Total Maximum Daily Loads for the Lower Cuyahoga River

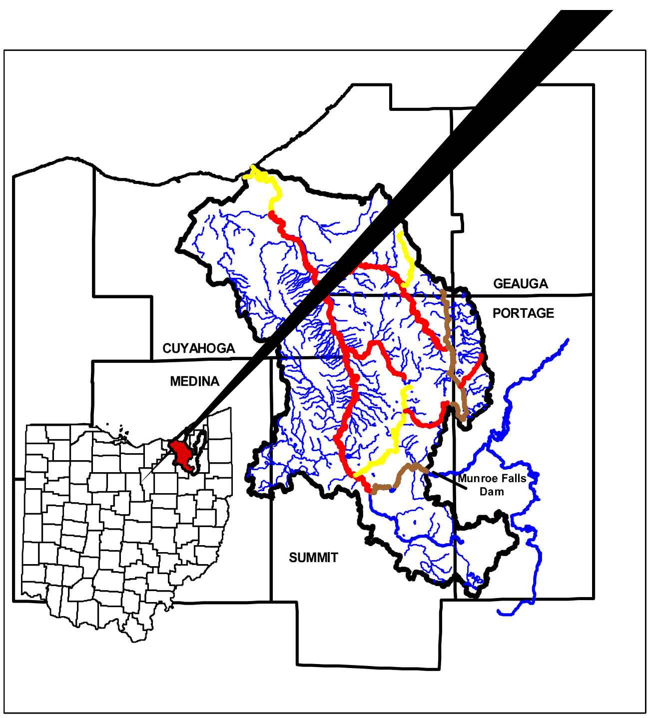
Final Report

prepared by

Ohio Environmental Protection Agency
Division of Surface Water

September 2003

The TMDL in Brief:



Basin:
Lower Cuyahoga River in the Lake Erie Basin
Study Area:
Lower 50 miles of Cuyahoga River and its tributaries.
Goal:
Attainment of the appropriate Aquatic Life Use
Major Causes:
Organic enrichment, toxicity, low dissolved oxygen, nutrients, and flow alteration
Major Sources:
Municipal discharges, combined sewer overflows, urban runoff, and industrial discharges.
Measure:
Total nitrogen, phosphorus, dissolved oxygen, bacteria, biological and habitat indices
Restoration Options:
Long term control plans for combined sewer overflows, urban runoff controls, habitat protection and restoration, septic system improvements, point source controls, and public education

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ACKNOWLEDGMENTS

The following Ohio EPA staff provided technical services for this project:

- Biology and Chemical Water Quality - Jack Freda, Charles Boucher, Robert Miltner, and Steve Tuckerman, Roger Thoma
- Nonpoint Source Issues - Dan Bogoevski, Mark Bergman
- Point Source Issues - Jennifer Bennage, Sandra Cappotto, Donna Kniss, and Bill Zawiski
- Project Leader - Dennis Lee
- Modeling - Erin Sherer
- Water Quality Standards - Chris Skalski
- Cuyahoga RAP - Kelvin Rogers

Many full- and part-time staff participated in field monitoring.

The National Park Service Cuyahoga Valley National Recreation Area and the Cleveland Metro Parks provided facilities for public meetings.

Bruce Cleland of America's Clean Water Foundation provided advice in the practical application of load duration curves in TMDL development. His assistance was made possible through ACWF's TMDL Circuit Rider Program.

Acknowledgment is made of the property owners who allowed Ohio EPA personnel access to the the Cuyahoga River and its tributaries.

Executive Summary

The Lower Cuyahoga River watershed is located in northeast Ohio, flowing through Summit and Cuyahoga counties on its way to Lake Erie. Tributaries to the watershed also drain part of Portage County and a very small section of Geauga County.

Historical pollution to the river was a result of heavy industrial and urban centers located between the Cities of Akron and Cleveland.

Based on Ohio EPA's monitoring of the Lower Cuyahoga River watershed, a number of water bodies within this watershed appear on Ohio's 303(d) list (Ohio's impaired waters listing). Organic enrichment, nutrients, bacteria, flow alteration, toxicity and degraded habitats are cited as the primary causes of impairment. Major sources of impairment include municipal and industrial point sources, combined sewer and sanitary sewer overflows and to a lesser extent natural conditions.

Stream surveys conducted in 2000 updated the information used to develop the 1998 303(d) list. Nutrients, while essential to the functioning of healthy aquatic ecosystems, can exert negative effects at relatively low concentrations by altering trophic dynamics, increasing algal and macrophyte production, increasing turbidity, decreasing average dissolved oxygen (D.O.) concentrations, and increasing fluctuations in diel dissolved oxygen and pH. Ohio's water quality standards include numerical biological criteria, which forms the basis of the numerical targets for the TMDLs. The success of the implementation actions resulting from the TMDLs will be evaluated by observed improvements in biological scores. Intermediate nutrient targets complement the biocriteria and are used as a tool to help evaluate the impact of nutrient loadings. These nutrient targets were based on a recent Ohio EPA technical bulletin (OEPA, 1999) which relate in-stream nutrient concentrations to aquatic community performance.

The Tinkers Creek subbasin continues to contain unknown sources as reasons for non attainment of aquatic life use goals. It is proposed that adaptive management be utilized as a mechanism to address water quality problems in the watershed. Stressor Identification (US EPA Stressor Identification Guidance Document) will be used to identify causes and sources for non attainment in this subbasin.

Reasonable assurances proposed for the Lower Cuyahoga River watershed include implementation of Long Term Control Plans for combined sewer overflows in the City of Akron and Northeast Ohio Regional Sewer District service areas. Phase II of the storm water regulations will involve over 83% of the watershed area and will be an essential part of water quality restoration.

Table 1. Components of the Lower Cuyahoga River TMDL Process

Study Area	Lower Cuyahoga River Basin: Munroe Falls Dam to mouth (RM 50.0 to 0.0)
1998 303(d) Listed Watersheds (***see Table 2 for segments***)	04110002 030 Cuyahoga River (below Breakneck Creek to below L. Cuyahoga R.) 04110002 040 Cuyahoga River (below L. Cuyahoga R. to below Brandywine Cr.) 04110002 050 Cuyahoga River (below Brandywine Cr. To below Tinkers Cr.) 04110002 060 Cuyahoga River (below Tinkers Cr. To Lake Erie)
Target Identification	Nutrients, sediment, dissolved oxygen, bacteria, and biological and habitat indices
Applicable Water Quality Criteria	<u>OAC 3745-1-04 (A)</u> Free from suspended solids and other substances that enter the waters as a result of human activity and that will settle to form objectionable sludge deposits, or that will adversely effect aquatic life. <u>OAC 3745-1-07</u> Dissolved Oxygen, instantaneous minimum: 4.0 (WWH) mg/l (Ship Channel DO 1.5 mg/l) 24-hour average: 5.0 (WWH) mg/l Fecal Coliform Bacteria: Geometric Mean 1000 mpn Maximum 2000 mpn Ecoregion Biocriteria, refer to Table 4 Applicable Water Criteria specific to Cuyahoga River Contained in Appendix K
Current Deviation from Target	Violations of instantaneous minimum dissolved oxygen criteria have been recorded. Exceedences of Chronic WQS criteria. Nutrients above background goals. Biological communities fail to achieve biocriteria.
Sources	Municipal treatment plants, industrial wastewater discharges, combined sewer overflows (CSO), sanitary sewer overflows (SSO), septic systems, habitat modification, loss of riparian zones, suburbanization, and urbanization.
Load Allocation	Refer to Tables 12 - 15.
Critical/Season Conditions	Critical conditions involve storm events initiating combined sewer overflows. Summer low flow conditions coupled with high temperatures are critical for low D.O.
Safety Margin	Implicit in calculations and explicit.
Implementation Plan	Of major importance to the Lower Cuyahoga River is the control of CSO's. Long Term Control Plans have been submitted for all CSO's in the Lower Cuyahoga River TMDL area.
Validation	Tiered approach to validation; assessment progression includes: 1. Confirmation of completion of implementation plan activities 2. Evaluation of attainment of chemical water quality criteria 3. Evaluation of attainment of recreational criteria 4. Evaluation of biological attainment
Public Participation	Public information sessions, newsletter, public notice of report, stakeholder groups.

1.0 INTRODUCTION

The Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritize waters for which technology-based limits alone do not ensure attainment of water quality standards. Lists of these waters (the Section 303(d) lists) are made available to the public and submitted to the U.S. Environmental Protection Agency (USEPA) in every even-numbered year (40 CFR 130.7(d) did not require a 303(d) list submittal in the year 2000). The Ohio Environmental Protection Agency (Ohio EPA) identified the Lower Cuyahoga River watershed as a priority impaired water on the 1998 and 2002 303(d) lists. The 1998 list was based on data collected through 1994. A new survey of the Cuyahoga River was completed in 2000, and this assessment was available for the 2002 list. A summary of the Lower Cuyahoga River watershed portion of the 1998 and 2002 303(d) lists is included in Table 2. A general overview of Ohio's water quality standards is included in Table 3. Specific use designations for the Cuyahoga River (OAC 3745-1-26) are included in Appendix K.

The Clean Water Act and USEPA regulations require that Total Maximum Daily Loads (TMDLs) be developed for all waters on the section 303(d) lists. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. The process of formulating TMDLs for specific pollutants is, therefore, a method by which impaired water body segments are identified and restoration solutions are developed. Ultimately, the goal of Ohio's TMDL process is full attainment of biological and chemical Water Quality Standards (WQS) and, subsequently, removal of water bodies from the 303(d) list. The Ohio EPA believes that developing TMDLs on a watershed basis (as opposed to solely focusing on impaired segments within a watershed) is an effective approach towards this goal.

This report serves to document the Lower Cuyahoga River TMDL process and provide for tangible actions to restore and maintain this water body. The main objectives of the report are to describe the water quality and habitat condition of the Lower Cuyahoga River and to quantitatively assess the factors affecting non or partial attainment of WQS. A draft implementation plan is also included. This plan identifies actions to address these factors and specifies monitoring to ensure actions are carried out and to measure the success of the actions proscribed. The report is organized in sections forming the progression of the TMDL process.

The primary causes of impairment in the Lower Cuyahoga River watershed are organic enrichment, nutrient enrichment, low instream dissolved oxygen, toxicity, sedimentation, and habitat degradation. Nutrient enrichment and organic enrichment are closely tied to each other in the TMDL area. Due to the large number of CSO's and sewage treatment plants in the TMDL area both appear as sources of non attainment. Addressing CSO's will help to deal with organic enrichment. The remaining nutrients, at this time, are believed to be associated with phosphorus. In limited sections of the watershed, small wetland dominated streams, natural background conditions contribute to non attainment.

Load-based TMDLs were calculated for phosphorus and bacteria. Habitat degradation and dissolved oxygen depletion are not load based quantities; however, the regulations provide for these types of impairing causes and ‘TMDL’ numbers were calculated for these as well. The Tinkers Creek sub-basin is uniquely impaired by as yet unknown sources in addition to the causes listed above.

Table 2. Summary of 303(d) List Status for the Lower Cuyahoga River Watershed

2002 303(d) List [1]		1998 303(d) List [1]		TMDL in this Report? [2]	Comments
Description	**Major Causes**	**Description**	**Major causes**		
Cuyahoga River (below Breakneck Creek to below Little Cuyahoga River) 04110002 030 Priority points: 9 (high)	• Unknown Toxicity • Nutrients • Siltation • OrgEnrich/DO • Flow Alteration • Habitat Alterations • Total Toxics • Bacteria	Little Cuyahoga River (Wingfoot Lake Outlet to Cuyahoga River) [OH 88 1]	• OrgEnrich/DO • Priority Organics • Metals • Unknown Toxicity	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Cuyahoga River (Breakneck Creek to Little Cuyahoga River) [OH 88 5]	• OrgEnrich/DO • Flow Alteration • Priority Organics • Thermal Modification	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Union Oil Tributary [OH 88 4.1]	• Habitat Alteration	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Ohio Canal [OH 88 1.2]	• OrgEnrich/DO • Habitat Alteration • Metals	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
Cuyahoga River (below Little Cuyahoga River to below Brandywine Creek) 04110002 040 Priority points: 9 (high)	• Unknown Toxicity • Nutrients • Flow Alteration • OrgEnrich/DO • Habitat Alteration	Cuyahoga River (Yellow Creek to Brandywine Creek) [OH 89 14]	• OrgEnrich/DO • Unknown Toxicity • Priority Organics • Siltation	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	Unknown toxicity may be addressed via the long-term control plans
		Brandywine Creek [OH 89 13]	• OrgEnrich/DO • Unknown Toxicity • Siltation	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	

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2002 303(d) List [1]		1998 303(d) List [1]		TMDL in this Report? [2]	Comments
Description	**Major Causes**	**Description**	**Major causes**		
		Cuyahoga River (Little Cuyahoga River to Yellow Creek) [OH 89 27]	• OrgEnrich/DO • Unknown Toxicity • Priority Organics	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	Unknown toxicity may be addressed via the long-term control plans
		Powers Brook [OH 89 30]	• OrgEnrich/DO • Ammonia	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	Ammonia source (WWTP) removed and tied into Akron WWTP.
		Yellow Creek [OH 89 25]	• OrgEnrich/DO (Threat)	☺	2000 Survey data show this stream to be in FULL attainment.
		Mud Brook [OH 89 29]	• OrgEnrich/DO • Flow Alteration • Habitat Alteration • Metals • Ammonia	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	Ammonia source removed; ammonia levels declined in 2000
Cuyahoga River (below Brandywine Creek to below Tinkers Creek) 04110002 050 Priority points: 8 (high)	• Unknown Toxicity • Nutrients • Flow Alteration • OrgEnrich/DO • Habitat Alteration • Oil and Grease • Natural Conditions	Cuyahoga River (Brandywine Creek to Tinkers Creek) [OH 89 11]	• OrgEnrich/DO • Siltation • Unknown Toxicity	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Tinkers Creek (headwaters to Pond Brook) [OH 89 9]	• OrgEnrich/DO • Metals • Unknown Toxicity • Nutrients • Habitat	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	

Table 2. Summary of 303(d) List Status for the Lower Cuyahoga River Watershed

2002 303(d) List [1]		1998 303(d) List [1]		TMDL in this Report? [2]	Comments
Description	**Major Causes**	**Description**	**Major causes**		
		Deer Lick Run [OH 89 8.2]	• Metals • Ammonia • OrgEnrich/DO	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Pond Brook [OH 89 10]	• Habitat Alteration • OrgEnrich/DO	☺	2000 Survey data show this stream to be in FULL attainment
		Trib. To Chippewa Creek [OH 89 12.1]	• Flow Alteration • Nutrients • OrgEnrich/DO	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Streetsboro Tributary To Tinkers Creek [OH 89 9.1]	• OrgEnrich/DO	☺	Source eliminated with construction of new WWTP on Tinkers Creek.
		Wood Creek [OH 89 8.1]	• Unknown	☺	2000 Survey data show this stream to be in FULL attainment.
		Beaver Meadow Run [OH 89 8.3]	• OrgEnrich/DO	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	

Table 2. Summary of 303(d) List Status for the Lower Cuyahoga River Watershed

2002 303(d) List [1]		1998 303(d) List [1]		TMDL in this Report? [2]	Comments
Description	**Major Causes**	**Description**	**Major causes**		
		Tinkers Creek (Pond Brook to Cuyahoga River) [OH 89 8]	• OrgEnrich/DO • Oil and Grease • Unknown • Nutrients • Siltation • Habitat Alteration • Suspended Solids	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Chippewa Creek [OH 89 12[	• Ammonia	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
Cuyahoga River (below Tinkers Creek to Big Creek) 04110002 060 Priority points: 8 (high)	• OrgEnrich/DO • Habitat Alteration • Flow Alteration • Metals	Cuyahoga River (Tinkers Creek to Big Creek) [OH 89 6]	• Chlorine • OrgEnrich/DO • Unknown Toxicity • Priority Organics • Siltation	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Mill Creek [OH 89 7]	• Ammonia • OrgEnrich/DO	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Big Creek [OH 89 5]	• OrgEnrich/DO • Unknown • Oil and Grease	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	

Table 2. Summary of 303(d) List Status for the Lower Cuyahoga River Watershed

2002 303(d) List [1]		1998 303(d) List [1]		TMDL in this Report? [2]	Comments
Description	**Major Causes**	**Description**	**Major causes**		
		Cuyahoga River (Big Creek to Lake Erie) [OH 89 1]	• OrgEnrich/DO • Habitat Alteration • Priority Organics • Metals • Ammonia • Other Inorganics • Oil and Grease • Unknown Toxicity • Siltation • Flow Alteration	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Ford Branch Big Creek [OH 89 5.1]	• OrgEnrich/DO	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	
		Kingsbury Run [OH 89 2]	• Priority Organics • Metals	• OrgEnrich/DO • Nutrients • Siltation • Habitat • Bacteria	

[1] The 1998 303(d) list was based on data collected before 1994. This report includes more current data collected through 2000, which formed the basis for the 2002 303(d).

[2] TMDL numbers are included for total phosphorus and bacteria. Low D.O. and altered habitat are not load based causes of impairment. Allocations for factors affecting instream D.O. (TP, NH_3,$cBOD_5$, D.O., shading) and habitat (components of the QHEI scores) are included and are considered to be a parallel concept to a 'TMDL' for load-based parameters.

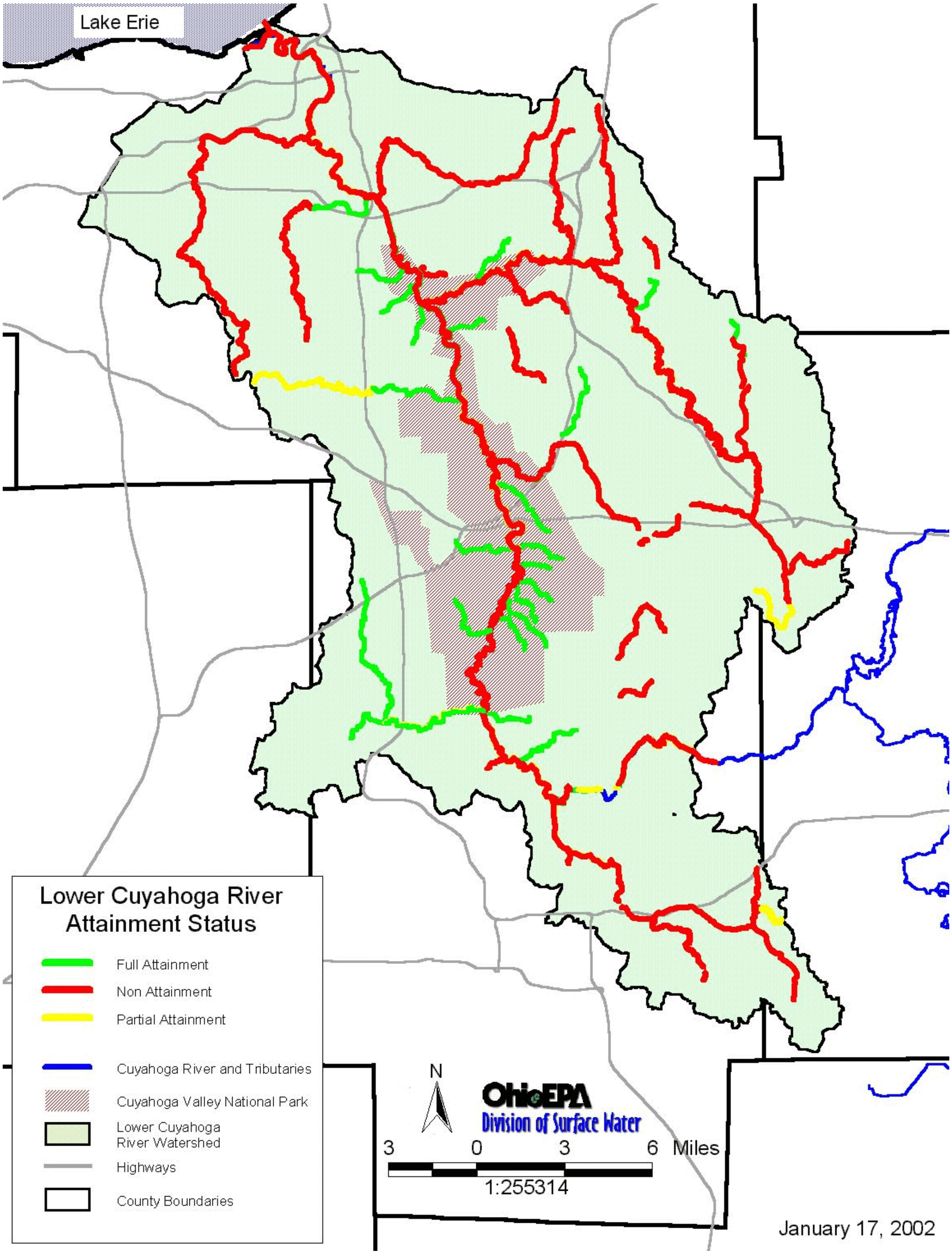
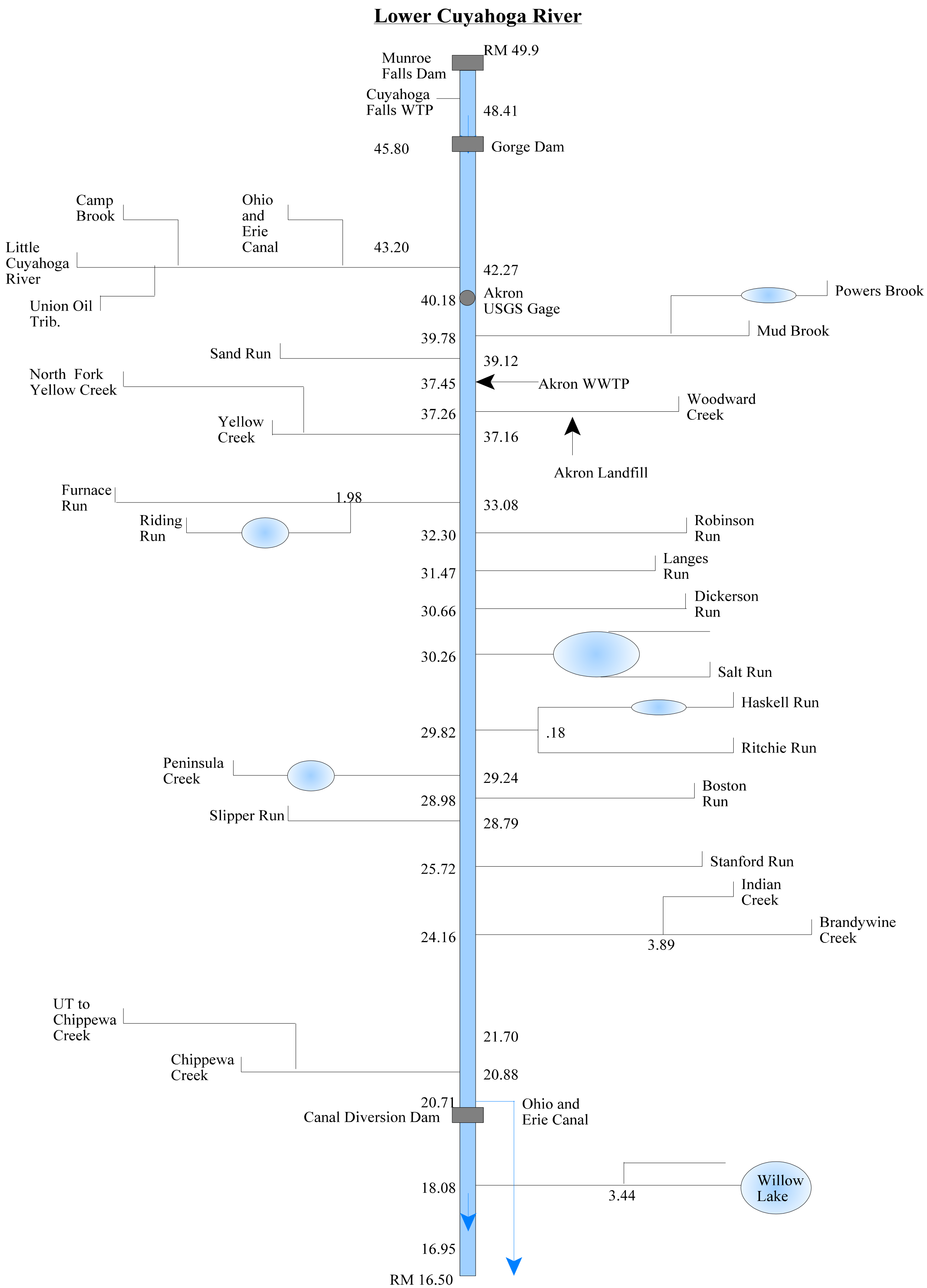


Figure 1. Lower Cuyahoga River Basin attainment status


Lower Cuyahoga River
RM 49.9
Munroe Falls Dam
Cuyahoga Falls WTP
48.41
45.80
Gorge Dam
Camp Brook
Ohio and Erie Canal
Little Cuyahoga River
43.20
42.27
Union Oil Trib.
40.18
Akron USGS Gage
Powers Brook
39.78
Mud Brook
Sand Run
39.12
North Fork Yellow Creek
37.45
Akron WWTP
37.26
Woodward Creek
Yellow Creek
37.16
Akron Landfill
Furnace Run
1.98
33.08
Riding Run
32.30
Robinson Run
31.47
Langes Run
30.66
Dickerson Run
30.26
Salt Run
Haskell Run
29.82
.18
Ritchie Run
Peninsula Creek
29.24
Boston Run
28.98
Slipper Run
28.79
25.72
Stanford Run
Indian Creek
24.16
3.89
Brandywine Creek
UT to Chippewa Creek
21.70
Chippewa Creek
20.88
20.71
Canal Diversion Dam
Ohio and Erie Canal
18.08
3.44
Willow Lake
16.95
RM 16.50

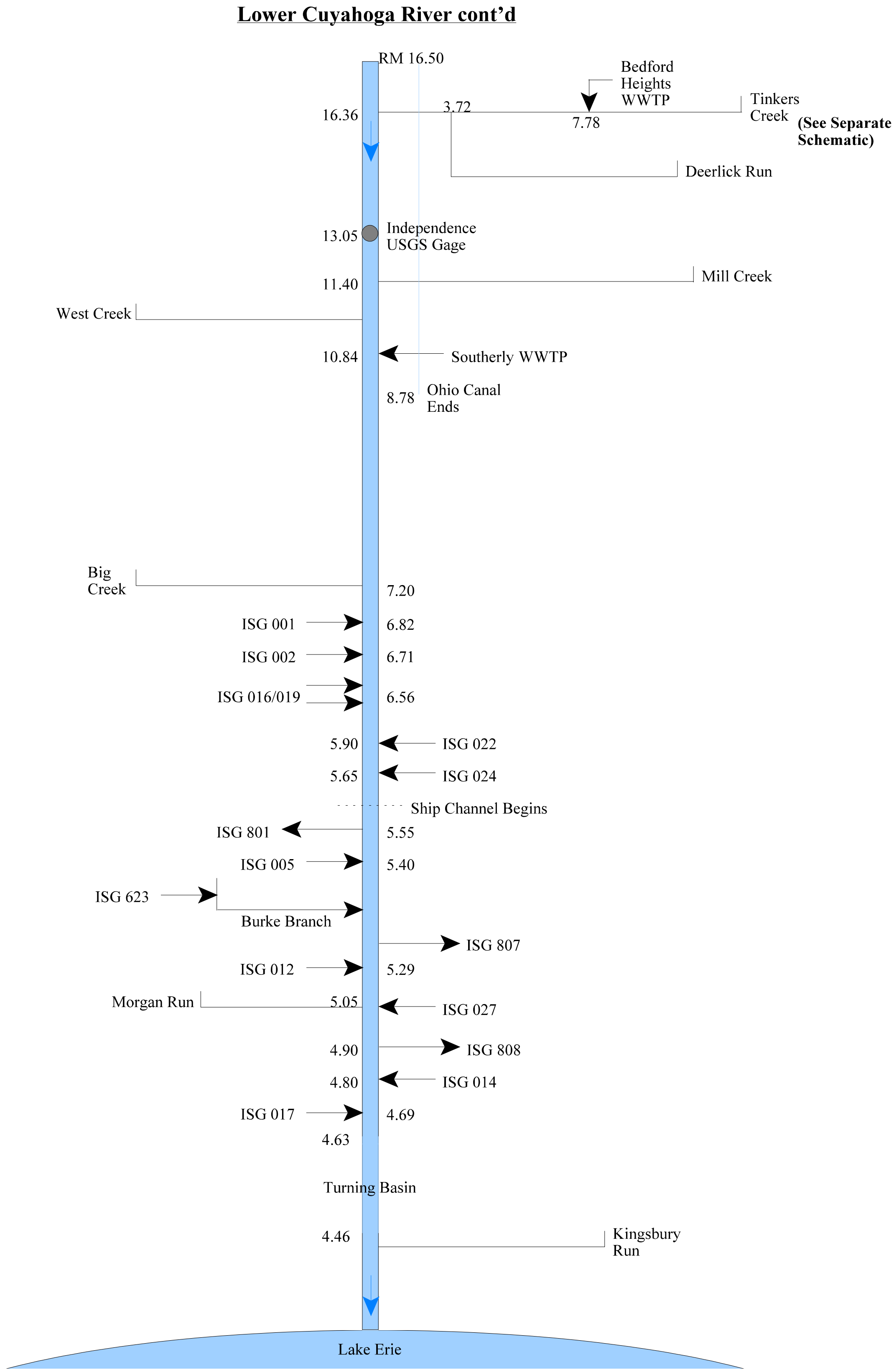


Figure 2a. Schematic representation of the Lower Cuyahoga River watershed

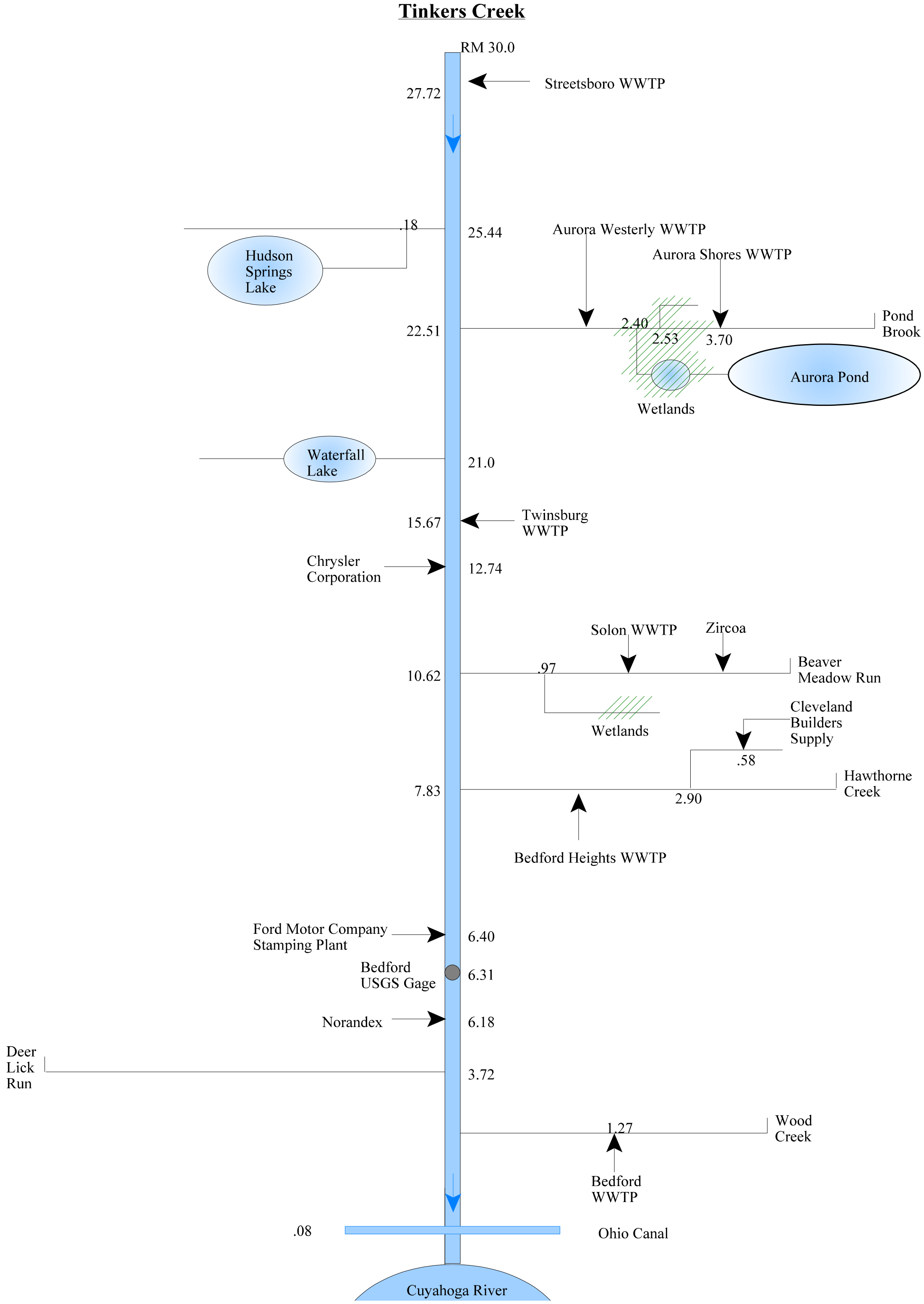


Figure 2b. Schematic representation of the Tinkers Creek watershed

2.0 WATERBODY OVERVIEW

2.1 Description of the Study Area

2.1.1 Cuyahoga River Basin

The Cuyahoga River basin drains 813 square miles and includes 1,220 stream miles spanning parts of Geauga, Medina, Portage, Summit and Cuyahoga counties, emptying into Lake Erie at Cleveland. As the river enters the lake, the harbor breakwall and the predominantly easterly littoral drift usually direct about 80 percent of the flow to the east, inside the breakwall.

The basin contains parts of three major physiographic provinces: the glaciated Allegheny Plateau, the till plains, and the lake plains. Most of the basin occurs in the glaciated Allegheny Plateau, and owes its topographic and hydrologic features to a complex glacial history. A small portion of the basin in southwest Cuyahoga County lies within the till plains, a relatively flat area more characteristic of north central and northwestern Ohio. The Cuyahoga River basin also cuts through the narrow border of the nearly level lake plains that surround Lake Erie and represents the ancient bottom of the predecessors to Lake Erie.

The Cuyahoga basin is situated within the Erie/Ontario Lake Plain (EOLP) ecoregion, a glacial plain that lies between the unglaciated Western Allegheny Plateau (WAP) ecoregion to the southeast and the relatively flat Eastern Corn Belt Plains (ECBP) ecoregion to the west and southwest. The EOLP ecoregion is characterized by glacial formations that can have a significant local relief of up to 300 feet and exhibits a mosaic of cropland, pasture, woodland, and urban areas. Soils are mainly derived from glacial till and lacustrine deposits and tend to be light colored, acidic, and moderately to highly erodible. Many glacial features characteristic of the EOLP ecoregion are found in the Cuyahoga River basin. The northern and eastern boundaries of this v-shaped watershed are largely defined by the terminal moraines left by two fingers of glacial ice. The retreating glaciers then buried the ancient river valleys with glacial outwash. The headwaters originate in northeastern Geauga County and flow southwest to Akron through relatively hilly knob and kettle topography. The river generally follows the course of the buried valleys, but does traverse a ridge of erosion resistant sandstone, resulting in the falls and cascades of Cuyahoga Falls. The river turns sharply to the northwest at the confluence with the Little Cuyahoga River in north Akron, then winds through outwash terraces, till plains, and till ridges before reaching the flat lake plain of the Cleveland area.

Land use patterns vary greatly from the upper basin that is primarily agricultural, to the lower basin which is among the most densely populated and industrialized urban areas in the state. Agriculture is the predominant land use in the upper basin, and while less prevalent in the middle basin, the soils are highly erodible and can result in significant sedimentation and nutrient loadings. Resource extraction and hydromodification are localized throughout the basin. The waters of the heavily populated areas of the middle and lower basin are influenced by urban and construction site runoff, combined/sanitary sewer overflows, and land disposal.

Part of the Cuyahoga River is a designated State Scenic River and several stream segments within the basin have been designated as State Resource Waters. The Cuyahoga River, from the Ohio Edison Dam to the mouth and the nearshore area two miles west to ten miles east of the mouth has been identified as an Area of Concern by the International Joint Commission. Twenty-two miles of the Cuyahoga River in the TMDL area flow through the Cuyahoga Valley National Park, additionally both the Cleveland Metro Parks and MetroParks Serving Summit County have waterways contained in their respective holdings (see Table 4a). The Cuyahoga River was also designated an American Heritage River in 1998.

2.1.2 Tinkers Creek Subbasin

Tinkers Creek is the largest tributary of the Cuyahoga River and drains portions of Portage, Geauga, Summit and Cuyahoga counties. Tinkers Creek has a drainage area of 96.4 square miles and a total length of about 30 miles and enters the Cuyahoga River at RM 16.36. The watershed lies on a glaciated plateau. Soils are mostly silt loam and clayey silt loam. Wetland swamps, bogs and fens are common in the upper watershed. Flows in the lower section of the creek are highly influenced by the discharge of treated wastewater from upstream WWTPs; in 1991 the combined effluent had a median discharge of 11.623 mgd or 17.9 cubic feet per second (cfs). Portions of the stream are on bedrock and form waterfalls which are a natural barrier to fish passage. The lower portions of the stream have formed the Tinkers Creek Gorge which is a National Natural Landmark. Recent acquisitions in the basin by MetroParks Serving Summit County and the Cleveland Metro Parks have increased the amount of protected watershed in the basin. Many local communities are also involved in protecting and acquiring parkland in the basin.

2.1.3 Little Cuyahoga River Subbasin

The Little Cuyahoga River subwatershed drains the Akron metropolitan area and is among the most urbanized and densely populated in the state. Housing density within the subbasin is most dense in political subdivisions located along the course of the river, and tends to increase from upstream to downstream (Figure 3). Urban runoff is a well documented source of nonpoint pollution to surface waters (see review by Schuler, 1994), the effects of which on aquatic life are usually exacerbated where sanitary and storm water sewers are combined and discharge into receiving streams (Yoder and Rankin, 1996). This watershed has been subjected to historical flow regulation for industrial purposes, remnants of some of the channel modifications still exist.

2.2 Water Quality and Biological Assessment

Under the Clean Water Act, every state must adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of "swimmable/fishable" waters. Table 3 provides a brief description of Ohio's water quality standards. Further information is available in Chapter 3745-1 of the Ohio Administrative Code (OAC) (http://www.epa.state.oh.us/dsw/wqs/criteria.html) and Appendix K.

Table 3. Summary of the components and examples of Ohio's Water Quality Standards

WQS Components	Examples of:	Description
Beneficial Use Designation	1. Water supply •Public (drinking) •Agricultural •Industrial 2. Recreational contact •Beaches (Bathing waters) •Swimming (Primary Contact) •Wading (Secondary Contact) 3. Aquatic life habitats (partial list): •Exceptional Warmwater (EWH) •Warmwater (WWH) •Modified Warmwater (MWH) •Limited Resource Water (LRW) •Cold Water Habitat (CWH) •State Resource Water	Designated uses reflect how the water is potentially used by humans and how well it supports a biological community. Every water in Ohio has a designated use or uses; however, not all uses apply to all waters (they are water body specific). Each use designation has an individual set of numeric criteria associated with it, which are necessary to protect the use designation. For example, a water that was designated as a drinking water supply and could support exceptional biology would have more stringent (lower) allowable concentrations of pollutants than would the average stream. Recreational uses indicate whether the water can be potentially used for swimming or if it may only be suitable for wading.
Numeric Criteria	1. Chemical	Represents the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Laboratory studies of organism's sensitivity to concentrations of chemicals exposed over varying time periods form the basis for these.
	2. Biological *Measures of fish health:* • Index of Biotic Integrity • Modified Index of Well Being *Measure of macroinvertebrate health:* • Invertebrate Community Index	Indicates the health of the instream biological community by using these 3 indices (measuring sticks). The numeric biological criteria (biocriteria) were developed using a large database of reference sites.
	3. Whole Effluent Toxicity (WET)	Measures the harmful effect of an effluent on living organisms (using toxicity tests).
	4. Bacteriological	Represents the level of bacteria protective of the potential recreational use.
Narrative Criteria (Also known as the "Free Froms")	General water quality criteria that apply to all surface waters. These criteria state that all waters shall be free from sludge, floating debris, oil and scum, color and odor producing materials, substances that are harmful to human, animal or aquatic life, nutrients in concentrations that may cause algal blooms, and free from a public health nuisance.	
Antidegradation Policy	This policy establishes situations under which the director may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need. Refer to http://www.epa.state.oh.us/dsw/wqs/wqs.html for more information.	

In the Lower Cuyahoga River study area, the aquatic life use designations that apply to various segments are Cold Water Habitat (CWH), Warmwater Habitat (WWH), Modified Warmwater Habitat (MWH), and Limited Resource Water (LRW). Waters designated as WWH are capable of supporting and maintaining a balanced integrated community of warmwater aquatic organisms (Note: a Coldwater Habitat is a trout stream). Attainment of aquatic life uses is measured in two ways. The first is criteria in the WQS for various pollutants are compared to measurements taken from the water to determine attainment for specific pollutants. The second way attainment is determined is by directly measuring fish and aquatic insect populations to see if they are comparable to those seen in least impacted areas of the same ecological region and aquatic life use. Attainment benchmarks from these least impacted areas are established in the WQS in the form of "biocriteria", which are then compared to the measurements obtained from the study area. If measurements of a stream do not achieve the three biocriteria (fish: Index of Biotic Integrity (IBI) and modified Index of Well-being (MIwb); aquatic insects: Invertebrate Community Index (ICI)) the stream is considered in "non attainment". If the stream measurements achieve some of the biological criteria, but not others, the stream is said to be in "partial- attainment". A stream that is in "partial attainment" is not achieving its designated aquatic life use, whereas a stream that meets all of the biocriteria benchmarks, it is said to be in full attainment.

Another type of use in the WQS is for recreational purposes. The recreational use for the majority of the Lower Cuyahoga River study area is Primary Contact Recreation (PCR). The criterion for the PCR designation is usually having a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. A water body that is too small and shallow to meet either criterion, the Secondary Contact Recreation (SCR) use may apply. The attainment status of PCR and SCR is determined using bacterial indicators; the criteria for each are specified in the Ohio WQS.

The Water Quality Standards designations contained in Ohio Administrative Code Chapter 3745-1-26 are included as Appendix K.

For the Lower Cuyahoga River TMDL, Ohio EPA conducted a detailed assessment of chemical (water column, effluent, sediment), physical (flows, habitat), and biological (fish and aquatic insect) conditions in order to determine if streams and rivers in the study area were attaining their designated uses. This information was conduced most recently in 2000 as part of the Comprehensive Water Quality Survey for the entire Cuyahoga River Basin. The basis for the listing of the Lower Cuyahoga River on the 303(d) list is the measurements that were obtained in an assessment conducted in 1996. Ohio EPA re-assessed the Lower Cuyahoga River study area in 2000. This TMDL report addresses both the results in the 303(d) list based on 1996 data and the results of the 2000 assessment. However, greater weight is given to the 2000 data, as it is most reflective of current watershed conditions. An aquatic life use attainment table for the Lower Cuyahoga River study area (Appendix D) is provided and is based on the 2000 sampling results; this data was not available for the 1998 303(d) list but will be used in the next listing cycle. The table is arranged from upstream to downstream and includes sampling locations indicated by river mile (RM, the mouth of the river considered river mile 0.0), the applicable biocriteria indices, the use attainment status (i.e. full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI) (an indicator of habitat quality), and comments for the sampling location. Where the aquatic life use designation (WWH or EWH), as determined by the 1998 assessment, is different than the use designation in effect prior to the 1998 survey, Appendix D provides the attainment status for both the existing and the recommended use designation.

Comprehensive water quality surveys of the Cuyahoga River Basin have been conducted most recently in 1991, 1996, and 2000. The 1991 survey (*Biological and Water Quality Study of the Cuyahoga River - EAS/1992-12-11*) may be found on Ohio EPA's Web site at: http://www.epa.state.oh.us/dsw/documents/cuyahg91.pdf The 1996 survey (*Biological and Water Quality Study of the Cuyahoga River and Selected Tributaries; Geauga, Portage, Summit and Cuyahoga Counties (Ohio). Volume 1. Appendices, Volume 2 - MAS/1998-12-4*) may be found on Ohio EPA's Web site at: http://www.epa.state.oh.us/dsw/documents/cuyvol1.pdf and http://www.epa.state.oh.us/dsw/documents/cuyvol2.pdf. The water quality study for the 1996 survey of the Little Cuyahoga River (*Biological and Water Quality Study of the Little Cuyahoga River and Tributaries - MAS/1997-12-9*) may be found on Ohio EPA's Web site at: http://www.epa.state.oh.us/dsw/documents/lcuytsd.pdf.

2.3 Causes and Sources of Impairment

The primary determination of impairment in rivers and streams in Ohio is straightforward – the numeric biocriteria are the principal arbiter of aquatic life use attainment and impairment.

Ohio EPA relies on an interpretation of multiple lines of evidence including water chemistry, sediment, habitat, effluent and land use data, biomonitoring results, and biological response to describe the causes (e.g., nutrients) and sources (e.g., agricultural runoff, municipal point sources, septic systems) associated with observed impairments. The initial assignment of the principal causes and sources of impairment that appear on the section 303(d) list do not necessarily represent a true "cause and effect" relationship. Rather they represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the survey data are based on previous experience with similar situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified.

2.3.1 Lower Cuyahoga River

The Lower Cuyahoga River watershed is impacted by both point sources (e.g., municipal wastewater treatment plants), nonpoint sources (e.g., runoff from urban areas) and combined sewer overflows. The lower Cuyahoga River receives combined sewer overflows from the City of Akron and the Northeast Ohio Regional Sewer District.

Appendix H details the causes and sources of impairment per stream and stream segment. Physical habitat attributes in most of the mainstem and tributaries are generally of high quality and typically include natural stream channels, coarse substrates and wooded riparian corridors. Urbanization in some areas of the watershed has resulted in altered stream hydrology, stream banks denuded of riparian vegetation and has exacerbated nutrient enrichment as well as impacted aquatic life. Impacts from urban land use typically arise from associated wastewater loadings and storm water runoff. In addition to increasing volumes of wastewater, changing land use patterns are also altering the rates and types of nonpoint pollutants discharged within the watershed. The land use distribution for the watershed is shown in Figure 3 and Tables 4 and 4a. Land cleared for construction can result in greatly accelerated rates of erosion and sedimentation of streams especially when sediment control measures are inadequate. Additionally, increased impervious surface area and storm water drainage systems typically follow new development and result in increased rates and volume of runoff that contribute a variety of pollutants including solids, nutrients, oils, and pesticides to streams. Impaired segments and causes of impairment for the Lower Cuyahoga River TMDL area are included in Table 2.

Predicting the magnitude of a specific impairment can be difficult in a watershed with multiple impairments. Some impairments, such as the Canal Diversion Dam, are more easily assigned a magnitude. The dam blocks fish passage for non-salmonids upstream. Other impairments are more difficult to assess. Combined sewer overflows do cause impairments, but assigning a magnitude of impact is difficult because the magnitude varies with rainfall and river stage. The 1998 303(d) report lists the impacts from CSO's as moderate to heavy. Additions of nutrients, oxygen demanding substances, toxics, and solids can be substantial. The frequency of specific overflows can also influence levels of impacts. Overflows which discharge more frequently at low flows may have greater impacts that an overflow which operated a few times per year at very high stream flows. As both the NEORSD and Akron combined sewer overflows become better controlled, water quality improvements are expected to follow.

Lower Cuyahoga River to Big Creek (River Miles (RM) 50.0 - 7.1)

Between Lake Rockwell and Akron (segment assessed in 1996 and 2000 surveys, also includes part of Middle Cuyahoga TMDL area), biological index scores decreased relative to the free-flowing reach upstream (Table 1). Organic enrichment, nutrient enrichment, low dissolved oxygen levels, flow alteration and habitat modification associated with reservoir releases and impoundments were considered the primary causes of impairment.

The river segment in Cuyahoga Falls immediately downstream from the Munroe Falls dam is the starting point for the Lower Cuyahoga TMDL and was in non-attainment due to nutrient enrichment and hydromodification. Implementation of the Middle Cuyahoga River TMDL is underway and may bring this segment into attainment.

Further downstream in the MetroParks Serving Summit County Gorge Park area, biological communities improved and met WWH biological criteria in the turbulent, free flowing reach between the Ohio Edison dam pool and Little Cuyahoga River (RMs 42.3-

44.6). The unique habitat conditions in the gorge help to ameliorate potential water quality impacts from upstream sources and Akron's four combined sewers in this section.

The American Whitewater Association lists the Cuyahoga River near Akron for canoeing and kayaking with class III to class V ratings from Broad Street to Cuyahoga Street. These ratings highlight the existing and potential high quality recreational use of this segment of the river. The run is iterrupted by the Gorge dam and a dam in Cuyahoga Falls downstream of Broad Street.

The City of Akron CSO system discharged a total of 860 million gallons in 2002. The CSOs discharged following as little as 0.1 inch of rain per hour. The Ohio Canal receives the greatest volume of combined sewer flow while the Little Cuyahoga River receives the largest number of discharge events. Evidence of SSO discharges to the Cuyahoga mainstem from the City of Cuyahoga Falls has been observed in the gorge area. These discharges contribute to serious water quality impacts in the Cuyahoga River and the Little Cuyahoga River basin. The adverse effects of these discharges include stream discoloration, odor, debris and litter, dissolved oxygen depletion, biological impairment, excessive bacteria levels and exceedences of chemical criteria, including acutely toxic concentrations of heavy metals.

Continuous monitor data from the city of Akron detected low D.O. concentrations both immediately upstream and downstream from the Akron WWTP during the summers of 1994-96. Concentrations were below 5 mg/l on six different dates during the summer of 1996 and 39 days during the summer of 1995. Most of the measurements were recorded at the 801 (upstream WWTP) sampling site and most were short lived, possibly corresponding to first flush events. However, the low D.O.s did not appear to be positively correlated to river flow (i.e., CSOs may discharge following rain events that are either too small or too localized to significantly affect mainstem flows). The results indicate potential chronic effects on biological communities from loadings of oxygen demanding substances associated with Akron CSOs or Cuyahoga Falls SSOs. However, biological impairment was most severe downstream from both the CSO and WWTP discharges.

Excepting D.O., the Cuyahoga River was in substantial compliance with chemical WQS and PCR criteria during dry weather. However, nitrate-nitrite, phosphorus, and zinc tended to increase in a step wise function below the Akron, NEORSD Southerly, and ISG (formerly LTV Steel) (zinc) discharges. Chronic enrichment and lack of nutrient assimilation between Akron and Cleveland suggests nutrient uptake by algae was either suppressed, or nutrients were present in concentrations saturating to algal uptake rates. Suppressed uptake rates may indicate chronic toxicity or light limitation. Saturated uptake rates demonstrate nutrients present in levels exceeding assimilative capacity.

Fecal coliform numbers continue to exceed the 1000/100 ml Primary Contact Recreation criterion between Akron and Cleveland when stream flow is elevated due to rain runoff. A similar finding was reported by the USGS in their extensive bacteriological survey of the lower Cuyahoga River (Francy et.al. 1993). The study concluded that the most significant source of fecal coliform bacteria was from bypasses of the secondary treatment process at the Akron WWTP.

Biological impairment in the Cuyahoga River downstream from Akron was manifest most strongly in the fish. Fish communities were poor or very poor at nearly all sites between Akron and Cleveland, beginning downstream from the Little Cuyahoga River. Both organism groups were in the fair to very poor ranges downstream from the Akron WWTP for a minimum of four river miles. Macroinvertebrates tended to reflect enrichment effects while fish exhibited more chronic or toxic influences downstream from Akron. US EPA and Ohio EPA recent investigations indicate possible adverse effects from endocrine disrupting compounds that were found in fish tissue. In contrast to the fish communities, macroinvertebrates gradually improved and reached very good to exceptional quality upstream from Cleveland.

Since 1996, the segment from the Little Cuyahoga River to Yellow Creek has shown significant improvement (particularly in the fish) beginning downstream from the Little Cuyahoga and extending downstream from the Akron WWTP. Good fish communities at the mouth of the Little Cuyahoga and improved fish communities in the mainstem downstream suggests the effectiveness of SSO elimination and CSO nine minimum controls by the city of Akron. The results could also reflect the gradual recovery from severely toxic conditions in the 1980s from urban runoff, industrial discharges, CSOs and SSOs. Fish recovery has historically lagged behind the macroinvertebrates which, throughout the 1990s, declined downstream from the Little Cuyahoga but maintained at least marginally good quality.

Biological community health declined below the Akron WWTP but 2000 results show significant improvement since 1996. Fish from RM 33.3 (Bolanz Rd, four miles dst. Akron WWTP) shifted from Very Poor in 1996 to Fair-Poor in 2000. Macroinvertebrates improved from Fair to Very Good. The trend continued downstream at Peninsula (RM 29) and attainment improved from Non to Partial. Communities reflected significant background enrichment but a lessening of the toxic influences and gross organic loadings in earlier surveys. Nutrient levels were elevated below Akron, but water chemistry is generally good except following rain events. Fish recovery in the Cuyahoga and other polluted streams has historically lagged behind the macroinvertebrates, so the 2000 results may reflect a continuation of the initial improving trends first observed in the late 1980s and early 1990s following decades of severe and toxic impacts.

Sampling downstream from Tinkers Creek at RM 15.6 found the first Full attainment of WWH ever recorded by Ohio EPA in the Cuyahoga River downstream from Akron. The improvement continued the recovery trend that began 25 miles upstream in the Akron area. Positive changes are primarily attributed to a lessening of toxic impacts and continued reductions in loadings from the Akron sewer system. Full attainment is believed to extend downstream to the confluence with Mill Creek.

Between Mill Creek and the Southerly WWTP the fish communities declined to the poor range. Besides urban/industrial runoff, CSO, and SSO stressors, a large Mill Creek sewer line break in February of 2000 is suspected of contributing to the decline. Fish improved to Fair downstream from Southerly WWTP discharge, resulting in Partial attainment. This represents a significant improvement over the poor/very poor fish communities (and Non attainment) in previous surveys. The results fit the overall improving trend in the lower Cuyahoga River between Akron and Cleveland.

Nutrient levels were elevated throughout the reach with both point and nonpoint contributors. Chronic water quality standard exceedences were detected during high stream flow events for copper, lead, and zinc and elevated concentrations of cadmium, chromium, and nickel were found in numerous high flow samples between Tinkers Creek and Big Creek..

Cuyahoga River Lacustuary
Big Creek to Lake Erie (RM 7.0-0.0)

This section of the river contains the Cuyahoga River navigation channel which, because of the characteristics of the channel has its own unique use designation. The aquatic life use designation for the navigation channel is either limited resource water - navigation maintenance or fish passage based upon the season and/or flow in the river. Ohio EPA sampling indicates that adult fish are able to utilize the navigation channel for passage upstream to suitable habitat to continue their life cycles. Recent studies by the Cuyahoga River RAP, indicate significant die-off of larval fish in the navigation channel. It is unclear whether this larval fish die off is significantly greater in the Cuyahoga River channel than in other Lake Erie tributaries. In the navigation channel, cumulative loadings and flows from the 21 ISG (formerly LTV) outfalls make it one of the largest point source discharges in the Cuyahoga River basin. However, few WWH chemical WQS exceedences were detected near the plant.

Other potential steel plant impacts were generally masked by conditions upstream and the poor habitat and water quality in the navigation channel. Poor and very poor biological communities coincide with the lack of suitable habitat, low dissolved oxygen, and chronically elevated ammonia and zinc levels between ISG and Lake Erie. While ISG appears to be a major source of zinc loadings, anaerobic decomposition of organic compounds in sediments may contribute to elevated ammonia-N levels. Under summer pH and temperature conditions, the average level of ammonia-nitrogen downstream from the ISG complex could exceed chronic toxicity levels although no recent WQ exceedences have been documented at the monthly NAWQMN station downstream from ISG.

The Big Creek to Navigation Channel segment evaluation used lacusturary sampling results from 1996 and 1999, and lotic sampling results immediately downstream from Big Creek in 1996 and 2000. Year 2000 sampling indicated significant improvement downstream from Big Creek since 1996 that likely coincides with CSO remediation work in the basin. Conversely, severely degraded fish communities found in 1999 may be the result of temporary bypasses of sanitary sewers authorized by Ohio EPA to allow construction of CSO controls.

The Old River Channel of the Cuyahoga is a portion of the river that was isolated when the U.S. Army Corps of Engineers dug a “short cut” from a bend in the river to Lake Erie. The river is dredged to maintain sufficient draft for lake freighters hauling primarily limestone and rock salt. The old channel is situated completely in an urban setting utilized for stone and salt storage, transportation networks, industrial operations and recreational activities. Two CSOs discharge into this river segment. The aquatic life use designation for the Old River Channel is the same as the navigation channel (i.e., either limited resource water, navigation maintenance, or fish passage based upon the season and/or flow in the river.)

Fish communities in the old river channel generally perform better than in the main navigation channel, but the fish contain a very high incidence of tumors, especially in bullhead populations. Based on the fish biological criteria indexes, this segment is considered in FULL attainment of the Cuyahoga River use designation

2.3.2 Lower Cuyahoga River Tributaries

The Lower Cuyahoga River tributaries are discussed here, listed from downstream to upstream.

Kingsbury Run (Confluence RM 4.15)

Kingsbury Run is an urban stream that has been culverted through much of its length and receives significant flows from the NEORSD CSOs. The NEORSD has installed in-stream treatment at the mouth of Kingsbury Run to control "floatables". The old Sohio refinery also has installed an instream oil/water separator in Kingsbury Run and the current land owner continues to maintain this structure. High concentrations of PAH compounds have been identified in Kingsbury Run sediments. The stream currently does not have a designated aquatic life use.

Big Creek (Confluence RM 7.2)

The results of the three sites monitored on Big Creek in 1996 (RMs 7.8, 3.1 and 0.2) indicated no Ohio WQS criteria exceedences excepting numerous violations of the Primary Contact Recreation criterion for Fecal Coliform bacteria. Predominant sources of impairment include CSOs, sanitary sewer overflows (SSOs), and urban runoff. NEORSD and Ohio EPA personnel have responded to numerous reports of sanitary discharges into Big Creek. Many of these were illegal tie-ins to storm sewers that were easily remediated, while other problems such as blockages or breaks have become more frequent. Many problems seem to stem from Parma and other areas in the Stickney Creek watershed (confluence RM 4.91).

Though warmwater habitat attributes were more prevalent than modified attributes, macrohabitats at the three sites evaluated in Big Creek were marginally suited to supporting warmwater stream faunas owing to storm water and urban runoff. Flashy scouring flows denuded the channel of natural cover, leaving behind fractured shale bedrock and artificial substrates (concrete and bricks) as the principle cover type. Riffles were embedded with silt and pulverized bedrock.

Effects of urban runoff were most manifest at the mouth, where the channel was braided with small gravel and pulverized shale. Because of the erodible nature of the parent shale bedrock, the channel was generally well developed and sinuous, especially at the most upstream site, and recovered free flowing character within the confines of revetments.

The fish communities lacked sensitive species, darters, insectivores and simple lithophils, implying habitat limitation and Stoneroller minnows dominated the catch at all sites. This combination of community attributes reflects habitat impacts, organic and nutrient enrichment related to urban storm water and CSOs. Community performance improved in 1996 when compared to the grossly polluted conditions observed in 1984. Compared to 1991 sampling, conditions near the mouth in 1996 (poor) were similar between surveys. Big Creek was not sampled in 2000 but the Cuyahoga River showed substantial improvement immediately downstream from the confluence. The results suggest an improving trend in Big Creek following CSO remediation projects conducted after 1996.

Big Creek Tributaries

Ford Branch Big Creek (Confluence RM 3.95)

This tributary to Big Creek receives the effluent from the Ford engine plant. The stream has been modified throughout its length and the majority of the stream is culverted and impacted by urban land use. Elevated metals in sediments compared to Ohio EPA least impacted reference sites were documented in 1996.

West Creek (Confluence RM 11.05)

West Creek is an urban, predominantly bedrock stream that drains portions of the Cleveland suburbs of Parma, Brooklyn Heights, Seven Hills and Independence. Small lowhead dams and channel modifications in the lower stream reaches contribute to poorer habitat. There are no CSOs but Sanitary Sewer Overflows (SSOs), and septic tanks are problematic throughout most of the creek. Like other urban streams within the Cleveland metropolitan area, NEORSD and Ohio EPA have routinely investigated reports of spills, sewer line blockages, and unauthorized discharges in the West Creek basin. Biological communities were mostly fair throughout the streams length. NEORSD macroinvertebrate sampling revealed significant declines in West Creek quality between 1991 and 1998. OEPA 2000 data and independent sampling conducted by the West Creek Preservation Committee indicates continued impairment.

Coliform exceedences were found throughout the creek. Several heavy metals exceedences were detected near the mouth. These exceedences coincided with extremely high suspended solids (TSS) in the stream during low flow conditions. The high TSS could not be traced back to its source, but is believed to be a result of construction activity.

Mill Creek (Confluence RM 11.49)

Mill Creek has improved to the extent that the grossly polluted conditions associated with dry weather sanitary sewer overflows (SSOs) in the early 1980s have been largely eliminated. Substantial remediation of SSOs, CSOs and exposed landfills near the mouth has been conducted in the last decade and CSO control projects are ongoing. However, in addition to the remaining CSOs and the background urban landscape, sanitary sewer overflows (SSOs) from aging sewers, spills, and landfills continue to severely impact communities.

In 1996 chemical samples were collected at RM 3.1 (adj. To State Route 14) and at the mouth of Mill Creek. At RM 3.1 Secondary Contact Recreation criterion violations for fecal coliform bacteria were detected under both dry weather and wet weather conditions. Municipal sewer systems in the Maple Heights/upper Mill Creek area have had chronic problems with collapsed sewer lines, sewer line blockages, illegal tie-ins, etc. (NEORSD annual reports 1992-1996). The bacteriological results provided further evidence of the need for rehabilitation of the sewer system in this area.

Numerous biological surveys conducted by Ohio EPA and NEORSD since 1991 show fish and macroinvertebrate community health has ranged from poor (1991, 1996, 2000, 2001) to fair (1995, 1996, 2000) to marginally good (1999 NEORSD macroinvertebrates). Two large sewer line breaks in particular may have affected OEPA results in 1991 and 2000.

Unnamed Trib. to Cuyahoga R. (Confluence at RM 15.11)

This very small Cuyahoga River tributary located just south of Cleveland near Independence. While there were indications of recovery from past channelization activity, habitat alteration and urban runoff were considered the primary causes and sources of impairment. Based on the recovering channel morphology, marginally good habitat quality, and high stream gradient, the WWH use designation is appropriate. The condition of both fish and macroinvertebrate communities was fair.

Tinkers Creek (Confluence RM 16.36)

The 1996 Tinkers Creek water chemistry data collected at RM 0.1 showed no exceedences of WQS Criteria. However, nitrate concentrations continue to be markedly elevated with a mean 6.81 mg/l (the 1991 mean was 7.6 mg/l). In contrast to lower Tinkers Creek, the median nitrate concentration from similarly sized reference streams in the EOLP ecoregion is 0.425 mg/l (n=298) (Ohio EPA 1999c). The excessive nitrates reflect the effluent dominated nature of the creek and improved ammonia nitrification at the major municipal WWTPs in the basin. While certainly less toxic than ammonia, it is possible that elevated nitrates may limit biological potential in Tinkers Creek. Water quality conditions at the mouth have not changed appreciably when compared to 1991 results.

The headwaters of Tinkers Creek are wetland influenced and support fair quality fish communities, fairly typical of swampy streams. Further downstream, fish communities drop to the poor range downstream from the Streetsboro WWTP. Changes to the watershed include increased stretches of channelized habitat and increased suburban development. Nutrient levels were elevated below the WWTP but other factors, such as barriers to fish migration (i.e., waterfalls located downstream at RM 5.6), excessive turbidity, or other unknown causes and sources of impairment may contribute to the NON attainment.

Tinkers Creek becomes increasingly urbanized and effluent dominated as it flows downstream. Physical habitat at the mouth of Tinkers Creek is capable of supporting a typical warmwater stream fauna; the QHEI score was 70.5. The channel was sinuous and well developed, and contained boulder, cobble and gravel substrates. Woody debris was also present in the channel. The creek receives inputs from major WWTPs in Aurora, Twinsburg, Bedford, Bedford Heights, and Solon. Nutrient levels were persistently elevated downstream from the point sources, particularly below the Solon WWTP (via Beaver Meadow Run) and Bedford Heights WWTP on Hawthorne Creek. Fish communities in 2000 remained in the poor to fair range and have shown minimal improvement over the past decade.

Macroinvertebrates meet WWH criteria but tended to decline from upstream to downstream. Significant improvement in the macroinvertebrates at RM 8.5 was related to the elimination of oil and grease contamination below the county garage since 1991.

Tinkers Creek Tributaries

Wood Creek (Confluence with Tinkers Creek RM 2.44)

Wood Creek is a small, urbanized, high gradient Tinkers Creek tributary. The headwaters receive urban drainage and wastewater from the Bedford WWTP and the lower reaches flow through a park. Habitat quality at the mouth (QHEI = 62) is adequate to support WWH. Nutrient levels (primarily nitrate) were elevated in 2000 and related to the WWTP discharge. There have been chronic problems in the past with pollutant spills and sewer overflows in the urban headwaters. These problems are similar to those found in the Mill Creek watershed as the Wood Creek and Mill Creek headwaters are adjacent to each other.

The existing LRW use was based on 1984 results. Steep gradient (91ft/mi.) and flashy flows were thought to preclude reestablishment of WWH communities. Fish were absent from 3 sites and macroinvertebrates were very low in density and diversity. 2000 results at the mouth show slight improvement in fish (IBI= 20/poor) and a significant increase in macroinvertebrate taxa (from 0 to 30). The 2000 results, coupled with reanalysis of the 1984 results indicate WWH is the more appropriate use. Similar small, steep gradient tributaries in the Cuyahoga River, Euclid Creek, and Chagrin basins are designated or attain WWH.

Deer Lick Run (Confluence with Tinkers Creek RM 3.72)

Deer Lick Run is a small, severe gradient (93 ft/mile) tributary in the Tinkers Creek gorge. Waterfalls and shallow, glide-type flow on bedrock preclude the establishment of WWH fish communities and for these reasons the stream is designated LRW (Limited Resource Water). Primary Contact Recreation criterion for fecal coliform bacteria and WWH chemical/physical criteria were met. The nearly inaccessible, and unsampled, mouth of the stream has a lower gradient and is assumed to be suitable for the designated WWH use.

NON attainment of the LRW designation was due to absence of fish, primarily a result of small drainage (< 1 sq. mi.), high gradient, and possibly historical elimination caused by (now eliminated) wastewater discharges. Macroinvertebrates were fair but improved significantly when compared to the poor, toxic conditions found during a previous, 1984 survey. If fish populations had been present historically, they were probably eliminated by the toxic impacts.

The upper reaches of Deer Lick Run are designate LRW but should be considered candidates for the Primary Headwater Designation (PHWH) designation (currently under development) when, and if, the designation is adopted.

Beaver Meadow Run (Confluence with Tinkers Creek RM 10.62)

Beaver Meadow Run is a small tributary to Tinkers Creek that receives the discharges from Zircoa and the Solon municipal WWTP. Zircoa discharges to the very headwaters of Beaver Meadow Run and contributes high loads and concentrations of dissolved solids to the stream. The stream segment downstream from Zircoa and upstream from the Solon WWTP was in non-attainment for both fish and macroinvertebrate communities.

Nutrient levels increased sharply, an ammonia violation was detected, and D.O. levels declined below the WWTP. The condition of fish (good) and macroinvertebrates (fair) resulted in Partial attainment downstream from the WWTP. Macroinvertebrate communities were predominated by nutrient tolerant forms. Species diversity and EPT taxa richness also tended to be lower below the WWTP than in other, similar small tributaries in the basin.

Partial attainment in 2000 was an improvement over Non attainment in 1991. Positive changes appear the result of improved waste treatment and repair of a broken sewer line. Ultraviolet disinfection replaced chlorination at the WWTP in 1996.

Pond Brook (Confluence with Tinkers Creek RM 22.51)

Pond Brook is a channelized, wetland stream designated MWH based on its low habitat quality and ongoing channel maintenance under the Ohio Drainage Law (ORC 6131) (1991 survey results). The stream is mostly pooled, and receives drainage from adjacent wetlands, suburban development, and effluent from two WWTPs. Fish and macro-invertebrates were fair but met the designated MWH use and is now in FULL attainment of its designated use based on 2000 survey results.

Unnamed Trib. (RM 0.18) to North Branch Tinkers Creek (RM 25.44)

The mouth of this small stream is in full attainment based upon qualitative macroinvertebrate sampling. Macroinvertebrate populations were similar to, or better than collections from similar WWH designated streams in the watershed. The headwaters (i.e., the North Branch) are in non attainment for both macroinvertebrates and fish communities due to habitat modifications and suburban development in Hudson. The WWH Use Designation is appropriate based upon the stream's natural channel morphology, sustained, late summer base-flow condition, and good quality community.

Unnamed Tributary to Tinkers Creek at RM 27.72

This tributary at the time of the 303(d) listing received the discharge from a WWTP in Streetsboro. A regional WWTP consolidated flows in 1985 from several package type WWTPs that discharged in the Streetsboro area and includes Humphrey Park, Gillie Estates, Arrowhead Estates and Rolling Hills. Despite the elimination of flows from the WWTPs, the tributary to Tinkers Creek was still in non-attainment. Land use, channel modification and natural conditions (wetlands) contribute to the non-attainment.

Sagamore Creek (Confluence RM 18.08)

This headwaters of Sagamore Creek is a small stream that drains portions of Sagamore Hills and Northfield. Land use consists of urban/industrial and suburban development. Several spills and unauthorized releases from industrial facilities have been documented to the stream. Failing septic systems have also been documented in the watershed. Sanitary sewers are currently being constructed to eliminate these domestic wastewater sources. Biological communities were fair and in non-attainment of the recommended WWH use.

The lower 2.3 miles of Sagamore Creek are located within the Cuyahoga Valley National Park. Biological communities near the mouth were of good quality and also met minimum standards for Coldwater Habitat (CWH) designation.

Chippewa Creek (Confluence RM 20.88)

Compared to a 1984 survey, fish populations in 1996 from the upper portion of the watershed were relatively unchanged and remained in non-attainment (poor quality). The Norton landfill had no noticeable effect on either the fish community or water quality of Chippewa Creek. Chippewa Creek was in substantial compliance with chemical WQS criteria throughout it's length. Substantial improvement in the fish community was documented near the mouth of Chippewa Creek. The comparative lack of improvement in the upper watershed was attributed to failing septic systems, nonpoint sources and upstream migration barriers posed by waterfalls which may hamper recruitment from downstream populations.

Chippewa Creek Tributaries

Unnamed Tributary to Chippewa Creek (RM 6.36)

This small headwater tributary to Chippewa Creek contains no known point source discharges. Suburban land use and construction activities (sewer construction) were believed to be the causes of non attainment. Contaminants from sewer bedding and backfill materials for the sewers were documented likely contributed to the non attainment.

Brandywine Creek (Confluence RM 24.17)

The upper watershed has seen significant suburban development in the Hudson area and several new, highly eutrophic lakes have been constructed in the headwaters. Poor quality biological communities and enriched conditions were observed at Prospect Rd. (RM 10.0), downstream from Hudson and upstream from the former Hudson #5 WWTP. However, no obvious water quality problems were detected in water chemistry samples. Communities improved but remained impaired (Partial attainment) at Hines Hill Road (RM 7.1) and reached Full attainment (good quality) near the mouth. Conditions near the mouth were much improved compared to 1996 collections and Full attainment documented in 2000 was the first recorded by Ohio EPA in Brandywine Creek since sampling began in1984. Natural barriers to fish migration (waterfall) may inhibit recolonization of the stream above the waterfall.

High conductivity levels encountered in 1996 near the mouth were not detected in 2000. The 1996 levels were traced as far upstream as Hudson. A specific source was not found but is believed to have originated from the Hudson WWTP. The Hudson plant was converted into a pump station in 1996 that directed waste to the NEORSD Southerly WWTP.

Brandywine Creek Tributaries

Indian Creek (Confluence with Brandywine Creek RM 3.89)

Indian Creek is a small Brandywine Creek tributary that receives urban/suburban drainage from the Macedonia area. Fish communities were marginally good but macroinvertebrate communities were fair, resulting in Partial attainment. Numerous tolerant snails (Physella) and oligochaetes at RM 1.0 suggest an organic enrichment/DO problem but no obvious indications of sewage were observed on-site or in chemical sampling. Stream habitat in the lower mile was fair (Avg QHEI = 49) but this section of the stream is historically channelized and listed under maintenance.

Based on attainment of the fish, lack of channel maintenance in the remainder of the basin, and adequate gradient (Avg.15.3 ft/mi.), the WWH use is recommended.

Haskell Run (Confluence RM 29.82)

Haskell Run is a small tributary to the Cuyahoga River that is mostly contained within the Cuyahoga Valley National Park. A Boy Scout Camp, a large lake, and several small package plants are located in upper basin. The Brandywine Golf Course is located in the lower reaches along Cuyahoga flood plain.

The stream is in full attainment immediately downstream from the from the small package WWTPs. Partial attainment was found in the stream near the mouth as it coursed through a golf course. Removal of the riparian vegetation and nutrients believed to be a result of golf course run-off resulted in fair quality macroinvertebrate communities. Except for sulfate, there were no obvious elevated chemical parameters in 2000. However, heavy algal growth below the golf course was also observed in 2001 during very low summer flows and points to elevated nutrient levels.

Yellow Creek (Confluence RM 37.16) and North Fork Yellow Creek (Confluence with Yellow Creek RM 4.64)

The North Fork of Yellow Creek was sampled immediately upstream from the Robinwood Hills WWTP. Fish communities were exceptional and improved over the good quality conditions found in 1991 by NEDO. Macroinvertebrates were considered marginally good due to the low number of mayfly, caddisfly and stonefly taxa (EPT = 5). However, the collections included several coldwater varieties and pollution intolerant midge taxa. Chemical sampling results suggest no significant water quality problems.

The lower 4-5 miles of Yellow Creek (downstream from the North Branch and Robinwood WWTP) continue to meet WWH criteria. Good to very good communities have been found since initial sampling was conducted in 1988.

Attainment was also Full upstream from the North Branch at RM 5.3. However, fish were only marginally good and macroinvertebrate health appeared strikingly different between the artificial substrate (very good quality) and natural substrate (approx. fair quality) samples. Excessive siltation appeared responsible for the lower quality populations with suburban development the suspected source. One fecal coliform exceedence and elevated suspended solids levels were detected in chemical samples.

Development pressures in the upper Yellow Creek basin appear the primary threat to continued attainment in the watershed. Yellow Creek also serves as fish refugia and repopulation epicenters for the Cuyahoga River mainstem.

Sand Run (Confluence RM 39.12)

Habitat in Sand Run was impaired by urban runoff and storm water from Akron and Fairlawn. The channel was sinuous and developed, contained a variety of substrates of differing sizes, and was bordered by a wide riparian corridor. However, flashy stream flows due to storm water severely eroded the banks and substrates were extensively embedded. Consequently, the habitat was marginally suited to warmwater habitat faunas. In addition to urban development in the headwaters, about five to seven small low-head dams are also located along the length of the stream. The dams could pose a barrier to fish migration and recolonization and should be evaluated for removal.

Fish communities in Sand Run were severely impacted by urban storm water runoff from the city of Fairlawn. Effects of flashy flows were evident in severe bank erosion, embedded substrates, and a destabilized channel. As such, only six species were collected, of which three were tolerant and composed 97% of the community. Macroinvertebrate collections near the mouth found only fifteen total taxa and three EPT taxa in very low densities.

Mud Brook (Confluence RM 39.78)

Biological communities near the mouth were in full attainment of the designated WWH criteria. The lower reaches of the stream are located in or near the Cuyahoga Valley National Park (CVNP) and serve an important function as fish refugia and repopulation epicenters for the Cuyahoga River mainstem. The drainages of the lower stream segments are mostly forested and characterized by high stream gradient, intact physical habitat and no documented WQS criteria exceedences.

Upper Mud Brook is sluggish, channelized, and wetland influenced. A six mile reach between RMS 10.7 - 4.7 was listed under ditch maintenance but currently there are no active programs for dredging. The biology was in NON attainment of the existing WWH use due to the poor fish community. Macroinvertebrates were marginally good based on quantitative sampling but qualitative sampling from the natural substrates appeared fair and reflected the lower available habitat and substrate quality (silt/sand). Low DO and high suspended solids levels were documented in chemical sampling.

Despite elimination of the Hudson #6 WWTP in 1987, the biological communities (particularly the fish) have show little improvement since 1984. NH3 levels were much lower in 2000 and DO improved to a lesser degree.

Historic channelization, low gradient (3.44 ft/mi), and lack of biological improvement was the basis for an MWH recommendation. However, numerous public and private organizations in the upper basin are involved in stream protection and restoration projects. These include the Hudson Land Conservancy, Hudson Garden Club, Wyoga Lake Home Owners Assn., the Cities of Hudson and Stow, the Cuyahoga RAP, ODNR (Nat. Areas and Preserves), and Ohio EPA. Based on land use files and landsat imagery, the upper watershed still has a large percentage of open space. With intervention, restoration efforts have a decent chance of success. “Downgrading” from WWH to MWH will likely lower interest in the watershed and make additional restoration efforts more unlikely. For these reasons, the WWH use should be retained.

Unnamed Trib. to Mud Brook (Confluence with Mud Brook at RM 5.48)

This is a small, channelized (lower section) former wetland stream choked with vegetation. Substrates were primarily soft sand and clay. Fish were fair and macroinvertebrates were poor, reflecting modified habitat and low DO levels. D.O. readings below 3.0 mg/l were routinely detected during chemical/physical sampling. Suburban development covers much of the upper basin.

Based on the habitat and biological conditions the lower mile of stream is a candidate for a modified (MWH) designation. However, because of widespread stream protection and restoration efforts in the surrounding Upper Mud Brook watershed, the WWH use is recommended. The restoration and stream protection efforts are watershed-based and could positively impact conditions in the Unnamed Tributary in the future.

Little Cuyahoga River (Confluence RM 42.27; Ohio Canal (Confluence with L. Cuyahoga River, RM 2.04))

These watersheds were characterized by hardened urban landscapes which often included CSO discharges (Little Cuyahoga River, Ohio Canal, Camp Brook), and marginal physical habitat, substrate, and riparian quality. Most stream segments experienced numerous chemical WQS criteria exceedences, pollutant spills and unauthorized discharges (Ohio EPA 1994), intermittent toxicity, and a legacy of historic environmental insults. Fish and macroinvertebrate communities were generally of poor quality and in non-attainment of WWH biocriteria.

Poor habitat, urbanization and City of Akron CSOs combine to create non-attainment of water quality standards in the portion of the Ohio Canal that is tributary to the Little Cuyahoga River. The largest flows from the Akron CSO system discharge to the canal. The City of Akron's initial implementation of nine minimum controls have resulted in improved water quality and aquatic communities, but sampling prior to 2000 revealed chemical/physical water quality exceedences, fecal coliform and E. coli bacteria primary contact recreation criteria and fish and macroinvertebrate biocriteria. Studies by USGS and the National Park indicate that the Ohio Canal is a significant source of bacterial contamination to the Cuyahoga mainstem.

Little Cuyahoga River Tributaries

Camp Brook (Confluence with L. Cuyahoga R. RM 4.11)

Camp Brook is a small tributary in Tallmadge and Akron that flows into the Little Cuyahoga River. The watershed is primarily urban/suburban that has had its channel modified throughout most of its length. The brook receives the discharge from a high volume CSO. In-stream toxicity was reported to the Ohio EPA but was not found in subsequent sampling. PAHs and metals in sediments. Biological communities were in non attainment of the designated WWH biological criteria, however no change in the use designation is recommended as the physical habitat was of sufficient quality to support a WWH fauna, and existing habitat impairment appeared to be related to upstream construction activities. The CSO (Rack 12) was identified as significant source of impairment. Overall, the physical habitat in Camp Brook was marginally capable of supporting warmwater communities.

Roosevelt Ditch (Confluence with L. Cuyahoga R. RM 8.69)

Roosevelt Ditch is an urban drainage way flowing through high density residential neighborhoods. The macroinvertebrate community in Roosevelt Ditch did not meet the biological criteria for WWH in a 1996 Ohio EPA survey. The City of Akron had sampled the biologic community at RM 0.1 and found good communities while the Ohio EPA survey in 1996 from the same location found poor communities. Differences between the evaluations are related to stream bank stabilization (rip-rap) and sewer line maintenance next to the site in 1996 which severely impacted the habitat. Concentrations of phosphorus, nitrate-nitrite, zinc and lead in the water column were highest in Roosevelt Ditch, again likely due to recent soil disturbance from sewer construction/stream modifications and adsorption of contaminants to soils washed into the stream.

Springfield Lake Outlet (Confluence with L. Cuyahoga R. RM 7.09)

Springfield lake outlet is a small tributary that drains Springfield Lake to the Little Cuyahoga River. Land use in the watershed is primarily urban/industrial. Fish communities in Springfield Lake Outlet reflect a disturbed environment. Storm water runoff negatively impacted both the habitat and fish community as evidenced by severe bank erosion and embedded and compacted substrates. Impacts to the fish community beyond habitat limitation is inferred from the high relative abundance of tolerant fishes and the absence of sensitive species, coupled with the same IBI score as RM 1.3 in Wingfoot Lake Outlet despite a 20 point swing in QHEI scores. Severely contaminated sediments may be a cause for continued impairment and the apparent toxic response in the fish community. Sediments in Springfield Lake Outlet are contaminated with polynuclear aromatic hydorcarbons, polychlorinated biphenyls and heavy metals. Recovery of the fish community in Springfield Lake Outlet will likely be tied to recovery in the Little Cuyahoga River. While still degraded, 1996 collections represented a significant improvement from *poor* to *fair* compared to a survey in 1986. Continued impacts in 1996 are probably related to urbanization and industrial land use.

Wingfoot Lake Outlet (Confluence with L. Cuyahoga R. RM 11.00)

Wingfoot lake outlet is a small tributary that drains Wingfoot Lake to the Little Cuyahoga River. Land use in the watershed is primarily rural/suburban with some agriculture and a small portion occupied by Industrial facilities in the Village of Mogadore. Biological communities were in non-attainment of WWH biological criteria. The stream is a channelized course generally lacking habitat attributes associated with normal streams but is relatively high gradient and could foster redevelopment of positive habitat attributes. Copper concentrations in the Little Cuyahoga River were highly and extremely elevated immediately downstream from Mogadore Reservoir and the Wingfoot Lake Outlet, respectively. Copper sulfate is a herbicide commonly used to control algae in reservoirs. Sediments in Wingfoot Lake Outlet were found to be contaminated with polynuclear aromatic hydorcarbons, polychlorinated biphenyls and heavy metals. Recovery of the fish community in Wingfoot Lake Outlet will likely be tied to recovery in the Little Cuyahoga

Union Oil Tributary (Confluence with L. Cuyahoga RM 11.59)

The Union Oil tributary was previously channelized, and as such, the habitat is now dominated by modified attributes and is impaired. The channel had limited development and sinuosity, substrates were embedded by sand and silt, and cover was composed mostly of overhanging vegetation. But, as it is not actively maintained and has a gradient sufficient to foster recovery, the channel has reestablished several warmwater attributes; specifically, cobbles and gravel substrate were exposed, woody debris supplied some cover, and several deep pools were formed.

Qualitative sampling was conducted in both 1986 and 1996 at RM 0.5. The 1996 sample included 34 total taxa and was predominated by net-spinning caddisflies, baetid mayflies, riffle beetles, and midges. Three taxa indicative of cold water habitats (the caddisfly *Ceratopsyche slossona*e, and midges *Prodiamesa olivarica* and *Micropsectra s*p) were also collected, suggesting groundwater moderates ambient stream temperatures. EPT taxa richness (4) was low and fell below that expected for similar streams in the ecoregion. While no obvious pollution impacts were observed, community performance was considered fair due primarily to low EPT taxa richness. Community performance declined from marginally good to fair between 1986 and 1996. The primary reason for the lower evaluation was low EPT taxa richness (four in 1996) compared to eight in 1986.

Table 4. Land use distribution in the Lower Cuyahoga River basin		
Land Use	**Acres**	**% of Total**
Open Water	4200	1.38%
Low Intensity Residential	65728	21.74%
High Intensity Residential	19737	6.53%
Commercial/Industrial/Transportation	33179	10.97%
Quarries/Strip Mines/Gravel	298	0.99%
Transitional	1038	0.34%
Deciduous Forest	108123	35.7%
Evergreen Forest	2980	0.98%
Mixed Forest	1734	0.57%
Grasslands/Herbaceous	115	0.03%
Pasture/Hay	34507	11.41%
Row Crops	14281	4.72%
Urban/Recreational Grasses	5878	1.94%
Woody Wetlands	8357	2.76%
Emergent Herbaceous Wetlands	2059	0.68%
Total:	**302214**	**100%**

Table 4a. Park land in the Lower Cuyahoga River TMDL area (302,214 total acres in TMDL watershed area)		
	Acres	% of TMDL Area
Cuyahoga Valley National Park	33,000	10.9
Ohio Department of Natural Resources	1,143	0.37
Cleveland Metroparks	6,913	2.28
MetroParks Serving Summit County	7,400	2.4

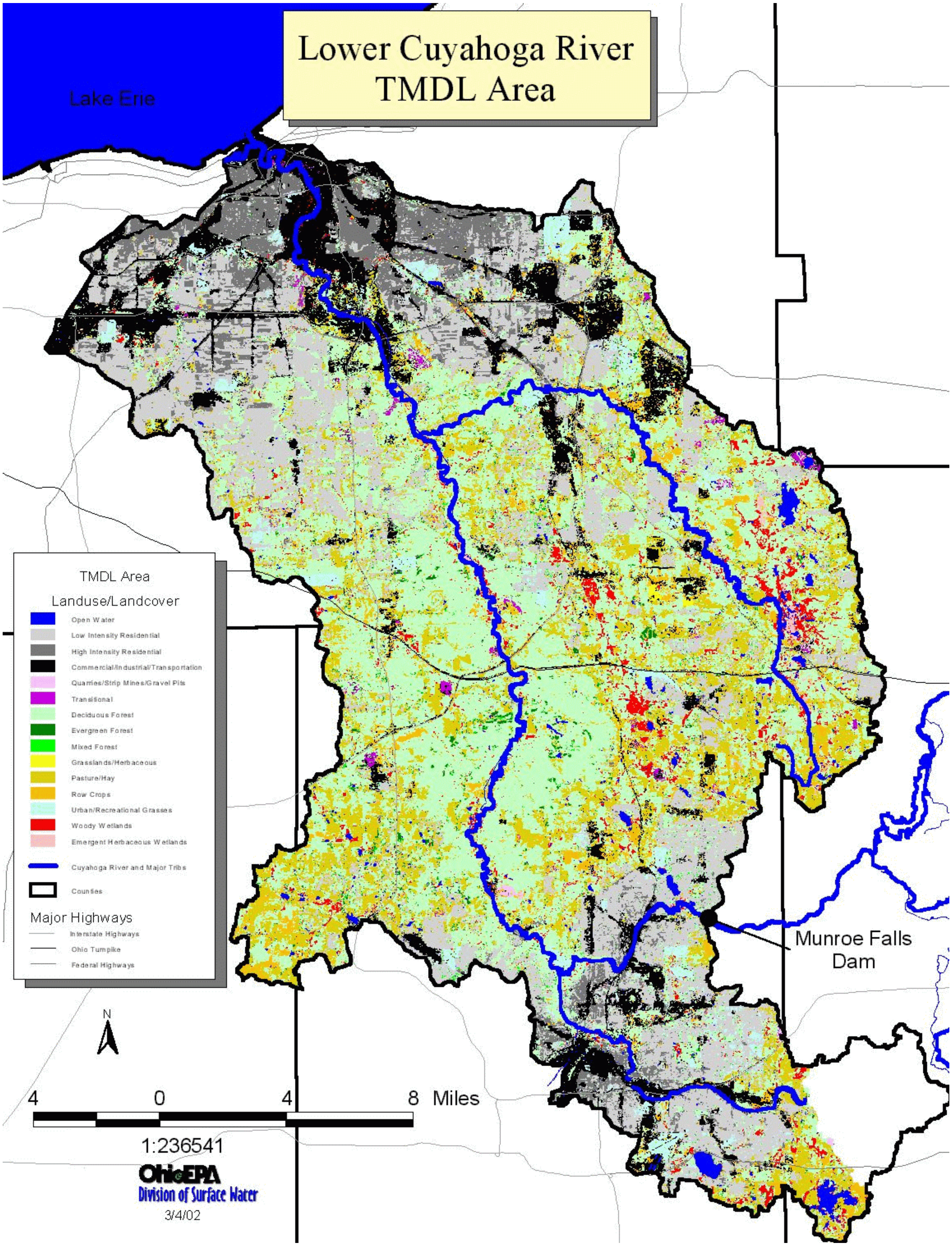


Figure 3. Land use/cover map for the Lower Cuyahoga River basin

3.0 PROBLEM STATEMENT

The goal of the TMDL process is full attainment of the Water Quality Standards (see Table 3). In particular, attainment of the numerical biological and dissolved oxygen criteria. As described in Section 2 the water quality and biological assessment of the Lower Cuyahoga River watershed indicates that the non-attainment of WQS is primarily due to organic enrichment, sedimentation and habitat degradation. These correspond to non-attainment of the criteria for dissolved oxygen and the numeric biocriteria.

3.1 Target Identification

The establishment of instream numeric targets is a significant component of the TMDL process. The numeric targets serve as a measure of comparison between observed instream conditions and conditions that are expected to restore the designated uses of the segment. The TMDL identifies the load reductions and other actions that are necessary to meet the target, thus resulting in the attainment of applicable water quality standards.

Numeric targets are derived directly or indirectly from state narrative or numeric water quality standards (OAC 3745-1). In Ohio, applicable biocriteria are appropriate numeric targets (see section 2.2). Determinations of current use attainment are based on a comparison of a stream's biological scores to the appropriate criteria, just as the success of any implementation actions resulting from the TMDLs will be evaluated by observed improvements in biological scores.

<u>Dissolved Oxygen</u>

The instream dissolved oxygen (D.O.) is the primary chemical/physical specific parameter not fully attaining WQS. The measurable endpoint of this TMDL process is to attain the D.O. water quality criterion at all times including summer, low flow critical conditions. The D.O. criteria for the Warmwater Habitat segments is a 5.0 mg/l average over a 24-hour period and a 4.0 mg/l minimum. For the Exceptional Warmwater Habitat segments the criteria is a 6.0 mg/l average over a 24-hour period and a 5.0 mg/l minimum. The Cuyahoga River Ship Channel (River Mile 5.6 - 0) has a minimum dissolved oxygen limit of 1.5 mg/l. Water Quality Standards specific to the Cuyahoga River are listed in Appendix K.

<u>Biocriteria</u>

The biocriteria are the final arbiter of attainment of a use designation. After the control strategies have been implemented, biological measures including the IBI, ICI, QHEI and MIwb will be used to validate biological improvement and biocriteria attainment. The current attainment status of the biocriteria is listed in Appendix D.

Nutrients

Numeric targets are derived directly or indirectly from state narrative or numeric water quality standards (OAC 3745-1). In Ohio, applicable biocriteria are appropriate numeric targets (see section 2.2). Determinations of current use attainment are based on a comparison of a stream's biological scores to the appropriate criteria, just as the success of any implementation actions resulting from the TMDLs will be evaluated by observed improvements in biological scores. Ohio EPA currently does not have statewide numeric criteria for nutrients but potential targets have been identified in a technical report entitled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (OEPA, 1999). This document provides the results of a study analyzing the effects of nutrients on the aquatic assemblages of Ohio streams and rivers. The study reaches a number of conclusions and stresses the importance of habitat and other factors, in addition to instream nutrient concentrations, as having an impact on the health of biologic communities. The study also includes proposed targets for nitrate+nitrite concentrations and total phosphorus concentrations based on observed concentrations at all sampled ecoregional sites. The total nitrate-nitrite and phosphorus targets are shown in Table 5. It is important to note that these nutrient targets are not codified in Ohio's water quality standards; therefore, there is a certain degree of flexibility as to how they can be used in a TMDL setting.

Table 5. Target Concentrations for Phosphorus and Nitrate-Nitrite

Target Concentrations for Phosphorus		
Erie-Ontario Lake Plain		Phosphorus Concentration (mg/l)
Headwaters	<20 mi^2	0.05
Wadable	>20 mi^2 <200 mi^2	0.07
Small Rivers	>200 mi2 <1000 mi^2	0.12
Target Concentrations for Nitrate-Nitrite		
Erie-Ontario Lake Plain		Nitrate-Nitrite Concentration (mg/l) (75th % value)
Headwaters	<20 mi^2	1.0
Wadable	>20 mi^2 <200 mi^2	1.05
Small Rivers	>200 mi2 <1000 mi^2	1.42

Habitat

Habitat loss has been identified as a cause of impairment in the Lower Cuyahoga River. OAC 3745-1-04(A) states that all waters of the state shall be free from suspended solids and other substances that enter the waters as a result of human activity and that will settle to form objectionable sludge deposits, or that will adversely effect aquatic life. However, no statewide numeric criteria have been developed specifically for sediment or TSS. Instead, target Qualitative Habitat Evaluation Index (QHEI) scores, based on reference data sites for some of the aquatic life use designations, can be used as surrogates.

The QHEI is a quantitative composite of six physical habitat variables used to 'score' a stream's habitat. The variables are: substrate, instream cover, riparian characteristics, channel characteristics, pool/riffle quality, and gradient and drainage area. It can be used to assess and evaluate a stream's aquatic habitat, and determine which of the 6 habitat components need to be improved to reach the QHEI target score. The substrate variable incorporates sediment quality and quantity and therefore, provides a numeric target for sedimentation.

The Warmwater Habitat use designation QHEI target is 60. In addition, since habitat is strongly correlated with the IBI biocriterion, the QHEI provides a target and format to evaluate how habitat issues and impairments effect attainment of the aquatic use designations. Degraded habitat has been identified as a major cause of non-attainment in several stream segments within the Upper Cuyahoga River TMDL area. Targets for habitat characteristics Lower Cuyahoga River are presented in Table 6 and QHEI data is presented in Appendix L and have been taken from the technical report entitled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (OEPA, 1999). Additional discussion of the Ohio EPA's QHEI methodology can be found in *The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (OEPA, 1989, web link:* http://www.epa.state.oh.us/dsw/documents/BioCrit88_QHEIIntro.pdf*)*

Table 6. QHEI attribute (criteria) that can serve as management goals or endpoints for efforts to restore, enhance, or protect aquatic life in streams.

Attribute	"Criteria" WWH	EWH
Number of any Modified Attributes	≤4	≤2
High Influence Modified Attributes	≤1	0
Substrate Metric Scores	≥13	≥15
Substrate Embeddedness Score	≥3	4
Channel Metric Score	≥14	≥15
Overall QHEI	≥60	≥75

Area of Concern

The Lower Cuyahoga River is also part of the Cuyahoga River Remedial Action Planning Area. The Great Lakes Water Quality Agreement of 1978, and its 1987 Protocol Amendments, required identification of Areas of Concern and identified a list of 14 beneficial use impairments to be addressed in the Remedial Action Plan. Annex 2 of the Great Lakes Water Quality Agreement contains the following beneficial use impairments:

- restrictions on fish and wildlife consumption;
- tainting of fish and wildlife flavor;
- degradation of fish wildlife populations;
- fish tumors or other deformities;
- bird or animal deformities or reproduction problems;
- degradation of benthos;
- restrictions on dredging activities;
- eutrophication or undesirable algae;
- restrictions on drinking water consumption, or taste and odor problems;
- beach closings;
- degradation of aesthetics;
- added costs to agriculture or industry;
- degradation of phytoplankton and zooplankton populations; and
- loss of fish and wildlife habitat.

A specific impairments list for the Cuyahoga River Area of Concern is contained in Section 3.2.

In 1988 the Ohio EPA appointed the Cuyahoga River RAP Coordinating Committee and charged them to identify the existing use impairments, their sources and causes, and to develop and implement remedial measures or actions to eliminate the impairments. The 1992 *Cuyahoga River Remedial Action Plan Stage One Report - Impairments of Beneficial Uses and Sources of Pollution in the Cuyahoga River Area of Concern* identified loss of habitat, non-point sources of pollution, dams, and combined sewer overflows as the principle causes of the use impairments in the lower Cuyahoga River watershed. Since that time, the RAP and its partner organizations have implemented numerous stream and wetland restoration and protection projects, educated local citizens about non-point source pollution and controls, supported combined sewer overflow control measures, and worked with local officials to implement riparian and wetland protection ordinances. Further information about the Cuyahoga River RAP and its current activities may be found in Appendix I.

3.2 Identification of Current Deviation from Target

Dissolved Oxygen

Dissolved oxygen data were collected under various flow and loading conditions in 1998. It is important to note that none of the data collection surveys were conducted under critical conditions; therefore, it is difficult to present a firm current deviation from the target as current critical condition instream D.O. concentrations have not been measured. The existing data, however, do give an estimate of the current deviation. The graphs on the next page give a picture of this deviation. A list of water quality violations detected in the 2000 survey is included in Appendix B.

Bacteria

Fecal coliform violations were present at numerous sites in the Lower Cuyahoga River TMDL area. A complete list of violations and exceedences of recreation criteria are identified in the 2000 survey is located in Appendix B. Water Quality Standards also include narrative criteria indicating that all waters are to be “free from public health nuisances associated with raw or poorly treated sewage.”

Habitat

Deviations from habitat goals are those QHEI values less than 60 for Warm Water Habitat streams. The graph in Figure 4 lists Cuyahoga River mainstem values in relation to the target score of 60.

Phosphorus

Phosphorus concentrations measured at levels above recommended target values are listed in Appendix G. Target phosphorus values are those discussed in Section 3.1 and presented in Table 5.

Biocriteria

As previously noted, the deviation or the attainment of the IBI, ICI, and MIwb is detailed in Appendix D. A more detailed description of Ohio EPA’s biocriteria can be found in Ohio EPA’s *Biological Criteria for the Protection of Aquatic Life*, web link at: http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html.

Area of Concern

Table 7 lists the current status of the Cuyahoga River Area of Concern in relation to the 14 beneficial use impairments. (Table is from *Cuyahoga River Remedial Action Plan State of the River Report and Proceedings of the October 25, 2001 Symposium, January 2002*)

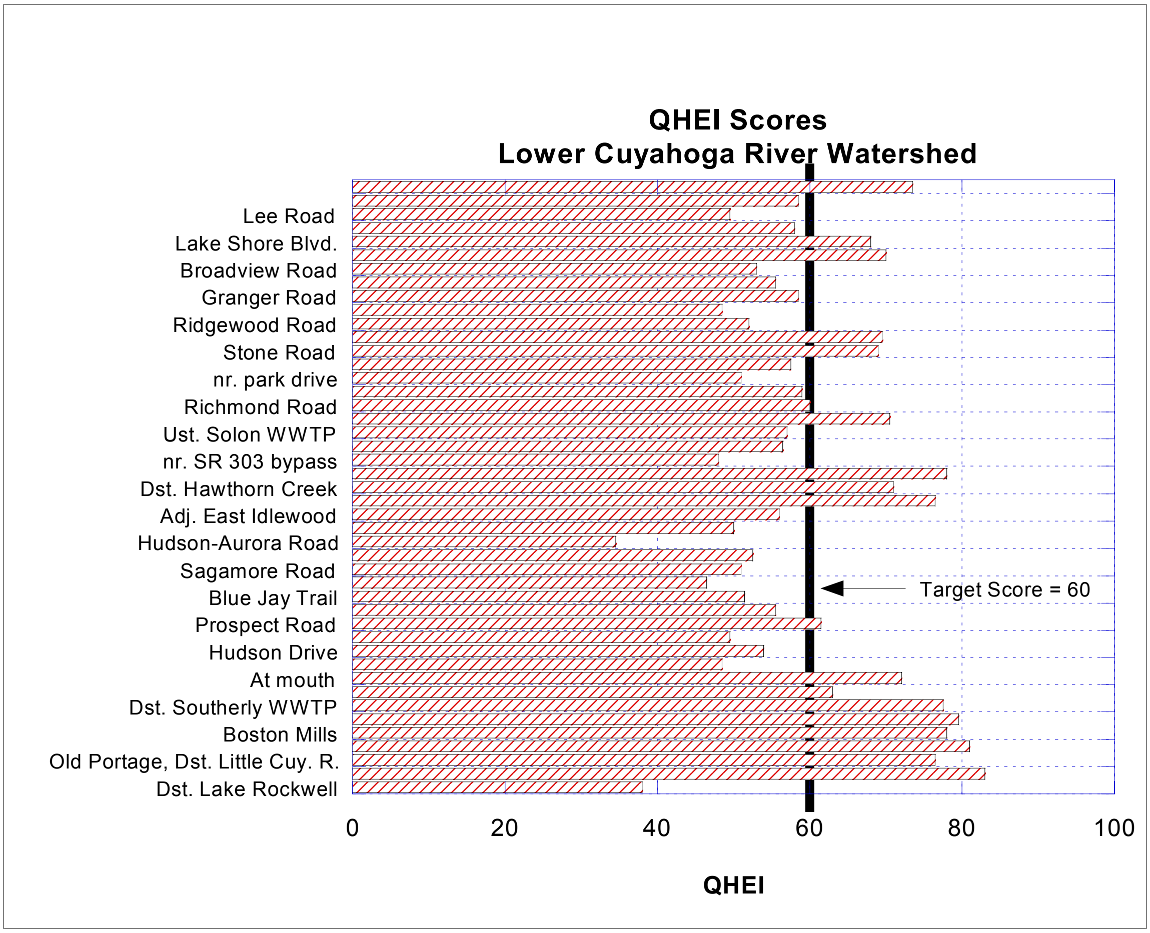


Figure 4 QHEI scores for the Lower Cuyahoga River

Table 7– Cuyahoga RAP beneficial use impairments

AQUATIC LIFE	**CURRENT STATUS**	**INDICATORS**
Degraded fish populations Previously considered "IMPAIRED"	MUCH BETTER, *but still impaired in some places*	Fish populations have improved significantly with over 70 species now found, including many pollution sensitive species such as smallmouth bass; fishing is now common along the lakefront and riverfront sites; in the 2000 OEPA survey fish communities in some portions of the Cuyahoga mainstem between Akron and Cleveland were found to be in PARTIAL or FULL attainment with fish community indices in 6 of 8 sites; RAP larval fish study found 32 species spawning upstream of the navigation channel or migrating through it; *however, fish community indices do not meet Ohio EPA criteria in many stream segments.*
Degraded benthos populations Previously considered "IMPAIRED" In places.	MUCH BETTER, *but still impaired in very few places*	Aquatic insects populations have returned to the Cuyahoga, including pollution sensitive species like mayflies. Benthic macroinvertebrate community indices now meet Ohio EPA criteria in nearly all stream segments; *however navigation channel and Lake Erie nearshore areas still have poor benthic communities - although no State criteria apply.*
Fish tumors & other deformities Previously considered "IMPAIRED"	BETTER, *but still impaired in a few places*	Reductions to background tumor levels have been noted in most areas; *however some sites still harbor bullheads with high tumor levels, particularly in the navigation channel.*
Degraded phytoplankton and zooplankton populations Previously considered "POSSIBLY IMPAIRED" (phytoplankton) or "UNKOWN" (zooplankton)	BETTER, *but further study needed to determine degree of impairment*	Toxic effluent and oxygen demanding pollutant discharges have been reduced or eliminated, resulting in improved plankton communities.
Loss of fish habitat Previously considered "NOT IMPAIRED" in mainstem; "IMPAIRED" in navigation channel	BETTER, *but more good habitat is needed to continue improvements in fish communities*	12,391 linear feet of streambanks have been restored by plantings & soil bioengineering techniques to provide improved fish and aquatic habitat; *however rapid wetland loss and urbanization contribute to future flooding, erosion problems, and poor water quality; lack of adequate habitat in navigation channel due to steel bulkhead and dredged depths contributes to low dissolved oxygen levels and depressed fish communities.*

RECREATION	**CURRENT STATUS**	**INDICATORS**
Elevated bacteria levels Previously considered "IMPAIRED PERIODICALLY"	BETTER, *but still impaired after rain events*	Concentrations of fecal coliform bacteria meet Ohio EPA standards during dry periods and frequency of beach closings has decreased; *however combined sewer overflows and nonpoint sources cause elevated bacteria levels during and after rainfall events, leading to contact advisories and periodic beach closings.*
Public access & recreation impairments Previously considered "IMPAIRED" in navigation channel and in nearshore Lake Erie, mainstem considered "NOT IMPAIRED"	BETTER, *but could be improved in some areas – future plans to extend Towpath Trail and Lake Erie Bikeway should help to reduce impairments.*	Millions of people enjoy the Cuyahoga River and Lake Erie nearshore: the Flats, the Stadiums, Rock & Roll Hall of Fame, Great Lakes Science Center and other North Coast Harbor attractions have made Cleveland a top tourist destination; bikers and hikers along the Towpath Trail have made the Cuyahoga Valley National Park one of the most visited in the nation; Cleveland MetroParks and MetroParks serving Summit County host thousands of annual visitors; *however direct access to the river and Lake Erie is very limited in the navigation channel and Cleveland lakefront.*

SOCIOECONOMIC FACTORS	**CURRENT STATUS**	**INDICATORS**
Degradation of aesthetics Previously considered "IMPAIRED"	BETTER, *but still degraded after rain events*	Over 50 tons of garbage and litter have been collected to date from area streams by volunteers; several tons of floatable debris is removed annually by combined sewer overflow nets; *however woody debris, litter, oily runoff from industrial and urban areas, and storm sewer & CSO outfalls still contribute to aesthetic problems after rainfall events.*
Eutrophication / undesirable algae Previously considered "UNKNOWN" in mainstem; "POSSIBLY IMPAIRED" in navigation channel; "IMPAIRED" in nearshore Lake Erie	BETTER, *But problems may still occur in a few areas*	The amount of algae in Lake Erie has decreased significantly in response to phosphorus bans, adequate flow conditions preclude river algae blooms; *however elevated nutrient levels in municipal wastewater and nonpoint source discharges may contribute to some localized eutrophic conditions along river and lakefront.*
Restrictions on Dredging Activities Previously considered "NOT IMPAIRED" in mainstem, "IMPAIRED IN PLACES" in naviigation channel; "IMPAIRED"	NO CHANGE	Disposal of dredged material from navigation channel still requires disposal in confined facility.
Added Costs to Agriculture or Industry Previously considered "NOT IMPAIRED"	NO CHANGE	No increases in costs to treat river water for use are known.

PUBLIC INVOLVEMENT AND EDUCATION	**CURRENT STATUS**	**INDICATORS**
Lack of public awareness of watershed issues	MUCH BETTER, *but more public education and citizen involvement is needed as a long term solution to eliminating river and lake problems*	Over 2000 school-aged youth have participated in watershed education events, storm drain stenciling, and river cleanup projects; 80 volunteers have implemented streambank restoration projects; 10 volunteers actively monitor 5 miles of stream for aquatic organism health; over 4000 people in civic groups, schools, libraries, special interest groups, and community organizations have attended presentations about watershed issues; local elected officials have participated in workshops on adoption of wetland and riparian protection mechanisms; successful stream stewardship programs have been initiated in Big Creek and Yellow Creek subwatersheds; annual RiverDay events held around entire Cuyahoga River watershed; numerous media coverage of Cuyahoga River issues, projects, and educational events; *however more education and local legislation is required to adequately address the remaining nonpoint sources of pollution and habitat restoration/protection needed to restore the beneficial uses of the mighty Cuyahoga River.*

3.3 Source Identification

Major sources of oxygen demanding substances and nutrients during the critical low flow periods are the municipal wastewater treatment plants and combined sewer overflow systems serving the City of Akron and Northeast Ohio Regional Sewer District located throughout the study area. Allocation of loads follows in Section 4.

Municipal treatment plants with design capacities over 1 million gallons per day (mgd) are considered major sources. The Lower Cuyahoga River mainstem has two major dischargers, The City of Akron (90 mgd), and the Northeast Ohio Regional Sewer District's Southerly Treatment Plant (175 mgd). The Tinkers Creek subbasin contains the remaining major dischargers in the Lower Cuyahoga River TMDL area. They are: The City of Aurora Westerly Plant (1.4 mgd), The City of Bedford (3.2 mgd), The City of Bedford Heights (7.5 mgd), the Portage County Streetsboro Plant (4.0 mgd), The City of Solon (5.8 mgd), and the City of Twinsburg (3.4 mgd, expansion approved to 4.95 mgd).

Combined sewer overflows contribute oxygen demanding substances, nutrients, pathogens, and other pollutants to the Lower Cuyahoga River TMDL area. Combined sewer overflows are part of both the City of Akron sewer system and Northeast Ohio Regional Sewer District.

The City of Akron (including suburban areas) has approximately 21% of the service area utilizing combined sewers. There are 38 regulating structures within the system (see Figure 5, Rack 39 has since been eliminated) which discharge combined sewage. Combined sewer overflows are located on the Cuyahoga River (5

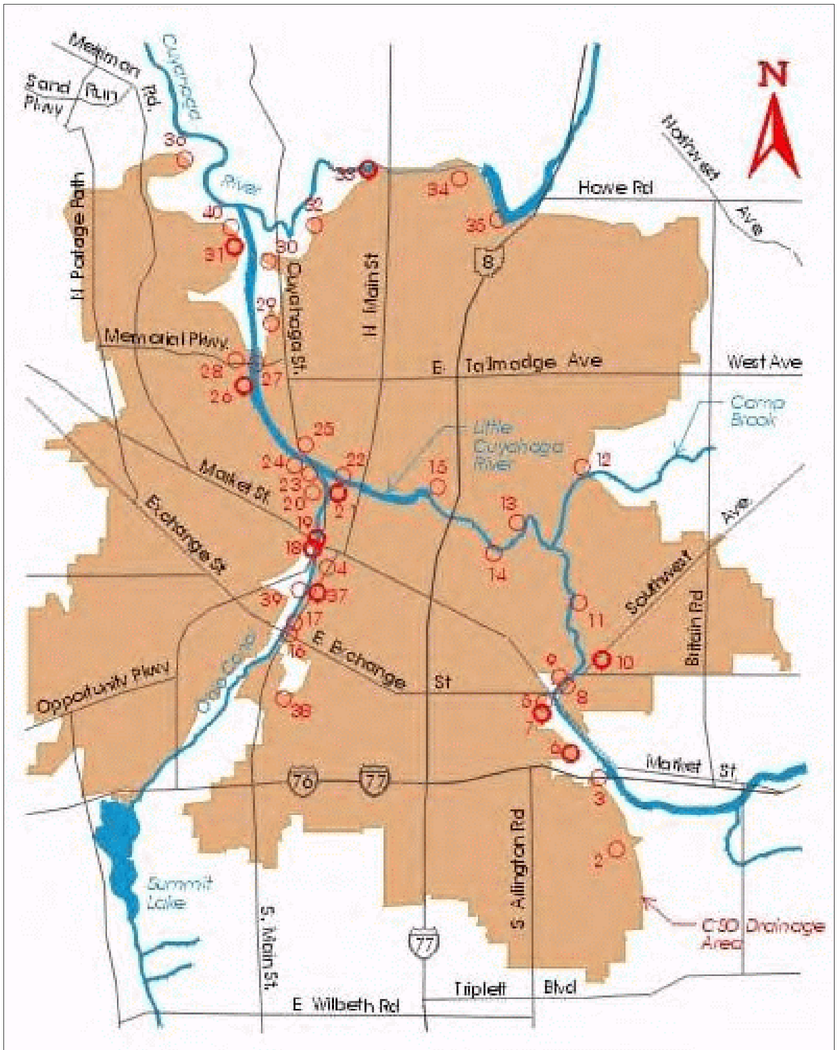


Figure 5 Combined sewer overflows in the City of Akron's service area

CSO's), the Little Cuyahoga River (24 CSO's), the Ohio and Erie Canal (8 CSO's), and Camp Brook (1 CSO).

The Northeast Ohio Regional Sewer District has three service areas which discharge combined sewage to the Lower Cuyahoga River TMDL area (SEE Figure 6). The Southerly WWTP has 53 CSO outfalls, the Westerly WWTP has 17 CSO outfalls, and the Easterly WWTP has 4 CSO outfalls. CSO outfalls are located on the following water bodies in the Lower Cuyahoga River TMDL area, Cuyahoga River (26 CSO's), Mill Creek (25 CSO's), Big Creek (15 CSO's), Wolf Creek (2 CSO's), Treadway Creek (2 CSO's), and West Creek, Spring Creek and the Ohio Canal which each have one CSO.

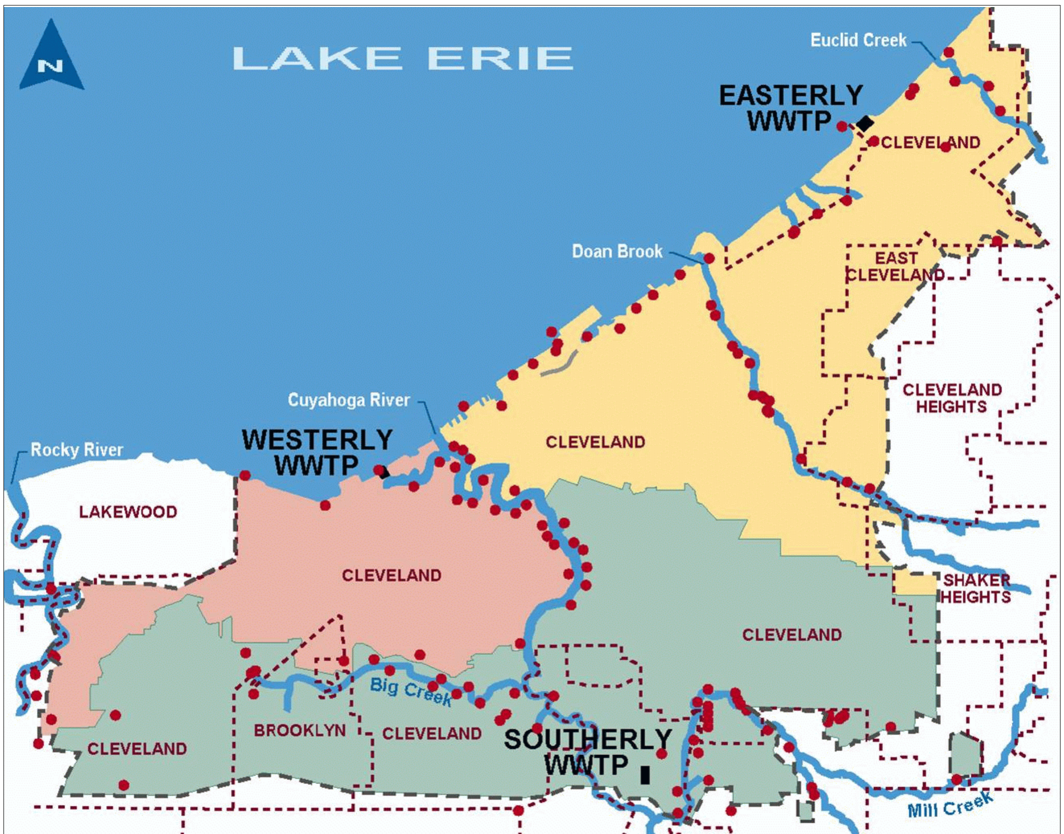


Figure 6 Combined sewer overflows in Northeast Ohio Regional Sewer District's service area

Failing or malfunctioning home sewage disposal systems are also identified as a source contributing to non-attainment in the Lower Cuyahoga River TMDL area. Home sewage disposal systems consist of both on-lot (ex. septic tanks and tile field) and off-lot discharges. The following information was assembled in a report titled **Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-Public Sewage Disposal Systems**, April 2001. The report was prepared for NOACA by CT Consultants of Willoughby. Information was presented by county and not by watershed, however it is a useful illustration of the potential pollution contribution from these sources. The Lower Cuyahoga River TMDL area includes parts of Cuyahoga, Summit, Portage, and small parts of Geauga and Medina Counties. It was estimated that there were 14,000 septic systems in Cuyahoga County, 31,330 in Summit County, 20,000 in Portage County, and 33,000 in Geauga County. Geauga County includes a very small part of TMDL area watershed and represents a fraction of the estimated total. Portage County includes the Tinkers Creek watershed, also a lesser part of the total septic systems. Summit County is divided between the Lower Cuyahoga River TMDL area and Tuscarawas River watershed, while Cuyahoga County included the Lower Cuyahoga River TMDL area, the Rocky River, Chagrin River, and numerous smaller Lake Erie tributaries. With septic systems it is important to note that independent of the number of systems actually in the watershed, failure rates of up to 24% were noted for some treatment systems. A specific example of septic tanks as a source of impairment can be taken from **The West Creek Valley Management Plan A Watershed Approach for the Future, September 2001**, prepared by the Cuyahoga County Planning Commission:

> *The West Creek watershed contains 837 home septic systems, according to the Cuyahoga County Board of Health. These systems, which include septic tanks, aeration systems, leaching fields, filter beds, or evapo-transpiration systems, were installed many years ago prior to the established municipal infrastructure system of sanitary sewer piping. According to the Cuyahoga County Board of Health, the most common septic systems within the West Creek watershed are the filter bed system and the aeration system: "These systems are similar in their treatment system. When properly operating, microorganisms within the system will break down the waste slowly before discharging the treated effluent." Due to the fact that these systems are over 30 years old, they are operationally deteriorating and no longer "provide proper treatment of wastewater." These older systems have begun to have malfunctions such as a broken motor on the aeration system or a blocked filter bed due to tree roots or collapsed pipes. In addition, these older systems were not designed in size for current use and standards.*
>
> *In 1998, the Cuyahoga County Board of Health performed a water quality analysis of West Creek in regards to these septic systems and their impact on the creek. Of the twenty sites tested in this study, fifteen of the sites reported samples with counts of fecal coliform that exceeded Ohio EPA standards (1,000 geometric mean fecal coliform content per 100ml). On-site observations included strong sewage odors, organics on the water surface, and the presence of "a white filamentous bacteria," which are also indicators of failing septic systems. Condensed phosphate, produced by detergent use, is another indicator that was tested for in this study. As stated in the Board of Health Report: "The main problem of total phosphorous in West Creek is due to poor treatment of septic discharge in the form of condensed phosphates from household detergents. A high total phosphorous count (Ohio EPA effluent standard of more than 1.0mg/L) at a particular discharge point presents evidence of contamination possibly from poorly treated wastewater." Six out of the twenty sites tested in this 1998 study exceeded the Ohio EPA standard. Results of this study indicate the serious threat that failed septic systems pose to water quality and human health in the watershed. Recommendations to either connect these individual systems to an existing sanitary line or reconstruction of the septic systems to a fully operable state should be considered for the immediate future.*

In addition to the above sources, urbanization and suburbanization also contribute to non attainment. Discharges from storm sewer systems also carry oxygen demanding substances, nutrients, and bacteria.

Dams also have impacts on the Lower Cuyahoga River TMDL area. Adverse impacts from dams can include a change in hydraulic regime, thermal and chemical water quality changes, and impaired habitat in the stream or river where they are located. A variety of impacts can result from the siting, construction, and operation of these facilities. Dams either reduce or eliminate the downstream flooding needed by some wetlands and riparian areas. Dams can also impede or block migration routes of fish.

There are currently four dams on the mainstem of the Lower Cuyahoga River and numerous dams on its tributaries. This TMDL will focus on removal and or modification of the Canal Diversion Dam located on the mainstem at river mile 21. Immediately downstream the Cuyahoga River is in FULL attainment (2000 survey data) of its designated use. This structure is one impediment to further upstream attainment. The structure also is a hazard for recreational use by canoeists and kayakers. The Canal Diversion Dam provides water to the historic Ohio and Erie Canal. Removal of the dam will take into account the need to provide an alternate suitable water source to the canal. All other dams in the Lower Cuyahoga are to be evaluated for removal.

4.0 TOTAL MAXIMUM DAILY LOADS

4.1 Background of TMDL Development Approach

4.1.1 Objective

A TMDL is a means for recommending controls needed to restore and maintain the quality of water resources (USEPA, 1991). TMDLs represent the total pollutant loading that a waterbody can receive without violating water quality standards. The TMDL process establishes allowable loadings for a waterbody based on the relationship between pollution sources and in-stream water quality conditions. 40 CFR §130.2(i) states that a TMDL calculation is the sum of the individual wasteload allocations for point sources and the load allocations for nonpoint sources and natural background in a given watershed, and that TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.

Pollutant loadings can be determined by multiplying an in-stream concentration by the flow under which it occurs. Because both flow and concentration vary over time, it is important to assess the entire range of data to understand the conditions under which water quality standards are exceeded. This TMDL utilizes the duration curve approach, which identifies the allowable load under the full range of flow conditions. The duration curve method provides a framework for comparing observed water quality data to the allowable load to evaluate when exceedances occur.

4.1.2 Application of Water Quality Targets

The attainment of WQS in Ohio requires meeting criteria protective of various beneficial uses including recreational activities, aquatic life, and water supply (refer to Table 3). Ohio recreational beneficial use attainment is based on fecal coliform and/or *Escherichia coli* (*E. coli*) bacteriological criteria. The lower Cuyahoga River is generally designated as a primary contact recreation water where there is an intermediate potential exposure to bacteria and a baseline level of disinfection required. The majority of bacteria data available in the watershed is for fecal coliform. Therefore, the TMDL modeling was performed for fecal coliform. However, it is expected that in the near future Ohio may rely solely on *E. coli* to determine this use attainment. An *E. coli* TMDL is included in this report to provide additional guidance as this issue is clarified.

Attainment of aquatic life beneficial uses are determined by direct sampling of the aquatic biological community (biocriteria). Chemical water quality criteria are established as a surrogate for direct measurement of the aquatic biological community to allow a determination if a particular pollutant is present in amounts that are projected to cause impairment of the designated aquatic life use. By limiting the loads of critical pollutants, a TMDL establishes a level of the pollutant(s) whereby an impairment to the aquatic life use is projected to be eliminated. In Ohio, this approach will be judged to be successful when direct measurement of the aquatic biological community results in the attainment of appropriate biocriteria designated use.

Some pollutants that affect aquatic organisms may be most appropriately measured with indirect, or surrogate, measurements. Based on an extensive database of synoptic measures of the aquatic communities and habitat quality, Ohio EPA has established a direct association between poor habitat quality and impaired biological communities. The condition of human-induced physical and hydrologic habitat modification degrades the quantity and the quality of dwelling places for aquatic life placing additional stress upon the biological community. Where habitat quality is poor, there is also a complex interaction among the remaining biota, and the pollutants heat, sediment, nitrate and phosphorus. This interaction can contribute to excessive algal growth and low dissolved oxygen, particularly during pre-dawn hours as algal colonies respire.

Ohio has designed a functional measure of habitat, the Qualitative Habitat Evaluation Index (QHEI), that can be used as a surrogate to establish a target by which reduction in the loading of the pollutants heat, sediment, nitrate and phosphorus can occur. Reducing the pollutant loads and improving the habitat will limit the aforementioned negative interactions. As in the case where achieving target loads for the surrogate pollutant $CBOD_5$ is expected to result in an improved dissolved oxygen regime in a stream, achieving habitat targets based on the QHEI are expected to have a similar result.

4.1.3 Linkages between Water Quality Impairments and Pollutants

Phosphorus and bacteria are identified impairing causes in this watershed and TMDLs are calculated for them (see Tables 12 and 14). Dissolved oxygen (D.O.) is a condition of the water column and is not a load based parameter; however, a low level of dissolved oxygen is an impairing cause particularly during the low flow, high temperature summer months. Many implementation actions to reduce phosphorus will also reduce sediment loads since phosphorus binds to sediment as a delivery mechanism to the stream.

Reductions in phosphorus and sediment (heavy sediment will inhibit growth by smothering/light starving the algae) will improve the level of D.O. by reducing algal growth, but these reductions on their own would not be sufficient to attain the D.O. criteria during critical conditions. Reductions in oxygen-demanding substances are needed, particularly for those loads that are consistently discharged to the streams during low-flow conditions. Namely, ammonia nitrogen (NH_3-N) and carbonaceous material which exerts a biochemical oxygen demand (CBOD). Water quality based wasteload allocations for these parameters will be included in the NPDES permits for facilities which are contributing to low dissolved oxygen levels in the stream and do not currently have such allocations. The combination of reducing the load of oxygen-demanding substances, reducing algal growth and increasing the capacity of the stream to hold dissolved oxygen through habitat improvements is a means for recommending controls to meet the D.O. water quality criteria and is, therefore, a D.O. “TMDL”.

Degraded or poor habitat is also a non-load based impairing cause in the Cuyahoga River watershed. Identification of which aspects of the habitat are degraded at particular points in the watershed is provided in this report as are benchmarks which can be used to set habitat goals. This is analogous to allocations of loads for pollutants. These recommended habitat "allocations" are a necessary means to meet biocriteria and water quality standards (in combination with the other TMDLs described above) and as such are a habitat "TMDL".

4.2 Method of Calculation

The load duration curve (LDC) approach was selected to determine the bacteria and phosphorus TMDLs. This advantages of this approach include:

- the available loading capacity (TMDL) is determined for the full range of flows instead of the more traditional single 'critical' flow approach;
- determination of the critical condition is not needed which is important for wet-weather related impairing sources;
- all types of pollutant sources are considered which is the intent of the TMDL process;
- yearly, seasonal, and daily variations are captured; and,
- clear and understandable method which provides a framework with which to communicate data and results to stakeholders and other interested parties.

The LDC establishes the TMDL. Existing data can be added to the LDC to show the flow condition(s) under which exceedences occur and the deviation between the existing in-stream quality and the TMDL. The likely types of impairing sources are also highlighted based on the problematic flow condition(s) which helps to guide implementation activities. This is especially useful where sufficient in-stream data exists to cover all flow conditions as is the case for the lower Cuyahoga TMDL.

LDCs do not necessarily provide a good technique for allocating the calculated TMDL; they do, however, provide guidance and a framework with which to express such allocations. Other modeling techniques described in 4.2.2 were used to assist the allocation process based on the cause and source being allocated to and data availability.

4.2.1 TMDL Development: Load Duration Curve

The first step of the load duration curve method is to calculate a flow duration curve using continuous flow data at the gage site of interest. A flow duration curve is the cumulative frequency distribution of the daily mean flow data over the applicable period of record of the flow gage. Figure 7 illustrates a flow duration curve using data from the Cuyahoga River at Independence gage. The curve compares the flow duration interval (FDI) - the percent of time a particular flow value is met or exceeded, to that flow value. A FDI is also referred to as a flow recurrence interval. Extremely high flows are rarely

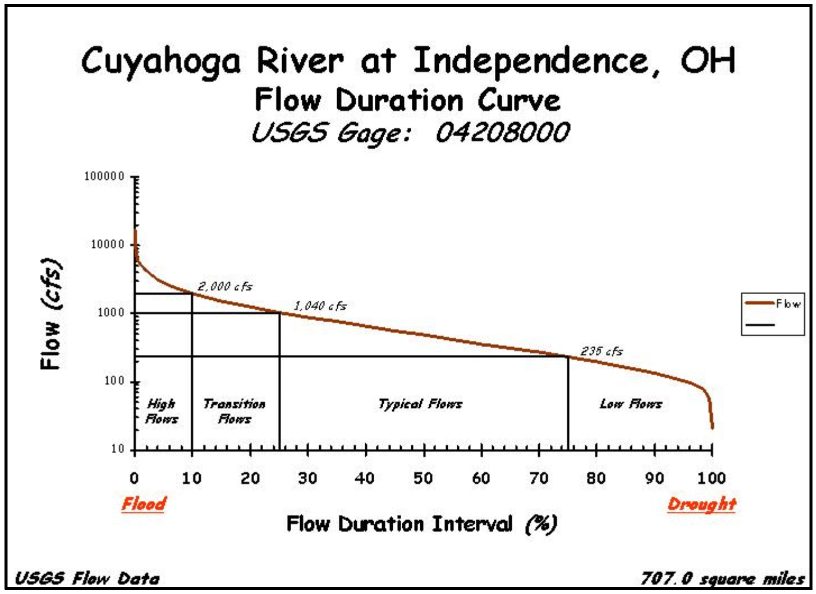


Figure 7. Flow Duration Curve for the Cuyahoga River at Independence

exceeded and have low FDI values; very low flows are often exceeded and have high FDI values. The flow duration curve includes all flows observed at the gage for the applicable period of record.

A load duration curve is then created by multiplying the flow duration curve flow values by the applicable water quality criterion or target and conversion factor. The independent x-axis remains as the FDI, and the dependent y-axis depicts the load at that point in the watershed. The curve represents the allowable load (or the TMDL) at each flow condition. The criteria and targets used in the development of the load duration curves are listed in Table 8.

Table 8. Criteria and targets used in developing the LDCs

Location	Phosphorus, Total (mg/l)	Fecal Coliform (cfu/100ml)	*E. coli* (cfu/100ml)
Cuyahoga R at Independence	0.12	1000	126
Tinkers Ck at Bedford	0.07	1000	126
Yellow Ck at Botzum	0.07	1000	126

cfu - Colony-forming units

The utility of the load duration curve can be enhanced by adding monitoring data. The observed pollutant concentration is multiplied by the instantaneous sample flow if available or the mean daily flow if not and a conversion factor to calculate the observed load. The FDI of the observed flow is used to plot these points on the LDC. The inclusion of the observed actual loads gives a good graphical representation of the condition of the water quality at this location in the river; flow related patterns can be easily seen. The points above the LDC show the current exceedence from the target load, and points on or below the curve indicate when the target is being met. This is demonstrated in Figure 8. Note that the graphs and figures in this report are best viewed with color; black and white tones will not be sufficient to see detail. These graphs show that the total phosphorus TMDL is not being met at all flow conditions under either daily or summer conditions. The straight line above the daily TMDL curve represents the power regression of the observed data points and serves as a trend indicator of the existing water quality conditions.

Monitoring data were available extensively in the lower Cuyahoga watershed. Ohio EPA has a long term sampling site on the Cuyahoga at Independence and an expansive database based on intensive watershed monitoring once every five years. In addition, many other entities contributed data and made this study possible. These data providers include:

- The Water Quality Laboratory at Heidelberg College in Tiffin, Ohio has a long-term sampling site at the Independence gage on the Cuyahoga River. The laboratory shared their comprehensive database which includes almost daily chemical grab samples and instantaneous flow readings from 1985 through 2002 - a total of 7202 in-stream phosphorus data points;

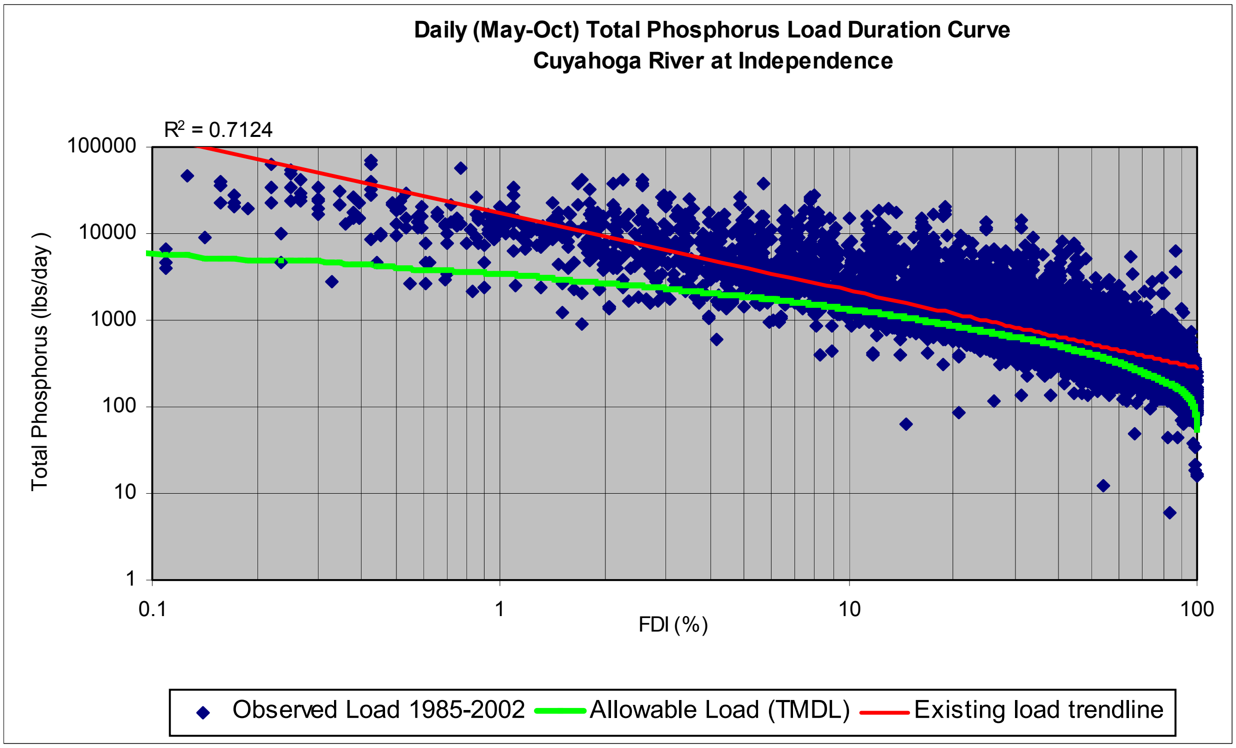
- USGS also has a strong sampling program in the lower Cuyahoga including bacteria and nutrient data as well as all of the flow data used in this study; these data are available on NWIS (http://waterdata.usgs.gov/oh/nwis/nwis);

- The City of Akron provided water quality and flow data for their CSO and reservoir system. This included in-stream data at various locations on the river and the results of their extensive CSO system modeling effort;

- Cleveland and the Northeast Ohio Regional Sewer District shared their water quality samples collected in the downstream portions of the watershed. Model results and guidance based on the city's CSO modeling effort were also provided;

- The Cuyahoga Valley National Recreation Park personnel provided the data from their sampling program of the area mainstem and tributaries for nutrients and bacteria.

Flow duration curves were developed using the full period of record for the gage of interest. The Independence flow duration curve is shown in Figure 7. Almost daily in-stream data were available at Independence from 1985 to May of 2002; the LDCs in Figure 8 are based on this period including the flow duration intervals used on the graphs. The allocation analysis was analyzed using data from 1996 through mid-2002 due to limited availability of some source data before 1996 and to be reflective of current conditions.



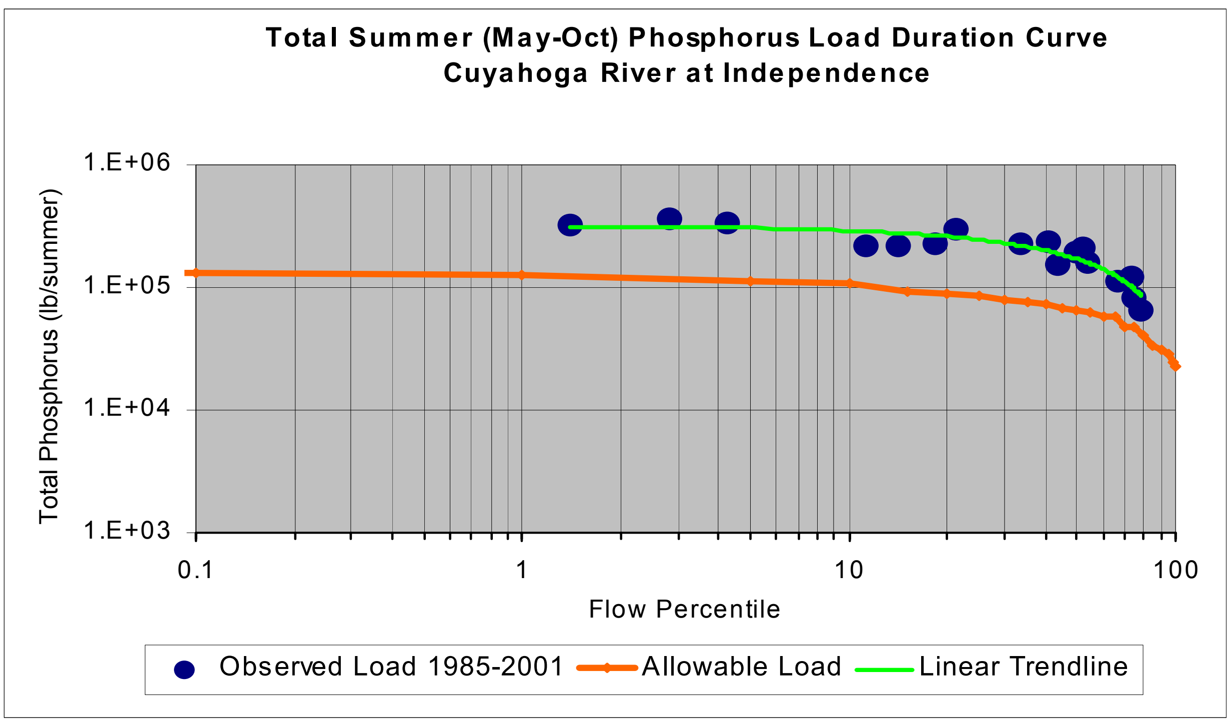


Figure 8. Total phosphorus total maximum daily and summer load duration curves (upper and lower graphs respectively) and existing loads for the Cuyahoga River at Independence

4.2.2 Allocation Methods

Many sources contribute to the total load in the stream. The categories of sources for this TMDL include:

- Nonpoint sources based on runoff over land
- Groundwater
- Reservoir releases and water diversions
- Point sources
- Septic systems
- Combined sewer overflows and bypasses

Each of these sources receives an allocated portion of the total allowable load. Other allocated categories include a margin of safety to account for uncertainty in the analysis, a reserve for future growth, and a loss term to account for in-stream processes which assimilate the pollutants. The method to determine the appropriate allocation for each of these sources and categories varied and is discussed more fully below. Table 9 presents an overview of the TMDL devloment process for the lower Cuyahoga River watershed.

<u>Nonpoint sources</u>

Characterizing the sub-watersheds:
The Soil and Water Assessment Tool (SWAT) was initially explored for its utility in modeling this watershed. As the model structure was built it became apparent that due to resource constraints, the abundant available in-stream data, and that many implementation actions in the watershed were already in place a model such as SWAT was not needed for this TMDL. However, much of the SWAT model was already built and could be utilized to support the allocation effort. SWAT is a GIS-based model and uses digital elevation information and guidance from the user to define watersheds. Land cover, soil data, and other information layers can then be grouped and analyzed per each defined watershed. The lower Cuyahoga was divided into 17 sub-watersheds.

The land cover data came from the USGS 1992 Ohio National Land Cover Data (NLCD) data set which has a spatial resolution of 30 meters. The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service created and maintains the State Soil Geographic (STATSGO) data base which was used to describe the soils for the lower Cuyahoga area. Once these data layers are imported into the model, threshold values can be set to eliminate minor land uses in each subbasin and redistribute this land area on a weighted average basis (DiLuzio, 2002). The threshold value for this project was 5% of the subbasin area. The land cover data summary after application of the threshold value from Lake Rockwell to both the Independence gage and to the bottom of the study area are summarized in Table 10. The sub-watershed divisions are shown in Figure 9. The land cover was an important component for calculating both total phosphorus and fecal coliform nonpoint source existing loads and allocations.

Table 9. Overview of the Lower Cuyahoga TMDL development process

Step in TMDL Process		*Method*	*Equation or Expression*	*Data sources*
1.	**Determine TMDL**	LDC	Flow * Target for each daily flow in the period of record	Flow: USGS Target: Ohio EPA
2.	**Show current deviation from TMDL**	LDC + Existing data	Graphical comparison includes trend line through the existing data	Existing load data: various sources, see ∮ 4.2.1
3.	**Quantification of existing load per source (necessary to be able to allocate TMDL)**: In-stream load = ∑WWTPs + ∑Reservoirs + ∑CSOs + ∑Septics + Groundwater + Runoff - Loss			
a.	WWTP	Actual data	Daily data from the monthly operating reports for each WWTP	Each individual entity
b.	Reservoir releases and diversions	Actual data	Daily flow and sporadic quality data	City of Akron, ODNR (diversion), Ohio EPA
c.	Combined sewer overflows	Actual data and SWMM predicted loads	Based on collected storm event data and calibrated models	City of Akron Cleveland
d.	Septic systems	Actual and extrapolation; GIS	Estimated aggregate daily septic load based on findings of survey	NOACA survey of sewage disposal systems
e.	Groundwater	Calculated using HYSEP	Daily baseflow estimates	USGS
f.	Runoff	*Bacteria:* FCLET	Monthly loading estimates	Various
		TP: Export coefficients and equation in 3 above	Solved equation 3 to determine only unknown (runoff) then compared this to runoff loads based on export coefficients to check reasonableness	Various
g.	Loss	*Bacteria:* regressions based on observed vs calculated	Compared well with USGS-determined decay rate. The decay rate does not apply well to this application given the large areal size and diffuse nature of much of the load; the regression analysis was used instead	
		TP: based on low flow differences between observed vs calculated	Compared well across all flow conditions.	
h.	In-stream load	Matched flows and concentrations by date and multiplied	Qinstant * Cgrab	Flow: USGS Concentration: Various; see ∮4.2.1

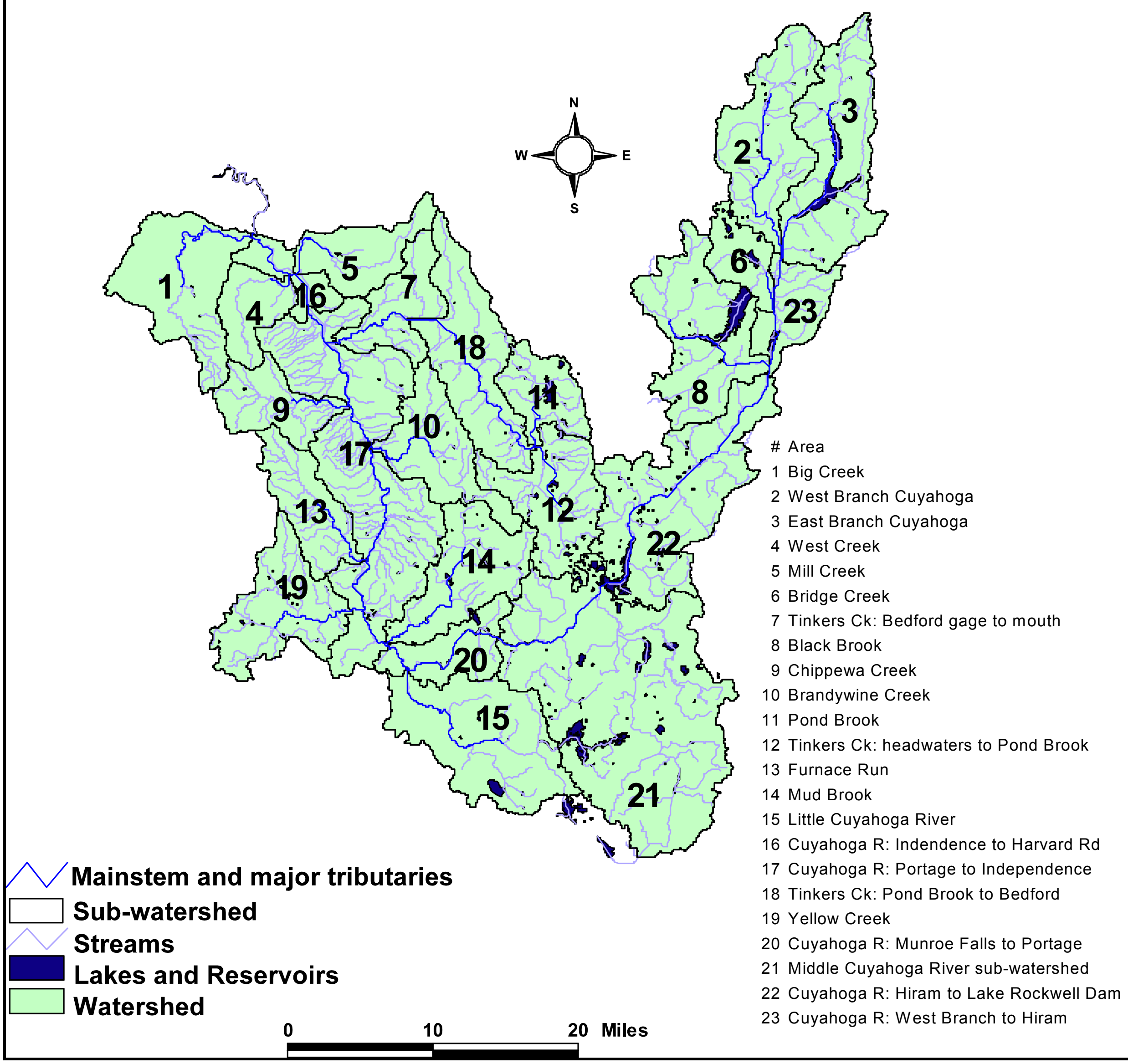
Table 9. Overview of the Lower Cuyahoga TMDL development process

Step in TMDL Process		*Method*	*Equation or Expression*	*Data sources*
4.	**Comparison/'calibration' of calculated existing source contributions with observed in-stream data first for flow then for loads on a daily and seasonal basis (are the estimates reasonable?)** In-stream load = ∑WWTPs + ∑Reservoirs + ∑CSOs + ∑Septics + Groundwater + Runoff - Loss Shown as stacked graphs - see Figures 13 and 14			
5.	**Allocation of allowable load** TMDL = WLA + LA + Background + Future Growth + Margin of Safety - Loss			
i.	TMDL	Calculated for each daily flow	Qdaily * Target; daily summed by season and averaged by year	Flow: USGS Target: Ohio EPA
ii.	WLA	Determined needed reduction for the lowest 10% of flows (WWTPs) and from LTCP (stormwater)	WLA = ∑WWTPs + ∑Regulated stormwater ∑Regulated stormwater = ∑CSOs + ∑MS4s (a portion of runoff)	Akron and Cleveland Long Term Control Plans MS4 applications
iii.	LA	Remaining amount after all other sources allocated	LA = TMDL - Loss - Background - Future Growth - Margin of Safety + Loss LA = ∑Reservoirs + ∑Septics + Runoff - ∑MS4s Checked to see if LA achievable (see Figure 10 for TP)	
iv.	Background	Groundwater	Same as existing.	
v.	Future Growth	Area-weighted the expected growth per county	Area-weighted average is 6% across the watershed upstream of Independence.	Census Bureau
vi.	Margin of Safety	Explicit 5%	The method used here is based on abundant and existing data; few assumptions or predictive models are used. The 5% agrees with other TMDLs across the country.	
vii.	Loss	Same equations as used to determine existing condition		
6.	**Habitat analysis**	QHEI	Graphically demonstrated; see Figures 4, 21, and 22.	
7.	**Dissolved oxygen analysis**	Multi-SMP	Water quality based effluent limitations for Akron WWTP; all other plants in the area have such where low D.O. expected	Various

Table 10. Land cover for the Lower Cuyahoga watershed

	Lake Rockwell to Independence:		Independence to Ship Channel (Harvard Ave):	
	Area (acres)	% of total area	Area (acres)	% of total area
Commercial	14210	5%	11674	23%
Forest	137285	44%	7555	15%
Pasture and Grass	63504	20%	1498	3%
Row Crop	23184	7%	0	0%
Urban-High Density	5103	2%	8547	17%
Urban-Medium and Low Density	57921	19%	20966	42%
Water and Wetlands	11214	3%	0	0%
Total:	312419	100%	50240	100%

Figure 9. The Cuyahoga Watershed and Model Divisions

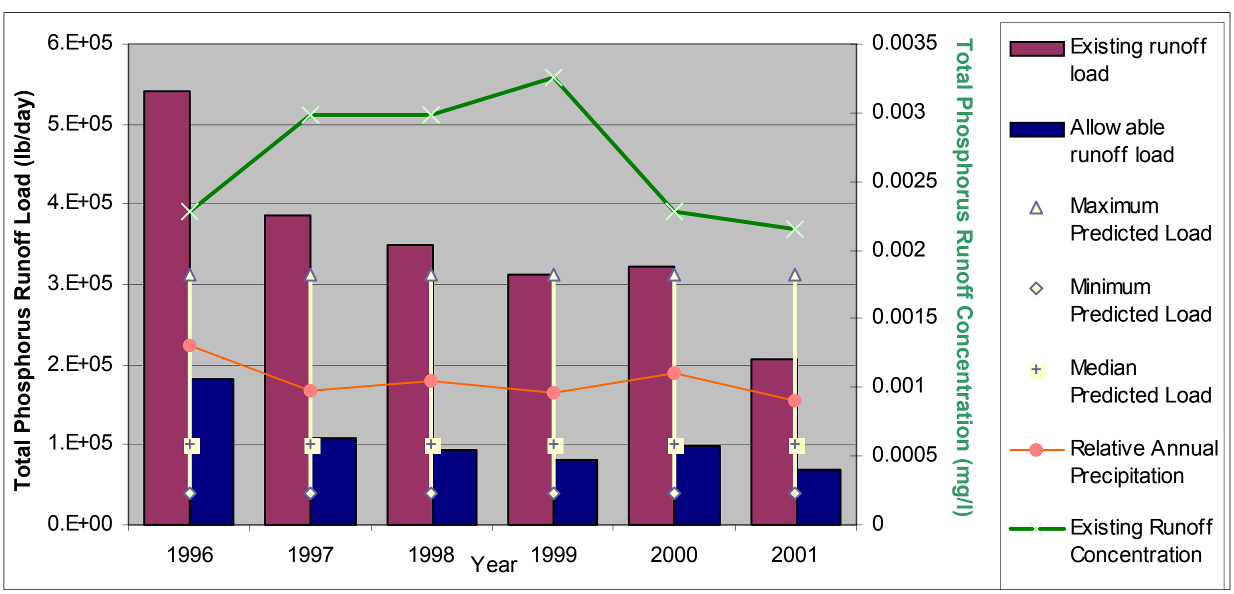


Total Phosphorus:
The total phosphorus load due to nonpoint source runoff was determined by summing all of the loads for the other sources and subtracting this summed load from the total load measured at Independence. The other sources of load were either directly measured such as the daily samples at point sources and reservoir releases or were able to be calculated with some degree of confidence. The difference between the in-stream measured load and this summed known load became the nonpoint source runoff load. Other unknown sources of load would be captured in this source as well but these would be minimal or unusual sources such as sewer line breaks or leaks.

A comparison of this load difference (the left column shown in dark red) which is assumed to be primarily nonpoint source runoff to the range of runoff loads based on export coefficients (the hi/lo bars in yellow) is shown in Figure 10. Export coefficients are an estimate of the mass per area per year a land use has been observed to produce. A range of export coefficients (maximum, minimum, median) for various land uses and soil types were determined from the literature. These values were multiplied by the area of the applicable land use and summed to determine a total ‘typical’ runoff load or the load from runoff we might predict or expect based on other river systems around the country. Note that although it appears as if the existing runoff load has decreased over time, this is more a function of less runoff flow than actual reductions in runoff quality as the green line marked with Xs in Figure 10 shows.

An alternate method using literature-based concentrations of runoff from various land uses and the SCS curve number method was also explored; however, the export coefficient method was more reflective of the observed runoff load.

Figure 10. Comparison of predicted (hi/lo lines), observed, and allowable annual total phosphorus runoff loads at Independence. Annual precipitation included.



Fecal Coliform:
The fecal coliform nonpoint source loading was determined using the Fecal Coliform Loading Estimation Tool (FCLET) developed by the U.S. EPA Office of Science and Technology and Tetra Tech, Inc. FCLET is a spreadsheet model that calculates the build up and loading rates of fecal coliform bacteria for different land covers and management practices. Wildlife, agricultural, and domestic animals are taken into account as are manure application and grazing practices. Table 11 shows the results of FCLET for the lower Cuyahoga River watershed.

Table 11. Total existing runoff bacteria load (cfu/day) at Independence as calculated by FCLET

Month	1st day of rain	Consecutive days
1	1.91E+16	1.06E+16
2	2.25E+16	1.25E+16
3	9.49E+16	5.27E+16
4	8.15E+16	5.43E+16
5	3.22E+16	2.15E+16
6	1.03E+16	6.89E+15
7	6.94E+15	4.62E+15
8	3.16E+16	2.11E+16
9	7.24E+15	4.83E+15
10	1.58E+16	8.79E+15
11	1.64E+16	9.13E+15
12	1.91E+16	1.06E+16

Groundwater
The portion of the stream flow due to groundwater was calculated using the USGS model HYSEP. HYSEP is a computer program that can be used to separate a streamflow hydrograph into baseflow and surface-runoff components. The base-flow component has traditionally been associated with groundwater discharge (USGS, 1996). A daily median groundwater component was calculated using the USGS flow gage data at Independence. The existing groundwater load was calculated by multiplying this daily groundwater flow rate by the estimated groundwater concentrations of total phosphorus and fecal coliform bacteria. Groundwater concentrations were based on USGS well data, baseflow measurements of unimpacted, reference streams in the watershed, and the Ohio EPA Background Water Quality Report (Brown, 1988).

Reservoir Release, Tuscawarus Diversion, and Point Sources
Almost daily median flow data were available for the Lake Rockwell outflow and the point sources from 1996 on. The Lake Rockwell outflow (referred to as a release in this project) is the output from the upper Cuyahoga watershed. The Lake Rockwell outflow generally flows freely through the spillway under higher flow conditions; however, Akron has flow control structures to regulate and shut off the flow as the public water supply levels dictate. The flow is generally regulated during lower flow conditions to a 3.5 MGD release (unless extreme drought necessitates further flow reductions).

The point sources frequently monitor the total phosphorus and fecal coliform concentrations in their effluent, and Akron samples the Lake Rockwell outflow and the upper Cuyahoga watershed approximately monthly. Where flow or concentration data were missing, the average value for that month based on measured data was used. A daily load value per entity was then calculated by multiplying the daily flow and daily concentration with a conversion factor. The point sources considered in this analysis include the following wastewater treatment plants: Akron, Bedford, Bedford Heights, Solon, Streetsboro, Twinsburg, Kent, Summit County Fishcreek, and Ravenna (NEORSD Southerly WWTP was included for the TMDL calculation at Harvard Avenue).

A diversion of flow from the neighboring Tuscawarus basin to the Cuyahoga basin via the Little Cuyahoga River exists as well. This diverted flow is a return flow to the watershed to account for the flow that goes to the Tuscawarus watershed further upstream. Flow is withdrawn from the Lake Rockwell reservoir, services Joint Economic Development Districts, and then is discharged to the Tuscawaras basin. Daily flow information from this return flow was available.

Septic Systems
A report presenting the results of a field survey of home sewage disposal systems in the Cuyahoga area provided the basis for the septic load analysis. The April 2001 report *Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-Public Sewage Disposal Systems* was coordinated by the Northeast Ohio Areawide Coordinating Agency (NOACA) and presents the numbers and an estimate of the

functionality of these systems installed since 1979 per county. Census data on sewage facilities added to this study for systems installed prior to 1979. The septic system loads were calculated based on a model developed by Mandel (1993) which uses system characterization by performance type and location and the number of systems as its main inputs. This method is also used in the Generalized Watershed Loading Functions model (Haith, *et al.*, 1992).

Combined Sewer Overflows

Combined sewer overflows exist in Akron and Cleveland. Both of these cities are currently finalizing long term control plans to minimize the overflows and bring them into compliance with federal standards. The existing volume and fecal coliform loading information was provided to Ohio EPA from the cities and their consultants and are based on rigorous modeling efforts. The City of Akron used XP-SWMM and WASP to determine the systems loads and impacts to the stream water quality.

Akron overflows occur upstream of the Independence gage, and a way was needed to adapt the CSO model output to what was being observed in the river and expressed on the duration curve. Bruce Cleland from the Clean Water Foundation developed a procedure to relate the CSO overflow events to the load duration curve method.

The existing fecal coliform load was provided to Ohio EPA by both Akron and Cleveland based on their studies. However, neither city included total phosphorus in their modeling work. Therefore, the total phosphorus load was based on the existing overflow volume per CSO multiplied by a total phosphorus concentration. Literature values and monitoring data for CSO total phosphorus concentrations was examined. The value that best fit with the observations at Independence was used.

The allocated loads for Akron and Cleveland were based on each city’s estimated overflow volume after implementation of their long term control plan strategies multiplied by an expected concentration based on the proposed control technologies. This was overflow specific as the control technology vary from overflow to overflow. These allocated loads and flows were adapted to the load duration curve approach using the same method as for the existing conditions.

Future Growth

A future growth factor of 6% was included in the allocation. This factor is the average of each county’s predicted future growth based on the US Census Bureau’s figures weighted by the land area of the county within the Cuyahoga watershed. The modeling is empirically based on existing conditions that will change as the watershed population density increases. The future growth term is designed to allow the TMDL to be applicable into the future and to account for this expected population increase.

In-stream Reactions (loss)

Total phosphorus in-stream reactions represent a net loss between upstream inputs and the output point of Independence. There is a capacity to assimilative some of the total phosphorus load into the system biomass or that settles out into deep sediments that do not normally get re-entrained into the system. This loss term was estimated as the median of the daily total observed load in the stream minus the daily total known input load for days without runoff. Loss occurs during runoff events as well but the runoff load was not a directly measured quantity. By removing this uncertain daily load from the equation, a more accurate loss term could be determined.

Fecal coliform bacteria also exhibit a die-off rate or loss term. Determination of this loss is obfuscated by several factors which can vary dramatically each day. Such factors include sunlight, temperature, predation, nutrient deficiencies, toxicity, settling and resuspension conditions, and in-stream growth of the bacteria. Die-off of organisms can be approximated by a first-order or exponential decay approach. The basic assumption here is that the rate of loss is proportional to the concentration (USEPA, 2001). This assumption held true for the lower Cuyahoga. USGS performed a study to determine the bacteria decay rates in this section of the Cuyahoga (Myers, 1998). This decay rate was applied to the total calculated daily input load and compared to both the observed loading at Independence and the loading as determined by the regression approach described in the following paragraph. Both the decay rate determined loads and the regression based loads reasonably estimated the observed loads and the results of both methods compared favorably. However, the decay rate approach is difficult to apply when the input loads are diffuse and widespread as the time scale to apply the decay rate to is skewed. It is not like a point source situation where the time and location of an input load is well known and the decay of this load slug can be tracked.

Instead, an exponential regression equation was determined relating the total load to the stream with the total load observed in the stream at Independence. Figure 11 shows the determination of this exponential relationship; Figure 12 shows how the predicted in-stream load compares with the actual. On a daily basis this relationship may have some wide variance in accuracy; however on an annual basis the average difference between predicted and observed is only 10%.

Figure 11. Relationship between observed in-stream load at Independence gage and the total upstream input load for fecal coliform

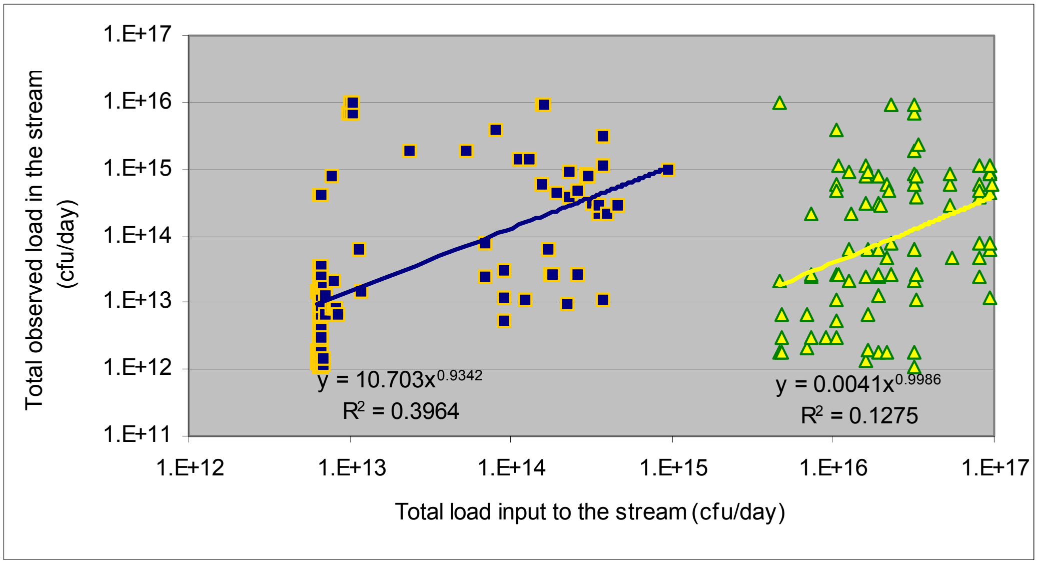
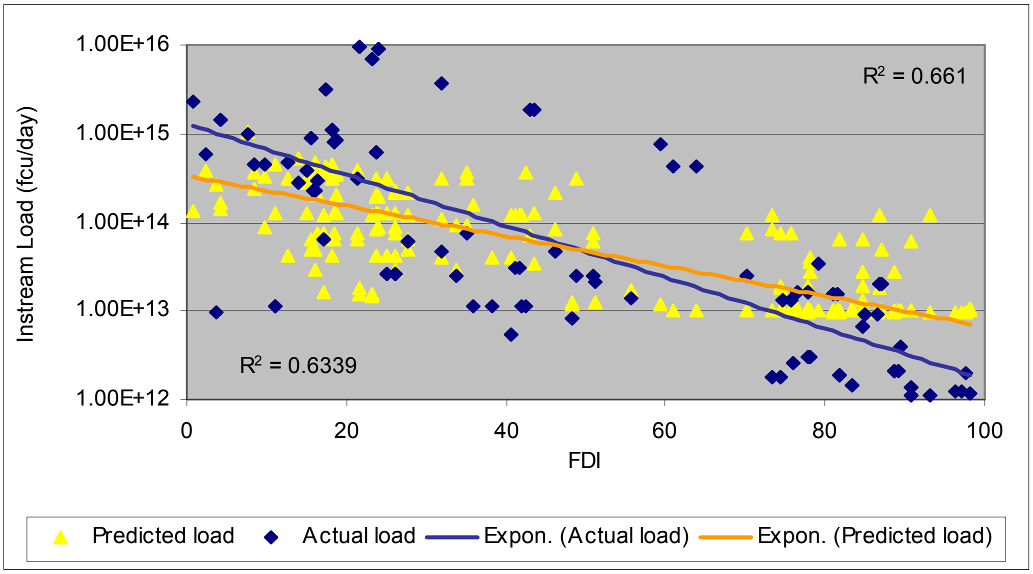


Figure 12. Comparison of the actual observed fecal coliform load at Independence and the exponential regression predicted load



General Approach and Calibration

The existing load from each of the sources and categories described above was determined with the exception of nonpoint source loads. These loads calculations are more uncertain than the loads from other sources due to specific runoff data and method limitations. The difference between the total known in-stream load and the sum of all of the other input loads and loss was estimated to be the load due to nonpoint sources. This quantity is referred to as the 'observed' load due to nonpoint sources. The predicted nonpoint loads were compared to this number in a calibration exercise to assist in determining which nonpoint source load calculation methods were the most reflective of reality.

Flows from the various sources were compared to the observed flow at Independence before the loadings were examined. Flow from most of the sources is an actual measured quantity and therefore, less uncertainty is associated with it than with load as some concentration data assumptions had to be made. Determining a relatively accurate flow balance is generally the first step in a predictive modeling approach. This empirically-based approach used the same approach. Figure 13 shows how the flow sources compare to each other under various flow regimes. It also includes pie charts depicting relative contributions to the total Independence flow in more detail than the stacked graphs.

The relative contributions of existing loads were also examined. Figure 14 presents the relative existing load contributions of the various sources for total phosphorus. The upper graph shows this for all flow conditions; the lower graph breaks down the low flow conditions further.

The total phosphorus allocations for septic systems and point source loads were determined by using only the low flow (FDI>90%) existing and allowable load data on non-runoff days. The average percent difference between these load quantities became the reduction percentage that septic systems and point sources needed to achieve. The CSO allocations were determined based on the Long Term Control Plans (LTCPs) for Akron and Cleveland. The needed runoff reductions were based on what additional load reductions were needed on wet weather days after incorporating all other load reductions.

The fecal coliform allocations for the CSOs were based on the LTCPs and these reductions were incorporated first. The reduction needed on non-runoff days was addressed through the septic system load which is in keeping with the improvements needed for total phosphorus reduction. Functioning septic systems will address both issues. The additional reduction needed to meet the TMDL on wet-weather days was addressed by the runoff non-point source loads. This approach is reasonable since there are few if any existing exceedences of the fecal coliform TMDL at low flow conditions where the point sources are the predominate stressor.

Appendix J gives further information on the modeling approach used for this TMDL, and provides load duration curves and other information for tributaries of the lower Cuyahoga watershed.

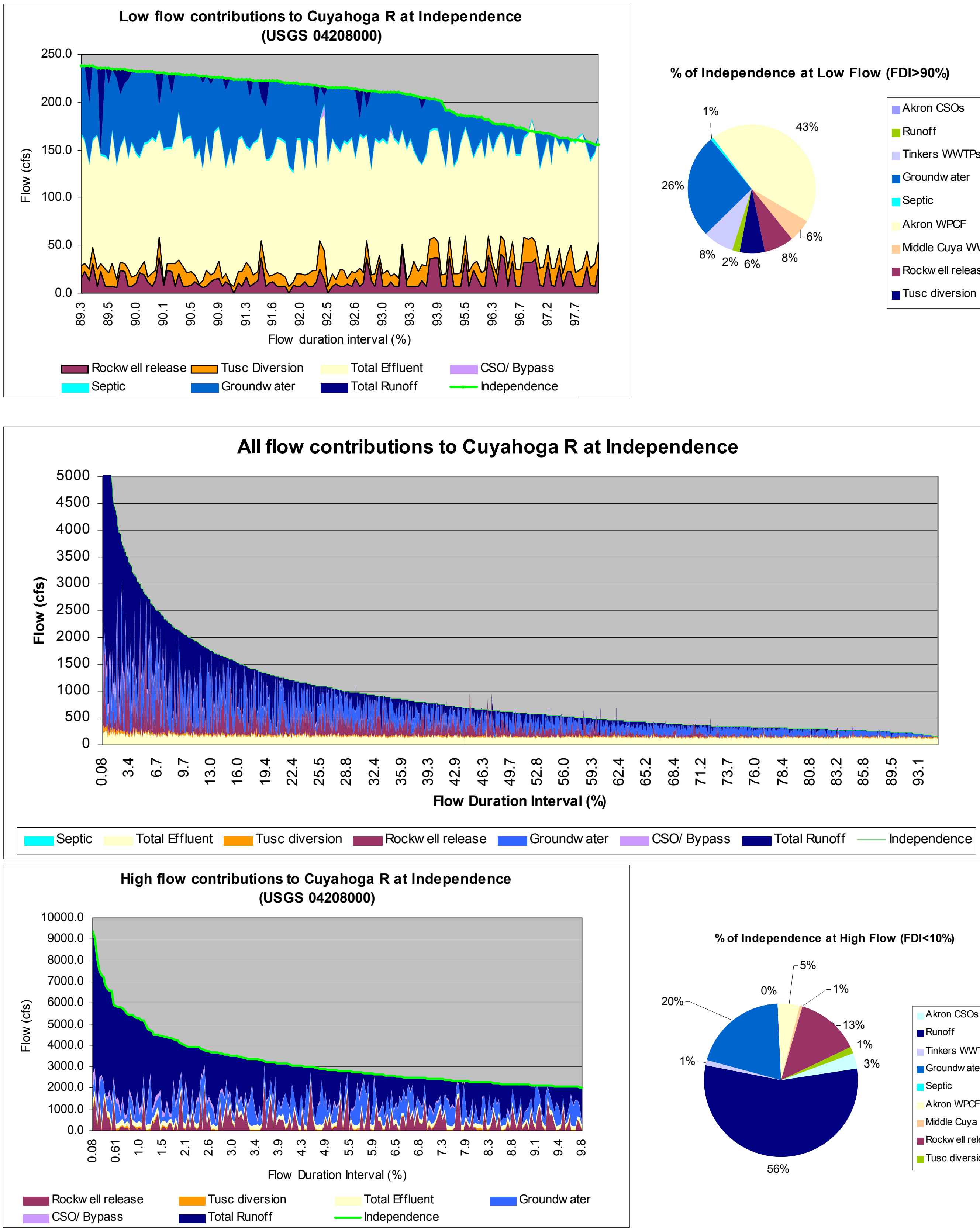
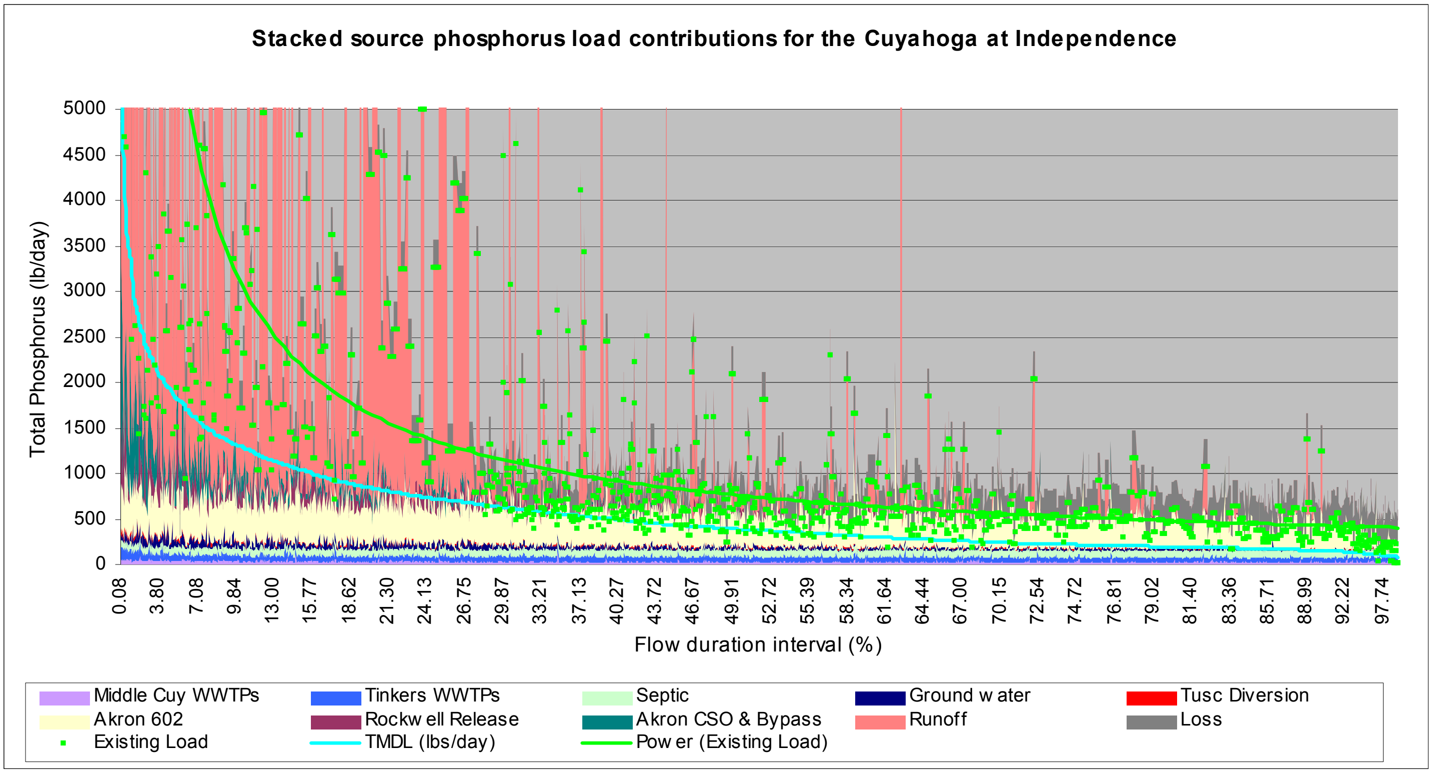


Figure 13. Stacked and percent flow contributions



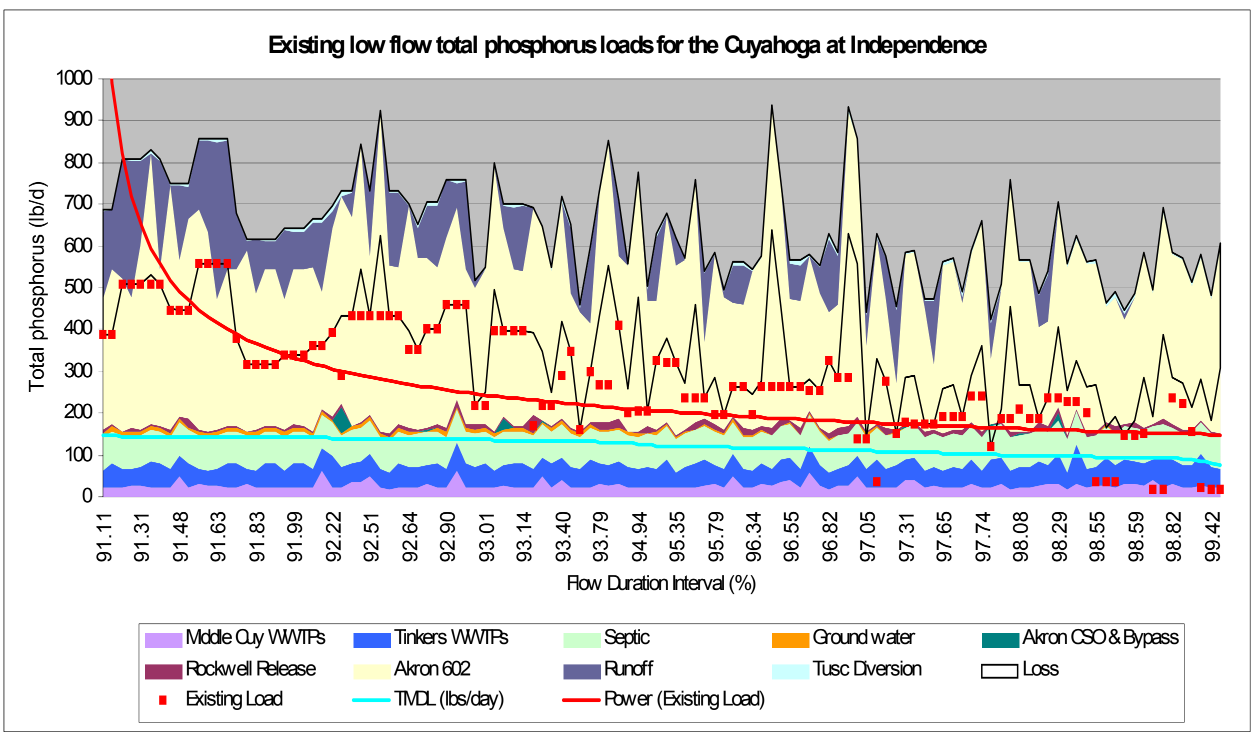


Figure 14. Total phosphorus existing loads to the Cuyahoga upstream of Independence. All flow conditions in upper graph and low flow conditions broken out further in lower graph.

4.2.3 Habitat Goals

Physical habitats were evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin, 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of in-stream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the habitat characteristics used to determine a QHEI score. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have 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. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with the WWH biological criteria. Scores greater than 75 frequently typify habitat conditions having the ability to support exceptional warmwater faunas. The QHEI can be used as a guide to direct restoration efforts for habitat and sediment load reductions and provides a monitoring tool to measure progress towards habitat and sediment load goals.

4.3 Critical Conditions and Seasonality

All known flow and recent historical seasonal conditions are included in this approach. The Cuyahoga at Independence flow gage record started in 1921 with only approximately a total of 10 years not in service. Therefore, about 71 years of daily flow data went into calculating the flow duration intervals. Almost daily detailed in-stream load data exists from 1985 to present to highlight the existing conditions. The TMDL and allocations were done to mesh with the flow duration intervals; therefore, all known conditions are accounted for including critical ones. One of the strengths of the load duration curve method is that it avoids determination of what the critical conditions are and what flow regime they occur under; instead it covers all flow conditions. Appendix J, Figures J15 and J16 show seasonal variation for flow and annual variation for water quality.

4.4 Margin of Safety

The statute and regulations require that a TMDL include a margin of safety to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA § 303(d)(1)(C), 40 C.F.R. § 130.7(c)(1)). EPA guidance explains that the margin of safety (MOS) may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified.

A margin of safety is incorporated both implicitly and explicitly into these TMDLs. An explicit margin of safety of 5% was included during the allocation process to account for uncertainty in the modeling approach. There are several areas where an implicit margin of safety is incorporated including the 303(d) listing process and the target development process. An explanation for each of these areas is provided below.

4.4.1 TMDL Priority 303(d) Listing

It is important to keep in mind during the evaluation of the TMDL a major difference in Ohio's program from other regional programs. In Ohio, one way a stream segment is listed on the 303(d) list is for failure to attain the appropriate aquatic life use as determined by direct measurement of the aquatic biological community. Many other regional or state programs rely solely on chemical samples in comparison to chemical criteria to determine water quality and designated use attainment. However, relying solely on chemical data does not take into account any of the parameters or other factors for which no criteria exist but that affect stream biology nor does it account for multiple stressor situations. Therefore, the chemical specific approach misses many biologically impaired streams and may not detect a problem until it is severe. Ohio's approach incorporates an increased level of assurance that Ohio's water quality problems are being identified. Likewise, delisting requires attainment of the aquatic life use determined by the direct measurement of the aquatic biological community. This provides a high level of assurance (and an implicit margin of safety) that if the TMDL allocations do not lead to sufficiently improved water quality then the segments remain on the list until true attainment is achieved.

4.4.2 Target Development

The use of nutrient targets that are based on data from relatively unimpacted reference sites provides an additional implicit safety factor. These data constitute a background concentration of nutrients in a stream; unimpacted streams generally have nutrient levels well below those needed to meet biological water quality standards. As the stream becomes impacted, nutrient levels can rise, but the stream can still meet the water quality standards based on other factors such as the presence of good habitat. Once the nutrient levels rise high enough or other factors change which no longer mitigate the effects of nutrients then the biological community is impacted, and the stream is impaired. By using nutrient targets based on data from relatively unimpacted sites (or sites that are conservatively in attainment of biological water quality criteria) the targets themselves are set at a conservative level. In other words, water quality attainment is likely to occur at levels higher than these targets and the difference between this actual level where attainment can be achieved and the selected target is an implicit margin of safety.

The habitat targets were selected using a method analogous to the nutrients method. The habitat targets and the specific aspects of the habitat that are degraded as provided with the QHEI model combine to add another layer of potential protection to achieving the WQS by providing additional guidance on an alternate means to reduce the nutrient load to the stream, mitigate the impacts of the nutrients in the stream, and directly improve an aspect of stream ecology vital to the biological community. Ohio EPA's ability to add habitat targets, and provide guidance on the improvement of the habitat is an implicit margin of safety made possible through extensive ecosystem monitoring and analysis, and should be recognized as a margin of safety in these TMDLs. Appendix J, Figure J17 shows the effects of using alternate targets to establish the TMDL.

4.5 TMDL Calculations

4.5.1 Load-Based Calculations:Total Phosphorus and Fecal Coliform

The total maximum daily load curves are shown in Figures 15 and 17. Figure 17 also shows the deviation from the current conditions for fecal coliform. The total allowable load and its allocations are given in Tables 12 and 13 for total phosphorus and 14 and 15 for fecal coliform. Average total maximum yearly loads and associated allocations are included in Table 17 for the Cuyahoga River at Harvard Ave which is the most downstream point in the study area. The water quality duration curve for total phosphorus at Harvard Avenue is included in Figure 19.

The necessary loading reductions are given in Table 16 which also compares the existing and allowable total loads for both total phosphorus and *E. coli*. Figure 16 depicts the relative percentage each source allocation makes to the total load for total phosphorus. Figure 18 shows the same for fecal coliform; both graphs for the Independence gage location on the Cuyahoga River. These reductions in combination with the other recommendations of this report (improved habitat and D.O. conditions) should attain standards in all segments.

The USEPA recommends that *E. coli* be the indicator bacteria used to determine if recreational use designations are being protected for. Currently Ohio EPA has a primary contact recreation criteria of 126 col/100 ml. However, little data existed in the watershed to support a TMDL analysis for *E. coli*. Figure 20 shows the *E. coli* TMDL curve applicable to the Cuyahoga River at the Independence gage. The future direction of the appropriate bacteriological criteria for Ohio are uncertain at this time; however, it is expected that *E. coli* will replace the fecal coliform criteria in the future. This expected direction should be kept in mind as implementation action decisions are being made in the watershed. The relative allocations should be similar for *E. coli* as for fecal coliform.

This approach assumes a direct relationship between loadings and concentrations and a constant assimilation factor (i.e., the in-stream concentrations of total phosphorus will respond to future changes in loading in the same manner as they respond to current loads). These simplifying assumptions are warranted by the fact that it is the cumulative, rather than the acute, loadings of nutrients that are impairing the biologic communities. Please refer to *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (OEPA, 1999) for a full discussion of the cumulative impacts of nutrients on Ohio rivers and streams.

Table 12. Total phosphorus total maximum daily loads and allocations (lbs/day) for the Cuyahoga River watershed upstream of the Independence gage

Hydrologic Condition: *FDI (%)*	**High** *0-10*	**Moist** *10-40*	**Transition** *40-60*	**Dry** *60-90*	**Low** *90-100*
Existing	8269	2851	766	581	286
Reduction Needed (%)	76	73	46	54	28
TMDL:	**1981**	**776**	**417**	**271**	**206**
Wasteload Allocation	704	386	370	366	360
Load Allocation	1236	521	247	131	95
Background	86	51	25	17	5
Future Growth	139	64	41	31	25
Margin of Safety	116	54	34	26	21
Loss	-300	-300	-300	-300	-300

Figure 15. Total phosphorus TMDL duration curve and allocations at Independence

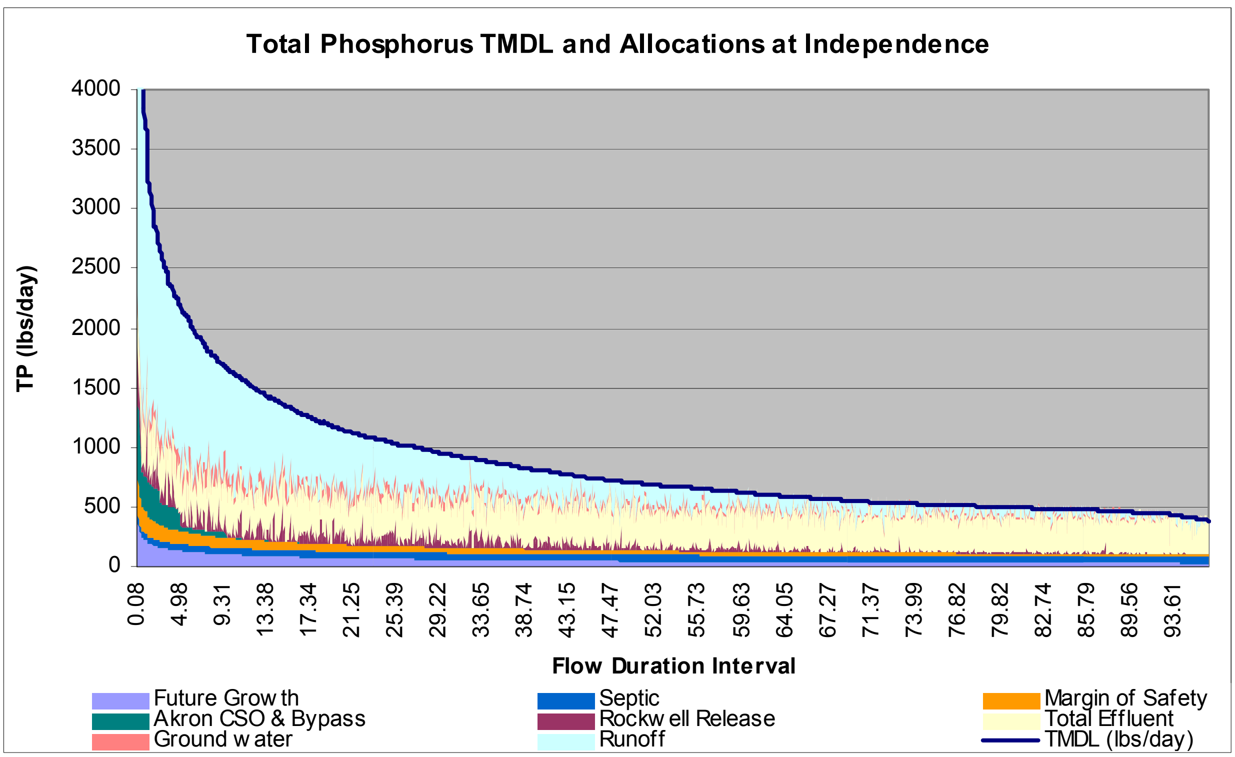
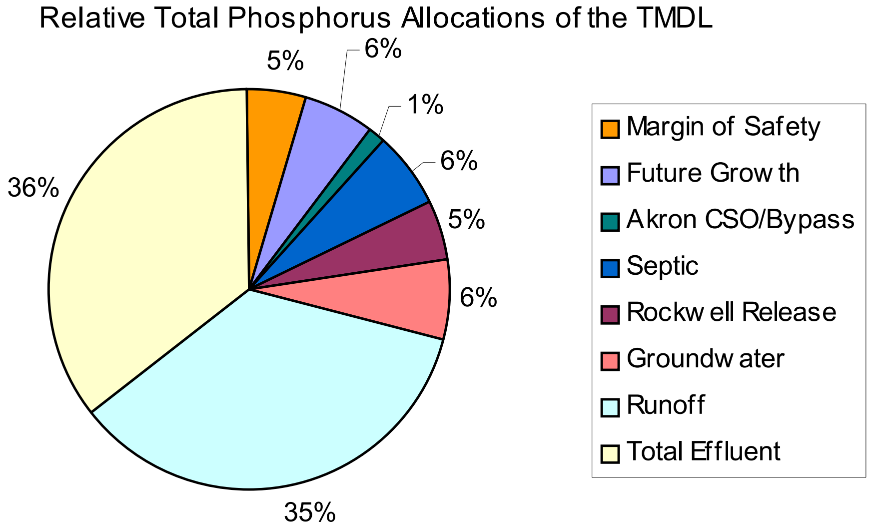


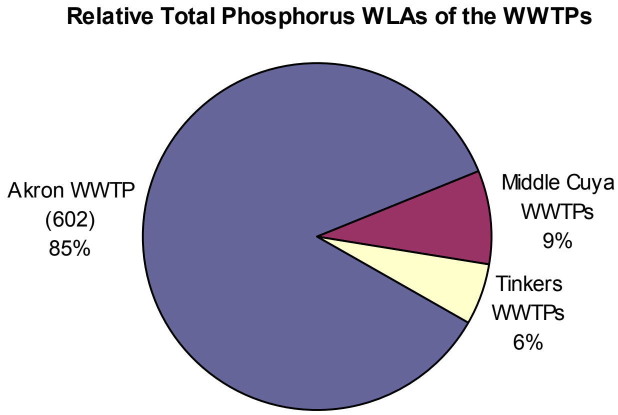
Table 13. Breakdown of total phosphorus allocations (lbs/day) for the Cuyahoga River watershed upstream of the Independence gage

Hydrologic Condition: *FDI (%)*	**High** *0-10*	**Moist** *10-40*	**Transition** *40-60*	**Dry** *60-90*	**Low** *90-100*
Wasteload Allocation:	**704**	**386**	**370**	**366**	**360**
Municipal separate storm sewer systems (MS4)	211	24	10	6	0
Akron CSOs*	133	2	0	0	0
Akron WWTP	272	272	272	272	272
Middle Cuyahoga WWTPs	29	29	29	29	29
Tinkers Ck WWTPs	59	59	59	59	59
Load Allocation:	**1236**	**521**	**247**	**131**	**95**
Reservoir and Diversions	137	78	43	18	12
Septic Systems	55	55	55	55	55
Unregulated runoff	1044	388	149	58	28

* These values are based on the DRAFT Akron Long Term Control Plan as of December, 2002. Any changes that are required to finalize the Akron LTCP would need to be reflected here. The intent of the TMDL is to reflect the LTCP not to drive it.

Figure 16. Relative TP Allocations of the TMDL, the WLA, and the LA at Independence





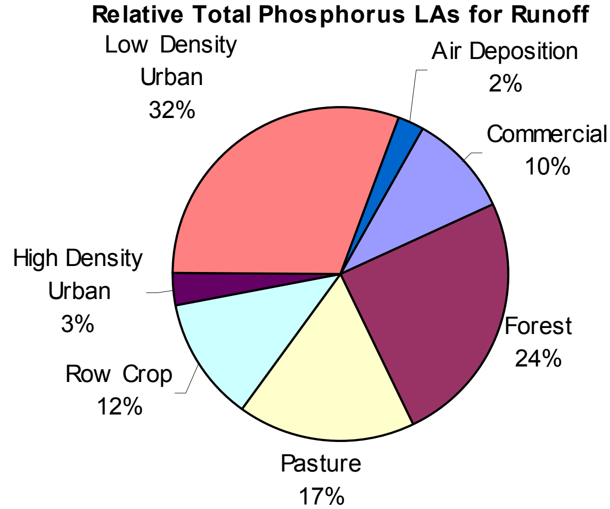


Figure 17. Fecal coliform TMDLs for single sample maximum and geometric mean criteria compared to existing load data for the Cuyahoga R at Independence.

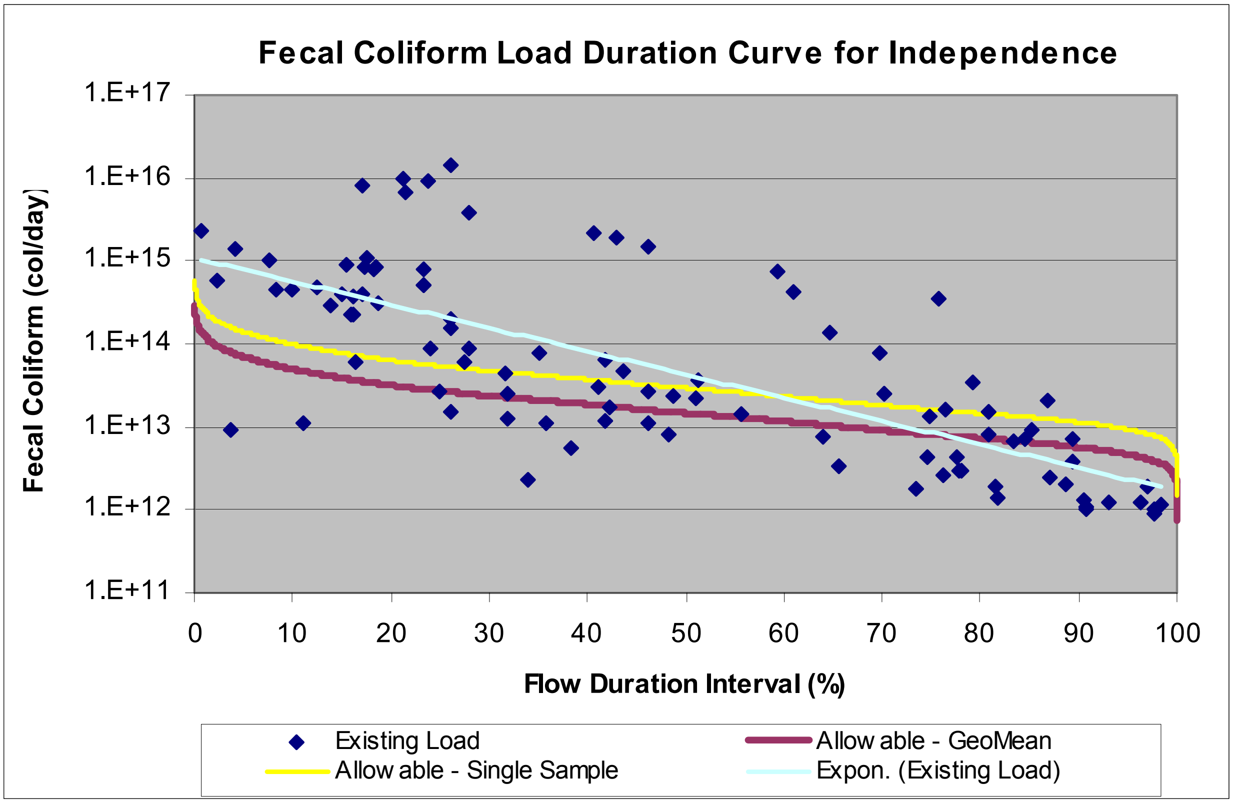


Table 14. Fecal coliform total maximum daily loads and allocations (lbs/day) for the Cuyahoga River watershed upstream of the Independence gage

Hydrologic Condition: *FDI (%)*	**High** *0-10*	**Moist** *10-40*	**Transition** *40-60*	**Dry** *60-90*	**Low** *90-100*
TMDL:	**7.66E+13**	**2.91E+13**	**1.46E+13**	**8.14E+12**	**4.69E+12**
Wasteload Allocation	6.51E+13	2.29E+13	2.26E+13	1.64E+13	7.45E+12
Load Allocation	1.27E+16	8.47E+15	8.39E+15	3.37E+15	2.69E+15
Background	4.92E+11	2.98E+11	1.52E+11	9.81E+10	3.92E+10
Future Growth	4.60E+12	1.75E+12	8.74E+11	4.88E+11	2.82E+11
Margin of Safety	3.83E+12	1.46E+12	7.28E+11	4.07E+11	2.35E+11
Loss	1.27E+16	8.47E+15	8.40E+15	3.38E+15	2.69E+15

Table 15. Breakdown of fecal coliform allocations (lbs/day) for the Cuyahoga River watershed upstream of the Independence gage

Hydrologic Condition: *FDI (%)*	**High** *0-10*	**Moist** *10-40*	**Transition** *40-60*	**Dry** *60-90*	**Low** *90-100*
Wasteload Allocation:	**6.51E+13**	**2.29E+13**	**2.26E+13**	**1.64E+13**	**7.45E+12**
Municipal separate storm sewer systems (MS4)	3.40E+13	2.26E+13	2.24E+13	1.62E+13	7.16E+12
Akron CSOs*	3.09E+13	1.21E+09	0.00E+00	0.00E+00	0.00E+00
Akron WWTP	2.31E+11	2.31E+11	2.31E+11	2.31E+11	2.31E+11
Middle Cuyahoga WWTPs	2.23E+10	2.23E+10	2.23E+10	2.23E+10	2.23E+10
Tinkers Ck WWTPs	2.79E+10	2.79E+10	2.79E+10	2.79E+10	2.79E+10
Load Allocation:	**1.27E+16**	**8.47E+15**	**8.39E+15**	**3.37E+15**	**2.69E+15**
Reservoir and Diversions	2.64E+11	1.60E+11	8.52E+10	2.73E+10	1.50E+10
Septic Systems	3.97E+12	3.97E+12	3.97E+12	3.97E+12	3.97E+12
Unregulated runoff	1.27E+16	8.47E+15	8.38E+15	3.37E+15	2.69E+15

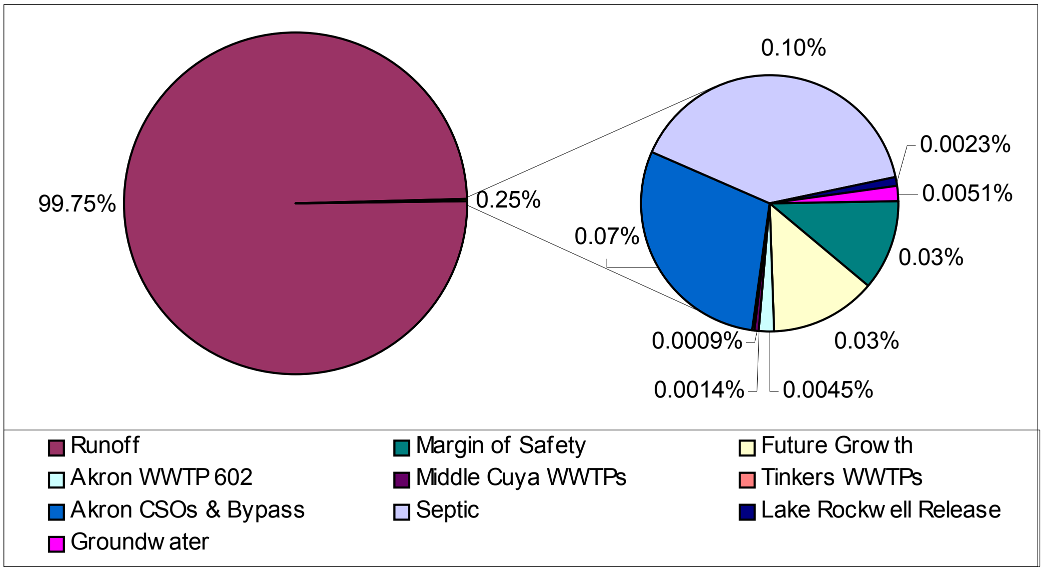
* These values are based on the DRAFT Akron Long Term Control Plan as of December, 2002. Any changes that are required to finalize the Akron LTCP would need to be reflected here. The intent of the TMDL is to reflect the LTCP not to drive it.

Table 16. Reduction percentage needed per source category for the Cuyahoga at Independence

	Fecal Coliform			Total Phosphorus		
Source	Existing Ave Load (cfu/year)	Allocated Ave Load (cfu/year)	% Reduction	Existing Ave Load (lb/year)	Allocated Ave Load (lb/year)	% Reduction
Runoff	3.47E+18	1.42E+18	59%	219716	113780	48%
Point Sources	9.70E+13	9.70E+13	0%	170580	120101	30%
Akron CSOs & Bypass	5.26E+16	1.05E+15	98%	34629	4635	87%*
Septic	2.27E+15	1.45E+15	36%	28831	20181	30%
Lake Rockwell Release	3.22E+13	3.22E+13	0%	22043	15847	28%
Groundwater	7.27E+13	7.27E+13	0%	12924	12924	0%

* The % reduction for TP associated with the Akron CSOs is expected only. The TP removal is incidental to the treatment methods proposed by Akron to treat for fecal coliform.

Figure 18. Relative contributions of fecal coliform TMDL allocations (upper graph) and non-point source runoff load allocations (lower graph) after implementation actions such as the LTCPs are completed.



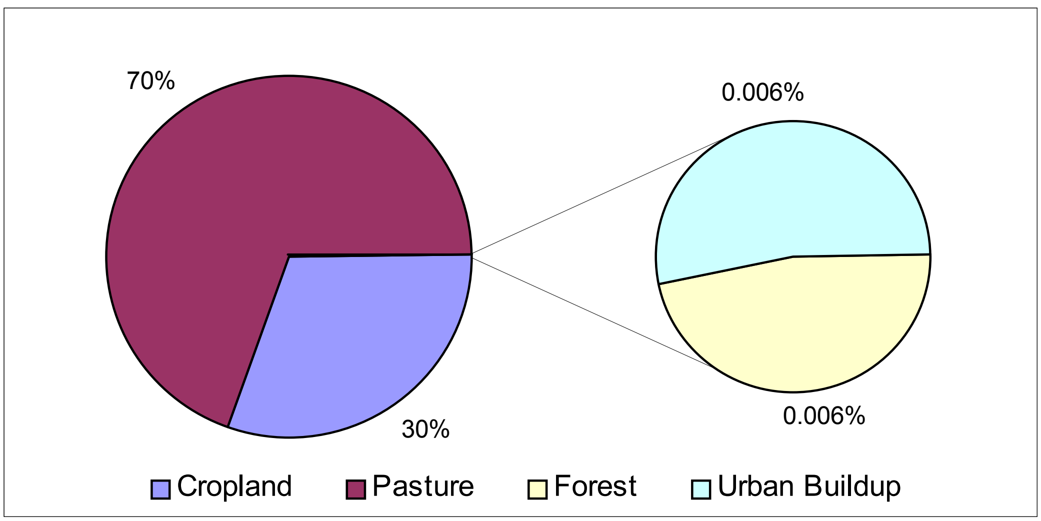


Table 17. Total Maximum Yearly Load and allocations for the Cuyahoga River watershed upstream of the Ship Channel (Harvard Avenue)[1]

TMYL[2]	TMYL Allocations								
	Runoff	WWTP[4]	Septic	Akron CSO	NEORSD CSO	Groundwater	Release (Res+Div)	Future Growth	MOS[3]
Total Phosphorus (lb/year)									
441295	139973	202926	20185	4726	887	14875	18884	19763	19076
Fecal Coliform (cfu/year)									
1.64E18	1.64E18	2.32E14	1.45E15	1.05E15	3.42E13	8.42E13	3.57E13	4.72E14	4.55E14

1 TMYL = Total Maximum Yearly Load; WLA = Wasteload Allocation (i.e., point source allocation); LA = Load Allocation, MOS = Margin of Safety, FDI = Flow Duration Interval, NEORSD = Northeast Ohio Regional Sewer District in the Cleveland area.

2 TMYL includes the in-stream loss term added to it.

3 Includes only the explicit 5% calculation.

The WWTP allocation includes a yearly allowable load for Southerly WWTP of 81283 lbs/year total phosphorus and 1.09E14 cfu/year for fecal coliform. This represents a total phosphorus permit limit for Southerly of 0.7 mg/l and no change in their current fecal coliform limit. All other WWTP allocations as shown in Tables 14 and 15 remain the same and are included in this WWTP total at Harvard Avenue.

Figure 19. Water quality duration curve for the Cuyahoga River at Lower Harvard Avenue

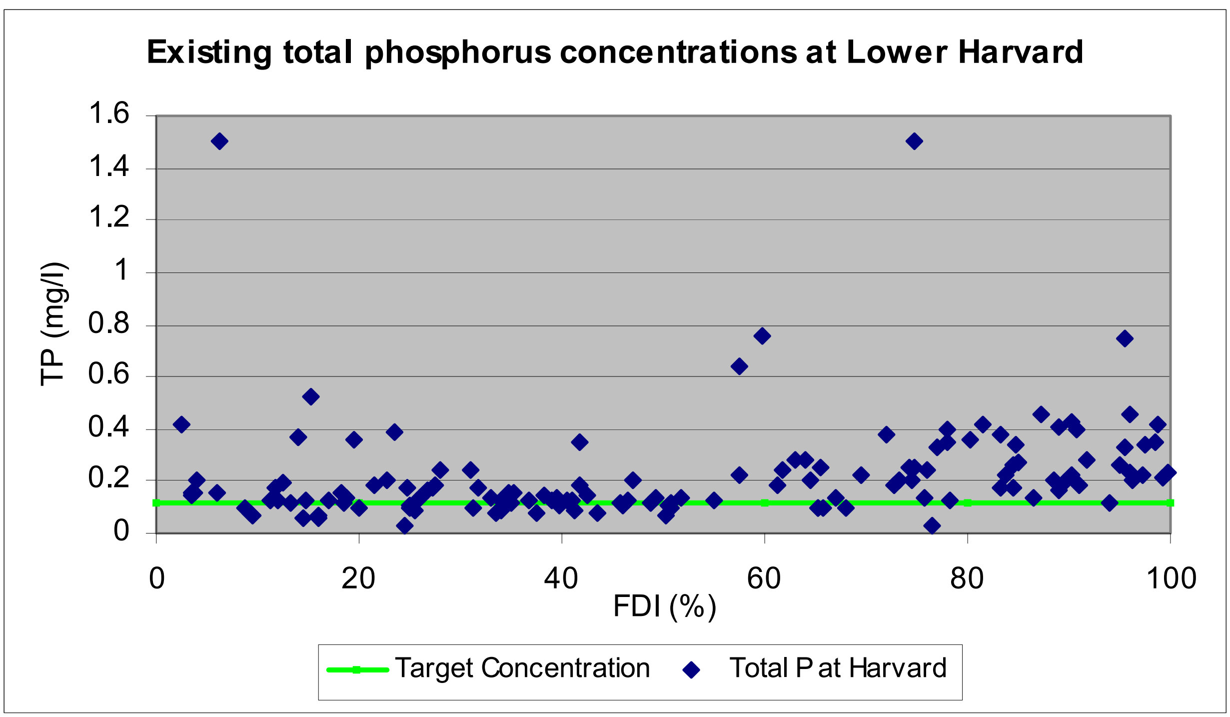
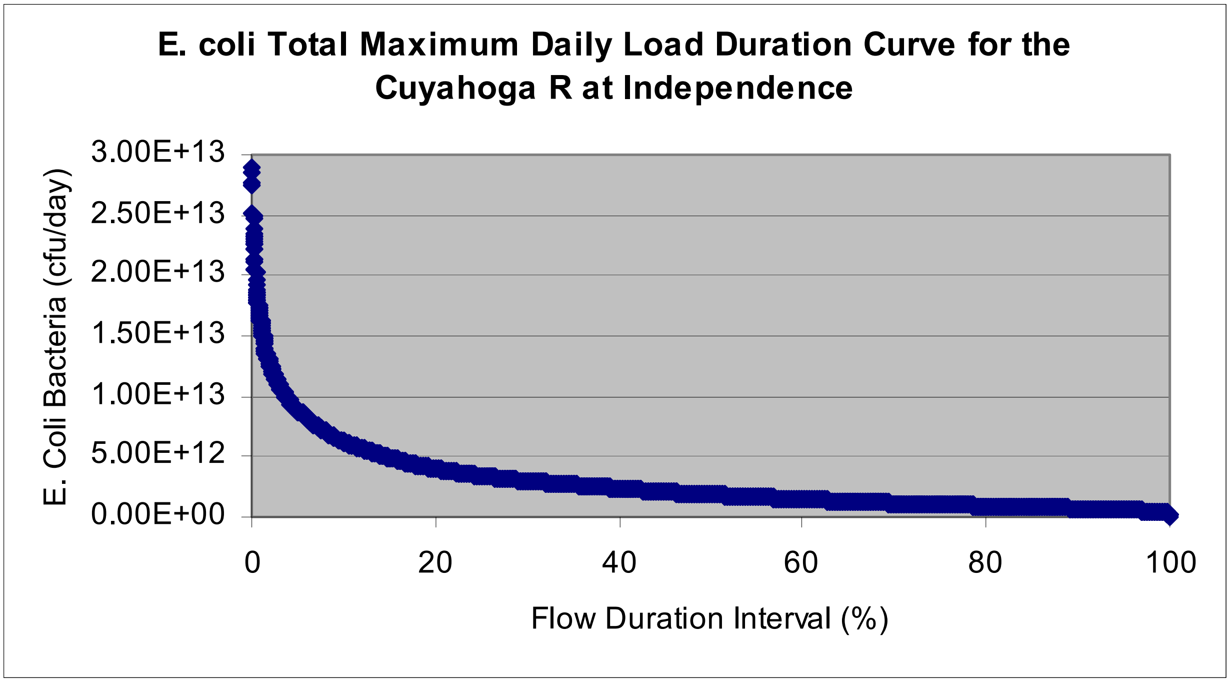


Figure 20. E. coli total maximum daily load as presented in a duration curve format based on a geometric mean standard of 126 fcu/100 ml.



4.5.2 Habitat Calculations for Aquatic Life

The detailed QHEI results are presented in Appendices M and N, and the QHEI scores per river mile are shown graphically in Figures 21 and 22. Figure 21 presents the information for the Cuyahoga River mainstem from Lake Rockwell to just upstream of the shipping channel at Harvard Avenue. Figure 20 presents this information for the tributaries. A trend analysis for the mainstem QHEIs is included in Figure 21.

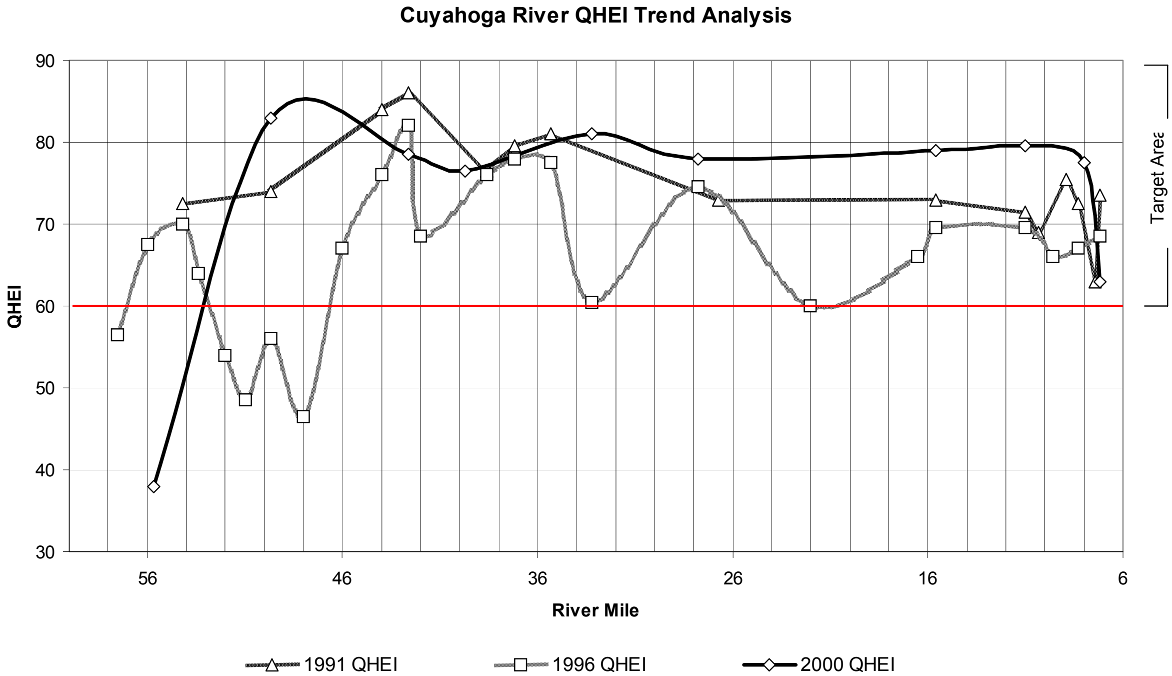


Figure 21. Lower Cuyahoga River QHEI scores per river mile for years 1991, 1996, and 2000

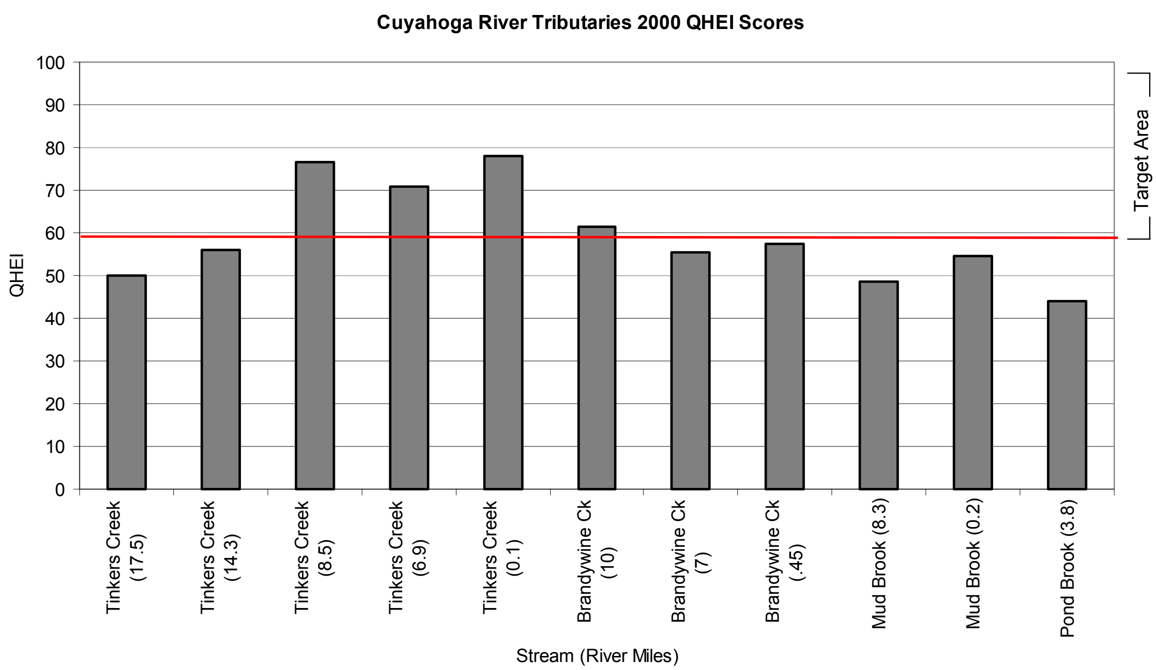


Figure 22. Lower Cuyahoga tributary QHEI scores from 2000

4.5.3 Dissolved Oxygen Water-Quality-Based Effluent Limitations for Akron WWTP

The permit renewal process for the Akron WWTP included determining water quality based effluent limitations for the Akron WWTP. These limitations were determined using the Multiple Discharge version of the Simplified Method Program (Multi-SMP) - a USEPA approved model. This model provides a simplified technique for calculating dissolved oxygen and un-ionized ammonia concentrations resulting from discharges from WWTPs into effluent dominated streams. The Cuyahoga River downstream of Akron is effluent dominated under low-flow conditions. The effluent limitations were developed for such critical low flow conditions by being based on the lowest seven day consecutive flow in a 10 year period and under summer temperature conditions. The following average limits are recommended in the summer to achieve the dissolved oxygen criteria downstream of the plant:

Ammonia-N:	1.5 mg/l
$CBOD_5$:	10 mg/l
Dissolved Oxygen:	5.0 mg/l
Total Phosphorus:	0.65 mg/l

5.0 PUBLIC PARTICIPATION

The Ohio EPA convened an external advisory group (EAG) in 1998 to assist the Agency with the development of the TMDL program in Ohio. The EAG met multiple times over eighteen months and in July, 2000, issued a report to the Director of Ohio EPA on their findings and recommendations.

A meeting was held with the Greater Cleveland Growth Association, Build Up Greater Cleveland on February 21, 2002 to discuss the Lower Cuyahoga River TMDL.

The initial stakeholders meeting was held on March 14, 2002. Over one hundred people attended this meeting. The presentation included a history of the TMDL process at Ohio EPA, an update to the stakeholders on the status of the Lower Cuyahoga TMDL, and discussion of the impaired segments and the causes and sources of impairment. A question and answer session followed the presentations.

A similar presentation was made to the Cuyahoga River Remedial Action Plan (RAP) Coordinating Committee at their meeting on May 23, 2002.

A meeting with representatives from the Soil and Water Conservation Districts (SWCD) in the basin was held on July 30, 2002. The purpose of that meeting was to bring together all the SWCD representatives to discuss what different efforts are underway in each county to deal with TMDL issues and to brainstorm other activities that the SWCDs could undertake in the future.

A meeting was held with stakeholders on August 27, 2002 to discuss water quality modeling for the Lower Cuyahoga River TMDL.

A meeting was held on September 17, 2002 with stakeholders to discuss water quality impacts associated with the Canal Diversion Dam located in the Cuyahoga Valley National Park. The meeting also served as the initial formation of a working group to mitigate water quality impacts while maintaining the functions and needs of various stakeholders.

A presentation was made on September 17, 2002 to the Sierra Club Portage Trail Group concerning the TMDL.

A presentation and meeting was held on September 19, 2002 with the Tinkers Creek Land Conservancy and Pond Brook Watershed Initiative concerning the TMDL. In addition, discussions centered on the adaptive management proposal for the Tinkers Creek subbasin.

A meeting was held on November 25, 2002 to present the current status of this TMDL and to receive additional comments from the stakeholders.

A meeting was held on May 16, 2003 with stakeholders to discuss and review water quality modeling for the Lower Cuyahoga River TMDL.

A meeting on the proposed draft TMDL report was held on June 19, 2003. Copies of a proposed draft were distributed at the meeting.

The public outreach activities also included a public comment period to review of the preliminary TMDL report prior to its submittal to U.S. EPA Region 5. A copy of the draft report was posted on Ohio EPA's web page on July 29, 2003. A summary of the public comments received is included as Appendix O in this report.

Public involvement is the keystone to the success of this TMDL project. Ohio EPA will continue to support the implementation process and will facilitate to the fullest extent possible an agreement acceptable to the communities and stakeholders in the study area and Ohio EPA. Ohio EPA is reluctant to rely solely on regulatory actions and strongly upholds the need for voluntary actions to bring these sections of the Cuyahoga River watershed into attainment.

6.0 IMPLEMENTATION AND MONITORING RECOMMENDATIONS

Restoration methods to bring an impaired waterbody into attainment with water quality standards generally involve an increase in the waterbody's capacity to assimilate pollutants, a reduction of pollutant loads to the waterbody, or some combination of both. As described in Section 2.0, the causes of impairment in the Lower Cuyahoga River are primarily nutrient enrichment, sedimentation, and stream habitat degradation. Therefore, an effective restoration strategy would include habitat improvements and reductions in pollutant loads potentially combined with some additional means of increasing the assimilative capacity of the stream.

6.1 Reasonable Assurances

As part of an implementation plan, reasonable assurances provide a level of confidence that the wasteload allocations and load allocations in TMDLs will be implemented by Federal, State, or local authorities and/or by voluntary action. The stakeholders will develop and document a list that differentiates the enforceable and non-enforceable selected actions necessary to achieve the restoration targets. Reasonable assurances for planned point source controls, such as wastewater treatment plant upgrades and changes to NPDES permits, will be a schedule for implementation of planned NPDES permit actions. For non-enforceable actions (certain nonpoint source activities), assurances must include 1) demonstration of adequate funding; 2) process by which agreements/arrangements between appropriate parties (e.g., governmental bodies, private landowners) will be reached; 3) assessment of the future of government programs which contribute to implementation actions; and 4) demonstration of anticipated effectiveness of the actions. It will be important to coordinate activities with those governmental entities that have jurisdiction and programs in place to implement the nonpoint source actions (e.g., county soil and water conservation district offices, county health departments, local Natural Resource Conservation Service offices of the U.S. Department of Agriculture, municipalities and local governmental offices).

6.1.1 Minimum Elements of an Approvable Implementation Plan

Whether an implementation plan is for one TMDL or a group of TMDLs, it should include at a minimum the following eight elements:

- Implementation actions/management measures (Table 18),
- Time line (Table 19),
- Reasonable assurances (Table 19),
- Legal or regulatory controls (Table 19),
- Time required to attain water quality standards (Table 20),
- Monitoring plan (Table 20),
- Milestones for attaining water quality standards (Table 20),
- TMDL revision procedures (Narrative).

6.1.1.1 Reasonable Assurances Summary

This is a summary of the regulatory, non-regulatory and incentive based actions applicable to or recommended for the Lower Cuyahoga River TMDL Area. Many of these activities deal specifically with the protection, restoration, or enhancement of habitat:

Regulatory:

- Appropriate permit limits for phosphorus, ammonia, dissolved oxygen, and CBOD for NPDES dischargers.
- Phase I and II storm water requirements
- riparian ordinances (model language is currently available from several sources)
- 208 plans- NOACA and NEFCO updated plans http://www.noaca.org/Clean_Water_2000/clean_water_2000.html) (NEFCO report is draft), http://www.co.summit.oh.us/NEFCOCleanWaterPlan.htm)
- county oversight of the inspection of semi-public wastewater treatment systems (HB 110 activities)
- Nine Minimum Controls for Combined Sewer Overflows

Non-regulatory:

- Finalization of an implementation plan (see 6.1.1) which includes these components:
  -septic system management
  -riparian corridor initiatives
  -point source controls
  -storm water management
  -education
  -dam removal
- Ohio EPA will continue to conduct chemical and biological sampling in the basin, following the five-year basin rotation strategy.

Incentive-based:

- 319-funded projects for the Lower Cuyahoga River basin which support the goals of this TMDL.
- Pursue various loan opportunities for WWTP, septic system, and riparian/habitat improvements (i.e. WRRSP, Revolving Loan Fund, conservation easements)

6.1.1.2 Implementation Actions, Time Line, and Reasonable Assurances

The implementation actions and measures are described in Table 18. The reasonable assurances are described in Table 19. A time line for implementation actions is included in both Tables 19 and 20.

<u>Combined Sewer Overflow</u>

The Lower Cuyahoga River watershed receives combined sewer overflows from the City of Akron and the Northeast Ohio Regional Sewer District. These overflows contribute to non attainment in the watershed by discharging large volumes of combined sewage containing bacteria, oxygen demanding substances, nutrient, suspended solids, and toxics from industrial wastewaters. The US EPA implemented a Combined Sewer Control Policy in April of 1994 and the Ohio EPA implemented a Combined Sewer Control Strategy in March of 1995.

The primary goal of Ohio's CSO Strategy (March, 1995) is to control CSOs so that they do not significantly contribute to violations of water quality standards or impairment of designated uses. Through provisions included in NPDES permits, all CSO communities must implement short-term controls, the nine minimum technology-based controls. If these are not sufficient to meet water quality standards, a community may be required to implement more extensive long-term controls. In addition, communities must characterize their collection systems and overflows, evaluate the wet weather treatment capabilities of their wastewater plants, and conduct instream bacterial monitoring. Both the City of Akron and Northeast Ohio Regional Sewer District must develop Long Term Control Plans to address CSO's. Long term control plans have been submitted to address all combined sewer overflows in the Lower Cuyahoga River TMDL area. Two (of the five submitted) have been approved as listed in Table 19. Additional details on the City of Akron CSO control program (approval pending) may be found at the following web address: http://ci.akron.oh.us/fp98/index.htm .

While not the sole source of pollution to the watershed, CSO's have significant impacts. Addressing CSO's in conjunction with issues associated with urbanization and suburbanization will help to restore the integrity of the Lower Cuyahoga River.

Storm Water Management

On December 8, 1999, USEPA promulgated the expansion of the existing National Pollutant Discharge Elimination System (NPDES) Storm Water Program by designating additional sources of storm water for regulation to protect water quality. Entities are required to obtain permit coverage by March 10, 2003.

Municipalities located in urbanized areas and that operate municipal separate storm sewer systems (MS4s) will be included in the program in the State of Ohio. A list of entities covered by the Phase II Storm Water Regulations is included in Appendix A. Pollutants from MS4s include floatables, oil and grease, as well as other pollutants from illicit discharges

Operators of small MS4s will be required to develop a storm water management program that implements six minimum measures, (listed below) which focus on a Best Management Practice (BMP) approach. The BMPs chosen by the MS4 must significantly reduce pollutants in urban storm water compared to existing levels in a cost-effective manner.

The Six Minimum Control Measures

- Public Education and Outreach Program on the impacts of storm water on surface water and possible steps to reduce storm water pollution. The program must be targeted at both the general community and commercial, industrial and institutional dischargers.

- Public Involvement and Participation in developing and implementing the Storm Water Management Plan.
- Elimination of Illicit Discharges to the MS4.
- Construction Site Storm Water Runoff Ordinance that requires the use of appropriate BMPs, pre-construction review of Storm Water Pollution Prevention Plans (SWP3s), site inspections during construction for compliance with the SWP3, and penalties for non-compliance.
- Post-Construction Storm Water Management Ordinance that requires the implementation of structural and non-structural BMPs within new development and redevelopment areas, including assurances of the long-term operation of these BMPs.
- Pollution Prevention and Good Housekeeping for municipal operations such as efforts to reduce storm water pollution from the maintenance of open space, parks and vehicle fleets.

These additional storm water control measures will help to improve water quality in the Lower Cuyahoga River. Reduction in the sediment load will improve both habitat and chemical water quality. Identification of illicit discharges to storm sewer systems will also improve water quality.

<u>Modification/Elimination of the Canal Diversion dam</u>
Initial discussions have begun on addressing the Canal Diversion dam and impacts associated with it. The dam is owned by the State of Ohio Department of Natural Resources and serves a function by providing a water source to the Ohio Canal. If removed, the Cuyahoga River would be restored to a free flowing state for its final 44 miles. This would also provide fish access to several high quality tributaries (Furnace Run, Yellow Creek) that are currently inaccessible to a majority of fish species. The only barriers to completing this project are securing a cost effective way to provide a water source to the Ohio Canal and funding for project design and construction. The Canal Diversion Dam provides water to the historic Ohio and Erie Canal. Removal of the dam will take into account the need to provide an alternate suitable water source to the canal.

<u>Evaluation of remaining dams on lower Cuyahoga River for removal</u>
All dams within the lower Cuyahoga River TMDL study area shall be evaluated for the feasibility of removal. The process shall begin by compiling an inventory of all dams in the study area. The inventory shall be prioritized for removal opportunities based on ecological benefits of removal.

<u>Semipublic Sewage Disposal Systems</u>
Improperly maintained small (generally less than 25, 000 gallons) sewage treatment systems can contribute oxygen demanding substances, nutrients, and bacteria to the Lower Cuyahoga River TMDL area. House Bill 110 programs are in place in Portage, Summit, and Cuyahoga Counties. These programs allow county health departments to register and inspect semipublic sewage disposal systems. Increased oversight will allow for improved operation and identification of malfunctioning systems. Enforcement of regulations will still be conducted by the Ohio EPA.

Household Sewage Disposal Systems
Septic systems and other forms of home sewage disposal can contribute to water quality impairments. They have been identified as major sources in West Creek (**The West Creek Valley Management Plan A Watershed Approach for the Future, September 2001**, prepared by the Cuyahoga County Planning Commission) and failure rates can be fairly high (**Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-Public Sewage Disposal Systems**, April 2001). Off-lot home sewage disposal systems have also identified as the number one risk within the Yellow Creek Watershed by NEFCO in the **Yellow Creek Watershed: Comprehensive Watershed Management Plan Phase 1**.

Improvements in treatment systems and elimination of discharges from unsewered areas will results in decreasing loadings of oxygen demanding substances, nutrients, and bacteria. This is also tied in to Phase II of the storm water regulations which require elimination of illicit discharges. Existing local health department inspection programs will be helpful in identifying problem areas. Adequate resources need to be provided to the health departments both financially and through legislation to ensure their ability to address this issue.

Proposed standards for inspection of home sewage disposal systems are included in the NOACA (Final) and NEFCO 208 (currently draft) plans.

208 Plan Updates
Currently 208 (Areawide Waste Treatment Management Plan prepared pursuant to Section 208 of the Clean Water Act) plans for the Lower Cuyahoga River TMDL area have been completed with the portion of the plan covering Portage and Summit Counties out for formal public review. The purpose of the plans are to address municipal wastewater treatment issues and nonpoint source pollution. The Lower Cuyahoga River TMDL area involves two planning agencies, Northeast Ohio Areawide Coordinating Agency (NOACA) for Cuyahoga and Geauga Counties, and the Northeast Ohio Four County Regional Planning and Development Organization (NEFCO) for Portage and Summit Counties. Resources are needed to sustain the Water Quality Management planning efforts at the area wide level so that plan recommendations will be acted on and adopted by local communities. Identifying an action in the 208 Plan for local government attention is only the first step.

Wetlands Protection
Wetlands are an important part of the watershed and perform many useful functions which relate to water quality. Preservation and enhancement of wetlands in the Lower Cuyahoga River TMDL area will help to improve water quality. It is recommended that no new permits to impact Category 2 and 3 wetlands be issued in the Lower Cuyahoga River TMDL area. All permits issued for impacts to Category 1 wetlands should ensure that mitigation is conducted on site if possible and at a minimum within the watershed area. If mitigation can not be conducted on site or within the watershed area, then a permit should not be issued for the proposed project.

The Cuyahoga Valley National Park (CVNP) has a Wetland Restoration Plan (to restore degraded wetlands) in development.

<u>Riparian Protection</u>
Protection of riparian zones plays an important role in stream integrity. Small stream are able to maintain thermal regimes with riparian protection. Open stream lacking riparian protection are influenced by sunlight which in addition to temperature increases, can stimulate algae and macrophyte growth. Additionally, protection and restoration of riparian zones along streams can help to exacerbate some of the effects caused by increasing impervious area. Streambank protection afforded by riparian zones also helps to reduce sediment and nutrient loading.

Two mechanisms are proposed to promote riparian protection. The first mechanism proposed is the passage of stream setback ordinances. Summit County recently passed an ordinance (Number 2002-154, April 29, 2002) establishing riparian setbacks. Riparian ordinances also currently exist in Medina County, Bath, and Brecksville. Another mechanism to promote riparian protection is comprehensive land use planning. Through the identification of sensitive natural areas communities can promote wise land use policy. These mechanisms are also promoted in the 208 plans.

The CVNP has a Riverbank Stabilization Plan (to address erosion threats to important park infrastructure) in development, and has recently requested technical assistance for developing a plan to restore riparian buffer areas specifically for ecological and habitat values and to improve water quality. CVNP is currently implementing new riparian and wetland buffer zone requirements for park farmers, park service mow crews and park development projects. The set-backs (50-250 ft.) will result in the cessation of agriculture or mowing in prescribed buffer zones. It is expected that natural processes will restore many riparian and wetland values and functions.

Evaluation of all 401/404 permit applications in the Lower Cuyahoga River TMDL area should require mitigation to be conducted on site if possible and at a minimum within the watershed area. If mitigation can not be conducted on site or within the watershed area, then a permit should not be issued for the proposed project. Export of both wetland mitigation and stream mitigation out of the watershed is a threat to restoration and improvement of habitat in the watershed.

<u>Point Source Control</u>
Adequate point source control mechanisms shall be utilized for all direct discharges in the Lower Cuyahoga River TMDL area. NPDES permits for point sources shall be prepared and issued with limits and conditions necessary to protect and restore water quality in the Lower Cuyahoga River TMDL area. When appropriate, Ohio EPA shall take enforcement actions necessary to maintain compliance with discharge permit limits.

<u>Tinkers Creek Adaptive Management</u>
Adaptive management shall be implemented in the Tinkers Creek watershed as a tool to identify stressors and implement controls necessary to achieve compliance with

water quality standards. The process shall contain the following steps.

1. Stressor Identification, utilizing the **Stressor Identification Guidance Document**, U.S. Environmental Protection Agency Office of Water, Washington, DC 20460, Office of Research and Development, Washington, DC 20460, EPA-822-B-00-025, December 2000
2. Address identified stressors utilizing existing management tools (examples include NPDES permits, enforcement, local health departments).

The management plan is included as Appendix C.

All NPDES permits within the Tinkers Creek watershed shall be modified or issued with the following language:

> *"The Lower Cuyahoga TMDL, identified the Tinkers Creek subbasin as an area with unidentified sources of stressors resulting in NONATTAINMENT of Ohio Water Quality Standards. A process known as adaptive management will be used to gather data, identify stressors, and implement appropriate controls needed to restore water quality in the Tinkers Creek subbasin. The permit holder shall be a member of the Tinkers Creek Restoration Group and be included in all notifications for activities pertaining to this project. Should stressor identification result in additional pollutant loading recommendations for permittees in the Tinkers Creek subbasin this permit shall be modified to reflect those recommendations.*
>
> *Schedule:*
> *January - December 2004 Gather Data*
> *June 2004 - June 2006 Conduct Stressor Identification*
> *June 2006 Begin to Implement Management Plan"*

Table 18. Description of implementation actions and measures

#	Implementation Actions & Management Measure	Effected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
1	Combined Sewer Control, Long Term Control Plans (LTCP)	Cuyahoga River and Tributaries? City of Akron, Northeast Ohio Regional Sewer District	CSO control programs will address oxygen demanding substances, bacteria, nutrients	CSO control is expected to be highly effective, effectiveness may be impacted by available finances to complete the program.
1a	NEORSD Mill Creek LTCP			
1b	NEORSD Westerly LTCP			
1c	NEORSD Southerly LTCP			
1d	NEORSD Easterly LTCP			
1e	City of Akron LTCP			
2	Phase II Storm water	Entire Lower Cuyahoga River TMDL area / See Appendix A for list of communities.	Storm water control will reduce sediment loading, eliminate illicit discharges to MS4s	If correctly implemented effectiveness will be very good.

Table 18. Description of implementation actions and measures

#	Implementation Actions & Management Measure	Effected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
3	Educational Programs	Entire Lower Cuyahoga River TMDL area	Educational programs within the area are existing and relatively strong. Education allows the public to be better informed on processes withing the watershed and their impacts to it.	An informed citizen body and informed public officials will be effective in promoting programs to restore water quality in the Lower Cuyahoga River TMDL area
4	Modification/elimination of the Canal Diversion Dam (also called the Station Road or Route 82 Dam)	Cuyahoga River and tributaries above RM 22/ National Park Service, Cleveland Metroparks, State of Ohio, City of Brecksville	Biological communities will be improved by addressing impacts associated with the dam. Dissolved oxygen deficits found in the impounded area behind the dam will be eliminated. Recreational opportunities will be enhances and made safer.	Dam removal /modification will be highly effective at removing one barrier to upstream attainment of water quality standards.
4a	Evaluation of all dams in Lower Cuyahoga River TMDL area for removal.	Cuyahoga River and its tributaries.	Biological communities will be improved by addressing impacts associated with the dam. Dissolved oxygen deficits found in the impounded areas behind dams will be eliminated. Recreational opportunities will be enhances and made safer.	Dam removal will be highly effective at removing one barrier to upstream attainment of water quality standards

Table 18. Description of implementation actions and measures

#	Implementation Actions & Management Measure	Effected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
5	House Bill 110 program	Cuyahoga River and tributaries/ County Health Departments, Ohio EPA, Regulated Entities	Inspections and proper maintenance of semipublic sewage treatment systems will allow for some reductions in the discharge of oxygen demanding substances and nutrients.	High, proper functioning sewage disposal systems will result in pollutant loading reductions. Unsewered areas and streams within them will derive greater benefits.
6	Household sewage disposal systems - Inspection and maintenance programs	Cuyahoga River and tributaries/ Local Health Departments, Home Owners	Inspections and proper maintenance of household sewage disposal systems will allow for some reductions in the discharge of oxygen demanding substances and nutrients.	High, proper functioning sewage disposal systems will result in pollutant loading reductions. Unsewered areas and streams within them will derive greater benefits.
7	208 updates	Cuyahoga River and tributaries/ NOACA, NEFCO	Comprehensive planning will help to promote better land use decisions and provide guidance to Ohio EPA and local sewer authorities. Storm water controls will help to reduce impacts associated wit development.	Very Good, if the guidance is followed.
8	Wetlands protection	Cuyahoga River and tributaries	Wetlands have a great number of benefits provided to the watershed, including water quality and flood protection.	Preservation, restoration, and enhancement of wetlands will be highly effective

Table 18. Description of implementation actions and measures

#	Implementation Actions & Management Measure	Effected Stream / Party	Parameters Effected/Benefits	Estimated Effectiveness
9	Riparian protection	Cuyahoga River and tributaries	Streambank stability, water quality, biological integrity	Very Good, if the guidance is followed and communities adopt riparian protection ordinances.
10	NPDES permit limits	Cuyahoga River and tributaries / All NPDES permit holders in TMDL area potentially effected	Pollutant reduction.	Very good if main source of impairment is from NPDES permitted dischargers.
11	Tinkers Creek Stressor Identification and Elimination Project	Tinkers Creek and its tributaries/ NPDES dischargers to Tinkers Creek, Municipalities and landowners within the watershed.	Identification of the stressor of stressors to the watershed is key/ benefits would be restoration of chemical and biological integrity.	High, if stressors are identified and addressed.

Table 19. Time line and reasonable assurances

#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics
1a	Approve Mill Creek LTCP	Ohio EPA	Approved 3-26-97	Both Ohio EPA and US EPA have CSO programs. Existing CSO permit for NEORSD.
1b	Approve Westerly LTCP	Ohio EPA	Approved 7-5-01	Both Ohio EPA and US EPA have CSO programs. Existing CSO permit for NEORSD.
1c	Approve Southerly LTCP	Ohio EPA	Submitted March of 2002	Both Ohio EPA and US EPA have CSO programs. Existing CSO permit for NEORSD.
1d	Approve Easterly LTCP	Ohio EPA	Submitted March of 2002	Both Ohio EPA and US EPA have CSO programs. Existing CSO permit for NEORSD.
1e	Approve Akron LTCP	Ohio EPA	Submitted December of 1998	Both Ohio EPA and US EPA have CSO programs.

Table 19. Time line and reasonable assurances				
#	**Action**	**Managing Party**	**Schedule**	**Reasonable Assurance Description/Specifics**
2	Phase II Storm water	Ohio EPA, Local Soil Water Conservation Districts	Compliance beginning in March of 2003	US EPA Phase II storm water regulations
3	Educational Programs	Ohio EPA, Cuyahoga RAP, Local Soil Water Conservation Districts	Ongoing	Continuation and expansion of existing educational programs. See Appendix I for Cuyahoga RAP activities.
4	Modification/ elimination of the Canal Diversion Dam	State of Ohio, National Park Service	Final design by December of 2003, initial implementation in 2004	Ohio Water Quality Standards, National Park System goals and guidelines, Public (ODNR) ownership of dam.
4a	Evaluation of all dams in Lower Cuyahoga River TMDL area for removal.	Ohio EPA, Individual dam owners, local park departments	Ongoing	Ohio Water Quality Standards
5	House Bill 110 program	Local Health Departments, Ohio EPA	Ongoing	House Bill 110 allows health departments and Ohio EPA to enter into contract for the purpose of licensing and inspecting semipublic sewage disposal systems. Existing regulations are utilized (ORC 6111)
6	Household sewage disposal systems	Local Health Departments, Ohio Department of Health	Ongoing	State and local home sewage treatment system regulations.

Table 19. Time line and reasonable assurances

#	Action	Managing Party	Schedule	Reasonable Assurance Description/Specifics
7	208 updates	NEFCO NOACA	NOACA completed in Nov. 2000 (for Cuyahoga, and Geauga counties, NEFCO currently in public hearings for draft plan (Summit and Portage counties)	Section 208 of the Clean Water Act
8	Wetlands protection	Ohio EPA US Army Corps of Engineers	Existing rules	Sections 401 and 404 of the Clean Water Act. State of Ohio wetland regulations (OAC 3745)
9	Riparian protection	Local Governments, National Park	Some existing some proposed	No direct reasonable assurances. Ancillary assurances may be tied to Phase II storm water regulations and comprehensive planning for local communities.
10	NPDES permit limits	Ohio EPA	Ongoing	Section 402 of the Clean Water Act, State of Ohio (ORC Chapter 6111)
11	Tinkers Creek Stressor Identification and Elimination Project	Ohio EPA, Local Health Departments	Begin in 2nd Quarter 2003	Section 402 of the Clean Water Act, State of Ohio (ORC Chapter 6111) , Section 208 of the Clean Water Act, State and local home sewage treatment system regulations, US EPA Phase II storm water regulations

Table 20. Time line: monitoring, tracking and implementation

Action	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Approve Mill Creek LTCP	LTCP approved March 26, 1997. Work ongoing.									
Approve Westerly LTCP	LTCP approved July 5, 2001. Work ongoing.									
Approve Southerly LTCP										

Table 20. Time line: monitoring, tracking and implementation

Action	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Approve Easterly LTCP	LTCP submitted March 28, 2002. Approval anticipated in 2003.									
Approve Akron LTCP	LTCP submitted December 1998. Approval anticipated in 2003.									
Phase II Storm water	Compliance by March 2003. Program ongoing									
Educational	Educational programs strong and ongoing.									
Modification/elimination of the Canal Diversion Dam	Discussion and Initial Design									
		Final Design. Public Input.								
			Implement Final Design							
					Monitor Effectiveness					
House Bill 110	Program approved for Cuyahoga, Portage, and Summit Counties. Ongoing.									
Household	Local Health Departments currently conduct inspections of home sewage disposal systems. Not all systems									
208 updates	NOACA 208 finalized in November 2000.									
	Draft report anticipated to be finalized in 2003.									
Wetlands protection	Program ongoing.									
Riparian protection	Summit County ordinance in place.									
	Work with and assist local governments to enact riparian protection ordinances.									
NPDES permit limits	Modify NPDES permits to reflect TMDL									
		Compliance schedule for treatment system modifications								

Table 20. Time line: monitoring, tracking and implementation

Action	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	Attain and maintain compliance with NPDES permit									
Tinkers Creek Stressor Identification and Elimination Project	Gather data									
	Stessor Identification									
			Implement Management Plan							

Note:
This is a working document. Schedules for some of the implementation actions have not been developed yet.

6.1.2 Proposed NPDES Language

All NPDES permits within the Tinkers Creek watershed shall be modified or issued with the following proposed language:

> "*The Lower Cuyahoga TMDL, identified the Tinkers Creek subbasin as an area with unidentified sources of stressors resulting in NONATTAINMENT of Ohio Water Quality Standards. A process known as adaptive management will be used to gather data, identify stressors, and implement appropriate controls needed to restore water quality in the Tinkers Creek subbasin. The permit holder shall be a member of the Tinkers Creek Restoration Group and be included in all notifications for activities pertaining to this project. Should stressor identification result in additional pollutant loading recommendations for permittees in the Tinkers Creek subbasin this permit shall be modified to reflect those recommendations.*
>
> *Schedule:*
> *January - December 2004* — *Gather Data*
> *June 2004 - June 2006* — *Conduct Stressor Identification*
> *June 2006* — *Begin to Implement Management Plan*"

6.1.3 Expected Effectiveness of Example Restoration Scenario

Predicting the success of the restoration scenario presents many difficulties. Initially the effectiveness rests on actual implementation of the recommendations. Assuming that they are implemented some predictions can be made.

Due to the length of time needed to address combined sewer overflows, large scale improvements in water quality may not be realized for 10 to 20 years. Initially, the City of

Akron LTCP will address larger volume CSO's. The volumes of CSO contributed by the Ohio Canal CSO's and Rack 40 on the Little Cuyahoga River are responsible for the majority of both flow volume and loadings. Trends in recovery support continued improvements in water quality.

Recovery will continue with improvements to both the City of Akron and Northeast Ohio Regional Sewer District collection systems. This improvement however faces possibilities of hindrance without interaction of other components of the implementation plan. Community growth needs to be conducted in ways that are compatible with watershed protection. Riparian protection is one way of promoting and improving watershed health. Development of comprehensive land management plans will also provide additional assurances for water quality protection. These issues are currently being addressed as communities integrate the value of natural resources with developmental pressures.

The Cuyahoga River is fortunate to have the Cuyahoga Valley National Park along 22 miles of its banks. Protection offered by the park can not be understated and it would be fair to say that restoration would be very difficult without its presence. The National Park Service is not the only land owner promoting preservation and stewardship in the Lower TMDL Study Area (Acreage of park land is located in Table 5a). Both Summit and Cuyahoga County have effective park programs with over 14,000 acres of land contained in their combined programs. Many local communities also have effective park programs. Aside from the preservation of land, these organizations also provide a valuable educational resource in the Lower Cuyahoga River TMDL area.

One of the areas that the Lower Cuyahoga River TMDL area excels in is the formation of watershed groups promoting awareness, stewardship, and education. These groups provide valuable local grassroots connection to waterways. Activism helps promote education and awareness while helping to keep state and federal agencies focused on issues in the Lower Cuyahoga River. Their continued involvement is crucial to restoring the water quality in the Lower Cuyahoga River. The following is a list of watershed based groups in the Lower Cuyahoga River:

- Cuyahoga River Remedial Action Plan
  www.cuyahogariverrap.org
- Friends of the Crooked River
  http://www.cuyahogariver.org/
- Hudson Land Conservancy
  http://www.hudsonlandconservancy.homestead.com/
- Little Cuyahoga River Conservancy
- Lock Eleven
- Mill Creek Watershed Partnership
- Pond Brook Watershed Initiative
- Tinkers Creek Land Conservancy
  http://community.cleveland.com/cc/tinkerscreek
- West Creek Preservation Committee
  http://www.westcreek.org/

- Yellow Creek Watershed Council
- Mud Brook Watershed Consortium

The above groups are to be commended for their efforts towards improving the Lower Cuyahoga River and its tributaries.

Removal and/or modification of the Canal Diversion dam is expected to result in rapid improvements to the immediate upstream river area. The river is in FULL attainment downstream and there is no reason to doubt that attainment would begin to be demonstrated above the dam, should it be removed. Just how far attainment would extend upstream is difficult to predict. It is reasonable to predict attainment moving upstream within the National Park boundaries provided the implementation actions previously discussed are undertaken.

6.2 Process for Monitoring and Revision

Ohio EPA will continue to monitor and assess the basin's chemical and biological water quality as part of the 5 year monitoring strategy. The next sampling is tentatively scheduled for 2005. Revisions to the TMDL report would be completed the following year.

Additional chemical, physical, and biological monitoring may be conducted as part of the Tinkers Creek Adaptive Management Plan.

Currently numerous other monitoring programs are planned or in progress which will provide additional data.

The Cuyahoga Valley National Park (CVNP) and the University of Akron have entered into a cooperative agreement to develop indicators for the assessment of wetland health in CVNP. The study is being conducted in 60 park wetlands based on wetland type (fen, marsh, wet meadow, shrub/scrub, and forested), size (<1 acre and > 1 acre), and human stressor (relatively unstressed compared to severely stressed, e.g. proximity to golf courses and farmlands). A range of ecological properties (e.g. water level, soil organic matter, plant diversity) from five major categories (water, vegetation, soils, biology, and landscape) will be monitored over the main part of the growing season. The resulting indicators will be placed within the context of assembly rules, which can potentially be used across broad geographical regions to develop strategies for wetland construction, habitat management and invasive species control.

The USGS, Ohio District, and CVNP will receive funding in 2004 to develop a method to rapidly estimate fecal-indicator bacteria concentrations in the Cuyahoga River. Improvement of water quality and enhanced use of the Cuyahoga River is a long-term goal of the NPS and our Federal, state, and local partners. Solutions to the problems associated with untreated or poorly treated discharges from combined sewers and wastewater treatment plants will require long-term planning and adequate financing.

Long-term solutions to these problems will likely require years to achieve; however, information on the quality of the river is needed now to protect public health. The overall goal of the project is to identify a method that best provides an estimate of concentrations of fecal-indicator bacteria so that park managers can provide daily information to the public on the safety of the river for recreational use.

Recently a workshop titled "A Sediment Transport Modeling Workshop for the Cuyahoga River Basin", was held August 7, 2003, at the Ohio Environmental Protection Agency's Northeast District Office in Twinsburg, Ohio. The Great Lakes Commission is providing technical and administrative support to the U.S. Army Corps of Engineers on this important initiative. The Cuyahoga River Basin has been selected as a priority watershed for the development of a sediment transport model under Section 516(e) of the Water Resources Development Act of 1996. This provision calls for the Secretary of the Army to consult/coordinate with the Great Lakes states in developing "a tributary sediment transport model for each major river system or set of major river systems depositing sediment into a Great Lakes federally authorized commercial harbor, channel maintenance project site, or Area of Concern identified under the Great Lakes Water Quality Agreement." The purpose of this local workshop is to provide an opportunity for community stakeholders to assist the U.S. Army Corps of Engineers in the development of a modeling tool that can be used by local land managers and decision makers to improve water quality by minimizing erosion and sedimentation problems in the Cuyahoga River Basin. The workshop will be an important first step in this process by gathering local input on the information needs and questions that local users need to have answered when making management decisions.

Upon reassessment of the river in the next monitoring cycle stream segments in non-attainment will go through the TMDL process. At that time additional restrictions should be considered which may include:

- No new household sewage treatment systems shall be sited (for segments where septic is identified as a source),
- No new sewer tie-ins (for segments where municipal point sources are identified as a source), and
- No new industrial permits or expansions (for segments where industrial point sources are identified as a source).

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