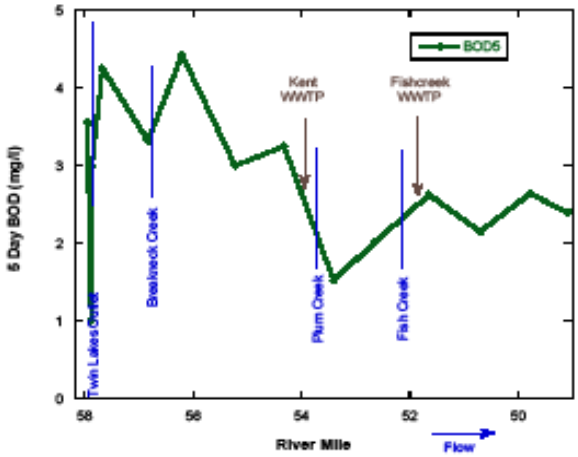
RIVER MILE	LOCATION	DATE	ORTHO-PO4 MG/L	PH SU	PHOS-TOT MG/L P	CHLRPHYL A UG/L	PHPHTN-AFLR MTHD UG/L	RESIDUE DISS MG/L	RESIDUE TOT NFLT MG/L	SO4-TOT MG/L	TOT ALK CaCO3 MG/L	TOT HARD CaCO3 MG/L	TKN MG/L	TEMP CENT	ZN, TOT UG/L
		7/19/2000		8.2	0.1			326	11	41	107	151	0.7	20.4	16
		7/25/2000		8.4	0.1			396	5	52	140	184	0.7	21.8	10
	CUYAHOGA R @ CUYAHOGA ST	8/3/2000		8.2	0.1			398	5	55	131	207	0.6	23.7	13
		8/10/2000		8.2	0.1			252	13	33	103	146	0.4	23.2	10
42.6		9/14/2000		8.3	0.1			440	5	58	128	216	0.7	20.9	11
		7/10/2007			0.1			464	105	60.9		241	1.7		23
	CUYAHOGA R. AT CUYAHOGA FALLS @ WATERWORKS PARK	7/11/2007			0.1			372	95	51.3		191	0.7		42
		8/27/2007	0		0.1			338	11	45.5		187	0.8		14
		9/19/2007	0		0.1			534	5	66.2		257	0.7		14
48		9/20/2007			0			548	5	66.9		255	0.7		10
		7/19/2000		7.9	0.1			276	25	42	101	146	0.9	20.6	15
	CUYAHOGA R NR SHELTER @ N SIDE OF WATERWORKS PK	7/25/2000		7.7	0.1			420	5	57	102	206	0.7	19.8	13
		8/3/2000		7.6	0.1			382	8.5	57.5	141.5	206	0.7	22.8	10
		8/10/2000		7.7	0.1			239.5	23.5	32	98.8	144	0.6	22.3	10
48.38		9/14/2000		7.8	0.2			376	5	57	138	207	1.2	20.5	10
	CUYAHOGA R UPST BIKE TRAIL BRDG UPST UNNAMED TRIB (49.07)	9/19/2007			0.1			466	10	66.7		246	0.8		18
		9/20/2007			0			490	10	66.9		236	0.7		11
49.1															
		6/29/2005		7.9	0.1			336	5	50.6	133	205	1	24.8	10
		8/2/2005		8.1	0.1			350	9	50.5	129	179	0.7	25.5	13
		8/18/2005		7.9	0.1			388	73	57.8	150	216	0.8	22.2	22
		7/10/2007			0.1			433	26.5	62.7		220.5	0.9		16.5
	CUYAHOGA R @ SR 91 AT MUNROE FALLS	7/11/2007			0.1			377	12.5	52.4		191	0.8		11.5
		7/12/2007	0		0.1	3.6	8.9	443	6.5	62	138	212	1.1		11.5
		8/27/2007	0		0.1			350	11	45.8		173	0.8		10
		9/19/2007	0		0.1			469	5	67.8		243.5	0.8		11.5
49.78		9/20/2007			0			492	6.5	66.3		242	0.9		11
	CUYAHOGA R @ MUNROE FALLS DAM POOL	6/29/2005		7.8	0.1			382	5	50.8	131	205	1	24.8	10
		8/2/2005		7.9	0.1			348	9	49.9	129	182	0.5	25.3	11
50		8/18/2005		7.8	0.2			380	66	52.4	146	207	0.9	22.3	33
		7/10/2007			0.1			456	20	65.9		226	1		29
	CUYAHOGA R NR MUNROE FALLS	7/11/2007			0.1			404	51	55.4		205	0.9		28
		9/19/2007			0.1			476	5	79.3		243	0.8		13
50.7		9/20/2007			0.1			494	6	67.6		241	0.8		10
	CUYAHOGA R DST UNNAMED TRIB (51.66), 0.15 MI. DST WWTP	8/28/2007	0		0.1			366	11	49.6		193	0.8		13
		9/19/2007			0.1			510	5	69.4		246	0.9		14
51.64		9/20/2007			0.1			518	5	70.5		243	0.8		10
		7/10/2007			0.1			720	5	94.2		242	1.6		46
	FISH CK WWTP EFFLUENT TO CUYAHOGA R	7/11/2007	0		0.1	0.4	0.3	721	5	92.2	177	243	1.7		48.5
		8/28/2007	0.1		0.1			712	5	83.6		242	1		39
		9/19/2007			0.2			736	5	95.8		243	1.2		45
51.82		9/20/2007	0.2		0.2			756	5	97		249	1.2		42.5
	CUYAHOGA R JUST UPST FISH CK WWTP	6/29/2005		7.8	0.1			586	9	73	191	316	1.3	20.9	10
		8/2/2005		7.8	0.1			328	8	45.3	126	179	0.8	25.2	15
51.83		8/18/2005		7.9	0.1			366	23	56.1	144	207	0.7	22.6	13

Appendix 8. Table of middle Cuyahoga River water sampling results 2000-2007.

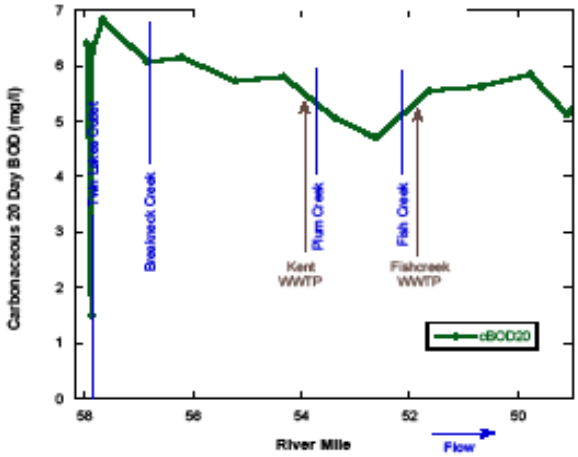
RIVER MILE	LOCATION	DATE	ORTHO-PO4 MG/L	PH SU	PHOS-TOT MG/L P	CHLRPHYL A UG/L	PHPHTN-AFLR MTHD UG/L	RESIDUE DISS MG/L	RESIDUE TOT NFLT MG/L	SO4-TOT MG/L	TOT ALK CaCO3 MG/L	TOT HARD CaCO3 MG/L	TKN MG/L	TEMP CENT	ZN, TOT UG/L
	CUYAHOGA R @ MIDDLEBURY RD AT KENT	7/10/2007			0.1			380	20	56.9		205	0.8		15
		7/11/2007			0.1			366	5	50.6		179	0.8		10
		9/19/2007			0.1			460	5	61.2		234	0.7		10
52.63		9/20/2007			0.1			456	5	69.3		229	0.8		10
	KENT WWTP 001 OUTFALL TO CUYAHOGA R	7/10/2007			0.4			832	5	125.5		231	1.4		36
		7/11/2007	0.3		0.4	0.2	0.2	791	5	125	114	244	1.2		43.5
		9/19/2007	0.4		0.5			1110	5	120		376	1.4		38
53.85		9/20/2007			0.4			1040	5	130		369	1.1		27.5
	CUYAHOGA R @ FULLER PARK UPST KENT WWTP	7/10/2007			0.1			362	61	50.7		177	0.6		24
		7/11/2007			0.1			380	54	56.3		196	0.9		31
		7/12/2007	0		0.1	2.8	11.2	388	8	57.3	118	193	2		10
		9/19/2007	0		0.1			388	7	56.5		222	0.6		12
54.32		9/20/2007			0.1			408	10	63.9		226	0.6		10
	CUYAHOGA R @ STOW ST	6/29/2005		8.1	0			368	5	41.8	127	193	0.9	24.2	10
		8/2/2005		7.9	0			304	9	41.3	122	165	0.7	24.1	10
54.59		8/18/2005		8	0.1			336	10	50.9	137	188	0.6	22.3	10
	CUYAHOGA R @ CRAIN AVE AT KENT	6/29/2005		8	0.1			340	7	45.2	123	188	0.9	24.2	10
		8/2/2005		7.7	0.1			302	10	41	119	174	0.6	24.1	10
		8/18/2005		8	0.1			336	9	50.5	130	188	0.7	22.4	10
		7/10/2007			0.1			336	14	44.2		179	0.8		22
		7/11/2007			0.2			374	72	55.8		193	0.9		29
		9/19/2007	0		0.1			392	5	56.4		219	0.6		10
55.22		9/20/2007			0.1			402	5	64.4		222	0.7		10
	CUYAHOGA R @ STANDING ROCK CEMETERY DST AMETEK	6/29/2005		8	0.1			332	5	44.9	125	191	0.9	24.1	10
		8/2/2005		7.8	0.1			300	9	39.8	119	168	0.7	24.2	10
55.8		8/18/2005		8.2	0.1			330	12	50.9	127	188	0.6	22.5	10

Appendix 9. Graphs of water quality sample results of the Middle Cuyahoga River, 2007

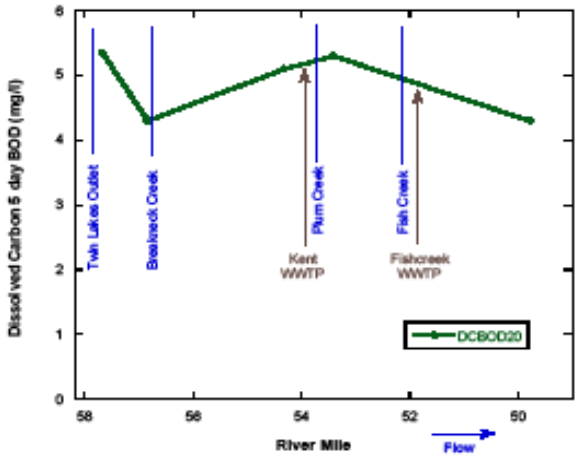
BOD5



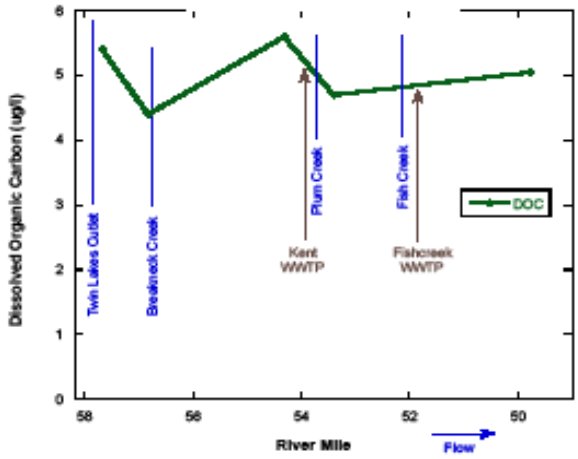
cBOD20



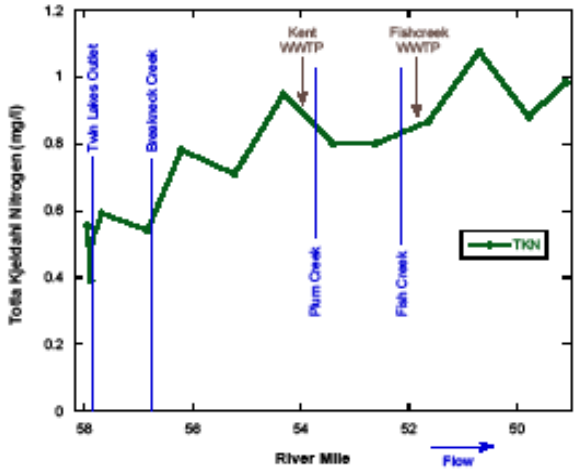
dcBOD20



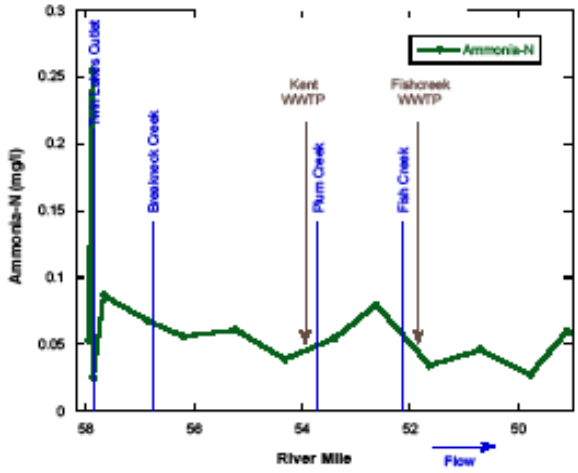
DOC



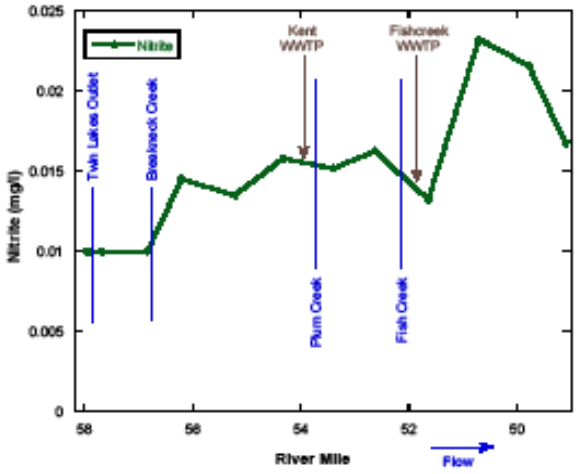
TKN



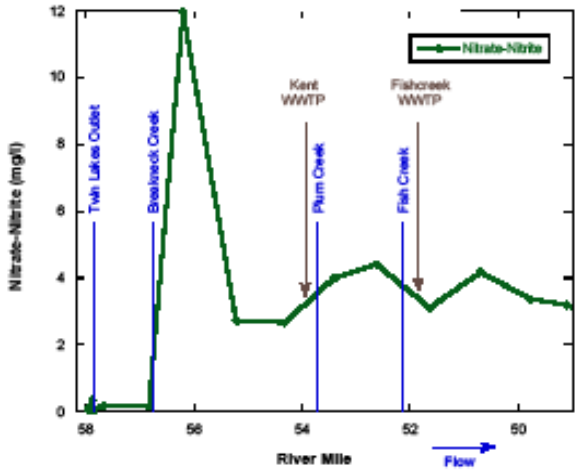
NH3



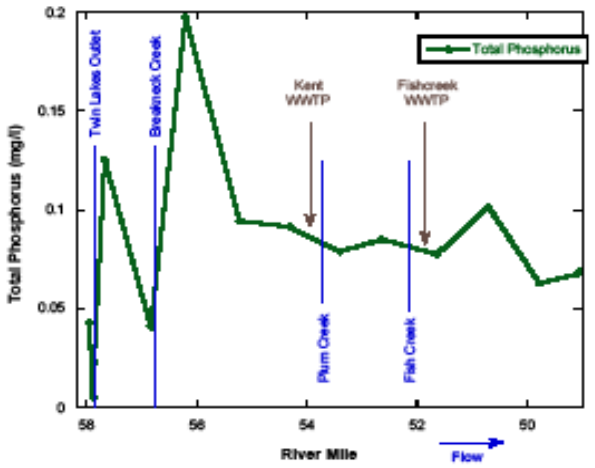
Nitrite



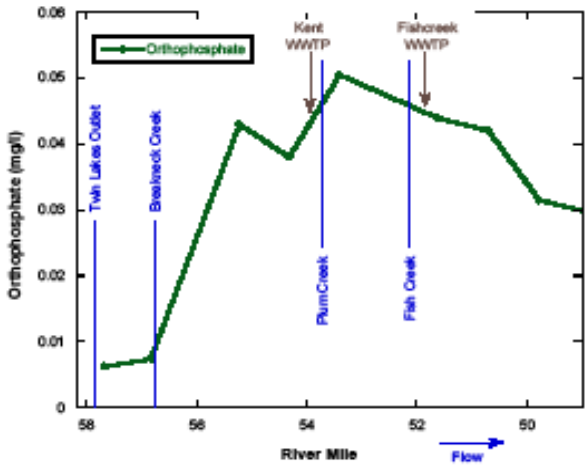
Nitrate-Nitrite



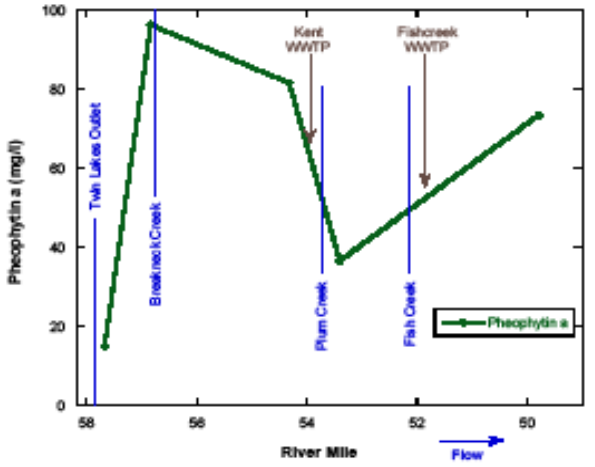
Phosphorus



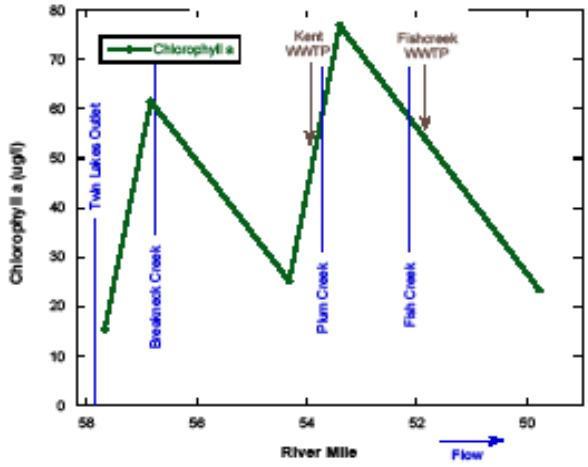
Orthophosphate



Pheophytin-a



Chorophyll-a



Appendix 10. Violations of NPDES permit requirements 2004-2007.

City of Kent 2004-2007 NPDES permit violations

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
3PD00031*MD	October 2004	001	pH, Minimum	1D Conc	6.5	6.4	10/29/2004
3PD00031*MD	April 2007	001	Copper, Total Recoverable	30D Conc	17	27.	4/1/2007

Twin Lakes 2004-2007 NPDES permit violations

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
3PH00038*FD	April 2004	001	Total Suspended Solids	7D Qty	31.0	44.9033	4/8/2004
3PH00038*FD	May 2004	001	Nitrogen, Ammonia (NH3	30D Conc	1.0	1.2	5/1/2004
3PH00038*FD	May 2004	001	Nitrogen, Ammonia (NH3	7D Conc	1.5	2.79	5/15/2004
3PH00038*FD	May 2004	001	Nitrogen, Ammonia (NH3	7D Conc	1.5	1.865	5/22/2004
3PH00038*FD	May 2004	001	Nitrogen, Ammonia (NH3	30D Qty	1.73	2.10237	5/1/2004
3PH00038*FD	May 2004	001	Nitrogen, Ammonia (NH3	7D Qty	2.6	5.18914	5/15/2004
3PH00038*FD	May 2004	001	Nitrogen, Ammonia (NH3	7D Qty	2.6	3.03118	5/22/2004
3PH00038*FD	January 2005	001	Total Suspended Solids	7D Qty	31.0	46.177	1/8/2005
3PH00038*FD	January 2005	001	pH	1D Conc	9.0	9.4	1/5/2005
3PH00038*FD	June 2005	002	Nitrogen, Ammonia (NH3	7D Conc	0.75	.91667	6/1/2005

Franklin Hills 2004-2007 NPDES permit violations

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
3PK00015*DD	January 2004	001	Total Suspended Solids	30D Conc	12	65.4285	1/1/2004
3PK00015*DD	January 2004	001	Total Suspended Solids	7D Conc	18	239.	1/1/2004
3PK00015*DD	January 2004	001	Total Suspended Solids	7D Conc	18	49.3333	1/22/2004
3PK00015*DD	January 2004	001	Total Suspended Solids	30D Qty	68.22	417.082	1/1/2004
3PK00015*DD	January 2004	001	Total Suspended Solids	7D Qty	102.33	1631.53	1/1/2004
3PK00015*DD	January 2004	001	Total Suspended Solids	7D Qty	102.33	238.263	1/22/2004
3PK00015*DD	February 2004	001	Total Suspended Solids	30D Conc	12	52.5454	2/1/2004
3PK00015*DD	February 2004	001	Total Suspended Solids	7D Conc	18	286.5	2/1/2004
3PK00015*DD	February 2004	001	Total Suspended Solids	30D Qty	68.22	295.969	2/1/2004
3PK00015*DD	February 2004	001	Total Suspended Solids	7D Qty	102.33	1616.92	2/1/2004
3PK00015*DD	February 2004	001	CBOD 5 day	7D Conc	15	31.5333	2/1/2004
3PK00015*DD	February 2004	001	CBOD 5 day	7D Qty	85.27	177.548	2/1/2004
3PK00015*DD	May 2004	001	Dissolved Oxygen	1D Conc	8.0	6.2	5/24/2004
3PK00015*DD	April 2005	002	Total Suspended Solids	7D Conc	9.0	10.5	4/1/2005
3PK00015*DD	April 2005	002	Total Suspended Solids	7D Qty	51.16	63.2265	4/1/2005
3PK00015*DD	April 2005	002	CBOD 5 day	7D Conc	7.5	8.025	4/1/2005
3PK00015*DD	April 2005	002	CBOD 5 day	7D Qty	42.63	49.0548	4/1/2005
3PK00015*DD	April 2005	002	Dissolved Oxygen	1D Conc	8.0	5.	4/3/2005
3PK00015*DD	May 2005	002	Nitrogen, Ammonia (NH3	7D Conc	0.75	.805	5/8/2005
3PK00015*DD	June 2005	002	Nitrogen, Ammonia (NH3	30D Conc	0.5	1.33538	6/1/2005
3PK00015*DD	June 2005	002	Nitrogen, Ammonia (NH3	30D Qty	2.84	3.54371	6/1/2005
3PK00015*DD	June 2005	002	CBOD 5 day	30D Conc	5.0	5.075	6/1/2005

Fishcreek 2004-2007 NPDES permit violations

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
3PK00012*FD	March 2004	001	Cadmium, Total Recover	1D Conc	13	54.	3/5/2004
3PK00012*FD	March 2004	001	Cadmium, Total Recover	30D Conc	0.9	54.	3/1/2004
3PK00012*FD	March 2004	001	Cadmium, Total Recover	1D Qty	0.246	1.01561	3/5/2004
3PK00012*FD	March 2004	001	Cadmium, Total Recover	30D Qty	0.017	1.01561	3/1/2004
3PK00012*FD	October 2004	001	Nitrogen, Ammonia (NH3	7D Conc	1.8	1.9	10/8/2004
3PK00012*FD	April 2004	001	Total Suspended Solids	7D Qty	272.5	404.400	4/8/2004
3PK00012*FD	April 2004	001	Phosphorus, Total (P)	7D Qty	22.7	23.8321	4/8/2004
3PK00012*FD	July 2004	001	Oil and Grease, Total	1D Conc	10	17.	7/6/2004
3PK00012*FD	May 2004	001	Nitrogen, Ammonia (NH3	7D Conc	1.8	2.	5/1/2004
3PK00012*FD	May 2004	001	Nitrogen, Ammonia (NH3	7D Qty	34.1	38.0744	5/1/2004
3PK00012*GD	January 2005	001	Total Suspended Solids	7D Qty	272.5	280.261	1/8/2005
3PK00012*GD	September 2005	001	pH, Minimum	1D Conc	6.5	5.9	9/29/2005
3PK00012*GD	September 2005	001	pH, Minimum	1D Conc	6.5	6.1	9/30/2005
3PK00012*GD	November 2005	001	pH, Minimum	1D Conc	6.5	6.4	11/26/2005
3PK00012*GD	October 2005	001	pH, Minimum	1D Conc	6.5	6.4	10/2/2005
3PK00012*GD	June 2006	001	Dissolved Oxygen	1D Conc	8.0	7.4	6/17/2006
3PK00012*GD	January 2006	001	Dissolved Oxygen	1D Conc	8.0	7.5	1/12/2006
3PK00012*GD	February 2006	001	Dissolved Oxygen	1D Conc	8.0	7.8	2/12/2006
3PK00012*HD	August 2007	001	Nitrogen, Ammonia (NH3	7D Conc	1.5	3.53333	8/8/2007
3PK00012*HD	August 2007	001	Nitrogen, Ammonia (NH3	7D Qty	45.4	59.5935	8/8/2007

Ravenna 2004-2007 NPDES permit violations

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
3PD00018*LD	January 2004	001	Total Suspended Solids	30D Conc	20	23.3846	1/1/2004
3PD00018*LD	January 2004	001	Total Suspended Solids	7D Conc	30	31.6666	1/15/2004
3PD00018*LD	January 2004	001	Nitrogen, Ammonia (NH3	30D Conc	8.1	15.34	1/1/2004
3PD00018*LD	January 2004	001	Nitrogen, Ammonia (NH3	7D Conc	12.1	15.2666	1/8/2004
3PD00018*LD	January 2004	001	Nitrogen, Ammonia (NH3	7D Conc	12.1	18.7666	1/15/2004
3PD00018*LD	January 2004	001	Nitrogen, Ammonia (NH3	7D Conc	12.1	18.4666	1/22/2004
3PD00018*LD	January 2004	001	Nitrogen, Ammonia (NH3	30D Qty	85.8	127.061	1/1/2004
3PD00018*LD	January 2004	001	Nitrogen, Ammonia (NH3	7D Qty	129	131.311	1/8/2004
3PD00018*LD	January 2004	001	Nitrogen, Ammonia (NH3	7D Qty	129	165.105	1/15/2004
3PD00018*LD	January 2004	001	Nitrogen, Ammonia (NH3	7D Qty	129	143.672	1/22/2004
3PD00018*LD	January 2004	001	CBOD 5 day	30D Conc	15	27.1538	1/1/2004
3PD00018*LD	January 2004	001	CBOD 5 day	7D Conc	23	27.3333	1/1/2004
3PD00018*LD	January 2004	001	CBOD 5 day	7D Conc	23	30.6666	1/15/2004
3PD00018*LD	January 2004	001	CBOD 5 day	7D Conc	23	31.3333	1/22/2004
3PD00018*LD	January 2004	001	CBOD 5 day	30D Qty	159	242.534	1/1/2004
3PD00018*LD	January 2004	001	CBOD 5 day	7D Qty	244	285.802	1/1/2004
3PD00018*LD	January 2004	001	CBOD 5 day	7D Qty	244	258.101	1/15/2004
3PD00018*LD	January 2004	001	CBOD 5 day	7D Qty	244	249.845	1/22/2004
3PD00018*LD	January 2004	001	Mercury, Total (Low Le	30D Conc	13	25.	1/1/2004

3PD00018*LD	April 2004	001	Total Suspended Solids	30D Conc	20	30.3076	4/1/2004
3PD00018*LD	April 2004	001	Total Suspended Solids	7D Conc	30	86.6666	4/8/2004
3PD00018*LD	April 2004	001	Total Suspended Solids	30D Qty	212	296.585	4/1/2004
3PD00018*LD	April 2004	001	Total Suspended Solids	7D Qty	318	805.687	4/8/2004
3PD00018*LD	April 2004	001	Nitrogen, Ammonia (NH3	30D Conc	8.1	9.65154	4/1/2004
3PD00018*LD	April 2004	001	Nitrogen, Ammonia (NH3	7D Conc	12.1	12.25	4/8/2004
3PD00018*LD	April 2004	001	Nitrogen, Ammonia (NH3	30D Qty	85.8	101.081	4/1/2004
3PD00018*LD	April 2004	001	Dissolved Oxygen	1D Conc	7.0	6.1	4/12/2004
3PD00018*LD	February 2004	001	Nitrogen, Ammonia (NH3	30D Conc	8.1	14.8730	2/1/2004
3PD00018*LD	February 2004	001	Nitrogen, Ammonia (NH3	7D Conc	12.1	16.4333	2/1/2004
3PD00018*LD	February 2004	001	Nitrogen, Ammonia (NH3	7D Conc	12.1	14.6666	2/8/2004
3PD00018*LD	February 2004	001	Nitrogen, Ammonia (NH3	7D Conc	12.1	16.0833	2/15/2004
3PD00018*LD	February 2004	001	Nitrogen, Ammonia (NH3	7D Conc	12.1	12.85	2/22/2004
3PD00018*LD	February 2004	001	Nitrogen, Ammonia (NH3	30D Qty	85.8	116.765	2/1/2004
3PD00018*LD	February 2004	001	Nitrogen, Ammonia (NH3	7D Qty	129	129.722	2/1/2004
3PD00018*LD	March 2004	001	Total Suspended Solids	30D Conc	20	42.5384	3/1/2004
3PD00018*LD	March 2004	001	Total Suspended Solids	7D Conc	30	31.	3/8/2004
3PD00018*LD	March 2004	001	Total Suspended Solids	7D Conc	30	46.6666	3/15/2004
3PD00018*LD	March 2004	001	Total Suspended Solids	7D Conc	30	77.6666	3/22/2004
3PD00018*LD	March 2004	001	Total Suspended Solids	30D Qty	212	452.245	3/1/2004
3PD00018*LD	March 2004	001	Total Suspended Solids	7D Qty	318	482.947	3/15/2004
3PD00018*LD	March 2004	001	Total Suspended Solids	7D Qty	318	862.871	3/22/2004
3PD00018*LD	March 2004	001	Nitrogen, Ammonia (NH3	30D Conc	8.1	11.1983	3/1/2004
3PD00018*LD	March 2004	001	Nitrogen, Ammonia (NH3	7D Conc	12.1	13.7375	3/1/2004
3PD00018*LD	March 2004	001	Nitrogen, Ammonia (NH3	30D Qty	85.8	111.826	3/1/2004
3PD00018*LD	March 2004	001	Copper, Total Recoverable	1D Conc	30	32.	3/3/2004
3PD00018*LD	March 2004	001	Copper, Total Recoverable	30D Conc	20	32.	3/1/2004
3PD00018*LD	March 2004	001	Copper, Total Recoverable	30D Qty	0.212	.26271	3/1/2004
3PD00018*LD	June 2004	001	Nitrogen, Ammonia (NH3	7D Conc	2.3	2.72667	6/8/2004
3PD00018*LD	June 2004	001	Nitrogen, Ammonia (NH3	7D Qty	20	24.8835	6/8/2004
3PD00018*LD	August 2004	001	Copper, Total Recoverable	30D Conc	20	24.	8/1/2004
3PD00018*LD	January 2005	001	Copper, Total Recoverable	30D Conc	20	28.	1/1/2005
3PD00018*LD	January 2005	001	Copper, Total Recoverable	1D Qty	0.317	.56487	1/12/2005
3PD00018*LD	January 2005	001	Copper, Total Recoverable	30D Qty	0.212	.56487	1/1/2005
3PD00018*LD	Nov 2004	001	Phosphorus, Total (P)	30D Conc	1.0	1.25	11/1/2004
3PD00018*LD	Nov 2004	001	Phosphorus, Total (P)	7D Conc	1.5	2.1	11/1/2004
3PD00018*LD	Nov 2004	001	Phosphorus, Total (P)	30D Qty	8.7	9.34923	11/1/2004
3PD00018*LD	Nov 2004	001	Phosphorus, Total (P)	7D Qty	13.1	18.1702	11/1/2004
3PD00018*LD	Nov 2004	001	Copper, Total Recoverable	1D Conc	30	38.	11/17/2004
3PD00018*LD	Nov 2004	001	Copper, Total Recoverable	30D Conc	20	38.	11/1/2004
3PD00018*LD	Nov 2004	001	Copper, Total Recoverable	30D Qty	0.212	.23272	11/1/2004
3PD00018*LD	May 2004	001	Total Suspended Solids	30D Conc	12	14.7692	5/1/2004
3PD00018*LD	May 2004	001	Total Suspended Solids	7D Conc	18	21.3333	5/15/2004
3PD00018*LD	May 2004	001	Total Suspended Solids	30D Qty	105	131.023	5/1/2004
3PD00018*LD	May 2004	001	Total Suspended Solids	7D Qty	157	179.227	5/15/2004
3PD00018*LD	May 2004	001	Nitrogen, Ammonia (NH3	7D Conc	2.3	2.36	5/1/2004
3PD00018*LD	May 2004	001	Nitrogen, Ammonia (NH3	30D Qty	13	13.2322	5/1/2004
3PD00018*LD	July 2004	001	Copper, Total Recoverable	1D Conc	30	37.	7/6/2004
3PD00018*LD	July 2004	001	Copper, Total Recoverable	30D Conc	20	37.	7/1/2004

3PD00018*LD	July 2004	001	Copper, Total Recoverable	30D Qty	0.212	.23009	7/1/2004
3PD00018*LD	Sept 2004	001	Phosphorus, Total (P)	30D Conc	1.0	2.23333	9/1/2004
3PD00018*LD	Sept 2004	001	Phosphorus, Total (P)	7D Conc	1.5	2.4	9/1/2004
3PD00018*LD	Sept 2004	001	Phosphorus, Total (P)	7D Conc	1.5	1.7	9/15/2004
3PD00018*LD	Sept 2004	001	Phosphorus, Total (P)	7D Conc	1.5	2.9	9/22/2004
3PD00018*LD	Sept 2004	001	Phosphorus, Total (P)	30D Qty	8.7	16.4397	9/1/2004
3PD00018*LD	Sept2004	001	Phosphorus, Total (P)	7D Qty	13.1	14.7399	9/1/2004
3PD00018*LD	Sept 2004	001	Phosphorus, Total (P)	7D Qty	13.1	24.0650	9/15/2004
3PD00018*LD	Sept 2004	001	Phosphorus, Total (P)	7D Qty	13.1	19.3954	9/22/2004
3PD00018*LD	Sept 2004	001	Copper, Total Recoverable	1D Conc	30	59.	9/1/2004
3PD00018*LD	Sept 2004	001	Copper, Total Recoverable	30D Conc	20	59.	9/1/2004
3PD00018*LD	Sept 2004	001	Copper, Total Recoverable	1D Qty	0.317	.41068	9/1/2004
3PD00018*LD	Sept 2004	001	Copper, Total Recoverable	30D Qty	0.212	.41068	9/1/2004
3PD00018*LD	Dec 2004	001	Copper, Total Recoverable	30D Conc	20	21.	12/1/2004
3PD00018*LD	April 2005	001	Copper, Total Recoverable	1D Conc	30	34.	4/6/2005
3PD00018*LD	April 2005	001	Copper, Total Recoverable	30D Conc	20	34.	4/1/2005
3PD00018*LD	April 2005	001	Copper, Total Recoverable	1D Qty	0.317	.45563	4/6/2005
3PD00018*LD	April 2005	001	Copper, Total Recoverable	30D Qty	0.212	.45563	4/1/2005
3PD00018*LD	May 2005	001	Copper, Total Recoverable	1D Conc	30	47.	5/11/2005
3PD00018*LD	May 2005	001	Copper, Total Recoverable	30D Conc	20	47.	5/1/2005
3PD00018*LD	May 2005	001	Copper, Total Recoverable	1D Qty	0.317	.34743	5/11/2005
3PD00018*LD	May 2005	001	Copper, Total Recoverable	30D Qty	0.212	.34743	5/1/2005
3PD00018*LD	July 2005	001	Copper, Total Recoverable	1D Conc	30	32.	7/5/2005
3PD00018*LD	July 2005	001	Copper, Total Recoverable	1D Conc	30	32.	7/6/2005
3PD00018*LD	July 2005	001	Copper, Total Recoverable	30D Conc	20	30.3333	7/1/2005
3PD00018*LD	February 2005	001	Copper, Total Recoverable	1D Conc	30	41.	2/2/2005
3PD00018*LD	February 2005	001	Copper, Total Recoverable	30D Conc	20	41.	2/1/2005
3PD00018*LD	February 2005	001	Copper, Total Recoverable	1D Qty	0.317	.32247	2/2/2005
3PD00018*LD	February 2005	001	Copper, Total Recoverable	30D Qty	0.212	.32247	2/1/2005
3PD00018*LD	June 2005	001	Copper, Total Recoverable	1D Conc	30	33.	6/1/2005
3PD00018*LD	June 2005	001	Copper, Total Recoverable	1D Conc	30	33.	6/30/2005
3PD00018*LD	June 2005	001	Copper, Total Recoverable	30D Conc	20	33.	6/1/2005
3PD00018*LD	June 2005	001	Copper, Total Recoverable	30D Qty	0.212	.25178	6/1/2005
3PD00018*LD	August 2005	001	Copper, Total Recoverable	30D Conc	20	27.	8/1/2005
3PD00018*LD	August 2005	001	Copper, Total Recoverable	30D Qty	0.212	.21785	8/1/2005
3PD00018*LD	March 2005	001	Copper, Total Recoverable	30D Conc	20	28.	3/1/2005
3PD00018*LD	March 2005	001	Copper, Total Recoverable	1D Qty	0.317	.3328	3/8/2005
3PD00018*LD	March 2005	001	Copper, Total Recoverable	30D Qty	0.212	.3328	3/1/2005
3PD00018*LD	Sept 2005	001	Copper, Total Recoverable	1D Conc	30	61.	9/13/2005
3PD00018*LD	Sept 2005	001	Copper, Total Recoverable	30D Conc	20	61.	9/1/2005
3PD00018*LD	Sept 2005	001	Copper, Total Recoverable	1D Qty	0.317	.44609	9/13/2005
3PD00018*LD	Sept 2005	001	Copper, Total Recoverable	30D Qty	0.212	.44609	9/1/2005
3PD00018*LD	Dec 2005	001	Copper, Total Recoverable	30D Conc	20	29.5	12/1/2005
3PD00018*LD	October 2005	001	Copper, Total Recoverable	1D Conc	30	72.	10/5/2005
3PD00018*LD	October 2005	001	Copper, Total Recoverable	30D Conc	20	44.5	10/1/2005
3PD00018*LD	October 2005	001	Copper, Total Recoverable	1D Qty	0.317	.55496	10/5/2005
3PD00018*LD	October 2005	001	Copper, Total Recoverable	30D Qty	0.212	.34219	10/1/2005
3PD00018*LD	March 2007	001	Copper, Total Recoverable	30D Conc	20	25.2	3/1/2007
3PD00018*LD	March 2007	001	Copper, Total Recoverable	30D Qty	0.212	.21208	3/1/2007

3PD00018*LD	March 2007	001	Mercury, Total (Low Le	30D Conc	1.3	1.95	3/1/2007
3PD00018*LD	February 2007	001	Mercury, Total (Low Le	30D Conc	1.3	4.6	2/1/2007
3PD00018*LD	June 2006	001	Phosphorus, Total (P)	7D Qty	13.1	15.4790	6/22/2006
3PD00018*LD	June 2006	001	Zinc, Total Recoverablebl	1D Conc	244	302.	6/4/2006
3PD00018*LD	June 2006	001	Copper, Total Recoverable	30D Conc	20	21.6	6/1/2006
3PD00018*LD	June 2006	001	Copper, Total Recoverable	1D Qty	0.317	.32084	6/22/2006
3PD00018*LD	June 2006	001	Copper, Total Recoverable	30D Qty	0.212	.21309	6/1/2006
3PD00018*LD	June 2006	001	Mercury, Total (Low Le	30D Conc	1.3	2.2	6/1/2006
3PD00018*LD	May 2006	001	Copper, Total Recoverable	30D Conc	20	21.36	5/1/2006
3PD00018*LD	May 2006	001	Mercury, Total (Low Le	30D Conc	1.3	1.4	5/1/2006
3PD00018*LD	January 2007	001	Mercury, Total (Low Le	30D Conc	1.3	4.45	1/1/2007
3PD00018*LD	Dec 2006	001	Mercury, Total (Low Le	30D Conc	1.3	1.65	12/1/2006
3PD00018*LD	April 2006	001	Copper, Total Recoverable	30D Conc	20	21.	4/1/2006
3PD00018*LD	April 2006	001	Mercury, Total (Low Le	30D Conc	1.3	2.7	4/1/2006
3PD00018*LD	August 2006	001	Dissolved Oxygen	1D Conc	8.0	7.9	8/4/2006
3PD00018*LD	August 2006	001	pH, Minimum	1D Conc	6.5	6.2	8/12/2006
3PD00018*LD	August 2006	001	pH, Minimum	1D Conc	6.5	6.4	8/22/2006
3PD00018*LD	August 2006	001	pH, Minimum	1D Conc	6.5	6.4	8/30/2006
3PD00018*LD	August 2006	001	Mercury, Total (Low Le	30D Conc	1.3	4.5	8/1/2006
3PD00018*LD	March 2006	001	Mercury, Total (Low Le	30D Conc	1.3	1.9	3/1/2006
3PD00018*LD	October 2006	001	Mercury, Total (Low Le	30D Conc	1.3	4.65	10/1/2006
3PD00018*LD	Sept 2006	001	Copper, Total Recoverable	30D Conc	20	20.8	9/1/2006
3PD00018*LD	Sept 2006	001	pH, Minimum	1D Conc	6.5	6.4	9/27/2006
3PD00018*LD	Nov 2006	001	Phosphorus, Total (P)	7D Qty	13.1	13.3519	11/15/2006
3PD00018*LD	July 2006	001	Copper, Total Recoverable	30D Conc	20	25.5	7/1/2006
3PD00018*LD	July 2006	001	Copper, Total Recoverable	30D Qty	0.212	.23005	7/1/2006
3PD00018*LD	July 2006	001	Dissolved Oxygen	1D Conc	8.0	7.8	7/21/2006
3PD00018*LD	July 2006	001	Dissolved Oxygen	1D Conc	8.0	7.6	7/22/2006
3PD00018*LD	July 2006	001	Dissolved Oxygen	1D Conc	8.0	7.7	7/31/2006
3PD00018*LD	June 2007	001	Copper, Total Recoverable	1D Conc	30	57.6	6/6/2007
3PD00018*LD	June 2007	001	Copper, Total Recoverable	30D Conc	20	57.6	6/1/2007
3PD00018*LD	June 2007	001	Copper, Total Recoverable	1D Qty	0.317	.35347	6/6/2007
3PD00018*LD	June 2007	001	Copper, Total Recoverable	30D Qty	0.212	.35347	6/1/2007
3PD00018*LD	June 2007	001	Mercury, Total (Low Le	30D Conc	1.3	2.14	6/1/2007
3PD00018*LD	May 2007	001	Copper, Total Recoverable	1D Conc	30	30.2	5/2/2007
3PD00018*LD	May 2007	001	Copper, Total Recoverable	30D Conc	20	30.2	5/1/2007
3PD00018*LD	May 2007	001	Copper, Total Recoverable	30D Qty	0.212	.2389	5/1/2007
3PD00018*LD	April 2007	001	Copper, Total Recoverable	1D Conc	30	52.	4/24/2007
3PD00018*LD	April 2007	001	Copper, Total Recoverable	30D Conc	20	36.85	4/1/2007
3PD00018*LD	April 2007	001	Copper, Total Recoverable	1D Qty	0.317	.36555	4/24/2007
3PD00018*LD	April 2007	001	Copper, Total Recoverable	30D Qty	0.212	.2722	4/1/2007
3PD00018*LD	April 2007	001	Mercury, Total (Low Le	30D Conc	1.3	3.85	4/1/2007

Akron WTP 2004-2007 NPDES permit violations

Permit No	Reporting Period	Station	Parameter	Limit Type	Limit	Reported Value	Violation Date
3IV00000*DD	April 2004	003	CBOD 5 day	1D Conc	15	37.	4/28/2004
3IV00000*DD	April 2004	003	CBOD 5 day	30D Conc	10	37.	4/1/2004
3IV00000*DD	Dec 2004	002	Total Suspended Solids	1D Conc	45	127.	12/1/2004
3IV00000*DD	Dec 2004	002	Total Suspended Solids	30D Conc	30	46.0666	12/1/2004
3IV00000*DD	Dec 2004	002	Total Suspended Solids	1D Qty	102	506.604	12/1/2004
3IV00000*DD	Dec 2004	002	Total Suspended Solids	30D Qty	68	190.334	12/1/2004
3IV00000*DD	Nov 2005	002	Total Suspended Solids	1D Conc	45	108.	11/2/2005
3IV00000*DD	Nov 2005	002	Total Suspended Solids	30D Conc	30	108.	11/1/2005
3IV00000*DD	Nov 2005	002	Total Suspended Solids	1D Qty	102	136.369	11/2/2005
3IV00000*DD	Nov 2005	002	Total Suspended Solids	30D Qty	68	136.369	11/1/2005